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REPORT ON SRS ACTIVITIES TO MARCH, 1981

by

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CONTENTS

1. INTRODUCTION

This is the first Annual Report on synchrotron radiation research and related activities since the completion of the storage ring (the SRS) at Daresbury Laboratory. The contents are primarily a summary of progress on the storage ring itself, on beamlines, experimental stations, data acquisition and processing facilities and on the build-up of ancillary laboratories and equipment.

In research, the Theory and Computational Science Division at Daresbury Laboratory has continued with important achievements in the areas of atomic spectroscopy and surface and bulk structural studies. The value of the TCS group activities to the whole synchrotron radiation research programme is clearly considerable. The initial links between theory and experiment were forged prior to the closure of the SRF in 1977. Since then, the theoretical programme has continued and extended and in surface science and EXAFS in particular now offers a good foundation from which the experimentalists can recommence their research on the SRS. This development can be seen in the comprehensive bibliography given in Appendix I which maps out the progress which has been made between April 1977 and March 1981.

At the end of this financial year, March 1981, the SRS is on the threshold of becoming an operational source for synchrotron radiation experiments. In addition collaboration with many different groups at several synchrotron radiation sources outside the UK has allowed a small, but vitally important level of expertise to be maintained by potential users of the SRS from the closure of the SRF in 1977. A summary is given of all overseas activities for the past year and, in addition, we are reminded by reference to Appendix I that research data derived from the SRF prior to March 1977 is continuing to be published. In annual reports in the future, the detailed research programme will be presented as a collection of short annual progress reports to be provided by each SRFC grant holder.

Appendix II presents information of great importance to the SRFC and to the user community. As with the bibliography on research publications (Appendix I) so the cumulative research programme reviewed here has been extended back beyond the immediate past year, to April 1977.

The SRFC is committed at present to the support of over eighty different research projects and their associated working groups. This number of approved grant holders is increasing steadily and may well imply total requirements for beam time at particular workstations which cannot be met at this stage. The grants made to many groups who applied to SRC in the period 1977-1979 are close to expiration and this information is contained in Appendix II. It is unfortunate where post doctoral research associateships are involved that individuals with grants close to termination are often closely linked with construction of the initial workstations on the SRS. Constraints imposed on the rate of development of future workstations are such that some grant holders will be unable to commence and many grant holders will be unable to complete their approved research programms until well into the Financial Year 1982/83 and this information is contained in Section 2.2.

Major SRFC grants are provided to support important research projects up to a maximum period of three years. In addition, access to the SRS is possible either as a "minor" or an "exploratory" user. Minor users will make brief visits to the SRS to make measurements using existing apparatus and receive financial support not exceeding £3K. Exploratory users will not be specifically funded but given assistance via Daresbury Laboratory to experiment with novel techniques or new kinds of apparatus or to make short feasibility studies prior to the submission of a major application.

With the SRS now operational, an extensive research programme already prepared, and this flexible system of access to the new facility established, we can anticipate an exciting and productive year ahead for synchrotron radiation research in the UK.

2. THE SYNCHROTRON RADIATION SOURCE AND FACILITIES

2.1 REPORT ON THE SRS

Introduction

The year has been an exciting one in that the Synchrotron Radiation Source, which has been under design and construction for five years finally has come into operation. The first beam line shutter was opened at the end of the year, almost exactly four years after the closure of NINA. Although the capital estimate has shown little increase on the October 1978 figure and in real terms is appreciably less than the original sanction, the project was severely affected by the financial measures taken by the Science Board during the second half of the year. These ware accommodated by delaying purchase of initial spares, at some risk, and by delaying those elements of the machine aimed at improving intensity by overcoming possible beam instabilities.

In the event it was a matter of some pride that the progress in machine construction allowed first injection trials to take place exactly at the time planned during the previous year. At the start of the year installation and electrical connection of the basic machine elements were in their final stages. At the end of the year synchrotron radiation emerged down line 6 into the experimental area (followed just after the end of the financial year by radiation down line 7).

The SRS was officially inaugurated on November 7th 1980 by the Rt. Hon. Mark Carlisle QC, MP, the Secretary of State for Education and Science.

The Construction Programme

Close supervision of the construction programme was essential to ensure that the limited manpower was employed to the best advantage. A committee, chaired by Mr. N. Marks, met regularly to direct installation, electrical wiring, and commissioning including the computer control system.

The vacuum system in the storage ring was mechanically complete by June 25th 1980 and, after considerable effort, leak-checked and under computer control by June 28th so that injection trials could start. After a month during which beaming took place in the evenings, a 2-month shut down was allowed for further installation and the finishing of temporary wiring. A further 6 weeks in November/December was allocated to bake-out of the ring to make a significant reduction in its base pressure. The whole vacuum chamber was raised, under computer control, to 200°C.

At the beginning of 1981 it became possible to redeploy much of the installation effort previously directed to machine building to completion of the first two beam lines, lines 6 and 7. This involved extensive electrical wiring to complete all the equipment and personnel safety interlocks but was achieved towards the end of the year to allow the beam shutters to be raised.

Several problems have affected the radio frequency system. The cavities have ceramic vacuum windows which are difficult to obtain. The failure of one window in the ring, as a result of excessive mechanical stresses, prevented full operation with four cavities until the end of 1980 so that until that time acceleration to full energy could not be attempted. Other problems with protection circuits, with cavity tuning control and with phasing were tackled and eventually have been overcome.

Concentration of effort on the r.f. window problem and on the main r.f. system reliability, together with restrictions on funding and delivery problems have delayed the attack on technological difficulties associated with other high power r.f. devices: the r.f. quadrupole, the Qs splitting cavity, the higher mode dampers and the single bunch chopping system. Of these, the latter was given highest priority and the deflectors installed at the end of the year, though the amplifiers were not complete. The other devices are all designed to overcome beam instabilities and it is gratifying that high circulating beam currents have in fact been achieved without them.

SRS Machine Performance

Electrons are injected into the storage ring at an energy of 600 MeV in bursts at a repetition rate of 10 Hz. Full specified performance is 370 mA current stored and accelerated to 2 GeV with 8 hour lifetime. First injection was attempted on June 29th 1980 and on June 30th a beam was repeatedly circulated for 100 ms, i.e. up to the next injection point. On July 2nd the first stored beam was achieved, 50 mA with a lifetime of one minute. At this stage the vacuum was only about 10^{-7} torr. Acceleration to nearly 1 GeV was achieved on July 10th and before the summer shutdown 200 mA had been accumulated at injection energy.

Up to the end of the year the time available for accelerator studies was severely restricted by installation work, plant commissioning and vacuum bake-out. Much effort went into improving the reliability of systems, particularly the r.f. By the end of 1980 a correctly phased r.f. system with all four cavities was available so that on January 16th 1981 acceleration up to nearly 2 GeV was achieved.

Many other studies, including injection conditions, closed orbit adjustment and the use of sextupoles have led to accumulation of beams approaching 300 mA. It also has become possible to accelerate relatively high currents without loss, for instance 100 mA up to 1.5 GeV, 80 mA to 1.8 GeV. With the exception of the area around one remaining leak, where the pressure is 10^{-9} torr, the base pressure is now 5×10^{-10} torr and beam lifetime at modest current is several hours. This reduces to 1-2 hours at higher currents due to photoelectron stimulated gas desorption.

On the storage ring, there are still a great number of investigations to carry out. Attention necessarily has been concentrated on the measures required to achieve reliable accumulation of beam, loss free acceleration, good beam position control and satisfactory operating parameters for the focusing quadrupoles and the r.f. cavities, all aimed at achieving reasonable conditions for experimenters. The small accelerator physics team, under the leadership of Mr. V.P. Suller, will be fully occupied over the next year or two in obtaining a greater understanding of the behaviour of the storage ring. Certain instability phenomena have already been observed. Firstly, a sudden loss of beam during accumulation which is a type of instability well understood and dependent critically on the tuning of the r.f. cavities. The second is a beam enlargement as a function of intensity which reduces lifetime and which has not yet been studied in detail.

Source Operational Organisation

During the year under review an Operations Section was formed under the leadership of Mr. N. Marks. This provides 3-man crews for 7-day, 2-shift operation with one technician working overnight to supervise the equipment in its stand-by condition and to ensure a smooth start-up in the morning. With the exception of one man, the crews were recruited

from within the Laboratory and this inevitably affected the rate of progress on outstanding items and on development work.

The Operations Section has however taken over responsibility for maintenance in many areas of the source. Crew training by the accelerator physicists is now an important on-going activity requiring allocations of machine time.

Safety is an important aspect of the crew leader's responsibility. This is controlled by the personnel safety interlock system, or by a Permit to Work system according to conditions.

Since much of the running during accelerator physics investigations has been at injection energy the cost of electricity was lower than had been estimated. This, together with a deliberate restraint on spending on initial capital spares and running spares, helped the overall financial position on the project by enabling more money to be spent on completion of beam lines and experimental stations.

SRS Improvement Programme

(a) Second harmonic cavity

The type of instability most likely to limit the achievable current in the SRS is the multibunch type, and countermeasures are included in the plans and in the Capital Estimate. During the year it was felt that insufficient attention had been given to the possibility of single-bunch instabilities of the form best counteracted by a second harmonic r.f. system. Some work was initiated on the design of such a system but has had to be stopped because of lack of resources, which also prevented purchase of components for such a system. In view of the increasing interest in using the SRS in the single bunch mode and achieving the highest possible current in such a mode, it may be important to recommence this work as soon as resources allow.

(b) Wiggler

The wiggler magnet, though significantly delayed, was successfully tested at the Rutherford Laboratory where it achieved a central field in excess of 5 Tesla. This project has caused considerable financial embarrassment to the Synchrotron Radiation project in that the manpower and overhead costs at Rutherford have been far in excess of the original estimate. The extra cost, some of it displaced into the current year, was completely accommodated within the "source" part of the budget in 1980/81. This cannot be repeated in 1981/82 and much of the increase must inevitably be at the expense of the experimental programme.

(c) High brightness lattice

During the year the SRFC was presented with a paper outlining methods whereby the storage ring could be improved. The main proposal, received with enthusiasm, was for a change in the magnet lattice to allow an order of magnitude improvement in brightness achieved by a reduction in size of the source cross section. This would make the source comparable with the latest generation of dedicated storage rings such as NSLS (Brookhaven) and BESSY (Berlin). A study to investigate the feasibility and approximate cost of this was set up under Mr. G. Saxon although little time could be given to this study during 1980/81. However, by the end of the year it was established that there were no theoretical reasons why a high brightness lattice could not be achieved. The difficulties lay in minimising the disruption to normal running and the cost of implementing the proposal. It is necessary to insert an extra quadrupole at the upstream end of each of 16 straight sections and also to provide additional sextupoles in half the straight sections. With conventional magnets a major re-engineering of each straight section is necessary to accommodate the modifications. An alternative proposal would be to use a superconducting quadrupole/sextupole magnet which would fit round the existing vacuum chamber. This magnet appears to be technologically feasible, but the cost of refrigeration may be considerable, particularly if the requirement is in excess of the spare capacity of the wiggler refrigerator.

It was not possible to allocate any money to this project during 80/81 nor was the Board able to provide any in 81/82. Only very limited manpower resources can at present be allocated to the study.

(d) Other projects

Resource restrictions prevented any progress being made in the development of important new ideas for the study of the "free electron laser", which, in principle, can give multi-megawatts of peak power at wavelengths from the optical region to the far infra-red and is easily tunable over a considerable range. We are therefore in danger of losing a unique opportunity to make an important initial contribution in a new field of research. Accelerator physicists on the SRS project continue to hold a watching brief and to join in discussions with interested scientists in Universities and in Industry. Theoretical studies of undulators and their radiation spectra have continued at a low level. It is hoped that, as resources permit, we shall carry out investigations on experimental undulator magnets, so that the Laboratory will be able to proceed to the design of such devices when required.

Experience at many Laboratories has proved the need to maintain a lively and interested accelerator physics team to ensure, not only the full exploitation and development of the existing source but also that longer term possibilities are not neglected. The preceding sections have outlined only some of the opportunities which exist for development and improvement of the source facilities over the next few years.

2.2 BEAM LINES AND EXPERIMENTAL STATIONS

At the time of writing (May 1981) the ADES workstation and grazing incidence monochromator on line 6 and the EXAFS station and the Protein crystallography station on line 7 have each taken beam and begun commissioning prior to "routine" operation in June/July 1981.

Installation of beam line vacuum equipment on lines 6 and 7 and construction of the hutches in the Inner Hall were almost complete at the time of the Inauguration of the SRS on November 7th. During the past year, much effort and time has been spent on the design of the modular control system for the beamlines, on the construction and installation of vital components in the Inner Hall such as the beam shutters, vacuum valves, pressure monitors and emergency-off modules. This modular system gives the user maximum control of his station whilst satisfying radiation safety requirements and, in the case of line 6, meeting stringent vacuum protection requirements also.

On line 6, the ADES (Angle Dispersed Electron Spectroscopy) system which was delivered to Daresbury in April 1980, has seen considerable use prior to its installation on the beamline by users exploiting conventional photon sources such as a helium discharge lamp and x-ray tubes. Operating experience with this apparatus has shown that this, and other workstations must purchase a number of vital pieces of the apparatus as spares or enter on a maintenance contract with manufacturers wherever it is possible. It is likely that for effective routine operation of the entire facility in the future, perhaps 10% of the cost of each major item of apparatus will be needed to maintain the equipment in running order at all times. The grazing incidence monochromator feeding the ADES station already has had a long history of use with synchrotron radiation sources in the UK and the USA and is currently under test in conjunction with its line 6 premirror.

The SEXAFS station was delivered to Daresbury Laboratory in March 1981 and the SEXAFS monochromator is now being commissioned jointly by Daresbury staff with considerable help from the user groups particularly from Liverpool and Warwick universities. The monochromator will be installed on line 6 in the summer of 1981. A further grazing incidence toroidal grating monochromator has been ordered for the third station to be commissioned on line 6.

On line 7, the EXAFS equipment installed within the EXAFS hutch is almost fully operational. The apparatus incorporates a high resolution vertically dispersing crystal monochromator which can operate under a vacuum of 10^{-3} torr or under helium and is tuneable from the beryllium window cut-off (~ 3.5 Å) to the SRS cut-off (~ 1 Å) The sample and detectors are mounted on an optical bench which can be translated vertically to follow the changing height of the exit beam from the monochromator, as the latter is tuned. Detectors include gas-filled ionisation chambers for transmission measurements, and NaI(Tl) scintillation counters for fluorescence measurements. Other features of the EXAFS station include entrance slits of lead and aluminium, which can be stopped down to enable high spectral resolution to be maintained at short wavelengths where the inherent divergence of the synchrotron radiation beam might otherwise be the limiting factor. A choice of monochromator modules is available, including an order-sorting 2-crystal design which

suppresses harmonics of the fundamental wavelength in its output beam. All motions of the slits, monochromator, and optical bench are under computer control. In 1981-82, it is planned to incorporate a horizontally and vertically focusing mirror in the beam-pipe, 6 m upstream from the EXAFS station. It has been estimated that, with focusing, the beam size could be reduced from ~ 30 mm x 5 mm to ~ 8 mm x 0.4 mm, an important improvement when small specimens are to be measured.

The second station on line 7 is for protein crystallography and is situated in a hutch close to EXAFS. This equipment has been assembled as a joint Daresbury/Keele University project and is essentially a horizontally-focusing, single curved crystal monochromator which gives a high intensity beam at the sample. By exchanging crystals it will be possible to select discrete wavelengths in the range 1 to 3 Å. An Arndt-Wonacott and a precession camera are both available for recording on photographic film the x-ray diffraction patterns produced by the protein crystal samples. In late 1981, it is planned to adapt the station to serve additionally for small-angle diffraction experiments.

New developments in electronic area detectors are being pursued. A TV image intensifier detection system is being developed for use on the wiggler beam line. This system will have a high counting rate capability, and detector elements having fine resolution, enabling diffraction and anomalous dispersion measurements to be undertaken on crystalline proteins with very large unit cells (in excess of 200 Å). A flat multiwire proportional chamber system is being constructed jointly by Rutherford and Daresbury Laboratories. This will allow dynamic experiments to be performed in the field of small-angle diffraction. The necessary station adaptation for this purpose includes provision of a cylindrical, platinum-coated quartz mirror for vertical focusing, which will also benefit the protein crystallography experiments by providing a higher flux incident on the small crystal samples (typically ~ 0.3 mm on an edge). A single wire linear electronic detector is also being developed in-house for small-angle diffraction and scattering experiments.

The three stations on line 7 in the Outer Hall provide facilities for x-ray topography and interferometry. Two topographic cameras are being installed, the first utilising unmonochromatised x-rays, and the second incorporating a double-axis crystal monochromator. Construction of both cameras has been undertaken by a group from Warwick University. Also contributing to the topography stations are groups from Durham and Strathclyde Universities. The former group has constructed a low-light-level television detector for direct display of x-ray topographs. This detector has been tested but, due to the relatively weak fluxes available from the laboratory x-ray set, it has not yet been possible to assess its performance for its intended application to synchrotron radiation. The Strathclyde group has nearly completed an environmental stage for mounting on the camera, in which samples can be subjected to variable pressure (up to 2 atmospheres) and temperature (25-1500°C). A software package, (SPECTRE) for computer control of the cameras is well advanced; pre-programmed operation will enable users to take advantage of the high speed movements of the camera when performing dynamic experiments. The interferometry station is being equipped with an x-ray interferometer provided by a group from King's College, London. Much of the equipment has been delivered to Daresbury, and the beamline extension, hutch and services should be available to users in June 1981.

Further Experimental Stations

Preparations for the succeeding phases of exploitation of the SRS will continue during 1981, concentrating on five new ports. These are the high-aperture port (line 12), the infrared port (line 13), the second evacuated beam line (line 3) and the Wiggler (line 9).

Delivery of the high-field superconducting magnet for line 9, which is being built at Rutherford Laboratory, is expected in August 1981. The x-ray flux falls off with horizontal angular position, defined with respect to the direction of the tangent line at the centre of the "wiggle" in the electron trajectory and it has been decided to construct the wiggler line to have an aperture of 64 mrad, although it is recognised that experimental stations lined up on the extremities of this fan will receive rather less of the short wavelength x-radiation than centrally positioned stations.

The so-called "High Aperture" port already is being assembled on the roof (gantry) of the storage ring. A silicon carbide concave premirror will collimate the radiation from 40 mradians of orbit which, after a second reflection, will be passed through a lithium fluoride window into a 0.8 m Czerny-Turner monochromator. This station is specifically designed to undertake time resolved fluorescence anisotropy measurements in the subnanosecond region using radiation polarised in the vertical plane at the sample. The collection and purification of a wide range of selected proteins is already underway for this work. In addition, the station will be used for routine excitation and fluorescence spectroscopy in the near VUV.

Plans by a group from Durham to use the far infrared portion of the SRS spectrum are based on collecting a very large aperture (~ 40 mrad × 70 mrad) beam from a silicon carbide mirror placed in the straight section behind magnet 13. The beam is transferred via a series of mirrors and finally extracted through a silicon window then further collimated and passed into an infrared interferometer. The interferometer is arranged in the radiometric mode, and will be used to calibrate the power of the synchrotron radiation in the wavelength range from 25 μm to 1 cm. This is accomplished by comparative measurements made against two alternative reference sources A and B (black bodies at different temperatures). The modules comprising the interferometer include polarising beam splitters, mirrors (one fixed, one movable), a beam-chopper unit, and a liquid helium-cooled infrared detector. If these radiometric measurements confirm theoretical predictions that the SRS is a broadband infrared source of superior intensity to standard laboratory sources, then the way will be opened to performing many experiments which are currently very difficult in that region of the spectrum. Some examples which have been suggested are: infrared transmission of highly absorbing samples, especially of chemicals in aqueous solution, studies of molecular dynamics of simple molecules in the liquid phase, and high resolution infrared spectroscopy of gases. An alternative station on this line will be used for very high flux measurements and timing studies in the near VUV region, when the interferometer is not in use.

The detailed engineering design is almost complete for line 3 - which ultimately will incorporate four workstations - and for the Wiggler line (line 9) which is planned to support three workstations initially with, possibly, four further stations to be completed later.

A comprehensive survey of existing and planned workstations is given in Table 1, while in Table 2 the development profile for the construction and commissioning periods is given for various stations. Table 2 is matched to the provision of funds and effort. It is important to recognise that in the early stages of operation of the SRS further delays may arise if problems occur in commissioning either the storage ring or the workstations. Significant periods of time will be needed to develop high current operation (i.e. > 100 mA) at 2 GeV, to commission the "single bunch mode" of operation and to install and commission the wiggler magnet within the next twelve months. Because radiation levels within the Inner Hall require that area to be cleared of personnel during injection into the storage ring, there is a very strong interaction between storage ring operation for machine physics development and installation and assembly of beam line and workstation equipment. These circumstances demand much attention and are planned and difficulties minimised by close interaction between the Daresbury machine and experimental groups, the Scheduling Committee and the Beam Ports Committee.

Finally, it must be stated that this extremely rapid growth rate in the number of workstations is, and will continue to be sustained only with the contribution of considerable efforts on the part of the many enthusiastic university user groups working in conjunction with the Laboratory in-house scientists. The forward look indicates 17 "independent" stations by 1982/83, but including dual topography stations, an extra arm on the infrared port to ease the load on HA12 port, and the SAS equipment in the PX station, a total of 20 is arrived at. With the planned operation of this number of workstations at the SRS during 1982/83, the existing complement of expert scientists on the Laboratory staff will be quite inadequate to staff individual stations. Unless the numbers of Daresbury-based scientists is increased, then the responsibility and expertise for maintainingsome stations must fall upon the shoulders of visiting users. This would be unsatisfactory both from the limited amount of user time at Daresbury and from the complete lack of continuity in the longer term.

2.3 DATA ACQUISITION, ELECTRONICS AND COMPUTING

Experimental Work Stations

Computer systems have been assembled and are being programmed for ADES, SEXAFS, EXAFS, X-Ray Topography (White Radiation Camera), X-Ray Topography (Double Crystal Camera), Protein Crystallography/SAS, the line 12 station, Infrared Interferometry and a 'time-of-flight' system for line 3.

Each of these stations has either an LSI-11/02 microcomputer or PDP-11/04 minicomputer controlling one or more CAMAC crates for the control of the experiment and data acquisition. The stations are thus independent of each other and can operate independently of the central parts of the data acquisition system (see fig. 1). This has enabled the major pieces of experimental apparatus to be developed along with their control and data acquisition software in users laboratories at their universities and in various laboratories at Daresbury. The X-ray Topography White Radiation Camera (Warwick Engineering) and the SEXAFS spectrometer (Warwick Physics) and the Infrared Interferometry (Durham Chemistry) systems have been returned to Daresbury for further development and the X-ray Topography Double Crystal Camera system and Time-of-Flight system have gone to Warwick (Engineering) and Reading (Physics) respectively.

The value of this independence of these systems during data-taking at the SRS will be that users need not interfere with one another when making changes to their systems. The Data Concentrator system to which they will be linked has sufficient disc capacity to ensure that data taking may proceed even when the central computer, the IBM 370/165, is off for several hours. Even without the Data Concentrator it will be possible to continue data taking, though with some inconvenience, on 'floppy' discs.

In order to simplify the programming of these stations, the language CATEX, which is essentially a BASIC compiler with CAMAC extensions, has been written. With a minimum of instruction, this has enabled users and SRE staff to program their own systems to a considerable extent.

An important decision taken and implemented this year has been to use the RT-11 operating system on the stations with a simple protocol for communication with the Data Concentrator. This frees memory for use by the data acquisition program and enables the use of FORTRAN where this is required.

Electronics and Instrumentation

The development of stepping motor drivers has been completed. These allow a large number of motors to be driven economically from one CAMAC module and are used by all stations.

A prototype fast Multi-channel Analyser CAMAC module (10 M samples/sec, 256 channels) has been completed satisfactorily and awaits user trials. Fluorescence EXAFS will be the first user of this unit. A summing amplifier, also for Fluorescence EXAFS in the first instance, will enable the fast MCA to be fed from five photomultipliers.

A high sensitivity current integrator has been specified and is being manufactured by an outside contractor. This will simplify data acquisition from ion-chambers and photomultipliers on both X-ray and VUV lines.

A contract has been placed with the Engineering Department at Warwick for the development of a multi-channel three-term sample environment controller. This will employ a microcomputer to provide a very flexible control over up to 16 temperature or other variables. This unit is required on the X-ray Topography stations and should have many other applications in the future.

Assistance is being given to the Physics Department at Warwick in the electronics for resistive film readout for channel plate detectors. Preliminary tests indicate a resolution of 0.2 mm.

A 10 cm single wire proportional chamber is being developed for Small Angle Scattering work on line 7, together with a delay line readout system. For the 2D multi-wire chamber, which is being developed by the Rutherford and Appleton Laboratories, Daresbury is developing the delay line readout, including a high-rate modular histogramming memory.

Data Retrieval and Analysis Facilities

The RAPPORT relational database system has been installed on the central computer. Details about each experimental data file will be automatically recorded in this database as the data is received by the central computer. This will simplify the location of data and its identification by users and by their analysis programs. It is anticipated that this database system will also be useful for accessing other scientific data.

A substantial library of programs and routines has been developed to support data reduction and analysis. The major programs have been obtained from users, other establishments and Theory and Computational Science Division. The work on these has been directed mainly at providing flexible data input suitable for SRS data files, maintaining them and documenting them. To date there are packages available for EXAFS analysis, X-ray Topography image simulation, Fluorescence Decay Analysis and spectral band fitting. These programs can be considered to be a part of the corresponding experimental stations.

Routines are available for incorporation in user-written programs for data smoothing, 2D and 3D graphical display and plotting, Fourier transforms and other basic spectrum manipulation functions.

Work is proceeding on a Ray-tracing package and a package for the display of photographic or simulated images. The GHOST-80 high-level interactive graphics package is being installed on the central computer.

Future Work

1981/82 will see the introduction of electronic area detectors on the SRS, in particular the MWPC for Protein Crystallography and Small Angle Scattering work and, about the end of the year, the TV area detector requiring larger computer systems to support them at the experimental stations.

Since the data acquisition system was designed it has become apparent that a number of stations require on-line analysis and feedback of their data that cannot reasonably be obtained from their station computers, and indeed almost all stations would benefit from such a facility. It has also become clear that the Laboratory's central computer will be inadequate for this purpose. Consideration will be given during this year to the best way to overcome this deficiency with a view to providing a solution in 1982/83.

2.4 BUILD-UP OF ANCILLARY LABORATORIES AND EQUIPMENT

The desirability of providing ancillary laboratories for SRS users while on site has been a recurring theme on the agenda of both the SRFC and the SRUM in recent years. In May 1979, the SRFC, in joint session with the SRUM, considered proposals for creating ancillary laboratories and equipping them. In November 1979, the SRFC discussed a further proposal for a biology/biochemistry support laboratory for synchrotron radiation users (SRFC 34/79). This and other new requirements were embodied in the paper "Forward Look for Building Work at Daresbury 1981/82 - 1984/85" which was put to the Science Board in January 1980. The Board included provision for this building work in its higher bid to Council. At its March 1980 meeting, Council set up a Joint Working Party of the Science and Nuclear Physics Boards which examined the Laboratory's overall building proposals. The Working Party had available to it the recommendations which an Advisory Panel for Biology Support at the SRS made in its report, dated July 1980, on the proposals originally put to the SRFC in November 1979. The Working Party recommended some cuts in the Laboratory's building scheme, but nevertheless suggested that 444 m^2 of new laboratory accommodation was the minimum necessary to support users of the NSF and SRS facilities. The SRFC was unable to make provision for the SRS share of the capital costs of the revised building programme within the existing 1980 Forward Look, but agreed that funds should be included in the 1981 Forward Look bid for a hostel extension, a biology support laboratory and some Portakabin offices. Science Board recommended that the bulk of these funds be provided in 1983/84.

Notwithstanding the above chequered history, a modest provision of laboratory space was possible in 1980-81, in part by conversion and renovation of existing buildings, and in part by completion of a new extension to the former Synchrotron Radiation Facility Building. The extension was originally discussed at the May 1978 meeting of the SRFC, and

was principally funded out of "Aid to the Construction Industry" funds. The position at the end of the report year (1980-81) may be summarised with reference to Fig. 2 which shows the locations of the available support laboratories for SRS users. These may be itemised as follows:

1. F-building (comprising the original SRF Building and its recent extension) which provides physical, chemical and biological preparation laboratories, microscope and balance rooms, experimental test area, plus a limited amount of office accommodation.
2. Linac Laboratory (so named from its original use of housing the NINA Linac injector) for general commissioning of apparatus prior to beamline installation.
3. Data Acquisition Room where the data- and link-concentrator computers are housed, and where users have access to the computer network via TSO terminals for data analysis and reduction, together with various read-out peripherals.
4. SRF Laboratory (E-block), an area at present largely taken up with storage of equipment.
5. Standard laboratory rooms in B block (rooms B20, B23 and half of B24) conveniently close to the in-house staff offices in B block.
6. Two 'Portakabins', equipped with photographic dark room facilities, specifically designed to meet the requirements of protein crystallography (PX) and topography (TOP) users.
7. A further photographic laboratory is planned by conversion of part of an existing building close to the topography end-station on beamline 7.

During the year, a number of additions were made to the scientific equipment provided in the several ancillary laboratories, in response to needs expressed by users. A list of available apparatus, including items acquired prior to 1980-81, is given below.

Equipment in Ancillary Laboratories

Vacuum evaporator and film thickness monitor: Microscope w/photographic accessories: Polarizing stereo zoom microscope: Ultrasonic cleaner: Chemical balances: Refrigerators: Fume cupboard: Glass blowing kit:

Spectrophotometer UV/Vis.: Leak detector: Vapour degreasing facility: pH meters: Freeze drier: Laminar flow recirculating cabinet: Vortex stirrer/mixer: Sonicator: Magnetic stirrers w/hot plates: Water still and butt: Water deioniser: Cold room: Photographic enlargers: X-ray generator: Film drying cabinet: Polishing and grinding equipment: Freezer: Dispensing pipettes: Ice flake maker: Ultra centrifuge: Dessicators: Water bath: Chromatography columns including fraction collector, UV monitor, Peristaltic Pump and Chart Recorder: Blender: Oxygen electrode w/recorder: Microsyringes: Microwave oven: Spot welder: Chemicals and glassware: Glassware drying cabinet.

3. THE SYNCHROTRON RADIATION RESEARCH PROGRAMME

3.1 THEORETICAL STUDIES

The Theory and Computational Science Division at Daresbury Laboratory is concerned with the electronic structure of atoms, molecules, solids and liquids, and its relationship to the experiments which will be carried out on the SRS. From these experiments, a more complete theoretical understanding of the structure of matter will emerge. Some of the highlights of our work follow; more details are to be found in the Laboratory's annual report. Appendix I includes a full bibliography of publications from the group since NINA closure in 1977.

Work has begun in the Theory Group on the theory of x-ray absorption near edge structure (XANES). This is the structure visible in the x-ray absorption cross section within about 50 eV of the edge, i.e. much lower than the true EXAFS (x-ray absorption fine structure) range. At these low energies the electrons excited by the x-rays undergo multiple scattering, so the fine structure in the data contains information about the symmetry of the local environment, bond angles, etc., in addition to the number of neighbours at different distances obtainable from EXAFS. To obtain this information a full multiple scattering calculation has been constructed for a cluster of atoms surrounding the absorbing atom. Results obtained so far indicate that the theory gives good agreement with experiment if accurate phase-shifts are used, and that XANES data are sufficiently sensitive to geometrical parameters to make the measurement a useful probe of local structure.

To test the sensitivity of XANES to bond angles a calculation was made for a notional transition metal carbonyl $X(CO)_6$. The near edge structure for K-shell absorption in the transition metal atom was calculated for an initial geometry in which the CO molecules are linearly disposed along the ± x,y,z axes, with the carbon atoms being closest to the metal. Further calculations were made for the oxygen shell rotated about the Z axis, thus changing the X-CO bond angle. True EXAFS would show no sensitivity, but XANES does change showing its sensitivity to bond angle. Much interest in this new technique has been shown by biologists who need more detailed information about active centres in molecules. Not only can XANES offer sensitivity to bond angles, it also has a higher intrinsic content of information per unit energy range of the spectrum - an important consideration in spectra for materials with low atomic number where EXAFS signals cut off at relatively low energies. Similar advantages are anticipated in surface EXAFS where the weak signal limits the useful energy range of spectra and where pair distribution functions are often not sufficient to provide a unique determination of the surface atomic geometry. Considerable development in the theory remains to be done but all the initial signs are that it will be possible to use XANES as a powerful structural tool.

There has been a great deal of interest in recent years in the phase transition on the W(001) surface, in which the surface atoms are displaced to form a $(\sqrt{2} \times \sqrt{2})R\ 45°$ structure on cooling below 370 K. In a similar phase transition on Mo(001) the reconstructed surface lattice is incommensurate with the ideal lattice, and this led to the idea that surface states at the Fermi energy might be coupled by these atomic displacements, leading to the formation of charge density waves and the stabilisation of the reconstruction. Theoretical work done in this laboratory suggested that surface states may determine the precise wave vector of reconstruction but most of the stabilisation energy comes from a more general interaction of the surface atoms with the substrate. To test these ideas, experiments have been carried out at Liverpool on the changes in photo-emission through the phase transition on W(001), calculations of the surface density of states using the matching Green function method, and photoemission using the PEOVER programs, have been used to help to understand the results. A surface state is indeed found experimentally which disperses up through the Fermi energy, in fair agreement with theory. On cooling the W(001) below the transition temperature the intensity of this state drops markedly at the wavevectors coupled by the reconstruction. This is what is expected theoretically, as the coupled surface states are split in energy, one state moving up through the Fermi energy and no longer contributing to the photoemission. As the surface states are seen in photoemission only over a limited region of the surface Brillouin zone it seems unlikely that they contribute very much stabilisation energy to the surface reconstruction. Work is currently in progress theoretically to understand other peaks in the photoemission spectra - some discrepancies still remain in the surface states on the unreconstructed surface.

Much of the work in atomic and molecular theory has involved the investigation of electron and photon collisions with atoms and molecules; the R-matrix method has been used, and its range of applications extended. Photon collisions are particularly interesting since they can lead to the ejection of electrons from the atom or molecule - a process to be studied experimentally on the SRS. When the collision energy is restricted so that only one electron can escape from the interacting system the method divides the problem into two parts. Whenever all electrons are close together and therefore indistinguishable, the solution of the complicated Schrodinger equation gives the "R-matrix" on the boundary surface of a spherical region centred on the nucleus. The R-matrix describes the influence of the interactions in this inner region on the escaping electron. The boundary is chosen so that the escaping electron is the only one to exist outside it and in this outer region can be considered as moving in the electrostatic potential generated by the nuclear charge and the other electrons of the system. Using the R-matrix on the boundary, information from both regions is linked together giving the overall solution to the problem.

An entirely separate area of interest has been the quadratic Zeeman effect in atoms. The energy levels and oscillator strengths for high Rydberg states of atomic hydrogen in magnetic fields of ~ 50 kG have been computed using an expansion in a Sturmian basis, solving the generalised eigenvalue problem, with banded matrices. It was possible to work with a

basis of up to 1500 Sturmian functions within the fast addressable memory of the Science Research Council's CRAY-1 when eigenvectors, for oscillator strengths, were to be found, or up to about 3000 when only the energy levels were calculated.

Oscillator strengths for transitions from the ground state of hydrogen have been calculated, the lowest lines corresponding to perturbed n=23 levels. The structure of the principal line and associated satellites is one that can be understood within the limits of first order perturbation theory. With increasing energy the line clusters show widening and closer proximity to neighbours until interpenetration occurs. Moreover the spacing between the most prominent lines approaches a constant value equal to 1.5 times the cyclotron frequency for this strength of magnetic field.

3.2 RESEARCH UNDERTAKEN AT OTHER INSTITUTES

Several UK university groups have undertaken research at overseas synchrotron radiation facilities, in many cases assisted by Daresbury Laboratory personnel or equipment.

In July 1980 four x-ray topographers, from the Universities of Durham, Strathclyde and Warwick, travelled to the Institute of Nuclear Physics, Novosibirsk, under the USSR/UK agreement on synchrotron radiation research. During a three-week visit, they were provided with the facilities of the VEPP-3 source to undertake a programme of eight experiments. One of these dealt with in situ polymerisation. Topographs were taken at suitable time intervals of the monomer TCDU (a substituted diacetylene) which was polymerised in and by the synchrotron radiation beam. Clear changes in the topographic images were observed, and by analysis of the changes in different reflections, it should be possible to determine the structural and microstructural alterations and their kinetics. This experiment is believed to be the first of its type, and could herald a new field of polymer research.

A Warwick University group also participated in collaborative topographic work at the DCI storage ring at Orsay, France. White radiation topographs of an FeSi single crystal were taken just before and after the onset of plastic deformation under the action of a tensile stress. The features in the topographs revealed defect structures in the crystal and magnetic domains. On exceeding the elastic limit catastrophic propagation of slip bands was observed. A series of mechanical tests of this type have given information on the mechanisms of initiation of deformation and on the structure of magnetic domains under stress.

Photoelectron emission experiments have been carried out by UK scientists at two synchrotron radiation centres in the United States. At Stanford, a Leicester University group collaborated with American research teams in angle-resolved and angle-integrated photoemission studies of metal, alloy and diamond surfaces. Of particular interest are the electronic and geometric properties of ultra-thin overlayers of metals on metal substrates. The work at Stanford included a joint study of the influence of surface impurities on the atomic order of condensed copper monolayers on an oriented copper substrate, using angle-resolved photoemission in the photon energy range 8 to 25 eV.

Another UK group, from Warwick University, has been active at the Stoughton (Wisconsin) Synchrotron Radiation Centre, in collaboration with American colleagues. Their experiments have been concerned with two topics: photoelectron diffraction from adsorbate core levels on metal surfaces, and photon-stimulated desorption. In the former, such systems as iodine adsorbed on silver, and tellurium adsorbed on nickel and on copper have been studied. In the latter, measurements have been made of the emission of positively charged ions of fluorine, chlorine and oxygen from adsorbed layers on tungsten surfaces when illuminated with synchrotron light.

Activity in the field of EXAFS has been considerable during the year, with scientists from Birkbeck College, Leeds, Manchester, Sussex and UMIST participating with Daresbury staff in experiments with overseas collaborators at EMBL (Hamburg) and at ACO (Orsay). Amongst samples submitted to this structure-determining technique were enzymes, such as xanthine oxidase, and superoxide dismutase, some anti-arthritic drugs containing gold, bone mineral (in a study of calcification of bone), and several oxide glasses. In the last mentioned case, structure stemming

from the K-absorption edge of sodium (wavelength = 11.5 Å) was measured to reveal the local structure around the Na ions for the first time. Conclusions drawn from this work have aroused interest because they are at variance with conventional ideas about the structural role of modifiers (i.e. Na_2O, CaO) in oxide glasses.

Daresbury effort has also been put into the related technique known as surface EXAFS, in collaboration with workers at Stanford. In this, the characteristic EXAFS structure is detected by electron yield measurements, rather than transmitted or fluorescent photon intensity measurements. In one series of experiments, on aluminium in various stages of oxidation, electron yield measurements were made above the oxygen K-edge. The O-Al distance was found to vary progressively from 1.75 ± 0.03 Å for the sub-monolayer oxide-like phase through 1.85-1.88 Å for a range of amorphous aluminas to 1.92 Å for bulk corundum (α - Al_2O_3). Interpretation of these data suggests that the short O-Al length in the first case implies an appreciable covalent bonding exists in the chemisorbed phase.

Atomic and molecular physics work has continued at the Bonn synchrotrons by the Imperial College and Reading groups. Illustrative of the latter group's work are measurements of cross sections for single and double photoionisation of atomic barium and ytterbium. A time-of-flight mass spectrometer was used to detect the singly and doubly charged ions produced by crossing an atomic beam of the metal vapour with light from a Seya monochromator.

At the National Bureau of Standards (USA) Daresbury effort has contributed to a collaborative programme in atomic and molecular photoelectron spectroscopy using the SURF-II 250 MeV storage ring. The diatomic gas molecules O_2, N_2 and CO have been studied, and photoelectron angular distributions and branching ratios for individual vibrational levels have been obtained in the region of autoionising resonances for these molecules.

Protein crystallography experiments have been actively pursued at the synchrotron radiation facilities in Hamburg and Orsay by groups from Birkbeck College, Bristol, Cambridge, Imperial College, Keele, Oxford and

York. High resolution data, and also some optimised anomalous dispersion measurements were taken on a variety of protein single crystals, such as pepsin, phosphorylase, insulin, haemoglobin and 6-phosphogluconate dehydrogenase.

Table 3 summarises the extensive range of research carried out during the past year.

Clearly once our own new facility has become fully operational, we shall have the opportunity (and a moral obligation!) to return some of the hospitality which has been extended to UK scientists not only during 1980/81 but over the four years since closure of NINA in 1977.

3.3 EXPLORATORY AGREEMENTS AT THE SRS

A number of applications to undertake exploratory work at the SRS have been received by the Director of Daresbury Laboratory. Table 4 lists the agreements approved in 1980/81.

It is hoped that the existence of the Exploratory Agreement procedure will add considerably to the vitality of the research programme at the SRS while interacting to a minimal extent with the conduct of the major research projects funded by the SRFC.

4. OTHER ACTIVITIES

4.1 THE BEAM PORTS COMMITTEE

The mechanism for the allocation and scheduling of experimental time on the SRS was discussed at length by the SRFC at its meetings in November 1979 and March 1980. It was decided to set up a "Beam Ports Committee" to handle the long-term planning schedule for SRS use. At its May meeting, the SRFC received a memorandum from Professor Ashmore, Director of the Daresbury Laboratory, proposing the membership criteria for the Beam Ports Committee. Professor R.H. Williams agreed to become the Chairman, and subsequently Professor G.V. Marr (Reading University), Dr. C.D. Garner (Manchester University), Dr. B.K. Tanner (Durham University) and Dr. R.T. Tregear (ARC, Babraham) accepted invitations to serve on the committee. Daresbury Laboratory staff members Dr. P.J. Duke, Dr. I.H. Munro and Mr. N. Marks were also appointed as members of the

committee along with Dr. K.R. Lea (Secretary). Subsequently Dr. J.B. West (Daresbury Laboratory, and Chairman of the Shift Scheduling Committee) was co-opted onto the committee.

The BPC held two meetings in 1980-81, the first in October 1980, and the second in 1981. The Chairman and the other university members undertook responsibility for schedule planning in specific areas of SRS experimentation, and agreed to liaise with the associated user communities, as follows:-

Professor Williams	-	ADES and SEXAFS
Dr. Garner	-	EXAFS
Professor Marr	-	Infrared, high aperture and VUV3 ports
Dr. Tanner	-	Topography and Interferometry
Dr. Tregear	-	Protein Crystallography and Fibre Diffraction

The Committee's work to date has been concerned with establishing the timetable for the commencement of scheduled running of the SRS, and of the commissioning and subsequent availability of the planned experimental stations. Taking the initial allocations of beam time made by the SRFC, the Committee has sought to accommodate these in a long term planning schedule, taking into account various practical constraints, e.g. compatibility problems between simultaneous users, turn-around time, allowance for machine physics investigations, and for technical work, maintenance and improvement of the experimental stations. The Committee has also overseen the setting up of the SRS Shift Scheduling Committee, which undertakes the fine detail of distributing shifts of beam time amongst the users within an individual cycle of SRS operation. A typical cycle is expected to consist of 6 weeks operation at the rate of 7 days per week, 2 shifts (nominally 8 hours each) per day, followed by a one or two week shutdown.

Amongst other matters which the BPC has had on its agenda, the topic of "Communication with Users" has been productive of recommendations about the submission of written annual reports, and the holding of an annual users meeting, the first of which has been set for 18th November 1981.

The BPC recommendations are regularly reported to the SRFC by the Chairman, Professor Williams, and the minutes of the BPC meetings are furnished to SRFC members for information. The role and functioning of the BPC is to be reviewed in the coming year (1981-82) in the light of operating experience.

4.2 USE OF THE SRS BY "NON-ENTITLED" USERS

During the latter part of the year discussions started with several organisations concerning possible use of the SRS by scientists who would not be funded by the SRC.

In almost all the cases the stage reached during the year 80/81 was purely exploratory with no commitment on either side and so reports would be premature at this stage. In two cases assistance with funding a research associate to work at Daresbury was being discussed.

4.3 THE EXPERIMENTAL PROGRAMME COMMITTEES

The successful operation of the SRS Facility will depend on the existence of a well defined research user community working closely with the "in-house" permanent scientists and based at the Laboratory. The EPC (chaired by Dr. I.H. Munro) includes a representative from each approved research project and is used as the forum for discussion and exchange of information on all aspects of the research programme at the SRS. Through its meetings, the "in-house" staff are regularly drawn together with visiting research teams to draw up the broad guidelines needed before detailed planning of beamlines and stations is begun. At the general meetings a consensus is frequently sought and obtained on topics such as access to lines and stations, ancillary laboratories and equipment, graphics facilities needed by users, etc. A number of specialist meetings have been held to define requirements for new beamlines or experimental stations: these have included meetings concerning the Wiggler lines and stations (October 1980), the design of the next x-ray line (November 1980) and lifetime experiments, the high aperture port and the infrared port (February 1981). A major meeting was held in March 1981 to discuss soft EXAFS, XANES, x-ray fluorescence, XPS, microscopy and lithography and laser plasma techniques. There was lively discussion in the area of soft x-ray microscopy - resolution and optics. Also an immediate requirement emerged for a scanning soft x-ray monochromator to serve the needs of EXAFS in the 3-20 Å regime. The meeting was undecided how to meet the requirements of XPS in the 100 eV-1 KeV (120 Å-12 Å) regime or how specifically to deliver coarse monochromatised high intensity SR for microscopy at 20-50 Å.

Future plans for the EPC in 1981 include the institution of regular seminars where users will describe their individual research programmes, participation in the First Annual SRS Users Meeting in November and the consideration of new research projects. These projects cover subjects as diverse as microscopy, circular dichroism and high resolution spectroscopy and the meeting together of users to discuss them is of great value in the generation of fresh proposals for the SRFC.

Two other Daresbury "in-house" committees, at least, are closely involved with research programme planning at the SRS. These are the Shift Scheduling Committee (Chairman Dr. J.B. West) with specific responsibility for detailed timetabling of SRS beam time, and the Instrumentation Committee (Chairman Dr. I.H. Munro) which discusses the scientific requirements of all new workstations and beamlines prior to the start of detailed engineering design.

APPENDIX I.

Cumulative list of synchrotron radiation related research publications from March 1977 (the shut-down date of the Synchrotron Radiation Facility on NINA) to March 1981.

The publications are arranged into groups: A. Experimental; B. Theory; C. SRS; and include Reports, Technical Memoranda and Preprints.

A large proportion of the material published during this four year period relates to data which was obtained at the SRF using NINA prior to 1st April 1977. In fact, some data from the SRF still has not been published.

The great value of a close interaction between theorists and experimentalists is strikingly evident in the publications in Groups A and B. The area of atomic and small molecular spectroscopy and especially in the field of photoelectron emission and electron scattering illustrate (via the publications list) the advantages of this collaboration at Daresbury Laboratory quite clearly. It will be important to continue this relationship into the future.

During the four year "shut-down" period, the Laboratory has convened a number of specialist meetings to stimulate and develop such activities at the SRS. This material is published usually in the form of Daresbury Laboratory Reports.

The quality and efficiency of the Daresbury Laboratory Publication Service has been noted and appreciated by many users in the past. The Committee should note, however, that the number of users associated with the SRS already is many times greater than for the previous SRF. When, in due course, publications from the new community of synchrotron radiation users are produced in proportion to their numbers, the DL Publication Service will become overwhelmed. In that case either additional support must be provided at the Laboratory, or alternative arrangements would have to be made for the preparation of material for publication.

EXPERIMENTAL

Reports

DL/SRF/R13 (Experimental)
R.B. Cundall and I.H. Munro
Applications of synchrotron radiation to the study of large molecules of chemical and biological interest: Proceedings of the Daresbury Study Weekend, 27-28 January, 1979.

Technical Memoranda

DL/SRF/TM9 (Experimental)
R.J. Booth, M.C.R. Symons, D.J. Bradshaw and K.R.Lea
The radiation damage research project at the SRF. 1977

DL/SRF/TM10 (Instrumentation)
J.H. Poole
Use of a diamond crystal detector in synchrotron radiation. 1977

DL/SRF/TM11 (Instrumentation)
J.B. West and G.P. Williams
The installation of an SRF grazing incidence monochromator at the Wisconsin storage ring. 1978

Preprints

DL/SRF/P60 (Experimental)
G.P. Williams, C. Norris and M.R. Howells
UPS spectra for Cu in the range 14 - 45 eV. 1977

DL/SRF/P64 (Instrumentation)
J.C. Hazelgrove, A.R. Faruqi, H.E. Huxley and U.W.Arndt
The design and use of a camera for low angle x-ray diffraction experiments with synchrotron radiation. 1977

DL/SRF/P66 (Experimental)
S.S. Hasnain, P Brint, T.D.S. Hamilton and I.H.Munro
Surface influence on the phosphorescent state ($^3B_{1u}$) of benzene in doped rare-gas solids. 1977

DL/SRF/P67 (Experimental)
P.R. Woodruff and G.V. Marr
The photoelectron spectrum of N_2, and partial cross sections as a function of photon energy from 16 to 40 eV. 1977

DL/SRF/P68 (Instrumentation)
M.R. Howells, D. Norman, G.P. Williams and J.B. West
A grazing incidence monochromator for synchrotron spectroscopy. 1977

DL/SRF/P70 (Experimental)
D.L. Miller, J.D. Dow, R.G. Houlgate, G.V. Marr and J.B. West
The photoionisation of krypton atoms; a comparison of pseudo-potential calculations with experimental data for the 4p asymmetry parameter and cross section as a function of the energy of the ejected photoelectron. 1977

DL/SRF/P73 (Experimental)
R.S. Holt, M. Cooper and K.R. Lea
Compton scattering with synchrotron radiation. 1977

DL/SRF/P75 (Experimental)
I.B. MacCormack and B.K. Tanner
Application of x-ray synchrotron topography to in situ studies of recrystallisation. 1977

DL/SRF/P77 (Experimental)
S.S. Hasnain, T.D.S.Hamilton, I.H. Munro and E.Pantos
Spectroscopic study of solid benzene and benzene isolated in rare-gas matrices. 1977

DL/SRF/P78 (Experimental)
S.S. Hasnain, P. Brint, T.D.S. Hamilton and I.H.Munro
Absorption spectrum of naphthalene in rare-gas matrices. 1977

DL/SRF/P79 (Experimental)
S.P. Shannon and K. Codling
Partial photoionisation cross section measurements for atomic cadmium and mercury. 1977

DL/SRF/P89 (Experimental)
G.V. Marr
Absolute photoionisation cross section curve for atomic helium. 1977

DL/SRF/P90 (Experimental)
J. Bordas and J. Randall
Small-angle scattering and diffraction experiments in biology and physics employing synchrotron radiation and energy dispersive techniques. 1977

DL/SRF/P94 (Experimental)
S.S. Hasnain, P. Brint, T.D.S. Hamilton and I.H.Munro
Luminescence excitation spectra of toluene and mesitylene in rare-gas matrices. 1977

DL/SRF/P97 (Experimental)
I.T. McGovern, A.W. Parke and R.H. Williams.
The energy dependence of the photoelectron attenuation length via the oxidation of silicon. 1977

DL/SRF/P98 (Experimental)
A.M. Glazer, M. Hidaka and J. Bordas
Energy-dispersive powder profile refinement using synchrotron radiation. 1977

DL/SRF/P99 (Experimental)
K. Codling, J.R. Hamley and J.B. West
The absolute photoabsorption cross section of atomic cadmium from the 4d threshold to 250 eV. 1977

DL/SRF/P100 (Experimental)
D. Norman and D.P. Woodruff
Energy dependence of electron inelastic scattering mean-free-paths using synchrotron radiation photoelectron spectroscopy. 1977

DL/SRF/P101 (Experimental)
D.J. Fabian, J. Gimzewski, A. Barrie and B. Dev
Excitation of Fe 1s core-level photoelectrons with synchrotron radiation. 1977

DL/SRF/P104 (Experimental)
A.J. Bourdillon, M. Glazer, M. Hidaka and J.Bordas
High-resolution energy-dispersive diffraction using synchrotron radiation. 1977

DL/SRF/P105 (Experimental)
S.S.Hasnain, T.D.S. Hamilton and I.H. Munro
Absorption coefficients of the $n = 1[\Gamma(3/2), \Gamma(1/2)]$ excitation region of solid krypton. 1977

DL/SRF/P107 (Experimental)
J. Bordas, J. Robertson and J. Jakobsson
Optical properties and band structure of SnS_2, $SnSe_2$, CdI_2, PbI_2, BiI_3 and BiOI. 1978

DL/SRF/P108 (Experimental)
M. Safa and B.K. Tanner
Antiferromagnetic domain wall motion in $KNiF_3$ and $KCoF_3$ observed by x-ray synchrotron topography. 1978

DL/SRF/P109 (Experimental)
D. Norman and D.P. Woodruff
Synchrotron radiation photoemission studies of the adsorption of oxygen on magnesium and aluminium. 1978

DL/SRF/P110 (Experimental)
D. Norman, C. Norris, G.P. Williams and D.P.Woodruff
Photoemitted intensities from core states of chalcogens on nickel up to 160 eV above threshold.

DL/SRF/P114 (Experimental)
A.J. Bourdillon, J. Bordas and F. Khumalo
The reflection spectrum of lead glass. 1978

DL/SRF/P121 (Experimental)
D.Norman and D.P. Woodruff
Plasmon loss structure in synchrotron radiation photoemission from Mg films. 1978

DL/SRF/P123 (Experimental)
J. Bordas, J. Woodhead-Galloway and D.W.L.Hukins
X-ray diffraction by collagen fibrils in costal cartilage using synchrotron radiation. 1978

DL/SRF/P124 (Experimental)
D.K. Bowen
The application of x-ray synchrotron radiation in metallography. 1978

DL/SRF/P130 (Experimental)
J.B. West and J. Morton
Absolute photoionisation cross section tables for xenon in the VUV and the soft x-ray regions. 1978

DL/SRF/P139 (Experimental)
D.G. McCoy, J.M. Morton and G.V. Marr
The angular distribution of photoelectrons as a function of photon energy for the ground state photoionisation of molecular oxygen. 1978

DL/SRF/P142
G.V. Marr, J.M. Morton, R.M. Holmes and D.G. McCoy
The angular distribution of photoelectrons from free molecules of N_2 and CO as a function of photon energy. 1978

DL/SRF/P147 (Experimental)
G.V. Marr
Photoionisation studies using synchrotron radiation. 1978

DL/SRF/P151 (Experimental)
G.N. Greaves
Intrinsic and modified defect states in silica. 1978

DL/SRF/P152 (Experimental)
K.R. Lea
Highlights of synchrotron radiation. 1978

DL/SRF/P153 (Experimental)
S.S. Hasnain, T.D.S.Hamilton, P. Brint, and I.H.Munro
Luminescence yield spectra of benzene and biphenyl in vacuum ultraviolet. 1978

DL/SRF/P154 (Experimental)
I.H. Munro
Synchrotron radiation and its applications to chemistry. 1978

DL/SRF/P158 (Experimental)
K. Codling
Atomic physics and synchrotron radiation. 1978

DL/SRF/P159 (Experimental)
D.M.P. Holland, K. Codling, J.B. West and G.V. Marr
Multiple photoionisation in the rare gases from threshold to 280 eV. 1978

DL/SRF/P162 (Experimental)
S.S.Hasnain and T.D.S. Hamilton
Photophysics of highly excited benzene and biphenyl.

DL/SCI/P174E
D.Norman, H.H.Farrell, M.M.Traum, N.V.Smith, D.P.Woodruff, B.W.Holland, M.S.Woolfson, C.W.Seabury, R.J.Purtell, R.P.Merrill and T.N.Rhodin
Photoelectron diffraction observations of adsorbates on nickel surfaces. 1979

DL/SCI/P176E
K. Codling
Atomic effects in XUV spectra of solids. 1979

DL/SCI/P179E
A.J. Bourdillon, R.F. Pettifer and E.A. Marseglia
EXAFS in niobium diselenide intercalated with rubidium. 1979

DL/SCI/P182E
Y. Chikaura and B.K. Tanner
Evidence of interactions between domain walls and dislocation in synchrotron x-radiation topographs of iron whisker crystals. 1979

DL/SCI/P183E
K.R. Lea
Synchrotron radiation in Britain. 1979

DL/SCI/P185E
G.V. Marr, R.M. Holmes and K. Codling
The angular distribution of photoelectrons from molecular hydrogen as a function of photon energy. 1979

DL/SCI/P189E
B.W. Holland, D. Norman and M.S. Woolfson
Optimal mode of data collection for surface structural studies by photoelectron diffraction. 1979

DL/SCI/P192E
G.V. Marr and R.M. Holmes
The angular distribution of photoelectrons from CH_4 as a function of photon energy from near threshold to 30 eV. 1979

DL/SCI/P193E
R.M. Holmes and G.V. Marr
The angular distribution of photoelectrons from N_2, O_2 and CO as a function of photon energy. 1979

DL/SCI/P195E
A.D. Cox and J.H. Beaumont
Polarisation dependence in the x-ray absorption spectrum of zinc fluoride. 1979

DL/SCI/P200E
G.F. Clark, B.K. Tanner and B.M.Wanklyn
X-ray topographic assessment of flux grown crystals of rare earth germanates ($R_2Ge_2O_7$). 1979

DL/SCI/P202E
I.M. Buckley-Golder and B.K. Tanner
Deformation of dislocation-free copper single crystals. Part III: In situ x-ray topography. 1979

DL/SCI/P203E
J.R. Helliwell and J.S. Worgan
Optimal geometry of a curved crystal monochromator for protein crystallography used with synchrotron radiation. 1979

DL/SCI/P209E
G.F. Clark and B.K. Tanner
Antiferromagnetic domain wall motion under external stress. 1980

DL/SCI/P216E
D.M.P. Holland and K. Codling
The double ionisation of barium between 20 and 25 eV 1980

DL/SCI/P219E
G.N. Greaves, A. Fontaine, P. Lagarde, D. Raoux, S.J. Gurman and S. Parke
EXAFS of silica and silicate glasses. 1980

DL/SCI/P220E
J. Bordas, R.C. Bray, S. Gutteridge, C.D. Garner and S.S. Hasnain
X-ray absorption spectroscopy of xanthine oxidase: the molybdenum centres of the functional and desulpho forms. 1980

DL/SCI/P228E
J.B. West
Progress in photoionisation spectroscopy of atoms and molecules: an experimental viewpoint. 1980

DL/SCI/P229E
K. Codling, A.C. Parr, R. Stockbauer, J.B. West and J.L. Dehmer
The effects of autoionisation in vibrational branching ratios and photoelectron angular distributions in molecular photoionisation: The formation of the ground state of O^+ between 574 Å and 600 Å. July, 1980.

DL/SCI/P230E
D.K. Bowen
X-ray microscopy and topography instrumentation and experiments on the SRS at Daresbury. July, 1980.

DL/SCI/P233E

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ACCELERATOR

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R.W. Silversides

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DL/SRF/P86 (Accelerator)
N. Marks
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R.J. Reid
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M.W. Poole
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V.P. Suller
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APPENDIX II

List of grants and agreements which have been approved by the SRFC in the period from March 1977 to March 1981. Those proposals marked "not funded" were considered to be worthy of support, but could not be supported because of particular financial constraints. Note that some grants were for work at overseas facilities.

The cumulative numbers of funded grants/agreements in each year (allowing for expired grants) have been

1977	1978	1979	1980	1981 (to March)
10	24	57	71 (12 expired)	81 (4 expired)

The first year of operation will clearly be a critical one for many users. The first group of experimental stations (in particular, those stations included within the Capital Sanction), were proposed and have been developed around the research interests of synchrotron radiation enthusiasts whose proposals were received in the period from 1977-1979. Several of these awards will expire before the grant holders or their P.D.R.A.'s will have had access to good beam from the SRS. The problem is acute for users whose requirements demand further development of the SRS, e.g. operation of the SRS in the "single bunch" or "multibunch" modes or use of the Wiggler.

SRC Award Reference No.	1977	
	17 February 1977 Meeting	
	Marr	Photoionisation of atoms and molecules using the Bonn synchrotron
	Glazer	Synchrotron radiation and x-ray diffraction
	McMillan	EXAFS studies of non-crystalline solids
	Tanner	X-ray topography of magnetic materials using synchrotron radiation
	Forty & McMillan	Development and application of EXAFS
Expired (March 1981)	26 May 1977 Meeting	
	Cooper	Compton scattering studies with synchrotron radiation
	14 November 1977 Meeting	
	Fabian	Electron structure of alloys by photo-electron spectroscopy and soft x-ray emission with synchrotron radiation
	Joyner	Application of extended x-ray absorption fine structure to the study of supported catalysts
	Glazer	Synchrotron radiation and x-ray diffraction
	Hamilton	VUV spectroscopy of aromatic hydrocarbons in rare gas solids
	1978	
	9 March 1978 Meeting	
GR/A 58425	(Lloyd, Hillier Garner, Barber & Urch	Feasibility study for a high resolution high sensitivity x-ray fluorescence spectrometer at the Daresbury SRF
	25 May 1978 Meeting	
GR/A 6699	Woodruff, Forty, King & Prutton	Surface EXAFS
	Waddington & Yarwood	Far infra-red spectroscopic studies using a synchrotron radiation source (Resubmitted in Nov. 1978)
GR/A 7142	Tanner	Video display of x-ray topographs
GR/A 68608	Marr & Codling	Coincidence studies including the photoionisation of small molecules by synchrotron radiation
GR/A 74395	Hart	X-ray dispersion corrections by x-ray interferometry
GR/A 74470	Norris	Photoelectron spectroscopy of metal surfaces using synchrotron radiation
GR/A 7434	Garner & Hukins	EXAFS studies of biological systems
GR/A 66857	Connerade	Atomic and molecular spectroscopy at the Bonn synchrotrons
Expired	Dolder & Peart	Photoionisation of positive ions

7 November 1978 Meeting

GR/A 65713	Waddington & Yarwood	Far infra-red spectroscopic studies using a synchrotron radiation source
GR/A 82987	Bowen	X-ray topography with synchrotron radiation
GR/A 77594	Glazer	SR and x-ray diffraction
GR/A 78805	G C King (& Read)	Study of threshold photo-double-ionisation using the DL SRS Facility

1979

8 March 1979 Meeting

GR/A 86299	Sherwood	Environmental chamber for synchrotron x-ray topography
GR/A 89238	Borrell & Thorne	Studies of photofragmentation at high photon energies using synchrotron radiation
GR/A 92399	Cundall & Munro	Subnanosecond time resolved fluorescence anisotropy studies using synchrotron radiation
GR/A 86885	Dore	Structural studies of molecular liquids with synchrotron radiation
Expired	Rawson, Parke & James	Exploratory experiments using synchrotron radiation to study oxide glasses
GR/A 90104	P J Sadler	EXAFS studies of metallo-drugs and proteins
GR/A 91897	Pettifer & Thomas	Some applications of EXAFS studies in solid state and surface chemistry

24 May 1979 Meeting

GR/A 95147	Williams	Photoelectron spectroscopy of solid surfaces
GR/B 13053	Norris	Photoelectron spectroscopy of metal surfaces at Daresbury
GR/A 95291	Woodruff & Norman	Angle-resolved photoemission from adsorbate structures
GR/B 02422	Hester	Optical multichannel Raman spectroscopy (Chemistry Committee)
GR/B 10380	Helliwell	X-ray structural investigation of 6-phosphogluconate dehydrogenase from bacillus stearothermophilus
GR/B 03016	Blundell	Synchrotron radiation studies of proteins
GR/B 16382	Blow	Tyrosyl tRNA synthetase diffraction study at ultimate resolution
Expired 31.3.81	Adams	High resolution (2.3 Å) x-ray structural study of 6-phosphogluconate dehydrogenase from sheep liver
GR/B 13107	Johnson	Synchrotron radiation studies on protein crystals
GR/B 06383	Elliott, Sayers & Whitburn	X-ray diffraction study of corneal collagen
GR/B 13039	Tregear	Protein crystallography line adaption for fibre diffraction and use on biological motile systems
GR/B 13152	Rodger	Diffraction studies on muscle
Cancelled	Joyner	Application of EXAFS to the study of supported catalysts
GR/B 00763	Gaskell	An EXAFS study of the structure of metallic alloy and oxide glasses
GR/B 00572	Yoffe, Marseglia & Bourdillon	EXAFS on Daresbury Storage Ring
GR/B 08752	Garner, Knowles & Blackburn	X-ray absorption spectroscopic studies of copper in biological and related chemical systems
GR/B 00787	Marr	Photoionisation of atoms and molecules using the Bonn synchrotron
GR/B 11714	Bowen	Dynamic studies in synchrotron radiation topography
GR/B 15330	Connerade	Reduction and analysis of data from Bonn-Imperial College synchrotron radiation experiments
Expired 31.3.81	Gillott	X-ray diffraction studies of metallic glasses
GR/A 98186	Tanner	Synchrotron x-radiation topography of magnetic materials

6 November 1979 Meeting

Expired 31.3.81	Dixon & Field	Electron-molecule collisions at meV resolution
GR/B 26121	Garner, Hukins & Hasnain	Fluorescence EXAFS studies of metal ions in biological systems
GR/B 25148	Roberts & Joyner	A study of surface molecular processes using synchrotron radiation
GR/B 26091	Brocklehurst	Synchrotron radiation study of fundamental processes in radiation chemistry
GR/B 27579	D A King & Richardson	Photoemission and photodesorption studies on metal single crystal surfaces

1980

12 March 1980 Meeting

	Bowen, Forty & Davies	Microanalytic studies of synchrotron radiation - not funded
	Sherwood	X-ray topographic studies of the decomposition of inorganic solids - not funded
GR/B 35727	Marr, Hillier & West	Angular resolved gas phase photoelectron spectroscopy at the SRS
GR/B 31132	Symons	Applications of ESR spectroscopy in the study of radiation processes (Chemistry Committee)
GR/B 32634	Woodruff & Norman	Angle resolved synchrotron radiation photoemission studies of surface structures
GR/B 33273	Hart	X-ray dispersion corrections by x-ray interferometry at the SRS
	Cundall & Bisby	Radiation damage to proteins by low energy x-irradiation using synchrotron radiation - not funded
GR/B 36458	Corner	Magnetic domain structure of gadolinium-terbium alloys using synchrotron radiation
GR/B 37011	Moore & Lang	Structural studies of diamond by synchrotron radiation topography
	Beagley, Greaves, McAuliffe & Dwyer	EXAFS studies of metal complexes in solution, including oxygen carriers, zeolite catalyst precursors and ammines - not funded

22 May 1980 Meeting

	Randall Pettigrew, Duke & Hasnain (Edinburgh & Daresbury)	Structural studies of the iron environment in haemoproteins using x-ray absorption specroscopy - not funded
GR/B 51222	Tallentire & Munro (Manchester & Daresbury)	Radiation damage induced in cells by monochromatic radiation from the SRS
GR/B 45634	Bray (Sussex)	The structure of molybdenum centres in enzymes from x-ray absorption spectroscopy
	Sherwood & Bloor (Strathclyde & QMC)	X-ray topography of polymer single crystals - not funded
GR/B 51154	Atkins (Bristol)	Application of synchrotron x-ray radiation to fibrous polymer structure and morphology
GR/B 47010	Potts (King's)	Frequency dependence and asymmetry in gas phase photoelectron spectroscopy using synchrotron radiation
GR/B 49847	Field (Bristol)	Electron-molecule reactions using a tunable photoionisation source of electrons - a pilot study - funded later
GR/B 49557	Blow, Wonacott & Franks (Imperial)	Synchrotron radiation facilities for protein and membrane structure research
GR/B 52311	Cooper (Warwick)	Magnetic Compton scattering with synchrotron radiation

	Daresbury Lab. with Dr A M Glazer and Dr P Thompson (Dept. Physics, Oxford University)	A powder diffraction facility for the SRS
	Daresbury Lab. with Dr J R Helliwell, (Dept. Physics, Keele University)	An electronic area detection system for protein crystallography, fibre diffraction and small angle scattering at the SRS

11 November 1980 Meeting

GR/B 56885	Willis & Hughes (Cambridge)	Synchrotron radiation angle resolved photoemission studies of iron systems at Wisconsin Facility
	Parke (Sheffield)	EXAFS study of glasses containing transition metal ions - not funded
	Sherwood (Strathclyde)	X-ray topographic studies of the decomposition of inorganic solids - not funded
GR/B 61283	Bowen, Forty & Davies (Warwick)	Microanalytic studies by synchrotron radiation
GR/B 56043	Harrison (Sheffield)	Structural studies on Ferritin: high resolution structure of apoferritin and its refinement (Biological Sciences Committee)
GR/B 53127	Cundall (p.p. Becker) (Salford)	Senior Visiting Fellowship
GR/B 57484	Catlow, Chadwick & Greaves (Univ. College; Kent; DL)	EXAFS studies of disorder in crystalline solids
GR/B 58863	Johnson, Lewis, Evans, Moyles & Wells (Cambridge; Southampton; Hull)	Structural studies on transition metal clusters by EXAFS
GR/B 57002	Williams (p.p. McGovern) (Coleraine)	Senior Visiting Fellowship
GR/B 64208	Dolder & Peart (Newcastle)	Interactions between ions and VUV radiation
GR/B 63300	Dodson (York)	The application of synchrotron radiation to structural studies on insulin in solution and the crystal
GR/B 65007	Baldwin, Carpenter & Rattle (Portsmouth)	X-ray scattering studies of chromatin chromosomal proteins and human growth hormone
GR/B 61696	Forty (Warwick)	EXAFS studies of amorphous alumina
GR/B 65434	Field (Bristol)	Electron-molecule studies using a tunable photoionisation source of electrons: a pilot study
	Randall, Pettigrew & Hasnain (Edinburgh; DL)	Application of EXAFS for determination of the ligand distances (up to 4 Å) around the Fe atom in haemoproteins - not funded
GR/B 57880	Gaskell (Cambridge)	Partial pair distribution functions in amorphous alloys and oxide glasses (Neutron Beam Committee)

16 March 1981 Meeting

APPLICANTS	INSTITUTION	PROJECT TITLE
Dr J P Connerade (BONN)	Imperial College	High resolution ultraviolet spectroscopy of atoms and molecules with and without magnetic fields
Dr R G Jordan and	Univ. of Birmingham and	Electronic structure of random substitutional alloys

Dr B L Gyorffy	Univ. of Bristol	
Prof G F Elliott and Dr E M Bartels	The Open University	Measurement of myosin axial spacing change due to ion binding in glycerinated and skinned striated muscle fibres - not funded
Prof J N Sherwood and Dr D Bloor	Univ. of Strathclyde and Queen Mary College	X-ray topography of polymer single crystals
Dr B Beagley, Dr G N Greaves, Dr C A McAuliffe and Dr J Dwyer	UMIST and DL	EXAFS studies (including solution studies) of zeolite systems and oxygen carriers
Prof R J Donovan and Dr I H Munro	Univ. of Edinburgh and DL	Spectroscopic and kinetic study of highly excited states of I_2, using synchrotron radiation
Dr. G. Thornton	Univ. of Manchester	An angle-resolved photoemission and photon-stimulated desorption study of the Sr TiO_3/H_2O system - II.
Dr. A. Miller and Dr R D B Fraser	Oxford University	Senior Visiting Fellow: Quantitative analysis of x-ray fibre diffraction patterns from collagen
Dr J L Finney	Birkbeck College	Synchrotron radiation studies of metallic glass structures using anomalous scattering
Dr D Starling	Univ. of Aston	Microtubule ultrastructure and polymerisation - a study using synchrotron radiation scattering
Dr D G Wilden and Dr J Comer	Univ. of Manchester	Photoelectron spectroscopy of auto-ionising states using multichannel detection
Sir John Randall	Univ. of Edinburgh	I. Studies of dynamics of hydrated biopolymers (QE & IENS). II. Adsorption of proteins by solids (SANS, SAXS, IR) (Biological Sciences Committee)
Mr Michael Dudley	Univ. of Warwick	Post-doctoral fellowship: microanalytic studies by synchrotron radiation
Dr H C Watson	Univ. of Bristol	Extension of the high resolution x-ray structurral studies on yeast phosphoglycerate mutase
Dr D W L Hukins	Univ. of Manchester	Synchrotron radiation study of collagen fibril reorientation in articular cartilage in osteoarthrosis (Funded by MRC)
Dr A Miller	Univ. of Oxford	Structural studies on influenza virus (Funded by MRC)

TABLE 1. PARAMETERS OF SRS EXPERIMENTAL STATIONS

BEAM LINE	STATION	FUNCTION	ANGULAR ACCEPTANCE	MONOCHROMATOR	WINDOWS*	PHOTON FLUX, SPOT SIZE, etc. (Estimate for 2 GeV 100 mA)	NOTE
6	6.1	Angle-dispersed electron spectroscopy (ADES I)	8 mrad (horiz)	Grazing incidence 50-300 Å, ~ 0.1 Å resolution	Windowless (uhv)	~ 2 × 10^{12} photons/s/Å at λ = 100 Å into 1 mm^2	
	6.2	ADES II	10 mrad	Grazing incidence toroidal grating 120-1200 Å, ~ .03 eV	Windowless (uhv)	~ 2 × 10^{14} photons/s/Å at λ = 200 Å	
	6.3	Surface EXAFS (SEXAFS)	10 mrad	Grating and crystal soft x-ray, 1.5-50 Å, ~ 2 eV resolution	Windowless (uhv)	~ 8 × 10^{13} photons/s/Å at λ = 10 Å into 1 mm^2	
7	7.1	Extended x-ray absorption fine structure (EXAFS)	2 mrad	Order-sorting 2-crystal Si 111 or Si 220 (1-3.5 Å)	Be window 35 mm wide at 16 m t = 35-50	~ 10^{11} photons/s at 1.5 Å in beam of dims 3×30 mm^2 (or less) at sample, and δλ/λ ~ 1.3×10^{-4}	
	7.2	Protein crystallography (PX)	3 mrad	Either curved Ge (111) crystal (1-3.5 Å) or (from 1981) vertically focusing mirror and horizontally focusing crystal	Be window 570 mm wide at 21 mm t = 45-60	~ 1.5×10^{11} photons/s at λ = 1.5 Å in beam of dims. 1.3×6.2 mm^2 at focus	Stations 7.2 and 7.3 are alternatives, not available concurrently
	7.3	Fibre diffraction (FD).				~ 1.5×10^{11} photons/s at λ = 1.5 Å in beam of dims. 1.3×0.4 mm^2 at focus	
	7.4	Interferometry (IF)	0.75 mrad	Order-sorting 2-crystal (1-3.5 Å)	Be window 40 mm dia. at 55 m t = 45	~ 4×10^{10} photons/s at 1.5 Å, δλ/λ ~ 1.3×10^{-4}	
	7.5	Topography (TOP2)	2.0 mrad	Monochromatic/ white radiation camera	Be window 130 mm wide or 20 mm dia. at 65 m t=45 or 35	~ 10^3 photons/s/um^2/0.1% δλ/λ at 1.5 Å. Beam 125×20 mm^2 (or less) at sample	Not available when station 7.6 in use
	7.6	Topography (TOP1)	0.5 mrad	White radiation camera	Be window 20 mm dia. at 80 m t = 55-65	~ 10^3/s/μm^2/0.1% δλ/λ at 1.5 Å or ~ 10^6 white photons/s/um^2 Beam 20 mm dia. at sample	Not available when station 7.5 in use
12	12.1	Fluorescence lifetime and time resolved spectroscopy	40 mrad(h) ×7 mrad(v)	Normal incidence > 1200 Å (Spex 1500 SP Czerny Turner)	LiF or silica	~ 4×10^7 photons per pulse in 0.1% δλ/λ for single bunch mode at 60 mA beam	
13	13.1	Infra-red spectroscopy	70 mrad(h) ×40 mrad(v)	Scanning interferometer 10^3-5 cm^{-1}	Silicon or sapphire		Either 13.1 or 13.2 may take beam
	13.2	Spectroscopy		Low dispersion monochromator (0.3 m)	LiF		
3	3.1	Soft EXAFS	~ 5 mrad	5-20 Å crystal	Windowless	~ 10^{13} photons/s	
	3.2	High resolution (5 metre)	3.5 mrad	400-3000 Å ~ .01 Å resolution	Windowless or LiF	~ 3×10^{12} photons/s at 1000 Å	
	3.3	Photoelectron spectroscopy (PES)	10 mrad	toroidal grating 120-1200 Å ~ .05 Å resolution	Windowless	~ 2×10^{14} photons/s at 200 Å	
	3.4	Normal Incidence spectroscopy (SEYA)	7.5 mrad	350-2500 Å ~ .5 Å resolution	Windowless or LiF	~ 5×10^{12} photons/s at 1000 Å	
9	9.1	EXAFS II		as 7.1, λ 0.2 Å	Be window		
	9.2	PX II		as 7.2, λ 0.2 Å	Be window		
	9.3	Powder diffraction			Be window		
	9.4	Topog III or Interf.			Be window		

* t = thickness of beryllium windows (between source and experiment) expressed in thou (1 thou = 0.0254 mm)

TABLE 2. PLANNED DEVELOPMENT PROFILE FOR 1981/1982

Station	Line
Ades I	6
Ades II	6
SEXAFS	6
EXAFS I	7
PX I	7
Interf.	7
Topog I	7
Topog II	7
Lifetimes	12
Infrared	13
Spectroscopy	13
Soft EXAFS	3
5 metre	3
Photoelec.	3
Seya	3
EXAFS II	9
PX II	9
SAS	9
TOPOG III	9

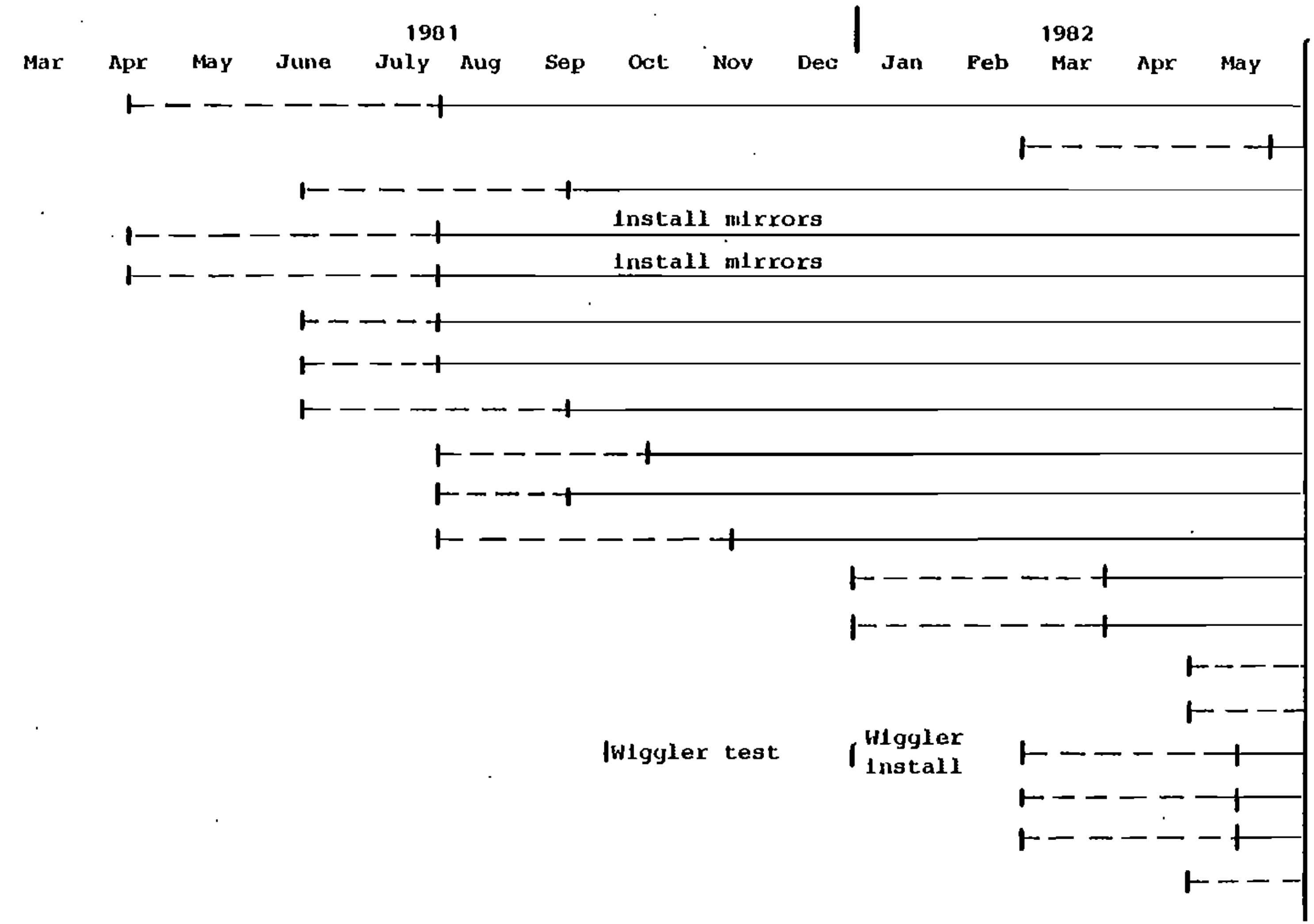


TABLE 3. OVERSEAS ACTIVITIES 1980/81

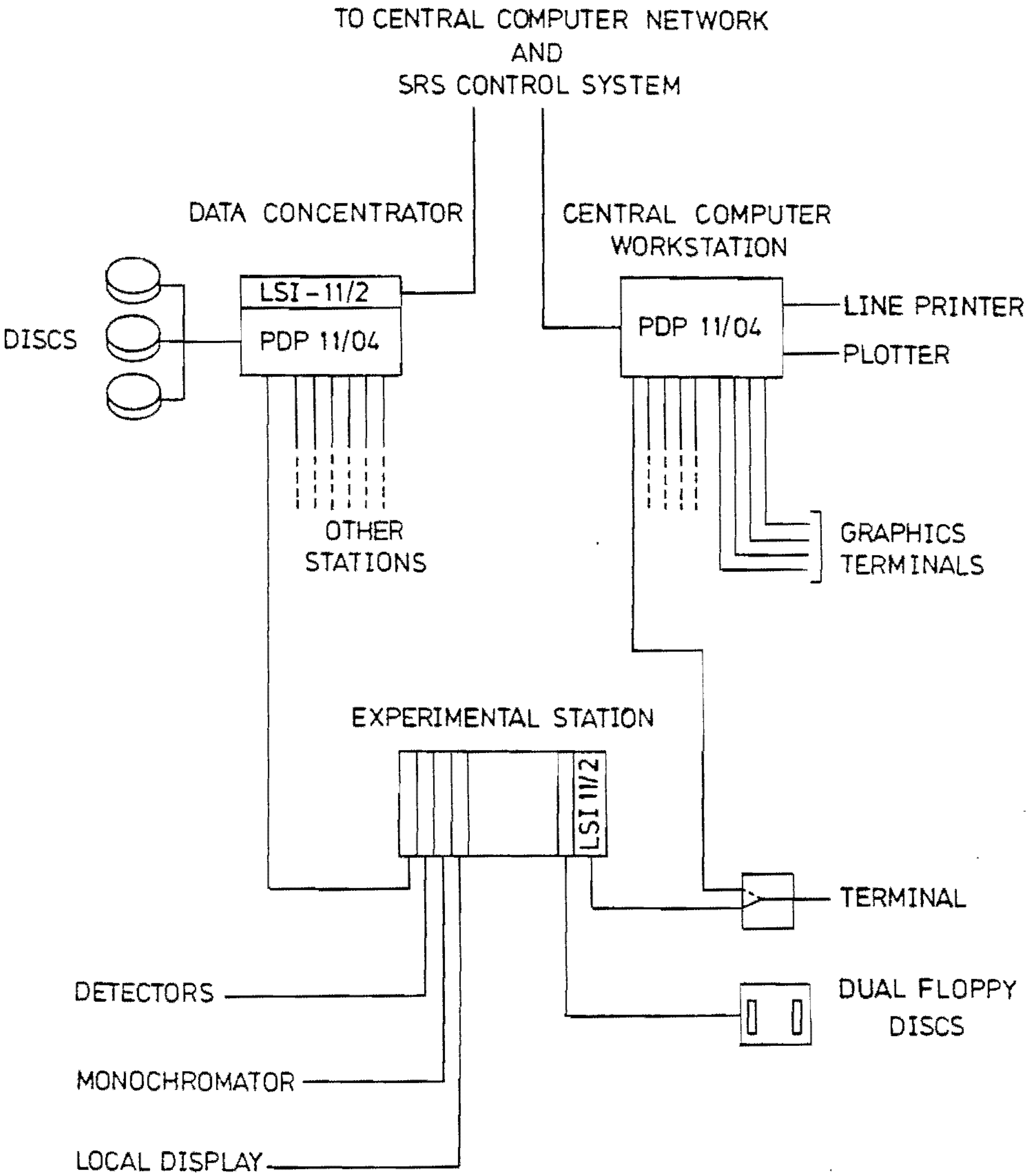
Machine	Experiment	System	Scientists
DORIS	EXAFS	Au and Pt drugs	Sadler, Greaves, Mazid
	EXAFS	Super Oxide Dismutase	Hasnain, Diakun, Blackburn, Miller et al
	EXAFS	Zirconate Glasses	Cox, McMillan
	EXAFS	Supported Catalysts	Joyner
DCI	EXAFS	Ca in bone (1) Rat (2) Mice	Miller, Hukins, Hasnain, Lagarde
ACO	EXAFS	Si and Na in glass	Greaves, Fontaine, Lagarde, Raoux et al
DORIS ADONE (PULS)	Powder Diffraction	Debye-Schlerrer patterns for various powders	Thompson, Glazer, Albianti
DORIS	Protein Crystallography	$K_2Pt(CN)_4$ bound to 6-phosphogluconate dehydrogenase	Helliwell, Bartunick, Adams
DORIS	Small Angle Diffraction	Ox retina	Elliott, Sayers
VEPP-3	X-ray Topography	In-situ polymerization of TCDU	Bowen, Davies, Clark
DCI	X-ray Topography	Plastic deformation of FeSi	Bowen
SPEAR	SEXAFS	Oxidation of Al	Norman, Brennan, Jaeger and Stohr
	SEXAFS	C, N, O & F K-edges	Stohr, Jaeger, Feldhaus , Brennan, Norman and Apai
	SEXAFS	Ion yield EXAFS	Jaeger, Feldhaus, Haase, Stohr, Hussain
	SEXAFS	Ion yield EXAFS	Rehn and Thornton
TANTALUS	Photoelectron diffraction	Te on Ni, I on Cu and Ni	Smith, Farrell, Traum, Woodruff,
	Photoelectron diffraction	Directional emission effects	Woolfson, Holland and Norman

Table 3 (cont)

SURF	Photoelectron spectroscopy	Ground state of O_2^+	Codling, Parr, Ederer, Cole, Stockbauer, West and Dehmer
	Photoelectron spectroscopy	Resonances in Ar and Xe	Codling, West, Parr, Dehmer and Stockbauer
	Photoelectron spectroscopy	Resonances in CO	Cole, Ederer, Stockbauer, Codling, Parr, West, Poliakoff and Dehmer
	Photoelectron spectroscopy	Autoionised resonances in CO^+	Ederer, Parr, Cole, Stockbauer, Dehmer, West and Codling
Bonn (2.5 GeV)	Photoelectron spectroscopy	N_2, O_2 and CO	Holmes and Marr
		CH_4	Marr and Holmes
		H_2	Marr, Holmes and Codling
SURF	Photoelectron spectroscopy	Hopfield bands of N_2 etc.	Parr, Ederer, Cole, West, Stockbauer, Codling and Dehmer
		$3\sigma_g$ photoionisation of N_2	West, Parr, Cole, Ederer, Stockbauer and Dehmer
Bonn (2.5 GeV)	Photoionisation spectroscopy	Double ionization of Ba	Holland and Codling
	Photoionisation spectroscopy	Double ionization of Tl and Pb	Holland and Codling
	Photoionisation spectroscopy	Double ionization of Ba and Yb	Holland, Codling and Chamberlain
ADONE (Wiggler)	X-ray Monochromators	Wiggler diagnostics and focusing	Worgan
SURF	UV Monochromator	Normal incidence high throughput	Ederer, Cole and West
	Angle resolved photoelectron spectroscopy	Atomic and molecular spectroscopy	Parr, Stockbauer, Cole, Ederer, Dehmer and West
Bonn (2.5 GeV)	Reflectivity in UHV	SiC mirrors	Kelly, West and Lloyd
ACO	Total yield EXAFS	Al foils	Woodruff and Jones

TABLE 4. APPLICATIONS FOR EXPLORATORY USE OF THE SRS

No.	Investigators	Institution	Title	Beam time in shifts	Experimental Station
1	Greaves, Helliwell, Quinn, Worgan and Allinson	Daresbury and Keele	Feasibility of polychromatic EXAFS	2 1	7.2 7.1
2	Huxley	MRC, Cambridge	Time-resolved x-ray diffraction studies on muscle contraction	4	7.3
3	Glazer, Thompson and Wood	Oxford	EXAFS on PLZT	3	7.1
4	Vasak and Hasnain	Zurich University and Daresbury	EXAFS of Cd and Zn rabbit metallothionein	3	7.1
5	Holt and Hasnain	Hannah Res. Inst., Ayr, Scotland and Daresbury	EXAFS study of milk calcium phosphates	3	7.1
6	M. Walkinshaw	Edinburgh	A high resolution crystal structure determination of the protein α-cobratoxin using SR	4	7.2



S.R.S. DATA AQUISITION SYSTEM

Fig. 1

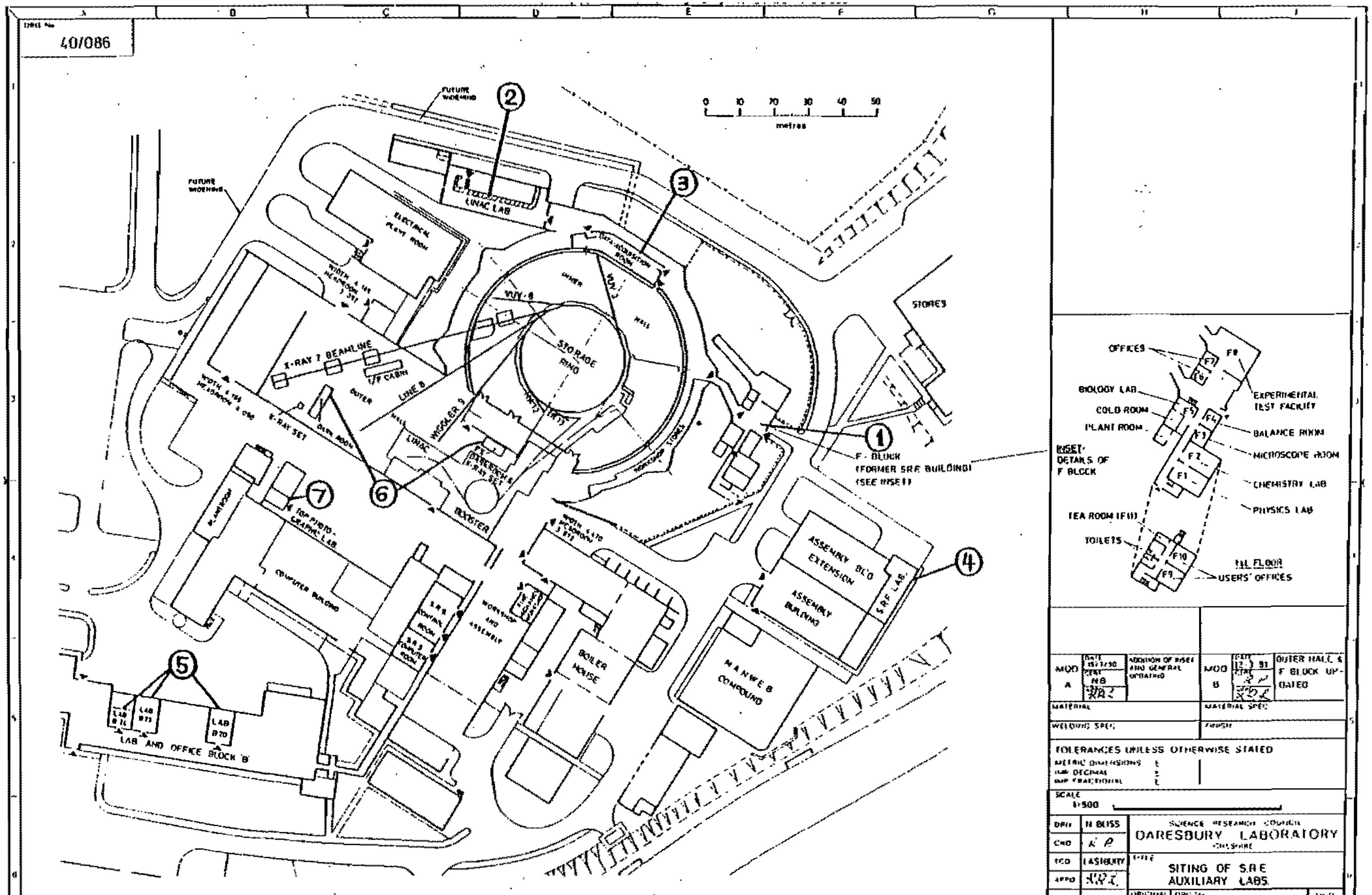


Fig.2 SITING OF SRF AUXILIARY LABS