SERC

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SCIENCE & ENGINEERING RESEARCH COUNCIL

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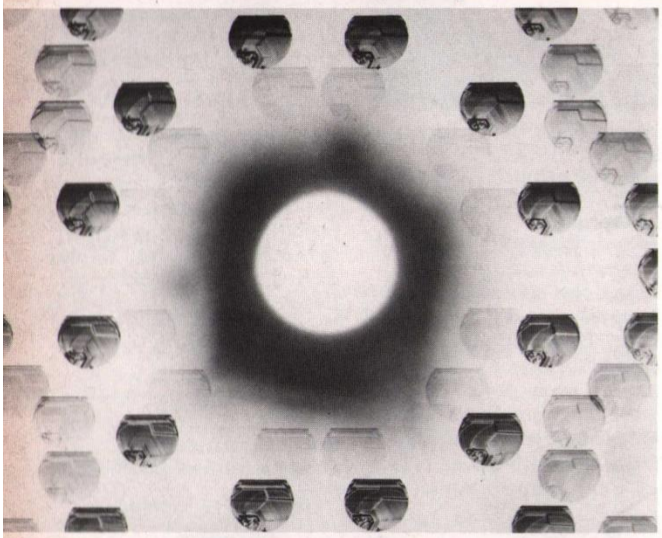

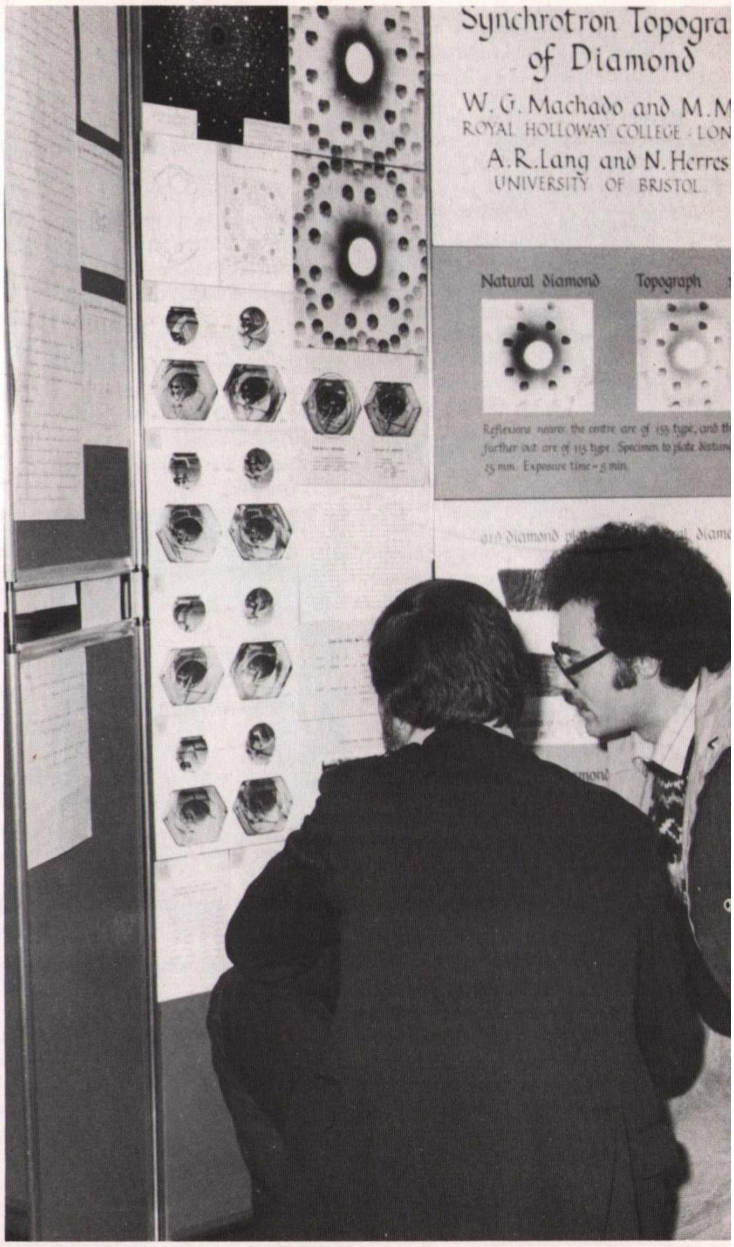

In this issue

SERC BULLETIN Vol 2 No 4

(Spring 1982)

ERRATA

PAGE 2

Column 3 paragraph 1 should read:

Professor Mark Henry Richmond, FRS, took office as Vice-Chancellor of the University of Manchester on 1 August 1981.

Column 3 paragraph 3, last sentence should read:

He was appointed Professor of Bacteriology in the University of Bristol in 1968. The University of Manchester appointed him Professor of Molecular Microbiology in 1981.

PAGE 14

Columns 1 and 2:

H should read H^-

Column 3 paragraph 1:

10^7 and 10^6 should read

10^{-7} and 10^{-6}

Columns 3 and 4: picture caption should read:

Prototype RF cavity. Copper discs cool the ferrite and are joined at their edges with RF 'finger strip' to make a good radiofrequency circuit. At the right-hand end is the tuning capacitor.

Column 5 paragraph 2:

25 microns should read 0.25 microns

Establishments of the Science & Engineering Research Council

SERC Central Office
Polaris House
North Star Avenue
Swindon SN2 1ET
Telephone (0793) 26222

SERC London Office
3-5 Charing Cross Road
London WC2H 0HW
Telephone 01-930 9162

Rutherford Appleton Laboratories (RAL)
Chilton, Didcot
Oxon OX11 0QX
Director Dr G Manning
Deputy Director
Professor J T Houghton FRS
Telephone
Abingdon (0235) 21900

Daresbury Laboratory
Daresbury, Warrington
Cheshire WA4 4AD
Director
Professor L L Green
Telephone
Warrington (0925) 65000

Royal Greenwich Observatory (RGO)
Herstmonceux Castle
Hailsham, East Sussex
BN27 1RP
Director
Professor A Boksenberg FRS
Telephone Herstmonceux
(032 181) 3171

Royal Observatory, Edinburgh (ROE)
Blackford Hill
Edinburgh EH9 3HJ
Astronomer Royal for Scotland and Director
Professor M S Longair
Telephone 031-667 3321

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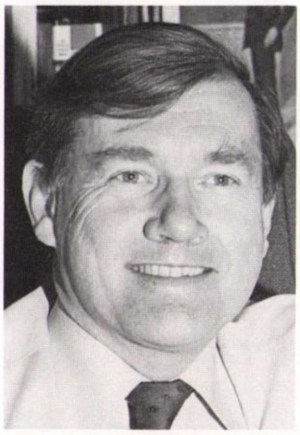
Enquiries and comments are welcome and should be addressed to the editor, Miss J Russell, at the Science and Engineering Research Council, Polaris House, North Star Avenue, Swindon SN2 1ET. Tel Swindon (0793) 26222.

New Council members

Professor John Cadogan, FRS, is Research Director of the BP Group. He joined BP as Chief Scientist, BP Research Centre in 1979, after ten years as Forbes Professor of Organic Chemistry at the University of Edinburgh and six years as Purdie Professor in the University of St. Andrews (during which period he acted as a consultant to the BP Group). For his researches in organic reaction mechanisms, short contact time reactions, organophosphorus chemistry and heterocyclic synthesis he was received many awards from the Chemical Society and the Royal Institute of Chemistry.

He is Visiting Professor of Chemistry at Imperial College, London and Honorary Professorial Fellow, University College of Swansea.

He has served as Chairman of SERC's Chemistry Committee and member of the Science Board. He is President-Elect of the Royal Society of Chemistry, becoming President in July 1982.



Professor Mark Henry Richmond, FRS, took office as Vice-Chancellor of the University of Bristol on 1 August 1981.

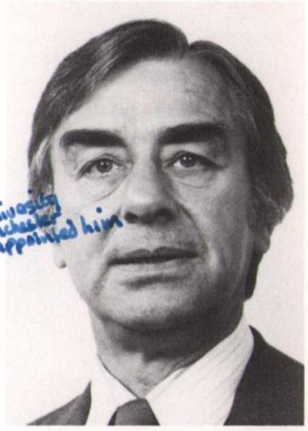
Professor Richmond has served on numerous national and international committees on microbiology and is a member of the DES Genetic Manipulation Advisory Group. He is the author of many papers on microbiology and biochemistry and has received awards from British, Czechoslovak and West German institutions.

After gaining his PhD from Cambridge in 1958, Mark Richmond joined the National Institute for Medical Research, Mill Hill, moving to the University of Edinburgh in 1965 as Senior Lecturer and then Reader. He was appointed Professor of Bacteriology in the University of Bristol in 1968 and Professor of Molecular Microbiology in 1981.

Dr W L Wilkinson, who was appointed to the Council in April 1981, is Chairman of SERC's Energy Committee. He is Assistant Director Research and Development in the Reprocessing Division of British Nuclear Fuels Ltd, Risley.

Having gained his PhD from Cambridge in 1956 and spent three years as lecturer in Chemical Engineering at University College, Swansea, William Wilkinson joined UKAEA where he worked on plant design and production management on a wide range of large-scale plants until 1967 when he was appointed Professor of Chemical Engineering, University of Bradford.

Dr Wilkinson's research interests are in flow, heat transfer and mixing, involving complex fluids; polymer processing operations; and process dynamics and control. He was elected to the Fellowship of Engineering in 1980, served as President of the Insitution of Chemical Engineers 1980-81 and has been a member of SERC's Engineering Board, Polymer Engineering Management Committee and Cooperative Research Grants Committee.



Front Cover:

The Synchrotron Radiation Facility at Daresbury Laboratory (see page 4)

Right: Poster session during the first full users' meeting since the SRS began scheduled operation in June 1981. More than 90 users attended the meeting, held at Daresbury on 18 November 1981. Two dozen poster stands displayed results obtained from some of the SRS experimental stations.

Top left: Synchrotron x-ray topograph of a slice of natural, gem-quality beryl crystal taken with the storage ring operating at 1.8 GeV and 190 mA. The diameter of each disc in the pattern is about 6mm and the whole array of spots shows the sixfold symmetry of the beryl crystal structure. Fine detail in the intensity pattern within each spot can be resolved down to a scale of about five micrometres: variations in this pattern correspond to the distribution of local crystal lattice defects with the crystal.

Exposure times with the Daresbury source are two to three orders of magnitude shorter than with conventional x-ray sources, and thereby open the way for performing dynamical studies such as the observation of moving dislocations, recrystallisation and phase changes.

Bottom left: Synchrotron x-ray topograph of a twinned diamond from Brazil; this photograph was taken at the SRS at the time of the users' meeting. Each spot contains microscopic information concerning the perfection of the crystal – in effect a collection of individual x-ray topographs taken with various reflections at the time with an exposure of 30 seconds (when the storage ring was operating at 1.8GeV and 120mA).

Council commentary

October and November 1981 meetings

Professor Kingman took the chair for the first time at the October Council meeting and welcomed four new members of Council: Mr Downs, Professor MacFarlane, Professor Richmond and Professor Wilcock.

The three new Establishment Directors, Professor Boksenberg, Professor Green and Dr Manning, were introduced and Dr Nicholson was congratulated on his appointment as Chief Scientist to the Central Policy Review Staff.

Professor Cadogan and Mr Hughes, who were also newly appointed to Council this session, attended their first meeting in November.

Financial Matters

Council considered the expenditure forecasts for 1981/82 submitted by the Boards and other major spending areas, which indicated that overall Council's domestic programme was approximately in balance.

Council's international activities were showing savings of about £900k based on exchange rates at the beginning of October. It was noted, however, that SERC was likely to receive inadequate compensation for inflation and exchange rate fluctuations on top of any cuts imposed on the Science Vote generally.

In the absence of specific guidance Council is proceeding on the assumption that the Forward Look main guideline will be equal to £196.7M pa throughout the period, which represents a level projection of the ABRC's recommendation for 1982/83.

ROSAT: X-ray astronomy satellite

Council discussed a proposal for UK participation in the German x-ray astronomy satellite mission, ROSAT, proposed for lauch in 1987. The intention is that a consortium of UK universities and RAL should provide a wide-field soft x-ray camera to complement the main German telescope on ROSAT. The UK contribution is estimated at £8.75M inclusive of launch costs but excluding the cost of staff directly employed by SERC. The ASR Board attached high priority to this project which it considered to be the most important x-ray mission of the next decade and one which would stimulate follow-up work in all wavebands.

Council fully endorsed the Board's views on the scientific excellence of the project and gave its approval at the November meeting.

Energy

Council considered options for its future support of energy research, both from a scientific and an administrative point of view. Scientifically the priorities were held to include programmes in energy storage, conservation and renewable energy sources, joint ventures with the energy supply industries aimed at strengthening the links between these industries and the academic community, and the development of energy-related education and training. A review of SERC's involvement in Heavy Ion Fusion, a potential power source of the twenty-first century, also came before Council. It was noted that there are prospects of using the SNS for studies relevant to the programme and that if the subject develops promisingly, then it would be appropriate to examine the possibility of establishing an expanded programme in collaboration with the Department of Energy and UKAEA.

It was agreed that the Council's interests in energy research would best be furthered by bringing the Energy Committee under the Engineering Board, while maintaining the involvement of Council through having a member of Council as Chairman of the Committee. The continuing services of the Energy Coordinator and of the Energy Research Support Unit at RAL were felt to be essential to the promotion of a positive SERC energy programme.

International collaboration

The Council noted the CERN and ILL annual reports for 1980 and the developments that had taken place during the year. On the basis of these reports, SERC's contributions to the 1982 budgets of the two organizations were approved. Progress has also been made towards collaboration with Japan and Poland following visits earlier in the year - a joint SERC/Royal Society Working Group went to Japan in September and a SERC delegation to Poland in May 1981. Prospects for collaboration with Japan look particularly promising and an initial list of key areas was identified including space science, molecular science and bio-technology. It was also felt, however, that collaboration should be extended to include traditional engineering interests.

Studentships and fellowships

The overall number of awards on offer in 1982 must inevitably reflect Council's difficult financial circumstances. In broad terms, Council accepted that research studentships should be held at last year's levels with the burden of the necessary reductions falling on advanced course studentships. This bears heavily on the interests of the Engineering Board for whom advanced courses fulfil an important role in relation to the needs of industry for trained manpower. Provision of CASE studentships will be slightly greater than that made last year and there will be extra awards available under the 'instant' scheme, in view of the heavy oversubscription experienced in 1981.

Advanced fellowships have been held at their 1981 level but fewer postdoctoral fellowships will be provided. Special replacement awards will be held at 15 rather than the planned decrease to 10. It was agreed that the re-introduction of reserve lists of candidates would help ensure that the take-up of awards matched allocations as closely as possible.

Remote sensing

A paper describing possible joint NERC and SERC participation in a national remote sensing programme was taken at the November meeting, when Council was joined for this item by Dr John Bowman, Secretary to NERC. Nationally and internationally there is a growing awareness that observations of the earth from space can lead to major practical, commercial and scientific advantages and a national programme in this field is, therefore, actively being considered under the lead of the Department of Industry. Further impetus to this activity has been given by the recent adoption of ERS-1, an oceans and sea satellite, within the framework of ESA. A joint NERC/SERC Committee on Climate Research established in April 1980 has set out the nature and scale on which the two Councils by acting in concert can contribute significantly to the national programme under discussion, using their unique expertise in oceanography, climatology, space instrumentation and image and data processing. Council lent its support to these proposals (as did NERC in October 1981) and authorised its officers to participate with these as a basis in the much wider negotiations now proceeding in Whitehall.

Council industrial seminars

Last year members of Council held a series of informal discussions with small groups of senior industrialists on topics of mutual interest. The purpose of these seminars has been to learn the views of industry on the relevance of current academic research and to discuss how SERC might help to meet more effectively the needs of industry for research and postgraduate education. Seminars have been held on telecommunications, metallurgy, biotechnology, high energy physics, process plant and civil engineering. Members of Council have found these meetings very beneficial and it is intended to run a further series this year. Some of the topics to be discussed will be marine technology, operational research, remote sensing and research relevant to the computing and automative industries.

SRS first results

Scientists from 33 British universities and colleges have begun to use SERC's newest central facility – the Synchrotron Radiation Source (SRS) at Daresbury Laboratory. To date some 60 user groups have had their research programmes funded. We illustrate here the variety of experiments which the exploitation of synchrontron radiation from the SRS allows.

The electromagnetic radiation emitted by the 2 GeV electron storage ring offers a number of attractions to experimentalists. Among these are high brightness, collimation, polarisation and time modulation, as well as a wide wavelength range extending through the x-ray, ultra-violet, visible and infra-red regions of the spectrum. In addition the light is produced in a high vacuum environment.

Before examining some of the experiments currently being undertaken using the facility it is useful to outline the instrumentation used and how it functions in a typical experiment. A monochromator receives a beam of light from the SRS, disperses it into its component wavelengths (or 'colours') and transmits a narrow band of wavelengths into a sample chamber. Here the sample under investigation, such as a crystal or biological material, is illuminated under controlled conditions. Finally, some process which occurs in the sample as a consequence of the irradiation, such as, for example, photoelectron emission, fluorescence or x-ray diffraction, is monitored by a detector.

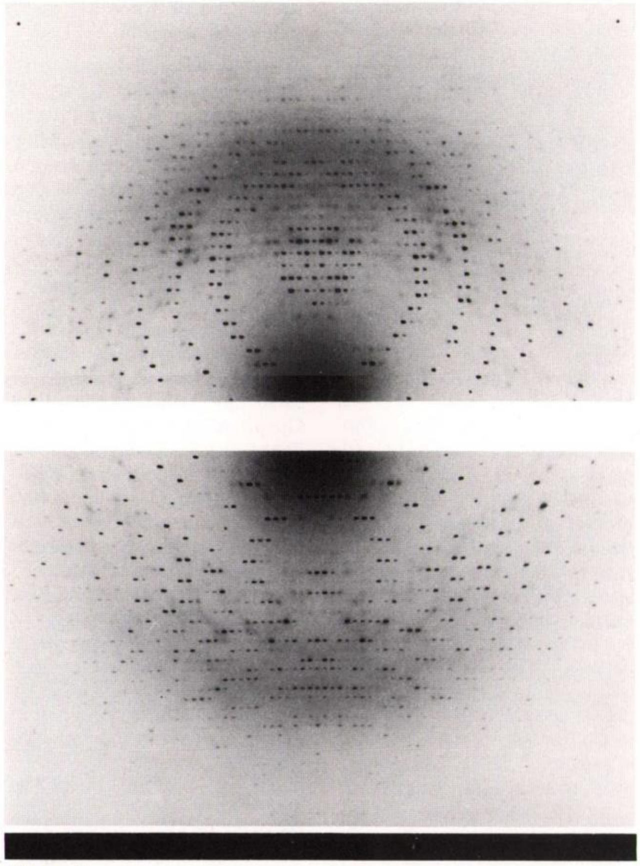


Figure 1
X-ray diffraction photograph of a protein crystal obtained with a 23-minute exposure to monochromatised synchrotron radiation of 1.488 A wavelength. The protein is 6-phosphogluconate dehydrogenase, which has a molecular weight of 50,000 Daltons.

Proteins

Protein x-ray crystallography is the first of four experiments to be outlined and for which data has recently been taken at the experimental station. This is a technique aimed at providing the complete 3-dimensional molecular architecture of globular biology macromolecules which include enzymes and hormones. Often crystalline samples of proteins are very weak diffractors of x-rays because the protein gives only small crystals or the protein unit which constitutes the sample is large. The high intensity and good collimation of the Daresbury SRS x-radiation is now allowing data to be obtained on such samples. For instance data collected by an Oxford group on tiny crystals of the enzyme β-lactamase were of superior accuracy to data obtained elsewhere, an essential requirement to make progress in the determination of this structure.

Even when larger crystals are available, the data needed to 'refine' macromolecular models ('high angle data') are most difficult to obtain because of the weak signal strength and susceptibility to the effects of sample irradiation damage. Often this means that it is impossible to obtain worthwhile data with a conventional source of x-rays, whereas more data can be obtained per sample and to higher angles with a more intense source. Data of the type shown in figure 1 have been collected (also by an Oxford group) from single protein crystals. An Imperial College group have taken test data for initial evaluation purposes on glyceraldehyde-3-phosphate dehydrogenase from *Bacillus Stearothermophilus* using the SRS operating at 1.8 GeV, 100mA, and this has indicated a a forty times reduction in exposure time over previous experimental techniques.

The wavelength-tuning applications of synchrotron radiation are of considerable interest in attempts to solve the so-called phase problem of crystallography utilising metal absorption edges. Test experiments done by the Keele/ Daresbury group as part of the commissioning programme of this first instrument for protein crystallography at the SRS have already indicated that full exploration of absorption edge fine structure is feasible for such optimised anomalous dispersion applications.

Surface science

Another experimental station, ADES, derives its name from its objective of angularly-dispersed electron spectroscopy. This technique, based on photoelectron emission, is much used in 'surface science' – the study of the properties of surfaces, with or without overlayers or adsorbed gases.

One of the most simple of all electronic devices is the Schottky diode which is made by depositing two metal contacts on to a semiconducting crystal. One of these contacts has to yield rectifying action. Amazingly, in spite of decades of research, the way these rectifying or barrier contacts are formed is still not well understood. In order to avoid detrimental effects from foreign atoms (or dirt!) on the semiconductor surface the Coleraine group deposit metals on to surfaces which are atomically clean and generated by cleavage in a vacuum of around 10^{-10} Torr. These surfaces and the interfaces thus formed are then probed in the ADES system on beamline VUV 6. For the first run the material chosen was GaSe (an old favourite of the Coleraine group) which has inert and highly perfect surfaces. Synchrotron radiation allows interactions to be studied right at these surfaces, ie in the outermost atomic layer.

A Coleraine/Dublin group were able to show that a number of metals react very strongly with the atomic layer of GaSe and in fact dissociate it, while others such as gold, silver and tin interact only very weakly with the surface. Figure 2 shows data illustrating this point. They demonstrate conclusively that provided one deals with the weakly interacting systems then the traditional theories of Schottky formation hold almost exactly. In fact the data

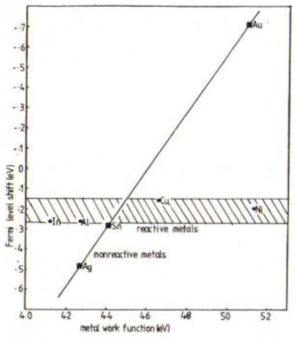


Figure 2

Plot of data obtained by photo-electron emission measurements from gallium-selenide surfaces coated with thin deposits of various metals, including the non-reactive gold, silver and tin.

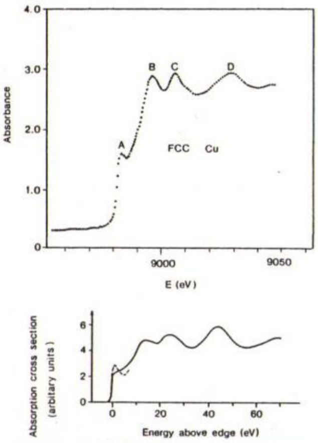


Figure 3

Near-edge x-ray absorption spectra for fcc copper.
(a) Experimental data
(b) Multiple scattering calculations incorporating four shells of atoms, totalling 56 in all.

reflect the theory better than any other system ever recorded. The defects formed by the chemical reactions, for the reactive metals, have been shown to dominate the barrier formation in this case. During a recent two-week run at the SRS the group were also able to study some metal overlayers on InP, another technologically important solid.

EXAFS

Although the phenomenon of extended x-ray absorption fine structure (EXAFS) was observed as early as 1920, EXAFS has only been transformed into a powerful structural technique with the availability of synchrotron radiation sources. Two features of synchrotron radiation have been important: one is the increased x-ray flux of more than 10^6 times that of a conventional x-ray tube; and the second is the continuous nature of the wavelength spectrum over a very wide range. During the last six years the technique has been successfully applied to thousands of samples ranging from enzymes, proteins, metals, glasses and catalysts. Two aspects make EXAFS a popular structural technique: first, there is no special requirement about the nature of the sample – it may be crystalline, amorphous, gaseous or in solution; and secondly, it is element-specific. Structural data (eg interatomic distances) can now be routinely obtained with a precision of $\leqslant$0.02Å for atoms within 3Å of the primary absorber.

At the SRS, two EXAFS experimental workstations are now complete; one is dedicated to surface studies of metals and is capable of probing atomic structure around an element as light as nitrogen. The other is a general purpose workstation to be used by chemists, biochemists, material scientists and biologists. Within the first few weeks of operation, good quality data was obtained on vanadium/titanium catalysts, calcium in milk and bone, platinum-based anti-cancer drugs, etc.

One of the serious limitations of the technique over the last few years has been the inability to interpret the fine structure observed in the absorption spectrum in the immediate vicinity of an x-ray absorption edge. Figure 3 shows data for copper obtained at the SRS, and it is this region which contains 'large' distance (>5Å) and angular information. A multiple scattering theory has been developed at Daresbury and used on a few test cases such as metallic copper (see figure 3 b). The measure of agreement augers well for obtaining angular information.

Topography

A fourth experimental station is that of topography which, unlike the others, does not include a monochromator. X-ray topography is a method of imaging crystals lattice variations by diffraction contrast and high quality x-ray topographs were produced on the white radiation camera a few hours after the completion of the 80 metre-long x-ray beamline at the SRS on 28 June 1981. This topography camera is an advanced computer-controlled instrument, designed and built at Warwick University, which transition metals (work of Warwick University in collaboration with the State University of New York, Stony Brook). This is a topograph of a (100) fracture surface of molybdenum, taken in reflection with g=011. The topology of the fracture surface is clearly seen, as are the areas of high dislocation generation (black) and individual dislocations generated by the passage of the crack. The dislocation and

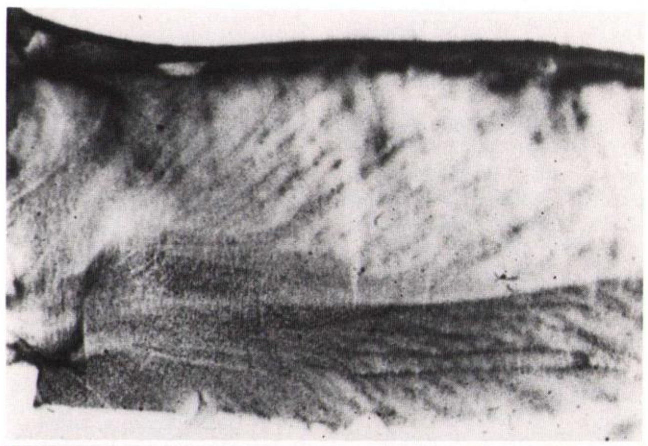


Figure 4

A fracture surface in molybdenum, imaged in an x-ray topograph taken with synchrotron radiation at the SRS.

is fitted with a versatile environmental stage and an x-ray TV detector designed respectively at Strathclyde and Durham Universities. It is intended both for rapid routine crystal assessment and characterization and for real-time studies of dynamical effects in materials. Both of these functions have already been performed. Good quality topographs have been obtained of silicon, iron-silicon, molybdenum, diamond, beryl, mica, benzophenone and other organic compounds, rare earth metal and cadmium telluride crystals. Dynamical experiments on mechanical deformation or iron-silicon crystals, with video-tape recording of the images, have also been performed. Research workers from Czechoslovakia, Germany, Brazil and China have used the facility in collaboration with the UK groups.

Figure 4 shows a novel application of synchrotron radiation topography, to the study of brittle fracture in

consequent lattice strain content contain the 'deformation history' of the crack and by careful mapping of such images it is possible to reconstruct the behaviour of the crack and understand the mechanism of crack propagation and blunting in these technically important materials.

The examples are just a few of the many experiments from which data have started to flow and represent only a sampling of the scope of the varied interdisciplinary researches made possible by access to synchrotron radiation.

The authors

Contributing to this article were Professor R H Williams (New University of Ulster) and Drs D K Bowen, S S Hasnain, J R Helliwell and K R Lea, the four latter serving *(inter alia)* as 'station-masters' on the Daresbury synchrotron radiation facility.

Specially promoted programmes

...two profiles

The Engineering Board's system of selective support, through its Specially Promoted Programmes (SPPs), was introduced in Vol 2 No 2 of the *Bulletin* (Spring1981) and a full list given of the coordinator and SERC contact for each programme. Here we bring you the second in a series in which we focus on the progress of each of the SPPs in turn.

Dies and moulds manufacture

The majority of metal forming processes, whether for plastics or metals, employ a mould or a die. The surface on the die or mould determines the product's surface quality and consequently high standards of finish are required. In 1976 the Manufacturing Technology Committee of SERC (then SRC) launched an SPP aimed at developing techniques which would radically improve the rates at which dies and moulds could be formed and finished, increase their lifetime by surface treatment and ultimately enable refurbishment after use.

Following the initial period of encouraging more research in the field, the programme was reviewed and the objectives focused on those areas with most potential application. Funds were concentrated on electro-discharge machining (EDM) in order to design and develop an EDM spark generator with adaptively controlled output to achieve maximum metal removal rate, minimum electrode wear and the desired surface quality.

Associated research was encouraged in the areas of surface treatment, superplastic alloys and heat treatment for die design. Support has been concentrated in nine university and polytechnic departments and the total funding to date has been £1.3M. The programme has been coordinated by Mr Peter Gough of Cheshire Engineering and Design Consultants Ltd.

One major achievement of the programme has been the development of a new technique in EDM which prevents damaging arcs.
A research team under Professor Bhattacharyya while he was at Birmingham University developed in collaboration with Agemaspark a computer-based system enabling continuous control of the spark. Using this system, if the spark arc condition deteriorates to the point where arcing normally occurs, machining is stopped and the head remains in a working position. The spark gap will be restored to correct conditions and machining will be resumed. The use of this technique, known as gap command machining, not only improves dramatically electrode wear but reduces the need for constant manual supervision of the process. Agemaspark are currently incorporating this technique in their new generation of EDM generators.

Work at Cranfield Institute of Technology has shown that radio frequency radiation may be used to distinguish sparking from destructive arcing. This feature is used in a programmable adaptive control system developed at Cranfield.

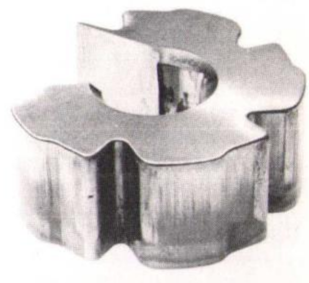
In the area of surface treatment and coating, Salford University has developed the process of ion plating which makes it possible to deposit ceramic coating into relatively deep holes. This extremely abrasive resistant surface promises to improve the working life of extrusion dies. One of the benefits of the process is that it deposits at a low temperature compared with chemical vapour deposition. In collaboration with industry, Salford aim to develop ion plating into a production technique suitable for all extrusion drawing and pressing operations. A team at Aston University has investigated the process of brush plating which allows plating without immersion *in situ*. The effectiveness of the process depends on the power of its electrolytes and Aston has developed a number of solutions that show certain improvements over existing proprietary brands.

Both Cranfield Institute of Technology and Birmingham University have made important contributions to the exploitation of superplasticity in metals used for the production of dies. Working with die steel, Cranfield has evolved an alternative to hot and cold hobbing – 'isothermal superplastic hobbing', which is capable of producing detailed surface finishes in deep cavities. Birmingham's project has brought the practical use of non-ferrous die alloys for hot stamping a great deal nearer practical usage, with its simplified method of sorting materials suitable for superplastic application.

Heat transfer devices – heat pipes, for example – smooth the temperature profile of the die to remove heat quickly to the die coolant. But it may be necessary to reduce heat transfer, or otherwise modify it, and it is here that tool designers have only experience to go on. At Northern Ireland Polytechnic, research has been concentrated on giving the designer a way of analysing the situation which will help him to optimise cooling.
Application of mathematical models to heat pipes has already yielded practical guidance on the cooling of long cores and thermal balancing.

Birmingham University has also tackled die and mould manufacturing's most acute problem – its dependence on manual skill. In the search to integrate CAD with production, in a computer-based system, the researchers have sought to derive the necessary production data to produce and finish pre-form dies from geometrical information present in the forging drawing. Since most forging dies are made by EDM, the main output is the production of tapes for NC machining of electrodes. The system depends on the fact that forging die cavites are of relatively simple form, and can be built up from a few basic geometric figures ('primitives') which occur frequently. These primitives have been built into the MODCON computer program.

Full details of the results of the programme will be presented at the Production Engineering and Productivity Conference at Olympia 2-6 March 1982. In addition, a handbook has been prepared. For copies of the handbook, or for any other information, contact Mr M Hotchkiss, Engineering Processes Secretariat, SERC Central Office, Swindon, extension 2155.



Cold-forming punch cap in BM2 – a sample taken from industry for plasma nitriding.

Instrumentation and measurement

In 1977 the Control Engineering Committee set up an SPP to stimulate research into novel instrumentation and measurement techniques applicable to process control and manufacturing industry. The Committee was particularly concerned that the widespread implementation of control systems was being impeded by the inadequate design of existing sensors and the lack of suitable measuring devices. The Committee identified several key areas in which it wished to encourage more research; these were industrial measurement techniques, basic transducer design, transmission systems, system design in on-line plant instrumentation and reliability and maintenance. Since the creation of the SPP, 50 grants have been awarded to a total value of £2.1M.

As a matter of policy the Committee has concentrated a proportion of the funding into a few control engineering groups which were designated centres for instrumentation and measurement research. At Bradford University research has focused on flow measurement, medical instrumentation and the control of polymerisation processes. The centre at City University is primarily investigating the application of signal and image processing and pattern recognition to instrumentation for automatic inspection. In 1979 a third centre was established at Warwick University for research into instrumentation for manufacturing industries and micro-engineering.

One outcome of the programme at Bradford University is the development of a powerful flow measurement technique (work on this has spread also to UMIST) ideal for difficult fluids - corrosive liquids, hot gases and especially two-phase flows such as slurries and pneumatically transported solids. Applied to pipe flow, the technique uses natural flow disturbances, particularly turbulence, to modulate an external source of radiation, eg ultrasound, at two points in the flow. Cross correlation of the two signals gives the transit time for the flow between the two points - and hence flow rate. Using ultrasound offers a 'clip-on' flow measurement ideal for process industries. Researchers at City University have employed advanced signal processing in the automatic optical surface inspection of steel strip, the sorting and gauging of components stamped from sheet material and the automatic visual inspection of printed circuit board tracks.

Much of the research funded at other institutions is also starting to show results. Work at Salford University has examined the problem of differential flow measurement. The accurate measurement of a small differential flow in and out of a process (for example, a kidney machine), where the common mode flow is large, calls for very high accuracy. The use of electromagnetic techniques to measure only the differential flow, yields accuracies approaching 1 part per million of the common mode flow. The approach is already being adopted for kidney machine instrumentation and the work has yielded considerable insight into the whole area of electromagnetic flow measurement techniques.

Lanchester Polytechnic is harnessing a range of simple electro-optical techniques for use in metrology applications for checking the profiles of small components and the position, diameter and alignment of holes. The emphasis is placed upon the development of low cost, robust, accurate instruments which are ideally suited to automation and will cope with long or short runs of components. To this end the work has been concentrated on the use of light beams and photocell receptors and simple microprocessor-based circuitry for signal interpretation rather than approaching the problem from the more complex (and expensive) direction of video signal processing.

Work at the University of Technology at Loughborough has applied holographic interferometry and laser speckle pattern interferometry to optical gauging. The techniques developed, which rely on putting optical data – interference patterns generated by split laser beams – into a 'picture' that can be picked up on a tv camera and subsequently electronically analysed, enable far higher resolution to be achieved than is possible with non-coherent light sources. The approach has already been widely used to analyse the vibrational modes in equipment as diverse as automotive engine blocks and musical instruments and it will prove an invaluable quality-assurance technique. Ultimately it could provide direct on-line feedback to machine tools to correct defects in components as they are produced.

Mr J Tallentire, formerly of ICI Plastics Division, was appointed programme coordinator in autumn 1980. His primary task is to increase industrial interest and take-up of the results which are already coming through from the programme. The Committee intends to continue its policy of developing centres and a fourth centre, at UMIST, to cover on-line plant measurement, automation and applied micro-electronics, has now been approved. The Committee is keen to encourage research which will exploit the use of optical fibres for the optical or optoelectronic transmission of plant data. Further details of the programme may be obtained from Mr Tallentire, Room 510, Physics Department, City University, St Johns Street, London EC1V 0HB (tel: 01-253 4399 ext 4416) or Mr W Bray, Secretary, Control and Instrumentation Sub-Committee, SERC Central Office, Swindon, ext 2401.

Coordinators for Construction Management SPP

Professor W D (Bill) Biggs and Dr Roger Flanagan, of the University of Reading's Department of Construction Management have been appointed as coordinators for the Construction Management SPP (announced in Spring 1981 *Bulletin* Vol 2 No 2). The unusual step of appointing two coordinators was taken in order to bring sufficient breadth of experience and expertise to bear on this wide and complex subject.

Professor Biggs has been Professor of Building Technology at Reading since 1973 and has had experience in the fields of metallurgy, engineering materials and engineering design. Dr Flanagan has recently joined the University as a lecturer following experience as an estimator and project surveyor working for building contractors and quality surveyors. The Council expects that Dr Flanagan's recent knowledge in the field together with Professor Biggs' experience in engineering research will provide an efficient co-ordinating team.

The coordinators will promote and encourage research into construction management processes and ensure that the results of such research are taken up by industry. The very nature of construction management research means that the coordinators will be expending considerable effort in forming and maintaining contacts with the building and civil engineering industries.

Those interested in the programme are invited to contact Professor Biggs or Dr Flanagan at the Department of Construction Management, University of Reading, Whiteknights, Reading RG6 2BU. Telephone Reading (0734) 85123.

AMPTE: international space plasma physics experiment

Rutherford Appleton Laboratory is to play a major part in an international study of plasma physics in space. The study known as AMPTE (Active Magnetospheric Particle Tracer Explorers) will employ spacecraft from the USA, Germany and the UK. The purpose is to investigate how solar energy, carried by the solar wind, is intercepted and stored in the magnetic fields and charged particles that form the comet-shaped magnetosphere surrounding the Earth out to distances of more than 100,000 kilometres. The stored energy ultimately becomes deposited in the upper atmosphere, mainly at high latitudes, where it produces heating, ionisation and the spectacular phenomenon of the Aurora Borealis.

The plan is for a satellite, being built in Germany at the Max Planck Institute for Extraterrestrial Physics, to release lithium ions into the solar wind to act as tracers. This will be done some 10,000 kilometres upstream of the magnetosphere. An American satellite, being constructed at the Johns Hopkins University, will be orbiting closer to the Earth in the region of the Ring Current, to detect the arrival of the ions and note the extent of their expected increase in energy. As well as releasing the tracer ions, the German spacecraft will record, with particle, wave and field detectors, the disturbances expected to be triggered by the sudden deposition of lithium ions in the natural plasma of the solar wind. Seven releases of lithium and barium ions are planned for various points along the route taken by solar wind ions and electrons. One of the barium releases, in the dawn Magnetosheath, is expected to be easily visible from the ground (from the Americas) and, for 30 minutes or so, to have every appearance of a comet. Other barium releases in the Plasma Sheet on the nightside of the Earth are expected to create magnetic cavities with an attendant wide range of plasma phenomena.

It was for the studies of the disturbance to the natural plasmas that a third spacecraft was required. The UK spacecraft will be a sub-satellite of the German craft which it will track in tandem along the same orbit. It will be capable of high resolution plasma measurements and add an extra dimension to the ion cloud studies. Workin with the German spacecraft, it will help to distinguish between temporal changes and spatial structures, an impossible task for a single moving vehicle.

The 'active' aspects of AMPTE, outlined above, form only part of the mission. Throughout most of the nine-month planned lifetime, the three spacecraft will study the natural particles, fields and waves of the magnetosphere. The quantities to be measured from the UK spacecraft and the groups involved are:

Magnetic fields	- Imperial College with the University of California at Los Angeles
Positive ions	- The Mullard Space Science Laboratory (MSSL)
Electrons	- The Rutherford Appleton Laboratory
Plasma waves	- The Universities of Sheffield and Sussex with the British Antarctic Survey
Wave-particle interactions	- University of Sussex

The three AMPTE spacecraft will be launched on a single Thor Delta vehicle from Cape Canaveral in Florida in August 1984.

The UK spacecraft, known as the UKS, is built around the conical adaptor linking the German and US satellites in the launch configuration. Attached to the cone are 12 sides supporting the solar array and experiment detectors, as shown in the diagram. The UKS is approximatley 1m in diameter and weights 69kg. It has two pairs of deployable booms, one pair carrying the magnetometer and wave-experiment search coil; and one pair the electric field experiment pre-amplifiers, the latter being approximately 7m tip-to-tip. The spacecraft will be spin-stabilised with its spin axis normal to the ecliptic plane. Attitude control will be effected by a magnetorquer coil and pressurised nitrogen thrusters guided by data provided by sun and earth sensors. The gas thrusters will also be used for station-keeping with the German satellite to maintain a separation of approximately 100km. This task will make use of an on-board radar being developed specially for the purpose.

Science data will be collected for at least four hours each 48-hour orbit, and transmitted in real-time via an s-band link to the 25m dish at Chilbolton, linked to the UK control centre at Chilton. The 12m dish at Chilton will be used for commanding and reception of spacecraft control data.

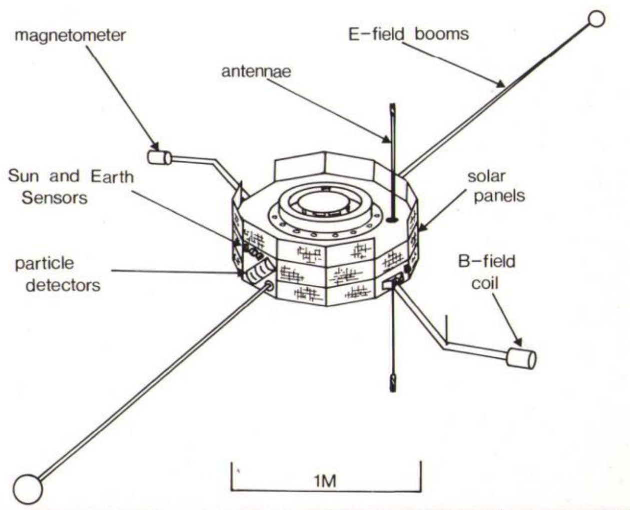
The UKS is being built as a collaborative effort between RAL and MSSL, with much of the hardware being produced in-house. There is also significant involvement of UK industry, with major contributions by COM-RAD Electronic Equipment Ltd , Spembly Technical Services Ltd and British Aerospace.

At least 75% of the spacecraft hardware is being produced in the UK. A mechanical model of the spacecraft has been used in structural tests in Germany and the UK and is currently being refurbished to become a fully working prototype in the spring of 1982. Flight model spacecraft fabrication will be completed towards the end of 1982, with delivery to Germany scheduled for September 1983.

Project Scientist:
Dr D A Bryant (RAL)

Project Manager:
Mr A K Ward (RAL)

The UK Spacecraft



The will to succeed

Professor Alec Boksenberg with a volume from the Airy Collection.

Professor Alec Boksenberg, FRS, creator of the Image Photon Counting System and hence a whole new generation of astronomical detectors, has taken over as Director of the Royal Greenwich Observatory at a time of massive new development. He talks with enthusiasm of his plans to *SERC Bulletin*.

"At the moment Britain has really quite superb astronomers yet is lacking adequate optical facilities," says Alec Boksenberg. "Now we are going to have La Palma Observatory and it will be the best observatory in the world if I have anything to do with it which I have."

Professor Boksenberg has clearcut objectives as Director of RGO and an iron determination to achieve them. His programme is simply to provide the best astronomers with the world's best facilties, to involve the universities on a collaborative basis at every level and to enable the public to share the achievements of the astronomers not only at the Observatory but also through the media.

In his new post he already exhibits the sort of vision and resolution that he showed when, still in his thirties, he evolved the Image Photon Counting System and managed to get time on the world's best telescope, at California's Palomar Observatory, in order to give it its first test run. It was impressively successful.

"The RGO's main task is to provide a superb observatory on La Palma for our astronomical community to use. Our astronomers must not only participate in providing the facility but, after observing with it and then interpreting the results, they must feed back their experiences so that the facility can be enhanced and, as time goes by, continue to develop and improve. I will still pursue my own research not only because I like it but I too need the feedback; only by using the observatory for research can one judge how successful it is. Technicians and theorists should mix with observers and no-one should work in isolation from the community. The astronomy population is not too large to work as one community, certainly within the UK. If we at RGO thought of ourselves solely as a service establishment we should fail. I will include the universities and the RGO in one joint effort.

"It is my declared aim, the one foremost in my mind, to merge university effort and establishment (in my case RGO) effort into one common endeavour. I think only in this way can we both succeed and also be efficient.

"This collaboration has already started, for example, in providing the instrumentation for the La Palma Observatory. Universities and the RGO are working together in an integrated and completely equal manner. It is not just a question of a consumer service – '*we* provide this for *you* to use' – it is a real combination of effort. Such collaboration, not only in instrumentation, could go much further if we were able to get together more readily."

This seemed a good moment to raise the Director's idea of an Astronomy Centre.

"The Castle at RGO is now very much under-used. I wish to fit it out and turn it into a residential Astronomy Centre where we could have discussion workshops, conferences big and small, and visits from university staff for longish periods, possibly on secondment (which could help universities financially).

"Secondments would make possible the merging of efforts that I was describing – bringing technical and astronomy expertise right in here, where the facilities and much of the instrumentation are being produced. One needs intensive participation, with people actually being on site, not just occasional consultations. In some cases the visits would be for a few weeks, sometimes maybe six months or so and this must mean bringing the family. So some of the accommodation within the Castle I should like to be family residential accommodation.

"In this way we could bring the community and RGO together in the common effort of astronomy. And that goes not only for providing the facilities in the first place; it is also essential to discuss the astronomical data that comes out. It is no use stopping at providing the facilities, we have to see it right through to getting brilliant astronomical interpretation as well. This is frequently very much assisted by having small groups of people in discussion workshops really brainstorming a problem.

I have plans for much of that and also for larger conferences. International participation is very important: we must bring RGO into the world scene. It is crucial to have visitors from international institutions. They have an excellent visitors' programme at the European Southern Observatory which works very well. We really need a similar arrangement here.

"So the castle, in its residential form, would be very active in bringing the community, both national and international, and the RGO together. I think it is vital to centralise discussions in the community and RGO is a most appropriate site.

"Of course, I don't want to give the impression that La Palma is merely an out-station. If La Palma is not effective then the rest is of little consequence. If an observer loses one minute of his or her time, that minute is remembered. It does not matter what gloss there is elsewhere; it is essential that one's observing time is used most efficiently.

"As far as I am concerned the La Palma Observatory and the RGO are one and the same. It is not an offshoot of RGO; it is what RGO is all about. It is a combination that works as a unit. One plan for the future is to have the La Palma Observatory Control Room, for its four telescopes, right here at RGO and to run the observatory remotely from here for our observers. I should like to extend this also to the Anglo-Australian Telescope and have an AAT control room here too. In this way you will not have to travel if you do not want to. I think travel is important; but too much travelling is wasteful and so having a control room here means you can be more flexible in arranging observing schedules, sharing the risk between observers so that you do not necessarily lose all your observing time if the weather is bad.

"Between us – RGO, our Dutch and Danish partners on La Palma, and the Royal Observatory at Edinburgh – we have an amazingly high quality of technical staff and astronomers in a broad community all working to the same end. We have organized ourselves for our common benefit. Starlink is an example of this approach: the efforts of each individual are accessible to everyone through the Starlink network and so everybody in the community is contributing to Starlink.

"In general should also like to publicise our achievements more. When we make a discovery, which is very frequent in astronomy, we should explain it to the general public through newspapers and television and not just publish in learned journals. I think we not only have a duty but should be delighted to work with the public in explaining ourselves, in showing that what we do is interesting and important."

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Advances in instrumentation at RGO

A prime function of the Royal Greenwich Observatory is the design, manufacture and operation of the optical instruments associated with their optical telescopes, in particular spectrometers and the detectors used with them.

Most of the work in optical astronomy is done on a small range of 'common user' auxiliary instruments, all of which must be kept ready for use all the time. The instrumentation can be interchanged and adapted for the individual research needs of each astronomer. Some of the most challenging problems arise in the need to employ new technical developments in those instruments while maintaining a standard of reliability and general presentation which is appropriate for a national facility.

The main instruments being manufactured at present are those for the 2.5 metre Isaac Newton Telescope (which was in Sussex but is now being installed at La Palma, Canary Islands). One of them is the spectrograph shown here. This will be the principal instrument use on the 2.5 metre telescope for spectroscopic studies of relatively faint objects such as quasars and the nuclei of galaxies and will probably be the most used instrument overall. A new optical design reduces light losses by 50% or more compared with previous designs and its operation has been enhanced with various remotely controlled mechanisms.

Image Photon Counting System

The principal detector system for this spectrograph will be an 'Image Photon Counting System' developed by Professor Boksenberg at University College, London (see page 9). There is a stringent requirement for mechanical rigidity in the spectrograph and detector system and so the flexure of the steel case was numerically analysed to verify the design. The instrument is to be attached to the telescope at its Cassegrain focus.

The intention is that the new instruments will be brought into use at the remote site without much further development, and so a 'telescope simulator' has been erected in the workshop area at Herstmonceux. It enables instruments to be tested in much the same conditions as will be experienced on the telescope proper. The spectrograph shown here is mounted on the simulator.

Demanding specification

This Cassegrain spectrograph will provide a spectral resolving power approaching 15,000. Higher resolving power together with a wide instantaneous wavelength coverage will be provided by a much larger spectrograph at the coudé focus. ('coudé' means 'bent' and refers to the way the beam of light is angled to a point that stays fixed as the telescope itself moves). The telescope at this focus has a focal length of 125 metres and the spectrograph is about ten metres long. It will provide a spectrum containing up to 20,000 simultaneously resolved and recorded wavelength elements, greatly exceeding what is possible on smaller instruments. The mechanical as well as the optical specification is again a demanding one, because the mechanical stability of the large frame must be much better than one arc second during a whole night. The temperature changes which might jeopardise this performance are reduced by the design of the building.

The instrument will employ photographic emulsions which have been developed in the last few years. There will be facilities for enhancing the sensitivity of the emulsions and for obtaining intensity linearisation as a function of wavelength. This coudé spectrograph is designed to provide accurate as well as voluminous photometric data; many atronomical discoveries have been due to the accuracy of an observation rather than the faintness of the object observed!

Direct sky images

Another new development is the automatic system for observing at the prime focus, where direct sky images are photographed, or recorded with the electronic camera. When the telescope was at Herstmonceux, the prime focus observer had to ride in a small cage in the middle of the telescope tube. His work involved focusing the telescope, locating and following a suitable guide star, and operating the camera. Most of the operations can now be carried out remotely from the control room, or are automatic, so that there is no longer any need for the astronomer to ride on the telescope.

RGO also has a small technical group developing the detector systems which will be used with the optical instruments. Currently the most promising development is in integrated silicon detector arrays. They should be particularly useful for observations in the red region of the spectrum and are well suited to automatic methods of data analysis. There are industrial concerns in this field but their main research is into television cameras operating at the usual frame rate.

Astronomers aim to use the available devices in a different mode; that is, to integrate light in a single frame during periods of up to two hours. The electronic and cryogenic techniques necessary have now been established. A detector system incorporating a 'Charge-Coupled Device' was commissioned by RGO staff on the Anglo-Australian Telescrope in September 1981 and they have installed another new detector system at the South African Astronomical Observatory. These are micro-processor-based devices which enable the observer to assess the progress of an observation very rapidly. The development of these instruments means that British astronomers will not only have new and improved telescopes but much more effective methods of utilising them.

RGB

RGO design engineer D W Gellatly, with the Cassegrain spectrograph attached to the telescope simulator at the Royal Greenwich Observatory.

Silicon imaging devices applied to astronomy at ROE

The Royal Observatory, Edinburgh, has developed a versatile low light level imaging camera system suitable for a range of astronomical applications. An all-solid-state silicon imaging device called a CCD (Charge Coupled Device) is used and operated in a slow-scan mode.

'Chargeimage'

The CCD target is exposed to light for an arbitrary time, like a photographic plate, and then the accumulated 'charge image' is read out electronically, amplified, digitised and passed to a minicomputer for immediate processing. Unlike photographic emulsions, however, the sensitivity of this photoelectric device is staggering and it surpasses other TV tube-type camera systems in mechanical and electrical simplicity and reliability. By cooling the small chip (15 x 9 mm active area) to temperatures below -100^{o}C, long exposures on the faintest astronomical objects become possible.

In the ROE CCD camera system, control is vested in a dedicated microprocessor. This enables the CCD either to stand alone, for laboratory work say, or to be used as a detector with a computer-controlled multi-purpose astronomical instrument which may be configured to perform imaging, low resolution spectroscopy or polarization measurements.

Increased efficiency

The CCD provides a means of observing many spatial and spectral elements of an image simultaneously giving a huge increase in efficiency.

In the ROE camera, the CCD is mounted in a vacuum about 20 mm behind the quartz window of a liquid nitrogen cryostat. In front of the cryostat window may be placed an electric shutter or a lens or both. When used for direct imaging the cryostat is attached with its shutter to a simple filter photometer whereas for spectroscopy a fast multi-element lens is used to focus a collimated beam dispersed by a transmission grating prism (a 'grism') yielding 40 n m/mm on the CCD.

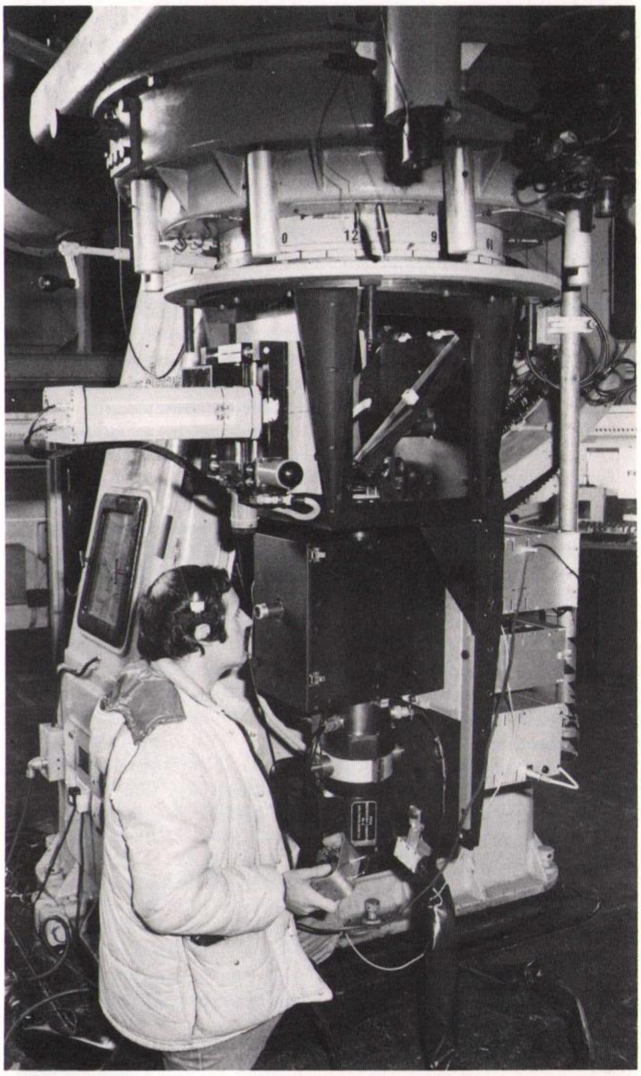
For polarimetry, the photometer or spectrograph sections are preceded by a polarimeter comprising basically a rotatable superachromatic halfwave plate of quartz and magnesium fluoride followed by a polarizing prism. In the spectrograph mode, the prism is a calcite beam displacer which yields two spectra physically separated on the CCD and orthogonally polarized. Imaging is also possible in the spectrograph mode by rotating the grisms out of the collimated beam and introducing a variety of filters.

Immediate decisions

At present the ROE system employs either an RCA CCD, having an array of 512 x 320 picture elements (pixels) each 0.030 mm square, or a GEC CCD, having 576 x 385 pixels each 0.022 mm square. To read out and digitise a full CCD frame and store the data on magnetic disc requires about 30 seconds but the data are then immediately available for processing and/or display on TV monitors, graphics terminals, plotters, etc. Thus the astronomer at the telescope can make immediate decisions regarding the quality and scientific content of the CCD images.

The ROE CCD imaging/spectropolarimeter system has the advantage of combining several functions in one transportable instrument, high sensitivity over a wide spectral range, flexibility and on-line data processing. For example, using the system on a large telescope one can obtain direct images through colour filters of faint galaxies and quasars and then obtain the flux and polarization spectrum and radial velocity (redshift) of these objects.

I McL



CCD camera system mounted on the 0.9m telescope at the Royal Observatory, Edinburgh. Guiding the telescope is Dr Ian McLean.

On the horizon

A special documentary TV programme, scheduled for transmission in April 1982, is being prepared by the BBC to celebrate the 25th anniversary of *The Sky at Night*, Patrick Moore's monthly astronomy feature (incidentally the longest continually running series on BBC TV). Filming has been carried out at SERC's facilities at the two Royal Observatories and in Australia, Hawaii and La Palma and it is hoped that the programme will include sequences from some or all of these.

SERC's strategy in distributed interactive computing

The emergence of cheap high powered single user computer systems with good interactive capabilities and standard communications interface heralds a completely new way for many research workers to achieve the major part of their computing requirements.

Within the next few years, many such systems will be available from different manufacturers. Consequently there is a danger of a variety of machines being employed in academic research, many of which are likely to have inadequate and incompatible systems software, leading to a dissipation of resources and considerable duplication of basic software development.

SERC sees a need for a coordinated plan to ensure that the academic community makes the best use of the resources available to it, especially its limited manpower. The Council has therefore decided on a policy of creating a common hardware and software base to act as a nucleus for future developments in single user workstation practice. Initially, the common software base will be Pascal and FORTRAN running under the Unix operating system implemented on the common hardware base of PERQ single user computers, linked locally by Cambridge Rings and nationally by the X-25 wide-area computer network. The PERQ will be joined by other machines as new products become available.

To assist in the implementation of this policy a small support team is being formed at the Rutherford Appleton Laboratory whose role will be to ensure that the systems software provided on the chosen machine types is satisfactory and to encourage the development of applications software through arrangements analogous to those of the ICF's Special Interest Groups. SERC's Boards and committees will consider grant applications involving requests for single user computers in the normal way. If the scientific programme is approved, the application will be referred to the support team who will arrange the supply of a machine to the applicant. All purchases will come from Board or committee funds but the single point of procurement will enable bulk orders to be placed so that discounts and reductions in delivery times can be obtained. Central purchasing of PERQs, the UK manufacture of which is due to begin in early 1982, will enable ICL to increase the scale of its production with greater confidence. An integral feature of Council's overall strategy is that SERC and ICL will collaborate extensively on the development of future PERQ-type machines and on software systems relevant to the interests of the academic community.

PERQ

The PERQ is an extremely powerful, single user workstation with a high precision display system which provides a significant improvement in the quality and speed of interaction. Although entirely self-contained, it also features standard communications interfaces offering network access to other local workstations or remote shared facilities. Its principal characteristics are:

High speed processor

Approximately 1 million 'high level' machine instructions per second giving around two-thirds the CPU power of a VAX 11/780. The CPU is micro-programmable for further speed gains.

High quality display

A4 size, 1024 x 768 pixel, high resolution black and white display featuring 60Hz non-interlaced refresh rate which enables pictures to be moved cleanly and rapidly as well as giving a significant improvement in the clarity of text and diagrams equal to a printed A4 page.

User friendly I/O devices

A 2-D tablet keyboard and voice synthesiser, allied to the high quality screen, enables a much improved man-machine interface to be created.

Large virtual memory

A 32-bit address, paged virtual memory system.

Local filestore

A 24 Mbyte Winchester disk and 1 Mbyte floppy give a single user a large amount of local storage capacity.

Fast communications

Local communication at 10 Mbits/sec via Cambridge Ring. Standard RS-232 serial and IEEE 488 parallel interfaces are also provided.

Common base policy

The whole academic community, not just computer science interests, is a major user and developer of software. The ease with which software can be developed and the extent to which it is easily interchangeable between machines can have a significant effect, therefore, on scientific productivity. The SERC believes that the programme it has initiated for single user machines will provide a way of removing many constraints on research output. Computing resources will be available locally with much greater freedom of access. Person to person and computer to computer links will be easier to establish and the prospects for collaboration and co-ordination improved. Commonality of hardware and software will maximise the opportunities for co-operation. A framework will be created in which software skills can be exploited, information on tools and techniques disseminated, and software made available in forms which can readily be adopted by the widest possible spectrum of users.

PERQ, and the new departure it represents, provides the incentive for creating a common hardware and software base in which the best of the existing tools, packages and techniques will be brought together in an overall framework, the effectiveness of which will be much greater than the sum of the individual elements. Work will be required in universities and at RAL to move existing software into the common base which will be complemented by selective purchasing and, in due course, by the direct results of research projects using the common base equipment.

The strategy which SERC is intending to pursue in distributed interactive computing is more than just a mechanism for standardising on one or two machine types. Its feasibility and timeliness are intimately related to a number of contemporary developments in computing.

The widespread availability of networks make common access possible to special tools or facilities which can be provided only on a limited number of sites.

The pace of technological development means that over the next few years the cost of single user systems will diminish while their quality and capability increase. Today's PERQ is therefore seen as only the first machine in the common hardware base.

RW/DHL

The compact PERQ single user computer installed at RAL

Developments in computing

The Council's Information Engineering Committee is responsible *inter alia* for research in the field of computing science. Described here are recent developments arising both from the Committee's specially promoted programme in Distributed Computing Systems and as further implementation of the recommendations of the 'Roberts Report'.

Distributed computing systems

The Specially Promoted Programme in Distributed Computing Systems (DCS), which started in 1977-78, now supports about 40 academic investigations, amounting to an investment of about £2.75M. The programme's objective is to gain an understanding of the principles of distributed computing and to establish engineering techniques to implement them. The programme is now entering its final phase - it will end in September 1984 - and effort is being concentrated on transferring the results of investigations to UK industry. To this end, the Council has appointed a part-time industrial coordinator with responsibility for establishing links between academic researchers within the programme and potential industrial users - principally in the computing hardware, software and applications sectors.

The DCS Industrial Coordinator is Mr. Fred Chambers, Logica Limited, 64 Newman Street, London W1A 4SE. Tel: 01-636 5440 ext 242.

Dataflow computing

A potential major product of the DCS Programme is the development of dataflow computing systems by Dr J Gurd and Dr I Watson of Manchester University who are world leaders in this field. Dataflow computers are able to execute many different parts of a program concurrently, achieving very high computing speeds. Potentially, they have much wider application than alternative parallel computers which rely on regular structure in hardware and software.

The Manchester Group has recently been awarded a four-year grant of £395k for the development of a prototype multi-ring dataflow computing system.

Implementing the 'Roberts Report'

The Roberts Report *(Proposed new initiatives in computing and computer applications* SRC, 1979) recommended, in the national interest, that the Council should take action to stimulate industrially relevant academic research on the following topics within computer science:

Software technology;
Database utilisation;
Systems reliability;
Man-machine interaction.

Progress on implementing these recommendations has been considerable.

Software technology

With the cost of computing power falling rapidly, there is an urgent need to find means of producing cheap, reliable software. The Engineering Board's Computing and Communications Sub-committee has appointed an officer to coordinate a research programme to respond to this challenge. The principal objectives of the programmes are:

- To stimulate more high-quality software engineering research;
- To improve the academic software technology base;
- To facilitate two-way technology transfer between industry and the academic world.

A major feature of the programme is the adoption of common hardware (ICL PERQ and Cambridge Ring) and software (Pascal and UNIX) bases. This approach will facilitate the transfer of results and ideas between research groups, reduce duplication of effort and enhance the attractiveness of the British products used (see facing page).

The Software Technology Coordinator is Mr R Witty of the Council's Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX, telephone: Abingdon (0235) 21900 ext 6218.

Database utilisation

Following a community meeting in September 1980, to which academics and industrialists were invited, two major consortia emerged which have subsequently received awards totalling almost £500,000 for research on multi-site distributed data-bases.

One consortium, centred on East Anglia University, is concerned with a heterogeneous distributed database system. Its objective is to agree standards for logical data description and query representation at the internal system level. The other members of the consortium are based at the Universities of Aberdeen, Bristol, Cardiff and Kent.

The other consortium, centred on Aberdeen University, will establish a homogeneous distributed database. The aim is, at each site, to study different aspects (eg suitable query languages and storage mechanisms) of the same system. The other centres within the consortium are Heriot-Watt and Stirling Universities and the Polytechnics of Leeds and Northern Ireland.

System reliability

A research group at Newcastle University, under Professor B Randell, has received long-term support from the Council for research on computer system reliability. The techniques developed are now at the stage where they should be transferred to industry. Consequently, the Council has awarded a grant of £148k to Dr T Anderson to design and construct, to full commercial standards, a command and control system embodying the reliability techniques developed at Newcastle. The investigation also receives support from the Ministry of Defence. It is hoped that this project will serve to demonstrate to industry the effectiveness and practicality of the reliability techniques developed with SERC support.

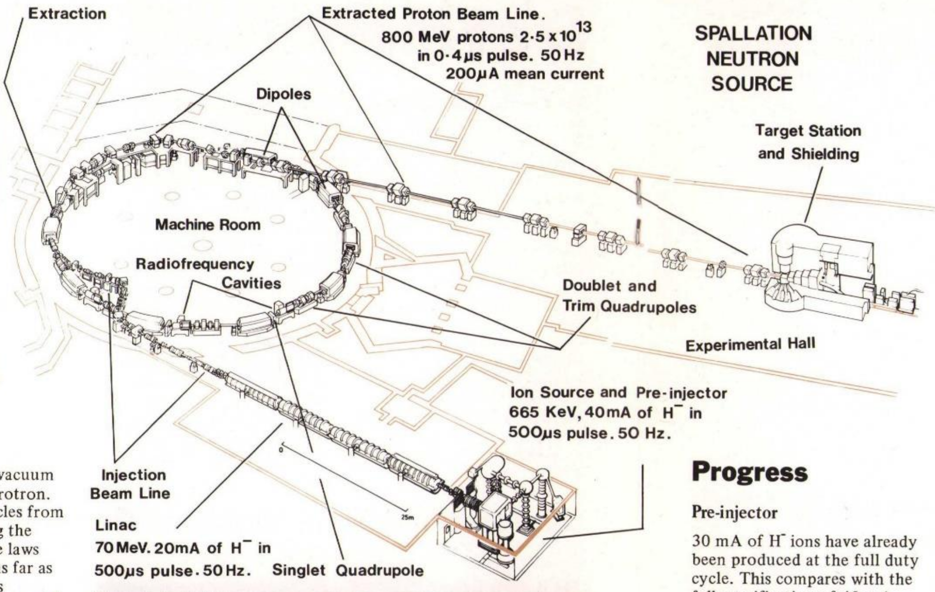
Man-machine interaction and knowledge-based systems

The Council is keen to receive proposals for industrially relevant research in man-machine interaction.

The possibility of establishing a coordinated research programme on knowledge-based systems, incorporating aspects of man-machine interaction, database utilisation, software technology and artificial intelligence, is being debated. Developments will be reported in subsequent issues of the *Bulletin*.

Further information on the programmes described above can be obtained from Mr J Monniot, SERC Central Office, Swindon, ext 2260.

Signs of the SNS



New equipment for the Spallation Neutron Source at the Rutherford Appleton Laboratory (RAL) at Chilton is now arriving. Here we review the progress being made on the accelerator part of the facility.

What is the SNS?

The SNS will make intense short pulses of neutrons by hitting a target of heavy metal with pulses of 800 MeV protons. Thirty fast neutrons are produced for each proton and these are slowed down in moderators close to the target to produce the highest available usable intensity of slow neutrons (about 1 eV energy). The SNS will be the most intense spallation source in the world, more than a factor of 10 up on existing facilities.

The SNS has three accelerators in tandem. In the pre-injector H^- ions are produced in a hydrogen discharge seeded with caesium. The H^- ions are initially accelerated in a column with 665 kilovolts DC across it. A pulse of ions lasting 500 micro-seconds then passes through the linear accelerator which accelerates them to a velocity equal to one third that of light, ie they have an energy of 70 million electron volts.

The SNS is a high current machine which requires that particles must be injected into the main accelerator, a synchrotron of 26 m mean radius, over a period equivalent to about 500 times the time taken for an ion to travel around the synchrotron. This process is known in the jargon as 'multi-turn injection'. Furthermore, sufficiently high particle densities could not be achieved by injecting, say, protons and continuing to inject further protons for the whole 500 turns. This would contravene physical laws which determine the density of particles of the same type and properties within the vacuum chamber of the synchrotron. By changing the particles from H^- into protons during the injection process these laws can be circumvented as far as their practical effect is concerned. To do this the H^- ions pass through a stripping foil which knocks off the electrons from the H and converts them to protons.

The protons are constrained in the vacuum chamber by a magnet system which bends the protons through 360° and also provides focusing fields. The magnet system is split into 10 similar sections, known as superperiods. Each superperiod contains a 36° bending magnet which also provides some focusing in the horizontal plane. Near to it is a focusing magnet, a singlet quadrupole, which produces a matching vertical focusing effect. The other main items in a superperiod are a pair of quadrupole magnets which give vertical and horizontal focusing. The bending magnet and the three quadrupoles are connected in series to the other superperiods and are powered from the power supply previously used on NINA at Daresbury. The power supply operates at about mains frequency, 50 Hz, and the current in the magnets is biased by a DC power supply so as to run between the current equivalent to 70 MeV protons and that required to energise the magnet to cater for 800 MeV protons. Tuning of the focusing properties of the magnet system is achieved by programmable trim quadrupoles.

A quadrupole doublet with trim quadrupoles mounted on their base. The ceramic chamber runs through the whole unit.

A high vacuum, between 10^{-7} and 10^{-6} torr, is required in the vacuum chamber to minimise losses of the protons as they travel about 15,000 times around the machine.

Six radiofrequency cavities are required to trap and form the injected protons into two bunches and to accelerate them to 800 MeV. The RF accelerating voltage has to keep in phase with the bunches of protons as they speed up and the frequency has to increase from 1.3 MHz to about 3.1 MHz during the 10 millisecond acceleration time. All six cavities have to be accurately controlled in voltage and phase. To provide the frequency shift the cavities have ferrite discs which can be biased to change the inductance of the cavity using essentially a 50 kW Hi-fi amplifier to provide the biasing current. When the protons have been accelerated they are kicked vertically out of the synchrotron using three very powerful kicker magnets.

The field in these magnets must rise from zero to full value in the time between bunches in the machine, ie in 0.22 micro-seconds, otherwise protons would be lost during the extraction process. The protons are then transported and focused by the extracted proton beam system on to the neutron-producing target in the main experimental hall.

The whole facility will be controlled using four mini-computers. Much of the equipment will be individually controlled by micro-computers feeding into the main control system.

Progress

Pre-injector

30 mA of H^- ions have already been produced at the full duty cycle. This compares with the full specification of 40 mA. The pre-injector 665 keV power supply and accelerator column have been tested to full voltage. H^- ions were run through the column towards the end of 1981.

Injector

The linac injector has had its cooling modified to cope with the increase of repetition rate from 1 to 50 Hz. All four tanks have been aligned. The pulsed power supplies feeding the four tanks have also to be uprated. One complete system has been built and radio-frequency power has been successfully fed into the first tank at full power.

Injection

The stripping foil needs to be 50 microgrammes/cm^2 (about 25 microns thick) with an area of 12 cm x 3 cm with one 12 cm edge unsupported. This is bigger than any equivalent foil known. Foils of aluminium oxide have been produced which are the right size and shape. They need to be tested with charged particles to ensure that they will stand the working temperature of about 800°C and any structural damage caused by the particles.

Magnet

The 20 main doublet quadrupoles and the 20 trim

Prototype ceramic vacuum chamber for the SNS bending magnet. In the background is a model of the bending magnet.

quadrupoles have been delivered and are being built up into ten units for the synchrotron. The prototype singlet quadrupole has been delivered and is to specification. The manufacturer of the main dipole magnet has had difficulties in sticking together the laminations into blocks which will make up the yoke of the bending magnet but a solution has now been found. The NINA power supply is being used as the main part of the power supply for the magnet system and has been installed in its new position.

Vacuum chambers

The vacuum chambers need to be non-conducting; otherwise they would be heated by the 50 Hz magnets and the field shape would be distorted. A novel design of ceramic chamber has been developed. Sections of chamber about 30 cm long are delivered by industry with a glass coating on the ends. These sections are vertically stacked accurately together and are then heated in an oven to 1100°C. The glass melts and forms a joint between sections which is strong, can withstand thermal shock and is not damaged by the radiation levels which will be encountered in SNS. All ten of the 3 m chambers for the quadrupole units have been built successfully as well as prototypes for the singlet quadrupole and the 5m bending magnet chambers. The latter chamber is somewhat more difficult to make. It covers an angle of 36° with radius of curvature 7 m. Since it is not stable when stacked vertically, two heating processes are necessary in the build-up. In the first, two-thirds of the chamber are stuck together with the remainder added later.

RF system

A complete prototype RF system has been built and is now undergoing tests. The ferrite 40 cm diameter rings have all been delivered together with the copper discs which cool the ferrite. Power supplies for feeding the RF valves have been ordered as have the power supplies supplying the ferrite biasing system.

Extraction

The design of the extraction kicker magnets is essentially complete and tests are in progress on various components. One recent success has been to achieve the 0.22 microsecond rise time on the kicker magnet field.

Extracted proton beam

The outline design is complete. Some shielding has been installed around the EPB which will reduce radiation levels so that the experimental hall can be permanently occupied.

Control system

The computers for the control system have been delivered. The software and hardware interfaces are being developed. One of the systems has been used for measuring the magnets after delivery.

Building modifications

The facility uses existing buildings in which the Nimrod complex was housed. After stripping out the equipment and carrying out some building modifications equipment is now beginning to be installed in the synchrotron room.

DAG

Materials preparation groups

The Council supports two university groups to prepare and supply highly specialised, well-characterised materials to meet the needs of the research community. One, under Dr G Garton, is at Oxford and the other under Dr D W Jones at Birmingham. Their programmes include the synthesis and ultrapurification of starting materials, the growth of single crystals, alloying, the physical and chemical investigation of new materials, and the development of new crystal growing and specimen fabrication techniques, with appropriate characterisation. The groups prepare single crystal specimens, either to a specification provided by the user or originating from their own research into new materials. The Oxford group is primarily concerned with the preparation of simple and complex oxides and halides of the transition and rare earth elements, as well as alloys of these elements. Most crystals are grown from pure or fluxed melts and significant effort is directed to the synthesis and purification of starter materials.

The Birmingham group is engaged in the development of processing and refining techniques which are applicable to a wide range of reactive/refractory metals, typified by the rare earth elements, their alloys and compounds, and with supplying well-characterised materials and specimens to the research community.

To enable the quality of research using these materials to be monitored and maintained at a high level, each user is required to provide the relevant group with an account of his proposed programme when requesting a material, and with a subsequent report of the research carried out. The group or groups may in some cases seek the advice and guidance of the Physics Committee. They make a charge to users for the 'consumable' cost of any materials supplied.

Researchers interested in obtaining materials are encouraged to contact the appropriate group directly. The addresses are:

Materials Preparation Group
Clarendon Laboratory
University of Oxford
Parks Road
Oxford OX1 3PU.
Telephone: Oxford (0865) 59291)

Contact: Dr G Garton, extension 223.

Centre for Materials Science
University of Birmingham
PO Box 363
Birmingham B15 2TT.
Telephone: Birmingham (021) 472 1301)

Contact: Dr D W Jones, extension 2163

High pressure facility

Since 1975 the Physics Committee has maintained for university and polytechnic researchers a high pressure facility at Standard Telecommunications Laboratories, Harlow, Essex. Highly specialised apparatus is provided, together with skilled technical advice and assistance. In March 1981 the Council's Science Board approved the renewal of the contract for support of the facility for a further three years until April 1984.

The attraction of high pressures in condensed phases lies primarily in the large scale and sometimes dramatic effects of significantly reduced lattice spacings.

High pressures are particularly relevant in the study of bonding, phase equilibria, lattice stability, electronic and ionic transport, optical spectra and material sysnthesis.

Of particular note have been achievements in the observation of new phase transitions in two-dimensional solids and amorphous arsenic, nuclear magnetic resonance (NMR) in iron alloys, and the determination of the three-level band structure and high electric field effects in GaAs and alloys such as $InAs_{1-x}P_x$.

New pressure cells have been designed at STL to provide the accurate measurements required in this wide range of experiments. These cells give pressures up to 100kbar (10Pa), and temperature down to 80K, enabling most normal physical measurements to be carried out on single crystals at very high static pressures.

To maintain and enhance the facility, new equipment is being installed to provide larger working volumes and lower temperatures; data handling is being updated and consideration is also being given to the provision of diamond anvil equipment for the 200kbar range together with the relevant x-ray facilities.

Prospective users wishing to discuss their requirements, or desiring more information on the current specification of the facility, should contact Mr J Penfold, STL Ltd, London Road, Harlow, Essex. Information on how to apply for time on the facility is available from Mr P Burnell, Physics Committee Secretariat, SERC Central Office, Swindon, extension 2215.

Extension of the ILL agreement

In 1979 the UK, with its partners France and Germany, agreed to a major modernisation programme for the Institut Laue Langevin (ILL) at Grenoble. The improved facilities enable the Institut to retain its position as a leading world centre for neutron beam research. The original Agreement between the three Governments was to run until 1982 but as a consequence of the modernisation programme the Agreement has recently been extended until 31 December 1982.

Future role of the Polymer Engineering Directorate

The Polymer Engineering Directorate was set up by SERC (then SRC) in 1976 'to mobilise the engineering-oriented skills of universities and polytechnics to help the UK polymer fabrication industry'. Since then PED has successfully co-ordinated the disparate programmes of research and development in academic institutions, stimulated many more and brought them closer to the needs of industry.
Over the last few months discussions with the Department of Industry have been taking place relating to the desirability of PED's becoming more closely involved with the Department's interests in polymers and it is now agreed that PED should widen its remit so as to provide a technical advisory and co-ordination role also for the DoI. The main advantage of PED's involvement with the DoI programme will be to achieve a greater degree of co-ordination between work supported by DoI and SERC; it will also help remove the barriers between research and subsequent development.

Teaching Company Scheme 'outstanding success'

A strategic review of the Teaching Company Scheme, undertaken during 1981 in order to assess its rapid growth and potential for continued expansion, concluded that the Scheme has so far been outstandingly successful.

The members of the Review Panel were unanimous in their commendation of the Scheme, pointing out that in the four years of its existence a new mechanism had been developed for dealing effectively and quickly with some of the most serious problems of UK manufacturing industry, with the weaknesses of the academic/industrial interface, and with some of the inadequacies of engineering teaching.

The Panel made the following principal recommendations, which have been endorsed by the Engineering Board:

- The Scheme should be continued for a second phase of about five years, with a review at the end of that time;
- For this period, it should continue to be operated by a central Directorate;
- The present basis of joint funding of the Scheme by SERC and the Department of Industry should be continued, but mechanisms should be developed for phasing in industrial support for both existing and new programmes;
- The budget of the Scheme and the number of programmes should be at least doubled. The extra funds required would be provided in approximately equal shares by SERC/DoI and the participating companies;
- Immediate consideration should be given to operation of the Scheme in other chosen sectors of industry beyond the area of batch manufacture in mechanical engineering in which most existing programmes are concentrated.

New Director for Teaching Company Scheme

The Council and the Department of Industry have appointed Professor D W Saunders as Director of the Teaching Company Scheme. Professor Saunders succeeds Dr John Wallace who has successfully built up the Scheme since its inception in 1976.

Professor Saunders has been involved in polymer engineering research and development since the mid-1940s. In 1960 he moved to the Cranfield Institute of Technology especially to expand work in the engineering exploitation of plastics. He became head of the Department of Materials in 1969. At Cranfield he has consistently worked to develop co-operation between industry and academic institutions, particularly at postgraduate level, and was closely involved in the setting up of SERC's Polymer Engineering Directorate. He has also served on a wide range of public bodies including the Plastics and Rubber Institute, of which he was Chairman 1975-76.

Professor Saunders' Teaching Company appointment is part-time. He will retain his leadership of the Polymer Group at Cranfield.

Professor Saunders

Dr Wallace will continue to act as a consultant for the Council and will advise on a wider range of collaborative schemes.

Long-term R&D requirements in civil engineering

The Civil Engineering Task Force, set up in October 1979 to identify priority areas for innovation and the consequent needs for R & D in civil engineering over the next 20 years or so, has now completed its study and presented its final report.

The Task Force was set up by SERC (then SRC) and the Departments of the Environment and Transport under the chairmanship of Mr (now Sir) Alan Muir Wood. The report is based on 72 detailed papers submitted by specialists in 39 produce areas and 28 disciplines or technologies relevant to civil engineering, including management. More than 700 individuals provided advice to the Task Force on these papers and on other matters relevant to the study.

The report identifies priority areas for R & D in civil engineering and construction, particularly in the areas of water, energy production and conservation, transport, building and housing, and identifies the changes to national priorities which the Task Force believes are urgently needed in these areas. It also examines the need for continuing authoritative advice on the objectives, priorities and balance of R & D programmes and makes recommendations on organisation and funding.

INFORMATION TECHNOLOGY 82

Throughout 1982 the Government is mounting a national campaign to promote a wider appreciation in industry and among the general public of the opportunities and benefits offered by information technology. The approach in industry will be to create greater management understanding and a willingness to introduce the new technology. A series of exhibitions, conferences and seminars will be held throughout the year and manufacturers and existing users of the technology will hold open days and provide demonstrations. The public programme is intended to stimulate interest and familiarity particularly in the young. This will be done by educational programmes, through the media, sponsored activities and touring public exhibitions.

The campaign is being co-ordinated by a national committee consisting of senior executives in education, telecommunications, government and the arts. A project team has been appointed with Mr Kenneth Barnes as project director.

The Council welcomes this campaign and is keen to assist by publicising the activities it supports in information technology. Academic departments active in the field have been asked to provide details of their research which can be used for publicity material or displays at exhibitions. Departments are asked to consider ways in which they might further help with the campaign. They may consider, for example, the possibility of an open day for local industry and schools. Advice and support for mounting such activities can be obtained from Mr Barnes, Project Director, Information Technology Year, 19 Bedford Row, London WC1R 4EB, telephone 01-405 4951.

Industrial interest in Large Electron Positron Project

The opportunities for British industry that will be presented when CERN starts placing orders for the Large Electron Positron (LEP) project have been publicised by SERC since LEP first began to look as if it would be adopted as the next large project in European high-energy physics research. Several methods have been used in this initiative: seminars, press articles, direct-mail and publicity via trade and research associations. The results have been very encouraging and by October 1981 some 70 firms from all industrial sectors had shown interest in the supply of specific items required by LEP. The most interesting development is that contact has been established with significant numbers of firms in the mechanical and civil sectors. In the latter area, an industrial delegation led by Mr (now Sir) Alan Muir Wood, a Council member, visited CERN in August 1981 to see at first hand the problems that would face a contractor drilling a tunnel under the Jura mountains.

Very little of the LEP equipment requirement is for 'off the shelf' goods. So that, although the sheer size of some of the orders makes them attractive to potential suppliers, there is also the spin-off into other markets that can arise as a result of the product development that occurs in meeting CERN's specifications. A less quantifiable by-product is the cachet that attaches to being a supplier to an organisation like CERN, where performance criteria are in general in advance of those in industry.

CERN's purchasing rules are very straightforward: assuming that tendering firms can meet the specification and the delivery date, then the lowest price quoted gets the order. There is little SERC can do to influence bid-costing inside British firms, but it is hoped that the publicity effort that we have undertaken will broaden the field and hence increase our chances.

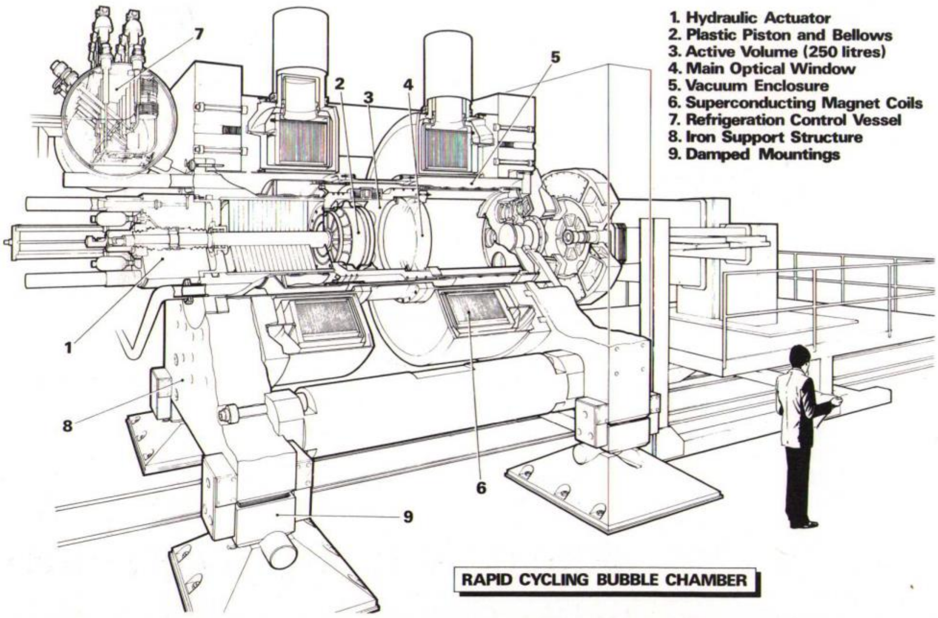
RCBC at CERN

A novel type of rapid-cycling bubble chamber (RCBC), designed and built at Rutherford Appleton Laboratory (RAL), is now in full use in experiments on the Super Proton Synchrotron at CERN. Design work began at RAL in 1977. In November 1980 the RCBC, by then installed at CERN, was operated successfully for the first time, producing photographs of cosmic rays. By June 1981 all three cameras were operational and by September some 1.3 million expansions had been performed under operating conditions and more than 200,000 photographs taken.

Initial testing to 25 Hz has shown the basic mechanical design to be good. The long term reliability with respect to fatigue failure has yet to be demonstrated.

The RCBC contains 250 litres of liquid hydrogen and is part of an experimental set-up known as the European Hybrid Spectrometer; it acts as both the target for the incoming beam of particles and a detector of the consequent collisions, locating these spatially. Several experiments involving British universities in international collaborations have already been approved to use the RCBC. The first of these have now started taking data.

The diagram shows the main features of the RCBC. The liquid hydrogen is contained in a horizontal, cylindrical, stainless steel structure which is fixed to the iron structure of the magnet at one end. The piston and the single-convolution bellows that seal it to the chamber are both made from glass-reinforced plastic which provides a low mass and gives no eddy-current heating in the non-uniform magnetic field. The low mass is important because the piston has to move very rapidly – typically through 8 mm in 5 milliseconds. The decompression stroke allows the hydrogen to be on the verge of boiling, so that charged particles passing through it produce bubble tracks. The compression stroke restores the insensitivity of the liquid hydrogen.



RAPID CYCLING BUBBLE CHAMBER

The optical system comprises three 50 mm cameras, capable of operating at up to 20 Hz, which see the chamber through a single large window by light from a reflective covering attached to the piston.

There has to be an accurately positioned exit aperture from the RCBC to allow particles to pass out for detection by electronic devices 'downstream'. To achieve this a thin (1.5 mm) stainless steel window has been welded into the chamber, with a matching composite window of aluminium supported by glass-reinforced plastic built into the cylindrical aluminium vacuum tank.

The research and development which has supported this unique and many-faceted project has been carried out by a combination of British industry, universities, RAL and CERN.

Fluidized bed combustion facility

The construction and commissioning of a high pressure fluidized bed combustion facility has recently been completed at the Rutherford Appleton Laboratory (RAL).

The facility was designed to enable a wide range of research to be undertaken on the combustion and gasification of coal and the physics of high pressure and high temperature systems.

As shown in the schematic flow diagram, air, nitrogen, carbon dioxide and steam are available as fluidizing gases and may be mixed before entering the bed. The fluidizing gases are preheated in a contra-flow heat exchanger by the combustor flue gases and then pass through the perforated bed support plate into the bed in the lower section of the combustor tube, which is constructed from a 0.1 metre diameter incaloy tube of overall length 1.5 metres. The bed and its contents may either be heated with external silicon carbide elements or cooled by air flow through a spiral duct on the outer surface of the combustor tube. Coal may be fed continuously or batch-wise. The flue gases pass through a cyclone collecting the elutriated material, on their way to the preheat exchanger. A small bleed stream is taken from the exchanger after pressure 'let-down' for gas analysis which is either performed continuously with non-dispersive infra-red analysers or batch-analysed in a gas chromatograph. The whole combustor assembly is housed in a pressure containment vessel, the pressures being equalised by pressure bleed from the heat exchanger unit. Observation of the combustion process is possible through a system of quartz windows and an angled stainless steel mirror.

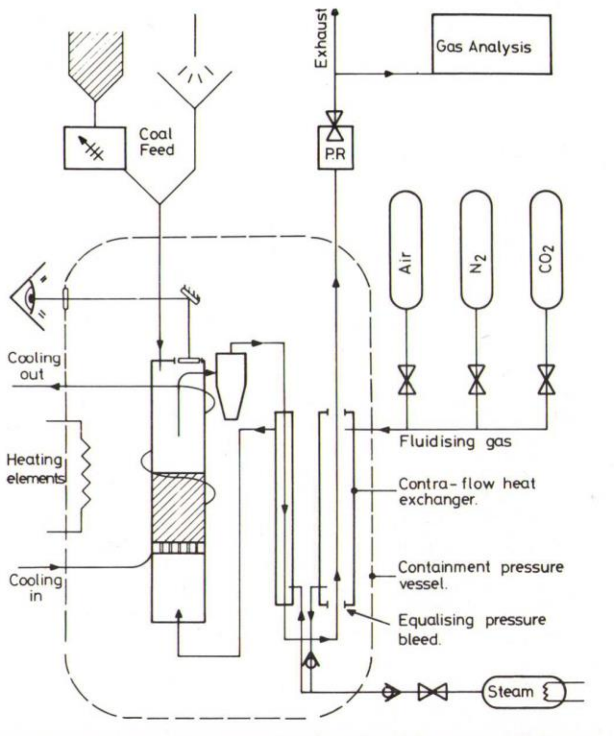
The facility was constructed for use by Professor J F Davidson FRS and his Chemical Engineering Group at Cambridge University in the study of:

- Minimum fluidizing velocity, the quiescent bed region, bubble size, bubble/slug stability, mass transfer and elutriation.
- Burn-out time of carbon particles and combustion efficiency.
- Gasification of carbon particles using air or steam.

Although the use of the facility in the early stages will be strongly oriented towards the Cambridge experimental programme it is, nevertheless, expected that running time should be available for other groups. In the longer term, it is hoped that the facility will be modified and extended to accommodate the needs of a range of users working in this field.

Because of the potential value of this central facility for research related to the Coal Technology Programme, the Coal Technology Sub-Committee wishes to publicise the existence of the facility to interested academic research groups. An open day was held at the facility in September 1981 and guests provided useful comments on possible future research. Potential topics so far identified include: particle elutriation; materials testing including corrosion studies, hot gas clean-up and the possible addition of a small gas turbine to the system.

Further information on the facility can be obtained from: Mr M N Wilson, Energy Projects Coordinator, RAL, telephone Abingdon (0235) 21900, or Mr G D Richards, Secretary of the Coal Technology Sub-Committee, SERC Central Office, Swindon, extension 2350.



Schematic flow diagram of the fluidized bed combustion facility.

Electrical machine core facility

SERC has now set up a facility for the formation of both laminated and solid steel cores by wire spark erosion. The facility is based in the Department for the Design of Machine Systems at the Cranfield Institute of Technology which has built up a considerable level of expertise in this type of machining. It has a current research programme on the performance of numerical control-wire electro-discharge machining using a FANUC D machine supplied by SERC.

The new arrangement extends the use of the existing machine in providing a service to university and polytechnic research workers in the electrical machines and allied fields whereby both laminated and solid cores of novel design for machines in the small to medium range can be formed to high accuracy, generally free of charge. It is hoped that the facility will increase the number of novel designs being developed and will be used for design optimisation in which several variants can be built economically and tested. The facility, which over the next two years will be able to handle workpieces that can be contained within an area of 370mm x 320mm and a stack height of 100mm, will also be suitable for producing punch and die sets for use on existing departmental presses. A more comprehensive service may be considered through the provision of a larger machine.

Access to the service will be open to all permanent research staff in British universities, polytechnics, technical colleges and similar institutions but priority will be given to holders of SERC research grants, prospective applicants for grants for preliminary pump-priming work and supervisors of SERC students. Approval will normally be given via the research grant procedure but written applications for pump-priming work and any other queries should be addressed to Mr Conrad Bray, Secretary of the Electrical Engineering Sub-Committee at SERC, Central Office, Swindon, ext 2102

The opening of EISCAT

The European Incoherent Scatter radar system (EISCAT) was formally opened by His Majesty The King of Sweden on 26 August 1981. The ceremony took place simultaneously at EISCAT's three sites in three countries (Finland, Norway and Sweden) with each Government's representative remaining on his own territory and speaking in English. Everything went well, and the EISCAT UHF radar system worked faultlessly. Playing leading parts in the day's proceedings were Sir Granville Beynon, current Chairman of the EISCAT Council; Professor Tor Hagfors, Director of EISCAT, and Mr Brian Oakley, Secretary of SERC.

EISCAT was conceived from discussions at the 1969 Assembly of the International Union of Radio Science (URSI). By then, the 'incoherent scatter' radar technique had already pròved itself as a powerful means of studying the upper atmosphere. Following the pioneering experiments in Illinois in 1957, incoherent scatter radars came into operation at the magnetic equator in Peru and Puerto Rico, and in Massachussetts, Alaska, France, UK and the USSR. The UK Multistatic experiment was in some ways a simple, low-powered forerunner of EISCAT: it was operated from 1971 to 1975 by Appleton Laboratory, University College, Wales and Royal Signals and Radar Establishment, using a transmitter at Malvern and receivers at Chilbolton, Aberystwyth and Jodrell Bank.

The signing of the EISCAT agreement in 1975, by representatives of SERC (then SRC) and corresponding bodies in Finland, France, German Federal Republic, Norway and Sweden, was soon followed by the placing of major orders, but despite the steady progress on the antennas and other hardware the project suffered frustrating delays, owing to problems with the UHF and (still incomplete) VHF transmitters.

The SERC has contributed one-quarter of the £13M capital cost of the facility and will continue to contribute one-quarter of the annual operating budget of about £1M.

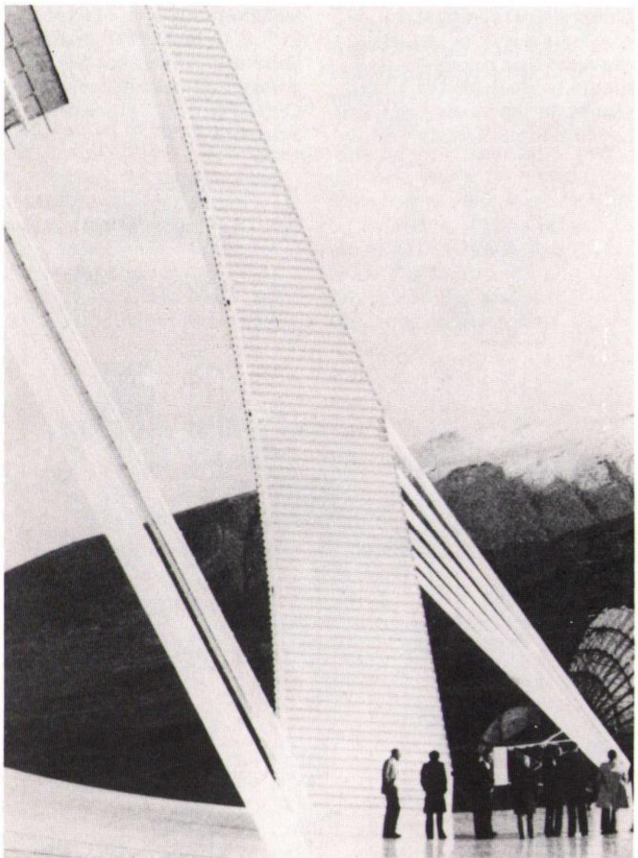
The incoherent scatter technique uses a VHF or UHF radio beam, too high in frequency to be reflected from the ionosphere in the manner used for communication purposes. Virtually all the radio energy penetrates the ionosphere and escapes into space; but a minute fraction (typically 10^{-11}) is scattered back by the free electrons in the ionosphere. The weak scattered signals are received, either by the transmitting antenna with suitable pulsing and gating, or by remote antennas with suitable geometry.

A typical ionospheric experiment involves transmitting megawatts of power and receiving mere picowatts from an ionospheric 'target volume' effectively only $1 cm^2$ in size. Each electron scatters with approximately the 'Thomson cross-section', $10^{-28} m^2$; but the influence of the accompanying positive ions renders the process much more complicated and informative than simple Thomson scattering. Complex plasma theory must be applied to exploit all the information in the received signals, taking account of the effects of the positive ions and the less direct, but nonetheless important, effects of the neutral air atoms and molecules. This done, the radar becomes a densitometer, thermometer and speedometer for the electrons, ions and neutral particles. It can also be used as an ion mass spectrometer, energetic particle spectrometer, ammeter, voltmeter and ohmmeter. It cannot do all these things all the time, but it can do several of them for enough of the time to build up detailed physical pictures of the upper atmosphere at heights of say 70-2000km (it could also be used to investigate the lower atmosphere at 10-25km).

Its capacity to gather data about the upper atmosphere is immense, especially in conjunction with satellites that provide horizontal coverage, rockets carrying *in situ* experiments, simpler radars that can continuously monitor electric fields and atmospheric waves in the ionosphere and other ground-based magnetic and optical instrumentation.

Already, EISCAT is said to be producing the world's finest ionospheric data, now under analysis at Rutherford Appleton Laboratory. The major current problems of upper atmospheric science are the dynamics of the upper atmosphere generally – how the whole system responds to its various energy sources – and the physical mechanisms underlying one major and spectacular source, the aurora. EISCAT will play a major part in unravelling these puzzles which break up into a host of smaller, intriguing topics, to which the several British university groups bring specialized interests and expertise in varied instrumental techniques.

The UK involvement in EISCAT has required the effort of many people: Dr Harry Atkinson (SERC) in the negotiations that brought the UK into the EISCAT agreement; Dr Nick Taylor (RSRE) in formulating EISCAT's scientific and technical specifications; Professor Tudor Jones of Leicester University has chaired the SERC EISCAT Time Allocation Panel; Dr Henry Rishbeth (RAL) is UK Project Scientist and was the first Chairman of the EISCAT Scientific Advisory Committee; Dr Phil Williams (UCW) is serving a term as Assistant Director of EISCAT, and Mr Gordon Rowe (SERC) has been Secretary of the EISCAT Council.



The EISCAT Scientific Advisory Committee inspects the EISCAT VHF 224 MHz antenna at Tromsø. The UHF 933 MHz antenna is in the background. (Photo – H Rishbeth)

Biotechnology head appointed

Dr W G Potter has been appointed Director of SERC's new Biotechnology Directorate (see *SERC Bulletin*, autumn 1981, Vol 2 No 3). Dr Potter was head of the Council's Engineering Division until he took up his new post in November 1981.

The new Directorate, supported jointly by the Council's Engineering and Science Boards in close cooperation with the Department of Industry, will be responsible for stimulating and coordinating research and training across all of the science and engineering subjects involved in biotechnology.

After obtaining a PhD in organic chemistry from London University, Geoff Potter joined the Ministry of Supply to work on the rheology of non-Newtonian systems. In 1955 he moved to the Shell group of companies where he held a number of senior managerial posts all concerned with the plastics and resins business. After 10 years with Shell, he joined the SERC (then SRC) where he has held the positions of deputy head of Science Division, head of the Science and Industry Group and, since 1974, head of the Engineering Division.

Dr Potter is the author of a number of books and papers, notably on epoxy resins.

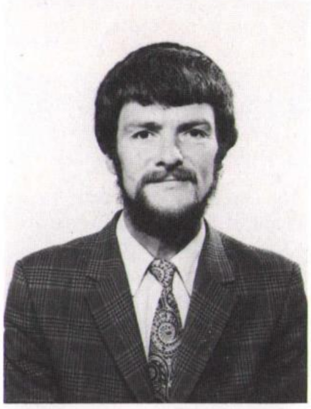
Energy Projects Coordinator

Following the death of Dr Jack Butterworth on 30 May 1981, Mr M N Wilson was appointed on 1 August 1981 as head of the Energy Research Support Unit (ERSU) and the SERC Energy Projects Coordinator.

Although Martin Wilson comes to the energy field from a career which has so far been predominantly in the area of applied superconductivity, he has nevertheless worked in several areas of energy research.

In 1963, after three years at UKAEA, he joined the Rutherford Laboratory to work on high energy particle beams and on the production of very high magnetic fields by means of capacitor discharge techniques. This led naturally to an interest in applied superconductivity and to a key role in the team which developed the filamentary composite superconductors, now being used in a variety of applications world-wide. The original motivation for developing this technology at RAL came from high energy physics research, but the Applied Superconductivity Group has subsequently worked on many other applications, some of them in the energy field, for example magnetic fusion technology and superconducting ac generators.

While retaining responsibility for the Applied Superconductivity Group in the future, Mr Wilson expects to spend the greater part of his time on energy matters. For example, having participated in several research projects where university workers have made good use of the extensive facilities at RAL, he hopes to encourage the use of the Co-funding Scheme which offers opportunities for university workers to contribute more effectively to the research needs of the energy supply industries.



Changes at the top

In Vol 2 No 1 of the *Bulletin* (November 1980) we ran a guide to 'Who's who at Central Office'. Since then some senior staff changes have made the guide out of date.

Secretary to the Council (Mr Brian Oakley) and the three Directors (Dr H Atkinson, Mr A Egginton and Mr J Visser) remain unchanged.

The rest of the team is now:

Head of Astronomy, Space and Radio Division: Dr Barry Martin;
Head of Nuclear Physics Division: Miss Valerie Bowell;
Head of Science Division: Dr Leo Hobbis;
Head of Engineering Division: Dr Paul Williams;
Establishment Officer: Mr Jack Beattie;
Finance Officer: Mr Lewes Addison;
Head of Secretary's Department: Dr John Fendlay.

Parallel computers revolution

The application of parallel computers to scientific problems has already resulted in many impressive advances but continued development is essential in order to solve many other problems, it was agreed at a highly successful conference at Chester College, Chester, in August last year.

The conference, entitled Vector and Parallel Processors in Computational Science, was organised by Daresbury Laboratory and attracted more than 300 delegates from 20 countries. The wide-ranging programme examined many of the revolutionary changes in Computational Science which have been stimulated by the widespread introduction of computers with a parallel architecture. Among the topics included were the present status and possible future directions of these computers, the development of languages and algorithms designed to exploit parallel architectures to the full, applications to scientific problems in astrophysics, plasma and fluid physics, nuclear physics, atomic and molecular physics, image processing, geophysics and weather forecasting.

The proceedings of the conference will be published as a special issue of *Computer Physics Communications* in the spring 1982.

Next generation of astronomers

Edinburgh proved to be a popular venue for the 1981 course on astronomy and space science for new research students. There were 61 students on the course, from all over Britain plus five from the Netherlands. It lasted two weeks with 49 sessions during which 19 astronomers from British universities and observatories covered as much as they could of the current state of research in astronomy and science.

The seminars were held in the Observatory, where the Astronomy Department of Edinburgh University is housed. PhD students took course members on a tour of the Observatory facilities, from the advanced COSMOS measuring machine, to the Crawford Library of early astronomical texts, to the UK Infrared Telescope simulation facility, to the Edinburgh node of the Starlink image and data processing network.

The Course Director was Professor Malcolm Longair, who is Astronomer Royal for Scotland and Regius Professor of Astronomy at Edinburgh as well as Director of the Observatory. In charge of the smooth running of all non-astronomical aspects of the course was Mr Bennet McInnes, the Observatory Secretary.

Short courses round-up

The Council is sponsoring two short courses for full-time postgraduate physics students in 1982. The courses are open to all students, but preference will be given to SERC-supported and self-supporting UK students with at least one year's research experience.

- **Computer and microprocessor aids in experiments**

This course, sponsored by the Physics Committee, will be held at the University of Manchester from 13-17 September inclusive. The course director is Professor F H Read, Department of Physics, University of Manchester. The course, for up to 20 students, is intended to give them an awareness of the contribution that on-line microprocessors or small computers might to their own experiments, and of the associated software and interfacing problems. Students wishing to attend the course should write to the course director.

- **Laser-plasma interactions**

This course, sponsored by the Laser Facility Committee, will be held at the University of St Andrews under the auspices of the Scottish Universities' Summer Schools in Physics from 1-14 August inclusive. The course director is Professor E W Laing, Department of Natural Philosophy, University of Glasgow. The course, 60 students, will provide a detailed account of recent developments in the rapidly advancing field of laser-plasma physics.

Application forms to attend the course may be obtained from the course secretary, Dr M B Hooper, Department of Natural Philosophy, University of Strathclyde, Glasgow G4 0NG.

Further information on these courses may be obtained from the course directors, at the addresses given above.

- **Computing and telecommunications course for OR students**

The Operational Research Panel of SERC's Mathematics Committee is staging a short course on Computing, Data Processing and Tele-communications for students in OR. The object of the course is to set out the state of the art in the technologies concerned and explore future developments. A mixture of lectures, discussions and demonstrations, the course will be held at Loughborough University on 19-21 April 1982. Priority will be given to SERC students in OR, and the full attendance costs of SERC students will be borne by the Council. Some places may be available for other students, on payment of the appropriate fees.
Further information may be obtained from Professor G Gregory, Department of Management Studies, The University of Technology, Loughborough.
Telephone: (0509) 63171.

- **Meeting on pulsed neutron sources**

A two-day meeting on Condensed Matter Research with Pulsed Neutron Sources is being arranged by Professor E W J Mitchell on 20 and 21 September 1982. The meeting will be held in the Clarendon Laboratory, Oxford, and will follow the conference being organised in Cambridge the previous week by the Institute of Physics to commemorate the 50th anniversary of the discovery of the neutron. The idea is to discuss the results obtained with the currently operating pulsed sources and any factors which are emerging concerning experimental procedures. It is hoped to have contributions from the various centres now operating pulsed neutron sources. In addition to the papers and a discussion programme each morning, visits are being arranged to the Spallation Neutron Source at the Rutherford Appleton Laboratory and to Harwell to see the LINAC. Further information may be obtained from Professor Mitchell, Clarendon Laboratory, Oxford.

- **Summer school in polymer engineering**

This September the Polymer Engineering Directorate will be sponsoring a further one-week summer school at Loughborough University of Technology. The aim of the school will be to give post graduate research students engaged in the various aspects of polymer research the opportunity to gain a better understanding of polymer processing and technology and an awareness of how real industrial problems are related to their own research. In addition, we will encourage engineering students not currently engaged in polymer research to participate in the summer school in order to extend their knowledge to the field of engineering with polymers.

The summer school will be residential and will be run by the Institute of Polymer Technology at Loughborough. As in previous years the emphasis will be on the practical side of processing; students will operate a number of polymer processing machines and there will also be a number of industrial visits arranged.

The course is designed to cater for the needs of first and second year research students. Priority will be given to SERC students and their full attendance costs will be borne by the Council, PED. Any surplus places may be allocated to non-SERC supported students on a first come, first served basis but PED regrets it will not be able to fund these.

Dates of summer school 6 – 10 September 1982. Nominations for students to attend the course should be made as early as possible.

Contact: Mrs H Lennon, Polymer Engineering Directorate, Garrick House, 3/5 Charing Cross Road, London WC2H 0HW. Telephone 01-930 9162.

PED school for academic engineers

The role of the Polymer Engineering Directorate in supporting industry-oriented research is widely recognised; its activities on education and training are less well developed. PED commissioned a pilot study of the specific needs for education and training of the UK polymer and polymer-using industries, which involved interviews with the six major official bodies and about 20 firms representative of the industry. Several themes emerge. First, industry has a much greater need for broad-based general engineers. Secondly, in view of the major and increasing contribution made by many non-metals to the national economy, not least in terms of performance, reliability, cost-effectiveness and high added-value, it seems strange that student engineers still lack a grounding in engineering with materials (including a fair share of polymers) rather than being almost exclusively centred on metals. There is a real need for provision of engineering with polymers which fits into and integrates with conventional undergraduate courses for all engineering students.

To encourage a greater recognition of the potential for engineering with polymers, PED is planning to fund a one-week advanced summer school at Manchester Polytechnic, to be held 13-17 September 1982. This school, for staff in engineering departments in UK institutions, will identify the main problems of teaching engineering with polymers and will discuss a range of practicable solutions developed in different types of institution for incorporating aspects of polymer engineering within the curriculum. The programme for this summer school will include opportunities for hands-on experience and some industrial visits.

For further information contact: Mrs H Lennon, Polymer Engineering Directorate, 3-5 Charing Cross Road, London WC2H 0HW, Telephone: 01-930 9162.

Magnetic spectrometer for Oxford

The magnetic spectrometer specially developed for the Oxford Nuclear Physics Laboratory, as a joint project between Oxford University and Rutherford Appleton Laboratory, was completed on 21 September 1981 with the detection of carbon ions scattered off gold at 42MeV.

Subsequent tests have shown an energy resolution of better than 1:1250 at the full acceptance solid angle of 8 milli steraradian. Experiments using the 9MV folded tandem Van de Graaff accelerator were started in January. It will be used by Oxford nuclear structure physicists and other UK university groups. It took four years to design and build and was completed within the initial budget.

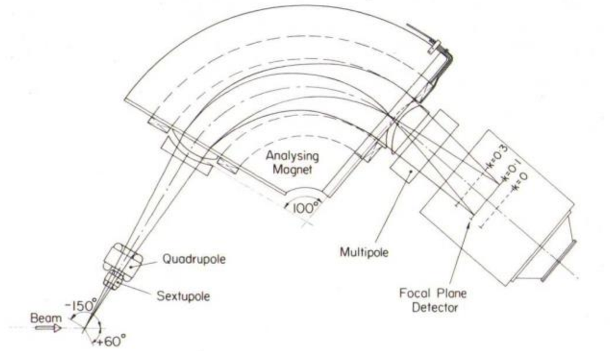
Since the physics is to study particles emerging from nuclear reactions at different angles of azimuth, all the items indicated in the figure (and weighing some 65 tonnes) are mounted on a pneumatically supported platform which is constrained to rotate from $+60^{o}$ to -150^{o} about a vertical axis through the target. This presents problems for supplies, current and cooling water, which have to be brought to this axis and then down a service tower. The maximum radial dimension for the complete assembly is 6.5m.

Initially the Oxford physicists hope to use the spectrometer for high resolution studies of light nuclei involved in heavy ion transfer reactions. Later, for heavy nuclei, the spectrometer's large solid angle coupled with excellent particle identification will be particularly useful for investigating the low cross-section reactions of neutron-rich nuclei.

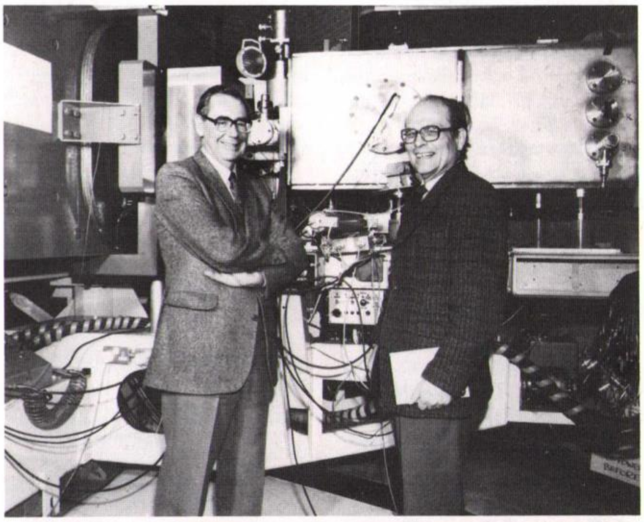
The spectrometer is based on a novel design developed by a joint Oxford/RAL team after considering the limitations of current designs. The arrangement of components along the beam path from experimenter's target to detector can be seen in the simplified layout in the figure. It also shows the analogy with an optical spectrometer, with the prism replaced by a magnet. With the notable exception of the very low carbon steel magnet yoke, which came from Europe, most other items have been made by British industry using the latest technology. As an example, the convex and concave shapes of the entry and exit faces of this magnet, which were specified from ray tracing calculations on the computer, were then generated on the detachable end pieces to a precision of ± .05mm by a numerically controlled milling machine. The poles of the input quadrupole were also made in a similar fashion. There is a long banana-shaped aluminium alloy vacuum vessel which, like the main magnet, required a large radius machine to effect the necessary profiling.

Extension field measurements have been carried out which have established that the required field gradients and shapes have been well achieved. First measurements with beam are also very encouraging.

This is the most recent example of a successful major joint project between a university group and RAL.



The layout of the Spectrometer.



Professor K W Allen (Left) of Oxford University and Dr J H Coupland, Project Leader at RAL, in front of the detector box at the output end of the Spectrometer.

Contact Professor K W Allen, Nuclear Physics Laboratory, Oxford University, Keble Road, Oxford, telephone (0865)59911.

Symposium on computer graphics

A symposium on computer graphics organised by the Computing Division of Rutherford Appleton Laboratory in October 1981 proved highly popular: 300 people applied for the 200 seats available. International experts were assembling at Abingdon for a meeting the following week of the ISO Graphics Working Group and RAL took the opportunity of their presence to hold the symposium. Five speakers gave presentations and took part in a lively panel discussion.

Peter Bono, from the Naval Underwater Systems Center in Connecticut, in a well-illustrated talk on 'Graphics Software – Past, Present and Future', discussed the division of available software into turnkey systems, application programs, graphics support and subroutine packages.

In contrast, Paul ten Hagen from the Mathematical Centre in Amsterdam, in 'Graphics Dialogue Programming', discussed the need for, and means of, separating the algorithmic and interactive parts of a program.

Jose Encarnacao of the Technische Hochschule, Darmstadt, described the R & D activities of the Interactive Graphics Group there, including the design of an interactive raster workstation for CAD applications and how such a workstation would interface with GKS (Graphical Kernel System).

Another facet of computer graphics was revealed by Jim Michener of Intermetrics Inc, Cambridge, Mass in his talk on Graphics Real-time Applications Display Support. He showed the use of GRADS in a project for the US Navy, to design an advanced integrated display system for aircraft cockpits. Bob Hopgood's 'Road to Graphics Standards' traced the progress from the proposal in the early seventies that GINO-F should be a standard, to the current international efforts to refine GKS by resolving all the outstanding technical issues (a process that was finally concluded the following week).

Opportunities for research training funded by the European Community

There can be no doubt that in some respects the UK does not take full advantage of the opportunities that membership of the European Community affords. The EC's programme of Scientific and Technical Training is a good - or rather bad - example. The new four-year appropriation for this programme amounts to 8.8M European Currency Units, representing an annual expenditure of about £1.4M. In recent years, UK applicants for studentships awarded under this programme have not matched either in number or average quality those from most of the other EC members. There are no national quotas, so the UK will continue to get poor value from this programme unless students and academic institutions show more interest.

The main objective of the EC Scientific and Technical Training programme is to enable young scientists and engineers to obtain training in research in fields covered by the Community's research programmes. **Direct Action** programmes, covering nuclear safety, future forms of energy, environment and resources, and measurements, standards and reference techniques, are carried out in the establishments of the EC Joint Research Centre situated at Geel (Belgium), Ispra (Italy), Karlsruhe (Germany) and Petten (Netherlands). Students will undertake their research training at a JRC, or at an academic or research institution where work is being carried out on an **Indirect Action** programme under contract to the EC. These programmes cover the fields of fusion and plasma physics, energy, radiation protection, management and storage of radioactive wastes, environmental and raw materials research, reference materials and methods, and plutonium recycling in light water reactors. Generally, the training must be undertaken in a Community country other than the student's country of origin or permanent residence.

Awards are made at several different levels:

undergraduates in the later stages of their studies may spend up to six months on a research project forming an integral part of their studies;

postgraduate students may spend up to three years preparing for a PhD, or a shorter period on specifc or interdisciplinary studies;

postdoctoral (or equivalent) workers may spend up to one year on research that complements their initial training.

These categories are not interpreted rigidly: applications are generally judged on the basis of the quality of the applicant (those not in the top 20% of their year are unlikely to succeed) and the quality and relevance of the proposed research.

Stipends and allowances depend on the category of the award holder and the place of tenure, but tend to be more generous than equivalent SERC awards.

For young UK scientists there is the opportunity of a period of research training abroad, working on a programme of direct relevance to the future needs of the EC.

For UK academic departments there is the opportunity to forge or reinforce collaborative research links with the Joint Research Centre and other research centres on the continent; for those departments holding EC research contracts there is also the possibility of persuading a bright young Community research student to join them.

For further information or advice, contact Secretary's Department, SERC Central Office, Swindon. Alternatively, full details can be obtained from:

Commission of European Communities
Directorate-General for Research, Science and Education
Scientific and Technical Education Unit
Rue de la Loi 20
B-1049 Brussels, Belgium.

D.V. Thomas

Dr Thomas is currently Chairman of the Advisory Committee on Programme Management for the EC's programme of Scientific and Technical Training

Monitoring research training

It is the Council's firm policy that its research awards are provided primarily to support the intellectually most able students, to assist them to progress from the learning of accepted knowledge to the study of areas where there are no accepted answers and to develop the necessary skills for the next stages of their careers. In this context the Council has accepted the view of its Postgraduate Training Committee that it should concern itself more directly with the quality of research training received by SERC-supported students (see Autumn 1981 *Bulletin*, Vol 2 No 3, p 25 'The Quality of Postgraduate Training').

As part of its drive to ensure that only those students who can genuinely profit from the training provided are supported, and to assist in the maintenance of as high a standard of training and supervision as possible, the Council agreed at its July 1981 meeting that the progress of its research students should be monitored more closely. Decisions were then taken that, *inter alia*, new arrangements should apply to probation assessments and that annual returns of 'PhDs completed' should be gathered from institutions.

Probation reports

Departments are now asked to return to SERC by 31 October each year a formal probation report on each first-year research student. This will incorporate an assessment of the overall quality/performance of the student, together with a positive recommendation on the continuance of the award. Where termination is recommended, it is hoped that, in appropriate cases, some recognition of the value of the work completed will be made by the institution. As an incentive to realistic appraisal, the Council has decided that where, because of the student's unsatisfactory progress, a studentship is terminated during or at the end of the first year, the Department will be entitled automatically to a replacement award.

Returns of 'PhDs completed'

The Council feels that some measure of a department's training capabilities may be given by the rate of PhD completion of its students. Departments are therefore being asked to make an annual return of SERC-supported students (starting this year with those who commenced training in 1977) indicating whether or not a thesis had been submitted. Submission of a thesis is regarded for the purposes of this exercise as 'completion', as SERC's concern is not with the award of degrees but that the student should have written up the results of his work.

The data obtained, among other factors, will be borne in mind by the Council in its allocation of studentship quotas. It is planned to publish a summary of the returns in the *Bulletin*.

Final reports

The Council is seeking assurance that students are making good use of their years of SERC support. Submission of an acceptable thesis at or soon after the completion of an award would suffice. The fact that a large proportion of students in recent years have not submitted a thesis within four years of the commencement of their awards (Spring 1981 *Bulletin*, Vol 2 No 2, p 24) is causing consideration to be given to the need to obtain some form of report on the outcome of each studentship at the end of the award.

Work permits for foreign nationals

It came to the Council's notice in 1980 that some institutions were experiencing difficulty in obtaining work permits for foreign nationals who were required to work on SERC-supported research. The Council therefore joined with the Committee of Vice-Chancellors and Principals (CVCP) and the Committee of Directors of Polytechnics (CDP) in making representations to the Department of Employment and the Home Office - the Government Departments responsible for operating the work permit scheme.

A series of meetings took place and the Department of Employment agreed to handle, from the summer of 1981, all applications for work permits for academic and research staff from publicly funded institutions of higher education or research at one central point - the Overseas Labour Section of the Department at Caxton House, Tothill Street, London SW1H SW1H 9NA. It should be noted that this does not affect the need to approach the Home Office first in respect of the employment of foreign nationals who are already in this country. The Home Office has agreed to exercise discretion in such cases and will no longer automatically require foreign students who are already in the UK to return to their native country before applying for a work permit.

The CVCP and CDP have issued guidance to their member-institutions about the way to prepare a work permit application so that it stands the best chance of being dealt with speedily - now within about four weeks of receipt by the Department.

Any SERC research grant holder hoping to employ a foreign national on SERC-supported research therefore seek advice from his or her institution at an early stage.

The new arrangements will be reviewed after about a year and any cases where the prosecution of any SERC-supported research has been unduly prejudiced by work permit difficulties should be reported to the Head of Finance II, SERC Central Office, Swindon. the Head of Finance II, SERC Central Office, Swindon.

New scheme for maths studentships

The Mathematics Committee has introduced a new experimental scheme for the allocation of Research Studentships to be taken up in the academic year 1982/83. The Committee has been concerned about the difficulties of small departments under the existing arrangements and the present scheme is introduced to provide a flow of high-calibre students.

The Committee will allocate fewer studentships through the normal quota procedure and will hold back a number to form a 'reserve pool' available for departments who have not been allocated quota awards. The departments will be able to nominate students by submitting the form RS2 (the form already in use for studentship nominations).

Applications must be received by 15 July, when degree results should be available. Applications unsuccessful at this stage of the Committee's procedures will contend for awards at the usual Appeals Stage without the need for further application to the Council.

Engineering Mathematics Studentship (EMS) Projects should be submitted for approval using Form RS1 by 31 December. No quota awards will be made but a proportion of the 'reserve pool' will be earmarked for EMS students. Nominations should be submitted on Form RS2 by 15 July.

The full details of these changes are explained in the letter PGA 17/81 already circulated to institutions.

Copies are available from SERC. These changes do not affect procedures of any other SERC Committee or Studentship Scheme.

For details contact Mr M A Game, Mathematical Committee Secretariat, SERC Central Office, Swindon, extension 2312.

Royal Society overseas fellowships

The Royal Society and SERC share several interests in fostering international collaboration and in particular have been working closely together in promoting contacts with scientists in Australasia and Japan.

The Council of the Royal Society has inaugurated two schemes whereby suitably qualified British Scientists may take the advantage of visiting fellowships in Australasia or Japan.

AUSTRALASIA

The scheme for Australasia aims to further collaboration between the scientific communities of the United Kingdom and those of Australia and New Zealand, with particular emphasis upon the improvement of individuals' access to major facilities including specialized laboratories; nuclear, astronomical and space science facilities; ships; and unique features of the geological or biological environment. In addition to offering fellowships in Australasia the scheme offers opportunities for visits to the UK by Australian or New Zealand scientists where particularly fruitful collaboration can be expected as a result of such a visit. In the latter case, potential UK hosts may apply on behalf of visitors. For successful applicants grants will be made in respect of : (d) travel to and from Australasia, (b) subsistance expenses to supplement an existing salary or assistance provided by the host institution; (c) special research expenditure including that related to field work.

JAPAN

The Royal Society under its Japan programme has concluded agreements with the Japan Society for the Promotion of Science to encourage and support interchange between scientists of the two countries. Under these agreements, exchanges which will normally be at postdoctoral, or higher level, will include:

(a) Fellowships - up to two years but always exceeding six months and

(b) Study Visit Awards - normally for senior scientists, for periods up to about three months but never less than two weeks.

Participants in the exchange programme will receive financial assistance for travel to and from Japan and a daily allowance towards subsistence and, in the case of a fellowship, a stipend may be paid.

Further details of these awards may be obtained from:

The Royal Society
6 Carlton House Terrace
London SW1Y 5AG

For Australasia -
Executive Secretary
(AAVF/FGM)

For Japan -
Executive Secretary (DJHG).

We would like to remind readers of the availability of SERC schemes to support international collaboration, details of which appeared in the June 1980 issue of the *Bulletin*. Further information may be obtained from the SERC subject Committee Secretariat with whom you normally deal or International and Fellowships Section, Central Office, Swindon (extension 2173).

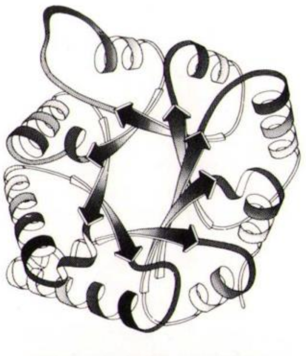
Achievements in biology — the role of the SERC

For many people the Council's name is probably more associated with engineering and 'big' science, such as nuclear physics and astronomy, than with biology. The SERC Biological Sciences Committee have sought to redress this with its new publication *Achievements in Biology – the role of SERC*, which sets out not only to inform a wider community about SERC's role in the support of biological research, but also to demonstrate that biology is no longer the 'soft' science it was once thought to be, but has now come of age.

A significant feature of progress in biological research over the last decade has been the many unexpected discoveries and innovations, often arising out of the application of results from one area of research to another, unrelated, area. The application of techniques used in physics and chemistry and increasing use of computers has also had a major impact in many areas of biology and in particular in molecular and cellular biology. Much of the basic research supported by SERC underpins the more applied research supported by other research councils and this leads to applications in industry, medicine and agriculture. Many potential future applications of current research are already clear – and nowhere more so than in genetic engineering. Here we summarise a few of the examples of research achievements outlined in the booklet.

Structural molecular biology
A good example of the application of techniques used in physics and chemistry and use of computers, is in the study of the architecture of large molecules, especially enzymes and nucleic acids. The determination of the structure of a number of enzymes over the past fifteen years has allowed their active sites to be determined in molecular detail and models for their catalytic mechanism and chemical specificity to be proposed.

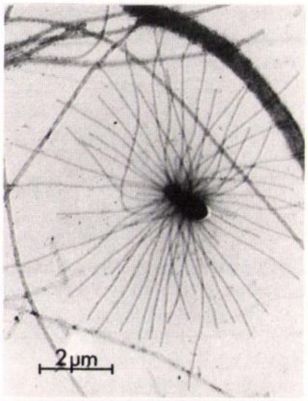
Applications of these fundamental studies on the structure and function of enzymes are beginning to emerge. The rational design of drugs with specific three dimensional structures able to interact with active sites of enzymes is well underway: for instance, inhibitors of the enzyme dihydrofolate reductase already have important applications as anticancer drugs and in the treatment of bacterial and parasitic infections.



1. A schematic diagram showing the arrangement of the major structural features in the enzyme triose phosphate isomerase. Consistent rules found to govern the arrangement of helices and sheets in proteins are of great help in the prediction of three dimensional structures directly from the sequence of amino acids in the protein.

Genes in action
Ten years ago, for all its power and elegance in fundamental research, molecular biology had produced little that was of immediate use in terms of broader application. This has now changed dramatically, with several examples of advances in molecular biology of outstanding potential in biotechnology, medicine and agriculture – of which genetic engineering is the most immediate. One of the most exciting advances in this area has been the development of techniques to obtain expression of a cloned gene, prokaryotic or eukaryotic, in a bacterial culture to allow the ready production of medically and economically important proteins and polypeptides as the gene products.

Basic research which led to the development of genetic engineering techniques was strongly supported by SERC long before the current upsurge in interest was triggered by the realization of its practical potential – or indeed before the term genetic engineering was first used.



2. A phase contrast micrograph of a freshwater bacterium with an unusual morphology. Such microorganisms should be valuable in future studies of morphogenesis and differentiation in prokaryotes.

Insect physiology and neurobiology
The UK occupies a strong international position in insect physiology research which SERC supports together with the other research councils. Fundamental and applied studies of the action of insecticides at the cellular level, particularly on chromosomes and nucleoli of salivary gland cells and on the patterns on activity of these cells, is currently providing insight into the influence of pesticides on the actions of hormones in insects. Food supplies are dependent upon the availability of efficient and cost-effective insecticides, yet the problem of insect pest resistance to chemical control measures is growing rapidly. Basic research on insect neurosecretion is well placed to relieve this problem over the next decade since the products of neurosecretory cells are fundamental to the development, biochemistry and physiology of insects. The rational development of new pesticides based upon the biology of the chemicals or neurohormones that these cells produce may provide a new range of control measures which, unlike many of those currently in use, could have the added advantage of species specificity.

The brain and visual function
An enduring problem in neurological research is the understanding of how the anatomy and physiology of the nervous system are related to behaviour. It is an area where a systematic approach to a particular problem can pay important dividends. Ten years ago the part of the brain known as the prestriate cortex was generally considered to be responsible for associating the input from visual stimuli with other types of information. Now we know that this part of the cortex is not merely an association area but is intimately involved in the actual sensory analysis of the visual environment; that the prestriate cortex is made up of different visual areas and that distinct parts of it analyse the visual environment by parcelling out specific types of information to other areas. These studies have now made it possible to embark upon a search for functional localisation within the visual cortex. The possibility of such localisation has been suggested many times in the past by clinicians but the evidence has until now been insufficient to establish the claim for such localisation of function. It should be possible in the near future to combine such detailed research with behavioural data, so that the full picture of the functional specialisation of specific areas of the visual cortex can be mapped.

Copies of *Achievements in Biology* are available free of charge from the Biological Sciences Committee Secretariat at SERC Central Office, Swindon, extension 2421.

Major new grants

POLYMER ENGINEERING DIRECTORATE

A special grant of £193k over three years to Professor D W Saunders and Dr M W Darlington (Cranfield Institute of Technology) for an investigation of production processing properties of thermoplastic composites, through the establishment of a compounding facility. This project has the backing of six British companies.

A special grant of £198k over three years to Professor D Hull (Liverpool University) for the development of energy absorbing materials and structures based on plastics. This project has received very strong financial and technical backing from three British companies.

NUCLEAR PHYSICS BOARD

Grants of up to £946,780 to Oxford University and up to £516,520 to Glasgow University over three years for experimental research in nuclear structure physics.

£¾m package for engines research

Under the Co-operative Research Grants Scheme, SERC has awarded a major four-year research grant that will enable Birmingham University's Department of Physics to continue to co-operate with Rolls-Royce in the development of engine diagnostic techniques based on radioisotopes. The Birmingham Radiation Centre, the joint research facility of Aston and Birmingham Universities, will provide strong support for this work. Burmah Castrol is also playing a major role and Amersham International are the contractors for isotopes.

The work was proposed and planned by the Birmingham University's Physics Department and the Radiation Centre in conjunction with the Advanced Projects Department of Rolls-Royce and RAL.

The programme involves developing a system using radioactive isotopes to trace the flow of liquids in pipe runs with particular reference, initially, to oil flows in engines. The aim is to build an equipment package small and compact enough to be carried by a commercial vehicle and used on site

The SERC grant consists of £136,000 to Birmingham University plus RAL services worth £167.00. The scheme requires the research and development work must be based upon the financial and technical resources of the industrial partners. In this case Rolls-Royce and Burmah Castrol are bringing financial support for the project up to almost £500,000 and the total value, increasing resources employed, to £750,000.

More lunar samples available for loan

The Council has been lent by NASA a package of 12 polished thin sections of lunar rocks and soils. An additional 12-sample package and two 6-sample encapsulated packages for schools will also be available soon. Educational institutions in in the UK teaching or popularising the sciences may borrow these packages from SERC.

No special equipment is needed to study the schools packages but a standard petrographic microscope, using polarised light, is required for the thin-section packages. Certain security procedures would, of course, have to be followed by all borrowers.

Further details are available from Mr Alan Brittain, Solar System Committee Secretariat, SERC Central Office, Swindon, extension 2366.

Some new publications from SERC

SERC annual report 1980-81

Report of the Science and Engineering Research Council for the year 1980-81 was published in November 1981. Copies are available from Government Bookshops (ISBN 0 901660 45 0), price £4 net.

Physics review

The 1980-81 review of the activities of the Physics Committee, *The Physics Committee Annual Review*, including statistical information, is available from the Committee's secretariat, SERC Central Office, Swindon, extension 2215 or 2262.

Science-based archaeology review

The Science-based Archaeology Committee Annual Review outlines the Committee's activities for the academic year 1980-81 and is intended as a source of general information. It is available from the Committee's secretariat, SERC Central Office, Swindon, extension 2362 or 2262.

Nuclear structure review

The Nuclear Structure Committee Annual Review 1980/81 is intended to provide the UK academic nuclear structure physics community, and others interested in the subject, with general information about the Committee's current policies and activities and the physics research achieved in the year.

Copies of the review can be obtained from the Nuclear Structure Secretariat, SERC Central Office, Swindon, extension 2223.

Particle physics report

The Particle Physics Committee Annual Report 1980/81 presents an introduction to the subject and the aims of research. An explanation of how research is organised in Britain leads into a description of the research facilities at CERN, on which British physicists are now very largely dependent for their research activities. There are items on future developments: the proton-antiproton collider now, and the Large Electron Positron project in the longer term. The report also includes full details of research grants, fellowships and studentships funded during the year.

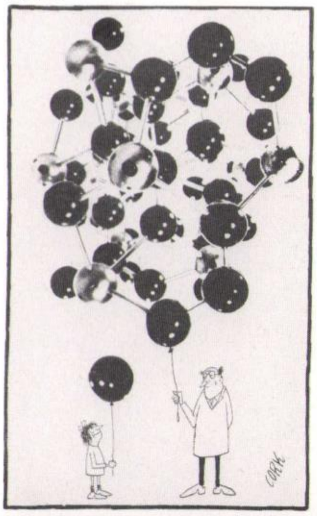
Copies can be obtained from the PPC Secretariat, SERC Central Office, Swindon, extension 2325.

Dies and moulds handbook

Dies and moulds: research on the problems involved in manufacture reviews the research supported by the Council's Specially Supported Programme on Dies and Moulds. It was prepared for the Council by Harry Challis and Chris Stanton with the Programme Coordinator Peter Gough; copies are available from the Engineering Processes Secretariat, SERC Central Office, extension 2250.

Grinding handbook

Grinding: research on the problems of grinding technology has been prepared by Stanton and Challis as a companion volume to *Dies and moulds*, this time in co-operation with the SPP Coordinator Ray Palmer. Again, copies are available from the Engineering Processes Secretariat, SERC Central Office, Swindon extension 2250.



Better insulated housing project at Abertridwr

The Abertridwr 'Better Insulated Houses' project, for which Rutherford Appleton Laboratory developed the energy monitoring system, is the most detailed study of methods and standards of insulation ever undertaken in occupied houses in the UK and is now well into its second year of monitoring.

The project, one of a series initiated by the Department of the Environment (Housing Development Directorate), involves 39 houses in a new 99-house estate built by the United Kingdom Housing Association at Abertridwr, three miles from Caerphilly. The houses perch on a hillside in a very exposed position. A control group of 19 houses is insulated to current standards. The remaining 20 are 'highly insulated', with double-thickness roof insulation, 30mm thick internal lining on the outer walls and an internal perimeter slab of floor insulation 1m wide by 1m deep.

The project is monitored by the Welsh School of Architecture, UWIST, jointly sponsored by the DoE and a research grant from SERC's Environment Committee, using sophisticated instrumentation designed by the Energy Research Support Unit at RAL.

The two main objectives are to study the cost effectiveness of the higher standards of insulation and the in-service operating efficiency of domestic gas central heating boilers - the second objective being essential in order to assess the first.

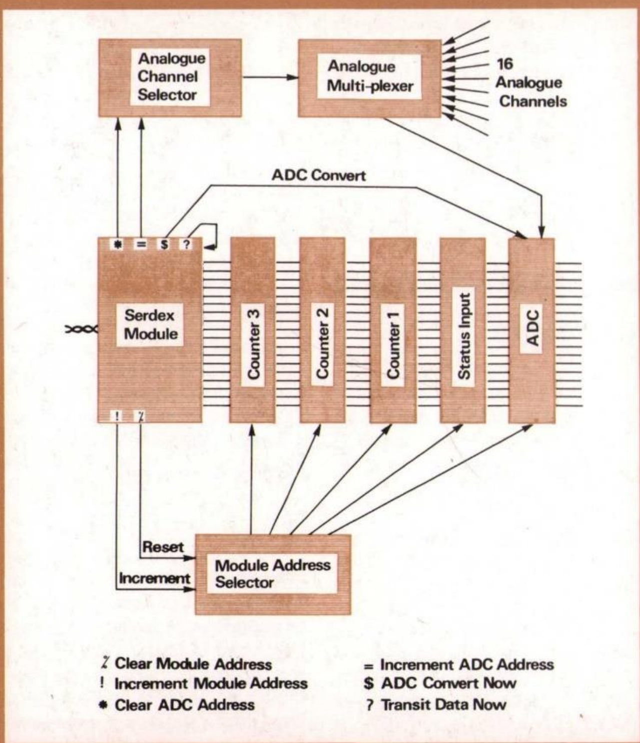
For the first objective, the quantity of data to be collected implied the use of a large data logger. For the second, commercially available heat meters proved to be inaccurate under the rapidly fluctuating temperatures of a gas central

The RAL investigation showed that it was possible to construct a data logging system around a mini-computer at a much lower price than any commercially available data logger of the required size. The computer is used to calculate the thermal output of the 39 boilers on-line before recording the data on magnetic tape with the rest of the information. It also has time available to do a certain amount of on-line analysis and validation of the data and equipment. It was decided to build a system tailored to the requirements of the project and yet with the possibility of being used elsewhere. Each house has an identical box that will convert the data from its own sensors and transmit this data back to a central point on demand.

The equipment has now been operating for more than a year. It is working well and analysis of the data is under way.

Contact: Dr W A Smith, RAL, (0235) 21900 ext 6600.

The housing estate at Abertridwr



Schematic representation of RAL's data logging system

Each of the 39 houses in the project has an identical data acquisition box, logging 850 items of information, some of it read out at 10 second intervals and averaged before being recorded on magnetic tape for later analysis.