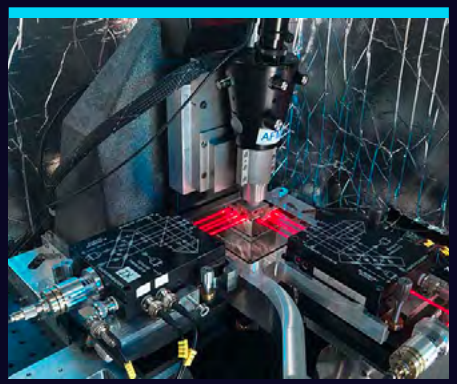
The Measure of our Success 2021

We provide confidence in measurement data *to enable innovation*



Atomic force microscope

We ensure trust in measurements and data *so trade can flourish*

Ionisation chamber on the joint NPL-Elekta linac

We help the UK *to be safer, healthier, greener and more prosperous*

Pollution monitoring system

We safeguard the future *and inspire the next generation*

School children at NPL's Water Rockets event

Introduction from Dr Peter Thompson | CEO

Hear from Prof Graeme Reid | Chair

Tap the buttons to navigate

The National Physical Laboratory (NPL) is the UK's National Metrology Institute, providing the measurement capability that underpins the UK's prosperity and quality of life.

2021 was another challenging year for everyone. NPL responded by continuing to deliver impact through our research and high-quality science and engineering.

Our **Measurement for Recovery (M4R)** programme harnessed the UK's measurement infrastructure to aid economic recovery during the COVID-19 pandemic. Throughout the programme, our capability and expertise supported over 600 UK businesses to innovate and grow.

From industry engagement to research outputs, 2021 saw truly ground-breaking work from NPL scientists and engineers. We shared our research findings ensuring NPL continued to play a leading role in the **international metrology community.**

We attended the global climate summit COP26, showcasing our involvement in **tackling climate change** and supporting the UK's **net zero targets.**

Our Measurement for our Planet campaign highlighted how we are delivering solutions for climate science and driving the decarbonisation of industry.

We inspired the next generation through our **outreach activities**, reaching over 80,000 participants. We remained committed to **upskilling** students and industry by clocking up over 42,000 hours on our e-learning platform.

We continued to apply our metrology 'mindset' to develop the UK's measurement infrastructure. Our major programmes, such as the **National Timing Centre**, the **National Measurement System**, the **NPL Quantum Programme** and the **CRUK Rosetta project**, are all tackling the key challenges faced by society.

Read on to discover the extraordinary impact of our excellent science and engineering. I am delighted to share the Measure of our Success 2021.

Dr Peter Thompson | CEO

Hear from **Prof Graeme Reid** | Chair

Our vision is to be an exemplary National Laboratory that undertakes excellent science and engineering and uses this to deliver extraordinary impact for the UK.

I have admired NPL throughout my career and it was a great privilege to be appointed Chair of NPL in 2021. The NPL Board brings together a wealth of experience to lead and support the NPL Executive team and provides a key relationship with NPL's owner, the UK Government Department for Business, Energy and Industrial Strategy.

As the UK's National Metrology Institute, NPL plays a pivotal role in the economy, expanding the **frontiers of science** while working in partnership with businesses and public bodies across the country.

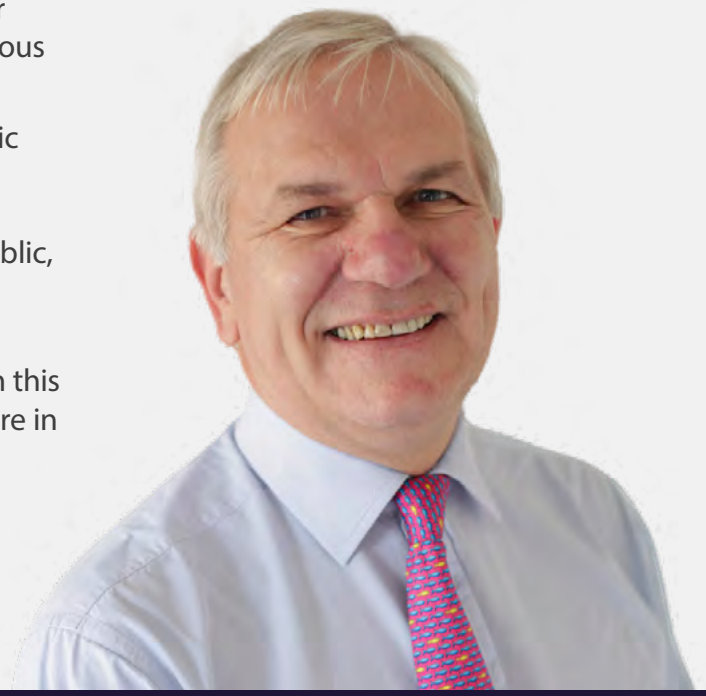
NPL supports **hundreds of firms** in an extraordinary range of sectors, from life sciences and manufacturing to quantum technologies and satellite communications.

We provide measurement science that underpins climate change mitigation, the **digital economy**, healthcare and more. Meanwhile, NPL nurtures the emerging generation of measurement scientists and engineers through our **Postgraduate Institute** and a vigorous programme of apprenticeships.

This support is delivered in a strategic partnership with the Universities of Strathclyde and Surrey along with numerous collaborators from the public, private and academic communities.

A few of NPL's many impacts on the economy and society are included in this report. We look forward to even more in the future.

Prof Graeme Reid | Chair



We provide confidence in measurement data *to enable innovation*

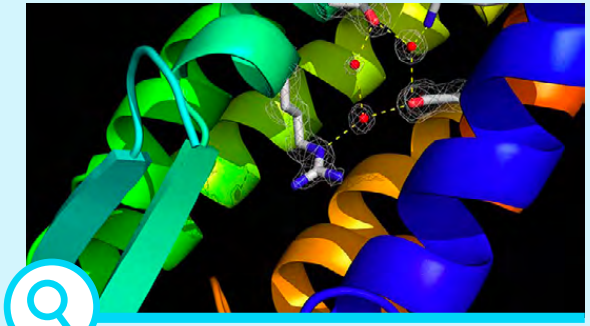
Improving quality of life through innovation | **Collaborating to drive progress** | **Providing input to Government strategy and thinking** | **Developing standards for commercial success**

NPL researchers identified key design considerations for making curved X-ray detectors, bringing clearer and safer X-rays a step closer to reality. Our scientists are now applying the measurement techniques developed in this project to other emerging electronic materials and products including IR sensors, solar cells and LED technologies.

Learn more...

Conceived at NPL, STAR-cc-OGSE provides innovative solutions to the pre-flight calibration of satellite instruments. The facility offers calibration and characterisation, while minimising the time and effort involved in the pre-launch vacuum test environment. It combines, in a single transportable package, the radiometric calibration capabilities which normally occupy three laboratories at NPL's Teddington site.

Learn more...



Validating a new dialysis-based protein crystallography methodology

NPL helped SWISSCI prove the viability of their novel crystallisation process, which will improve drug design and the treatment of illnesses.

Read the full case study...

NPL was a partner in the KAIROS project which delivered a vertical cavity surface emitting laser for atomic clocks used in precision timing, GPS-free navigation and primary time standard applications.

Learn more...

Our people *create impact*

Dr Ian Robinson, NPL Fellow, was made an Officer of the Order of the British Empire (OBE) in the Queen's Birthday Honours list 2021 for his services to measurement science.

Learn more...

We provide confidence in measurement data *to enable innovation*

NPL's biometrology laboratory is hosting Vironova's MiniTEM system (Transmission Electron Microscope). The microscope has expanded NPL's electron microscopy capability and imaging facilities, and is helping to power the UK's life science sector.

Learn more...

To develop the capability to assure UK leadership in the testing, innovation and commercial realisation of autonomous vessels, NPL worked with Lloyd's Register to develop an assurance framework for maritime autonomy.

Learn more...

NPL is developing ultra-stable lasers and optical clocks to improve satellite navigation systems, earth observation and large-scale tests of physics in future UK Space Agency and European Space Agency missions.

Learn more...

NPL's Measurement for Quantum scheme helped companies from all over the UK working on quantum technologies to overcome barriers to innovation. During 2021, thirty new projects were launched and 23 completed, almost all of which helped small or micro companies.

Learn more...

An international team, including scientists from NPL, visualised the photoreceptor AR3 for the first time and at unprecedented resolution. These advances in optogenetics will open the door to rapid development of new tools and methodologies in neuroscience, cell biology and beyond.

Learn more...

Our people *create impact*

Dr Emma Woolliams, Principal Research Scientist, joined the Expert Group for the Sentinel 2 Copernicus mission to support in establishing priorities for the new mission.

Learn more...

We provide confidence in measurement data *to enable innovation*

NPL delivers over £100m of programmes per year on behalf of BEIS, applying metrology expertise to develop the UK's measurement infrastructure.

NPL supported the development of Government plans and strategies:

- **UK Innovation Strategy**
- **Innovate UK Action Plan**
- **Action Plan for Standards for the 4th Industrial revolution**
- **National AI Strategy**
- **National Cyber Security Strategy**

Dr Penny Owen, Commercial Director, spoke at the Knowledge Assets Launch event, describing the opportunities and challenges associated with commercialising NPL's game-changing technologies.

NPL supported the Environment Agency's Chief Scientist's annual review, where our framework for monitoring methane was cited as helping a range of industries reduce their methane emissions.

Our people *create impact*

Fiona Auty, former Head of Government Relations, received the Medal of the Order of the British Empire for her services to science and engineering communication. She retired in November 2021.

Learn more...

Reducing reliance on plastic drums as part of the green recovery

NPL developed a new test method to validate the performance of Fibrestar Drums' sustainable, low carbon products.

Read the full case study...

We provide confidence in measurement data *to enable innovation*

Improving quality of life through innovation | Collaborating to drive progress | Providing input to Government strategy and thinking | **Developing standards for commercial success**

Our metrology provides confidence in data

NPL is a founding partner in a new alliance formed to create new, industry-wide professional standards for data science, which are needed to ensure an ethical and well-governed approach, enabling confidence in how data is used.

Learn more...

The development of standards is vital to enable digital technologies to thrive. NPL is a partner in a consortium which published an action plan to unlock the value of standards for innovation and the fourth industrial revolution.

Learn more...

We set standards to support the UK quantum industry

MicroCarb is the first European space mission to utilise STAR-cc-OGSE, and it aims to characterise greenhouse gas fluxes on the Earth's surface. NPL is underpinning the measurements, providing traceability and confidence in the outputs of the mission.

Learn more...

NPL launched its state-of-the-art cryo-transmission electron microscopy laboratory which will help to establish metrology for engineering biology and improve biomanufacturing.

Learn more...

We build trust in digital standards

Watch: Space4Climate's video describing the MicroCarb mission

We provide confidence in measurement data *to enable innovation*

Improving quality of life through innovation | Collaborating to drive progress | Providing input to Government strategy and thinking | **Developing standards for commercial success**

We define standards for confidence in data

Building an 'open' quantum ecosystem will accelerate the commercialisation of the UK quantum technology sector. A consortium, led by NPL and Riverlane, has developed an open-source hardware abstraction layer (HAL) that makes software portable across different quantum computing platforms.

"Our HAL effectively allows programmers to 'write once, run anywhere', ensuring the widest possible use of our consortium's technologies and opening up the ecosystem to new players, generating additional commercial opportunities."

Dr Leonie Mueck
Chief Product Officer of Riverlane

Learn more...

We set standards to support the UK quantum industry

Increasing the scalability of cryogenic interconnects for quantum computing

Bridging the boundary between cryogenic quantum systems and room temperature controls will help support the development of quantum computers.

Read the full case study...

We build trust in digital standards

NPL and BSI launched a new panel bringing together parties from across the UK quantum technology landscape to set new standards.

Learn more...

The NPL Quantum Programme

We provide confidence in measurement data *to enable innovation*

We define standards for confidence in data

NPL is working, in partnership with an industrial-academic consortium, on a programme to digitalise testing, sponsored by the Aerospace Technology Institute. Using digital methods to correlate test data and simulation, the results will help build confidence in product performance.

Learn more...

NPL joined the Medicines Manufacturing Innovation Centre's consortium to drive the standardisation and adoption of digital manufacturing technology.

Learn more...

The assurance of sensor performance is a critical safety issue for self driving vehicles. NPL, in collaboration with the Met Office and over 50 stakeholders, commenced work to assure this technology.

Learn more...

We set standards to support the UK quantum industry

"The use of digital standards in industry will enable calibration information to travel with measurement data throughout a supply chain, from sensor to decision point, providing confidence in data quality to improve efficiency. We are working with NMIs, research organisations and government to develop standards and the tools to help people use those standards."

Louise Wright
Head of Digital Metrology, NPL

We build trust in digital standards

Our people *create impact*

Warda Heetun, Research Scientist and former NPL apprentice, was awarded one of the first 100 International Atomic Energy Agency (IAEA) Marie Sklodowska-Curie Fellowships.

Learn more...

We ensure trust in measurements and data *so trade can flourish*

Annually, through the National Measurement System (NMS), the UK Government funds NPL, and other laboratories, with £94m to provide traceable and increasingly accurate standards of measurement. Our expertise is passed on to UK stakeholders by a coordinated programme of knowledge transfer.

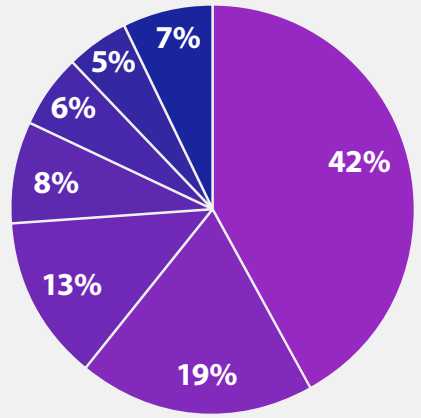
- Every year, more than **70,000 UK businesses** demonstrate traceability to UK standards through calibrations originating at the NMS laboratories.
- The NMS laboratories undertake **collaborative projects** with hundreds of businesses every year.
- The NMS **supports the UK's drive to influence international standards.**

The quality of work produced by the NMS is recognised as world-leading, contributing to the UK's science superpower status.

As the UK's National Metrology Institute, NPL is responsible for developing and maintaining the nation's primary measurement standards.

- **In 2021, NPL provided UK and global customers access to over 200 measurement products and services, along with expertise from leading measurement science and engineering experts.**
- **We supported over 1,000 customers from more than 60 countries.**

We deliver measurement services to industries in a range of sectors



- 42% Manufacturing and process control
- 19% Health
- 13% Energy
- 8% NMS Markets
- 6% Digital
- 5% Education
- 7% Other

We ensure trust in measurements and data *so trade can flourish*

We provided industry with our excellent science capability

NPL's High Accuracy Inspection System (HAIS) monitors and inspects nuclear waste stores to provide a greater understanding of the evolution of nuclear materials and safe storage conditions. A trial of HAIS was deployed to Sellafield Ltd to help underpin their storage strategy, reduce costs and provide vital information for future store design.

Learn more...

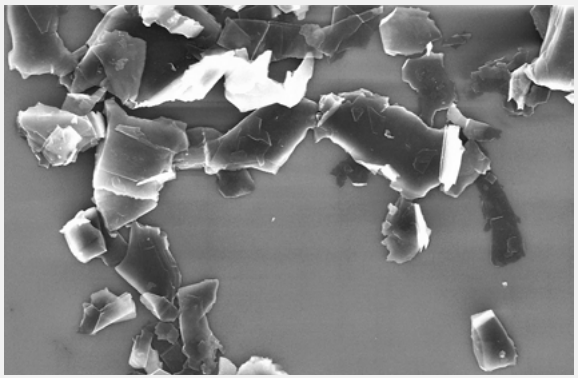
Scientists at NPL used Nuclear Magnetic Resonance Proton Relaxation to rapidly characterise the surface chemistry of carbon 2D materials in liquids. This has the potential to be used as a quality control process and could be integrated into a production line.

Learn more...

Our Mechanical Test Facility supported industrial innovation

NPL, in collaboration with international partners, developed the technical specification SO/TS 21356-1:2021. It will be used for measuring the structural properties of graphene, both powders or in a liquid dispersion, instilling trust in the supply chain.

Learn more...



Graphene nanoplatelets magnified 20,000 times

The Advanced Machinery & Productivity Initiative

Improving safety in automated vehicles

NPL is building a sensor modelling framework to facilitate a standardised approach to testing automated vehicles.

Read the full case study...

We ensure trust in measurements and data *so trade can flourish*

NPL opened its state-of-the-art Mechanical Test Facility (MTF) in January 2021. The MTF provides industry with a turnkey capability to evaluate and characterise new materials and products that demand a high level of assurance derived from test data.

The facility supports businesses by enabling the early uptake of new materials, allowing quicker product development and encouraging innovative applications.

Learn more...

MTF workshop

"As businesses continue to face diverse challenges, using this facility will help to support their recovery through innovation.

It will also ensure businesses can contribute to the green recovery and net zero ambitions by helping them better harness the power of advanced materials technology."

Mark Summers
Head of Advanced Manufacturing, NPL

We ensure trust in measurements and data *so trade can flourish*

The Advanced Machinery & Productivity Initiative (AMPI) secured a £22.6m grant from the UKRI Strength in Places Fund to deliver a 5-year programme of industrial-led innovation and growth within the advanced machinery sector across the North of England.

NPL led the consortium working with local businesses, universities and Rochdale Development Agency, which engaged with over 50 organisations from the advanced machinery sector.

Learn more...

Artist's impression of a future building for the AMPI Institute, based in Rochdale. Fairhurst Design Group.

"Manufacturing has always been key to creating jobs and spreading opportunity. Today's £22.6 million investment, which could create up to 560 high skilled jobs across West Yorkshire and Greater Manchester, shows that as we move into a world where industry adopts more automated and autonomous robotic systems, this is still the case. [...] We plan to harness the skills and ingenuity of every corner of the UK in order to cement our status as a global Science Superpower."

Amanda Solloway
former Science Minister.

We ensure trust in measurements and data *so trade can flourish*

M4R at a glance

The Measurement for Recovery (M4R) programme harnessed our metrology expertise to help support UK businesses to innovate and grow post COVID-19.

The programme has accelerated innovation, improved efficiency and brought confidence to decision making and investment. The programme provided access to expertise from the UK's network of national measurement laboratories that deliver the National Measurement System.

M4R ran during 2020 and 2021.

Learn more...

737 applications from **530** UK businesses.

80% of applications were from small or micro businesses.

300 companies said NPL helped them develop a new or improved product or process.

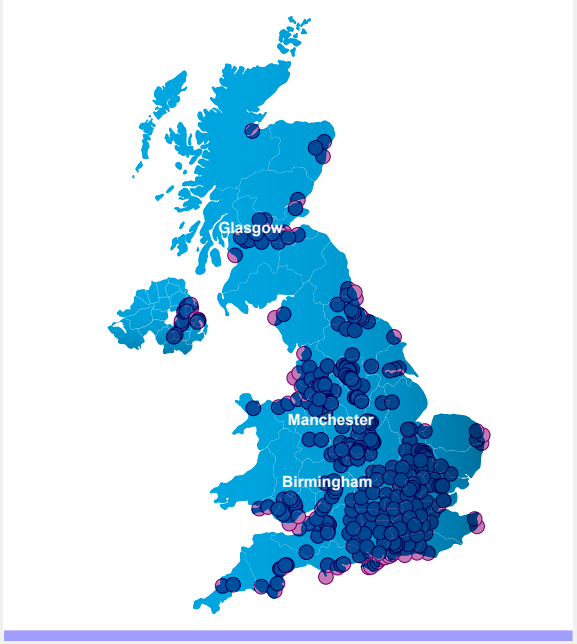
64% expect to see increased sales in new or existing markets.

62% expect to secure more investment for their project.

31% expect to see reduced costs through decreased production or material costs.

320 projects completed in 2021.

M4R case studies



Geographical spread of M4R projects

We ensure trust in measurements and data *so trade can flourish*

M4R at a glance

M4R case studies

Improving Centrego's electrochemical devices

NPL characterised the performance of Centrego's prototype device by testing its electrochemical cells under different conditions. We indicated routes for improving product lifetime, allowing the product to be brought to market for affordable use in the NHS.

"The speed, the ease, the communications and the delivery were fundamental to the success of the product. "

Robin Turner - Founder and Director, Centrego

Read the full case study...

Independent verification of Creavo's novel heart disorder diagnostic device

NPL carried out highly-specialised magnetic measurements to provide independent verification about the performance of Creavo's equipment.

"It's about the quality and pedigree that NPL bring as a third party to verify the results we've obtained. If we claim a certain sensitivity, we can reference back to the NPL figures."

Dominic Lavin - Lead Research Physicist, Creavo

Read the full case study...

Proving the technology that will underpin the UK's national spaceflight services

NPL helped to validate AltaRange's ground station and presented solutions for optimising the design of their antenna measurement systems, supporting space launches across the UK and beyond.

"NPL's expertise has helped us greatly in identifying the exact challenges remaining in our antenna feeds. NPL has both clarified and accelerated our route to market."

Andy Grey – Director, AltaRange

Read the full case study...

We ensure trust in measurements and data *so trade can flourish*

- NPL staff sit on 716 committees for standards, science and international metrology.
- NPL contributed to CIPM's Digital Task Group, and its associated Expert Group.
- Dr Fernando Castro, Head of Science for Materials Metrology, and Sam Gnaniah, Senior Research Scientist, were appointed as Chair and Secretary of Versailles Project on Advanced Materials and Standards (VAMAS).
- Dr Peter Thompson, CEO, presented to the annual BIPM Directors meeting on NPL's COVID-19 response and Measurement for Recovery programme.
- Prof JT Janssen, Chief Scientist, spoke about NPL's Technology and Measurement Foresighting at the International Measurement Confederation conference, BEIS and the National Institute of Metrology of China.

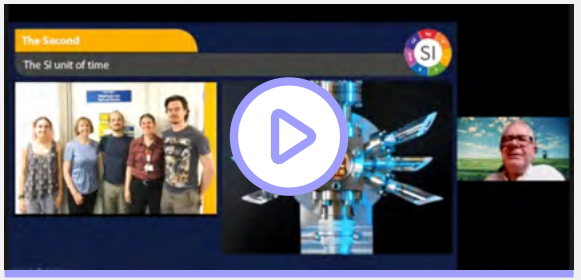
We celebrated World Metrology Day

The theme for World Metrology Day 2021 was Measurement for Health. To celebrate we ran a variety of activities.

246 industry and metrology professionals registered for our webinar **Looking to the future: Measurement for Health.**

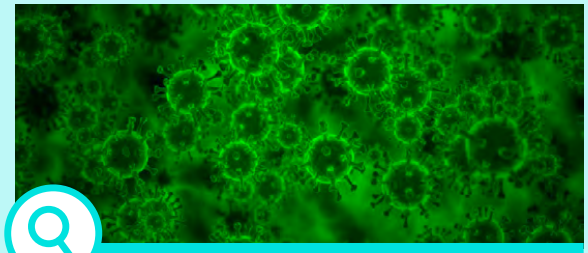
4,520 students from **95** schools attended assemblies which included a virtual lab tour and a 'hands-on' workshop.

Watch: World Metrology Day 2021 Webinar



Watch: primary school assembly

We help the UK *to be a safer, healthier, greener and more prosperous place to live*



Commercialising self-cleaning face masks to combat COVID-19 waste

NPL helped Breathe Smarter identify the best materials to manufacture self-cleaning electronic face masks to reduce waste from the disposal of single wear face coverings.

Read the full case study...

Download NPL's COVID Response report here:

NPL provided essential calibration of industrial **sterilisation** devices which helped meet the challenge of maintaining medical and PPE supply chains, as well as developing new diagnostic tests.

We developed a graphene **bio-sensor** for detecting COVID-19 and other viruses. It has received Government Office for Technology Transfer funding.

NPL helped more than 20 companies to test their **PPE** face masks and shields, boosting supply. Our work enabled millions of facemasks from first time manufacturers to reach the UK market.

We completed a Made Smarter NW Pilot project to create a **digital demonstrator** which measures the filtration properties of materials used in face masks.

The paper **Antiviral surfaces and coatings and their mechanisms of action** was published in Communications Materials and received 14,000 views and 20 citations.

Download the article...

Supporting the NHS during the COVID-19 pandemic

We used our data science expertise to support the Royal Free London on a number of issues including helping them to manage patient flow and optimise cancer pathways.

Read the full case study...

We help the UK *to be a safer, healthier, greener and more prosperous place to live*

NPL supported IntelliDigest in turning food waste into sustainable chemicals.

"NPL were very knowledgeable about gas analysis and delivered what we needed to a high standard. The output was very valuable to our product development and has reduced our time to market by three months."

Ifeyinwa Kanu
Founder and CEO, IntelliDigest

Learn more...

Metrology helps to benchmark and compare the performance and lifetime of new materials in Li-ion batteries. NPL is supporting the Faraday Institution project 'FutureCat' by developing more reliable test protocols.

Learn more...

NPL supported C-Capture with the development of their novel carbon capture technology. The unique, solvent based technology will be used to remove carbon dioxide from the atmosphere to help decarbonise industry.

Learn more...

Supporting decarbonisation of the transport sector

NPL developed a low-cost online hydrogen fuel quality monitoring system.

Read the full case study...

Our people *create impact*

Alice Harling, Head of the Atmospheric Environmental Science Department, was appointed Fellow of the Royal Society of Chemistry in recognition of an outstanding contribution to the chemical sciences.

Learn more...

We help the UK *to be a safer, healthier, greener and more prosperous place to live*

The 'Measurement for our planet' campaign shone a light on how NPL is delivering solutions for climate science, emissions measurement and innovation that will drive the decarbonisation of industry.

As part of our activities at the global climate summit, COP26, we:

- showcased the work of NPL scientists through live-streamed and in-person 'Ask the experts' sessions on the Space4Climate exhibition stand. These sessions reached over 100 visitors each day.
- participated in Space4Climate video content to raise awareness of the importance of climate monitoring from space.
- were invited by the Department of International Trade to mark Science and Innovation day by talking about metrology's role in climate change.
- hosted a 'Creating Policy Impact from Science' webinar aimed at government audiences, which had 87 attendees.
- ran our 'Measurement for Climate Action' webinar, which had 387 attendees from 20 countries who heard how metrology improves confidence in data.

Watch: Providing confidence in climate action Measurement for our planet

Outreach on climate action

- We ran three online Measurement at Home activities to tie in with COP26.
- We hosted two online assemblies which engaged **10,334** secondary and **4,712** primary students.
- We ran online measurement workshops for primary schools with a reach of **4,278** students in **137** classrooms.
- Our Climate Change Poster Challenge generated **198** entrants from **20** schools.

Entries to the Climate Change Poster Challenge

See more here...

We help the UK *to be a safer, healthier, greener and more prosperous place to live*

Supporting healthcare at a glance

NPL supported BLOC Laboratories to verify its technology for analysing the stability of advanced therapeutics. The technology has the potential for cheaper, safer and faster development of new medicines.

Learn more...

Antimicrobial resistance is a long-standing problem. NPL led a consortium which demonstrated how accurate measurements can decipher the physics of biological processes and offer innovative solutions.

Learn more...

NPL and collaborators built a European network to provide a sustainable source of high purity medical radionuclides to improve treatment outcomes for cancer.

Learn more...

Impact on the NHS

NPL is proud to support the NHS. In 2021 we worked with hospitals and specialist care centres in over 50 individual trusts across the UK, to providing products and services that helped NHS institutions to offer better quality care. This impact was delivered through a wide range of capability, including radiotherapy calibration, auditing and dosimetry training, alongside our radionuclide calibration and data science expertise.

The CRUK Rosetta Project

By improving the metrology, calibration and validation of quantitative Magnetic Resonance Imaging (MRI), it is possible to ensure consistency and comparability between sites and scanners. NPL, as part of a consortium, is undertaking a project to to expedite the deployment of new techniques.

Learn more...

Our people *create impact*

Prof Bajram Zeqiri was appointed as a Fellow of the Royal Academy of Engineering.

Learn more...

We help the UK *to be a safer, healthier, greener and more prosperous place to live*

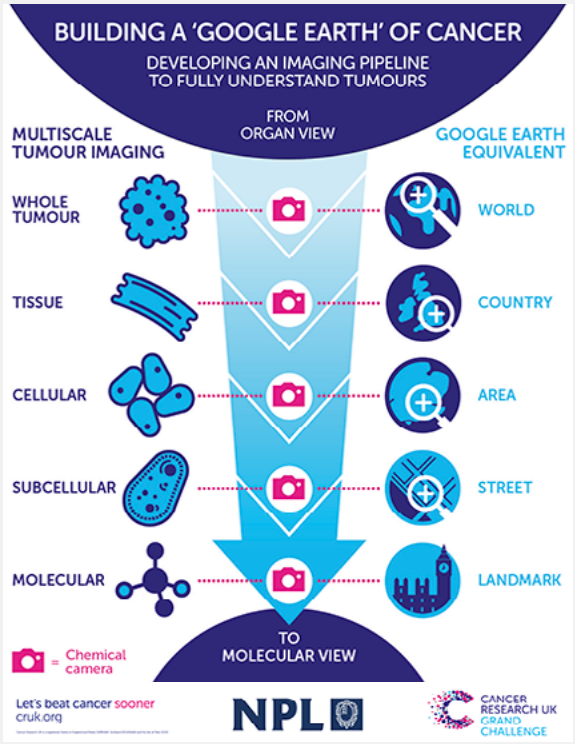
Supporting healthcare at a glance

The CRUK Rosetta project is helping to beat cancer sooner

NPL is currently leading the **Cancer Research UK** Grand Challenge 'Rosetta' programme. Working with the Cancer Research UK Beatson Institute and the University of Glasgow, the team recently studied a particular genetic subtype of colon cancer and the common mutant KRAS oncogene. They discovered important mechanisms which help to understand how this type of cancer can grow and how to treat it.

Learn more...

The CRUK Rosetta Project



"These exciting results show the power of using sensitive, untargeted imaging methods to examine extremely complex tissues. This work is providing new ideas for future therapeutic strategies."

Prof Josephine Bunch
NPL Fellow, National Centre of Excellence in Mass Spectroscopy Imaging

We help the UK *to be a safer, healthier, greener and more prosperous place to live*

The NPL Quantum Programme supports UK industry's need for independent evaluation, standards and measurement to deliver new quantum technologies.
We are a partner in the UK National Quantum Technologies Programme, and coordinate the UK approach to new standards for quantum technology, in collaboration with BSI. We host many PhD students, training the next generation of quantum scientists and engineers.

During 2021, NPL was a partner in more than 20 industry-led quantum projects, creating new products and services for UK companies. The NPL-invented MINAC (Miniature Atomic Clock) was developed in partnership with dstl and Teledyne e2v, and part-funded by Innovate UK. A pre-production MINAC was trialled by the Royal Navy, the first time a surface ship has been equipped with quantum technology.

Learn more...

The National Centre of Excellence in Mass Spectrometry Imaging at NPL collaborated with the University of Surrey and Ionoptika Ltd to show how a single fingerprint left at a crime scene could determine whether someone had touched or ingested class A drugs. This will improve forensic science capabilities.

Learn more...

NPL and the University of Surrey developed a high-frequency beamforming testbed to improve wireless communications, which will ensure the UK's 5G infrastructure is robust in crowded public settings.

Learn more...

The NPL-led National Timing Centre (NTC) programme funded new projects to ensure resilient time for the future.
Through the NTC programme, NPL aims to increase resilience in time dissemination to underpin a reliable timing service for the future.

Working closely with our NTC partner, Innovate UK, we successfully closed the first industry funding call on time resilience, distribution, trust, assurance and security. The £2m (+£1.1m matched by industry) programme resulted in 17 successful project launches.

Learn more...

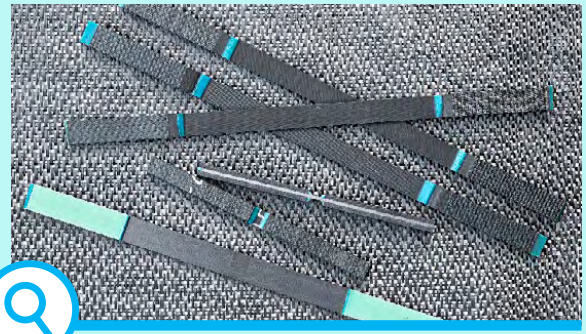
We safeguard the future *and inspire the next generation*

2021 was a challenging year due to COVID-19 safety measures, however we were able to train 281 learners in classrooms for 611 days.

Our **e-learning platform** saw 2,921 enrolments on courses, clocking up 42,883 hours of online learning.

The first e-learning course supporting the National Timing Centre Programme, 'Introduction to Time and Frequency Measurement' was launched. It had over 120 registrations within 2 months and 100% of learners said that they would recommend the course to colleagues.

Learn more...



Training in composite materials standards and certification

NPL has designed a new Composite Materials Standards and Certification course which provides practical knowledge on how to design, test and use these materials in new applications.

Read the full case study...

Apprenticeship programme highlights

- 11 apprentices successfully graduated from our programme, with 82% staying on within NPL.
- We continued to support early career development by recruiting 14 new apprentices.
- The Institute of Physics recognised NPL with their 2021 Apprenticeship Employer Award **"...for developing an award-winning apprentice programme which has inspired the next generation of scientists and engineers and enabled innovation to thrive by fostering energetic, passionate and talented young people."**

We safeguard the future *and inspire the next generation*

During 2021 the **Postgraduate Institute for Measurement Science (PGI)**, in partnership with Strategic Partners the University of Strathclyde and University of Surrey, delivered sustained growth in the number of PhD studentships and collaborators, with a 12% increase in projects compared with 2020.

- **20** new projects with industry.
- **217** ongoing projects.
- Working with **33** UK universities.

In November, the PGI delivered an online seminar as part of the COP26 Universities Network Innovation Showcase to 128 participants. The discussion included Airbus, Ricardo and the Met Office.

Over 100 people attended the PGI's student-led Annual Conference which focused on:

- Creating a science based economy.
- Linking research excellence through communities.
- Ensuring wellbeing for all.

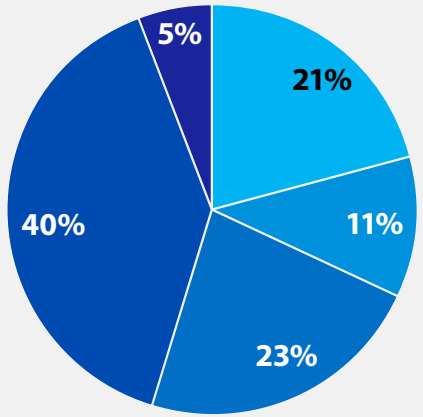
The PGI ran a competition inviting researchers to communicate their work in an accessible way to the diverse Twitter audience.

Learn more...

"The collaboration between NPL and University of Surrey has significantly increased the impact of my work, allowing access to the world class facilities at both institutions and invaluable discussions with experts"

Liz Legge - University of Surrey
Project: Physicochemical characterisation of graphene based 2D materials for industrial applications

Destination of PGI researchers



21%	NPL
11%	Research
23%	Academia
40%	Industry
5%	Other

We safeguard the future *and inspire the next generation*

Published papers and reports

- **141** NPL staff were invited to give talks or presentations to organisations, conferences or universities.
- **115** NPL staff have joint academic positions in universities or research institutions.
- **457** papers by NPL scientists were published in peer-reviewed scientific journals.
- **75%** of publications were co-authored with external collaborators.
- **1** in **10** papers had industrial co-authors.

View all NPL publications

Disseminating information about new results and sharing our original research with other scientists is essential for the evolution of science.

Key papers published in 2021 included:

Angular momentum generation in nuclear fission provided detailed measurements to improve our understanding of the underlying physical processes of nuclear power production.

Download the article...

Energy transition: Enabling carbon capture, usage and storage prioritises crucial measurement challenges that need to be addressed to remove and store greenhouse gases before they reach the atmosphere.

Download the report...

Podcasts and events

Atomic clocks compared with astounding accuracy covers the findings from the Boulder Atomic Clock Optical Network Collaboration which compared atomic clocks, brought the redefinition of the second a step closer and aided the search for dark matter.

Download the article...

Our people *create impact*

Prof JT Janssen, Chief Scientist, was appointed as a Fellow of the Royal Academy of Engineering.

Learn more...

We safeguard the future *and inspire the next generation*

Podcasts

Warda Heetun, Research Scientist, discussed the skills we need to deliver a green economy and the importance of making talent pipelines more inclusive.

Learn more...

Andrew Pollard, Science Area Leader, described his research in understanding the measurement of graphene, and helping companies innovate in sustainability.

Learn more...

Alex Jones, Principal Research Scientist, explored the role of quantum technology in various biological processes and the range of applications this could lead to.

Learn more...

Events at a glance

Despite COVID-19, we still managed to connect with key audiences via events, conferences and webinars resulting in:

- **74** events hosted.
- **61%** of events were online.
- **9,628** event registrations.
- **82%** attendance rate.
- **106** countries represented.

We hosted the Bushy House Open Day in September in person. Just under 1,000 members of public came along to enjoy the history and beauty of Bushy House and find out about NPL's science.

Bushy House

We safeguard the future *and inspire the next generation*

Getting people interested in science, maths and engineering is really important to NPL. We strive to promote the importance of measurement and our work through a range of outreach activities.

In a year challenged by COVID-19, NPL's outreach audiences and events were often impacted. Nevertheless, **355** NPL staff met or assisted **80,396** participants through **122** events.

The NPL Water Rockets Challenge was our first 'in person' event of 2021. **50** enthusiastic staff assisted **14** teams from local schools to battle it out to become our water rocket champion.

Water Rockets Challenge

Virtual Physical Laboratory (VPLab)

Our physics simulations helped teachers to teach online and set work for students at home.

There were **30,000** downloads during the January - March lockdown.

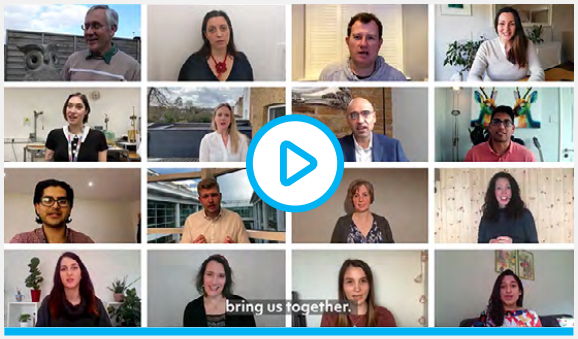
Measurement at Home

We launched 6 new Measurement at Home challenges which were a chance for everyone to have some fun and learn about the science of measurement. 50% were related to climate change, inspired by COP26.

- **11,000** pages views of our Measurement at Home challenges.
- **2,000** views of the Measurement at Home YouTube videos.

We safeguard the future *and inspire the next generation*

Throughout 2021, our Health and Safety policies prioritised creating a COVID-safe environment which allowed our **1,102 scientists, engineers and skilled professionals** to continue to operate and deliver impact during the pandemic.



Watch: Our people - Ready to be part of something amazing?

During the pandemic many of our staff worked on site as their roles could not be carried out remotely. As restrictions began to ease, we welcomed many employees back to site and trialled hybrid working. We listened to their feedback on how it was going:

- **83%** of respondents agreed that hybrid working worked for them personally.
- **88%** felt their quality of work was not compromised.
- **59%** of identified greater flexibility to their work life balance as a benefit.

"It has given me a greater sense of wellbeing and job satisfaction whilst also allowing me to improve my lifestyle outside of work."

Promoting mental health

- We promoted wellness action plans as a practical tool for staff.
- In May 2021 we launched our new Mental Health Sharepoint site to raise awareness and make support easily accessible. It has been viewed over 1,200 times.
- We continued the roll out of our mental health training for line managers, with a further 55 staff completing the training.

We safeguard the future *and inspire the next generation*

NPL's goal to attract, engage and retain a diverse workforce where people feel they belong and can contribute their genuine selves at work, remains a priority. The impact of our work is vital to our success, so ensuring diversity in our staff is the key to inspiring creativity and accelerating our progress.

Championing disability

- In December 2021 we developed a new disability and long-term condition policy.
- Our newly launched disability SharePoint site provides staff with the resources to better understand disability.

We shared over 50 internal news stories and blogs, raising awareness of our in-house activities. We celebrated key events such as international women's day, LGBTQ+ history month and #PurpleLightUp, a celebration of International Day of Persons with Disabilities.

NPL, Teddington on PurpleLightUp day

We celebrated Alan Turing's work at NPL on the Automatic Computing Engine (ACE) Pilot Machine, one of the first computers built in UK. In June 2021, Alan Turing and his work were featured on the new £50 note.

Learn more...

£50 note, issued in June 2021

We safeguard the future *and inspire the next generation*

Research integrity is a bedrock for trust, rigorous accuracy and reproducibility of our research. Our people are required to act with integrity and comply with our code of conduct and ethics policy. We produced a guide to authorship of scientific publications to support best practice. We are committed to the principles of the Concordat to support research integrity.

Learn more...

We have introduced a new Knowledge Management System which is a centralised repository of NPL published reports, with 700 records added in 2021. It follows a peer review process to uphold our research integrity standards.

Watch: The role of metrology in improving reproducibility

Improving reproducibility in science data

NPL developed software tools to capture and combine metadata with the primary data at the point of measurement. This allows us to digitally capture metadata in a standardised way.

Read the full case study...

We safeguard the future *and inspire the next generation*

We upgraded our infrastructure to include **energy efficiency measures**, such as using LED's moving to sensor-based light switching, toilets and taps.

We instigated a **plastic free approach** to food services with biodegradable cutlery and appropriate waste disposal to maximise recycling.

The **food waste** from our canteen is recycled to produce power, bio-fuel and nutrient-rich digestate that can be used as fertiliser. The used coffee grounds are available for any NPL gardeners to collect.

We encouraged the use of **sustainable transport** wherever possible, especially cycling and walking to work. We installed electric car charging ports.

We switched our defined contribution default fund so that our people know their **pension funds** are invested with the environment and our planet in mind. We also included a fully green fund in our portfolio which is available to our employees as a self-select fund.

We continued our active approach to nurturing and protecting trees and woodlands on our site to encourage biodiversity, and created a wildflower meadow next to our on-site car park.

NPL on-site wildflower meadow

NPL

The Measure of our Success 2021

To find out more about NPL:
npl.co.uk

To get in touch:
npl.co.uk/contact
020 8977 3222

Hampton Road
Teddington
Middlesex
TW11 0LW

This document has been designed for digital use, please consider the environment before printing.