Bulletin
of the Rutherford Appleton Laboratory
2 Feb 1983 No.2

An Eventful Week for RAL

The week from Thursday 20 January, 1983 until Wednesday 26 January, 1983 saw three RAL projects achieving important results. Such a three fold coincidence is a unique occasion and one that the Laboratory considers merits notice - this special issue of the Bulletin reports on the three events. They are:-

1. The report on Thursday 20 January that five decays of the intermediate boson had been found in the UA1 experiment on the $\bar{p}p$ collider at CERN.

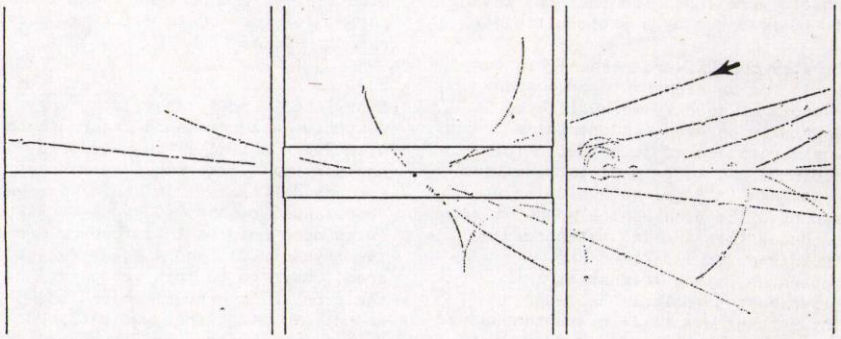
2. At 7.12 pm on Sunday 23 January the injector for the SNS accelerated H^- ions to 70 MeV for the first time.

3. At 2.17 am on Wednesday 26 January IRAS was successfully launched from California and the control station here at RAL took command soon after.

All of these projects started several years ago. A large number of RAL staff have worked extremely hard over these years to bring the projects to this stage. I, and all the Division Heads wish to offer the staff and our University colleagues our warmest congratulations, we thank them for their efforts, and we wish them continuing success with their projects - all three will continue and I am confident will report further achievements in the future.

Geoff Manning

RAL, QMC and Birmingham Join Forces



One of the five events observed by UA1. The electron track, identified with an arrow, has a measured momentum of 53 ± 6 GeV/c with a large missing momentum on the opposite side.

Those of you who saw the BBC "Horizon" programme on Monday 24 January will begin to understand the excitement caused by the recent announcement that evidence for the intermediate vector boson W, has been observed in the UA1 and UA2 experiments using the SPS proton-anti proton collider at CERN.

This discovery is a crucial result for the recent theories which attempt to unite the weak and the electromagnetic forces, which until the early 1970's were believed to be two unrelated phenomena. The weak force governs the decay of particles and controls the production of energy within the sun, while the electromagnetic force governs the behaviour of charged particles and currents - it describes the working of objects such as electric motors, radio waves, micro-computers etc. Weinberg, Salam and Glashow were awarded the Nobel Prize in 1980 for their theory that combines these two apparently separate forces in a single framework. Their new theory requires the existence of a mediating charged particle called the intermediate vector boson (W ±) - they predict its mass as approximately 80 times that of the proton (80 GeV). The result from the UA1 experiment at CERN agrees with this prediction and the rate of production also agrees with that predicted by the theory.

This discovery is just reward for six years of intense activity at CERN and RAL. The idea for the proton-antiproton collider, which uses the 300 GeV proton accelerator (SPS) as a storage ring, was first talked about in 1976. The two experiments were approved in 1978 and first results were obtained at the end of 1981. However the beam intensities then were too low for any chance of W bosons to be produced, and so it was not until late in 1982 that the collider was run at sufficient intensity for these particles to be found.

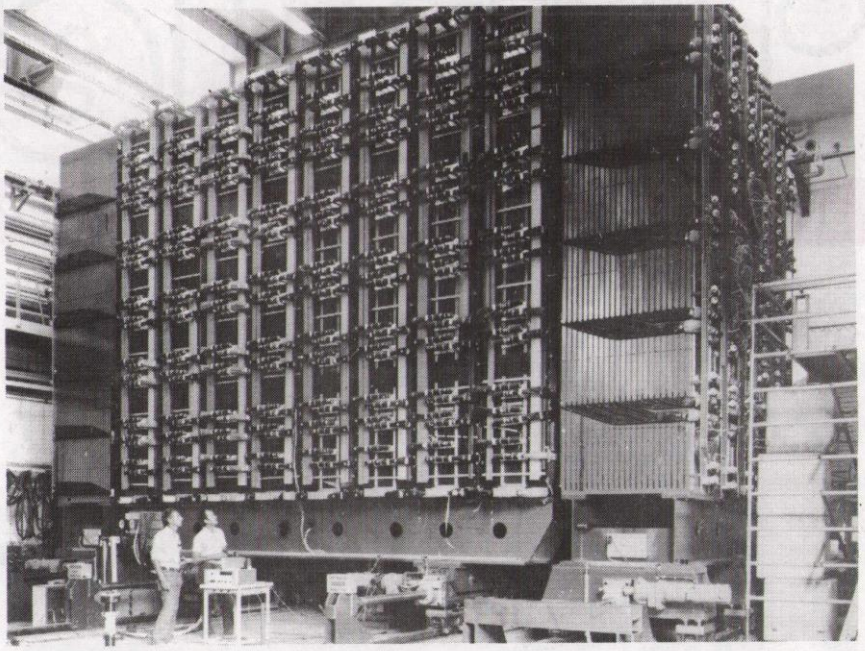
(continued over)

UA1 Team effort

Where do the UK groups fit into the story? The UA1 collaboration, led by Carlo Rubbia, consists of about 120 international physicists, including 22 from Queen Mary College, Birmingham University and RAL. The experiment which has been described in earlier *Bulletins*, consists of a central drift chamber inside a magnetic field of 0.7 tesla, which records the tracks of all the charged particles from the collisions.

Completely surrounding this chamber are arrays of counters used to measure the energies of the particles produced in the collisions. These arrays are called electromagnetic and hadronic calorimeters. The former measures the energies of electrons, γ rays and π^0's while the latter measures the energies of the strongly interacting particles (protons, neutrons etc). This hadron calorimeter was built by the UK groups and is constructed of 1cm thick scintillators placed inside slots in the iron of the return yoke of the magnet. Something like 7000 sheets were installed each one having to be read out by a photomultiplier.

Finally the UK were responsible for producing an electronic processor capable of quickly measuring the energy in an event and deciding whether to record it or not. This decision had to be made between beam crossings ($\sim 4\,\mu s$) to avoid losing events. The electronics group at RAL produced this special processor and this is a vital part of the apparatus, since it enables the experiment to select the few interesting events from the thousands that are produced every second when data taking.



Side view of the assembled hadron calorimeter. The slots in the iron, the photomultiplier tubes and light guides are clearly visible. (Photo: CERN)

Every sheet had to have its energy response measured and a laser system with 7000 optical fibres was used to monitor these responses and correct for any drifts. All of this work was coordinated by the PAG group at RAL (with some help or interference from the physicists!) and a great deal of credit must go to this group for their untiring enthusiasm and the amount of effort that was put in during the construction stages of the experiment.

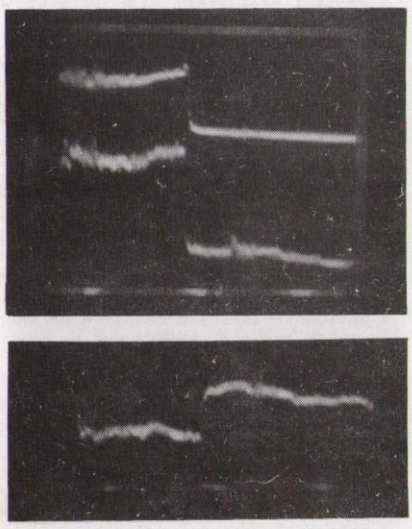
Evidence for the 'W'

What is the evidence that the W has been seen? This particle is so heavy (80 GeV) that it is created at rest (small energy of motion). The W is unstable and decays quickly to lighter particles. One identifiable mode is its decay into an electron and an anti neutrino. When the W decays at rest it has to conserve momentum, and thus we should see a high energy electron (approx 40 GeV)

The World's Most Powerful Neutron Source is on Target

On Sunday 23 January the Spallation Neutron Source project reached one of its target milestones with the first acceleration to 70MeV of an H^- ion beam by the Injector Linac.

Operational activity to attempt acceleration had started earlier in the week, following the successful commissioning of the last of the four accelerating cavities [tanks] to full rf accelerating field level. A 10MeV beam, first produced in April last year, was re-established from the first tank on Tuesday and on Thursday the beam energy was raised to 30MeV with the operation of the second tank. In anticipation that the final critical items of equipment could be installed in time, an operational run was quickly scheduled for Sunday, for an attempt to operate all four tanks and achieve the full 70MeV design energy. And so it was, following an early start that morning, that the hard work of an enthusiastic crew was rewarded first by the energy raised to 50MeV and finally, at 7.12pm, to 70MeV.



Although everyone is delighted in achieving this result, much still remains to be done before the SNS first produces neutrons in 1984. The beam transport line to the synchrotron has to be installed, in parallel with completion of the synchrotron ring, prior to injection studies and first acceleration studies later this year.

Pulsed H^- ion beam from the SNS Injector

a. 665KeV beam at the linac input, (4mA).

b. 70MeV beam at the linac output, (150 A).

c. 70MeV beam after passing through a 68MeV threshold foil. The pulse is inverted due to the stripping of the H^- ions to H^+ ions, ie to protons.

in the direction and a missing momentum of 40 GeV opposite the electron (the anti neutrino escapes unobserved taking 40GeV with it). This is exactly what has been seen at CERN. In UA1 800,000 events were recorded on magnetic tape and careful computer selection reduced this number to about 40 events which were then scanned using a powerful graphics display system called Megatek. In the 40 events 5 have the characteristics mentioned above - a high energy electron accompanied by a large amount of missing momentum in the opposite direction. One such event is displayed in the figure *(p.1)* where the arrow indicates the high energy electron. These 5 events have been used to give a mass for the W boson and the result is

$$M_W = 81 \pm 5 \text{ GeV/c}^2$$

Which is in excellent agreement with the Weinberg Salam Glashow prediction of 82 ± 2 GeV/c^2

The UA2 experiment also has four such events which have similar characteristics to the UA1 events. These observations should be confirmed with better accuracy during 1983 when the neutral partner of the W called the Z^0 will be searched for. This is somewhat heavier than the W, with the clear decay into two electrons or two muons. Unfortunately it is produced less frequently than the W and will require more data before it is observed.

The Laboratory and the two University groups should be congratulated on their achievement.

R J Homer

IRAS is Launched Oh So Smoothly

A new "space era" began at RAL at 3.30am on January 26 when the IRAS Control Centre swung into action for the first time, monitoring the first pass of IRAS, the Infra-Red Astronomical Satellite, which will provide the most sensitive and detailed infrared whole-sky survey to date.

This event, the culmination of 7 years intense effort by an international team of scientists and engineers, was relayed live to the Lecture Theatre where those not able to participate were able to share the tension and excitement of this unique occasion.

And it was truly a night to be remembered.

From the moment Dr Geoff Manning began his speech of welcome to a Lecture Theatre thronged with staff, guests, pressmen, television and radio representatives (including Patrick Moore), the tension and excitement mounted. The smoothness of the launch was awesomely impressive, lift-off occurring to the second.

Presentations by Dr Eric Dunford (UK Project Manager) Professor Dick Jennings (UK Project Scientist) and the explanations of the sequence of events as they occurred, given by other members of the IRAS team, were punctuated by the voices of the launch and mission controls. As each milestone in the mission was achieved the cheering grew louder until the

Dr Graham Thomas and Mr Jon Fairclough examining a fifth scale model of the IRAS satellite.
82 RB 1229.

ovation which greeted the news that the Control Centre had picked up IRAS and were monitoring its first pass over Chilton, was thunderous - a well merited tribute, not only to the scientific achievement of the IRAS team, but also to all who had joined them in making the Presentation equally as successful.

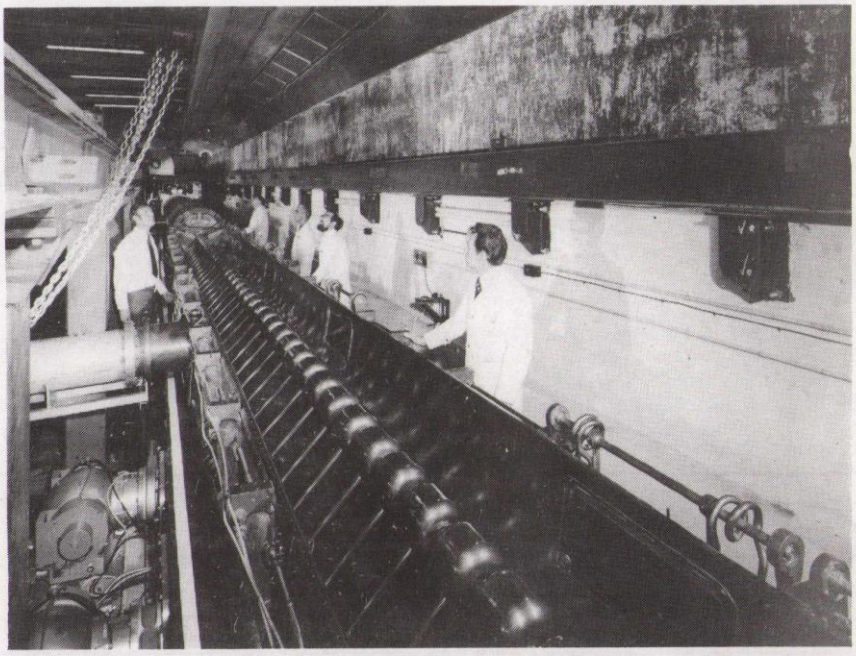
Launched by a Delta rocket from the Western Test Range in California into a 900km high near-polar orbit at 2.17 am GMT on 26 January, IRAS will

(see over)

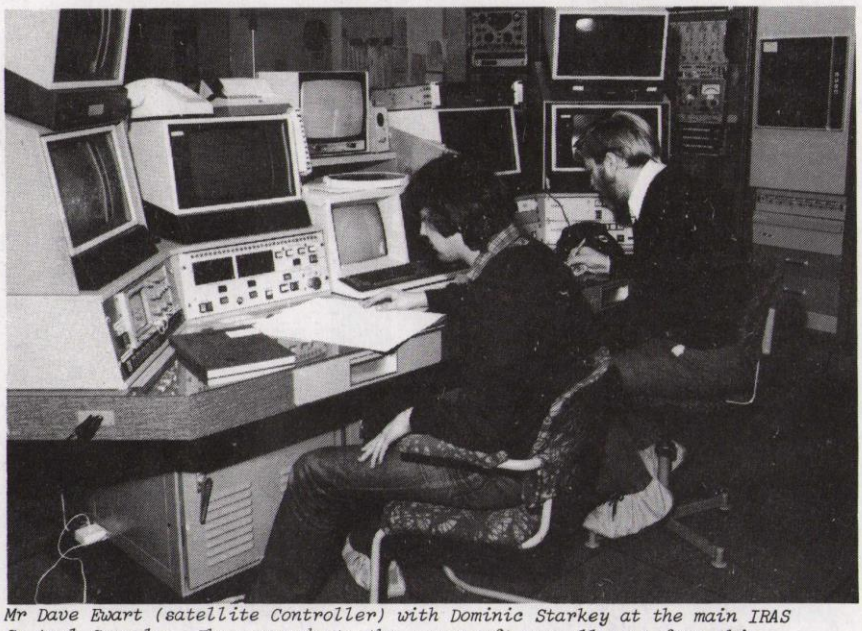
In another area (R55), the target station is being constructed of steel and concrete ready to receive its uranium target in Eastertime 1984. In parallel with all of this the instruments, on which the neutron science will be carried out, are being designed, built and (some) tested out on the Harwell linac.

1984 should see the start of the experimental programme and hence twenty years after the start of Nimrod and six years after its death a new accelerator, the SNS, will be operational in the Laboratory.

N D West



View of one of the four tanks of the 70 MeV linear accelerator during refurbishment. The drift tubes, betweeen which the particles are given accelerating kicks, are clearly visible.



Mr Dave Ewart (satellite Controller) with Dominic Starkey at the main IRAS Control Console. The commands to the spacecraft are all sent from this console.

83RB1234

circle the Earth 14 times a day, the stored data in the on-board computer/ tape recorder being relayed to RAL twice daily, where it will be digitised, sorted and distributed. The satellite will survey the whole sky in four infra-red wavelength bands (centred at 10, 20, 50 and 100 microns) with a sensitivity 1000 times that achieved by ground based observations. The far-infra-red is essentially inaccessible to ground-based observatories due to atmospheric absorption.

New fields to explore

Scientifically, IRAS is an extremely exciting prospect because it will be surveying the last largely unexplored region of the electromagnetic spectrum. The mission is expected to identify sources never before seen from Earth. It will add significantly to our knowledge of, among other things, star formation regions where stars are believed to form in massive clouds of gas and dust within spiral galaxies like our own. These newborn stars radiate at first as intense infra-red sources. At optical wavelengths we are not able to see the actual centre of our own Galaxy - dust obliterates the short optical waves before they reach us. But, the longer infra-red waves are able to travel through this dust barrier, and reveal a fascinating variety of sources.

Throughout the history of Astronomy better instruments have always led to important and exciting discoveries. IRAS will undoubtedly reveal quite unexpected classes of objects.

International effort

The project involves the Netherlands, the USA and the UK. The Netherlands, through the Netherlands Agency for Aerospace Programmes are providing the spacecraft and the non-survey experiment package. The United States, through the National Aeronautics and Space Administration, are providing the telescope syste and survey instrument, the launch vehicle (a two-stage Delta 3910 rocket) and are responsible for the final data analysis centre. The UK contribution, centred on Chilton, (involving groups from University College, London; Queen Mary College and the University of Leeds as well as RAL), is the responsibility for the ground station, the operations control centre and data acquisition software. This Mission Operations organisation at RAL comprises a number of teams whose tasks, broadly divide into pre-pass planning, pass execution and post pass analysis.

To do these tasks about 100 scientists and engineers will work at RAL during the satellite's lifetime (about 9 months).

The Satellite

The IRAS is composed of two major units the infrared experiment hardware and the spacecraft. Together they form a cylinder with a length of 3.5 metres and a diameter of 1.5 metres which, at launch, will weigh about 1100kg. The experiment hardware is comprised of a cooled Cassegrain like (Ritchey-Chretien) telescope with a 60cm beryllium primary mirror and (situated at the focal plane of the telescope) an array of 62 infrared detectors for the survey, a low-resolution infrared spectrometer, a mapping photometer and a star-counting instrument for statistical work. Visual star sensors provide accurate attitude checks.

In order to detect the weak infrared signal from astronomical objects above that from itself, the telescope system is surrounded and cooled by a liquid helium cryostat which, by virtue of its extremely low temperature ($\gtrsim$1.6K) emits negligible infrared radiation. The boil-off rate of the liquid helium dictates the mission lifetime of around 9 months.

The spacecraft part of the satellite contains the hardware and software for controlling its attitude while in orbit, and for storing the collected data and relaying it to the ground station at RAL.

Bulletin

Editor: Jean Banford
Building R20
Rutherford Appleton Laboratory
Chilton, Didcot, Oxon OX11 0QX
Abingdon (0235) 21900 ext 5484

Deadline for insertions:

INTERNAL Events

CONDENSED MATTER SCIENCE SEMINARS
R3 CONF ROOM - 1330hrs

8 Feb — B R Coles/Imperial
"Magnetism versus Superconductivity in Cobalt Alloys"

15 Feb — M Th Rekveldt/Delft
"Polarised Neutron Research at Delft"

NIMROD LECTURES
LECTURE THEATRE - 1400hrs

1 Feb — M Corden/Birmingham
"Large P_T Electrons in UA1"

7 Feb — Prof R Ely/UC Belfast
"Free Quark Searches"

14 Feb — Prof J Paton/Oxford
"A Flux Tube Model of Hadrons"

ASTROPHYSICS SEMINARS
R61 CONF RM - 1400hrs

9 Feb — Dr Kashi Nandy/ROE
"Nuclear Regions of Hot Spot Galaxies"

23 Feb — Prof R D Davies/NRAL Manchester
"A 21cm Hydrogen-line Standard Candle for Cosmology and the Density of the Universe"

RAL LECTURE
LECTURE THEATRE - 1515hrs

10 Feb — Prof D Michie/Edinburgh
'The Knowledge Acquisition Problem in Expert Systems Work'

SAFETY FILM
LECTURE THEATRE - 1200hrs, 1240hrs AND 1320hrs

16 Feb — 'GET A MOVE ON'

HEP SEMINARS
R61 CONF ROOM - 1100 hrs

2 Feb — Dr A Buras/Munich
"Aspects of Supersymmetric" Technicolour

4 Feb R61 1400hrs — S Yarker/RAL
"Report on the Frascati Conference Jan 1983"

9 Feb — Dr H Burkhart/Heidelburg
"Observations of a Narrow State at 2.46 GeV/c^2- a Candidate for a Charmed Strange Baryon A^+"

16 Feb — Prof T Kibble/Imperial
"Monopoles and Strings in the Early Universe"

17 Feb — Dr K Konishi/Pisa
"Is Weak Interaction Symmetry Broken by Ordinary Colour Forces?"

EXTERNAL Events

PHYSICS & GEOPHYSICS COLLOQUIA
H H WILLS LAB-BRISTOL-1700hrs

7 Feb — Dr A F Gibson/RAL
"Lasers with Beer Bottle Optics - or the Applications of Optical Phase-conjugation"

14 Feb — Dr D Cherns/Oxford
"Transmission Electron Microscope Studies of Dislocation Climb in Metals and Semiconductors"

ELEM PART PHYS SEMINARS
NPD - OXFORD - 1430 hrs

3 Feb — Prof P Kenney/Notre Dame
"Unusual States in $\pi^-\pi^+ \to \pi^o\pi^o$ Spectroscopy"

SHEP SEMINARS
SOUTHAMPTON - 1400 hrs

4 Feb — R R Morgan/DAMTP
"Stochastic Simulation of Turbulent Effects"

THEORETICAL PHYSICS SEMINARS
MANCHESTER - 1430 hrs

3 Feb — Dr K Heyde/Gent
The Nuclear Shell-Model: 'A Way to Understand Collective Motion in the Nucleus'

9 Feb — Dr K Bowler/Edinburgh
The Spectrum of Lattice QCD

16 Feb — Dr J K Storrow/Manchester
"Baryon Exchange Reactions"

HEP SEMINARS
MANCHESTER - 1430 hrs

1 Feb — Dr Michael Pennington/Durham.
"What Only LEAR Can Teach Us about the Hadron Spectrum"

8 Feb — Dr Keith Potter /CERN.
"The LEP Accelerator Project and Beyond"

THEO PART PHYS SEMINARS
DAMTP - CAMBRIDGE - 1500hrs

4 Feb — M Green/QMC
"Superfield Theories of Superstrings"

11 Feb — D Broadhurst/OU
"Can QCD Sum Rules Fix the Properties of a Single Resonance?"

18 Feb — P Orland/Imperial
"Construction of a Dual Meissner Effect in Lattice Gauge Theories"

ELEM PART THEO SEMINARS
NPL - OXFORD - 1430 hrs

4 Feb — Dr G Thompson/Southampton.
"Generalised Slavnov-Taylor Identities"

RAL Lectures

The next lecture in this series will be held on Thursday 10 February at 3.15 pm in the Lecture Theatre

THE KNOWLEDGE ACQUISITION PROBLEM

IN EXPERT SYSTEMS WORK

by

Professor D Michie

Machine Intelligence Research Unit
University of Edinburgh

Half a dozen expert consultation systems have so far become visible products. The majority have been commercially still-born, receiving only ceremonial burial in the academic literature.

This talk will analyse two reasons for the above state of affairs:

(1) the choice of model (in particular as between "heuristic" and "casual") needs to be carefully related to properties of the particular application;

2) in his capacity of knowledge source, the domain specialist has ordinarily been asked to communicate expert rules by explicit description. Acquisition of rules by machine induction from expert-supplied examples is a practical and promising alternative.

FOR YOUR DIARY: The next lecture will be on Thursday 24 March by Dr S V M Clube, The Royal Observatory, Edinburgh, and entitled "Spiral Arms, Cometary Impacts and the Catastrophe Theory of Extinctions".

RAL TECHNOLOGY LECTURES

The next lecture in this series will be held on Monday 7 February 1983 at 10.30 am in the R22 Lecture Theatre. This is an additional Lecture to the original programme.

'ENGINEERING in the SERC'

by

Dr Paul R Williams

Engineering Division, SERC

In 1981 Engineering was added to the Council's name in recognition of the increasing emphasis placed on the support of engineering research in universities and polytechnics. The support of engineering is now the largest single component of the Council's domestic budget. The growth in engineering has brought with it a new style of research management for SERC, where co-ordination and direction operate alongside the traditional responsive reaction to applications for support.

The talk will outline the objectives of the Engineering Board, comment on its programme and highlight new career opportunities for engineers and technologists in the context of SERC support for engineering research.

FOR YOUR DIARY: The next lecture will be on Thursday 24 February by Professor R M Needham, University of Cambridge and will be entitled "New Direction in Computing Research".

SAFETY FILM

GET A MOVE ON!

Nothing personal in the heading! We have booked a brand new safety film with the title 'GET A MOVE ON' for general showing in the Lecture Theatre on Wednesday 16 February 1983 at 12.00 hrs, 12.40 hrs and 13.20 hrs.

Many of the injuries which are reported in the Laboratory, occur when employees, particularly industrials, are 'handling goods'. This film deals with the movements associated with handling and lifting and is recommended for everyone to see whether they lift or handle goods at work or at home.

Trade Exhibition

Hewlett Packard will be exhibiting their optoelectronic, RF and microwave components in a one-day exhibition on Tuesday 1 March in R20 Conference Room from 10.00 to 16.00 hours.

Missing

John Langridge, Ext 5537/5574 has lost an Electronic Thermometer Model 510. Label no R010680. Would anyone knowing of its whereabouts kindly contact him.

Computing Seminar

This seminar will take place on Tuesday 15 February in the Atlas Colloquium at 3.15pm

Pascal Present Past and Future

by

D W Barron
Computer Studies Group
University of Southampton

From its inception as a langugage to assist the teaching of structured programming, Pascal has developed into one of the most widely used and implemented langugage, available on everything from an 8080 to a CRAY-1. In the seminar we will take a critical look at Pascal to see why, despite its acknowledged faults, it has been adopted as a major component of the Common Base Policy. In conclusion we will look to the future of Pascal, especially in the context of ADA.

Library Notice

Library users will have noticed that we have been tucking computer terminals amongst the pot plants. The catalogue from 1976 is now available as a database on the Prime E computer and can be searched from these, or almost any other terminal around the site. A beginners guide has been circulated and library staff will be making appointments for individual training sessions. So if a female voice asks you to "come and see me sometime" we're sorry - it's the Library not Mae West.

British Library Book

The undernoted book lent to us by the British Library has "walked" from Brian Colyer's office before he had a chance to see it! If it does not re-appear we will be charged for it. If discovered please return to the Library.

GEMANT, A Frictional phenomena
British Library loan no UG 23912.

Sales to Employees

The sale of scrap metal and plastics will take place, subject to the usual conditions, on 4 and 18 February at the R40 scrap compound from 1200-1230hrs.

Thanks

Jim and Janet Foster wish to thank all their friends and colleagues from G & R and Instrumentation Divisions for the cards, gifts and good wishes received on the occasion of their marriage.

Film Badge Notice

It is PERIOD **2** colour strip PINK Please check that you are wearing the correct dosimeter, and that ALL old ones are returned.