Diamond

General Information

Diamond works like a giant microscope, harnessing the power of electrons to produce bright light that scientists can use to study anything from fossils to jet engines to viruses and vaccines.

The machine speeds up electrons to near light speeds so that they give off a light 10 billion times brighter than the sun. These bright beams are then directed off into laboratories known as 'beamlines'. Here, scientists use the light to study a vast range of subject matter. Whether it's fragments of ancient paintings or unknown virus structures, at the synchrotron, scientists can study their samples in atomic detail.

Diamond is a not-for-profit limited company funded as a joint venture by the UK Government through the Science & Technology Facilities Council (STFC) in partnership with the Wellcome Trust. The synchrotron is free at the point of access through a competitive application process, provided that the results are in the public domain. Thousands of researchers from both academia and industry use Diamond to conduct experiments, assisted by approximately 500 staff.

The scope for industrial research and development at Diamond is greater than ever before, and the number of organisations using Diamond through the proprietary access mode now exceeds 70, ranging in size from small start-ups to global corporations. While the pharmaceutical sector is still the predominant user of Diamond beamlines, an increase in both usage and income is being seen throughout the physical sciences. Today, companies such as GSK, AstraZeneca, Heptares, Rolls-Royce and Infineum are supported by Diamond's dedicated Industrial liaison group.

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.

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Facts and Figures: 2013/14

- when operations began: 2007
- energy: 3 GeV, 300mA
- scheduled user hours: 58,536
- expenditure (excluding VAT): operations £42.5m, capital £25.5m
- number of users: 7,577
- number of proposals submitted: 1,079
- shifts requested: 13,597
- number of publications: 600
- user affiliation breakdown: 6% industry, 94% academia
- usage type: 5,277 visits, 2,300 remote
- success in maintaining beam: 98.2%

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Societal Impact

Energy: Solar wallpaper

Earth is exposed to enough sunlight in a couple of hours to power the entire world for a year; that's why it's so important to harness the sun's power. At Diamond, scientists are developing technology to create solar panels that are so flexible and cheap that they could be installed just like wallpaper on the outside of buildings.

Living with environmental change: Trapping noxious gas

Greenhouse gasses are damaging to the environment, but research at Diamond is helping to develop new materials which can capture and remove them from the atmosphere. Scientists at Diamond scrutinise the properties of naturally occurring materials and use them to develop advanced new materials. If fitted to energy stations, carbon capture materials could help reduce our carbon emissions, giving us cleaner, purer air.

Global uncertainty: Radioactive waste storage

Nuclear waste storage is one of the most pressing issues faced by governments around the world. Teams working at Diamond are studying the impact of radiation damage in different minerals to help engineer holding facilities capable of safely storing waste for 1 million years.

Lifelong health & wellbeing: Fighting antibiotic resistance

Diamond is helping to combat the rise of antibiotic resistant bugs by allowing scientists to uncover the mechanisms by which bacteria defend themselves against drugs. A group of scientists have used Diamond to determine how certain bacteria construct their outer layer of defence, providing a target for new classes of antibiotics that would sidestep current resistance mechanisms.

Global food security: Addressing global hunger

Wheat is one of the world's most popular foods; however, the human body isn't able to effectively absorb all of the rich nutrients inside wheat. By reducing the amount of a compound called 'phytate' in the grains, scientists at Diamond are helping to develop wheat that is far more nutritious. One billion people are permanently hungry and millions die each year as a consequence of deficiencies of iron and zinc; but these small changes to grains could help alleviate malnutrition worldwide.

Digital economy: Energy-efficient tech

Data storage technology generally uses magnetism to read and write binary code which is translated into sound and vision on a computer. However, the magnets need a good deal of power to function effectively. Scientists at Diamond are studying the properties of magnetic materials in order to develop more efficient technology that doesn't consume as much power. In this way, synchrotron light is helping to develop the next generation of energy-efficient gadgets.

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Future Perspective

There are 24 beamlines now operational at Diamond, and this number will rise to 33 once Phase III of construction is completed in 2018. Upcoming developments on the Resonant Inelastic X-ray Scattering (RIXS) beamline (I21), Versatile Soft X-ray (VERSOX) beamline (B07), and the dedicated X-PDF station (I15-1) will see Diamond gain a host of beamlines offering new approaches to scientific challenges.

The construction of the Electron Microscopy Facility is a particularly interesting development for Diamond, as it will combine three different elements – the Hard X-ray nanoprobe beamline (I14), an electron imaging centre for biology, and an electron microscopy centre for physical sciences – under one roof. The new facility is the first project at Diamond that seeks to co-locate both synchrotron and non-synchrotron facilities. This physical proximity will create new synergies in efforts to tackle common problems in image analysis and sample handling; what's more, the novel set up demonstrates Diamond's evolving approach to the services it provides.

The two microscopes for the physical sciences centre will be supplied by Johnson Matthey and Oxford University and operated under strategic collaboration agreements to provide for substantial dedicated peer reviewed user access. Similarly, the electron imaging centre for biology is funded by a £15.6 million grant from the Wellcome Trust, the Medical Research Council, and the Biotechnology and Biological Sciences Research Council. This collaboration will create stronger links between Diamond as a research centre and universities, research institutes, and industry.

Web : www.diamond.ac.uk/Home
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Diamond will also take a leading role in leading the UK contribution to the new XFEL facility in Hamburg, providing a UK hub where scientists can prepare their samples. Funded by the Wellcome Trust, the Biotechnology and Biological Sciences Research Council (BBSRC) and the Medical Research Council (MRC), along with a number of European partners, the UK efforts of the SFX consortium are led by the University of St Andrews and Diamond Light Source.

The UK hub, which will be based at Diamond, will enable users of the SFX facility to fully prepare for their experiments in Hamburg. In-house experts will work with the researchers to ensure that their experimental samples are suitable and flight-ready before sending them off for transit. There will also be a dedicated fibre link from Hamburg to Harwell enabling researchers to carry out data analysis back in the UK.

Over five years between 2014 and 2019 the UK funders will contribute £5.64M to the construction of SFX at European XFEL. As a lead partner in the SFX consortium the UK will secure dedicated time during the five year development, and will develop significant expertise in this game-changing technique at the UK hub at Diamond. Following this the UK will be eligible for open access time after peer review, which is likely to be extremely competitive on an international scale. Having secured dedicated time as part of the SFX consortium, and developed expertise at the hub, UK scientists are likely to be well placed to secure experimental time.