annual report 1978

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institut max von laue · paul langevin · grenoble · france

Applications for the use of ILL facilities

All research proposals have to be submitted to the Scientific Council for approval. The Council meet twice each year and the closing dates for the acceptance of applications are:

February 15 and August 31.

The completed research proposal forms should be sent to:

The Office of the Scientific Secretary
Institut Max von Laue - Paul Langevin
156 X
38042 Grenoble Cedex
France

Tel.: (76) 97.41.11 Ext.: 82.44 Telex: 320621 F

(Appropriate application forms may be obtained on request from the above office).

Under normal circumstances the ILL makes no charge for the use of its facilities. However special equipment, (other than the existing instruments, counters, standard cryostats and shielding requirements) must be provided by the user. This applies particularly to the experimental samples which must, in all cases, be provided by the user. Chemistry and Biology laboratory facilities are available for any necessary sample preparation.

The ILL makes a limited contribution towards the travel and subsistence expenses for experimentalists coming from approved laboratories in the three member countries. (Details on request).

The cover was designed using the diffraction pattern of frog muscle obtained on D11, a small angle scattering facility.

couverture maquette roger DAVID.

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156 X · 38042 grenoble cedex · france tél.(76) 97 · 41 · 11

View of the ILL with the river Drac in the background.

the institut max von laue · paul langevin

The Institut Max von Laue - Paul Langevin (ILL) at Grenoble was formally founded in January 1967, with the signature of an intergovernmental convention between France and the Federal Republic of Germany. The aim was to provide the scientific community of the affiliated countries with a unique neutron beam facility applicable in fields such as the physics of condensed matter, chemistry, biology, nuclear physics and materials sciences. The construction of the Institut and its high flux reactor was undertaken as a joint French-German project, with a total capital investment of 335 million FF. The reactor went critical in August 1971 and reached its full power of 57 MW for first time in December 1971. The year 1972 saw the start-up of the cold and hot sources, the first instruments and the beginning of the experimental programme. On January 1, 1973, the United Kingdom joined the Institut as a third equal partner, contributing its share to the total capital investment. The corresponding intergovernmental convention was formally signed in July 1974 by the pertinent ministers from the three affiliated countries.

The ILL is a non-trading company under French civil law. The three countries are represented by the following Associates:
- Kernforschungszentrum Karlsruhe GmbH, Germany (formerly GfK)
- Centre National de la Recherche Scientifique, France
- Commissariat à l'Energie Atomique, France
- Science Research Council, United Kingdom.

These Associates are represented on a Steering Committee, which establishes the general rules of the management of the ILL. The Institut is headed by a Director and two Assistant Directors, all with a five year tenure, the former to be nominated alternately by the German and the British Associate, the other two by the remaining Associates. A Scientific Council, nominated by the Associates, advises the Directors on the scientific programme and on practical aspects relating to its operation.

The scientific users' community of the ILL is represented in 8 Subcommittees of the Scientific Council, which meet twice a year to select those research proposals which are to be carried out at the neutron beam facilities of the ILL. A further Subcommittee of the Scientific Council deals with questions of instrumentation, serving as a discussion platform between the ILL and its external users.

The purpose of the ILL thus differs fundamentally from most other research institutes. It is a central facility created so that chemistry, physics, biology and metallurgy specialists from laboratories in the partner countries can use the unique power of neutron techniques to broaden the attack on their problems. Designing and operating instruments and helping the visiting users to carry out their experiments is thus the principal task of the Institut's own scientists. The experimental use of the instruments by ILL staff is subject to the same approval system as their use by external teams.

visits to the I.L.L.

On 4 October Mr. B.W. Oakley (at left in the photograph above), the new Secretary of the Science Research Council, visited the ILL with Mr. M.O. Robins (right). Mr Robins retired at the end of 1978 both from the SRC and as Chairman of the ILL Steering Committee. They are seen here with Dr. White and Mr. Bureau du Colombier (ILL).

A delegation from China visited the ILL on 17 October. The picture below shows Mr. Ny Tsi-Ze, Vice-President of the Chinese Academy of Sciences, with some members of his group.

introduction

The two main elements in the ILL's scientific programme during 1978 were to implement as fully as possible the scientific programme decided by the Scientific Council and to establish a programme of investment in new neutron techniques and for the basic installations of the Institut in preparation for the modernisation programme.

The reactor has continued to operate well, the only major problem being a water leak in the high pressure heat exchanger of the cold source compressor, which caused a shutdown of eight days. The time was recuperated by an extended cycle over Christmas 1978 and the total number of days used for experiments was 262.6 out of a total possible of 264.

The instrument development programme had three main elements:

1) Basic studies on neutron sources and the neutron guides;
2) Investment in new technique designed to improve the present instruments or to allow new instrument types to be evolved;

3) The construction of new instruments was started again in 1978 after the voluntary decision in 1977, for financial reasons, to begin no new instruments before those at present under construction were terminated.

An overall view of the instrument programme will be given in the next section.

A major programme to study and improve the thermal neutron guide tubes was started in 1978. The evolution of their transmission since installation showed that three out of the four used tubes have essentially not changed their flux despite some radiation damage to the guide tube noses near the reactor face. A study to produce improved guide tube noses for the eventual replacement of the present ones has been started. The programme to use curved monochromators and neutron optics to increase the intensity available from the thermal neutron guide tubes, started in 1977, has been carried further with installation of such a monochromator at the IN3 3-axis spectrometer. The whole of the H24 guide-line has been rebuilt to allow the installation during 1978/79 of the new instruments IN13 (variable energy backscattering spectrometer), D19 (short wavelength multidetector for crystallography), and D10 (spin echo, 3-axis and thermal diffuse scattering spectrometer). Each of these instruments may use at least twice the height of the neutron guide that was available previously, thereby making instruments at the thermal neutron guides more comparable with those of the reactor face from the point of view of neutron flux at the sample.

To support the programme of the Scientific Council and the systematic improvement of present instruments, the budget for the instrument groups, under the supervision of the Senior Scientists, was again given high financial priority in 1978. Some improvement of instrument operating performance has already been noticed as a result of this policy, which will be maintained throughout the period of the modernisation programme.

During 1978 the responsibilities of the instrument groups were further strengthened by a re-organisation of the Department of Exploitation following the resignation of M. Droulers, who had been both Head of the Reactor and Head of the Department of Exploitation. One of the Senior Scientists, Dr. Jane Brown, has been made Head of the new Instrument Operation Department, which comprises the instrument groups and the associated technicians. The intention of this re-organisation is to bring closer together the scientific and technical members of the Institut concerned with the instrument exploitation programme. A new Head of the Reactor has been chosen, M. Franzetti, and M. Faudou has been promoted to Head of the Technical Department as well as retaining his post as Head of the Project Office. M. Jacquemain, formerly Head of the Technical Department, will assume fully the role he has been taking during the last two years of Délégué Technique attached to the Direction.

At the Scientific Council the number of proposals presented increased in both March and October 1978 (Figure 1).

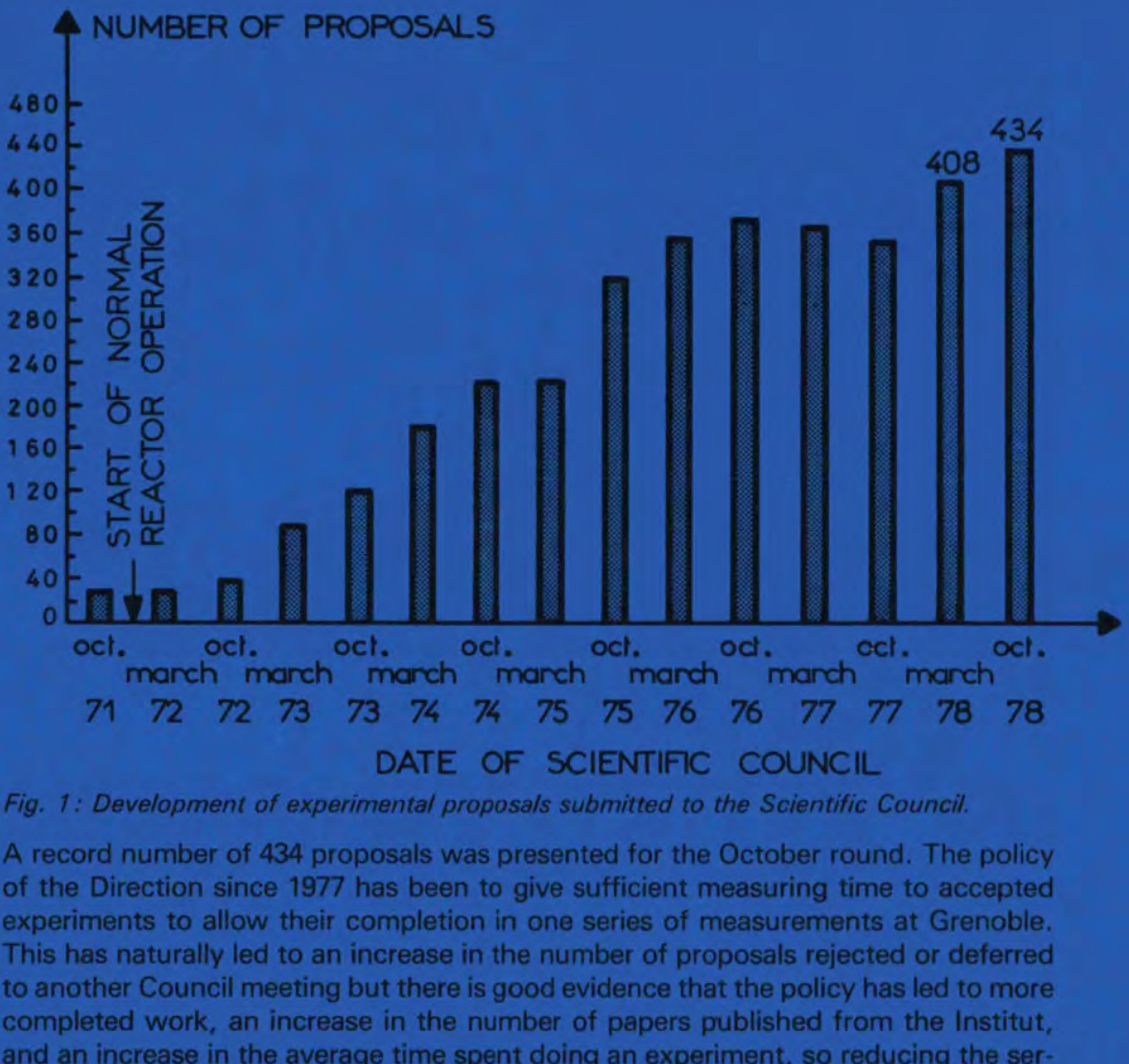


Fig. 1: Development of experimental proposals submitted to the Scientific Council.

A record number of 434 proposals was presented for the October round. The policy of the Direction since 1977 has been to give sufficient measuring time to accepted experiments to allow their completion in one series of measurements at Grenoble. This has naturally led to an increase in the number of proposals rejected or deferred to another Council meeting but there is good evidence that the policy has led to more completed work, an increase in the number of papers published from the Institut, and an increase in the average time spent doing an experiment, so reducing the service load on ILL staff. Concurrently with this policy the Direction has systematically set aside, before the time was shared in the Scientific Council, periods of time on chosen instruments to allow campaigns of measurements lasting for periods of weeks, when this was crucial to the success of the experiment. This policy has been adopted to allow extremely difficult or protracted experiments the chance to be done at the ILL in competition with the large number of experiments which take shorter measuring periods.

The changes in committee structure of the Scientific Council, made in October 1977, have promoted scientific discussion of proposals as well as involving a wider field of expert advice on proposals. During 1978 and in 1979 some members of the Scientific Council and its sub-committees, who have served the Institut for a number of years, will come to the normal period at which their membership should finish. I should like to thank them for their services to the Institut and for the important work they have done to install the neutron programme here.

The reports from instrument groups and colleges illustrate some of the high points of the scientific and technical programme during 1978. Amongst these should be noted the progress in the production, storage and use of ultra cold neutrons to be used in experiments such as the neutron electric dipole moment experiment. As well, in the field of fundamental and nuclear physics, a good start has been made to the programme for measuring the neutrino cross-section and eventually neutrino oscillations, as well as the systematic study of the nuclear energy level schemes for the actinides. In the area of crystal excitations the work on molecular crystal dynamics of naphthalene has perhaps been one of the most extensive studies of its kind ever made, and in the domain of crystallography one can note the progress made in the determination of paramagnetic electron densities by polarised neutron scattering and in the determination of the high resolution crystal structure of lysozyme. The programme of work on liquid ^3He has continued at temperatures near 20 mK. In the area of biology a notable new understanding of the distribution of protein and R.N.A. in the structure of bushy stunt mosaic virus has been gained by small angle scattering from solutions and by studies on single crystals with contrast variation. In the domain of chemistry, measurements on the structure of adsorbed monolayers and their excitations are novel and will have important repercussions. Again, in the area of chemical physics, measurements with the spin echo machine, IN11, have verified the validity of dynamical scaling in the use of hydro-dynamical theory down to distances of at least 10Å for the motions of polymers in solution. The distribution of neutron time amongst various categories of experiments is shown in Table I.

TABLE I

EXPERIMENTAL PROGRAMME JANUARY 1st to DECEMBER 31st, 1978

	BIOLOGY	CHEMISTRY	CRYSTAL STUCTURE	MAGNETIC STRUCTURE	LIQUIDS AND AMORPHOUS	DIFFUSE SCATTERING	PHONONS	MAGNETIC EXCITATIONS	PHASE TRANSITIONS	NUCLEAR PHYSICS	SCIENTIFIC TEST AND FEASIBILITY EXPERIMENTS	TOTAL
INSTRUMENT DAYS	213	572	769	554	573	567	250	205	659	874	487	5713
NUMBER OF EXPERIMENTS	59	126	91	63	63	80	27	19	77	62	161	828
NUMBER OF INSTRUMENTS INVOLVED	6	13	11	7	15	15	6	6	13	5	19	30
MONOCHROMATOR AND INSTRUMENT DEVELOPMENT EXPERIMENTS (INCL. D13)					INSTRUMENT DAYS NUMBER OF EXPERIMENTS							543 135

There has been an active programme of workshops at the Institut to discuss scientific developments in new fields and to support the discussions within the Institut on the instrument development programme, especially in connection with the modernisation programme proposals. Workshops have been held on the interest and feasibility of an intense capture g-ray source in the reactor, neutron interferometry, neutrons in helium, the dynamics of molecular crystals, and on diffuse-elastic and quasi-elastic neutron scattering from defects. These workshops have brought together neutron workers and 'non-neutron' specialists in the chosen scientific domain. In connection with the preparation of instruments for the 'second souffle' programme, workshops were held on multidetectors, spin echo spectrometry and diffuse scattering, and spin echo spectrometry for 3-axis measurements. From these workshops new ideas for instruments have emerged which are being elaborated and will be presented systematically to the Instrument Sub-committee of the Scientific Council.

During 1978 a major concern for the whole Institut, and for its associate partners, was to take the necessary steps to prepare for the 'second souffle' — modernisation programme — expected to start in 1979, following the decision, in principle, of the Steering Committee of the Institut at its meeting of 2 December 1977 to install such a modernisation programme. The Scientific Council, at its meeting in March 1978, reaffirmed the need and its full support for the programme developed by the Institut with the help of Council and sub-committee members. The Associates appointed a special commission composed of Dr. L.C.W. Hobbis (Convenor, Rutherford Laboratory), Prof. W. Gläser (Garching) and Prof. D. Cribier (CEA-Saclay), to act from the Associates' side to recommend options in case the full financial funding could not be attained. At the same time a commission was appointed by the Director to give independent expert advice on the Institut's proposals for replacement of the central computer and the relationship between the needs for central computing and computing power at the measuring instruments. The reports of these commissions were presented at the Programme & Means sub-committee of the Steering Committee at its meeting in July 1978 and a recommendation on the level of finance of approximately 80MF plus induced costs over five years was formulated. At the Steering Committee meeting in December 1978 the Associates were not yet ready for the full financial commitment over a period of five years, but recognizing the importance to start at once with a modernisation programme, agreed to the additional sum for the 1979 investment budget proposed by the Institut, the part concerned with long-term investments (approximately 50 %) to be blocked until the financial horizon was more clear in mid-1979.

The most urgent items comprising the proposed modernisation programme are therefore planned for implementation in 1979 with decisions following during the year on long-term items such as buildings.

J.W. WHITE

1

instrumentation

introduction

Investment in the instrument sector in 1978 was aimed at improving the functioning of presently-installed instruments at the reactor and to develop new techniques for neutron physics, thereby permitting, in early 1979, decisions to implement these techniques on existing and novel machines.

An important aspect of the improvement of existing machines was the budgetary priority given to the instrument groups described below. Another aspect was the high priority given to the NICOLE replacement and preparations for the CARINE replacement. It is now expected that the whole of the NICOLE replacement will be finished by mid-1979, including the implementation of programs for immediate data assessment at the instrument. The change-over of instruments such as D11 and D17 has already produced a qualitative improvement in their efficiency of operation. The systems are now reliable for data collection but the chief improvement is the interaction now possible between the user and his experiment which allows optimisation of the experiment. At both D11 and D17 there is a set of programs for a first order data treatment and the user is able to verify, during the measurement, whether his preconceived models for fitting the data are correct, and in such a case to determine whether the statistics obtained are adequate to obtain the parameters for the model. In cases of poor agreement, the initial model serves to indicate the level of statistics needed for treating more complex models. Such programs will be installed progressively on other instruments in the NICOLE and CARINE replacement during 1979, as more and more computer power becomes available at the instruments. Definitive data reduction and modelling will continue to be done on the central computer. Comparison of the performance of spectrometers in the last three years (Table II) shows some of the effects of the priority given to the instrument group and minicomputer investment programmes in budgets over the last two years.

TABLE II - TIME LOST (1) DUE TO TECHNICAL PROBLEMS (DAYS)

Year	1976	1977	1978
Reactor operating days	262.4	257	263 (2)
Diffraction Group			
D1A powder diffractometer	7.5	24.2	8.3 (3)
D8 single Xtal diffractometer	50.7	36.3	20.6 (4)
Three Axis Group			
IN2 3-axis spectrometer	27.5	30.3	37.1 (5)
Vercors Group			
IN5 time of flight spectrometer	49.6	37.7	17.8 (6)
Nuclear Physics Group			
PN1 Lohengrin fission product separator	52.4	39.0	67.0 (7)

The days lost for 1978 correspond to the 219 days of operation until 30/9/78 (*) see p. 18.

(1) Losses include mechanical, electronic, computer and cryogenics failures.

(2) Extrapolated to six cycles of operation on the basis of five cycles until 30 September 1978.

(3) Normal random losses due to instrument failure and modifications.

(4) Improvement when instrument taken off CARINE onto dedicated computer.

(5) This includes a big loss due to cryogenics failures.

(6) Improvements due to preventive maintenance on chopper bearings.

(7) Includes H.T. stability problems, turbo pump problems, camac problems, and nuclear magnetic resonance problems with probe. The largest part of this lost time was due to NICOLE/CAMAC problems. The situation will improve with dedicated computer now being installed as part of the NICOLE replacement.

The three main areas of investment, apart from the instrument group and computing budgets, are:

1) Studies of new sources and guides;

2) Improvement of neutron technique;

3) The start of new instruments.

In all these cases the principles of the modernisation programme — no compromise, complementarity and computing — have entered to a greater or lesser degree.

sources and guides

The technical study of a replacement for the present cold source, to improve by a factor of approximately 2 the cold neutron intensity for the cold neutron guide tubes, has progressed during 1978. This source, as originally conceived, was designed so that an ultra cold neutron beam could also be extracted from the liquid deuterium pool and initially both of these aspects have been kept in the analysis. Nevertheless, an overriding principle is that the source should be optimised to produce the best possible cold neutron beams, even at the expense of the ultra cold neutron intensity. At the limit, the exclusion of the ultra cold neutron beam would be accepted in preference to a serious loss in cold neutron intensity. The design study is now well advanced and the dossier is in a sufficiently prepared state to be submitted to safety authorities during 1979. The objective will be to have an agreement to install this source during 1981.

Experiments reported in detail under new experimental techniques and in College 3 'Fundamental and Nuclear Physics' show that ultra cold neutrons may be produced efficiently by moderation of thermal or cold neutrons in liquid helium. This idea is now being extensively studied by a group at Sussex University and at the ILL with the objective of producing ultra cold neutron densities of the order of 10^2 to 10^3 greater than had previously been imagined possible. This will be of greatest possible importance for such experiments as detecting the neutron electric dipole moment.

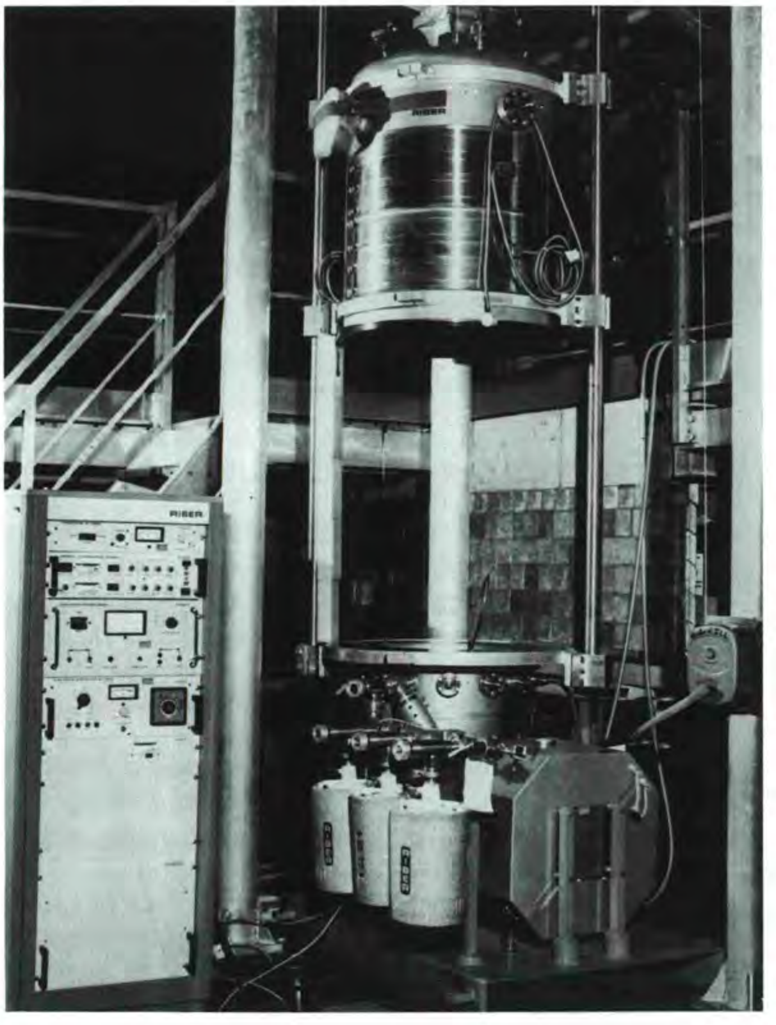
As mentioned in the Introduction, an extensive review of the evolution in conductivity of the thermal neutron guide tubes was made during 1978. This was in connection with the need to be able to predict with some certainty the evolution in the future of the conductivity of these guides and also with the project to use focussing monochromators etc. for exploitation of the whole neutron guide beam height rather than simply a fraction as in the previous method of exploitation. The disadvantages of using the whole guide height are that the same beam is shared by several instruments, but for fixed wavelength machines it has become apparent that beams may be extracted from the guide with little interference to instruments further along the guide-line. Exactly how far this principle can be taken for the up-thermal guides with somewhat different instruments will be evaluated in the years to come. If the principle can be extensively applied, it will mean that factors of at least 2, and sometimes 3 to 4, can be obtained for thermal neutrons on the guides, with the advantage of low background in the neutron guide hall.

developments in technique

Developments of monochromators, and in particular of beryllium for an efficient hot neutron monochromator, have been pursued with vigour in 1978. A full report is given in the Monochromator section. It is sufficient to say here that the hoped-for possibility of growing beryllium crystals suitable for neutron monochromators will be realised initially by the construction of mosaics of small crystals which have been properly deformed according to techniques developed at the Institut Laue-Langevin.

The evaporator for producing non-polarising and polarising mirrors, as well as supermirrors, was given the highest priority during 1978 for construction of mechanical parts and for the informatics to automate the deposition of mirrors. These parts are now finished and a programme of study to systematically improve the quality of the mirrors, as well as for their routine production, will begin in the first months of 1979. The instrument IN12 was also placed in the highest possible category for finishing in 1978, thereby also allowing a practical test as soon as possible of the new system of motor control and shaft drives, proposed by the Commission on this subject during 1977/78. The present results are that, for 3-axis spectrometers, the new system is a great improvement on past technique. If this proves to be so after several months of tests in service as a 3-axis spectrometer, a systematic standardisation of the movements on 3-axis spectrometers will follow. The second line of mini-computers adopted by the Institut in 1977 has also been installed for the first time on the IN12 instrument. Programs were developed and a high priority was given in 1978. These programs will eventually be suitable for transfer to other 3-axis type instruments if operation is satisfactory on IN12.

Multidetector development aimed at the pseudo-one dimensional multidetector D19 progressed during the year and the high pressure tests on this counter were in the final stages of completion in December 1978. The mechanical part of the D19 test instrument for installation on the H24 guide will be completed in the Spring of 1979 and it is expected that tests on the methods of operating a pseudo-one dimensional multidetector for crystallographic studies will begin then. Further reports occur later in this volume. One aspect of the production of this pseudo-one dimensional multidetector at higher pressures was the production of a small prototype which itself has been found useful for instruments. Installation of such a small prototype on D16 will be made during 1979 as a result of these developments.



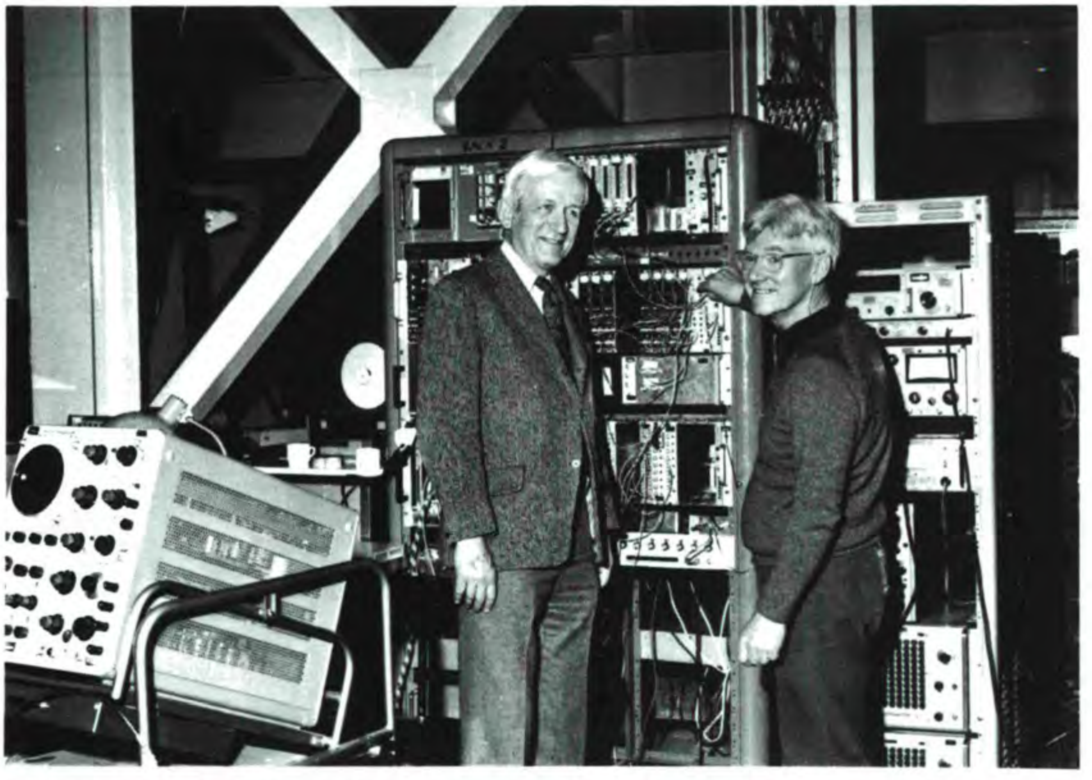
New evaporator system for producing supermirrors.

new instrument developments

These developments are summarised in the Tables which follow. It will be remembered that, for budgetary and man-power shortage, no new instruments were begun in 1977. In 1978 the highest priority was given to finishing the instruments IN12, D18 and D19. These should come into operation in 1979.

An aspect of the development of new technique which is also itself an instrument given high priority in 1978 was the implementation of a spin echo option on the D10 3-axis diffractometer. This option is designed to allow the higher energy resolution available in spin echo to be used in the first instance to make a systematic separation of the thermal diffuse scattering from elastic Bragg scattering in soft crystals. The same apparatus, though, is available to test the ideas of energy and momentum focussing in 3-axis spectrometry using spin echo spectrometry. Tests of these new ideas will occur early in 1979.

Finally during 1978 the new instruments IN6 (high intensity, time-focussing, time-of-flight spectrometer for 4Å - 6Å neutrons) and IN13 (the back-scattering spectrometer with thermally-scanned monochromator for thermal neutrons) were started.



N.F. Ramsey and K. Smith, two of the originators of the proposal to measure the electric dipole moment (EDM) of the neutron, (see page 84).

INSTRUMENT OPERATING STATISTIC

THE REACTOR HAS OPERATE
15 DAYS WERE AFFECTED B
(13.6 DAYS WERE RECUPERATED B

Instruments	Total operating time (days)	Loss of beam-time (days)	Coll. 3	Coll. 4	Coll. 5	Coll. 6	Coll. 7	Coll. 8
IN1	195.9	66.7		101.0		9.5	10.7	
IN2	222.5	40.1		182.0			22.9	
IN3	217.1	45.5		138.2		37.5	19.5	
IN4	210.1	52.5		6.0		24.7	45.9	
IN5	238.2	24.4				53.1	67.0	23.2
IN8	212.9	49.7		179.0		15.3		
IN10	239.0	23.6		26.2		34.8	35.1	9.6
IN11	238.1	24.5				63.0	66.8	
D1A	247.8	14.8			179.6		3.8	
D1B	251.3	11.3			157.9	16.9	7.2	
D2	234.9	27.7			123.5	48.0		
D3	214.1	48.5			177.1			
D4	254.6	8.0				194.8		8.3
D5	231.0	31.6		13.0	119.9	20.3	17.9	
D7	213.6	49.0				20.9	149.0	
D8	237.2	25.4			168.3			37.9
D9	219.6	43.0		33.8	150.1		8.0	
D10	206.0	56.6		38.5	104.3		50.8	
D11	230.0	32.6			1.6	7.9	41.1	64.5
D12	228.5	34.1		29.0	124.5			
D13	99.0							
D15	215.6	47.0			196.0			
D16	238.2	24.4			97.8			62.1
D17	246.2	16.4			14.0	27.8	35.5	81.0
PN1	194.0	68.6	150.0					
PN2	216.0	46.6	211.0					
PN3 (G1)	248.0	14.6	248.0					
PN3 (G2/3)	233.3	29.3	233.3					
PN4	30.6		30.6					
PN5								
PN6	220.0	42.6	220.0					

JANUARY TO DECEMBER 1978)

OR 262.6 DAYS DURING THE YEAR
NSCHEDULED SHUT-DOWNS
XTENDING THE OPERATING CYCLE)

Coll. 9	Internal test, feasibility, and instrument improvement experiments	Comments
63.4	11.3	Shut-down for 2nd cycle - instrument modification
	17.6	See Table II
7.3	14.6	21 days lost due to H24 guide replacement
112.5	21.0	Loss included 27 days for instrument rebuild and NICOLE II tests
72.1	22.8	See Table II
	18.6	Electronic, Tanzboden and CARINE failures
107.8	25.5	
35.1	73.2	Operational ILL instrument from January 1978
5.0	59.4	See Table II
22.1	47.2	
29.8	33.6	
	37.0	S/C magnet problems + 14 days with no user
12.2	39.3	
	59.9	
	43.7	NICOLE PDP 11/34 change-over
	31.0	See Table II
	27.7	Cryogenic and CARINE problems
	12.4	Out of commission (1 cycle) for H24 guide and instrument rebuild
55.7	51.1	
	75.0	
	99.0	38 short-term experiments recorded
	19.6	Encoder and PDP8 failures
5.0	73.3	
38.9	49.0	
	44.0	Failures listed in Table II
	5.0	17 days lost due to damage to target change apparatus
		Use restricted by experimental requirement and positioning of PN3 (G1)
		Two long-term experiments in progress (EDM, storage ring Table VII)

TABLE IV - PROJECTS IN PROGRESS

IN6	(New name for IN5B). High intensity time-of flight spectrometer in the λ-range 4.1 - 5.9 Å. It will have three focussing monochromator crystals (pyrolytic graphite) 20 cm high; a Fermi-chopper; 2 m flight path; 400 elliptical ^3He detectors covering 4 m². The monochromator assembly will be tested early 1979. Tests on the time-focussing principle will begin when the chopper system will be available (April 1979). The instrument should be completed by November 1979 and extensive tests will take place until the end of the year. It is expected that IN6 will be fully operational early 1980.
IN12	Triple axis spectrometer on cold guide H142. The major mechanical construction of this instrument has been terminated as of December 1978. At present the spectrometer is being fitted with small items such as collimator mountings, optical benches to support monitors, and so on. Initially, the analyser shielding blocks will be moved "manually", but an automatic system is under development and will be installed in Spring 1979. Final touches are being made to the electronics and both the microcomputer, for motor control, and the SOLAR 16-40 for calculation and "main-programme", are being tested. The "manual" step-motor control units have been tested. The control program has been essentially completed and the first tests of the motor drive system using the computers are under way. Optical alignment, followed by neutron alignment, will commence in January 1979. There will then be a period of "mise au point" — reduction of background, etc — but it is hoped to attempt a test experiment by next Spring.
IN13	This is a backscattering spectrometer on a thermal guide operating at 2.2 Å. The monochromator zone has now been constructed and installed on the H24 guide. Tests with the monochromator furnace will be carried out early in 1979. It will be computer controlled, using a dedicated PDP11/34. The analyser zone is now under definition and will be constructed for the October 1979 shutdown. First test experiments should be possible early in 1980.
D10	During 1979, D10 will be used to test the neutron spin echo (NSE) method applied to a three axis spectrometer. In particular the use of NSE for the supression of thermal diffuse scattering and for high-resolution phonon spectroscopy will be studied. The magnets, electronics and mechanical components necessary for these tests have been ordered and installation should commence early in 1979.
D18A	The mechanical parts of the instrument — diffractometer bench, rotating platform (carrying the spring suspension system), and monochromator shield — have been installed. The electronic modules and the elementary microprocessor software for the instrument control system have been developed, and are currently under test. First neutron experiments are planned for January 1979, continuing the measurements carried out with the S12 prototype instrument.
D19	During 1978 the pressure vessel for the D19 detector has been built and pressure tests on it have been completed. The geometry in which the detector will be used has been defined. The design of the goniometer and its implantation in a test position on the H24 guide has been finished and it is expected that the part manufacture of the mechanical parts of the instrument will be complete early in 1979. Further details of the progress of this project will be found in the report of the diffraction instrument group.

TABLE V - PROJECTS UNDER DEFINITION

IN1	The new instrument will be a "non compromise" construction not sharing a hot beam with another instrument. It will be as compact as possible with a stationary monochromator (no translation). One expects to obtain a Be-monochromator from the development by A. Freund. Studies are on the way to maintain measuring facilities as exist now on D4.
IN4	At present the improvement or rebuild of IN4 is being studied. The new version will have the option of using one monochromator crystal only for experiments with relaxed resolution but with higher flux.
IN8 B	A dedicated computer with new electronics and new shaft drive systems will be implemented. The new system will be as close as is reasonable to the one developed for IN12.
IN10 B	A detailed project study (mechanics and electronics) of the Doppler drive of the instrument was started at the end of 1978 and will be finished spring 1979. It is planned to test and implement this device on IN10 behind its actual Doppler drive. The new system will increase the energy range of the backscattering spectrometer by more than one order of magnitude.
IN20	It is proposed to rebuild IN2 on a thermal beam inside the reactor hall with a single crystal monochromator to improve the intensity and the usable energy range. The monochromator will be built such, that polarized neutrons can be produced for thermal beam polarisation analysis experiments. The instrument, in unpolarised mode, is intended to meet part of the great over demand for thermal three axis beam time.
D7 B	The operation with polarized neutrons will be improved by the introduction of a supermirror system, instead of polarising Heusler crystals.
Liquid Helium UCN-Source	A new ultra cold neutron source will be constructed at the guide H17 where UCN are produced by down scattering of 10 Å neutrons in liquid helium at about 1K. The helium container will be operated in a storage mode producing a high UCN density which is necessary for the experiment searching for an EDM of the neutron. The technical studies will be finished in spring 1979 and the project should be realized by the beginning of 1980.

TABLE VI - SPECIAL PROJECTS

Monochromators	The production of plastically deformed Ge, Si and Cu monochromators tailored to the experimental requirements is well under control, and thus most of the effort in materials development has been devoted to Be. It has been shown that plastic deformation of good quality Be single crystals gives excellent results (see the report of the instrument group "monochromators") and the production of a vertically focussing, composite Be monochromator for the new IN1 has been started. Other materials studies have been carried out on Heusler alloys as neutron polarizer and on the efficiency of perfect Si crystals as a filter for thermal and fast neutrons. As practically all new monochromators will be of the vertically focussing type, a modular focussing device is under development. The effect of cooling on monochromator efficiency has been investigated and gains of 20-30 % in reflectivity can be obtained under certain circumstances.
Optimised Shaft Control	The Working Group set up in 1977 to study the problems of automatic shaft control for triple-axis spectrometers and diffractometers reported early in the year. The setting times being obtained on the drive system installed on IN12 are felt to be fully satisfactory. For diffractometers, some further studies and prototype developments are in hand.
S3 Evaporator	The S3 evaporator for the development and production of neutron super mirrors has nearly been completed this year. A substrate holder assembly has been designed and built together with a neutron beam and detector system. These permit the direct observation of the neutron reflectivity of the mirrors during evaporation. For automatic running, a computer control system has been designed and is being installed.
Improvement of Guide H24	Following the studies undertaken for the preparation of the modernisation programme, it seemed necessary to entirely rethink the use of the thermal guides and the distribution of the instruments on these guides on the basis of the following principle: to no longer assign only a part of the available section of the incident beam, but on the contrary as far as possible to keep the maximum beam height by using focussing monochromators, transparent at the unused wavelengths. Following this principle H24 (total height 200 mm) from the beginning of 1979 will supply the instruments IN3, IN13, D19 and D10 with beam heights varying from 50 to 100 or 125 mm respectively. Other guides will be modified later if the hoped for results are obtained.
Replacement of Guide Noses	A decrease in flux of the order of 25 % was observed with guide H25 during 1978, so in the long shutdown in October an appraisal was made of the state of the guides. It seemed that the aging under flux of the glass used for the guides was causing fractures which could lead, in the near future, to the most exposed section of guides becoming non-serviceable (that is the first 10 m of each guide). A study has been undertaken to look at: 1) choosing a new type of glass more resistant to the flux 2) the preparation of a means of replacing the damaged areas within a maximum of 2 years. The main part of this work will be carried out during 1979.

TABLE VII

SPECIAL INSTRUMENTS AND SPECIAL BEAM EXPERIMENTS CARRIED OUT OR IN PREPARATION IN 1978

TITLE	PROPOSERS
Evaporator for producing super mirrors	ILL
Parity non-conservation effects in polarized neutron physics	Ispra, ISN-Grenoble
Spin rotation experiments	University of Sussex
Time reversal invariance experiment	University of Sussex
Concentration profiles by (n,α) (n,p) experiments	TU-München, FU-Berlin
Storage ring for ultracold neutrons	University of Bonn
Magnetic neutron bottle	University of Bonn
Neutron half life experiment	University of Sussex
Measurement of the neutron charge	Univ. Bayreuth, TU-München
Measurement of the neutron electric dipole moment using a bottle for ultra cold neutrons	University of Sussex, Harvard, Rutherford Lab.
In beam NMR spectrometer	University of Heidelberg
Experiment on the neutrino rest mass	Caltech, TU-München, ISN-Grenoble
Neutron experiments with living cells	University of Uppsala
Gamma directional distribution from oriented nuclei	University of Sussex
γ-γ directional correlation after neutron capture	University of Sussex
β and $\bar{\nu}$ spectrum from ^{235}U	TU-Braunschweig
Neutron topography	ILL
High precision lattice parameters	Ispra, ILL
(n,α) $(n,\gamma\alpha)$ (n,p) (n,f) reactions in heavy isotopes	Ispra, Mol
Fission physics with external beams	Saclay, CEN-Grenoble, Ispra

instruments which became operational in 1978

PN7 - polarized cold neutron beam for fundamental physics

The PN7 instrument is essentially a high efficiency beam of polarized cold neutrons available for various experimental positions in the S1 area, on guide H142 (flux: 1.4 10^9n $cm^{-2}s^{-1}$, peaked at $\lambda = 4.4$ Å).

It includes:

— a polarizer, which is a 25 cm full length bent guide of the Soller type, with the same aperture ($s = 5 \times 3\,cm^2$) as the beam guide H142. The mirrors are magnetized by a permanent magnet of 1.4 kG field intensity.

— a current sheet unit working as a spin flipper for which aluminium and copper strips are used. A constant current 10 amp power supply together with a solid state switch allows the possibility of reversing periodically the spin orientation, with a rise time of the current, in the whole system, of less than 1 m sec. A couple of coils are added for far flipping magnetic fields compensation.

— a set of permanent magnets ((guide field) 8 to 10 Oe) eliminates depolarization over the beam path up to the region of interest, and aligns the spin orientation in the required direction through adiabatic processes.

This high intensity polarized cold beam is used for fundamental nuclear physics experiments.

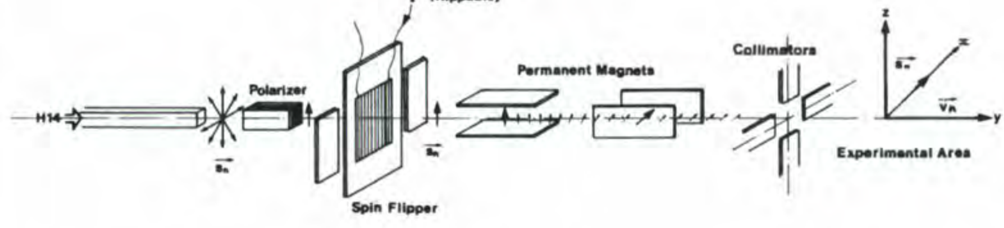


Fig. 2: Schematic view of PN7, polarised cold neutron beam for fundamental physics.

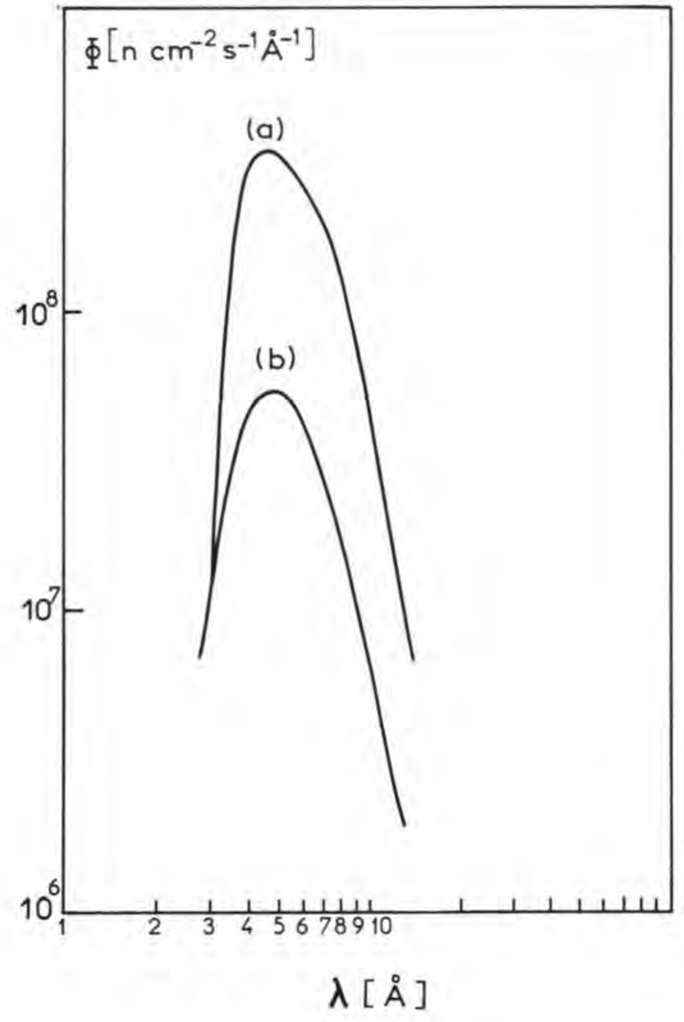


Fig. 3: Neutron wavelength spectra of the PN7 instrument. Curve (a): guide H 142 spectrum. Curve (b): polarized beam spectrum.

Instrument details

Beam tube: H142

Incident flux: 1.4×10^9 n $cm^{-2}s^{-1}$ over a $5 \times 3\,cm^2$ cross-section.

Incident wavelength range: see fig. 3.

Polarizer efficiency: 90 %

Polarizer total transmission efficiency: 15 %

Polarized flux: 2×10^8 n cm^{-2} s^{-1} ($5 \times 3\,cm^2$ cross-section).

Flipper efficiency: 98 ± 2 % at 10 amp.

Residual flipping field at the "target" level: $< 10^{-5}$ Oe.

Horizontal divergency } same as guide tube
Vertical divergency

new experimental techniques

production of ultra cold neutrons in superfluid helium 4

(P. Ageron - W. Mampe)

If UCN could be produced inside a completely closed and "ideal" bottle, much higher UCN densities (about 1 000 UCN cm^{-3}) could be produced, as compared to bottles filled through an opening with a UCN beam from an external UCN source (densities < 1 UCN cm^{-3} for any existing UCN sources). As proposed by R. Golub and J.M. Pendlebury [1], neutrons with an energy of about 1 meV can lose all their energy, and thus be converted into UCN, by down scattering on superfluid helium 4 at about 1 K.

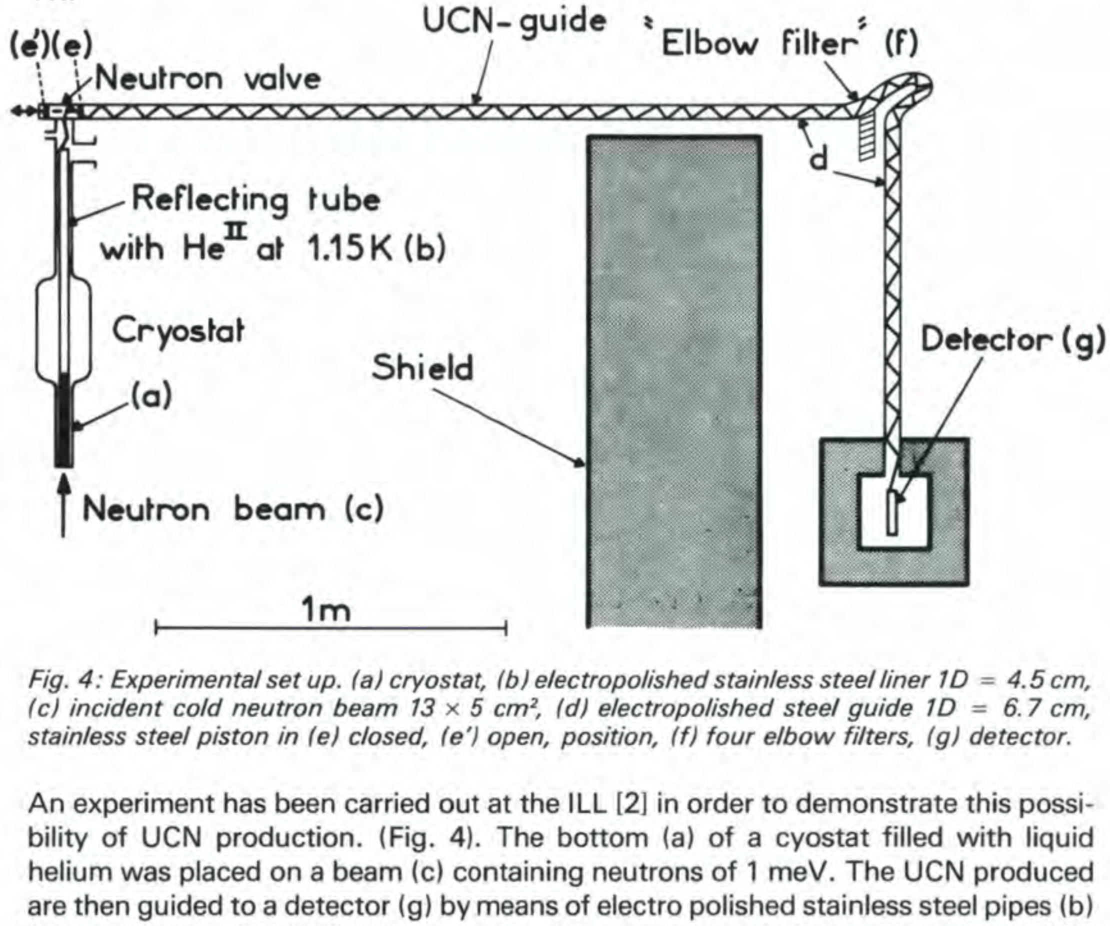


Fig. 4: Experimental set up. (a) cryostat, (b) electropolished stainless steel liner 1D = 4.5 cm, (c) incident cold neutron beam 13 × 5 cm², (d) electropolished steel guide 1D = 6.7 cm, stainless steel piston in (e) closed, (e') open, position, (f) four elbow filters, (g) detector.

An experiment has been carried out at the ILL [2] in order to demonstrate this possibility of UCN production. (Fig. 4). The bottom (a) of a cyostat filled with liquid helium was placed on a beam (c) containing neutrons of 1 meV. The UCN produced are then guided to a detector (g) by means of electro polished stainless steel pipes (b) (d) and "elbow filter" (f). Along such a path, neutrons of higher energy than UCN are eliminated whereas the measured transmission of the UCN is still about 17 %. In addition a UCN valve can be closed (e) or opened (e') in order to separate the UCN counting rate from the background. A vacuum pump was used to lower the vapour pressure over the helium bath, thus to cool the helium.

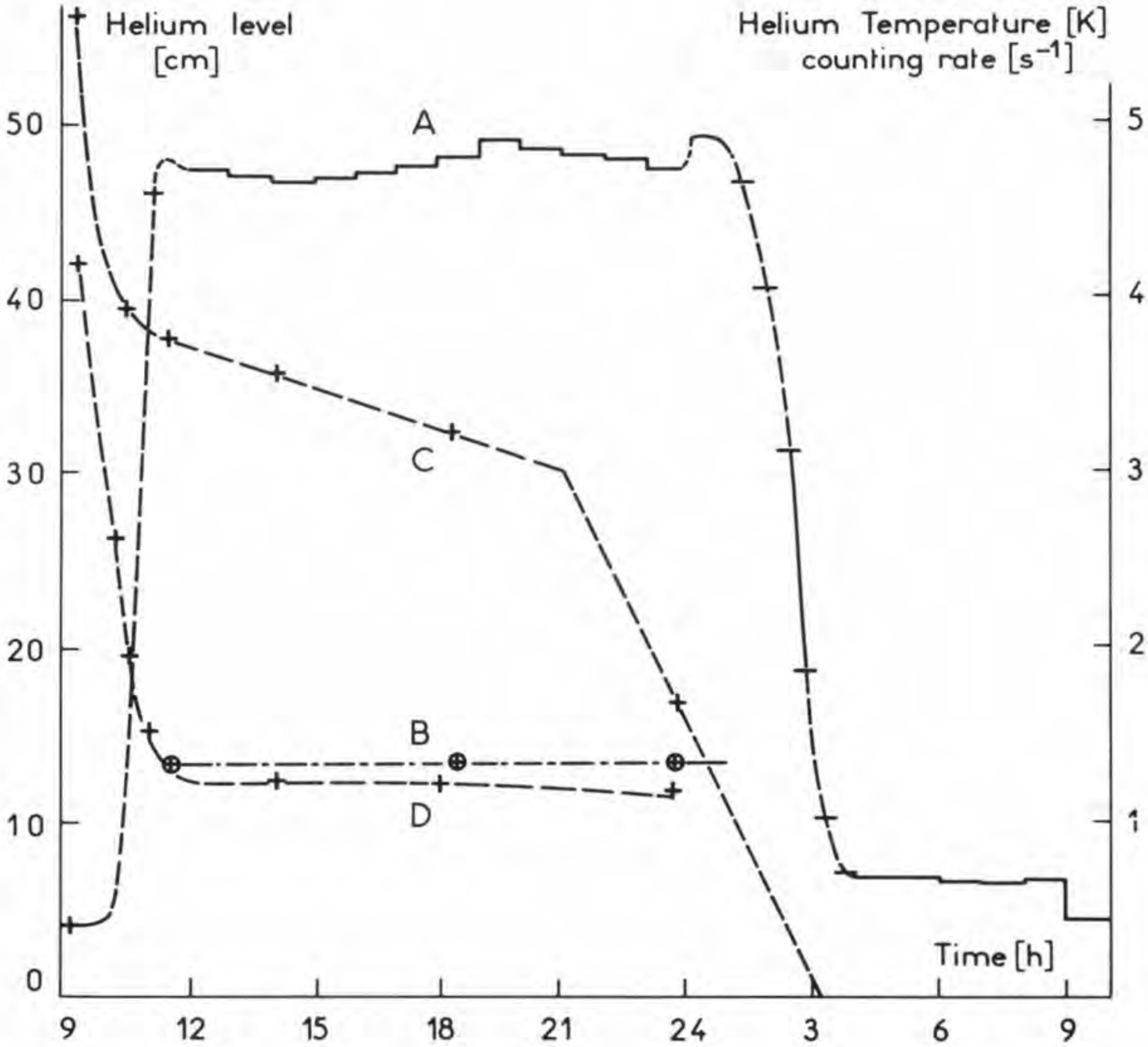


Fig. 5: Counting rate, (A) open position, (B) closed position, (C) liquid helium level above the bottom of the cryostat, (D) helium temperature, as a function of time.

The counting rate was recorded as a function of time, with the UCN valve either open (curve A) or closed (curve B) as well as the temperature (curve D) and the level (curve C) of the liquid helium. (Fig. 5).

At the beginning of the experiment the UCN counting rate rose rapidly as soon as the helium temperature was lower than 2 - 3 K and then remained stable as long as the bottom of the cryostat was still filled with liquid helium at a temperature decreasing slowly from 1.3 to about 1.15 K. It finally decreased down to background level when the volume of liquid helium exposed to the incident beam began to decrease.

The measured net UCN counting rate, about 3.5 c/s was in reasonable agreement with the predicted one, about 4.4 c/s, considering the uncertainties (on the incident spectrum, on the various transmission factors etc.) in the calculation.

Based on this principle of UCN production two experiments are presently in preparation :

(1) a spherical magnetic bottle for the precise measurements of the neutron life time

(2) a pulsed UCN source for the search of an electric dipole moment of the neutron.

(1) R. Golub, J.M. Pendlebury Phys. Lett 62 A (1977) 337

(2) P. Ageron, W. Mampe, R. Golub, J.M. Pendlebury Phys. Lett 66 A (1978) 469.

2

instrument operation department

introduction

During 1978 reorganisation within the Institut has created this new department which unites the instrument groups: nuclear physics, three axis spectrometry, diffraction, time of flight and diffuse scattering with the monochromator group, the central group and the sample environment group. This new department therefore has overall responsibility for the operation and improvement of the instruments and for enabling the visitors to carry out their experiments. The activities of the different groups of the department during 1978 are outlined in the sections which follow.

INSTRUMENT GROUPS

Fundamental and nuclear physics

Three-axis

Time of flight and diffuse scattering

Diffraction

OTHER GROUPS

Monochromator group

Central group

Sample environment group

instrument group 'fundamental and nuclear physics'

PN1	:	Fission Product Spectrometer (LOHENGRIN) on beam tube H9
PN2	:	Beta Spectrometer (BILL) on the vertical beam tube V3
PN3	:	Three Curved Crystal Gamma Spectrometers (GAMS 1, 2, 3) on the through going beam tube H6/H7
PN4	:	Ge(Li) Anti-Compton and Pair Spectrometers on the through going beam tube H7
PN5	:	Ultra-Cold Neutron (UCN) Source on the inclined beam tube IH3
PN6	:	On-Line Mass Separator for Thermally Ionized Fission Products (OSTIS) on neutron guide H23L
PN7	:	Cold Polarized Neutron Beam on neutron guide H14L
H17	:	Cold neutron guide: liquid helium UCN source (in preparation)
H18	:	Cold neutron guide: determination of the neutron half-life (S37)
H22	:	Thermal neutron guide: neutron induced particle emission (S10); γ-γ angular correlation (S31); neutron induced fission; γ-γ-ray directional distribution from oriented nuclei (S34)
IH1	:	Very intense neutron beam tube: neutron-induced fission (S16, S38)
base-ment	:	Neutrino experiments.

PN1 - fission product spectrometer "lohengrin"

(H. Schrader, G. Siegert)

During 1978 the mass spectrometer was operational for 182 days (70 % of the reactor time). The beam time has been used for 14 experiments in collaboration with external research groups (144 days) and for several test runs (38 days). About 70 % of the beam time for experiments has been used to study the ^{235}U thermal neutron fission and 30 % for nuclear spectroscopy, mainly the measurement of $Q\beta$-values.

The performance of a new high tension power supply has been studied. A new measuring and control resistor device is under construction.

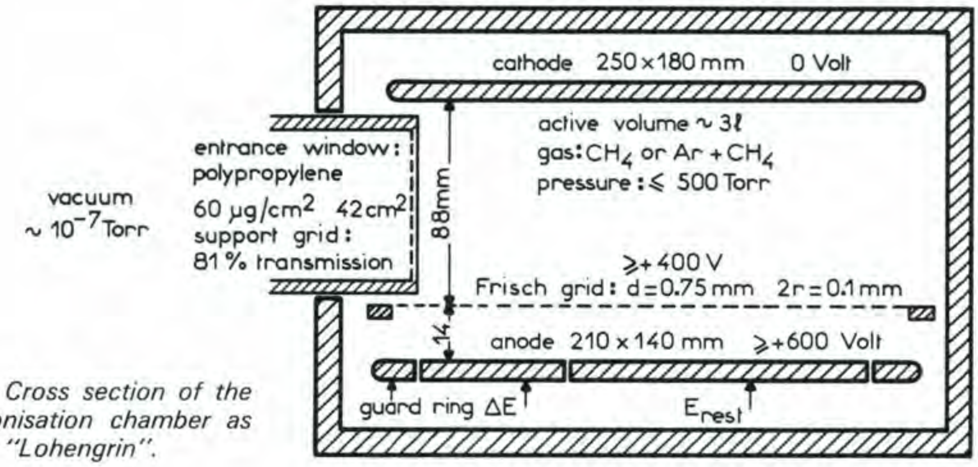


Fig. 6: Cross section of the ΔE, E-ionisation chamber as used at "Lohengrin".

A high resolution ionization chamber has been developed by Quade and Rudolph (University of Munich) and Siegert (ILL). (Fig. 6). An energy resolution of better than 650 KeV has been achieved for fission products, working in the total absorption mode of the chamber. Furthermore the residual energy of fission products after passing a plastic absorber has been measured with the ionization chamber. Thus a nuclear charge resolving power of $Z/\Delta Z > 50$ has been obtained for fission products of 93 MeV (light group).

PN2 - beta spectrometer "bill"

(K. Schreckenbach, H. Faust)

In 1978 the beta spectrometer BILL was working continuously for about 90 % of the reactor time. More than 30 different measurements have been performed in nuclear and atomic physics.

The data acquisition programmes at the PDP11 control computer have been further developed and a disc unit was incorporated in the system. The new system (foreground - background RT 11) allows the execution of computer programmes parallel to a running measurement. It is now possible to reduce data from the multi-detector system on-line and to run evaluation programmes.

PN3 - curved crystal gamma spectrometers "gams 1" and "gams 2/3"

(H.G. Börner, W.F. Davidson, G. Barreau)

During 1978 the curved crystal spectrometers GAMS1 and GAMS2/3 were running for 95 % and 80 % respectively of the reactor time.

Modifications of the target change apparatus have been carried out to enable targets to be inserted into the source holder tube by remote control. The whole source changing operation can be controlled by a TV camera. Consequently, the manipulation and the storage of strongly radioactive targets can be performed in a much safer and simpler manner than before.

At the GAMS1 spectrometer a disc unit has been installed together with a new software system (RT11) for the PDP11 computer. An additional benefit is the possibility to analyse data in situ.

PN4 - Ge(Li) pair and anti-compton spectrometers

(D.D. Warner, G. Barreau)

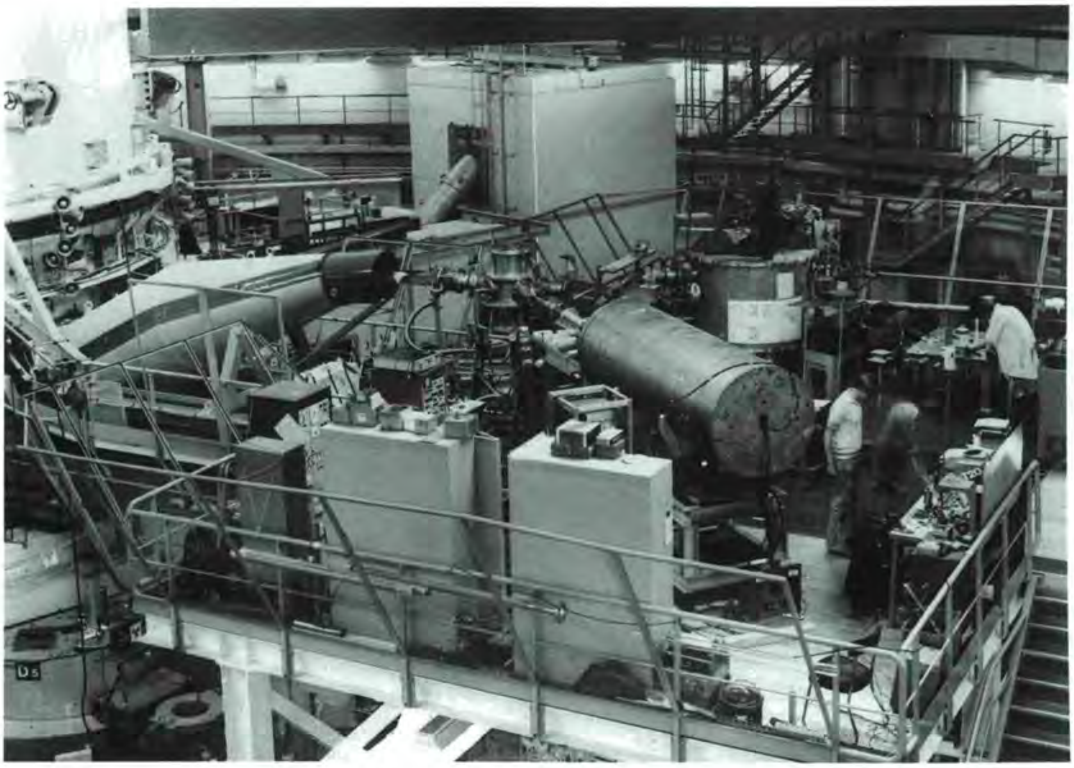
The Ge(Li) pair spectrometer was fully operational throughout 1978. The detector for the anti-Compton spectrometer was again returned for repair due to failure to maintain its specifications, but has been available during the latter part of the year.

Spectra of high energy γ-rays following thermal neutron capture in 6 different targets were obtained. During the annual shut-down, a clean-drift was performed on the pair spectrometer Ge (Li) crystal, which has reestablished its original energy resolution of 1.9 keV at 1.33 MeV.

PN5 - ultra cold neutron source

(P. Ageron, W. Mampe)

The ultra cold neutron (UCN) source has been extensively used in 1978. Three long-term experiments have been performed. The beam switcher for the three beam positions has been completed, including a safety system against malfunction. The storage time of UCN in a copper bottle has been studied. In particular the temperature dependence and the effect of covering the walls with deuterium has been investigated. The UCN transmission has been measured for various reflecting liners foreseen for the new UCN source.



General view of the Ultra-Cold Neutron Source (PN5). The picture shows (from left to right) the UCN guide system and its shielding, then the beam distributions box, from which the left-hand beam goes to the magnetic storage ring for ultra-cold neutrons, and the right-hand beam to the neutron electric dipole moment experiment, which is installed in the long cylindrical shield.

PN6 - on-line mass separator "ostis" for thermally ionized fission products

(K.D. Wünsch until June, B. Pfeiffer, G. Jung, G. Siegert)

In 1978 the high demand for the on-line mass separator OSTIS continued. This instrument was operational for 87 % of the reactor time and 12 experiments were performed in this period (including two ion source tests). Due to an improved ion source the intensity of separated fission products could be increased appreciably. Thus it was not only possible to extend the range of investigation of neutron-rich isotopes to the very short-lived ones ^{100}Rb, ^{100}Sr and ^{148}Cs (^{100}Rb has a half-life as short as 50 ms), but also to start new types of experiments such as γ-γ angular correlation measurements and spectroscopy of β^--delayed neutrons in coincidence with γ-rays. In addition, the high background of γ-radiation at the measuring position could be reduced by an order of magnitude due to improved shielding from the neighbouring neutron guide. A newly developed indirectly heated ion-source was tested for the first time at the end of the year. This new type of source will allow the possibility of working at higher temperatures and hence also to ionize the rare earth elements.

PN7 - polarized neutron beam

(B. Vignon, W. Mampe)

A new polarized neutron beam has been developed during the first half of 1978 (total flux = 2×10^8 n/cm². sec, beam area = 15 cm², overall polarization = 90 %) together with a new spin-flipper, which is an aluminium current sheet (efficiency near 100 %). With these high characteristics the planned measurement of the asymmetry in the polarized neutron capture by deuterium becomes feasible with an expected accuracy of 10^{-6}. According to the experimental requirements for such an experiment two large NaI(Tℓ) crystals (9'' diameter, 5'' thick) have been mounted on each side of a heavy water target. An electronic system with very low drift is used with an effective temperature stabilization. The background contribution was reduced significantly.

The Special Instrument S43, intended to search for a parity violating neutron spin rotation on passage through tin or bismuth, is in the process of being installed at PN7 on the Neutron Guide H14. A monochromator of synthetic mica has been installed creating a new beam, H142. Tests to evaluate neutron fluxes and beam profiles are currently underway.

special beam experiments

(W. Mampe, D.D. Warner, P. Perrin, G. Siegert, C. Guet)

The neutron beams H17, H18, H22 and IH1 were used continuously and successfully throughout 1978 for nuclear spectroscopy, fission and fundamental physics research.

At H17 studies for an essentially new method of producing ultra cold neutrons (UCN) in liquid helium are currently under way. The down-scattering of 9 Å neutrons in liquid helium at 1.1° K has been investigated. The measured production rate of 3 - 4 UCN per cm³. sec agrees well with theoretical predictions and is a fundamental value for a new UCN source.

At H22 a new casemate has been built. Measurements with radioactive targets can be performed now under safe conditions.

A multiparameter data acquisition system for experiments in nuclear and fundamental physics has nearly been completed, and will have the capability of registering events of up to 4 parameters with "list-mode" output to a magnetic tape. A display is incorporated for an on-line visualization.

Co-ordinator: K. SCHRECKENBACH

instrument group 'three-axis spectrometers'

IN1	:	On the hot source (beam tube H8)
IN2	:	On the thermal beam tube H13
IN3	:	On guide tube H24
IN8	:	On the thermal beam tube H10
IN12	:	On the cold guide H14

During the year 1978 the only instrument to function in a completely reliable manner was IN2. Unfortunately the operation of IN1, IN3 and IN8 has been disturbed by frequent electronic breakdowns.

The modifications made to the existing instruments were minor.

The slowness of Carine remains a problem, especially during the alignment of the instruments; its replacement by SOLARS 16-40 should make a significant improvement.

IN1 - hot source 3-axis

(J.R.D. Copley and J. Tomkinson)

The IN1 spectrometer as a whole has had a relatively successful year in 1978. A massive overhaul of the machine was undertaken in March and has resulted in a significant reduction in the amount of beam time lost. The setting speed of the various driving units was optimised, and IN1 is possibly the fastest setting triple-axis in the Institut. We still have some problems with the primary shielding rotation, $2\theta m$. A determined attempt has been made to reduce the background scattering coming from around the sample area, and a new diaphragm for the monochromatic beam has been fitted.

The present triple-axis analyser/detector system, long regarded as inadequately shielded, will be replaced by a new "compact system", (the detector moving within the analyser protection). Detailed designs for this were started in November.

The beryllium filter analyser/detector system has been equipped with its new multidetector and commissioning tests will be undertaken shortly. We expect a significant improvement of the signal to noise ratio.

IN2 - thermal beam 3-axis with a double monochromator

(B. Dorner, W.J. Fitzgerald and C. Joffrin)

IN2 is the oldest three-axis spectrometer at the ILL. Its double monochromator allows large Bragg angles (up to $2\theta = 165°$; $2\theta = 145°$ was used twice successfully) and produces a very clean monochromatic beam; but the intensity is much lower than for example on IN8. Unfortunately the smallest Bragg angle is limited to $2\theta = 37°$. Serious discussions have started about rebuilding IN2 with a single crystal monochromator which is the most compact solution possible.

IN2 has been in regular use for the last year and has been working satisfactorily. The performance suffered from serious breakdowns of cryogenic equipment.

Most experiments have used pyrolytic graphite as the monochromator and analyser, using the pyrolytic graphite filter in the monochromatic beam for $E_I = 3.55$ THz and the Be-filter for $E_I = 1.25$ THz. The new "Rutherford Lab. collimators" are used throughout. A collection of 10', 20', 30', 40' and 60' collimators exists, which are exchangeable between IN2, IN3 and IN8. A new heavy load goniometer on the sample table was installed which has an open space of 250 mm between the middle of the beam and the surface of the goniometer and allows tilts of $\pm 20°$.

IN 3 - focussing 3-axis spectrometer

(J. Lefebvre and R. Scherm (until 1.9.1978))

IN3 has operated satisfactorily during the past year apart from minor electronic and Carine problems. Pyrolytic graphite and Cu(111) have equally been used as monochromator crystals in the energy range from 1 to 9 THz. The horizontally curved pyrolytic graphite analyser has proved extremely useful for some special experiments.

During the annual shut-down, the modification of the H24 guide tube has allowed the extension of the height of the incident beam from 50 mm to 75 mm. Vertically curved monochromators (pyrolytic graphite, Cu(111), and Ge(111) in the near future) are available to use the full height of the incident beam at the sample position. A third RL-collimator has been installed between the analyser and detector.

IN8 - thermal beam 3-axis

(C. Escribe, R. Pynn and R. Currat)

Since November 1975, when IN8 became available to users, it has always been in high demand. This is because it has a higher flux than other ILL thermal beam 3-axis spectrometers (IN2, IN3) and its maximum energy transfers can reach 20 THz.

2 of the 4 monochromator crystals mounted on the turret have a variable vertical curvature (PG(002) and Ge 111). These are very useful for small samples. The flux gain is 2.5 for incident wavelengths between 1.5 and 4 Å.

The new RL-collimators will be available starting October 1978, the first between monochromator and sample, the second between sample and analyser. This new improvement should give more flux at the sample, especially for small collimations (10', 20').

Both diaphragms before the sample are now motorised and can be controlled from a distance; this reduces the radiation hazard to users of the instrument.

Except for the frequent breakdowns of electronics and cryogenic equipment and the slowness of the Carine computer system the instrument has operated satisfactorily.

IN12 - triple-axis spectrometer on "cold" guide H142

(W. Stirling)

During this year, the major construction work on IN12 has been carried out. The automatic control of the monochromator shielding blocks has been tested and preliminary tests of the motors driving the sample table and analyser-detector system have been performed. Of the mechanical work, only the automation of the analyser shielding blocks remains to be done.

The new step-motor control electronics have been tested, and preliminary tests under micro-computer control have been made. Computer program development is underway, with a full-scale simulation almost completed. The spectrometer should undergo tests under full computer control (SOLAR 16-40) by the end of the year when calibration with neutrons will be started.

It is hoped that the first "test experiments" can be attempted by Spring 1979.

Co-ordinator: C. ESCRIBE

instruments group "time of flight and diffuse scattering"

IN4	:	Rotating crystal spectrometer on thermal tube H12
IN5	:	Multichopper spectrometer on cold guide H16
IN7	:	Double monochromator and Fermi chopper spectrometer on thermal tube H5
IN10	:	Backscattering spectrometer on cold guide H15
IN11	:	Spin echo spectrometer on cold guide H14
D7	:	Diffuse scattering spectrometer on cold guide H15
D11	:	Small angle and diffuse scattering spectrometer on cold guide H15
D16	:	Four circle MK 6 diffractometer on cold guide H16
D17	:	Low-q - high resolution spectrometer on cold guide H17
IN6	:	Focussing spectrometer on cold guide H15 (under construction)
IN13	:	New backscattering spectrometer for short wavelength on thermal guide H24 (under construction).

IN4 - time of flight spectrometer

(J.-B. Suck, P. Poncet, R. Richardson)

31 experiments were performed on IN4 in 1978. During the reactor shut-down in October the secondary spectrometer of the instrument has been turned and shifted one metre nearer to the reactor. This shift should increase the intensity at the sample position by about 15 to 20 %. The scattering angles available now range from + 141 to − 9 degrees, thus opening the possibility of carrying out experiments with thermal neutrons at low Q. This enables several experiments to be done on IN4 which were not possible there up to now, especially in the field of magnetic scattering and investigations in liquids. The four detector positions at the smallest angles will be equipped with 15 cm long He^3 detectors to maintain an appropriate Q-resolution. A new argon box had to be built and adapted to the new geometry of the spectrometer.

At the beginning of 1979 the instrument will be connected to the new NICOLE system. Test experiments are planned for the end of 1978. With the new system it is hoped to obtain a better control of the performance of the spectrometer and a much quicker access to the results during the measurement.

IN5 - multichopper spectrometer

(A.J. Dianoux, F. Douchin, H. Scheuer)

The instrument has performed satisfactorily during the year. 38 experiments were carried out, 4 of them being disturbed by chopper breakdowns. It seems that the preventive change, three times a year, of all ball bearings has improved the situation compared to 1977. It has to be noted that the programme has been set up carefully by regrouping experiments needing either 10,000 or 15,000 rpm, thus reducing the number of speed changes.

During the annual shutdown, the alignment of the neutron guide links between the choppers has been controlled optically. A new monitor has been placed in front of the first chopper to control the neutron flux in the guide.

The installation of a new series of 400 ^3He detectors has nearly been completed. A series of 200 detectors had to be ordered from another manufacturer, since the original firm felt unable to produce detectors meeting the ILL requirement of low background. The original amplifiers are progressively replaced by smaller ones, integrated into the detector housing. This permits easy changes of the detector configuration. A study has been made for mounting smaller detectors (12 cm). These detectors will cover the small angle region between 1.9° and 9°. They will be installed by 1979. The new system of grouping the detector units has been extended. This allows all kinds of grouping of the detectors before sending the signal to the time-of-flight coding unit.

A new variable temperature He cryostat with an inner diameter of 70 mm has been ordered, and will, hopefully, be installed by early 1979. A new oven with very high temperature stability and low gradient is now operational ($T < 400°C$). A new thermostatic unit covers the range of temperatures between − 30°C and 100°C with the standard IN5 sample cans.

For the replacement of the NICOLE computer system a PDP 11/34 has been installed. The tests are currently under way. Initially the new computer will have to fulfil all the functions performed by the NICOLE system. In a later stage an enlargement of the data treatment facilities is envisaged following the development of the sophisticated software foreseen for IN6.

IN7 - double monochromator and fermi chopper spectrometer

(A.P. Murani)

The spectrometer suffered a serious breakdown at the beginning of the year due to failure of the time-of-flight unit and the Nova computer on loan from KFK Karlsruhe. So far no replacements or repairs have been effected. The user programme has consequently suffered a long delay and finally the proposers of all the scheduled experiments have been asked to resubmit their proposals for IN4. It is intended to discontinue IN7 unless a solution is found to replace its data acquisition system with the ILL-standard system for time-of-flight spectrometers.

IN10 - backscattering spectrometer

(A. Heidemann, G. Jenkin)

The spectrometer was running without problem during 1978. 39 experiments were performed. 9 of them were unscheduled ones which could be carried out during the test periods necessary to check the performance of new hard- and software such as a Plessey dual disc and the Dec software RT11. On-line data fitting and direct data transfer from the PDP 11 to the PDP 10 are now standard procedures. The sample table was equipped with an encoder. A new silicon analyser consisting of 2,000 single crystal slices was made with an area of $0.5\,m^2$. The aim to cover completely the scattering angle range from -20° to $+160^\circ$ with analysers will be reached by the end of 1979. A lifting device for the sample cryostats and furnace, and a new support for nine detectors will be available in early 1979.

The necessary improvements of the mechanics of the analyser system could not be made due to budget limitations. They are planned for 1979. A project study is under way for the extension of the energy range up to meV values.

IN11 - spin echo spectrometer

(J. Hayter and F. Mezei)

The spectrometer is now in routine operation, with 176 days requested at the October Science Council meeting (8 experiments using a total of 103 days were scheduled). Both hardware and software continued to evolve during the year, and, in particular, a Tektronix display terminal was added to the machine. Other hardware improvements included the provision of an evacuable sample box for small-angle scattering, improved metering of the magnet supplies, and the installation of circular Braunschweig neutron guides throughout the machine. A new multi-terminal software monitor has been implemented (RT11-VO3) together with a new machine control monitor program, MAUI. Two users may now use the computer simultaneously, one performing data analysis while the other runs an experiment. Machine control is through a liberal free format instruction set, with generalized JOB and DATA file storage. Sequences of experiments may be defined and executed from indirect command files using a single EXECUTE command, with data-files being named automatically if desired.

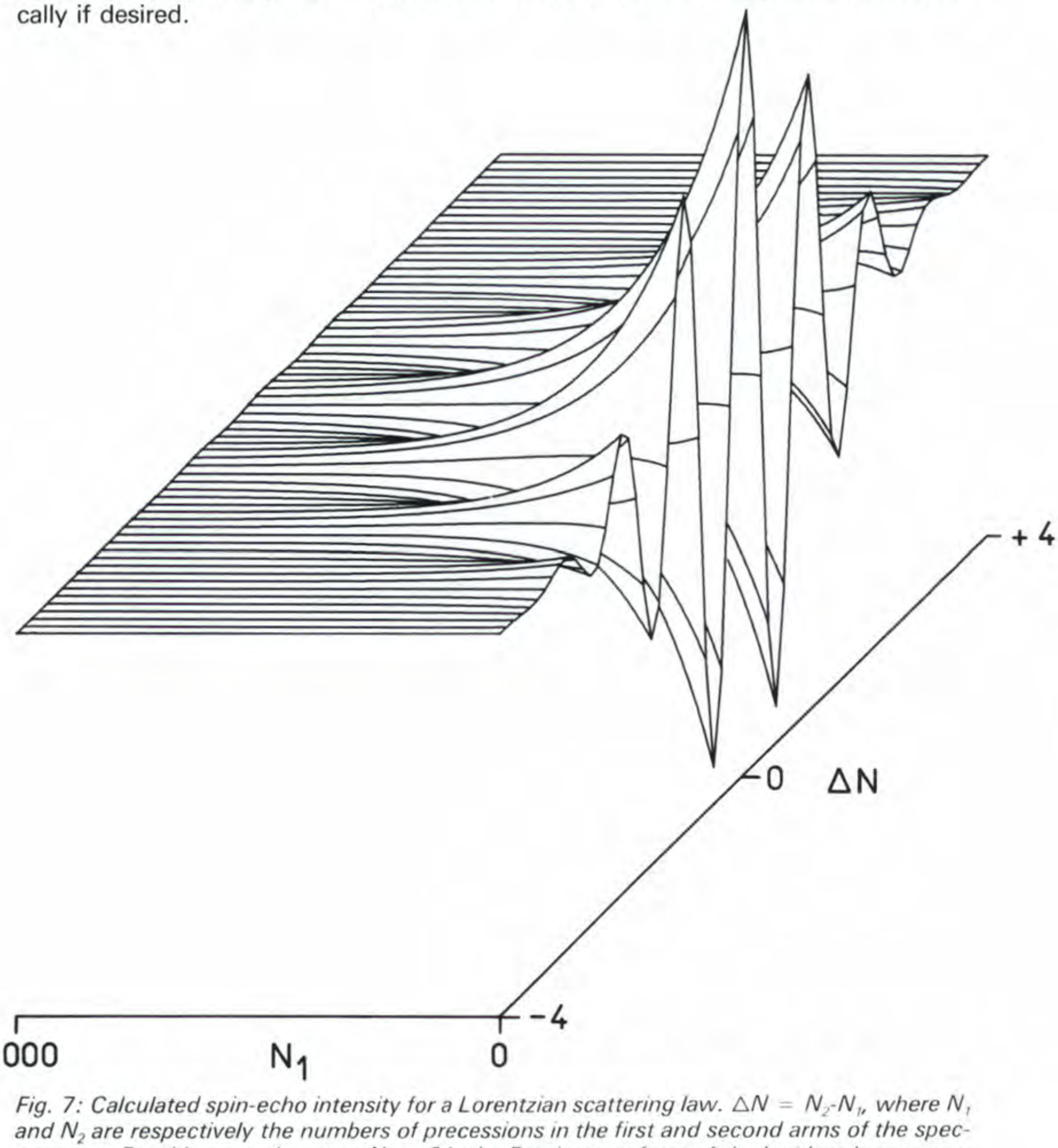


Fig. 7: Calculated spin-echo intensity for a Lorentzian scattering law. $\Delta N = N_2 - N_1$, where N_1 and N_2 are respectively the numbers of precessions in the first and second arms of the spectrometer. For this case, the curve $N_1 = 0$ is the Fourier transform of the incident beam spectrum, and the curve $\Delta N = 0$ is its Laplace transform, the Laplace variable being proportional to the Lorentzian width.
(Hayter and Penfold).

The machine has proved highly successful as a tool for studying polymer dynamics in the time domain, and energy transfers of 0.01 μeV have been resolved at momentum transfers as small as 0.027 $Å^{-1}$. Polymer experiments have been performed by the Imperial College and Jülich/Mainz groups, and some preliminary tests on small-angle inelastic scattering from viruses (ILL) and haemoglobin (Paris) have been undertaken. In the polarization analysis mode the spectrometer has been used to separate coherent from incoherent scattering in palladium deuteride. A successful study of the roton line-width in ^4He has also been made, using an asymmetric magnetic configuration. A comprehensive program of studies of ^4He and $^3He/^4He$ mixtures is envisaged in the coming year.

D7 - diffuse scattering spectrometer

(W. Just, A. Murani)

After nearly 6 years of operation the link between D7 and the NICOLE system which assured instrument control and data acquisition was cut in June 1978 and was replaced by a new dedicated PDP 11/34 computer. The new system offers a wide range of facilities for immediate data handling and instrument control, especially by means of a direct link to the "concentrator", a PDP 11/55 computer.

In view of the 2ème souffle, plans for improving D7 have been elaborated. The suggested improvements are mainly intended to increase the available flux at the sample by means of focussing monochromators and by using polarizing supermirrors for neutron polarization.

A very fast control and power unit for dynamical spin flip operation for use on D7 in the polarized neutron mode was developed by G. Badurek.

D11 - small angle and diffuse scattering spectrometer

(G. Göltz, R. Duplessix, J. Haas)

Since November 1977 the instrument has been controlled by a PDP 11/40 computer. Programs are available for the on-line treatment of isotropic spectra. A third terminal giving faster output facilities has also been installed.

A new chopper with a disc rotating in vacuum for TOF measurements has been available since May. The sample changer, which can be installed in the "cloche" position, is now working in a test mode. Another sample changer, foreseen for the two chimney positions in the diffuse scattering vessel, has to be tested and will be available next year.

A new sample cryostat with sapphire single-crystal beam windows has been in use since September 1978.

Test runs have been performed with the diffuse scattering part, and simultaneously with both the small angle and the diffuse scattering device with and without TOF-mode. Some work will still be necessary to write a new computer program allowing better synchronous control of both devices and giving more flexibility for the use of sample changers etc. This program should be ready in spring 1979 and even for normal small angle scattering experiments the content of the 32 counters for diffuse scattering will be available and will give more information.

D16 - four circle MK6 diffractometer

(G. Zaccai, S. Wilson)

In the past year, successful experiments have been carried out in a number of fields of interest. These include membrane and liquid crystal structures, a wide range of surface adsorption studies, reaction kinetics, clay structures, and extinction at longer wavelengths.

With the installation of the Tanzboden and the improved monochromator shielding, D16 now has a continuously accessible wavelength range from 2.8 Å to 5.8 Å with the pyrolytic graphite monochromator. Tests with a temporary mica monochromator demonstrated the availability of a useful neutron flux as far out as 10 Å to 12 Å. Design studies are in hand for a rotatable monochromator support, remotely controlled, with positions for four monochromators. This would eventually give a continuous wavelength range from 2 Å to 12 Å.

The surface absorption and kinetic experiments, using a small linear detector, have provided convincing evidence of the need to equip D16 with its own area detector (64 × 16 cells, covering 10° in 2θ, 5° vertically). This will be delivered in the early part of 1979, and it is hoped that the initial stages of its integration into the data collection system will be completed by late Summer 1979. This detector will also permit structure determinations to be carried out on interesting biological crystals with very large unit cells ($a_0 \sim 400$ Å). In view of the considerably increased speed of data collection possible in some experiments (1 frame of 1024 points in 1/10 second), and the increased complexity of data storage and data reduction brought about by the introduction of the area detector, a request is being made for the purchase of a dedicated computer for D16, with the power and data storage capacity essential for providing satisfactory support for the experiments now clearly feasible on the instrument.

D17 - low-q-high-resolution spectrometer

(M. Roth, P. Timmins, G. Bentley)

D17 has been equipped with a computer controlled Eulerian cradle which is used for diffraction studies on biological single crystals. Because of the small size of these samples, the background had to be reduced as much as possible. This has been achieved by using very thin glass windows in the direct beam. A special beam stop combined with a monitor for transmission measurements and measurement monitoring has been installed. A vacuum vessel with sample changer for measurements with samples at controlled temperatures (near room temperature) is under development and will be available soon. Programs have been written for convenient on-line data treatment.

IN6 - focussing time-of-flight spectrometer

(A.J. Dianoux)

The design of this instrument, originally called IN5B because it was envisaged as a relief in the range 4-6 Å for the overload of IN5, has made good progress during the year (see progress report 78 DI 212S).

The monochromator consists of a set of three composite, vertically curved, pyrolytic graphite crystals with a mosaic spread of 0.4°. It will use the full height (20 cm) of the guide and focus the beam on an area of 5 × 3 cm² at the sample position which will be 210 cm from the monochromator. The expected elastic resolution will lie between 170 μev and 50 μev for the two extreme wavelengths of 4.1 Å and 5.9 Å. The flux at the sample position should be about three times that of IN5.

The time-focussing will be achieved by pulsing the beam with a Fermi chopper with a small divergence of the order of the guide divergence, and a small slot length to assure a good transmission.

The flight path will be 2 m and the detector bank will house 400 elliptical detectors, covering 4 m². The detectors will be in fixed positions, thus removing the inconvenience (in workload and reliability) of moving them.

The data acquisition system will be based upon a PDP 11/34 with a memory of 48 K words. It has been envisaged that there will be a versatile data treatment programme which will allow the recording of the spectra on a constant Q scale, and looking at them directly at the instrument.

The monochromator system will be tested early 1979 and tests on the time-focussing principle will begin as soon as the chopper system has been delivered (April 1979). It is expected that IN6 will be fully operational by early 1980.

IN13 - backscattering spectrometer for short wavelengths

(J.L. Buevoz)

IN13 is located on the H24 thermal guide, which has been rebuilt during the shut down in October 1978. The special 3-walled guide of IN13 has now been installed. The helium box, XY table and deflector, monochromator support and shielding have been completed. A prototype of the monochromator furnace has been tested and the final design has now been completed. The furnace will be operational at the beginning of 1979. Tests with neutrons will then be possible. The design study of the analyzer assembly will start by the end of 1978. The PDP 11/34 computer for the instrument control has been delivered and will be used for initial tests of the monochromator temperature scans. First test experiments on the complete spectrometer are foreseen for mid 1980.

Co-ordinators: R. SCHERM
A. HEIDEMANN

instrument group 'diffraction instruments'

D1A	:	High resolution powder diffractometer on thermal guide H22
D1B	:	Multidetector on thermal guide H22
D2	:	High flux 2-axis diffractometer on thermal beam H11
D3	:	Two-axis polarized neutron diffractometer with lifting counter on thermal beam H5
D4	:	Liquids diffractometer on hot beam H8
D5	:	Three-axis polarization analysis spectrometer on hot beam H4
D8	:	High flux four circle diffractometer on thermal beam H11
D9	:	Four circle diffractometer on hot beam H3
D10A/B	:	Four circle three-axis diffractometer on thermal guide H24
D12	:	Neutron cameras on thermal guide H23
D15	:	Four circle Mk6 diffractometer on inclined thermal beam IH4
D18	:	Neutron interferometer on neutron guide H25
D19	:	2D multidetector to be installed for tests on thermal guide H24
LI4/5/7	:	X-ray laboratories
S20	:	Neutron diffraction topography
S21	:	High resolution double crystal spectrometer

The only instruments in the diffraction group which are currently in the construction phase are D18, the neutron interferometer and D19, the diffractometer-multidetector project. All other instruments in the group operated routinely during the year and were between them responsible for about one third of the experiments carried out at the Institut. Amongst projects for instrument improvement the group has given high priority to the replacement of Carine. At the end of 1978 D1B, D2 and D5 will be the only instruments still controlled by the Carine system. D1B already has its own SEMS computer but the development of the control system has been delayed owing to programming difficulties.

The introduction of dedicated computers has contributed significantly to the efficiency of the diffractometers both in the control and data handling and by giving greater reliability. The D8 system which will serve as a prototype for the single crystal diffractometers has been extremely successful and popular with the users. A similar success is anticipated with the new D1A system, which, when coupled with the data handling programs on the PDP10, should allow very rapid determination of crystal structures. With the exception of D10, which is undergoing major changes during the latter part of 1978, all improvements to the diffractometers have been carried out without disruption of the user program.

Throughout the year the group has benefited from the support provided by the technical and scientific services and would like to thank A. Barthélémy of SCIAD, who has been responsible for most of the software development associated with the control and data acquisition of the diffractometers. The group meets weekly to discuss problems, both scientific and technical, and to disseminate information. The projects currently being discussed include the permutation of D8 and D2 with IN2 to enable their continued coexistence once D8 is replaced by D19 and the permutation of D5 with D3 to permit higher resolution in polarisation analysis experiments, whilst retaining the possibility of making classical polarised neutron experiments over a wide range of incident wavelengths.

D1A - high resolution powder diffractometer

(A.W. Hewat, C. Vettier)

In 1978, the Carine computer control of D1A was replaced by a dedicated Micro-I system from the British firm Plessey. This new computer, based on the large scale integrated circuit version of the PDP11 (LSI-11), provides a powerful means of on-line supervision and data reduction, comparable to the much more expensive systems used elsewhere. In fact, the same operating system program (RT11), discs and interfaces are used as for existing PDP11's; this permitted a very rapid conversion, without disruption of the user program. Instead of sending the data to an intermediate concentrator computer, the new D1A system will be linked directly to the central DEC-10.

The second major development project on D1A has been the work on high pressure cells. Two cells have been ordered, based on developments in the CNRS Grenoble laboratories. These cells will be used for both single crystal and powder samples at up to 40 kbar. Tests were also performed on a second type of clamped cell from the Brillouin laboratory of Saclay, and on a He-gas pressure cell developed for the Rutherford Laboratory.

Towards the end of 1978, Mr. Heathman became technician for D1A and D12, following a period of almost two years with no technician on D1A. This, together with the Carine replacement, will make it easier to satisfy the continuing high demand on D1A time (43 proposals in 1978).

D1B - two-axis diffractometer with multidetector

(G. Bomchil and P. Convert)

D1B continued to operate satisfactorily throughout the year. All experiments have been performed efficiently with a low rate of technical failure. An automatic variation of temperature for the cryostat is now available and is regularly used by the experimentalists. It will be improved to allow 16 different temperatures to be selected instead of 8, which are currently available. (A. Bresson, ILL SCIAD). Available on the PDP10 are a set of programs for fast and efficient data reduction and analysis (P. Wolfers). Two major improvements foreseen for 1978 or early 1979 have been delayed. The dedicated computer for D1B (Solar 16.40) arrived April 1978 but will not be in operation before October 1979 (date given by the Technical Service ILL-SCIAD). A study of the focussing monochromator has only recently commenced owing to the heavy demand placed on the monochromator group.

D2 - high flux two-axis diffractometer

(C. Marti)

The heavy demand for D2 and its age necessitates the replacement of the electronics and the introduction of a dedicated computer. However, a decision is awaited concerning a more powerful instrument incorporating a large multidetector for kinetic measurements. Nevertheless different parts of the electronics have been renewed, thus reducing the chance of breakdown. A super-conducting magnet with a 50 KG horizontal field is now in service.

Although obsolescent, D2 still retains the highest neutron flux in the world and is the most efficient diffractometer for small Q measurements. Therefore, during 1978, many phase transitions have been studied, for example, the melting of a two dimensional solid or the order-disorder in alloys. Experiments concerned with magnetic scattering or liquids continue to be prevalent.

D3 - two-axis polarised neutron diffractometer with tilting detector

(F. Tasset and P.J. Brown)

Few changes have been made to the instrument this year, and it has performed continuously and reliably. The old instrument teletype, worn out by three years of continuous operation, has been replaced by an LA36 which prints the results much faster and much more quietly. The cryo-flipper has now been in regular service for more than a year; it has proved extremely satisfactory and allows rapid changes of wavelength and continuous variation of the sample field without interaction with the flipping efficiency. Minor improvements have been made in the control software including the addition of commands to allow reading and monitoring of a digital voltmeter. On the mechanical side the collimator support has been rebuilt using optical bench modules to give much improved rigidity, and greater precision and reproducibility in alignment.

D4 - two-axis liquids diffractometer on the hot source

(P. Chieux, P. Poncet and S. Cummings (from 1.10.78))

The ^{3}Helium multidetector has been operating on D4 for the whole year, in a conventional way, using 2θ scans. The data reduction is carried out as before on the PDP10 computer. A full set of data reduction programs has been implemented to combine and correct the intensity versus angle values obtained by each multidetector cell. The goniometer is now operated via a NIM microprocessor which allows complex repetitive scans to be performed. A new high temperature furnace with an extremely low background level has been provided by an outside user (designed in collaboration with the ILL), and tests have been made up to 2050°C. High temperature equipment (up to 1800°C and 200 bars) prepared under the same conditions, has also been successfully tested.

D5 - three-axis polarisation analysis spectrometer

(K.R.A. Ziebeck and D. Givord)

The versatility of D5 once again gave rise to a heavy scientific program, which was completed satisfactorily. Changes to the instrument have taken place throughout the year without disruption of the user program. The success and efficiency of the changes are largely due to Mr. A. Perkins.

During 1978 the instrument has been increasingly used in the polarisation analysis mode and effort has been made to optimise these measurements. Analyser shielding in the form of a conventional drum exists and magnetic guides are aligned and supported on optic benches. A symmetric, permanent magnet is now used for the analysing crystals which facilitates centring and alignment. In addition, supports are available for mounting diaphragms in a reproducible manner before and after the sample. For single crystal samples, a second automatic goniometer and translations can be provided, which enable the sample to be aligned with respect to both the magnetic field and the diffractometer. The magnet, providing either a horizontal or vertical field, has proved very satisfactory for the polarisation analysis experiments.

New collimators and diaphragms are also available for single crystal diffraction experiments.

Vertical or horizontal fields up to 4.8 T can be provided over the temperature range 1.5-450 K and it is hoped that by mid 1979 a 10 T superconducting magnet, H vertical, will be available. At present the maximum temperature available is 900 K, with a furnace for use with the horizontal field magnet. During 1979 an improved furnace will be available for use with vertical and horizontal fields.

Development of new polarising crystals suitable for use with short wavelength neutrons and with minimal second order contamination is taking place. By July 1979 a Fe^{57} polarising crystal should be available with a reflectivity comparable to Cu_2MnAl but with a resolution similar to that of the current CoFe crystals.

D5 is still "controlled" by Carine. The reliability of the computer reflects its age and the majority of the time lost on D5 is caused by the failure of Carine. Furthermore the size and complexity of programs used to control D5 are such that they fill the disc space, thus preventing any recording or storage of results. The lack of reliability, slowness of execution and the absence of data handling makes the replacement of Carine by a dedicated computer a major requirement for 1979. It is intended to implement the D3 system which has proved very successful.

D8 - high flux four circle diffractometer

(C. Riekel and S. Mason)

D8 now functions very efficiently under PDP11 control and the programs are updated as required by the users. The installation of a large linear detector is not expected now before late 1980, and this may possibly occur at the same time as a transfer of D8 to a new position on the reactor.

D9 - four circle diffractometer with short wavelengths

(M. Lehmann and G. Bentley)

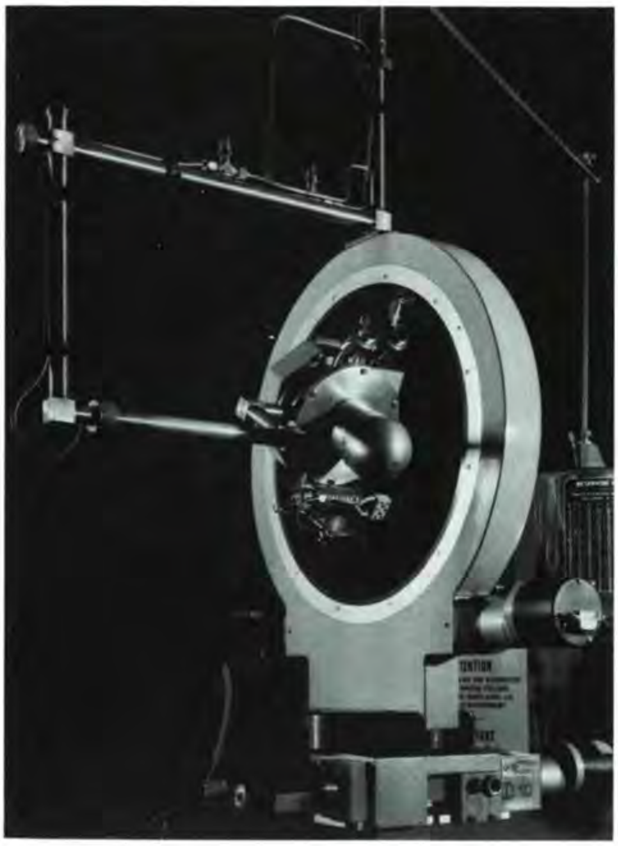
As in the previous year, D9 continued to operate efficiently. A new detector shielding, mounted on an arm which turns around a vertical axis, has replaced the tanzboden detector. The new arrangement has reduced the setting time to a value consistent with that permitted by Carine. For special experiments the tanzboden arm can be reinstalled on request. Temperatures up to 1100°K are now possible using a gas flow furnace developed by the CNRS Grenoble.

In October 1978 a PDP11 computer was ordered for D9 and it is hoped that this will be implemented early in 1979 using the D8 system.

D10 A/B - high resolution four circle three-axis spectrometer

(C. Zeyen and A. Filhol)

D10 operated efficiently throughout the year. More than half the experiments used the analyser facility to discriminate between elastic and inelastic scattering. Some interesting experiments were performed in the field of diffuse scattering from defects



D10 Precision Eulerian Cradle with new Helium flow cryostat for the temperature range of 4 to 300 K. Full angular degrees of freedom are kept with this cryostat. Low thermal losses in the Helium syphon are obtained by two gas cooled rotating Johnston joints and gold plated ducts suspended magnetically (SmCo permanent magnets) within the vacuum tubes for efficient thermal isolation.

in various alloys. These investigations have highlighted the requirements of the experiments concerned with thermal neutron diffuse scattering at large momentum transfers: namely

a) the possibility of collecting three dimensional data at variable temperatures using the Eulerian cradle.

b) the possibility of good energy resolution provided by the analysing crystal.

A gas flow furnace, for sample temperatures up to 1100 K, has been installed and used successfully. It is hoped to extend the system to higher temperatures. During the long reactor shutdown of October, D10 was dismantled to enable the H24 guide tube to be reconstructed with a larger cross-section. An improved D10 should be ready by early 1979. The improvements are:

a) an automatic monochromator shielding enabling a continuously variable incident wavelength.

b) larger vertical focussing and variable radius monochromator and analyser which will provide relaxed momentum resolution and more intensity. High resolution experiments will however suffer a reduction in flux due to the presence of two new monochromators in the guide tube before D10 (IN13 and D19).

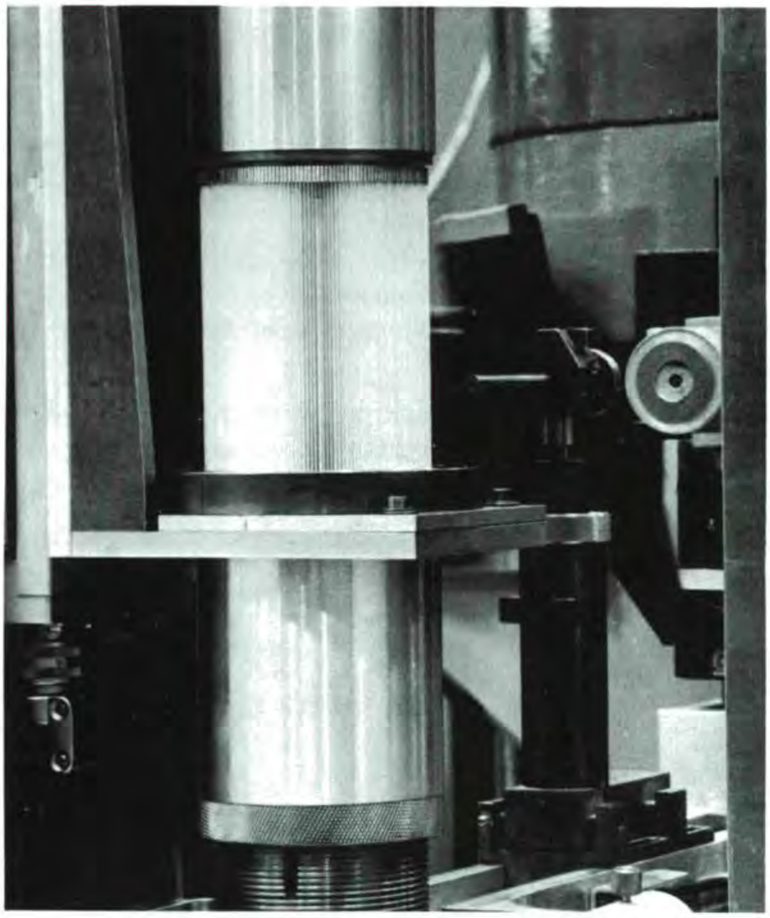
c) a new Eulerian cradle.

d) a dedicated PDP 11-34 computer using the LSD software has been installed. Finally a test of the spin echo technique, together with triple axis spectroscopy, is foreseen for the spring of 1979. The aim is to obtain better energy resolution to separate inelastic and elastic components (TDS), and to perform high resolution spectroscopy tests using spin echo focussing.

D12 - neutron camera

(A. Wright)

During the year D12 has been in routine operation for exploratory investigations of phase transitions, order-disorder phenomena and magnetic effects in crystals at low temperatures. The height of the oscillating radial collimators has been increased to improve the background on rotation photographs, thus allowing the observation of very weak superlattice reflections. Improvements to the electronics which control the step motors for the omega rotation and the camera translation now enable the shafts to turn more rapidly, facilitating the initial alignment. The calibration of the thermocouples used to determine the temperature of the sample in the cryostat has been performed, using crystals with known phase transitions. The possibility of using the instrument for investigations above room temperature is currently being pursued.



Rotating collimator (Venetian blinds) on D12.

D15 - four-circle diffractometer on the inclined beam tube IH2

(J.M. Savariault, S. Wilson)

In 1978 a two stage refrigerator has been set up on the Mark VI Eulerian cradle of the D15 diffractometer. Measurements can be made in equatorial geometry in a temperature range 12-300 K. Problems which arose during the first tests have been solved and following a further trial the equipment will be working by mid 1979. A liquid nitrogen container has been put on the D15 platform with an automatic filling device. This provides a constant liquid nitrogen level in the helium cryostat, used in normal beam geometry experiments. Tests of electronic controls and calculation of possible monochromator angles have been made and a new neutron wavelength is now available ($\lambda \sim 0.866$ Å). The separation of the computer control between D15 and D16 diffractometers is in progress. A new teletype allows access to the control and crystallographic programs without interference from D16 (which shares the same computer).

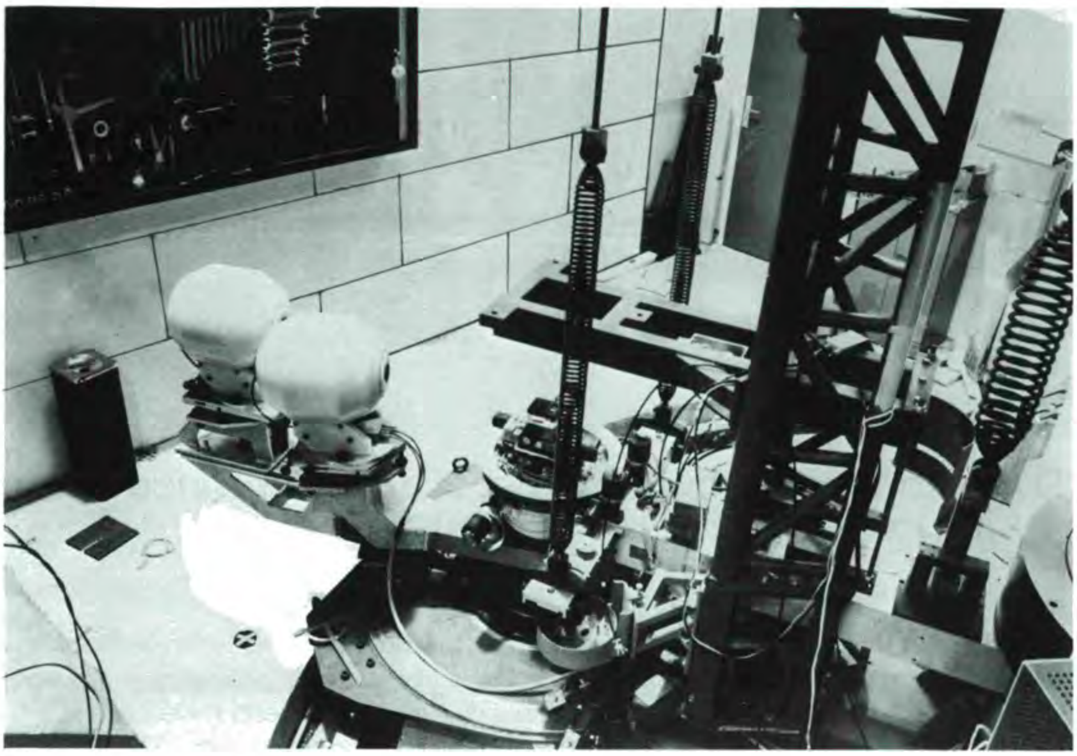
D18 - diffractometer for neutron interferometry

(W. Bauspiess, M. Schlenker, W. Graeff, G. Badurek)

During the first half of the year some experiments have been carried out on the prototype version S12, as well as on the optical bench of the new diffractometer D18, installed in a test position.

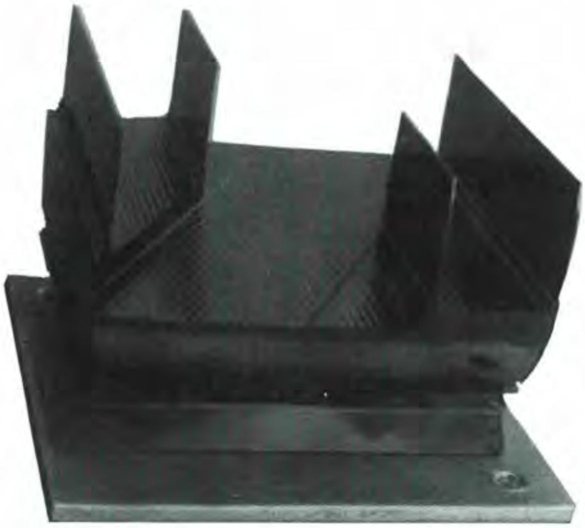
Using photographic detection techniques, studies have been carried out on phase contrast imagery with the interferometer, and on development of new interferometer types. A converter screen of enriched Gd has been ordered to improve the exposure time, which is currently 2 days.

Test measurements for the use of polarized neutrons with the interferometer demonstrated that a prismatic magnetic field inserted into the beam path, between the perfect crystal monochromator and the interferometer, is a suitable tool to polarise the neutrons used by the interferometer. A polarization very close to unity has been obtained.



General view of D18.

The shutdown periods of June, August and October have been used to assemble the mechanical parts of the new instrument: diffractometer bench, monochromator shield, and the rotatable platform with the spring suspension system for the diffractometer are now installed at the D18A position of the H25 neutron guide.



Skew-symmetric LLL interferometer crystal for D18.

The components of the electronic control system have been developed, as well as a dialogue oriented microprocessor program. The connection to the mechanics and to a Micro I computer is planned for the end of the year, so that the instrument will probably start operation in January 1979.

D19 - multidetector for single crystal studies

(M. Thomas)

Description of the project

The D19 multidetector has 512 × 16 wires placed so as to cover an angular range of 64° × 4°. It is designed to be efficient for neutrons in the range 1-2 Å wavelength and is therefore to be filled with He at a pressure of 10 bars. It is to be used for single crystal diffraction from large molecules.

The choice of operating mode for the multidetector has been guided by the intention that it shall serve in some way as a prototype for an eventual large 2-dimensional detector. The detector will be mounted in a vertical plane on a tanzboden drive system, so that it subtends 32° above and below the equatorial plane of a conventional 4-circle goniometer. The tanzboden drive will enable the detector to be driven through the whole range of scattering angles, thus synthesizing the results, which would be obtainable with a full 2-dimensional system. The diffractometer and the data collection are to be controlled by a dedicated PDP 11 computer. During the period of tests of the multidetector and development and testing of the data collection system the instrument D19 will be placed on the guide H24 in the old D6 position. It is proposed that finally it should be moved into the reactor to replace the D8 diffractometer.

Current status of the project

The project is now developing on three fronts.

(1) THE DETECTOR ITSELF. The pressure vessel has been completed, some difficulty has been encountered in obtaining satisfactory leak proof plugs for the input and output wires, but it is hoped that this problem is now solved. Pressure tests have been carried out in November and after that the insertion of the electrodes can start. The first tests with neutrons should be possible early in the new year.

(2) THE DIFFRACTOMETER. The design of the diffractometer has been completed. It is hoped that the construction will start in the very near future.

(3) THE CONTROL AND DATA HANDLING SYSTEM. The PDP 11 computer is at the Institut and the system for control of the diffractometer will follow the lines of the system already working on D8. The position as regards data handling is less satisfactory because of lack of man-power.

LI 4/5/7 X-ray laboratories

(P.J. Brown)

These facilities which enable complementary and preparative studies for subsequent neutron measurements, functioned normally during 1977.

S20 - neutron diffraction topography

(M. Schlenker)

S20, the special instrument for neutron diffraction topography financed by Laboratoire Louis Néel du CNRS, Grenoble, has been used mainly for investigations of antiferromagnetic domains in nickel oxide (NiO) and manganese fluoride (MaF_2). In the latter case, work was routinely carried out at 20 K, using one of the Cryogenics Group's closed-circuit helium refrigerators, with a special tail designed for small specimen-photographic detector distances and machined at CNRS.

The instrument's operation was stopped in September because of the reconstruction work on the guide H24 from which it receives neutrons. It should be available again in January 79, without major changes.

S21 - high resolution double crystal spectrometer

(C. Zeyen)

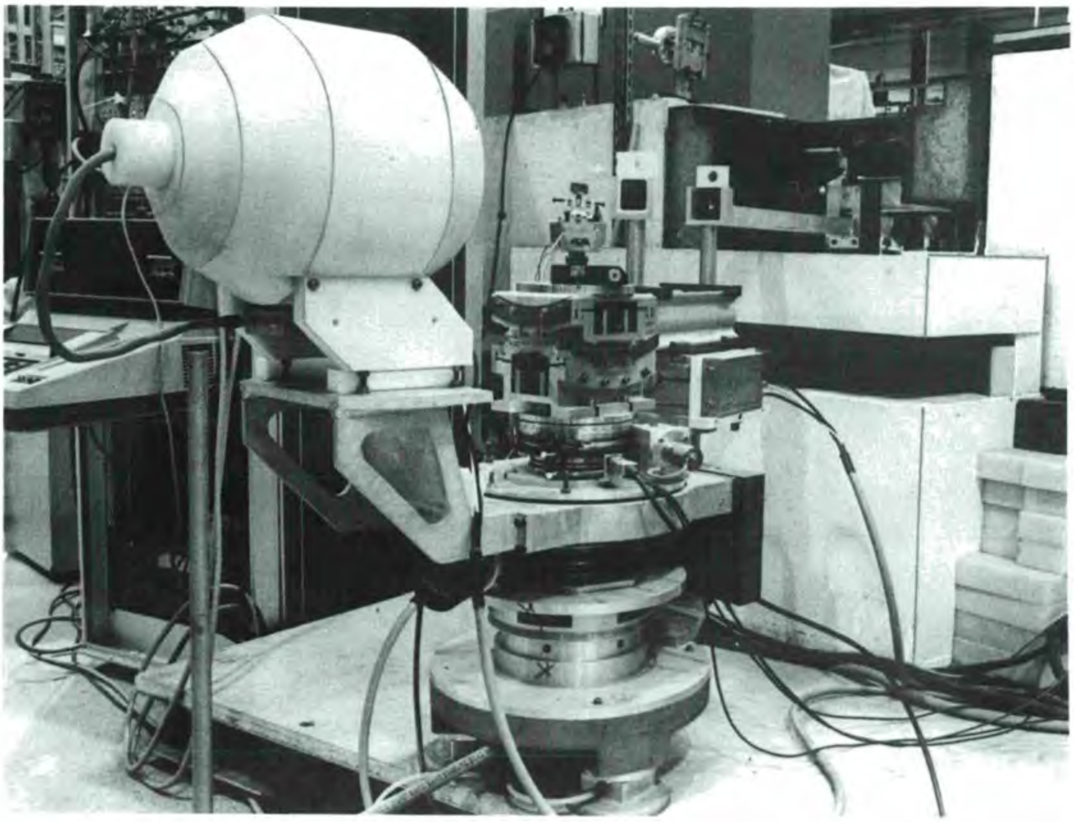
This instrument has been rebuilt as a result of the modifications to the H24 thermal guide. Using a graphite deflector crystal, the double crystal set up will now be situated on a Tanzboden unit out of the direct beam. This solves the radioprotection problems and guarantees better access to the instrument. During the year, one of our special cryostats was modified to take a high pressure cell. High temperature furnaces (3000 K) have been built by the Max-Planck-Institut, Stuttgart for a joint project to study defects in thermal equilibrium near the melting point of metals and alloys. This project aims at a very accurate and simultaneous measurement of lattice parameters (neutron diffraction) and changes of length (laser interferometry) and is expected to yield defect concentrations in a very direct way.

Co-ordinator: K.R.A. ZIEBECK

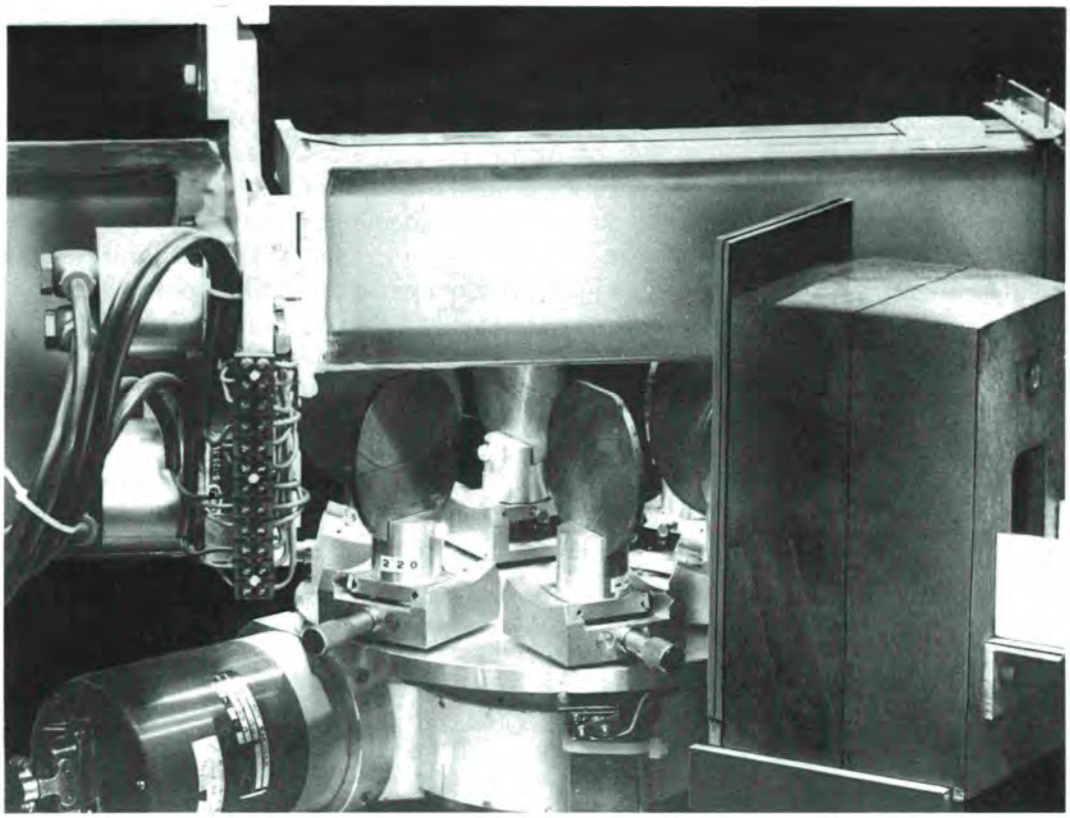
'monochromator group'

D13A	:	Neutron double-crystal diffractometer on thermal guid H24
D13B	:	High precision neutron double-crystal diffractometer on thermal guide H24
D13C	:	Neutron single crystal orientation and test instrument on H23
LI 2A	:	X-ray double-crystal diffractometer
LI 2B	:	X-ray crystal orientation unit
LI 3	:	Gamma-ray diffractometer

Laboratory for single crystal preparation.



General view of D13C.



Six Ge perfect crystal monochromators can be used alternatively on D13C.

instruments

No major modifications have been carried out. D13A, equipped with a new beam-defining slit system of the IN3 type, performed normally on the testing of single or multiple crystal monochromators, aligning procedures and other special experiments. Due to a complete restructuring of the instruments on H24, D13A and B have had to stop operation between the annual reactor shut-down and the beginning of 1979. However, as D13C had become operational in March 1978 it was possible to shift some of the D13A experimental load to D13C. This new machine of the tanzboden type provides a larger neutron beam of higher intensity and its use is mainly foreseen for the assembly of multi-crystal focussing monochromator systems.

The Gamma-ray diffractometer LI3 served routinely for in-beam plastic deformation of Ge and Si crystals and the determination of the intrinsic mosaic structure in imperfect single crystal specimens. In the domain of basic research several diffraction experiments on structural phase transitions and atomic form factors have been carried out on this instrument.

development of monochromator materials

The production of Cu, Si and Ge monochromator crystals with isotropic or anisotropic mosaic spread up to several degrees is well under control. Most of the effort has been devoted to the development of Be monochromators. Several samples with homogeneous but too small mosaic spread have been cut out of large grains contained in an as-grown crystal rod and plastically deformed at low temperatures. Despite twinning, which occurred during the deformation process, the dislocation density created was sufficiently high to produce a mosaic pattern like that shown in Fig. 8. Both absolute reflectivity and width are somewhat below the values expected from theory for an ideal monochromator crystal but on the other hand, compared with other materials, this piece of Be showed the best efficiency ever observed under similar experimental conditions.

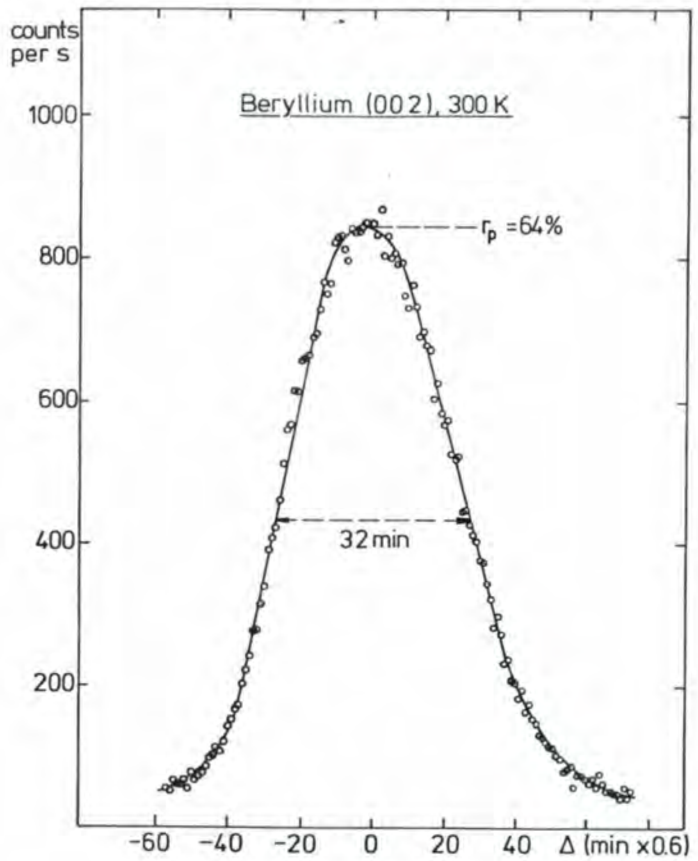


Fig. 8: "Neutron rocking curve (λ = 1.5 Å) of a plastically deformed Be single crystal".

The size of these crystals is at present relatively small but large enough for composing a large monochromator. The next steps in this development, which is going on jointly with the Max-Planck-Institut für Metallforschung, Stuttgart and Leybold-Heraeus, Hanau, are to increase the grain size by optimizing the growth conditions and to grow crystals with larger diameters.

The use of expanded highly oriented graphite as a long wavelength monochromator is under investigation. The intercalated C_8K compound showed an increase of the (002) lattice spacing from 3.35 Å to 5.40 Å whereas the mosaic spread of 0.5° rose to 2.4° which is somewhat high.

A joint project with the PTB Braunschweig, CNRS Grenoble and the firm Cristal-Tec, Grenoble, has been started on the production of Heusler alloys as polarizing monochromators.

composite systems and bent crystals

The development of vertically focussing monochromators for elastic and inelastic scattering techniques has led to a very high demand for such composite systems. The assembly of the 21 × 15 cm² vertically and horizontally focussing monochromator for IN6 is almost terminated and D19 will soon be equipped with a vertically curved Si (220) monochromator. Other focussing systems are planned for D1B, D8, D7, IN3, D2, IN8, IN12 and the new IN1. In this framework a modular system for focussing monochromators with a variable radius of curvature is under development.

basic studies of monochromator and filter materials

The temperature dependence of the reflectivity and transmission of Be crystals has been studied as a function of neutron wavelength. At $\lambda = 1$ Å a 20 % gain in reflectivity has been observed when cooling from 300 K to 77 K. This gain, based on the reduction of inelastic scattering, should still increase for shorter wavelengths. However, multiple scattering processes are then more difficult to avoid and will again reduce the gain factor.

Transmission studies of Si filters as a function of temperature and neutron energy have been undertaken in conjunction with the PTB Braunschweig. These investigations are aimed at the effect of zero point energy on the filter properties which becomes quite important especially for high neutron energies.

The γ-ray and neutron diffraction experiments on cold-worked Cu crystals, which will be studied by means of electron microscopy at Oxford University, are nearly terminated. It is hoped to have a better understanding of the relation between dislocation cell structure and mosaic model parameters which play an important role in monochromator development.

Co-ordinator: A. FREUND

central group

General assistance has been provided on a routine basis for the installation of experimental equipment, in particular cryostats and furnaces and repositioning of detectors, in the necessary provision of services (air, water, electricity, liquid Helium and Nitrogen, Helium recovery, etc.), and in the installation and regular testing of safety circuits and the establishment of operating instructions.

Major interventions were required concerning the modification of the instruments and shielding on the guide H24, the installation of D18, IN12, IN6, S51 and S37, and in the modification to D16 and IN4. Modifications were also made to the γ shielding in the primary casemates of IN4 and D3. Specially adapted lifting equipment has been built to assist in mounting and dismounting experimental shields.

In collaboration with the Reactor Department, the Helium and Nitrogen gas distribution lines have been extended, and a new gas effluent line installed in the neutron guide building. The ARC electrical supply has also been extended to provide a stable guaranteed supply to new instrument computers.

In order to satisfy the requests for clean, air conditioned zones in the neutron guide building for instrument computers, (whilst minimising the use of the limited available space), an air conditioned cabin has been constructed on a mezzanine floor. The computers for IN12, S43, PN7, S51, D1B and S31 are now grouped in the same area.

In addition to the routine work, special development projects have been carried out with other departments and with the instrument groups some of which are indicated below:

- Analysis of safety hazards have been carried out for irradiation of dangerous samples including Th, Pu, U, Np, Am, Cf, Bk, D_2O and T_2O on the instruments Gams, Bill, S16, PN7, D2, D3, D5 and D1B. Assistance has been given to scientific staff in the preparation of these samples using the special handling facilities of the alpha laboratory, and in the safety problems arising during the period of the experiments.
- In collaboration with the Department Technique work has started to equip instruments with electrical safety protection for use in emergency.
- Report on world sources of stable isotopes.
- Collaboration with Radioprotection and Project Office in defining necessary protection for the following experiments: guide H24, IN1, IN13, D11, IN4, IN6, IN12, IN8, S10, S51, D16, S43, PN7, H9, H18, D18, D9, IN5, S3 and the neutrino experiment.
- Examination of necessary eventual modification to the Reactor Hot Cell.
- Modification to the alpha laboratory, i.e. construction of shielded storage area and shielded observation area, etc.

- Limitation of permitted solvents allowed for general use, and implementation of central free service distribution in ventilated cupboards.
- Study of problems associated with the fabrication of sintered Lithium Fluoride plates for use as beam shutters, and definition of new production procedures.
- Coordination of studies for the modification of Lohengrin to allow irradiation of alpha emitters including characteristics of sources, study of different possibilities of loading, unloading and examining of the sources and their eventual disposal.
- Photography of new installations during the construction phase, and specialised equipment which is not normally visible, for display purposes.
- Development of focussing systems, and specification, purchase and alignment of new monochromators, (with γ rays and neutrons).
- Testing of the prototype unit for the two stage closed cycle refrigerator unit on D15 has been completed, and a number of modifications incorporated as a result. These include a more precise coupling between the sample and the phi motor, more flexible pressure lines, and the addition of a cooled zeolite container to avoid the necessity of a permanently attached pumping set.
- Water cooled specimen unit has been designed, manufactured, and used on D8, in the range + 1° to 200° C.
- Design studies in progress include single stage refrigerator unit for use on X-ray equipment, and a mount for a 2 stage unit on D9.
- The availability of 12 closed circuit refrigerators has necessitated the setting up of a spares and maintenance service.
- The evaporator for the S3 supermirror instrument was fully tested, and the mechanical and electronic development is now expected to be completed early in 1979.
- A simulation program was written to investigate supermirror properties, and to examine various geometries concerning their possible use as polarisers and analysers. The results obtained were presented at the workshop on 'Diffuse Elastic and Quasielastic Neutron Scattering from Defects in Solids'.
- The Tektronix graphics library was rewritten in assembly language to allow its use on small computers. The program size was reduced by 50 % with an increase in speed of a factor of 3.
- In collaboration with the Detector Group a study was made of the influence of filling pressure and addition of heavy gases (Argon, Krypton and Xenon) on the spatial resolution of BF_3 and He^3 multidetectors.
- Continuation of the construction of the D19 multidetector with special reference to the problems associated with the electrical feedthroughs, wire supports, printed circuits, etc.

  Construction of test jig for the testing of amplifiers and preamplifiers, and mechanical equipment used in the testing of multi-detectors.
- Design and preparation of plans for multidetectors on D4, D2 and D16.

- Assistance with the neutron testing of detectors.
- Preparation and assistance with experiments of adsorption isotherms of D_2O on AgI, and the construction of a second glass gas introduction line. Operation and modification of the UHV pumping system, quadrupole spectrometer and microbalance, and preparation of an operation manual.

sample environment group

1 vacuum

The vacuum stock has increased from 323 to 345 units. The aging of the equipment is indicated by an increase in the duration of repairs, but their number has remained approximately constant (650).

The introduction of automatic control of 10 pumps maintaining the vacuum on neutron guides has made it possible to divide their operation time by ten, hence a corresponding reduction in wear and in maintenance work on these pumps. The system is now being generally introduced.

2 cryogenic fluids

2.1. Liquid nitrogen

Consumption : 345,138 litres at 0.34 F/litre.

2.2. Liquid helium

Consumption : 51,564 litres (+ 12 %).

Average cost per litre, including losses : 13 F. Gas supplied under self-service system : 3,232 m³. Gas losses : 12,000 m³ (34 %).

The increase in losses is due to the shortage of staff for operation and maintenance of the recovery system (in some months losses exceeded 50 %). Since 1st September an effort has been made on this point, losses were then considerably reduced and are at present less than 10 %.

For economy reasons, the liquid storage capacity is small (1,600 litres), which causes problems during the two or three annual peaks at 2,000 litres/week.

3 cryostats

3.1. Current operation

The usable stock is 50 cryostats, including 10 closed circuit machines.

An increasing number of cryostats have been allocated to particular instruments, bringing the total from 28 up to 38.

The experimental statistics show 261 experiments at low temperatures (using one or more cryostats), giving a total of 2,700 days.

3.2. Development

There have been developments on cryostat parts. For example, calibrated impedances which determine a liquid helium flow are frequently blocked by impurities in suspension in the helium. Previously to clear an impedance it was necessary to heat the whole cryostat, hence a delay of 24 to 48 hours before restarting. These impedances are now incorporated in the needle of the cold valve, and can thus be removed and cleared in a few minutes.

3.3. Very low temperatures

Several experiments have been completed on liquid helium at very low temperatures, with 3 different cryostats (ILL dilution refrigerator, SRC dilution refrigerator, ILL He^3 cryostat).

A small-dimension experiment on super-fluid helium (Vycor glass), with the He^3 cryostat, could not be carried out because of leaks (porosity) in the sample introduction system. When the system was repaired a similar experiment was completed successfully.

Measurements at very low temperatures are now, if not easy, at least possible, thanks to the efforts made since 1977.

3.4. Superconducting coils

Two cryostats with superconducting Helmholtz pairs are in operation. In 2 cases there is a 5 Tesla field, but the configuration is different — one of the fields is vertical and the other horizontal.

A new cryostat with a 10 T coil has been ordered and should be operational by the end of 1979.

The complexity of the use of these systems has necessitated the transfer of a full-time technician to the perfecting and use of these systems (a technician originally intended to work on very low temperature systems).

4 furnaces

The statistics show 97 experiments with a furnace, with a total duration of 682 days. On two occasions all ten furnaces available were in use simultaneously.

One 400° furnace with very good temperature stability and homogeneity has been developed and built.

A furnace with very unusual geometry has been designed for S6, with strict constraints on the dimensions (width 74 mm, passage of high frequency cables, windows transparent to beta radiation). This furnace is under construction.

The completion of the 2,000°C horizontal-axis furnace has been delayed by several difficulties, the main one being due to the sample-holder crucible, which must:

(1) be relatively transparent to neutrons,
(2) retain sufficient mechanical strength,
(3) not alloy with the sample.

5 high pressure

A gas cell for P = 4 Kbar and T = 4 k has been developed for current requirements. The number of high pressure-low temperature experiments is increasing, and two cryostats suitable for these requirements are under construction.

6 automation of temperature control

A first prototype has been designed in collaboration with the instrument control and data acquisition group (SCIAD) and construction is in progress. The final stage will start in a few weeks. As the most urgent requirements have proved to be for cryostats rather than for furnaces, the original idea of starting on the simpler problem (the furnaces) has been changed; the first instrument will be equipped experimentally in 1979 and will permit the simplified automatic control of a cryostat.

experimenters came to the ILL from these research centres or universities in 1978

3

colleges

introduction

All the internal scientific activity of the Institut is grouped into "colleges" with particular scientific interests.

The following is the current list of colleges:

College 2	:	Theory
College 3	:	Fundamental and Nuclear Physics
College 4	:	Excitations
College 5	:	Structures
College 6	:	Liquids, gases and amorphous materials
College 7	:	Imperfections
College 8	:	Structural biology
College 9	:	Chemistry

Each College corresponds to a Subcommittee of the Scientific Council of the ILL, which advises the directors on the scientific programme. New research proposals submitted to the ILL will first be examined by the Colleges with respect to their technical feasibility and then be presented to the Council Subcommittees. A further task of the College is to contribute to a smooth carrying-out of the experiments by appointing local contacts and by advising the instrument responsible as well as the Scientific Secretary on the time schedules for the various instruments.

college 2 'theory'

members of the college

Bartel J.	(since 1/8/78)
Béal-Monod M.T.	
Brack M.	(to 1/9/78)
Burkhardt T.W.	(to 1/10/78)
Comte C.	
Fogedby H.	
Haldane F.D.M.	
Hüller A.	(to 1/9/78)
Iche G.	(CNRS)
Johnston R.	
Lavis D.	(since 1/10/78)
Loveluck J.M.	
Lovesey S.W.	
Nozières P.	
Schuck P.	
Sherrington D.	
Southern B.W.	
Theumann A.	(to 1/8/78)
Young P.	(to 1/10/78)

visiting scientists

Bhaduri R.
Castaing B.
Dzyaloshinsky I.E.
Gorkov L.P.
Graef H.
Grest G.S.
Harris R.
Hubbard J.
Jancovici B.
Licciardello D.
Moore M.
Pines D.
Raich J.
Ring P.
Sakurai A.
Schick M.
Sjolander A.
Thorpe M.
Widom B.

(this list does not include short visits of a few days)

The theory college has continued to concentrate its efforts in the study of various problems in the areas of both condensed matter physics and nuclear theory. The past year has seen the membership of the college undergo considerable changes, and this evolution is expected to continue in 1979. Five theorists have left during the year (Brack, Burkhardt, Iche, Theumann, and Young) but this loss has been partially compensated by the recent arrival of two short term visitors (Lavis and Graef).

scientific activities in 1978

The theory college has continued to pursue several well established interests (eg. phase transitions and critical phenomena, spin glasses, dilute magnets, static and dynamic properties of one-dimensional magnetic systems, magnetic ordering of liquid ^3He, valence instabilities, Kondo effect, semiclassical theories of nuclear matter, nuclear fission). However, short term visitors during the spring and fall, as well as a program of summer visitors, have proved to be very stimulating, and valuable in keeping the college abreast of recent developments in other fields. The theory college and its visitors have participated in the seminars on theoretical physics, organized by P. Nozières, which provide an important link between the college and the theorists from all the other scientific establishments in the Grenoble area. The college members have also contributed to the weekly ILL seminars, organized this year by D. Sherrington, which are intended for a wider scientific audience. In addition, D. Haldane has organized an informal tea-time discussion group in order that all scientists at the ILL can exchange ideas informally or discuss recent articles that have attracted interest in the published literature.

It is difficult to classify the topics that have been studied in 1978 by the college members, but the major activities can be summarized as follows:

'Spin dynamics of one-dimensional magnets'

The spin dynamics of the Heisenberg chain in a magnetic field has been studied by J. Loveluck using computer simulation methods. Crossover behaviour of the correlation functions of a classical planar chain in an applied field has also been examined by Loveluck using a transfer matrix formalism. The dynamics of an Ising chain in a skew magnetic field has been studied by H. Fogedby, as well as the dynamics of solitons and magnons in a continuum version of the classical Heisenberg chain.

'Magnetic ordering and dynamics of ^3He'

The study of two dimensional itinerant spin systems as a model of helium in contact with a substrate was undertaken by M.T. Béal-Monod and the dynamics of vacancies in solid ^3He were also investigated by Nozières, Castaing and Haldane.

'Kondo effect, local moments, and valence fluctuations'

A scaling theory approach to the spin 1/2 Kondo model was developed by P. Nozières to obtain the low temperature properties. D. Haldane also applied scaling theory to the Anderson model of a single magnetic impurity which contains both mixed valence and Kondo limits.

'Phase transitions and critical phenomena'

Various types of renormalization group techniques have been applied to many different problems by members of the college. P. Young applied RG methods to the study of defect melting in two dimensions. Burkhardt and Southern examined optimal procedures of truncating RG equations for Ising systems. Young and Lavis applied block spin techniques to investigate the critical behaviour of a bonded lattice fluid on a triangular lattice. This model is also being studied by Southern and Lavis using real space renormalization group (RSRG) methods to obtain a gas-liquid-solid phase diagram. Burkhardt and Southern used RSRG methods to calculate the critical exponents for bond and site percolation in both two and three dimensions.

'Spin glasses and dilute magnets'

A comparison of the effects of dilution and the competition between ferro- and antiferromagnetism in Ising spin glasses was performed by Southern and Young using RSRG techniques. Some exactly soluble models of quenched disordered systems were considered by D. Sherrington. Although the statics of these models is trivial, the dynamics is non-trivial. Sherrington and Johnston are currently studying the localization of spin waves in a one dimensional spin glass model by computer simulation. A. Theumann also studied a one dimensional spin glass model with long range interactions.

'Rotational tunnelling in molecular solids'

A study of librations and tunnelling transitions in molecular solids was undertaken by A. Hüller and J. Raich to obtain information about the intermolecular forces which determine the static and dynamic properties of these materials.

'Nuclear physics'

The nuclear theorists continued their study of nuclear matter using semiclassical techniques. Schuck, Brack, Bartel and Bhaduri performed calculations of nuclear density distributions and ground state energies in a self consistent manner. The use of semiclassical methods was extended to nonlocal potentials by Schuck and Durand (ISN) and a semiclassical treatment of superfluidity in nuclei was carried out by Schuck and Bengston (CENG). Brack, Graef and Schuck considered a semiclassical treatment of nuclear Coulomb potentials. A comparison of the various Boson expansion techniques employed in nuclear physics was also carried out by Schuck and Ring. A WKB method was used by Schuck and Brenig to study the bombardment of chemisorbed atoms with electrons.

Secretary: B.W. SOUTHERN

college 3 'fundamental and nuclear physics'

members of the college

Ageron P.	
Almeida J.	
Avenier M.	
Asghar M.	
Barreau G.	
Bauspiess W.	
Blachot J.	(CENG)
Blakeway S.	
Bocquet J.-P.	(CENG)
Börner H.	(Jülich)
Brack M.	
Braumandl F.	
Cavaignac J.-F.	(ISN)
Charvet J.-L.	(ISN)
Crancon J.	(CENG)
Davidson W.F.	
Decker R.	(Giessen)
Von Egidy T.	
Emsallem A.	(Lyon)
Faust H.	
Greene G.	(Harvard)
Guet C.	
Hawerkamp K.	
Hungerford P.	
Jeuch P.	
Jung G.	
Koglin E.	
Mampe W.	
Monnand E.	(CENG)
Nifenecker H.	(CENG)
Perrin P.E.J.	(CENG)
Pfeiffer B.	(Giessen)
Ristori C.	(CENG)
Schrader H.	
Schreckenbach K.	
Schussler F.	(CENG)
Schuck P.	
Siegert G.	
Smith K.	(Sussex)
Sumner T.	
Vignon B.	(ISN)
Warner D.	
Wünsch K.D.	(Giessen)

visiting scientists

Alexeev V.L.	
Boehm F.	(Pasadena)
Byrne J.	(Sussex)
Casten R.F.	(Brookhaven)
Von Feilitzsch F.	
Gähler R.	
Golikov V.	(Dubna)
Golub R.	(Sussex)
Hoff R.W.	(Livermore)
Khazov J.	(Leningrad)
Kondurov I.	(Leningrad)
Lougheed R.	(Livermore)
Luschikov V.	(Dubna)
Mössbauer R.	(Munich)
Moreh R.	(Beer Sheva)
Münnich F.	(Braunschweig)
Paul W.	(Bonn)
Pendlebury J.	(Sussex)
Ramsey N.	(Harvard)
Rauch H.	(Vienna)
Tokunaga Y.	(Jülich)
Trinks U.	(Bonn)
Wagemans C.	(Mol)
White D.	(Oregon)
Wilson R.	(Harvard)
Wollnik H.	(Giessen)

general summary

The scientific activity of College 3 can be divided into 3 main categories:

1) Study of the fission process with the mass-separator LOHENGRIN and the neutron guides IH1 and H22. The experiments dealt with mass and charge distributions of fission fragments, to look for isomer formation and studies of α particle accompanied fission.

2) High precision nuclear spectroscopy is performed with the (n,γ) reaction by the beta spectrometer BILL, the gamma spectrometers GAMS and the pair and anti-Compton spectrometers. Nuclear spectroscopy of fission products is currently carried out with the mass separators LOHENGRIN and OSTIS.

3) Fundamental Physics. The experiments dealt with properties of the neutron (Half-life, electric charge and electric dipole moment of the neutron), ultra-cold neutron studies, parity violation and neutrino physics.

In October 1977, a total of 55 proposals were submitted, of which 43 were accepted. The corresponding figures for March 1978 were 45 and 37 respectively.

scientific trends and highlights in 1978

Nuclear fission experiments

It is well known that one of the first observations concerning the fission process was the strong preference for heavy nuclei at low excitation energy to fission into fragments of unequal mass. At ILL, much effort has been devoted to the experimental study of mass, kinetic energy and charge distributions of fission fragments for thermal fission of some actinide nuclei (^{233}U and ^{235}U).

MASS SEPARATOR LOHENGRIN

During this year, the study of the system $^{235}U(n_{th},f)$ has been continued and extended.

- The nuclear charge yield and the mass yield for the heavy fission products group have been investigated for the masses 132... 138.
- The kinetic energy distribution for thermal fission of ^{235}U was studied for several masses around the symmetric fission of the nucleus. In spite of great experimental difficulties (low yield, high background arising from the tail of the asymmetric events distribution), very interesting results have been obtained: the width of the kinetic energy distribution was found to be in good agreement with values obtained from other methods. Preliminary analysis of the data seems to indicate a decrease in the width of the kinetic energy distribution when the mass ratio approaches unity.
- The programme to investigate the dependence of isomer formation on the fragment kinetic energy has been extended; the observed dependencies are significant of a change in the spins of the fission fragments and are representative of the behaviour of the nucleus undergoing fission.

FISSION STUDIES USING SPECIAL EXPERIMENTAL ARRANGEMENTS:

In addition to the mass separator LOHENGRIN, two neutron beams (IH1, H22) are currently used to study several features of the fission process. Mass and kinetic energy distributions, fission cross-section for thermal neutrons and detailed studies of long range α particle-accompanied fission. Briefly, the different experiments which have been carried out are:

– **Mass and kinetic energy distribution**

A very promising method of separating the masses of fission fragments with high kinetic energy has been used with success. In this method one measures the time difference between the times of flight of the two complementary fragments. A mass resolution better than 1 amu was obtained for high kinetic energy events from thermal fission of ^{235}U. This new method has been applied to thermal fission of ^{233}U and ^{239}Pu. Both experiments have been finished and data analysis is under way. Using more conventional methods (double energy measurements), the mass and energy distribution of fission fragments from $^{239}Pu(n,f)$, $^{231}Pa(n,f)$ and $^{241}Am(n,f)$ have been investigated in detail. In the case of the reaction $^{231}Pa(n,f)$, the global mass distribution shows fine structure at masses around 134, 138, 139, 141, 143 and 145. The dip in kinetic energy at symmetric fission is 14.8 $\pm$ 4.2 MeV compared to 20.6 $\pm$ 1 MeV for $^{235}U(n,f)$.

– **Fission cross-section by thermal neutron**

The $^{231}Pa(n_{th},f)$ cross-section has also been measured relative to the fission cross-section for ^{235}U fission cross-section. A value of (20 $\pm$ 1)mb was obtained for the ^{231}Pa fission cross-section.

– **Long range α-particle-accompanied fission of ^{235}U**

The measurements have been extended to a detailed investigation of α particles emitted in the direction of flight of the fragment (polar emission). Data analysis is currently in progress.

It is worthwhile to stress that this experimental effort has been complemented by theoretical calculations. The work on semi-classical theory of nuclear matter was continued in cooperation with a group of physicists from CENG. We tried to calculate, by the semi-classical approach, the deformation energies of nascent fission fragments between the second saddle point and the scission point. The existence of a minimum in the potential energy surface around the scission point has been explored.

Nuclear spectroscopy

BETA SPECTROMETER BILL, GAMMA SPECTROMETERS GAMS, PAIR AND ANTI-COMPTON SPECTROMETERS

The main research activity is devoted to high precision nuclear spectroscopy of nuclei excited by neutron capture. Two regions of the nuclide chart have been investigated in more detail in order to establish new nuclear structure systematics.

— Studies in the actinide nuclei region

This programme was started a few years ago in cooperation with Livermore, KFA Jülich, Brookhaven, Mol and the university of Fribourg (Switzerland). During 1978, 3 odd neutron nuclei (^{231}Th, ^{237}U and ^{245}Pu) and 3 odd-odd nuclei (^{238}Np, ^{244}Am and ^{250}Bk) have been investigated. The measured multipolarities of many transitions in odd neutron actinides have led to the identification of many collective excitations coupled to single particle states. For the first time a systematic survey of vibrational energies in odd Th and U isotopes has been deduced. Data evaluation concerning odd-odd nuclei is currently in progress.

— Studies in the transitional nuclei region

Studies of the nuclear structure of the transitional nuclei in the W-OS-Pt region were continued. One of the more interesting results to emerge was the discovery, for the first time, of a new nuclear symmetry namely the 0(6) symmetry of the interacting boson model. The verification of this symmetry, in ^{196}Pt, depended crucially on the detection of weak, low energy, intra sequence γ rays between high lying states. Such data were provided by the GAMS curved crystal spectrometers. The impact of this discovery is discussed in the "search and discovery" section of the July 1978 issue of "Physics Today".

Some other spectroscopic studies worthy of note are on the high intrinsic states in ^{168}Er, level scheme studies of ^{114}In, ^{116}In and on the energy splitting of proton-neutron configuration, in odd-odd ^{122}Sb and ^{124}Sn.

NUCLEAR SPECTROSCOPY ON FISSION PRODUCTS

Nuclear spectroscopy of neutron rich nuclei and the search for new isotopes are currently carried out with the on-line separator OSTIS, and sometimes with the mass separator LOHENGRIN. Nuclear spectroscopy of the nuclei far from stability include the following activities:

— γ and conversion electron spectroscopy

This was used to establish the level schemes (energies and spin levels) for several nuclei in the mass-chains 143-144-145 and 146.

— Half life determinations

Due to an improved ion source on OSTIS, the intensity of separated fission products has been increased appreciably and the 3 following new isotopes were identified: ^{100}Rb (50 $\pm$ 10 ms), ^{100}Sr (170 $\pm$ 80 ms) and ^{148}Cs (130 $\pm$ 40 ms).

— $Q\beta$ measurements

The systematic investigation of $Q\beta$ values, which started a few years ago on LOHENGRIN and OSTIS, have shown the existence of subshell closure effects on nuclear binding energies for neutron number N = 56 and proton number Z = 38.

— Energy spectra of β delayed neutrons

It has been shown in the past that these spectra show pronounced structure depending on the type of the final nucleus and the density of levels accessible to neutron decay. Interesting results have been obtained in high resolution n-γ coincidences for $^{95}Rb(\beta,n\gamma)^{94}Sr$ and $^{94}Rb(\beta,n\gamma)^{93}Sr$ decay. Peak analysis and construction of βstrength functions are in preparation.

— **Angular correlations**

The on-line angular correlation system has been used both on OSTIS and also on the thermal neutron beam H22. Coincidences and correlations have been carried out on Yb, Dy and Xe isotopes following thermal neutron capture, and on the decays of ^{142}Cs and ^{144}Cs produced by OSTIS. The latter measurements have led for the first time to firm spin assignments for levels in ^{142}Ba and ^{144}Ba and have thus identified the onset of deformation in the neutron rich Ba isotopes.

NUCLEAR SPECTROSCOPY BY CHARGED PARTICLE EMISSION FOLLOWING NEUTRON CAPTURE

A programme to study the reactions (n,γp) and (n,$\gamma\alpha$) was started a few years ago at the beam tube H22. The high quality of this neutron beam (low background from fast neutron and γ rays) makes feasible the investigation of very low cross-sections. During 1978 an interesting result has been provided by the reaction $^{40}K(n,\gamma\alpha)^{37}Cl$ where one has observed a fine structure in the α spectrum. Regarding the level density near the capture state energy (10.96 MeV) and the separation of the α lines (17 keV), there is a good chance that these α lines are coming from individual levels in ^{41}K near 9.5 MeV.

Nuclear methods applied to atomic physics

To complete the systematics of actinide nuclei, energies, natural widths and relative intensities of K-X rays, transition lines have been measured for several actinides between Z = 88 and Z = 98 (Ra, Ac, Th, Pa, Cm, Bk and Cf). An overall agreement was observed with recent theoretical values.

The atomic photoeffect has been studied with the Beta spectrometer BILL in the hitherto unexplored energy region of 1 to 9 MeV. Lines of the reaction $^{48}Ti(n,\gamma)$ have been used as a γ source and were converted at Au and U foils. Even the L subshell photoelectrons could be resolved in the whole energy region. The intensity ratios between atomic shells, such as I(L1)/I(K), have been determined with a precision of 3 % and agree well with the theoretical predictions of Scofield. Angular distributions and cross-section measurements are in progress.

In the decay of ^{165}Dy and ^{166}Dy, chemical effects on the outer shell conversion electrons have been investigated by measuring the conversion lines of M1 transitions with BILL. Their intensities are proportional to the electron contact densities at the nucleus, a value which is important for Mössbauer isomer shifts. The ratio $I_e(0_I)/I_e(M_1)$ increases by 3.0 ± 0.8 % as one goes from the oxide to the metallic form, which can be attributed to the additional electron contact density from conduction electrons.

Fundamental physics

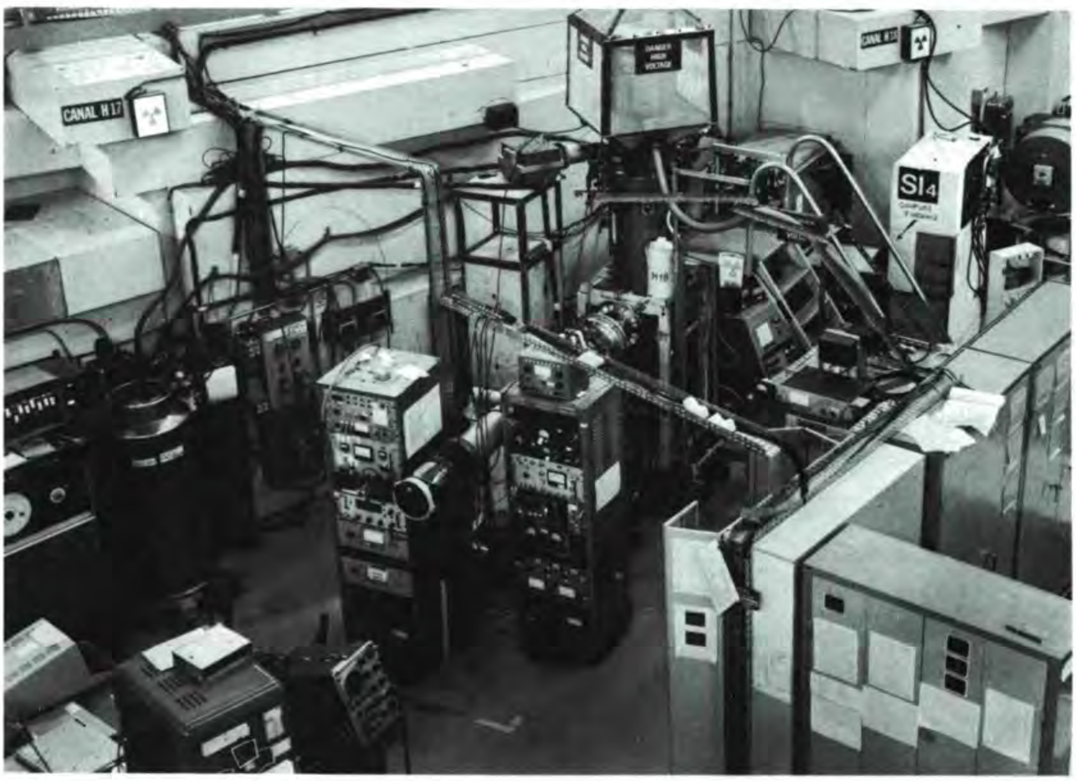
PROPERTIES OF THE NEUTRON

— **Magnetic storage of the neutron** (University of Bonn)

Neutrons were stored in a toroidal superconducting magnet ring by use of their magnetic moment. Storage of up to 45 minutes has been successfully achieved. A pure exponential decay of the neutron has been measured with a period of 907 $\pm$ 70 s. This has permitted the establishment of a lower limit for the half life of the neutron.

— **Half life of the neutron** (University of Sussex)

An experiment for the improved measurement of the neutron life-time has been performed and finished in September 1978. Protons from β-decay of slow neutrons were trapped by combination of electric and magnetic field and detected. Data evaluation is still going on.



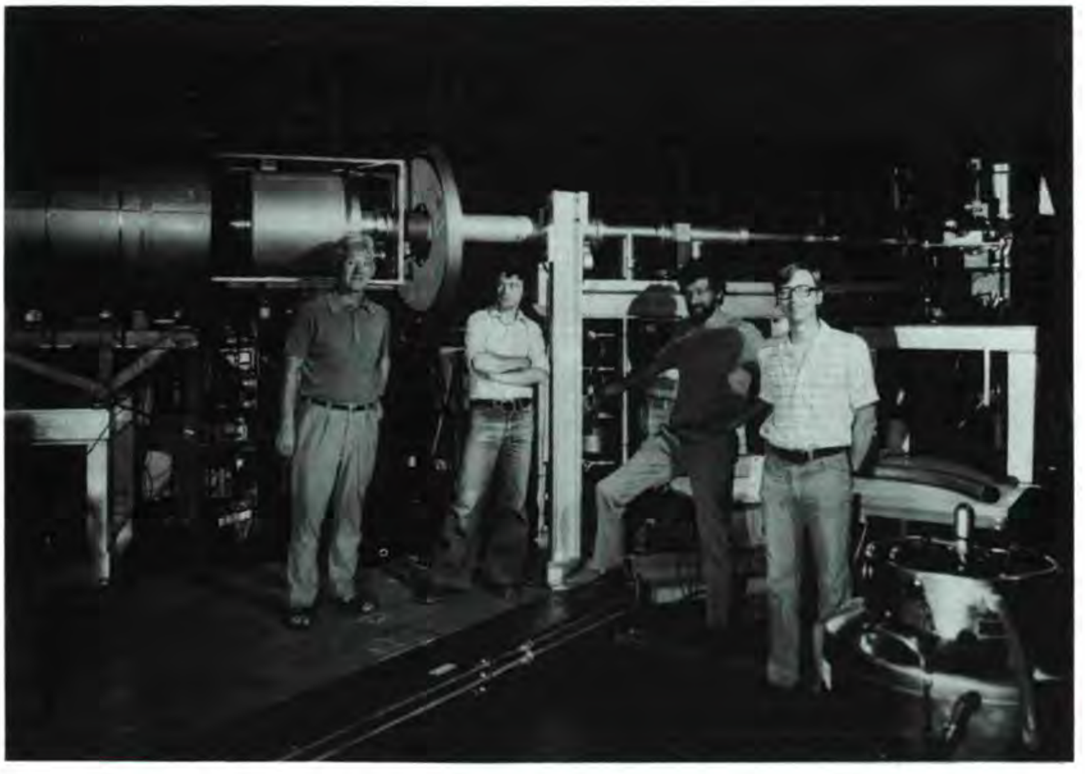
Apparatus for determining the neutron lifetime by counting decay protons stored in an electromagnetic trap. The central feature of the system is a vertical cryostat containing superconducting magnetic field coils and trapping electrodes coupled to a post-acceleration device for protons released from the trap.

— **Electric charge of the neutron** (University of Bayreuth)

In October 1978, an experiment was set up in order to search for an electric charge of the neutron. A neutron beam passes through a high electric field over a length of 9 m. A shift of the interference pattern of this beam is looked for when the electric field is reversed.

— **Electric dipole moment determination (EDM)** (University of Sussex, Harvard University, ORNL, and Rutherford Laboratory)

An apparatus of the new generation of experiments using ultra cold neutrons (UCN) for the search of an electric dipole moment (EDM) of the neutron has been installed at the ILL UCN source. UCN give the advantage that the interaction time of an eventual EDM of the neutron with a strong electric field is 3 to 4 orders of magnitude longer than with cold neutrons and that velocity dependent errors are significantly suppressed.



Sussex-ILL team in front of the neutron electric dipole moment experiment. In the picture the magnetic shield has been withdrawn and the UCN storage vessel can be seen.

In 1978 transmission measurements of different tubes have been performed and the efficiency of various polarizers for UCN has been studied. First neutron magnetic resonance curves were measured having a resonance width of 0.04 Hz in a 30 Hz field after 20 sec. of storage in a copper bottle. An improved Mu metal shield, the final beryllium storage vessel and an improved polarizer system are now in preparation.

PARITY VIOLATION EXPERIMENTS (ISN, Grenoble)

The programme to search for parity violation in nuclear processes has been continued. The aim is to measure the asymmetry of the photon with respect to the neutron spin in the radiative capture reaction. Asymmetry measurements have been performed with the N-P system and in the $^{35}Cl\ (n,\gamma)^{36}Cl$ and $^{117}Sn(n,\gamma)^{118}Sn$ reactions. A similar experiment in the N-D system is currently under way with a new polarized neutron beam and a heavy water target.

NEUTRINO PHYSICS (ISN Grenoble, Technical University of Munich and California Institute of Technology, Pasadena)

The programme to measure the neutrino cross-section and neutrino beam oscillations is progressing well. This experiment has been installed in the basement of the reactor. The shielding of the detector has almost been completed. During the first part of 1978, several experiments were performed with a small prototype of the neutrino detector in order to check the efficiency of the anti-coincidence system against cosmic-ray background. In this way, a great improvement in the lower level of sensitivity has been obtained. In parallel, the components of the detector have been built at the different laboratories involved in this experiment. The whole detection system has now been assembled.

Initial stage of the set-up for the experiment on the measurement of neutrino oscillations.

As part of this programme the continuous beta-spectrum from fission products in the $^{235}U(n,f)$ reaction has been measured with the beta spectrometer BILL. The corresponding antineutrino spectrum deduced from this measurement indicated a serious disagreement with the theoretical calculations of Avignon et al. for higher energies.

seminars and workshops

In 1978, the Fundamental and Nuclear Physics College organized 27 seminars dealing with nuclear structure, fission, heavy ion collisions, atomic and fundamental physics.

Visiting Scientists contributed with 20 seminars - 7 talks were given by physicists from Grenoble.

Two workshops took place at ILL which had strong connections with nuclear physics. On 1-2 June 1978, a workshop on intense γ ray source for research in solid state physics, chemistry and nuclear physics has been proposed for the future scientific programme of the ILL (See College 5 for details). On 3-5 June 1978 a workshop on neutron interferometry was held at ILL. It was attended by approximately 80 participants from 11 countries. 34 papers were presented (See College 5).

Secretary: G. BARREAU

college 4 'excitations'

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general summary

The experiments carried out in College 4 are concerned with the collective excitations of (generally) crystalline solids. Principal subject divisions, as used by ILL for administrative purposes are:

04-01 : Lattice dynamics (phonons)
04-02 : Dynamics of structural phase transitions
04-03 : Magnetic excitations (magnons)
04-04 : Dynamics of magnetic phase transitions

The College has approximately 27 members of whom about 12 are actively engaged in experimental work at ILL. Most College 4 experiments are carried out on one of the three axis spectrometers (IN1, IN2, IN3, IN8) although occasional use is made of diffractometers (D5, D10), time-of-flight spectrometers (IN4, IN5) and high resolution machines (IN10, IN11). During the year January to December 1978, 71 experiments have been performed under the auspices of College 4. The distribution of experiments among the key-number categories has shown no significant change since the last report. Also unchanged are the disappointingly large time losses resulting from equipment failure, and the status of IN12. This spectrometer, which will be available to external users in the second half of 1979, has recently been installed on its neutron guide (see photograph below).

IN12 during construction. On the left is the sample table in front of the monochromator shielding; on the right the analyser-detector assembly.

scientific trends and highlights of 1978

Among the many measurements which have been made at ILL of phonon dispersion curves, those on Naphthalene [1] have probably involved more concerted effort and a more extended collaboration of external users than any other. Detailed measurements of 12 intermolecular dispersion curves have been made at 6 K and 100 K in five symmetry directions. Less detailed measurements have been carried out at 200 K and 300 K. The phonon frequencies are found to decrease rapidly with increasing temperature. Phonon frequencies along two symmetry directions have been found to increase by about 10 % at 100 K when a pressure of 3 K bar is applied. The "6-exp" interatomic potential yields a reasonable qualitative description of the dispersion curves but the calculated frequencies often differ from the measured ones by as much as 20 %. Futher refinement of the lattice dynamical model is therefore required.

Using a large single crystal of the non-absorbing Cd^{110} isotope, a group from the Kurchatov Institute was able to make very accurate measurements of phonon frequencies in this material. A number of small, abrupt changes of the group velocity of some phonon branches were attributed to electron-phonon coupling. Some of the anomalies were of the well-known Kohn type, whilst others appeared to result from higher-order electron-phonon scattering processes [2].

The study of structural phase transitions continues unabated along traditional lines. Measurements have been made, for example on Hg_2Cl_2, a material which undergoes a ferroelastic phase transition at 185 K [3]. The transition is induced by the condensation of a transverse acoustic mode at the zone boundary. As the transition temperature is approached from above, the mode softens. However, there is no sign of increased broadening of the mode nor is there any central peak. Such a peak is found in Thiourea as a precursor to an incommensurable structural transition. In this substance, many of the modes whose wavevectors are close to that of the low-temperature distortion show a marked temperature dependence (softening) above the transition, and further measurements are in progress to determine the detailed behaviour of this system. Structural transitions of the order-disorder type have also received attention. In $NaNO_3$, for example, the frequencies of modes corresponding to librations of the NO_3^- ions have been measured as a function of temperature in the high and low temperature phases. A model which accounts adequately for the observations has been proposed.

Although soft modes are often encountered in connection with structural phase transitions they are less frequently associated with magnetic transitions. However, in a recent experiment which nicely combines expertise in crystal growth, neutron scattering technique and the controlled application of stress, such a phenomenon has been observed in Praseodymium [4]. Dispersion relations of magnetic excitons propagating on the hexagonal sites of double-h.c.p. Praseodymium have been measured with uniaxial stress applied in the [$1\bar{2}10$] direction. The mode of lowest energy ("longitudinal optic") along the ΓM direction softens with increasing stress as shown in Figure 9. Elastic satellite reflections have been observed which correspond to a

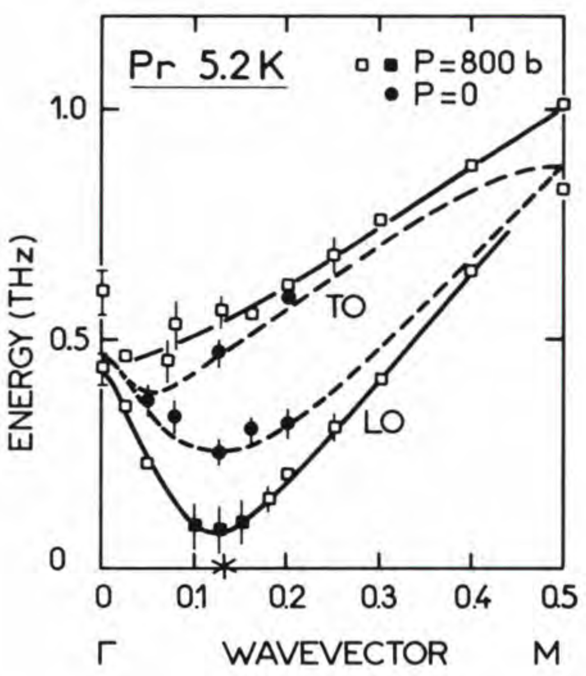

Fig. 9: Dispersion relations for magnetic excitons propagating on the hexagonal sites of Pr at T = 5.2 K.
The symbol x denotes the satellite position.

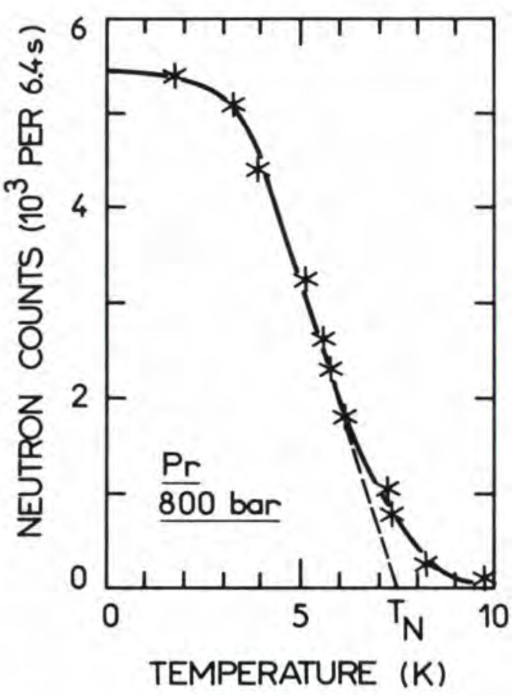

Fig. 10: Temperature dependence of the peak intensity of the (Q0Q̄ 3) satellite reflexion observed in Pr when a uniaxial stress is applied along the [$1\bar{2}10$] direction.

longitudinally modulated long-range magnetic ordering. Figure 10 shows the temperature dependence of the intensity of one such satellite for an applied stress of 800 bar. At this stress, the Néel temperature is estimated to be 7.5 ± 0.5 K. These observations are in excellent agreement with results of calculations of the magnetoelastic coupling by Jensen [5]. Futher detailed work on the stress-induced ordering in Praseodymium is planned.

Magnon dispersion relations have also been measured in the ferromagnetic Heusler alloy $Pd_2MnIn_{0.25}Sn_{0.75}$. Variation of the Indium : Tin ratio in this compound causes a marked change in the type of magnetic order without altering the chemical (Heusler) structure. For this reason a series of measurements of magnetic excitations in alloys of varying composition is planned.

Experiments to investigate the dynamical aspects of the magnetic phase transition in Dysprosium have been started with a crystal of naturally-occurring Dysprosium. In spite of the high neutron capture cross-section of this material, well-defined magnons have been observed in the ferromagnetic phase at two temperatures and with applied fields of up to 2.5 T. The results have been fitted by a model which involves seven exchange constants which, at zero field, agree with those found in previous measurements on an isotopically enriched crystal [6]. Future studies will be carried out in the helical phase especially in the region in which the magnetic spiral is expected to be commensurable with the lattice structure.

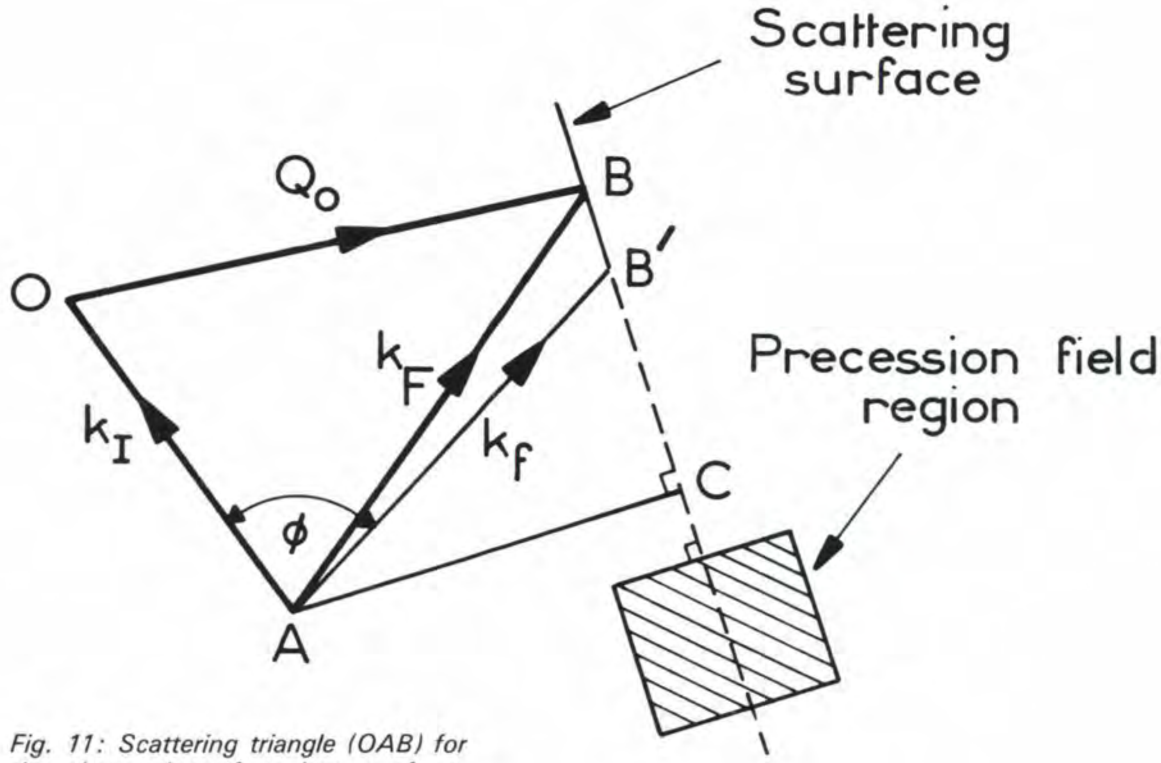

Fig. 11: Scattering triangle (OAB) for the observation of a phonon of nominal) wavevector $\vec{Q}_o$. The figure demonstrates the method used to choose the orientation of the precession field magnet through which the scattered neutron beam passes.

This year, plans for a test of the application of neutron spin echo (NSE) to three-axis spectrometry were drawn up [7]. The idea, which will be tried on D10, is to use NSE to measure, among other things, phonon linewidths. For the NSE method to work, the spin of a neutron must undergo the same number of Larmor precessions before and after scattering from a sample whose fluctuation spectrum has zero energy-width. A measured departure from this condition gives a sensitive measure of the energy-width of the spectrum. To see how the condition may be achieved for phonon scattering we refer to the scattering triangle (fig. 11).

$\vec{k}_I$ and $\vec{k}_F$ are the mean initial and final neutron wavevectors. Even if all incident neutrons had wavevector $\vec{k}_I$, different final wavevectors $\vec{k}_f$ would be observed at different scattering angles Ø. The locus of $\vec{k}_f$ is the scattering surface which, in the neighbourhood of $\vec{Q}_o$, is linear. The number of spin precessions would be the same for each scattered neutron if this number depended only on the component (AC) of $\vec{k}_f$ perpendicular to the scattering surface. This dependence can be achieved by applying a magnetic precession field (perpendicular to the paper) over a rectangle whose orientation with respect to $\vec{k}_F$ is that of the cross hatched region. It is this "tilted magnet" geometry (which is repeated in the incident beam also) which will be tested on D10.

workshops

In connection with the Scientific Council of October 1978 a workshop on Molecular Crystals was held. Some 90 scientists from 10 countries participated in this two-day event which served both to define the state of the art in this field and to elucidate problems requiring attention. Next spring (1979) a workshop on "The contribution of inelastic neutron scattering to current problems in magnetism" is planned.

acknowledgements

The members of College 4 would like to thank Bill Stirling, who has set an example of high efficiency as College Secretary over the past two years.

Secretary: R. PYNN

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college 5 'structures'

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general summary

As in preceding years the instruments used by members of the college are mainly found within the diffraction group. The table gives a list of the instruments most frequently used as well as the number of experiments for which proposals had been accepted by the subcommittee 5 of the scientific council. As usual the proposed experiments covered a wide range of structural and magnetic investigations using either powder diffraction techniques (instruments D1A, D1B, D2) or measurements on single crystals (D3, D5, D8, D9, D10, D12, D15), and the experimental variables were most often temperature (covering the range 1.5 to 2300°K), magnetic field (up to 4.8 T) and pressure (up to 30 kbar). The necessary experimental equipment has been under constant development and improvements are reported in the section describing the activities of the diffraction group. Pilot studies on the transfer of the instruments from the CARINE system to individual computers have been done. This has required sustained effort from members of the college in order to create and improve program systems, and a first step toward a higher level of direct interaction with the experiment, using screen display of the measurements and on-line computer control of experimental variables, is being taken. At the moment the single crystal diffractometer D8 and the powder diffractometer D1A are operating successfully with individual computers, and in extreme cases data collection rates have been increased by a factor of three.

The college has been strongly engaged as well in discussions concerning further developments of the instruments and design of new apparatus. The discussion has centred around multidetector systems and their applications, and principles for measurements on the instrument D19, which is a "one and a half" dimensional detector for single crystal studies, are being worked out. A multidetector for powder work especially designed for very high count rates (D20) has been proposed, and various models have been discussed in detail. Discussions on techniques for suppression of thermal diffuse scattering have taken place, and members of the college are engaged in the construction on instrument D10 of a filter using the neutron spin-echo technique for this purpose.

TABLE VIII

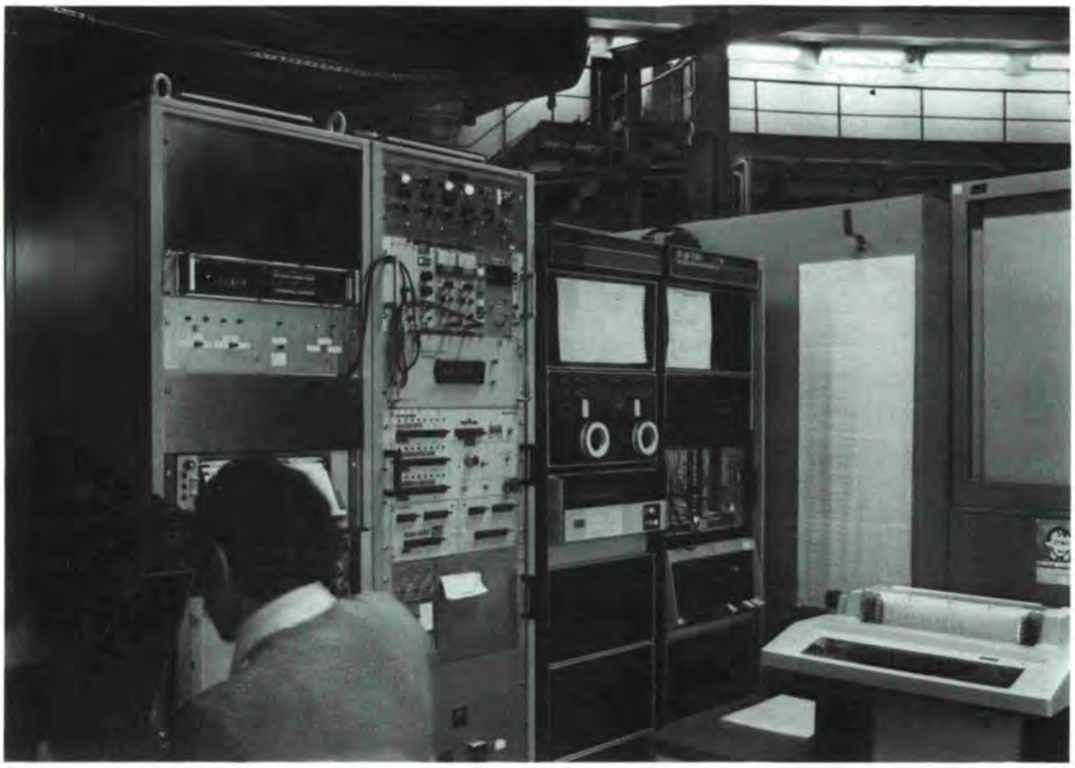
Experiments which were accepted by subcommittee 5 for execution in 1978

Instrument	D1A	D1B	D2	D3	D5	D8	D9	D10	D12	D15	Other	Total
No. of experiments	32	31	16	15	11	13	13	8	12	14	15	180
No. of days used	173	148	96	196	117	151	147	90	156	178		

scientific trends and highlights in 1978

Electron densities

Interest within the college in the determination of electron densities by comparative X-ray and neutron diffraction studies remains high. The study of oxalic acid dihydrate, which is part of a project suggested by the International Union of Crystallography in order to assess reproducibility in charge density determinations continued by measurements on D9 using a wavelength of 0.53 Å. Comparisons with previous measurements on D8 using a wavelength of 0.84 Å showed very good agreement and indicated that the parameters obtained from neutron measurements are reproducible, although they might be biased for example by thermal diffuse scattering. Neutron measurements were done on hydrogen peroxide, which melts at 0°C, and where the single crystal was grown in situ. The electron density analysis is now completed showing the oxygen to have sp^3 hybridisation with one lone-pair pointing in the direction of the hydrogen bond. Other hydrogen bonded compounds where neutron data were collected for the purpose of electron density studies were sodium hydrogen maleate trihydrate and lithium nitrate trihydrate. The aim of these studies is to map out the environment of the hydrogen bond in order to see a change in charge distribution when the bond length is varied. It now seems that the major features are nearly constant for most of the bonds presently studied. Pyrite (FeS_2) was



The D8 data acquisition system including new computer.

studied at low temperature for combination with γ-ray diffraction data, and beryllium was studied at room temperature in order to measure the anharmonicity in the thermal motion. It was, however, found that the observed isotropic temperature parameter was 25 % smaller than the same parameter measured previously by X-rays and this difference is now being further investigated.

Structural evolution with temperature

Studies of the structural evolution with temperature using single crystals were carried out for a series of compounds. Of special interest to the members of the college were studies of changes in a one-dimensional metal-like conductor TCNQ-salt and the changes in the structure of β-quartz between 600 and 1 000°C.

Structural phase transitions

Structural phase transitions have continued to be an important part of the work on the high resolution powder diffractometer D1A. With continued improvements in intensity, it is now feasible to measure the evolution of each phase with temperature. For example, in $KCaF_3$ and $RbCaF_3$ these results, when compared with those of NMR and neutron inelastic scattering, help to explain the details of the transition mechanism. Other systems, such as the proposed high temperature transition in V_2O_3 have proved more difficult, although it is clear that even weakly scattering vanadium atoms can be located precisely. There is however a growing interest in order - disorder problems and super-ionic conductors, such as Na_2UBr_6. In this material the different structures were obtained with almost no a priori crystallographic knowledge. The increasing power of more direct methods of finding structures from powder patterns is also illustrated by the use of difference Fourier techniques for locating hydrogen atoms in several perhydrates.

The D1A CARINE replacement (indicated by operator). The Micro-1 computer, manufactured by the British Company "Plessey" is one of the smallest and least expensive parts of the electronics, but uses the same operating system and peripherals as the larger PDP11's.

Hydrogen sponges

Using both the profile analysis technique and following in detail variations of the width of the individual reflections, Al and Mn substituted $LaNi_5$ hydrogen sponges were studied. In the pure alloy, broadening of some reflections indicated that the powder grains were subdivided into filaments, whereas this effect disappeared in the Al and Mn substituted compounds. The hydrogen atoms in compounds of the type $LaNi_{5-x}MxHy$ were found to be widely spread over the possible sites, with a preference for the 6 m site.

High pressures have now become an almost standard technique, ranging from work on metal-insulator and magnetic systems to simple organic materials such as naphthalene. In the photo below a pressure cell used for these powder diffraction experiments is shown.

High pressure cell used at ILL for neutron scattering. Maximum pressure is 30 kbar for single crystal samples and 40 kbar for polycrystalline samples. This cell has been designed by the SNCI High Pressure Group.

Diffuse paramagnetic scattering

The full potential of D5 was exploited in a series of experiments in which polarisation analysis was used to isolate the diffuse paramagnetic scattering of a number of 3d metallic systems. It was confirmed that chromium, the archetypal itinerant antiferromagnetic metal, shows negligible magnetic diffuse scattering between 70 and 400 K within the energy window $\pm$ 5 meV. On the other hand α-manganese, currently also thought to be an itinerant antiferromagnet, gave significant diffuse scattering above the Néel transition which increased with temperature between 100 and 300 K. The value at 300 K was consistent with localised moments having magnitudes comparable to those found in the antiferromagnetic phase. MnSi, which is thought to be a typical weak itinerant ferromagnet, also gives diffuse magnetic scattering above the Curie temperature, the intensity being that to be expected from a localised system with effective moment 2.2 μB. This value should be compared with the ordered moment of 0.4 μB. There is evidence that in MnSi most of the diffuse magnetic scattering persists in the ordered magnetic phase. These results demonstrate clearly the ambivalent character of d-electrons in metals which seem able to exhibit at one and the same time both itinerant and localised properties.

Magnetisation densities

Amongst studies of the spatial distribution of magnetisation density using the classical polarised neutron technique two studies show results of particular interest. The ferromagnet $K_5V_3F_{14}$ is the first example in which the magnetisation density of the V^{3+} ion has been studied in detail. The spin and orbital moments are oppositely directed and of comparable magnitude. The magnetisation density in this case is very sensitive to the form of the ground state wave-function and it should be possible, as in the case of rare earth systems, to derive the coefficients of the wave-function from the neutron scattering results. Paramagnetic UGe_3 on the other hand is of interest because it shows very clearly polarisation of a normally non-magnetic atom. The paramagnetic moment in UGe_3 was aligned in a field of 4.8 T. The Fourier projection of Figure 12 shows the aligned magnetisation density obtained from the

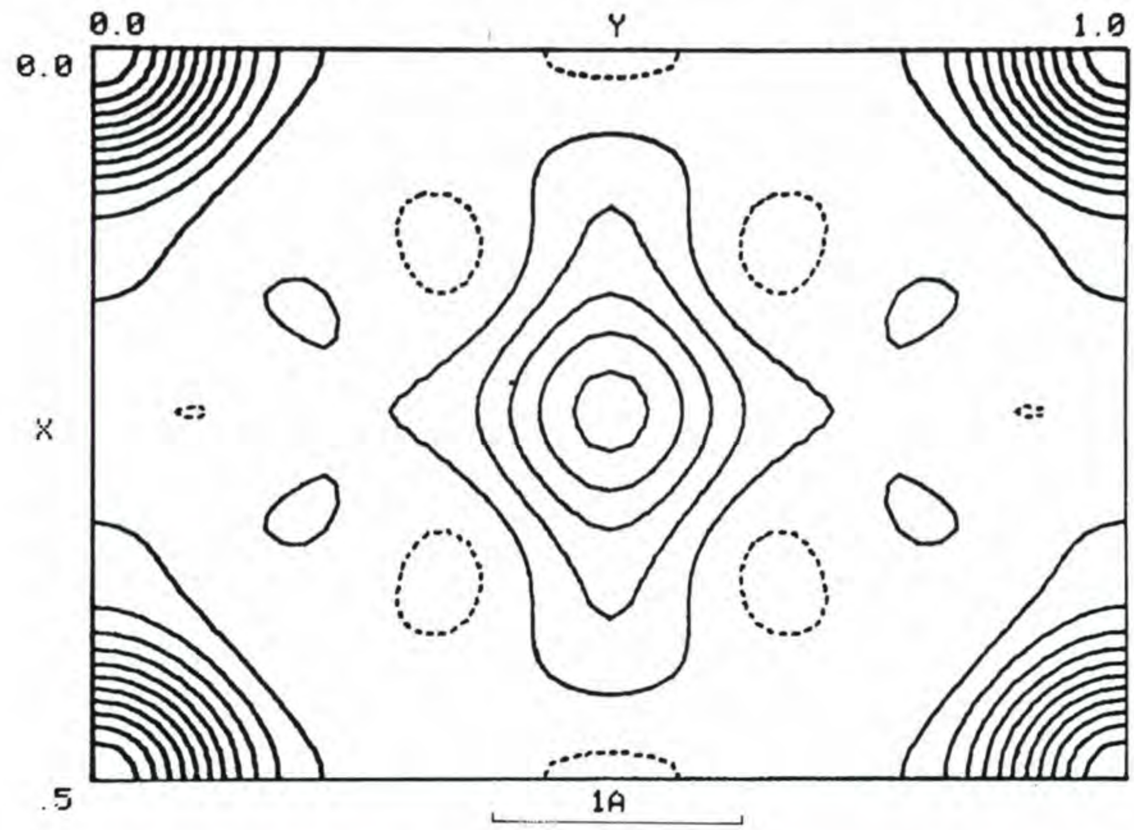


Fig. 12: The paramagnetic spin density of UGe_3 in the 110 projection. The Ge atom is in the centre surrounded by U atoms at the corners.

results, the bulk of the density is associated with the uranium atoms at the corners of the figure but very significant density is also located around the germanium atom at the centre. The elongation of the germanium density in directions between uranium atoms may indicate that it has antibonding p-character.

Because of high absorption for thermal neutrons compounds containing for example Sm and Gd must be studied at short wavelengths. This year $SmAl_2$ and SmZn have been examined. The Sm form factor is strongly dependent on the mixing by exchange and crystal field of the higher multiplets into the ground multiplet. This has allowed determination of exchange and crystal field parameters, and a large polarisation of the conduction electrons was shown to exist. The polarised neutron study of $HoFe_2$ was terminated. The magnetic moment found for iron is $\mu = 1.8\ \mu_B$, with an induced contribution due to interactions with holmium of 0.25 μ_B. These values are in very good agreement with band calculations. Difficulties arise in the interpretation of the value found for the holmium moment, 9.15 μ_B. Indeed, calculating the wave function with the exchange and crystal field parameters already known in this alloy, one obtains 9.9 μ_B. The reason for this inconsistency is as yet not clear.

Structure of physisorbed gases

Using mainly the powder diffractometers D1B and D2 many results have been obtained on the structure of physisorbed gases. These investigations are aimed at describing the structure of the adsorbed gas on the surface for various gas concentrations as well as to study the phase transformations taking place when the temperature is varied. Using changes of the 001 line of the substrate it was possible to deduce that when ^{36}Ar or CD_4 were absorbed on the cleavage face of MnI_2 and PbI_2 a first layer would condense at a distance of 3.5 Å from the surface followed by a second and third layer at similar interplanar distances when more gas was added. The first-order liquid - solid transition in the building of the first layer of NO on graphite was demonstrated by the coexistence of the solid and liquid diffraction patterns, and the nature of melting was studied in argon on graphite. Using a coverage of slightly lower than one atom-layer, melting was found to be continuous over the range of 20° to 60° K. This is very different from the case of CF_4 covering graphite in approximately half atom layers. Here the melting takes place over less than one degree. Dynamics of adsorbed layers have been studied as well, and a first order behaviour of ferrodimensional gas - liquid transition of CD_4 on graphite has been confirmed by observing a constant mobility from quasi elastic scattering in the coexistence region.

Neutron interferometry

Due to the installation of the final version of the interferometer D18, experiments carried out on a prototype were limited to the first half of the year. After the manufacture of new interferometer crystals some experiments have been carried out on neutron phase contrast imagery using photographic detection. In addition measurements with a double crystal setup of perfect silicon crystals have demonstrated the possibility of using the spin dependent splitting of neutrons in a prismatic magnetic field for beam polarisation to a degree close to unity. This new polarisation technique would be especially well adapted to interferometry with polarized neutrons. Finally a short series of measurements showed the ability of the new instrument to detect angular deviations of neutron beams of the order of 10^{-3} seconds of arc using the oscillatory fine structure of the Laue case rocking curve.

Special Instrument S20

The special instrument for neutron diffraction topography, S20, financed by Laboratoire Louis Néel, CNRS, Grenoble, was mainly used by José Baruchel, from this laboratory, in cooperation with M. Schlenker, temporarily at ILL.

The work was focussed on the investigation of antiferromagnetic domains, for which neutron topography is the only direct method of observation, and as such, in spite of limited resolution, very valuable.

Unusually simple domain configurations, consisting of a single T (or $\vec{q}$) domain with a few large S domains were observed in NiO specimens (kindly provided by Drs. Saito, Nakahigashi and Kurosawa from the University of Osaka Prefecture, Japan). The S domains showed unexpected contrast on topographs made using nuclear reflections; this effect was also found to exist on X-ray topographs, and, after further experiments on the synchrotron radiation at LURE (Orsay), now seems to be well understood and to be associated with magnetostriction and the twinned structure of the specimens.

In MnF_2, the work was directed towards understanding the physics of the 180° antiferromagnetic domains, which are clearly visible using polarized neutron topography, but which no other technique seems to be able to reveal - and which, as a result, are quite unfamiliar. The effect of applying a magnetic field while cooling through the Néel temperature, and, to some extent, the effect of stress, were investigated. No physical model has yet been found, and work will continue.

seminars and workshops

The college arranges in collaboration with the diffraction group a weekly meeting, which is either used for reporting on matters concerning the technical and scientific life of the college and diffraction group or is used for seminars. During the year the thesis students have reported on progress in their work, and all the instruments employed by the college have been presented. Seminars, of which there have been approximately a dozen, have covered magnetic work such as the Patterson technique in solving magnetic structures, new equipment including diffractometers for spallation source diffraction and Doppler effect measurements of ^{238}U and Sn. Hydrogen bonding has been reviewed in two talks, and within the field of charge density distributions topics have ranged from expansion of atoms in molecular bonding over a quantum model of the X-ray coherent diffraction experiment to γ-ray measurements of structure factors.

Two workshops were organised in June 1978. On June 1st and 2nd a workshop with the title: "The Application of Intense Capture Gamma-Ray Sources" took place (organized by A. Freund). The aim of the workshop was to discuss source properties and possible research applications of a high intensity γ-ray source, which has been proposed for the future scientific programme of the ILL.

The following topics were discussed: within Nuclear Physics the main interest was in (γ,γ') reactions and the corresponding spectroscopic studies, but (γ,n) spectroscopy had also been envisaged. The source could be used for fundamental scattering processes such as Rayleigh and Delbrück scattering, which aim at investigations of higher shell form factors, dispersive scattering and nuclear polarizabilities, and employing the overlap of source lines with resonant levels in the sample zero-point vibration and strength of chemical bonding could be studied. γ-ray sources are already much used both in measurements of structure amplitudes, crystal characterisation and Compton scattering, and the application of a much stronger source was

Participants at the Workshop on Neutron Interferometry in June 1978.

discussed. Finally comparisons with synchroton radiation indicated that the γ-source would be more powerful for photon energies above $\sim$ 150 keV, and it was concluded that whereas nuclear physics and resonant scattering experiments would preferably be done at an on-line source, the other fields of research were best carried out using off-line operation.

On June 3rd to 5th an "International Workshop on Neutron Interferometry" (organised by Professors U. Bonse, Dortmund and H. Rauch, Vienna) was held at the ILL. This time the discussion was centred around the neutron interferometer and perfect crystal device, D18, although many other topics were treated in the 34 papers presented.

Some of the subjects of discussion were: within interferometer optics, the question of whether a spherical wave or an incoherent plane wave superposition approach should be used, and the possibility of mirror interferometry using very cold neutrons. Neutron optics included reports on Fresnel diffraction of cold neutrons and the application of D18 for investigations of diffraction by perfect crystals. Finally interferometer measurements of many types were outlined such as observations of gravity and acceleration effects, demonstration of basic quantum mechanics, phase contrast imagery for materials characterization, measurements of structure factors for reflections other than the 000 reflection, small angle scattering and determination of scattering lengths for various purposes ranging from chemical analysis to possible variation with temperature.

The meeting attracted about 80 participants, and the proceedings will be published in book form.

Secretary: M.S. LEHMANN

college 6 'liquids, gases and amorphous materials'

members of the college

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Blétry J.	(Univ. of Grenoble)	Lechner R.E.	
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Cummings S.		Pynn R.	
Cyrot F.	(CNRS)	Richardson R.	
Desre P.	(Univ. of Grenoble)	Scherm R.	
Dianoux A.J.		Stirling W.G.	
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Fitzgerald M.		Volino F.	(CNRS)
Hilton P.		Wright A.F.	

general summary

The topics concentrated in this College cover diffraction and inelastic scattering of neutrons in various types of liquids, amorphous systems and gases. In the past year experiments were performed in the fields of liquids and amorphous substances, but no experiment has been carried out in gases. All key-words of the College (see end of this Annual Report) were represented by one or several experiments this year.

Of the instruments D4 was the only one which was exclusively used by College 6. D1B and D2 were often used by the College, with equal demand for time on both instruments. Other diffractometers used were D5, D7, D11 and D17. Resulting from the special problems connected with the investigations of the dynamics of disordered systems, most of the inelastic neutron scattering experiments were performed on the time of flight instruments IN5 - and to a lesser extent - IN4. IN10 was used for high resolution experiments and, for the first time, IN11 was scheduled. The triple-axis spectrometers IN1, IN3 and IN8 have been used mainly for measurements of the scattering law at constant momentum transfers. 66 experiments were performed in 1978.

In March 1978, 33 proposals were submitted, of which 20 were resubmissions or continuations. Of these, 27 were accepted. In October 1978, 40 proposals were submitted - 18 resubmissions and continuations. Beam time was allocated for 31 of these. More than a quarter of the submitted proposals dealt with the investigation of the structure of amorphous systems.

In addition to the proposals the future of the D4 diffractometer was discussed and the Subcommittee clearly stressed the necessity to keep D4 as long as no superior diffractometer is operating and accessible elsewhere.

scientific trends in 1978

A brief summary of some of the results obtained during 1978 will be given.

Quantum liquids

The neutron spin echo method has been used to extend the study of the lifetime of rotons in superfluid ^4He to lower temperatures. The width of the roton line at a momentum transfer corresponding to that of the roton minimum was measured. The

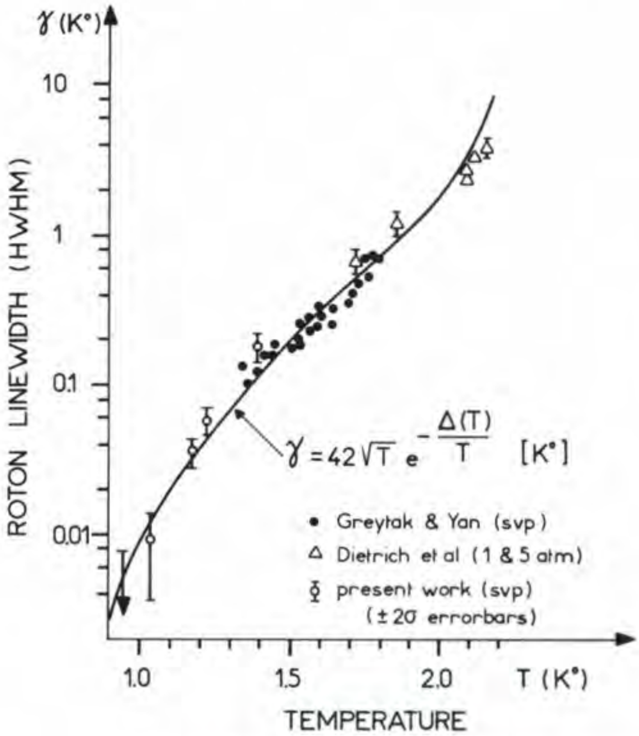

Fig. 13: Linewidth of the rotons in ^4He as a function of temperature.
• light scattering results
△ neutron scattering
o present results taken on IN11 by F. Mezei (to be published).

results in Fig. 13 show the strong temperature dependence of the roton line width, predicted by the theory of Landau and Khatlatnikov, thus giving strong evidence that the two roton interaction is still the leading mechanism of roton decay over the extended range of more than two decades in line width. The measurements of the line width of rotons in dilute mixtures of ^3He in ^4He has been extended to higher and lower temperatures compared to the previous measurements.

Monatomic liquids

A first experiment on the scattering law of liquid lead near its triple point at low momentum transfers has been carried out. The results are still preliminary and have to be confirmed by a second experiment. However, the results obtained so far already clearly show the existence of propagating collective excitations in liquid lead, with wavelengths as small as 5 to 6 Å. For the momentum transfers measured so far a reasonable dispersion of these modes has been found.

Binary and molecular liquids

A detailed study of the structure of oxidised liquid Rubidium showed that the isolated ion-oxide clusters found in the solid phase persist in the liquid phase near the triple point.

A high temperature experiment, now possible at D4 ($T \leqslant 2300$ K), has been performed on a system of Ni-V alloys. As there was almost no contribution from the Vanadium to the coherent scattering, the Ni-Ni distribution in this alloy was determined directly. The structure factor showed a pre-peak. Its intensity rose with increasing V-concentration.

In the field of molecular liquids, the trend towards studying more complicated systems has continued. In combining results of X-ray measurements with those of neutron diffraction experiments using the isotope substitution method, it has now been possible to extract the first four terms of the spherical harmonics expansion.

Aqueous solutions

From the investigation of the structure of aqueous solutions there is now strong evidence that the chlorine water conformation is insensitive to the types of cations in the solution. In addition, it was found that the cation hydration was similar in the cases of concentrated $NiCl_2$ and $CaCl_2$. In a study of the concentration dependence of the Nickel hydration, a significant change in the angle between the plane of the water molecule and the Ni-O axis has been observed, proceeding from larger angles at high concentrations to an in-plane situation in the more dilute case.

Amorphous systems

New experiments carried out with small angle neutron scattering (SANS) on a cordierite glass-ceramic ($2MgO\ 2Al_2O_3\ 5SiO_2 + 10\,\%\ TiO_2$) have led to a clearer understanding of the influence of heat treatment below Tg on the nucleation and growth of phase separation in the crystallisation process. The heat treatment below Tg is now recognized as a nucleation stage which defines the path which the crystallisation will take. A surprising outcome of these experiments was the long time period necessary to complete this nucleation process (up to 20 hours for the cordierite glass).

Liquid crystals

Incoherent quasielastic neutron scattering experiments on aligned samples of IBPBAC in its smectic E, B and A phases have given insight into the diffusive molecular motion (with correlation times $< 10^{-10}$ sec) in these phases. In the E and B phases translational diffusion perpendicular to the layers was restricted by a high potential barrier (~ 30 KJ/mole) to crossing between layers. In the smectic B phase the molecules were able to undergo a restricted uniaxial rotational diffusion about their long axes ($D_r \sim 2.10^{10}$ r/sec) but in the smectic E phase, only a very restricted librational motion (orientational order parameter, $< \cos\varnothing > \sim 0.8$) has been observed. In the smectic A phase the barrier to crossing between layers was very much reduced ($\sim$ 10 KJ/mole) and the molecules underwent unrestricted uniaxial rotational diffusion ($D_r \sim 5.10^{10}$ r/sec) and some directional fluctuation of the long molecular axes.

This year progress was made in a consistent interpretation of the results taken on the same liquid crystal system with different methods (incoherent neutron scattering, NMR, NQR).

seminars

13 seminars at the ILL dealt with subjects covered by this college: quantum liquids (3), simple liquids (1), alloys (4), molecular liquids (2), amorphous systems (1), and liquid crystals (2).

An informal panel discussion was held with outside experts about developments in the field of binary alloys.

On the occasion of the fifteenth Low Temperature Conference at Grenoble, a very fruitful one-day workshop on 'Neutrons in Helium' was held at the ILL.

acknowledgements

The members of College 6 would like to thank J. Copley for his work as College Secretary.

Secretary: J.-B. SUCK

college 7 'imperfections'

members of the college:

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Hewat A.
Jenkin G.
Just W.
Lechner R.E.
Mezei F.
Murani A.P.
Nilsson G.
Roth M.
Scheuer H.
Suck J.-B.
Wright A.
Young A.P.
Zeyen C.
Ziebeck K.R.A.

general summary

The college's scientific activities are divided into 7 different groups corresponding to the keyword system given at the end of this report. The range of instruments used is exceptionally large since it includes triple axis spectrometers (IN1, IN2 and IN3), time-of-flight machines (IN4, IN5, IN7 unfortunately shut down this year), very high resolution spectrometers such as the backscattering instrument IN10 and the neutron spin echo spectrometer IN11. Diffractometers are used for structural work (D1A, D1B, D9, D10, D16), diffuse scattering problems (D7, D10) or small angle scattering (D11, D17) as well as polarisation analysis (D5). As in the past the special instruments S6 (In-beam NMR), S30 (concentration profiles by (n,α) and (n,p) nuclear reactions) and S44 (channelling and blocking experiments) are used for college 7 activities. A newcomer for this college, the S21 instrument (high precision lattice parameter variations) will be used for the study of equilibrium vacancy concentrations in materials at high temperatures.

The number of proposals in this year's March meeting was 53 of which 37 were given beam time. At the October meeting 53 experiments out of 65 were given beam time. A large part of the proposals of this college are related to long term projects so that only about 30 % of the proposals are really concerned with new problems. The trend is towards the study of materials of technological relevance.

Reports on the activities of the special instruments S6, S20 and S21 were given to the scientific subcommittee. A further operation of these instruments was recommended, S21 was recommended to become an ILL instrument.

scientific trends and highlights in 1978

Spin glasses

A continued effort for the study of spin glass systems could be observed this year. A systematic study of the room temperature spin dynamics of binary Cu-Mn spin glasses over the concentration range of 1 to 7 atomic percent Mn revealed the phenomena of exchange narrowing. It appeared that the Korringa relaxation was responsible for intrinsic broadening of the paramagnetic spectrum of Mn in Cu, which can be well described by a simple Lorentzian of half width $\sim$ 2 meV at 300 K in the dilute limit. Exchange interactions between the spins, which increase with increasing solute concentration, lead to apparent narrowing of the spectrum at low q-values, to increased broadening at higher q's, and generally to departures from the single Lorentzian spectral forms.

Critical magnetic scattering

The study of critical magnetic scattering in Nickel was carried out very close to the critical temperature. Reduced temperatures of less than 10^{-5} were obtained. The results show that maximum critical scattering occurs at a temperature slightly above T_c. This is due to the non zero value of the critical exponent η. In order to investigate multicritical behaviour uniaxial compression was applied to the Nickel single crystal samples. On approaching T_c a crossover from a Heisenberg- to an Ising-like behaviour was observed.

Intermediate valence compounds

Measurements of the quasielastic central mode of the intermediate valence compound $CeAl_3$ in the temperature range $1.5 < T < 125$ K showed a constant temperature independent spectral width below 2 K but which increased as $T^{1/2}$ for temperatures above 2 K. A possible interpretation of this behaviour is that it reflected the passage from a Fermi liquid of f-electrons at low temperatures to a classical liquid at higher temperatures. This first observation of the $T^{1/2}$ temperature dependence was due to the fact that the characteristic temperature T_0 associated with valence fluctuations was low for $CeAl_3$ ($\sim$ 1 - 2 K), whereas for other intermediate valence systems studied previously the characteristic temperature was rather high ($\sim$ 100 K) so that measurements of a much larger temperature range need to be made to observe the same effect.

Huang scattering

Defect and disorder scattering has been carefully investigated in various systems. Huang scattering in NbD_x has been measured at high temperatures using neutron triple-axis techniques (D10) to filter out the inelastic scattering (TDS). Preliminary studies had been performed on irradiated MgO and Li^7F single crystals yielding directly the double force tensor corresponding to the distortion field around the defects created by irradiation. In NbD_x Huang scattering was observed near the critical point (T_c = 171°C, x = 30 at.% deuterium). Since this scattering is proportional to the concentration fluctuations, important information on macroscopic density modes predicted by theory is expected from these results.

In-beam NMR spectroscopy

Measurements have been carried out for the first time of the β-decay asymmetry and the magnetic moment of $^{24}Na^{m}$ ($T_{1/2}$ = 20 ms), which was produced by capture of polarized neutrons in NaF and Na metal; this nuclide has been established as a new probe for in-beam NMR spectrometry. In preliminary measurements on the superionic conductor Li_3N, ionic motion below LNT could be inferred from the dependence of the ^{8}Li nuclear polarization on temperature and magnetic field. In pure and doped crystals of InP and InSb NMR curves and relaxation rates of ^{116}In nuclei were measured. The relaxation behaviour of nuclei stopped on undisturbed or disturbed lattice sites after the (n,γ)-capture process could be observed separately. The former relax due to purely quadrupolar interaction whereas the latter lose their polarization additionally by paramagnetic interaction with nearby defect centres.

Oxygen diffusion

New investigations on the oxygen diffusion in rare earth oxides at high temperatures have been initiated. Neutron diffraction studies on the sesquioxides La_2O_3 and Nd_2O_3 have led to describing the two high temperature phases "H" and "X" by statistical models with high oxygen disorder. (Fig. 14).

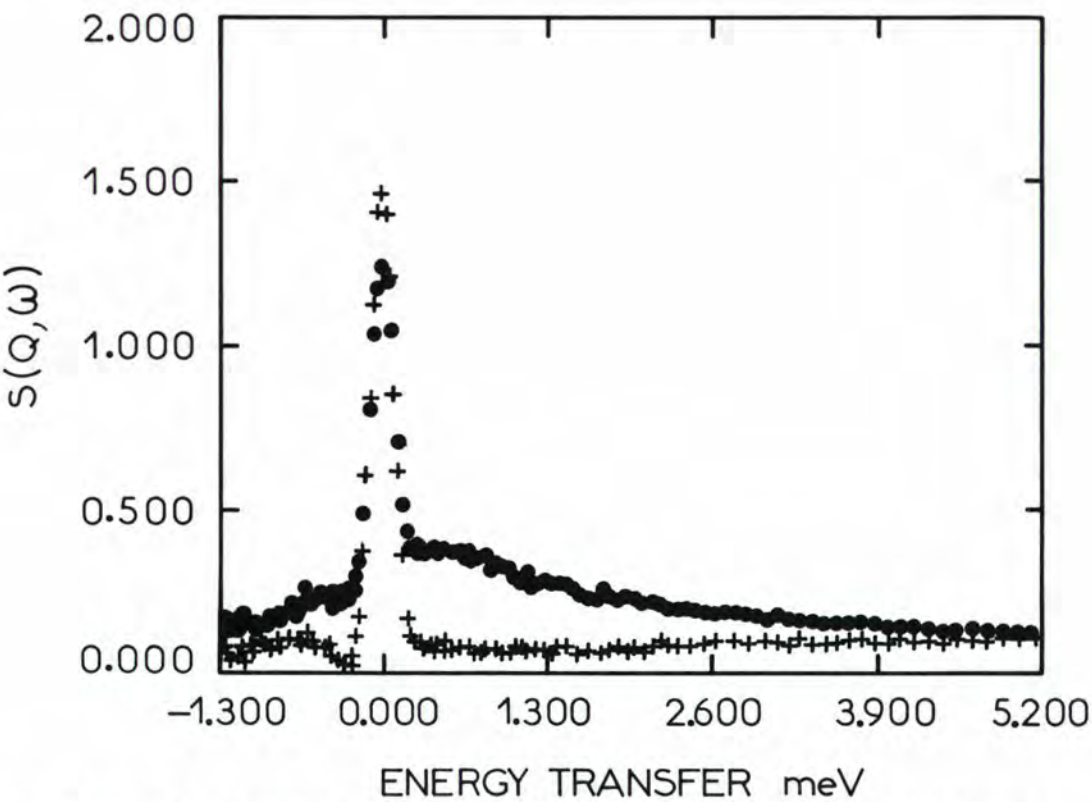

Fig. 14: Time of flight spectra (vanadium normalized, furnace background substracted) of La_2O_3 at 1910°C, A phase just below the H phase transformation (curve + + +) and at 2230°C, X phase. The elastic peak arises from Lanthanum scattering only since the scatterring cross section of oxygen is purely coherent. Furthermore the intensity decrease of the elastic peak with increasing temperature corresponds precisely to the decrease of the La-Debye-Waller factor.

Preliminary TOF experiments on IN5 on these two compounds at 2050°C and 2250°C in the "H" and "X" phases have shown that this disorder is of a dynamic nature as in superionic conductors. At such high temperatures no other spectroscopic method could have been applied. These data should lead to a good description of the oxygen motion and to a determination of the localized motion and the long range translational diffusion.

Superionic conductors

In the field of superionic conductors several studies are underway. This year a determination of the temperature dependence of the density-of-states in PbF_2 was completed. A weighted single phonon density-of-states has been measured at 10, 300, 660 and 900 K using IN4. At 10 K a good agreement was found with a calculation from the dispersion relation. At higher temperatures the optic modes were observed to broaden into a high energy tail consistent with strong anharmonicity or extensive disorder near the superionic transition temperature $T_c = 700$ K.

Interesting results on superionic $SrCl_2$ single crystals were also obtained by triple-axis and TOF measurements.

The quasielastic scattering which was found above the superionic transition temperature $T_c \simeq 1000$ K was strongly dependent on both the magnitude and direction of the scattering vector $\underline{Q}$. This suggests that the diffusive motion of the chlorine ions, which is related to the ionic conductivity, is anisotropic and especially influenced by the crystal field.

seminars and workshops

Three college 7 seminars were held this year on typical college 7 subjects such as Magnetic Alloys and superionic conductors.

A workshop on "Diffuse Elastic and Quasielastic Neutron Scattering from Defects in Solids" was held from October 16 to 18 at St. Pierre de Chartreuse near Grenoble.

10 ILL scientists and about 25 from outside attended this workshop. Diffuse scattering from both nuclear defects and magnetic impurities was discussed. An important section was devoted to instrument discussions pointing out the need for future developments of the ILL instruments used for diffuse scattering namely (D7, D10, D11, D17, D5). The proceedings will be published in J. Phys.

Secretary: Claude ZEYEN

college 8 'structural biology'

members of the college

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Chauvin C.	(CENG)
Chenevas P.	
Cuillel M.	
Dianoux A.	
Haas J.	(Mainz/ILL)
Ibel K.	
Jacrot B.	
Lehmann M.	
Lewit-Bentley A.	
Mason S.	
Rustichelli F.	(EURATOM)
Suck J.	
Timmins P.	
Torbet J.	(Max Planck Inst. Grenoble)
White J.	
Zaccai J.	

AT EMBL

Berthet C.
Boras F.
Cusack S.
Jessior J.C.
Lindley H.
Miller A.
Simpson K.
Tocchetti D.

visiting scientists

Engleman D.	(Yale)
Larsson B.	(Uppsala)

general summary

The main interest of College 8 is in the determination of the structure of biological molecules and molecular complexes. The emphasis is on the determination of low resolution two-component structures by low angle solution scattering, where use of deuterium/hydrogen exchange allows a wide exploitation of the contrast variation method. In addition, both high and low angle single crystal studies are of major importance as are diffraction studies of partially ordered systems such as fibres or membranes. Some preliminary studies on the dynamics of biological systems, and in particular their associated water, have also been completed and first results are beginning to appear.

The most heavily used instruments for biological experiments are the elastic scattering cold neutron machines : D11 (solution scattering + fibre diffraction), D16 (fibres and membranes), D17 (low angle single crystal diffraction, solution scattering, fibres + membranes). High resolution crystallographic studies are carried out on the high flux diffractometer D8.

In 1978, there were 68 proposals submitted of which 44 were accepted in whole or in part. In addition, the principle of test-time was continued on D11 enabling several important feasibility tests to be carried out prior to the submission of definitive proposals. The trend continued towards experiments requiring sophisticated biochemical preparation and sample characterisation much of which must be done at the ILL before and during the neutron scattering experiments.

scientific trends and highlights of 1978

The field of structural biology, being necessarily multi-disciplinary, lends itself naturally to collaboration between outside users and ILL scientists. Thus, in addition to helping users who are working independently in their use of the instrument, there is a wide variety of experiments in which both outside user and ILL scientists collaborate. In addition, there are a few fields, such as protein crystallography and low resolution single crystal contrast variation, requiring constant development and elaboration of technique, which are best covered by internal ILL scientists who are close to the equipment involved. Some of the progress in these fields will be illustrated below.

One of the most important subjects within structural molecular biology is that of protein-nucleic acid interactions and it is precisely in this domain that neutron scattering is proving to be a powerful tool. Thus, in the last year important advances have been made in the study of ^{t}RNA amino-acyl synthetase interactions with ^{t}RNA by groups from Strasbourg and Paris in collaboration with J. Zaccai and B. Jacrot. Interesting structural changes of the enzyme have been observed and, although conformational changes are well-known for certain enzymes, it is the first time that the structural parameters of such a change have been measured. Advances continue to be made in the field of ribosome structure, notably by the group of Stuhrmann in collaboration with J. Haas, who have determined the distance between the 30S and 50S sub-units within the intact 70S particle by specific deuteration of one sub-unit. The importance of ribosome structure was demonstrated by the acceptance at the October Scientific Council of 5 proposals from different groups in this field. The coordination of such related projects involving heavy biochemical investment is clearly desirable and a workshop to discuss such a possibility has been organized to take place in Heidelberg in January 1979.

Several interesting experiments on virus structure have been carried out. In one preliminary test by Mme Tripier (Strasbourg) in collaboration with B. Jacrot, the frog virus FV3 was investigated by low angle scattering. First results showed the possibility of deriving structural information from this lipid coated DNA virus having a diameter of 1600 Å and molecular weight of 350×10^{6}. The solution studies of tomato bushy stunt virus are largely complete and have shown, in the spherically averaged model, that both the RNA and protein have a strongly bimodal distribution (Fig. 15). These results are entirely complementary to those from X-ray crystallography where, due to problems of disorder, it was not possible to identify the RNA at high resolution. The low resolution neutron crystallographic study on this virus is continuing and should be able to transform the spherically averaged model into a true 3-dimensional one. Major advances in this field during the last year have been made due to extensive software and hardware developments to the instrument D17 allowing automatic collection of crystallographic data.

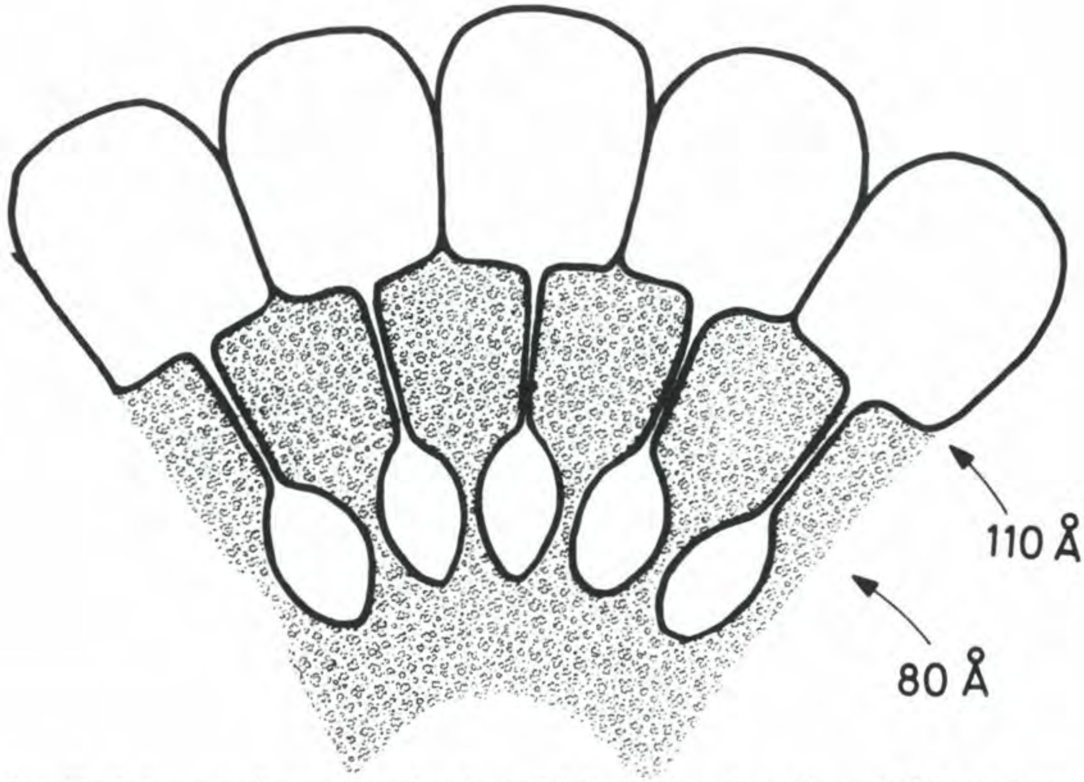
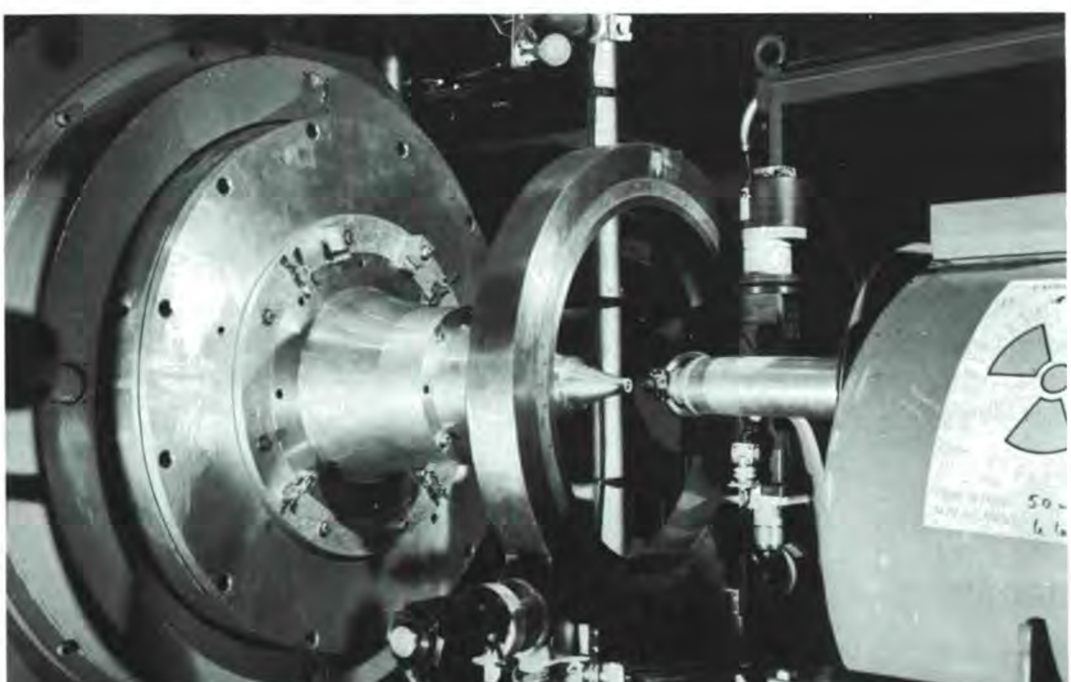


Fig. 15: Schematic diagram showing the radial distribution of protein and RNA in tomato bushy stunt virus as determined by low angle neutron scattering from solution. (from Chauvin, Jacrot + Witz, J. Mol. Biol (1978) 124 641-651).



Close up view of the low angle scattering instrument D17 as modified for collecting low resolution crystallographic data. These modifications include the provision of an automatically controlled Eulerian cradle & very thin quartz windows on the collimator and detector apertures to reduce background scattering.

A contrast variation study of single crystals of nucleosome core particles has just been started by J. Finch (Cambridge), A. Lewit-Bentley (ILL) and P. Timmins (ILL). First results indicate that, to 25 Å resolution, the data are of a quality comparable to those obtained from X-rays, and that use of the contrast variation method should provide new information on the DNA-histone interactions.

Experiments by Torbet (Max Planck Inst., Grenoble) and Marvin (EMBL, Heidelberg), on the gene-5-protein-DNA complex of the fd bacteriophage have shown that each protein sub-unit interacts with 5 DNA base pairs and that the DNA is embedded inside the particle. They have also shown that the helical sub-units of the bacteriophage pf1 can reversibly change their pitch along the axis of the phage as a function of temperature. This may have important implications for the mode of action of the phage.

Another important field of research is lipid-protein interactions in which several significant advances have been made. A study by Charles and Semeriva (Marseilles) in collaboration with Chabre (CENG) on the interaction of colipase with bile salts has established the geometrical organisation of the enzyme-salt micelle complex. Preliminary experiments on nerve myelin containing deuterated choline have been carried out by D. Worcester (QEC, London) in collaboration with the group of E. Oldfield (University of Illinois), which should provide information on lipid asymmetry with respect to the inner and outer surfaces of the membranes. Some valuable work on the determination of membrane thicknesses has also been carried out by Sadler (Bristol) and Worcester.

In the field of high resolution single crystal diffraction, the work on lysozyme by G. Bentley and S. Mason is progressing well. A high quality data set now exists and analysis is under way. A large effort has gone into the implementation of programs for the structure refinement and first maps showing tentative hydrogen atom positions have been produced. In an experiment on vitamin B_{12} co-enzyme, by J. Finney and P. Lindley (Birkbeck College, London) in collaboration with P. Timmins, data were collected to a resolution of 0.95 Å on a single crystal grown from D_2O. Refinement of this structure will enable a detailed description to be made of the water structure associated with the molecule for comparison with predictions made from theoretical calculations on the interactions of water with biological macromolecules.

The biochemistry laboratory has been widely used in the past year and has been vitally important in the success of several experiments. The constant activity of College members has been an important factor in the maintenance and functioning of this laboratory.

seminars

The College has been stimulated by a series of monthly seminars with speakers (both from the ILL and EMBL) on a wide variety of topics. In addition many informal meetings have allowed fruitful discussions to take place on a wide range of problems.

College Secretary: P.A. TIMMINS

college 9 "chemistry"

members of the college

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Beaufils J.P.		Lechner R.	
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Bomchil G.		Leslie M.	
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Dianoux A.J.		Richardson R.	(Univ. Exeter)
Duplessix R.		Riekel C.	
Ghosh R.		Soubeyroux J.L.	
Haas J.		Tabony J.	
Harris N.		Thorel P.	(CENG)
Hayter J.		Tomkinson J.	
Heitjans P.	(Univ. Heidelberg)	Volino F.	(CENG)
Jacrot B.		Wright A.	
Jenkin G.			

general summary

Polymer science continued to make a major contribution to the activities of the Chemistry College in 1978. The demand for beam-time for small angle neutron scattering from polymers still far exceeds supply even with routine operation of D17 taking the burden of the higher Q-range measurements. The spin-echo spectrometer is now in routine operation. Early experiments on polymer dynamics by two groups in the field of small angle inelastic coherent neutron scattering indicate that this technique will be very useful in the polymer field. Molecular spectroscopy continues along well established lines with measurements of model compounds for the interpretation of heterogeneous catalysis studies, and with increasing activity from French groups studying hydrogen-bonded compounds. Since the IN4 detector bank has been tilted about the sample position allowing measurements at low scattering angles on both sides of the direct beam, more complete studies of inelastic scattering from molecular fluids can now be performed. Studies of tunnelling transitions on both molecular crystals and adsorbed species by high resolution incoherent neutron inelastic scattering, and the use of quasi-elastic neutron scattering to study dynamic disorder and diffusion in plastic crystals and clays and intercalates continues to give exciting results and maintain a high degree of interest. In the field of physical chemistry of surfaces and adsorbed layers the complementary techniques of neutron diffraction, small angle neutron scattering, neutron quasi-elastic and inelastic scattering together with nuclear magnetic resonance are now being used together to obtain the maximum of information about systems whose structure and dynamics were practically unknown a few years ago.

instrument usage by the chemistry college

Polymer science at the ILL is dominated by work on the SANS instruments D11 and D17 for which the time demands are increasing, due in part to work on orientated (anisotropic) systems for which counting times are often more than ten times higher than for isotropic systems. Work on polymer dynamics is, however, increasing from a low level of activity with the use of IN11. IN1 in the beryllium filter mode and IN4 are principally used in the college for molecular spectroscopy, and the college uses about one half of the total allocated time of IN5 and IN10 for inelastic and quasi-elastic studies.

TABLE IX
PRINCIPAL INSTRUMENT USAGE BY COLLEGE 9 (DAYS)

Instrument	Total time available for all colleges (days)	Time requested (days)	Time allocated (days)
D11	182	83	50
D17	191	50	37
IN1	166	108	60
IN4	177	220	101
IN5	179	195	71
IN10	190	155	81

scientific trends and highlights of 1978

1) Polymers

In 1978 a redistribution of the various interests has appeared. The amount of small angle neutron scattering work performed on single polymers in solution is diminishing but remains of interest in the cases of partially labelled chains (ILL) and polyelectrolytes (Saclay, Mainz). Interest is increasing in microemulsions and micelles (Nancy, Strasbourg) of various polymeric systems with new teams turning to neutron scattering studies. More groups are now concerned with oriented structures caused by stretching in both crystalline and amorphous polymers. New work has also started on the morphology of ionomers. Overall, due to the diversity of the subject, there is a steady increase in the number of teams participating in small angle neutron scattering on polymers, although the field is still dominated by three large groups. The first neutron time-domain studies of polymer dynamics in dilute solution were performed on IN11 in the spring by the Imperial College group (09-02-207). These and other experiments by the Jülich/Mainz group (09-02-205) have confirmed the early promise of the method as a tool for polymer studies. Results from the work are shown in Fig. 16.

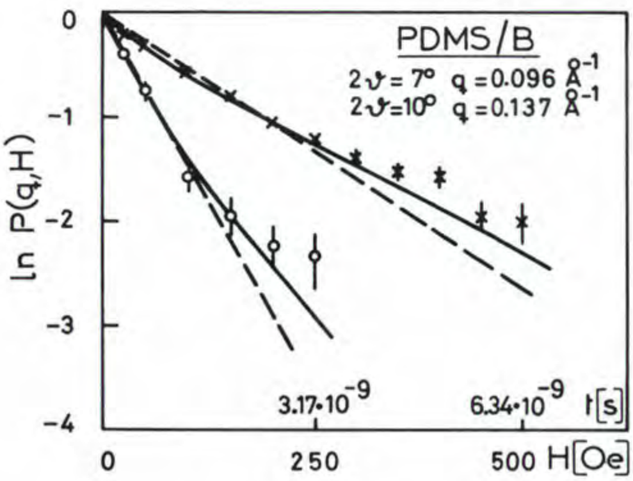


Fig. 16: Polarisation ln P(q,H) as a function of magnetic field H corresponding to time t. Solid lines: Scattering law as calculated by Dubois-Violette et al; Dashed line: exponential decay function.

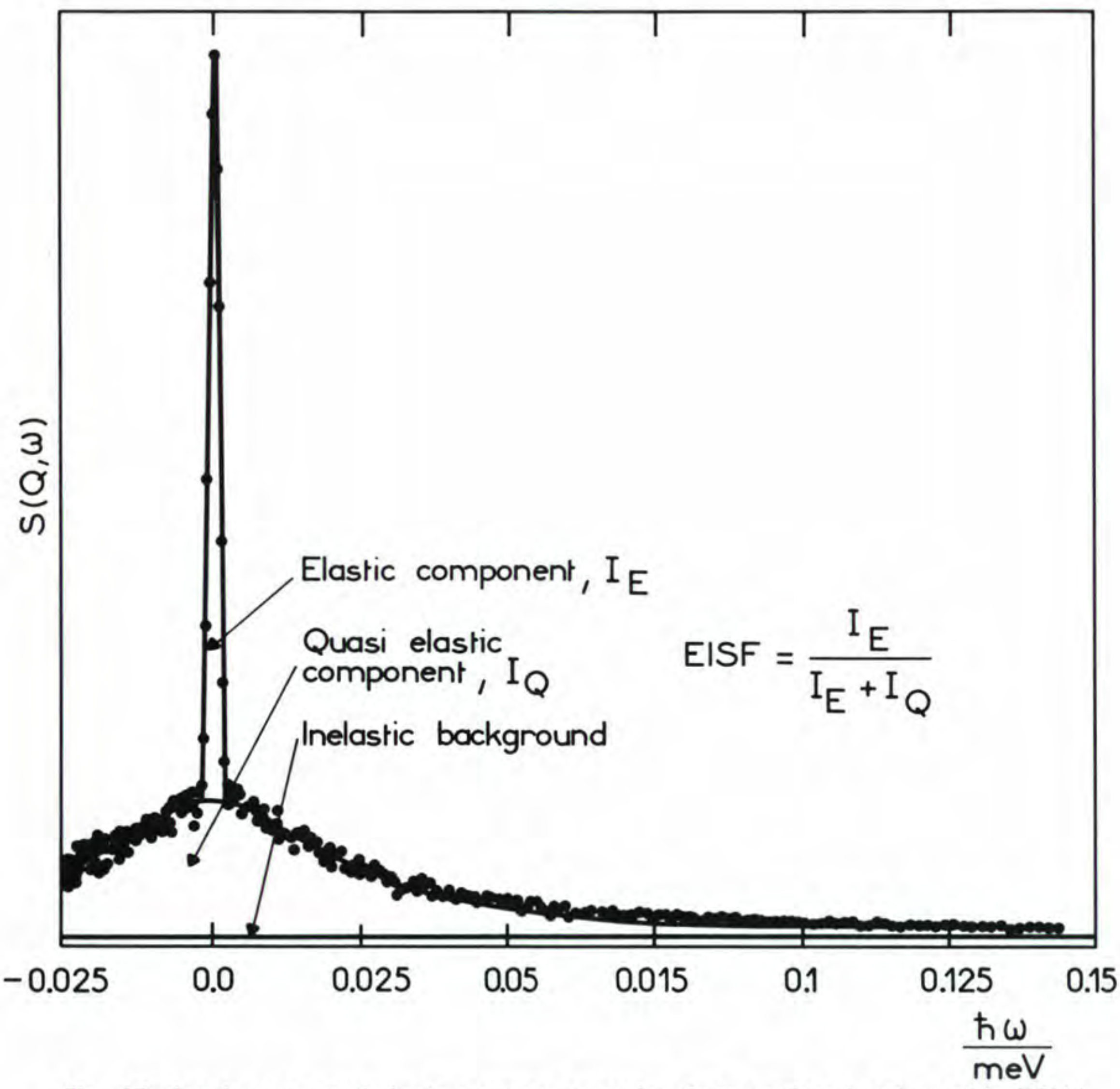


Fig. 17: Incoherent quasi-elastic neutron scattering from tertiary butyl cyanide [$(CH_3)_3$ C.CN] as measured using IN5.

2) Molecular spectroscopy

The technique of incoherent quasi-elastic scattering was successfully applied to several problems concerning molecular rotation in the solid state. The measurement of the elastic incoherent structure factor (EISF) of succinonitrile (using IN5) has permitted the determination of the time scale of molecular reorientation and rotational isomerisation which are strongly coupled. In the cubic high temperature "rotator" phase of NaOH the molecular rotation of the OH^- was found to be clearly intermediate between isotropic rotational diffusion and rotational jump diffusion. The structure and dynamic disorder of tertiary butyl cyanide have been studied in detail. EISF calculations show that in phase 1 at 270 K the molecules undergo rotational diffusion about the C-CN axes, which gives an elastic peak and a broadened contribution to the quasielastic spectrum as shown in Fig. 17. At lower temperatures (phase II) the molecules reorient about their C-CN axes between 3 sites with a gradual change in structure and dynamics through the phase transition. In both phases it is shown that methyl groups rotate about their C-C axes but at a slower rate than the whole body rotation. A series of fine experiments have been performed on IN3, IN5 and IN10 in order to get detailed information about the tunnelling motion of the CH_3 group in MDBP and metal acetates. The temperature dependence was measured with high accuracy to test a stochastic model for the dynamic averaging of the splitting of the thermally occupied states. The torsional spectra of MDBP measured on IN3 exhibit doublet structure where one component is broadened. This unexpected result shows that high resolution torsional spectroscopy offers very detailed information on molecular motions at low temperatures. The pressure dependence of the tunnel splittings will soon be explored to probe the shape of the hindering potential.

3) Surface chemistry

Rotational tunnelling transitions of methane adsorbed upon the surface of graphitized carbon black have been observed in incoherent neutron inelastic scattering. Two transitions are observed at 58 μeV and 108 μeV which arise from a barrier to rotation about axes parallel to the surface. Rotational diffusion occurs about axes perpendicular to the surface. The tunnelling spectrum broadens both with increasing temperature (Fig. 18) and with the addition of a second adsorbed layer, when an inelastic component appears corresponding to a hindered rotation. The interaction of minerals and clays with water and organic molecules continues to be explored by measurements of quasi-elastic broadening and by diffraction. This work by several groups is of importance in understanding the role of catalysts in organic chemistry, and the behaviour of organic molecules in a soil environment. Small angle scattering studies of sodium laurate adsorbed upon a colloidal solution of polystyrene balls, and of non ionic surfactants adsorbed upon polystyrene latex have advanced well. Using contrast variation detailed information is gained about the structure and thickness of the adsorbed soap layer as a function of temperature and concentration, which cannot be obtained by other methods. Adsorbed layers of NH_3 on graphite and H_2O on AgI studied by diffraction and quasi-elastic measurements have given very detailed results about the structure and dynamics of the adsorbed phases. Above the bulk melting point 193 K, NH_3 forms a fluid layer on graphite with rapid 2 dimensional and rotational diffusion. Below 193 K clusters begin to form which at lower temperatures lead to desorption of the NH_3 to form crystallites. An equilibrium thus exists between

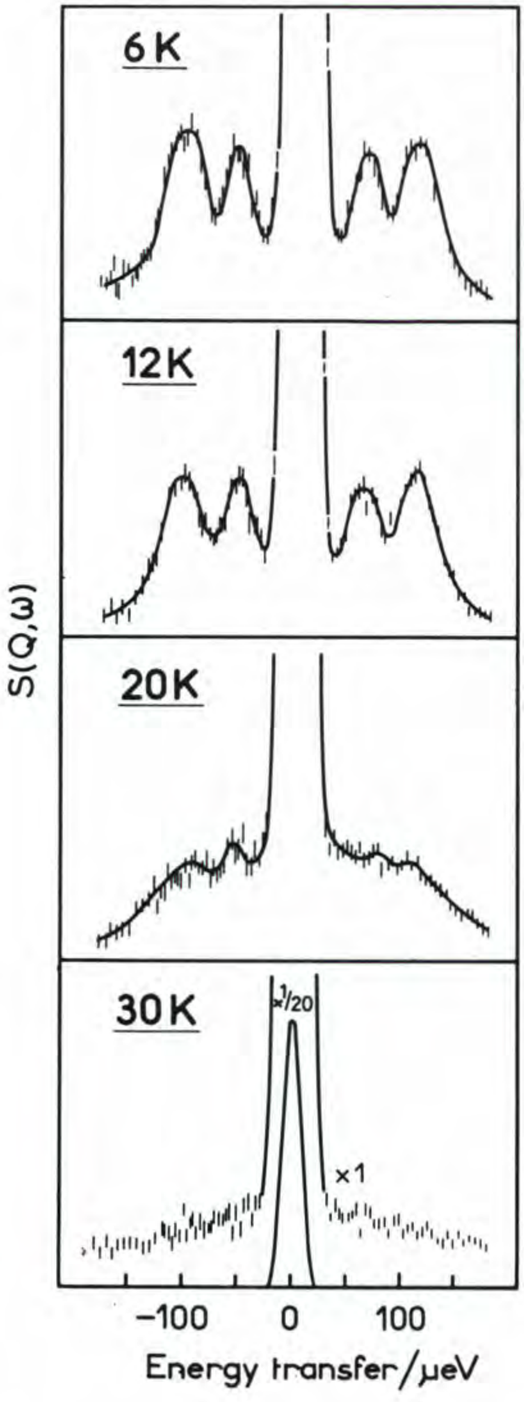


Fig. 18: Tunnelling spectrum of 0.7 layers of CH_4 on Vulcan III at various temperatures.

the bulk solid and the adsorbed liquid. It is probable that heterogeneous nucleation arises from the cluster formation in the adsorbed fluid state.

Satisfying results have been achieved in the use of force field calculations of the model compound $C_6H_6Cr(Co)_3$ for the interpretation of chemisorbed benzene on Raney nickel. Taking a new evaluation of the force field of $C_6H_6Cr(Co)_3$ good agreement with the neutron spectrum was obtained which in turn has enabled the observed neutron intensity data of chemisorbed benzene to be understood. For the chemisorbed benzene the stretching force constant V(c-c) is reduced by 10 per cent, and Kekulé ring interaction by 15 per cent. The physical picture is of a flat benzene molecule situated at 1.5 ± 0.5 Å from the metal surface. The relatively high value of the force constant Ni-C of 1-mdyne $Å^{-1}$ indicates that the molecule is strongly attached to the surface. 20 % of the benzene molecules are decomposed by the strong Ni interaction as shown by appreciable scattering measured between 800 and 1200 cm^{-1} attributed to Ni-H bonding.

seminars and workshops

Prof. I. Mills (Reading) gave a seminar on high resolution I.R. spectroscopy entitled "The very low frequency vibration of the carbon sub-oxide molecule". An entertaining seminar was given by Prof. R. Hoppe (Giessen) on synthetic problems in inorganic chemistry.

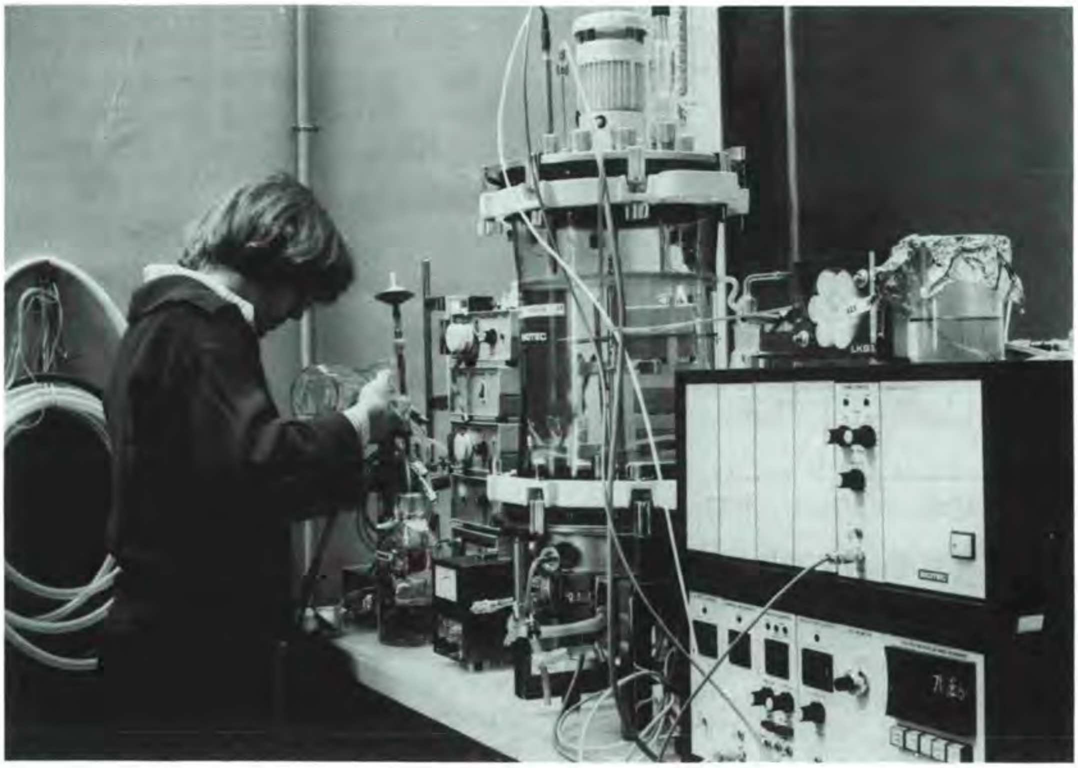
A workshop on the dynamics of molecular crystals organised by colleges 4 and 9 attracted a large international participation in the week of the October 1978 Scientific Council.

Secretary: A. WRIGHT

european molecular biology laboratory, grenoble

The arrival of several new users this year brought the total of user-groups in the EMBL facility to 18. These biologist-users originate from 7 countries. The distance between the EMBL and the neutron guide hall of ILL has made it desirable to place some more equipment such as the Density-meter in the ILL itself and thus help the ILL in-house group at the same time. Given the number of biology proposals at ILL, it is likely that the number of biologist-users at EMBL has reached a plateau for the moment. The in-house staff of EMBL has also now reached its statutory complement.

The important new addition to the laboratory this year has been the deuteration facility. This is now underway and deuterated bacteria (E.coli) have been requested for the major project on the 50 S subunit of bacterial ribosomes. In-house EMBL projects on chromatin structure, virus structure and a structural analysis of key steps in protein synthesis are also in progress, often in collaboration with groups from other laboratories. The deuteration facility should extend the value of neutron scattering to these projects.



Work at EMBL: Fermenter used in the growth of deuterated bacteria. This permits experiments on selected macromolecular components of the bacteria.

Gel chromatography columns used in the separation of biological macromolecules.

The research program on connective tissue continues. The one-dimensional structure which is understood in some detail is being extensively exploited. Low-angle X-ray diffraction revealed a stage intermediate between uncalcified and fully calcified tendon. The interpretation of these 'intermediate' patterns strongly suggests that the process of calcification involves a specific nucleating site in the collagen 'gap' region and is not simply a non-specific filling of the gap with calcium phosphate. The process of mineralisation of connective tissue is central to both normal development of animal frameworks and in pathological states such as arthritis and arteriosclerosis. The X-ray diffraction patterns from the annular fibrosus of intervertebral discs have been greatly improved in the past year by taking account of the microanatomy of the disc. Diffraction data are being obtained from purified Type II collagen (in collaboration with D. Herbage, Lyon) in order to investigate the protein-proteoglycan interaction in cartilage.

The three-dimensional molecular arrangement in tendons is still unknown. This is being investigated by a combined X-ray/Electron microscopy approach. Medium angle X-ray diffraction is being used to monitor the effects on the native molecular arrangement of fixation, staining, dehydration and embedding. The aim is to preserve the native structure through the preparative procedures for electron microscopy and finally visualise the transverse lattice by electron microscopy. The results of this project are likely to be of general value in developing preparative techniques in electron microscopy.

Application of Brillouin scattering to biological fibres is still being developed and has now been applied to collagen, bone, silk, α-keratin and feather keratin. In 1979 it is planned to start Rayleigh scattering.

Progress has been made in the initial attempts to determine the amino-acid sequence of the rod portion of the myosin molecule from muscle. Techniques have been developed for the large scale preparation of total rod (TR), light meromyosin (LMM) and subfragment I (SI) from rabbit skeletal muscle myosin. Isoelectric focussing in urea has emerged as the best method for purification of high molecular weight fragments. Specific cleavage of TR and LMM at bonds involving cysteine has been achieved using the cyanolation reaction.

A. MILLER

4

technical department

introduction

The Technical Department is responsible:

1) for support to the scientists in preparation of technical and financial studies of new projects or major modifications. It is also the function of the Project Office to provide technical co-ordination and financial follow-up during construction;
2) for the design, construction and handling of all mechanical systems, an important part of which is the basic structure of scientific instruments. This is the field of the Mechanical Construction and Maintenance Section;
3) for the mechanical, sheet-metal and special products workshop, the construction, equipping and maintenance of buildings and installations, through the Workshops, Fittings and Maintenance Section.

project office

The table below shows the proportion of the scientific investment budget devoted to instrument improvements or to new instrument projects.

TABLE X
INVESTMENT FOR INSTRUMENT IMPROVEMENTS OR NEW INSTRUMENT PROJECTS

	1977	1978	Estimate at 24.11.78
1. For current improvements to instruments in operation	44.5 %	43 %	Including CARINE (200 KF)
2. For completion of instruments (IN12, D18, UCN source)	25.8 %	6 %	
3. New instruments or projects (D19, IN6, IN13, S3, D10 Spin Echo) and major work caused by H24	11.5 %	39 %	
4. Miscellaneous			
Cryostat pool, work on Safety, background noise	18.2 %	9 %	
Preparation studies for the modernization programme		3 %	

A comparison with 1977 shows:

- the number of modifications and improvements effected on instruments in operation (approximately 30), the cost of which each year is equivalent to or higher than that of a new instrument;
- the great effort made in 1978 on new projects, due partly to a reduction in this field in 1977 due to lack of funds and partly to the need to strengthen certain technological fields (multidetectors, supermirrors, Spin Echo techniques) with a view to the modernization programme.

The commencement of studies for the modernization programme (essentially for the replacement of the cold source).

In 1978 the Project Office was guided by the following basic ideas:

1. The urgency of the start up and tests of the new triple axis instrument IN12, because of the implications of the results of these tests for the technical options for future triple axis instruments (duration and simultaneity of positioning adjustments) and for the Interferometer D18.

2. The development of technologies on which the instruments of the next generation are based. An evaporator permitting the automatic production of multilayers and their continuous testing on a neutron beam should start operating at beginning of 1979.

3. The need to improve conditions of use of the thermal guides (better flux distribution, improvement of shielding for the reduction of neutron background noise). A complete reconstruction of the guide H24 will make it possible to improve the flux available on IN3, and at the same time to install the new high resolution spectrometer IN13 and a test area for the future multidetector diffractometer D19.

   At the same time, considerable improvements were carried out on the high resolution diffractometer D10 affecting its shielding, mechanical operation, and data control and acquisition.

   Major instrument movements are planned for the future if this new use of guide H24 proves to be efficient.

4. The urgency of defining the future distribution of the instruments on the thermal guides, the study of which is related closely to the urgency of the reconstruction of IN1 and to certain important options under the modernization programme.

5. The optimization of the conditions of use of alpha-emitter samples on the fission product mass spectrometer PN1.

6. The need to initiate replacement studies to the cold source. This replacement will be accompanied by a considerable gain in comparison with the present cold guides and by the installation of a new ultra cold neutron source.

7. The need to provide efficient technical support for the special experiments (in 1978 the neutrino detector).

mechanical construction and maintenance section

The main activities of the section are:

Assistance in certain specific work connected with the operation of instruments and in particular the quest for improvements in connection with maintenance.

Design and construction work for adapting particular experiments to existing instruments.

The design and construction of new instruments and the extension of beam instruments.

Technical investment by examination of new solutions suitable for new instruments with the view to a greater reliability and increased standardization of components.

Among the major work in the first category of activity are:

IN8 with the installation of automatic diaphragms, the improvement of collimator supports with the view to interchangeability and more efficient protection against background noise;

IN3 with a more homogeneous monochromator shielding, permitting a larger useful beam;

D11 and D17 using selectors of respectively 10 % and 4 % resolution with frictionless seals and new safety devices making preventive maintenance more efficient.

As regards work on the structure of existing instruments:

The use of a standardized chopper on PN5.

The adaptation of the support for the superconducting coils on D3.

The installation of a new goniometer more suitable for cryostats on IN2.

This ILL prototype permits X, φ angles of $\pm 20°$, and two others are under construction for IN8 and IN12.

As regards the activities related to new experimental instruments, the following may be mentioned:

The installation of mechanical second phase assemblies for IN6, i.e. monochromator and experimental platform on H15;

The commissioning for IN12 of a new control system for vertically mobile blocks for the monochromator shielding heads;

Construction of a platform for installation of electronic control racks for experiments at the end of guides H22, H23, H24;

The installation of the new guide H24 with the new experiments (monochromator zone) IN13, D19, D10, S21, D13.

The displacement of the IN4 detection system to permit small angle measurements.

Among the technical investments we have carried out:

Examinations of the changes at low frequency in the D18 interferometer bench [f = ($\sim$ 0.5 to 0.7 Hz)].

Construction of choppers under vacuum with use of frictionless seals for D7.

Stability measurements of new skirts for high powered aircushions, used for sample handling equipment.

Commissioning of the D17 4 % selector using differential joint technique.

Tests on pins suitable for fast chopper pivots; these pins use mixed aerostatic and aerodynamic systems.

The speeds of 40,000 rpm achieved correspond to linear speeds of 80 m/sec. A detailed analysis of the transitory and damping modes is in progress.

The overall activity of the ILL design office can be analysed as follows:

Work on experiments: fitting, improvements, maintenance of 12 instruments. 2,660 hours, on 650 of which there was external assistance.

Studies for completion of instruments under construction (IN12-D12), corresponding to 1,676 hours, 336 of which were sub-contracted.

New installations such as the new guide required 4,330 hours of work, including 1,950 hours of external work.

The new instruments IN6 and IN13 required 2,700 hours; 300 hours were devoted to miscellaneous developments.

This gives a total of 9,766 hours, 3,956 of which were sub-contracted.

mechanical construction

1. the mechanical engineering and sheet-metal workshops

permit the ILL to make a considerable part of the items required for experiments with its own facilities. With 7 productive staff they provided approximately 10600 hours of work, which satisfied 320 requests for work of a duration of 1 day or more. Of the requests recorded, 63 % were for the experiments, 20 % for the reactor and 17 % for general requirements. Work on experiments was based on design studies of the Mechanical Construction and Maintenance Section. Approximately 28 % of the potential time of these workshops was devoted to small non-recorded jobs, for which there was no design, generally urgent, but which are the secondary function of the workshops.

The facilities of the two ILL sheet-metal workshops (main workshop and Construction and Maintenance workshop) are being reorganized to permit more effective use of staff and machines.

2. the "self-service" workshop

has confirmed its great value in complementing the small workshops near the instruments.

This workshop, with 3 lathes and 3 milling machines, was used this year by an average of about 10 technicians a day. The quality and accuracy of the parts produced bear witness to the experience of the staff and the usefulness of this system. The stock of machines is fully utilized, and its extension and replacement are in progress. The possibility is under consideration of having a second staff member in this workshop, to advise users, sharpen tools and do work himself. An extension of the equipment of this workshop for small sheet-metal and welding jobs is at present under consideration.

3. the "special products" workshop,

with 1 part-time employee, has continued to produce the usual radioprotection material and neutron absorbents. The work is in the form of moulding, sintering, glueing or painting.

4. the "primary materials" store,

operated and controlled by the Administration and Finance Department, is now physically part of the ILL general stores.

fittings and maintenance

The activities of this group are in the following fields:

1. Design studies, follow-up of construction work by external firms on major work such as:

   Construction, equipping and re-installation of the new general stores.

   Conversion of the former stores into a maintenance workshop for the increased stock of vacuum parts.

   Construction of a central conference room on the second floor of the main building, permitting an increase of 2 offices at the front of the building.

   Construction of 2 offices on a roof terrace area of the main building.

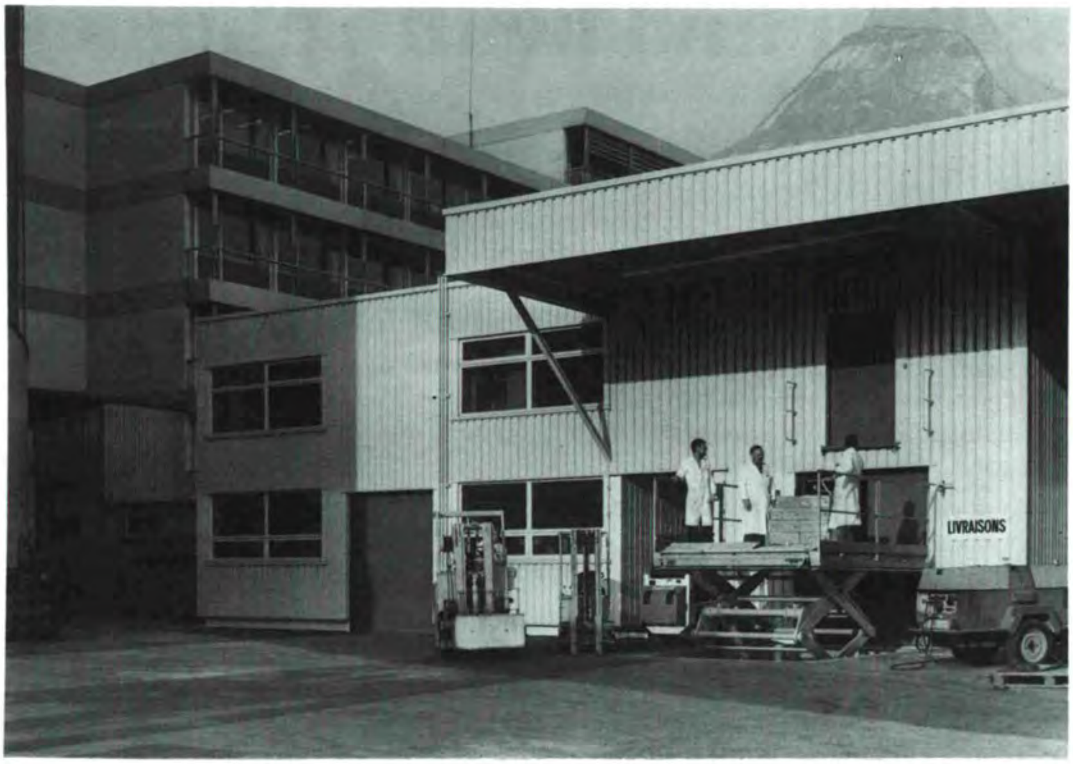
2. Completion by ILL staff of all or part of the additional fitting work involved.
3. Miscellaneous equipment on the experiments, as requested by scientists.
4. All handling and transportation within the ILL and to some extent outside (Grenoble, CENG).
5. Maintenance and repair of the general technical facilities.

   This sector represents an increasing load because of the very noticeable general aging of the installations.

6. Ensuring that installations conform with the safety regulations, and work to improve safety conditions in general.
7. Cleaning and general maintenance of buildings, lawns and roads by external contracts.
8. Organization and maintenance of furniture for the whole Institut.
9. Basic studies for the resolution of problems of rooms (offices, laboratories, workshops) raised by the increase in scientific and technical activities at the ILL.

Rooms for the medical service, decontamination or 'nuisances' workshop, cafeteria and reception for guest scientists, dispersion of rooms for experimental technicians, general storage facilities.

The increase in the workload of the fitting and maintenance section and the delay accumulated in the past have led to a considerable increase this year in the use of external staff working in groups of ILL staff: on an average, 5 persons in 1978 in comparison with 2 In 1977.



Extension to the general stores, showing external goods lift.

safety and health physics section

The section has taken action at the various levels where safety is involved: assessment of working conditions, monitoring of intervention work, control of risks.

assessment of working conditions

The section has taken part in safety analyses carried out in connection with the use of radioactive products and dangerous materials, in connection with modification to the installations, and the assessment of conditions of intervention work in a radioactive zone.

Various workplaces have been studied for noise, lighting, etc.

monitoring of intervention work

Health physics staff have monitored work carried out in radioactive zones. Additional shielding has had to be installed, because of the increase in radioactivity in the installations due to aging. Particular reference should be made to the modification work in the detritiation building, the decontamination of the D_2O exchangers and the intervention work in the swimming pool, which is referred to elsewhere.

During 1978 we have had to deal with an increase in the number and scale of decontamination operations. There is a significant increase in the waste products and in their activity. This development makes it necessary to reconsider the facilities required.

control of risks

The control facilities have been adapted to the development of the ILL experimental programme, characterized by the use of alpha emitters. The safety circuit in the reactor hall has been supplemented by a loop permitting monitoring of alpha contamination in the vicinity of the instruments where transuranians are likely to be used.

The permanent monitoring of the chimney gases has been supplemented by measurements of alpha emission.

The health physics laboratory has been equipped with an alpha spectrometry device.

There has been no significant change in individual film dosimetry, approximately 6000 films distributed; on the other hand, environment dosimetry has increased by 20 %.

remote monitoring

The remote monitoring network has been modernized, as regards handling of alarms, and extended to reduce response times in case of accident.

The training and information of staff on safety problems have been mainly directed towards newcomers.

In addition, at the request of the Technical Department, the section has carried out neutron flux measurement by activation of gold foils placed in the experimental instruments (126 detectors were used in 1978).

5

reactor operation department

reactor operation in 1978

The system of operation used since 1975 has been maintained. The programme planned for 1978 was for 264 days of reactor operation, divided into 6 cycles of 44 days of continuous operation, each followed by a shut-down of 12 days allowing the fuel element to be changed and certain minor work to be carried out. There was also a shut-down of about 5 weeks in the month of October allowing major maintenance and reconstruction work to be carried out on the reactor and the instruments.

actual timetable

CYCLE 1-78 Commenced Wednesday, January 4th, ended Friday, February 17th. The scheduled dates were maintained. There was no incident during the cycle.

CYCLE 2-78 Initially scheduled from Tuesday, February 28th until Thursday, April 13th. However, the reactor was shut down on two separate occasions (Tuesday, March 7th and Friday, March 17th), as the result of a strike, resulting in a poison-out in both cases. The operating time lost was recovered almost entirely by delaying the end of the cycle until April 17th.

CYCLE 3-78 Commenced Tuesday, April 25th, ended Thursday, June 8th. There was no incident during the cycle.

CYCLE 4-78 Commenced Tuesday, June 20th, ended Thursday, August 3rd. There was no incident during the cycle.

CYCLE 5-78 Commenced Thursday, August 17th, ended Saturday, September 30th. There was no incident during the cycle.

ANNUAL SHUT-DOWN FROM SATURDAY, SEPTEMBER 30th UNTIL TUESDAY, NOVEMBER 7th

The work planned was completed satisfactorily.

The following items are particularly worthy of note: the replacement of two safety rods and the control rod, the internal examination of the reactor block with a television camera, the decontamination of the main heat exchangers, the replacement of the safety chambers by new models, the examination of the in-pile part of the neutron guides, etc.

CYCLE 6-78 Dates scheduled: from Tuesday, November 7th until Thursday, December 21st.

The start-up and the first part of the cycle were without incident. However, it should be noted that some light water entered the in-pile part of the neutron guides causing a reduction of flux on the thermal guides for several days until the water could be completely evacuated. This cycle was interrupted from Friday, December 1st due to a fault occurring on the Cold Source.

The reactor started up again on Friday, December 8th.

On 19 December a general failure of the French high-voltage power supply caused a further reactor shut-down with Xenon poisoning. The reactor started up again on 21 December, and the end of the cycle was postponed until 30 December, which obviously involved the operation of the reactor over the Christmas period.

data for 1978

— Number of days originally scheduled	264
— Actual number of days of operation	262.6
— Actual operating time (Equivalent days at full power)	256.2
— Actual operating time in relation to time scheduled	99.5 %
— Actual operating time (percentage of year)	71.9 %
— Number of fuel elements used	6
— Number of fuel elements actually despatched for reprocessing	7
— Number of unscheduled shut-downs	12
— Number of shut-downs with Xenon poisoning	4

In spite of the two shut-downs in December, the reactor operation can be regarded as satisfactory since three cycles out of six were completed without any unscheduled shut-downs. The prolongation of the two interrupted cycles allowed the operating time lost to be almost entirely recovered.

analysis of unscheduled shut-downs

The definition remains the same as in 1977. A significant reduction in unscheduled shut-downs may be noted (38 in 1977, 12 in 1978). This is partly due to progress in the more sensitive areas, and partly due to the absence of external incidents such as mains power cuts.

There were four shut-downs not followed by an immediate restart. The first two shut-downs were due to a strike rather than to a technical fault. The third shut-down was due to a fault in the Cold Source and is analysed elsewhere.

The fourth shut-down was due to a national failure of the high-voltage network. The emergency diesels operated correctly, but their function is to provide a supply for the safety systems, and not to provide the power necessary for normal operation of the reactor. If such incidents are repeated it would be necessary to consider the installation of equipment to provide an alternative supply if there is a failure of the external power supply.

operation of the sub-assemblies

The detritiation plant has operated according to the needs of the HFR (maintenance of the tritium content of the heavy water below 3 Ci/dm^3). In addition, part of the time available has been used for processing of tritiated water from outside the ILL. One of these contracts has made it possible to demonstrate the capacity of the installation to supply heavy water with a very low tritium content ($<$20 mCi/dm^3).

The Hot Source has continued to operate satisfactorily.

The Cold Source operated without incident until the beginning of the sixth cycle, at which point the significant leak detected on the cooler of one of the two helium compressors caused a shut-down of seven days for repairs, drying-out and starting-up again.

It will only be possible to establish the causes of this leak after replacement and examination of the faulty exchanger.

major work and modifications

Safety rods: Examination of the safety rods placed in October 1977 and in January 1978 has shown that the nickel coating was not sticking perfectly. A study is going to be carried out to try and remedy this problem.

After the replacement of three safety rods in 1978 and one in 1977, the oldest (installed in July 1974) will be replaced at the beginning of 1979.

This will necessitate buying a set of absorbents so as to have available for any eventuality a complete replacement set of absorbents.

Pneumatic tubes: The pneumatic tube V5 was dismantled and a new tube was ordered, received and installed during the October shut-down.

The pneumatic tube V3L was taken out of service after the containers had jammed a number of times.

The tube V3C which had not been used since the construction of the reactor was installed instead of V3L, thus allowing a rapid restart of the pneumatic system.

Neutron guides: Examination of the in-pile part of the guides has shown the damage suffered by the glass parts subjected to a high flux of neutrons. The replacement of these parts is being considered. This constitutes a major operation.

Control: A new container and new safety chambers have been installed, thus ending the modification of this part. This will bring about a significant increase in the life of this equipment leading to a reduction of the maintenance work necessary on this equipment in the swimming pool.

Circuits: Decontamination work carried out on the main heat exchangers has succeeded in eliminating more than 15 curies of Cobalt 60. This allows access to the equipment for various repairs and inspections to be carried out.

A test bench with small heavy water pumps has been installed. Positive results on the life expectancy of the pumps can now be hoped for.

The heavy water distillation plant has been decontaminated and will be able to operate again after repair work.

A new storage system which is being installed will permit the heavy water supply to the detritiation to be significantly improved as regards gamma activity. A new system for gaseous effluents is being installed in the neutron guide hall. It will start operation at the beginning of 1979.

Fuel elements: Seven fuel elements were sent to the reprocessing plant at Savannah River during 1978.

The use of two extra transport containers due in 1979 should eliminate the delay built up in the reprocessing of the fuel elements next year.

Detritiation plant: An important modification has been made necessary by the deterioration caused by the action of the tritium on the valves used in the plant. This modification is in progress, as are certain changes made necessary by the processing of considerable quantities of heavy water coming from outside the ILL.

Electricity: A group of accumulators is being installed for the electrical supply system for the computers. This system should ensure an extremely reliable electrical supply to the experiments.

general trend of gamma quantities and activities

The main cause of the rise in radioactivity in the heavy water circuits observed since 1976 has been discovered. It is due to nickel particles (containing cobalt) coming from the coating on the safety rods.

Due to the cleaning work carried out on the main heat exchangers and also to a great effort on maintenance carried out on the reactor block it is hoped to stabilise the total radiation received by the operating staff in 1979. Total radiation was appreciably higher in 1978 in comparison to 1977.

For 1978, the problem of coating the safety rods has resulted in important consequences as regards the gamma quantities and activity of the liquid effluents produced; also there are problems of contamination of the swimming pools, hot cells etc, resulting in the permanent use of masks for all work carried out on equipment in these areas.

6

computing and electronics department

1978 has seen significant developments in the scheme to provide each instrument with its own computer, and also the start of the project to replace the DEC-10 Central Computer.

However the steadily increasing quantity of electronics and other hardware has not been matched by sufficient resources for their support, and there is some concern over the maintenance of all this equipment in the future.

instrument control and data acquisition service

This Service is responsible for developments, improvements and maintenance of ILL electronic equipment, instrument control electronics, instrument computer systems and detectors.

The assignment of instruments to control systems at the end of 1978 was as follows:

In routine operation

CARINE systems (using Télémécanique T2000 computers)

CARINE 1:	D1B, D2, D5, D9
CARINE 2:	IN1, IN2, IN3, IN8
CARINE 3:	Stand-by

NICOLE systems (using Telefunken TR86 computers)

NICOLE 1:	IN4, IN5, PN1
NICOLE 2:	Stand-by

PDP-11 network (11/55 concentrator; 11/34 on each instrument): D7.

Free-standing PDP 11's (various types): IN10, IN11, D3, D8, D11, D17, PN2, PN3 (GAMS1), PN3 (GAMS2/3).

Other free-standing systems: D1A (Plessey Micro 1), D15/16 (PDP-8).

Under development and test

To be attached to PDP-11 network:	IN4, IN5, IN6, PN1
Free-standing PDP 11/34s:	IN13, D9, D10, D19
SOLAR 16/40:	IN12, D1B
Plessey Micro 1:	D18, S3

1 maintenance

CARINE computers showed a significantly lower failure rate in 1978 than in the two previous years. This appears to be the consequence of several factors: a thorough hardware overhaul, followed by the replacement of some memory, magnetic tape units and terminals, the freezing of the operational software, and the reduction of the load following the disconnection of D8. On the other hand, the control electronics continues to give cause for concern on some instruments, particularly IN8. It is planned that this will be replaced as quickly as possible.

NICOLE, which is nearing the end of its life, has also given little trouble, there having been only three instruments connected to it since the Summer.

The individual computer systems have, on the whole, continued to show good reliability.

Maintenance of general electronic devices still presents problems, but an increased budget has enabled a higher level of spares and equipment for loan to be held.

2 improvements (existing instruments)

The NICOLE Replacement project is entering its final phase. D7 was the first instrument to change over, during the Summer, with IN5 scheduled to follow at the end of the year. The remaining two instruments will change over early in 1979. It should be noted however that changeover usually takes place as soon as the set of facilities available is as good as that available on the old system. There is still much to be done in the domain of data inspection and monitoring if the potential of the new system is to be fully exploited.

CARINE replacement, although not an explicit project, can be considered to have started in 1977 with the transfer of D8, and has gained momentum in 1978. D1A was provided with a Micro 1 and left CARINE in November. The Micro 1 is a microcomputer based on the DEC LSI 11 microprocessor and thus can use the same instrument interface and software as a PDP 11. It is a very economical solution for an instrument which does not have complicated control programs. A PDP 11/34 is on order for D9, and since this will copy the D8 system, a smooth changeover is anticipated. For D10 (also using a PDP 11/34) the situation is more complex since the instrument is being rebuilt with a spin-echo option and new electronics. The other instrument imminently scheduled to leave CARINE is D1B. This has also been a difficult project, since being controlled by a Solar 16/40 there is a considerable amount of new electronics to be constructed.

A number of instruments have acquired improved peripherals. The Tektronix 4010 graphics terminal is becoming very popular for the on-line inspection of data. The control program for D11 has been modified to allow the wide-angle detectors (D11B) to be used with the multidetector (D11A) in the same experiment.

Additional detectors have been provided for IN4 and IN5, whilst IN11 now has a 400 channel analyser and the Eulerian cradle of D17 has been motorised.

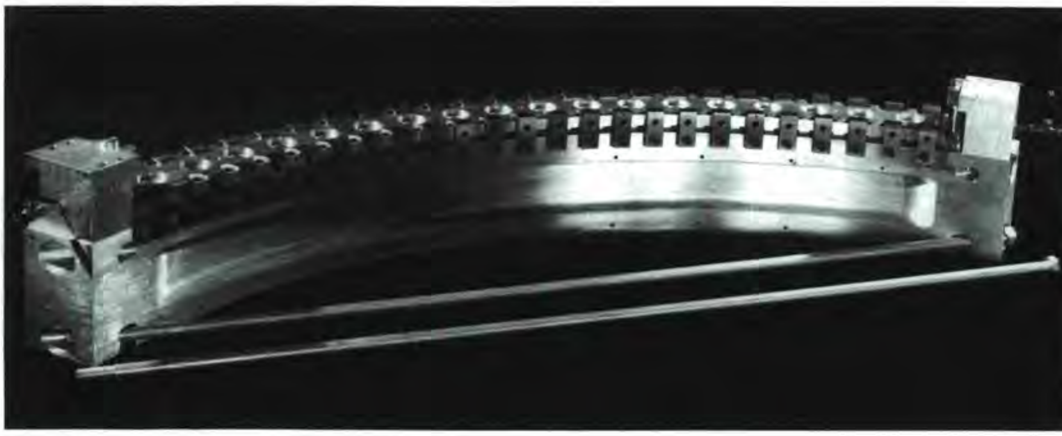
A 'multiparameter' system, comprising CAMAC controlled memory linked to a PDP 11/20 with magnetic tape units, is now available to support nuclear physics experiments of the multiple event coincidence type.

3 new instruments

The control system for IN12, based on a SOLAR 16/40, has been largely tested out off-line, but final tests have been delayed owing to mechanical problems on the instrument. This is the first of a new line of minicomputers which it is hoped to introduce more generally, and so far it has performed well.

In spite of considerable difficulties associated with its high pressure technology, the multidetector D19 is now nearing completion. The data acquisition system (PDP 11/34) is ready for the tests which should start shortly.

D18 has also made progress during the year. It has been decided that it should be controlled by a Micro 1, but retaining the Motorola M6800 microprocessor to drive the electronics.



Multidetector (to be mounted vertically) for D19.

Following the decision to automate the production of supermirrors, the evaporator, known as S3, is also being equipped with a Micro 1.

Support for the new time-of flight instrument, IN6, is under way. It will, in large measure, copy IN5, having a PDP 11/34 connected to the Network.

Following discussions amongst the scientists concerned, it has been confirmed that the control programs for the new backscattering instrument, IN13, should follow those of IN10, as far as possible, and a PDP 11/34 has been acquired. Control electronics for the monochromator and deflector is under development, special attention being paid to the temperature control of the monochromator.

4 studies, prototypes and long-term developments

The next backscattering instrument, IN10B, is foreseen to have a new type of Doppler device, known as the Bauer wheel. Electronics to support this are to be tested out on IN10.

Prototype work on new DC amplifiers has been started in order to use modular DC motor control in the LETI electronics.

Work is proceeding in collaboration with the Cryogenics Service to provide computerised control of cryostats. In the context of providing a comprehensive support service to the scientists, the development of various electronic modules continues.

In the field of detectors, several small one and two-dimensional multidetectors have been built and tried out on various instruments. Improved detector electronics has been provided, and the development of a faster multidetector logic system has been started.

Feasibility studies are also being started for a fast one-dimensional banana-type detector for surface studies and kinetic experiments, and for a large, fast, two-dimensional detector for protein crystallography. These projects pose challenging technical problems, and the latter one will also permit rates of multi-channel data acquisition not previously encountered.

central computer service

1 operations

The DEC System 10 Central Computer provides a general computing service for ILL scientists, and a data inspection service for visitors performing experiments at ILL. The system is in great demand, being fully saturated during the normal working hours and intensively used at other times. It is only the knowledge that it is hoped to replace it by something more powerful in 1980 that enables users to live with the access difficulties and inadequate resources.

With a limited lifetime in view, all enhancements to the configuration, however necessary they may seem, have been difficult to justify. The dilemma has been resolved by acquiring, wherever possible, second-hand equipment. In this way one disc unit, one magnetic tape unit, 8 terminal lines and a memory access channel have been added. This has enabled the Service to keep up with the growth in program libraries, and provide links to instrument control computers that lack data transfer media.

A new version of the TOPS-10 operating system (6.03) has been installed, but the virtual memory option has not been invoked because the configuration lacks a fast swapping device.

2 data handling

The organisation of storage of experimental data on the DEC 10 dates back to 1972, being designed exclusively for handling data coming from the CARINE and NICOLE systems. With the changeover to individual data acquisition systems and the introduction of new types of instrument it became evident that the time was ripe to make a change to a more flexible organisational structure. This has been a major task, since all access routines have had to be rewritten. One important change was to make the new structure independent of specific DEC-10 characteristics so that in the event of a computer of a different type being acquired the changeover would present fewer problems.

The amount of data being received from the instruments has not changed significantly, since no new instruments have come into operation during the year.

3 graphics

The Versatek electrostatic plotter is regarded as a most valuable tool, but the generation of the magnetic tapes to drive it is very time consuming. The Service's own efforts to improve the software were suspended when an improved program was received from Versatek. It is still foreseen that the best mode of operation will be to have the Versatek on-line to the PDP 11/55, receiving its data from the DEC-10 either by magnetic tape or direct link.

Another graph plotting device in great demand is the 'hardcopy' device attached to the Tektronix graphical displays. Intensive use has led to rather frequent breakdowns, and a second such device has been ordered.

4 general support for users

A new edition of the DEC-10 Users Guide has been produced, the first revision since it originally appeared in 1973.

Work to improve programming aids, and in various branches of applied mathematics has continued.

5 replacement of the DEC-10

The Service has been working to a timetable which foresees the replacement of the DEC-10 coming into operation in the Summer of 1980.

Discussions have taken place with possible suppliers, and several visits have been paid to recent installations in Europe whose workload resembles that of ILL. After intensive discussions with scientists' representatives on the likely changes in future computing needs, a technical specification was drawn up. In order to have an independent view, the Director appointed a Commission of three experts from appropriate national laboratories in the member countries to study the matter. They found themselves in broad agreement with the ILL as to the size of machine required, and made some very constructive supplementary remarks concerning the configuration and analysis of offers.

Thus the invitation to tender for a machine having a power of about 2.8 times that of the DEC-10 was sent out in September. At the time of writing, the offers are under examination.

A new building will be needed to house the replacement computer. Discussions on the design of this have proceeded under the guidance of Département Technique.

7

administration

personnel

The Personnel Section is responsible for the administration and payment of the ILL staff. This constitutes a very varied range of activities.

A certain number of subjects have been chosen this year to give an idea of the ILL staff, their length of service and age, salary changes, promotions and staff representation.

staff

The tables below show staff numbers for 31.12.78, the breakdown of staff into categories and nationality and also the increase in staff by nationalities from 1973 to 1978.

ILL staff numbered 417 on 31.12.78. This represents an increase of 20 in comparison with 31.12.76 and 2 in comparison with 31.12.77.

TABLE XI
STAFF SITUATION

Categories (1)	Position on 31.12.77 (2)	Changes in 1978		Difference + or − (5)	Position on 31.12.78 (6)	Change % column 4 compared with column 2 (7)*
		Recruitment and internal changes (3)	Departures and internal changes (4)			
1. Scientists	76	15	17	−2	74	22 %
2. Technical and administrative "Cadres"	60	2	4	−2	58	7 %
3. Thesis students	30	2	3	−1	29	10 %
4. Technicians	144	6	3	+3	147	2 %
5. Others	105	6	2	+4	109	1.5 %
TOTAL	415	31	29	2	417	7 %

* Percentage of ILL staff who left the Institut in 1978 in comparison with staff numbers for 31.12.77.

It is worth noting that the number of new arrivals (31) is approximately the same as the departures.

As in previous years the largest group of staff movements (50 %) is essentially due to the limited-term contracts of the scientific staff.

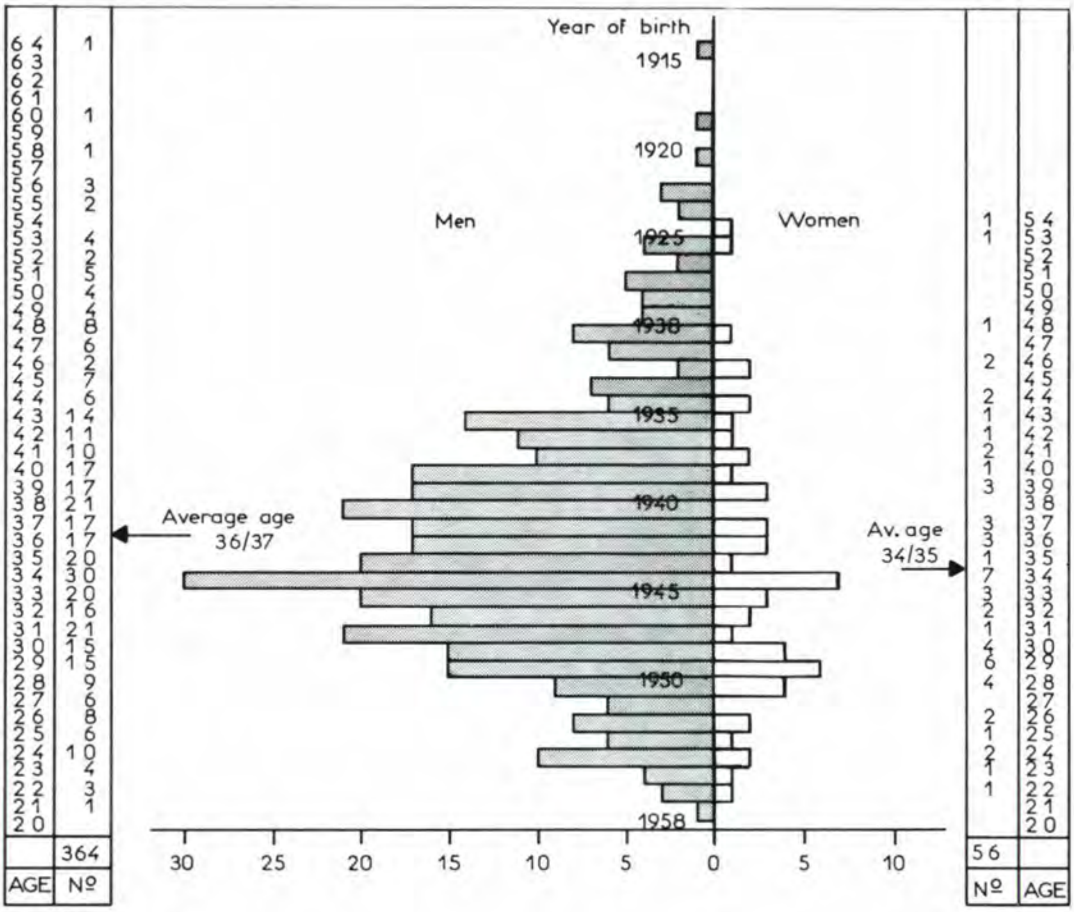


Fig. 19: Age Structure.

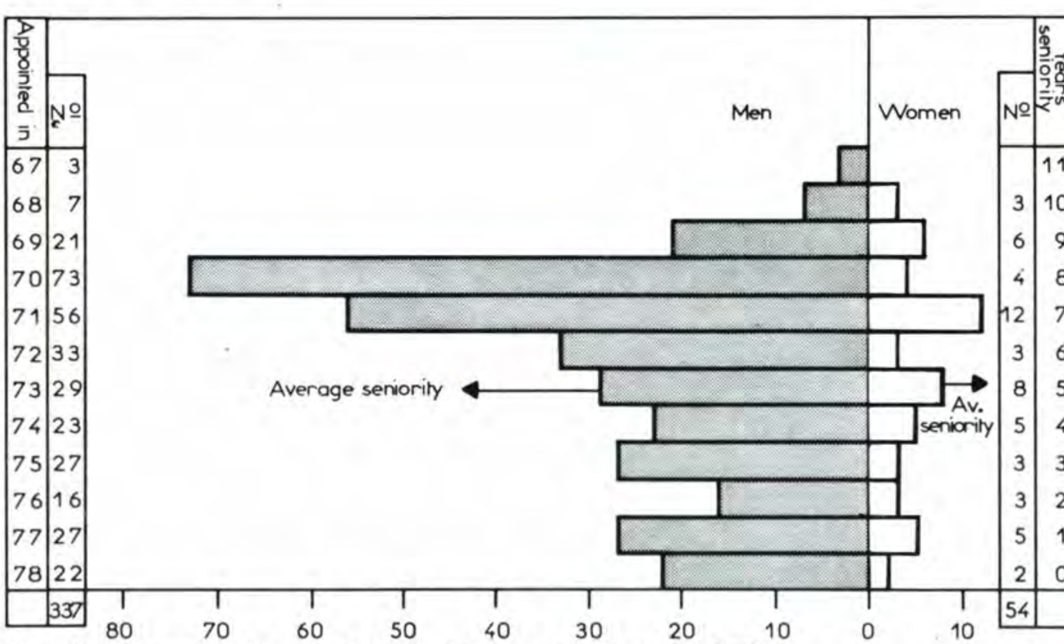


Fig. 20: Seniority of ILL staff (excl. thesis students) at 31.12.78

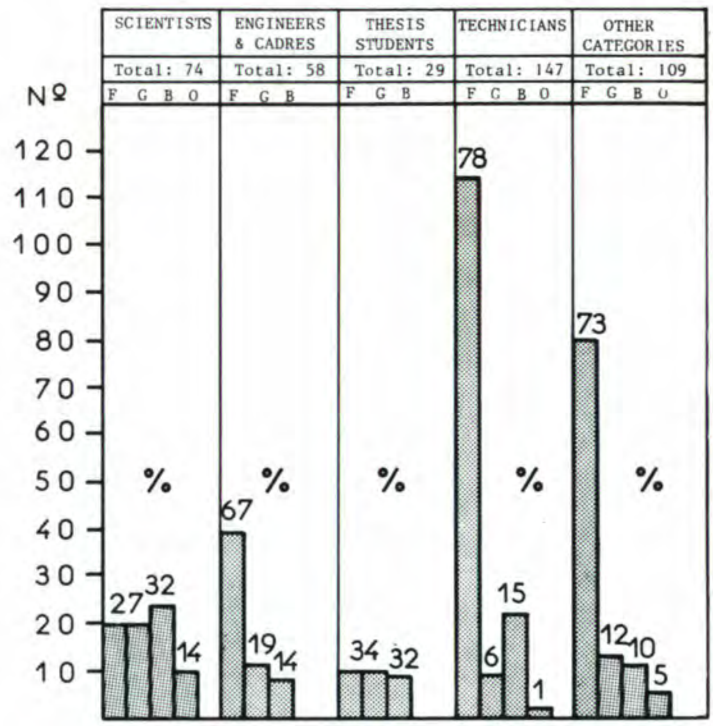


Fig. 21: Staff by category and nationality at 31.12.78.
F. = French; G. = German; B. = British; O. = Other.

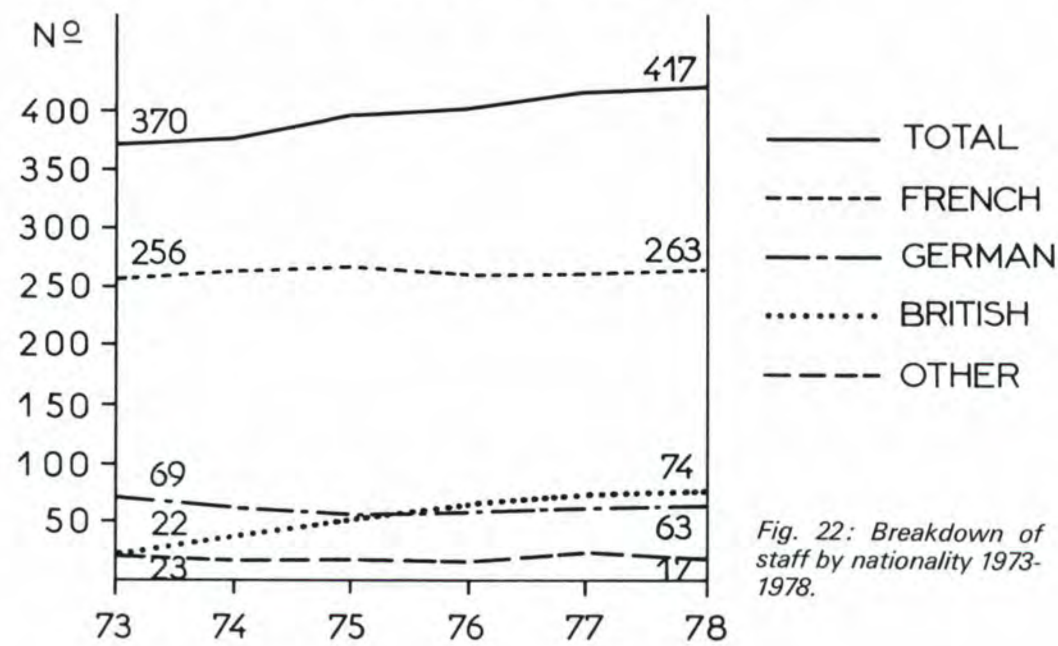


Fig. 22: Breakdown of staff by nationality 1973-1978.

The increase in British personnel (up 52 in 5 years) is particularly worthy of note. This figure is greater than the total staff increase (up 47).

salary changes

As regards general salary increases, ILL implements the various measures applied at the CEA.

Thus for 1978, the application at the ILL of the Salary Agreements signed at the CEA caused a salary increase of 9.7 %. Of this 0.4 % is due to an improvement in purchasing power and 0.2 % to the reduction in negative regional weighting.

Adjustments are envisaged at the beginning of 1979 if the official price index for 1978 should be higher than the increases granted for the maintenance of purchasing power.

promotions

The percentage for promotions within the budget for staff costs represented 1.42 % In 1978.

A progressive decrease of this percentage may be noted since 1974 (1.64 %) which is explained by staff moving into categories with a lower advancement rate.

An agreement signed with the trade unions on 20 March 1978 foresees the fixing of the advancement rate at 1.3 % in 1979 if the "deuxième souffle" is accepted by the Steering Committee.

staff representation

The staff are represented by:

a) Three union branches:

CGT, CFDT, FO

b) Works Committee (Comité d'Entreprise):

— number of representatives:

'Annexe I' = 2 members (1 CFDT + 1 FO)
2 substitutes (1 CFDT + 1 FO)

'Annexe II' = 4 members (2 CFDT + 1 CGT + 1 FO)
4 substitutes (2 CFDT + 1 CGT + 1 FO)

The next elections take place in February/March 1979.

Allocation 1978 = 2.45 % of the budget for Staff Costs.

c) Health and Safety Committee (C.H.S.):

6 representatives

d) Staff Representatives:

'Annexe I ' = 3 members (2 CFDT + 1 FO)
3 substitutes (2 CFDT + 1 FO)

'Annexe II' = 4 members (1 CFDT + 2 CGT + 1 FO)
4 substitutes (2 CFDT + 1 CGT + 1 FO)

(Next elections February/March 1979)

e) Management/Union Careers Commission:

6 representatives + 4 substitutes.

'relations sociales'

(Figures up to 30 November 1978)

This section looks after administrative, social and medical problems of ILL staff and Guest Scientists.

I — activities undertaken by the section on behalf of ILL staff

Medical Problems:

The Medical Service, as set up at the beginning of 1977, is now an integral part of the ILL's life. Staff undergo regular check-ups, have thorough medical examinations (twice a year for those working regularly in the restricted area — that is to say 180 ILL staff and 37 Guest Scientists — and once a year for all others).

Numbers of medical examinations:

Regular : 503
Recruitment : 69
Return to work after illness with an absence of more than 3 weeks, or industrial accident: 17.

The Section organised two blood collections during the year in conjunction with the Isère Blood Transfusion Centre. 106 people volunteered.

The Section has the role of "Works Correspondent" with the Social Security: the staff's illness records are collected, completed and checked by a member of staff before being transferred to the Social Security for payment. These documents are then returned for supplementary refunds by the ILL "Société Mutualiste" or by IRRAPRI (superannuation fund for Cadres).

TABLE XII — ILL STAFF'S ILLNESS RECORDS HANDLED AND THE TOTAL AMOUNTS REIMBURSED UP TO NOVEMBER 30 1978

Year	Social Security	Sté Mutualiste du Personnel ILL		IRRAPRI		Prise en charge (1)
		Cases	Sums reimbursed	Cases	Sums reimbursed	
1976	6170	4715	210843	218	39095	197
1977	6380	4675	205623	271	45047	305
1978 (11 months)	6892	5293	239313	278	46852	447

(1) "Prise en charge" means the attestation of membership of the "Société Mutualiste du Personnel iLL", which enables staff to avoid the payment of charges outstanding after the Social Security has paid its share, in accordance with the agreement with the hospital.

Absences due to illness, industrial accident, maternity:

TABLE XIII

STOPPAGES DUE TO ILLNESS WITH A MEDICAL CERTIFICATE

Year	No. of absences			incl. absences of more than 30 days:	Total working days sick leave
	'Cadres'	'Non-cadres'	Total		
1975	20	115	135	9	1 558
1976	13	85	98	6	1 666
1977	31	107	138	12	1 692
1978	28	109	137	11	1 356

• Industrial accidents:

20 accidents, 15 of which resulted in 86 working days' sick leave (20 and 19 accidents in 1976 and 1977), one of which resulted in sick leave of more than 30 days.

• Maternity:

5 cases resulting in 476 days of absence (399 working days), paid for by the Social Security and ILL.

• Health Cures:

3 cases involving 51 working days' absence.

In all, the total number of days' absence for industrial accidents, illness, maternity and health cures represents 2.48 % of the theoretical total of days worked in 1978.

Assistance for housing:

This takes two different forms:

• Looking for flats or houses for new arrivals. We have helped about 40 people in this way.

• Purchase of houses or flats:

In spite of an increase in construction costs, a number of staff have started the process of purchasing an apartment or house.

14 loans were granted in 1978 (28 loans in 1977 and 21 in 1976) amounting to a grand total of F. 400,500 which comes from the "1 %" fund set aside for Housing Assistance.

Staff Training:

During the first 6 months of 1978, 137 staff attended 5,864 hours of training. These figures when broken down result in:

2,539 hours' language studies (French, German, English)
2,638 hours' technical studies
687 hours' general or cultural studies

As regards languages, the demand for German classes enjoyed a renewal of interest during the second 6 months of 1978, following a slight slackening off of interest during the last 3 years. This will allow the organisation of a new course for beginners in the near future for French and British technicians.

On the subject of technical training, the section tries to favour in-depth courses in preference to short-term studies which can only give an introduction to a particular subject rather than a comprehensive training.

— Five technicians did electrical courses, doing 200 hours study and practical work. This training will be completed by a further 120 hours' work in 1979.

— Three technicians are finishing or have already finished a programme specially organised at Grenoble and initiated by the ILL, within the framework of the CNAM (Conservatoire National des Arts et Métiers) in conjunction with the Institute for Nuclear Sciences and the University. These technicians have thus obtained credits allowing them to obtain either the CNAM diploma as an engineer or the nuclear DEST (Diplôme d'Etudes Supérieures Techniques).

As regards general studies, following the request of the non-French staff, a 32-hour course has been organised by the ILL on "Institutions in France". This venture has met with great success. The course is now taking place at the CENG (Centre d'Etudes Nucléaires de Grenoble).

The preparation of staff training is carried out in conjunction with the Subcommittee on Training of the ILL Comité d'Entreprise (works committee) in a constructive atmosphere.

Elsewhere, the Section maintains a close and fruitful contact with the Training Services of the CNRS and the CENG.

Visits by ILL staff

The table below shows how the number and the cost of visits have changed between 1977 and the first 11 months of 1978. An increase in the number of visits and a decrease in the average cost of each visit may be noted: this is explained by the setting-up of a system of annual payment limits for the scientists, which enables them to organise their journeys more economically.

TABLE XIV — VISITS OF ILL STAFF:
BREAKDOWN BY PROFESSIONAL CATEGORY AND NATIONALITY (1977/1978)
(REIMBURSED UP TO 30-11-78)

Category	No. 1977-1978		Visits with reimbursement				No. of visits without reimbursement		
			Total cost		Average cost				
	1977	1978	1977	1978	1977	1978	1976	1977	1978
Annex I (Cadres)									
- Scientists									
French	49	54	45835.55	57715.28	935.41	1068.80	21	40	37
German	51	52	80126.37	95853.85	1571.10	1843.34	21	36	31
British	43	48	69207.77	67463.82	1609.48	1405.49	19	29	17
Others	25	19	28679.19	26748.50	1147.16	1407.81	7	15	17
- Thesis Students									
French	18	40	18220.00	34701.65	1012.22	867.54	5	2	4
German	21	23	36494.90	33104.38	1737.85	1439.32	3	4	1
British	11	14	24366.54	25302.83	2215.14	1807.34	4		
Others									
- Engineers and Cadres									
French	76	103	64646.45	85077.08	850.61	825.99	6	7	4
German	54	56	75371.87	79242.80	1395.77	1415.05		5	3
British	13	13	15928.45	15926.66	1225.26	1225.12	1		2
Others									
TOTAL ANNEX I (Cadres)	361	421	458877.09	521136.85	1271.12	1237.85	87	138	116
Annex II (Non-cadres)									
French	114	134	56337.30	46869.18	494.18	349.77	16	12	13
German	13	4	14816.27	3029.74	1139.71	757.43	3		
British	10	14	8774.20	5352.33	877.42	382.30	1		
Others		1		100.28		100.28	1		
TOTAL ANNEX II	137	153	79927.77	55351.53	583.41	361.77	21	12	13
GRAND TOTAL	499	580	538804.86	576488.38	1079.76	993.34	108	149	123

II — activities on behalf of guest scientists:

The administrative work for the Guest Scientists raises many different and new problems.

The table XV shows the number of visits to the ILL made by scientists using the reactor, attending workshops, staying for a sabbatical year or coming to give seminars. Visiting scientists are grouped by nationality and the figures refer to the first 11 months of 1978:

TABLE XV — VISITING SCIENTISTS DURING THE FIRST 11 MONTHS GROUPED BY NATIONALITY

	French	German	British	Others	TOTAL
With expenses paid	215	290	294 (1)	118 (2)	917
Without expenses paid	170	131	128 (1)	208 (2)	637
GRAND TOTAL	385	421	422	326	1 554

(1) This figure includes an estimate of the number of British scientists arriving through the intermediary of the SRC, known up to 30.9.78.

(2) Australian scientists are included in "others".

During 1978, the ILL's contacts with the Soviet laboratories of Dubna, Gatchina (Leningrad) and the Kurchatov Institute were extended.

The ILL received the following at Grenoble:

3 Scientists from Dubna (119 days paid by ILL)
6 Scientists from Gatchina (288 days paid by ILL)
2 Scientists from Kurchatov (60 days paid by ILL)

The following ILL scientists went to the USSR:

2 to Dubna (total stay: 20 days)
2 to Gatchina (total stay: 25 days)

III — schooling

As in previous years the primary school "La Houille Blanche" received an average of 50 children, whose mother tongue is either English or German. This school works to the satisfaction of everyone concerned: children, parents and teachers.

The special "European" classes for the first, second and third years at the Lycée des Eaux Claires were a little more difficult to organise. Nevertheless, the grammar school tries within its relatively limited means to welcome young foreigners under the best possible conditions. This situation is greatly helped by the ILL's provision of German and British teachers.

The ILL has approached the recently appointed director of education at Grenoble, with the idea of creating special international sections within a grammar school at Grenoble. This would lead progressively to the introduction of an international baccalaureat. The director seems interested in this possibility and, in spite of the inevitable bureaucracy involved, the ILL does not despair of bringing about such an examination after a reasonable period.

finance

1. budget and accounts

The budget approved for 1978 provided for a total expenditure of 112.1 million francs. Of this 2.3 million francs were to be covered by the ILL's own income and 109.8 million francs by the contributions of the associates. These figures incorporate a credit figure of 688,635 francs brought forward from 1977, plus a figure of 150,000 francs which represents additional income.

The provisional annual accounts for 1978 for actual expenditure, in comparison with the actual expenditure for 1977 (excluding taxes), are as follows:

TABLE XVI — COMPARISON OF EXPENDITURE IN 1978 AND 1977

	1978 (x 1000 F)	% of total	1977 (x 1000 F)	% of total
a) Operation				
Consumable materials and small equipment	7370	6.6	6489	6.5
Fuel elements	17300	15.5	14087	14.0
Staff costs	54300	48.7	47530	47.2
Taxes	274	0.2	121	0.1
Long-term service contracts	8960	8.0	8425	8.4
Other work, supplies and services from third parties	5690	5.1	5799	5.8
Transport, removal and travel expenses	866	0.8	925	0.9
Miscellaneous administrative costs	3140	2.8	3202	3.2
Total operation	97900	87.7	86578	86.1
b) Investments				
Buildings	396	0.4	332	0.4
Equipment (except experimental equipment)	2070	1.8	1260	1.3
Experimental equipment	8600	7.7	10486	10.4
Other investments	2700	2.4	1852	1.8
Total investments	13766	12.3	13930	13.9
Total expenditure	111666	100.0	100508	100.0

TABLE XVII — COMPARISON OF INCOME IN 1978 AND 1977

	1978 (x 1000 F)	% of total	1977 (x 1000 F)	% of total
c) Income				
ILL's own income	2300	2.0	1861	1,9
Grants from Associates	109366	98.0	98647	98.1
Total income	111666	100.0	100508	100.00

1. The operation expenditure increased from 86.6 million francs to 97.9 million francs (+13%) in comparison with the previous year. This increase was mainly due to the budget for fuel elements (+23.6%). During the course of 1978, the Institut acquired 48 kg of 93% enriched uranium from COGEMA. There was also an increase in the Staff Costs budget in 1978.
2. The investment expenditure was reduced from 13.9 to 13.8 million francs in relation to the previous year.

   In 1978 the Institut undertook the construction of a general store and a goods reception area. The increase in budget expenditure spent on equipment is due in particular to various fittings and installations of a technical nature.

2. expenditure trends 1974-79

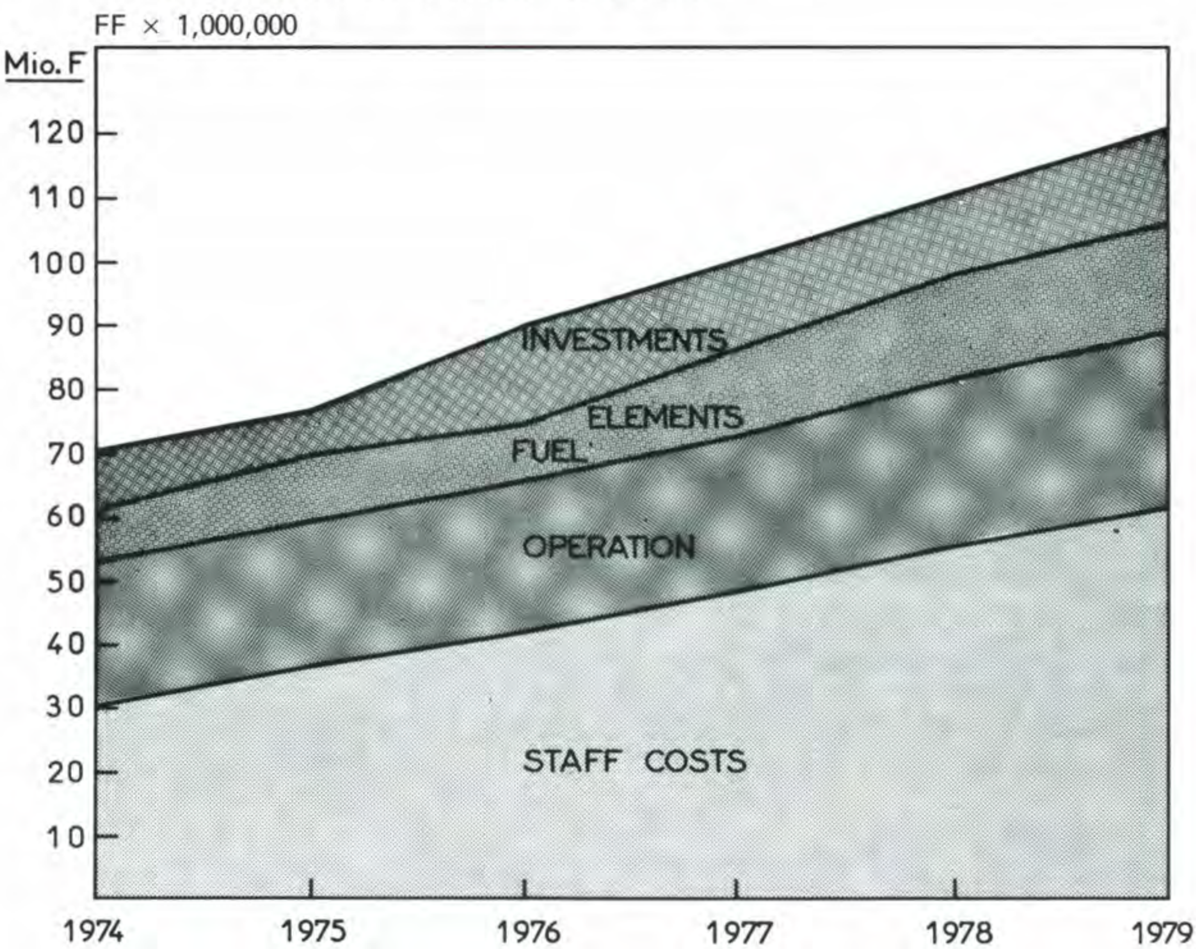


Fig. 23: Implementation of the Budget 1974-1978.

3. purchasing

In 1978 a total of 5,764 purchase orders in comparison with 5,187 in the previous year were handled by the purchasing section.

There is close cooperation with the technical and scientific areas on all purchases. The distribution of orders in the partner countries is as follows:

TABLE XVIII – DISTRIBUTION OF ORDERS IN THE PARTNER COUNTRIES

	1978 (x 1 000 F)	% of total	1977 (x 1 000 F)	% of total
Total orders	44 462	100	33 226	100
Distribution				
France	29 928	67.3	16 800	50.6
Germany	8 189	18.2	11 900	35.8
U.K.	2 239	5.0	906	2.7
Others	4 106	9.5	3 620	10.9

The increase in 1978 is due in particular to the contract agreed with COGEMA for the purchase of 48 kg of uranium.

Our efforts to achieve a better distribution of orders in future will continue, with particular regard to the contracts placed in the U.K.

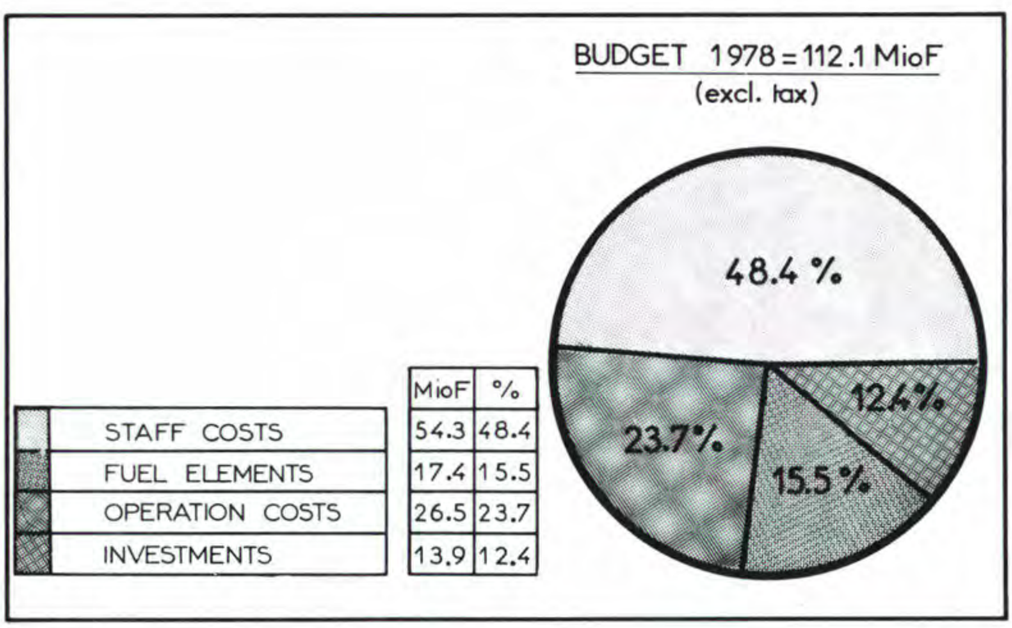


Fig. 24: Budget 1978.

EXPERIMENTS PERFORMED AT THE ILL IN 1978

The following is a list of experimental reports relating to experiments carried out at the ILL up to Septembrer 30, 1978. These reports are published in full in the Annex to the Annual Report for 1978, which also includes the Author Index for this list.

(Reports received after January 20, 1979 will be published in the Annex to the Annual Report for 1979).

(* Reports marked with an asterisk are not available for publication).

COLLEGE 3

03 01 060	Decay energies of even-A heavy fission products. F. Münnich, U. Keyser, H. Berg, B. Pahlmann (Braunschweig) E. Monnand (CEN-G) K. Hawerkamp, H. Schrader (ILL)	PN1
03 01 066	Decay energies of even-A heavy fission products. F. Münnich, H. Berg, U. Keyser, B. Pahlmann (Braunschweig) K. Hawerkamp, H. Schrader (ILL) E. Monnand (CEN-G) B. Pfeiffer (Giessen)	PN1
03 11 013 (03 11 08)	Mass yield measurements and determination of the average energy distance of the decay chain to the stable end product. J. Greif, W. Kaiser, H. Wollnik (Giessen) G. Siegert, K.D. Wünsch (ILL)	PN1
03 11 020	Nuclear charge distribution of heavy mass region fission products at various kinetic energies and ionic charge states of the fragments (chain 137, ^{235}U (nth, f)). H. Meixler, H. Braun, H.O. Denschlag, W. Faubel, W. Pörsch (Mainz) H. Schrader, G. Siegert (ILL)	PN1
03 11 021	Plasma time delay measurements for fission fragments incident on silicon surface barrier detectors. E.C. Finch, C.F.G. Delaney (Dublin) M. Asghar (ILL)	PN1
03 11 022*	Average nuclear charge of fission products selected according to mass and kinetic energy. J. Greif (Giessen) G. Siegert, E. Koglin (ILL)	PN1
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5 21 74	Structural determination of doped and undoped Li_4SiO_4. B.E.F. Fender, J. Talbot (Oxford) A.F. Wright (ILL)	D1A
5 21 76	Powder profile refinement of acetanilide-D_5. G.E. Bacon, E.J. Lisher (Sheffield)	D1A
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5 22 95	Magnetic ordering and crystal phase transition in FeS. M. Wintenberger (CEN and CNRS, Grenoble)	D1B
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5 23 122	Magnetic structure of $DyMg_2$ and $TmMg_2$. A. Loidl (Mainz) M. Müllner (Frankfurt)	D1B
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5 23 129	The magnetic and crystal structure of braunite. I. Abs-Wurmbach, Y. Khan, T.M. Sabine (Bochum)	D1A
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5 23 133	Magnetic short range ordering in 1-D compounds $FeMgBO_4$ and $FeMgBO_5$ A. Wiedenmann, P. Burlet (CEN, Grenoble) H. Scheuer, P. Convert (ILL)	D1B
5 23 135	See 5 23 120	
05 24 107	2-D structure of ^{36}Ar adsorbed on PbI_2. Y. Larher, B. Gilquin (Saclay) B. Croset, C. Marti (ILL) P. Thorel (CEN, Grenoble)	D1B
5 24 109	Methane ou Vulcan. R.K. Thomas, T. Rayment (Oxford) G. Bomchil (ILL)	D1B
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5 25 109B (5 24 112)	Neutron diffraction from clay-water systems (high resolution studies of compacted samples) D. Cebula, R.K. Thomas (Oxford) J.W. White (ILL) R. H. Ottewill (Bristol)	D16
5 25 109B	Preliminary diffraction studies of the hydration of Laponite G, a synthetic smectite. M.H.B. Hayes, D.K. Ross, J.I. Langford (Birmingham)	D16
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5 25 114	Small angle scattering from montmorillonite sols. R.K. Thomas, D.J. Cebula, M. Owen (Oxford)	D11, D17
5 25 115	The structure of naphthalene as a function of temperature. G.S. Pawley, E. Baharie (Edinburgh)	D1A, D1B
5 25 118	Investigation on the formation and structure of D_xMoS_2. C. Riekel (ILL) C.J. Wright (Harwell) R. Moyes, P. Wells (Hull)	D1B

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5 31 43	Magnetic form factor fo V^{3+} in $K_5V_3F_{14}$. (Nuclear structure refinement) J.B. Forsyth (Rutherford) P.J. Brown (ILL)	D15
5 31 43	Magnetic form factor of V^{3+} in $K_5V_3F_{14}$. J.B. Forsyth (Rutherford) P.J. Brown (ILL)	D3
5 31 47	See 5 31 35	
5 32 28A	The structure of manganese Tutton salt at 4.2 K. B.E.F. Fender, J. Pilley (Oxford) J.B. Forsyth (Rutherford)	D15
5 32 37B	Spin density in $GdCl_3$. P. Radhakrishna (Léon Brillouin, Saclay) P.J. Brown (ILL)	D5
5 32 39	Magnetic moment distribution in V_2O_3. P.J. Brown, K.R.A. Ziebeck (ILL) M.M.R. Costa (Coimbra)	D3
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5 32 52	Spin density in CoPc. R. Mason, G.A. Williams (Sussex)	D3
5 32 53	Crystal structure of $(CD_3ND_3)_2CuCl_4$. P. Radhakrishna (Léon Brillouin, Saclay) P.J. Brown (ILL)	D15
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5 34 52	Paramagnetic scattering by α-manganese. P.J. Brown, K.R.A Ziebeck (ILL)	D5
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06 01 038*	^4He film in vycor. R. Scherm, J. Joffrin (ILL) B. Lambert, D. Salin, R. Perzinski (Université Paris VI)	
06 01 040	The roton lifetime in ^3He-^4He mixtures. P.A. Hilton (Edinburgh and ILL) R. Scherm, W.G. Stirling (ILL)	IN5
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06 01 043	The structure of solid ^4He boundary layers between grafoil and high-pressure liquid ^4He. R. Scherm (Braunschweig) H. Wiechert, B. Stühn (Mainz) H.J. Lauter (ILL)	D1B, D7
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06 02 010E	Excitations in ^3He under pressure. P.A. Hilton (Edinburgh and ILL) R.A. Cowley (Edinburgh) R. Scherm, W.G. Stirling (ILL)	IN5
06 02 035	Pressure dependence of the coherent dynamical structure factor of liquid argon. P. Verkerk, L.A. de Graaf, A.A. van Well, A.J.W. Bouwman (Delft) J.B. Suck, J.R.D. Copley (ILL)	IN4
06 02 037	Collective excitations in liquid lead at small wave-vectors. J.R.D. Copley, B. Dorner, J.B. Suck (ILL) O. Söderström (Stockholm)	IN8
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06 03 094	Neutron scattering study of liquid Ni-V alloys. J. Blétry, P. Desré, J.L. Lemarchand C. Senillou (LTPCM, Grenoble)	D4
06 03 095	Concentration fluctuations in undercooled PbSn alloys. C. Lemaignan (CEN, Grenoble) J. Blétry, P. Desré (LTPCM, Grenoble)	D17
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06 07 004 (06 03 016G)	Structural properties of aqueous solutions. J.E. Enderby, S. Cummings (Bristol)	D4
06 07 005 06 07 005A	The structure of aqueous solutions. J.E. Enderby, G.W. Neilson, J. Newsome (Bristol)	D4
06 07 006 06 07 006A	Aqueous solutions - pressure effects. G.W. Neilson, J.E. Enderby (Bristol)	D2
06 08 004	Phase separation in TiO_2 doped magnesium aluminosilicate glass ceramic. B.E.F. Fender, J. Talbot (Oxford) A.F. Wright (ILL)	D11A
06 08 06	Atomic structure in amorphous YNi_2. D. Givord (ILL) A. Liénard (CEN, Grenoble) J.P. Rebouillat (CNRS, Grenoble)	D1B
06 08 007	Scattering law for vitreous silica at high Q. R.N. Sinclair (Harwell) A.C. Wright (Reading)	IN1
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06 09 007A	Collective excitations in liquid crystals. A.J. Leadbetter (Exeter) R.M. Richardson (Exeter and ILL) J. Lefebvre (ILL)	IN3

06 09 010*	Neutron diffraction from the nematic liquid crystal PAA. T. Riste (Kjeller) R. Pynn (ILL)	D2
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06 11 007	Critical opalescence. J. Goulon, J.L. Rivail (Nancy)	D11
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07 01 069	Binary alloys (Cu-Mn). A.P. Murani (ILL)	IN5
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07 01 085	Chemical inhomogeneities in invar alloys. A. Chamberod (CEN-G) M. Roth (ILL)	D17
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07 01 087	Investigation of polarized neutron diffuse scattering in binary $Fe_{1-x}Sb_x$ alloys. M.C. Cadeville, F. Gautier (Strasbourg)	D7
07 01 089	Spin dynamics of 4f Spin glass systems. K. Baberschke (Berlin) M. Loewenhaupt (Jülich) H. Scheuer (ILL)	D7
07 01 090	Small angle scattering from CrFe alloys. B.D. Rainford, S.K. Burke, R. Cywinski, J.R. Davis (London)	D17, D11
07 01 091	Relaxation rates of dilute Kondo intermediate valence systems. S. Horn (Köln) F. Steglich, M. Loewenhaupt (Jülich)	D7
07 01 093	Spin relaxation and spin dynamics of $Al_2Mn_3Si_3O_{12}$ glass. W. Prandl, W. Nägele (Tübingen) P.v. Blanckenhagen (Karlsruhe)	IN4
07 01 095	Diffuse neutron scattering by Heisenberg and Ising amorphous spin glasses. K. Knorr, W. Nägele, W. Prandl (Tübingen) P. Convert (ILL)	D1B
07 01 096	Polarisation analysis study of spin ordering in concentrated CuMn alloys. B.D. Rainford, S.K. Burke, J.R. Davis (London)	D5
7 01 097	Dependence of critical magnetic scattering on the momentum transfer K. Stierstadt, W.v. Hörsten (München) G. Kostorz, R. Anders (ILL)	D11
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07 01 100	Dynamics of spin glasses. F. Mezei, A.P. Murani (ILL)	IN11
07 02 039*	$NdMg_3$. G. Will, M.O. Bargouth (Bonn)	IN4
07 02 042	Valence fluctuations in YbCuAl. F.R. de Boer, W. Mattens (Amsterdam) G.H. Lander (Argonne)	IN4
07 02 043	Neutron inelastic scattering from the compound $CeAl_3$. A.P. Murani (ILL) K. Knorr (Mainz) K.H.J. Buschow (Eindhoven)	IN5
07 02 044 (07 02 030)	Dilute Van Vleck paramagnets : line widths of crystal field transitions in the single ion and spin glass regime. M. Loewenhaupt (Jülich) H.E. Hönig (Frankfurt)	D7
07 02 047	Crystalline electric field levels of U in UPd_3. N. Shamir, H. Shaked (Beer-sheva) A.P. Murani (ILL)	IN4
07 03 045	Neutron diffraction topography. M. Schlenker (CNRS, Grenoble and ILL) J. Baruchel, C. Mazure-Espejo (CNRS Grenoble)	S20
07 03 064*	Short range order parameters in AlCu. J.B. Cohen (Evanston) M. Roth, G. Kostorz (ILL)	D10

07 03 065A — Study of AlZn decomposition by neutron S.A.S. — D17
P. Guyot, B. Bruno (LTPCM, Grenoble)

07 03 069 — Precipitation state in an extruded Al-Zn-Mg alloy. — D11A
I. Bognar, J.E. Epperson, V. Gerold, K.W. Gerstenberg (Stuttgart)
G. Kostorz (ILL)

07 03 076 — Etude par diffusion neutronique de la précipitation $\gamma' Ni_3(TiAl)$ dans l'incoloy 800 vieilli à 550° C. — D11A
G. Sainford, G. Robert, G. Nombalais, M. Auffrey, A. Silvent (CEN-G)
M. Roth (ILL)

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S. Messoloras, R.J. Stewart (Reading).

07 03 082 — Multiple scattering effects in small-angle scattering from voids. — D11
J.E. Epperson, K.W. Gerstenberg (Stuttgart)
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07 03 084 — Short range order determination in $^{62}Ni_3Fe$ single crystal quenched from 530° C. — D10
M. Fayard, F. Bley, Y. Calvayrac, M. Bessiere, S. Lefebvre (ENSCP, Paris)
M. Roth (ILL)

07 03 084A — Short range order determination in a single crystal $^{62}Ni_3Fe$ quenched from different temperatures. — D10
M. Fayard, F. Bley, M. Bessiere, S. Lefebvre (ENSCP, Paris)
M. Roth (ILL)

07 03 085 — Small angle neutron scattering on aged aluminium-magnesium single crystals. — D17
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07 03 086A — Phase decomposition in quenched Au-Pt alloys. — D11A
H. Herman, S.P. Singhal (Stony Brook)
G. Kostorz (ILL)
M. Suenaga (Brookhaven)

07 03 087 — Etude du déplacement des atomes dans les alliages fer-aluminium. — D10
P. Lesbats (Saint-Etienne)

07 03 088 — Investigation of the growth of clusters in aluminium-magnesium-zinc-alloys. — D7
P. Auger, M. Bernole (Rouen)
O. Blaschko, G. Ernst, G. Quittner (Seibersdorf)
M. Roth (ILL)

07 03 089 — Diffuse scattering in RbI in the pressure region of structural metastability. — D10
O. Blaschko, G. Ernst, G. Quittner (Seibersdorf)
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07 04 002 — Influence of (n,γ)-recoil defects on the spin-lattice relaxation of ^{116}In (τ = 20 s) in InP and InSb single crystals. — S6
H. Ackermann, B. Bader, W. Buttler, K. Dörr, F. Fujara, H. Grupp, P. Heitjans, G. Kiese, A. Körblein, H. Lauter, H.-J. Stöckmann (Heidelberg (Marburg) and ILL)

07 04 002A — Cross-relaxation processes in nuclear radiation detected NMR. — S6
H. Ackermann, W. Buttler, K. Dörr, D. Dubbers, F. Fujara, H. Grupp, P. Heitjans, G. Kiese, A. Körblein, H.-J. Stöckmann (Heidelberg (Marburg) and ILL).

07 04 003 — Spin-lattice relaxation of ^{8}Li nuclei in $^{7}LiNbO_3$ single crystals. — S6
H. Ackermann, B. Bader, W. Buttler, K. Dörr, F. Fujara, H. Grupp, P. Heitjans, G. Kiese, A. Körblein, H.-J. Stöckmann (Heidelberg (Marburg) and ILL)

07 05 023 — Resolution study of neutron groups from Al TA(ζ00) phonons. — IN3
K. Böning, G.S. Bauer, W.D. Teuchert (München)

07 06 052A — Tunneling of protons in Nb-N_x-H_y. — IN10
D. Richter (Jülich)
A. Magerl, G. Alefeld, H. Wipf (München)

07 06 062 — Hydrogen spectra of HNb_6I_{11}. — IN1
B.E.F. Fender, A. Barrett (Oxford)
A. Simon (Stuttgart)

07 06 063 — Diffusion in β-phase Pd/H and Pd/D. — IN5
D.K. Ross, I.S. Anderson (Birmingham)
C.J. Carlile (Rutherford)

07 06 070 — Elastic diffuse scattering from βPdD_x to study the 50K transition. — D7
D.K. Ross, I.S. Anderson (Birmingham)
C.J. Carlile (Rutherford)

07 06 072 — Incoherent structure factor of H in $NbH_{0.11}$. — IN2
V. Lottner, U. Buchenau (Jülich)
W.J. Fitzgerald (ILL)

07 06 073 (07 06 057A) — Structure factor measurement on β-phase PdD below 50K. — D10
D.K. Ross (Birmingham)
C.J. Carlile (Rutherford)

07 06 077* — Temperature dependence of phonon relaxation in Nb loaded with H. — IN3
G. Alefeld, A. Magerl, W.D. Teuchert (München)

07 06 078 — Self-diffusion in Na below the melting-point. — IN10, IN11
A. Seeger, H. Mehrer (Stuttgart)
G. Göltz, A. Heidemann (ILL)

07 06 084 — Band modes of hydrogen in the bcc metals Nb, V and Ta. — IN2
V. Lottner, H.R. Schober (Jülich)
W.J. Fitzgerald (ILL)

07 06 Test	Superlattice reflections in β-Pd/D. D.K. Ross, I.S. Anderson (Birmingham) C.J. Carlile (Rutherford)	D12
07 07 001	Translational diffusion in $LiIO_3$. W. Press, H. Grimm (Jülich) S. Haussühl (Köln)	IN10
07 07 005	Study of chlorine ion diffusion in the superionic conductor $SrCl_2$. M.H. Dickens, W. Hayes (Oxford) M.T. Hutchings (Harwell) R.E. Lechner (ILL)	IN5
07 07 005	Study of ionic mobility in the superionic conductor $SrCl_2$. M.H. Dickens, W. Hayes (Oxford) M.T. Hutchings (Harwell) R.E. Lechner (ILL)	IN5
07 07 006*	Structural studies of lithium electrolytes. C.R.A. Catlow, B. Steele (London)	D1A
7 07 11	Anion-excess strontium chloride. B..E.F. Fender, P.J. Bendall (Oxford) C.R.A. Catlow (London)	D9
07 07 012	Anion diffusion in superionic $SrCl_2$. M.H. Dickens, W. Hayes (Oxford) M.T. Hutchings (Harwell)	IN11

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08 01 019B	A low resolution neutron diffraction study of crystallized tomato bushy stunt virus (TBSV). A. Lewit, P. Timmins, G. Bentley (ILL) J. Witz (Strasbourg)	D17
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08 02 012G	Characterization of E. Coli 5S RNA and 5S RNA protein-complexes. W. Hoppe, E. Imsel, R.P. May, P. Stöckel, I. Strell (Martinsried) H.G. Wittmann, S. Lorenz, V.A. Erdmann (Berlin)	D11A
08 02 29 08 02 38B	Investigation on tRNA/Amino-acyl tRNA-synthetase interactions. S. Blanquet, P. Dessen (Palaiseau) R. Giegé, D. Moras, J.C. Thierry (Strasbourg) P. Morin (Montpellier) C. Zaccai, B. Jacrot (ILL)	D11
08 02 042A	Structure of the ribonucleoprotein strand. I.N. Serdyuk, A.S. Spirin (Poustchino)	D11
08 02 050	Studies of colipase: binding to bile salts micelles. M. Charles, M. Semeriva (Marseille)	D17
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08 02 058	Structural studies on alfalfa mosaic virus. J.E. Mellema (Leiden) A. Miller, S. Cusak (EMBL, Grenoble)	D11A
08 03 002B 08 03 002H	Neutron scattering studies of chromatin. J.P. Baldwin, E.M. Bradbury, B.G. Carpenter, G.G. Kneale, R.P. Hjelm, P. Suau, G.W. Braddock (Portsmouth)	D11
08 03 005D	The structure of small spherical viruses. B. Jacrot, C. Chauvin (ILL) J. Witz, G. Lebeurier, M. Cuillel (Strasbourg)	D11
08 03 027	Collagen-water system. G.T. Jenkin, J.W. White, P. Chieux (ILL) A. Miller (EMBL, Grenoble)	D4
08 03 029A	Structure of insect flight muscle. C.D. Rodger (Oxford) D.L. Worcester (London) A. Miller (EMBL, Grenoble)	D17
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08 03 Test	Small molecule contrast studies of chromatin core particles. J.P. Baldwin, E.M. Bradbury, G.G. Kneale, P. Suau, G.W. Braddock (Portsmouth)	D11
08 04 008A	Low-frequency vibrations in lysozyme by neutron TOF spectroscopy. H. D. Bartunik (Hamburg) P. Jollès (Université Paris V) J. Berthou (Université Paris VI) A.J. Dianoux (ILL)	IN5
08 04 012B	Dynamic structure of DNA in solution. R.E. Lechner (ILL) R.C. Oberthür (Mainz)	IN5, IN10
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08 04 020	Molecular dynamics of hydrated proteins. J. Randall (Edinburgh) H.D. Middendorf (London)	IN5

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08 05 016R 08 05 016A	Binding of polyene antibiotic to phospholipid-cholesterol membranes. F. Podo, R. Strom (Roma) C. Crifo (Cagliari) G. Zaccai (ILL)	D16
08 05 019C	Neutron diffraction by mammalian erythrocyte membranes. J. Randall, A.H. Maddy, S. Gilmour (Edinburgh) J. Torbet (ILL)	D11A
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08 07 006	The structure of the corneal stroma. G.F. Elliott, S.B. Whitburn, P.A. Timmins (Oxford)	D11
08 Test	Interaction of serum amyloid protein with polyanions. R.B. Sim (CEN-G)	D17
08 Test	Small angle scattering studies on human immunoglobulin G. P.M. Johnson (Liverpool)	D17
08 Test	Lac-repressor. M. Charlier, J.C. Maurizot, C. Hélène (Orléans) C. Zaccai (ILL)	D11

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09 01 207A	Conformation of a semi-crystalline polymer in bulk (isotactic polystyrene) H. Benoit, C. Picot, J.M. Guenet (Strasbourg)	D11, D17
09 01 208 08 02 052	Polyelectrolytic behaviour of DNA including electrostatic potential in DNA-solutions R.C. Oberthür (Mainz)	D11, D17
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09 01 215B	The effect of temperature and concentration on the dimensions of a polymer chain in solution. R.W. Richards (Glasgow) A. Maconnachie, G. Allen (London)	D11
09 01 217	Conformation in two phase polymeric systems. J.S. Higgins, G. Allen, A. Maconnachie (London)	D17
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09 01 220	Scattered intensity by stretched polystyrene bulk. F. Boué (Léon Brillouin, Saclay)	D11, D17
09 01 222A	Microémulsions. C. Taupin, R. Ober (Collège de France, Paris) P. Delord, C. Cabos (Montpellier)	D11A, D17
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09 01 223	Conformation of chain molecules in polymer melts and in crystalline polymers. E.W. Fischer, M. Stamm (Mainz)	D1B
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09 01 225	Chain conformation in hot stretched and relaxed polystyrene. F. Boué, J.P. Cotton, B. Farnoux, G. Jannink, M. Nierlich, C. Williams (Léon Brillouin, Saclay) H. Benoit, C. Picot (Strasbourg) R. Duplessix (ILL)	D11A, D17A,
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09 01 229	Consistency between neutron and light scattering measurements in semi-dilute polymer solutions. F. Boué, J.P. Cotton, B. Farnoux, G. Jannink, M. Nierlich, C. Williams (Léon Brillouin, Saclay) H. Benoit, C. Picot (Strasbourg) R. Duplessix (ILL)	D11, D17
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LIST OF THESES

The experimental work of which was carried out at ILL.

D. HERRMANN-RONZAUD	Thèse de Doctorat d'Etat, Université Scientifique et Médicale de Grenoble et Institut National Polytechnique de Grenoble (Oct. 1978). Etude de Composés Antiferromagnétiques Isolants soumis à des Contraintes Uniaxiales. (78HE380).

The experimental work of which was carried out at ILL **by visiting theses students.**

J.M. ALMEIDA	Thèse de 3e Cycle, Université Scientifique et Médicale de Grenoble (Avril 1978). Etats Collectifs de l'^{235}U excités dans la Capture Radiative de Neutrons Thermiques par l'^{234}U.
M. FITZGERALD	Doktorarbeit, Karlsruhe (Dez. 1978). "Röntgen- und Neutronenstreuung an flüssigen Methylhalogeniden zur Bestimmung der Molekülpaarverteilungsfunktion".
F. FUJARA	Doktorarbeit, Heidelberg (1978). Kreuzrelaxation neutronenaktivierter β-Strahler in Metallen und Ionenkristallen.
A. KÖRBLEIN	Doktorarbeit, Heidelberg (1978). Selbstdiffusion in Lithium-Legierungen und Spin-Gitter Relaxation von ^{8}Li.
E. HOLLAND-MORITZ	Doktorarbeit, Jülich (Juni 1978). Magnetische Neutronenstreuexperimente zum Relaxationsverhalten von Zwischenvalenten Seltenen-Erd-Verdindungen.
K.J. KÜGLER	Doktorarbeit, Bonn (Juli 1978). Ein Injektionssystem für einen Neutronenspeicherring.

WORKSHOPS ORGANIZED BY THE ILL IN 1978

Workshop on "Possibilités d'Etudes Physico-chimiques par Diffusion de Neutrons. (organized by J. Joffrin - A.J. Dianoux, ILL and Mme C. Taupin - Collège de France).	Institut des Sciences Nucléaires, Grenoble, 27-28 April 1978
International Workshop on the Application of Intense Capture Gamma-Ray Sources. (organized by A. Freund) Proceedings to be published in Nucl. Instrum. & Methods.	ILL June 1-2, 1978
Workshop on Neutron Interferometry (organized by B. Maier, ILL and U. Bonse (Dortmund) - H. Rauch (Vienna)). Proceedings: To be published, under the editorship of U. Bonse and M. Rauch. (Oxford University Press, in press).	ILL June 5-7, 1978
Workshop on Helium (organized by R. Scherm)	ILL Aug. 30, 1978
Workshop on Dynamics in Molecular Crystals (organized by H. Stiller - Jülich and B. Dorner - ILL).	ILL Oct. 16-17, 1978
Workshop on Diffuse Elastic and Quasielastic Neutron Scattering from Defects in Solids (organized by G. Göltz, W. Just and M. Roth - ILL).	St. Pierre de Chartreuse Oct. 16-18, 1978

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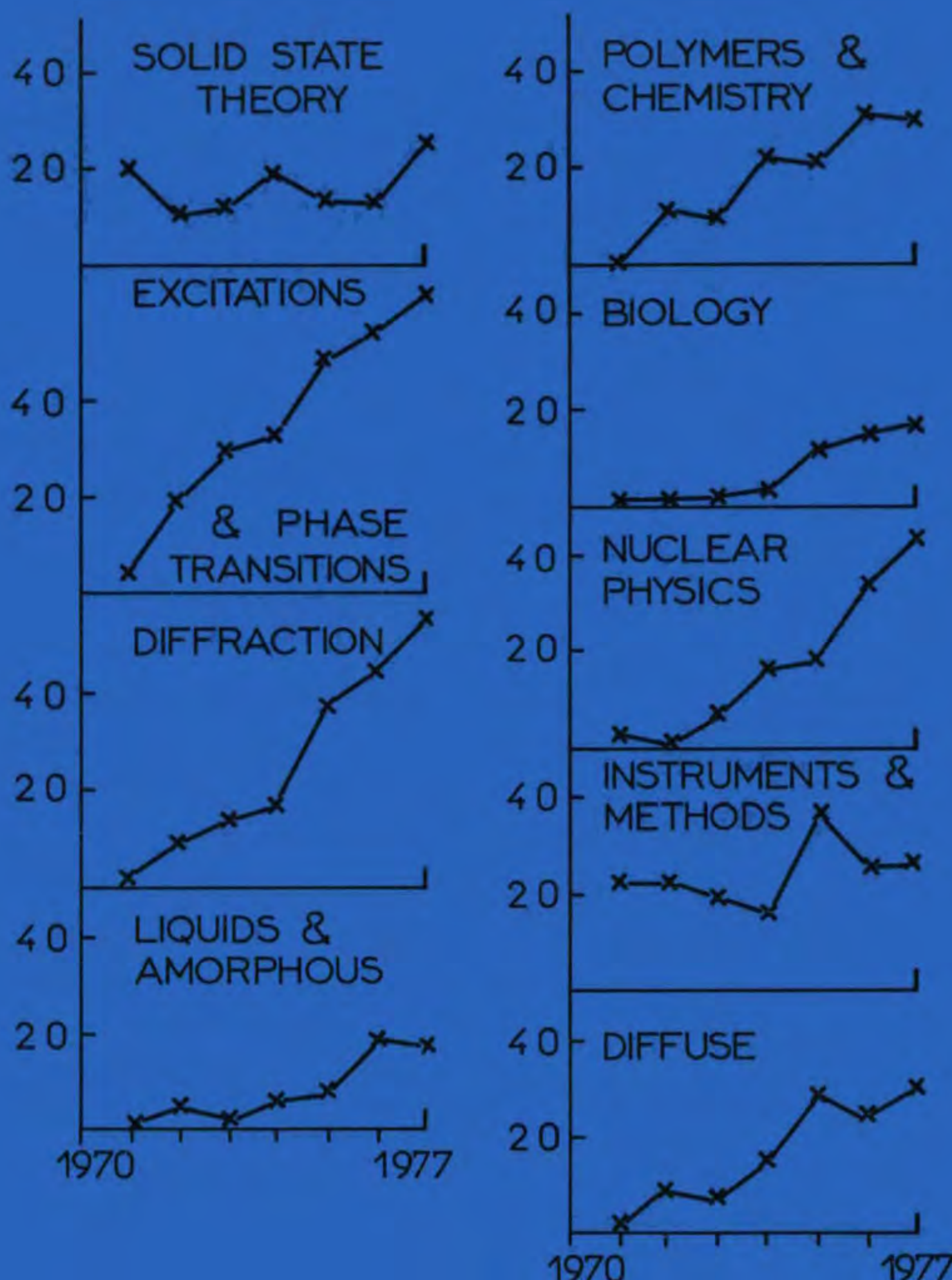

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PUBLICATIONS INDEX BY AUTHORS

This is intended as an index to the previous list. It gives all the publications in which a person has cooperated, but need not have been the principal author.

VERGÄNGLICHKEIT

Flugsand der Stunden. Leise fortwährende Schwindung
auch noch des glücklich gesegneten Baus.
Leben weht immer. Schon ragen ohne Verbindung
die nicht mehr tragenden Säulen heraus.

Aber Verfall: Ist er trauriger, als der Fontäne
Rückkehr zum Spiegel, den sie mit Schimmer bestaubt?
Halten wir uns dem Wandel zwischen die Zähne,
daß er uns völlig begreift in sein schauendes Haupt.

MUTABILITY

Quicksand of hours! Perpetual quiet disappearance
even of the blessedest pile into dust.
Life's always blowing. Already with no coherence
those uncarrying columns outthrust.

Decay: does it yield more cause, though, for lamentation
than the fountain's return to the mirror its ripples bespread?
Let us hold ourselves between the teeth of Mutation,
till it gets us completely into its gazing head.

Muzot, c. end of February 1924.

L'ÉPHÉMÈRE

Sable des heures. Discrète, continue,
ruine des bâtiments, même bénis.
Toujours souffle la vie. On voit déjà
s'isoler les colonnes qui ne portent plus.

Est-ce donc plus amer que le retour au miroir
de la fontaine qui le poudre de reflets?
Changement, nous te resterons dans les mâchoires
pour être bien compris dans ton visage qui regarde.

Traduits par Philippe Jaccottet
Éditions du Seuil, 1972.

RAINER MARIA RILKE

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keyword system for the classification of proposals

COLLEGE 3 (Fundamental and Nuclear Physics)

3-01 (Lohengrin Experiments), nuclear spectroscopy on fission products
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3-03 Beam experiments using nuclear reactions
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4-02 Dynamics of Structural Phase Transitions
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- magnon-phonon hybridisation

4-04 Dynamics of Magnetic Critical Scattering
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5-15 Structural changes and phase transitions induced by temperature, pressure, fields, etc.
5-16 Special applications of single crystal measurements
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- superstructures
- diffuseness of reflections
- methodic questions (anomalous scattering, extinction, etc.)
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5-17 Magnetic ordering

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6-06 Molten salts
6-07 Ionic solutions (excluding chemical reactions)
6-08 Glasses (pure glasses only) and amorphous materials
6-09 Mesophases (liquid crystals, plastic crystals) pure systems only
6-11 Critical scattering of fluids

(Each item includes the dynamic and the structural aspect)

COLLEGE 7 (Imperfections)

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annex : vortex line spectroscopy

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COLLEGE 9 (Chemistry)

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9-02 Polymers, and oligomers —
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- phonons in polymers

9-03 Molecules in Solution (liquid or solid) - Quasi-elastic Scattering from
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- reorientational motions
- tunnelling

9-04 Molecules in Solution or Solid State - Inelastic Scattering from
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- vibrational, torsional modes

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- colloid chemistry problems (e. g. Micellar or hexagonal phases, water in clays, polyelectrolytes, etc.)

9-06 Dynamics of physisorbed and chemisorbed systems
- catalysis
- molecules chemisorbed on surfaces (e.g. H_2 on Raney -Nickel, C_2H_2 in zeolites, etc.)
- Dynamics of molecules in layered intercalates

This form is available on request from the Office of the Scientific Secretary at the ILL and for British Users also from Mr D. Salter SRC, Rutherford Lab., Chilton Oxon

guide-lines

for the submission of a research proposal for use of neutron beams of the ILL high flux reactor

Dear Colleague,

Before completing the attached form, you are requested to carefully read the following points which are essential for the forwarding of your proposal to the Scientific Council of the ILL.

CONTENTS OF THE APPLICATION

Insufficient information on your research project may lead to a postponement of your proposal. It is essential that amongst other information, the proposal should contain :

- **An outline of the scientific background and relevant features of the envisaged experiment.**
- **The reasons for carrying out the experiment at the HFR.**
- **A realistic date for the availability of all experimental equipment including samples (not provided by the ILL).**
- **The dates when it is absolutely impossible for you to carry out your experiment (see attached reactor schedule) in the scheduling period under consideration.**
- **The key-word number (see reverse side) and up-to-date list of references.**

Please respect also the following points when completing the proposal form :

MAILING OF YOUR PROPOSAL :

Each experimental proposal should be addressed to the Office of the Scientific Secretary (Dr Bernd MAIER, Institut Laue-Langevin, 156X, Centre de Tri, 38042 Grenoble-Cedex, France) from where it will be forwarded automatically to the pertinent review-boards.

DEAD-LINES FOR SUBMISSION :

The various subcommittees of the ILL which, in general, review each proposal, meet twice a year. For the submission of a proposal, a dead-line of one month prior to the subcommittee meetings has been established in order to allow for sufficient time to pass the proposal on to the different refereeing boards.

The dead-lines are :

FEBRUARY 15 and
AUGUST 31, respectively.

The dead-line is one week earlier in each case for ILL personnel and long term visitors.

The Office of the Scientific Secretary has to be very strict in respecting the dead-line. Proposals arriving after the dead-line will be automatically eliminated from the forthcoming review and submitted to the subsequent Council meeting 6 months later.

N.B. : If you intend submitting a proposal by post allow sufficient time for delivery before the dead-line.

FILLING-IN OF THE FORM :

- **It is compulsory for proposals to be submitted in English, since the members of the various review boards are of different nationalities.**
- **The text must be type-written.**
- **The available space on the form has to be strictly respected. Additional sheets will not be photocopied !!!**

CONTINUATION OF PROPOSALS :

If you intend to submit a proposal which implies a continuation of experiments you should not forget to send a report on the previous measurements. Experimental groups which have failed to supply a report will receive no further allocations of beam-time by the Scientific Council.

For these reports only the standard form issued by the Office of the Scientific Secretary will be accepted. The form is available on request from this Office or at the reception desk at ILL (for British users also from Mr D. Salter, Rutherford Lab., Chilton, Oxon).

ADDITIONAL INFORMATION WITH RESPECT TO YOUR PROPOSAL

LOCAL CONTACT :

The ILL requires that all external users have a permanent member of the scientific or technical staff of the Institut assigned to their experiment (local contact). The local contact would assist the user to prepare and perform his experiment with respect to scientific and technical aspects. Furthermore, as he will have had experience in running the instrument concerned, he will thus ensure an efficient utilization of the allocated beam time.

If necessary the pertinent College Secretary will help to establish such contacts. In case he cannot find an ILL collaborator interested in the research subject concerned, the external user is asked to proceed in one of the two following ways :

a - The user comes to Grenoble and discusses the envisaged measurements with competent ILL staff members and, this way, tries to find an interested local collaborator by himself.

b - The user sends one of his co-workers to the ILL for a sufficiently long period in order to become familiar with the instrument concerned. This co-worker can then fulfill the role of a local contact.

On being informed of the name of his local contact the user communicates with him as soon as possible to discuss the requirements, both scientific and technical, of the forthcoming experiment. For example, monochromator requirements, detectors positions, cryostat availability; all such items must be settled well in advance of the experiment date, in order to minimize losses of beam time.

REVIEW PROCEDURES FOR EXPERIMENT PROPOSAL :

A proposal for an experiment requiring beam time which has been received by the Office of the Scientific Secretary will be submitted to the pertinent College within the Institut and simultaneously forwarded to the members of the sub-committees of the Scientific Council. The College itself examines all new proposals with respect to the practical and technical aspects, with the sub-committees assessing the scientific merit and assigning priorities. There are at present 7 subcommittees :

- « Nuclear and Fundamental Physics »
- « Pure Crystals » (Excitations)
- « Crystallographic and Magnetic Structures »
- « Liquids and Amorphous Substances »
- « Imperfections »
- « Biology »
- « Chemistry ».

The Scientific Council of the ILL receives and reviews the recommendations from the various subcommittees and acts as an advisory committee to the Director who has the final authority. This Council serves mainly to coordinate the various projects, to establish general guide-lines for the scientific policy and to define priorities within the experiment programme of the Institut.

SCIENTIFIC COUNCIL DECISIONS :

Immediately after each meeting of the Scientific Council the user will be informed by the Scientific Secretary whether or not his research proposal has been accepted. He will also be informed at the same time of the name of his local contact.

EXPERIMENT TIME SCHEDULES :

Six monthly time schedules incorporating the Scientific Council decisions are normally compiled in the few weeks following a Council meeting.

It is therefore essential that requests for specific dates and modifications to suggested dates are communicated to the Scientific Secretary as soon as possible (by telephone or preferably in writing).

TIME VALIDITY OF ACCEPTED PROPOSALS :

The sub-committees of the Scientific Council will accept only as many experiments as can be actually carried out in a period of 8 months following a Council meeting. All proposals accepted and not carried out due to special reasons within 8 months from the date of acceptance will normally be automatically removed from the instrument programme, although the Council will, in a few necessary cases, deviate from this rule. If the applicants still maintain an interest in their proposal after the expiration of this time limit, they are then requested to resubmit their proposal to the next meeting of the Scientific Council. In this case an informal letter addressed to the Office of the Scientific Secretary will do. Since the Office of the Scientific Secretary, in general, gives three months notice of the time schedule for the experiment, the applicant will be able to see whether his work can still be carried out within the 8 months period, and still have sufficient time to meet the proposal dead-lines of February 15th and August 31st with a possible re-submission.

PUBLICATIONS :

a - Co-authors of the ILL in scientific publications :

ILL staff have spent a considerable time building up the existing facilities which are put at the disposal of users.
The Institut therefore, considers it natural that ILL staff participating extensively in the performance of user experiments will have a just chance to become co-authors of publications. Co-authorship should be discussed before starting an experiment.

b - Acknowledgement of the ILL in scientific papers :

For an organisation such as the ILL, providing experimental facilities and a forum for scientific discussions to a large number of scientists affiliated to other research institutes or universities, it is essential, for the enhancement of its professional and scientific reputation, that full acknowledgement be given in any relevant publication.
It is suggested that a foot-note to the title of the paper be added on the first page, mentioning a temporary affiliation to the ILL for the duration of the work carried out and in addition the publication should contain an acknowledgement, following the usual procedure, of the names of all ILL staff (as well as any ILL co-authors) who have made a major contribution to the preparation, performance or evaluation of the results of the experiment.

PAYMENT AND REIMBURSEMENT OF EXPENSES BY THE ILL

It should be noted that the ILL, in general, provides the neutron beams and standard measuring equipment, such as existing spectrometers, counters, standard cryostats and shielding equipment. It is normally assumed that any necessary special equipment including samples, will be provided by the neutron beam users.

The INSTITUT does not provide salaries for visiting users. If required, however, the ILL may reimburse for one experimentalist only, if his affiliation is a British, French or German laboratory or university, one round trip fare and per diem for a limited period, in which the experimentalist concerned actually prepares and carries out the measurements. If scientists from different laboratories are included on the original proposal, the above rules apply separately. It is only in exceptional cases that travel and subsistence fees for more than 1 experimentalist from the same laboratory can be supported by the ILL. Transport costs for major experimental facilities cannot be paid by the ILL. No subsistence allowances are granted for data analysis after the conclusion of an experiment. Exceptions to this rule need the approval of the Scientific Secretary.

Institut Laue-Langevin, 156X Centre de Tri,
38042 - GRENOBLE CEDEX - FRANCE
Tél. (76) 97-41-11

For travel problems, hotel accomodation etc. please telephone extension 82-82.
For all scientific problems (including time schedules) please telephone extension 82-44 (B. Maier) or 81-79 (G.A. Briggs).