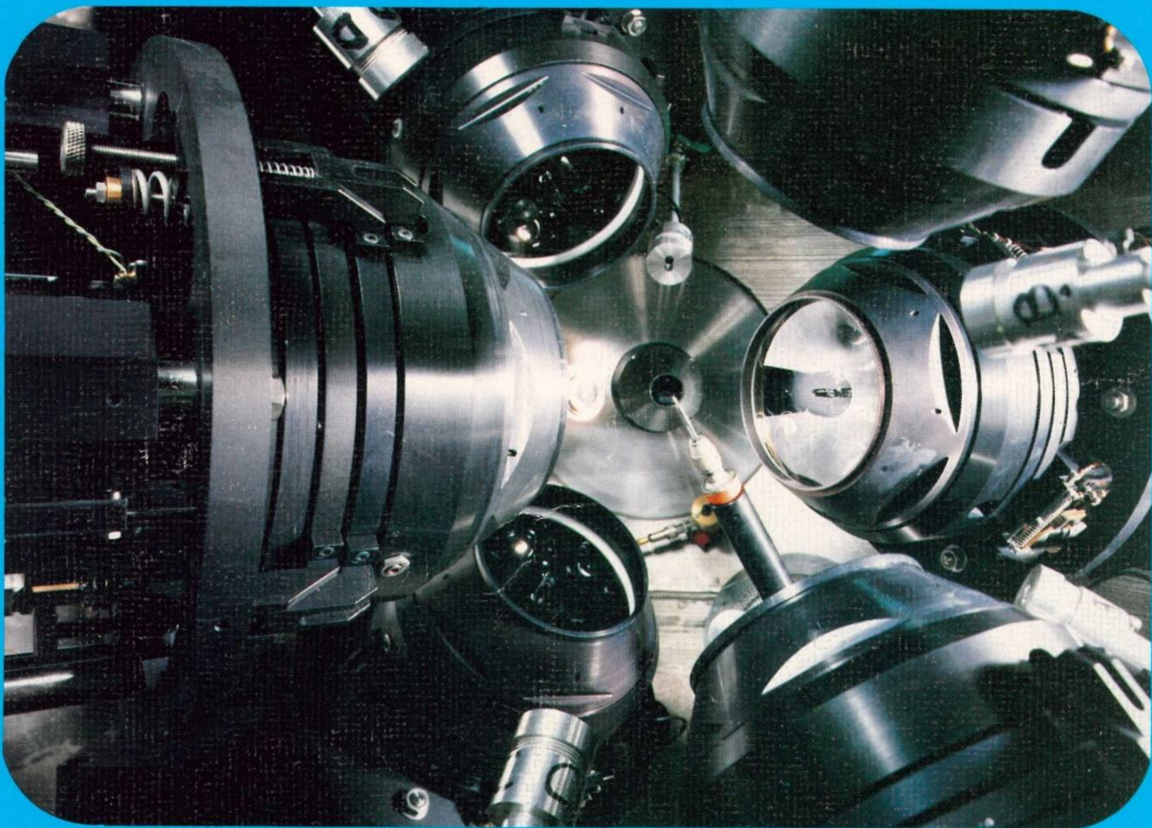
CENTRAL LASER FACILITY



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The Science and Engineering Research Council provides a Central Laser Facility at the Rutherford Appleton Laboratory for the primary purpose of research by UK universities. The facility is equipped with lasers which are too complex and costly to be set up in individual universities.

New users of the Facility are always welcome and its use is free of charge to UK university groups who are successful in a peer review process. The SERC particularly wishes to encourage international and industrial use of the Facility. Further details for both academic and non academic users are given in the enclosed leaflets.

The main facilities are:

A VULCAN: a multi-beam, multi-terawatt glass laser operating at wavelengths of 1.05 μm, 0.53 μm and 0.35 μm. Two target areas provide facilities for laser compression and laser plasma interaction studies, X-ray laser research and also for the application of laser plasmas as sources of X-rays or charged particles, e.g. in solid state physics, biology and astrophysics.

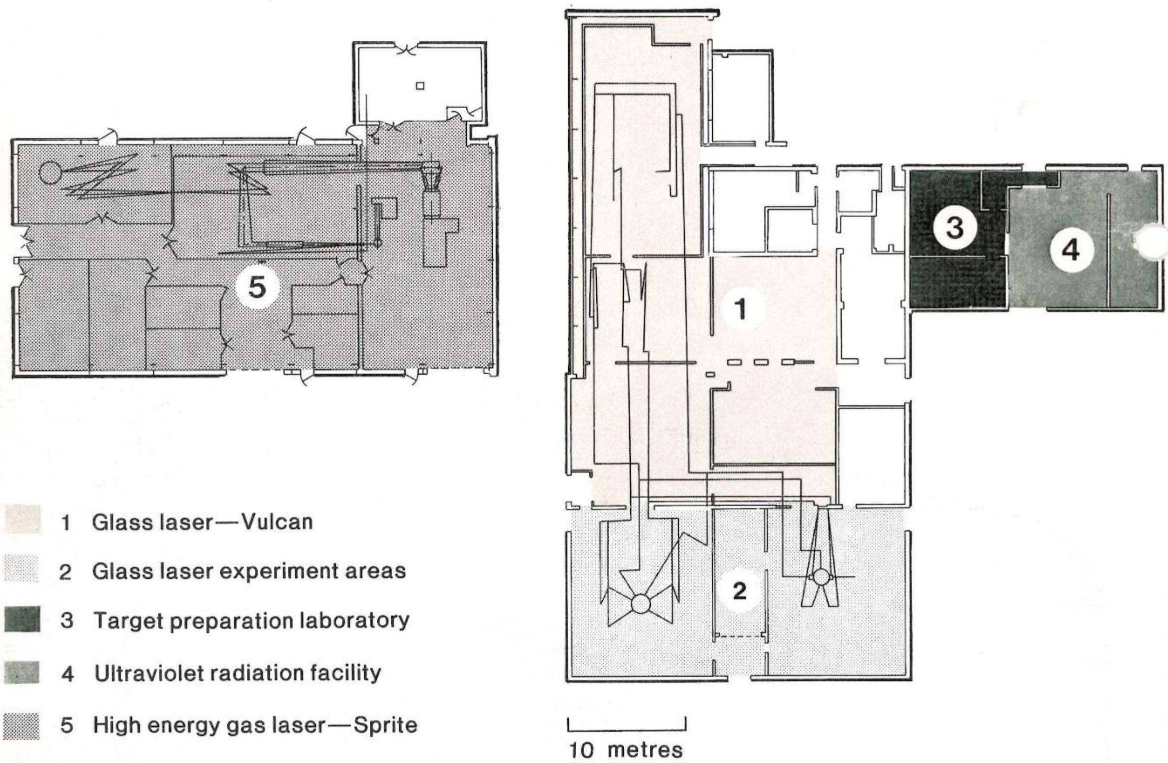
B Ultraviolet Radiation Facility (UVRF): this offers several high repetition rate pulsed lasers (some of which are tunable) operating throughout the visible and UV spectral regions. The UVRF offers very flexible facilities and is used for photochemistry, biology, plasma physics and non linear optics.

C SPRITE: a 200 Joule Krypton Fluoride laser operating at 249 nm. Sprite is used for gas laser research, laser kinetics and semiconductor surface physics.

D Target Preparation Facility: This group offers a wide range of expertise in microfabrication techniques, mainly associated with the VULCAN experiments.

E Theory and Computation: A range of sophisticated computer codes are available in the general areas of optics, plasma physics, hydrodynamics and atomic physics. Staff may be available to assist in the design and analysis of experiments.

Further details are given in the enclosed leaflets.



HWP

Lasers for Scientific Research

W T Toner

The Laser Support Facility at Rutherford Appleton Laboratory is three years old and now has six lasers on loan to universities and experiments running in four laboratories at RAL. Any member of academic staff can apply for laser loans or for time on lasers at RAL for research in chemistry, biology or physics. Researchers in thirty institutions have published over sixty papers since 1985 on topics ranging from enzyme catalysis to the ionisation of molecules on a femtosecond timescale. The facilities may also be hired by researchers in other fields or by industry. BP, Rolls Royce and STC are among the customers.

The LSF staff of five scientists are supported by CLF technicians and by a small laser development group. Such a small group cannot cover all of laser based science so the initial effort has been concentrated on providing an extensive suite of pulsed tunable dye lasers with excimer or YAG pumps. These lasers are much in demand and this choice also makes best use of the back-up expertise of other staff at RAL. The general aim is to provide state-of-the-art equipment which is too expensive for most groups to acquire without a major grant, or too complex for any but specialist laser groups to maintain, such as the picosecond system based at RAL.

The lasers at RAL are scheduled in much the same way as a station on ISIS. The loan pool had no obvious precedent in the UK although a successful model was provided by the NSF's San Francisco Laser Center. Loans of up to three months at a time are made to users anywhere in the UK: Edinburgh, Essex, Sussex and Southampton have all had loans. Staff inspect the site - the 'small' lasers of the LSF weigh up to half a ton - and arrange for the laser to be delivered and for maintenance. At the end of the period the laser is moved to the next user. The scheme was not without its teething troubles. For example, the cold weather of 1986 revealed that after draining in the recommended way one of the lasers still contained quite enough coolant to damage the laser when frozen. But on the whole the lasers have turned out to be much less delicate than had been feared.

The main purpose of the LSF is to enable more good science to be done. The few examples given below have been chosen to give the flavour of the work and to illustrate the benefits of the cross-disciplinary collaborations which grow naturally from the development of common facilities by a community of users.

The biological applications of LSF lasers have great diversity. At University College London a loan pool laser is used to saturate the photosynthesis in large enough samples of plant material for later analysis by electron paramagnetic resonance. Research at Kings College London, again using a loan pool laser, has shown that one-dimensional 'facilitated diffusion' of proteins along DNA chains can be observed and measured. In this work a chopped beam from an ion laser was focussed to an intensity high enough to induce localised bleaching and fluorescence produced by a probe beam was used to measure the recovery time of the bleached region, from which the diffusion rate of the protein (histone H1) could be deduced. At RAL, good progress is being made in an ambitious study of in-vivo DNA damage repair mechanisms by a Birmingham- Sussex-MRC collaboration using a radioactively labelled "caged" repair inhibitor whose synthesis alone is a formidable challenge. Live mammalian cells permeated with this material in its inert, caged form are irradiated with a pulse of ultraviolet light of 248nm wavelength which damages the cellular DNA but has no effect on the caged compound. At a later time a pulse of light of 351nm wavelength breaks the cage to activate the repair inhibitor and a subsequent radio-assay measures the uptake of the inhibitor and thus the amount of unrepaired damage. Other biology experiments at RAL include picosecond measurements of photosynthesis (Lancashire Polytechnic - RAL), picosecond fluorescence measurements of genetically engineered proteins (Bristol - RAL) and the development of scanning X-ray microscopy techniques using X-rays produced by high repetition rate lasers focussed to micron-sized spots (Kings College - RAL), a programme which originated in experiments on the high power VULCAN and SPRITE lasers.

Research in chemistry accounts for over two thirds of LSF use but there is space for only one or two examples. The gas phase is represented by the work of a group from Reading who have used a multipass absorption cell to study the kinetics of reactions of the dimethyl silane radical with unsaturated hydrocarbons and related species. An excimer laser generates the radical by photolysis of pentamethyl silane and an ion laser is used to probe the radical concentration. Reaction rates were found to depend progressively on the availability of the π electron from the donor to fill the empty p orbital of the radical. The results have given new insights into addition reactions. Gas phase reactions have also been studied in Birmingham, Edinburgh, Heriot-Watt, Manchester, Nottingham and Southampton. Work in solid state chemistry is exemplified by a classic study made at Oxford of two photon absorption in single crystals of $Cs_2 UO_2 Cl_4$ cooled to 4.2K. The data clearly reveal the electronic origin transitions of 13 of the 14 excited states below 33,000 cm^{-1} and polarisation data enable a complete symmetry analysis to be made. The clarity of the spectrum is illustrated in figure 1. Chemists from Loughborough, Nottingham, Lancashire Polytechnic and East Anglia are also active users of the picosecond laser.

The spread of advanced techniques through the community is well illustrated by the Raman scattering programme at RAL where methods developed by York and the Royal Institution for an extensive study of anthraquinones were used by Birmingham and York for work on enzyme catalysis, by Belfast for measurements on organometallic complexes and by BP for the analysis of hydrocarbon mixtures. Results have included the first observation of an acyl enzyme intermediate in naturally occurring enzyme catalysis and the first examples of Resonance Raman Scattering from metal-ligand-charge-transfer states of copper complexes and from transients in the photolysis of the Fischer complex. Picosecond Raman techniques are now being developed.

Physicists also use LSF lasers. Loans have been made to Strathclyde for work on phase conjugation, to Essex for measurements of phonon spectra and to Imperial College for measurements of line shapes in dense plasmas. The picosecond facilities at RAL excite the greatest interest. The most elaborate experiment was to transmit a train of pulses at 746nm through a 70 meter optical fibre to another building where a selected pulse was amplified, converted to 248.6nm and injected into the SPRITE laser chain for amplification to an energy exceeding one Joule. SPRITE now has its own picosecond source and has produced a world record output of 2.5 Joules in 3.5 picoseconds. The simplest experiment from the laser point of view was the excitation of luminescence in amorphous semiconductors mounted in a helium cryostat brought by a group from Exeter. The success of their measurements of luminescence decay helped make the case for a picosecond system at Exeter.

From a physics point of view the most exciting results have come from a Reading-RAL collaboration studying molecular dissociation. For this work the pulse was shortened to 600 femtoseconds and intensities in the focal spot exceeded $10^{16}Wcm^{2}$ generating electric field strengths which were a substantial fraction of the binding fields of the atoms. Figure 2 shows the chamber in which the beam was focussed and figure 3 is an ion time-of-flight spectrum from the dissociation of nitrogen. Dissociative ionisation was found to proceed sequentially from singly to doubly, triply and quadruply ionised molecules and then in a two-electron jump to the sextuply charged molecule. The time taken for the whole process is estimated at less than 30 femtoseconds by considering the velocity with which highly charged ions separate under coulomb repulsion. This work is now being extended to higher intensities using excimer lasers to amplify the sub-picosecond pulses.

The LSF user base continues to expand in numbers and breadth of subject and staff look forward to an equally stimulating programme in the next three years.

CONTENTS

I THE SCIENTIFIC PROGRAMME OF THE CENTRAL LASER FACILITY

The primary purpose of the SERC Central Facility (CLF) is to provide advanced research facilities for use by UK universities. In addition the SERC welcomes international collaboration in the exploitation of the CLF and its use by industry and other Government laboratories.

The CLF was established in 1975 and its scientific programme and equipment have developed vigorously under the management of the Laser Facility Committee which is a representative committee of university staff and other non SERC experts. The scope of the scientific programme reflects the interests of the user community, membership of which is open to all UK university staff. The programme is determined by procedures described in more detail in the enclosed notes on "Use of the facilities and participation in the scientific programme". The main themes of current research can be broadly summarised as:

A Plasma Physics

1 The physics of ultra-dense, strongly interacting plasmas of high net ion charge, and related departures from "classical" plasma behaviour.

2 The study of non-linear interaction of high intensity laser beams with matter, including parametric instability effects, stimulated scattering processes and relativistic corrections.

3 The study of energy transport in plasmas including the heat flux limit in a steep temperature gradient, heat flow in dense strongly interacting plasma, heat flow instabilities and energy transport by photons.

4 The study of laser-generated implosions in relation to the generation of dense plasmas and to inertial confinement fusion research.

B Laser Support Facility

Multidisciplinary applications of repetitively pulsed and frequency tunable lasers in physics, chemistry, biology and materials processing covering the frequency range from the VUV to the near infrared. Picosecond laser applications and development.

Laser Loan Pool - provision and support of laser equipment on short term loan to University users engaged in work related to the Science Board programme.

C X - Ray Lasers

X-ray laser development exploiting inversion occurring naturally in laser-generated plasmas or induced by intense X-ray pumping from another laser-produced plasma.

D Applications of Laser Produced Plasmas

Development and application of laser plasmas as pulsed, intense, X-ray sources (both line and continuum), and as sources of charged particles or pressure impulses for applications in physics, chemistry and biology. Of particular importance are the use of X-rays for surface science and EXAFS investigations on nanosecond timescales and the microscopy of in vivo biological and botanical specimens.

E Short wavelength Lasers

Development of very high power ultra-violet lasers of high efficiency, for applications in plasma physics and in other aspects of physics and chemistry.

The work of the Central Laser Facility is described fully in its own annual report and is summarised in the annual report of the Rutherford Appleton Laboratory. Copies of these and further information about the facilities can be obtained from:

Dr M H Key
Division Head, Laser Division
Rutherford Appleton Laboratory
Chilton
Didcot
OX11 0QX

Tel: (0235) 21900 extension 5582

II USE OF THE FACILITIES AND PARTICIPATION IN THE SCIENTIFIC PROGRAMME

(a) UK Universities

Any UK university staff member or research student can use the facilities for approved scientific work. No charge is made to the university and travel and subsistence costs are met by the SERC.

Potential new users of the CLF are always welcome. First enquiries should be addressed to:

Dr M H Key
Division Head, Laser Division
Rutherford Appleton Laboratory
Chilton
Didcot
OX11 0QX

Tel: (0235) 21900 extension 5582

CLF staff can advise on the feasibility of potential new uses of the CLF's lasers and on the procedure for obtaining access to the lasers in particular cases

There are various ways in which scientific work can be approved and scheduled. These are based on the principle of peer review by university staff with appropriate scientific expertise.

Grant applications for substantial experimental or theoretical research programmes in the Science Board area can be made through the normal channels and will be considered by either the Subject Committees of the Science Board or by the Laser Facility Committee (LFC), the latter dealing with grants for work based wholly or mainly at the CLF.

A sub committee of the LFC (the Laser Support Facility Panel LSFP) deals with applications requiring only use of the lasers (on loan or in situ) provided in the Laser Support Facility. Special application forms can be obtained from the CLF or SERC Central Office.

Deadline dates for applications for use of the LSF are 15 September, 15 December and 1 April for non-grant holders (Form LSF2), and 1 October, 1 January and 1 May for grant holders (Form LSF1).

Scheduling of grant holders experiments is handled through two committees.

The High Power Laser Scheduling Committee (HPLSC) schedules work using the High Power lasers (VULCAN and SPRITE). The committees meet three times per annum to schedule specific proposals for experiments of one to several weeks duration. Scheduling meetings are preceded by informal meetings of specialist scientific groups which serve as a forum where proposals are discussed and assessed and collaborations arranged. Proposals from non grant holders for short trial experiments are also considered by the scientific groups HPLSC, and a few per cent of laser time may be allocated to these. Bids for first experiments by new users are generally treated more favourably than bids from established users who face fairly stiff competition.

Scheduling of the LSF lasers is carried out by the Laser Support Facility Scheduling Committee which acts on recommendations for the LSFP. Loans of 2 to 3 months duration are scheduled on the basis of the LSFC's response to the initial grant application.

Use of the LSF lasers at RAL is scheduled on the basis of the LSFP's judgment of bids from grant holders for specific experiment of one to a few weeks duration forming part of their approved programmes.

A few per cent of the laser time is reserved for allocation by the Head of the Laser Division in a shorter timescale and may be allocated to non grant hoders for short trial experiments.

Bids should be made directly to Dr M H Key, (see address above).

(b) International Collaboration

The SERC through its Laser Facility Committee encourages international collaboration in the exploitation of the Central Laser Facility.

This can take place at various levels. The simplest level is collaboration between individual UK university scientists and their overseas colleagues in experiments proposed through the normal channels by the UK university.

At the next level an overseas user can buy time for an experiment. In this case there is no need for reference to the competitive scheduling procedure but only a small fraction of the operational time can be allocated in this way.

Finally, SERC can, where appropriate, enter into international partnership agreements involving joint programmes of research and shared funding of facilities. All enquiries concerning international collaboration should be addressed to:

Dr M H Key
(see address above)

(c) Industrial and Government Research

Industrial organisations and Government laboratories are invited to buy laser time at the CLF, without reference to the competitive scheduling procedure. Assistance in the use of the lasers and advice on experiments is given by CLF staff. Company confidential work can be carried out. Applications should be addressed to:

Dr M H Key
(see address above).

III THE VULCAN ND GLASS LASER SYSTEM

The glass laser has been designed with versatility as its main object. Thus while the capabilities described below are those currently available it is possible for requirements outside of these parameters to be met by suitable prior arrangement.

VULCAN is a six beam laser system with a nominal operating wavelength of 1.053 μm. At the heart of the laser are two synchronised oscillators which are currently a unique facility. These oscillators produce a "long" pulse whose duration can be varied between 0.7 and 25ns FWHM synchronised within 5ps jitter to a second pulse that can be varied between 70ps and 0.5ns. These two pulses are independently amplified and can be fed in any combination into two output channels. A schematic layout of the laser system is shown in Figure 1.

Full power shots are available at 20 minute intervals. For short pulses of less than 200ps the output is currently limited to 0.5TW per beam (50J in 100ps) while for long pulses greater than 700ps this limit is 200J/beam. These powers and energies represent 3TW and ~ 1kJ in the six beam array. These outputs are at a wavelength of 1.053μm but can be converted with approximately 50% efficiency into the "green" (0.527μm) or "blue" (0.351μm). Further details of these options are listed under the experimental areas.

For alignment purposes lower energy shots of a few Joules/channel are available on a 5 minute cycle. Additionally a synchronous low power short pulse probing beam is available at 10mJ on a 9sec cycle or 100mJ on a 2 min cycle. This probe beam can be converted to a wide range of wavelengths for optical probing or triggering purposes. Electrical trigger signals are also available both prior to a shot and synchronous with the shot.

The range of pulses available and the output capabilities are being constantly developed in response to user demand and further developments to meet new experimental requirements will always be considered. (For example a two frequency output for beat wave accelerator studies has recently been accomplished).

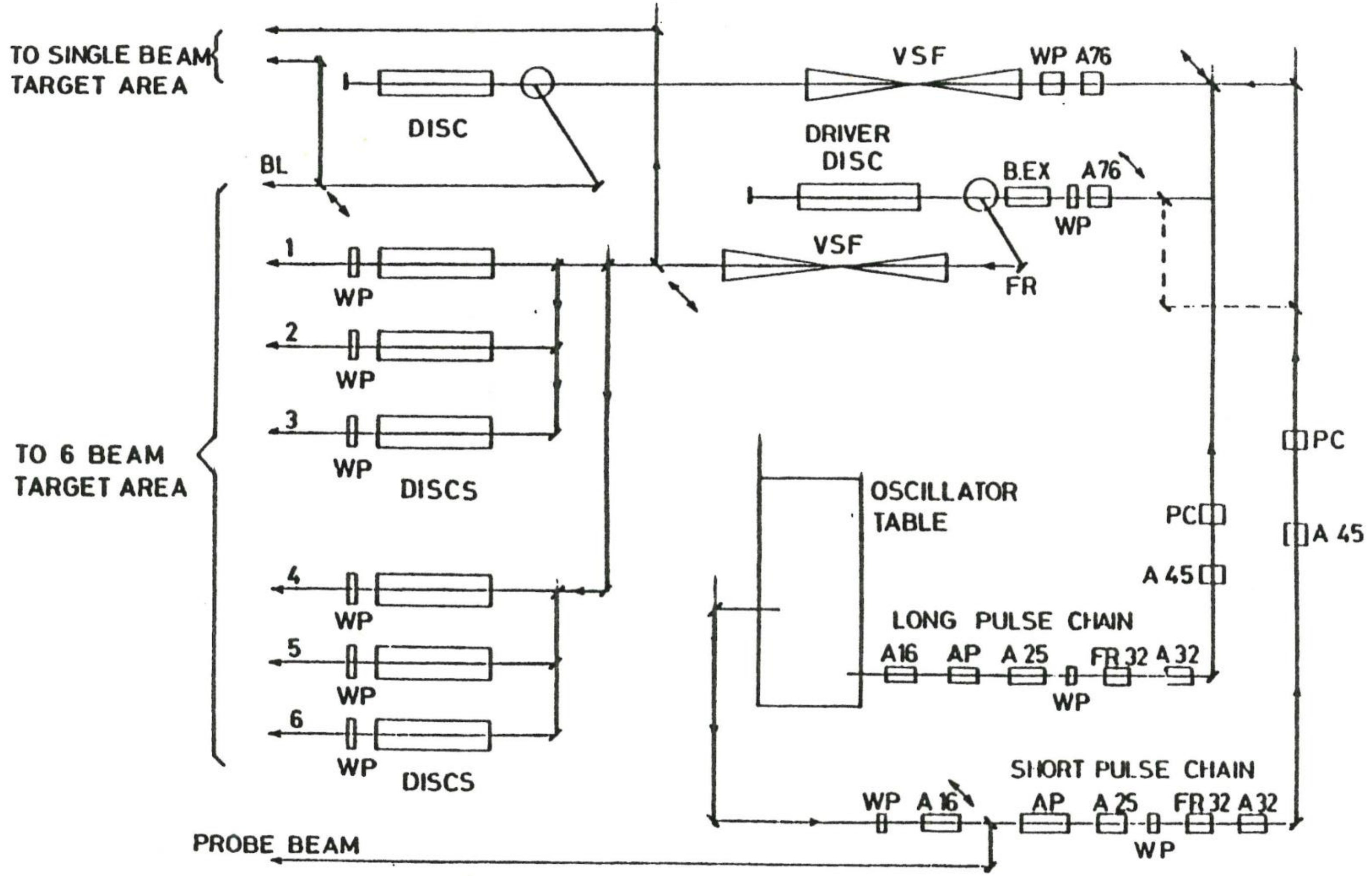

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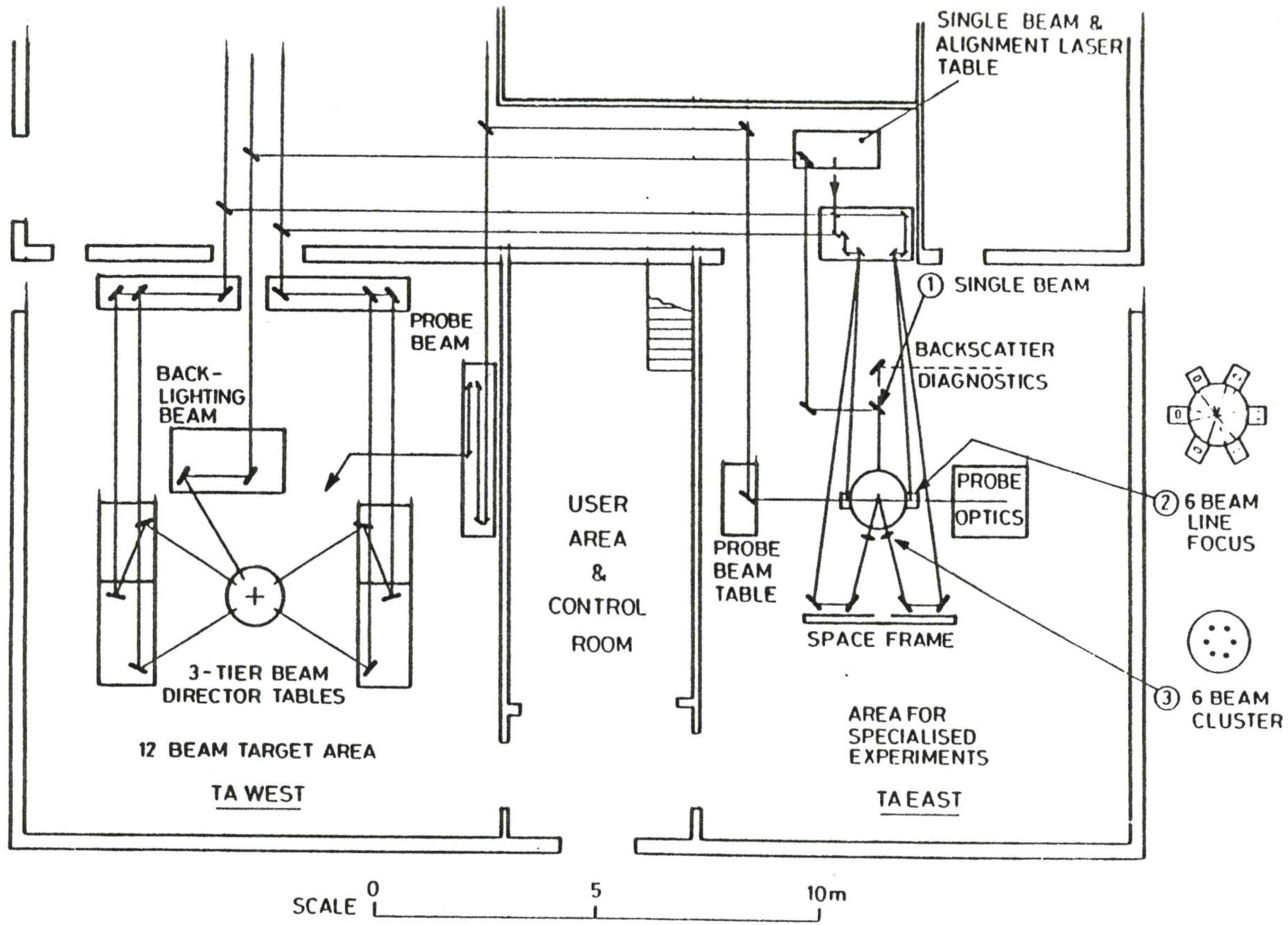
Figure 1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(a) VULCAN Target Area Facilities

Two experimental or "target" areas are provided for users of the VULCAN Nd glass laser.

Target Area West

This provides for 12 beam irradiation in dodecahedral symmetry using aspheric f/2.5 focusing lenses. The main use of this area is for symmetric illumination "compression" and energy transport experiments. The 12 beam illumination may be at 1.05 μm or 0.53 μm, and different beams can operate at different wavelengths.

An additional beam is provided, which can have a different pulselength and timing from the other beams. This is focused by an f/2.5 lens and is normally used for X-ray radiography.

The target and illumination optics are contained in a vacuum vessel 0.6 m in radius which is liberally provided with access ports.

Target Area East

This provides maximum flexibility in the illumination geometry including a six beam cylindrically symmetric line focus and six beams in a "cluster" for maximum energy density on flat targets. A large aperture single beam of higher energy and improved optical quality is also planned for this area. The harmonics of the glass laser output from 1.05 μm to 0.26 μm will be available for at least some of the illumination geometries as funds allow.

Experiments in Target Area East can also be performed in users own vacuum vessels.

A schematic layout of the target area facilities is shown in Figure 2.

Diagnostic Equipment

The VULCAN target areas are provided with a short pulse optical probe/trigger beam at 1.05 μm. This pulse may be harmonic converted and Raman shifted to a variety of wavelengths in the visible and near UV. Optics for interferometry, shadowgraphy, Schlieren imaging and Faraday rotation are available.

Three optical streak cameras are available, one coupled to an OMA detector. S1 infra red/visible and S20 visible/near UV streak tubes are available. Other optical equipment includes 0.5 m and 1.0 m grating spectrographs.

Two X-ray streak cameras with imaging or spectrally resolving inputs are provided, also a variety of X-ray and VUV spectrometers and filtered X-ray diodes.

An offline single beam target chamber on VULCAN, a 20 pps Nd Yag laser and a DC X-ray source are available to facilitate off line setting up of instruments.

(b) Target preparation facilities

The Target Preparation Group is able to supply at short notice a very wide range of targets for all aspects of the laser programme.

Extensive facilities exist for the processing and handling of glass microshells so that target quality shells can be selected from raw material, filled with gas, fully characterized in terms of uniformity, wall thickness and diameter and finally mounted on a fine carbon fibre ready for experimental use. At present raw material is available to select targets within the range 50 - 300 μm diameter and 1 to 5 μm wall thickness with wall uniformity of better than 10%. Such shells are available either empty or filled with DT gas mixture at 10 or 20 Bar pressure. In addition equipment is available to fill shells with H_2, D_2, Neon or Argon at pressures up to 50 Bar.

As well as glass shells, low X-ray opacity polystyrene shells of high quality can be manufactured in the 50 - 200 μm dia range with wall thickness from 2 to 12 μm. Such shells are available filled with up to 4 Bar of the chlorine containing gas Freon 12.

Solid spheres are available in a wide range of materials such as polythene, polystyrene, B_4C, Ti, V, Cu, Mg, U and glass with diameters up to 300 μm.

Using vapour phase and plasma polymerization techniques polymer coatings can be applied uniformly to glass microshell and solid sphere targets for certain experiments. Coatings up to 10 μm thick can be applied and accurately measured. Thin (< 0.25 μm) metallic coatings can also be applied uniformly to spherical targets.

Coatings up to a few μm thick of a very range of materials can be applied to various target substrates using techniques such as thermal evaporation and r.f. and d.c. diode and triode sputtering. Multilayer targets can be readily fabricated using sequential evaporation techniques with layer thicknesses monitored to a few % accuracy. A wide range of thin polymer and metal foils are available from 0.1 μm up to several 100 μm thick for target substrates.

Microdisc or lollipop type targets can be fabricated from polymer or metals by precision punching or evaporation techniques in the diameter range from 100 to 550 μm with thickness from 1 to 20 μm. Such disc targets can be manufactured with a one dimensional, up to 100 line per mm, ripple pattern for certain experiments while various periodicity modulations can be applied using reactive ion beam milling or ArF laser etching techniques.

Shell and disc targets are generally mounted on thin (< 10 μm) carbon fibres but in addition such fibres are available for X-ray laser experiments in the diameter range 3 to 20 μm.

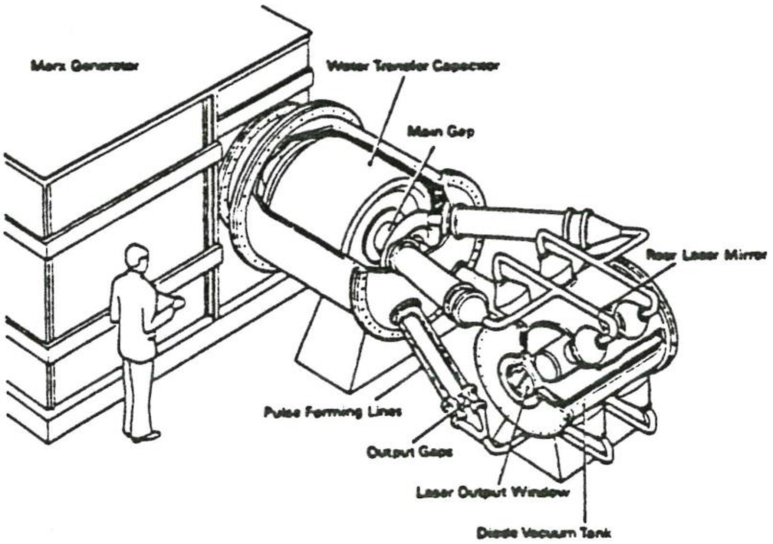
A very wide range of microscopy equipment is available for characterizing shell, disc and foil targets. This includes many conventional and interference optical microscopes together wtih a scanning electron and X-ray microscope. For handling small laser targets a variety of micromanipulators are used.

IV HIGH POWER GAS LASER - SPRITE

(a) Laser Installation

SPRITE is an electron - beam pumped Krypton fluoride gas laser which produces 200J pulses of approximately 60ns duration at a wavelength of 249nm. The laser beam has a diameter of 25cm and by using an unstable resonator cavity highly focusable beams of 100 µrad divergence are produced. SPRITE is a low repetition rate system which can be pulsed every 5 minutes, this limit being set by power supply current available.

SPRITE is used both for scheduled expeirments and for in-house gas laser research. It will be used as the main power amplifier in a new laser system now being constructed to generate 150J, 8ns UV laser pulses. This output will be achieved in 8 beams by compressing the power available from SPRITE in 60ns into a pulse of 1ns duration by using angular optical multiplexing and Raman amplification in gaseous methane (CH_4) will be used to combine the eight beams into a single beam of high optical quality. This 100J laser beam will be generated at a wavelength of 268nm which is the 1st Stokes Raman wavelength of methane. A multi-kilojoule laser based on this principle may be constructed later and high power picosecond pulses operation may be developed.



About 20% of the time on SPRITE is made available to users. Its main application is as an intense source of soft X-rays for example in solid structure physics (EXAFS and small angle diffraction) or biological high resolution imaging. Applications in photochemistry at higher energies than available in the UVRF will also be possible.

(b) SPRITE Target Area

The single beam from SPRITE is focused using a f/10 fused silica lens into a 0.5 metre radius vacuum vessel. About 100J of energy at 249nm can be delivered onto target in 100ns giving 5 x 10^{13} W cm^{-2} in a 40μm focal spot.

V THE LASER SUPPORT FACILITY

(a) Loan Pool Lasers

Operation of loan scheme

Once an approved loan has been scheduled, LSF staff inspect the site, arrange transport, install the laser and check its performance on site. They carry out field maintenance as required or arrange for it to be done by the laser manufacturer. At the end of the loan, they recover the laser.

The user's safety officer is informed at an early stage that the loan is to be made.

(1) Datachrome 5000 (Quantel)

20 HzQ Switched YAG 10ns pulse width $0.7cm^{-1}$ linewidth
1064nm: 700mJ/532nm: 260mJ/355nm: 105mJ.

Dye Laser .08cm linewidth
60mJ at 580nm
Stokes Raman to 1900nm
Mixing, Doubling, Doubling+Mixing
AntiStokes Raman to 190nm

(2) JK 2000 (JK Laser)

10 HzQ Switched YAG 20ns pulse width
1060nm; 500mJ/532nm; 150mJ/355nm; 55mJ

Dye Laser $0.1cm^{-1}$ linewidth
25mJ at 580nm

(3) Additional Available in 1986

Excimer pumped dye laser+doubler+Raman

Tunable dye laser with pump

Ar Ion laser + Standing wave dye laser

CO_2 Waveguide laser

Streak Camera

(b) Lasers for use at RAL

(1) EMG 150 ETS The EMG 150 ETS is a line-narrowed excimer with a high energy pulsed output. It can be operated with KrF (249nm), ArF (193nm), and XeF (351nm). The system has an oscillator and amplifier incorporated into a single housing. The oscillator facilitates narrow line operation of the normally broad laser transition. Typical output line widths are $0.3cm^{-1}$ for KrF, $3cm^{-1}$ for ArF and $2cm^{-1}$ for XeF. The line is also tunables over the excimer band. The amplifier cavity is formed by an unstable resonator and is injection locked by the oscillator beam. Energies of 700mJ with KrF and 200mJ with ArF can be obtained in pulse lengths of 20ns and 11ns respectively. The beam is horizontally polarised and has a low divergence. Pulse repetition rates of up to 10Hz can be used. Oscillator and amplifier can be run as separate synchronised lasers using different gas mixes if required.

(2) EMG 101E (XeCl) This laser is run on the XeCl excimer producing 180mJ, 15ns pulses at 308nm at a repetition frequency of up to 40Hz. The laser can be used for experiments on its own but it is more normally used as a pump for the dye laser described below.

(3) FL 2002E (Dye Laser) This tunable laser is pumped by the EMG 101E XeCl laser. The pulse duration is ~ 10ns and a line width of $0.2cm^{-1}$ can readily be obtained over the wavelength range 330-970nm with pulse energy of > 1mJ. By using an intracavity etalon somewhat reduced energies can be produced at linewidths of ~ $0.04cm^{-1}$. Second harmonic generation crystals are available to extend the wavelength range down to 220nm. This laser can also be pumped by the EMG 150 ETS if necessary.

The dye laser can also be used with a H_2 Raman cell to generate tunable radiation down to ~ 125nm by high order anti-Stokes Raman scattering.

(4) KX-1 This laser operates at a maximum repetition rate of 1Hz with a pulse duration of 20ns. It produces 30mJ at 157nm, 175mJ at 193nm, 250mJ at 249nm and 125mJ at 351nm respectively. Its main purpose is to provide high energies at the 157nm VUV wavelength.

(5) Picosecond Laser System

This consists of a Spectra Physics 3000 series actively modelocked frequency doubled YAG laser synchroneously pumping a 375 dye laser. The dye laser pulse width is 2.5ps at 590nm and the average power at 82MHz is 80mWatt. A Quanta-Ray DCRZ frequency doubled Q switched YAG operating at 10Hz is used to pump a 3-stage dye amplifier. Output pulses are 500μJ at 590nm. Frequency doubling and tripling crystals are available and over 50μJ/pulse has been obtained at 295nm. The dye fundamental operating range explored so far extends from 560 to 680nm.

It is intended to develop this system to provide picosecond and sub-picosecond pulses over a wide range of wavelengths. The pump lasers can be used without the dye lasers if necessary.

(6) System capabilities

Each laser is operated in a self-contained lab but beams may be sent from one lab to another via (shuttered) holes. Patch panel connections between labs enable the lasers to be fired simultaneously. It is when they are operated together as a complete system that their full potential can be exploited. The Lambda Physik lasers are fitted with thyratron switches so that they can both be fired in synchronism at high repetition rate with a jitter of ~ 2-3nsec. A particularly powerful arrangement is to use the line-narrowed EMG 150 ETS in conjunction with the excimer pumped dye laser, which can produce tunable radiation from 320-980nm. The two lasers may then be fired in synchronism or with a predetermined time delay for use in pump-and-probe types of experiments.

The LSF can accommodate simultaneous running of several different experiments.

(c) Ancillary Equipment for use at RAL

(1) EG & G OMA Systems Data acquisition can be achieved using the EG & G PARC Optical Multichannel Analyser (OMA 2) system. This comprises a detector (either the model 1420 Diode Array or the model 1254/01 Vidicon) with its associated controller (1216 or 1218) and the 1215 console for processing data. There are two 1215 consoles, allowing the simultaneous operation of diode array and vidicon.

The 1420 diode array is intensified and has a spectral response of 200-900nm. Each channel is 25μm wide and the resolution is limited to ~ 4 channels (FWHM). It has 1024 channels of which 700 are intensified. The 1254/01 Silicon Intensified Target Vidicon has a UV Scintillator which extends the sensitivity into the UV. The response is 190-800nm. There are 500 channels of 25μm width and the resolution is 3 channels (FWHM). The 1216/1218 Controllers are 16-bit computer peripherals which support detector scanning and signal processing.

The 1215 console allows storage of spectra on disk. It can be used in real time for setting-up and calibration purposes. There is a wide range of facilities for data manipulation. These include background subtract, data smoothing, area under curves, and logarithmic plots. The scanning of the detector can be synchronised with the laser, or one can accumulate a large number of shots when looking at low level signals.

Fast transient work is possible using the 1211 high voltage pulser. This permits gated operation of the detectors. The minimum gate width is 5ns for the diode array or 40ns for the vidicon. There is an output for an analogue X-Y recorder so that copies can be obtained.

The work of the Central Laser Facility is described fully in its own annual report and is summarised in the annual report of the Rutherford Appleton Laboratory. Copies of these and further information about the facilities can be obtained from:

Division Head
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Rutherford Appleton Laboratory
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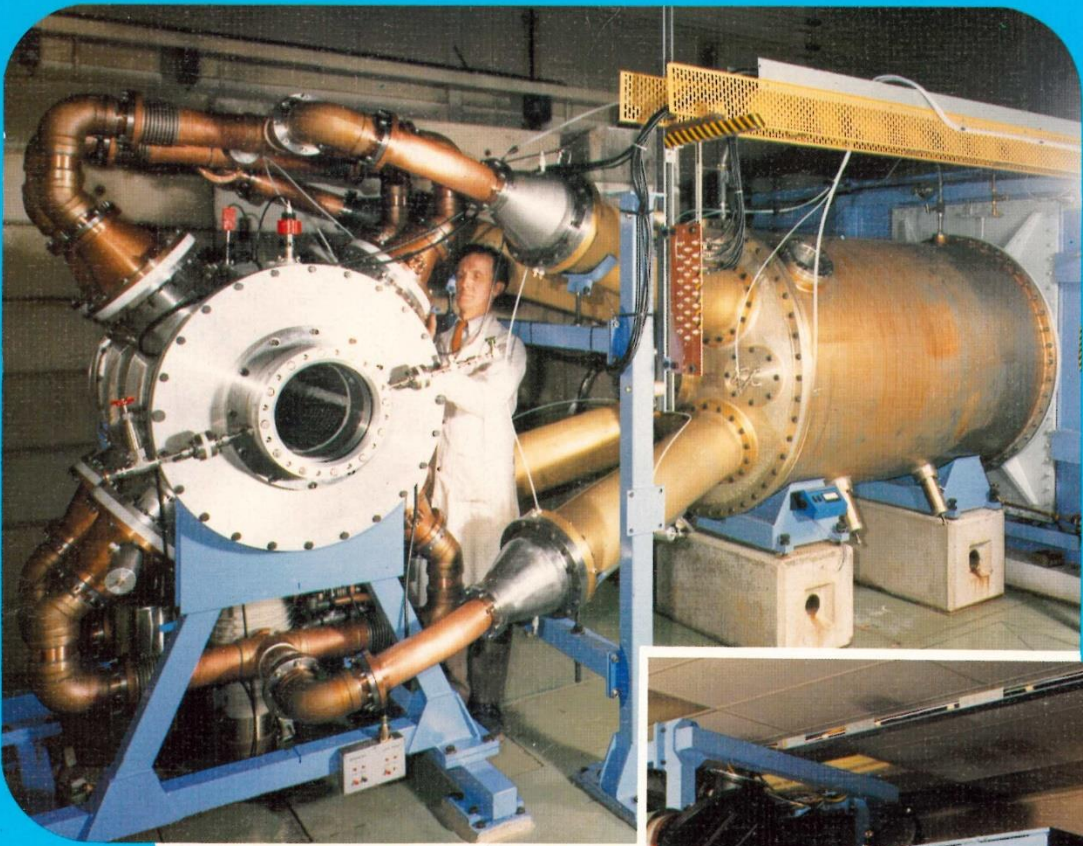
Tel: (0235) 21900 extension 5582

Front cover: Inside VULCAN target chamber

Back cover top: The SPRITE Krypton Fluoride laser.

Back cover bottom: VULCAN disc amplifiers.

Below: UVRF equipment.



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