Bulletin
of the Rutherford Appleton Laboratory 20 Oct 1986 No. 11

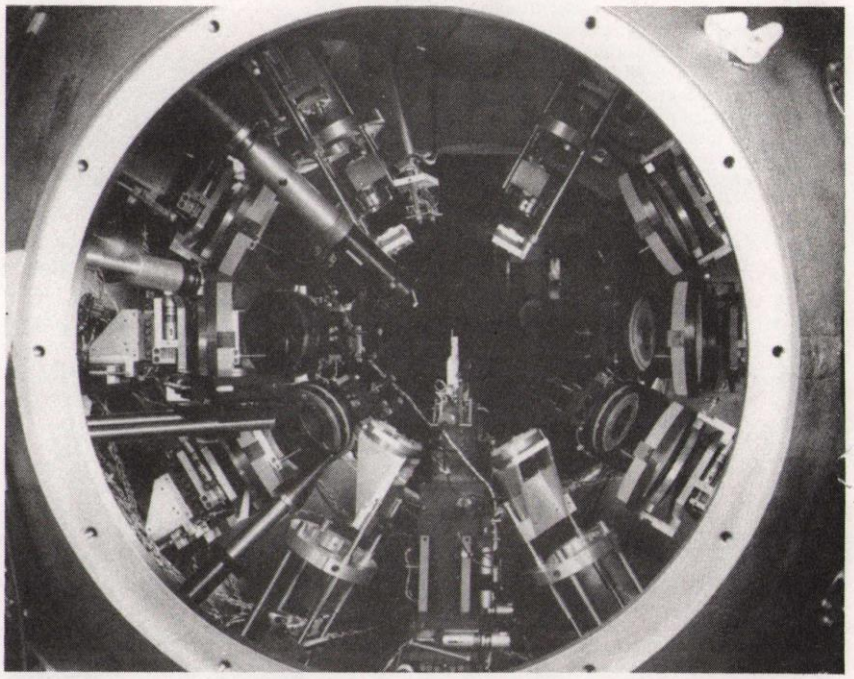
X-ray laser breakthrough at RAL

Experiments carried out in June and July at the Central Laser Facility (CLF) by a consortium of UK researchers have demonstrated laser amplification at a wavelength of 8 nanometres. This exciting result puts the UK scientists ahead of the world in the quest to develop lasers at the shortest possible wavelengths. The goal is to reach wavelengths in the 'water window' below 4 nanometres when the X-rays can penetrate water but are absorbed strongly by carbon-based materials such as proteins. This could open the door to the future possibility of 3-dimensional holographic study of the structure of living cells.

A recent surge of interest in XUV lasers came in 1984 when experiments with the largest laser in the world (the Nova facility in the USA) demonstrated strong laser amplification at 21 nanometres. Work at the CLF was held up at that time by budget cuts due to the fall in the value of sterling (a familiar tale!) and construction of a highly novel system for XUV laser research was delayed until the Summer of 1985. The new system, using off-axis reflection from spherical mirrors to produce an aberration free line focus, was an immediate success. Its first use demonstrated 50 fold laser amplification at 18 nanometres. The experiments used the unique optical design to irradiate up to 2 cm lengths of 7 micrometre diameter carbon fibres with the full six beam power of the Vulcan neodymium glass laser facility.

The capability to irradiate such a small cylindrical target makes it possible to use a different laser concept from that developed in the USA and moreover one which is more easily scaled to shorter wavelength. As a result, despite being out-gunned in laser power by a factor of 30 (100 TWatt Nova laser compared to 3 TWatt Vulcan laser), the UK groups were able to design an experiment using a 7 mm by 7 μm diameter fibre target coated with Lithium Fluoride to produce laser action at 8 nm (while the US work has reached a limit of 11 nm).

The essential mechanism of the laser is fairly easy to understand though the detailed theoretical description is highly complex and requires the use of numerical modelling in a super computer.



View inside the target chamber showing the target mount at the centre and the arrangement of lenses and mirrors to produce line focus. 85FC 5373.

The thin cylindrical target is intensely heated by the focused power of the laser and during the extremely short pulse (70 picoseconds) a surface layer just a few hundreds of nanometres thick is raised to a temperature of several million degrees. The atoms become fully ionised to form a plasma of bare nuclei (F^{9+}) and free electrons. The hot plasma layer has enormous internal pressure (more than 10 million atmospheres!) and explodes away from the cylindrical core. As it expands it cools adiabatically and in about a nanosecond its temperature drops as much as ten fold. At the lower temperature electrons recombine rapidly with the bare nuclei but tend to fill the higher energy orbits of the hydrogen-like F^{8+} ions. Laser amplification is produced for transitions between the n = 3 and n = 2 levels because more electrons are in the higher n = 3 state.

Measuring the laser amplification is difficult since it lasts for less than 10^{-9} sec and is confined to within 0.2 mm of the fibre target. Two novel time resolving spectrometers based on the state-of-the-art variable periodicity grazing incidence diffraction gratings were developed to record the emission spectra along the axis and transverse to the fibre.

The axial to transverse intensity ratio indicated 10 fold amplification in a length of 7 mm. That is as much length as Vulcan is capable of adequately heating for the fluorine laser. More amplification and shorter wavelength need more laser power and/or improved efficiency in the laser design. Both are possible and a wavelength of 8 nm is tantalisingly close to the water window ...

M H Key

The consortium included groups from Queens University Belfast, University of Hull, Imperial College and RAL.

European CREST committee see space work at RAL

Members of the Committee on Scientific and Technological Research (CREST) were guests of RAL on Thursday 25 September. CREST, the senior advisory committee to the European Council and Commission on scientific and technical matters, was holding its September meeting at the European Centre for Medium Range Weather Forecasts at Shinfield Park, so took the opportunity of visiting the Laboratory.

The afternoon's programme included short presentations on the role of SERC/RAL in UK science by Paul Williams (Deputy Director RAL) the formation, status and structure of the British National Space Centre (BNSC) by Jack Leeming (Director, Policy and Planning, BNSC) and the space programme of RAL by John Harries (Associate Director, ASR, RAL). These talks, followed by a tour of the Laboratory's space projects and experimental facilities, gave them an idea of the considerable size and scope of RAL/BNSC's programme inspace science and technology.

Some members of the CREST committee making a clean-room inspection of the CHASE experiment (flown on 29 July 1985 on NASA's Spacelab 2 mission) which is being prepared for post-flight calibration and subsequent reflight. 86RC 4535

HEP Summer School 1986

This year's RAL Summer School for young high energy physicists took place for the usual 2 weeks in September. 25 post-graduate students from 16 UK institutions, which have particle physics groups, attended.

The school followed a well tried and successful format of lectures, private study and tutorials. The latter, took place in the late afternoon in the pleasant surroundings of Cosener's House in Abingdon. The mornings and early afternoon were spent at RAL using the lecture theatre and library. In the evenings at Cosener's House there were seminars, usually given by the students themselves, in which they discussed some interesting aspects of their experimental projects. In hindsight all were agreed that the only quiet moments of the busy schedule were to be found on the daily bus trips to and from Cosener's House where the variety of routes chosen by the drivers still remains a mystery!

Like its predecessors, the 1986 school seems to have been a success. Apart from its formal academic achievements, informal discussion between all, both staff and students, generated much interesting physics and may even have solved some problems on experiments at CERN, DESY and SLAC! It certainly enlightened one or two theoretical lecturers at the school for whom a phototube was as unfamiliar as dimensional regularisation was for the students .... and indeed for many of the staff!!

86FC 4343

Much of the credit for this stimulating and pleasant atmosphere at the school must go to RAL and to the hospitality of Cosener's House. We hope therefore that any inconvenience caused by the sudden influx of exuberant problem solvers to the library and coffee lounge was not too much to bear and thank all at RAL who tolerated this intrusion and who contributed to the success of the 1986 school.

Sales to Employees

The sale of scrap materials to RAL staff will take place on 31 October and 14 and 28 November from 1200-1230 hrs in the R24 scrap compound.

Thanks

Edna and Trudi, (the last of the scanners) thank everyone for their gifts and flowers.

We have enjoyed knowing you all. Cheerio to those we missed, they write.

Royal Society lecture at Oxford

Dr Igor Larin from the Institute of Chemical Physics,USSR Academy of Science Sciences, will lecture on "Elementary Chemical Processes of the Central and Upper Atmosphere", at the Physical Chemistry Laboratory, South Parks Road, Oxford. The talk is timed for 2.15pm.

Internal Events

ASTROPHYSICS EVENTS
R61 CONF ROOM - 1400 hrs

29 Oct. Dr Richard Harrison/RAL
'Solar coronal mass ejection during flares'

12 Nov. Dr D H Lumb/Leicester
'CCD's for x-ray observations'

26 Nov. Prof. Ian Robson/Lancs. Poly
'Far Infrared astronomy - an overview'

NEUTRON DIVISION SEMINARS
R3 CONF ROOM - 1330 hrs

4 Nov. C Lambert/Lancaster
'Dynamical properties of granular structures'.

25 Nov. R Holt/RAL
'Photon Compton scattering'

Industry Year Open Days

Potential apprentices from Berkshire, Oxfordshire and Wiltshire attended Schools' Open Day's at RAL on Monday and Tuesday 6 and 7 October to see for themselves the diversity of options open to skilled craftsmen, at the Laboratory in particular and in industry generally.

Organised as RAL's contribution to Industry Year 1986, the event attracted over 150 fifth formers from 15 schools to tour the drawing offices, workshops and laboratories of Instrumentation Division, where the design, manufacture and development of major facilities for our wide ranging scientific programme, is carried out.

Welcoming the students, project engineer Bryan Wyborn breifly painted an overall picture of the work of RAL, highlighting the diversity of skills required to produce the special apparatus commissioned by experimenting teams working in fields ranging from space projects to high energy physics.

The tour guided them through the various stages of engineering necessary to construct a complex piece of experimental equipment, the demonstrations underlining the need for the pooled expertise of scientists, engineers, technicians and craftsmen often working at the leading-edge of engineering knowledge.

The visit took in computer aided design in the drawing offices, printed circuits to major rig assemblies in the electrical workshops and development and assembly work in the mechanical workshops. The students were also introduced to special welding techniques, material testing, precision resin casting, production of detectors for CERN and a wide range of measuring instruments used in inspection and quality control.

The venture also proved popular with RAL staff not normally allowed (for safety) the run of the workshops. They too welcome the opportunity to see for themselves, as did Radio Oxford which featured the event on the Tuesday morning programme 'Oxford A.M.'

Keith Sinclair explains the computer-controlled measuring machine to pupils from Cherwell School. 86RC 4574

Three of a kind

86RC 4423

Not a 'spot the difference' competition but three young RAL apprentices, Mark Wheeler, Jackie Allen and Colin McKeown receiving their deeds of apprenticeship from Director Geoff Manning on Thursday 18 September.

The three (pictured from left to right) are the latest graduates of RAL's electronics training school and have already started work as RAL craftsmen; Mark in Geophysics and Radio Division, Jackie with Electronics section and Colin in Technology Division.

86RC 4424.

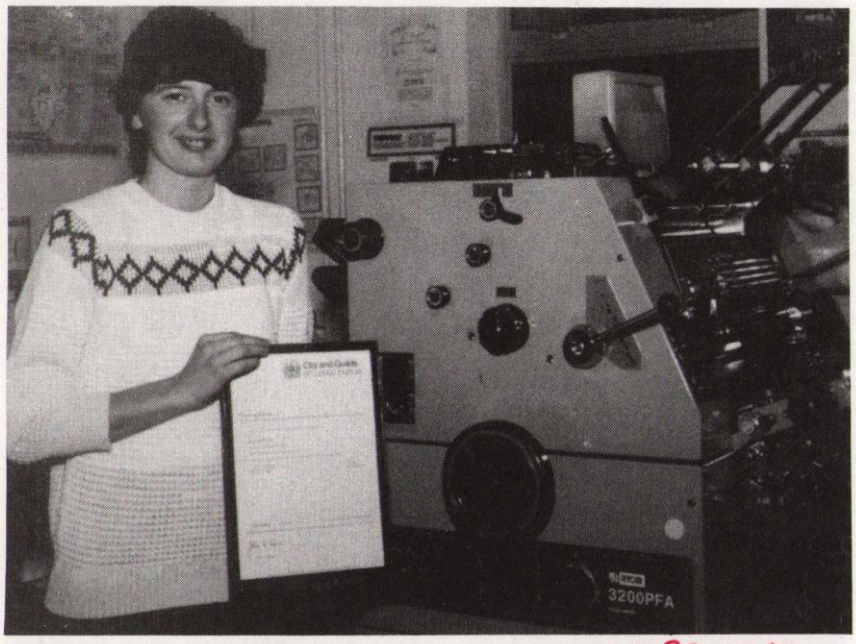
Presenting the deeds in the traditional tankards, Dr Manning congratulated them and expressed his pleasure that they had decided to stay at RAL. 'I hope you will see this as a beginning to new goals and new opportunities,' he said. "Best wishes, I hope you stay for a long while."

The Electronics Apprentice School started in 1980 when the Laboratory was having difficulty recruiting electronics craftsmen. So far there has been a 100% success in the training programme with a bonus of successes outside. Alan Saxby, one of the initial intake, has recently been promoted to PTO and two current apprentices, Paul Rabbett and Adrian Marsh have won prizes at the Newbury and District training group.

86RC 4425

The scheme continues, managed as it has been since it's inception, by Vic Cloake and John Hunt. Four more lads joined early in September bringing the total, trained and in training, to 25.

Printer Pam gets prize



86 RC 4490 .

Pam King of Reprographic section has just completed her course in Reprographic Techniques at Watford College by gaining a distinction to her City and Guilds certificate.

Like her colleagues Ray Smith and Linda Tipper before her, she also believes in collecting a prize as well.

Pam will be presented with the 'Tom Cowley Award', a new prize for meritorious performance, at a ceremony at the college on 30 January 1987.

A spokesperson for the section said, 'Its not an unusual occurence for us - just another genius off RAL Reprographic's production line - we expect it!'.

Many congratulations Pam.

Poppy Appeal

3-8 November 1986

The Royal British Legion helps the ex-service community in a variety of forms. For example, did you know that the Legion is the biggest private employer of disabled people in the country, offering the dignity of work to men and women otherwise deemed unemployable?
Please give GENEROUSLY to enable them to continue with their worthwhile work.

RAL's last scanners say Goodbye

On Monday 29 September the last two practicing RAL scanners Edna Jones and Trudi Buckner held a wake for the Scanning Laboratory.

It was a proper Wake; a celebration in honour of the 'deceased' with food, drink, laughter and old friends remembering times gone by.

Flowers and chocolates were presented to Edna and Trudi by Wilbur Venus with thanks for work well done, a gesture much appreciated by them both?

For over 24 years nearly 250 scanners worked at the Laboratory's tables and an outsider at the feast quickly became aware that it hadn't only been a place of work but doubled as a club and Ladies College combined. From it, members moved out into the four corners of RAL until their old-girls network must be formidable.

Now the Scanning Lab is closed but the comradeship continues - next event the Christmas reunion.

To Edna and Trudi, best wishes for the future, and to the Classes of '62,'63, '64, 65 .....

Film Badge Notice

It is period 11, Colour-strip ORANGE. Please be sure you are wearing the correct dosimeter and return all beta-gamma films and fast neutron badges promptly.

NEXT FILM ISSUE

Monday 3 November.

Trade Exhibition

Tektronix (UK) Ltd are exhibiting their latest range of computer graphics products on Tuesday 11 November in R12 Conference Room from 10.30-16.00 hrs.

This will include 4200 series terminals, 4120 series workstations and 4400 series A.I. terminals.

Spectramass Ltd will be demonstrating their Residual Gas Analyser and pressure measuring equipment in R12 Conference Room on Friday 7 November from 10.00 - 16.00 hrs.

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