

Ultra Cold Neutrons at ILL

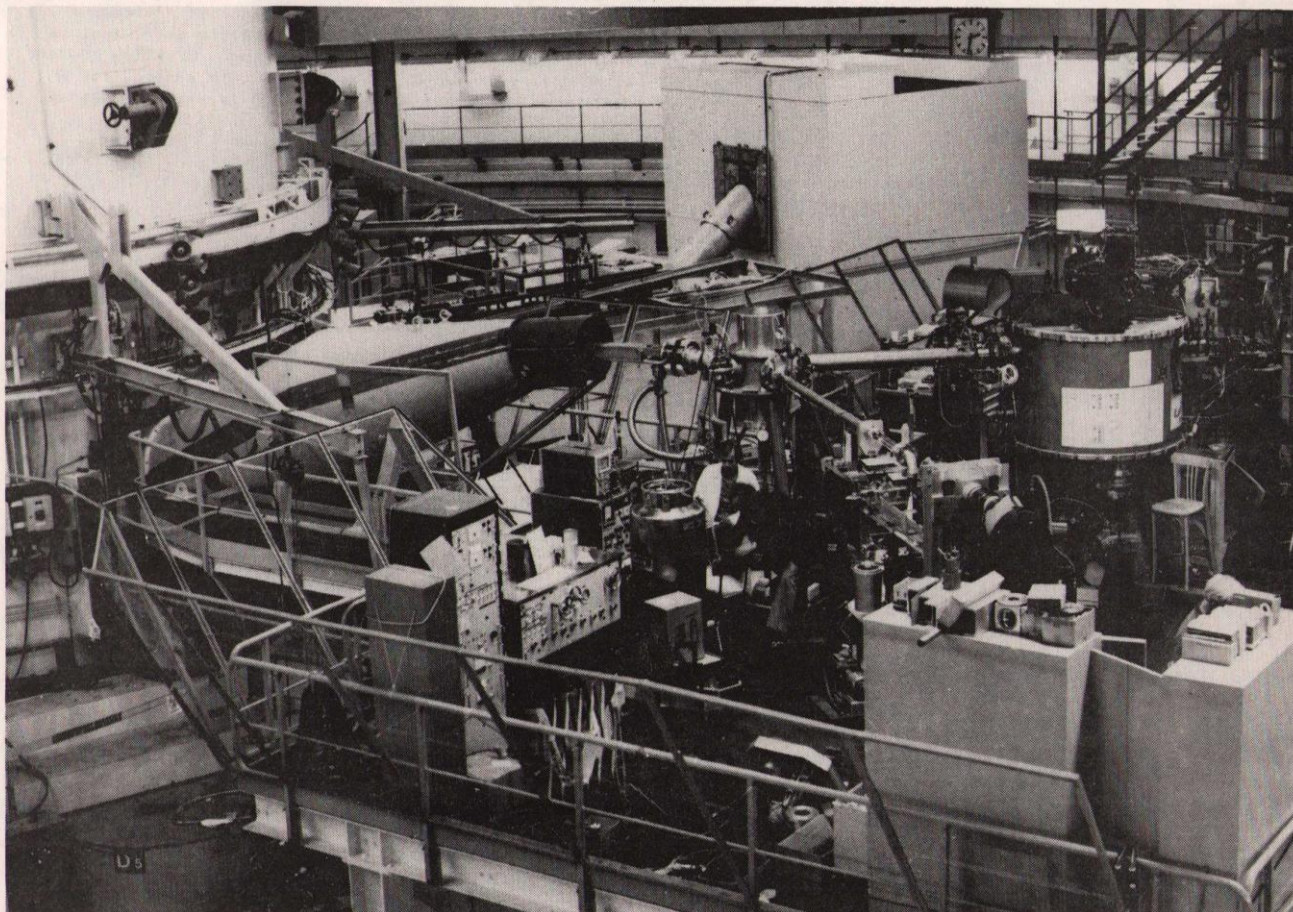


Photo: Looking like the nose of a 'Concorde' (left centre), the out-of-pile section terminates in a switching station, the two exit tubes feeding (top), the superconducting neutron storage rung from the University of Bonn and (lower) into the installation (bottom right hand corner) for measurement of the electric dipole moment of the neutron by the Sussex University team.

The Editor wishes to thank Harold Wroe for the free use of information contained in his technical report on the new facility, now in use at ILL Grenoble, from which the following shortened and simplified article has been produced. The successful construction of the in-pile part of the facility is due to the combined efforts of members of NBRU and Technology Division.

An interesting new facility, the Ultra Cold Neutron Facility came into operation during April 1977 at ILL for which the RL supplied the in-pile part and a clean vacuum system. The first "ultra cold neutrons" were observed in the early hours of 26 April and the facility has operated with satisfactory intensity since then.

The term "ultra cold neutrons" (UCN) was first coined by Russian workers at Dubna to describe that portion of the neutron energy spectrum in a moderator which contains extremely slow, (< 10 m/s) neutrons having very low energy (a few $\times 10^{-7}$ eV) and very long wavelength

(> 400 Å). The neutrons in a moderator can be thought of as a gas roughly in thermal equilibrium with the moderator itself. The peak of the energy distribution occurs at about 2.5×10^{-2} eV for a moderator at about room temperature, corresponding to a wavelength of 1.8 Å (these are "thermal neutrons") but a small fraction of the neutrons lose almost all their energy, by chance collisions, and are moving very slowly.

These UCN have remarkable properties: for example they are reflected off many surfaces at any angle of incidence and so can be transmitted easily down pipes and stored in material containers (bottled neutrons); their main use is for certain fundamental experiments in nuclear physics such as an accurate measurement of the neutron life time. For an account of this work see "Neutron in Bottles" by Dr R Golub of Sussex University (New Scientist Aug 22 1974). They may also provide a new way of examining surfaces of materials.

INTERNAL EVENTS

NIMROD LECTURE SERIES

Monday 16 January
1130
Lecture Theatre

Predictions from Quantum - Chromodynamics for large P_T Production in Strong, Weak and Electromagnetic Processes.

Dr C H Llewellyn-Smith/Oxford

HEP SEMINAR

Tuesday 17 January @ 1100
R61 Conference Room

Spectra and Decays of Radial Excitations

A Bradley/Durham University

COMPUTING SEMINAR

Tuesday 17 January
1400
R27 Colloquium

Fault Tolerant Software. *Dr T Anderson/University of Newcastle*

The need for reliable complex systems motivates the development of techniques by which acceptable service can be maintained even in the presence of residual errors. The salient features of a proposed computer architecture are described which provides a high level of detection of errors such as the corruption of code and data. Experiences in running this system are recounted with respect to execution of erroneous algorithms and deliberate attempts to corrupt the system.

HEP SEMINAR

Wednesday 18 January @ 1100
R61 Conference Room

Cosmic Ray Evidence on Hadronic Interaction Above 10 TeV

M Hillias/Leeds University

NIMROD LECTURE SERIES

Monday 23 & 30 January

Please watch "TODAY" Notice Boards

COMPUTING SEMINAR

Tuesday 24 January @ 1400
R27 Colloquium

Work on Computer Networks in Computing and Automation Division

J W Burren/C & A Division, RL

HEP SEMINAR

Wednesday 25 January @ 1100
R61 Conference Room

Low Energy K^- Interactions and Σ Production

Dr J Miller/UCL

There are some very interesting technical problems in extracting UCN from a reactor. For example the cross-section for absorption of slow neutrons increases with the neutron wavelength, so that UCN, with wavelengths of hundreds of Å are easily absorbed by a few mm of most common constructional materials. The in-pile part of the ILL facility consists of three concentric tubes, 6 m long inserted into one of the inclined beam holes; it sounds simple but the tubes are rather special - in sizes, tolerances and composition.

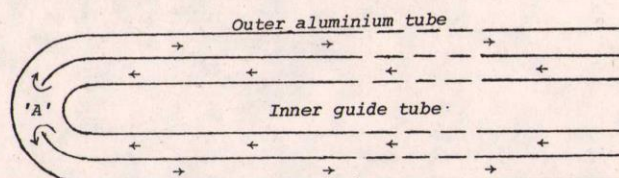
The outer tube is aluminium alloy 82.55 mm ($3\frac{1}{4}$ ") OD, the lower end being closed by a welded on hemispherical dome of the same alloy, the electron beam welding being superbly done by the British Aircraft Corporation in a huge vacuum chamber originally used in the Concorde project.

The stainless steel inner guide tube, 69.85 mm ($2\frac{3}{4}$ ") OD, which has its bore mechanically honed and electro-polished, is closed at the lower end by a thin Zircaloy dome which transmits the UCN with acceptable absorption losses. Joining the dome to this tube was a major problem since Zircaloy and stainless steel cannot be reliably welded by conventional methods. Two separate solutions were followed throughout the project; one developed in the UK, (originally by AERE) using friction welding and carried out by the Welding Institute and the other, a method of diffusion welding undertaken in France. The friction method, which uses an aluminium transition piece only 0.7 mm thick, an important feature in order to minimise UCN losses, exhibited on test, signs of corrosion when placed in the ILL cooling water circuit in spite of satisfactory tests at Harwell. The diffusion method was therefore chosen (metals at the junction diffuse into one another) although the losses are higher owing to the exposure of several cm of Zircaloy to the UCN on the inside.

In the annular space between the inner and outer tubes, a third tube of thin walled stainless steel is fitted to separate the "go" and "return" water flows ensuring that the coolant reaches the lower end where there is

considerable nuclear heating owing to the high neutron and gamma-ray flux.

The sketch shows the arrangement of the tubes, the cooling water flow (indicated by arrows) and at 'A', the area where the thermal flux is "re-moderated".



The cooling water also forms a "secondary moderator", ie although the ultra cold neutrons in the moderator of the reactor itself are not transmitted by the beam tube and the outer aluminium tube of the facility, the thermal flux is "re-moderated" in the cooling water, the very low energy tail of the energy spectrum being re-established. These UCN can then escape through the Zircaloy window and travel up the inner stainless guide tube.

The out-of-pile section of the facility was made at ILL and consists of a curved glass guide tube, inside a vacuum vessel, surrounded by massive shielding. The shielding, weighing several tons, is necessary because the in-pile part looks directly at the reactor moderator with no shielding or filters whatever in the beam path. As well as the shielding function, the curved guide brings the UCN beam into a convenient horizontal from the inclined beam hole which is at 30° to the horizontal. This brings the beam out at a height of about 5 m above the floor of the reactor hall so that a massive structure is required to support the shielding and a working platform for experiments.

The first detection of UCN was performed by a time-of-flight measurement using a mechanical chopper and the first nuclear physics experiments are now going ahead.

EXTERNAL EVENTS

HEP SEMINARS/ROOM A, DAMPT, CAMBRIDGE UNIV - 1500 hrs

- 19 Jan: Dr M Kosterlita/Birmingham - Planar rotator models in two dimensions
26 Jan: Dr A J Macfarlane - Point splitting.

THEORY GROUP SEMINARS/DARESBURY LAB - 1400 hrs

- 16 Jan: Prof H A Weidenmuller/Oxf - Statistical description of deeply inelastic heavy ion scattering
23 Jan: Dr P T Greenland/DL - Low energy charge transfer in highly stripped systems
30 Jan: Dr G Ringer/Minnesota - Studies of collision dynamics using molecular beams.

HEP SEMINAR/MANCHESTER UNIV - 1600 hrs

- 24 Jan: B Dickinson - Electroproduction in the resonance region.

THEORETICAL PHYSICS SEMINARS/MANCHESTER UNIV - 1430 hrs

- 18 Jan: Prof H A Weidenmuller/Heidelberg & Oxf - consequences of isospin mixing for compound nucleus reactions
25 Jan: Dr R Jones/Birmingham - Eigenvalues of large random matrices.

THEORETICAL PHYSICS SEMINARS/QMC - 1615 hrs

- 16 Jan: Prof A M Green/Helsinki & SX - The N-N potential and isobar nuclei
23 Jan: Dr L J Landaa/Bedford - Phase transitions for classical lattice systems and quantum fields
30 Jan: Prof Sir Sam Edwards/Cambridge - The role of functional integrals in physics.

NUCL PHYS DIV COLLOQUIUM/CONF RM, BLDG 8.9, AERE - 1530 hrs

- 19 Jan: Dr B H Patrick/NP Div - Working with the "Neutrons" and the "Photons" at N.B.S.

More Suggestions Awards

At the last meeting of the Local Suggestions Awards Committee held on 26 October 1977 the following awards were approved:

Mr J Clewett	Administration	R1	£5
Mr C A Grant	"	R1	£10
Mrs R Moore	"	R59	£10
Mr R D Pike	"	R2	£5
Mr R E Smith	"	R25	£10
Mr R A Walters	"	R25	£10
Mr C R Gascoigne	Engineering	R59	£10
Mr R P Hogan	"	R9	£10
Mr H Webb	"	R9	£5
Mr A P Franks	Instrumentation	R9	£10
Mr J J Spencer	"	R12	£5
		R12	£10

Mr B J Smith)			
Mr E A Cox	)	Nimrod	R8	£36
Mr D D Abbley)			
Mr W G Black	)	"	R2	£10
Mr N R Goddard	)	"	R51	£5
Mr D W Martin	)	"	R51	£5
Mr D J Price	)	"	R2	£10
Mr T D Wickens	)	"	R2	£45
	)	"		£5
	)	"		£10
Mr B J Smith	)	"	R8	£20
	)	"		£45
	)	"		£30
Mr H Windless	)	"	R2	£10

OVERSEAS VISITS Dr J C Hart, Dr P L Woodworth and

Mr B J Payne, to DESY, Hamburg,
15-17 Jan, to attend TASSO collaboration meeting.
Mr N J Diserens, to the USA, 15 Jan-1 Feb, to present a joint paper at the EHD Symposium at Fort Collins, Colorado.
Mr R C Carter and Mr K F Quinton, to CERN, 16-26 Jan, to assist with first cooldown of RCB bellows test rig.
Dr C J S Damerell, to CERN, 16-22 and 30 Jan-2 Feb, to work on WA3 analysis and single electron proposal.
Dr J Carr, to CERN, 16-27 Jan, to work on EMC experiment and attend collaboration meeting.
Mr G Tappern and Mr D Moore, to CERN, 15-20 and 18-20 Jan respectively for installation of Muon beamline equipment.
Mr M D Jeffs and Mr J Hoskins, to CERN, 18-27 Jan, for repair, test and modification of electronic equipment.
Dr R J N Phillips, to the USA, 18 Jan-2 Feb, to visit the University of Wisconsin.
Dr G E Kalmus, to CERN, 22-26 Jan, to attend BUG Meeting, SPSC Meeting and WA30 preparation.
Dr M A R Kemp, to CERN, 11-20, 23-27 Jan, to work on e/y experiment.

RUTHERFORD LABORATORY LECTURE Advance notice - the next lecture, on Tuesday 31 January at 1515 hours in the Lecture Theatre will be given by Patrick Moore. Full details in the next issue of the Bulletin.

REC SOC DANCE A dance will be held on Friday, 27 January from 8 till 1. Dancing to TYME PIECE - Buffet - Tickets £1.50, from usual contacts.

THANKS EXPRESSED Brenda Swetman wishes to thank all her friends for the lovely presents on the occasion of her departure.

FILM BADGE NOTICE It is Period 1, 1978. Colour Strip - BLUE for $\beta\gamma$ films and neutron packs. Please check that you are wearing the correct dosimeter and that all old ones are returned.
Six monthly dosimeter change for people with surnames commencing A B C and D.

LOST A silver filegree bracelet, in the vicinity of Bldg R1 on Friday 6 January. A reward is being offered to the finder as the article is of sentimental value to the owner, Christine Sutton, Room 1.86, R1 Ext 567.

CHESS TOURNAMENT After four rounds, the leader in the 1977-78 tournament is defending champion Peter Craske with four points, followed by Roy Culliford on three and a half and Peter Hemmings with three points.

At the moment the position is very tight but with another five rounds to go, anything could happen.
The defending champion expresses the wish for a Happy New Year to all Chess Players on site, adding "We could do with a few more of you becoming active again".

CHRISTIAN FELLOWSHIP Commencing Friday 13 and 20 January, a new series of Bible Studies entitled "Everyday life in the Words of the Bible". The subject for the first study, which will be led by Dennis Williams, is 'Daily Worship in the home' and all are welcome to come along. There will be time for general discussion and if you would like further details, please contact any committee member.

All are welcome to attend on Friday 27 January when we have a visiting speaker for the half-hour lunch-time meeting.

For the present, all meetings will be held in the Conference Room, fourth floor, Bldg R2, at 1230 hours.

STOP PRESS

HARWELL FILM SOCIETY Tuesday and Wednesday, 24 & 25 January
at 1945 hours in the Lecture Theatre.
'Images', directed by Robert Altman,
is a beautiful lyrical film which lives up to its title.
It provided Suzannah York with her most testing role to
date, combining fantasy and reality in a startlingly
original way.

HORTICULTURAL SOCIETY LECTURE Thursday, 26 January at
1930 hours in the RL Lecture
Theatre. Entrance fee 25p
including refreshments. Mr Ken Burras of the Oxford
Botanical Gardens, an old friend of the Hort Soc, will
give an illustrated lecture on the 'The Amazon'. From
previous experience one can be sure of a fascinating
talk with some really top class colour slides. As an
added enticement, there will be a raffle.

EXTERNAL EVENTS AT:

MANCHESTER UNIV, 1615 hrs

25 Jan: Dr P C W Davies/UCL - Time asymmetry and
cosmology.

SOUTHAMPTON UNIV, 1430 hrs

20 Jan: Prof R C Hwa/RL & Oregon - Quark parton model
with large parton K_T .

27 Jan: Dr P D Jarvis - New symmetries for elementary
particles.

OXFORD, NP DEPT, 1430 hrs

23 Jan: Prof S Bashkin/Arizona - Beam-foil spectroscopy
from 2-500 MeV.

RUTHERFORD LABORATORY BULLETIN

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