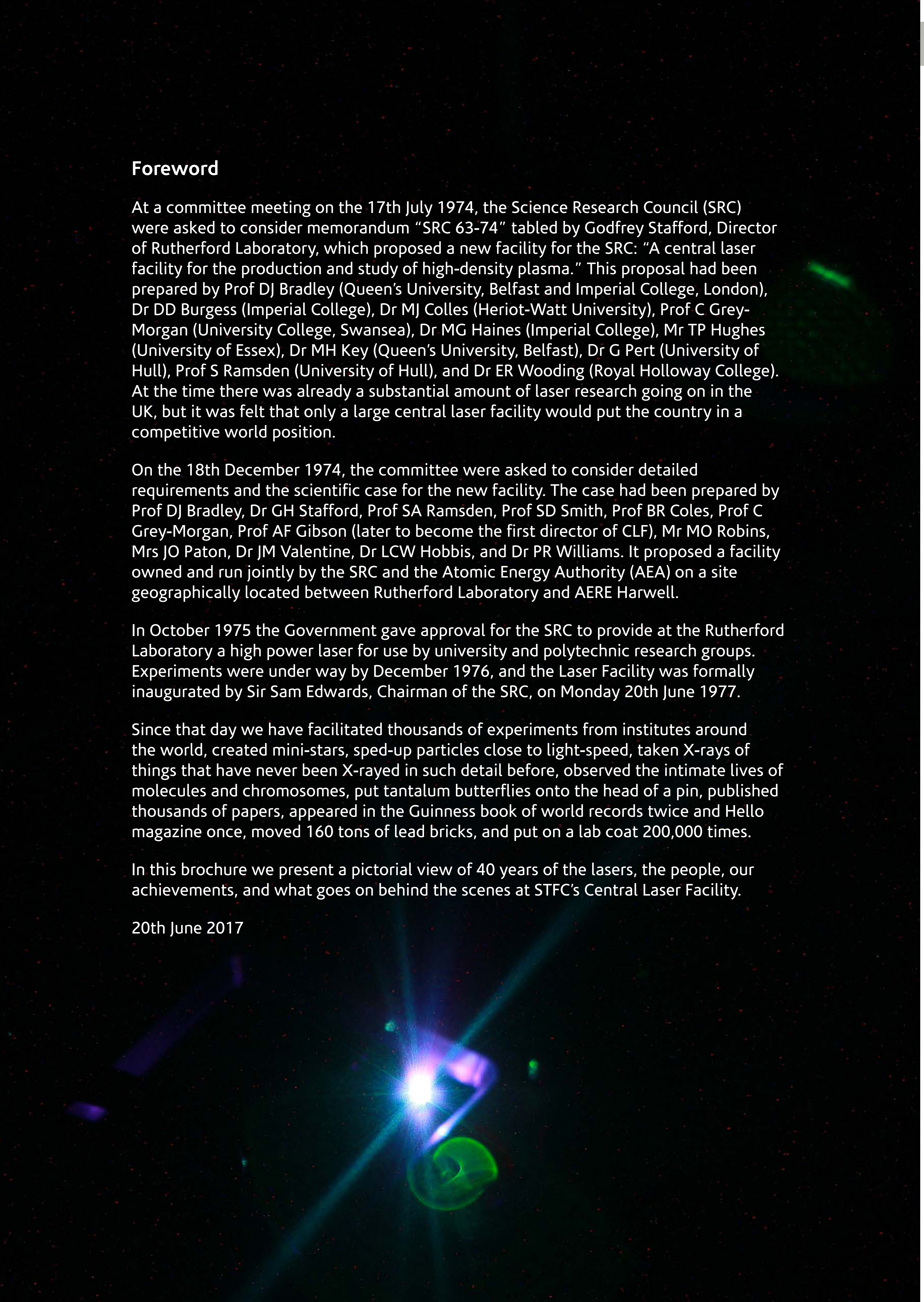
40 YEARS OF SCIENCE
AND INNOVATION

Central Laser Facility

40 YEARS IN PICTURES

Science & Technology
Facilities Council



Foreword

At a committee meeting on the 17th July 1974, the Science Research Council (SRC) were asked to consider memorandum "SRC 63-74" tabled by Godfrey Stafford, Director of Rutherford Laboratory, which proposed a new facility for the SRC: "A central laser facility for the production and study of high-density plasma." This proposal had been prepared by Prof DJ Bradley (Queen's University, Belfast and Imperial College, London), Dr DD Burgess (Imperial College), Dr MJ Colles (Heriot-Watt University), Prof C Grey-Morgan (University College, Swansea), Dr MG Haines (Imperial College), Mr TP Hughes (University of Essex), Dr MH Key (Queen's University, Belfast), Dr G Pert (University of Hull), Prof S Ramsden (University of Hull), and Dr ER Wooding (Royal Holloway College). At the time there was already a substantial amount of laser research going on in the UK, but it was felt that only a large central laser facility would put the country in a competitive world position.

On the 18th December 1974, the committee were asked to consider detailed requirements and the scientific case for the new facility. The case had been prepared by Prof DJ Bradley, Dr GH Stafford, Prof SA Ramsden, Prof SD Smith, Prof BR Coles, Prof C Grey-Morgan, Prof AF Gibson (later to become the first director of CLF), Mr MO Robins, Mrs JO Paton, Dr JM Valentine, Dr LCW Hobbis, and Dr PR Williams. It proposed a facility owned and run jointly by the SRC and the Atomic Energy Authority (AEA) on a site geographically located between Rutherford Laboratory and AERE Harwell.

In October 1975 the Government gave approval for the SRC to provide at the Rutherford Laboratory a high power laser for use by university and polytechnic research groups. Experiments were under way by December 1976, and the Laser Facility was formally inaugurated by Sir Sam Edwards, Chairman of the SRC, on Monday 20th June 1977.

Since that day we have facilitated thousands of experiments from institutes around the world, created mini-stars, sped-up particles close to light-speed, taken X-rays of things that have never been X-rayed in such detail before, observed the intimate lives of molecules and chromosomes, put tantalum butterflies onto the head of a pin, published thousands of papers, appeared in the Guinness book of world records twice and Hello magazine once, moved 160 tons of lead bricks, and put on a lab coat 200,000 times.

In this brochure we present a pictorial view of 40 years of the lasers, the people, our achievements, and what goes on behind the scenes at STFC's Central Laser Facility.

20th June 2017

1977

Laser Facility Inauguration Ceremony

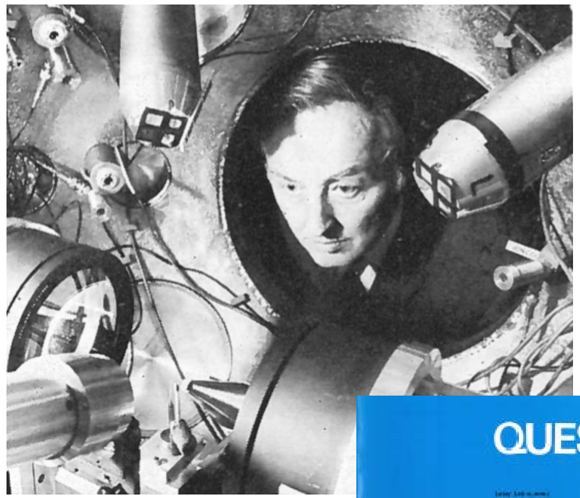
On Monday 20th June 1977 – inauguration day – guests assembled in the Director's Conference Room to be greeted by Dr Alan Gibson (Director of the Facility), and Dr Paul Williams (Deputy Director of the Facility, later Director of Rutherford Appleton Laboratory). They were given a tour of the facility, the clean rooms, and the new laser which was known at the time as the Neodymium Glass Laser (Nd:glass) (see later for an explanation). Shortly after noon, Sir Sam Edwards (Chairman of the SRC) pressed the laser FIRE button. The warning tone sounded and everybody waited for the two minute charging time to end. At 12:06 the laser fired what just so happened to be compression shot number 50. A number of bangs followed as champagne corks were popped. The guests were then treated to lunch in the R22 Restaurant, followed by speeches.

The Right Honourable Mrs Shirley Williams MP, Secretary of State for Education and Science, was represented by Mr W Ulrich (Deputy Secretary, DES). Other VIPs included Dr Godfrey Stafford (Director of RAL), Dr Lewis Roberts (Director of AERE Harwell), Prof Sir Herman Bondi (Chief Scientific Adviser to the Department of Energy), Dr G Brett (Head of Quantel SA in France, a company which still supplies pump lasers to us), and Dr L Reed (Vice President of ILC Technology Inc, USA, suppliers of the disc amplifiers).

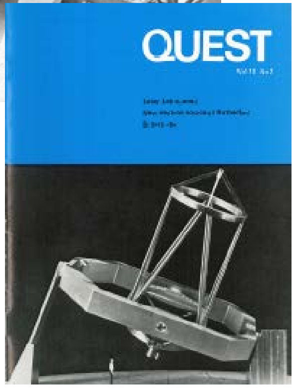
The Nd:glass laser is still in use, although it has been upgraded considerably since 1977, and is now CLF's flagship laser facility *Vulcan*.

Sir Sam Edwards presses the FIRE button. (24032)

Prof Alan Gibson (Director of the Laser Facility), Prof Dan Bradley (Head of the Department of Physics, Imperial College), Sir Sam Edwards (SRC chairman), and Godfrey Stafford (Director of RAL) toast the new facility. (24019)



Alan Gibson, head of the Laser Facility, looks inside the laser target vessel showing small stem supporting micro balloon target sphere. (Keystone Press)



From "Quest" (the house journal of the Science Research Council) vol 10, num 2, April 1977.

"Proposal for an SRC central laser facility for the production and study of high-density plasma," 1974. The proposal was strictly confidential at the time due to the advanced technical details it included.

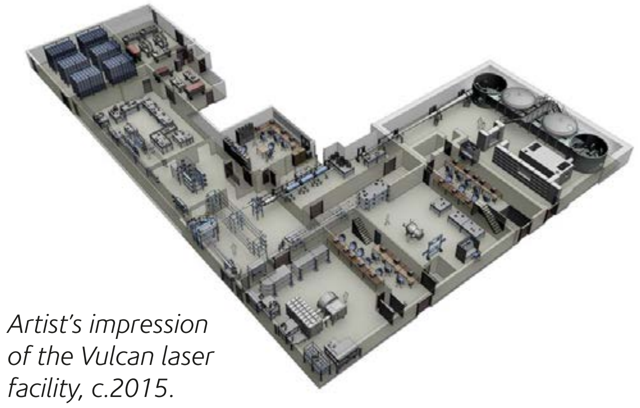
Vulcan

CLF's flagship facility, Vulcan, dates back to 1970's when it began as a relatively modest 100 Gigawatt laser (10 Joules in 100 picoseconds). A picosecond is 10^{-12} seconds so a Vulcan pulse was a piece of light 3cm long.

Over the last 40 years, Vulcan has been extensively modified and upgraded, and Target Areas have been introduced to meet the needs of the science. The first shot in the 12-beam Target Area West happened in June 1984; the first shot in the seven-beam Target Area East happened just over a year later in October 1985, and there was yet another major upgrade in 2000 to build Target Area Petawatt (TAP).

Vulcan now has a footprint equivalent to that of two Olympic-sized swimming pools. It delivers pulses of light containing up to one petawatt (10^{15} Watts) of power which can super-heat matter to millions of degrees, in a pulse that lasts only half-a-trillionth of a second, focussed down to a spot smaller than a width of a human hair. Many experiments on Vulcan attempt to recreate conditions found only in stars or planetary cores.

In 1980, Alan Gibson decided that the Nd:glass laser should be renamed something more media-friendly. Various suggestions were made including "British Universities' Neodymium Glass Laser Equipment," but the eventual choice was one in Latin proposed by Roger Evans: VULCAN (Versicolor Ultima Lux Cohaerens pro Academica Nostra) or "The latest multi-coloured coherent light for our academics."



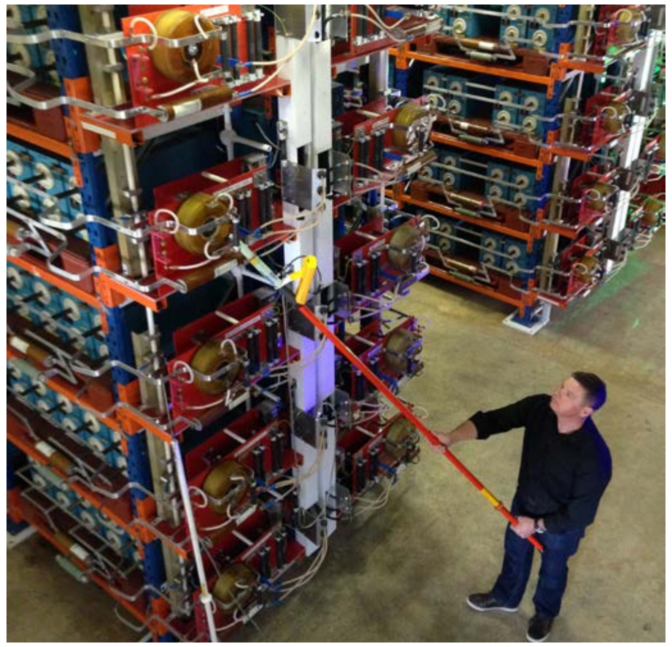
Artist's impression of the Vulcan laser facility, c.2015.

Components of the laser were delivered to the west end of R1 on 25th September 1976. (22598)

Vulcan glass rod amplifier chain housed in Laser Area 1. (22845)

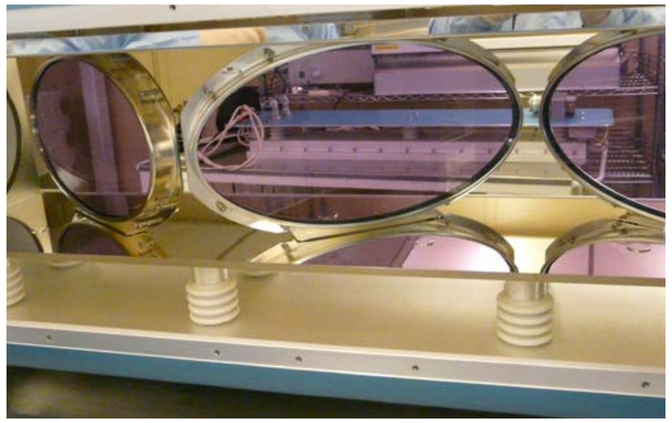
The first shot from the laser was fired on 28th April 1977. This was a two beam compression of a gas-filled micro-balloon target.

The target chamber in Target Area East. The laser light here is usually infrared, but for this experiment it has been converted to green. Specks of dust in the air mean that it is just about possible to see the path of the beam as it goes into the window of the chamber; the patterns on the ceiling are caused by interference of light coming from different windows, 1984. (84FC4554)



Mark Pitts demonstrates the voltmeter-on-a-stick used to test the Pulse Forming Network (PFN) in the Capacitor Bank Room.

Dave Pepler in the Vulcan Control Room, late 1980's/ early 1990's.



Vulcan disc amplifiers. These are arranged in a zigzag formation at Brewster's angle to the beam in order to minimise reflection losses from the surfaces. They are purple in colour because of the neodymium "doping" (contained) in the glass which converts the energy from the flash-lamps into laser light.

A picture of the "main 6" 108mm diameter amplifiers in the Vulcan Laser Area, 1983. (83FC1737)

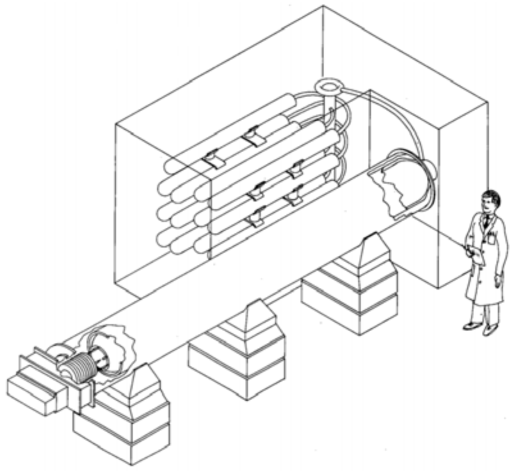
Electron-beam Laser Facility (ELF)

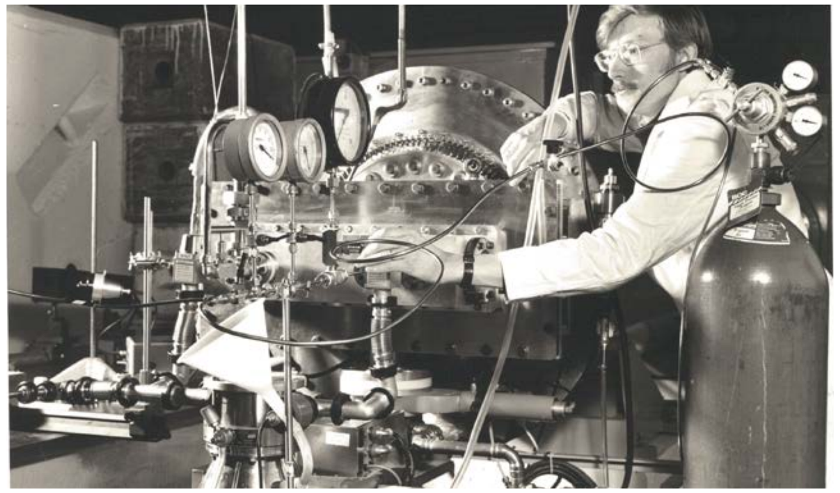
In 1978 there was a strong interest in inertial-fusion applications, and the development of high power lasers which would produce light in the necessary ultraviolet wavelengths.

The Electron-beam Laser Facility (ELF) was developed in CLF for such applications. ELF used electron beams to excite gaseous media such as krypton fluoride (KrF) to produce the laser.

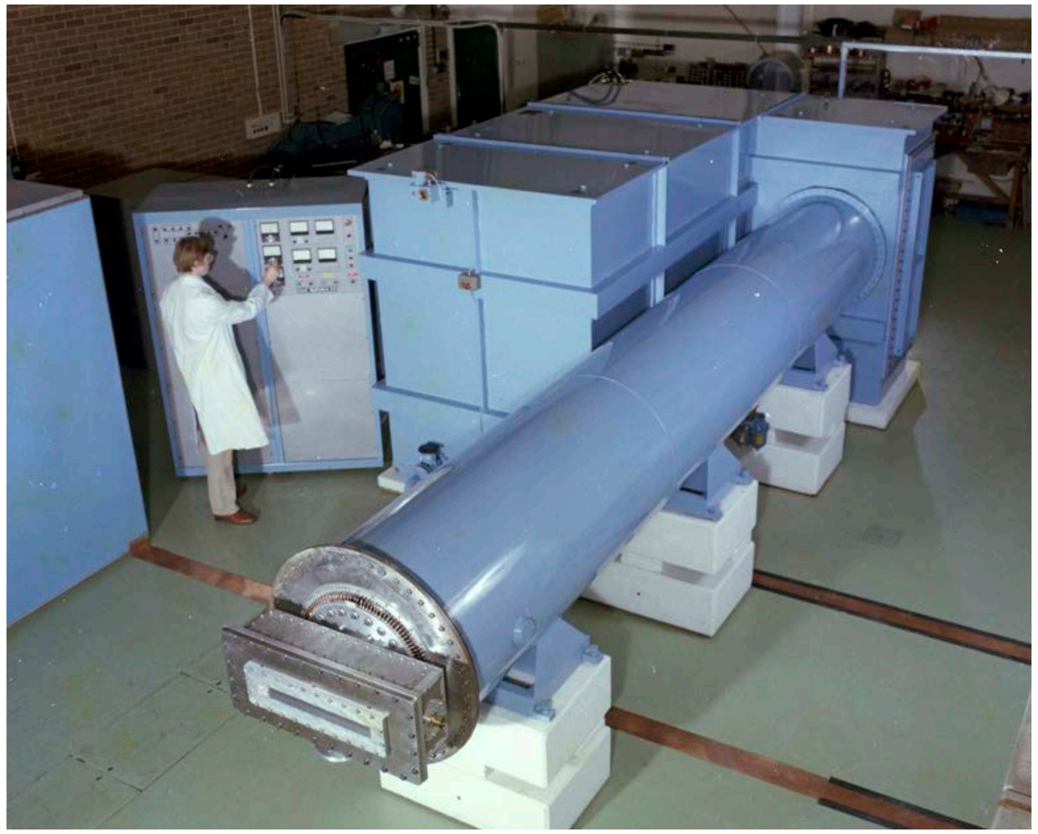
Commissioning of ELF began in November 1978. In addition to performing user experiments, ELF was used to optimise aspects of the design of its successor, SPRITE.

On Monday 12th March 1979 ELF was fully commissioned and was recorded as having a 50 nanosecond electron-beam pulse with more than 3000 Joules of energy. The electron beam itself was (5x50) cm^2 and could operate up to 1.5 MeV.





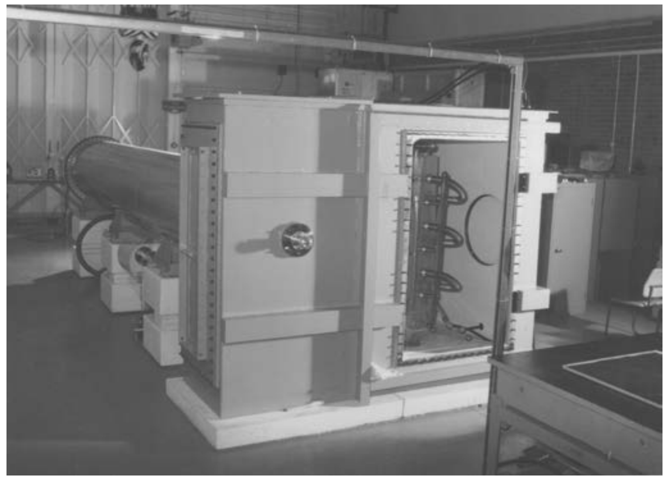
Chris Edwards adjusting the pressure of gas in the laser cell, 1979. (28656)



Chris Edwards monitoring ELF. The long blue cylinder is the Blumlein pulse-forming line (named after its inventor, the British engineer Alan Blumlein). The blue cabinet at the far end is the Marx bank generator; the silver rectangular box fastened to the end of the Blumlein is the diode chamber. The single electron beam came out through the slit window. (28255)

Marx generators

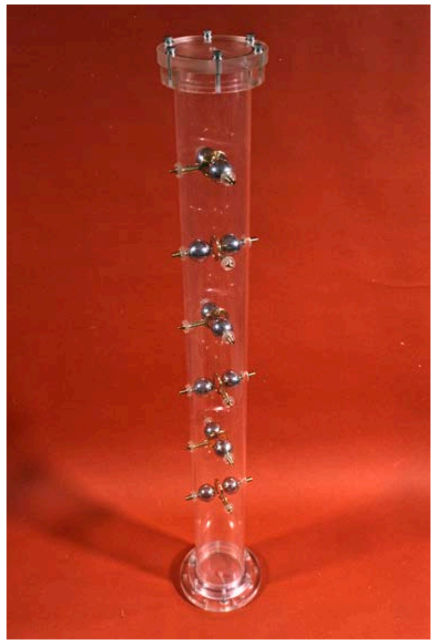
Marx generators were named after the German electrical engineer Erwin Otto Marx. They create a high-voltage pulse from a low-voltage DC supply by charging a number of capacitors in parallel, then suddenly connecting them in series. High-power lasers rely on such high-voltage generators to run flash lamps.



The ELF Marx bank with one access door in position, the other open for viewing. Note the large knob for external adjustment of the Blumlein switch spacing, 1978. (26220)

End view of a Marx bank generator with the access panel removed, showing spark-gap column and charging resistor tubes filled with a turquoise copper sulphate solution, 1978. (27812)

This photo is of the tank before it was filled with a very unpleasant brown mineral oil used as an insulator. Once the oil had been added you had to be very careful not to drop anything into the tank as it was almost impossible to retrieve it, and almost impossible to wash the smell of oil out of your clothes. The engineers used only steel tools so that if something did drop in, it could be fished-out using a magnet on the end of a string.

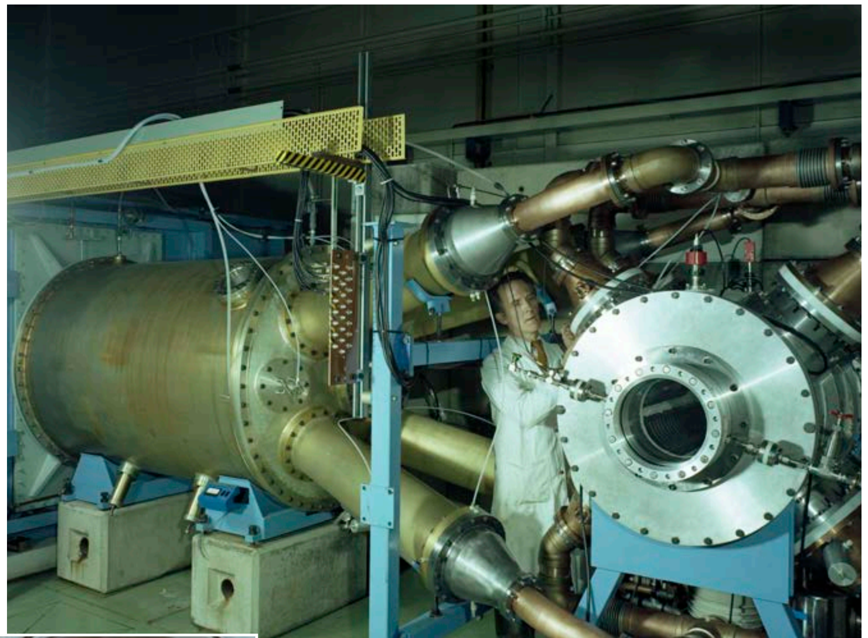


A studio portrait of a Marx spark-gap column; in reality this was about 1.5m in height. The pairs of stainless steel electrodes are the switches that connect the Marx capacitors when the machine is fired. (27554)

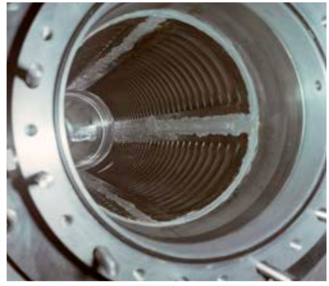
1982 to 1995

Sprite

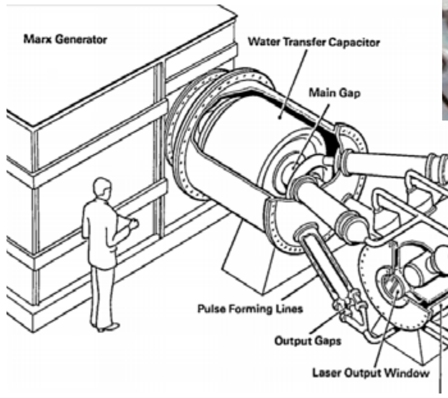
Sprite was an e-beam-pumped krypton fluoride (KrF) laser, the successor to the ELF machine. It began operations in May 1982, when the first experiments were on phase conjugation with RGH (Rare-Gas Halide) lasers. By 1983, it was the most powerful operational KrF laser in the world, and in 1984 the world's first high-power KrF laser to be used for the irradiation of targets.



Dave Wood examines the barrel-shaped Sprite water capacitor connected to the four pulse forming lines, 1982. (82FC1672)



The interior of the Sprite pressure cell. The electron beams entered the cell through four "windows" of titanium metal foil cemented inside slots in a stainless steel tube. The slots were bridged by ribs to prevent the foil being pushed into the vacuum outside by the pressure of the laser gases (krypton, fluorine and helium) inside the cell, 1982. (82RC1687)

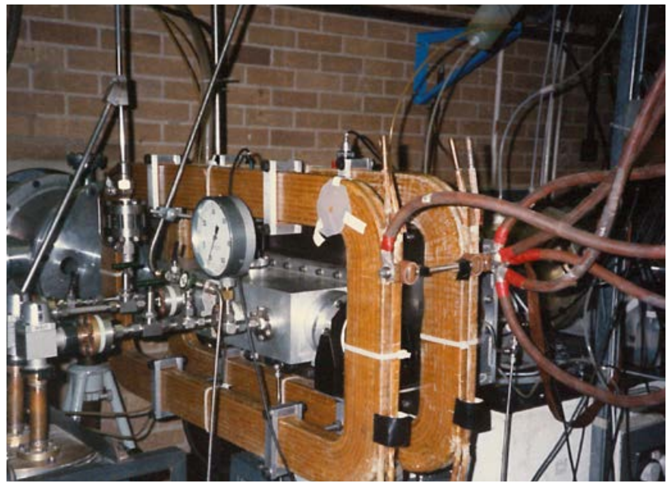


The titanium foils in the Sprite cell gave four years of service and survived 9700 shots before being replaced in July 1994.

Raman amplifier in the Sprite multiplexing room.

Chris Hooker adjusting the Raman amplifier in the Sprite multiplexing room. The green pipe behind Chris transports the laser beams into and out of the Sprite laser cell on the other side of the wall, 1988. (88FC3341)

Following a safety tour, the comment was made that "The mirrors on blue stands should be stored more neatly." Clearly someone had not realised that the stands were part of the optical system of the laser, and that they had been positioned with millimetre precision.



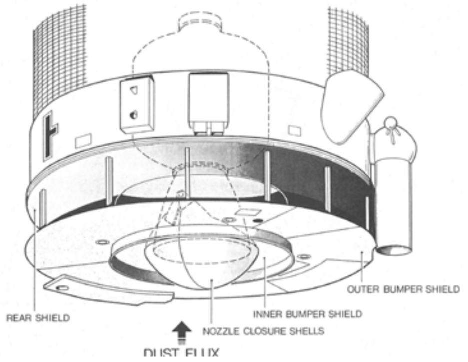
Sprite used an e-beam pumped KrF pre-amplifier laser system named Goblin. This was behind a brick wall in a rather inaccessible part of the laboratory so this is the only photo we can find.

The Goblin laser cell and gas pipework. The rectangular orange loops are magnetic coils needed to shape the electron beam. Laser pulses travelled from the multiplexer room down the pipe emerging through the wall, through the laser cell, then back via the same route.

Sprite's last shot was fired by Paul Williams in a small ceremony on 31st March 1995; it was then re-purposed as part of the amplifier section of a new laser called Titania.

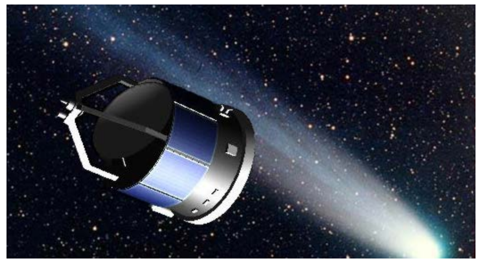
1993 to 1995 Sprite's mission in the study of Halley's Comet

The Dust Impact Detection SYstem (DIDSY) on the Giotto spacecraft was designed both to protect it from impacts of cometary dust particles moving at around 60,000 mph, and to measure the number and sizes of those impacts as the probe flew through the tail of Halley's comet.



The DIDSY instrument was tested and calibrated in various ways, one of which was by firing pulsed laser beams at the dust shield. The energy and duration of a laser shot were similar to those of a small dust particle impacting the shield.

The ESA spacecraft Giotto was launched in July 1995 on a mission to fly past Halley's Comet, which it encountered on 13th March 1986. The Sprite laser was used for calibrating some instruments on board Giotto.



Artist's rendering of European Giotto spacecraft approaching Halley's comet. Photo credit: Andrzej Mirecki - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5265223.

Laser Support Facility / Lasers *for* Science Facility (LSF)

The Ultra Violet Radiation Facility (UVRF) was set up in April 1982 to provide laser expertise to non-laser experts in chemistry and biological research. By 1984 it had become so successful that, in response to the requirements of universities, the Laser Support Facility (LSF) was announced. This incorporated various laboratories, and introduced the Laser Loan Pool (LLP) whereby universities could borrow lasers for use at their own institutes.

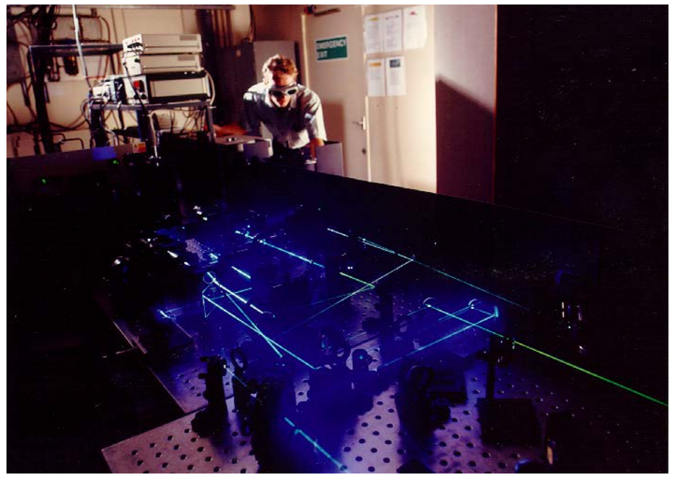
The LSF laboratories were housed along the ground floor corridor of R1 and were initially intended for picosecond, nanosecond and X-ray research. The use and names of the laboratories changed significantly over the years however as the programme of work altered. In the 1990s two new laboratories were added: the Femtosecond Laboratory (later moved to R7 to become the Astra laser facility) and the X-ray Laboratory.

By 2003 the LSF comprised a world-leading Time-Resolved Resonance Raman (TR^3) Spectroscopy Facility, the Picosecond Infra-Red Absoption and Transient Excitation (PIRATE) project, the Laser Microscopy Laboratory, the Laser Tweezers Facility, and the Laser Loan Pool.

Jan Szechi in the Nanosecond Laboratory, 1985. (85FC5159)

Tony Parker setting up a copper-vapour laser in the Time-Resolved Resonance Raman (TR^3) facility, 1992. (92RC3455)

The Picosecond Laboratory later became the Ultrafast Spectroscopy Laboratory, with the first experiments scheduled in 1996.



Phil Taday building the dual Optical Parametric Amplifier (OPA) facility in the Ultrafast Spectroscopy Laboratory in collaboration with Pavel Matousek and Mike Towrie.

The OPA facility was based on solid-state technology which allowed higher peak-powers and greater tuneability than other types of laser. At lower energies, it could be used to initiate reactions in biological samples without damaging them. This was a world first – lasers had not been used in this way before.

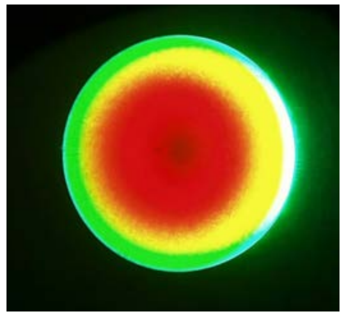
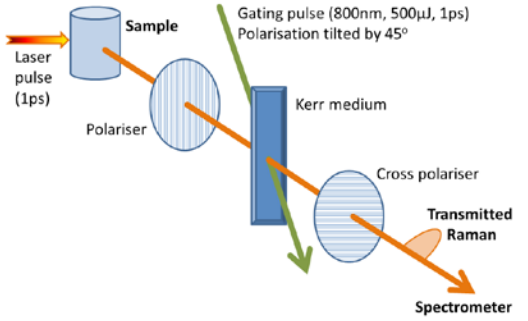


Image generated by an OPA laser in the 1990's. This light pulse is only 100 femtoseconds long (a femtosecond is 10^{-15} seconds) so can capture snapshots of molecular reactions as they occur.



In 1993 the TR^3 Spectroscopy Facility was enhanced by the introduction of an optical technique known as the Kerr gated Raman collection system. The Kerr medium acts as an optical shutter, and enabled scientists to observe for the first time very faint Raman signals emitted by samples which would otherwise have been swamped by the much stronger fluorescence signals.

Ultrafast Laboratory facilities were used during the RAL Open Days in 1998 to "print" visitor's names in the middle of blocks of Perspex using a femtosecond laser linked to a Hewlett-Packard plotter. These little souvenirs were very popular, and demonstrated the precision of the laser beam.

Based on an idea by Malcolm Higgins, a novel use of lasers was pioneered by Tony Parker and colleagues in 2000 in an attempt to solve Railtrack's leaves-on-the-line problem. A laser was used to ablate (burn-off) leaves from a 20mm strip on each rail. A company – LaserThor – was set up, and trials started in 2000. Work is continuing in the Netherlands.

This photo shows a section of rail track; the white spots are laser marks, and the dark patches residue of leaf ablation.

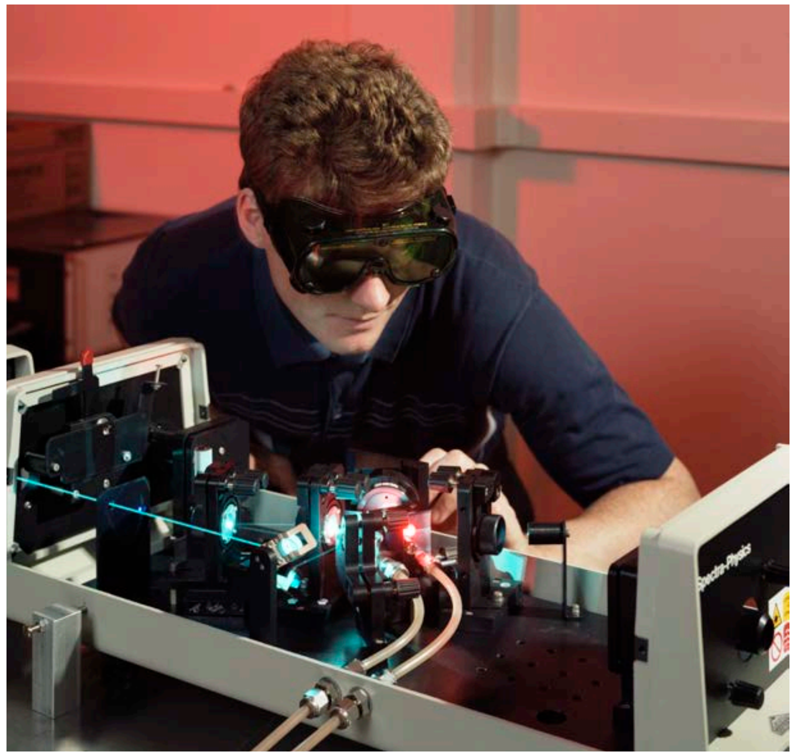
In 1995, LSF was rebranded as the "Lasers *for* Science Facility" to reflect its mission to enhance the use of lasers throughout all scientific disciplines, and in 2009/2010 it moved home from the by now rather cramped ground floor of R1 into purpose-built facilities in the Research Complex at Harwell (RCaH).

Laser Loan Pool (LLP)

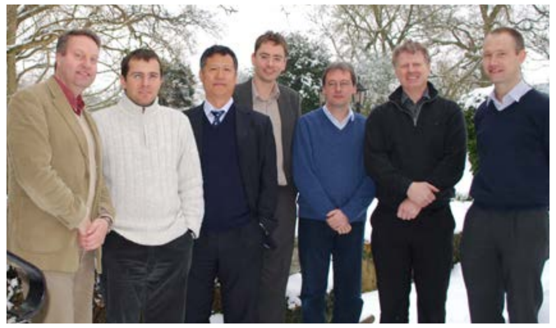
Demand for time on the Ultra Violet Radiation Facility (UVRF) began to exceed time available so in 1984 a Laser Support Facility (LSF) was announced. One of the functions of LSF was to run the Laser Loan Pool (LLP).

The Laser Loan Pool officially began on 1st May 1985. It was funded by EPSRC, operated a range of state-of-the-art excimer and dye lasers, and provided national support for a wide range of research programmes in chemistry, physics, life science, materials and engineering. The lasers were "moved to the unmovable" and loaned to UK academics for use in their home institutions for periods of up to three (later extended to six) months.

By the time of its closure in 2016, the Laser Loan Pool had supported 76 departments in 49 institutes across the UK and Europe, including Diamond Light Source and CERN. (The researchers were from the UK, but the lasers could be taken elsewhere.)



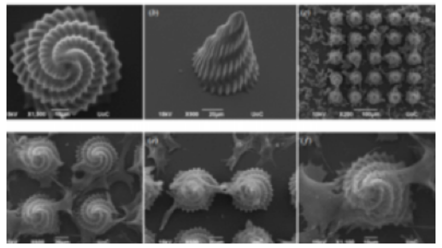
Mike Towrie working on the CW titanium sapphire (TiS) laser belonging to the Laser Loan Pool, 1990. (90FC3753)



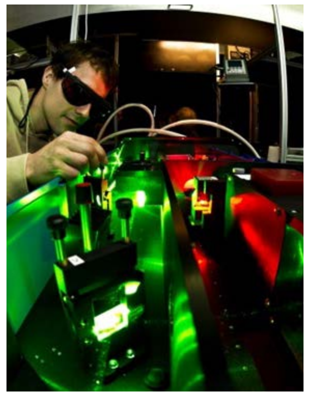
The Laser Loan Pool steering committee at the January meeting in Cosener's House, Abingdon, January 2010.

From left to right, Tony Parker (CLF), Pavlos Lagoudakis (University of Southampton), Lin Li (University of Manchester), Andrew Hudson (University of Sheffield), Michael Hippler (University of Sheffield), Mike Towrie (CLF) and Ian Clark (CLF).

Laser Loan Pool dye lasers on the Cinétique de Réaction en Ecoulement Supersonique Uniforme (CRESU) apparatus at Birmingham University, 1998. It was expected that molecules would become dormant when cooled to 15 degrees Kelvin. This experiment demonstrated that this was not actually the case, and therefore that it was theoretically possible for water on meteors in space to perform chemical reactions.



Sheffield University used a Loan Pool laser to create 3D nanometre-scale biocompatible structures for tissue scaffolds, 2011.



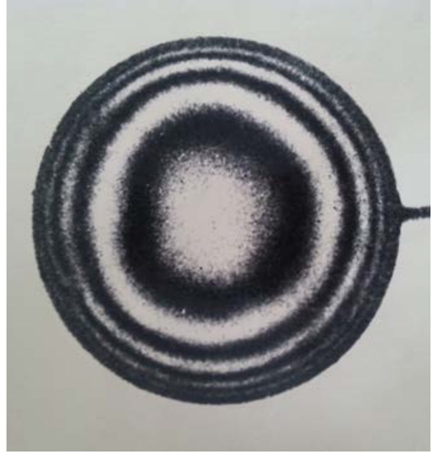
In 2011 one of the Laser Loan Pool's systems was taken to CERN to support the research of Kieren Flanagan who was looking at ways to improve the design of the Isotope Separator On Line Detector (ISOLDE) beam line.

Target Preparation Laboratory

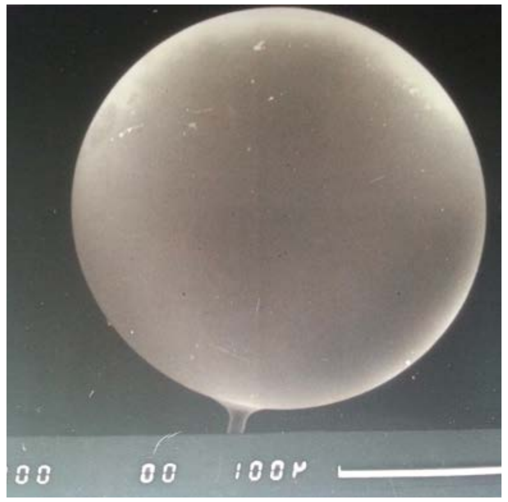
The Thin Film Coating Laboratory, 1982. Cyril Brown is leaning on the low-particulate wooden cabinets, while Beryl Child is just seen on the left through the viewing window to the Target Preparation Microassembly Laboratory, 1982. (82FC2223)

From the beginning, CLF had a Target Preparation Laboratory which made micro-targets for use on laser experiments.

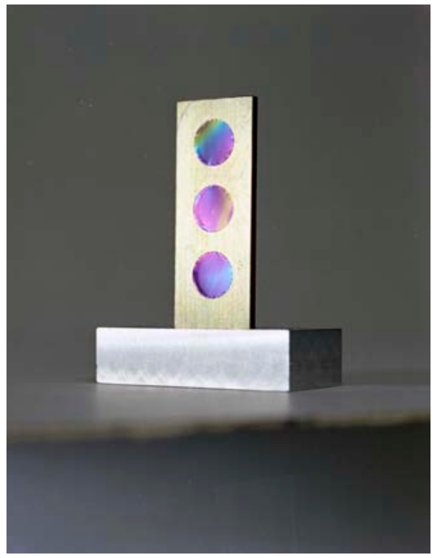
Until the early 1980s, the majority of targets used were spherical hollow glass spheres typically 50-300μm in diameter, with a glass wall thickness of about 1μm. The spheres were usually filled with an inert gas such as neon or argon.



To be useable in experiments, the targets had to be absolutely spherical, have a smooth surface finish and uniform wall thickness. Quality was verified by examining the fringe pattern on an interference microscope, such as the one seen here.



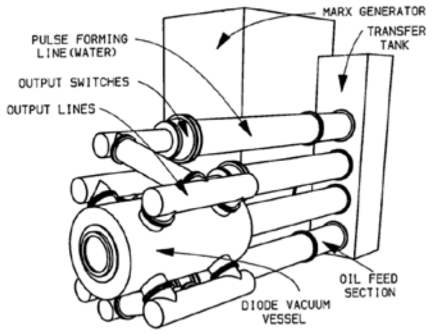
Glass shell micro-target glued to carbon fibre.



Formvar (a type of plastic) foils on a three-target holder. Even in the early days, thin foil targets were in demand although not in the quantities required for microspheres. (23199)

Titania

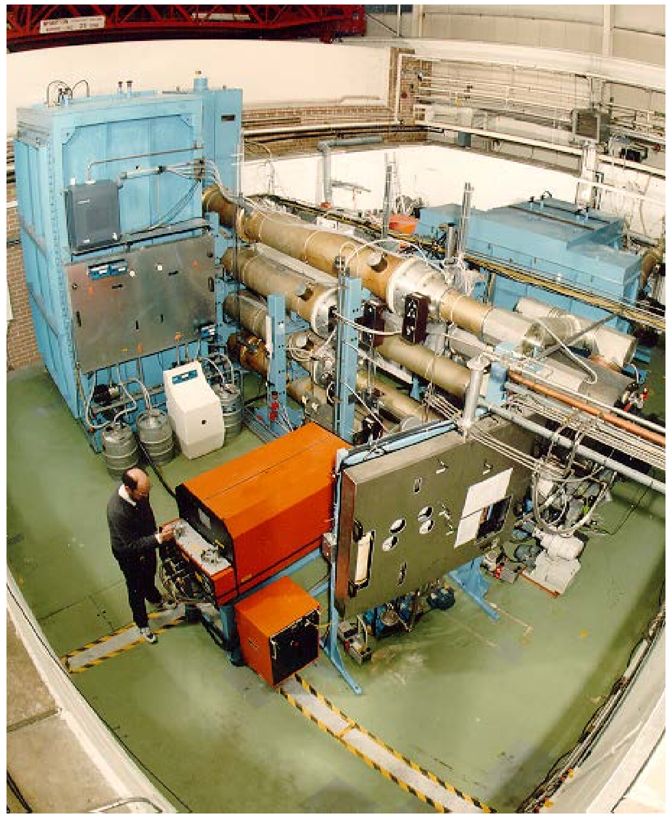
Titania succeeded the Sprite laser and was designed to produce higher brightness than any other laser in the UV range. In its short-pulse mode, Titania produced the highest brightness and shortest pulse of any high-power laser in the world.



The inauguration of Titania as a facility was on Tuesday 2nd April 1996. Mike Key (Director of the facility) said a few words, then Paul Williams (CEO of CCLRC) was handed the keypad and given specific instructions as to which button to push – "Not the red one!" There was a 30-second charging sequence then… nothing. They tried again a couple of times without success, and finally decided to take the visitors on a tour of the facility while the technicians sorted everything out. After a reboot of the control system, they did successfully fire a shot and BBC Radio Oxford went home with their story.

Titania module under assembly in R7. In the photograph are (from left to right) John Govans, Sally-Ann Brind, Dave Wood and Andy Frackiewicz. The red velvet of the electron emitters is just visible.

Sally-Ann Brind looking down the barrel of the vacuum vessel. The red panels are the cathodes of the electron guns, and are made of actual velvet, which acts as a good electron emitter because its fine hairs enhance the electric field, 1994. (94RC2911)



Graeme Hirst in the Titania laser bay in R2 adjusting the trigger laser. The orange box was a small KrF laser, the beam of which was used to trigger spark-gaps for switching the high-voltage pulses in the Titania machine. The tall blue cabinet at the back is a Marx bank.

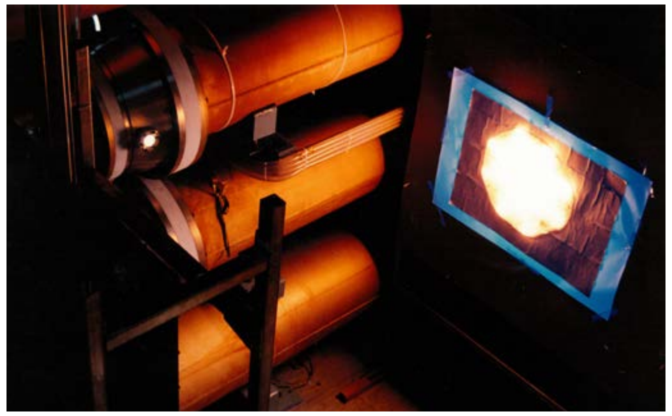
In a flight of Shakespearean whimsy, Titania's control system was called Cobweb. Its 20,000 lines of code were written in Turbo Pascal, and ran on Viglen PCs using "RAM drive" messaging. Up to 100 separate data items, or 1Mb of data, were recorded on each shot; these were then stored in a relational database.

In June, shortly after the first burn shot was taken, the chamber was flooded with sulphur hexafluoride (SF_6) as part of a test to measure electron beam energy. The Titania team knew that the chamber was lined with titanium foil; unfortunately they did not know that titanium burns in SF_6. They took a few shots then sat back to discuss the data.

Luckily someone happened to glance at the camera feed from the chamber. "It's on fire!"

The gas was quickly vented, but it took the team several weeks to determine the safest way of dealing with the gas, and how to wash out the cell with dilute sodium hydroxide solution to remove the titanium tetrafluoride (TiF_4) formed in the fire.

Peter Norreys examines the Titania target chamber.



The first laser burn shot from Titania, 1994. The beam from the laser struck pieces of chart-recorder paper taped to a sheet of card, blackening the coating to show the beam profile 42cm in diameter. This shot was at relatively low power, but the bang it made was probably heard in the next building. (94MC6151)

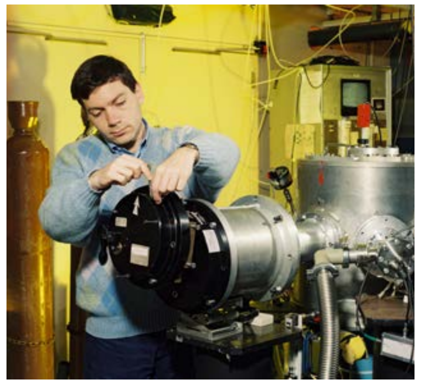
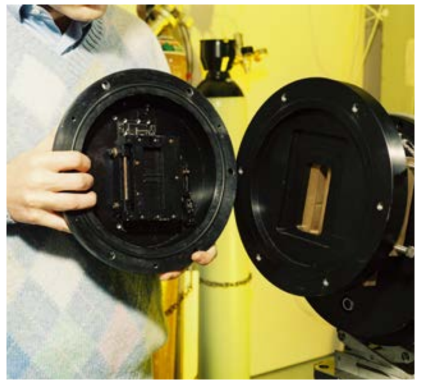
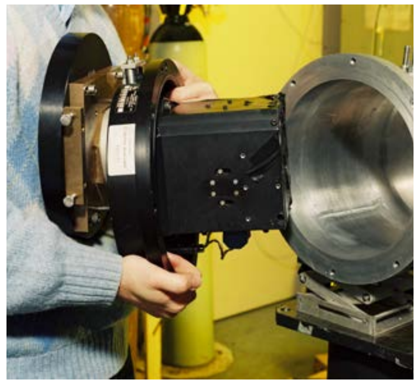
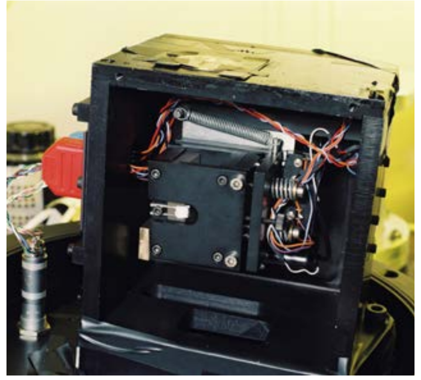
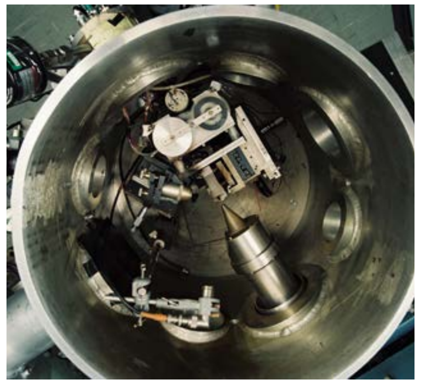
Commemorating the first burn on Titania are (back row) Andy Kidd, Graeme Hirst, Steve Angood, Mick Shaw (Group Leader), Chris Hooker, Bill Lester, Harry Medhurst, (front row) Andy Visser, John Stapleton, and James Lister, 1994. (94RC6153)

X-ray Laboratory

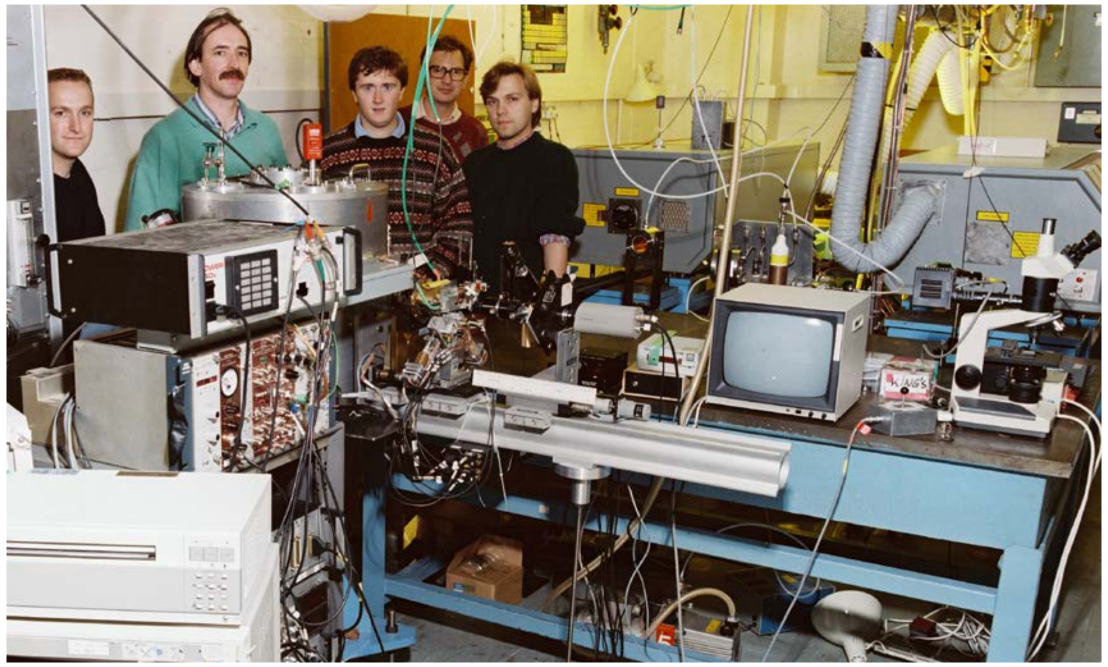
The X-ray Laboratory was originally part of the Laser Support Facility's nanosecond laser research program, and was set up in 1993 to further develop laser-plasma experiments performed on Sprite.

Krypton fluoride pumped dye lasers were used to produce the X-rays. Typical applications included DNA damage and repair studies, X-ray microscopy for biological cells, and nano-lithography of electronic devices (the University of Birmingham, in collaboration with the Space Science Department and the Central Microstructure Facility).

The facility was closed down in 2002.

Alexandro Nottolo opening the off-axis spectrometer, late 1990s.



The X-ray Laboratory, c.1995. Edmund Turcu (X-ray Lab Manager, second from right), Prof Alan Michette (King's College London, second from left), and PhD students during an experiment to develop an X-ray microscope for live biological cells in water.

Astra

Astra was an ultrashort pulse Chirped-Pulse Amplification (CPA) laser using titanium-doped sapphire (TiS) as its gain medium. It was built to take advantage of the new CPA technique and to ensure that CLF was at the forefront of short-pulse plasma physics.

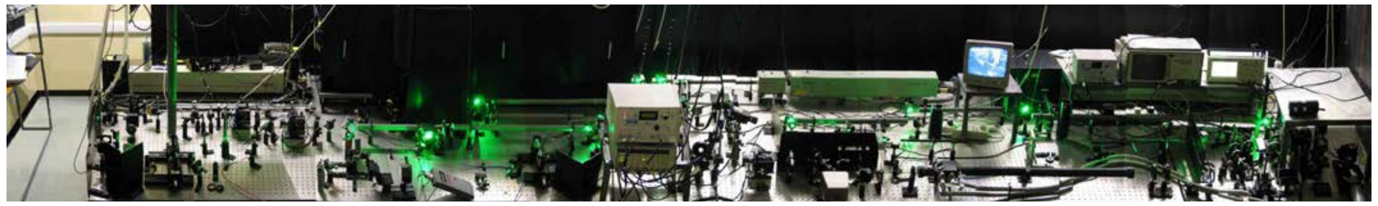
Two target areas were in operation: one used for experiments on photo-physics and photo-chemistry, the other for generating high harmonics and experiments on electron acceleration.

In 2007, Astra was upgraded to become the front-end of the Gemini laser.

Titanium-doped sapphire (TiS) crystal, the heart of Astra's third amplifier.

Chris Hooker (leaning) and Edwin Divall (standing) discussing the alignment of Astra amplifier 1 in Laser Area 1, March 2006.

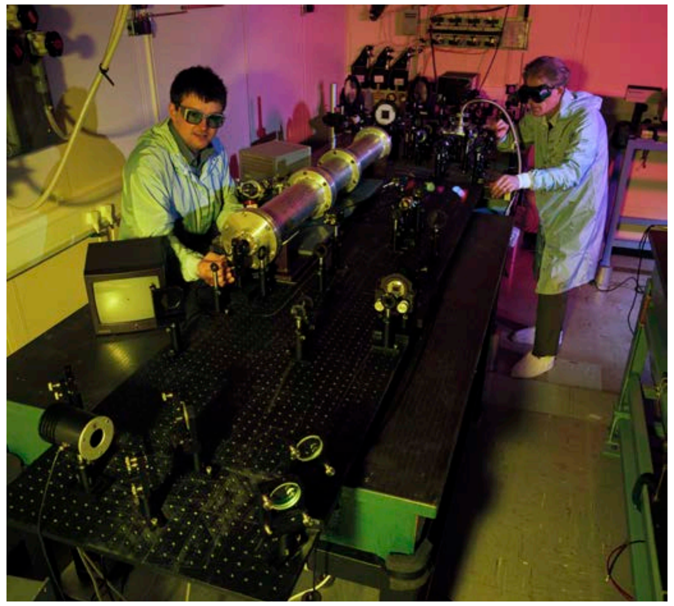
The Astra team in the Control Room, December 2004. Back row: Edwin Divall, Edmund Turcu, Andrew Langley. Middle row: Jodie Smith, Peta Foster. Front row: Klaus Ertel, John Collier, Chris Hooker, Oleg Chekhlov.



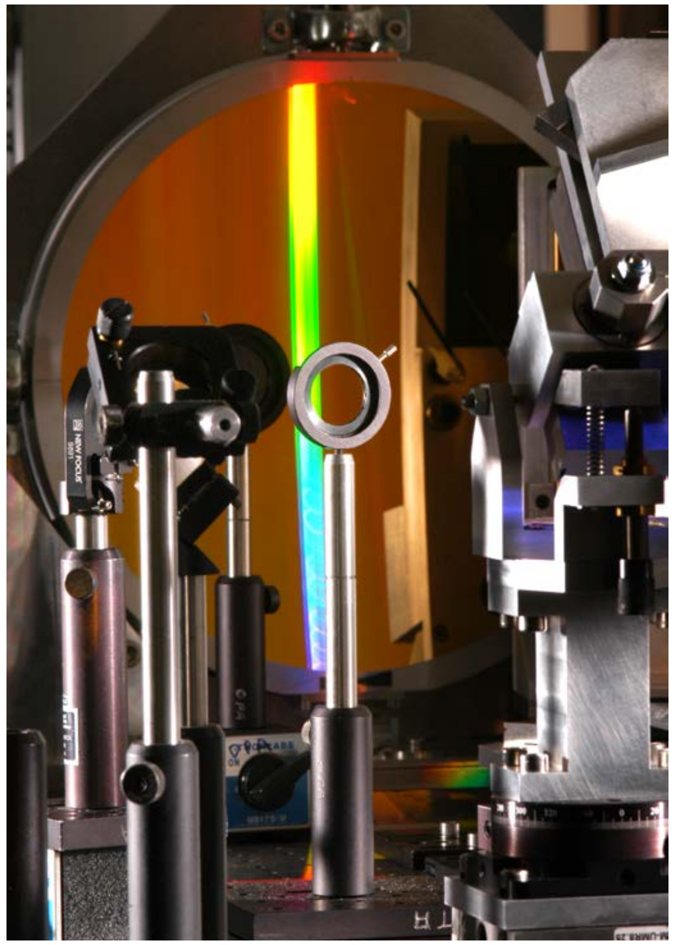
Panorama of (from left to right) Astra Amplifiers 1 and 2.

Optical Parametric Chirped Pulse Amplification (OPCPA)

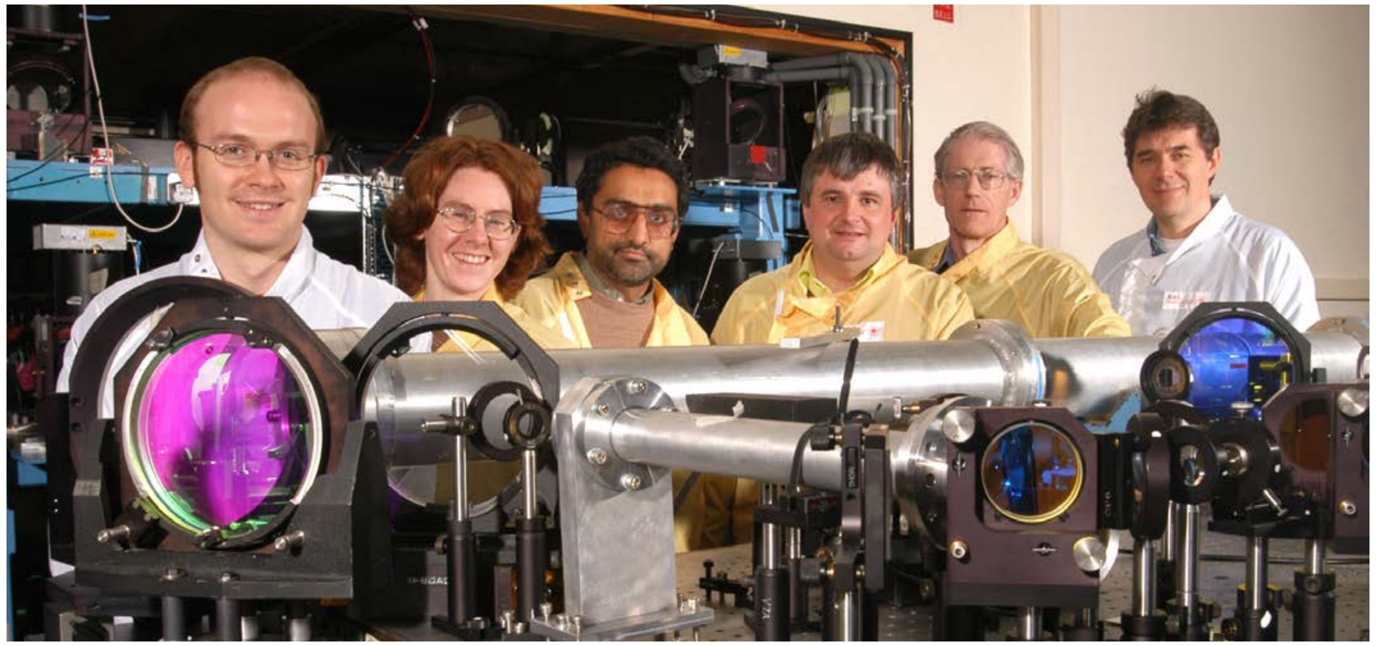
CLF pioneered the development of Optical Parametric Chirped Pulse Amplification (OPCPA), using amplifier crystals to transfer energy from a pump laser to amplify the main pulse. There was a programme of small-scale tests in Vulcan. The system was then installed in the amplifier section of the laser where it increased power output by an order of magnitude, and was a successful proof-of-concept for the next generation of the laser facility.



John Collier and Ian Ross aligning an OPCPA test system, 1999. (99RC1329)



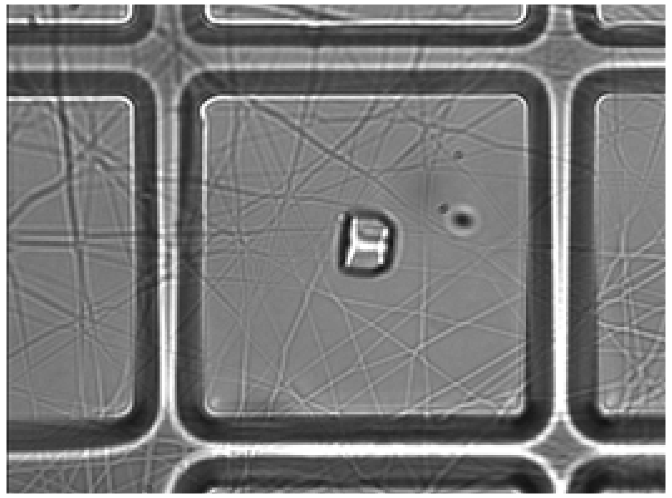
An optical pulse stretcher, part of the OPCPA system in Vulcan Target Area East, 2004. (04EC2048)



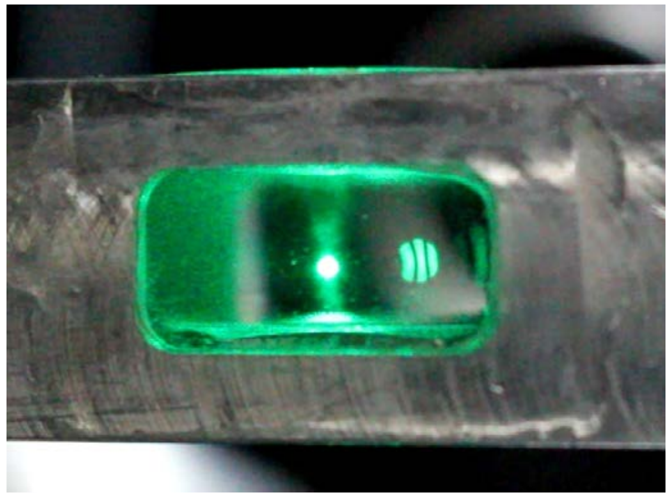
The OPCPA test system installed in Vulcan Target Area East, 2004. In the photo are Phil Bates, Margaret Notley, Waseem Shaikh, John Collier, Ian Ross and Oleg Chekhlov. (04EC2052)

Laser tweezers

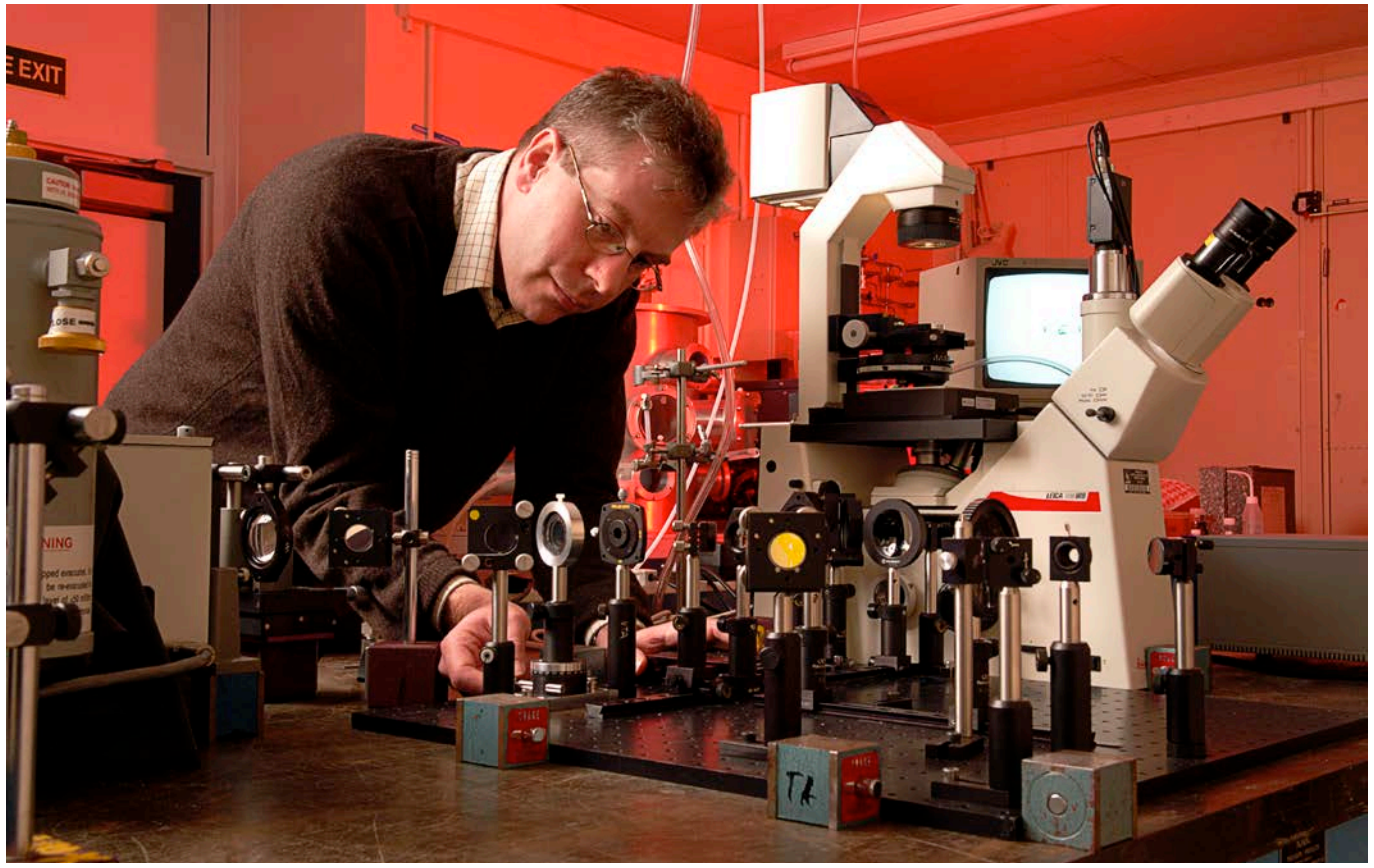
A project with ICI investigated colloid science (ie. paint!). ICI wanted to measure particle-particle forces in order to calculate how long they needed to stir colourant into paint to ensure it was homogenous. This led to a new method of optical trapping, or "tweezers," whereby (more usually) biological objects such as single living cells could be held and manipulated to assist study in microscopic detail.



Laser tweezers loading micron-sized protein crystals on micro-meshes covered with a spider's-web of electro-spun fibres, 2013. This work was done in collaboration with Diamond Light Source.



Trapping microscopic airborne particles for respiratory therapy and atmospheric chemistry studies, 2016.



Andy Ward with the Raman Tweezers kit in the LSF nanosecond laboratory, 2005. (05EC1418)

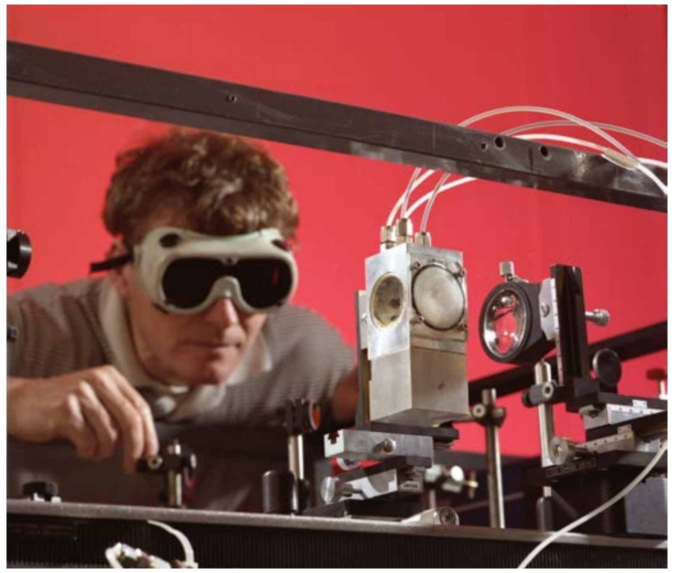
The Picosecond Infra-Red Absoption and Transient Excitation (PIRATE) project

In February 1999 the EPSRC funded the Picosecond Infrared Absorption and Transient Excitation project (PIRATE). This exploited developments in solid-state laser technology and used two independently tuneable beams to enable visualisation of short timescale molecular dynamics. It was used for experiments in chemistry, physics, biological and material sciences.

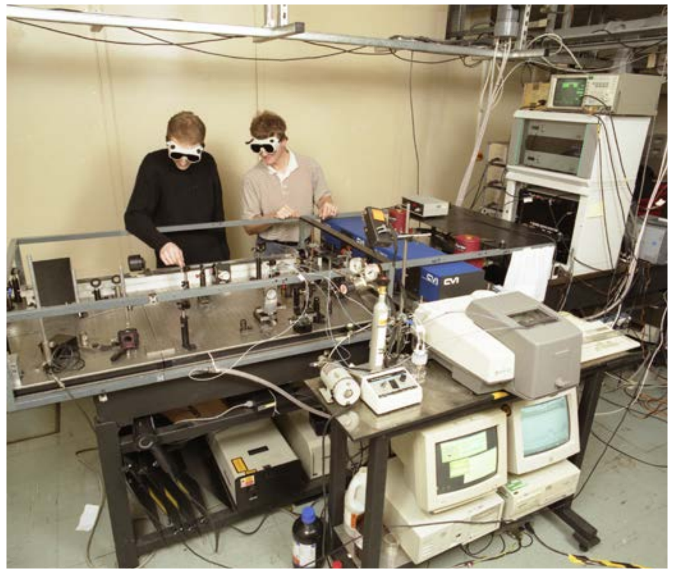
Some parts of the PIRATE hardware have now been incorporated into the ULTRA facility.

The beginnings of PIRATE at the 9th Time-Resolved Vibrational Spectroscopy Conference in Tucson, Arizona in 1999. From left to right: Mike Towrie, Pavel Matousek, Mike George, Tony Parker and David Grills.

Editor's note: This is the photo the team chose. It will not surprise you to learn that the project logo is Captain Pugwash as depicted in the books by John Ryan – it was that sort of project…



Mike Towrie lining-up PIRATE, 2000. (00RC5377)



David Grills and Mike Towrie setting up the first experiment on PIRATE, 2000. (00RC5372)

Upgrading Vulcan with Target Area Petawatt (TAP)

To meet the needs of experiments requiring faster particle acceleration and higher energies, and to maintain its international position, Vulcan was upgraded in 2000 from 100 terawatts (a terawatt is 10^{12} Watts) to one petawatt (10^{15} Watts). The name of the new Target Area is Target Area Petawatt (TAP).

The TAP compression chamber weighs 71 tons and consists of three sections: two cylindrical vessels each holding one of the 1m aperture pulse compression gratings, connected by a 13m centre section which transports the beam under vacuum between the gratings.

Ground work begins outside R1, digging up what used to be the Director's car park. The new building was approximately 21.5m x 24.5m in size, consisting of a brick faced external skin, 30 cm thick concrete radiation shielding walls, and an aluminium skin roof.

Finished Vulcan Petawatt building, 2001. (01RC1105)

Three-section compression chamber. The "shipping container" target chamber (right) is made of 125 mm thick mild steel, is 5m x 3m x 2m in size, and weighs 60 tons. It is now surrounded by 100 tons of lead (about half of which was supplied by the ISIS facility), 50 tons of concrete, and 20mm thick aluminium plates, 2002. (02EC1630)

TAP was formally opened on 10th April 2002 by Prof David King FRS, Chief Scientific Advisor to the UK. In the photo are Chris Edwards, Henry Hutchinson, Prof King and John Wood (CEO of CCLRC). (02EC1864)

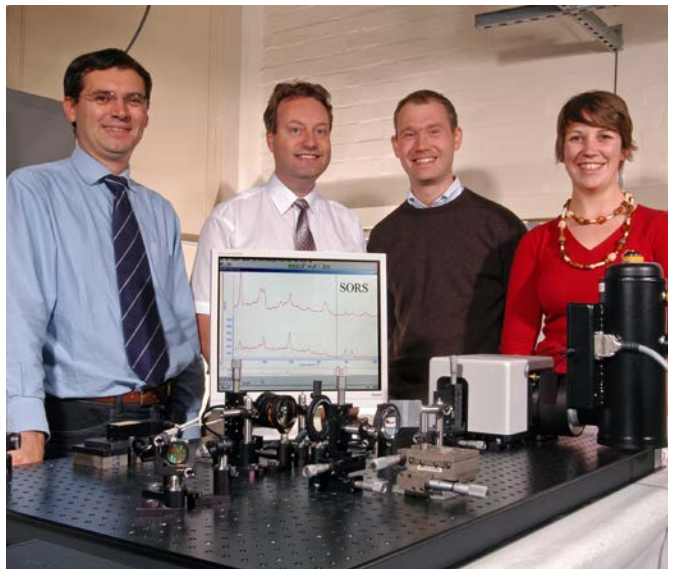
Vulcan made it into the Guinness book of records in both 2004 and 2005. Accepting the award from David Hawksett (Science Editor, GWR) are Henry Hutchinson (Director of CLF), and Colin Danson (Vulcan Group Leader). (04EC1845)

The certificate and a copy of the book still take pride of place in the Vulcan Control Room.

Spatially Offset Raman Spectroscopy (SORS)

Spatially Offset Raman Spectroscopy (SORS) is a non-destructive technique developed in the LSF Ultrafast Laboratory to determine the chemical composition of an object under an obscuring surface such as paint, skin or plastic. By shining a laser at the surface of a material and observing the colour of light scattered away from the point of illumination, scientists can determine the chemical composition of the material underneath the surface.

Cobalt Light Systems Ltd received the Queen's Award for Enterprise in 2015, and the Royal Academy of Engineering's MacRobert Award in 2014.



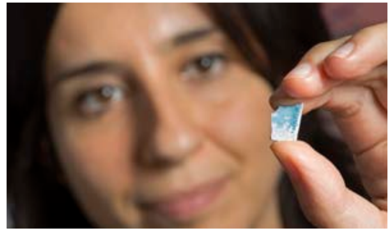
The initial SORS group: Pavel Matousek, Tony Parker, Ian Clark and Kate Ronayne, 2005. (05EC3728)

Work on SORS techniques has led to the development of the Insight100 machine, a bottled liquid screener for use in airports. This was developed and marketed by an STFC spin-out company Cobalt Light Systems Ltd. There are about 400 operational units in 70 airports across Europe and Asia; Heathrow alone has over 80. It is hoped that this technology will allow the relaxation of airline restrictions on bringing liquids on board aircraft.

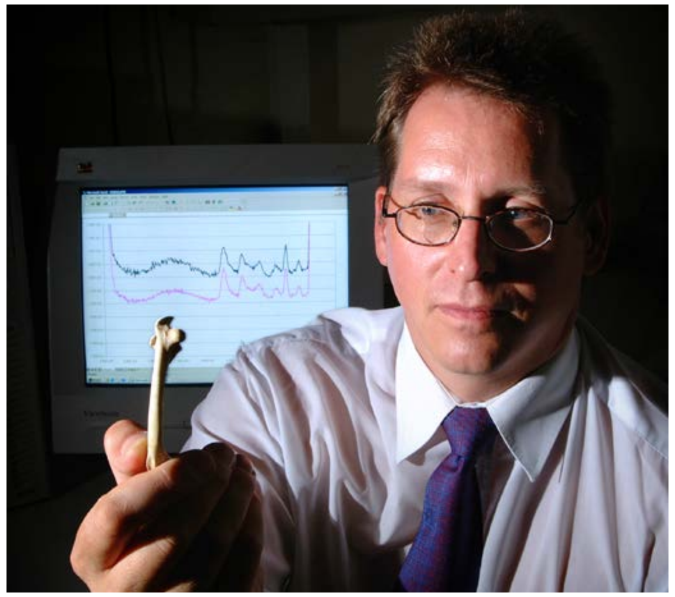
A miniaturised version of the detector (micro-SORS) is being developed for the analysis of murals and sculptures in situ. This will enable heritage conservators to assess the condition of plaster, stone, and micro-metre thick layers of paint before any conservation work is attempted.

Pavel Matousek (CLF) and Claudia Conti (Istituto per la Conservazione e la Valorizzazione dei Beni Culturali) using a piece of modern ceramic in preparation for the analysis of samples taken from murals and sculptures in Sacred Mounts, 15th and 17th century devotional chapels in Northern Italy, 2014. (14EC4401)

Polychrome stucco sculpture of Christ, Ossuccio Sacred Mount near Como, Italy; the white circle indicates the area under investigation.



Claudia Conti holds a test sample, 2014. (14EC4422)



SORS has many medical applications including the analysis of tablets inside plastic bottles or blister packs for pharmaceutical control, examining bone beneath skin for evidence of disease such as osteoporosis, and in the detection of breast and prostate cancers.

Edward Draper (Imperial College) in the Ultrafast Spectroscopy Laboratory analysing animal bones in the study of osteoporosis, 2003. (03EC2777)

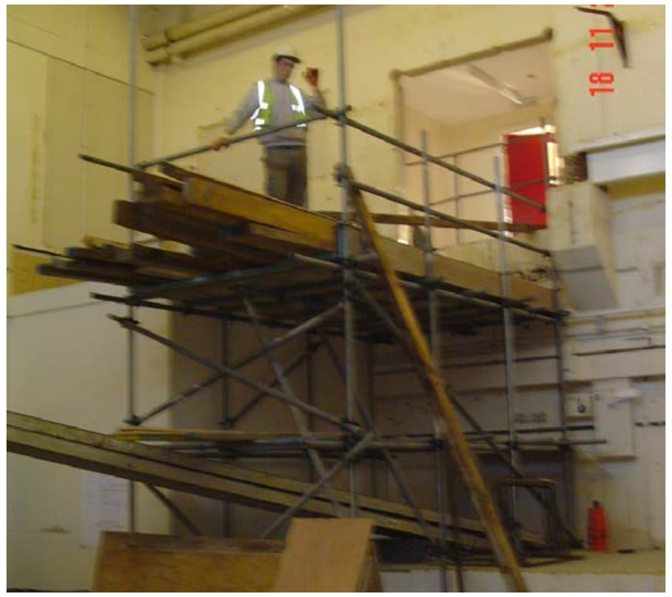
SORS can also be used to analyse the contents of bottles to determine whether they contain a harmless liquid such as milk, cosmetics or medicines, or a dangerous chemical such as acid or explosives.

Pavel Matousek demonstrating the SORS technique, 2011. (11EC2894)

Constructing the Gemini building

A three year programme to upgrade the Astra laser facility began in 2004. This was to be a two-beam laser system called Gemini.

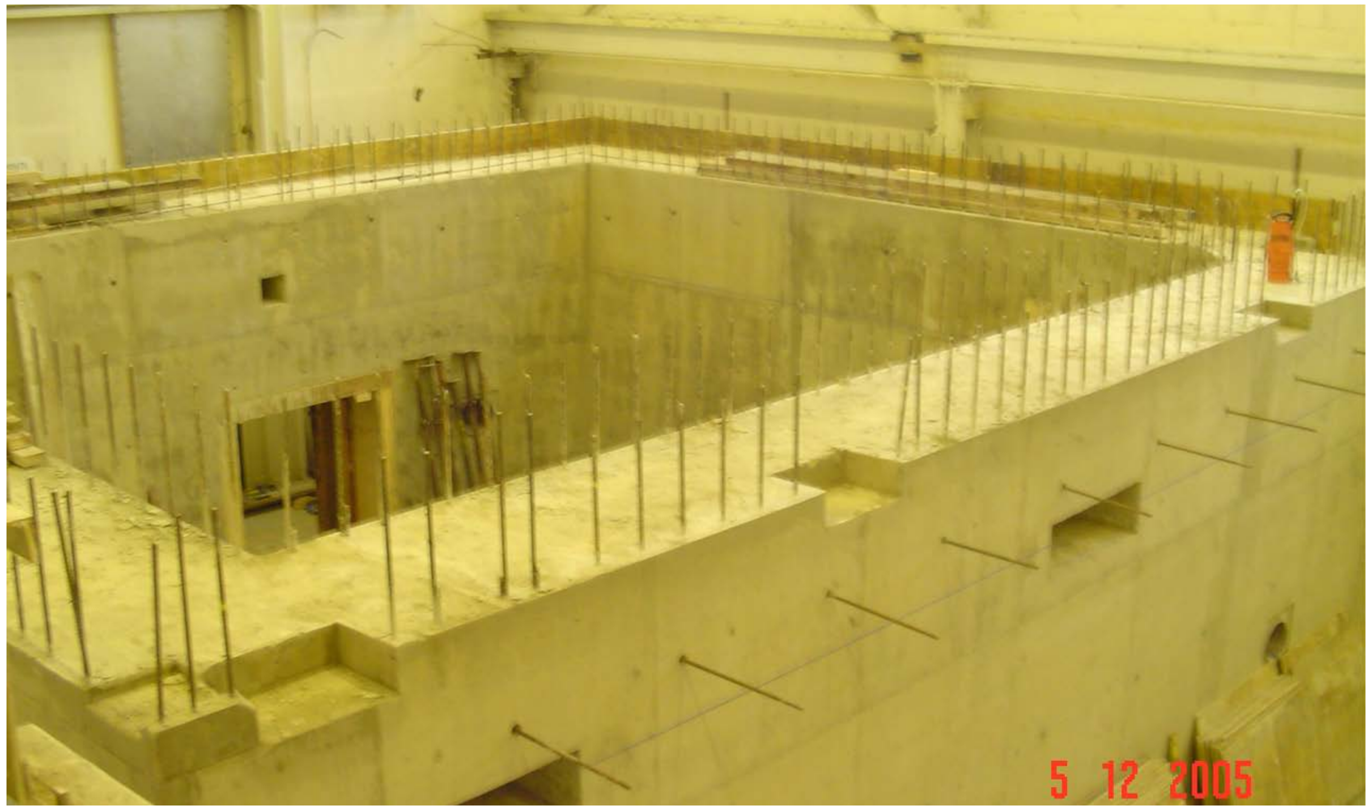
The building in which Astra was housed required modification to accommodate a new Target Area (TA3) and associated Control Room, a new Laser Area (LA3) directly above the TA3 bunker, and to convert the old Titania Target Area Control Room into what is now the Services Area.



Build-up of shuttering for the TA3 bunker. The doorway hanging in mid-air is the door into Laser Area 3.

Service tunnel looking west towards ISIS, June 2005.

The photos used here are taken from the engineering operational logs.

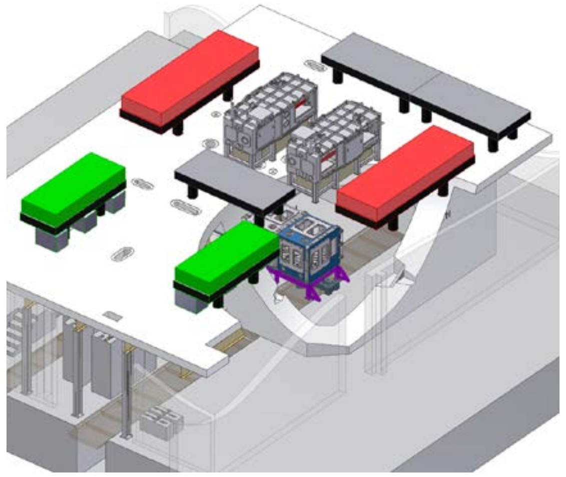


Target Area 3 bunker from the south east corner showing the metre-thick concrete walls, December 2005. The roof of TA3/floor of LA3 has yet to be added so you can see the entrance door to the bunker.

Gemini

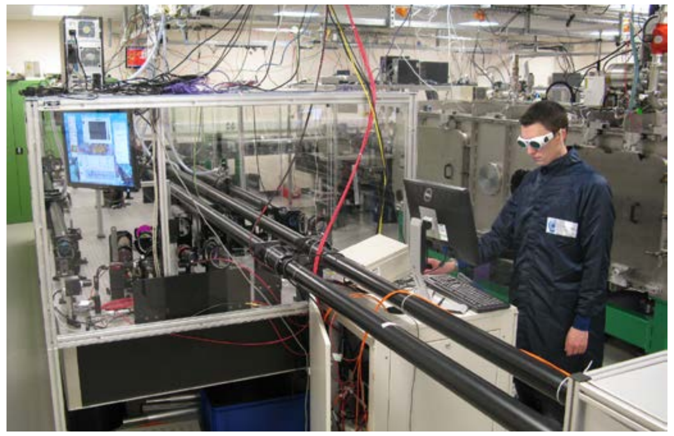
Gemini is a high-energy titanium-doped sapphire (TiS) laser that takes the pulses from Astra as input. Gemini can deliver up to 15 Joules in each of its two beams, with pulse duration of 40 femtoseconds. It is principally used for experiments in electron and proton acceleration and the generation of intense X-rays for imaging applications.

Compressor chamber being craned in.



3D CAD visualisation of Gemini Laser Area 3 and Target Area 3, viewed from the north east corner. The green blocks are the two Quantel pump lasers; the red blocks are the north and south amplifers with two compression chambers between. The target chamber for TA3 (purple legs) is just seen on the floor below.

South compressor chamber installed, 2007. One of the gold-coated gratings used for pulse compression can be seen at the far end of the chamber. (07EC3604)



Bryn Parry in Gemini LA3, 2015. The corner of the south Quantel pump laser cabinet is just visible in the corner of the picture; the black pipes are for beam transport.

The two Quantel pump lasers were delivered on 28th November 2006. The lorry driver got lost somewhere near Chilton so Chris Hooker had to guide him in – in French! The delay was fortuitous however as the weather had cleared by the time the lasers were unloaded.

The Astra Gemini facility was opened by Ian Pearson MP, Minister of State for Science and Innovation, on the 28th November 2007. The unveiling ceremony was held in LA3, and the plaque is now mounted on the wall of the Presentation Area in R7. (07EC4507)

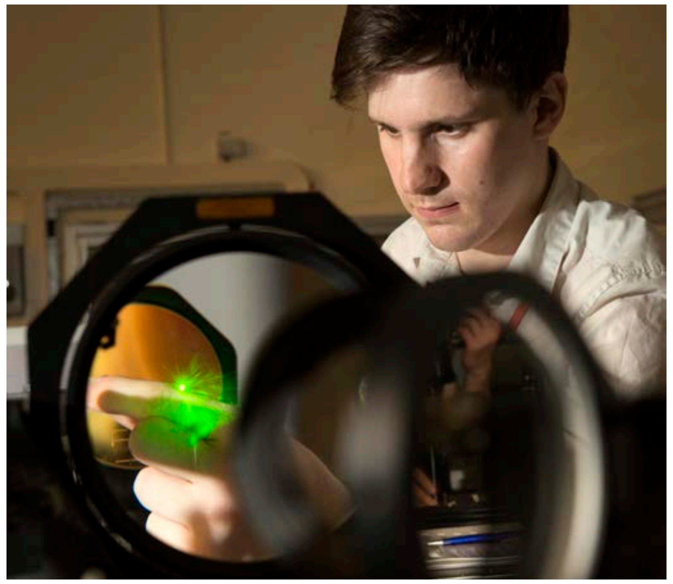
CLF Training Weeks

Since 2000, CLF has run Training Weeks to help new researchers make the best use of their allocated time on the laser facilities. The training covers many topics including high-power lasers, how to set up diagnostics, alignment of laser beams and focusing optics, good vacuum practice, drive systems, target fabrication and alignment, handling optical components, best experimental practice and all aspects of safety.

The goal is to teach facility users the best way to work in the CLF, and help them avoid common mistakes so that their experiments are as successful as possible.

Phil Rice explains the operation of a UHV (ultra-high vacuum) chamber. (15EC1109)

Handling a Dewar of liquid nitrogen, 2000.



Laser alignment exercise. (14EC2885)

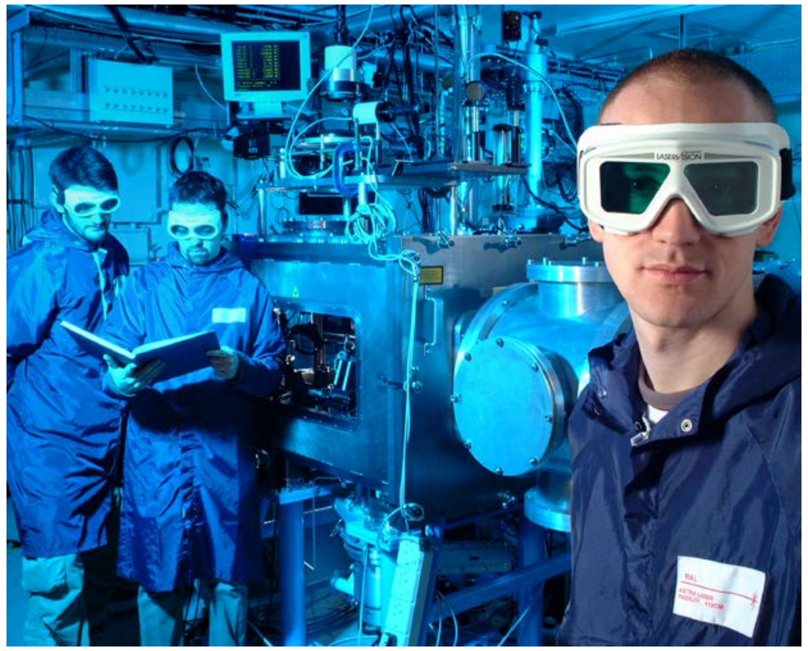
Setting-up optics in a Target Chamber. (08EC4263)

Stuart Mangles talks about electron acceleration. (14EC2932)

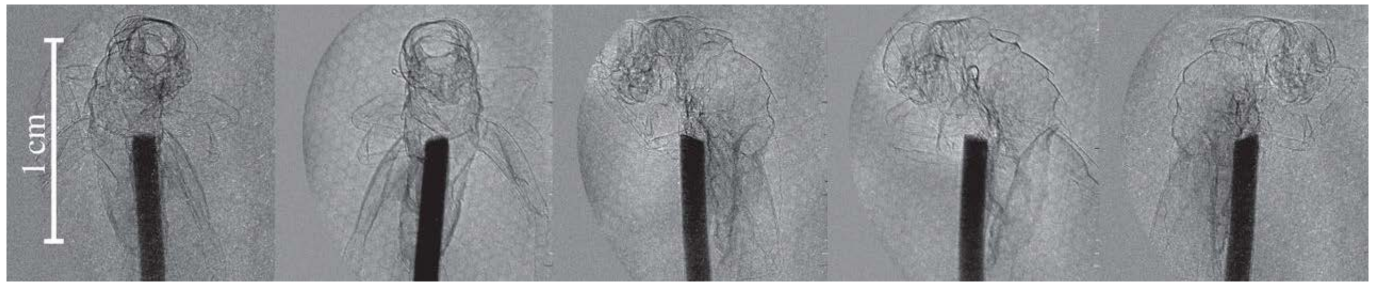
Experiments in Astra and Gemini

Dream Beam: A landmark experiment conducted in the Astra facility proved for the first time that lasers can be used to produce high quality, near-light speed electron beams in a centimetre as opposed to a kilometre-long accelerator. This was a collaboration between Imperial College, the University of Strathclyde, UCLA, USA and CLF, and was published as a cover article of Nature in 2004.

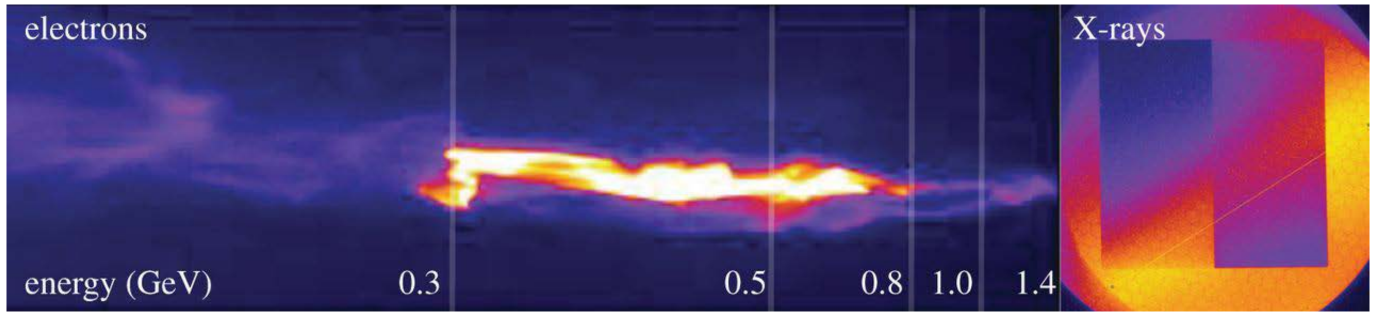
X-ray phase-contrast imaging: Electrons accelerated by a laser generate high-quality X-ray beams by "betatron oscillation." These X-rays are capable of producing high-resolution (few-micron level) images and can be used to distinguish very small differences in material densities (known as "phase contrast"), unlike hospital or dental X-rays which detect differences in absorption. This experiment in 2014 demonstrated phase-contrast imaging of a field cricket using X-rays generated by Gemini, and was a collaboration between Imperial College, University College, Instituto Superior Técnico, Portugal and CLF.



Alec Thomas, Chris Murphy and Stuart Mangles in Astra Target Area 2, 2004. (04EC1993)



Phase contrast images of a cricket taken with the betatron source.



Raw images of characteristic electron spectra and the corresponding X-ray beams.

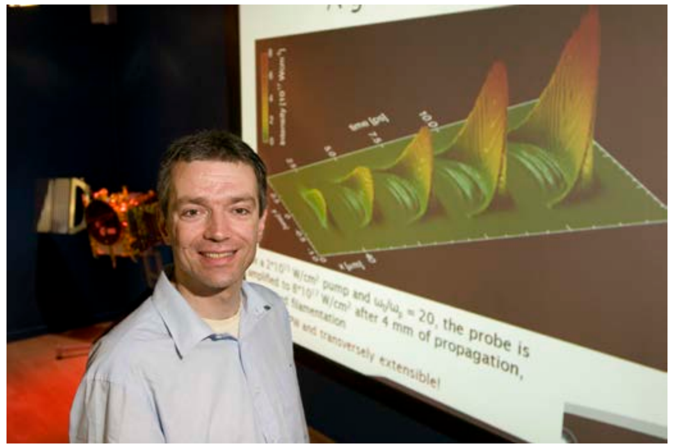
2007 to present

SCARF-LEXICON

The amount of diagnostic data generated on experiments is continually increasing. It has now reached a point where it cannot be stored or analysed on a single computer. The data now require specialist support, such as that provided by STFC's eScience (now Scientific Computing) Department.

The Plasma Physics Group uses a cluster of computers known as the SCARF-LEXICON (Scientific Computing Application Resources for Facilities) to perform complex numerical simulations of plasmas, and analyses of data produced by the Vulcan and Gemini lasers.

Peter Norreys (CLF) and Neil Geddes (eScience) at the launch of the SCARF-LEXICON cluster, June 2007. (07EC3183)



Raoul Trines giving his presentation during the inaugural event for the CLF's second high-performance computer cluster SCARF-LEXICON II. (10EC3369)

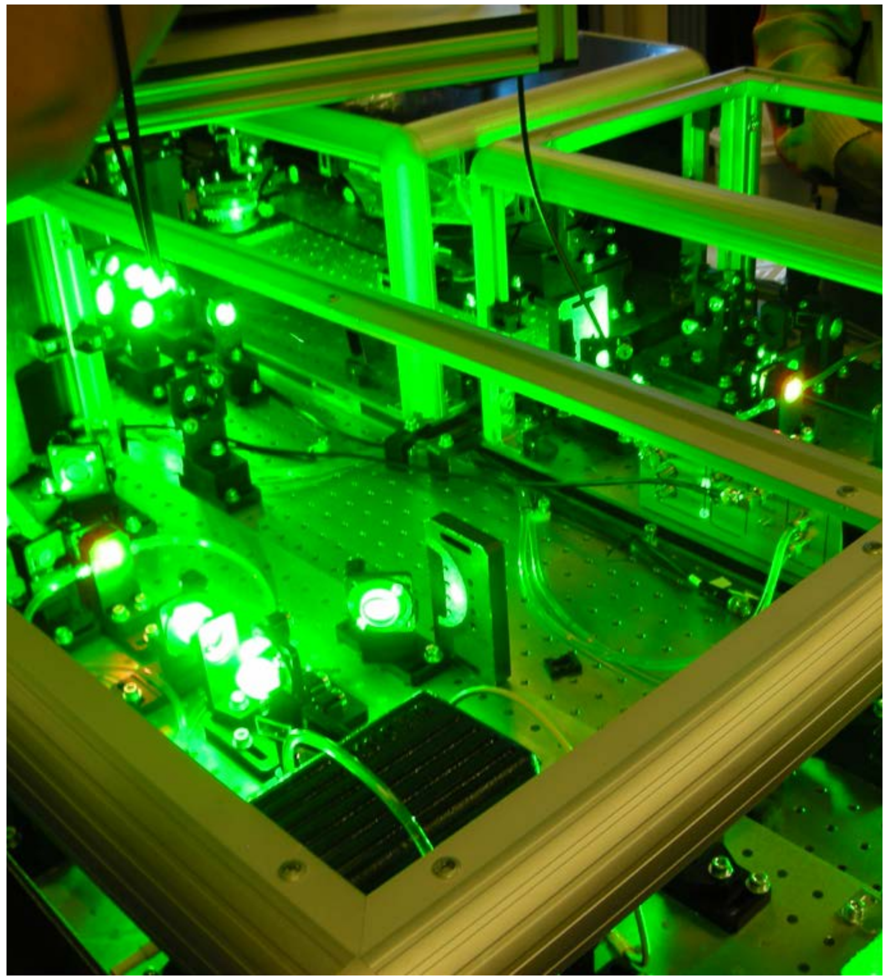
A computer simulation of a sequence of snapshots of the growing pulse in a Raman amplifier, showing that the pulse can be amplified while its envelope remains smooth.

2008 to present

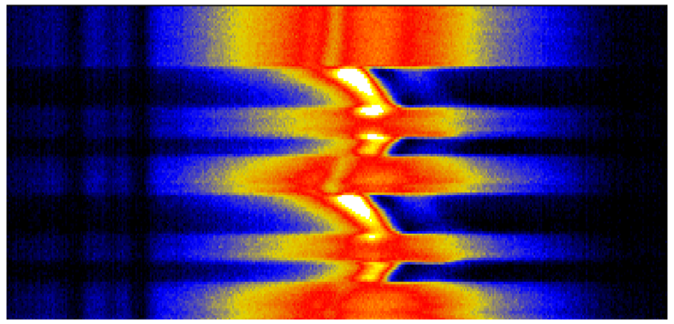
ULTRA

ULTRA developed from the PIRATE project as part of the LSF Ultrafast Spectroscopy Laboratory. It is a time-resolved spectrometer which uses multiple lasers of different colours and a suite of specialist cameras. The ultrashort laser pulses used allow the spectrometer to film at speeds fast enough to capture the movement of molecules during chemical and biological reactions. By detecting tiny colour changes, the dynamic structures of the molecules can be deduced.

ULTRA began operation in 2008, and is jointly funded by STFC and BBSRC. For the future, ULTRA and Artemis seek to work together towards the introduction of new facilities that span the mid-IR to XUV.



Commissioning ULTRA, demonstrating its high repetition-rate tuneable laser.



This image illustrates how molecular catalysts work. These molecules in solution are designed to break down CO_2 on electrode surfaces; ULTRA is able to distinguish between the very small number of molecules that happen to be at the electrode's surface, and the overwhelmingly large number of molecules swimming freely in solution.

In this false colour image, left to right represents the different colours of light that these molecules make, revealing their structure. Bottom to top shows how the colours (and the molecules) change when voltages are applied to the electrode. (From an experiment by the University of Liverpool in collaboration with CLF, 2017.)

Ian Clark and Michelle Hamilton in the ULTRA laboratory, 2013. (13EC1363)

Other stations on ULTRA include Time-Resolved Multiple Probe spectroscopy (TRMP) and LIFEtime which probe reactions 100,000 times a second. Experiments on these stations explore the fundamental chemistry of molecular reactions in solution, and use infra-red light to create molecular switches, enabling scientists to watch electron and energy flow in DNA.

2008

Mechanical workshop and TFab refurbishment

The Mechanical Workshop and Target Preparation Laboratory were refurbished in 2008, extending into a new corridor built between the old laboratories in R1 and the side of Vulcan TAP. (08EC1384)

The Target Preparation Laboratory was renamed Target Fabrication ("TFab" for short) at the same time to align with other groups internationally.

Mike Dunne does the honours at the Grand Opening in July 2008. (08EC2831)

The R1 Cleanroom Complex was refurbished in 2015 to provide improved storage capability and enable better quality assurance of the many optics used in CLF.

Trevor Winstone inspecting a transmission sphere in the Interferometer Room. Behind him is the interferometer used for characterising the metre scale optics used in Vulcan. The end of a 208 disc amplifier can be seen through the door into the Amplifier Pre-assembly Room. (15EC2100)

2009

HRH Prince Andrew visits

HRH Prince Andrew, The Duke of York, is given a demonstration of Vulcan during his visit to RAL, April 2009. The visit was featured in Hello magazine. (09EC1642)

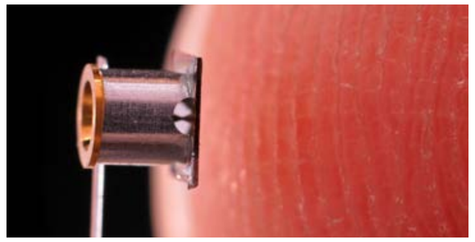
2008 to present

Target Fabrication Laboratory

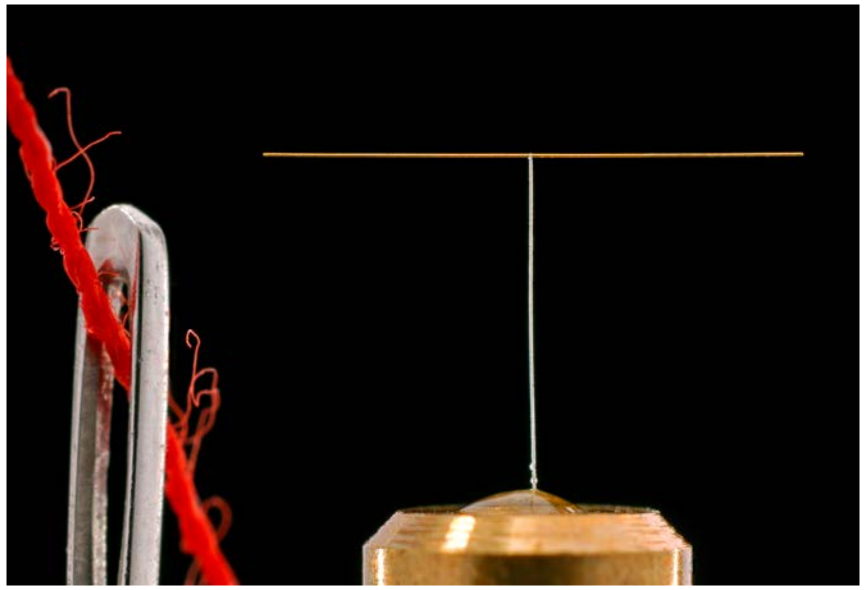
CLF has a world-class Target Fabrication Laboratory capable of producing a huge variety of solid micro-targets which are shot on its high power lasers.

Micro-targets are typically less than a few millimetres in size, and are made using a variety of methods including thin film coating and silicon wafer based techniques. 3D micro-targets are usually assembled by hand from very small, very accurately made micro-components.

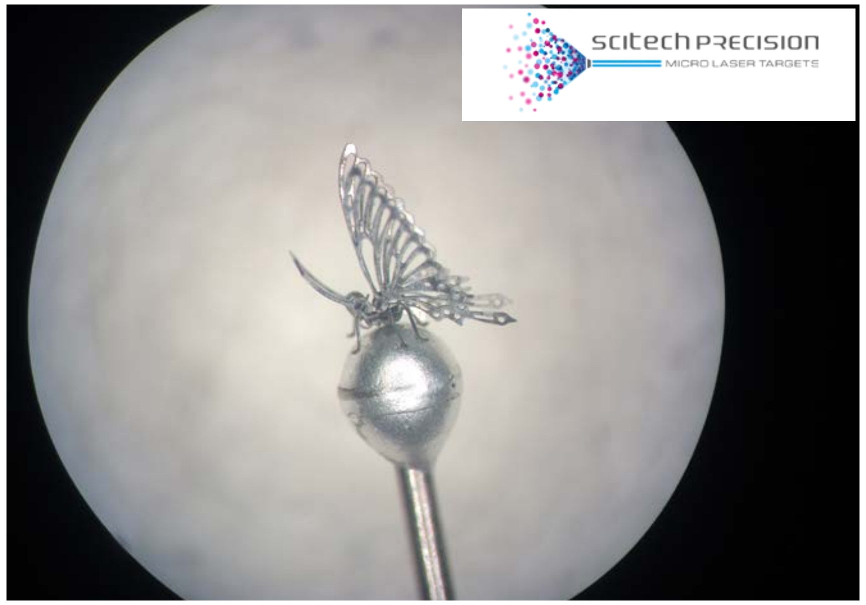
Some targets are assembled from components which have been micro-machined. The Tantafly was Laser Machined by Scitech Precision for Press and PR purposes. His 12 individual components were machined from a sheet of 25 micron tantalum, and then assembled by Donna Wyatt of Target Fabrication Group as if a (very small) 3D jigsaw puzzle. The Tantafly is 2.5mm from wing-tip to nose and 2.5mm from wing-tip to foot.



Cone target. The point inside the target on the right is the reflection of the cone tip on the left. The target has been assembled to ensure an offset from the foil of 2 microns, 2005. (05EC4294)



Thin wire target. The top wire is made from gold and is 20 microns in diameter (about a quarter the width of a human hair). (A micron is 10^{-6}, or one millionth of a metre.) One end of the gold wire has been polished to sub-micron smoothness, 2005. (05EC4316A)

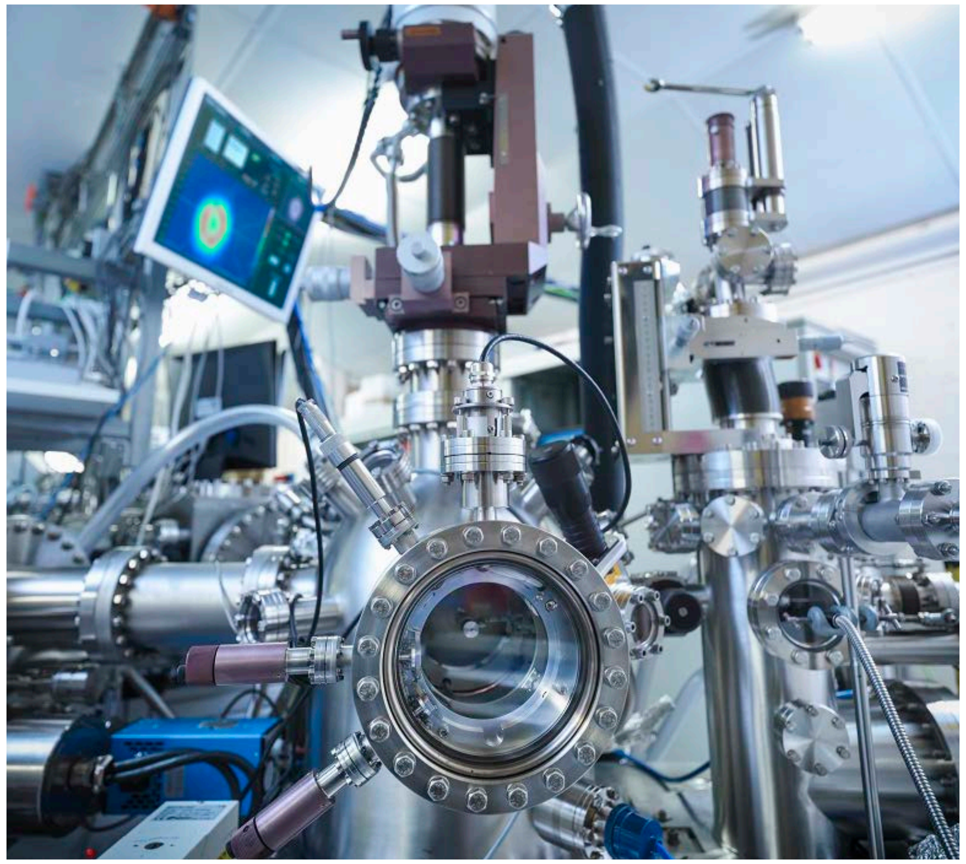


The Tantafly: A tantalum butterfly on the head of a pin.

Panoramic view of the Target Fabrication Characterisation room, 2017.

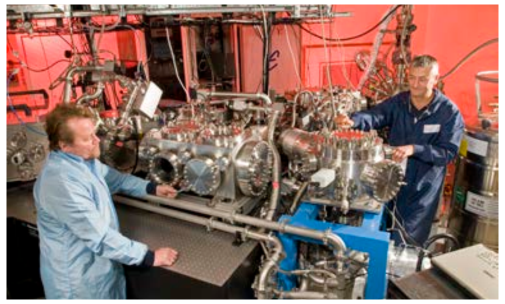
Artemis

Artemis is designed for ultrafast science with extreme ultraviolet pulses (XUV), a dedicated facility which grew out of the photo-physics and photo-chemistry work being done in Astra Target Area 1. Experiments on Artemis investigate electron dynamics in condensed matter and gas-phase molecules.



Artemis, 2012.

Dan Wolff, Chris Froud and Emma Springate on the Artemis beamline, 2008. (08EC4394)



Simon Spurdle and Toby Strange assemble the new atomic and molecular physics end-station in Artemis, 2010. (10EC3006)

Ricardo Torres, Thomas Siegel, Chris Froud and Imma Procino (Imperial College) with Emma Springate (CLF, second left) in Artemis after the first successful user experiment. This looked at high harmonics generated from aligned molecules (a gas of molecules, which has been driven with a laser pulse so that they all line up parallel to each other) using a long wavelength pulse, 2009. (09EC2374)

Building the Research Complex at Harwell (RCaH)

The Research Complex at Harwell (RCaH) is a multi-disciplinary laboratory for cutting-edge research in physical and life sciences – a “research hotel” for UK academics.

The Research Complex at Harwell was officially opened on Friday 9th July 2010 by Sir Leszek Borysiewicz, MRC Chief Executive. One of the speakers at the event was Venkatraman Ramakrishnan, 2009 winner of the Nobel Prize for chemistry. (13EC2742)

The MRC is leading the project on behalf of RCUK, in partnership with BBSRC, EPSRC, NERC, STFC and Diamond.

MRC Office area, November 2008.

The RCaH provides laboratory space for 150 people working in the areas of biological imaging, drug development and delivery, chemical processing, surface and nanoscience, and energy research.

Mick Selley setting-up the laboratory for the time-resolved infra-red spectroscopy station on Ultra, March 2010.

Optics Clustered to OutPut Unique Solutions (OCTOPUS) Facility

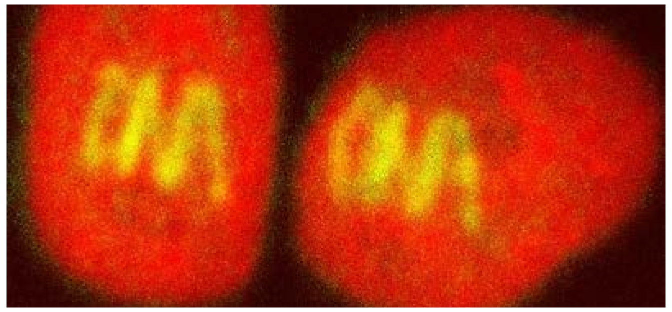
Early work in LSF included experiments to understand what happens when DNA is damaged. A confocal microscope system was developed as part of a project with Imperial College in about 1998, looking at the use of photodynamic therapy in the treatment of tumour cells.

Stan Botchway in the Laser Microscopy Laboratory, the pre-cursor to OCTOPUS at RAL, 2000. (00RC5366)

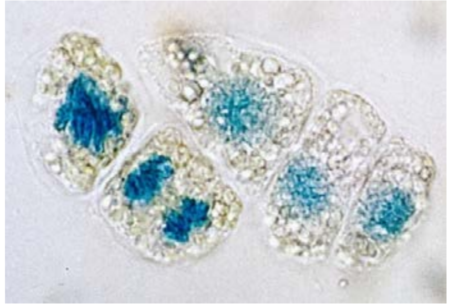
Kevin Henbest in the Laser Microscopy Laboratory, c.1997. A Gated Image Intensifier (GOI) camera can be seen on the bench to the left of the white confocal microscope; in the background is the "cavity dumper" laser.

At the beginning of 2009, the Advanced Single Molecule Imaging and Dynamics (ASMID) facility located at Daresbury Laboratory relocated to RAL to join with existing facilities and form the current Optics Clustered to OutPut Unique Solutions (OCTOPUS) facility.

OCTOPUS is a "life science imaging" facility which uses microscopes and a variety of multicolour light sources to image biological systems in real time. It can track interactions between molecules, such as protein-protein interactions to understand how proteins communicate with each other and the environment.



Lasers are used to score lines across a cell to mimic the damage caused by radiation, and then study how the cells repair themselves, 2001. This is a promotional shot to illustrate the technique – "DNA" etched onto a genome – the ultimate fingerprint!



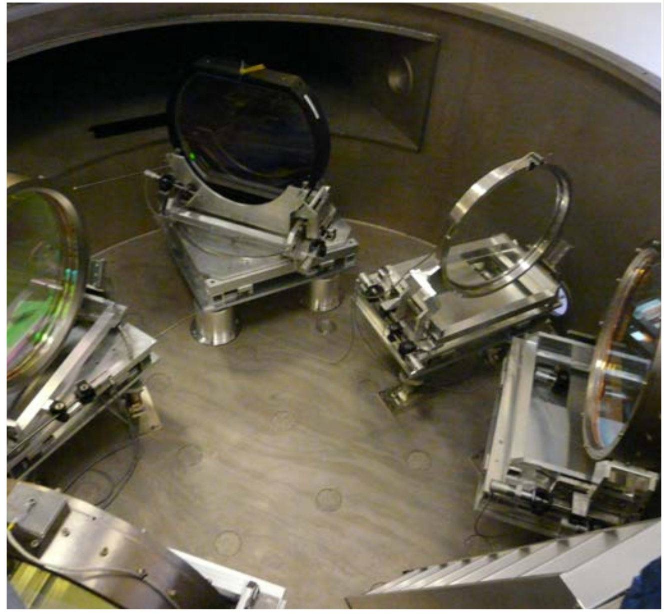
The nuclei of plants such as onions and yew can act as sinks for polyphenols, especially during cell processes that require high metabolic activity such as the mitosis of cancer cells. Studying the behaviour of these polyphenols will hopefully lead to improved medical treatments in the future. (This picture is from a collaborative project between the University of Reading, the Technical University of Munich, Oxford Brookes University and CLF, 2012.)

Sarah Needham, Daniel Rolfe, Dave Clarke, Marisa Martin-Fernandez and Stephen Webb in the OCTOPUS laboratory, 2009. (09EC1211)

Replacing optics in Vulcan

During April and May 2011 Andy Frackiewicz and Trevor Winstone, assisted by clean-room specialist Sonya Chapman, took advantage of down-time in Vulcan TAP to do some maintenance. After nine years of operation, the 940 mm diameter, 1480 lines/mm gratings and 600 mm diameter, 1.8m focal length parabola were damaged and needed replacing. Some of the 940 mm diameter mirrors were also showing signs of crazing where the layers of coating had separated.

It was a very delicate operation. Some of the optics are almost a metre in diameter, weigh 750 kg and cost £150K.



About to climb down into the south compressor tank.

Even a person's breath can cause problems.

Each day, the two 4.5 metric tonne compressor lids were craned off before work could start. This operation alone took an hour each time, but the delay was mostly due to housework as you cannot open up a clean vacuum vessel unless you are confident that the area outside is as dust-free as possible.

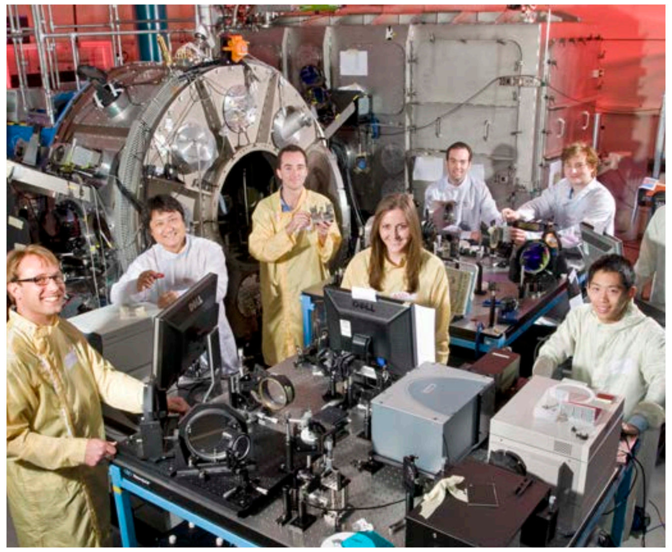
2012

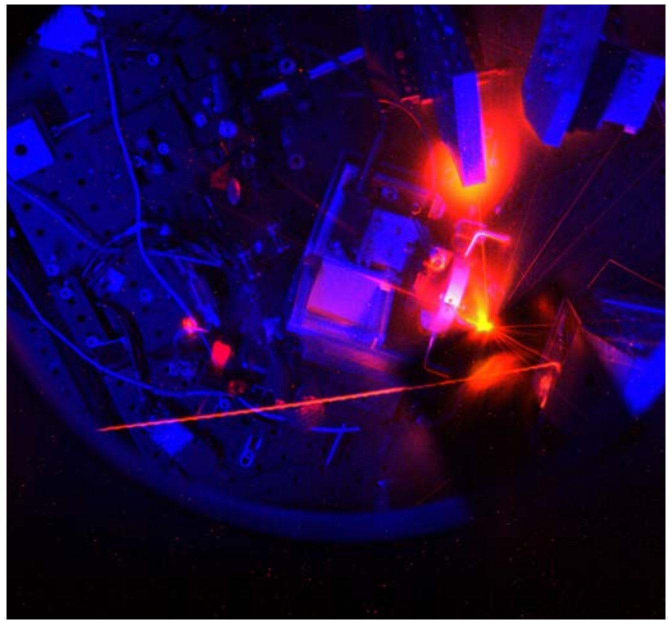
Experiments in Vulcan

Supernovas in the Lab: The universities of Oxford, Edinburgh, Strathclyde, York, Michigan, Chicago, Osaka, Queens University, Belfast, ETH Zürich, LLNL USA, CNRS France and CLF performed an experiment in 2012 to investigate cosmic turbulence in a supernova such as Cassiopeia A. (12EC2658)

A supernova is a stellar explosion. When such explosions occur, they send out shock waves which can collect dust and other debris in their path in what is known as a supernova remnant (SNR). Most SNRs have regular features, but Cassiopeia A has an anomalous, irregular shape.

This experiment was amongst *Physics World's* top 10 breakthroughs in 2014.

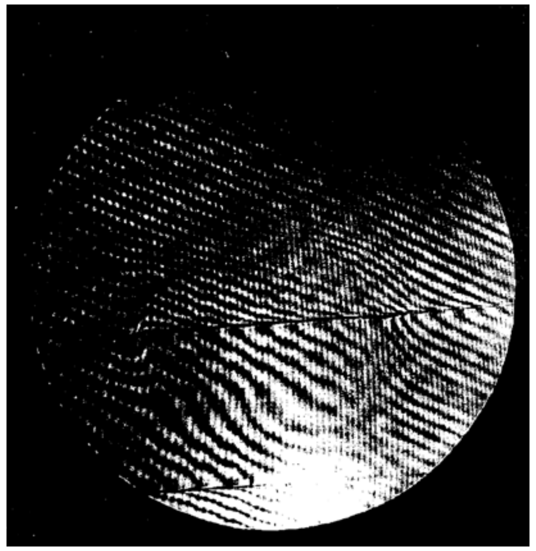




Electron jets: This plasma image was taken on an active experiment in Vulcan. The experiment was a collaboration between the University of Strathclyde, the University of Shanghai and CLF. It aimed to characterise the magnetic field formation driven by the propagation of fast electron beams in glass. The laser interaction in the centre produces ion beams from a thin target interaction. The bright lines are from extremely hot, fast target debris bouncing around the chamber. Some of this debris is rotating at high speed, generating a helical-like structure in the debris paths.

This image was taken using a commercial SLR camera. Even though it is operated on the fastest shutter available, the entire laser-plasma interaction evolves over a single frame so a time integrated image is produced.

Early X-ray laser experiments: During the early 1980s, a research group at the University of Hull led by Geoff Pert FRS performed pioneering experiments on X-ray lasers. These were based on recombination in laser-irradiated carbon-fibre targets, and various schemes involving X-ray photo-excitation such as Ne IX by Na X.



Interferogram of a carbon-fibre target obtained on shot 20 at a time of 1 nanosecond after the peak of the main pulse, 24th November 1983.

2014

100,000 shots on Gemini

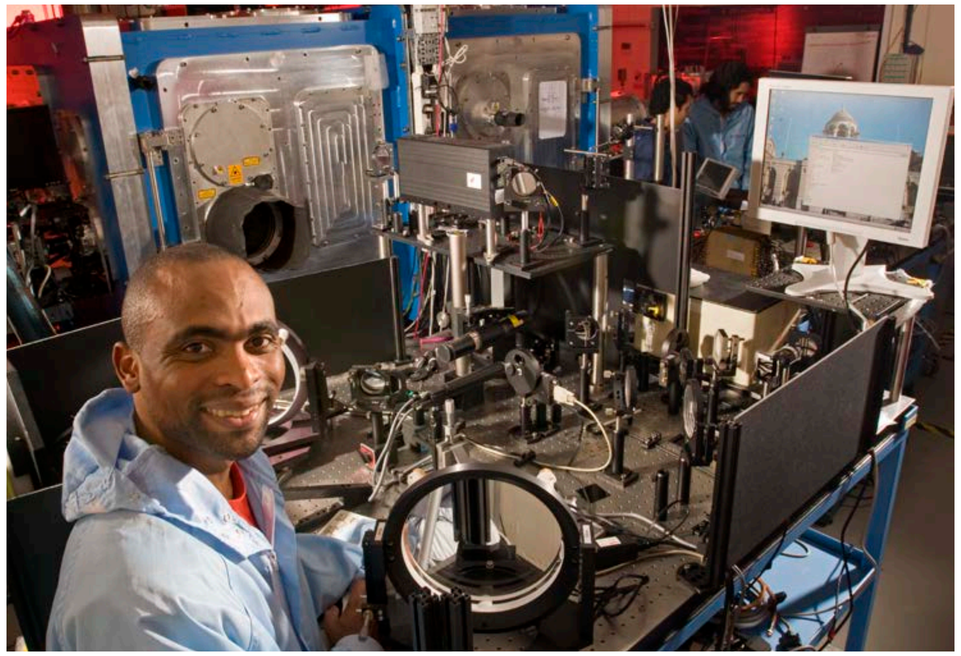
Marking the occasion of the first shot on Gemini in September 2007. The pulse length at around that time was 45 femtoseconds with 15 Joules of energy.

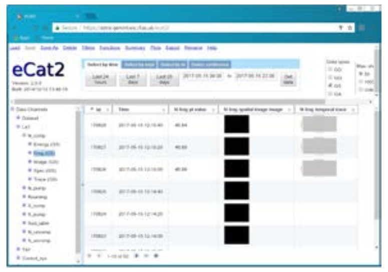
Pictured in Target Area 3 are Rajeev Pattathil, Chris John, Klaus Ertel, Richard Bickerton, Brian Wyborn, Brian Landowski, Peta Foster (holding the first target), Bryn Parry, Steve Blake, Steve Hawkes, Oleg Chekhlov, Bill Lester, Darren Neville (just seen), Dave Neely, Margaret Notley and Chris Hooker.

Marking the occasion of the 100,000th shot on Gemini at 18:43 on Friday 14th March 2014. The pulse length on that shot was 46.62 femtoseconds with 13.45 Joules of energy.

Pictured in Target Area 3 Control Room are Chris Gregory, Rajeev Pattathil, Tom Anderson, Chris Spindloe, Steve Blake, James Green, Chris Hooker, Nicola Booth, Darren Neville, Steve Hawkes, Bryn Parry, Victoria Marshall, Peter Brummitt, Oleg Chekhlov and Dave Neely.

Nicholas Bourgeois from Oxford University in Target Area 3 during a radiation study experiment in collaboration with Strathclyde University, 2008. (08EC5211)

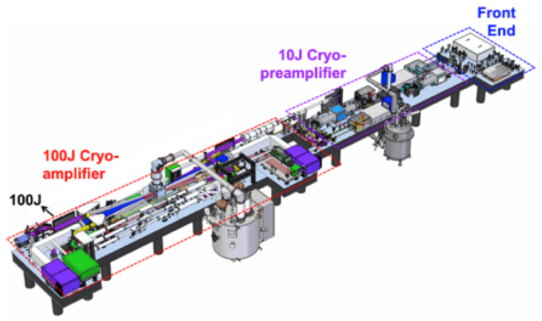




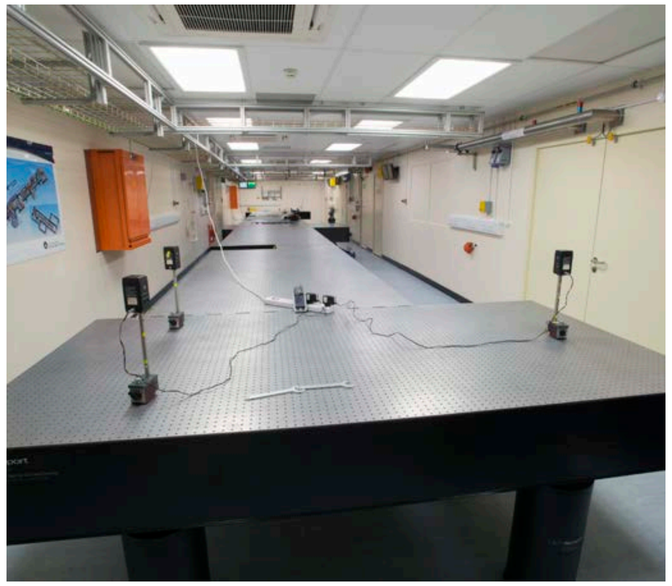
Gemini was due to come on-line in 2008 firing a shot every 20 seconds, so the amount of data generated was about to go up by several orders of magnitude. A collaboration between CLF, eScience (now the Scientific Computing Department), and CICT resulted in a suite of tools to manage and analyse not only diagnostic data, but also laser and facility status data. These tools are still in use today; many people will recognise the names eCAT and Penguin, and it is this software which enables us to determine shot parameters.

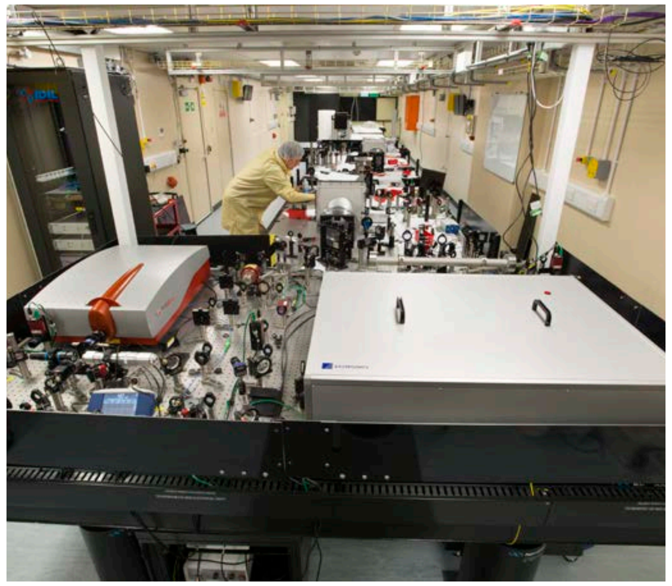
DiPOLE-100 aka HiLASE

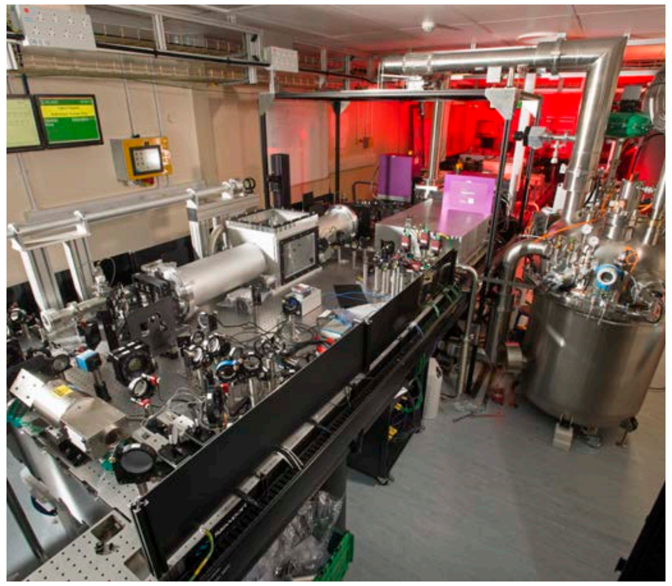
DiPOLE 100 was the scaled-up 100 Joule version of another laser named DiPOLE. It took just under two years to build at RAL, proved that it could run for over an hour without operator intervention, and was then packed-up to be shipped to the Czech Institute of Physics where it was commissioned in collaboration with CLF staff.

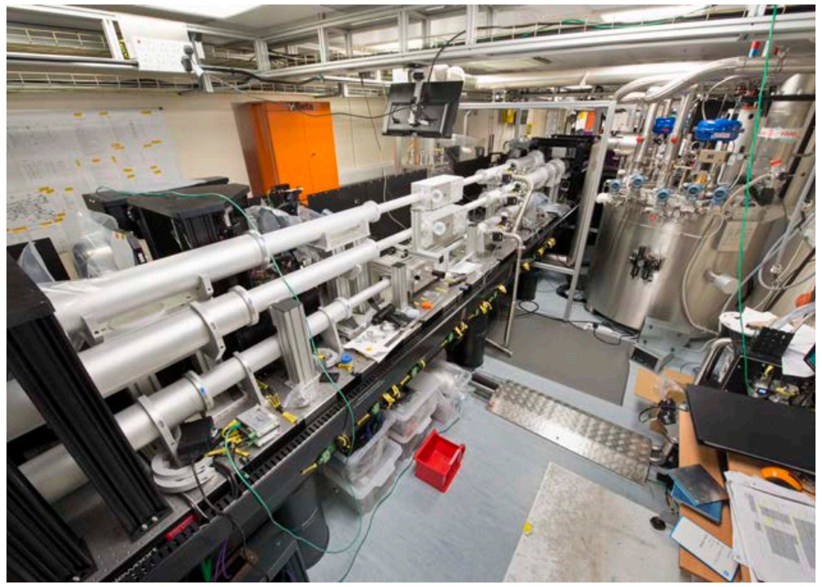



Laser room ready for population, March 2014. (14EC2505)


Tables ready, May 2014. (14EC2520)


Installation of the front end, July 2014. (14EC3657)


10 Joule amplifier section, January 2015. (15EC1247)

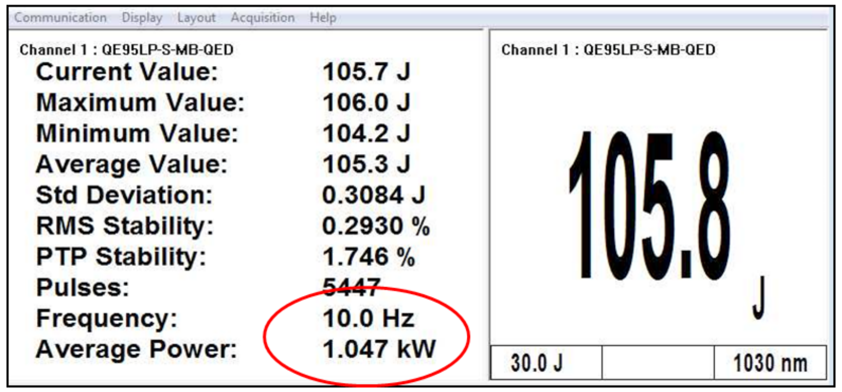

100 Joule amplifier section, March 2015. (15EC1997)


100 Joule pump field lens looking at the amplifier head, November 2015. (15EC4741)


We've done it! 3rd November 2015. (15EC4760)

The DiPOLE 100 team: Adrian Thomas, Ian Hollingham, Waseem Shaikh, Mark Dominey, Andrew Lintern, Jonathan Phillips, Thomas Butcher, Justin Greenhalgh, Paul Mason, Dave Richards, Klaus Ertel, Nicki Wallace, Brian Landowski, John Hill, Oleg Chekhlov, David Michel, Mike Tyldesley, Mariastefania De Vido, Chris Edwards, John Collier, Steve Blake, Jodie Smith and Isabella Rey.

World's first kW average power nanosecond diode-pumped solid state laser



```
Channel 1 : QE95LP-S-MB-QED
Current Value:        105.7 J
Maximum Value:        106.0 J
Minimum Value:        104.2 J
Average Value:        105.3 J
Std Deviation:        0.3084 J
RMS Stability:        0.2930 %
PTP Stability:        1.746 %
Pulses:               5447
Frequency:            10.0 Hz
Average Power:        1.047 kW

Channel 1 : QE95LP-S-MB-QED
105.8
J
30.0 J                1030 nm
```

100 Joules was the target; DiPOLE 100 achieved more than that on 16th December 2016. It is now the highest average-power nanosecond pulsed diode-pumped solid-state laser in the world.

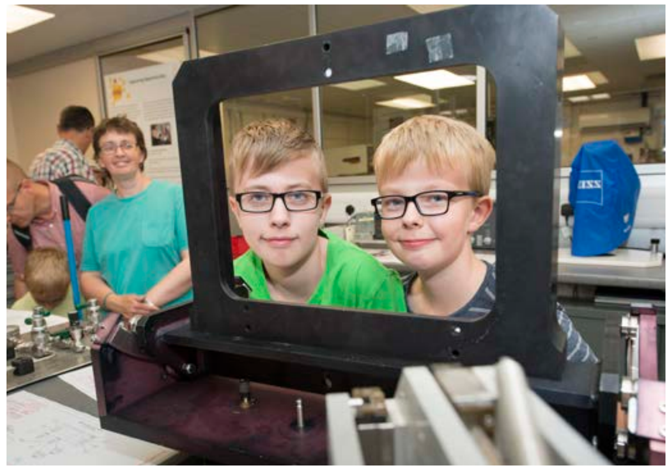
2015

Rutherford Appleton Laboratory Open Week

Prof John Collier welcomes HRH Prince Andrew, The Duke of York, to one of the CLF displays at the start of the 2015 RAL Open Week. From left to right: James Green, The Duke of York, Andrew Taylor, Peta Foster and John Collier. (15EC2989)

The Vulcan team ready to tackle the public on Saturday. Back row: Ian Musgrave, Dave Pepler, Andy Kidd, Aaron Moss, Andy Frackiewicz, Trevor Winstone, Adam Jenson, David Shepherd. Front row: Sonya Chapman, Nathan Cole, Bryn Parry.

Discovering how to focus a laser using 20 eye-safe lasers, a large parabola, and a mist generator. (15EC3248)



Examining a Vulcan mirror mount. (15EC3239)

CLF and STFC toured the country with the "Incredible Power of Light" roadshow as part of IYL2015 – the International Year of Light. The show travelled 4,748 miles over 94 days, visiting 13 venues including the Scottish Parliament, the National Assembly for Wales, Science Museums in London and Ulster, the Big Bang Fair at Birmingham's NEC and, most importantly, the Rutherford Appleton Laboratory's Open Week!

2016

2016 Christmas Meeting of the High Power Laser User Community

CLF have held "Christmas Meetings" since 2000 for all users. The 2016 instance of this great CLF tradition was held at Abingdon School (in Abingdon of course). This was the second time the meeting had been held at the school, but had proved so popular (according to the community) and so effective (according to our administrative staff) that we were eager to return.

As usual the meeting was crammed with talks from PhD students and post-docs from the CLF user community, with around 180 people attending. There were three tutorial talks from Robert Kingham, Nigel Woolsey and David Neely, and a poster session held in the school's Yang Centre.

(Our thanks to Raoul Trines for the original text of this item.)

The group photo is also a tradition. (16EC5112)

Robert Kingham (Imperial College) talking about non-local transport in laser-solid interactions. (16EC5088)

Delegates Chris Thornton (CLF) and Robert Shalloo (University of Oxford). (16EC5073)

2017

Our 2017 artist in residence: Helen Towrie

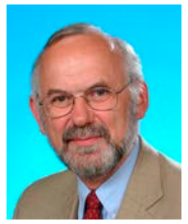
Helen Towrie is our 2017 artist in residence, working with Ceri Brenner on the CLF Social Media presence. Helen is creating a set of illustrations representing the many different lasers in CLF… Octopus, Gemini, Artemis and Vulcan to name but a few. These are designed to appeal to the younger generation of scientists – to excite and enthuse them, and to show that science is not full of complicated subjects they won't understand, but rather fascinating subjects we are just beginning to explore.

CLF Directors

Prof Alan Gibson FRS,
CLF Director
1977 – 1983

Prof Mike Key,
CLF Director
1983 – 1994 and
1995 – 1996

Dr Bill Toner,
CLF Director
1994 – 1995



Prof Henry Hutchinson,
CLF Director
1996 – 2006

Prof Mike Dunne,
CLF Director
2006 – 2010

Prof John Collier,
CLF Director
2010 – present

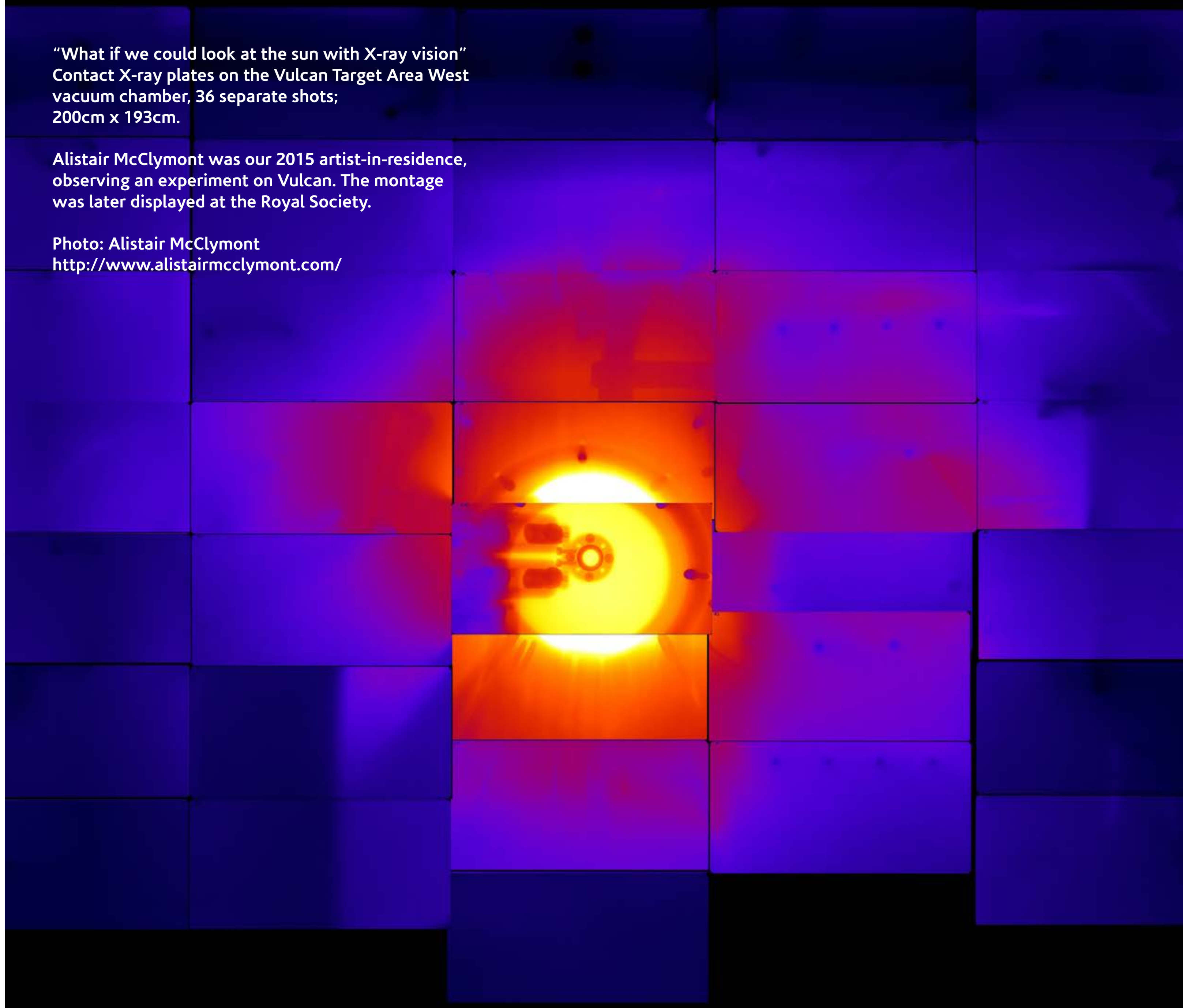
Panorama of the new CLF Visitor Centre in R1, opened in 2012.

Acknowledgements

A huge "thank you" to everyone who contributed ideas, photographs, captions, memories, scientific explanations, and inspiration. Like so much of what we do in CLF, this has been a tremendous collaborative project. I have learned so much, and have had so much fun putting it all together. Here's to the next 40 years!

Victoria Marshall, 20th June 2017

Munadi Ahmad
Ric Allott
Graham Arthur
Saumyabrata Banerjee
Jorge Bernardino De La Serna
Stan Botchway
Ceri Brenner
Pete Brummit
Tom Butcher
David Carroll
Sonya Chapman
Oleg Chekhlov
Rob Clarke
David Clements
John Collier
Mariastefania De Vido
Paul Donaldson
Chris Edwards
Andy Frackiewicz
James Green
Greg Greetham
Robert Heathcote
Cristina Hernandez-Gomez
Graeme Hirst
Steve Hook
Chris Hooker
Aasia Hughes
Yiftach Katzir
Andy Kidd
Pavel Matousek
Ian Musgrave
David Neely
Margaret Notley
Jonathan Oldfield
Tony Parker
Rajeev Pattathil
Dave Pepler
Jonathan Phillips
Mark Pitts
Alex Robinson
Waseem Shaikh
Christopher Spindloe
Emma Springate
Christopher Thornton
Daniel Symes
Martin Tolley
Helen Towrie
Mike Towrie
Raoul Trines
Edmund Turcu
Andy Ward
Graham Wiggins
Trevor Winstone
Donna Wyatt
Brian Wyborn



"What if we could look at the sun with X-ray vision"
Contact X-ray plates on the Vulcan Target Area West vacuum chamber, 36 separate shots;
200cm x 193cm.

Alistair McClymont was our 2015 artist-in-residence, observing an experiment on Vulcan. The montage was later displayed at the Royal Society.

Photo: Alistair McClymont
http://www.alistairmcclymont.com/

Work experience student Catherine Moon from a school in Abingdon prepares to experience a laser, 8th July 2011. (11EC2704)

Laser interaction with the target in Vulcan using very high optical filtering, 2013.

Designed and printed by RCUK's internal service provider

40 CLF central laser facility

YEARS OF SCIENCE
AND INNOVATION

Science & Technology
Facilities Council