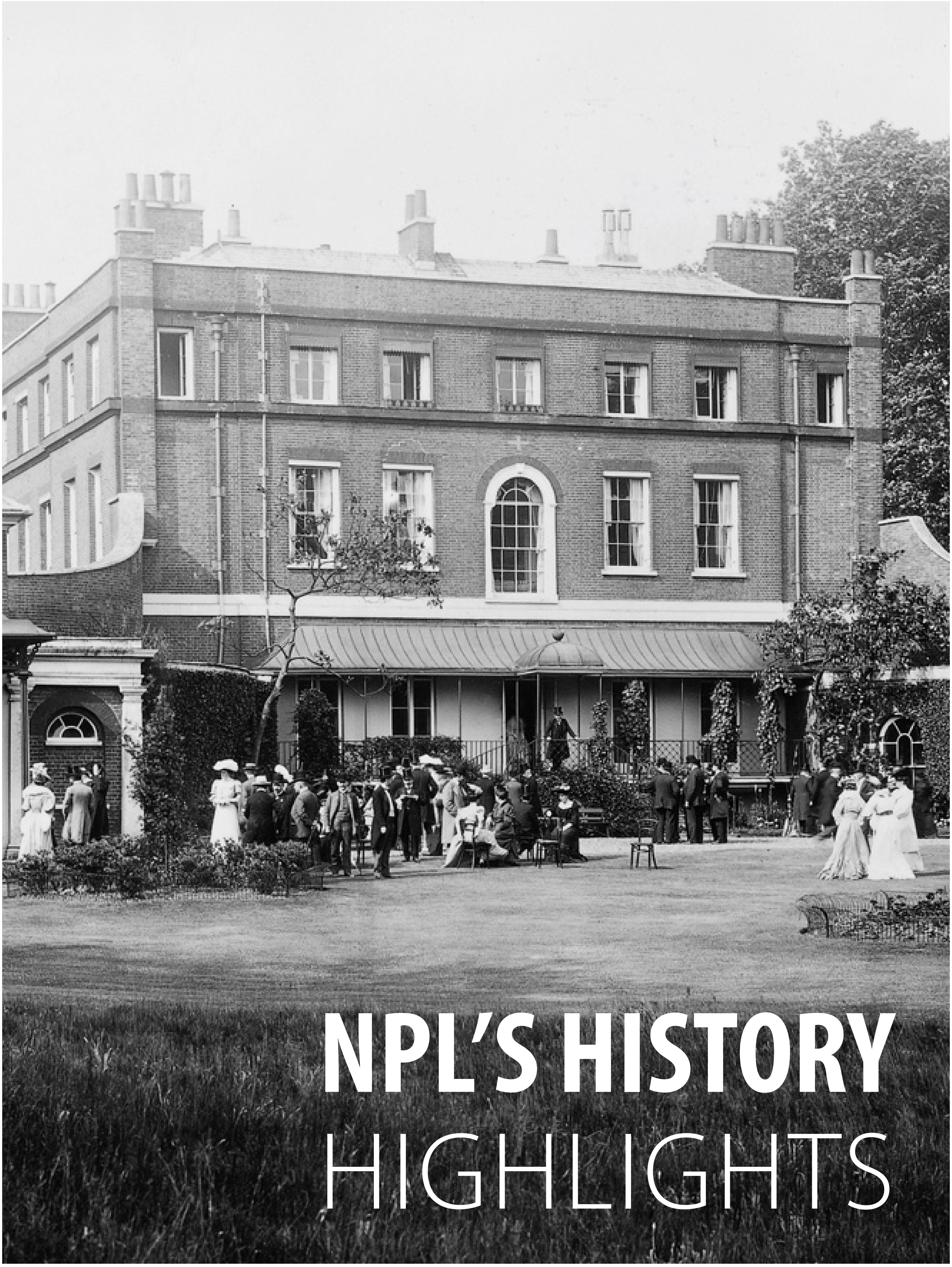
NPL

National Physical Laboratory



NPL'S HISTORY HIGHLIGHTS

www.npl.co.uk/history

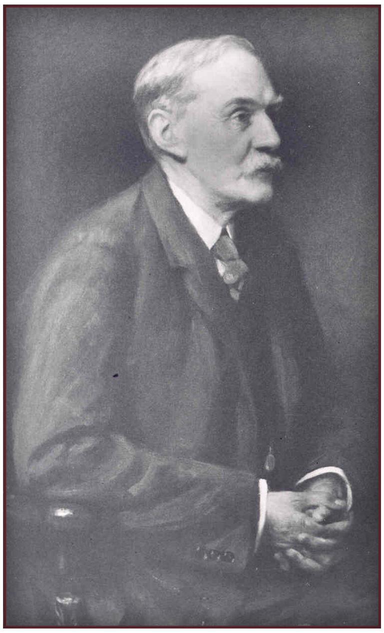
NPL's history

The National Physical Laboratory (NPL) has been making world-leading scientific discoveries since it was established in 1900 at Bushy House, Teddington, in order to 'bring scientific knowledge to bear practically upon our everyday industrial and commercial life'.

NPL has since established itself as a world-class centre of excellence in measurement science, maintaining the nation's primary standards of measurement while developing such innovations as radar, computer network packet switching, atomic clocks and, more recently, the world's first room-temperature maser. Many of Britain's most renowned scientists have been involved in work at NPL, including Alan Turing, Louis Essen and Donald Davies.

Today NPL remains true to its core mission. NPL's science helps to save lives, protect the environment and enable citizens to feel safe and secure, as well as supporting international trade and innovation in the commercial world.

1900



1900
NPL begins

On 1 January 1900 the Royal Society appointed the first Director of NPL, Richard Tetley Glazebrook FRS.

At the end of 1900, the First Commissioner of Her Majesty's Works wrote to the president of the Royal Society that "Her Majesty, the Queen, has granted to the Commissioner of Works, by her Grace and Favour, Bushy House and Grounds for the use of the National Physical Laboratory under the direction of the Royal Society."

1902
Opening of NPL

The National Physical Laboratory was formally opened on 19 March 1902 by HRH The Prince of Wales. The ceremony took place in a large bay of the Engineering Building.

The Prince said: "I believe that in the National Physical Laboratory we have the first instance of the State taking part in scientific research. The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more than this? Does it not show in a very practical way that the nation is beginning to realise that if its commercial supremacy is to be maintained, greater facilities must be given for furthering the application of science to commerce and industry?"

1906
Department of Metallurgy and Metallurgical Chemistry begins

Walter Rosenhain joined NPL in 1906 and during the next 25 years held the position of Superintendent of the Department of Metallurgy and Metallurgical Chemistry. He was a brilliant investigator and gained for NPL the reputation of being one of the best equipped research laboratories in the world.

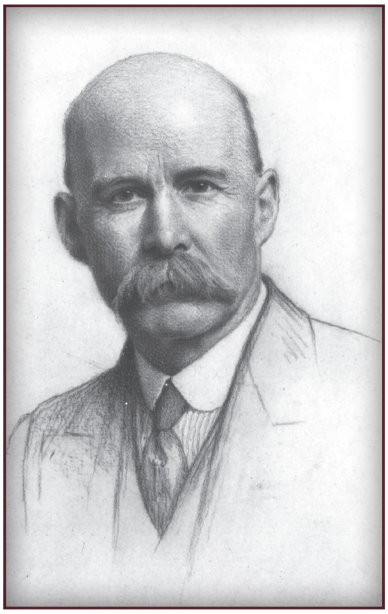
From the start it was Rosenhain's aim to undertake fundamental research with every precaution to achieve the highest possible degree of accuracy, and at the same time to meet the growing needs of industry.

1907

1907
NPL began testing taximeters

NPL began testing taximeters which continued for over 50 years. At its peak about 10,000 were tested each year.

1908

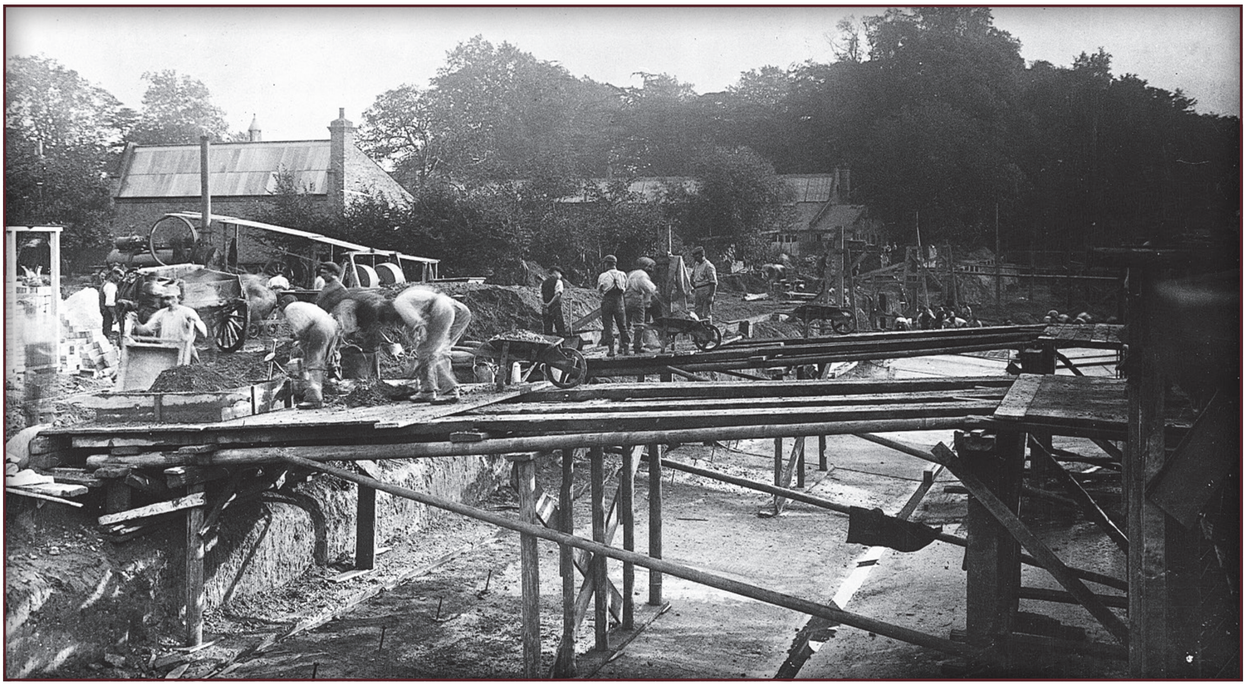


1908
NPL begins testing on aeroplanes and airships

One of NPL's earliest areas of research after its foundation was in the magnitude and distribution of wind forces on structures such as bridges and roofs.

In 1908, these techniques were brought to the study of flight, leading to rapid advances in the efficiency and safety of the aeroplane and to increased recognition of the general value of scientific research in its application to engineering problems.

Sir Thomas Stanton, Superintendent of NPL's Engineering Department was a pioneer in the science of wind tunnel testing, built at NPL in 1919.



1911
No 1 Ship Tank opened

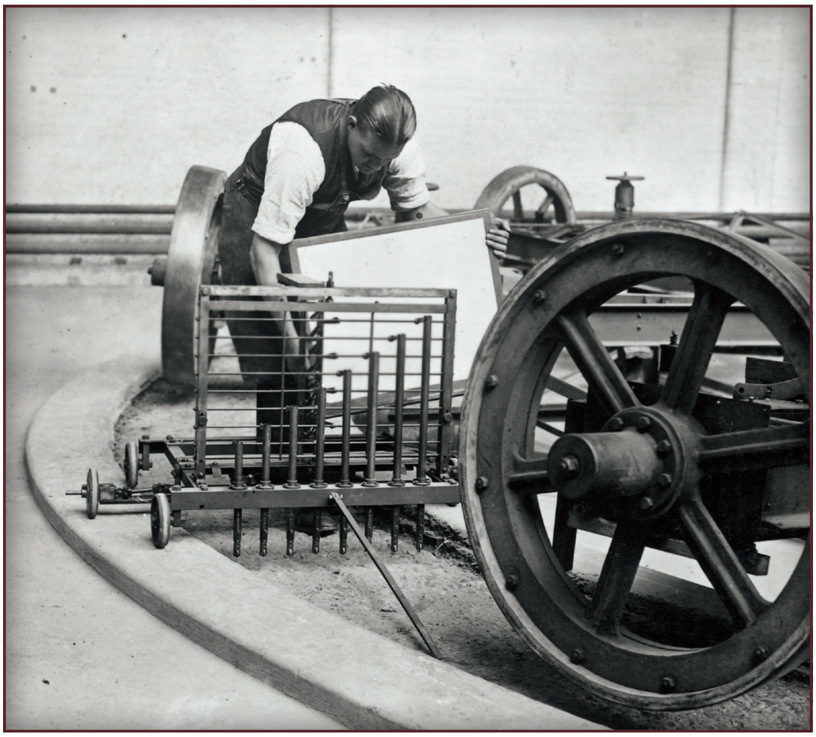
The first ship tank was completed and filled during September of 1910, and officially opened by Lord Rayleigh on 5 July 1911.

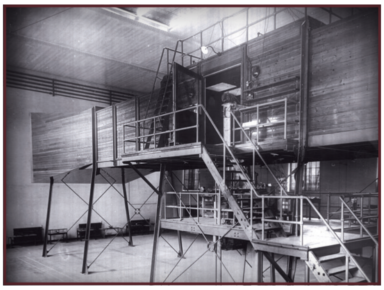
It was 150 m by 9 m wide and held 5000 tonnes of water with a centre depth of 3.75 m. It was initially known as 'The National Experimental Tank', later the 'William Froude National Tank' or the 'Yarrow Tank'. Later still, when the second ship tank was built, it became known simply as 'No 1 Tank'.

1911
NPL begins vehicle testing

From 1911 until 1933, NPL carried out various research into vehicles and transport, including: road surface testing, impact of motor vehicles, loudness of car horns, and the effect of skidding.

NPL developed a machine for testing the endurance and wear of concrete and other road surfaces. The mechanism of skidding was explored using a motor cycle and special sidecar, the wheel of which had multiple movement and braking facilities.



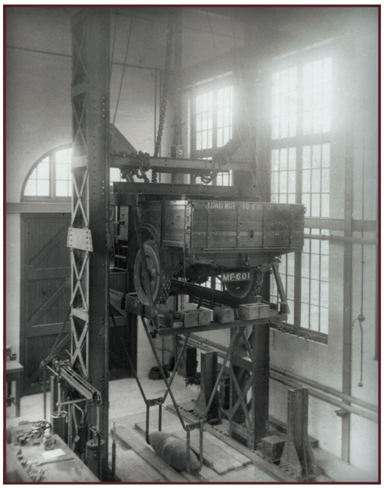


1919
Duplex wind tunnel built

The Duplex wind tunnel was completed in 1919. It had a cross-section of 2 m by 4 m.

During the first world war, activity in aerodynamics expanded dramatically and NPL made major contributions to advances in theoretical and practical aspects of the stability of aeroplanes, airships, kite balloons and parachutes. Techniques had been developed for testing scale models of wings, ailerons, propellers and of complete models of aeroplanes in wind tunnels.

In 1925, the Duplex was used to test a 1/5 scale model of the Bristol Fighter aircraft, which until the Boeing 707 was the most tested aircraft of all time.



1920
Introducing materials testing

The Engineering Department acquired many new state-of-the-art machines to test engineering materials. Properties that could be measured by 1920 included: strength, elasticity, ductility, hardness, abrasion resistance, fatigue resistance and impact resistance.

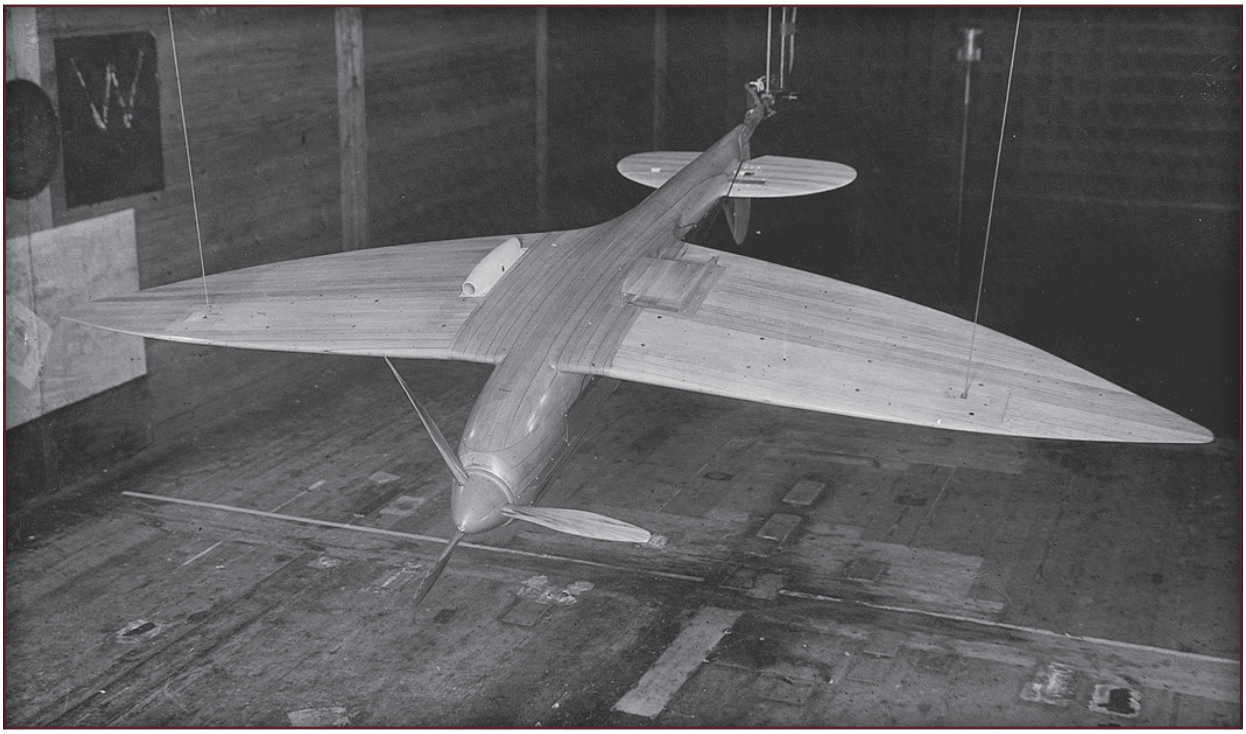
The mechanical properties of spring steels were investigated including the development of test methods for complete laminated springs fitted to lorries. The machine shown above was built to test the endurance of such springs.

By this time, routine test work amounted to around 1,000 to 1,500 items per year and covered a wide range: strength of materials, tests of the efficiency of engines and gears, testing of agricultural tractors and implements, of steam pipe coverings, pressure gauges, lubricants, bearing materials, chains, fans, etc.

1923
Ventilation of the House of Commons

In the early 1920s, the Engineering Department was asked to improve the ventilation in the debating chamber of the House of Commons.

Experiments were carried out at NPL on a 1/8 scale model and improvements recommended. The direction of air flow in the chamber was demonstrated by observing smoke produced by a special firework.



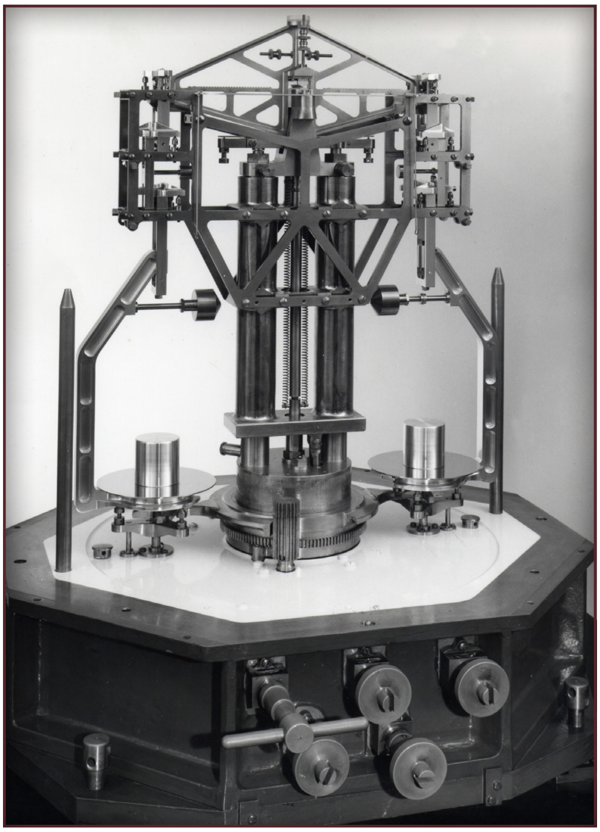
1927
Testing the Schneider Trophy winner

The Duplex wind tunnel ran all day and all night to resolve an instability in the Air Ministry's entry for the Schneider Trophy. The plane won the prize and then went on to retain it in 1929 and 1931. These planes were the forerunners of the later famous Spitfire.

1932
High precision balance installed

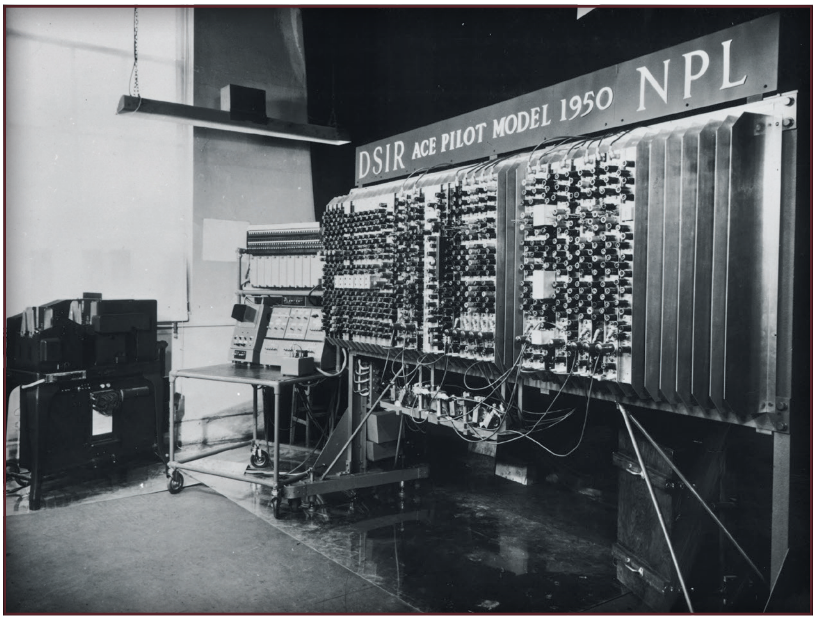
In 1932, a new precision balance of NPL design came into service. It was installed in a closely controlled temperature environment in the basement of Bushy House, where it remains to this day.

For highest accuracy, the weights must be interchanged on the balance planes without separating the knife edges from their bearing planes. This is done by steadying the beam after determining the equilibrium position. All operations are carried out by remote control from outside the balance enclosure.



1935

1946



1935

Radar is invented at NPL

In February 1935, Robert Watson-Watt presented his report titled 'The Detection of Aircraft by Radio Methods' to the newly formed committee for the scientific survey of air defence. Robert Watson-Watt was the Superintendent of a new radio department at NPL.

A trial followed using the BBC's short-wave (about 50 metres wavelength) radio transmitter at Daventry against a Heyford Bomber. The trial was a success and resulted in the design and installation of a chain of radar stations along the east and south coast of England in time for the outbreak of war in 1939.

1946

Work began on the world's first Automatic Computing Engine (ACE)

Work begins on the world's first Automatic computing Engine (ACE) with the final improved version going into service in 1958. The total cost of developing the ACE was £250,000.

Alan Turing was part of a group being formed for the design, construction and use of a large automatic computing engine. During his time at NPL, he made the first plan of the ACE and carried out a great deal of pioneering work in the design of subroutines.

It was soon used for solving partial differential equations for use in applications including the design of aircraft, ships and electronic apparatus.

1947
NPL mobile acoustical laboratory launched

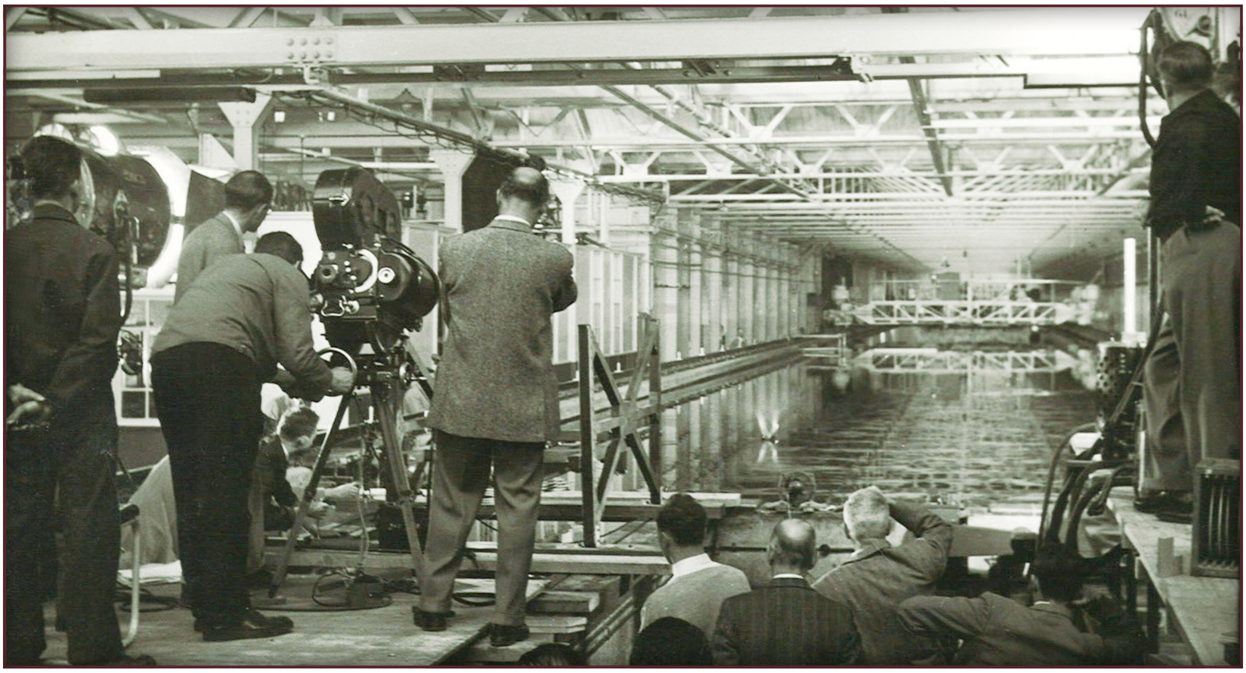
The measurement of noise was greatly assisted by the arrival of a new mobile laboratory - the first of its kind in the UK. This was said to have travelled more than 4,000 miles in its first six months of operation, being employed in measurements of the noise from jet-engines, test cells and investigations of noise reductions in new post-war factories.

1953
Newton's apple tree planted at NPL

The tree was presented by Sir Edward Salisbury, Director of Kew Gardens in 1953.

It is derived from a graft taken from an old tree in Newton's mother's garden in Woolsthorpe, near Grantham in Lincolnshire.

According to accounts it was the fall of an apple from this tree which suggested to Newton that the force of gravity, which made the apple fall, was also the force that kept the moon on its path.



1953

1953
Filming of The Dam Busters movie

Part of The Dam Busters movie was filmed at NPL. Early tests of the bouncing bomb were undertaken at NPL in the ship tanks in 1942. The bombs were successfully deployed in May 1943.

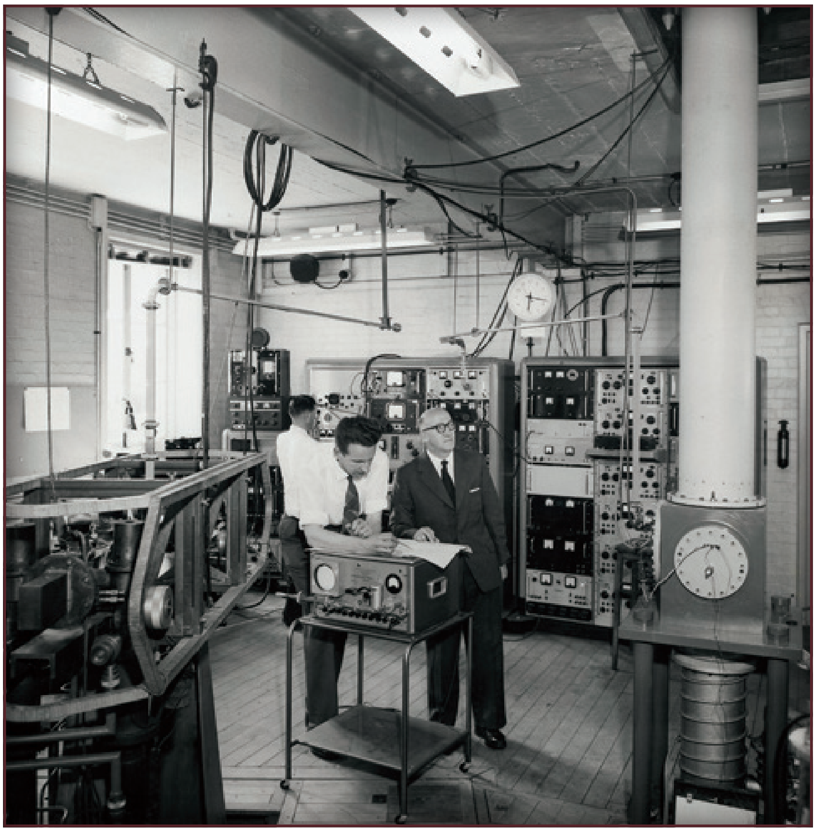
1955

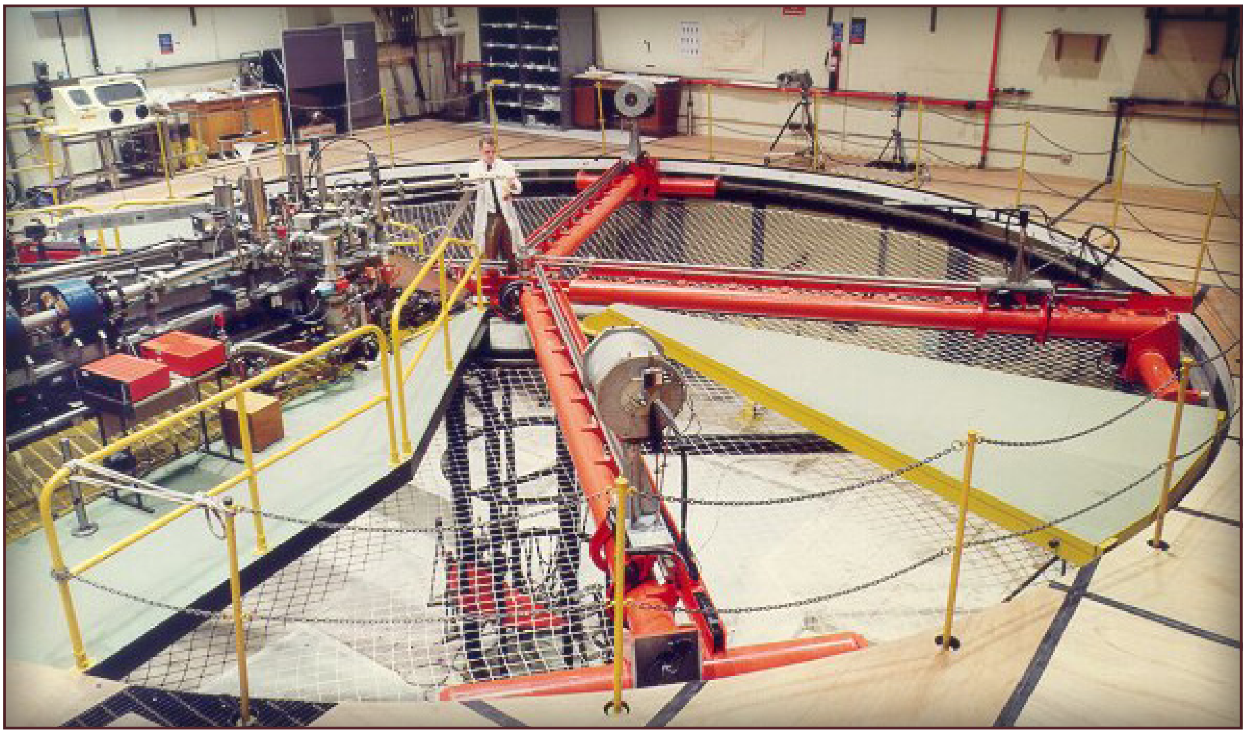
1955
First accurate caesium atomic clock

NPL developed the first accurate caesium atomic clock in 1955, which led to the internationally agreed definition of the second being based on atomic time.

The clock was developed by Louis Essen. Following a trip to America to see early versions of atomic clocks, he designed and built one that delivered much greater accuracy and stability, based on transition between the two hyperfine levels of the ground state of the caesium-133 atom.

Successive developments of this have remained the fundamental standard up to the present day.





1962

1962
3.5 MV Van de Graaff accelerator installed

This picture shows the experimental area of the Van de Graaff accelerator facility.

The Van de Graaff accelerator is used to accelerate a beam of protons or deuterons that is directed on to selected target materials on the end of an evacuated flight tube, thereby producing neutron fields by nuclear reactions. Voltages of up to 3.5 MV are generated, providing beam energies of up to 3.5 MeV (mega electron volts). A 3.5 MeV proton has a velocity of about a tenth of the velocity of light. The neutron fields, which have energies from a few keV to
20 MeV according to which nuclear reaction is utilised, are used mainly to calibrate monitors used for radiological protection.

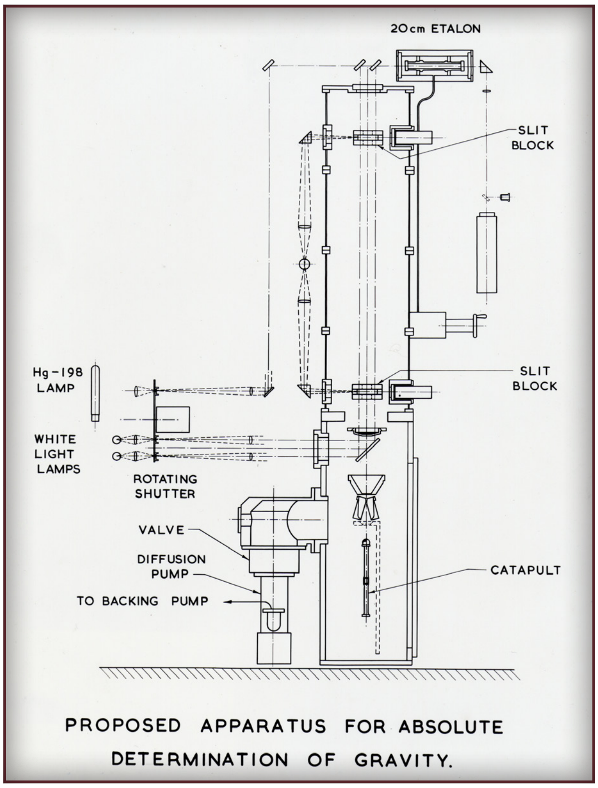
1964

1964
Colour standards adopted

In 1964, the International Commission on Illumination published its data on standard observers, which is the basis of all colour measurements, still in use today. Dr Walter Stiles undertook this work at NPL.

1965

1966



1965
Absolute determination of *g*

In 1965, a new more, accurate determination of acceleration due to gravity (*g*) was made by NPL.

A more precise knowledge of the value of *g* was demanded in various applications and the problem was simultaneously addressed by a number of scientific nations.

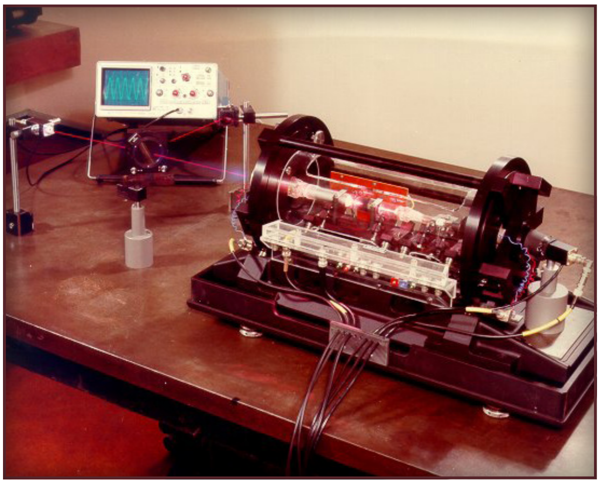
NPL's approach was a symmetrical free motion method, in which a glass ball was timed in upward and downward passages in a vacuum across two horizontal planes separated by a vertical distance of about a metre. The planes were defined by a pair of slits, the ball serving to focus light from one slit onto the other. Distances were measured interferometrically, and time measured by NPL's standard frequency service.

The new value for *g* was found to be 9.8118177 metres per second squared, lower than the previously determined figure.

1966
Packet-switching developed at NPL

NPL begins development of a technique for transmitting long messages of data by splitting them into chunks and temporarily storing them at computer nodes. This still forms the basis of the worldwide complex of computer communications systems today.

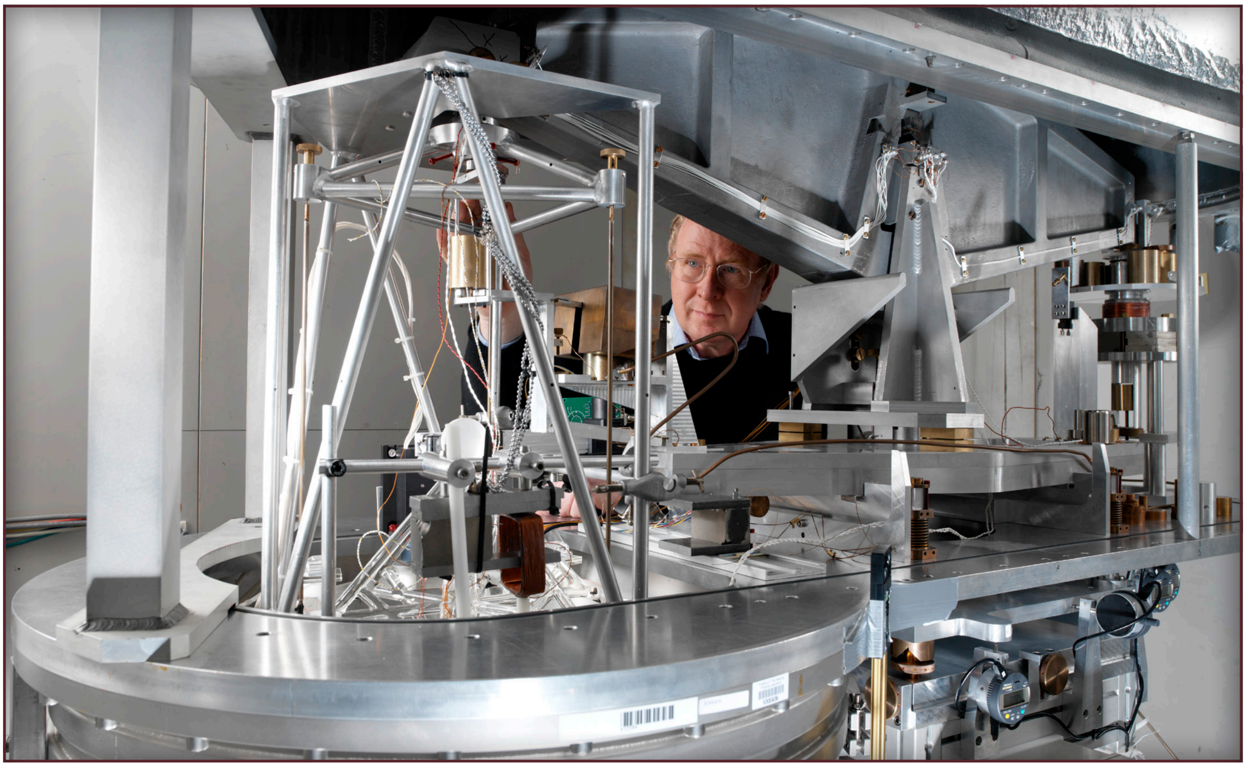
The technique, called 'packet-switching', was developed by Donald Davies. The first practical networks using packet-switching were introduced to the NPL local network, by the early 1970s this was providing a range of on-line services to some 200 users. This demonstration provided a much needed steer to the development of the Arpanet, which would evolve into the Internet we know today.



1974
Laser wavelength measurement

In 1974, the wavelength of an NPL constructed iodine-stabilised helium-neon laser was measured to be 633 nm. Lasers are now used in many branches of modern metrology.

At NPL, the metre is realised through the radiation from analogous 633 nm iodine-stabilised helium-neon lasers. Mechanical actions, for example the movement of a balance, are often measured using a technique called laser interferometry.

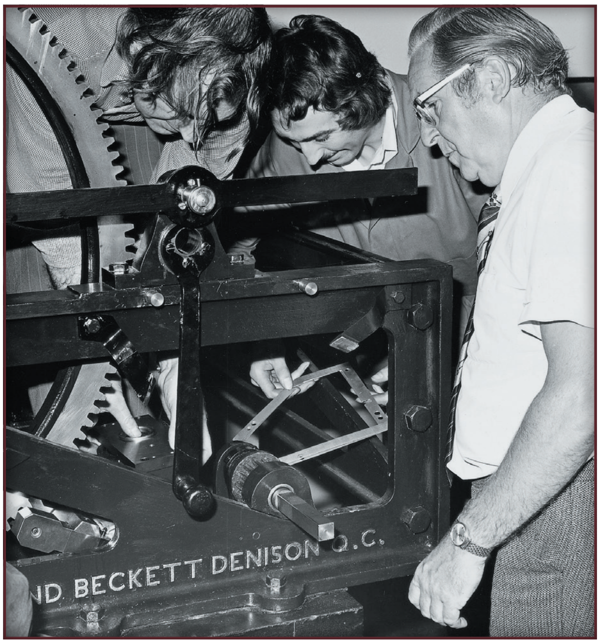


1975
Watt balance first proposed by NPL

The principle of the watt balance was first proposed by Dr Bryan Kibble at NPL. Since then, two watt balances have been built and operated at NPL by Bryan Kibble and Ian Robinson. The original (Mark I) balance operated in air and was used to determine the ampere in terms of the SI base units: the kilogram, the metre and the second. The second (Mark II) balance was designed to measure the Planck constant with the aim of redefining the kilogram. It operates in vacuum to eliminate the effects of the atmosphere on mass and velocity measurements.

Measurements made with the NPL Mark II apparatus at the National Research Council Institute for National Measurement Standards in Canada have produced the lowest uncertainty measurement of the Planck constant in the world to date. The result is in agreement with that of the Avogadro project and therefore underpins the effort to redefine the kilogram in terms of the Planck constant in 2018.

1976



1976
Fail-safe brakes for Big Ben

NPL designed and fitted fail-safe brakes for the chiming mechanism of Big Ben.

A dramatic example of NPL service to the community happened in 1976, when the chiming mechanism of the Great Clock of the Palace of Westminster (Big Ben) disintegrated after almost continuous service since 1854.

The shaft of the fly-governor failed, the driving weights fell 50 m to ground level and so accelerated the chiming mechanism. NPL identified the cause of the failure and designed a fail-safe device for the quarter-chiming mechanism to prevent similar disasters in future.

1979

1979
NPL weighs Concorde

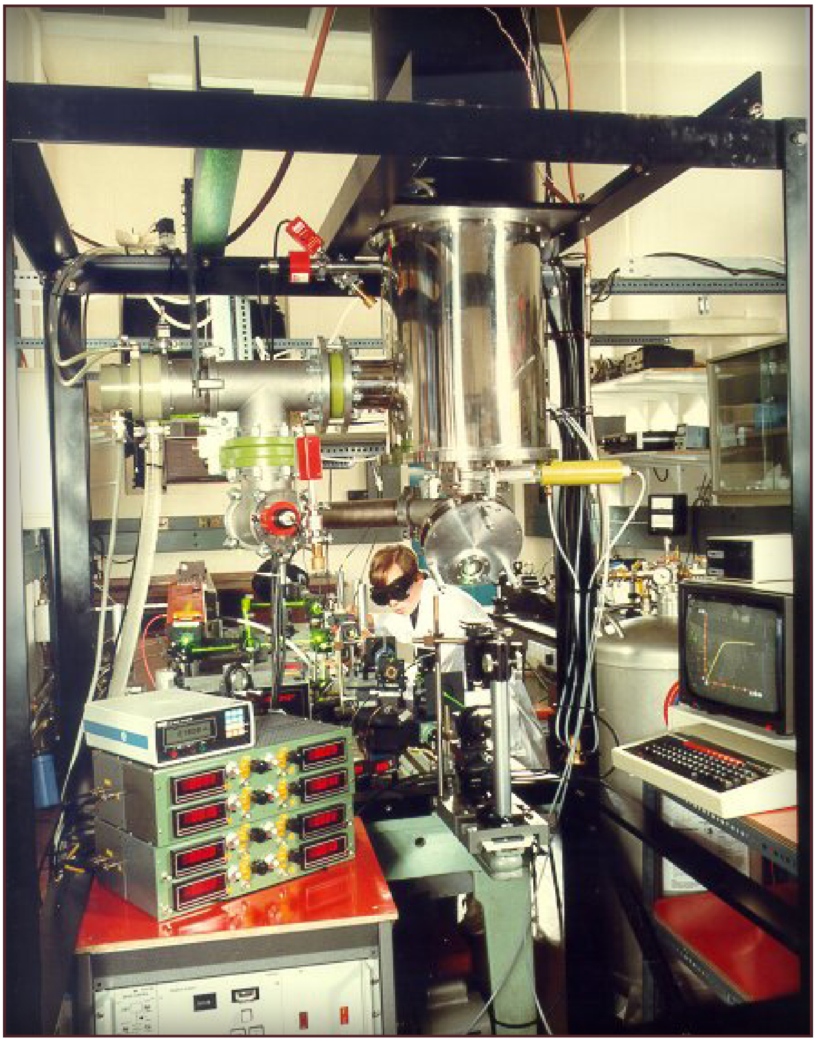
NPL took on the challenge of weighing Concorde to enable it to pass air safety certificates before going into public service.

Concorde was weighed by means of weighing platforms that were calibrated at NPL. The empty weight of the aircraft was determined to be a sprightly 78,700 kg.

1984
Environmental measurement

NPL's mobile laboratories for environmental testing take to the road in 1984.

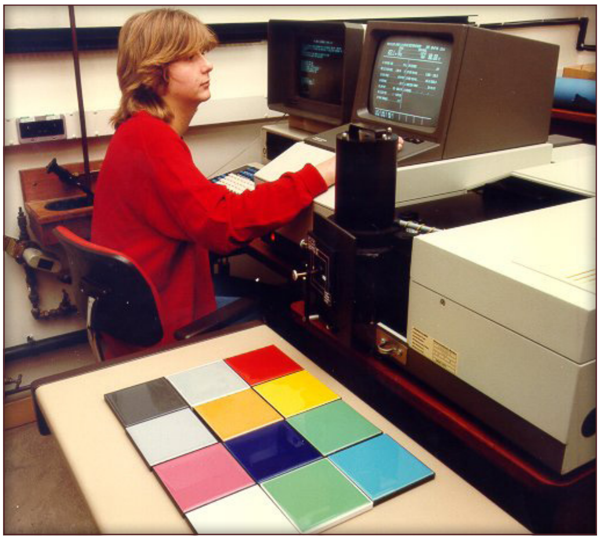
In the early 1980s, NPL developed mobile laboratories capable of remote, range-resolved or integrated-path measurements of a wide range of trace gases at distances of up to several kilometres.



1984
Cryogenic radiometer

In the 1970s, NPL developed the first cryogenic radiometer.

This was the best experimental realisation of the Stefan-Boltzmann constant and remains the accepted experimental value to this day.



1989
NPL colour standards receive Queen's Award for Technological Achievement

The Ceramic Colour Standards were first produced in 1969 in collaboration with industry, trade associations and academic partners to check instrumental accuracy of colour measuring instruments.

The current set of tiles, series II, was launched in 1983, by which time over 1,000 sets of tiles had been issued worldwide. NPL's improvements to the standard resulted in NPL winning the Queen's Award in 1989.

1992
1.2 MN deadweight force testing machine

In 1992, the 1.2 MN deadweight force standard machine was installed at NPL.

One of the largest such machines in the world, the 1.2 MN deadweight force standard machine replaced the old 500 kN machine. NPL's facilities were significantly improved by its larger capacity, ability to perform hysteresis testing, and uncertainty of applied force of only +/- 0.001 %.

Features of this machine include its 55 stainless steel weights, split scalepan, and the ability to be computer controlled.

The photograph shows only the very top of the machine - it is more than three storeys high (not including its foundations).

1995
Paul Vigoureux produces his last NPL Report

Paul Vigoureux joined the Electricity Division of NPL in 1925. His scientific career, at NPL and with the Admiralty Scientific Service, spanned seven decades.

It was his contributions to the units of magnetism and electricity that are most notable, particularly to the shape and introduction of the International System of Units: the SI units. Vigoureux, through his work, greatly helped the process of reaching agreement as to what the SI should be, both in the decisions and in translating key documents between French and English.

1998
Work starts on NPL's new laboratory

In 1998, the foundations are laid for the world's largest and most sophisticated measurement facility. Almost 100 years of sporadic growth and demolitions have resulted in a mixture of buildings spread over much of NPL's existing 82-acre site. The new scheme was an opportunity to consolidate the laboratory and provide more up-to-date, efficient facilities whilst greatly improving the setting of the laboratory.

2000

2000

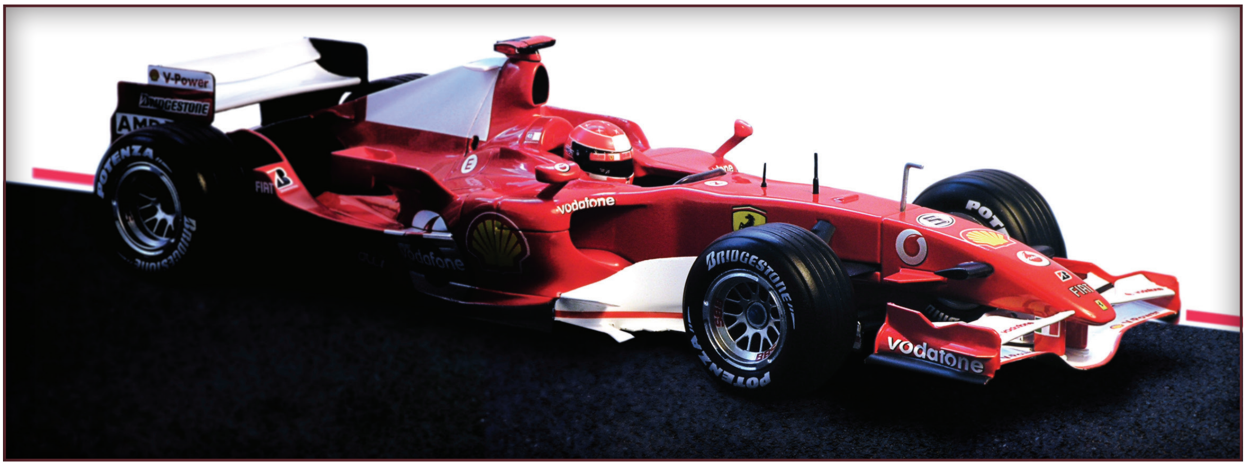
2000
NPL starts biotechnology research

Responding to the changing demands on measurement, NPL opens a new biotechnology laboratory to support measurement challenges experienced in the biomedical and pharmaceutical industries.

2000
Europe's largest underwater Acoustics Pressure Vessel arrives at NPL

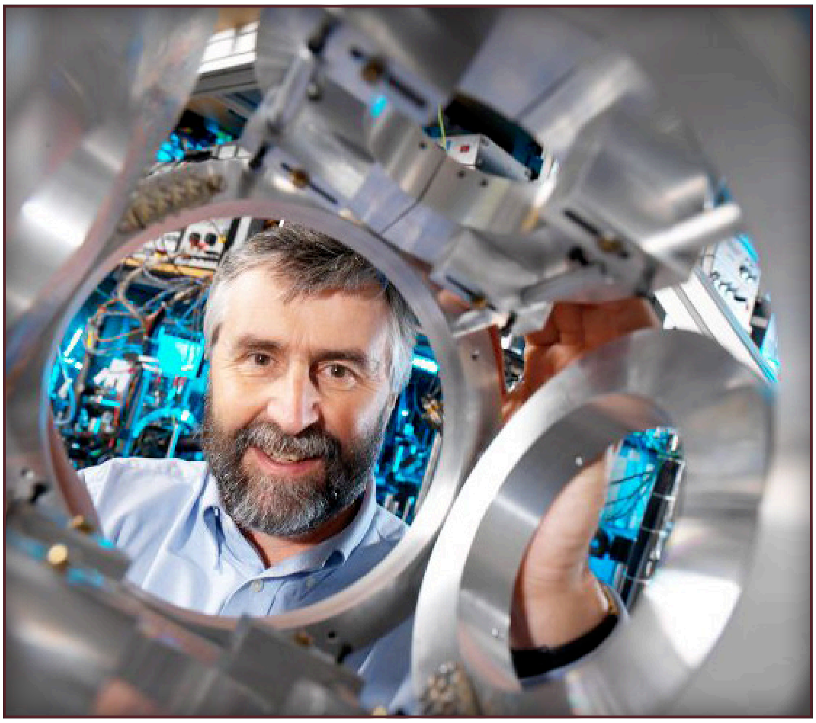
A facility of strategic importance at the National Physical Laboratory provides vital measurements demanded by manufacturers and designers of sonar equipment used in the oil and gas, oceanographic and defence industries. The facility also strengthens fields as diverse as the identification of fish stocks, seismic measurements and the location of buried artefacts under the seabed.

The purpose-built unit is the only such commercially available testing facility in Europe. It can simulate sea conditions at depths of up to 700 m and at temperatures of between 2 °C and 35 °C. Previously, trials and acceptance tests had to be undertaken in the USA or involved expensive sea trials.



2002
NPL helps Formula 1 racing

NPL provides materials expertise to the Federation Internationale de L'Automobile (FIA) to ensure teams respect the rules of F1 racing without compromising the safety and competitiveness of the sport.



2004
New method for measuring time developed

NPL announces results for a new technique to measure time using optical frequency, which could provide a ten-fold improvement in time measurement accuracy.

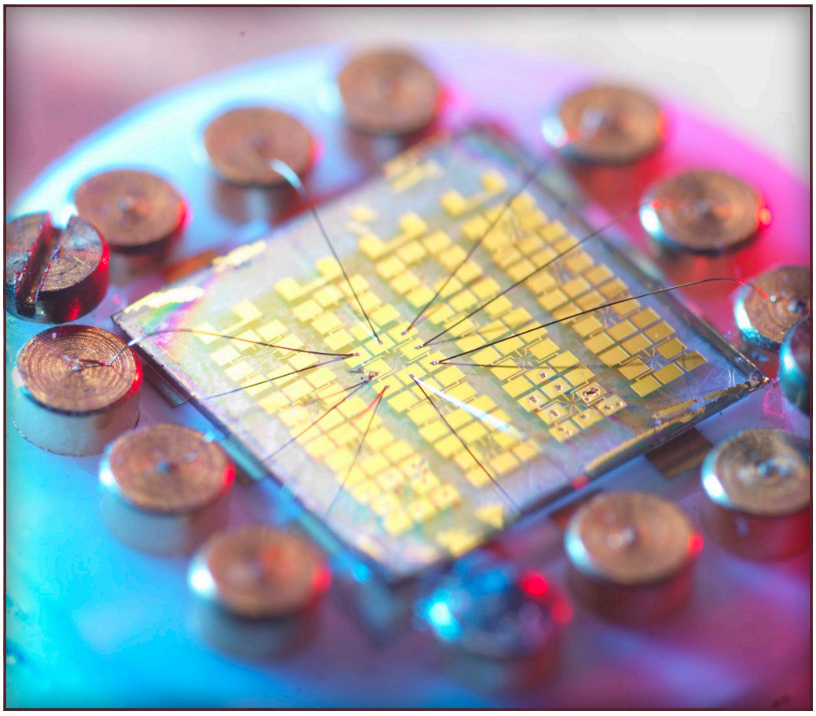
The technique involves freezing a single strontium atom to about -273 °C by bombarding it with billions of tiny packages of light. The atom then moves precisely between two energy states, like the ticking of a clock. A laser beam is then locked onto this 'ticking', which provides an optical frequency that can be measured.

2007
NPL time signal moves

The antenna that broadcasts the time throughout the UK on behalf of NPL is moved from Rugby to Cumbria in a change of contract.

2002
2004
2007

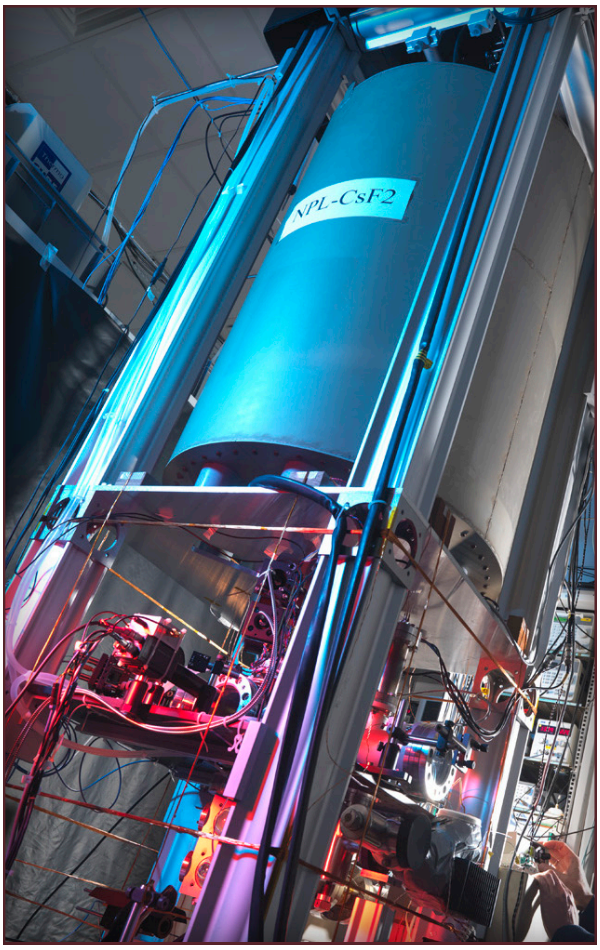
2010



2010
Graphene and the Nobel Prize for Physics

The Nobel Committee cited NPL's pioneering work in the metrology of graphene to illustrate the scientific background for the 2010 Nobel Prize for Physics.

2011



2011
The world's most accurate clock

NPL's caesium fountain atomic clock, known as NPL-CsF2, is revealed to be the most accurate long-term timekeeper in the world as it would lose or gain only one second over 138 million years.

The clock is used as the primary frequency standard for the measurement of time in the UK and contributes to the worldwide timescales used for global communications, satellite navigation and time stamping of financial transactions.

2011
TRUTHS

The Traceable Radiometry Underpinning Terrestrial- and Helio-Studies (TRUTHS) is a benchmark satellite calibration system. The proposed mission would provide the data needed to reduce uncertainty in climate forecasting and its realisation is one of the long-term objectives of the Centre for Carbon Measurement at NPL.

TRUTHS has the potential to position NPL and the UK as the go-to source for the most accurate space-borne climate data.

TRUTHS will also provide policy makers with the confidence to take quick, decisive and 'fit for purpose' action, encouraging the world's governments to take critical decisions on appropriate mitigation and adaptation strategies.

2012
Launch of the Centre for Carbon Measurement at NPL

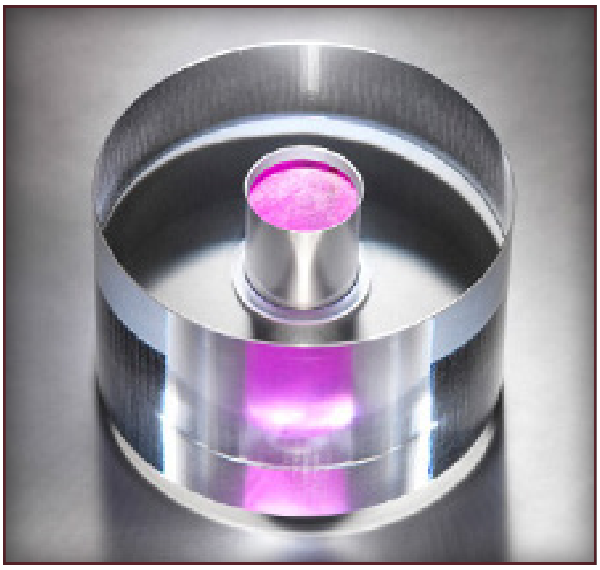
The Centre for Carbon Measurement is launched to reduce uncertainties in climate data, provide the robust measurement required to account for, price and trade carbon emissions, and help accelerate the development of low carbon technologies.

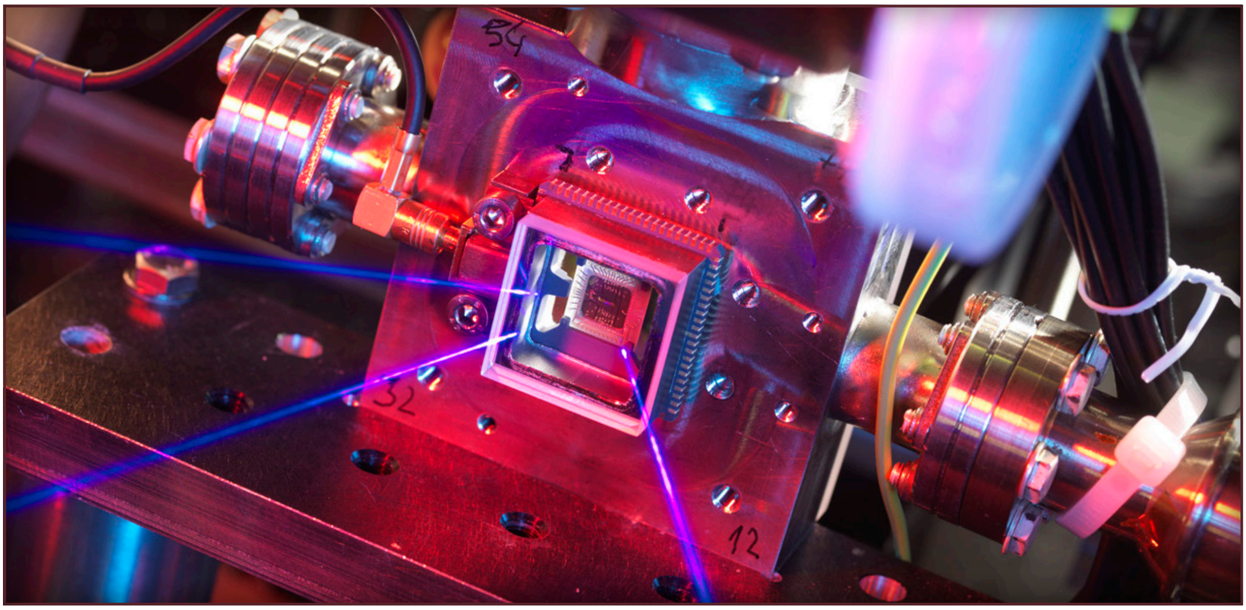
The Centre brings together academic and business partners with government and builds on NPL's capabilities in environmental measurement and low carbon projects.

2012

2012
World's first room-temperature maser

Scientists from NPL demonstrate, for the first time, a solid-state 'MASER' (microwave amplification by stimulated emission of radiation) capable of operating at room temperature, paving the way for its widespread adoption. The team from NPL and Imperial College London has demonstrated masing in a solid-state device working in air at room temperature with no applied magnetic field. This breakthrough means that the cost to manufacture and operate MASERs could be dramatically reduced, which could lead to them becoming as widely used as LASER technology.



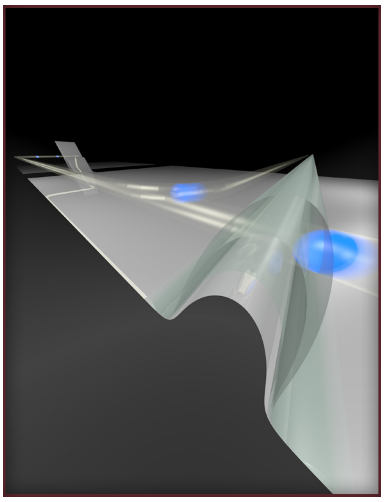


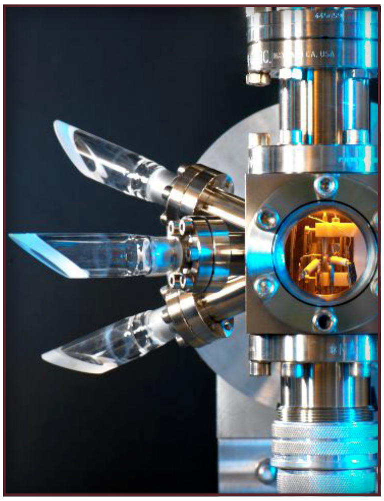
2012

2012
Trapping ions on a chip

A ground-breaking device, demonstrated for the first time at NPL, could help usher in the era of quantum computing. Quantum algorithms can perform certain calculations exponentially faster than classical systems and quantum cryptography could improve data security to an almost unbeatable level. This technology is based on the use of entangled particles known as qubits to perform calculations.

NPL's novel device is a 3D ion microtrap array made from a silica-on-silicon wafer using a scalable microfabrication process. Scientists were able to confine individual ions, as well as strings of 14 ions, in a single segment. The microfabrication process will enable the creation of more complex devices which could handle even larger numbers of ions, while retaining the ability to control individual particles.





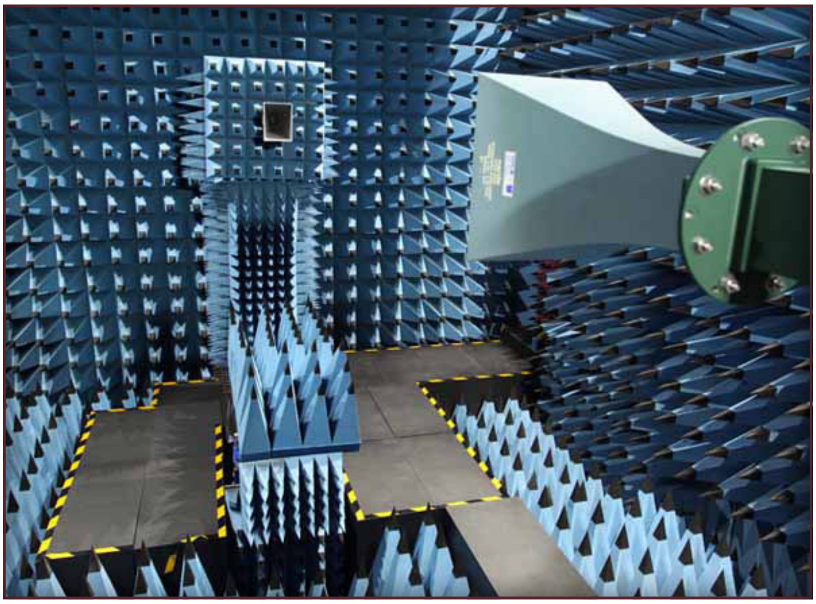
2013
NPL*Time*®

A new service called NPL*Time*® was launched, offering the financial sector a certified precise time signal, directly traceable to Coordinated Universal Time (UTC) and independent of GPS. This removes susceptibility to problems such as jamming and solar storms.

2013
Worlds first graphene single electron pump

The present definition of the SI unit of electric current, the ampere, is vulnerable to drift and instability, and is not sufficient to meet the accuracy needs of present and future electrical measurement.

An innovation from NPL and the University of Cambridge could pave the way for redefining the ampere in terms of a fundamental physical constant. The team successfully produced the first single electron pump made from graphene, which creates a flow of individual electrons, emitting them one at a time at a steady rate. Exploiting the unique properties of graphene enables fast operation of the pump, overcoming the Achilles' heel of metallic pumps, slow pumping speed. This provides the electron flow rate needed to create a new standard for electrical current based on electron charge.



2015
Official opening of NPL installed antenna range at NIM China

Following two years of design, construction, installation, validation and training, an NPL project to install an antenna extrapolation range at the National Institute of Metrology (NIM) in China was officially opened in April 2015.

Since opening a new campus in Changping, north-west Beijing, NIM has been keen to improve its microwave antenna measurement facilities through collaboration with NPL.

Over the course of the project, the NPL team made multiple site visits, produced over 300 design drawings and manufactured and tested hundreds of parts. In addition to the hardware supplied, the project also included the provision of software, procedures, validation and training.

National Physical Laboratory

The National Physical Laboratory (NPL) is the UK's National Measurement Institute. At the heart of our mission is delivering impact by disseminating research and measurement best practice and traceability for the economic and social benefit of the nation.

Keep in touch with us

Sign up to receive regular updates: **www.npl.co.uk/keep-in-touch**
Follow NPL on Twitter: **www.twitter.com/npl**
Become a Facebook fan: **www.facebook.com/npldigital**
Subscribe on YouTube: **www.youtube.com/npldigital**

National Physical Laboratory
Hampton Road
Teddington
Middlesex
TW11 0LW
Switchboard **020 8977 3222**
www.npl.co.uk/contact

Cover image:

1906. A garden party in the grounds of Bushy House on the occasion of the opening of the Electrotechnics building.