

# Bulletin

of the Rutherford Appleton Laboratory

30 Nov. 1981 No.21

## Success at the CERN Collider

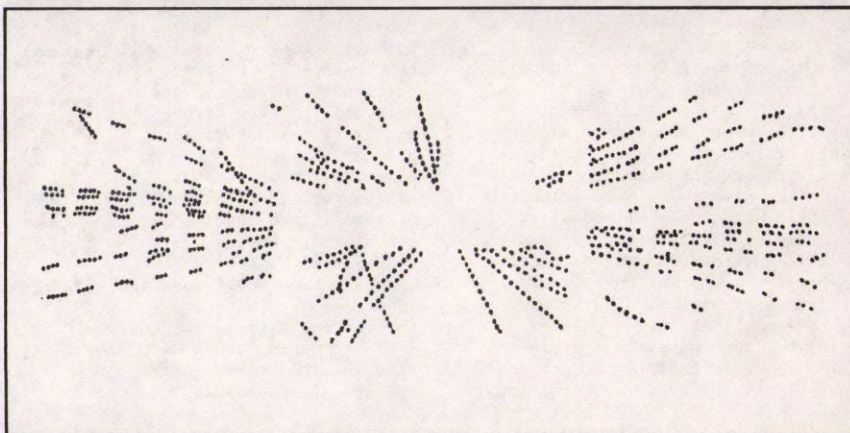
A WORLD RECORD has been achieved with the new proton-antiproton colliding beam machine at CERN in Geneva. At 4.55am on 10 July beams of 270 GeV protons and 270 GeV antiprotons were brought into head-on collision, making available 540 GeV of energy to produce new heavy particles of matter. This is the highest energy attainable in any laboratory in the world, and exceeds the previous record at the CERN Intersecting Storage Rings by almost a factor of ten. In this article we report the early success of experiments at the Collider which involve UK physicists.

### The Preparations

The proton-antiproton project was begun at CERN in 1977 (see *Bulletin* No 5 March 1980 and No 1 January 1981). There are two new underground experimental areas where the bunches of protons and antiprotons, circulating in opposite directions inside the same vacuum vessel of the CERN Super Proton Synchrotron, are made to collide. There are several Underground Area experiments, of which UA1 (30m underground) and UA5 (60m underground) have British involvement.

International teams of scientists and engineers have toiled for many years to design, build and test large-scale apparatus. Much of the equipment was prepared in the universities and at the national laboratories of the collaborating institutions. The apparatus for experiments UA1 and UA5 was installed in the underground caverns, was in place for the first collisions and has operated during the subsequent machine testing periods.

Stable beam conditions were achieved during tests in October and November. With two bunches of protons and one bunch of antiprotons circulating in the machine at very low intensity, the luminosity was about  $10^{25} \text{ cm}^{-2} \text{ sec}^{-1}$ . However, the interaction rate was sufficient to record thousands of proton-antiproton collisions in experiments UA1 and UA5. Typical events from the early runs are shown in the figure.



The upper photograph shows a stereo view of a proton-antiproton collision at 540 GeV as recorded in a streamer chamber of the UA5 experiment. The lower picture shows an offline reconstruction of an event recorded in the central drift chamber of experiment UA1.

### UA5

Experiment UA5 is a collaboration between university groups at Bonn, Brussels, Cambridge and Stockholm and CERN. The experiment uses two 6m long streamer chambers to make visible the trajectories of charged particles produced in the proton-antiproton collisions. The chambers are positioned above and below a beam-crossing point, so that a typical event is seen in each streamer chamber as a "star" of tracks radiating outwards from the (unseen) interaction point.

Each streamer chamber event is photographed via a mirror system that gives two stereoscopic views of the tracks, permitting eventual reconstruction of the events in space. The figure shows both stereo views for one of the chambers. The complete event has a similar number of particles in the second streamer chamber.

The events were obtained by triggering the apparatus using specially constructed scintillation counters to record an unbiased sample of events. In this way the

(Continued over)



## CERN Collider (Cont'd from pl.)

UA5 team hopes to obtain very rapid information on the general features of the interactions at this new energy regime available at the Collider.

## UA1

Experiment UA1 is a collaboration involving British, French, German, Italian, Austrian, American and CERN scientists, including teams from Birmingham University, Queen Mary College London and RAL. It uses a large electronic detector (about 2,000 tonnes) covering nearly  $4\pi$  of the interaction solid angle and includes a massive dipole magnet (11m x 6m x 6m).

A large volume drift chamber (6m long x 2.4m diameter) acts as the central detector. This is surrounded

by calorimeters which detect the electromagnetic and hadronic interactions of the produced particles. There are detectors to identify muons outside the magnet and other apparatus covers the small angles upstream and downstream of the collision point. The magnet can produce a horizontal field of 7 kG perpendicular to the beam direction, enabling the momentum of the charged particles to be determined within the central detector.

The interaction rate in the detector for the early test runs was about 1 event per second. A typical event taken in November is shown in the figure. A vertex can be clearly identified and one observes the high multiplicity of the tracks, particularly along the beam direction.

## Great Expectations

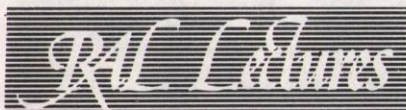
The UA5 detector has now been moved out of the beam for a while and the

team is busy analysing the exciting new data.

UA1 has a programme of several years running. In future periods a significant increase in the beam intensities is expected (the design luminosity is  $10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$ ) such that the production and observation of the "intermediate vector bosons",  $W^\pm$  and  $Z^0$ , should become possible in some of the experiments (UA1 and UA2). The existence of these particles, with masses around 80GeV as predicted by Salam and Weinberg, is crucial to the theory which attempts to unify the weak and electromagnetic interactions.

Excitement is mounting as new phenomena, some only previously glimpsed in Cosmic Ray events, are now readily produced in the Laboratory.

(We thank members of the UA1 and UA5 teams for this exciting news from the Collider).



The next lecture in this series will take place in the Lecture Theatre on Thursday 3 December at 3.15pm.

### ACHIEVEMENTS AND PROSPECTS IN X-RAY ASTRONOMY

by  
Professor K A Pounds FRS  
Leicester University  
Chairman of the Astronomy, Space  
and Radio Board

Satellite observations have shown substantial X-ray emission to be a common property of astronomical objects as diverse as main sequence stars and high red shift quasars. The study of discrete sources and of the sky background at KeV energies is shedding new light on several topical astrophysical questions, such as the final stages of stellar evolution, the energy sources in active galactic nuclei, hot gas in clusters and the gross structure of the Universe.

The lecture will describe some recent work in these areas and outline future prospects.

The next European Physical Society's Sectional Conference on the Atomic and Molecular Physics of Ionised Gases will be held in Oxford, United Kingdom, on 1-3 September 1982. It will follow along similar lines to previous conferences of this series with twelve invited speakers giving reviews of their own areas of specialisation.

Contributed papers in the following subject areas will be presented in poster sessions: The atomic and molecular physics of non-equilibrium plasmas, laser plasmas, negative ion plasmas, fusion plasmas, astrophysical plasmas and plasmas in the upper atmosphere. Special emphasis will be given to Rydberg atom collisions and spectroscopy, radiation induced collisions, spectral line broadening and shift, recombination, non thermal distributions and spectroscopic diagnostics.

For further information please write to Mrs M Sherwen, ESCAPIG Conference Secretariat, R20.



### SYNCHROTRON RADIATION- THE LIGHT FANTASTIC

by  
Ian Munro  
Daresbury Laboratory

Lecture Theatre - Thursday 10 December  
3.15pm

The properties of synchrotron radiation will be discussed and a brief review given of storage ring sources, with particular reference to the SRS at Daresbury Laboratory - at present the only purpose-built source in the world to be totally dedicated to synchrotron radiation research.

Dr Munro will also give his personal view of the contributions these sources have made and will make, in the future in science and technology.

## Appointment for Lovesey

Stephen Lovesey, group leader for condensed matter theory in the Neutron Division, has been appointed visiting Senior Fellow at the Department of Physics, University of Southampton. He expects to spend about one day each week in the department, which has just created the basis of a condensed matter theory group.

## Trade Exhibition

Verospeed Ltd will be holding a one-day exhibition of their new lines, including circuit boards, rechargeable batteries, semiconductors, heatsinks, laboratory modules, enclosures, connectors and electronic modules on Wednesday 2 December in R20 Conference Room from 10.00 to 16.00 hrs.

## Missing

Two items are missing from R25 Heavy Duty Laboratory:

- 1) Avometer Model 8, Serial No 26897-469
- 2) Ekco Industrial Fan type EH17, RAL No R010748

Please contact John Magraw, Ext 559, if you know where either of these items can be found.

## Film Badge Notice

It is Period 13 Colour strip ORANGE.

Please check that you are wearing the correct film and all old ones are returned. These films are to be worn for 5 weeks.

Next film change 4 January 1982.



# Royal Occasion for EISCAT

EISCAT - TROMSØ 0907UT 3 JULY 1981

*EISCAT, a powerful scientific radar system, for which Dr Henry Rishbeth of RAL is the United Kingdom Project Scientist, was officially inaugurated by His Majesty the King of Sweden on 26 August 1981.*

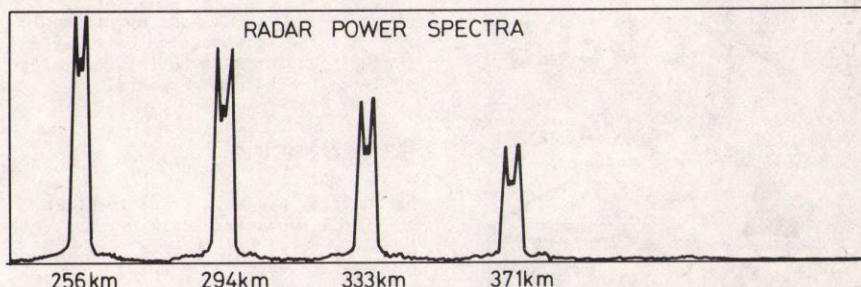
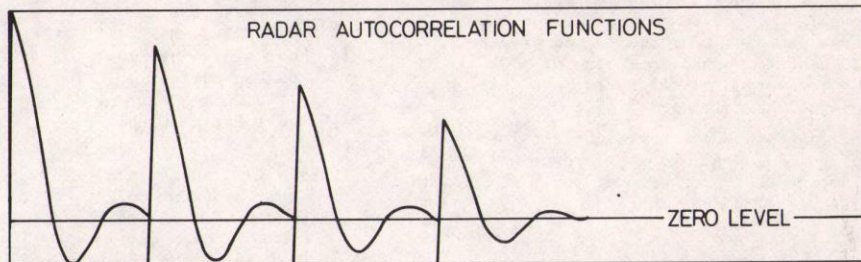
*In this article Dr Rishbeth gives us the background to the development of this new tool for studying the upper atmosphere and an introduction to plans for the future of this major international project.*

The opening ceremony took place simultaneously at EISCAT's three sites in three countries (Finland, Norway and Sweden) with each Government's representatives remaining on his own territory and speaking in (to him) a foreign language, English. Everything went well and the EISCAT VHF radar system worked faultlessly (for the first time ever, it was said). To end the day there was a reindeer dinner in Kiruna's fine Town Hall, at which Mr Brian Oakley, Secretary, spoke for the SERC.

## The Beginning

Conceived from discussions at the 1969 General Assembly of URSI, the International Union of Radio Science, EISCAT (European Incoherent SCATter radar system) has been built to study the upper atmosphere. Its prime purpose is to measure winds, temperatures and electric fields and currents in the ionosphere - the part from about 70 to 700 kilometres. It can also be used to study the lower atmosphere at 10-25 kilometres. Furthermore, it will probe (up to 2000 kilometres or so) the base of the magnetosphere, the Earth's tenuous envelope of charged particles and magnetic field. It can thus study the physics of the 'Aurora Borealis' or 'Northern Lights', nature's grand spectacle caused by the precipitation of magnetospheric particles into the upper atmosphere. The links between the sun and upper atmosphere phenomena - especially the aurora - are still a major scientific puzzle. Though sunspot activity is high this year and rare displays of aurora have been seen from England, normally aurora are seen only at high latitudes, so EISCAT has been built there.

Currently, the major problems of upper atmosphere science are the dynamics of the region generally - how the whole system responds to its various energy sources - and the physical mechanisms underlying one spectacular source, the aurora. EISCAT will play a major part in unravelling these questions. The general problems break up into a host of smaller intriguing topics, to which several British university groups involved with EISCAT bring specialised interests and expertise in varied instrumental techniques.



## THE FIRST EISCAT IONOSPHERIC SPECTRA

*The first VHF EISCAT data: Autocorrelation functions and their equivalent spectra from four height ranges centred at 256, 294, 333 and 371km. The detailed shape of the spectra varies with height, depending on the ion density and velocity and the electron and ion temperature.*

## Incoherent Scatter Technique

EISCAT has powerful transmitters and big antennae located at three sites: Tromsø in Norway, Kiruna in Sweden and Sodankyla in Finland. These three countries together with Britain, France and Germany make up the partnership. The curious term 'incoherent scatter' denotes the radio technique used by EISCAT. This has been used in several places ranging from Peru to Alaska and including Malvern, where Appleton Laboratory scientists were involved with RSRE and University College, Wales during the early seventies.

Incoherent scatter uses a VHF or UHF radio beam, too high in frequency to be reflected from the ionosphere in the manner used for communication purposes. Virtually all the radio energy penetrates the ionosphere and escapes into space, but a minute fraction (typically  $10^{-11}$ ) is scattered back by free electrons in the ionosphere. The weak scattered signals are received, either by transmitting antenna with suitable pulsing and gating or by remote antennae with suitable geometry.

## Versatile

It is an 'Acre-Megawatt' business: acres of antenna, megawatts of power. EISCAT has two radars, a VHF and a still unfinished VHF system.

Using appropriate data analysis methods, the radar can variously become (according to the mode of operation) a densitometer, thermometer and speedometer for electrons, ions and neutral particles. It can also be used as an ion mass spectrometer, energetic particle spectrometer, ammeter, voltmeter and ohmmeter. Either alone, or better still in conjunction with rockets, satellites and ground-based radios, optical and magnetic instruments, EISCAT provides an immense capability for gathering information.

## Support for Many Projects

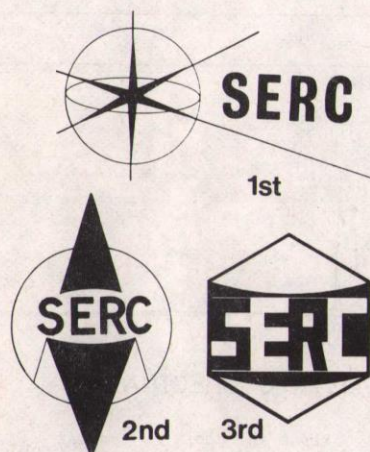
Already, EISCAT is said to be producing the world's finest ionospheric data, now under analysis at the Rutherford Appleton Laboratory, specimens of which now adorn the walls outside the RAL EISCAT team's office in R25. Next month, it is planned to use EISCAT to support University College, London rocket experiments in conjunction with passes of the Dynamics Explorer satellite; to co-operate with Ulster College observations of night air glow from Spitzbergen; to observe the effect on the ionosphere of the German high-frequency radio 'heating transmitter' at Tromsø, an experiment in which Leicester University is involved; and for Lancaster University's investigations of small-scale ionospheric structure.



## SERC Logo - Winners

For those of us who have been awaiting the result of the SERC Logo Competition with impatience, the outcome is now revealed. Joe Paxton of RGO won the first prize of £70, the second prize of £20 went to Norman King also of RGO, and our very own Bill Burton was awarded the third prize of £10.

Joe Paxton seems to have a flair for designing logos, it being his creation that was used when we owed our allegiance to the SRC.



The winning entry is now to be presented to our Chairman, Prof. J Kingman, for his decision as to whether the logo will be adopted throughout the SERC.

A total entry of 115 was received and the Logo Competition Committee thanks all staff who submitted entries.

## Music for Pleasure

Nigel Angold is now taking bookings for concerts at the Albert Hall on Friday 29 January and Friday 5 February. The programme will be the same on both evenings,

*Overture - Leonore 3 - Beethoven*

*Piano Concerto 1 - Rachmaninov*

*Symphony 7 - Beethoven.*

Booking closes on Monday 14 December. Please contact Nigel, Ext 6508, for further information.

## Harlequin Players

The Harlequin Players  
present  
THE EXORCISM  
(a ghost story for Xmas)  
by Don Taylor  
8.00pm  
Harwell Social Club  
Thurs 10, Fri 11, & Sat 12 Dec  
Tickets £1 & 50p from:-  
Pam Coulthard, Ext 6622  
Bob Hall, Ext 6371

Harlequin Players is the new name of the Harwell Dramatic Society. We feel our new name reflects our membership which is made up of people from all the sites around Harwell, including a large number of Rutherford Appleton Laboratory personnel.

## Barn Dancing

Derek Cragg has been asked to start this as a lunchtime activity. Anyone interested? Please ring D.C. on Ext 6620.

## Coffee at Cosener's

RAL wives group will hold their Christmas coffee morning at the Cosener's House, Abingdon, from 10.30am to 12 noon on Tuesday 8 December when all wives are invited to come and enjoy a glass of sherry and a mince pie as well as coffee. We hope to see many friends - old and new.

For more information please contact: Mary Rousseau, Wantage 3676 or Ann Corbett, Abingdon 20434.

## Sales to Employees

The sale of scrap metal and plastics as set out in RLN 12/73 will be made on 4 and 18 December.

Sales now take place at the rear of R24 Store from 1200-1230hrs.

## Library Notice

Someone has left a book in the Library entitled "Light Scattering by Irregularly Shaped Particles" by D W Schuerman. Will the owner, who appears to belong to 'Laser Radar Group', please collect it.

## Careers Convention

At this time of year many local schools arrange careers conventions for their pupils in the higher forms. These are held outside normal school hours, when many local employers are asked to send representatives to the school. They display enticing posters describing their work and sit at small tables where they try to answer questions from individual pupils and parents.

Three members of the Rutherford Appleton Laboratory recently attended a convention at Wallingford School to talk about opportunities in computing: Julian Gallop and Kate Crennell of Computing Division and Des Ould of Technology Division.

Our interests included Starlink, graphics molecular model drawing, text processing and computer aided design (CAD) and manufacture (CAM), but we did our best to answer questions about computing opportunities in other areas of work at RAL.

There were many questions, ranging from 'What do you do with computers?' to 'I've never heard of RAL, where is it and what does it do?'.

Most questioners wanted to know which academic qualifications were needed, how many 'O' levels, in what subjects, whether 'A' levels or a University degree would be better, or whether they should leave school at 16 and try to get some form of apprenticeship. They were usually surprised when we stressed the importance of 'O' level English language, to help them understand computer manuals.

We felt that the most important thing was to show the pupils that computing as a career may be entered from various backgrounds and disciplines, that computers are not just 'number crunchers' these days, and that there are opportunities for work with computers for many kinds of people, not just the people who are brilliant at maths at school.

### Note to Parents

If your local school is arranging a careers convention, why not suggest they ask RAL to send someone along? Requests should be addressed to the Training Officer, Mr T Gubbins, Ext 266, who will ask appropriate employees to attend, when he knows which aspects of our work are to be described.

Computing Division has been attending these conventions for several years and now has suitable displays and leaflets. For information about these contact J Brown, Ext 6609.

# Bulletin

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Deadline for insertions:



# INTERNAL Events

## ASTROPHYSICS SEMINARS R61 CONF.RM - 1400hrs

- 2 Dec: Robert M E Fosbury/RGO  
'Gas in Elliptical Galaxies'
- 16 Dec: Richard E Ellis/Durham  
'Recent Galaxy Surveys and their Implications'

An extra SEMINAR will take place in the Lecture Theatre at 1030hrs on Friday 4 December.

Richard Stephenson/Liverpool  
'Solar Variability Over the Past Millenium'

## REMOTE SOUNDING SEMINARS R61 CONF.RM - 1530hrs

- 1 Dec: Dr D J Drewry/SPRI, Cambridge  
'Remote Sounding Needs in Glaciology'
- 15 Dec: Dr J Ballard/RAL  
'On the Measurement of Stratospheric Winds using Pressure-Modulated Radiometry'

## CONDENSED MATTER SCIENCE SEMINAR R3 CONF.ROOM - 0930hrs

- 1 Dec: M G Brereton/Leeds  
'Gauge Theories, Entanglements and Rubber Elasticity'
- 8 Dec: J W White/Oxford  
'Ideas for New Neutron Instruments'
- 1: Ultra Cold Neutrons'

SAFETY FILM SHOW  
LECTURE THEATRE - 1230, 1315,  
1400 hrs  
15 December 'Starting Out'

# EXTERNAL Events

## THEO.PHYS.SEMINARS TPD.LECT.TH. - HARWELL - 1400hrs

- 8 Dec: Mr A Parslow Pearce/Oxford  
'Computing in Musical Analysis'
- 15 Dec: Prof M R C McDowell/RHC  
'Driver Behaviour in Traffic'

## NPD COLLOQUIUM CONF.RM.H8 - HARWELL - 1530hrs

- 10 Dec: Dr G Dearnaley/AERE  
'Modifying Materials with Ion Beams'

## PHYSICS COLLOQUIA CLARENDON LAB - OXFORD - 1615hrs

- 4 Dec: Prof Carl Wunch/MIT  
'The Ocean Circulation and its Measurement from Space'

## THEO.PHYS.SEMINARS QMC - London - 1615hrs

- 7 Dec: Dr N Roley/Daresbury  
'High Spin States in Nuclei'
- 14 Dec: Prof I C Percival/QMC  
'The Transition to Chaos'

## THEORY GROUP SEMINARS DARESBUURY - 1400hrs

- 7 Dec: Dr V R Saunders/Daresbury  
'Large Scale Direct CI Method'
- 15 Dec: Dr D Bullett/Bath  
'Bonding in Transition-metal Compounds and at Surfaces'

## HEP SEMINARS DAMPT - CAMBRIDGE - 1500hrs

- 4 Dec: R Petronzio/CERN  
'Perturbative QCD'

## PART.PHYS.DISC.GP MEETINGS BIRMINGHAM - 1615hrs

- 4 Dec: Dr M Jobes/Birmingham  
'Photoproduction of Charm at 20GeV'

## THEO.PHYS.SEMINARS MANCHESTER - 1430hrs

- 9 Dec: A Bray/Manchester  
'Spin Glasses : The Hole Story'

## HEP SEMINARS MANCHESTER - 1430hrs

- 10 Dec: Ms P Rankin/IC  
'Charm Photoproduction at 20 GeV/c'

## HIGH ENERGY TECH SEMINARS MANCHESTER - 1430hrs

- 'Drift Chamber Developments in Manchester - Electrodeless, TARDIS, radial'

## SHEP SEMINARS SOUTHAMPTON - 1430hrs

- 11 Dec: A Leggett/Sussex  
'Quantum Tunnelling on the Macroscopic Scale'

## Christmas Theory Meeting at RAL

WEDNESDAY, 16 DECEMBER

14.00

T. Banks

Composite models

16.00

F.E. Close

Spectroscopy 1981

THURSDAY, 17 DECEMBER

09.50

T.W.B. Kibble

Cosmology and particle physics

11.45

S.W. Hawking

The cosmological constant

14.15

A. Astbury

Physics at the CERN  $\bar{p}p$  collider

16.05

C. Llewellyn Smith

The standard model and beyond

FRIDAY, 18 DECEMBER

09.50

G. Parisi

Lattice gauge theories

11.45

P. Olesen

Loop dynamics in gauge theories

14.15

S. Ferrara

Supersymmetry