Science Research Council

Rutherford and Appleton Laboratories

Open Days
8-12 July 1980
at Chilton, Oxfordshire

Quarks to Quasars

Guide Book

Contents

See pages 14-15 for the Chilton Site Plan.

Foreword

The series of Open Days which are being held from 8 to 12 July 1980 provide an opportunity to show you something of the wide range of our research and development activities in science and engineering. This work is undertaken in collaboration with universities and polytechnics, in an environment which is very much an extension of their own research facilities, and with government departments and industry.

Our scientific interests span many fields, including particle physics, the physics of laser produced plasmas, neutron beam research, geophysics and radio, astrophysics and space science. This wide range of activities, summarised in our Open Days theme "Quarks to Quasars", includes fundamental studies through a range from the smallest particles inside the nucleus ("quarks") to those compact sources of enormous energy ("quasars") located far out in space.

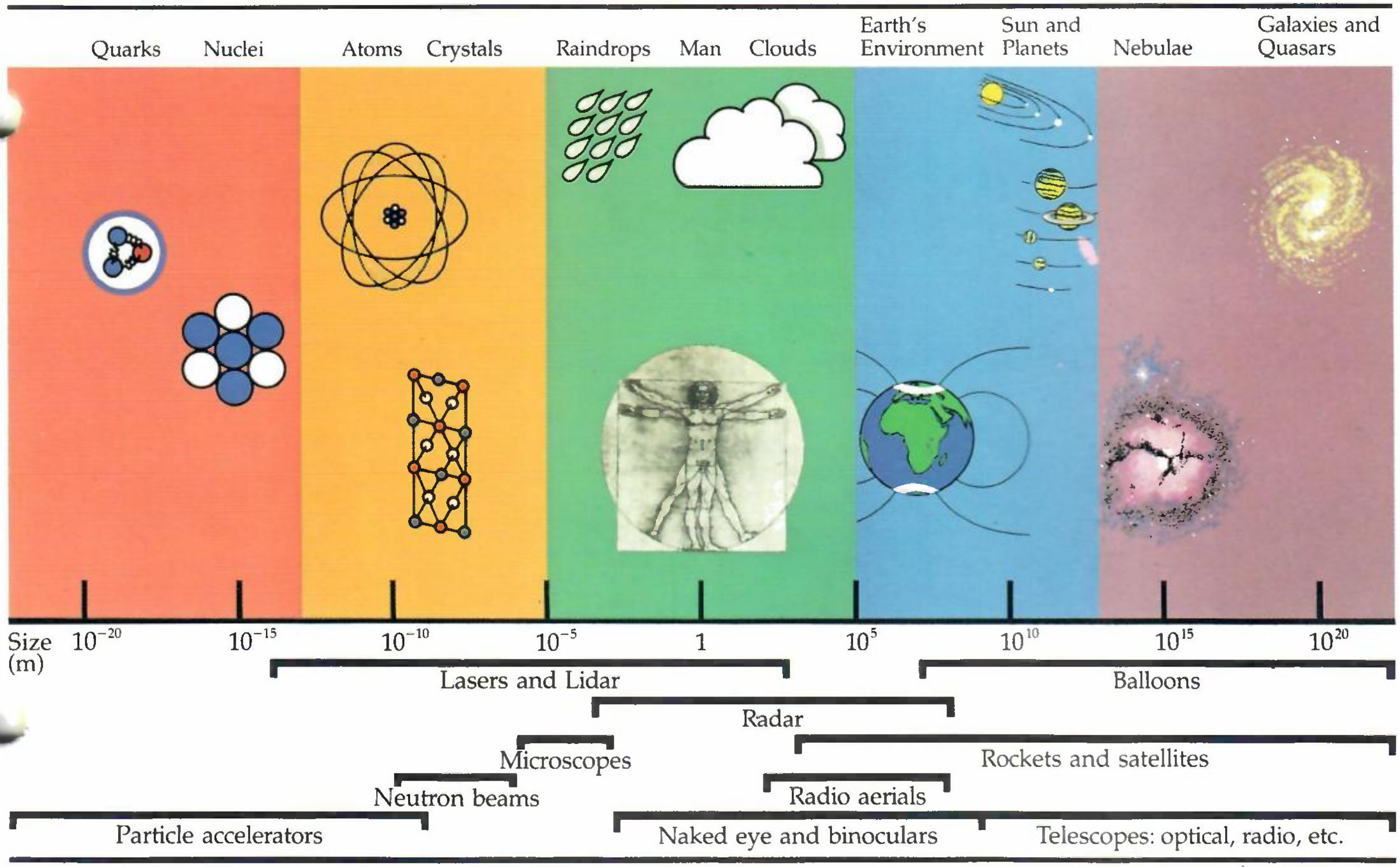
In addition many projects in technology and engineering are undertaken, including work on electron beam lithography, superconductivity, energy research, interactive computing design, special instrumentation and electronics. Our extensive computing resources which are utilised throughout this range of activities serve a community of over 1500 users, mainly in the universities.

We have among our staff a wide range of scientific and engineering disciplines and skills. Many are actively engaged in collaborative research projects, whilst others provide essential support for experiments and facilities both here and overseas. In addition there are staff designing, building and developing sophisticated equipment, instrumentation and advanced computer software. This collective expertise has enabled us to contribute to scientific challenges on an ever broadening front.

We welcome you to our Open Days. You will find that there is much to see and our staff will be happy to discuss their work with you. We hope you have an enjoyable and stimulating day.

G H Stafford
Director General

Quarks to Quasars



"Quarks to Quasars" symbolises the wide range of scientific investigations with which the Rutherford and Appleton Laboratories are associated. The various areas of interest are conveniently depicted in a spectrum related to the scale (or size) of the phenomena involved (as shown in the illustration). At one end there are the fine details inside the atomic nucleus (the so-called "quarks") whilst at the other end are the mysterious phenomena such as "black holes" and "quasars" found in outer space.

The knowledge and understanding over this spectrum is

being actively pursued by the scientific programmes on display during the Open Days.

Moving across the spectrum of size — the smallest particles, quarks and nuclei, are studied by particle physicists. The properties of atoms and molecules are investigated by scientists from many disciplines including physics, chemistry, biology and by engineers. Man-sized phenomena, symbolised by raindrops or clouds in the illustration, are much more within our own general experience. They can frequently be seen by eye or at least with the use of a microscope or a telescope. There remain, however, many facets of their behaviour still to be explored and understood. Moving towards the top end of the size spectrum, we come to effects surrounding the Earth, the study of the Planets and out into space. It is difficult to comprehend that a bright spot on a detailed photograph of the stars may be a whole galaxy, millions of light years away. There is also a range of other phenomena, not visible to the eye, but detectable over a wide band of wavelengths which requires investigation.

Studies across the spectrum also present a technological challenge, since each scale of size requires different techniques to search out and study the phenomena. To peer inside the nucleus we use the fundamental particles themselves as probes, brought to high energies using particle accelerators. Atoms and crystals can be studied with laser beams or low energy neutron beams. Near the size of human experience we rely on everyday visual techniques, together with laser and radar beams. Studies of the Earth's atmosphere and beyond require a variety of detectors and telescopes both on the ground and mounted on balloons, rockets or satellites.

Through "Quarks to Quasars" we seek to provide a feeling of the enormous variation in size of the phenomena being studied, and of the requirements and constraints these place on the investigations. The exhibits show how and why they are being tackled together with some of the results of our efforts. The colours of the spectrum (from red to purple) are used in the heading of the exhibits to identify where the various topics fit into the overall theme.

The Central Exhibition (Area 1) provides through the theme an introduction to the more detailed exhibits which are on display throughout the site. The staff demonstrating the various exhibits are available to discuss the work with you and there are technical leaflets available locally which provide more detailed information.

The Exhibition Areas

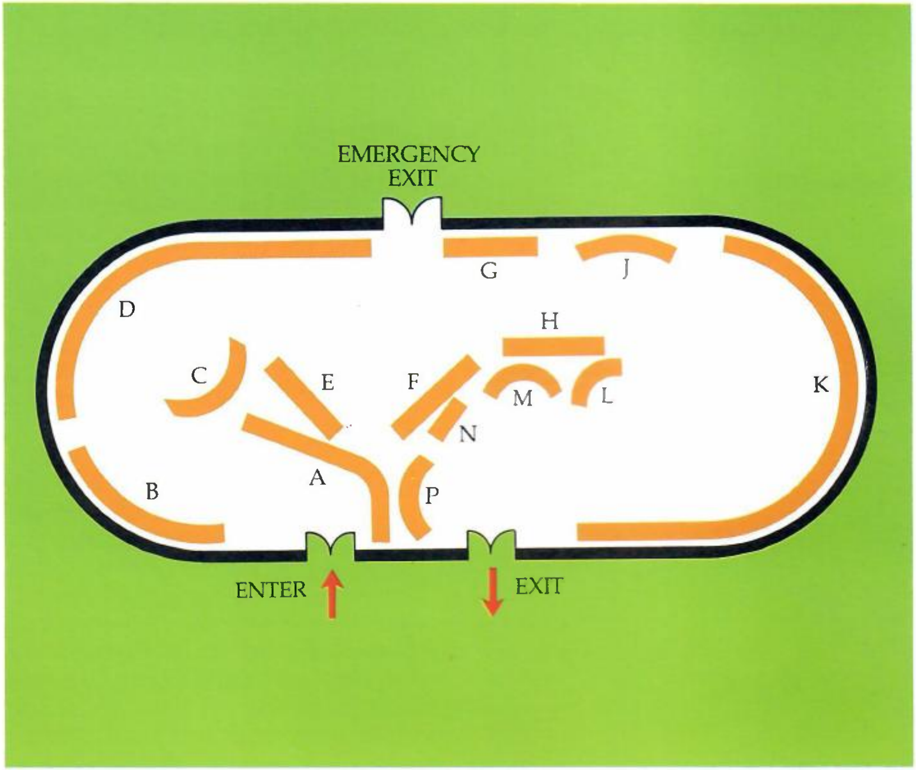
Nine exhibition areas cover the wide range of activities of the Rutherford and Appleton Laboratories. We hope that you find time to visit most of the displays during your stay.

The Central Exhibition

The Central Exhibition surveys the range of research from "Quarks to Quasars" undertaken in collaboration with academic institutions.

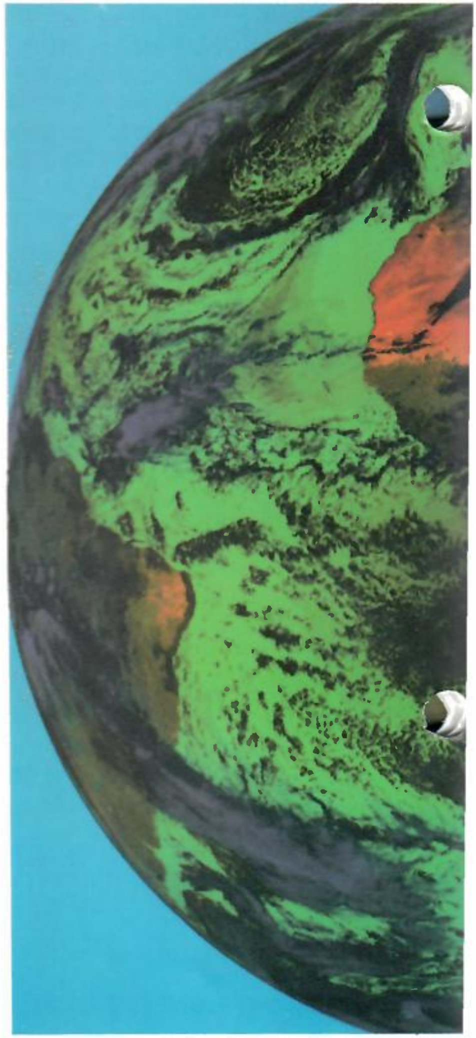
The following list of exhibits makes reference to the location of the eight other exhibition areas which specialise in particular subjects.

Plan of Exhibition Area 1



Display	Exhibit
A	Introduction, the theme and associated academic institutions.
B	Laser and plasma physics (also exhibition area 5)
C	Neutron beam science and the Spallation Neutron Source (also exhibition areas 6 and 7)

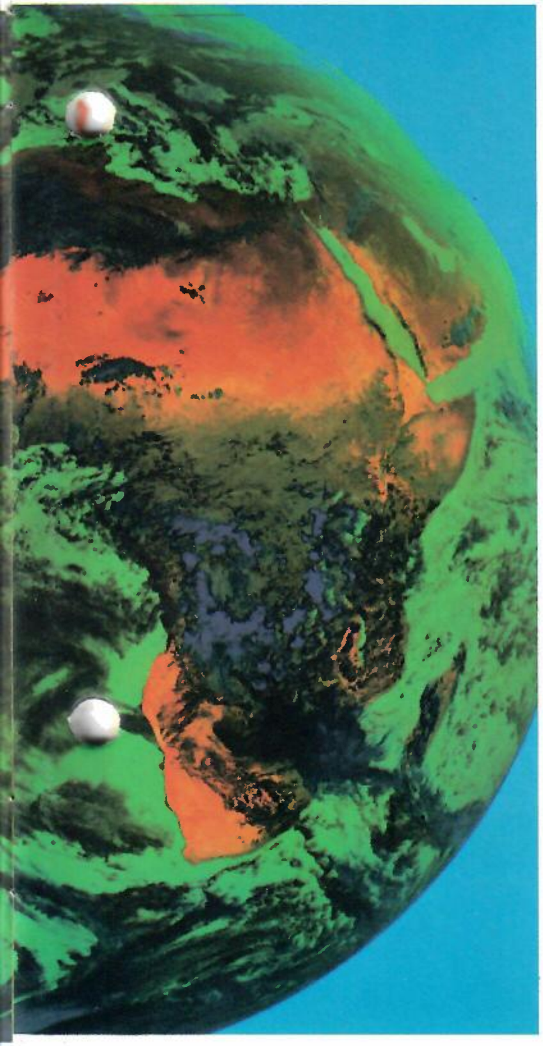
A coloured Meteosat image of the Earth produced by the Interactive Planetary Image Processing System at University College, London. The green shows the "visible" image, red is infra-red radiation and blue is water vapour (Photo: UCL).



D	Fundamental particles: from crystal structure to quarks, the detection of particles, and accelerator facilities (also exhibition areas 3 and 8)
E	Electronics, energy and special equipment (also exhibition area 8)
F	Cryogenics and superconductivity, electron beam lithography, computer-aided design, materials and structures (also exhibition areas 3 and 6)
G	Computing (also exhibition area 9)
H	Applications of electromagnetic waves in communications, geophysics and astronomy (also exhibition areas 2 and 9)
J	Radio research (also exhibition area 2)
K	Space probes: balloons, rockets and satellites (also exhibition areas 2 and 6)
L	Space programme support: the Infra-Red Astronomical Satellite and image processing (also exhibition areas 2, 3 and 9)
M	Modern launch vehicles (also exhibition area 2)
N	Climate observations from space (also exhibition area 2)
P	Astronomical objects: from the sun to quasars (also exhibition area 2)

Radio and Space

This exhibition, located in a marquee adjacent to the Central Exhibition, is arranged in four sections:



Remote Sensing

Astronomers have made observations at wavelengths in the visible region for centuries, but today the spectral range is far wider than the visible, and space vehicles provide platforms from which to examine terrestrial and planetary surfaces and atmospheres. These space-based observations, allied to image processing techniques and the powerful data processing capabilities afforded by computers, are making possible the examination of the Earth and other planets in much greater detail than hitherto.

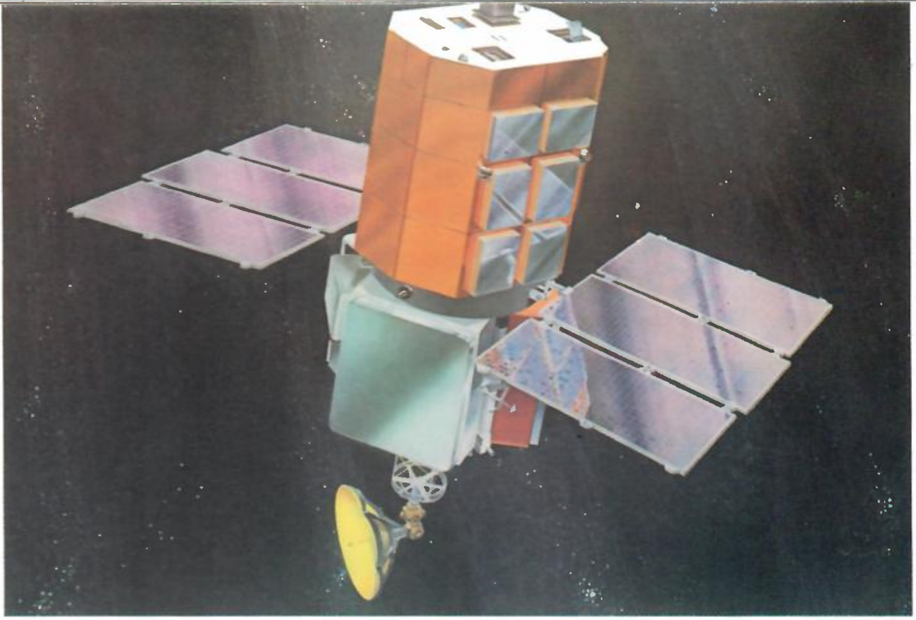
The exhibit describes experiments, most of which are carried out in collaboration with universities, ranging from ground-based observations of the surface of the Atlantic Ocean using HF radar techniques, to satellite-borne microwave and infra-red systems for observing the Earth's atmosphere and oceans and also the surfaces of other planets.

Solar-Terrestrial Physics

The Earth and its environment is bathed in radiation from the Sun which extends from the X-ray region at very short wavelengths through the ultra-violet, visible, infra-red and microwave regions to the very long radio wavelengths. Streams of particles emanating from the Sun (the solar wind) also impact upon the Earth's outer atmosphere. The study of the interaction between solar radiation and the Earth's atmosphere is called solar-terrestrial physics. In this subject solar, atmospheric and geomagnetic phenomena are examined by balloon, rocket and satellite-borne probes aided by radiowave and laser radar techniques.

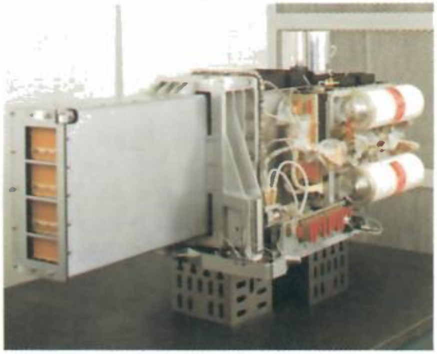
An X-ray image of the Sun.

The exhibit indicates the areas in which new discoveries are expected to be made using the European Incoherent Scatter facility (EISCAT)



An artist's sketch of the Solar Maximum Mission Satellite. (NASA illustration)

Part of the hardware of the X-ray polychromator which is operating on board the Solar Maximum Mission Satellite.



at present being built in Scandinavia by six countries including the UK. The involvement of UK universities in the SRC's balloon and rocket programmes is described, together with results obtained by some of these rockets and also by the laser radar facility which was designed for atmospheric studies.

Space Astronomy

In present-day astronomy, the detection and analysis of all types of radiation are important. Each tells something different about the nature of the cosmos: for example, certain radio emissions originate from objects undergoing violent change, X-rays and ultra-violet radiation from particularly hot regions, infra-red radiation from comparatively cool regions. Of the various types of radiation from outer space, only visible light, some infra-red and radiowaves can penetrate the Earth's atmosphere to be detected at ground level. Astronomical observations at other wavelengths have been made possible over the past few decades by lifting equipment into the clarity of space above the atmosphere's obscuring blanket using balloons, rockets or satellites. Many of the exciting new discoveries in astronomy, such as quasars and black holes, have only been possible because of observations from space.

The exhibit highlights recent and future involvement in major space projects. The X-ray polychromator instrument is one of several solar experiments carried out on the Solar Maximum Mission satellite. Since its launch in February 1980, the satellite has produced a wealth of unique high quality solar observations, and is helping in particular to uncover the mechanisms of solar flares.

Astronomical experiments in many recent satellite missions have incorporated detectors similar to TV cameras which are used in the focal plane of telescopes or spectrographs to transmit high resolution images to the ground stations. The considerable practical expertise which we have built up over recent years is now being applied to image processing on the Space Telescope Faint Object Camera.

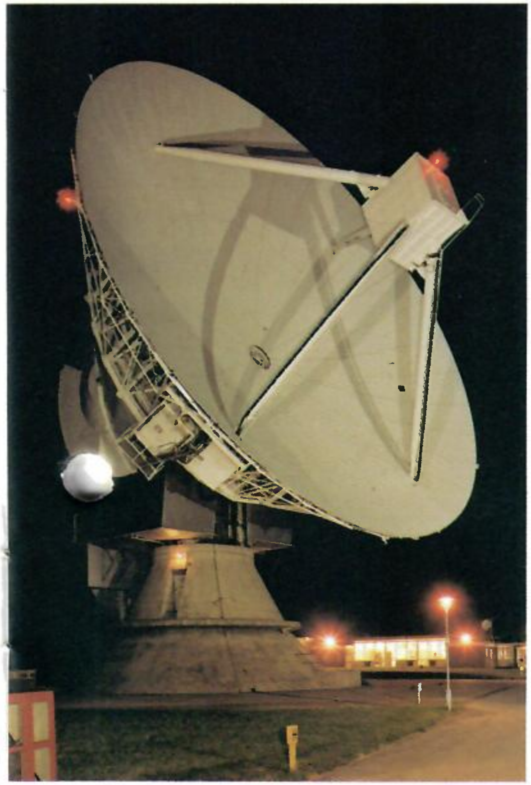
Communications

The efficient use of radiowaves depends upon a thorough understanding of their interaction with the media through which they pass. Radio communication at relatively low frequencies through reflection from the ionosphere still needs to be improved; ionospheric research continues to provide challenges for both the scientist and the communications engineer. The pressing need to provide more communications channels and with higher data rates has opened up new fields of study in the propagation of microwaves, and has led to the development of satellite communication links; these are particularly affected by the

Area 3

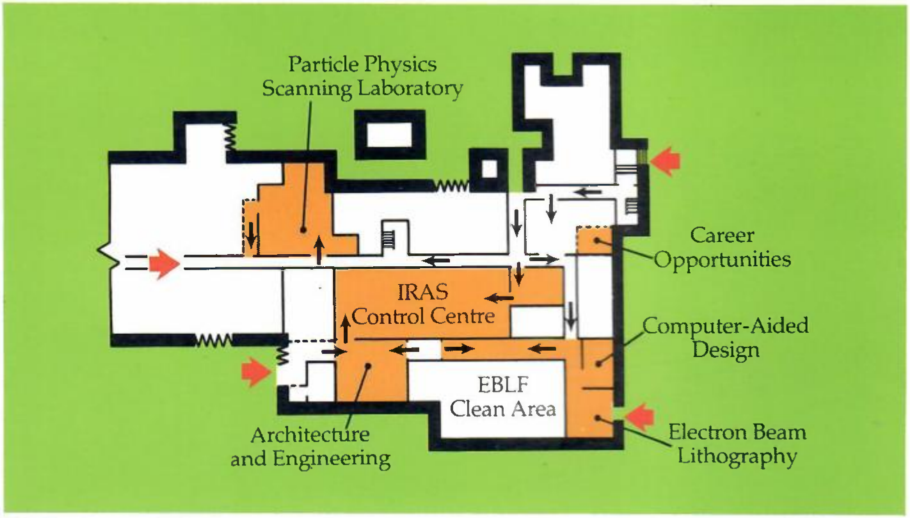
There are 5 separate exhibits in this area which are arranged in the East Wing of Building R1, as shown in the plan.

conditions in the lower atmosphere. Some recent studies of the effects of rainfall on terrestrial microwave systems and also on satellite links is presented, and some of our microwave and millimetre-wave laboratory work and test facilities are described.



View of the 25m diameter antenna at Chilbolton.

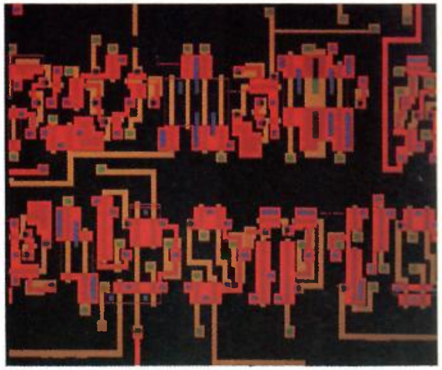
Plan of Exhibition Area 3



Electron Beam Lithography

At the Electron Beam Lithography Facility, a fine electron beam is used to draw precision masks (or patterns) for the manufacture of microcircuits for university and polytechnic research projects. The masks define the intricate geometrical patterns which, when projected sequentially on to a suitable substrate, build up tens of thousands of electronic components on a single silicon wafer or chip. The Facility contains the equipment to produce high precision masks under the direct control of a computer. A full range of necessary supporting equipment can be seen installed in the ultra-clean laboratory and the various stages of manufacture are described.

The design and layout of the chips is performed using the **computer-aided design** program "Gaelic", which produces an output used by the Facility to make the set of mask plates. This use of interactive graphics techniques is demonstrated, together with other applications in general engineering, such as the computation of eddy currents, electromagnet and electrical machine performance and the design of electron optics for microcircuit fabrication.



An example of the rastergraphic technique for integrated microcircuit design.

Infra-Red Astronomical Satellite

The Infra-Red Astronomical Satellite (IRAS) is a collaborative project involving the United States, the Netherlands and the United Kingdom. The prime objective is to carry out a complete survey of the infra-red sky; in addition some time will be available for scientists to observe particular infra-red objects. The launch is planned for 1982, and the expected lifetime is one year.

The United States have the responsibility for building the prime scientific instrument and for producing the final IRAS catalogue. The Netherlands are providing the spacecraft and some additional instruments.

The United Kingdom and the Netherlands are responsible for the Tracking Station and the Operations Control Centre, located at Chilton, which handle 700 million bits of data every 24 hours. A preliminary analysis facility is being prepared at Chilton to monitor the mission-critical aspects of scientific data analysis. The 12m diameter antenna is visible on the site, and the Operations Control Centre is open for your inspection in this area.

The 12m diameter antenna which is being set up to track the Infra-Red Astronomical Satellite.

Particle Physics Scanning Laboratory

This exhibit illustrates the application of the bubble chamber technique to particle physics research. Chambers containing super-heated liquids are used to detect elementary charged particles which leave trails of tiny bubbles as they pass through. The interactions of the elementary particles are recorded by photographing the tracks. Three current experiments are on display, showing film taken using bubble chambers at the CERN Laboratory (Geneva, Switzerland) and at SLAC (California, USA). The chambers range in size from a small high resolution chamber (LEBC) which has a diameter of only *20 cm* to the big European chamber (BEBC) which has a diameter of *3.7 metres*. The three experiments are:–

1. The search for charm particles using the LEBC chamber at CERN.
2. The search for baryonium states produced in antiproton-proton interactions in the SLAC 60-inch chamber. This is a hybrid experiment combining both the bubble chamber and the

Scanning bubble chamber film to learn about the interaction of fundamental particles.

electronic counter techniques.

3. The study of neutrino interactions in the BEBC chamber at CERN.

The scanning and measuring of film from these experiments is in progress. There are also exhibits illustrating the application of microcomputers to the problem of data collection and control of film measuring machines.

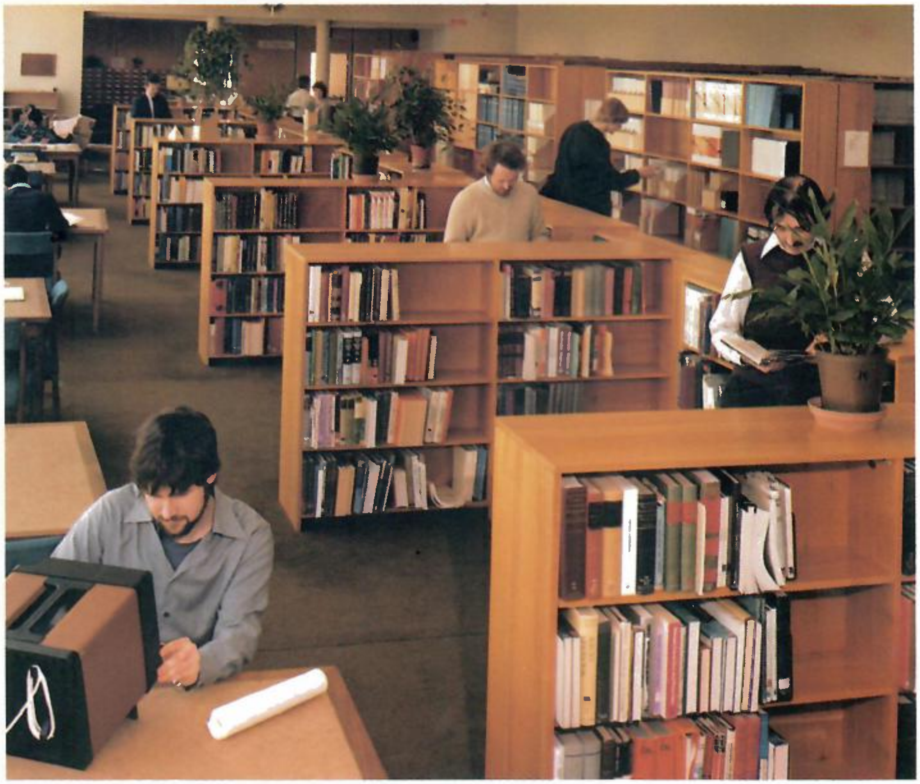
Architecture and Engineering

This exhibit covers activities in Architecture and Engineering with displays of photographs and drawings of projects carried out at various SRC establishments. A consulting service is provided for the design, construction and maintenance of buildings and plant, some of which are of a highly specialised nature. The emphasis laced on various aspects of energy conservation is also displayed.

Career Opportunities

In this area we show something of the range of work undertaken particularly by younger staff at the Rutherford and Appleton Laboratories. Information is also available about careers and further education within the SRC and in science and engineering in general.

The Main Library.

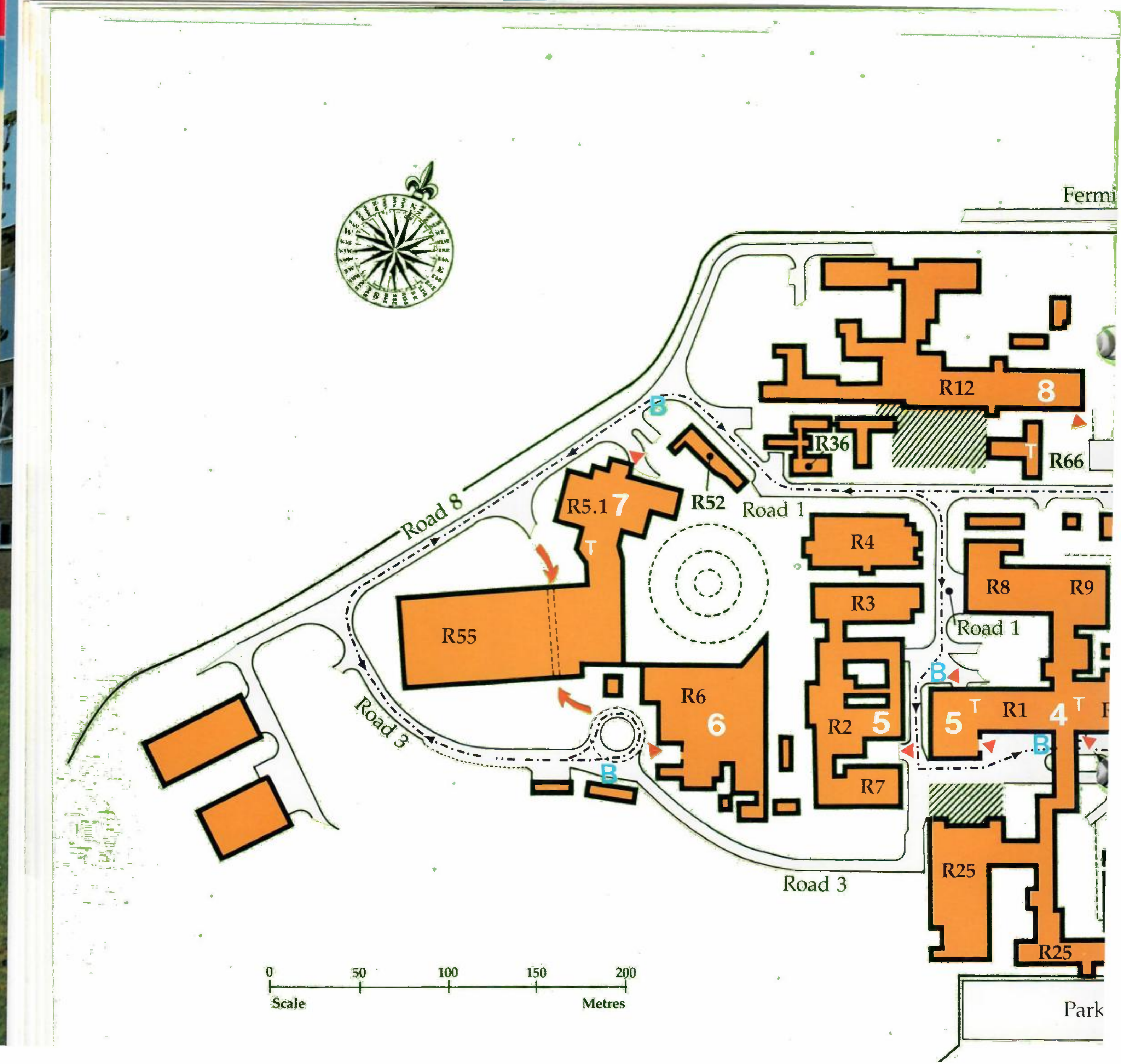


Science Research Council

In the Entrance Foyer to Building R1 is a display illustrating the role of the Science Research Council in developing the sciences, maintaining the capacity for research and supporting higher education.

Library

On the first floor, the Main Library is open for your inspection. This area contains a display of some of the publications and reports on our work, and there are regular demonstrations of on-line computer-aided information retrieval.



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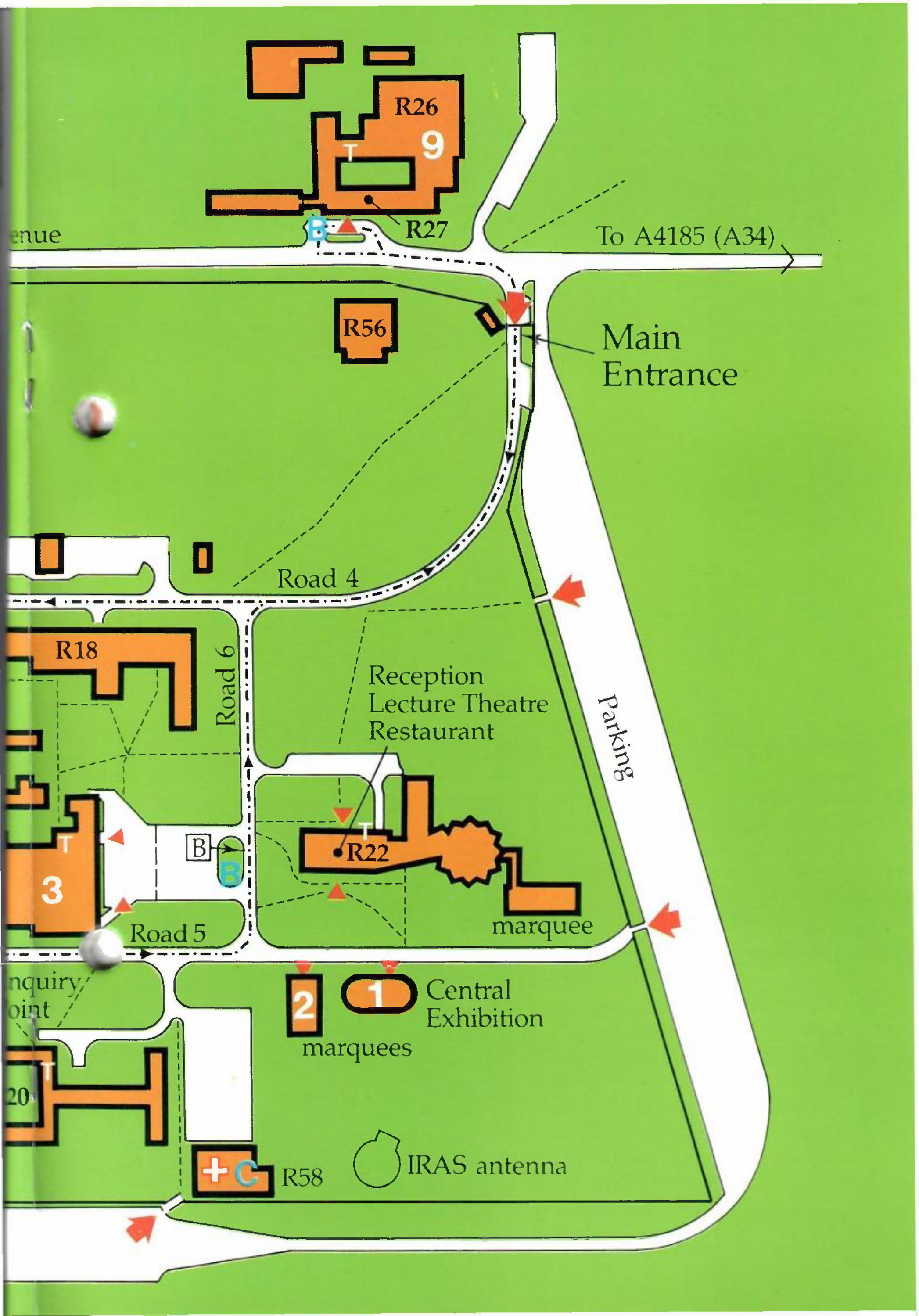


Site Plan

T	Toilet
B	Bus Stop
[B]	Bus to Didcot Station *(Wednesday to Friday)*
·–►–·	Bus Route *(Wednesday to Friday)*
✚	Visitors' First Aid
C	Children's Crêche *(Saturday)*
-----	Pathways
▶	Entrance to Exhibition Areas
➡	Entrance to the Chilton site

Area 1 The Central Exhibition

Area 2 Radio and Space

Area 3 Electron Beam Lithography
Infra-Red Astronomical Satellite
Particle Physics Scanning Laborator
Architecture and Engineering
Career Opportunities

Area 4 Science Research Council
Library

Area 5 Central Laser Facility

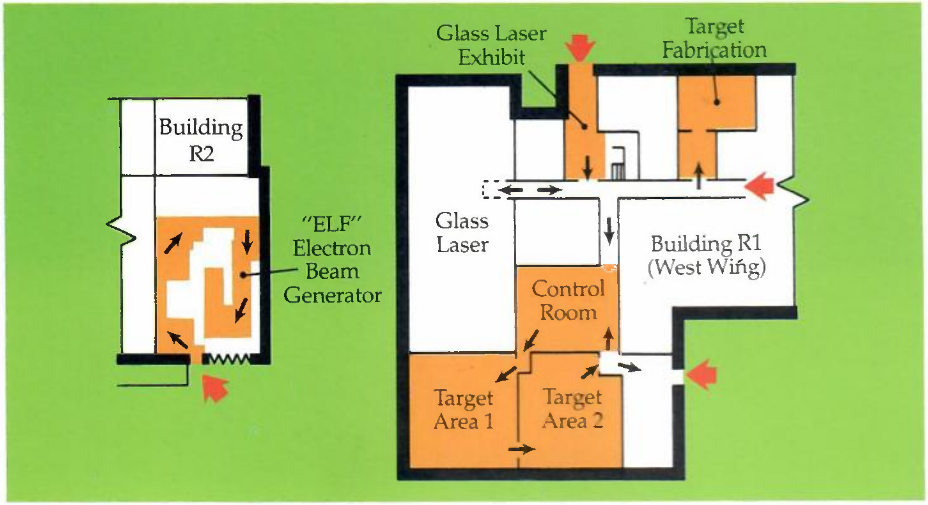
Area 6 Stabilised Balloon Platform
Advanced Technology
Neutron Beam Science
Spallation Neutron Source

Area 7 The 70 MeV Linear Accelerator

Area 8 Particle Physics
Special Instrumentation

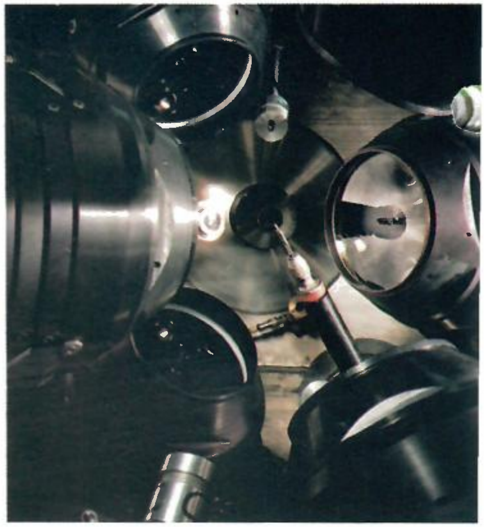
Area 9 Computing

Plan of Exhibition Area 5



Area 5

An interior view of the six-beam target chamber, used for laser compression experiments.



Central Laser Facility

The West Wing of Building R1 houses one of the world's most powerful research lasers. The Central Laser Facility provides a high power neodymium-glass laser for university research in the areas of laser-produced plasmas and laser compression. Research is also under way to develop new, efficient gas lasers for plasma physics and other applications; the electron beam generator ("ELF") is available for this work. The following areas are on show:

Glass Laser Installation — The 2 terawatt (2 million million watts), 6-beam neodymium-glass laser is housed in a temperature-controlled clean room. The various components of this complex laser system are described in the Foyer.

Target Areas — Two target areas are on display. The first is used for 6-beam laser compression experiments and the second is for single-beam interaction physics studies. Target chambers, plasma diagnostic equipment and laser beam-steering optics are on show.

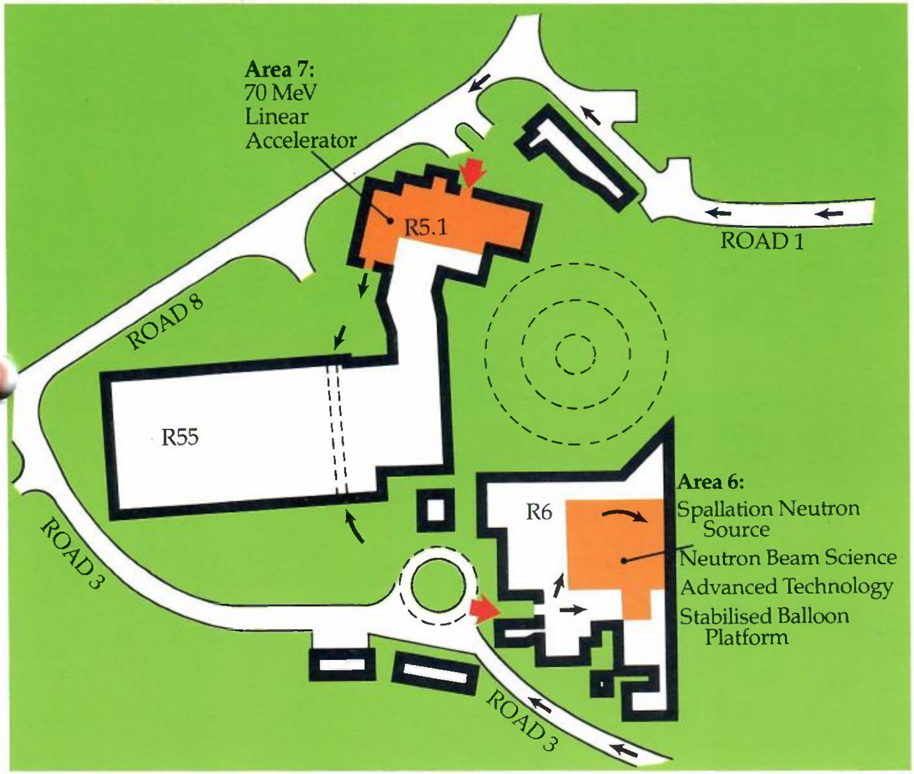
Target Fabrication — Laser plasmas are generated by focusing the high power laser beams on to specially constructed, sub-millimetre sized targets. Both spherical and planar targets are used. This exhibit demonstrates the various processes involved in the fabrication of these delicate and complex assemblies. Final target inspection is performed using a scanning electron microscope which is operating in this area.

Gas Lasers — Gas laser research is carried out using a 1.5 million volt, 60,000 amp, electron-beam generator ("ELF") as an excitation source. The high power generator and gas laser equipment are on display in Building R2.

"ELF" — a high current electron beam generator for gas laser research.

Area 6

Four exhibits are located in Building R6 (as shown on the plan) which is accessed via Roads 1 or 3.

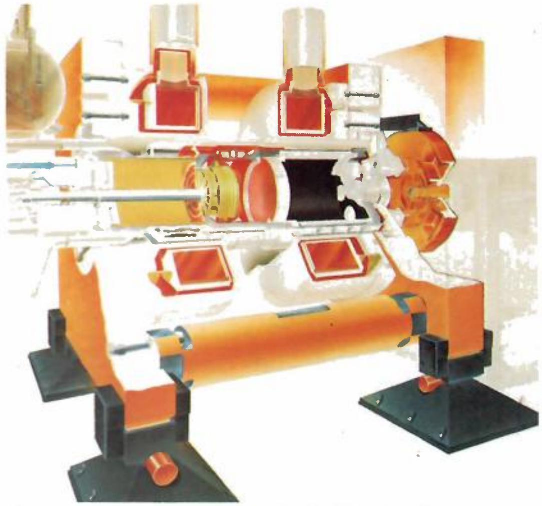


Plan of Exhibition Areas 6 and 7

Stabilised Balloon Platform

The stabilised balloon platform on view is a prototype 3-axis stabilised gondola which supports balloon-borne apparatus for UK university research. It is designed to carry equipment weighing 40 kilogrammes to altitudes of 40 kilometres. Its function is to locate and track optically faint celestial objects over long periods with extremely precise (arc-second) pointing accuracy. The platform is regularly flown from the National Scientific Balloon Facility in Palestine, Texas.

Inflating a million cubic foot balloon which will support the stabilised balloon platform.

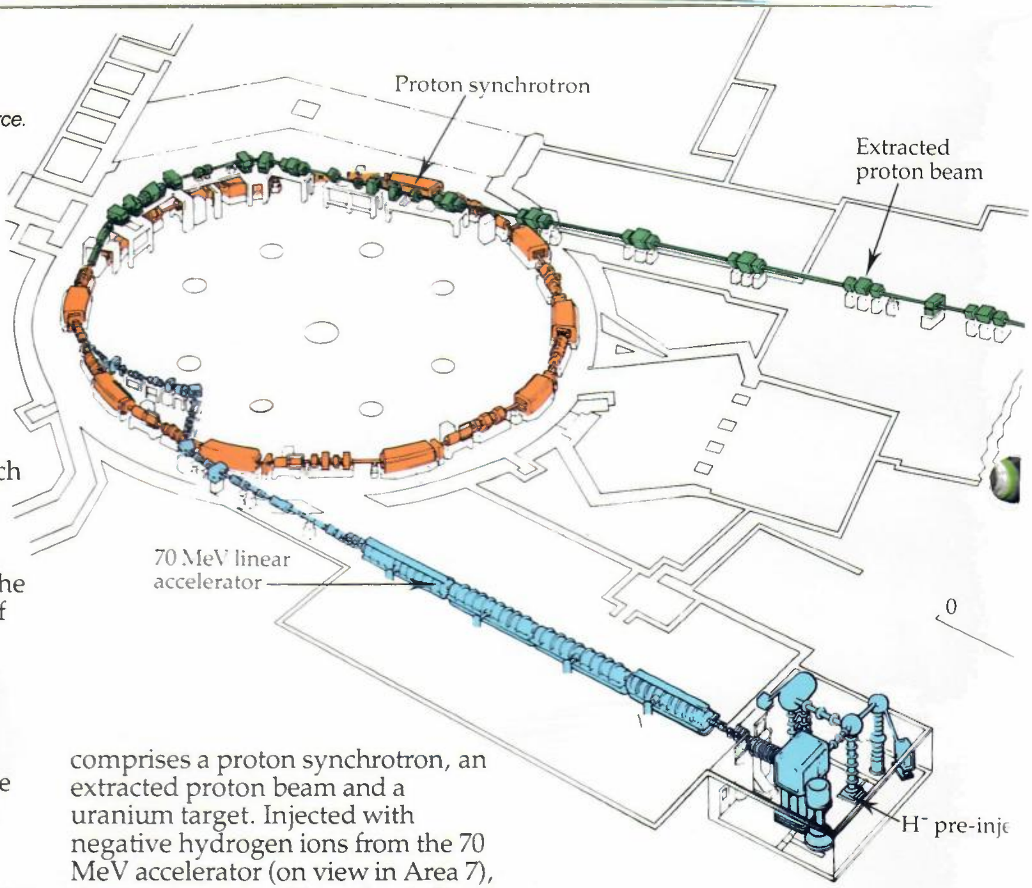


Artist's sketch of the rapid cycling bubble chamber.

Advanced Technology

The exhibit highlights recent technological developments at low and high temperatures and in materials and structures. At low temperature, there is a demonstration of the phenomenon of superconductivity. The function and operation of a rapid cycling bubble chamber, and the design details of a novel type of regenerative compressor are explained. High temperature research is demonstrated by means of a fluidised combustion facility, used in the efficient combustion of various grades of coal.

Layout of the Spallation Neutron Source.



The materials and structures aspects include a summary of the material testing and fabrication techniques applied to problems such as the construction of windmill blades, superconducting magnets and a telescope for detecting millimetre wavelength radiation. The purpose and construction details of the telescope are also illustrated.

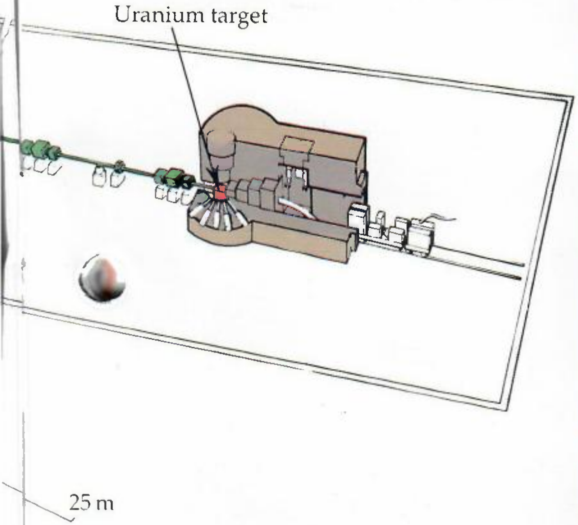
Neutron Beam Science

Neutron beams provide a powerful probe for physicists, chemists and biologists to study the structure and properties of matter. Support is provided for neutron scattering research by universities using reactors and the electron linac at Harwell and at the high flux reactor at the Institut Laue-Langevin in Grenoble. Our activities include scientific collaboration with university scientists, the provision of technical support for their work and the development of new instruments and techniques.

Spallation Neutron Source

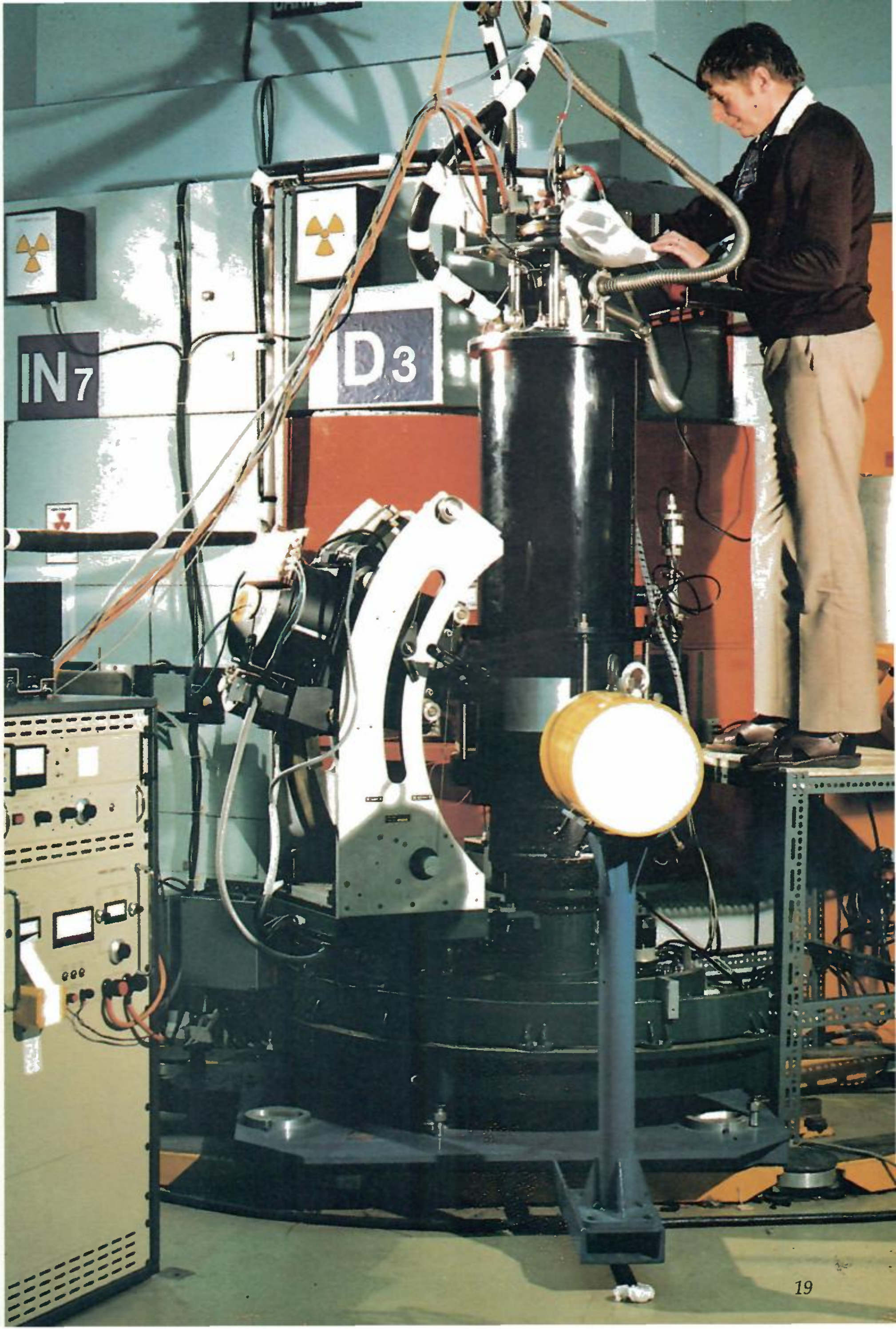
A new, high intensity, pulsed neutron source — the Spallation Neutron Source (SNS) — is currently being constructed on site to provide UK universities with a powerful facility for condensed matter research in the mid-1980s. The new source comprises a proton synchrotron, an extracted proton beam and a uranium target. Injected with negative hydrogen ions from the 70 MeV accelerator (on view in Area 7), the synchrotron will accelerate 2 to 3 $\times 10^{13}$ protons per pulse to 800 MeV at 50 cycles per second. The beam will then be extracted and transported to the target assembly with its moderators, reflectors and bulk shielding, which will act as an intense neutron source. The neutrons are collimated and travel down 18 channels to the awaiting experimental instruments.

The display highlights the progress on all fronts in the construction of the SNS, and indicates some of its other proposed uses: for example, as a bio-medical pion beam facility. A selection of synchrotron ring magnets, both prototypes and production versions, can be seen in a test and measurement area, together with a power supply development rig, and an on-line demonstration of a quadrupole magnet being measured with harmonic analysis equipment. The measurement system is computer controlled and provides useful experience for the final development phase of the machine control system. Ceramic vacuum vessels and pumping apparatus are on view, and the scheme for alignment of ring components is set up for inspection. Components of the synchrotron radio frequency accelerating system are on display with prototype beam detectors and monitors. Various hardware items



associated with control and basic services are featured, together with models of the machine and target station.

A major activity is underway preparing apparatus for the exploitation of the SNS. It is envisaged that about 20 to 25 instruments will be needed, and about half are at an advanced stage of design. The display on **Neutron Beam Science** concentrates on this preparatory work, including a general layout of the proposed SNS instruments with some described in more detail. The computer control of the instruments and the data acquisition scheme are described. Demonstrations include a working position-sensitive detector, examples of the development of high-speed rotors and a model of a diffraction experiment.



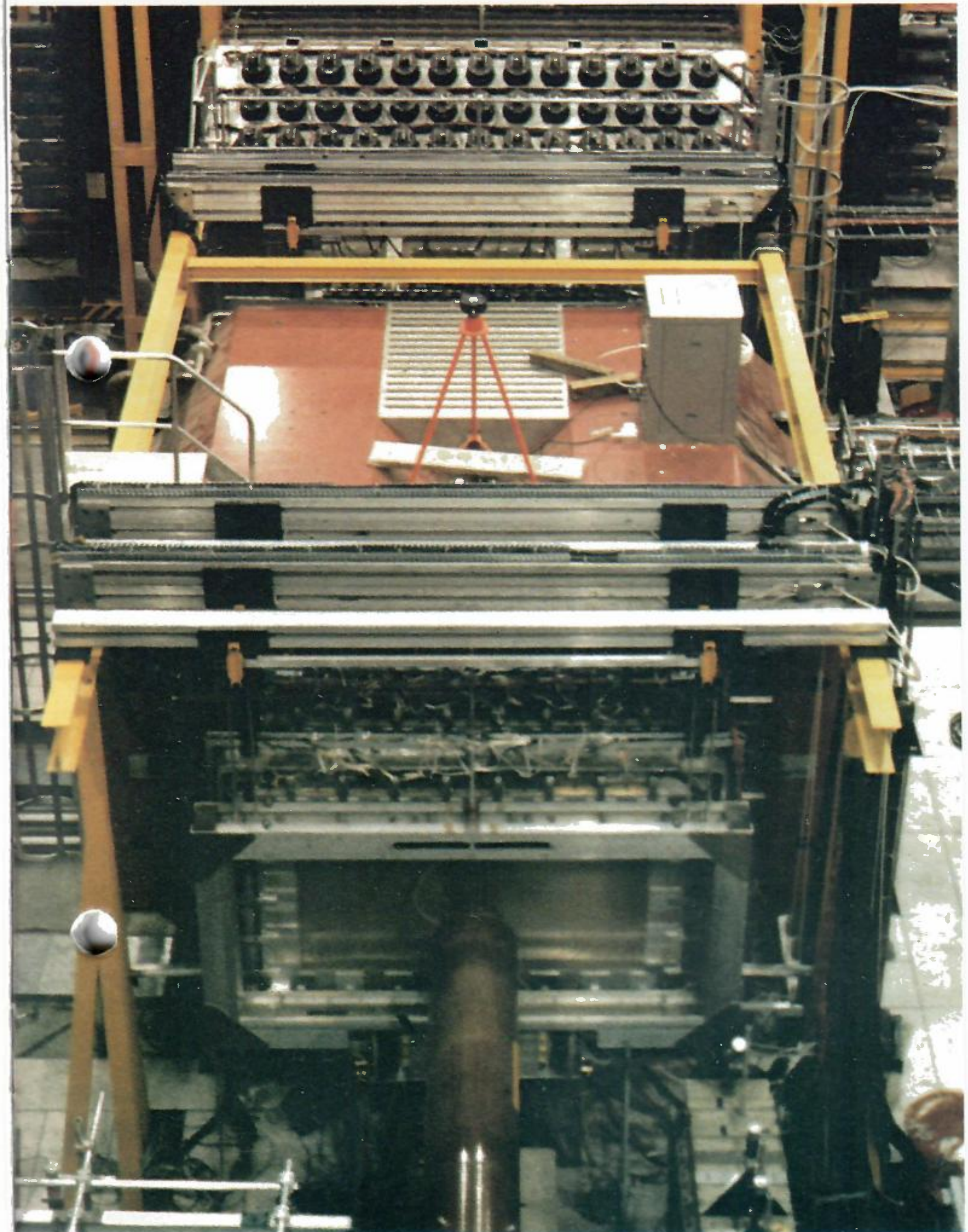
A typical instrument used in neutron beam research at the Institut Laue-Langevin in Grenoble. This diffractometer (D3) is designed for experiments in which the specimen is irradiated by a beam of polarised neutrons (Photo: ILL).

Area 7

The 70 MeV Linear Accelerator

The 70 million electron volt accelerator is to be used as the injector for the Spallation Neutron Source. Originally built as a new injector for the Nimrod proton synchrotron, it has been modified for use with the SNS. The pre-injector, the four main accelerating tanks of the linac and the associated high-power drive units are all on view in Building R5.1. (See page 17 for the location plan).

View of the pre-injector for the 70 MeV linac.



Area 8

Two topics are displayed in this area in Building R12.

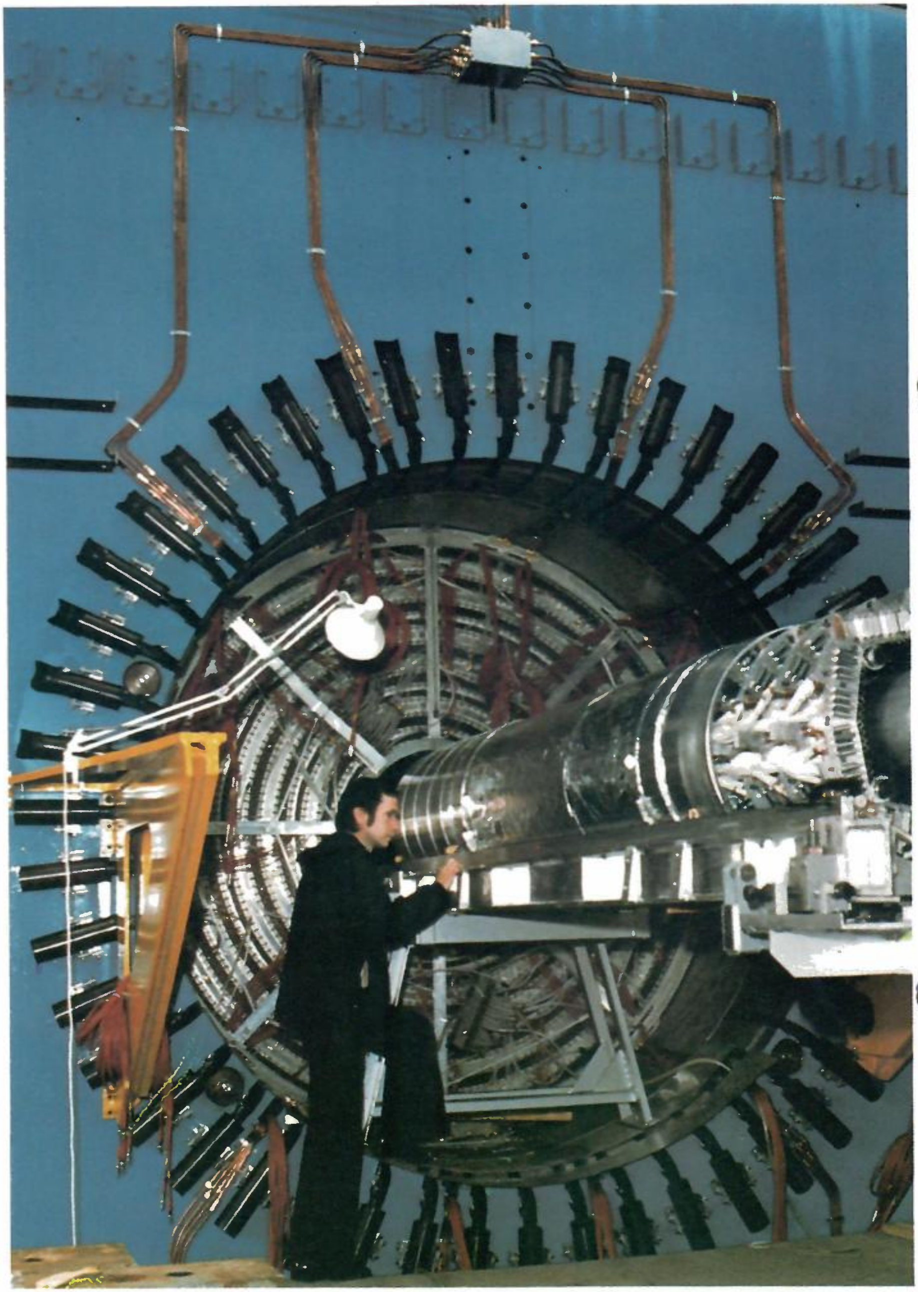
Particle Physics

There is close involvement in research into the nature of the fundamental constituents of matter, both through the scientific collaboration with UK university teams working in large international experiments, and in the provision of technical support in the design, manufacture and installation of complex sets of detector systems. These experiments require the support of substantial central computing facilities. This exhibit highlights the recent trends in particle physics research and describes a selection of the current experiments.

The first three experiments on display involve high energy particle beams incident on fixed targets at the CERN Laboratory (Geneva, Switzerland). The European muon experiment uses an intense beam of penetrating "muon" particles to probe the quark structure inside the proton. The hyperon experiment provides a unique facility for the study of short-lived particles. The charm search experiment is an attempt to select events which give rise to rare "charmed" particles.

Apparatus at the CERN Laboratory which uses high energy muons to probe the quark structure inside the proton (Photo: CERN).

View of the TASSO central detector during installation at the PETRA storage rings (Photo: DESY).



The most energetic probing of matter takes place at colliding beam accelerators. Experiments at three of these facilities are on display. The Intersecting Storage Rings at the CERN Laboratory are used to collide two beams of protons of energy 32 GeV (32 thousand million electron volts). The wide-angle scattering from these head-on collisions reveals the details of the forces acting between quarks. Experiments on the PETRA storage rings at the DESY Laboratory in Hamburg have studied the collisions of 36 GeV electrons with 36 GeV positrons. The results have yielded direct evidence for the "gluon" that binds quarks together inside the proton. An adaptation of the Super Proton Synchrotron at CERN plans to collide 280 GeV protons with 280 GeV antiprotons in 1981. The "collider" will search for the elusive Z^0 and $W^\pm$ particles, predicted in the electro-weak theory of Nobel Prizewinners Salam, Glashow and Weinberg.

At the lowest energies, fundamental work is done on the properties of cold neutrons, using the ILL reactor at Grenoble. One experiment is measuring the lifetime of the neutron with greatly increased precision, while another is making a highly sensitive search for the neutron electric dipole moment.

An X-ray bone-mass measurement system undergoing clinical tests at Leeds General Infirmary.

Special Instrumentation

The study of high energy particles requires large-size detectors (often several metres square) capable of locating particle trajectories with high accuracy (typically to within 0.2 mm), and this must be combined with minimal weight in the sensitive regions. Techniques have been developed using chambers made of thin wires and foam plastics to meet these extreme requirements. Several types of particle detector are on view, including a demonstration of a weaving machine used in the fabrication of multiwire proportional chambers.

A display of special detectors is set up to highlight new techniques, such as a secondary emission device with extremely high rate capability and high spatial accuracy. There is "spin-off" from the development of some types of detector which finds application in the medical field. A multiwire proportional chamber system has been adapted for the measurement of bone mass, and another device (a "positron" camera) is used to produce images of certain glands inside the body using positron annihilation events. Accurate positional information is invaluable in many applications, and techniques have been developed using artificial delay lines to produce precision readout over large areas.

A display is set up to illustrate the design and manufacture of electronic equipment, featuring the "wire wrap" method of construction and a typical hybrid circuit board. The servicing of electronic modules is demonstrated and applications are described involving microprocessors and hybrid circuits.

Support is given for university energy research projects. The displays describe recent plans to obtain energy from wind power and contain the details of an aerogenerator (windmill) built for Cambridge University. The problem of heat storage is highlighted in the design of a thermochemical heat pump/storage system based on the combination of sulphuric acid and water. Prototype hardware used in this study is on display.

The Abertridwr "better insulated houses" project is one of a series designed to assess the effectiveness of higher standards of insulation in domestic houses. Assistance has been provided in the design of the data logging system and selection of instruments, some of which are on show.

Heavy ion fusion has attracted considerable interest in providing a possible source for future energy needs. The feasibility of using heavy ions to initiate inertially confined

Area 9

fusion is discussed, although there is a wide range of problems to be solved before a system can be designed. Some of these problems are under study in UK universities and at Chilton.

A 6.5 kilowatt aerogenerator built at Chilton for Cambridge University.

The IBM 360/195 engineering consoles.

Computing

A wide range of computing equipment installed in the Atlas Centre is open for your inspection. There are various exhibits and demonstrations.

The IBM 360/195 and 3032 computer complex is scheduled to provide a normal service to its population of about 1,500 users located mainly in the universities. Users obtain access to the facilities through workstations and terminals installed at their local institution, and connected by Post Office data communications lines. The Chilton end of these connections and an example of the workstation with a range of terminal devices are on view.

Interaction with a computer program using a light pen.

An exhibit shows aspects of the work in computer networks and data communications. When two computers communicate with each other, they have to use agreed message standards to transfer data. There are now internationally agreed standards for passing messages between computers. We are engaged in adopting these to establish linkages between the various computers installed by the Science Research Council. The work will rationalise the diversity of existing connections. Studies and experiments in high-speed data transmission for local and long-range connections are going ahead. Data transmission as part of the STELLA project is scheduled at set times during the Open Days: this involves the transfer of data between the ground station antenna mounted on the roof of the Atlas Centre and the geostationary orbiting OTS space satellite.

The Science Research Council has set up an Interactive Computing Facility (ICF) principally to provide improved design aids for university engineering research. Most of the computing equipment is installed in universities and polytechnics. An exhibit dealing with the ICF provides an insight into the breadth of the facilities available and this is supported by a number of simultaneous demonstrations, scheduled throughout the day. The topics covered are: finite element mesh generation, computer assisted architectural design, control engineering, plotting facilities for circuit layout, crystal structure search and retrieval, generation of diagrams in colour, input of diagrams and drawings, and the use of central computing resources.

Further exhibits cover activities which are at an early stage of development. These are in Distributed Computing Systems and in Robotics, programmes co-ordinated at Chilton, and in the Starlink project which will provide astronomers with advanced facilities for data reduction and image processing of stellar data.

The use of the FR80 microfilm recorder is featured in an exhibit dealing with text processing in science and the publication of results from computational studies.

Further Information

Exhibition Areas 2 to 9 contain displays on specific fields of research. Technical leaflets are available in these areas to provide more detailed information on particular projects or techniques. If you have further enquiries, please do not hesitate to contact the person whose name appears on the technical leaflet, or the head of the Division involved.

Film Show

There is a film programme, shown at regular times in the Lecture Theatre (Building R22).

Organisation of the Rutherford and Appleton Laboratories.

Director General:
G H Stafford, CBE, FRS
Director Rutherford:
G Manning
Director Appleton:
J T Houghton, FRS

The Laboratories are organised on a Divisional basis. Although the functions of each Division are shown separately, many of the projects involve the collaborative working of more than one Division.

Administration Division

General administrative services for the Laboratories, for visiting scientists and for the UK participation in overseas research programmes. Health and safety services at the Laboratories.

Division Head and Secretary of the Laboratories: J M Valentine

Computing Division

Computer applications, data communications network development, and management of the SRC batch and interactive computing facilities.

Division Head: F R A Hopgood

Engineering & Building Works Division

Provision of electrical, mechanical, building and environmental services. The Division includes the Council Works Unit which caters for other SRC establishments as well as the Laboratories.

Division Head: H C Brooks

Geophysics & Radio Division

Radio propagation and system studies for communications applications. Use of the 25m Chilbolton radio telescope. Radio and satellite-borne investigations of the atmosphere and oceans. Advice and support in research using rockets and balloons.

Division Head: J T Houghton, FRS

High Energy Physics Division

Experiments in particle physics and nuclear physics in collaboration with university groups. Support for teams of scientists from the UK and abroad, and supervision of UK involvement in the CERN and DESY research programmes.

Division Head: J J Thresher

Instrumentation Division

Design and manufacture of special physics apparatus and electronics for use by experimental teams. Control of central workshops and outside manufacture. Support for energy research.

Division Head: T G Walker

Laser Division

Experimental and theoretical research in laser-plasma interactions and laser compression in collaboration with university groups. Development of high power laser systems.

Division Head: A F Gibson, FRS

Neutron Division

Support for neutron scattering research by universities using reactors and the electron linac at Harwell and the high flux reactor at the Institut Laue-Langevin, Grenoble. Participation in experiments. Development of instruments and techniques. Preparation for the exploitation of the Spallation Neutron Source.

Acting Division Head: H Wroe

Space & Astrophysics Division

Study of solar and stellar ultra-violet and X-rays. Planning, co-ordination and support of scientific satellite projects. Satellite ground control and data processing.

Division Head: A H Gabriel

Spallation Neutron Source Division

Development, construction and installation of the Spallation Neutron Source.

Division Head: D A Gray

Technology Division

Design, development and construction of major items of experimental apparatus. Exploitation and application of new techniques, especially in cryogenics, superconductivity, electron beam lithography and chemical technology.

Division Head: D B Thomas

Theory Division

Research in the theory of elementary particles.

Division Head: R J N Phillips

Quarks to
Quasars

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