

# Bulletin

of the Rutherford Appleton Laboratory

11 Nov 1985 No.14

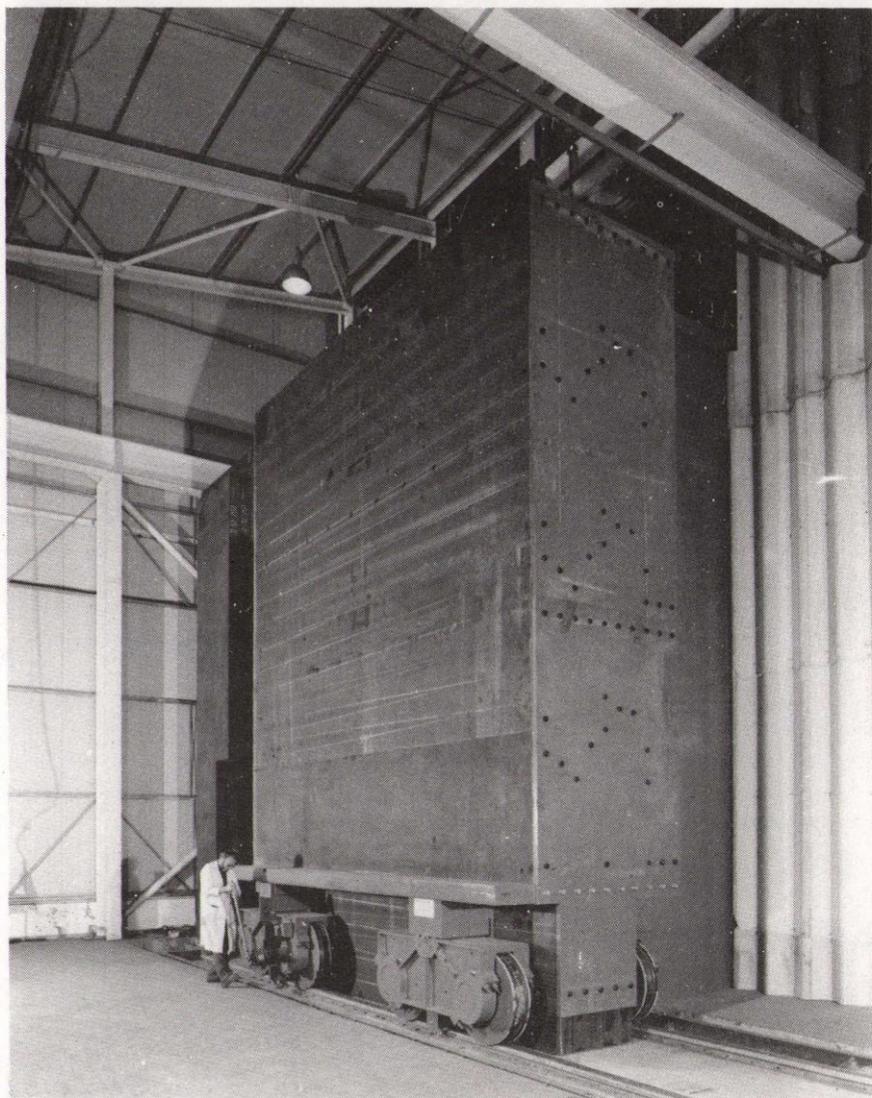
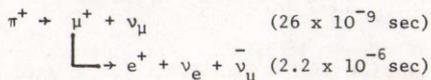
## KARMEN Looks at ISIS Neutrinos

Fifty years ago there was an energy crisis. Radioactive  $\beta$ -decay of nuclei appeared to be occurring in a process which violated the cherished concept of total energy conservation. In a last ditch effort to save physics from chaos a German physicist Pauli proposed in 1931 that the missing energy be carried away by an unseen, hypothetical particle of great penetration power with zero mass and zero electric charge. This is the neutrino.

The intervening years have witnessed a remarkable development of experimental detection techniques. To such an extent that these neutrinos, whose interaction lengths are measured in light years rather than centimetres, can be detected and their interaction characteristics established. Neutrinos from nuclear fission reactors and high energy particle accelerators have shown that three forms of neutrinos exist; associated with the different charged leptons of electron, muon and tau. The origin of these generation differences is unknown and is one of the great unsolved problems in current high energy particle physics.

The enigma of the neutrino remains and it is in an effort to solve some of these basic questions regarding the static and low energy properties of the neutrinos that the KARMEN collaboration has been formed at the Spallation Neutron Source, ISIS at RAL.

Although primarily a source of neutrons for condensed matter studies, it was recognised from the earliest days of the proposed facility that the same target station which gives neutrons would provide a unique source of neutrinos. The short time pulses of the accelerator ( $2 \times 100$  nsec every 20 milliseconds) would give two pulses of neutrinos separated in time. One of muon neutrinos from pion decay on a nanosecond time scale and the other of electron and anti-muon neutrinos from muon decay on a microsecond scale.



The KARMEN neutrino blockhouse front-door being hand-cranked into place. At this stage it had not received its bright blue livery.

It is this time separation of pulses which makes ISIS a unique source for neutrino physics.

At full intensity ISIS will produce  $5 \times 10^{13}$  neutrinos  $\cdot \text{sec}^{-1}$  of each type. The prompt muon neutrinos ( $\nu_\mu$ ) will be monoenergetic at 30 MeV whilst those in the delayed pulse ( $\nu_e$  and  $\bar{\nu}_\mu$ ) will be distributed in energy up to 53 MeV.

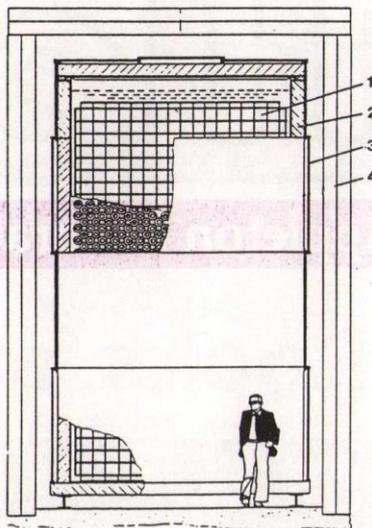
In order to detect neutrinos, massive instruments of good spatial and energy resolution are needed. Even so interaction rates are low (few per day at most) and backgrounds from extraneous sources are a problem. To overcome this, extensive shielding is necessary and it is this which today provides the most visible evidence of neutrino detection activity at ISIS.

(cont'd over)

## KARMEN *(cont'd from p1)*

The KARMEN collaboration has designed and now had built a 6000 tonne iron shield which forms a massive neutrino blockhouse with inner dimensions 10m x 4m x 7m set 14 metres from the ISIS target station. It has 2m thick iron walls and an iron roof with a thickness of 3m. A 600 tonne sliding door provides access to this bunker. Within this blockhouse it is proposed to set two detector systems; one a total energy calorimeter using liquid scintillator and the other a high precision tracking device with the specific intent of measuring in detail neutrino-electron scattering. Each will weigh around 50 tonnes and be moved in and out of the bunker on air pads.

The first of these detectors is well on the way to completion. It uses 60,000 litres of mineral oil liquid scintillator to observe neutrino induced reactions with  $C^{12}$  and hydrogen nuclei of the organic material. Very thin totally reflecting double lucite layers are assembled to provide a structure of 512 optically separated modules (18 cm x 17.4 cm x 350 cm) viewed at each end by two 3" Phillips phototubes. A total of 2300 phototubes, which are presently under test at RAL by Instrumentation Division. The double walled tank containing the scintillator is contained in an inner passive iron shielding of 18 cm thickness which also provides mechanical strength. An active plastic scintillator veto shield is set outside this and will be used to identify charged particle cosmic ray background which penetrates the main iron shield.



Front view of the detector.

1. Detector volume.
2. Inner iron shield.
3. Active shield against cosmic muons.
4. Neutrino blockhouse.

It is hoped that the first neutrinos will be detected with this system during 1986 and a series of experiments on neutrino properties begun. The main thrust of the initial experiments will be directed towards the question of the purity of lepton states and whether neutrinos have mass. If lepton number is not absolutely conserved and if neutrinos have mass, then physical neutrinos may be composed from different

neutrino mass eigenstates. This can then lead to the occurrence of neutrino oscillations.

Two neutrino oscillation experiments will be carried out. In one  $\nu_\mu \rightarrow \nu_e$  transitions with prompt neutrinos will be searched for by seeking electrons from the inverse  $\beta$ -decay  $\nu_e + c^{12} \rightarrow e^- + N^{12}$  -17.3 MeV. The  $N^{12}$  nucleus undergoes  $\beta^+$  decay with a lifetime of 12 nsec and an energy less than 16.3 MeV. This gives an excellent event signature practically eliminating all background; an electron produced within the  $\nu_\mu$  source time followed by a delayed positron at the same location within the detector. In the second experiment oscillations of the type  $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$  will be looked for using delayed neutrinos. As there are no  $\bar{\nu}_e$  in the source neutrino beam of ISIS, the appearance of  $\bar{\nu}_e$  will be evidence of oscillations. The selective reaction  $\bar{\nu}_e + p \rightarrow e^+ + n$  is very distinct: a positron within the neutrino source time after the beam pulse carrying up to 50 MeV energy followed by neutron capture within the body of the scintillator. Gadolinium will be used to capture the neutrons which then releases for detection about 9 MeV of  $\gamma$ -ray energy into the scintillator. In two full beam years of ISIS operation the experiments will be sensitive to neutrino mass differences of 0.05 eV<sup>2</sup>.

Further experiments will be carried out over the following years on basic properties of neutrinos as well as on their interactions with nuclei and electrons. Any anomalous behaviour will be eagerly sought as an indication for understanding the different generations of leptons.

K Green

## Another Idea Pays Off



Allan Ross has saved much time and a good deal of frustration for the CERN Omega, Ring Image Cerenkov detector experimental team, by inventing a very simple tool for, in essence, removing very thin wires from very inaccessible places through very small holes.

The Cerenkov detectors have at their heart what is essentially a multiwire proportional chamber and it was the breaking of the anode wires in these components and their occasional fouling of the drift area that was causing a problem.

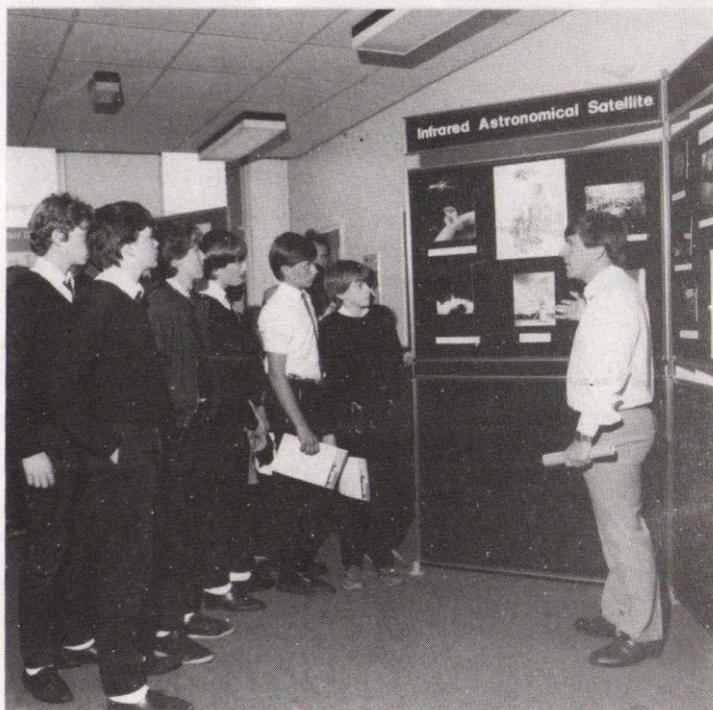
To remove them meant dismantling the detectors and opening them to the air with the resultant need to purge the chambers on reassembly. This exercise could result in the wastage of 2 days out of an experimental running period of 17 days.

The job can now be done in a few minutes.

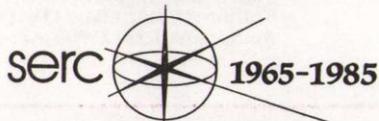
For this he was awarded £150 under the Suggestions Award Scheme, and was presented with the cheque by his Division Head, Dr Ron Newport on Friday 18 October.

"I'm happy to be able to present this award at such a convenient time", said Ron, referring to Allan's nuptials of the following day, "Congratulations".

# Rutherford Appleton Laboratory Schools Open Days



20th Anniversary



SCIENCE AND ENGINEERING RESEARCH COUNCIL

The Laboratory was host to pupils from twenty eight schools from Berkshire, Oxfordshire and Wiltshire on 3 and 4 October as part of the celebration of the 20th Anniversary of the SERC.

In a drive to stimulate interest in science and engineering amongst young people, Schools Open Days were arranged at all SERC establishments this autumn and RAL was pleased to be able to welcome about 700 young guests.

In addition to seeing a video of the Laboratory at work, they saw special demonstrations highlighting the Lab's activities, and it was hoped, shown that the fields of science and engineering can be fascinating and rewarding areas of work with many direct and indirect applications and benefits.

The undertaking was approached with drive and enthusiasm by the many RAL staff involved as demonstrators and guides to an endless stream of eager young people. It was hard work, but we think we also enjoyed it, and to judge from subsequent letters of appreciation it had a gratifying impact on many of our guests.

## What's in a Name!

"Ours is called 'Daisy'. What's yours called?" So runs the theme of the current advertising campaign of a well known car manufacturer who's name, for the sake of National Pride and the home industry just up the road, I will not mention.

Unless you live in a world of your own, were on leave or have only been watching TV Commercials, you will have noticed that Rutherford Appleton Laboratory has been choosing a name for OUR latest 'Family Treasure', the Spallation Neutron Source.

Naming day was a rather good occasion. We got a rather well known shopkeeper's daughter here to perform the actual ceremony, but how did we choose the name?

Owning a vehicle is always a sort of love/hate relationship. You get one you think is good looking and which you think you can afford, you go out for a few trial spins to show it off and make it the envy of your friends and neighbours and find out what are its vices and virtues and what accessories you might add to make it even more attractive. You even give it a little 'thrash' down a motorway to check on its ultimate performance and then, by association you think of a suitable name.

The author's first vehicle, a Vespa Scooter, was, like Beatrix Potter's character Jemima Puddleduck, "low slung to the ground" and so it rejoiced in the name 'Jemima'. One of my first cars, a 1933 Morris 10/4, was purchased on February 14th, a popular Saints day, and so for the rest of its life was known as 'Valentine'.

That's more or less what we have been doing in the last few months with the Spallation Neutron Source but before we reveal the chosen name let's carry the analogy with cars a bit further: The Lab used to be a private car owner - called that one 'Nimrod' - something to do with a Mighty Hunter hidden in the ground. Then the model we wanted got outside our price range so we went to a rental firm on the Continent. Now we're back in business as a rental firm in our own right with a demonstrated World beating model that should bring the customers flocking from British Universities and from Universities and Laboratories overseas. We hope there may still be time for some of us, as well as keeping it maintained, to occasionally give it a test drive to see what other accessories we might fit to make it even better.

We asked Mrs T to say that "Ours is called ISIS". She (ISIS) was an Egyptian fertility goddess - with a fertile imagination you could say it stands for International Spallation

Intense Source - anyway it has good associations with that reach of the Thames just up the road from here.

We hope she (Mrs T) will dip into the National Cash Register from time to time to give us enough money to run it and buy it a few embellishments to keep the customers happy, and not look for others who might 'Try Harder'.

Will it help the local car industry? Well it just might. Already neutrons have been used to study the dynamic performance of lubricants in engines and measure the temperatures of components still within the engine. We can study molecules used for catalysis - which may lead to new fuels and to cleaner exhausts, stress in metals - which may lead to stronger safer cars, and the properties of magnetic materials - which might just result in a really viable electrically propelled one.

If, by the way, you are wondering what 'Daisy' was - she was a green Morris Oxford, Registration UPF 12, about which my children used to say 'Uph-a-daisy'!! Should you further ask the name of my present car - a Ford Cortina estate with registration letters KLS - then I must say 'It hasn't got one' but it might be called KLauS because it was made in Germany or 'Lottie' because for many years the back of it was always full of gardening tools going to and fro to my allotment. The main reason is that someone told me 'Cortina' was latin for 'kettle' which seemed name enough for a tin-pot Ford!!

T Jones

## Account Closed

Roy Brabben, a popular member of the small AERE Contracts team working at RAL retired on 24th September 1985. Roy had worked on the Chilton site for 19 years, in 3 stints. He came first to NIRNS in 1962 to issue small value orders along with Phyllis Preveneers (Preu) and the late Geoff Hardaker. He was recalled to AERE in 1966, returning to Rutherford in 1969 to look after large engineering contracts. Promotion came in 1980 which meant another spell at AERE and he finally came back in 1981 to take charge of 2B Contracts Section. Roy was closely connected with all the major SERC projects - PLA, NIMROD, EBLF, DELPHI, Laser and SNS (now ISIS).

A presentation party was arranged for Friday 20th September 1985 in the AERE Social Club but when Roy went off sick two days before doubts arose whether it would take place. However, a telephone call on the Friday morning

confirmed that he would be present and with over 100 friends and colleagues, past and present from RAL, Swindon Office and AERE to wish him well - plus one or two draughts of Morlands amber liquid - the patient rallied and a good time was had by all. Peter Hartley, Chief Contracts and Stores Officer, AERE thanked Roy for his 26 valiant years as a first rate Ambassador of the Contracts Section and wittily sketched in his pre-AERE career. This encompassed the Aircraft Industry, the Fleet Air Arm, M.O.S., his own grocery business and looking after the distribution of frozen fish! Roy's outside interests were equally varied, ranging from Horticultural Societies, Industrial Archaeology, help with an annual summer school for the blind to amateur drama. Peter Hartley then presented Roy with £130.00 to go towards the purchase of a music centre; a record; a tape and a card brimming with hundreds of names and suitable comments. A bouquet was given to Mrs Brabben.

In thanking everyone for their gifts and good wishes, Roy said that he had enjoyed working in the various contracts sections and in a way was sorry to be leaving. In his dealings over the years with literally hundreds of users he said that he had gained a great deal of knowledge from the scientists and engineers of both sites. He closed by wishing every success to ISIS, a project he had been closely involved with from the very beginning.

## Coffee at Cosener's

Come and join us for sherry and mince pies at our Christmas coffee morning on

Wednesday 18 December

at The Cosener's House, Abingdon from 10.30 am until noon. Bring your pre-school children, and any newcomers to the area.

Meetings are held monthly, and bookings for the new year will be made shortly - please watch this space!

Details about our gatherings can be obtained from

Celia Lockwood  
6 Long Barn  
High Street  
Sutton Courtenay

Tel: Abingdon 847266

Zoe Patrick  
3 Bosley's Orchard  
Grove  
Wantage

Tel: Wantage 68809

# Bulletin

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# Arts and Crafts 1985

What does one write, about the fifth in a series of events each of which seems at the time to be of unsurpassable quality and interest?

The 1985 RAL Art and Craft Exhibition created such a problem for the reporter of this latest excellent presentation. Superlatives all used up, she must just announce - It gets better and better!

Once again it was a joy to be able to spend a pleasant lunchtime or two, admiring, marvelling and vowing to try (for the 1987 exhibition) to emulate to some degree the professionalism and imagination displayed at the current show.

At every show different talents come to light and last years painter can suddenly become this years sculptor. The range of exhibits widened again this year with the introduction of the Model Railway Clubs unusual new layout - a corner of West Virginia featuring the Campbellsville Squawcreek and Western Railroad with its narrow gauge locos, box-cars, cabooses, trestle bridge, diner and sherrifs office. The Camera Club also put in a first appearance with some enchanting and dramatic work.

Examples of woodwork, clock-making, tapestry, embroidery, knitting, sculpture and, an hour-glass Appalachian dulcimer, all were much admired.

To Fran Childs, Cathy Doidge and Nick Whitehead the organisers of this year's exhibition; to all who helped in so many ways and especially to the exhibitors, thanks for making the event such a success.

And - RAL was not the only beneficiary of the occasion, SSNAP a charity supporting the Special Care Baby Unit at the John Radcliffe Maternity Hospital, will receive a gift of £50, generously donated by visitors to the exhibition.



## NIMROD LECTURES

R61 CONF ROOM - 1400 HRS

- 11 Nov M G Bowler/Oxford  
Bose-Einstein Correlations  
Coherence and Chaos, with  
Particular Application to  
 $e^+e^-$  Annihilation.
- 18 Nov F E Close/RAL  
How the EMC Effect affects  
Nuclear Physics
- 25 Nov R Barloutand/Saclay  
Latest Results from the  
FREJUS Proton Decay  
Experiment

## HEP SEMINARS

R61 CONF ROOM - 1100 HRS

- 13 Nov K Bell/RAL  
A Review of Baryon  
Production in  $e^+e^-$   
Annihilation
- 20 Nov Theory Group/RAL  
Theorist Stories
- 27 Nov IOP Meeting (IC)



The next lecture in this series will be held on Thursday 21 November 1985 at 3.15 pm in Conference Room 12, Building R68. PLEASE NOTE CHANGE OF VENUE.

**EXPERIMENTS AND TECHNIQUES  
TOWARDS THE DETECTION OF  
GRAVITATIONAL RADIATION**

by

**DR NORMA A ROBERTSON  
DEPARTMENT OF NATURAL PHILOSOPHY  
THE UNIVERSITY OF GLASGOW**

At present the detection of gravitational radiation is probably one of the most challenging fields of experimental physics, in which the development of new and more sensitive techniques of measurement is constantly required. Work in this field at the University of Glasgow has been carried out for several years, more recently involving the development of long baseline laser interferometric detectors.

After giving a brief introduction to the field of gravitational radiation detection, Dr Robertson will describe the current work at Glasgow and the possible future direction of such experiments.

**FOR YOUR DIARY:** The next lecture in the series will be held on Thursday 19 December 1985 by Mr N J Phillips of Loughborough University, and will be entitled "Holography - where is it going".

### I'll read that again

Last issue's article on Giotto would have made much more sense had the second line not, somehow, slipped quietly away.

The passage should begin "After several nail-biting weeks since the 2 July launch of the Giotto spacecraft etc"

And - whilst we are on the subject of poor proof-reading, KARMEN is the acronym for Karlsruhe Rutherford Medium Energy Neutrino experiment. Apologies to all!

### Bulletin News

The Bulletin Office (plus Jean Banford) has moved to Room 287, R1. The telephone extension remains the same. 5484.

### Sales to Employees

The sale of scrap metal etc will take place on Friday 22 November from noon to 12.30 in the R24 scrap compound.

## Internal Events

NEUTRON DIV. SEMINARS  
R3 CONF. RM - 1330 hrs.

- 12 Nov. K Parlinski/Julich  
'Molecular Dynamics of the  
Molecular Spin - glass  
 $Rb_{1-x}(ND_4)_x D_2 PO_4$
- 26 Nov. Kalliopi Trohidou/Athens  
'Neutron Scattering off  
Electrons in Metals'
- 3 Dec. Martin Morris/Met Office  
'Introduction to Hurricanes'

ASTROPHYSICS SEMINARS  
R61 or R68 CONF. RMS - 1400 hrs

- 13 Nov. Dr Alan Penny/RAL  
(R61) 'The Age of the Universe'
- 27 Nov. Dr Bob Dickens/RAL  
(R68) 'Dark Matter in Clusters  
of Galaxies'

GEOPHYSICS SEMINARS  
R68 CONF. RM - 1400 hrs

- 26 Nov. Dr G Peckham  
'The Microwave Limb  
sounder for UARS
- 21 Nov. Graham Lister/Max-Planck  
Numerical Computational  
requirement for AMPTE  
This Lecture is in Conf.rm 1 R1.

### Christian Fellowship

Fellowship meetings are held on Thursdays in R2 Conference Room at 12.30 pm. Visitors are always welcome. Programme for November/December

- Nov. 14 Visit of new Rector -  
Rev. Christopher Stott
- Nov. 21 Prayer Meeting - Ray Powell
- Nov. 29 Music & Praise - Steve Walters  
FRIDAY

- Dec 5 Bible Study - Denis Williams
- Dec 12 Prayer Meeting - Jimmy Darius
- Dec 19 CAROL SERVICE and Bookstall  
Main Lecture Theatre R22

Enquiries to Margaret Summers Ext: 5617.

### Film Badge Notice

It is period 12. Colour strip ORANGE. Please be sure you are wearing the correct dosimeter, and return old ones.

### Please may we have our Bridge back?

HEP OPAL group lent (as a favour) in April, a Loan Pool Autobalance Capacitor Bridge, LP1826, to someone whose name we have since lost!

Please would the borrower now return it to us, R1 B04.

## External Events

PHYSICS COLLOQUIA.  
CLARENDON LAB - OXFORD - 1615 hrs

- 15 Nov. Prof A W Wolfendale, FRS/  
Durham  
'Cosmic Rays, Clouds and  
Comets'
- 22 Nov. Dr M Duff/CERN  
'Beyond the Fourth Dimension'
- 29 Nov. Dr J H Mulvey/Oxford  
'Higher Energy Particle  
Accelerators: Problems  
and Prospects'

ELEM. PART PHYS. SEMINARS.  
NPD - OXFORD - 1430 hrs.

- 14 Nov. 'Higgs' Afternoon.  
Drs D Ross, G Ross, Louis Lyons  
and R Cashmore will speak on  
various aspects of the subject.
- 21 Nov. Dr J Rushbrook/Cambridge  
'First Results from the 900  
GeV Pulsed Collider'
- 28 Nov. Dr D Davis/UCL  
'The Direct Observation of  
Beauty (Bottom) Particles

SEMINARS IN PLASMA SCIENCE  
DEPT. ENG. SCI - OXFORD - 1615 hrs

- 12 Nov. Dr J E Allen/Oxford  
'Some Research on  
Double Layers'
- 19 Nov. Dr D F Shaw/Radcliffe Sci.Lib.  
'Access to Information  
Sources in Plasma Physics'
- 26 Nov. Dr N M P Benjamin/Oxford  
'American Developments in  
Chip Manufacture'

### Thanks

"Dear Colleagues" writes Tom Randle "Thank you all for the retirement present (a multimeter) which I am sure will be very useful on many occasions.

You have been a stimulating bunch of people to work with and you have contributed much to my happiness at RAL.

May the Lab thrive and prosper".

Jim Alder would like to say thank you for the gift of the Radio on his retirement.

"I shall get many hours of pleasure listening to it and thinking of my many friends at the Lab. To all I missed, saying cheerio, sorry! Best of luck to you all."

### Missing

Susan Read would like to know of the whereabouts of a Churchill Cooler Serial No. 33868/9. Please contact her on Ext 5433.

Would the person/s who borrowed two telephone handsets from the Upper Ground Floor, R3, please return them to Room UG 17 R3.