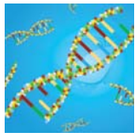
STFC's Central Laser Facility

All the colours of the rainbow and more

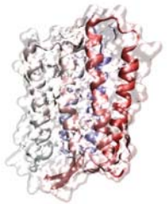
A major part of the CLF is the Lasers for Science Facility. This offers one of the most concentrated and versatile array of laser systems and expertise in the world. The facility is divided into three sections:

The Molecular Structure and Dynamics Group houses the

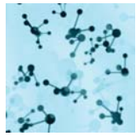


ULTRA facility for advanced time-resolved spectroscopy. ULTRA combines laser, detector and sample-manipulation technology to study molecular dynamics (on the femtosecond to microsecond timescales) to address scientific problems in the physical and life sciences. A range of ultrafast light sources give unprecedented flexibility to combine multiple beams, multiple colours (ultraviolet to mid-infrared), mixed timing patterns (fs-µs) and pulse lengths.

The Functional Biosystems Imaging Group is the home of the OCTOPUS cluster, which is a new-concept, advanced imaging facility that can combine multiple techniques in a single experimental campaign. The techniques and expertise permit instant observation of living cells to follow the behaviour of single molecules (including proteins, DNA, neurotransmitters and drugs) to find new ways of treating and diagnosing disease.



The Laser Loan Pool provides a variety of state-of-the-art



commercial laser systems to support UK researchers for use at their home laboratories. The loaned lasers fulfil an important niche for newly appointed academics; they provide a test-bed for new ideas; and they allow rapid access to lasers when they are needed. The programme is funded by EPSRC.

For further information, please contact:

Central Laser Facility

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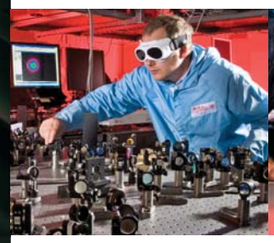
Science & Technology Facilities Council

EPSRC
Engineering and Physical Sciences Research Council

Lasers in our lives
50 years of impact

Science & Technology Facilities Council

STFC's Central Laser Facility



Provides an internationally leading range of laser systems for academia and industry

Vulcan — HIGHEST POWER OF ALL

Vulcan is one of the most powerful and versatile laser systems in the world. This unique facility delivers a focused beam – which, for 1 picosecond (0.000000000001 seconds), is 10,000 times more powerful than the output of the National Grid – to support a wide-ranging research programme in fundamental physics and advanced applications relevant to clean energy and medicine. The international HiPER laser fusion project has grown from the success of the Vulcan laser and the ingenuity of its international user community of research scientists.

Looking to the future, Vulcan is now embarking on a major upgrade to increase its power by a factor of 10 and its focused intensity by a factor of 100.

Astra Gemini — HIGH REPETITION RATE

Astra Gemini Astra Gemini delivers laser pulses at the petawatt (a million billion watts) scale, with unsurpassed intensity and in an entirely new 'high-repetition rate' regime. Its two beams can deliver one pulse every 20 seconds (compared to once every 20 minutes for conventional systems such as Vulcan). This makes it extremely useful for the detailed study of laser-driven particle acceleration, opening up a transformation in accelerator science and technology.

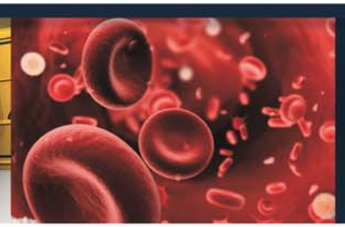
Artemis — THE SHORTEST PULSES

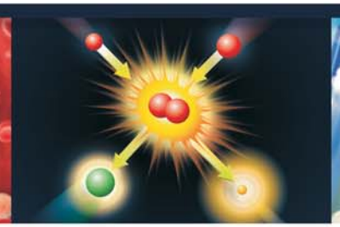
Artemis is an ultrafast soft X-ray science facility based on a high repetition rate, few optical-cycle tuneable laser sources and ultra-fast XUV pulses.

These synchronised sources are coupled to end-stations for materials science, atomic and molecular physics, and chemistry. Artemis brings together femtosecond laser and synchrotron technologies to enable new science in the emerging field of ultrafast X-rays.

Why do we care about lasers?

Today, lasers impact almost every aspect of life…





…from medicine to manufacturing, from communications to measurement and from research and analysis to entertainment. This is ironic for a device that was initially described as a 'solution looking for a problem'. In fact, during its first 50 years, the laser has been nothing short of revolutionary! We can only wonder what the next 50 years will bring.

fact

Estimates suggest that the world market for lasers in 2007 was worth more than

£4Bn!

Measurement and analysis

Measurement and analysis have been transformed by the laser. Surveyors use lasers to mark out roads and construction sites, the military use them to determine the position of targets and even NASA has utilised lasers to measure the distance of the Moon from the Earth.

Laser analysis of chemical and physical structures has allowed factories to manage quality control efficiently. Laser techniques have been adopted by aluminium-manufacturing plants to monitor accurately the proportion of constituent metals in alloys. They also play a crucial role in the inspection of pharmaceuticals.

Defence and national security

The world is on high alert for potential terrorist attacks, and security is of high priority. Detecting explosives and biochemical hazards are just a few examples of how lasers can strengthen our national security.

fact

The total number of laser patents issued since its invention is well over

50,000

Medicine and health

Only one year after its invention, the laser was being used in a medical procedure. This happened in December 1961 at the Columbia-Presbyterian Hospital, where a ruby laser was used to destroy an eye tumour.

Today, lasers are commonly employed in most medical disciplines including dermatology, dentistry, cardiology, neurosurgery and eye surgery, because of their ability to deliver high-precision treatments, whilst remaining minimally invasive. Laser-based therapies and diagnostic methods represent an area of huge future potential.

Energy

Because lasers can generate extreme pressures and temperatures, they can be employed to ignite nuclear fusion – the same process that powers our Sun.

Research into laser-driven nuclear fusion is currently underway and promises to address our increasingly demanding energy requirements.

In addition, scientists are exploiting lasers for the development of solar cells.

Communications

Long-distance telecommunications and broadband internet depend on the transmission of light pulses along optical fibres. These light pulses are both generated and relayed via lasers. This revolutionary method of communication is replacing less efficient copper wire-based networks, and is the foundation of the internet and information age.

Environment and climate

Climate change is one of our most immediate challenges. Deforestation and the burning of fossil fuels are the likely causes for the increased concentrations of greenhouse gases in the Earth's atmosphere.

Lasers can be used to analyse the concentrations of these gases and even to monitor their effects on ecosystems.

Manufacturing

Lasers are employed across the manufacturing industry, as tools capable of delivering intense cutting or welding power with high precision. Their ability to manipulate and transform materials makes them ideal for the automobile, computer, and clothing industries – to name but a few. In fact, it is difficult to find a modern consumer product that has not seen a laser during its manufacturing.

What are lasers?

Light
Amplification by
Stimulated
Emission of
Radiation

Lasers are concentrated beams of electromagnetic radiation (light) travelling in a particular direction.

The defining properties of laser light are that the light waves are coherent (all travelling in harmony with one another) and that they are usually of one wavelength, or colour.

By harnessing these properties in a device that reflects light back and forth in an energised medium, it is possible to generate an amplified light source, or laser.

A brief history

The conception of the laser traces back to a theory proposed by Albert Einstein in 1917.

It was Einstein's theoretical understanding of the interactions between light and matter that paved the way for the first laser. However, it was not until 1960 that the first working optical ruby laser was built by Theodore Maiman. Over the past 50 years, the laser has evolved considerably, and many new varieties have been developed. Due to their extreme versatility, lasers have become invaluable tools across a multitude of applications.

Where STFC fits into the picture

The UK specialises in research using and creating high-power lasers.

STFC's Central Laser Facility (CLF), sited at the Rutherford Appleton Laboratory has been at the forefront of innovative laser technology and research for more than 30 years.