CLRC
COUNCIL FOR THE CENTRAL LABORATORY
OF THE RESEARCH COUNCILS

Central Laser Facility
Rutherford Appleton Laboratory

HIGHLIGHTS 1994-95

Contents

Cover photograph: Apprentice Sally-Ann Brind looks into the Titania laser vessel

Preface : M H Key

This report gives a summary of the recent achievements of researchers and staff working at the Central Laser Facility (CLF).

The past year has been highly productive, with important and exciting results obtained in numerous areas. Contributions have been chosen to show the broad spectrum of CLF research and facility development. Complete scientific and technical details of the programme, and a list of arising publications, are available in the CLF Annual Report (RAL-TR-95-025).

It is a pleasure to record my thanks to the editor of this publication, Dr Mick Shaw, and to Bill Toner, who led the CLF during the past year. Bill retired at the end of August 1995, and we look forward to his visits to us as a user of the facility in his new role as visiting Fellow at the University of Oxford. Bill's outstanding contribution to the CLF is recorded with appreciation on the events page.

(This report is also available on the Internet at http: //www.nd.rl.ac.uk/lasers/)

Events

Harry Medhurst retires after 17 years in the Central Laser Facility. Mick Shaw presenting him with a memento of the early days with Sprite. (95 RC 3650).

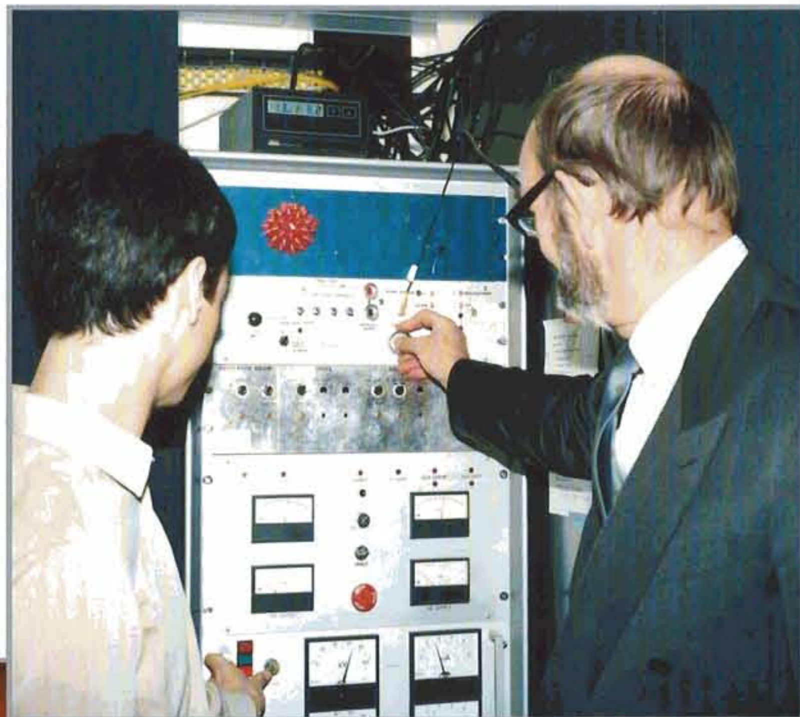
Delegates to the 23rd meeting of the European Conference on Laser Interaction with Matter jointly hosted by the CLF and St Johns College, Oxford, September 1994. (94 RC 5349).

Head of the CLF Professor Mike Key is awarded the prestigious Max-Born prize of The Institute of Physics and the Deutsche Physikalische Gesselschaft.

Leading members of the CLF's user community Professor G J Pert and Professor I W M Smith are elected Fellows of The Royal Society.

Longair Review Panel reports "Outstanding science" at the CLF and recommends continued operation from RAL.

Events



CCLRC's Chief Executive Paul Williams fires the last shot on Sprite. (95 RC 2090).

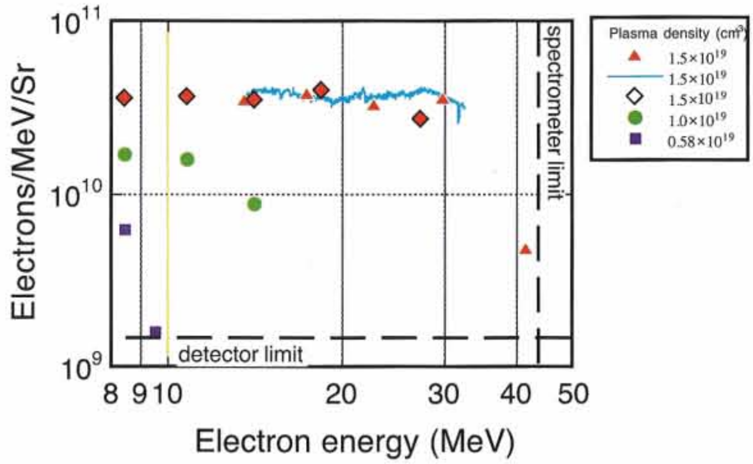
9 Nov 1994 first laser shot from the Titania Laser Module. (94 MB 6151).

Bill Toner with Pru Backway from EPSRC and the Laser Support Facility team on the occasion of Bill's last chairmanship of The LSF Scheduling Committee. (95 RC 3869).

Bill Toner joined the laser facility in 1977 after many achievements in the field of high energy physics. Bill was initially responsible for operating and developing the target area facilities for Vulcan. He was then appointed first group leader for the LSF in 1986, before becoming Deputy Head of the CLF in 1990 and Acting Facility Head in 1995. He has been enormously influential in shaping the development of the CLF and is a highly valued colleague and friend to staff and facility users alike.

Highest electric field ever produced in the laboratory accelerates electrons to 44 MeV

Miniature particle accelerators using laser acceleration took a step closer to realisation after an experiment conducted by a team from Imperial College, UCLA, Ecole Polytechnique, Livermore and RAL.

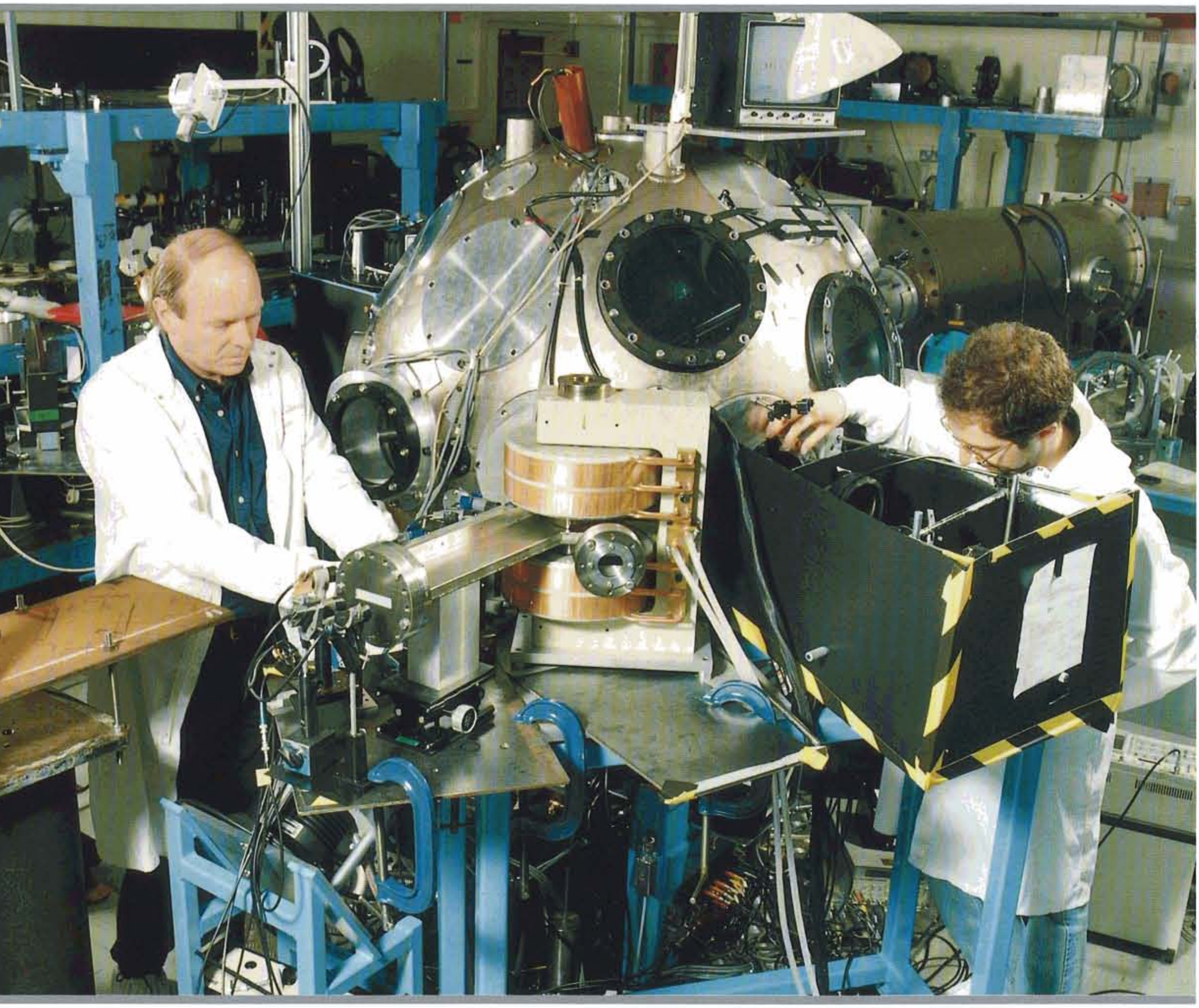


Spectrum of accelerated electrons at different plasma densities.

A 25 J, sub-picosecond laser pulse from the Vulcan CPA facility at RAL was focused into a jet of helium gas giving rise to a self-resonant wakefield that traps and accelerates plasma electrons to very high energies. The latest results show the acceleration of electrons up to 44 MeV with electric fields of over 100 GV/m which is the highest collective field ever produced in a laboratory and is roughly four orders of magnitude higher than conventional accelerators.

Collaboration:
A Modena, Z Najmudin, A E Dangor — Imperial College, London
C E Clayton, K A Marsh, C Joshi — UCLA, USA
V Malka — Ecole Polytechnique, France
C B Darrow — LLNL, Livermore, USA
C N Danson, D Neely, F N Walsh — RAL, UK

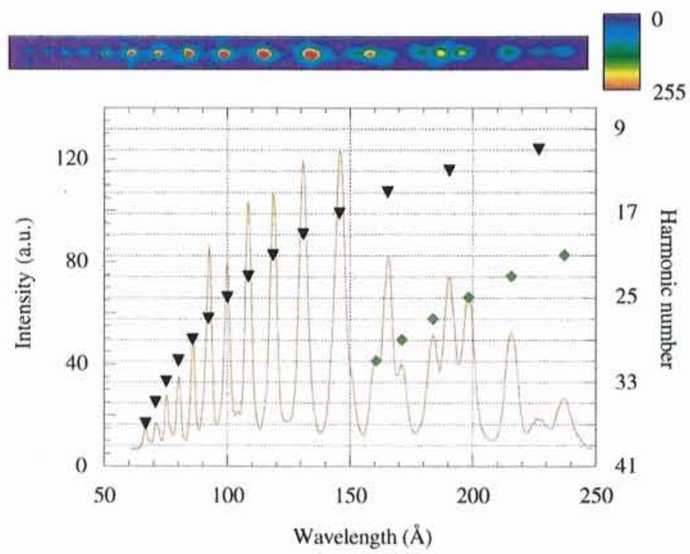
Ken Marsh of UCLA and Astori Modena of Imperial College adjust diagnostics in Target Area West. (94 RC 6648).



Shortest wavelength produced by harmonic generation from femtosecond KrF laser pulses

The world record for the shortest wavelength ever produced by harmonic generation has been obtained by a team from Oxford University, The University of Alberta and RAL using the Sprite CPA laser beam.

Up to 250 mJ of laser energy at 248 nm in a pulse duration of 380 femtoseconds was focused into gas jets of helium or neon. The highest resolved harmonic was the 37th, giving a wavelength of 6.7 nm, although deconvolution of the figure indicates light was produced up to the 49th (5.0 nm). Simulations showed that the effect of ions in the focus was to increase the harmonic conversion efficiency. A peak power of over 80 kW was obtained at the 7th harmonic (35.5 nm) in the helium gas jet.



Soft X-ray spectrum of high harmonics from the Sprite KrF laser. Triangles are first order, diamonds second order.

Collaboration:
S G Preston, M Zepf, A Sanpera,
W J Blyth, C G Smith, M H Key, J S Wark — University of Oxford
A A Offenberger — University of Alberta
D Neely, M H Key — RAL

Short pulse irradiation produces high-gain recombination X-ray lasers at 18.2 and 11.1 nm

The use of picosecond pulse irradiation has been instrumental in achieving high gain from recombination X-ray lasers for the first time. Carbon fibres, 5 mm long, were irradiated with 20 J in 2 picoseconds from the Vulcan CPA laser. A peak gain coefficient of 17 cm^{-1} was obtained on the hydrogen-like Balmer alpha transition in carbon VI at 18.2 nm.

When the fibre was coated with copper, high laser gain at 11.1 nm was observed from transitions in sodium-like copper.

These results show promise for opening the way to laser action at shorter wavelengths in the biologically important water window between 2.2 and 4.5 nm.

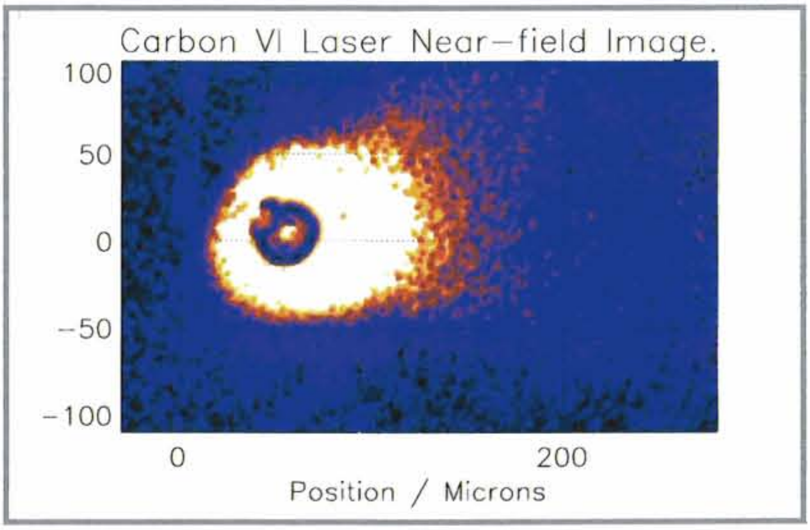


Image showing the intensity distribution of the carbon VI X-ray laser at the exit plane of the recombining plasma.

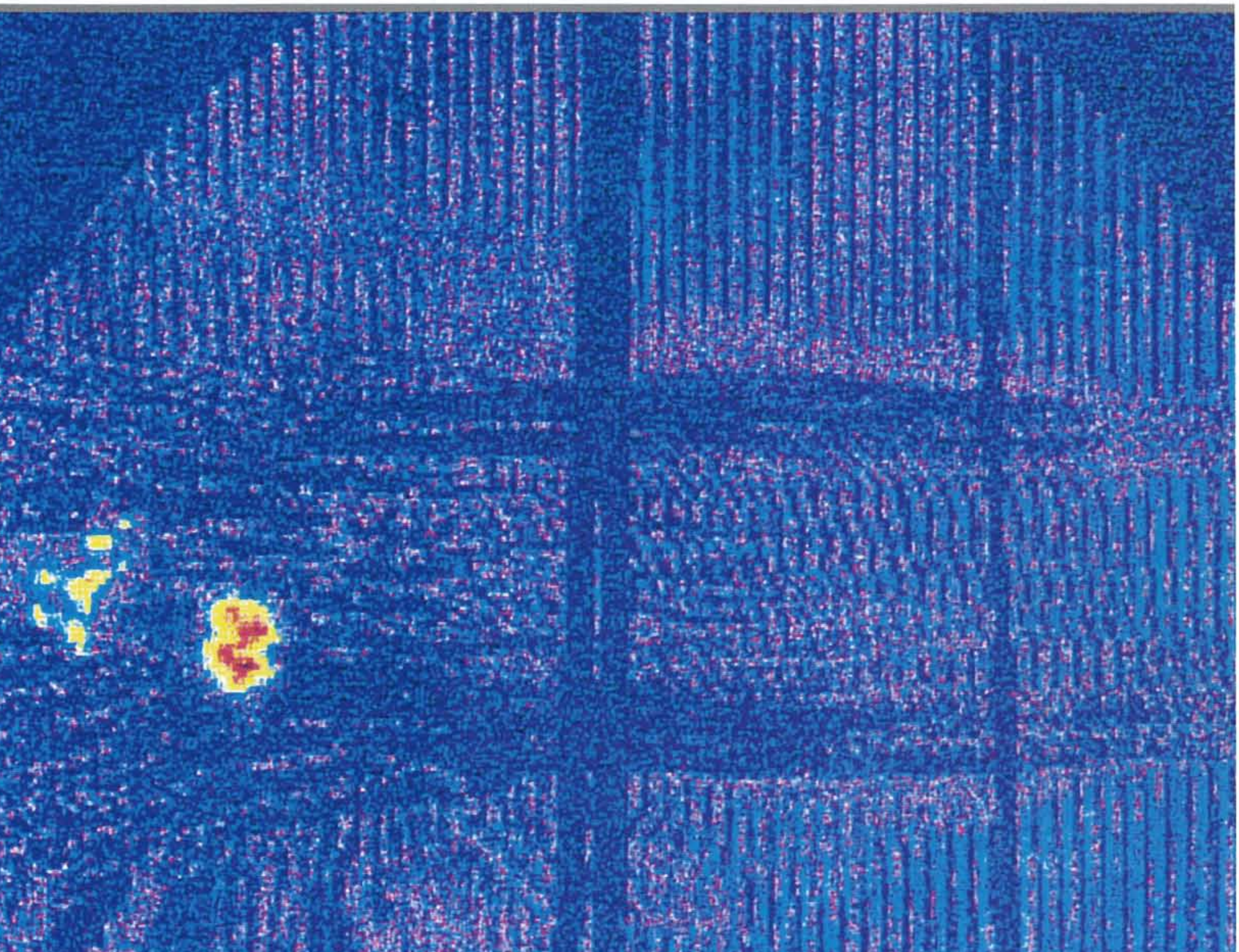
Collaboration:
J Zhang, M H Key — University of Oxford
G J Tallents, A Behjat, A Demir, M Holden, P Zeitoun — University of Essex
C L S Lewis, A G McPhee — Queens University, Belfast
G J Pert, S A Ramsden — University of York
E E Fill, Y Li, D Schlogel, J Steingruber — MPI, Garching
Y F Shao — IAPCM, Beijing
Y L You — INPC, Chengdu
M H Key, S J Rose, D Neely, P A Norreys, C Danson, F Walsh — RAL

High power laser pulses guided in preformed plasma channels

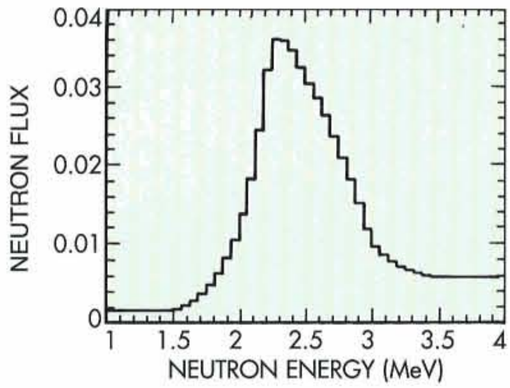
The guiding of high power laser beams through dense plasma is an important issue in some X-ray laser schemes and in particular in the "fast igniter" concept for laser fusion. Results obtained using the Vulcan CPA beam show that a laser beam with an irradiance of 10^{18} Wcm^{-2} can be guided in a dense plasma ($n_e = 5 \times 10^{19}$ cm^{-3}). The trick is to preform a plasma channel with a low power pulse at the 1 to 10 % level prior to the main pulse. With a preformed plasma, strong density gradients are avoided and the laser beam propagates and focuses rather than defocusing as it does without the prepulse.

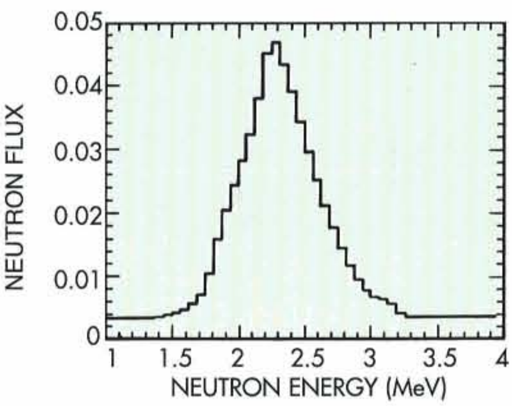
Collaboration:
A J Mackinnon, M Borghesi,
A Iwasi, O Willi Imperial College, London
F N Walsh RAL, UK

Moiré deflectometer image of a laser guided channel. The laser enters from the right. The red spot results from self emission from the plasma due to beam focusing.



4 x 10^9 neutrons obtained by picosecond irradiation of deuterated plastic targets





Spectra of neutron energies emitted from the deuterated plastic target in the forward (top) and backward (bottom) directions

Deuterated plastic targets, irradiated at more than 10^{18} Wcm^{-2} by the Vulcan CPA beam have produced the largest yield of neutrons ever measured at the CLF from the D + D → ^{3}He + n fusion reaction. More than 10^9 neutrons with characteristic energy of 2.45 MeV were obtained per laser shot, giving a Q value (fusion energy released/laser energy on target) of 0.02%. The neutrons were found to be emitted isotropically from the target.

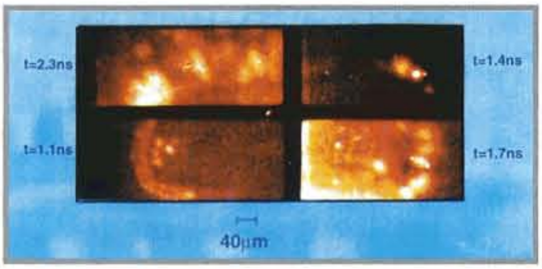
Calculations suggest that the observed fusion neutrons could not have originated from a thermalized plasma but are more likely due to a beam of fast deuterons driven into the target by light pressure. The isotropic emission can be explained by scattering off carbon atoms.

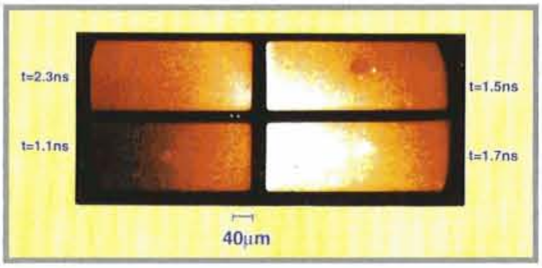
These results show that the energy deposited by fast ions may play a significant role in the "fast igniter" concept for laser fusion.

Collaboration:

A P Fews	University of Bristol
A E Dangor, A R Bell, F N Beg, P Lee, M Tatarakis	Imperial College
B A Hammel, M Glinsky	LLNL, USA
P A Norreys	RAL

Foam promises smooth fusion implosions





Transmission radiographs of a foil target irradiated by a coherent laser beam. Top: without FDD. Bottom: with FDD

One of the major problems in inertial confinement fusion results from the non-uniformities in the laser beams used to irradiate the fusion capsule. These non-uniformities are imprinted onto the ablation surface seeding the growth of Rayleigh-Taylor instability which impairs the symmetry of the implosion.

A novel "Foam-buffered Direct Drive" smoothing scheme, called FDD, has recently been shown to reduce the imprinting problem. The surface of the capsule is coated with a low density foam layer having a very thin outer layer of high-Z material, such as gold. This outer layer converts the very first part of the laser pulse into a brief flash of soft X-rays which turns the foam overcoat into a smooth plasma.

Experiments carried out by the Imperial College group on the Vulcan laser at RAL and on the Trident laser at Los Alamos, backed up by numerical simulations, have shown a substantial reduction in the initial imprinting of laser non-uniformities. They indicate that FDD may provide sufficient smoothing to make direct drive an attractive route for fusion ignition.

Collaboration:
R J Taylor, D Hoarty, C Meyer, A Iwasi, O Willi — Imperial College, London
J P Dahlberg, D E Fyfe, J H Gardiner — NRL, Washington DC

X-ray lithography using a laser plasma source produces 200 nm gate for field effect transistors

A collaboration between RAL, The University of Edinburgh, Kings College London and Leica Cambridge has successfully employed the RAL X-Ray Source to produce a 200 nm gate structure in a field effect transistor. Device structures around this scalelength will be required for a future 1 Gbit DRAM.

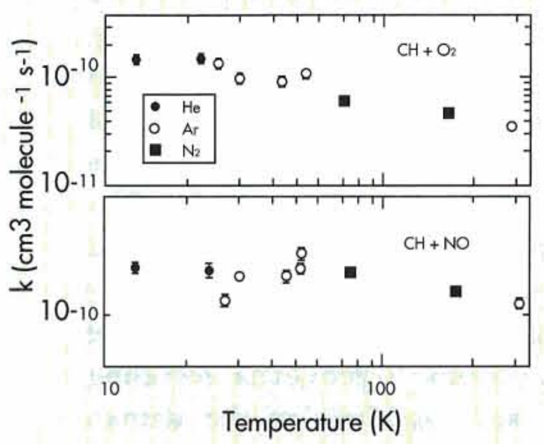
The RAL X-Ray Source produced 100 mW of X-ray power at a wavelength of 1 nm by focusing a train of picosecond KrF laser pulses onto a copper tape target. The X-ray lithography was carried out using 1:1 printing through an X-ray mask. Only the gate structure was defined by X-ray lithography, the remaining parts of the FET being produced using conventional lithography.

The resulting device showed excellent quasi-long channel operation and demonstrated that the laser produced X-ray source is a credible candidate for the future 1 Gbit technology.

Patterned 200 nm doped polysilicon gate electrode produced by laser X-ray lithography.

Collaboration:
C M Reeves, A M Gundlach, J T M Stevenson, A J Walton, A W S Ross — University of Edinburgh
P Anastasi, R Burge — Kings College, London
P Mitchell — Leica, Cambridge Ltd.
I C E Turcu, P Prewett, R A Lawes — RAL

Chemical reactions go fast at low temperatures



Rate constants for the reactions CH + O_2 and CH + NO as a function of temperature measured in the CRESU apparatus.

Results which have turned conventional chemical wisdom on its head have been obtained from a joint UK/French experiment using lasers from the RAL Laser Loan Pool. Reactions between neutral species generally go more slowly the lower the temperature. However, a collaborative experiment between the Universities of Birmingham and Rennes have found some reactions of simple radicals such as CH, OH and CN actually speeding up as the temperature was reduced down to as low as 13 degrees Kelvin.

The experiments were conducted in the unique low temperature CRESU (Cinetique de Reaction en Ecoulement Supersonique Uniform) apparatus at Rennes. Two Loan Pool lasers were used to provide both the source of radicals by pulsed photolysis and their subsequent measurement by laser induced fluorescence.

These results have profound implications, not just for reaction rate theory, but also in astrophysics. The formation of molecules at very low temperatures in dense interstellar clouds was previously thought to be due to reactions of charged species. It now appears that neutrals play a vital role and our view of chemistry in deep space will have to change.

Collaboration:
I R Sims, I W M Smith — University of Birmingham
B R Rowe — Universite de Rennes

Dense gas clouds in M16 - a region of starbirth and planet formation. Image from Hubble Space Telescope.

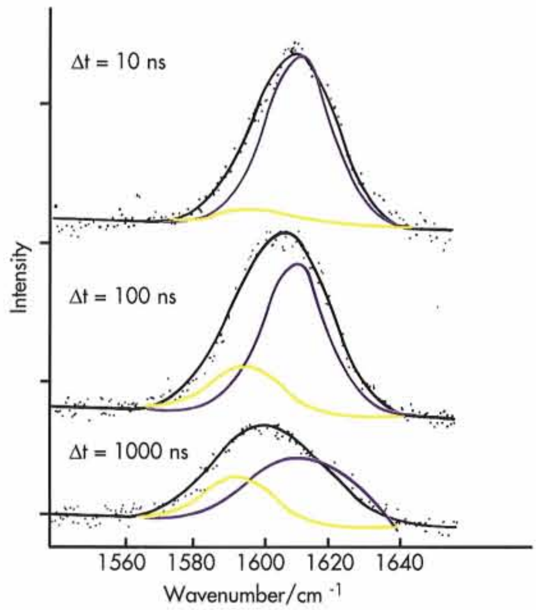
Vitamin E and vitamin C protect us by working together

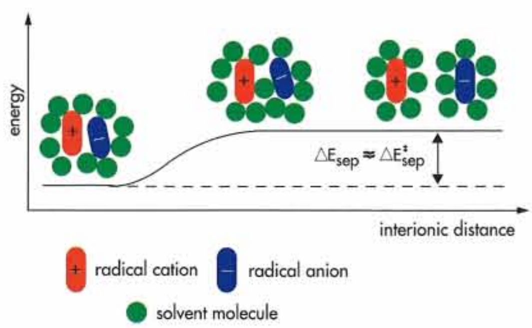
Although vitamin E is only a minor constituent of cells, it plays a vitally important role by eliminating harmful free radicals which are responsible for premature ageing and cancer. Each de-activation transforms the vitamin to its radical and since there is so little to begin with, a recycling reaction must be supposed to follow. It was controversial to suggest that vitamin C, which dissolves in water, could be responsible for regenerating a vitamin which dissolves in fat. Using techniques to mimic cells in their natural environment, and lasers to produce the vitamin E radical, it was possible to prove that recycling does occur, at a high rate. Analysis of the Raman spectrum, which varied with solvent polarity, showed that the vitamin E radical is located at the surface of the cell where it is accessible to the vitamin C, resolving the controversy. The spectrum also cast new light on the structure of the vitamin E radical. Further experiments have shown that vitamins E and C not only de-activate free radicals but also prevent their formation by directly quenching reactive electronically excited states such as singlet oxygen.

Collaboration:
R H Bisby University of Salford
A W Parker RAL

Vitamins are the picture of health. (93 RC 2896).

The give and take in an electron transfer process





The upper part of the figure shows a Raman band from the spectrum of the electron donor 1,2,4-trimethoxyybenzene. The peak is made up of two components: the purple line is from the geminate ion pair while the yellow line is the solvent separated ion. Mathematical analysis of these bands allows the thermodynamics of the separation of the radical ions, the red and blue ellipses, to be measured. The green spheres represent solvent molecules.

Time-resolved resonance Raman spectroscopy performed at different temperatures has allowed the first observation of the birth of the solvated ion from the geminate ion pair.

The transfer of an electron from one molecule to another is one of the simplest and most fundamental of chemical reactions, relevant to fields as different as photosynthesis and imaging technology, and yet this experiment gave the first direct measurement of the parameters of the theory. A laser pulse was used to create an excited state which can remove an electron, ie oxidise, another molecule present in the solution. As an initial step the two molecules collide to form an excited complex, called an exciplex, which is followed by the electron jumping from one molecule, the electron donor, to the other, the electron acceptor. This produces a geminate ion pair which separates to ultimately give solvated ions required for driving chemical reactions.

The work has measured the distance between the donor and acceptor within the geminate ion pair as 7.5 Angstroms and the energy required to separate them as 0.04 eV. This energy corresponds to the ions moving to a distance of 9.5 Angstroms. This increase matches the diameter of the solvent molecule pushing them apart.

Collaboration:
D Phillips, B Nohova — Imperial College, London
E Vauthey — University of Fribourg
A W Parker — RAL

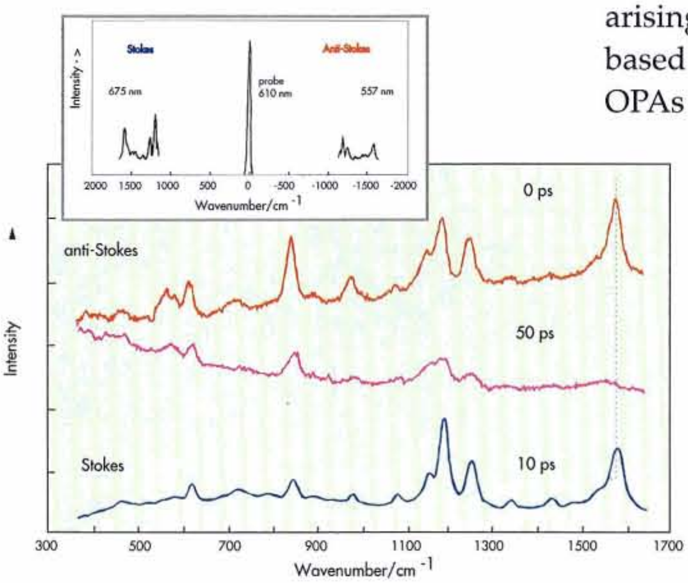
Photoexcited molecules need time to relax

The most rapid events in chemistry take place within a single molecule and are illustrated here by results on the vibrational relaxation (cooling) of photoexcited trans-stilbene. A pump pulse excites the molecule and a probe pulse tuned to resonance with a higher lying excited state is used to generate resonance Raman spectra.

Hot molecules can give up vibrational energy in the Raman scattering process, resulting in an up-shifted "anti-Stokes" spectrum. In the spectra shown here, the intensities of some high frequency bands decrease markedly relative to the majority, suggesting that excited states of these vibrations are highly populated - hot - to begin with, and then cool in about ten picoseconds, at least twenty times more slowly than expected.

This is the first time it has been possible to watch an excited state molecule in solution cool in this way, in real time. In these experiments the probe beam could not be tuned independently of the pump, preventing a study of the Raman excitation profile to resolve some of the issues arising from these measurements. A new laser system based on optical parametric operational amplifiers - OPAs - is being built to overcome this limitation.

Anti-Stokes spectra of photoexcited trans-stilbene in solution. The spectra show dramatic changes in the relative band intensities with time occurring at least an order of magnitude more slowly than expected from previous theories. A Stokes spectrum is shown for comparison. The inset shows types of Raman scattering in which probe photons gain (anti-Stokes) or lose (Stokes) energy in the interaction with molecule.



Collaboration:
D L Faria, J N Moore, R E Hester — University of York
M Towrie, P Matousek, A W Parker, W T Toner — RAL

The Vulcan glass laser system

Facilities

The Central Laser Facility at The Rutherford Appleton Laboratory provides access to large scale laser systems for researchers from the United Kingdom and other countries within the European Union. The Facility runs high power glass and KrF laser systems and a number of smaller, mostly tuneable lasers. The CLF operates a policy of continuously upgrading the laser facilities on offer.

Vulcan is the main high power laser system at the Central Laser Facility. It is a powerful and versatile glass laser system capable of delivering up to 2.6 kJ of laser energy in nanosecond pulses and over 30 TW power in sub-picosecond pulses at a fundamental wavelength of 1054 nm. Target irradiation at the second harmonic, 527 nm is also available. Various pulse length combinations between 500 fs and 10 ns can be provided.

The subpicosecond pulse is produced using the technique of chirped pulse amplification (CPA). In this mode a low intensity pulse is stretched in time from a few hundred femtoseconds to a few hundred picoseconds and then amplified before being recompressed just prior to being focused onto the target. Recompression is carried out using a pair of rectangular gold-coated diffraction gratings with the final grating situated within the target vacuum chamber. The maximum energy which can be delivered to target in this mode is limited by grating damage to 30 J. Experiments using the Vulcan beams are carried out in four target areas.

In the year ending March 1995, Vulcan fired 3439 laser shots to target areas.

Researchers from the University of Southampton with the Nd: LMA sub-picosecond oscillator which was developed for the front end of the Vulcan CPA system. (93 RC 4690).

Vulcan target areas

Beams from the Vulcan glass laser can be directed into one of four target areas.

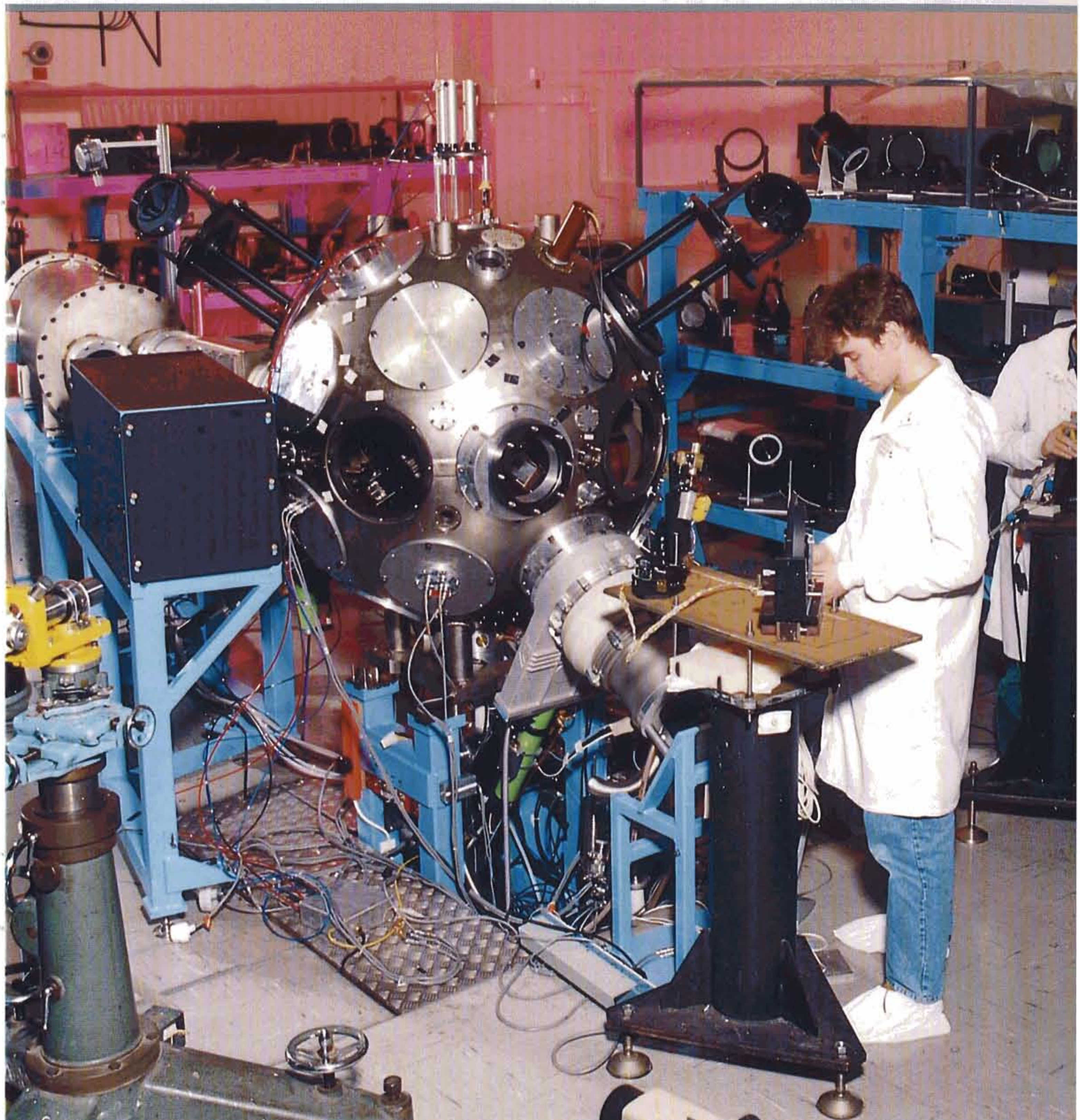
Target Area West is dedicated to short pulse, high intensity interactions using the 150 mm diameter CPA beam which can be focused to a spot of less than 20 μm or a 10 mm long line focus in the centre of the spherical chamber. Additionally, long pulse beams can be used in conjunction with the CPA beam and a low power frequency doubled or tripled sub-ps optical probe beam is also available.

Target Area East is a highly versatile area which is routinely set up to use all eight of the Vulcan laser beams. A 30 μm wide line focus of between 7 and 40 mm length can be produced and a cylindrical chamber can be added which allows a single sided cluster geometry. For a 1 ns duration laser pulse the six 108 mm diameter beams can each deliver 200 J and the 150 mm beams can deliver 300 J giving a total laser energy of 1.8 kJ at a wavelength of 1054 nm. Frequency doubling crystals are available for all eight beams.

Target Area Two uses three of the 108 mm diameter laser beams in long pulse mode (0.1 to 10 ns) at either the fundamental wavelength or second harmonic. For 1 ns duration laser pulses up to 200 J per beam can be supplied into this area.

Target Area Four is the smallest of the Vulcan target areas. It is set up to use a single 40 mm diameter long-pulse beam which can deliver up to 10 J at 1054 nm in a 1 ns duration pulse at a repetition rate of one shot every few minutes.

Target area staff set up the Vulcan CPA chamber in target area West.
(94 RC 2485).



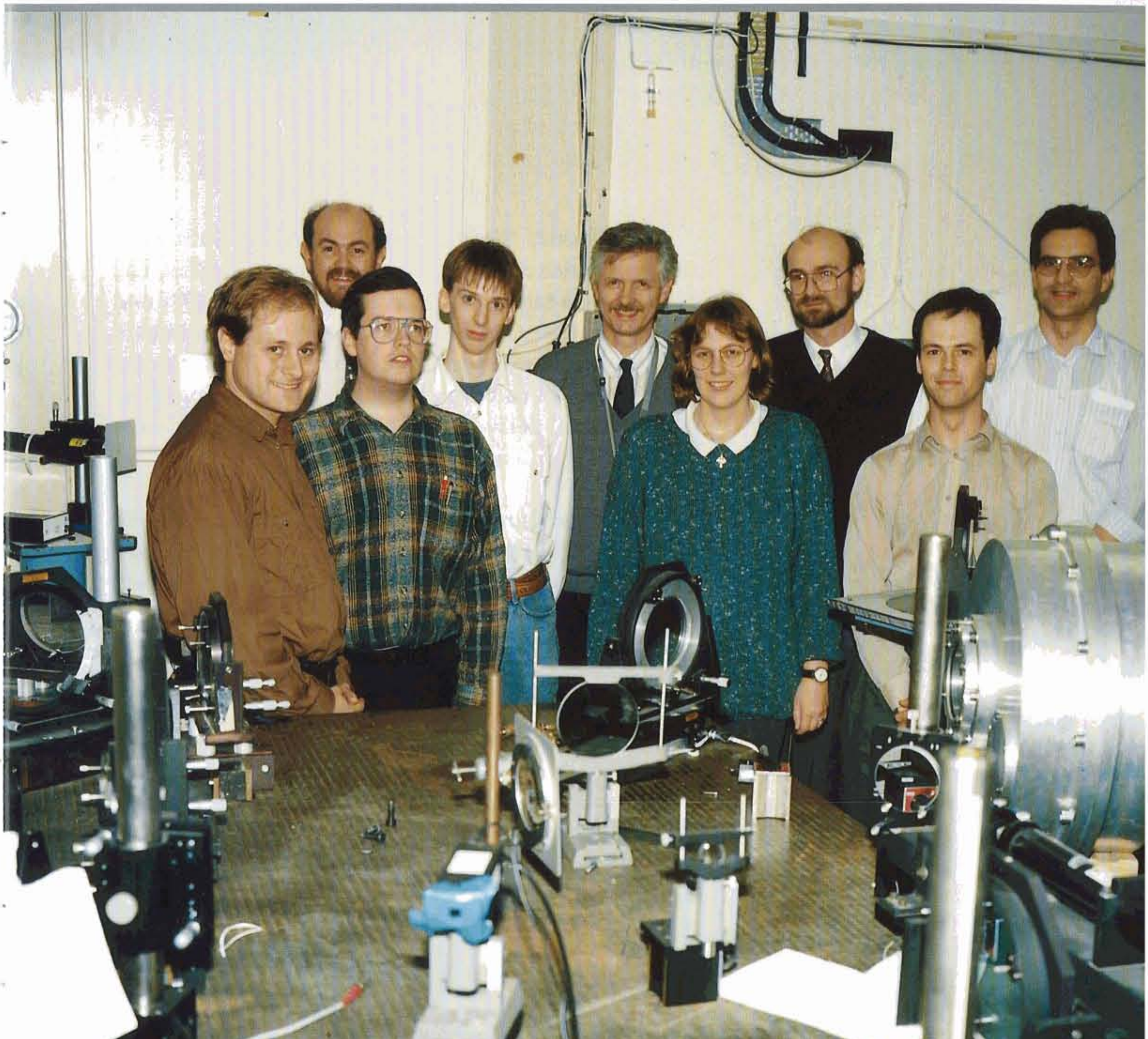
The Sprite KrF laser

In 1994/5 the Sprite krypton fluoride laser system was operated both in chirped pulse amplification (CPA) mode, when it delivered 1 TW of 249 nm light to target in 300 fs pulses, and in 268 nm Raman mode, when peak energies of 10 J in pulse durations ranging from 12 to 60 ps were available. The near diffraction-limited beam quality of the Raman system allowed intensities of >10^{19} W cm^{-2} to be reached.

The Sprite system operates a single target area with a single 100 mm diameter beam. Because the laser medium is gaseous it can be cooled quickly after a laser shot. At the busiest times Sprite has operated at up to 10 shots per hour.

During the year ending March 1995 Sprite fired 2187 laser shots to target. On the 31 March 1995 Dr Paul Williams fired the last shot on the Sprite laser. During 1995/96 the KrF laser facility is undergoing an extensive upgrade which will replace the Sprite system with a very much more powerful system - Titania.

Team from Friedrich-Schiller University, Jena with the Sprite operations team in the Sprite target area. (95 RC 2100).



The Titania KrF laser

Like Sprite, Titania will operate in both CPA (chirped pulse amplification) and Raman modes. The first beam to target will be available by April 1996 and will be a single CPA beam capable of being focused to an intensity in excess of 10^{20} W cm^{-2}. In Raman mode, which should come on line in the following year, Titania will deliver 400 J to target in four near diffraction-limited beams.

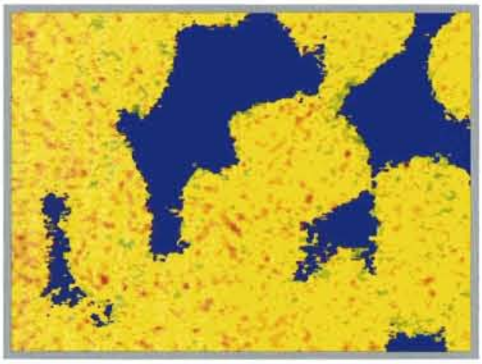
The largest single component in the new Titania system will be the final amplifier module. In the past year this module has undergone final assembly and testing. On 9 November 1994 it fired its first laser shot. The uniformity of pumping across the 42 cm aperture is considerably better than on the Sprite module, with an rms variation of just 3%. This should result in much more uniform beams delivered to target.

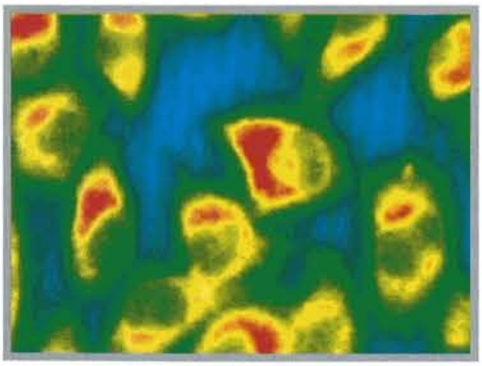
The optical design and layout of Titania is complete. The system will occupy approximately 1000 m^2 and join up buildings R2 and R7. Initially, a single target area will be served by both the CPA and Raman beams.

The Titania laser vessel. The eight electron beam cathodes which surround the laser are made from red cotton velvet!. (94 RC 2904).

The Laser Support Facility

Top: fluorescence intensity map, and bottom: fluorescence lifetime map of V79-4 Chinese hamster lung fibroblasts stained with a sulphonated phthalocyanine photosensitizer. Images taken with the confocal microscope.





The LSF provides user scientists and technologists with a wide range of lasers, laser-based techniques and expertise in their use. It is divided into five laser laboratories.

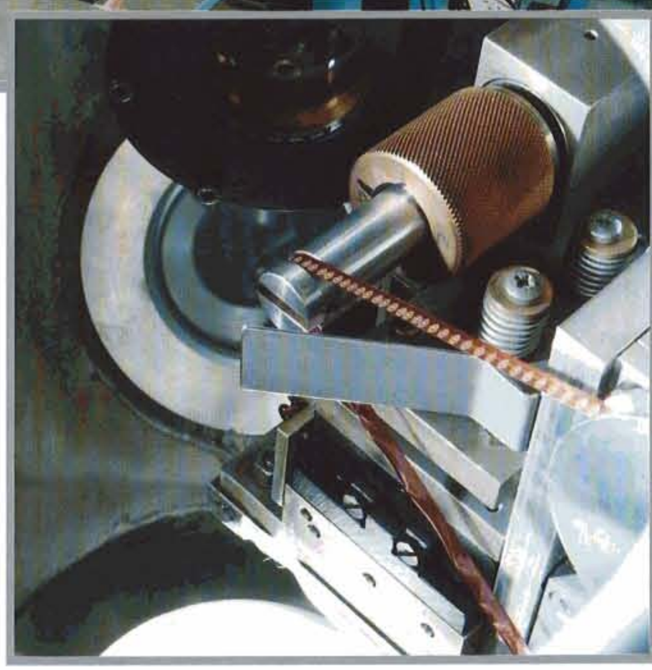
The Confocal Microscopy Laboratory has been recently established with a versatile laser-based fluorescence microscope having a time resolution of 120 ps. Samples are optically excited with a Nd:YAG-pumped dye-laser emitting pulses of 10 ps duration over the wavelength range 560 - 640 nm. Frequency doubling allows wavelengths in the UV from 280 - 320 nm to be achieved.

The Femtosecond Laboratory is primarily concerned with user experiments investigating the interaction of intense ultrashort pulses of light with matter. The laboratory uses a titanium sapphire oscillator to generate optical pulses between 50 and 100 fs in duration at wavelengths around 750 nm and by harmonic conversion to 350 nm. These pulses are amplified to energies up to 300 μJ per pulse so that intensities greater than $5x10^{15}$ W cm^{-2} can be obtained by focusing.

The Nanosecond Laboratory offers a diverse range of techniques to investigate the dynamics of chemical reactions and the intermediates that form on a time scale down to a few nanoseconds. Time-resolved resonance Raman spectroscopy, laser flash photolysis and resonance-enhanced multi-photon ionisation are the main techniques employed. Two excimer-pumped dye lasers, used as pump and probe, are both tunable between 205 and 900 nm.

Mark Thompson, a PhD student from the University of Reading, adjusts an interferometer built to shape the temporal profile of 50 fs laser pulses. (95 RC 3419).

Andy Weedall, a student on industrial training from Coventry University aligns a laser in the nanosecond laboratory. (95 RC 3295).



Tape transport system of the laser produced X-ray source. The copper tape, which provides a fresh target for each laser pulse, produces characterisitc X-rays of around 1 nm wavelength. (91 RC 1004).

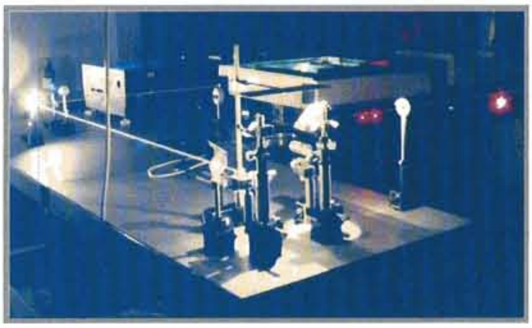
The Laser Support Facility

The Laser X-Ray Source offers a broad wavelength range of bright X-rays of high average power which have applications in fields as diverse as radiation medicine and X-ray lithography. High conversion efficiency of laser light to X-rays is obtained by using a train of picosecond pulses amplified to high power in two high repetition rate KrF lasers. Average X-ray power of 1 Watt into 2π has been obtained at a wavelength of 1 nm.

Dr Pavel Matousek adjusting the home-built Optical Parametric Amplifier in the Ultrafast Laboratory. (95 FC 4790)

The Ultrafast Laboratory is being developed during 1995 to provide femtosecond transient-absorption and picosecond time-resolved Raman spectroscopies. The laser source comprises a titanium-sapphire oscillator and a 40 kHz regenerative amplifier producing 17 μJ pulses of 130 fs duration tunable over the wavelength range 760 - 860 nm. This is used to pump two optical parametric amplifiers (OPAs) to generate independently tunable light between 480 and 730 nm with pulse energies exceeding 40 nJ. Tunable second harmonic and frequency mixed wavelengths will also be available.

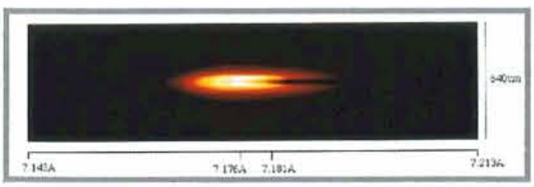
Laser Loan Pool



Loan Pool lasers probe ultra-low temperature reactions in the CRESU apparatus at the Université de Rennes, France. (93 FC 1124).

The Laser Loan Pool provides scientific lasers for researchers to use in their own laboratories. The lasers can be borrowed for feasibility experiments, used in extended research programmes or to enhance existing research facilities. The loan periods normally last from between 3 and 6 months. The range of lasers available include nanosecond-pulsed Nd:YAG-pumped dye lasers which, with harmonic generation, cover most of the visible and UV spectrum to about 260 nm. A fluorine excimer laser is available (157 nm), two 5W (all-lines) argon-ion lasers and a CW titanium-sapphire laser.

Theory and computation



Computer code simulation of spatially resolved, Doppler shifted emission at the aluminium Lyman-alpha wavelength. A 50 µm wire is assumed irradiated at 4×10^{14} W cm^{-2} in a 600 ps pulse.

The Theory and Computation Group provides support for experimentalists in the design and interpretation of high-power laser experiments at the CLF. The Group maintains a suite of computer codes which allow the experimentalist to simulate the plasmas produced by the interaction of high-power laser light with both solid and gas targets.

Access to facilities

There are three calls per year for proposals for experiments requiring access to LSF and High Power Laser facilities. Each proposal is assessed by a panel of specialists who determine scientific priorities and advise on strategic research themes of the CLF programme. Proposals will normally be for research themes already supported by grants from the Research Councils, although a small proportion of beam time is scheduled for proof-of-principle experiments to assist in the preparation of a grant application.

Researchers within the European Union (but outside UK) have the opportunity to bid for time at the CLF through a Large Facilities Access contract. Several groups have already performed extremely successful experiments under this arrangement. More EU funded experiments are scheduled in the coming year.

Commercial access to the CLF's facilities is also available on a full costs basis.

Enquiries for further information by new potential users should be made to the Head of the CLF:

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