SERC BULLETIN

SCIENCE & ENGINEERING RESEARCH COUNCIL

Volume 2 Number 9 Autumn 1983

In this issue

Establishments of the Science and 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
Telphone 01-930 9162

Rutherford Appleton Laboratory (RAL)
Chilton, Didcot, Oxon OX1 0QX
Director Dr G Manning
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 (0323) 833171

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

Polymer Engineering Directorate
11 Hobart Place, London SW1W 0HL
Telephone 01-235 7286

The Science and Engineering Research Council is one of five councils funded through the Department of Education and Science. Its primary purpose is to sustain standards of education and research in the universities and polytechnics through the provision of grants and studentships and by the facilities which its own establishments provide for academic research. The *SERC Bulletin* summarises topics concerned with the policy, programmes and reports of SERC.

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.

ISSN 0262-7671

Front cover picture

Sixth-formers from Northern Ireland visit Daresbury Laboratory's main computer facilities. See Holmes-Hines Bequest, page 3.

Brian Oakley heads new Alvey Directorate

Mr Brian Oakley CBE, Secretary to the Council, left SERC at the end of May 1983 to head the new Alvey Directorate set up to run the Government's national advanced information technology programme. The programme is supported jointly by the Department of Trade and Industry, the Ministry of Defence, SERC and industry: the academic part of the programme will be supported 100% by SERC while the industrial components receive 50% support from industry, 50% from the DTI and MoD.

Mr Oakley, who is 56, joined the Council as Secretary in 1978 from the Department of Industry where he was head of its Research Requirements Division. He had previously worked in the Ministry of Technology's Computing Division and, before that, in the Telecommunications Research (later Royal Signals and Radar) Establishment, Malvern. He is a Fellow of the Institute of Physics and of the British Computer Society.

Mr Brian Oakley

For further information on the Alvey Directorate, contact:

Mr B W Oakley CBE
Director, Alvey Directorate
Room 1131, Department of Industry
Millbank Tower
Millbank, London SW1P 4QU
Telephone: 01-211 8109.

SERC directors : changed responsibilities

Mr Tony Egginton remains responsible for the Engineering Division and the Special Directorates and is now called Director, Engineering.

Mr John Visser, Director of Administration, is also acting as Secretary to the Council.

Dr Harry Atkinson, Director of Astronomy, Space & Radio and Nuclear Physics, becomes in addition responsible for Science Division and for the overall coordination of international activities. He is now called Director, Science.

Major moves and appointments

Professor John Houghton CBE, FRS, Deputy Director of Rutherford Appleton Laboratory, succeeded Sir John Mason as Director General of the Meteorological Office on 1 October 1983.

Professor Houghton, who is Professor of Atmospheric Physics at Oxford University, has been involved for more than 20 years with the development of instruments for the observation of the atmosphere from space.

Dr Paul Williams has been appointed Deputy Director and Head of the Technology Division of Rutherford Appleton Laboratory on promotion, in succession to Professor Houghton.

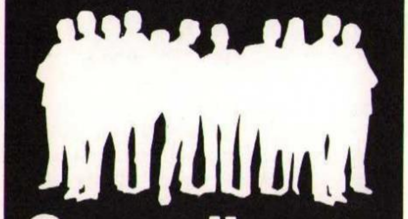
Dr Robert Voss has moved to Central Office, Swindon, from Daresbury Laboratory to take over the post of Head of Engineering Division from Dr Williams.

Dr David B Thomas has been appointed Director of Information Technology. Dr Thomas is Director for intelligent knowledge-based systems (IKBS) and SERC liaison for the Alvey Directorate.

Mr Peter Maxwell has become Establishment Officer at Central Office, Swindon, on the retirement of Mr Jack Beattie.

Dr Nicholas Lawrence has been appointed Deputy Laboratory Secretary, RAL, in succession to Mr Peter Maxwell.

Dr Peter Davies has been appointed Observatory Secretary, Royal Greenwich Observatory.



Council commentary

Estimates 1983-84 and Forward Look

In April and May, Council discussed arrangements for dealing with the deficit on international subscriptions caused by exchange rate variations and the effect of this on the Council's estimates. The deficit amounted to £4.3 million and as no immediate assistance was forthcoming from the Treasury, it was left to Council to make cuts to its domestic programme to keep within its cash limit of £254.5 million. At its May meeting, Council decided to find the deficit by reducing the working allocation of each of the four Boards by £1 million and that of central support, central computing and administration by £0.3 million.

Details of the 1983 Forward Look were submitted to the Advisory Board for the Research Councils in April. The funds available under the main guideline were £273.5 million (1984-85), £288 million (1985-86) and £296.63 million (1986-87) at cash planning levels. These figures indicate that the decline in real terms of SERC's budget, apart from special allocations like that for information technology, is likely to continue.

Compared with the 1982 Forward Look, the main guideline shows a modest transfer from nuclear physics and astronomy to other science and engineering. With the present investment in high energy physics and astronomy near the minimum necessary, Council argued strongly that the ABRC should press for a significant increase in the Science Vote as a whole.

Members were very conscious that the proportion of 'alpha' graded research applications which Council had been able to fund has been decreasing steadily, a particularly serious problem in the Science Board area. The effect of this trend is considered to be particularly damaging in the longer term so that Council presented a bid for additional funds to be devoted to research grants.

A further additional bid was presented in respect of a proposal to set up a Special Directorate in the application of computers for manufacturing engineering. This area is recognised generally as potentially an important influence on the country's long term economic future, and Council feels it is now timely to give a major boost to research and training in that area.

The Forward Look included two further additional bids: one to support a new space mission in x-ray astronomy, the High Throughput Spectrometer Mission, and the other to cover estimated increases on SERC's international subscriptions due to exchange rate variations.

Report of the Nuclear Structure Review Committee

The report of the Review Committee, under the Chairmanship of Professor E W J Mitchell, was presented to Council in February. Its remit was to review the state of nuclear structure physics in the UK as well as considering the future of the Nuclear Structure Facility at SERC's Daresbury Laboratory. Its recommendations were approved by Council, and it was agreed that the report should be published (see page 27).

Space and Research Grant Review Committees

At its March meeting, Council agreed to set up two special review committees: the Space Review Committee, under the chairmanship of Professor Mark Richmond, will conduct a detailed investigation into many aspects of the council's space programme and expects to present a report to Council by December 1983; and the Research Grants Review Committee, under the chairmanship of Professor Sir Jack Lewis, is to consider ways of providing improved statistical information on research grants, better insights into successs rates of grant applications and how these influence the nature and number of applications.

Age limits on SERC studentship schemes

Also in March, Council reconsidered its policy on age limits for candidates for its studentship schemes and agreed that applications should be considered on merit without regard to age so that the present age limit of 30 is abolished.

Laser systems at the Central Laser Facility

A new phase in the development of the central laser facilities at the Rutherford Appleton Laboratory was given Council approval in April. The proposals approved represent the first phase of the new development programme following the report of the Franklin Panel in 1982.

Special Replacement Scheme

Council in May looked afresh at its Special Replacement Scheme in view especially of the advent of the Government's 'New Blood' scheme. It concluded that the Scheme should continue in operation and saw flexibility in its operation as essential.

Collaborative Training Awards Scheme

In July Council reviewed its Collaborative Training Awards (CTA) scheme and, while convinced that the scheme remained valuable, decided that in view of its low level of take-up it should be assimilated into the better known and very successful Cooperative Awards in Science and Engineering (CASE) scheme.

Holmes—Hines Bequest

The second award of the Holmes-Hines Memorial Fund was presented to the Physics Department at the Queen's University of Belfast, for its work with sixth forms. The Department used the £750 award to bring over a party of lower sixth form students from Northern Ireland for a day visit in June to Daresbury Laboratory and Jodrell Bank Radio Astronomy Observatory. At Daresbury, they were shown around the Synchrotron Radiation Source, the Nuclear Structure Facility and the main computer area and were able to talk to scientists about their research programmes.

At Jodrell Bank, they toured the visitor centre, including the British Telecom display on satellite communications which shows the link between basic research and the practical world; and saw some of the work being done on the Merlin interferometer network in which the Mk 1A radio telescope is used in conjunction with five other telescopes spread over the country for making maps of such astronomically interesting objects as quasars.

The Holmes-Hines Award is the result of a bequest to SERC from the late Miss Frances Hines, a modern languages teacher with a lifelong interest in scientific research. The gift is to sponsor activities related to science for which public funds might not be available.

Training boost for information technology

When the Government announced its £100 million three-year programme for boosting information technology (IT) in December 1982, SERC was given the task of administering the £21 million postgraduate package of 200 extra fellowships, about 470 research studentships and more than 3700 advanced course studentships (ACS). A small IT Training Group has been set up in Engineering Division and the Postgraduate Training Support Section has been strengthened in order to administer the new awards.

The main emphasis in the postgraduate part of the initiative has been placed on 'conversion courses' in order to increase the highly qualified manpower available in the discipline to meet the expected expansion: almost 90% of the new ACS are for the IT conversion course programme.

IT covers information acquisition, handling and use involving the latest techniques in microelectronics, computing and telecommunications.

The aim of the programme is to recruit good quality graduates with the right aptitude, from non-IT science and engineering, economics, management or the arts, and convert them into IT practitioners. The conversion courses are up to 15 months in length and at postgraduate Diploma and MSc levels.

As about £3.55 million was allocated for IT training for 1983-84, SERC had to act very quickly to launch this first phase. The response from universities was overwhelming, both for increased studentship quotas to boost existing conversion courses and for new courses. The bids for the new studentships were about three times as great as the number available, demonstrating a readiness to increase the training effort in IT even further. A separate pool of ACS was made available for polytechnics and 16 new or enhanced postgraduate courses were selected in ten polytechnics. Thus SERC has been able to increase the number of conversion courses this year from 20 to 50 (in 40 institutions well spread across the country) and the number of SERC studentships on these courses from about 90 to 900. In addition, the numbers have doubled on specialist IT courses, where the intake consists mainly of graduates from IT and related subjects.

In judging new course applications, the Council's criteria included the quality of the course, the general research and training capability of the department, interdepartmental collaboration and industrial interest, relevance and involvement. Typically, the courses are based in computing or electronics departments, with high-level support facilities and opportunities for much practical experience. They are designed to be demanding, aimed at high-fliers who, with nine to 15 months' intensive 'conversion', should be equipped to take up rewarding and challenging careers in a wide range of information activities in industry or commerce.

Besides the boost in advanced course training, SERC has been able to award 120 additional three-year postgraduate research studentships for 1983-84 (this number to increase to 190 in 1985-6), and 45 research fellowships in IT (to double by 1985-6). These appointments will strengthen the IT research community at all levels and increase effort in those areas identified in the Alvey Report.

A comparison of figures for conversion and specialist courses before and after the initiative looks like this:

Table 1 – 1982	Courses	Quota allocation	Total Take-up
Conversion	20	60	88
Specialist	25	69	100
Total	45	129	188

Table 2 – 1983	Courses	Quota allocation	Total available (actual)
Conversion – existing	20)		
	) 50	740	900
– new	30)		
Specialist	30	180	190
Total	80	920	1090

A busy practical session on the MSc Computing Science course at North Staffordshire Polytechnic. For every hour of lecture on the course, the students have an hour's tutorial and practical time and also get on to the terminals for additional practical experience whenever they can.

A thick sandwich for postgraduates

One example of how SERC's programme of additional support for training in information technology, especially for postgraduate 'conversion' to IT, is taking effect is in North Staffordshire Polytechnic. Its Department of Computing has been running an MSc course in computing science for more than a decade. This year the course has been revised and expanded: 30 students started the 15-month basic course this October, as against half a dozen last year, and a fair proportion of them have come with little experience of the world of computing.

Seven months in industry

The course structure is very unusual, being a sandwich course taking 18 months to three years in all. The Poly describes it as a 'thick sandwich' as it consists of a four- to six-month introductory course, seven months in industry, back to the classroom for a further 15 weeks, and then the dissertation in the student's own time (which can take anything from three months to two years). A more typical MSc conversion course would consist of a term for an introductory or general module, a set of optional modules in the second term or so and a practical project, usually with industry, in the last four to six months.

Students can take the first period of the North Staffordshire MSc programme either as a continuation course, if they already hold first degrees (or equivalent) in computing, or as a 'conversion' course from some other discipline. For those in the former category, the first study period lasts 15 weeks, during which students take two modules of their choice; those in the latter take a separate 22-week course which contains two compulsory modules covering programming principles with data processing and computer systems. In the second study period, after their seven months' industrial experience, all students combine on one course and choose a further two modules leading to an MSc.

Two SERC-supported students, Dick Taylor and Tony Walker, have just completed the course, apart from the dissertation. They came from very different backgrounds and for very different reasons. Tony, with an HND in computing, came mostly for the industrial experience that the 'thick sandwich' offered, found working for a small telecommunications company on Deeside very rewarding and has high hopes of getting a job in a similar firm fairly quickly. Dick, on the other hand, had a first degree in fine art, plus four years' experience in computer graphics.

Chatting over a couple of the micro terminals are SERC-supported students (left to right) Tony Walker and Dick Taylor, who have now completed the course, and Nitin Patel and John Melling, who are now doing the 'industrial filling' part of the sandwich.

For him, learning the technology was an essential element of the course. He spent his industrial period working on a graphical display package for the Electricity Research Council. He and Tony chose the same modules, real-time computing and systems programming, in their second study period.

Variety of backgrounds

Other students' backgrounds reveal an interesting variety: two more SERC-supported students who have now just started their industrial experience, John Melling and Nitin Patel, both have British Computing Society Part II qualifications; Francis Tam, who found his industrial sandwich with IBM 'really great', came straight to the course from a first degree in computing science at Queen Mary College; Christine Johnson and Barbara O'Connor, on the other hand, were lecturers in the Education Department at the Poly, Christine in chemistry and education, Barbara in maths and education. When the Education Department was axed in last year's cuts, they opted for retraining in information technology. Christine, who has a doctorate in biochemistry, experienced an initial culture shock as a complete newcomer to computing, but found coming to grips with different concepts and a new language was very rewarding. Her life has taken quite a change of direction: having mastered the course, she now does some tutoring on it, in information retrieval and real time computing.

Commercial software

The industrial sandwich is an essential ingredient in both the undergraduate and postgraduate computer courses at North Staffordshire. The Head of Computing, Dr H L W Jackson, feels strongly that students must get into industry to acquire a proper sense of computing science in action. What is more, it helps them to get placed after graduation. The staff also spend six-month periods in industry every few years and they have continuing close contact: the department writes a lot of software, for big customers such as ICL and GEC as well as for small firms. Now they need more equipment; they have four mainframe machines and numerous micros but there are sometimes queues of students trying to get a place at a terminal. All of which reflects the appeal and challenge of information technology and the timeliness of the new government initiative.

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SERC's initiative in intelligent knowledge - based systems

The importance of the information technology (IT) industry and the central role of computing within that industry is universally recognised, and there is no doubt that the coming decade will see IT applied to a huge range of new tasks in industry, commerce, public service and domestic life. Much of the development so far has been driven and paced by the achievements of silicon technology in making massive increases in complexity and performance with correspondingly large reductions in cost. In general progress has been very much slower in systematic methods for applying IT to solve complex problems. In particular the 'software crisis' is a serious symptom of the limitations inherent in the current 'conventional' approach to specifying, designing and programming complex systems. These problems have been becoming steadily more apparent in recent years and will rapidly become the dominant limiting factor in our ability to apply ever more powerful computing hardware to solve complex real world problems.

A major contribution to coping with these problems, and hence to significant advances in computing, will come from research in artificial intelligence (AI) and formal methods, coupled with work on novel approaches to computer architectures. These advances will be based on completely different approaches to problem solving and programming, owing much less to brute force and *ad hoc* design and much more to formal knowledge representation and manipulation and human-oriented problem solving and interaction. The term 'intelligent knowledge-based systems' (IKBS) has been coined to denote the first main generation of these systems that will emerge during the next few years.

What are IKBS?

IKBS are defined as semi- or limited-intelligence systems for carrying out a single, but complex, task. They are characterised by large, incomplete, uncertain or changing knowledge bases, by the use of inference procedures for manipulating this knowledge in response to variegated or unreliable inputs in a changing environment and by sophisticated and flexible control mechanisms.

Primitive examples of such 'applied AI' systems already exist as commercial systems doing non-trivial tasks, for example expert systems in areas such as medical diagnostics, natural language systems. There is a considerable and growing body of evidence that IKBS are likely to have a major impact on UK industry from the late '80s onwards in a wide range of applications from robot assembly to office automation. The likely significance of IKBS for all industrial nations has been pointed out recently by a number of major initiatives including the Japanese Fifth Generation Computer Project, various US statements and the Alvey report. All these agree that IKBS will become an increasingly major part of information technology as a whole and therefore IKBS are of enormous economic significance for all industrial nations.

Part of IT initiative

Within the SERC the proposals for an initiative in IKBS date back to September 1981 when an ad hoc panel was set up to produce a detailed proposal for action. The resulting proposal for a Specially Promoted Programme (SPP) in IKBS emerged in 1982. In parallel there was activity within SERC that has led to plans for an Information Technology Directorate as an integral part of the national Alvey Directorate which covers work in industry, academic establishments and government laboratories. SERC's IKBS Programme is now going ahead as part of that initiative.

The SPP document proposed, as a first step towards implementation of the programme, that SERC should hold a Research Area Review Meeting on IKBS. This meeting was held in September 1982 and served on the one hand to inform the community of the various proposals being made, and on the other to obtain from the community its positive reactions to the SPP proposal in the form of research topic and project suggestions and requirements, and community R&D groupings.

The SPP document also proposed that an essential preliminary to the programme was a study of the architecture of IKBS in order to define a conceptual framework for the UK IKBS community and to refine the programme's research and development objectives. The IKBS Architecture Study was funded by DoI and SERC in October 1982 and ran for six months as an intensive study directly involving some 30 academic and industrial consultants. In view of the expected announcement of the Alvey programme the remit of the Architecture Study was widened to include recommendations for the UK's overall industrial/academic collaboration on IKBS.

As well as producing a wealth of technical material the study formulated a programme for action designed to bring research results to effective exploitation as rapidly as possible. Five categories of research and development activity are planned.

- *immediate 'show me' projects* for industry awareness of current IKBS products and achievements
- *short term development projects* to promote early industry collaboration
- *longer term demonstrator projects* to promote industry-led R & D collaboration towards possible systems
- *research themes* – directed longer-term research on high priority topics by coordinated research groups
- *individual research* – normal 'long term' research by individuals and groups across the whole field of IKBS.

The present UK IKBS community is small and is not yet in a position to sustain a major programme of the scale required. An urgent priority for training was therefore identified in the SPP proposal as a foundation of the programme, and initial steps have been taken in the context of the recent DES initiative in support of IT, which provides funds for additional permanent university posts, IT fellowships and studentships.

A further requirement is to establish an adequate computing infrastructure for the community. Steps are being taken to provide that support, both in terms of networked computing power and the development and maintenance of IKBS languages and software environments.

Further details about the programme may be obtained from:

Mr W P Sharpe, Rutherford Appleton Laboratory, telephone Abingdon (0235) 21900 ext 6394.

Sprite - a high energy krypton fluoride gas laser

For the past three years scientists and engineers at the Rutherford Appleton Laboratory have been constructing a high power krypton fluoride (KrF) laser, Sprite. The project came to a successful conclusion earlier this year with the laser achieving an energy output of 220 J in a pulse of approximately 50 nsec duration.

The operating wavelength of 249 nm is considered to be near optimum for use in laser compression and laser fusion studies. Experimental and theoretical work has shown that high density implosions can be achieved more readily using short wavelength lasers and for some years now RAL staff have been studying the potential of KrF for application to laser compression research. This type of research is at present carried out at RAL using the 6-beam neodymium-glass laser, VULCAN, which provides high power pulses at wavelengths of 1.05 μm, 530 nm, and 350 nm. Thus the new gas laser, Sprite, operating at 249 nm, complements existing facilities by extending the wavelength coverage to shorter wavelengths.

In operation, the high pressure cylindrical laser cell (100 cm long x 26 cm diameter) is pumped from four sides by 450 keV, 90 kA electron-beam pulses of 60 nsec duration. Most of the hardware shown in the picture is the pulsed power equipment needed to generate high voltage accelerating pulses for the electron-beams. The laser beam output is obtained from the window aperture visible in the centre left section of the apparatus. Deionised water is used extensively in the system as a high voltage insulating medium, a role to which it is well suited because of the short duration of the voltage pulses generated by the machine. An added advantage is that the large dielectric constant of water (80) results in a high electrical energy storage density and therefore a comparatively compact laser system.

The pulsed power system

The primary energy source for Sprite is a 12-stage 20 kJ Marx generator. This is used to pulse-charge a 40 nF water capacitor (the large cylinder seen right in the picture) to a voltage of 800 kV in 1.2 μsec. At peak-charge voltage a laser-triggered sulphur hexafluoride spark gap transfers this energy to four water-filled 5 Ω pulse forming lines (PFLs) charging them to 900 kV in 150 ns. At peak volts on the PFLs, laser-triggered output switches are fired and 60 nsec, 450 kV (half the charge voltage) pulses are transmitted to the four cold-cathode electron-beam diodes which are designed to act as matched loads for the PFLs. The extensive use of laser-triggered switching makes this machine unique in the world and allows for very efficient utilisation of the stored electrical energy.

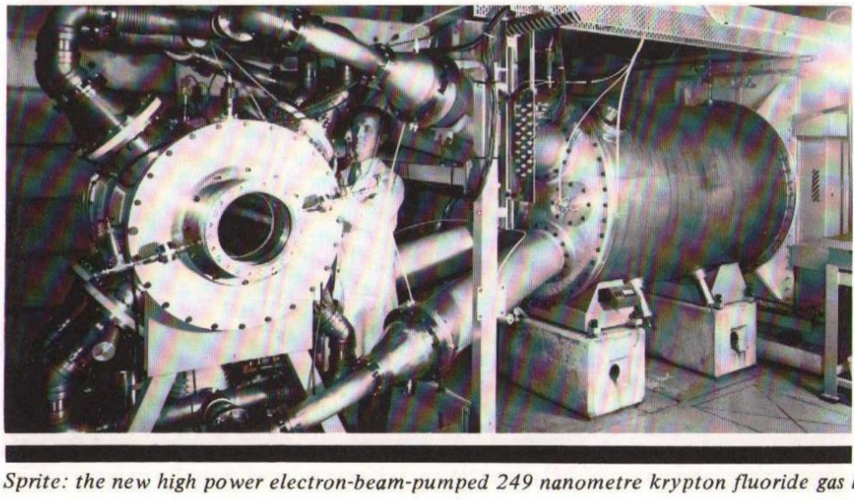
On application of the high voltage pulses, 90kA electron-beams are generated in the diodes which are held under vaccum. These beams are transported to the high pressure (2 atm) laser gas through large area titanium foil windows the thickness of which (35 μm) is chosen so they are impermeable to the laser gas while allowing the electron-beams to pass through unattenuated. The krypton fluoride laser gas mixture typically consists of 90% argon, just over 9% krypton and less than 1% fluorine at a pressure of approximately 2 atmospheres. The exact gas pressure in the laser cell is adjusted to provide efficient stopping of the electron-beams and their energy is dumped in the gas in the form of ionisation which by a series of kinetic processes leads to the formation of the excited KrF laser species. The maximum energy deposited in the gas is measured to be approximately 3 kJ.

Laser performance

First laser tests with Sprite were performed using a resonator consisting of an aluminised rear reflector and a flat quartz output coupler. Laser pulses of 220 J energy and 50 nsec duration were obtained representing an overall system efficiency of more than 1%. For future experiments it is necessary to produce a high energy beam of narrow spectral linewidth and low divergence. A 26 cm diameter unstable resonator cavity has thus been installed on Sprite and this is injection-locked by a master oscillator which 'seeds' the large aperture resonator with a lower power beam having the desired optical characteristics. In this configuration the Sprite output is typically 160 J with a beam divergence of 100 μR and a line-width of 0.3 cm^{-1}.

Future plans

The Sprite laser is one of the most powerful KrF lasers in the world. In order to capitalise on this expertise for plasma physics research it will, however, be necessary to compress the available energy into a pulse of 1 nsec duration giving a laser power of more than 100 GW. The requisite x50 temporal pulse compression will be achieved using the techniques of optical multiplexing and Raman amplification. In multiplexing, energy is extracted from the laser amplifier by a series of short duration pulses which pass through the system in sequence. Each pulse is directed through the amplifier at a small angle to the others and power gain is achieved by using optical delay lines at the output to 'stack' the short pulses on target. Raman amplifiers will be used in the system to provide beam clean-up and target isolation from pre-pulse. Present plans are to build an optical multiplexer with Sprite as the final power amplifier, to provide UV laser pulses of 100 J energy and 1 nsec duration for plasma physics research. This system will also test the feasibility of constructing a 5 kJ/1 nsec UV laser to be built in the future. The availability of this very high power system would help to keep the UK laser-plasma community at the forefront of compression physics research.



Sprite: the new high power electron-beam-pumped 249 nanometre krypton fluoride gas laser.

News from the SRS

The scientific programme at the Synchrotron Radiation Source (SRS) at Daresbury Laboratory is gaining momentum. The SRS is being used for spectroscopic, microscopic and structural studies of matter ranging from atomic and molecular species to cellular and solid crystalline samples. The experimental programme is both interdisciplinary and international on a wide front.

The SRS was the world's first purpose-built x-ray source dedicated to synchrotron radiation experiments. The experiments began in 1981 and, by July 1983, 13 experimental stations were in use with a further nine stations due to be commissioned by mid-1984. The stations cover a wide variety of scientific techniques and, consequently, experimenters are being attracted from a wide range of disciplines such as chemistry, physics, biology, medicine and materials science, both from UK academic and industrial communities and also from abroad, particularly the Netherlands and Sweden.

Among recent scientific highlights have been work on the influenza virus and on the photoionisation of atomic ions.

Solution scattering from influenza virus

Influenza virus (IV) is roughly spherical in shape and composed of concentric shells of different macromolecules. This is shown diagrammatically in figure 1. In the central core is the virus 'gene' ribonucleic acid (RNA) which accounts for only some 2% of the IV mass. This is surrounded by nucleoprotein which in turn is enclosed by a shell of M-protein. These shells are enveloped by a membrane bilayer some 4nm thick and, finally, by the surface of the virus. This consists of 'spikes' of the proteins haemoglutinin and neuraminidase which are the antigenic determinants of the virus. Small angle neutron scattering has led to the first accurate molecular weight determination of the IV particle and to precise values for the radial positions and the masses of the various shells. The x-ray work at the SRS is aimed at extending the model for IV to higher resolution and at studying structural alterations in the virus during the infective cycle. Different virus types and strains are being compared to examine the structural result of antigenic shift and drift which are the origin of influenza epidemics.

Figure 1 shows the type of information which can be obtained by solution scattering. The radius and mass of the various shells can be determined. In addition, diffraction maxima, which are believed to correspond to interference between the outer spike proteins, have now been observed at the SRS. The structures of these proteins have been determined by single crystal studies and one aim of the solution scattering is to include the shape of these proteins in the analysis and obtain a model of the virus surface. One particularly interesting aspect is the change in the structure which occurs at different pH values. These are thought to mimic changes which occur during the infective cycle when the viruses are encapsulated into lysozomes. Study of the fixed (vaccine) and unfixed virus might then show how the inactivation takes place to produce a safe vaccine.

X-ray scattering at the SRS, which gives scattering patterns similar to that shown in figure 2, has established that type A and type B influenza virus have a very similar structure, like that shown in figure 1. However the precise arrangement of the surface spikes is not yet known; the new x-ray data collected at the SRS will be used to test models for the surface structure, and even on preliminary analysis it is already clear that it rules out a model suggested on the basis of neutron scattering alone. This type of analysis is most powerful when the same type of specimen is studied both by neutrons (available at the Institut Laue-Langevin at Grenoble) and by x-rays (at the SRS), and the scattering data further complemented by good physical biochemical measurements such as precision densitometry and photon correlation spectroscopy.

This project is a collaborative venture by a Dutch group led by Dr J Mellema (Leiden) and a UK group led by Dr A Miller (Oxford).

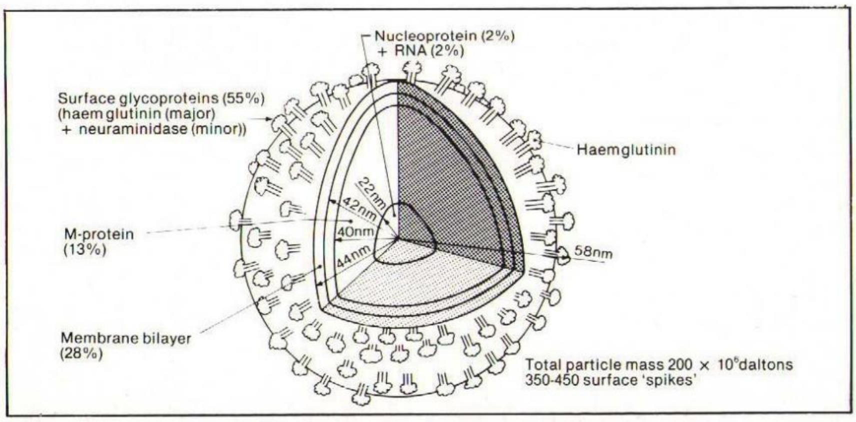


Figure 1 The influenza virus (B) particle by solution scattering.

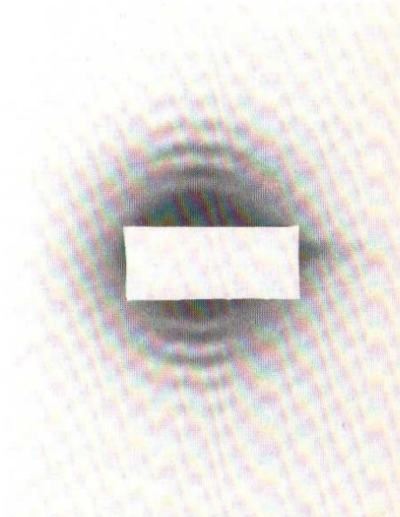
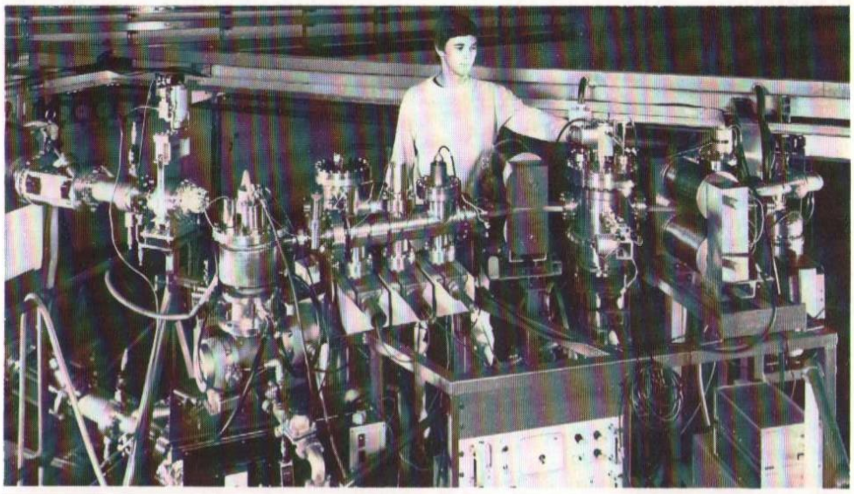


Figure 2
Solution scattering pattern given by a large, spherical virus (Iridescent virus). The scattering corresponds to the spherical average of the squared Fourier transform of an individual particle. The diffraction ripples merge into each other in the horizontal direction due to the large horizontal source size of the SRS. The High Brightness Lattice will allow a non-smeared pattern to be obtained.

Photoionisation of atomic ions — a first for the SRS



The measurements of absolute photoionisation cross-sections of atomic ions are of fundamental importance to atmospheric and solar physics, and they constitute a new branch of atomic spectroscopy since, for example, structure in the ionisation function provides information about the position and importance of autoionising states. Even for neutral atomic species, except for the rare gases, photoionisation cross-section measurements are rarely known to better than a factor of two and theoreticians find difficulty in describing, with reliability, the absorption processes that occur in the earth's upper atmosphere and the sun's photosphere. For ionic species, present in great abundance in those atmospheres, there are no measurements with which theorists can compare their predictions. Several years ago Professor K T Dolder and Dr B Peart of the Atomic Physics Department at Newcastle University proposed an experiment to make such measurements using the SRS. Under existing experimental conditions, the probability of photoionisation is small, but it can be enhanced by merging the photon and ion beams over a 10 cm path length. This requires accurate collimation of both beams and careful measurements of their spatial overlap if *absolute* cross-sections are to be measured. In the experiment undertaken by SERC research student Ian Lyons at the SRS, Ba^{+} ions were chosen for study, and they were produced by surface ionisation of the neutral atoms. They were then focused and collimated into a well-defined beam. A second magnetic field separated the singly-charged from the doubly-charged Ba^{++} ions formed by photoionisation and by collisions with residual gas, directing them towards a particle counter. After much frustration with faulty equipment, a doubly-charged ion signal was seen, and it transpires that the cross-section must be two orders of magnitude higher than predicted by theory, which presently neglects inner shell effects. Once improved optics are installed at the SRS experimental station, then a whole new field of work should be open.

New grants of special interest

The Council, through its Synchrotron Radiation Facility Committee, awarded about £800,000 in the 1982-83 session for research grants involving use of the SRS.
Three recent grants are:

Dr G C King (Manchester University): support over two years for *Threshold electron spectroscopy* involving use of stations on SRS line 3. This grant is for work in a field which is in the forefront of atomic physics and for which very advanced theory exists, which allows direct study of correlation effects.

Professor J N Sherwood (Strathclyde University): support over three years for *The influence of mechanical deformation of product crystals in industrial crystallisation processes* involving use of the SRS x-ray topography facilities. This grant is for work which falls under the Engineering Board's SPP for Particulate Technology and has arisen out of collaboration between Professor Sherwood, UMIST and ICI. It concerns looking at the detailed aspects of the inter-relationships between mechanical deformation and growth kinetics and is of relevance to industrial crystallisation processes.

Professor R H Williams (New University of Ulster): support over three years for *Transition metal refractory rare earth metal silicides* involving use of stations on SRS line 6. This is the first Cooperative Research Grant involving the SRS; the industrial partner, GEC, will also make a financial contribution and will look at the technological aspects. The silicides have significant potential application as contacts and interconnections in microelectronic devices and the grant is for work to probe their detailed atomic structure, the precise nature of the interface and their interaction with gases and other metals.

High Brightness Lattice upgrading

Approval was recently given by the Council and the Department of Education and Science for a modification to the SRS known as the High Brightness Lattice (HBL) upgrading. A combination of quadrupole magnets when inserted into the storage ring in certain places, will result in the SRS beam brightness being increased significantly thus yielding substantial improvements for many experiments. For instance, in biology and medicine, or in any application where only small samples or low concentrations of active material are available, the limiting factor is often the number of photons which can be focused on to the specimen in unit time. The HBL upgrading will give an approximately ten-fold decrease in the area of the radiating electron beam and should bring a broad range of new science into view. In particular the HBL upgrading will be essential for the improved realisation of such topics as high resolution x-ray microscopy, protein crystallography, x-ray topography and time-resolved fibre diffraction and will allow the SRS to stay competitive on a world scale for many years. The HBL upgrading is scheduled to begin in the autumn of 1985 and a period of six months will be required for installation and recommissioning. UK researchers may be funded to use overseas synchrotron radiation sources during the shutdown if necessary.

SRS Small Grants Scheme See page 25.

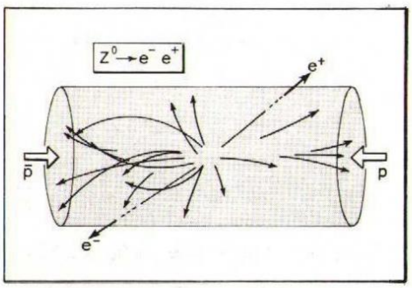
First the W - now the Z

British physicists in an international team in Geneva have been involved in a second major discovery in particle physics this year. Working at CERN, the European Organisation for Nuclear Research, the team has observed the Z° intermediate boson which, with the charged W particles discovered earlier this year (see *Bulletin* Vol 2 No 8, Summer 1983), completes the set of three particles predicted in the theory combining the weak and electromagnetic forces of nature. Four examples of the Z° intermediate boson were identified in May among large amounts of data from experiment UA-1 on CERN's proton-antiproton collider.

Altogether, 130 scientists from 13 universities and laboratories are involved in the UA-1 experiment including British physicists led by Professor J D Dowell (Birmingham University), Professor P I P Kalmus (Queen Mary College) and Dr A Astbury of SERC's Rutherford Appleton Laboratory. SERC provides support for UK particle physicists and access to the world-class facilities at CERN.

The Z° is a member of a trio of particles predicted by the electroweak theory to unify two of the four basic forces in nature: the electromagnetic and the weak nuclear forces. Many had believed that a particle so elusive and so difficult to produce could not be discovered so speedily. Its identification, following intensive periods of data analysis, is proof of the originality, selectivity and reliability of the equipment operated round the clock to translate into reality the brilliant ideas put forward by the boson hunters.

The event was discovered using the very large detector built and operated by the UA-1 collaboration. The detector records the tracks of the many charged particles emerging when the proton and its antiproton collide head on with a combined energy of 540 GeV (the highest man-made particle collision energy ever studied). The low rate of Z° events requires that intense beams of antiprotons be produced and already the record luminosities achieved last year have been surpassed as a result of brilliant accelerator physics at CERN. Exploitation of the collider by the experimental physicists has yielded a further triumph for European scientific collaboration.



Computer reconstruction of tracks induced in the central detector of the UA-1 experiment at CERN after a proton-antiproton collision on 28 May 1983. The full energy (270+270 GeV) of the two colliding objects is transformed into secondary particles whose total masses and energies amount to the 540 GeV available.

Amongst the collision products there may be a W boson and (ten times less frequently) a Z° boson. The production frequency depends on the SPS 'luminosity' ie the rate of collisions per cm^2 (of the beam) per second. For example, the SPS had to operate day and night from early April until the end of May to produce the first four Z°s. Two of the tracks in the figure indicate decay products of a Z° born at the central collision point. They are an electron and its antiparticle, a positron. The tracks carry 45 and 47 GeV of energy, ie a total (allowing for some energy spread) of some 97 GeV as predicted by theory for the Z° mass.

UK firms win LEP project orders

British firms have won four important contracts from CERN in Geneva. The contracts are for the supply of components for the LEP project – a large electron-positron storage ring research facility, to be housed in a 26 km circular tunnel, on which work is just starting.

Morfax Limited, of Mitcham (Surrey), are to supply 130 radio-frequency storage cavities for the LEP machine (see *SERC Bulletin* Vol 2 No 7, Spring 1983). RF power is used to accelerate the electrons and positrons circulating round the LEP ring in a vacuum chamber. A large part of this power is normally dissipated as heat. In the LEP design, the power will be transferred into spherical storage cavities for the periods between the passage of each bunch of particles; this will give much lower power dissipation and a significant saving in energy requirements.

The storage cavities are made of high-purity copper. They are spherical, with a diameter of about 1.2m and a wall thickness of about 6mm. They must withstand very high vacuum, must be made to very accurate dimensions and have excellent surface finish and cleanliness standards. They will each be made up from two hemispheres, produced by a spinning operation. Jointing techniques are electron-beam welding and vacuum brazing. The contract is worth £1.35M.

NEI Peebles, of East Pilton (Edinburgh), have been awarded a contract to supply magnetic systems for the pre-injector for the LEP machine. This pre-injector comprises two linear accelerators, an accumulator ring that will collect and hold dense bunches of electrons and positrons, and a synchrotron to accelerate them to an energy of 3.5 GeV for injection into the main ring. The contract for the magnets and their associated equipment is worth £200,000.

Balfour Beatty Power Construction Limited, of Kirkby (Liverpool), are to supply waveguides to carry the radio-frequency power to the accelerating cavities in LEP. The waveguides comprise rectangular tubing made of sheet aluminium alloy 5mm thick. The inner and outer surfaces are coated with a protective chromate layer, and each section of tube has flanges welded on to each end so that they may be joined together. A total of about 450 units is required, in various shapes (straight sections and several different types of curve and junction) of which the largest is about 1.3 metres long.

Radiation Dynamics Limited, of Swindon (Wiltshire), will make the electron gun for LEP. It is this device that is the initial source of electrons. Operating on an intermittent cycle, it will produce bunches of electrons that after several stages of acceleration, storage and focusing will eventually travel round the main ring of LEP and permit physics experiments that are expected to throw new light on the nature of matter.

These contracts were won against intense competition from firms in the other 12 member-states of CERN (Austria, Belgium, Denmark, France, W Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland). They are the first results of a publicity effort mounted by SERC in conjunction with the British Overseas Trade Board and the UK Consulate in Geneva, to inform British industry of the high-technology export opportunities in the LEP project.

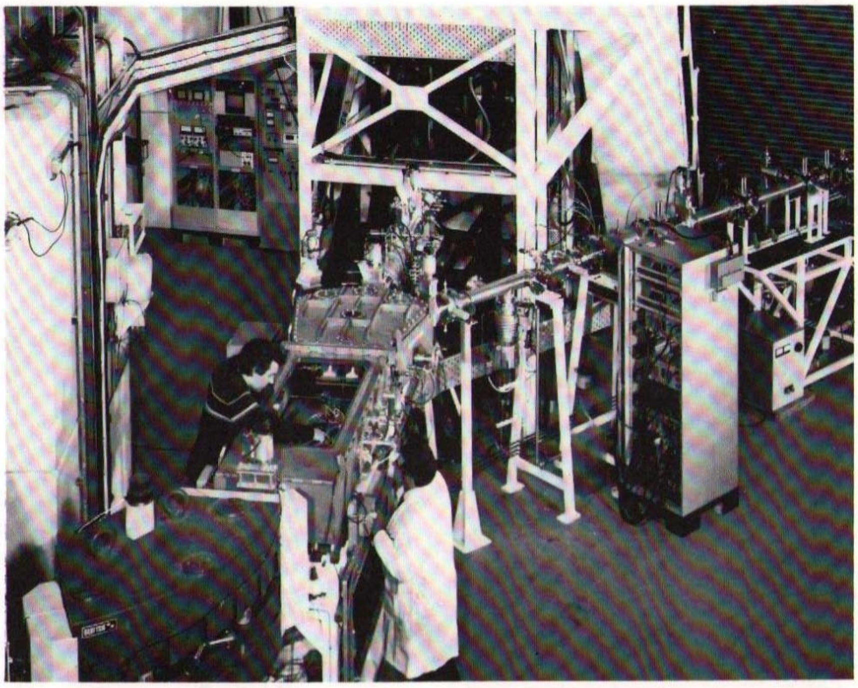
NSF reaches 20 MV

The Nuclear Structure Facility (NSF) at the Daresbury Laboratory in Cheshire produced its first experimental nuclear physics results towards the end of 1982. Since then, the accelerator has settled into regular operation, and the experimenters have been very busy studying a wide variety of nuclear phenomena. Some of the first results on rapidly rotating nuclei were reported in *SERC Bulletin* Vol 2 No 8, Summer 1983.

The NSF comprises a large tandem electrostatic accelerator connected (at present) to six experimental stations. At the centre of the accelerator is the high voltage terminal and the overall performance of the facility depends most critically upon the voltage that can be maintained stably on this terminal. As soon as it was clear that the terminal was stable up to 18 MV (the highest voltage available for research in the world), the main emphasis was placed on pursuing a planned programme of experimental research. In the meantime, the performance of the accelerator has been carefully monitored and gradually improved. There is good reason to proceed cautiously: the energy released during a sudden discharge is sufficient to risk damaging the vital vacuum tube that carries the particle beam through the accelerator; such discharges must be kept to a minimum. Caution has certainly paid off and the maximum stable terminal voltage was raised to 20 MV in April 1983. Thus the NSF has achieved its initial design voltage and it is now a clear world leader.

The main aim of the NSF is to further research into the physics of the atomic nucleus. Some of the first experiments studied rapidly rotating nuclei, using a complicated array of more than 60 gamma-ray detectors. Evidence for two particularly interesting phenomena has been found in separate experiments: the breakdown of pairing (the 'superconducting' phase of nuclei) and the disintegration of collective nuclear rotation. Both of these occur through the action of the Coriolis force (that is, its quantum mechanical equivalent) on the rapidly rotating nuclei.

Other experimental stations have been brought into operation and are producing interesting physics. Inside a precision scattering chamber, the break-up of heavy ions following nuclear collisions is being studied by a novel technique, leading to an understanding of the way that protons and neutrons cluster together and then fly apart, and giving detailed knowledge of these intermediate clusters. In another experiment, the way in which colliding



The Daresbury Isotope Separator, showing adjustments being made in the focal-plane box. The straight-ahead beam line goes to a dilution refrigerator for nuclear orientation studies, and the beam line going to the right is set up to study laser resonance fluorescence.

nuclei can exchange electric charge (without exchange of neutrons and protons) is being investigated.

A sophisticated magnetic spectrometer, consisting of dipole, quadrupole and multipole magnets, has been successfully commissioned. One of the first experiments using this device has been to measure accurately the mass of ^{21}O. This is an exotic nucleus with eight protons and 13 neutrons – normal ^{16}O has only eight neutrons. The door is now open to investigate excited states in this nucleus – if any exist! The present data are most encouraging. Another experiment is looking for the fundamental effect of non-central nuclear forces on the structure of ^{6}Li. A third experiment has found that when nuclei collide and separate, apparently without exchange of either mass or charge, the detailed structure of adjacent nuclei can have a dominant influence on the interaction – never before realised. Many other experiments are under way, but it is early days yet to comment on the significance of their findings.

One major experimental facility that is in the midst of commissioning is the Daresbury Isotope Separator. This separates out, in fractions of a second, particular chosen isotopes from the many that are produced in nuclear collisions and transports the isotopes to a region remote from the collisions, where sensitive measurements can be made in a low-background environmnent. Two specialised and complementary facilities are attached to the isotope separator: a dilution refrigerator which cools the nuclei almost to absolute zero (6 mK), and a laser facility for the study of atomic hyperfine shifts through resonance fluorescence. With these facilities, shapes, sizes and electromagnetic moments can be measured for very unstable and short-lived nuclei. The isotope separator itself has been successfully tested on-line to the NSF; the first full experiments, with both the laser facility and the dilution refrigerator, are about to be undertaken.

The results from these initial experiments using the NSF are very encouraging. Physicists from many British universities have been involved – Manchester, Liverpool, Birmingham, Bradford, Oxford, London, Sussex, Edinburgh and Glasgow, as well as overseas institutions. The community is looking forward to the coming months and years of high-quality nuclear physics research.

P M Walker
Daresbury Laboratory

Call for 'new look' in engineering

A report presented to the Engineering Board in June 1983 proposes changes both in the balance of Council support for engineering and in the way engineers are trained. The report is by the Working Party set up by the Board in Autumn 1982, chaired by Dr Robert Lickley F Eng, to look into postgraduate training in design and to propose a strategy to encourage grant applications with a major design content.

The Working Party notes that design has been the subject of numerous inquiries over the years and comments that: "Much of the present day concern about engineering and engineering design is almost identical to that voiced in the middle of the nineteenth century." It sees little point in repeating the work of so many past committees and, after broadly endorsing the findings of the Design Council's Moulton Report (1976) and noting that relatively little had been done to implement its recommendations, says that: "Design is the very core of engineering and the education of engineers should reflect this."

Continuing this theme, the report recommends that courses should repeatedly go through a cycle of teaching new knowledge, followed by laboratory or field work and a design exercise to put the new theoretical and practical knowledge into proper context. In order to strengthen this recommendation, it proposes that the institutions be urged to validate only those courses which have this essential design orientation. Dr Lickley emphasises the unanimous view of the Working Party that design should be a main subject in all undergraduate courses.

It recommends a flexible and pragmatic approach to postgraduate education in design, with a long PhD design project, a one-year taught MSc, short courses linking up to form a modular MSc, and a variety of distance learning, computer-aided training, training within industry and other methods to give a continuing education in design for the practising engineer. Close links with industry are repeatedly emphasised and are seen as being essential to proper education in design; a further extension of the Teaching Company Scheme into design projects is strongly recommended as one way of achieving this.

The full implementation of this report would change the balance of SERC's engineering support and, in the longer term, the teaching of engineering in universities and polytechnics. It is important to proceed with the maximum support from the engineering community and therefore the Board, while warmly welcoming the report and generally endorsing its findings, intended to return to its consideration at its autumn meeting. In the meantime, it has asked its committees to give careful and encouraging consideration to approaches from university and polytechnic engineering departments for support for design-centred applications and will look for an increase in the numbers of such proposals.

For further information, contact Mr A Spurway, SERC Central Office (ext 2102).

European collaboration in semiconductor modelling

On 18 April 1983 the European Commission signed a contract to provide half of the cost of a £2 million programme to develop better methods for modelling the behaviour of semiconductors under its microelectronics technology initiative.

The three year programme brings together industrial and academic expertise from the UK, the Netherlands and the Republic of Ireland. The contract was won against considerable competition and is a further example of the trend towards large collaborative projects in information technology.

SERC is the prime contractor for the programme, working through the Rutherford Appleton Laboratory to provide the project management. The other partners are the General Electric Company at its Hirst Research Centre in Wembley; Nederlandse Philips Bedrijven BV in Eindhoven; University College of Swansea and Trinity College, Dublin.

The aim of the programme is to develop robust and efficient numerical models to simulate the detailed physical behaviour of semiconductor devices. These models will be valid for a wide range of problems including metal oxide semiconductor (MOS) and bipolar transistors, and be capable of producing results on a powerful computer in a reasonable time.

Since the discovery of the transistor in 1948, its application to modern electronics has had a dramatic effect upon industry, commerce and indeed our everyday life. The development of semiconductor technology has been so rapid that it has not allowed the full exploitation of each technique before being overtaken by the next. This has led to a rather incomplete understanding of present-day devices. There is an urgent need, as highlighted in the Alvey Report, for a better understanding of the physical processes in sub-micron semiconductor devices and for the development of numerical models to simulate their performance.

The present programme aims to pool the expertise and resources of industry and the academic sector to increase the understanding and predictive power of the designer of semiconductor devices. This presents some formidable numerical problems at the forefront of research. The numerical models will be based upon Poisson's equation, the two current continuity equations and the temperature equation, incorporating the physical effects relevant at sub-micron dimensions.

The numerical models, together with the results from test problems, will be fully documented. A final report will be forwarded to the Commission for distribution within the European Community. The partners will also provide test facilities for a 12-month period following the end of the contract for the use of interested parties within the EEC. The results will give industrial companies within the Community an essential advantage in the competitive world market in the design and manufacture of semiconductor devices.

C W Trowbridge
Project manager, RAL

Co-funded research scheme with nationalised energy industries

SERC has recently concluded agreements for the joint funding of university research with the Central Electricity Generating Board (CEGB), the British Gas Corporation (BGC) and the National Coal Board(NCB).

Announcing these agreements at a press conference convened in the CEGB headquarters, SERC's Chairman, Professor J F C Kingman, emphasized the long-term need for research on all aspects of energy supply and utilization, despite today's apparent energy surplus. The objectives of 'co-funding' are to promote coordinated programmes of good quality academic research which will be relevant to the needs of the energy supply industries, and also to strengthen the links between university researchers and their industrial colleagues.

In addition to co-funding, each of the cooperating partners will continue their own independent support of university research, primarily through research grants from SERC and extra-mural research contracts from the industries.

Each of the three schemes will be administered by a small panel of experts from the industry, universities and SERC, assisted by a coordinator. Broadly speaking, the industry will be responsible for deciding the subject content of the research-programme and SERC for maintaining academic standards. Total expenditure on each scheme will rise to about £¼ million pa, with SERC and the industrial partner each contributing 50% of the cost. Grants will be disbursed to universities and polytechnics through the usual SERC channels.

SERC's initiative in setting up these schemes was welcomed at the conference by the directors with responsibility for research in the industries concerned: Dr T Broom for CEGB, Mr G Clerehugh for BGC and Mr L J Mills for the NCB.

Emphasizing the value which their industries place on contacts with the academic community, they described some of the work currently being supported by means of fellowships, studentships, research contracts and research grants. The current level of support is in excess of £½ million from each of the industries. For co-funding, the industries have identified priority areas in which they wish to stimulate research proposals. Further information may be obtained from Dr Martin Wilson, Head of the Energy Research Support Unit at RAL (telephone Abingdon (0235) 44-5275) or from Mr George Gallagher-Daggitt also at ERSU (telephone Abingdon (0235) 21900 ext 6266). The coordinator for CEGB co-funded projects is Dr John Andrews at the Marchwood Engineering Laboratories (telephone Southampton (0703) 86 5711 ext 205). The coordinator for NCB co-funded projects is Mr J Launder (telephone Woking (048 62) 62450).

Advance in welding control

SERC supports research into the improvement of a wide range of basic manufacturing processes.

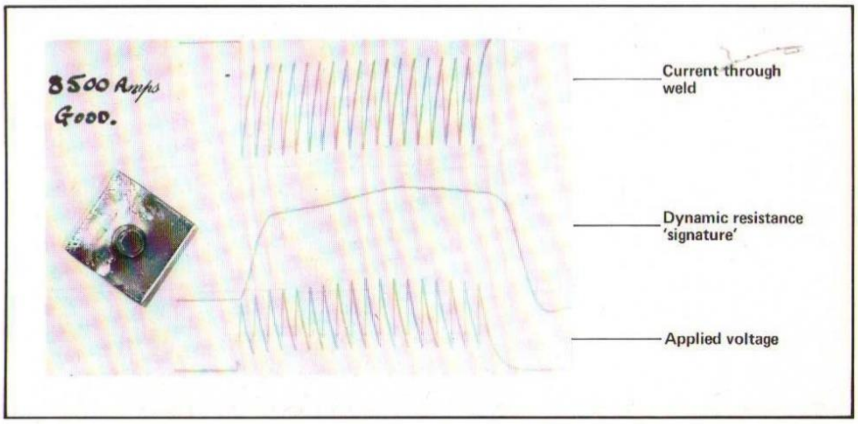
Resistance spot welding is such a process, used widely in manufacturing, including the automobile and aerospace industries. A modern motor car body may contain many thousand spot welds. Manufacturers are vitally concerned not only to produce good welds consistently but also to know unequivocally – without expensive and inconvenient destructive testing – that welds are acceptable for their application.

A team at Aston University, led by Dr R Andrews in the Department of Production Technology and Production Management, has received SERC's support over nearly a decade for research aimed at improving the reliability of resistance welding. Their efforts have been strengthened by a collaboration with a group under Dr D C Hodgson at Birmingham University which contributes extensive microprocessor expertise.

With valuable technical support from Rubery Owen Ltd, an automatic weld monitor has been produced. The instrument – based on a microprocessor – monitors the applied voltage and resultant current through the weld. The variation of the dynamic resistance (ie instantaneous voltage divided by instantaneous current) during the welding process is expressed as a 'signature' which has been shown to be closely related to the weld quality. This is then compared with an ideal signature stored in the microprocessor's memory and, if the difference is too great, the monitor automatically signifies that the weld is substandard. Thus the monitor is capable of providing *in-process* quality control.

Current research is concentrated on the problems of spot welding coated steels. These are being adopted increasingly in motor cars where the pressure to reduce vehicle weight and extend body life has led to the use of thinner steels with corrosion-resistant coatings. The coatings used (eg zinc) have an adverse effect on the performance of welding electrodes, increasing the need for reliable in-process monitoring of weld quality.

The welding monitor is exciting much industrial interest. For example it is being evaluated for use on the production line with a major UK motor manufacturer and, with another firm, for the welding of handles on large oil and paint drums. In both cases the consequences of weld failure in use could be disastrous. More than 200 enquiries have been received from potential users of the monitor. Further details of this project may be obtained from Dr Andrews (telephone 021-359 3611 ext 4441) or Dr Hodgson (telephone 021-472 1301, ext 3412).



A typical weld 'signature'

PED's future to b

The Polymer Engineering Directorate's third major review meeting was held at Loughborough University, 11-13 April 1983, and was attended by a record gathering of polymer engineers, scientists and industrialists. In all, more than 260 delegates registered for the conference and one of the major talking points was the future of the Directorate.

There was, therefore, a packed auditorium for the presentation by Mr Brian Oakley (then Secretary of SERC) on 'The future of PED'. He said that the PED had been established in 1976 with the objectives of stimulating research in polymer

Mr Oakley announces the décision on PED's future

engineering, of coordinating the academic work, and involving industry. It had succeeded in those objectives, but it was now time for the Directorate to move on in order to become closer to industry. Discussions had taken place with leaders in the industry whose views had been unambiguous against a merger of PED into the Rubber & Plastics Research Association (RAPRA), which he would personally have regarded as a natural move. In view of the opposition to such a move, he suggested instead that the Plastics & Rubber Institute should be asked to act *in loco parentis*, possibly during a transitional period to a more permanent location.

Mr Oakley outlined the problems that would face the Council if PED continued as one of its direct responsibilities. It would, for example, inhibit the Council's initiatives in establishing other directorates – such as in information technology – where stimulus was required. He was able to allay the fears expressed by a number of academics and said that there need be no interruption in, or diminution of, support for polymer engineering research from the Council. As in the past, that would depend entirely on the quality of research proposals put forward. Tbe mechanism by which the proposals were handled might change, but there would still be a major role played by the Directorate.

The meeting charted some major advances in polymer engineering, not the least of which was the continuing work at Liverpool University on energy-absorbing composite materials which heralds

The Polymer Engineering D stimulate research in polym coordinate academic work a has succeeded in those obje to move on and become clos

a possible revolution in impact-absorbing zones in transport. The work is being carried out under Professor Derek Hull and forms the core of his PED-funded research. Professor I M Ward of Leeds University, who has recently been elected as a Fellow of the Royal Society for his work on polymers, has received a series of awards from SERC and PED covering the science of highly oriented polymers and the development of high performance, high modulus, textile fibres and larger artifacts. He presented his work on die drawing and extrusion processes for forming a range of polymers and the results of this work should have important industrial applications.

Among other highlights were the presentations of Professor Mike Bevis of Brunel University, who gave an interesting overview of his suite of PED programmes covering the processing, on-line assessment and product performance of polymers; Mr David Cowburn on the mechanical performance of automotive V-belts – work which is providing new insights into the traditional theory; and Dr Paul Isherwood who gave an extremely interesting and industrially-relevant presentation on improved cutting efficiency and performance of polymer granulators.

The meeting contained a streamed session; one half was devoted to education and

One of the displays at the Loughborough meeting: the PED thermal imaging system

Liverpool University's exhibit on their energy

closer to industry

ıctorate was set up to r engineering, to d involve industry. It tives and it is now time r to industry

training which covered in particular PED's recent report on the extent of polymer teaching in engineering departments and the various ways in which PED is encouraging the inclusion of more polymers on traditional engineering courses. This half also included a discussion on short courses and continuing education, and the use of case studies as teaching aids. The other half of the session, under the title 'support for innovation', illustrated the various forms of assistance available to companies to pursue research, or research-and-development, ideas, and how PED could help to develop these ideas into reality. Mr Alan Sherrin from Dunlop Technology gave an excellent presentation of the company's 'carbon-reinforced carbon' project, supported by a Department of Industry grant, which had applications from the aerospace industry (brakes for Concorde) to the medical field in artificial bone replacements and in encouraging the regrowth of skin tissue.

Guest speaker at the review meeting was Dr Bill Madden, Research Director – Petrochemicals and Plastics Division, ICI. He emphasised the national importance of the plastics industry employing as it did, directly and indirectly, some 350,000 people and having an annual turnover of over £3 billion. Although currently in recession, it was, when viewed over the longer term, a highly successful industry. He foresaw the opportunities for growth of the industry by 1990 and spoke optimistically of the long-term future of PED as a continuing mechanism for bringing together the collective resources of academic and industrial research departments.

Assessment sheets completed by those attending showed the meeting had been wholly successful in projecting the current research and coordination activities of the Directorate. It also provided a valuable forum in which members of the polymer engineering community exchanged ideas both formally and informally. Indeed the Directorate expects to see the fruits of these discusssions in an increase in research proposals over the next 12 months.

Copies of the review papers can be obtained from PED.

Advanced Summer School reunion
Eighteen of the lecturers who had attended the Directorate's first Advanced Summer School in 1982 met again during and after the Loughborough review meeting. to discuss their attempts to incorporate more on polymers within the engineering curriculum. Almost all reported success in at least one of the following: lecture courses, design studies, laboratory and project work and staff seminars. To maintain momentum among themselves and encourage other engineering lecturers, members of the meeting recommended that the following should be provided: an information and resources pack, a periodical newsletter, a competition for students' projects, a series of regional meetings on specific issues, and video-recordings of some lectures given at the summer school and at the review meeting.

The reunion meeting identified minor changes that would strengthen the programme for the second Advanced Summer School held, again at Manchester Polytechnic, in September 1983. Further detailed information about the Advanced Summer Schools or the reunion can be obtained from PED offices (see below).

PED's change of address

As a preliminary to the Polymer Engineering Directorate's move out of SERC by the Autumn of 1984, the Directorate has taken offices in the Plastics and Rubber Institute. All future correspondence with the Directorate should be addressed to:
Polymer Engineering Directorate
11 Hobart Place
London SW1W 0HL
Telephone: 01-235 7286
Telex: 912881

orbing composites programme

A quiet moment among the exhibition stands

Quasar research at RGO

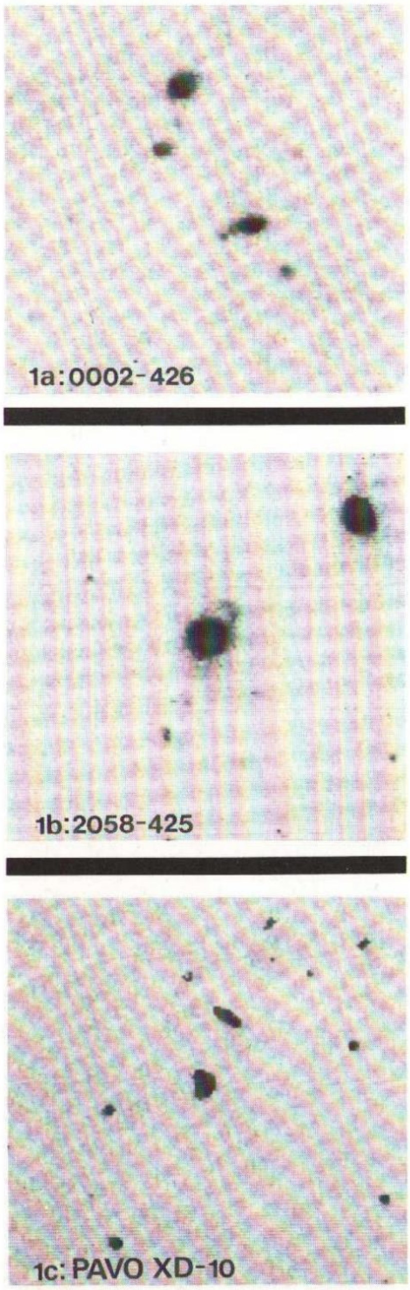


Figure 1
Deep images of three QSOs, obtained with the RGO CCD camera on the Danish 1.5m telescope at ESO/La Silla, Chile, in a collaboration with astronomers from Copenhagen University Observatory and Istituto di Astrofisica Spaziale, Rome. The QSOs are the central objects in each 1 arcmin² field, and have redshifts of 0.12 (Figure 1a), 0.22 (1b), and 0.72 (1c). North is at the top, east to the left in each image.

Researchers at the Royal Greenwich Observatory (RGO) are pursuing a suite of collaborative programmes to look at fundamental aspects of QSOs, from their appearance in integrated light to the most detailed information that can be obtained from their spectra. These programmes are designed to make the greatest demands on modern and powerful astronomical instruments – new optical designs, solid-state and photon counting detectors – many of which have originated from the RGO or from the RGO in collaboration with UK universities via SERC grants. Some results from these programmes are described here, and more are planned for forthcoming issues of the *Bulletin*.

Deep images

It is 21 years since QSOs (quasi-stellar objects, or 'quasars' in popular jargon) were discovered. They remain enigmatic. It is generally accepted that they are the most distant and most luminous objects which we can observe and that they represent the super-active nucleii of galaxies. As a class, they are distinctive as blue star-like objects whose optical spectra show a flat continuum extending into the ultraviolet (the so called 'UV excess') together with a few very broad emission lines. The emission lines show enormous 'redshifts': they are shifted to wavelengths longer than the rest wavelengths by amounts $\Delta\lambda$ where $\Delta\lambda/\lambda$ (z, or the redshift) ranges from 0.1 to 3.78. About 10% of QSOs are radio emitters, some showing the double-lobed structure of powerful radio galaxies, and others having intense and compact radio cores with complex structures and intensity variations on time-scales of days to years.

A direct way to explore the nature of QSOs is by deep photography; if they are super-active nucleii, the underlying galaxy should appear. In practice, the experiment is difficult with conventional photographic techniques because the QSO may outshine the host galaxy by large factors, and photographic plates have non-linear response and limited dynamic range. The new generation of area detectors, charge coupled devices or CCDs, have superb linearity and dynamic range and are ideal for such observations.

Figure 1 gives examples of QSO images obtained with an RGO CCD camera on a telescope of modest size, but at a site providing excellent high-resolution (1 arcsec) images. Figure 1a shows an underlying structure which is undoubtedly a galaxy. Figure 1b shows a spectacular underlying structure with nebulosity to the south and north; that to the north resembles an arm from a spiral galaxy. Figure 1c shows – again – a structure which is dramatically non-stellar, underlying a QSO which is a strong x-ray source. Detail in 1c is burnt out and a better representation is in figure 2. The remarkable structure is clearly double, and this is the highest redshift QSO for which underlying structure has been detected.

For most of the low redshift QSOs in the sample observed, underlying nebulosity was detected. In all cases, this nebulosity *could* be a galaxy; but it is evident from the figures that there is no obviously predominant type of galaxy. In particular, it is certain that QSOs do not only occur as nucleii of giant elliptical galaxies, nor do they only occur in the brightest galaxy in the cluster. However there is a strong indication that cluster membership and gravitational interactions are involved. All the QSOs of figure 1 have nearby companion galaxies.

These are tantalizing beginnings to a project in which complete statistical analysis together with spectroscopic observations of the nebulosities will be essential for firm conclusions.

Dr J V Wall
Head of Astrophysics and Astrometry, RGO

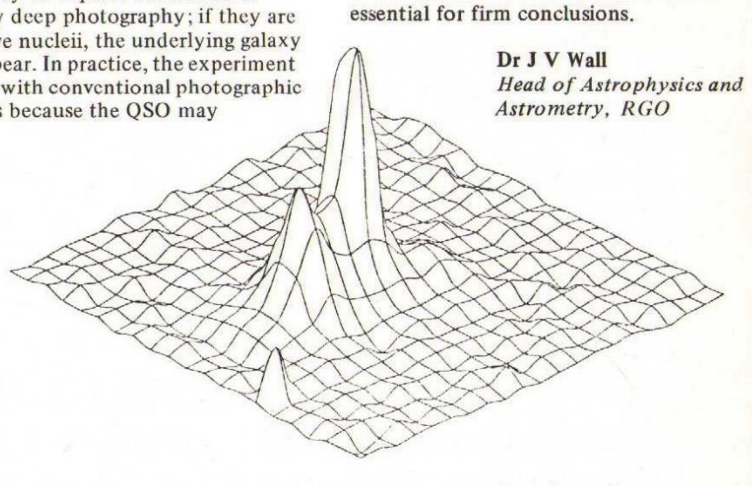


Figure 2
A STARLINK intensity map of the QSO image of figure 1c, the QSO at a redshift of 0.72.

New spectrometer for UKIRT

The 3.8 m UK Infrared Telescope sited on the 4,200 m peak of Mauna Kea, Hawaii, is equipped with a range of common-user instruments. The latest addition, a 1-5 μm Cooled Grating Spectrometer, represents the 'state-of-the-art' for spectroscopic instruments of its type.

The 1-5 μm spectral region is particularly rich in both atomic and molecular spectral features and, because of the accessibility of many of these lines from ground-based telescopes, it has become a region of intense interest for infrared astronomers. For example, studies of the rotation/vibration spectrum of molecular hydrogen have given an insight into the kinematics of molecular clouds such as the one in Orion where star formation is thought to be taking place. Observations of the Brackett series of emission lines of atomic hydrogen on the other hand have yielded information on the effects of dust in objects ranging from circumstellar dust shells to galactic nuclei, while observations of the emission from the dust itself may lead to an understanding of its composition and the emission mechanisms involved.

It was to meet this need for a spectroscopic facility in the near-infrared that a single-channel Cooled Grating Spectrometer (CGS I) was delivered to Hawaii in January 1982. The most recent addition to the instrumentation suite (CGS II) is a direct development from CGS I but with the addition of an array of seven Indium Antimonide detectors. It is this array which makes CGS II currently the most sensitive instrument of its type in the world. By allowing a seven point spectrum (of an emission line, for example) to be taken at one time, the array not only improves the efficiency by a factor of seven but also reduces the effect of temporal changes in atmospheric transmission during the observation.

At infrared wavelengths it is necessary to cool instruments down to cryogenic temperatures to reduce both unwanted background radiation and noise from the detector and associated electronics. In CGS II the optics are cooled using liquid ntirogen while the detector array and its pre-amp package are cooled using solid nitrogen. Naturally this requirement places severe constraints on the design and engineering of a spectrometer. These problems were overcome however by a team of engineers and scientists in the Technology Unit of the Royal Observatory, Edinburgh, where the instrument was designed and constructed.

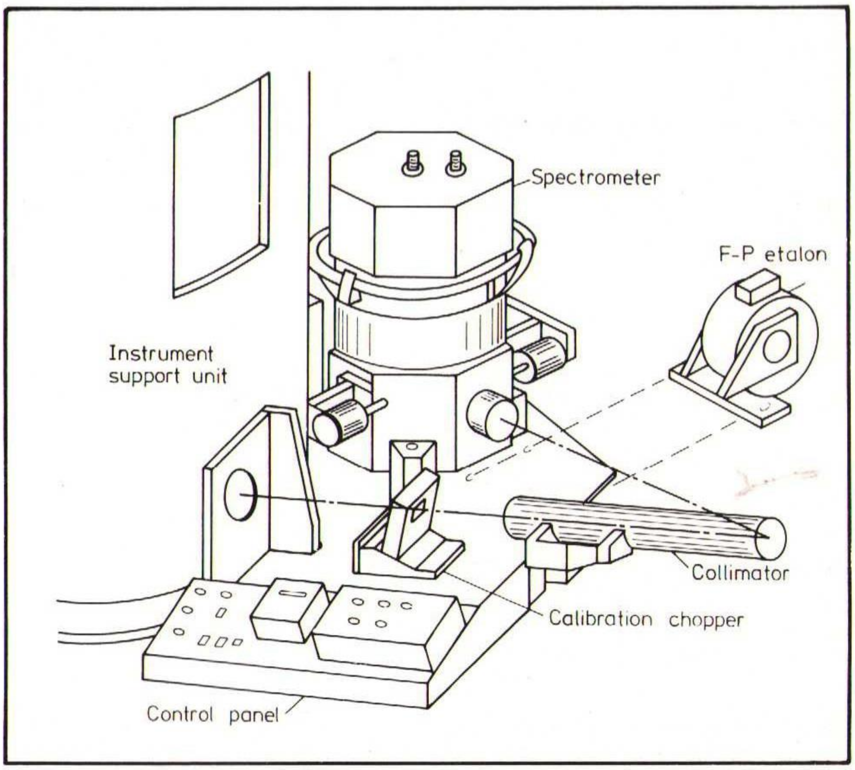
The spectrometer uses a pair of interchangeable gold-coated replica gratings on copper substrates, working in Littrow configuration. A 30° off-axis parabolic mirror with a focal length of 150 mm acts as both collimator and camera. Selection of the entrance apertures and order-sorting filters is controlled remotely, as is the position of the gratings. The detector elements themselves form the exit apertures of the system. The instrument can work over the whole 1-5 μm range and has a resolution $\lambda/\Delta\lambda$ of about 500 over that range.

In terms of a doppler-shift velocity this resolution corresponds to roughly 600 km s^{-1}. To enable astronomers to study the kinematics of objects with velocities down to 10 km s^{-1} a range of Fabry-Perot etalons have also recently been delivered to the telescope for use in conjunction with the spectrometer.

The instrument is designed to be mounted on the instrument support unit at the cassegrain focus of the telescope. This support unit enables the astronomer to select from a number of instruments by rotating a small dichroic mirror. The mount for CGS II incorporates spectral lamps and a small light chopper for calibration as well as a mounting system for the Fabry-Perot etalons.

CGS II was delivered to Hawaii in January 1983 and, along with its associated control and data acquisition electronics and software, is now commissioned as a common-user instrument. The spectrometer has already been used for a number of scientific programs including measurements of reddening in Seyfert galaxies, studies of helium emission in our galactic centre, observations of HII regions in external galaxies and measurements of emission lines from Wolf-Rayet stars. CGS II is expected to play a major role in keeping the UK Infrared Telescope at the forefront of infrared astronomy over the next few years.

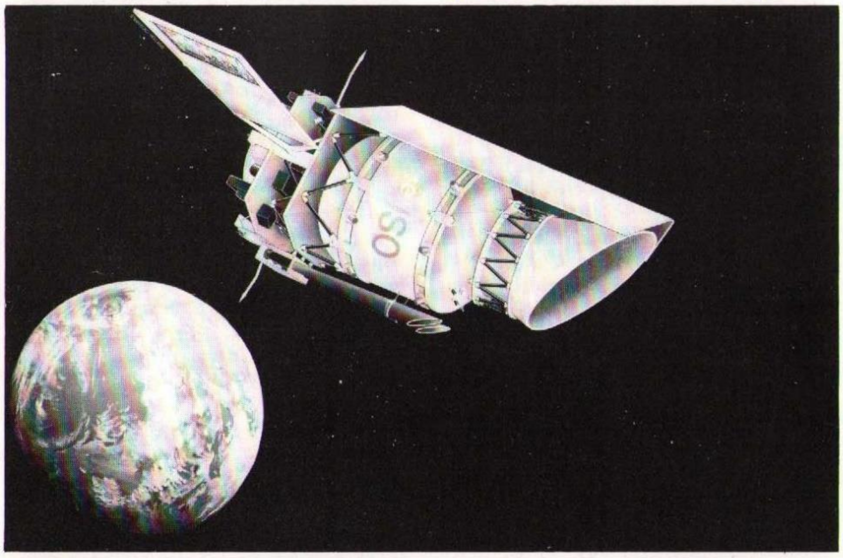
Dr Richard Wade
Project Scientist, UKIRT Unit, Royal Observatory, Edinburgh.



Diagrammatic representation of CGS II, the Cooled Grating Spectrometer recently commissioned at the UK Infrared Telescope in Hawaii for astronomical observations in the 1-5μm spectral region. It uses an array of seven indium antimonide detectors to make it the most sensitive instrument of its type in the world.

ESA votes for infrared astronomy

The European Space Agency's Science Programme Committee, at its meeting in March, selected for its next project the Infrared Space Observatory (ISO) for development and planned launch in the early 1990s. Originally proposed in 1979, by a group of European scientists including University College London and Rutherford Appleton Laboratory, the scientific case for a cryogenically cooled telescope with focal plane instrumentation for infrared submillimetre astronomy and atmospheric research was accepted but there were doubts about the technical feasibility of the cryogenic system. Continuing interest from the European community, at the time of the development of the IRAS programme and the German Infrared Laboratory (GIRL) for Spacelab, led to ESA supporting further feasibility studies on a suitable cryogenic system capable of providng for long-operation flights. Studies showed that a dual cryogen system of liquid helium and liquid hydrogen would provide a minimum lifetime of 1½ years.



An artist's impression of the Infrared Space Observatory

ISO will consist of a 60 cm diameter telescope and scientific instrumentation at the focal plane, all being cryogenically cooled down to 3° K. The scientific instrumentation, which will be built and funded by consortia of scientific teams, will be selected by ESA in response to an 'announcement of opportunity' to be issued late in 1983. The model payload consists of spectrometers (2 to 70μm wavelength range), an infrared camera array (of 2 to 5μm and possibly 6 to 18μm) and a photometer/polarimeter (8 to 120μm and possibly to 200μm). Being an observatory facility, ISO will complement and extend the scientific achievements of the all-sky survey by IRAS, through studies of stars and their formation, galaxies, molecular clouds, constituents and dynamics of nebulae, interstellar dust particles and possibly also planetary atmospheres and comets. Early in its mission IRAS detected comets and considerably more will be known about comets and their environment following international collaboration in the study of Halley's comet in 1986. The main contribution will be by the European Space Agency with its GIOTTO satellite carrying 10 experiments including the Dust Impact Detection System (DIDSY) provided by Kent University and the plasma wave analyser provided by the Mullard Space Science Laboratory.

IRAS: continuing achievement

The Infrared Astronomical Satellite (IRAS) has been making headlines with its discoveries: on 26 April, the new Comet IRAS-Araki-Alcock was spotted, so large and bright it was soon clearly visible with the naked eye; on 13 May, a second, much fainter and more distant, comet was seen; and, also in May, two regions where stars like our own Sun are being born were observed.

The regions were within dark dust clouds in our own Galaxy and several very young stars, called protostars, were detected by the telescope on IRAS. The protostars are no more than one million years old and are just now coalescing out of the dust and gas clouds. According to astronomers, the newly discovered protostars are much like the Sun was during its early stages of formation 4.6 billion years ago and solar systems of planets could also be forming around the young stars. The discoveries are among the first of protostars that will become low-luminosity stars like our Sun.

The stars are still enshrouded in the placental gas and dust so that only a faint infrared glow is detectable by IRAS. In less than a million years, radiation and strong stellar winds will clear away the surrounding materials and the new stars will be seen in visible light.

IRAS observations of protostars will help to determine what processes initiate star formation and help to explain the conditions under which our own Solar System formed.

IRAS telescope observations of the Andromeda Galaxy (M31) have also been processed into an image and show areas of intense infrared emission, indicative of star formation. Project scientists expect more than two million infrared objects will be observed during the mission. IRAS is a joint project of the US (NASA), the Netherlands Space Agency and SERC. Data are received at the Rutherford Appleton Laboratory and final processing of the data will be conducted at the Jet Propulsion Laboratory in California, where a catalogue and sky map of infrared sources will be produced.

Spacelab 2 will carry UK experiments into orbit

The second flight of Spacelab, the modular laboratory built by the European Space Agency (ESA) for the Space Shuttle system, will take place in April 1985. This nine-day mission will carry twelve investigations covering a wide range of disciplines, ranging from biology to astronomy. Two of the major experiments will be provided by UK scientific groups, who were successful in bidding against substantial international competition. As this is an early proving flight of the Spacelab system, the cost of launch and integration is covered by NASA and not charged to experimenters.

The experiments, currently undergoing pre-delivery qualification tests in the UK before delivery to NASA for integration in Spacelab later this year, are CHASE – a joint project between the Mullard Space Science Laboratory, University College London and the Space and Astrophysics Division of the Rutherford Appleton Laboratory (RAL) – and a Coded Mask Telescope being constructed at Birmingham University.

CHASE

The acronym CHASE describes the first objective of the joint experiment: Coronal Helium Abundance Spacelab Experiment. After hydrogen, helium is the second most abundant element in the universe, having about 10% concentration, by number in atoms. Yet in spite of this, the value of the abundance is poorly known. Existing measurements lie between 5% and 25%. It is expected that CHASE, by using a new technique, will determine this abundance in the solar corona to an accuracy of 10% of the actual concentration. There are good reasons to believe that the coronal abundance would be typical of the Sun as a whole and that the solar abundance will be typical of the Universe as a whole, as it will have been very little increased by nucleosynthesis in stellar interiors. Thus the measurement would have direct bearing on the primeval abundance, the concentration produced in the 'big bang' at the origin of the universe, and is therefore an important test of cosmological models.

In addition, knowledge of the solar helium abundance is crucial to understanding all regions of the Sun, its core, convection zone, chromosphere and corona, since it affects directly most of the physical properties, the density, equation of state, ionization state, thermal and electrical conductivity, viscosity, opacity and radiative energy loss.

CHASE consists of a 2 metre grazing-incidence spectrometer covering the range 140Å to 1350Å, illuminated by a two-reflection grazing-incidence telescope. The basic helium abundance measurement will be carried out by studying the hydrogen 1216Å and ionized helium 304Å radiation re-emitted by the corona through resonance scatter of the bright light at these wavelengths emitted from the solar disc. In other modes of operation, the instrument will make detailed studies of the temperature, density and evolution of a variety of other solar structures.

CHASE will be mounted on the Instrument Pointing System, supplied by ESA together with three other experiments for co-ordinated solar studies. This assembly of instruments will be controlled for much of the time by one of the two payload specialists who are being specially trained to fly with the mission.

Coded Mask Telescope

The second UK experiment currently undergoing qualification tests is the Coded Mask Telescope. This instrument in fact consists of two telescopes mounted side by side, carried on a pointing mount which allows them to point at targets relatively independently of the Orbiter Vehicle thus giving efficient utilisation of the mission duration. The telescope will be given operational instructions about once per orbit, either by the Spacelab payload specialists or from the payload crew in the mission control centre. It will then operate fairly autonomously until the instructions are updated. The entire control system is duplicated. On the adjacent pallet is CHASE and its group of solar experiments and if the two sets of telescopes were to collide – the Birmingham instrument is over eleven feet high – there could be some risk that the Orbiter cargo bay doors might not be able to be closed again for re-entry. Accordingly, one control system operates the telescope while the second monitors its performance, ready to take over if it detects evidence of a malfunction. Because of this feature as well as the normal crew operation of the instrument, considerable astronaut training is planned. The first session took place at Birmingham in April, when a group of six astronauts did their best – unsuccessfully – to make the collision-avoidance system misbehave.

Once in orbit a major target for the telescope will be the central region of the Milky Way. The main objectives are to obtain high spatial resolution images of the x-ray sky in the energy range 2.5 to 25KeV, photon energies not accessible to current x-ray optical systems. By these means, clusters of galaxies may be mapped in the continuum and the FeKα line at 7KeV, using this spectral feature as a tracer for non-primordial material, and the Galactic Centre, which is heavily obscured by large photoelectric absorption at lower photon energies, may be examined. The 'coded mask' technique uses an opaque sheet with a pattern of apertures to cast a shadowgram of the scene to be imaged on to a position-sensitive detector. The shadowgram will be telemetred to the ground and subsequently transformed by computer analysis into an image.

For the most part the instrument has been designed and built at Birmingham. It is, however, a very large project and the group have received valuable help, particularly at times of peak activity, from RAL, who are making all the thermal blankets and have assisted in the assembly of the flight detectors.

Examining the Birmingham University Coded Mask Telescope are (kneeling) payload specialist Diane Prinze, (centre) astronaut Karl G Heinze and (right) Birmingham researcher Chris Eyles.

Photo: Birmingham Post & Mail

Neutron physics at the SNS

An agreement has been signed with the Kernforschungszentrum Karlsruhe (KfK) for a major new facility that will allow several new physics experiments to be carried out at the Spallation Neutron Source (SNS) at the Rutherford Appleton Laboratory.

Neutrinos are produced as a 'by-product' of the SNS, whose primary function is to produce pulsed beams of neutrons to act as probes for experiments in a wide range of scientific disciplines. The new experiments are therefore 'parasitic' and they do not interfere with the functioning of the SNS in its normal role.

Under the agreement, a team from KfK will set up several detectors in a shielded 'bunker' near the SNS target area. Neutrons are produced by stopping the primary beam of protons in the spallation target. At the same time, the collisions give rise to large quantities of other particles including pions, which decay rapidly producing neutrinos. As a result of its pulsed nature with very low duty cycle, the SNS is a uniquely powerful source of neutrinos.

In recent years interest in neutrino physics has grown rapidly. Neutrinos carry no electric charge, and have been thought for many years to be massless. But there is a discrepancy between the measured number of neutrinos emitted by the sun and the rate of emission calculated from theory. This deficiency could be explained if neutrinos had a very small but finite mass. The experiments will allow the investigation of several other aspects of neutrino qualities and behaviour, including their interactions with other fundamental particles. This information will provide useful tests of the current theories of the composition and interactions of matter.

The experiments will be conducted by the KfK team with participants from British universities; the agreement allows for further extension of participation. It is expected that the first results will emerge in two to three years.

World's largest submillimetre-wave telescope

The first earth was turned at an official ceremony in April, near the 4,200m summit of Mauna Kea on the island of Hawaii, to mark the start of the construction of the Millimetre-wave Telescope (MT). With a 15m diameter, it will be the world's largest telescope able to operate at wavelengths shorter than one millimetre. It is being built by SERC in partnership with the Netherlands Organisation for the Advancement of Pure Science (ZWO) and through an arrangement with Hawaii University and will be officially known as the UK/NL Millimetre-wave Telescope. The installation should be completed in 1986.

The opening up of these new wavebands for detailed astronomical observation will help to explain such mysteries as the formation of new stars, the nature of quasars and the evolution of galaxies. Chemists will have the opportunity to study complex molecules present in space which may provide a key to the origin of life itself.

To make such observations possible the reflecting dish needs to be much more accurately shaped than existing radio telescopes and located at a high altitude where the air is exceptionally clear and dry. Special equipment for detecting and amplifying the very faint signals from enormously distant astronomical objects is being developed in both the UK and the Netherlands.

The engineering and installation of the MT is being carried out by a team at Rutherford Appleton Laboratory, in collaboration with the universities and observatories in the UK and the Netherlands, including the Mullard Radio Astronomy Observatory at Cambridge University and the Royal Observatory, Edinburgh (ROE).

The operation of the telescope will be the responsibility of ROE who already operate UKIRT (SERC's Infrared Telescope, also on Mauna Kea). Much of the observing with the MT will be carried out under remote control, at first from the UKIRT building or the sea-level base in Hawaii, but later direct from the UK and the Netherlands using computer communications networks.

The capital cost of the project will be £7 million, of which 80% is to be provided by SERC and 20% by the ZWO. The budget for the joint operation with the UKIRT will be in the region of £1.5 million per year.

EXOSAT probes x-ray sources

The European Space Agency's European X-ray Astronomy Satellite (EXOSAT), launched on 26 May 1983, observed its first x-ray source at the end of June. This was the black-hole candidate Cygnus X-1 and, even in its preliminary observation, EXOSAT obtained more fast-timing data on this important object than in the total observations by earlier spacecraft.

Following Cygnus X-1, the EXOSAT telescopes were pointed at the young galactic supernova remnant, Cassiopeia A. Images received from the EXOSAT low-energy telescope show an intense ball of hot gas, expanding from the site of the initial stellar explosion, circa 1634 AD. The proportional counter arrays show clear features characteristic of the heavy elements of iron and the sulphur, silicon, magnesium group, supporting the view that it is in such massive stellar explosions that all the elements other than primordial hydrogen and helium are produced.

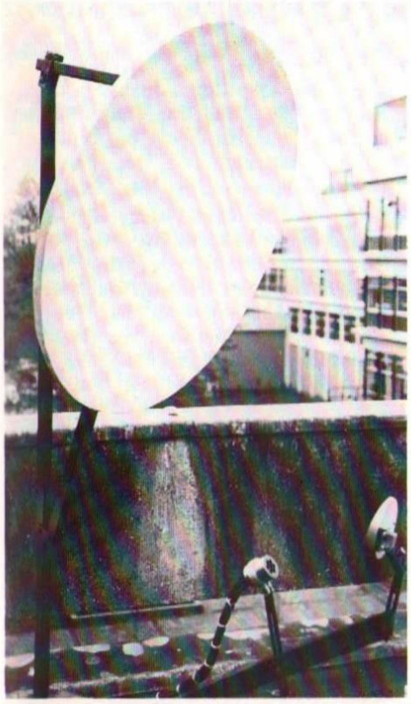
All four scientific instruments that make up EXOSAT's payload have considerable UK participation. They are:

- the array of gas-filled proportional counters designed and developed by Leicester University in collaboration with the Max Planck Institute, Garching, and Tubingen University;
- the two imaging telescopes designed and calibrated by the Mullard Space Science Laboratory (MSSL) of University College London, the Space Science Laboratory, Utrecht, and the Cosmic Ray Working Group, Leiden;
- a gas scintillation proportional counter, a newly developed instrument being flown on a satellite for the first time, designed and developed by ESA's Space Science Department with support from MSSL and university groups in Milan and Palermo.

EXOSAT is in a highly eliptical operational orbit (340 km to 192,000 km). It is the first x-ray astronomy satellite to be operated in a deep space orbit, all previous (mainly US) missions choosing a low attitude (400 - 800 km) orbit. The spacecraft is operated from the European Space Operations Centre (ESOC) in Darmstadt, West Germany, where the EXOSAT observatory ground systems are located. It is now expected to have a lifetime of over three years.

Antennas for satellite broadcasting and satellite communication

The imminent introduction of satellite broadcasting in Western Europe and of communication systems using satellites has provided a great stimulus for those involved in UK antenna research. The Electromagnetics Applications Group, in the Department of Electrical and Electronic Engineering, Queen Mary College, London, is tackling a variety of problems related to these services under an SERC programme and is benefiting from close collaboration with UK industry and the European Space Agency.



Offset dual reflector antenna at Queen Mary College, London.

In both types of satellite service there are challenges at the two ends of the microwave link. For satellite broadcasting, the radiated beam from the geostationary satellite must be contoured so that energy is neither unduly wasted by falling on areas such as the sea nor allowed to create interference in countries outside the sevice area. Although microwave reflector antennas have been widely used since World War II, the problem of 2-D beam synthesis remains one of the most difficult of antenna problems currently being tackled. This is especially the case when constraints of polarisation purity are also introduced.

For satellite communication systems, the basic satellite antenna problem is one of providing well isolated multiple-beams to illuminate and receive signals from terminals located within regions, typically of the size of the UK. Future systems will probably call for antennas which will allow the beams to be changed electronically. This requirement, among others, has stimulated intense research on array-fed reflector antennas, the use of complete arrays being precluded on cost grounds.

The earth-station terminal antenna is not without problems either. In order to maintain a low cost, the beam has to be efficient in that it should subtend the narrowest angle consistent with antenna size. The picture shows a high performance dual-reflector antenna, designed at QMC under a previous SERC grant. The design follows the principles of the Cassegrain optical telescope but uses an off-set secondary reflector and feed which allows the beam to and from the main reflector to be free of scattering effects. This enables a high performance to be achieved especially in respect of side-lobe energy transmitted (or received) from angles away from the preferred boresight direction. This type of improved performance is likely to become a design requirement in future systems.

QMC, with the help of SERC and companies such as Andrew Antennas and ERA Technology Ltd, are involved in other areas of research for improving the design methods and uses of antennas.

Peter Clarricoats

Professor Clarricoats is Head of Electrical and Electronic Engineering, Queen Mary College, London.

Radio propagation

One of the functions of the new Radio Communications Research Unit at the Rutherford Appleton Laboratory is to run the departmental users' radio propagation programme. The programme is monitored by the Departmental Users' Committee, which represents the Home Office, Ministry of Defence, Government Communications Headquarters, British Telecom and the British Broadcasting Corporation, and is closely oriented towards the future needs of national user organisations.

Radio propagation research is an interdisciplinary subject which encompasses aspects of communications engineering, basic electromagnetic wave propagation, radio meteorology and ionospheric physics. Although the current programme places much emphasis on satellite communication, mobile radio, radar studies and use of millimetre waves, topics concerning ionospheric communication are also included. RAL staff play the major part in this programme, although they contract out a significant portion to 16 university and industrial groups through extra-mural research agreements. Of the work carried out at RAL, analytical and theoretical studies are conducted at Chilton, and much of the experimental work is performed at the Chilbolton site in Hampshire. This includes use of the 25 m diameter steerable antenna in several roles – radar studies of the microstructure and distribution of rain, studies of mechanisms causing radio interference, and scintillation on paths to and from satellites. Operational ionosondes located at Ditton Park (Slough), South Uist and the Falkland Islands are also maintained through this programme. The nature of the programme is wide ranging, covering propagation effects at wavelengths from tens of kilometres to the optical (eleven orders of magnitude).

The results from the programme of work are freely available to UK organisations, not only the departmental users. They also contribute to the UK activities in the International Radio Consultative Committee of the International Telecommunications Union, and in European Community Cooperative Projects in Science and Technology, with considerable RAL participation.

For further information, contact Mr M P M Hall, Departmental Users' Committee Secretary, RAL; telephone Abingdon (0235) 21900 (ext 6650).

Particulate technology: first annual review

The first year of the programme established by the Chemical Engineering Subcommittee has seen an encouraging response from the community. Since its commencement in September 1982 five awards totalling £250,000 have been approved. An open meeting held in January 1983 at the Scientific Societies' Lecture Theatre in London was attended by over 100 people, approximately half of whom were from industrial organisations and half from universities and polytechnics. The Institutes of Chemical and Mechanical Engineering were also represented.

Subsequently the Steering Group for the SPP have reappraised the criteria for inclusion of work in the programme. The central aim of the SPP continues to be to complement empirical knowhow by a fundamental understanding of solids processing operations in order to improve existing practice or develop completely new processes. Specific fields of endeavour are particle formation, solid–liquid separation and the handling and processing of particulate solids. The key criterion in the latter field is that particle–particle contact is the predominant mechanism affecting process performance. For example, dense-phase conveying but not dilute-phase conveying is included. Proposals are invited which are concerned with the control of particle formation in order to produce defined physical properties; new and novel approaches to solid–liquid separation; in the handling field, to processes such as mixing, abrasion, attrition, flocculation, feeding and transport at high solids concentration and engineering aspects of pharmaceutical solids manufacture.

Examples of industrial problems in these areas include the following:

- The accurate control of precipitation where more than one crystalline phase can be produced is very important in processes such as aspirin production, where different phases have different solubilities, and in dyestuff and pigment production, where some crystalline phases are more stable than others.
- The separation of solid–liquid suspensions is a particular problem in processes dealing with biological or high value products where product degradation is unacceptable.
- The effect of paste formulation and processing on product quality is important to a wide range of industries including foodstuffs, ceramics and pharmaceuticals.
- In pharmaceutical tableting, the processing conditions affect the post-compaction properties of tablets. An understanding of these mechanisms should lead to improved machine design and enable a wider variety of powders to be pelletized.

Anyone thinking of applying for a research grant in the field of particulate technology should contact:

Mr L J Ford
Coordinator,
Particulate Technology SPP,
ICI,
New Science Group,
PO Box 11,
The Heath,
Runcorn,
Cheshire WA7 4QE;
telephone Runcorn (0928) 511364
or 513635.

SERC support for powder metallurgy

In 1982 SERC, jointly with the Department of Industry, appointed Dr Ivor Jenkins CBE to coordinate and stimulate research in powder processing, both within industry and in universities and polytechnics, on behalf of the two bodies. Within SERC, the programme is administered by the Material Committee's Processing Subcommittee and covers both metals and non metals. The main emphasis so far has been on metallic powder.

The production of components from powdered metals has a number of advantages over more conventionally forged, cast or machine-wrought parts. The use of powders makes it possible to control and hence markedly improve the properties of the component, and can allow fabrication of alloys and other materials not possible by any other method. The parts are normally competitive in cost as the use of the powder eliminates stages in the normal fabrication by allowing parts to be produced closer to their eventual shape thus reducing machining costs and the amount of scrap produced.

In spite of their advantages, there are problems associated with powder-produced parts which have delayed the speed with which powder-formed components are introduced into manufacturing industry. Since taking up his appointment, Dr Jenkins has held extensive discussions both with the powder metallurgy industry and with interested academic groups. The aim has been to identify the research needed to overcome these problems to make powder-formed products more widely acceptable and to gauge the extent of current research. In the light of these discussions the subcommittee has identified the following topics to which it will give priority in considering research grant proposals from universities and polytechnics.

- **Sintered engineering components**

The first priority is to find methods of densification without massive post-sintering consolidation. It is considered that there are a number of ways in which this could be achieved, including research into the identification of engineering alloys which would produce a transient liquid phase on sintering.

It is recognised that it will be difficult for research programmes in this area to be formulated in isolation. For this reason a workshop is being planned for the early autumn to bring together a limited number of invited academics and industrialists to discuss the problem and to draw up a strategy for achieving these objectives.

• **Hard materials**

There is a need to find novel methods of forming hard metal components. Problem areas which have been identified, and which require further discussion with the industry and academics include: the rapid production of components difficult to produce on standard presses without resorting to pre-sintering machining; the production of large components without the use of conventional compaction methods (the techniques that need to be examined include injection moulding, centrifugal casting, slip casting, etc); and improved, cost effective techniques for the granulation of carbide powders prior to consolidation.

• **High speed steels**

Basic investigations are needed into sintering mechanisms and the metal cutting performance of sintered high speed steels of the T and M types.

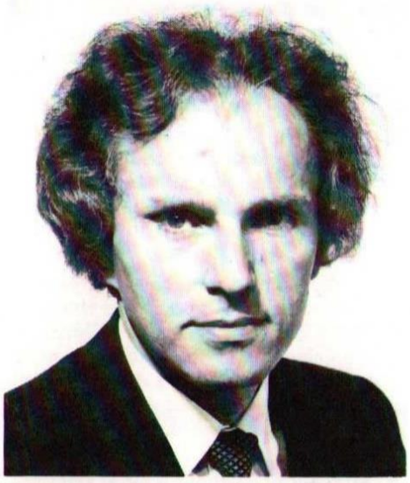
For further information on the programme, contact Dr Jenkins at Drift Cottage, Worthing, Dereham, Norfolk NR20 5HJ; telephone Elmham (036281) 601. For advice on applying for SERC support or information concerning the workshop on sintered engineering components, contact Mr Nigel Birch at SERC Central Office (ext 2111).

Pattern analysis coordinator

Dr Josef Kittler has been appointed Coordinator for Pattern Analysis by the Information Engineering Committee's Computing and Communication Subcommittee, following the SERC survey and review meeting on image processing (*SERC Bulletin* Vol 2 No 8, Summer 1983). Pattern analysis covers research in image and other sensory data processing and interpretation. Dr Kittler will be responsible for:

- coordinating existing SERC-funded work in pattern analysis
- stimulating basic research in pattern analysis, and
- stimulating applied pattern analysis research in the information technology area.

A seven-man panel under the chairmanship of Professor J R Ullmann, Sheffield University, has been set up by the British Pattern Recognition Association to advise SERC through Dr Kittler in his new role.



Dr Josef Kittler

It is hoped that the appointment of the Pattern Analysis Coordinator will lead to enhancement of current research efforts directed to solving problems of machine perception which has all pervasive applicability ranging from automatic interpretation of remote sensing, cartographic and medical images, through target detection and identification, to robot vision, man–machine interface and ultimately, general-purpose computer vision.

Dr Kittler has had more than 13 years of experience in pattern recognition and image processing. In 1980 he joined Rutherford Appleton Laboratory where he is in charge of research projects in computer vision for robotics, and remote sensing data analysis. He is a member of the Editorial Board of *Pattern Recognition, Pattern Recognition Letters, Image and Vision Computing,* and Associate Editor of *IEEE Transactions on Pattern Analysis and Machine Intelligence.*

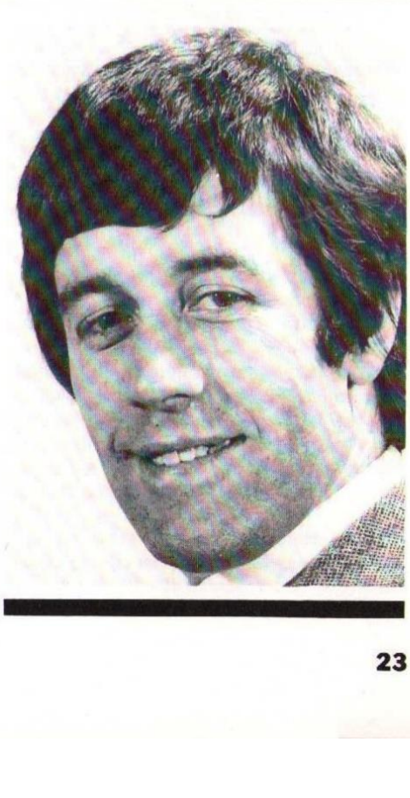
He would welcome enquiries from anyone interested in contributing to these efforts. He can be contacted at RAL (Technology Division); telephone Abingdon (0235) 21900 (ext 6292).

Clemson Award to Dr David Williams

Dr David Williams, Department of Dental Sciences, Liverpool University, has received the prestigious Clemson Award for contributions to the literature in biomaterials.

Dr Williams has for the past three years served on Council's Medical Engineering Subcommittee of the Materials Committee.

He was presented with the award by the Society for Biomaterials at its annual meeting held this year at Birmingham, Alabama. The award originates from Clemson University which held the first International Biomaterials Meetings in the early 1970s. Three are presented by the Society each year, covering all clinical and scientific disciplines associated with biomaterials. The last British recipient was Professor Sir John Charnley, the orthopaedic surgeon who developed the first successful hip joint replacement prosthesis.



Dr David Williams

STUDENTSHIPS

Research studentships — extension to awards

SERC research studentships are awarded for a period of not more than three years. The circumstances in which they can be extended are limited: thus while the Council gives sympathetic consideration to cases where the student has been absent through illness, no extension is possible when it has proved difficult to complete the project, or when time has been lost through the student's transferring between institutions. The recent publication of the booklet *Research student and supervisor: an approach to good supervisory practice* has given the Council the opportunity to review and set out its practice in considering cases where progress has been hindered by matters outside the control of the student or the institution.

The authors of the booklet recognise that it is impossible to prescribe a framework or set a timetable for studentships in all subjects. Nevertheless, the booklet endorses the general principles which the Council follows in making provision for postgraduate awards. In particular the booklet confirms the view that it should be normal practice for a student to complete his PhD, including presentation of a thesis, within his three years' postgraduate training and the authors suggest guidelines for achieving this goal. The guidelines relate as much to the conduct of the supervisor as the student and in particular are concerned with the way in which the research project should be selected and structured in order to ensure that it has the best possible chance of reaching a satisfactory conclusion within the prescribed period of the award.

One aspect that supervisors should consider initially is whether it is advisable for a research student to embark on a project whose success depends upon the successful commissioning of a major facility.

As the studentship progresses, there are milestones, identified in the booklet, when the student and the supervisor should review the stituation. These are:

- (where appropriate) by the end of the first 12 months the design of new apparatus should be well on the way to completion;

- by the time 15 months has elapsed the supervisor should have assessed whether the work can be expected to be brought to a timely conclusion. If not the student should be transferred to a different topic perhaps less exciting but more likely to lead to the timely production of a thesis;

- after about 27 months (ie at the beginning of the third year) the student should have obtained all the results which will go into the main body of the thesis; and

- by about half way through the final year (say after 30 months) the student should have completed his basic investigation (experimental or theoretical) and analysed the data.

Requests to extend awards will be judged in conjunction with the first year Probation Report against the above criteria and will also take into account whether any attempt has been made to modify the project to ensure the timely completion of the research training.

If the Council were to extend the period of support for a substantial number of students it would necessarily have to make a smaller number of awards, and it is not felt that the academic community would be well served as a result. Extensions to awards are therefore only likely to be awarded in exceptional circumstances.

Closing dates for applications

A reminder to institutions that applications should be sent in by the following closing dates:

Research studentships:	
Application for an allocation of studentships	31 December
Advanced course studentships:	
Application for acceptance of a course	31 October
Application for an allocation of studentships	31 October
Cooperative Awards in Science and Engineering	
Application for approval of a project	31 January and 31 May

FELLOWSHIPS

Toshiba fellowships for UK scientists

Starting this year, two fellowships will be offered annually which are designed to improve contacts between Japan and the UK. They will offer UK scientists the opportunity of working in Japanese high technology laboratories for up to two years. The scheme results from talks between Sir Hugh Cortazzi, the British Ambassador in Japan, and Mr Shoichi Saba, President of Toshiba Corporation.

Candidates of British nationality, aged under 35, who have PhDs or equivalent and are engaged in research at a UK academic or Government laboratory, may apply.

Fellows appointed will work with Japanese scientists and engineers at the Toshiba Research and Development Centre, on the outskirts of Tokyo. In areas such as: VLSI device design simulation (CAD); semiconductor technology (crystal growth, surface physics and opto-electronics); electro-magnetic waves; surface acoustic waves; and pattern recognition.

Each fellowship will initially be for 12 months extendable up to two years and worth £24,000 pa plus allowances for travel. Successful candidates will be encouraged to study Japanese traditions and culture.

Selection will be made annually by Toshiba Corporation in consultation with SERC and the next closing date for applications is 31 December 1983.

Further information is available from:
Toshiba Fellowship Programme
Toshiba Corporation (London Office)
Audrey House
Ely Place, London EC1N 6SN
Telephone 01-242 7295

Senior fellowships 1983

This table shows the allocation, the number of applications and distribution of awards in 1983 between the various fellowships schemes and the Special Replacement Scheme.

*In addition, nine awards tenable in Europe were taken over from the Royal Society for support under the NATO programme and two awards allocated to NERC.

† Provisional figure

Type	Allocation	Applications	Awards
Senior	1	19	3
Advanced	18	80	18
Postdoctoral	54	259	54*
RS/SERC industrial	7	10	6†
Special replacement	7	16	9

Three senior fellows

This scheme enables a small number of outstanding academic scientists and engineers to devote themselves full-time to research, free from the restrictions imposed by their normal duties, for periods of up to five years.

Many of the 19 applications received this year for Senior Fellowships were of an exceptionally high quality. Council had previously decided that the aims of the scheme could be met if awards were normally limited to one or two a year but, in view of the high quality, Council decided that three awards should be made for 1983 to:

Professor D R Cox (Imperial College) for studies of asymptotic theory of statistical inference;

Professor R J Ellis (Warwick University) for studies of structure and expression of nuclear genes for chloroplast proteins in higher plants; and

Professor C T C Wall (Liverpool University) for the study of singularities of smooth mappings: topology and applications.

Industrial fellowships widen horizons

The Royal Society/SERC Industrial Fellowships Scheme is proving highly successful and the two sponsoring bodies are looking forward to receiving further applications in any of the wide range of subjects in science and technology normally supported by SERC.

Since the Scheme began in 1980, twenty awards have been made. The primary objective is to enhance communication between scientists and engineers in academic institutions and those in industry, the universities and polytechnics in order to meet the needs of UK industry in areas of fast-changing science and technology, and giving academic institutions a fresh industrial input.

The Industrial Fellowships Scheme enables technologists from academic institutions to undertake research projects in industry for periods from six months to two years. Similar opportunities exist for industrial employees to carry out research or course development work in academic departments. The major share of the cost is borne jointly by SERC and the Royal Society (£103,000 in 1982-83). 1982-83 alone).

Of the awards made so far, eleven involve university researchers working in industry. Applications of the scheme are extremely varied including, for example, the monitoring of electric motors; design of generators; creep-feed, cam and roll-grinding machinery; catabolic plasmids with degradative function; feasibility of a portable coal-fired power plant; research into the properties of materials such as structural masonry; human blood cells; optical fibres; corrosion of metal structures and the recovery of metal from ores. Projects include an application of design and audit procedures and the development of courses in marketing and business.

For further information, contact the consultant for the Scheme, Dr David G Jones, at Miller's Stone, Mere Platts Road, Mere, Cheshire WA16 6QF; telephone Knutsford (0565) 51576; or the Fellowships Section (Mr P Black), SERC Central Office, Swindon (ext 2206).

The SRS Small Grants Scheme

SERC has recently introduced a Small Grants scheme for the Synchrotron Radiation Facility. The new scheme is intermediate in scope between the 'SRS exploratory agreement' scheme and the more substantial SERC research grants scheme.

Funding of up to £5,000 is available per proposal and the amount of SRS beam time available for acceptable projects is related to the SRS technique or scientific area involved. In setting up this new scheme, SERC's Synchrotron Radiation Facility Committee wished to create a mechanism by which small projects of outstanding promise can be considered and investigated more quickly than under the normal SERC arrangements and thus help to maintain the competitiveness of British science. There are no closing dates and decisions take only a few weeks compared to the usual three-month period. Intending applicants should use forms RG2 and UP2 (1+5 copies) with a sixth copy to Daresbury Laboratory. Further enquiries should be directed to one of the Secretaries of the SRFC; on technical aspects, to Dr Ken Lea, Daresbury Laboratory; telephone Warrington (0925) 65000; on administrative aspects, Dr Eric Wharton, SERC Central Office (ext 2222).

Research grants for overseas travel

As part of its policy to encourage international collaboration, the Council is extending its arrangements for support by research grants for overseas travel.

As from 1 September 1983, grants for overseas travel and subsistence expenses for visits to discuss, plan or develop specific research within the Council's field of interest are no longer restricted to Europe.

Applications specifically for travel and subsistence costs for any overseas visits should now be made on form RG2. Requests for funds of less than £20,000 may be submitted at any time and will be dealt with by the office on a 'quick turn-around' basis.

The former European Short Visit Grant scheme has been subsumed by these arrangements.

For further information contact Miss Lesley Powell, SERC Central Office (ext 2208).

Major new grants

February — July 1983

ASTRONOMY, SPACE AND RADIO BOARD

Professor Sir Robert Boyd and Professor J L Culhane (University College London): £703,200 over one year for space research at Mullard Space Science Laboratory.

Professor F G Smith (Manchester University): £513,900 over one year for radio astronomy research at Jodrell Bank.

Dr F J Hynds (Imperial College of Science and Technology): £419,500 for cosmic ray and solar charged particle investigations out of the ecliptic

Professor P C Hedgecock (Imperial College of Science and Technology): £420,747 for interplanetary magnetic field measurements in the heliosphere.

Dr J A M McDonnell (Kent University): £306,464 for a Dust Impact Detection System (DIDSY) for the Giotto Comet Halley Mission.

Professor K A Pounds (Leicester University): up to £473,400 over one year for x-ray astronomy and astrophysics research.*

Professor A Hewish (Cambridge University): up to £415,000 over one year, support of the Mullard Radio Astronomy Observatory.*

Professor M J Rees (Cambridge University): up to £320,800 over four years for research in theoretical astronomy.*

Dr E J Kibblewhite (Cambridge University): up to £306,100 over four years for the common user facility for automated photographic measurements.*

**Provisional figures*

SCIENCE BOARD

Professor Sir Sam Edwards, Professor V Heine and Dr J C Inkson (Cambridge University): £409,500 over four years as a special rolling grant to investigate the theory of condensed matter.

MARINE TECHNOLOGY DIRECTORATE

Special four year rolling grants to Marine Technology centres at:

	£
Cranfield Institute of Technology	662,000
Glasgow University	1,257,000
Heriot-Watt University	2,206,000
London University (Imperial College of Science and Technology and University College)	3,464,000
Newcastle University	1,501,000
North West Universities Consortium	3,136,000
Strathclyde University	980,000

ENGINEERING BOARD

Professor A P Anderson, Dr J C Bennett and Dr B Chambers (Sheffield University): £449,712 over four years, plus RAL facilities and Central Computer and Telecommunications Agency fees totalling £35,000 for microwave and millimetre wave antennas, image diagnostics and digital image processing.

Professor J Mavor, Dr P B Denyer, Dr M A Jack (Edinburgh University); £243,900 plus facilities at a notional cost of £124,200 over three years as a special rolling grant with review after one year, for VLSI circuits for digital signal processing.

Professor C D Wilkinson, Professor J Lamb, Dr S P Beaumont, Professor R P Ferrier and Dr J N Chapman (Glasgow University): £454,408 plus facilities at a notional cost of £88,660 as a special grant over three years subject to annual review, for applications and development of a very high resolution electron beam and x-ray lithographic system.

Dr A Gibson and Mr R A Lawes (RAL): a joint Department of Trade and Industry/ SERC research project to be performed at Rutherford Appleton Laboratory and Oxford University: £356,500 over three years (DTI have agreed to make a matching contribution), for the application of ultra-violet lasers to microcircuit fabrication.

Professor P S Brandon (Cambridge University): £190,000 over three years, for Digital Systems Laboratory.

Dr J R Jordan (Edinburgh University): £256,000 over three years, for Digital Systems Laboratory.

Mr P D Lines (Hatfield Polytechnic): £180,000 over three years, for Digital Systems Laboratory.

Professor E T Powner (UMIST): £218,000 over three years, for Digital Systems Laboratory.

Professor A P Anderson (Sheffield University): special rolling grant of £450,000 over four years plus use of Rutherford Appleton Laboratory antenna facilities, for microwave and millimetre wave antennas, image diagnostics and digital image processing.

Professor P J B Clarricoats (Queen Mary College): special rolling grant of £224,000 over four years, for microwave antennas for satellite and terrestrial communications systems (see page 21).

NUCLEAR PHYSICS BOARD

Rolling programme grants to particle physics experimental groups at Birmingham (up to £636,000), Cambridge (up to £412,000), Glasgow (up to £722,000), Imperial College of Science and Technology (up to £959,000), Liverpool (up to £503,000), Manchester (up to £493,000), Oxford (up to £840,000), and University College London (up to £467,000), each over a period of three years.

Employment of support staff on research grants

Council has decided to rationalise the rules governing employment of technicians, workshop and other staff to reflect the flexibility inherent in the SERC research grant scheme.

In future the Council will meet the costs (excluding overheads) of any support staff, temporary or permanent, employed by institutions, in respect of the time actually expended on SERC research grants.

It is not Council's intention to provide increased technical effort on research grants, but rather to allow institutions greater flexibility in utilising their available staff. SERC will continue to award technical or other support only when it is justified by the research project and it is more than institutions could reasonably be expected to provide from their own resources.

This change in procedure for support staff does not, however, alter the Council's prohibition on meeting the costs of permanent research staff in institutions.

Details of the new arrangements were notified to Finance Officers at institutions by letter RG5/83 on 25 May 1983.

Additional copies of the letter and further information may be obtained from Miss Lesley Powell, SERC Central Office (ext 2208).

Some new publications

Nuclear structure physics in the UK

The report of the Nuclear Structure Review Committee, set up by SERC under the chairmanship of Professor E W J Mitchell CBE, has been published under the title *Nuclear Structure Physics in the UK.* It is the first of a series of investigations of the Council's major activities. Copies are available from the Public Relations Unit, SERC Central Office, Swindon (ext 2256).

Reports from Engineering Division

Notebook for field measurements of energy in buildings, available from the Environment Committee Secretariat at SERC Central Office, Swindon (ext 2165).

Joint SERC-SSRC Committee annual report 1981-82, available from the Committee Secretariat at SERC Central Office, Swindon (ext 2429).

Energy Committee annual report 1981-82, available from the Energy Research Support Unit at Rutherford Appleton Laboratory (ext 5440).

Instrumentation and Measurement Specially Promoted Programme: interim report, available from the Information Engineering Committee Secretariat, SERC Central Office, Swindon (ext 2159).

Precision forming

The Engineering Processes Committee is determining industrially-related research priorities in precision forming in conjunction with the Department of Trade and Industry. So far, the following three reports have been published:
Cold and warm forging: proceedings of a community meeting;

A survey of applications in industry for the precision forming of metal components and the related needs for research;

The current and future requirements for research and development on cool and warm forging: report of an industrial workshop.

Further reports in the series (eg on casting technologies) are in preparation. The reports are available from Mr J Monniot, SERC Central Office, Swindon (ext 2443).

The challenge of nuclear physics

Aimed at the non-specialist reader, *The challenge and impact of nuclear physics* gives an overview of the subject and the role of the academic community. Copies are available from the Nuclear Structure Committee Secretariat, SERC Central Office, Swindon (ext 2223).

Science-based archaeology

Two reports are now available: *Science-based archaeology 1978-81,* a review of the activities of the Science-based Archaeology Committee over a four year period; and the *Science-based Archaeology Committee annual review 1981-82.* Both reports are available from the Committee Secretariat at SERC Central Office, Swindon (ext 2262).

Particle physics report

The Particle Physics Committee's *Annual Report 1982/83* introduces the subject and aims of the research programmes, analyses the use made by the British community of international facilities, and presents a summary of the year's results, with a brief look at future developments. It includes details of research grants, fellowships and studentships funded during the year. Copies can be obtained from the Particle Physics Committee Secretariat, SERC Central Office, Swindon (ext 2325).

Nuclear structure review

The Nuclear Structure Committee's *Annual Review 1982-83* is intended to provide the 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 undertaken during the year. Copies can be obtained from the Nuclear Structure Committee Secretariat, SERC Central Office, Swindon (ext 2223).

Polymer research in Europe

The ad hoc Committee on Polymer Science of the European Science Foundation has carried out an inquiry into facilities available in non-industrial polymer laboratories in Europe. This forms part of its programme to stimulate research in polymer science in Europe, in particular by improving collaboration between the different laboratories.

The outcome of this inquiry was published in December 1982 as an inventory of big facilities and specialised laboratories, techniques and methods entitled *Polymer research in Europe-II.*

Copies of the report are available from The Secretariat, European Science Foundation, 1 Quai Lezay-Marnesia, F67000 Strasbourg.

Astronomy in Edinburgh

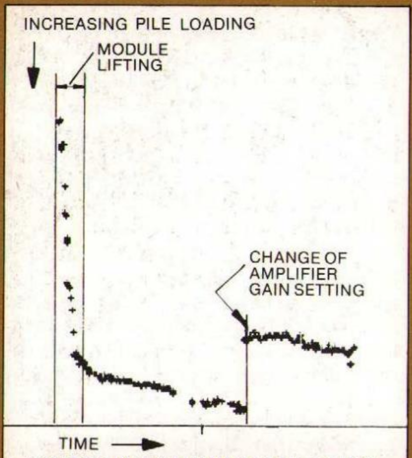
Professor Hermann A Brück, formerly Astronomer Royal for Scotland and Director of the Royal Observatory, Edinburgh (1957 to 1975), has produced a new book, *The story of astronomy in Edinburgh from its beginnings until 1975,* as a contribution to the celebrations of the 400th anniversary of Edinburgh University. Copies of the 150-page, fully illustrated book are available from booksellers or from Edinburgh University Press (price £8.50, ISBN 0 85224 480 0).

Magnus foundation monitoring

Instruments to monitor the foundation behaviour of the BP Magnus platform – the largest steel structure and the most northerly in the North Sea – have now been operating successfully for over a year of their planned two-year life (see *SERC Bulletin* Vol 2 No 5, Summer 1982). The results are expected to give improved design guidance on the balance between economic foundation construction and platform stability.

Two of the projects involved in the extensive system of instrumentation are jointly funded by BP and SERC's Marine Technology Directorate: Professor Poskitt's team at Queen Mary College aims to determine pile behaviour; and Professor Burland's soil mechanics group at Imperial College is measuring the settlement of the platform.

The QMC instruments check both lateral behaviour of the piles under severe storm loading and redistribution of load between the individual piles of one leg or between the pile group as a whole and the mud mat. The instruments have strain transducers attached to the pile walls to monitor both the axial and bending forces. At the same time the forces on the pile group as a whole are measured by strain gauges on the leg and on the main braces at pile-cap level.



TYPICAL PILE STRAIN GAUGE OUTPUT

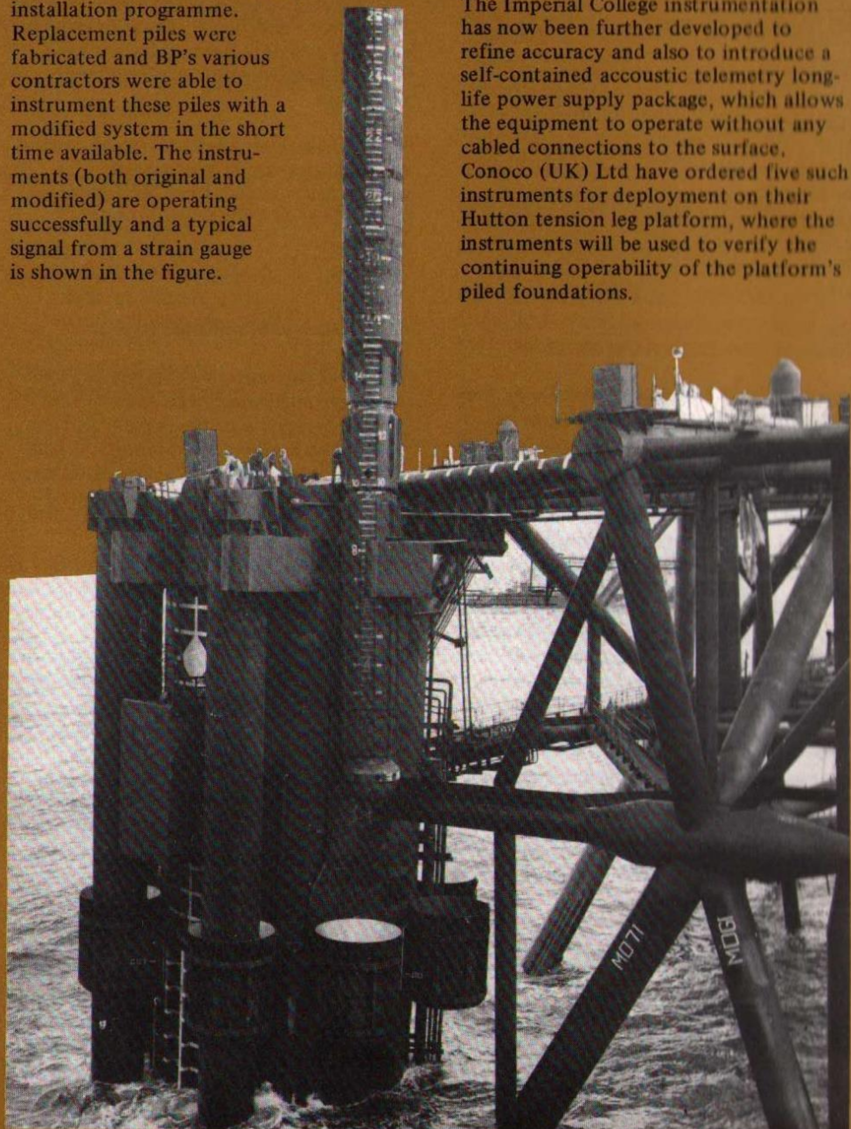
The piles were installed by driving with large hydraulic hammers. During this phase the pile wall stresses probably reached 70% of yield and accelerations were in the region of 600 g for a few milli-seconds during delivery of each blow. To survive such conditions mechanical and electrical components of a very high quality were necessary if they were not to lose their sensitivity as a result of such treatment. In addition when the platform is operational it creates a noisy electrical environment. The instrumentation must be able to operate under such circumstances without loss of signals.

These two aspects were identified early in the programme as requiring a considerable amount of work from both the civil and electrical engineering staff at QMC. As a result a large programme of experimental work involving both impact and high pressure testing was undertaken to determine the behaviour of the various components.

The Magnus structure was a self-floating structure and some of the piles were pre-installed in the structure and sealed at each end with membranes to contribute to its buoyancy. During upending, some of the piles fell from the sleeves to the seabed and could not be recovered in time to meet the installation programme. Replacement piles were fabricated and BP's various contractors were able to instrument these piles with a modified system in the short time available. The instruments (both original and modified) are operating successfully and a typical signal from a strain gauge is shown in the figure.

Imperial College's soil mechanics section developed and manufactured two settlement gauge systems for the Magnus programme. A novel design was employed which used the different densities of oil and mercury to convert the relative displacement between two points into changes in differential pressure which could be expressed electrically with special transducers. The gauges were designed to measure relative displacements of up to 600 mm with an accuracy of 1 mm; the achieved accuracy has been considerably better than specified. Once the platform was positioned in the Magnus field, divers deployed the gauges during two breaks in the piling operations.

The Imperial College instrumentation has now been further developed to refine accuracy and also to introduce a self-contained accoustic telemetry long-life power supply package, which allows the equipment to operate without any cabled connections to the surface. Conoco (UK) Ltd have ordered five such instruments for deployment on their Hutton tension leg platform, where the instruments will be used to verify the continuing operability of the platform's piled foundations.



Underwater hammer driving a pile on leg A-4 on the jacket section of the production platform in BP's Magnus oilfield.
Photo: BP