

Science Community Focus

Bright Lights, Big Science

The physical phenomenon that has helped to shape human history and open up our world

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Lighting Up Our World

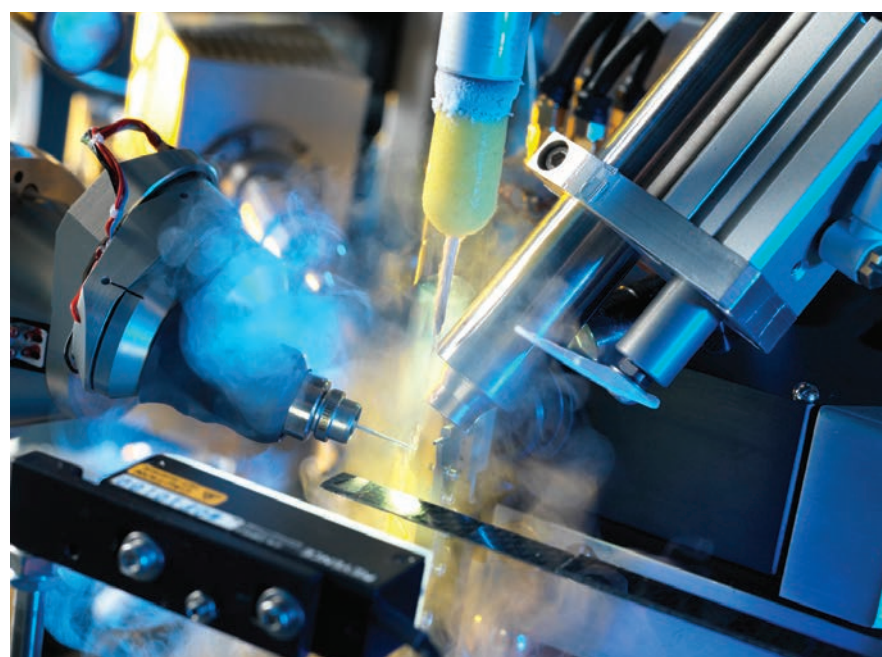
The story of light is the story of life itself. From bacteria, to plants, to human beings, all species on Earth depend in some way on light to survive. But light is not just the foundation of our existence, it is also a tool for exploration and advancement. From the discovery of fire, to the invention of synchrotrons, throughout history light has helped to make our lives safer and more comfortable; and what is more, light has been the key ingredient allowing us to uncover more about the universe around us.

In fact, light permeates every aspect of our lives in ways that we might not even realise. The world runs on visible light, and 20% of global energy consumption is spent on lighting, but this is just one small element of the spectrum. Other forms of light, including ultraviolet and X-rays, have also helped to shape our experience of the world. The internet, one of the defining technologies of modern life, uses ultra-short light data pulses; the future of energy will depend in part on solar and fusion power; and some of the world's most advanced scientific machines produce tailored forms of light that help us to explore the universe on the atomic and molecular scale.

We benefit from the intersections between light and science every day. Advances in medicine and technology have their roots in light-based technology, because light forms the basis for modern microscopes and other scientific research tools. And the better we become at harnessing the power of light, the more we can see. Advanced light technology has allowed us to scrutinise interactions, structures, and processes in astonishing detail. And by illuminating this information, light technology can help us to both better understand fundamental chemical and physical laws, and to apply our knowledge and develop cutting edge drugs and materials.

The International Year of Light

In recognition of all that light has contributed to human history and its continued potential as a means to expand our understanding and engender new advances, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has declared 2015 the



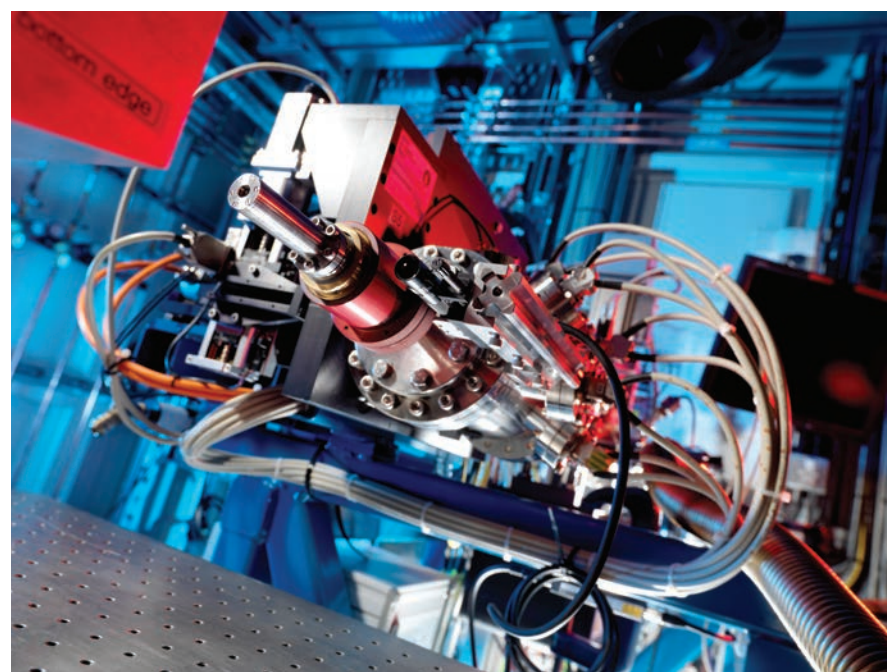
The experimental set up on one of Diamond's MX beamlines, I04

International Year of Light and Light-based Technologies. The opening ceremony took place at UNESCO headquarters in Paris in January 2015, marking the beginning of a year-long series of global activities. Throughout the year, festivals, talks, and public events have taken place all over the world, from Moscow, to Melbourne, to Mumbai, in celebration of all that light has to offer.

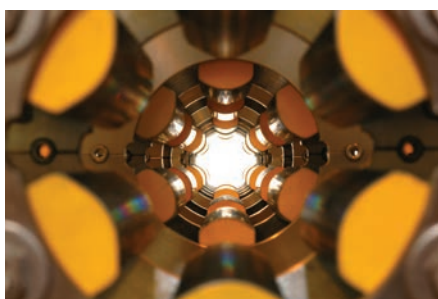
In the UK, over 40 individuals and organisations representing science, engineering, culture, and the arts worked throughout the year to create an impactful national programme of events and activities. Together, these organisations helped to fulfil the UN's aim of improving public and political understanding of the central role that light plays in the modern world. With some of the most advanced light-based technology facilities in the world, the UK emblematises the continued significance of light to new research and discovery. But the International Year of Light is not purely about celebrating advanced light-based technology; the event also seeks to raise awareness of the other end of the spectrum: light poverty.

The Problem of Light Poverty

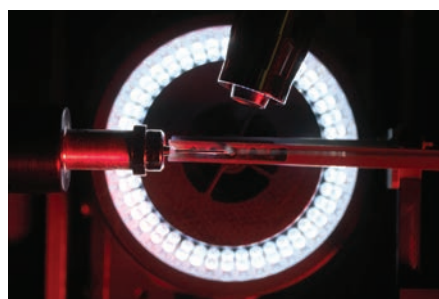
In large parts of the developing world, even very basic access to light is limited. Over 20% of the world's population is currently in light poverty and for these people life after sunset means either sheer darkness or the light of only candles and kerosene lamps. In addition to the harmful impact of breathing in toxic smoke from these devices, the lack of effective lighting infrastructure has a profound impact on these



The equipment on Diamond's non-crystalline diffraction beamline, I22



One of the magnets that drives electrons around Diamond's storage ring



The high tech machinery on microfocus MX beamline I24

individuals in a variety of other ways. Their working hours, and therefore income, is curtailed; access to education and reading is compromised; and healthcare is seriously affected – in parts of the world, hospitals simply have to shut down at night.

A vital goal of the International Year of Light is to highlight the problem of global light poverty and to emphasise what can be done to counteract it. As well as the necessary investment and infrastructure improvements, science has an important part to play in addressing this issue. Research into cheaper LEDs is helping to make reliable light more accessible for even the poorest communities; and advancements in photovoltaics are making it feasible for families in the developing world to access clean, safe, and affordable light whilst remaining off the grid.

In addition to alleviating light poverty, light-based technologies have the capacity to improve conditions in the developing world in myriad other ways, from advanced medicines to specialised agricultural resources. Part of the mission of International Year of Light is to create greater awareness of the potential of light-based technologies to address many of the challenges facing the African continent in particular. The initiative looks to expand educational opportunities and research infrastructure in African countries to support the study and application of light-based technologies for the benefit of the population.

Diamond: The UK's Brightest Light

A central goal of the International Year of Light is to demonstrate that the products of light-based technologies have the capacity to benefit lives all around the world. Back in the UK, one of the brightest lights in the solar system is nestled away in the Oxfordshire countryside. Located on the Harwell Campus, Diamond Light Source is a prominent light-based technology facility known as a synchrotron.

The facility is shaped like a giant ring, about the size of Wembley Stadium. Complex machinery including hundreds of magnets speed electrons around this ring at near light speeds, and this acceleration causes them to give off a light 10 billion times brighter than the sun. Bright beams are then directed off into laboratories known as 'beamlines'. Here, scientists use the light to study a vast range of subject matter, from new medicines and treatments for disease to innovative engineering and cutting-edge technology.



Aerial view of the Diamond synchrotron

Diamond is a prime example of the continued significance of light to our lives. The intense beams allow us to see more, and this enhanced vision has many different applications, from learning more about the fundamental laws and structure of life, to developing products that improve society and the conditions of humankind.

Diamond's intense light is used by over 3000 scientists and 85 industrial companies; the synchrotron supports a broad range of science and has helped to yield a number of advances. Recently, Diamond was involved in the development of a new vaccine for foot-and-mouth disease, a devastating livestock virus that is endemic throughout much of the developing world. The new vaccine, which is currently at trial stage in livestock, promises to save huge amounts of money and improve conditions for agricultural workers in parts of the world where the virus is a constant plague.

Other research projects include scrutinising the body's immune system to identify new ways of combatting cancer and HIV. The brightness of the light that Diamond produces allows scientists to actually see the body's own cells fighting off invading pathogens. With a more thorough understanding of this process, it should be possible to enhance the cancer and HIV-killing elements of the body's immune system to prevent the diseases from spreading.

And it's not just the life sciences where Diamond shines. Scientists are using the light to explore advanced components for automobiles and aerospace; the facility is helping to expand our knowledge of graphene and other pioneering materials that could soon revolutionise consumer technology; and the bright beams are allowing users to explore geological phenomena, making us better prepared for natural disasters like earthquakes and volcanic eruptions.

Bright Light for the Future



Diamond holds regular open days and school visits

From unpicking the history of the dinosaurs to investigating the nature of the cosmos, Diamond and other light-based technology facilities are at the centre of modern exploration and discovery. Diamond is just one of many institutions, including Downing Street and CERN, celebrating the historic Year of Light; and the facility has joined others in the UK to organise open days, festivals, and creative content, including films and magazine features. Bringing together the public and the scientific community, these initiatives have helped to highlight the integral role light plays in cutting-edge technology and its significance for the future.

Light is at the centre of our being, and harnessing it has been the basis for our advancement as a species. Hundreds of thousands of years after the discovery of fire, we are still developing our mastery of light to help protect ourselves from harm, make our lives more comfortable, and explore dark corners of the world.

The applications of light and light-based technologies have expanded into areas our ancestors could never have imagined, but there is still so much more that light can help us to discover. But one thing is for certain: light underscores the foundations of our existence, and has guided the path of humanity in myriad ways. We've come a long way since early humans first learned to harness the power of this physical phenomenon, but light remains our greatest tool for survival, and it will continue to shape our story for all time.

Diamond Light Source is the UK's synchrotron science facility. It is used by thousands of scientists to explore the atomic and molecular nature of matter, supporting advances in medicine, engineering, and technology. Approximately 10,000 times more powerful than a traditional microscope, Diamond is one of the most advanced scientific facilities in the world, and its pioneering capabilities are helping to keep the UK at the forefront of scientific research.

All images Credit: Courtesy of Diamond Light Source.

Find out more about Diamond at www.diamond.ac.uk