



annual report 1975

institut max von laue · paul langevin
156 X-38042 grenoble cedex-france tél.(76)97-41-11

Application for use of I.L.L. facilities.

All research proposals should be sent to the Office of the Scientific Secretary :

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Institut Laue-Langevin
156X
38042 Grenoble Cedex
France

Tél. (76) 97.41.11 poste 82.44

Appropriate forms are obtainable on request from this office.

The closing dates for acceptance of applications are as follows :

August 31 and February 15.

All proposals are submitted to the Scientific Council for approval.

It should be noted that the ILL in general provides free of charge the neutron beams and standard measuring equipment, such as existing spectrometers, counters, standard cryostats and shielding equipment. Other special equipment, in particular samples, must be provided by the user.

The ILL pays for travel and subsistence of one experimentalist per experiment for personnel from laboratories of the 3 member countries.



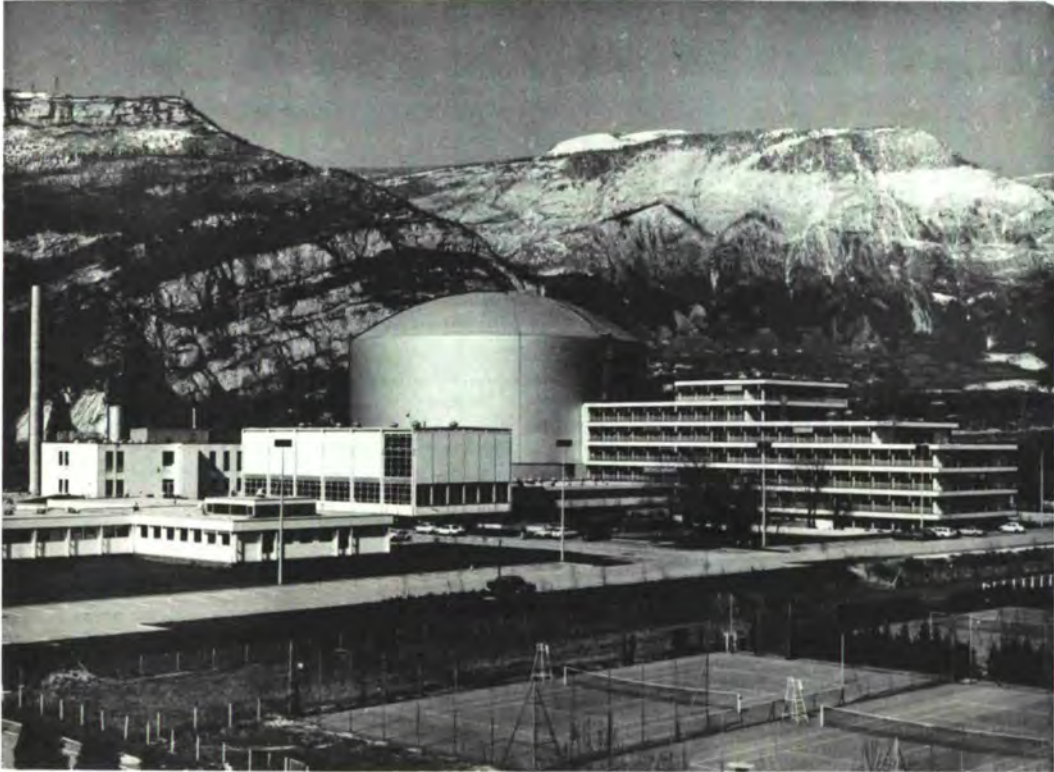
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The Institut Laue-Langevin with the Vercors Mountains in the background.

external organisation of the institut laue-langevin 1975

associates of the institut

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	same members					Kendrew	
						Miller	

internal organisation of the institut laue-langevin at 1.12.75

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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 institute 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 program. On January 1, 1973, the United Kingdom joined the Institute 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 :

- Gesellschaft für Kernforschung mbH Karlsruhe, Germany
- Centre National de la Recherche Scientifique, France
- Commissariat à l'Énergie 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 Institute 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 complementary 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 user's 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 Institute'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.



Meeting of the Scientific Council at the I.L.L.

introduction

GENERAL REMARKS ON THE INSTITUTE'S ACTIVITIES IN 1975

In 1975 the implementation of the programme of measurements approved by the Scientific Council continued to receive absolute priority.

On the whole the extensive programme ran satisfactorily, which was mainly due to the largely trouble-free operation of the reactor and the improved international collaboration between very varied laboratories and groups of research workers.

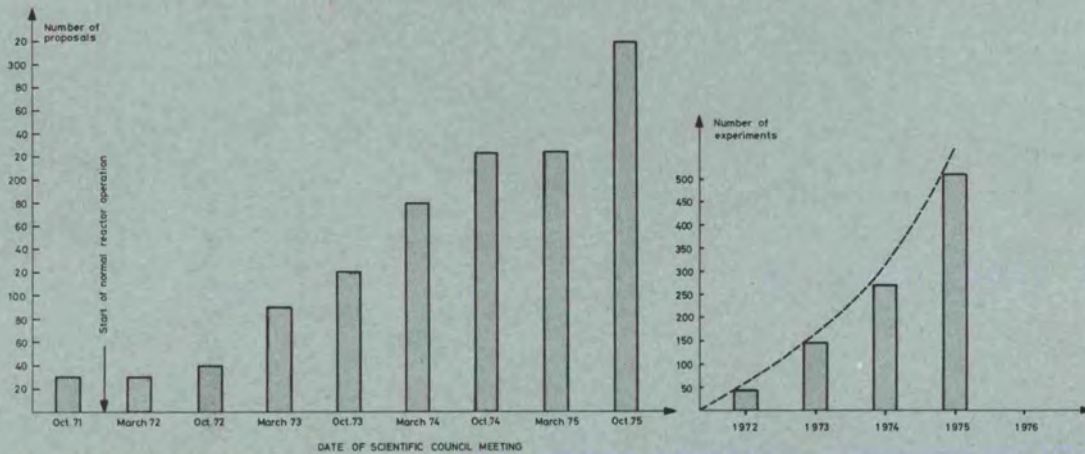


Fig. 1 : Development of the number of submitted scientific proposals during the first 4 years of reactor operation.

Fig. 2 : Development of the number of experiments carried out at the I.L.L. during the first 4 years of reactor operation.

The demand for measuring time on the neutron spectrometers and on the directly used neutron beams at the Institute is continually increasing, as shown by Fig. 1. This development is extremely welcome, but makes it increasingly difficult for the 7 Subcommittees, charged with the selection of the experiments, to choose among the proposals submitted. A direct consequence of this is the increasing demands on the scientific quality of the experimental programme to be carried out. The possibility exists of transferring to the other reactors some experiments which cannot be carried out in Grenoble purely because the capacity restrictions are very limited, but the majority of experiments proposed require either the high flux or the unique instrumental facilities of the I.L.L. In the long term, the situation may become somewhat easier, when a number of special spectrometers under construction at several medium flux reactors in the three member states have started operation and can be used in particular for preparatory experiments. In 1975 a total of 535 experi-

ments were performed at the I.L.L. ; individual experiments ranging in time from a few hours up to a complete year. About 1000 scientists from 136 different institutes in 16 countries visited the I.L.L.. The following table, which covers the period January 1, 1975 to December 31, 1975 illustrates the diversity and scope of the experimental programme :

EXPERIMENTAL PROGRAMME JANUARY 1-st TO DECEMBER 31-st 1975

Major areas of Scientific interest	Number of Instrument days	Number of Experiments	Number of Instruments Involved
Biology	216	49	4
Chemistry	237	41	6
Crystal Structure	623	60	8
Liquids and amorphous	466	52	10
Diffuse Scattering	307	59	10
Phonons	388	38	7
Phase transitions	121	11	4
Magnetic Structure	658	71	8
Magnons	190	20	4
Crystal field effects	125	14	3
Nuclear physics	947	62	6
Scientific test and feasibility experiments	284	58	21
Total	4562	535	

In addition to the implementation of the measuring programme, further progress was made on the development of new instruments and techniques within the limitations of available staff and technical and financial capacity. In some cases there has been close cooperation with other institutes and research centres in the three member states. The commissioning of three new spectrometers has again considerably increased the measuring facilities and capacity of the Institute. The new instruments are the triple axis spectrometer IN8, which has a particularly high

neutron flux, the four circle diffractometer D9, which operates on the hot source, and the diffractometer D3 operating with polarised neutrons. This means that at the end of 1975 there was a total of 27 different neutron spectrometers of varying types in routine measuring operation. In addition 15 special measuring points were available for on-line experiments on cold and thermal neutron guides. The research and construction work on a further 7 instruments continued and was restarted on 3 additional instruments. The instruments under construction included in particular a spin-echo spectrometer, an ultra-cold neutron source and a neutron interferometer. With all these instruments the I.L.L. is in the not too distant future approaching saturation of its instrument positions and thus the necessity of closing down existing capacity to permit the installation of new instruments.

To meet the excess demand for measuring time, the Institute made special efforts to rationalize further the utilization of the instruments in operation by suitable measures. It was possible in a number of cases to achieve considerable reductions in deadtime in instrument operation by technical modifications, such as improvements in the mechanical design, the software and the sample changing conditions. In addition special efforts were devoted to the development of high reflectivity monochromators, and in this field particular progress was made in obtaining homogeneous mosaic structures. There was also considerable progress in the development of efficient polarizers and analyzers for white neutron beams.

An excellent degree of utilization of the reactor operation was again achieved in 1975. A total of 6 168 operating hours was achieved out of a planned 6 288 hours including 492 hours operation at 45 MW. Allowing for scheduled and unscheduled shutdowns the reactor was available for 98% of the time for measuring operation. No nuclear incidents occurred during the year affecting the operation of the reactor and no members of staff were subjected to more than the permitted annual radiation dose.

Increasing difficulties resulted from the shortage of technical staff for operation and maintenance of the neutron spectrometers and the ancillary equipment in the field of electronics, cryogenics and furnaces. These difficulties increased with the commissioning of new spectrometers and made particularly difficult the implementation of the necessary shift work outside regular working hours. That part of the internal I.L.L. research programme concerned with new instrument developments was also necessarily delayed by these staff shortages. The previously separate sections "Electronics" and "Informatique" were combined into a new section "Instrument Control and Data Acquisition". A new central group of technicians has been set up to deal with urgent problems.

From 1982 it is possible in principle for the associates of the Institute to give 2 years' notice to withdraw from the I.L.L. In connection with this a technical commission has been established to prepare a realistic estimate of the useful life of the reactor, so as to provide a basis for the desired reconsideration of the life of the Institute by the governments concerned.

The total budget of the I.L.L. in 1975 amounted to 76.8 million Francs, and the number of staff was 395 (December 31, 1975).

The following report gives a survey of the state of the experimental facilities at I.L.L. and of the scientific work carried out in 1975.

Although the Institute in principle is devoting its entire scientific activity to fundamental research it is quite obvious that many experiments have been yielding results which are of close or immediate value with respect to possible applications. The present report covers also the main technical and administrative activities of the Institute.

Grenoble, January 5 1976

R.L. MÖSSBAUER.

instrumentation

introduction

The only innovation introduced into the organisation of the instrumental activity was the creation of a small "Central Group" of technicians in the Experimental Support Service, who are ready to be sent to any instrument or area, in an emergency, in order to rectify faults and ensure maximum utilisation by users of the available beam time. In general the organization works in a routine way, as it has to do in an Institut which has performed more than 500 experiments in one year, with 27 major instruments (including nuclear physics) in operation.

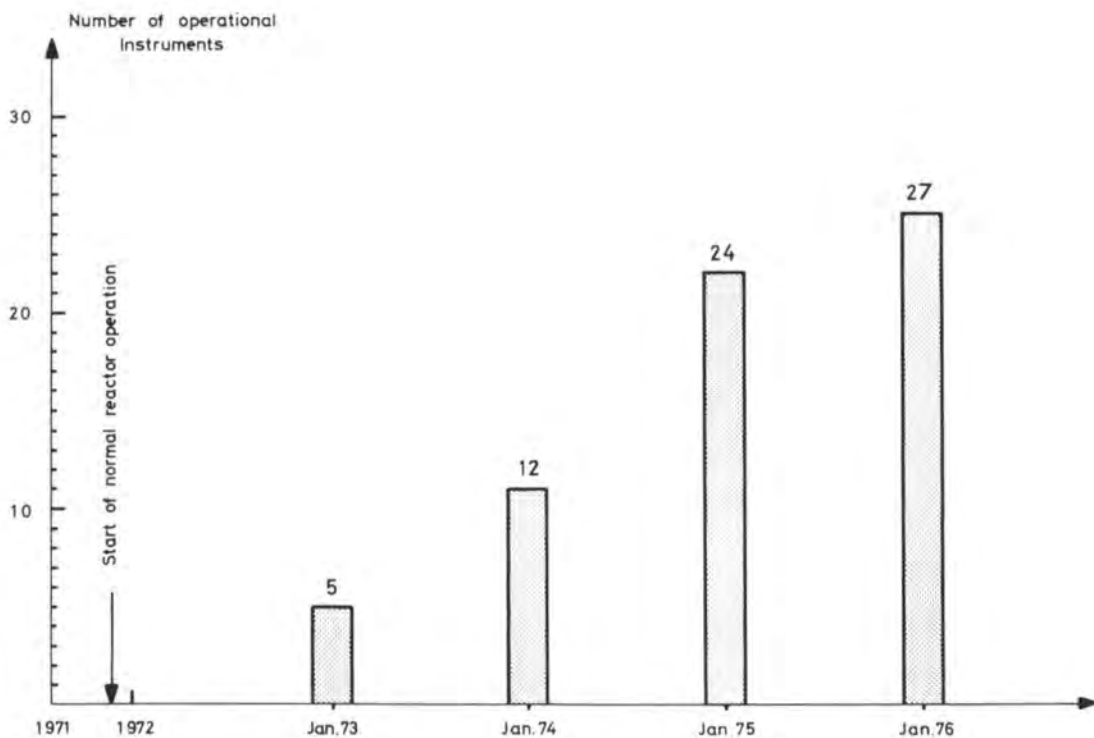
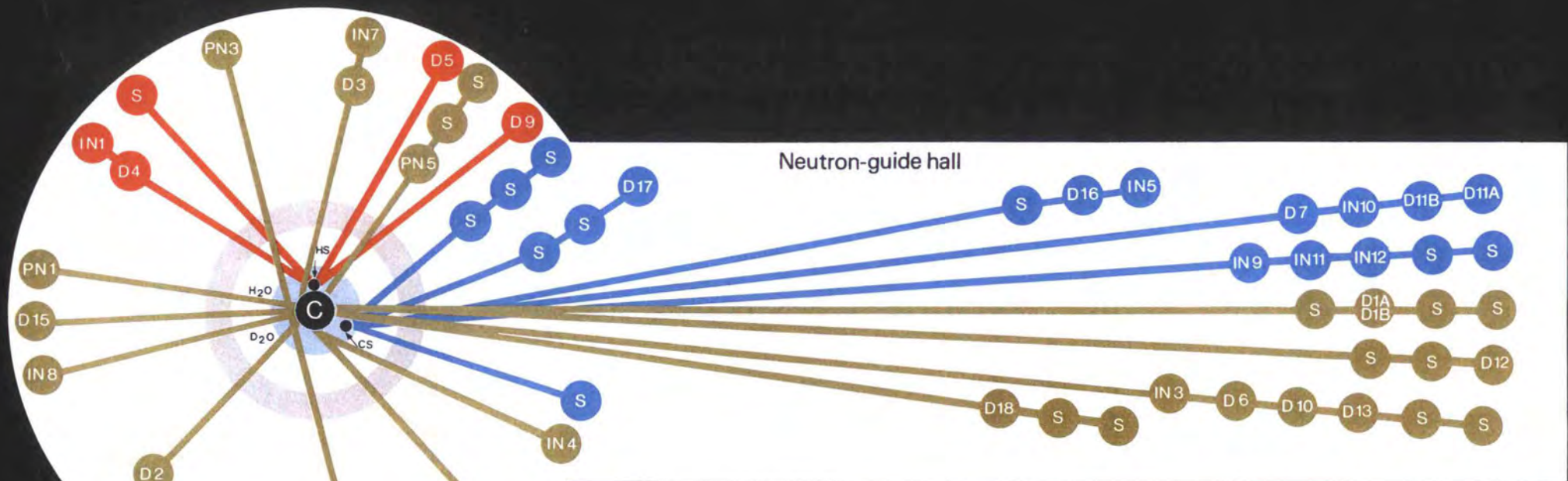


Fig. 3 : Number of operational instruments permanently installed covering the first 4 years of reactor operation.

beam tube arrangement and instruments at the H.F.R. of the I.L.L.



■ Hot neutrons	D1A TWO-AXIS (powders)	D11B Diffuse scattering apparatus	IN1 Three-axis spectrometer
■ Cold neutrons	D1B TWO-AXIS (powders)	D12 Diffractometer (mod. laue method)	IN2 Three-axis spectrometer
■ Thermal neutrons	D2 TWO-AXIS powders & single crystals	D13 Crystal testing apparatus	IN3 Three-axis spectrometer
C Reactor core	D3 TWO-AXIS (pol. neutrons)	D15 MARK VI Diffractometer	IN4 Rotating crystal spectrometer
HS Hot source	D4 TWO-AXIS (liquids)	D16 MARK VI Diffractometer	IN5 Multi chopper
CS Cold source	D5 THREE-AXIS (pol. neutrons)	D17 Small angle scattering apparatus	IN7 Statistical chopper
	D6 Hedgehog diffractometer	D18 Neutron interferometer	IN8 Three-axis spectrometer
	D7 Diffuse scattering apparatus	PN1 Fission product spectrometer	IN9 TOF polarisation spectrometer
	D8 Four circle diffractometer	PN2 Conversion electron spectrometer	IN10 Backscattering spectrometer
	D9 Four circle diffractometer	PN3 Gamma ray spectrometer	IN11 Spin-echo spectrometer
	D10 Three-axis el. scattering	PN4 Anti compton spectrometer	IN12 Three-axis spectrometer
	D11A Small angle scattering apparatus	PN5 Ultra cold neutron source	

- D Diffractometer
- IN Spectrometer for Inelastic Neutron Scattering
- PN Nuclear Physics Instrument
- S Special Beam Instrument

As for the new projects, we take into account the experience we have gained on the loading of existing instruments. As far as possible, within the manpower and budget limitations, we are attempting to respond to the trends which appear in the users' needs. This is typically the case for the small energy transfer spectrometers, etc.

In addition, with the decision to construct a neutron interferometer (with possibly a polarised version) and the launching of the Ultra Cold Neutron projects, we are pursuing our programme of innovation in neutron instrumentation.

It is clear that the development of our "instrumental park" is still vigorous.

The presentation of the instrument situation, in several tables, will follow the one adopted last year, and in addition, this year, we present a detailed description of the 3 new instruments (D3, D9, IN8) which became fully operational during the course of 1975.

TABLE 1 - INSTRUMENT OPERATION STATISTICS 1975

During 1975 the reactor operated for 257 days (of which 20.5 days were at 45 MW) out of a scheduled programme of 262 days. A number of unscheduled short shutdowns (17) occurred causing loss of beam time after start-up whilst waiting for the hot source to stabilise.

Instru- ment	Total opera- tional time (days)	Loss of beam time (days)	Coll. 3	Coll. 4	Coll. 5	Coll. 6	Coll. 7	Coll. 8	Coll. 9	Test + Ali- gnment Ex- periments + Setting-up time during change over of experi- ments.	
IN1	232.6	24.4		156.3		19.8	24.3		15.0	17.2	Beryllium Filter Facility installed
IN2	235.4	21.6		188.6			16.4			30.4	
IN3	189.8	12.2		115.8			33.6			40.4	Instrument out of commission from September 1975 to January 1976 for modifications.
IN4	232.0	25.0		60.8		40.0	63.5		26.6	41.1	
IN5	221.3	35.7		29.1		80.6	12.8	8.0	78.7	12.1	400 new detectors will be installed during 1976. At present 20 have been tested.
IN7	171.6	86.4					69.6			102.0	Proposals under discussion to increase the number of detectors in order to improve the throughput of experiments and complement IN4.
IN8	74.0			30.0						44.0	Commissioning and scientific evaluation experiments completed in November 1975. Instrument is now fully operational.
IN10	228.7	28.3	4.0	76.9		30.4	25.1		61.1	31.2	
D1A	234.0	23.0			175.8					58.2	The final reactor cycle of 1975 was devoted to the installation of a multi-detector and the subsequent tests.
D1B	236.4	20.6			119.5	9.8	10.3	3.8	9.1	83.9	Installation of new proportional multicounter during 1975
D2	211.9	45.1			122.0	14.2	10.7			65.0	New Soller slits installed (α_1 and α_3). Resolution greatly improved. Operation of the diffractometer has been simplified.
D3	205.3	7.7			162.7					42.6	This instrument became fully operational in March 1975. The ancillary equipment includes a superconducting magnet-max. field of

D1	238.0	19.0			123.8	58.4	25.8			29.1	Superconducting magnet available - field strength 48 KOe.	
D6	153.0	104.0			29.5					123.5	Work has continued to improve the experimental performance of this instrument. Further work is necessary. Suitable samples have been investigated where possible.	
D7	134.6	34.4				6.0	112.4			16.2	Instrument out of commission for 2 reactor cycles for installation of polarised neutron facility.	
D8	235.8	21.2			115.5			99.0		21.3		
D9	154.5	12.5			37.4			60.2		56.9	The commissioning and scientific evaluation of this instrument was completed during the year and it is now fully operational.	
D10	231.6	25.4		16.6	205.7					9.3		
D11A	221.9	35.1			2.0	12.0	74.4	83.5	28.1	21.9	The test experiments include 8.8 days for in-house test on reactor cold source material.	
D12			Continued use for suitable scientific evaluation experiments									Continuing development work on modified Laue technique using film methods. Installation completed of 2nd beam for Weisenberg techniques.
D13	227.0	30.0	This general purpose instrument was used for 93 short term experiments during 1975									Used for curved/planar monochromator research, sample orientation, neutron topography, etc.
D15			Installation on inclined beam tube completed									Diffractionmeter operating under computer control. Analysis of monoenergetic beam and resolution in progress.
D16	217.0	40.0			22.0			115.5		79.5	Continued use for biological feasibility experiments. Out of commission December 1975 for D17 construction.	
PN1	243.5	12.5	240.0							3.5		
PN2	186.8	26.2	164.8							22.0	The figures for the last reactor cycle (November/December) have not been included. PDP 11/20 installed during year.	
GAMS1	234.4	22.6	221.4							13.0	Instrument was briefly out of service for pair spectrum and modifications. Decay measurements taken during reactor shut-downs.	
GAMS2 GAMS3	222.0	35.0	213.9							8.1	This instrument is taken out of service when it is necessary to collect pair spectra.	
PN4	107.0		107.0								This spectrometer is used in conjunction with GAMS1. It is only operational when GAMS1 is out of the direct beam.	

TABLE II - PROJECTS IN PROGRESS (1975)

IN 12	Conventional Triple Axis spectrometer on a cold neutron guide. This instrument was delayed during 1975 for budgetary reasons. Final design is now completed and the spectrometer will be available to users by the end of 1976.
IN 9	TOF spectrometer with polarised proton filter for polarisation analysis of inelastic and diffuse scattering. The progress on this instrument has been hindered by the need to share a beam position with the developing IN 11 and by the low intensity and poor homogeneity of the available beam. At present the average polarisation of the target is 90% with a transmittance of 0.22.
IN 11	Major mechanical installation is now complete and the instrument is operating under computer control. Development work on magnetic mirrors is still continuing and it is expected that supplementary mechanical and electronic work together with instrument evaluation tests will occupy the first semester of 1976 after which an extensive period of scientific evaluation experiments will commence.
D 11 B	The scattering chamber and major in-beam items have been installed and the mechanical work is now complete. Installation of counting chain electronics and computer control is in progress and suitable experimental proposals will be discussed by the Scientific Council in March 1976.
PN 5 UCN	The project is now completely defined for all aspects including the temperature converter, guide and membrane. The detailed design has commenced at the Rutherford Laboratory for the "in-pile" section and at the I.L.L. for the external section and the security system. The principal contracts for the manufacture of the equipment will be placed at the end of 1975 and beginning of 1976 for a completion date set for October 1976.
D 17 S.A.S.	Penetration of Reactor Shell and installation of new guide is now complete. The instruments, electronics and computer control will be assembled and installed in April 1976.
D 18 A	This instrument, a neutron interferometer (with unpolarised neutrons), has operated successfully in its prototype form. It is now being rebuilt in its final version to enable routine approved experiments to be carried out.

TABLE III - PROJECTS UNDER DEFINITION

IN 10 B	This is a backscattering instrument designed to complement the performance of the present IN 10 and use the same beam. Detailed planning and cost evaluation is due for completion in June 1976 by which time it is expected the Spin Echo Spectrometer will have produced results enabling a definitive comparison to be made between the two systems.
IN 13	The scientific definition and cost evaluation of this instrument has a projected completion date of June 1976. IN 13 is envisaged as a Backscattering spectrometer with an energy range extending up to 200 μeV and a resolution of between 5 and 10 μeV up to a Q of 6 \AA^{-1} . Energy variation will be effected by a temperature scan of the monochromator.
D 18 B	Neutron interferometer with polarised neutrons.

TABLE IV - SPECIAL PROJECTS

Polarization Devices	<p>Work is continuing on a compact magnetic polarization system using Cu_2MnAl crystals. Polarizing mirrors are in a final stage of development at the Rutherford Laboratory and will be tested "in situ" on IN 11 in January 1976.</p> <p>Other methods of producing polarisation mirrors are being investigated at the CEN-Grenoble and devices with a polarization in excess of 95% have been produced. It is hoped to manufacture a small polarization guide on completion of transmission studies.</p>
Neutron Phosphor screen D 14	<p>This data collection system consisting of a ZnS screen activated with Li^6 or Gd and viewed by an image intensifier and TV ISOCON will be subjected to operational trials early in 1976. Summing circuitry problems have been largely overcome but for the time being image processing will be carried out in the DEC 10 due to memory limitations of the PDP 11/40.</p>
Monochromators	<p>High reflectivity Cu and NbD monochromators are produced routinely with variable mosaic spread between $5'$ and $90'$. Development of hot pressed Si and Ge crystals is continuing. Composite vertically and/or horizontally curved monochromator systems are in preparation.</p>

TABLE V - SPECIAL EXPERIMENTS

Instrument Number	College	Beam tube	Title
S 1	03-03-004	H 142 L	Weak interaction between nucleons
S 4	03-03-010	H 18 L	Magnetic moment of the neutron
S 6	07-04-002 A	H 25 U	In-beam NMR spectrometer
S 8	-----	H 22 U	Electronic Chopper
S 10	03-03-025	H 22 W	(n, α) - reactions
S 13	06-02-009	H 17	He-surface
S 14	03-03-001	H 142 L	Time reversal invariance
S 15	03-03-002	H 6	Parity violation in the $n + p \rightarrow d + \gamma$ reaction
S 16	03-03-016	IH 1	α - accompanied fission
S 19	07-06-003	H 18	Vortex in superconductors
S 20	07-03-045	H 24 W	Neutron topography
S 21	05-01-100	H 24 W	High precision lattice parameter studies near phase transitions
S 22	03-03-008	IH 3	Neutron bottle UCN
S 23	03-03-007	IH 3	Neutron storage ring for UCN
S 24	03-03-009	H 18	2 - γ decay in n-p capture
S 25	03-03-011	H 22 M	Protein content in seeds
S 26	03-03-012	D 16	2 π rotations
S 27	03-03-013	H 22 W	Chemical effects by n-capture
S 28	03-03-015	H 23 L	Isotope separator OSTIS
S 29	03-03-019	H 25	Neutron separation energy of ^{137}Xe
S 30	03-03-020	H 25 M	Concentration profiles by (n, α)
S 31	03-03-021	H 22 U	γ directional distribution of oriented nuclei
S 32	01-003 R	Special H 14	h/m determination

instruments which became operational in 1975

THE POLARISED NEUTRON DIFFRACTOMETER D3

D3 is a two-axis diffractometer designed for experiments in which the specimen is irradiated by a beam of polarised neutrons and the scattered intensity is measured. Measurements are made with the incident neutron beam polarised either parallel or anti-parallel to the ω -axis of the diffractometer which is usually the magnetisation direction in the sample.

The equipment is situated on the thermal beam hole H5, which it shares with the statistical chopper IN7 (see Fig. 4). A variable wavelength polarised beam is provided, since it is invaluable in the determination of extinction corrections and for checking on the significance of Renninger reflections. The flux available at 0.7 Å is still sufficient for this type of measurement, even though the instrument is on a thermal hole. Measurements at still shorter wavelengths can be carried out on D5 which receives its neutrons from the hot source.

The monochromator assembly is contained in a plug which can readily be replaced. Each plug contains a polarising monochromator magnetised by a permanent magnet and aligned to scatter the polarised beam in the horizontal plane. Adjustment of the monochromator angle, $2\theta_M$, is provided by a manually controlled stepping motor, the angle being continuously displayed. A set of wedges enables $2\theta_M$ to be varied in 3° steps between 18° and 51° . The wedge which carries the magnetic collimator also contains an R.F. spin flipper whose signal amplitude must be set by hand to that appropriate to the selected wavelength. Table 6 lists the available incident neutron wavelengths. The diffractometer can be moved manually to the pre-adjusted position for each wedge.

The diffractometer is provided with $2\theta, \nu$ (counter tilt out of the horizontal plane) and ω motions. The magnet at the specimen position can provide fields of up to 2 T in a 12 mm gap at room temperature and a cryostat is provided for work at 4.2 or 80 K at fields of up to 1.8 T. Positioning and the measurement and assessment of data are under the control of a dedicated PDP 11/40 computer. The computer is connected to the apparatus by a system conforming to the CAMAC standards. All diffractometer shafts can be driven simultaneously, either by hand switches or under computer control. All the angles are continuously displayed. The PDP 11 system contains programs which run the diffractometer and allow the user to assess data previously collected, inspect the status of the diffractometer and prepare a new programme of work. The system allows great flexibility in experimental design and makes it easy for individual users to provide control programs.

D3 Incident Wavelengths (Å)

$2\theta_M$ design	Cu_2MnAlI	Co_9Fe_8	$2\theta_M$	Cu_2MnAlI	Co_9Fe_8
18	1.074	0.5529	36	2.122	1.092
21	1.251	0.6439	39	2.293	1.180
24	1.428	0.7348	42	2.462	1.267
27	1.603	0.825	45	2.629	1.352
30	1.778	0.9146	48	2.794	1.437
33	1.951	1.003	51	2.957	1.521

A system of programs has been written for the DEC10 computer which enables the DEC tapes containing the results of experiments to be read and processed to give the ratios of magnetic to nuclear structure factors where polarisation measurements have been made or integrated intensity values for the two spin states when the measurements are step-by-step scans through Bragg peaks. Programs are also available for writing files to DEC tapes on the DEC10 which can subsequently be used to control experiments on D3.

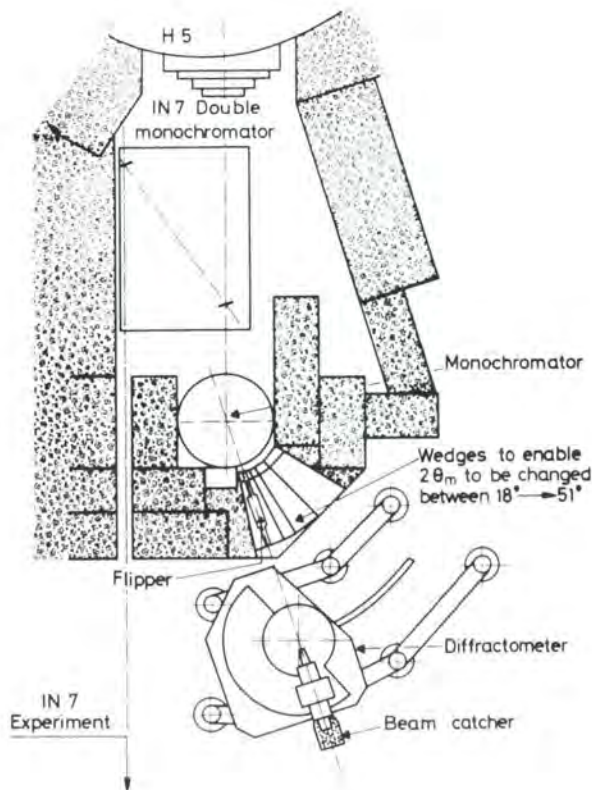


Fig. 4 : Schematic view of the new polarised neutron two-axis diffractometer D3.

THE FOUR-CIRCLE DIFFRACTOMETER D9 ON THE HOT SOURCE

D9 is a four circle diffractometer with the Eulerian cradle and detector placed on individual Tanzboden units. It is located at the hot source with a distance of 10 m between the source and the monochromator crystal giving very high resolution even for the short wavelength part of the spectrum. At present the monochromator crystal is a Cu(200) in transmission geometry giving at the sample position, at a distance of 2.00 m from monochromator, a flux of 3×10^6 n/cm²/sec for $\lambda = 0.5 \text{ \AA}$ increasing to the double at $\lambda = 0.8 \text{ \AA}$. The monochromator shielding is at present equipped with five fixed exits, giving access to the above mentioned wavelength range, but a protection with a continuous choice of monochromator exit angle is being constructed. The Eulerian cradle has full freedom in ϕ and χ over $\pm 180^\circ$ and the maximum angles are in the worst case for 2θ and ω 130° and 70° , respectively.

The diffractometer was finally aligned in January and February, and first attempts of extinction in BaTiO₃ and SrF₂ to phase determination in Gd and Sm Insulin. temperature measurements have been carried out by visitors as well as I.L.L. physicists ranging from hydrogen bond studies in α -glutamic acid, potassium hydrogen dicrotonate and N-benzoyl-DL-leucyl glycine ethylester over studies of extinction in BaTiO₃ and SrF₂ to phase determination in Gd and Sm Insulin.

The measurements on the above mentioned series of single crystals have shown that data of good internal consistency can be obtained, and taking into account that the short wavelength gives access to a larger portion of reciprocal space than usual, it is foreseen that the diffractometer will be used for high precision studies of simple compounds for example for use in combination with X-ray diffraction measurements for the study of electron density distributions. For this purpose a cryostat is at present being installed, which will give access to temperatures down to 40°K. In addition the wavelength range from 0.5 to 0.9 Å makes the diffractometer very useful for experimental phase determination using the anomalous dispersion of ¹¹³Cd and ¹⁴⁹Sm.

At present Cu and Ge monochromators are available, but when D₂ doped Nb monochromators are available they will be used and should give a two fold increase in the flux.

To exemplify the resolution and flux a $\theta - 2\theta$ scan of the 111 direction of a Cu sample crystal, 8 mm³ large, is shown (Fig. 5). The monochromator was Cu(200) in transmission with $2\theta_M = 17.0^\circ$ and $\lambda = 0.537 \text{ \AA}$. The natural background for a detector aperture of 1 cm² is of the order of 5 c/min, and the maximum accessible $\sin \theta/\lambda$ was 1.5 \AA^{-1} .

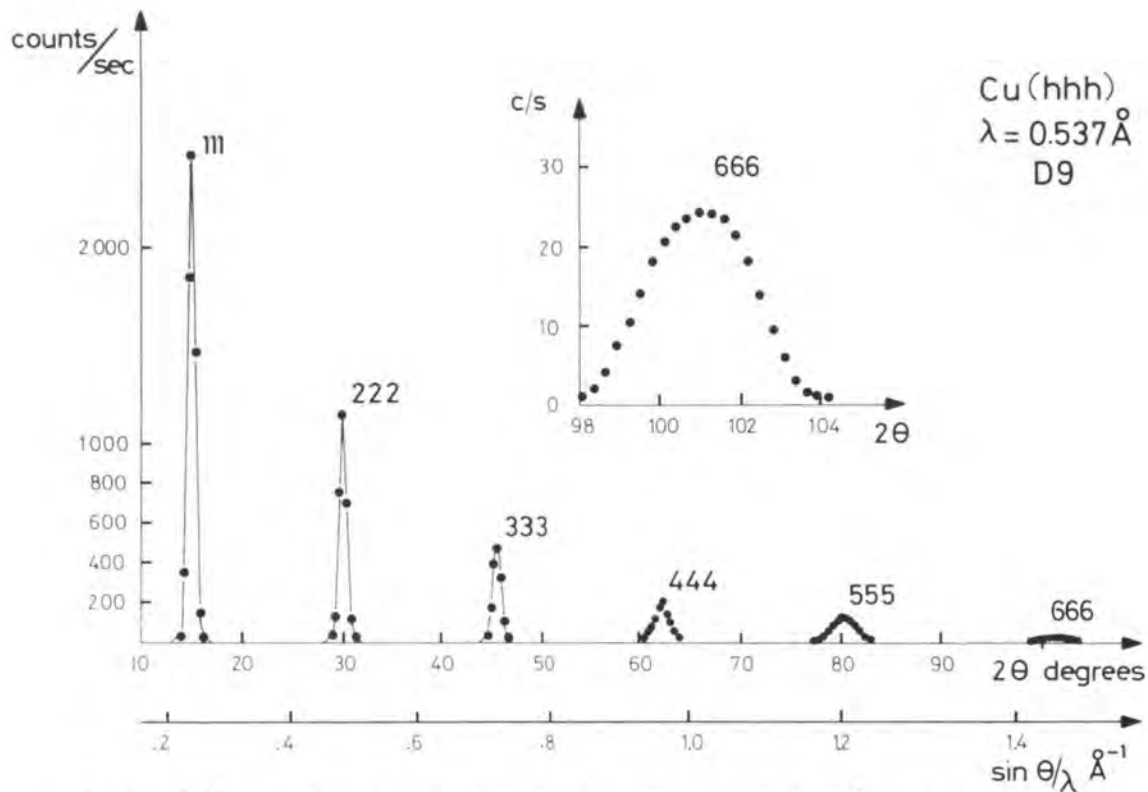


Fig. 5 : Θ - 2Θ scan of the 111 direction of a Cu sample crystal (8 mm^3) carried out on the new four-circle diffractometer D9 (J. Schneider and M.S. Lehmann).

THE TRIPLE-AXIS SPECTROMETER IN 8

IN 8 is a conventional, single monochromator, 3-axis spectrometer with variable incident energy, installed on thermal beam H10.

It is designed for inelastic measurements on single crystals over a wide range of energy and momentum transfer.

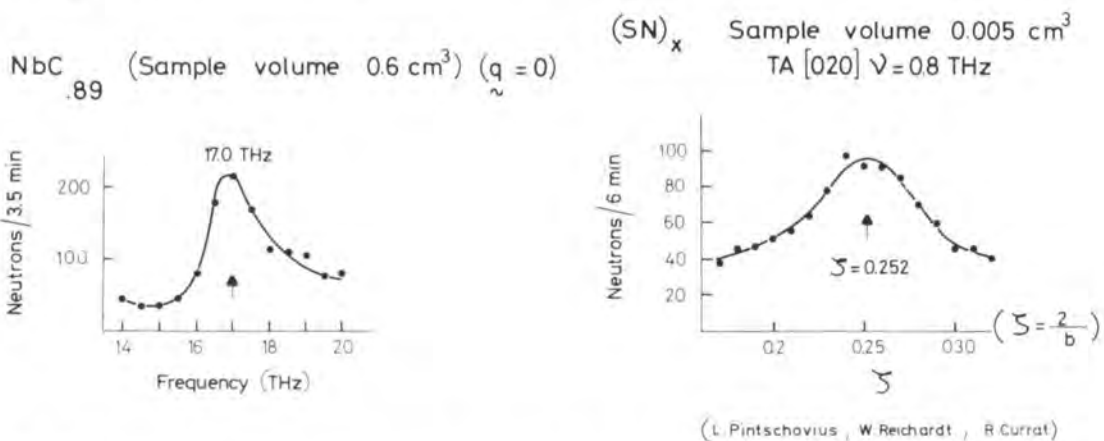


Fig. 6 : Two phonon groups obtained under very different conditions on the new three-axis spectrometer IN8.

INSTRUMENT CHARACTERISTICS

The attached sketch (Fig. 7) shows the principal features of the spectrometer :

1. Monochromator stage :

The incident wavelength selection is obtained through the simultaneous positioning of the monochromator (translation and rotation) together with the rotation of the shielding drum which supports the monochromator to sample collimator. The Bragg angle on the crystal monochromator can thus be varied between 10 and 45°.

In addition a set of 4 monochromator crystals are mounted on a rotating turret, in a semi-permanent way. The selection and alignment of the proper crystal is entirely performed from the control panel of the instrument.

Variable in-pile collimation (from 10 to 50') is also available.

2. Specimen table and analyser stage :

The rest of the spectrometer is essentially built from standard I.L.L. Tanzboden elements. The specimen, analyser and detector tables are connected to each other by sliding arms. This provides for some degree of flexibility in the adjustment of inter-table distances.

The heavy polyethylene and paraffin shielding around the analyser and detector is to compensate the high neutron background in that part of the Reactor Hall.

3. Presently the instrument is connected to the Carine 2 system.

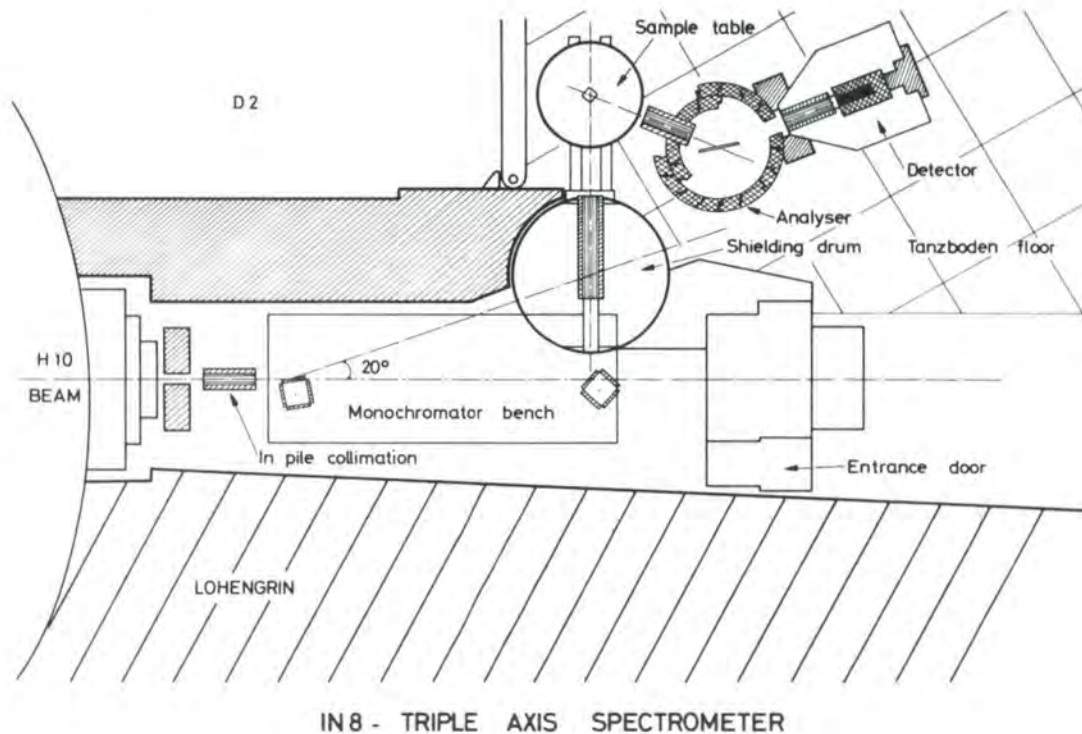


Fig. 7 : Schematic view of the new three-axis spectrometer IN8.

INSTRUMENT PERFORMANCE

1. Flux

Rough measurements of the monochromatic flux at the monitor position have been performed for a few crystals (PG 002, Cu111, Cu 220) at a few selected wavelengths. The results (summarized in table below) are compared with calculated estimates for the flux based on :

- the reactor thermal flux ($\phi \cong 1.2 \times 10^{15}$ n/cm²/s)
- the diameter of the source ($\phi \cong 10$ cm)
- the characteristics of the various crystals used (mosaic spread and reflectivity)
- the transmission of higher order filters (when used).

Crystal	Mosaic	ϕ Calc.	Reflectivity	Filter	ϕ Corr. Calc.	ϕ Meas.
Cu 220 ($K_i=4,7\text{\AA}^{-1}$)	23'	$3.3 \cdot 10^7$	50%	no	$1.65 \cdot 10^7$	$1.3 \cdot 10^7$
Cu 111 ($K_i=4.7\text{\AA}^{-1}$)	30'	$7.8 \cdot 10^7$	40%	no	$3.1 \cdot 10^7$	$3.4 \cdot 10^7$
Cu 111 ($K_i=2.67\text{\AA}^{-1}$)	30'	$4.1 \cdot 10^7$	40%	PG (60%)	$1.0 \cdot 10^7$	$0.75 \cdot 10^7$
PG 002 ($K_i=2.67\text{\AA}^{-1}$)	30'	$7.5 \cdot 10^7$	60%	PG (60%)	$2.7 \cdot 10^7$	$2.8 \cdot 10^7$
PG 002 ($K_i=1.54\text{\AA}^{-1}$)	30'	$1.8 \cdot 10^7$	60%	PG (60%)	$0.65 \cdot 10^7$	$0.45 \cdot 10^7$

Comparison between measured and calculated fluxes (n/cm²/s).

The agreement is seen to be quite satisfactory in view of the uncertainties inherent in both the measurements and the calculation.

Comparative intensity measurements have also been made using standard samples (TiSe₂, MgF₂, FeRh etc.).

They show a gain in flux of a factor of 5 to 10 over IN2 (at 14 meV incident energy). With respect to IN 1, the instrument seems to be competitive at least up to 15 THz (energy transfer).

2. Background and Resolution

Systematic background measurements have not been performed. Comparative measurements seem to indicate that the signal to noise ratio is as good as on IN 2 and in general better than on IN 1.

The resolution ellipsoid has been mapped out using a perfect crystal and found to be in reasonable agreement with a Cooper-Nathans type calculation.

3. Two phonon groups obtained under very different conditions are enclosed in order to illustrate the capabilities of the instrument at high and low energies (see Fig. 6).
4. A schematic presentation of the instrument is given in Fig. 7.

instrument group1 «conventional three-axis spectrometers»

- IN1 : on the hot source (beam-tube H8)
- IN2 : on thermal beam-tube H13
- IN8 : on thermal beam-tube H10
- IN12 : on cold guide H142.

This year has seen the continued operation of IN1 and IN2 and the final commissioning of IN8. At the same time a clear decision was taken to go ahead with the design and construction of IN12.

IN1 – HOT SOURCE 3-AXIS (J. Copley and D. Tocchetti)

In general the instrument has been operating satisfactorily despite the need for a major overhaul. Since the machine is unique and in heavy demand, an extended shut-down has not been seriously contemplated so far. An effort to lower the instrument's background is planned for the near future.

As usual, most of the experimental work has been in the field of high energy magnetic excitations (FeRh, FeO, NiS, Mn, Heusler alloys), and high energy phonons. In addition several chemistry experiments have been performed using the Be filter analyser-detector in conjunction with an Al monochromator. The highlight of the year was undoubtedly the ^{60}Ni experiment by H. Mook and coworkers which led to the first measurements of "optical" magnons in this substance.

IN2 – THERMAL BEAM 3-AXIS WITH A DOUBLE MONOCHROMATOR.

(B. Dorner)

Because of the priority given to the construction of IN8 and IN12, IN2 has not been the object of any important technical development, except for the installation of a precision drive on the monochromator drum.

Once again, the instrument has proved very productive and versatile in the medium energy range, as illustrated by the variety of experiments performed during the year : phonon measurements in AgBr, TBBA, Si under pressure, irradiated Al ; studies of anharmonic effects in K, CuCl ; studies on phase transitions in SbSI, RbCaF₃, TbVO₄, TmAsO₄, NaOD ; studies of low dimensional features in phonon or magnon dispersion curves in CsNiF₃, TiSe₂, PbI₂, HgI₂, GeS ; etc.

In the future some improvement in the flux is to be expected with the installation of larger graphite monochromators. The availability of higher thermal fluxes on IN8 will probably restrict the future use of IN2 to experiments which require either large scattering angles or good horizontal and vertical q -resolution.

IN8 – THERMAL BEAM 3-AXIS (R. Currat)

The instrument is now fully operational. A series of tests has shown a substantial gain in flux in the medium energy range, as compared to IN2 without any appreciable loss in signal to noise ratio. At higher energies the instrument appears to be competitive with IN1 for energy transfers up to 15 THz. The good performance of the instrument, in terms of flux and background, is the result of the following features: single monochromator, heavy casemate and analyser shielding, short distances and better quality crystals.

On the other hand, some flexibility in the operation of the instrument is lost due to severe angular limitations. The instrument has been available for scheduled experiments since November 1975.

IN12 – 3-AXIS ON A COLD GUIDE (W. Stirling)

After a reappraisal of possible positions for this instrument (either H142 or the inclined hole H1), a definite decision has been taken to construct IN12 on the cold neutron guide tube H142. Also several modifications have been made to the mechanical design. This machine should be more compact and should move faster than conventional I.L.L. 3-axis instruments. A study of alternative computer control systems to the CARINE system is under way. Construction will begin in the summer of 1976 and first operation is expected during the first half of 1977.

Co-ordinator : R. Currat.



The new three-axis spectrometer IN8.

instrument group 2

«special triple axis spectrometers»

The group includes the following instruments :

D10 : Four-circle diffractometer at the thermal neutron guide H24

IN3 : Three-axis spectrometer at the thermal neutron guide H24.

D10 – FOUR-CIRCLE DIFFRACTOMETER AT THE THERMAL GUIDE H24.
(C. Zeyen)

Improvements :

1. The whole software has been completely rewritten in collaboration with programming staff and D8/D9 responsables. It is easier to use, significantly faster and now performs automatic crystal centering sequences. A faster printer has been installed, reducing output times.
2. The reliability of the cryostat (4-circle) at low temperatures (~ 10 K) has been improved. A new cryostat for temperatures below 4.2 K is being designed. A temperature stabilized housing for the electronic racks has been installed for more reliability and better stability of temperature control units.
3. A new vertically curved Cu(200) monochromator is currently being tested. It is expected to enhance the flux at the sample by at least a factor of 3.
Performed measurements : user experiments

Measurements performed by users :

- (a) Low temperature structures : $\text{TEA}^+(\text{TCHO})_2$ – (4000 independent reflections measured the first time at I.L.L.).
 Al(OH)_3
- (b) Room temperature structures : BaTiO_3 (extinction problems, measurements at different λ 's)
- (c) Diffuse scattering (Huang –, Critical –) : (using the instrument in the D10B configuration)
 MgO , K_2SnCl_6 , Anorthite, ND_4Cl
- (d) Magnetic properties : CrB_2 , $\text{Gd}^{160}\text{Cl}_2$
- (e) Electron density work (metal-metal bonding) : p-nitro pyridine N-oxide.

IN3 – TRIPLE AXIS SPECTROMETER AT THE THERMAL GUIDE H24.
(R. Scherm)

IN3 has now been in continuous operation since March 1974 for scheduled experi-

ments as a standard triple axis machine.

The program to use curved analyzers as "neutron-lenses" has been pursued further. The "zoom lens", a curved graphite analyzer the curvature of which is computer controlled, has been used routinely. It proved especially useful for the measurement of flat branches (gain in solid angle factor 5). It is intended to put more emphasis on this development in the following year.

Since September 15 the spectrometer has been subject to a major modification with the following aims :

- new mechanics allow accurate positioning ($1/100^\circ$)
- improved monochromator and analyzer-detector shield
- E_0 can be scanned automatically
- quick and reproducible change of monochromator, analyzer crystals, collimators, diaphragms and filters. (This permits us to adapt energy or resolution rapidly to the problem without having to go through a cumbersome alignment procedure).

IN3 will be operational again on February 1 1976.

Co-ordinator : R. Schem.

instrument group 3 «time of flight»

This group covers the following instruments :

- IN4 : Rotating crystal spectrometer on thermal beam-tube H12
- IN5 : Multi-chopper spectrometer on the cold source H16
- IN7 : Instrument on the thermal beam-tube H5 including two versions :
 - IN7A : Mechanical statistical chopper spectrometer
 - IN7B : Periodic chopper spectrometer

The test assembly for electronic chopper called S8 has been partially dismantled but remains free for new developments in this technique as regards the main elements (High magnetic field pulse modulator).

IN4 – ROTATING CRYSTAL SPECTROMETER (J.B. Suck)

(for 1975-first six months : Instrument Responsible : W. Drexel)

In 1975 25 experiments were performed on the TOF instrument IN4. The results were excellent in resolution and statistics. For one of these measurements the rotating crystal system was replaced by a Fermi-type chopper borrowed from Karlsruhe Research Centre (GFK). This alternative should be studied in more detail in 1976. An air-lock system has been mounted on the IN4 horizontal cryostat, allowing much more rapid sample changes than before.

Extensive neutron background measurements were performed which show that noise can be drastically reduced by better shielding the detector area. This was effected during the annual reactor shutdown in October. At the same time, the flight path between the primary and secondary spectrometers was improved and shielded.

In the near future it will be necessary to have a better reproducibility of sample position, according to the device (cryostat position, etc.) as well as for detector mounting. The latter can be achieved by completing the present number of detectors (136) to the total capacity of 244, eliminating any change in detector position.

Still not completely solved is the question of more efficient crystal monochromators of suitable size for the IN4 beam (10 x 8 cm)

In 1976 there will be available a furnace (up to 400°C) which is being built jointly with IN5. The data acquisition system will be bridged by a NOVA computer on loan from GFK (Karlsruhe) until the existing Nicole system can be replaced by a new one currently under study at I.L.L.

IN5 – MULTICHOPPER SPECTROMETER (F. Douchin and R. Lechner)

In 1975 thirty-seven experiments were carried out, corresponding to an average beam time of about six days per experiment. Using the IN5 program package developed in 1974, most of the experimental data was immediately corrected and transformed to the scattering law, in preparation for theoretical analysis by the user.

The continuity of instrument running has improved throughout the year, and in particular during the summer period. Spectrometer development has continued in four main directions :

1. Improvement of resolution

This can be achieved by increasing chopper speed beyond the present 10,000 rpm (and to a maximum of 20,000 rpm), and by allowing use of wavelengths between 11 and 20 Å for small Q measurements.

For safety reasons the first point is developed on two choppers of the Bertin-I.L.L. model supplied after the first four were used on the spectrometer itself. The corresponding power-units were supplied by ISPRA Euratom Centre, one in June and the other in December 1975. Long-range tests were begun in September and will lead to an increase in chopper velocity by the spring of 1976. A test station has been mounted for this purpose in the I.L.L. neutron guide hall. For long wavelength work a special chopper wheel (one slot) has been supplied and mounted. The corresponding electronic phasing system could not be supplied by ISPRA and is under development at the I.L.L. electronics section (SCIAD). The water cooling system of the choppers has also been changed to give more flexible service.



Chopper disk for the multi-chopper spectrometer IN5.

2. Data acquisition system
The Nicole computer-linked acquisition system of IN5 was changed to a CAMAC standard during the October annual reactor shutdown, allowing better maintenance conditions, new facilities for data handling and spectrometer control, and further developments such as automatic wavelength changing control, and simultaneous measurements of three or four spectra (sample, sample holders, vanadium, etc.). Remote monitoring by the Reactor Control Room staff has proved very efficient for the choppers all through the year but has still to be improved for data acquisition problems.
3. Sample environment
The instrument cryostat works satisfactorily but must be modified in 1976 to allow simultaneous measurement of three samples and lower gradient. The lifting device will also be changed for the same reasons and a larger sample helium-filled box mounted. The 400°C furnace developed by I.L.L. and SEDTI (CENG) was delivered for testing in December. It allows measurements with very low gradients and very thin material in the beam. This furnace can also be mounted horizontally on the IN4 spectrometer. A standardised system of spare parts allows preparation and a quick succession of experiments on the facility.
4. Detector system
Following the decision of the I.L.L. Directors to authorize the purchase of 400 new ^3He detectors for IN5 during 1975 and 1976, a first group of 20 new detectors has been ordered for tests. The aim of these tests is to secure perfect matching of the new detectors with the 400 already mounted ones and long-range stability. The complete system is planned for mounting during the October 1976 annual reactor shutdown, but operation can be partially started earlier. Simultaneously, the maximum number of spectra will be increased from 64 to 128 with better grouping possibilities.

General Problems

A great improvement in the life of chopper ball bearings has been noted in 1975 : roughly from 3000 to 6000 hours. This seems to result from precautions taken to avoid grease pollution and from the effects of continuous vacuum pumping. The consumption of Helium in the main flight path has also fallen by a factor of two. This factor was maintained after an accidental opening of the area. The proportion of air in Helium is monitored by periodic sampling. The detector angles are always changed by technicians according to a permanent schedule, saving time and electronic problems. A short test experiment has been performed using such low angles as two degrees which has shown that the neutron background remains very low under those conditions.

IN7 – STATISTICAL CHOPPER – FERMI CHOPPER SPECTROMETER (A.P. Murani)

Since becoming reoperational in late 1974, after installation of D3, the spectrometer has been used to carry out some long-delayed experiments mainly involving studies of crystalline electric fields in metallic systems. However, the limitations of the

statistical correlation method with a fixed duty cycle (50%) for observing small inelastic scattering peaks in the presence of large incoherent elastic scattering from the sample soon became apparent in many of these experiments.

A Fermi chopper has been installed recently inside the concrete casement with the sample position just outside it, and a new detector arm allowing a flight path of 2 m between the sample and detectors has also been constructed. The gain in flux (factor 3) plus the larger solid angle subtended by the detectors at the sample (factor 4) are however outweighed by the smaller duty cycle ($\sim 1\%$) of the Fermi chopper. Within the limited available space in this configuration it would be possible to increase the number of detectors by a factor of 5. This will enable the spectrometer to be useful in sharing some of the load with IN4 for experiments not requiring very high resolution. The original statistical chopper and the movable detector arm (flight path 4 m) will also be available for any experiments calling for their use.

Co-ordinator : F. Douchin.

instrument group 4 «crystallographic instruments»

This group includes the following instruments :

- D6 : Hedgehog Diffractometer with 100 movable counters on the thermal guide H24
- D8 : Four-circle high flux diffractometer on the thermal beam tube H11
- D9 : Four-circle diffractometer on the hot source (H3)
- D12 : Neutron film techniques on the thermal guide H23
- D15 : Four-circle Mk6 diffractometer on the inclined thermal tube IH4
- D16 : Four-circle Mk6 diffractometer on the cold source (guide tube H16)
- Li4 : Three-circle Siemens X-ray Diffractometer.

D6 – THE HEDGEHOG DIFFRACTOMETER (B. Klar, K. Ziebeck)

The 100 movable counters operate with respect to zero positions which are defined by mechanical microswitches. As it appeared that these zero positions have changed slightly with time, it was decided to remeasure them. For this purpose, the Eulerian cradle was replaced by a theodolite at the centre of the sphere. The centres of the 100 detectors were then measured under different conditions and the results analysed with a computer program. In collaboration with D. Hohlwein, a new curved Ge monochromator (dimensions 230 x 20 x 4 mm, radius of curvature 6.8 m, mean wavelength 2.3 Å) was tested and yielded promising results. At the same time a new motorized monochromator support was installed.

D8 – FOUR-CIRCLE HIGH FLUX DIFFRACTOMETER

(S. A. Mason)

D8 has operated satisfactorily during the whole year, and no mechanical modifications have been necessary. The "elastic-diffraction" mode of operation - fixed angle graphite analyser between sample and detector - has been used for routine collection of protein structure data. A new monochromator-to-sample collimator system has been designed to allow α_2 to be changed more easily. A closed-cycle refrigerator for $T > 40$ K has been ordered ; it is similar to the D9 device. A much more flexible program control system, common to D8, D9, D10 is under test : it includes rotation about the scattering vector, automatic centering, etc. The latest flux measurements on D8 gave 1.54×10^7 n cm⁻² s⁻¹ at 1.2 Å.

D9 – FOUR-CIRCLE SHORT WAVELENGTH DIFFRACTOMETER

(M. S. Lehmann)

This diffractometer was commissioned in 1975 and the first routine measurements have shown very satisfactory results. The flux, $3 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ at 0.5 \AA and $5 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ at 0.8 \AA from Cu [200] in transmission is probably not sufficient for the proposed application of anomalous dispersive phasing of large structures, at least until multidetectors become available. However, the relatively good flux at very short wavelengths makes D9 unique for high spatial resolution work on small molecules. With this change of emphasis, the demand for D9 is expected to increase dramatically when the refrigerator now being installed becomes available early in 1976. Temperatures down to 40 K in the four-circle mode will be possible.

D12 – NEUTRON FILM TECHNIQUES (D. Hohlwein)

The primary beam has been split for Weissenberg and Precession cameras in addition to the Modified Laue camera ; the latter is based on a bent copper monochromator which gives a flux of $9.8 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ for a wavelength spread of 7% at 1.3 \AA . With the recently completed programs for the automatic film scanner at Orsay, the intensities of 2000 reflections on 35 films were measured. In 1976, a cryostat will extend the range of application to magnetic structures, structural transitions and critical scattering. A greatly increased demand for these techniques can be expected when they become more widely known outside the I.L.L.



The new four-circle Mark VI diffractometer D15 on the inclined hole IH4

D15 — FOUR-CIRCLE Mk6 DIFFRACTOMETER ON AN INCLINED HOLE
(M. Thomas and S. Wilson)

The initial difficulties in mounting a major instrument on an inclined hole were overcome, and installation was completed by the end of 1975. The shielding is now adequate and the instrument has been aligned both optically and with neutrons. Flux measurements using dysprosium and gadolinium give $7 \times 10^9 \text{ n cm}^{-2} \text{ s}^{-1} \text{ \AA}^{-1}$ at the monochromator and $8 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ at the sample for 1.17 \AA neutrons from Cu [331] in transmission at an angle of $2\Theta_M = 90^\circ$. The area of homogeneity at the sample is 1 cm^2 . Final tests are underway, but the instrument will be available for scheduling at the spring 1976 meeting of the Scientific Council. As well as four-circle structure work at high flux, D15 can also be used with a large cryostat in the lifting counter mode. Temperatures down to 1.5 K can then be obtained, and the diffractometer will be unique for magnetic structures and critical scattering.

D16 — FOUR-CIRCLE Mk6 DIFFRACTOMETER ON A COLD GUIDE
(G. Zaccai and S. Wilson)

This instrument shares a PDP8 computer with D15, and an additional 24 K of memory has recently been purchased to permit greater flexibility in the programming and data collection. D16 is increasingly used for biological structure work because of the long wavelengths available : between 2.2 \AA and 5.5 \AA from an $80'$ pyrolytic graphite monochromator, with a Be filter above 3.95 \AA to reduce $\lambda/2$. The flux is $4 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ at 2.4 \AA , but of course depends on the collimation selected. Söller collimators at the counter can also be used for high resolution small angle scattering. A multidetector, which we hope to have in 1976, should greatly increase the data collection rate.

Li4 — THREE-CIRCLE X-RAY DIFFRACTOMETER (M. Thomas)

This instrument can complement the neutron diffractometers for work on XN difference techniques, since a nitrogen gas flow cryostat is available. In 1976 it is hoped to replace the paper tape data collection with a simple magnetic tape unit.

Co-ordinator : 1975 M. Thomas
1976 A. W. Hewat

instrument group 5 «diffuse scattering»

This group includes the following instruments :

On the cold guide H15

- IN10 : Back-scattering spectrometer
- D7 : Diffuse scattering spectrometer
- D11A : Small angle scattering spectrometer
- D11B : Small angle and diffuse scattering spectrometer
- S19 : "Vortex" small angle diffractometer on cold guide H18
- D17 : New small angle scattering spectrometer under construction on an extended cold guide H17.

1. — APPARATUS IN FULL OPERATION

IN10 – BACK SCATTERING SPECTROMETER

(A. Heidemann, S. Howells)

The instrument has been running successfully during its second year of full operation. 28 experiments have been performed, corresponding to about 20 scientific projects. Three publications have already appeared, six are to be published and the remaining experiments are as yet incomplete due to insufficient measuring time.

The main fields investigated were :

- Quasi elastic incoherent scattering in liquid crystals, plastic crystals, polymers and polymer solutions, metals and metal hydrides and superionics
- Critical scattering (an investigation of the central mode in Sr Ti O_3)
- Hyperfine interactions.

A number of important improvements and extensions have been made to the apparatus in 1975.

1. The number of detectors has been increased from 5 to 8 enabling spectra at 8 different Q-values to be measured simultaneously.
2. The number of Si(311) analysers has been doubled.
3. A second Doppler drive has been constructed and put in operation, doubling the previous energy range ($\Delta E = \pm 18 \mu\text{eV}$ for Si(111) and $\Delta E = \pm 30 \mu\text{eV}$ for Si(311)).
4. For investigation of critical scattering at phase transitions the mechanics were extended to include step-motor controlled sample orientation, and movement of a new analyser arm. A Be-filter was introduced to eliminate higher order contamination. For this experiment new sapphire monochromators and analysers were tested and put in operation.

$$\text{Al}_2\text{O}_3 (222) \quad E_0 = 4.2 \text{ meV}, \quad \Delta E (\text{FWHM}) = 0.8 \mu\text{eV}$$

$$Q\text{-range} = 0.01 < Q < 2.9 \text{ \AA}^{-1}, \quad \Delta Q \sim 0.005 \text{ \AA}^{-1}$$

Flux at specimen $5 \times 10^3 \text{ n cm}^{-2} \text{ S}^{-1}$ after chopper (duty cycle 30%)

5. The memory of the PDP11 has been extended from 8 to 16 K and a connection to the PDP10 established. The software has been greatly extended and on-line BASIC programming is now possible. Data may be transferred directly to and from the PDP10 enabling on-line data treatment during an experiment. Further improvements planned for next year include better positioning of the analyser container and codable goniometers and turntables to be controlled by the computer.

D7 – DIFFUSE SCATTERING APPARATUS (W. Just, P. Radhakrishna)

During this year the instrument was modified to operate with polarized neutrons for the first time (J.F. Barthélemy and R. Rebesco) and functioned in this mode for three reactor cycles. The very satisfactory performance was demonstrated in magnetic diffuse scattering experiments on a number of systems (eg Cu-Ni, Fe-V, P. Radhakrishna et al). Improvements of the polariser are planned in order to increase the flux - the present polariser is $\text{Cu}_2 \text{ Al Mn}$. Dr. K. Mika of KFA-Jülich has supplied a package of programs which allow rapid data analysis of diffuse scattering scans. These programs were adapted for use on the PDP10 by O. Tillier.

D11A – SMALL ANGLE SCATTERING SPECTROMETER

(K. Ibel, J. Haas)

1975 was the first year of uninterrupted operation where losses in measuring time were less than 20%. Difficulties caused at the beginning of the year by a high background of epithermal neutrons have been largely solved by better shielding of neighbouring thermal guides. A breakdown of the medium-resolution mechanical selector "Brunhilde" in June allowed some improvements to be made during the period of repair. Notably the maximum speed of rotation was increased, giving a maximum Q-value of 0.9 \AA^{-1} .

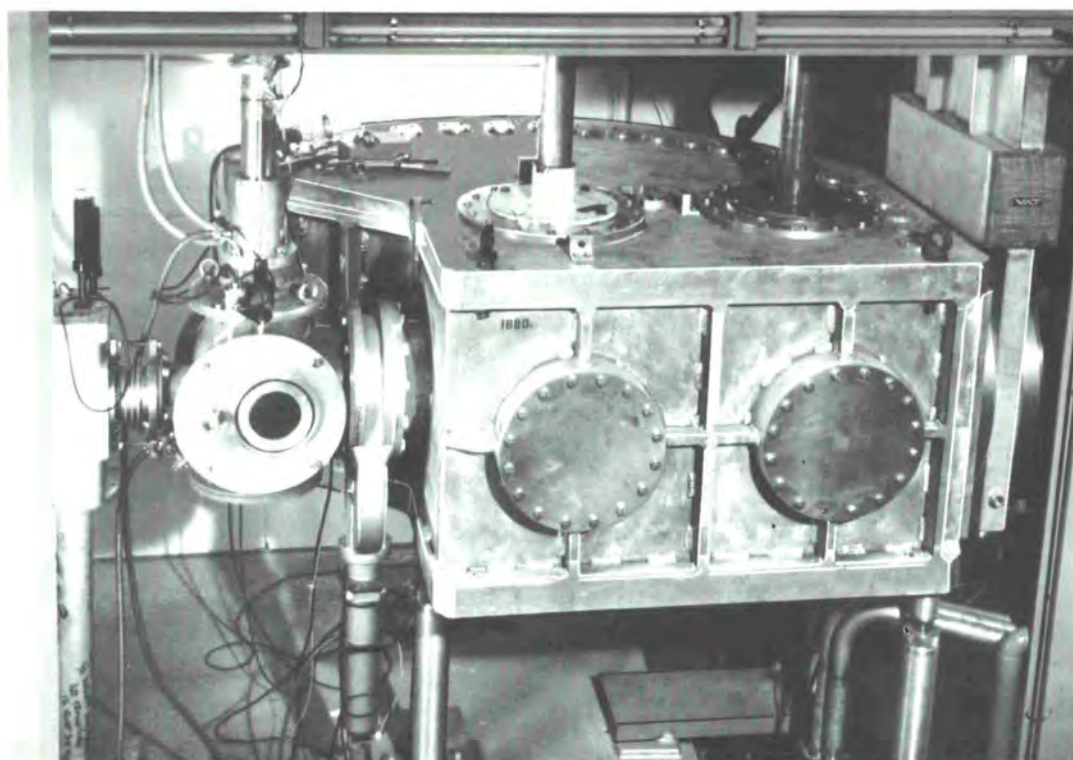
A large sample vessel associated with the implementation of D11B has been installed during the long shut-down in October causing no major difficulties at the subsequent start-up. This installation also includes a chopper near the sample position and allowed first inelastic experiments to be performed in November.

2. – APPARATUS UNDER CONSTRUCTION

D11B – SMALL ANGLE AND DIFFUSE SCATTERING

(G. Kostorz)

The new diffuse scattering bank, a large gate valve to separate the diffuse scattering vessel and the long tube containing the D11A multidetector, and other in-beam components have been received from the Rutherford Laboratory which is participating in the realisation of the D11B instrument. The mechanical integration of D11B into the D11A beam line and vacuum system was completed in early November 1975. Scheduled experiments on D11A are now continuing using the new sample ports, an entirely modified vacuum control system, and the new platform and shielding structure around the sample area (which also includes a chopper). The shielding will be completed on the IN12 side in 1976, and the platform will be modified to allow access to the H14 side of the instrument and convenient use of all sample ports.



The new small angle and diffuse scattering spectrometer D11B

The D11B detectors (32 helium-3 detector tubes) have been installed and will be linked to the data acquisition system in early 1976. All hardware is available and the software development is progressing on the PDP 11/40 with the DECRSX 11 D operating system. This computer will also control D11A data acquisition and common devices like velocity selector, background shutter, goniometers, sample changers, etc. The PDP 11/40 will allow for on-line data treatment within limits that are currently being studied. A data line to the DEC 10 computer will also be provided.

A cryostat with a five/eight-position sample changer for use on D11B has recently been tested at the Rutherford Laboratory and will be delivered to I.L.L. in early 1976.

D19 – "VORTEX" SMALL ANGLE DIFFRACTOMETER (P. Thorel)

This elementary small angle scattering apparatus was operational for two months from 10 June to 8 August. Experiments included study of lamella dichalcogenides (Nb Se_2) and preliminary tests of sample choice for experiments on direct measurement of the flux show velocity in type II semiconductors.

The wavelength of the incident neutrons varies between 18 and 32 Å. The angular resolution is 0.4° giving $\Delta Q = 4 \times 10^{-3} \text{ \AA}^{-1}$ at 20 Å. The wavelength resolution $\Delta\lambda/\lambda = 7\%$ and the flux on the sample is $5 \times 10^3 \text{ cm}^{-2} \text{ s}^{-1}$ at 20 Å.

The instrument is equipped with a liquid He cryostat containing a goniometer coupled to a superconducting coil producing a maximum vertical field of 2 Tesla. S19 will be rebuilt at the beginning of 1976 with some modifications giving higher flux at the longer wavelengths.

D17 – SMALL ANGLE SCATTERING SPECTROMETER (M. Roth)

The decision to construct a new small angle scattering apparatus was taken during this year and work is already under way. The H17 cold guide has been extended into the neutron guide hall. The computer has been delivered and the software is being tested. The mechanical construction and the electronics have both been started. The installation and first tests are planned for spring 1976 and it is hoped to have the apparatus operational for visitors in early summer.

The spectrometer will use 10 Å incident neutrons and cover the region of reciprocal space between 3×10^{-3} and 1 \AA^{-1} with initially a 10% resolution. This resolution will later be improved and equipment for polarised neutrons will be installed. Several possible polarising and analysing systems are under consideration.

Co-ordinator : Julia Higgins.



Part of neutron guide for D17, the new small angle scattering apparatus (under construction). The picture also shows the space between the outer (concrete) and inner (steel) shells of the reactor building.

instrument group 6 «powder spectrometers»

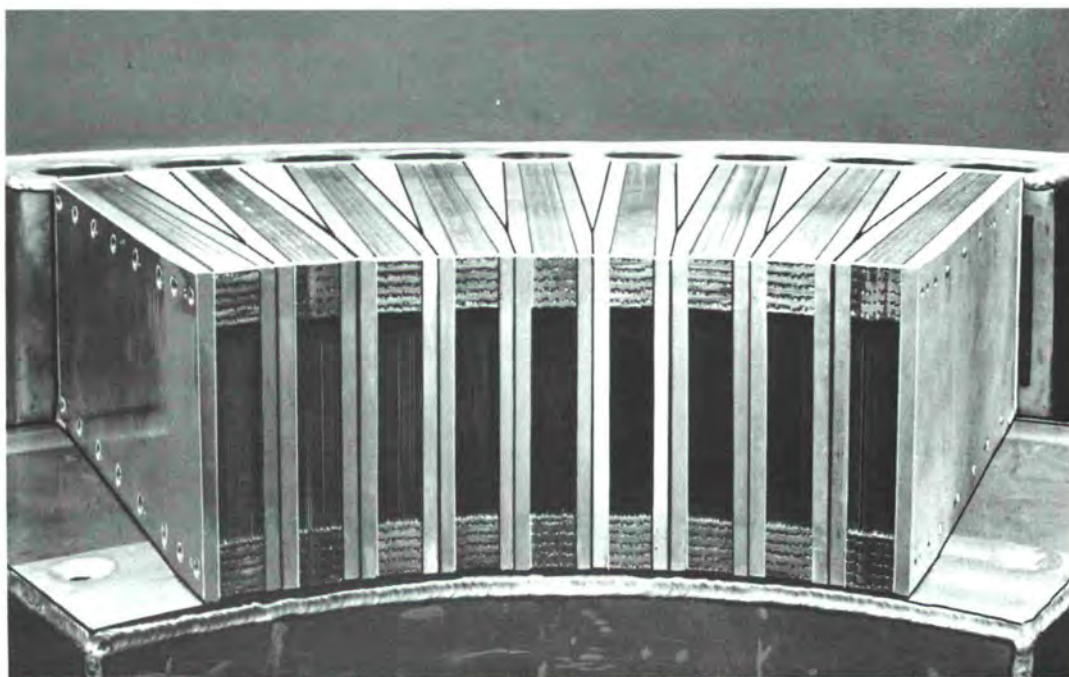
This group includes the following instruments :

- D1A : Two-axis high resolution diffractometer for powders and single crystals on thermal guide H22
- D1B : Two-axis diffractometer with multidetector on thermal guide H22
- D2 : Two-axis high flux diffractometer for powders and single crystals on thermal tube H11
- D4 : Two-axis "liquid spectrometer" on the hot source, tube H8.

D1A – TWO-AXIS HIGH RESOLUTION DIFFRACTOMETER FOR POWDERS AND SINGLE CRYSTALS

(A. W. Hewat)

D1A now has a much improved performance, due mainly to the replacement of the old single counter by a bank of eight high pressure helium counters with mylar foil collimators. These 10' collimators, the first fruit of a Rutherford Laboratory development, transmit over 95%, each giving a gain factor of x4 over the old collimator/counter. The total intensity gain is therefore x30. The line shapes for the different collimators, even at high resolution, are identical, so there is no problem in adding together the profiles. However, the effective intensity of D1A is still only 20% of that of D2, which has the advantage of being on the reactor itself, rather than on a guide tube.



New mylar foil collimator bank for the high resolution powder diffractometer D1A. This increases the effective intensity by a factor of 30, a little larger than the gain factor of 25 predicted by Lomer and Hewat (I.L.L. report 1974).

D1B – TWO-AXIS DIFFRACTOMETER WITH MULTIDETECTOR

(P. Convert and P. Thorel from November 1975)

The good performance of this instrument now is well known. The stability is better than 0.3% on 4 days and 1% on 2 months. The accuracy of intensity measurement on the whole multidetector is near 1%. The resolution is good : $\Delta d/d = 0.8\%$ (FWHM) with a wavelength of 2.4 Å and a sample diameter of 10 mm. The simultaneity of measurement on a large continuous range of scattering angle (80°) is found to be very interesting particularly for new types of experiments (samples cooled with a dilution cryostat down to 0.06°K ; very high temperatures, 2200°C ; kinetic experiments ; physisorbed gas ; . . .). We have built and used satisfactorily a system of continuous rotation (5 or 10 rpm) of the sample in a variable temperature cryostat with measurement of the temperature on the sample during the rotation.

D2 – TWO-AXIS HIGH FLUX DIFFRACTOMETER FOR POWDERS AND SINGLE CRYSTALS

(C. Berthet until 31.10.75, K. Ziebeck from 1.11.75)

The instrument has worked satisfactorily all the year. The efficiency of the protection of the 4 counters bank has been increased with polyethylene for fast neutrons. The background has also been reduced by two means : use of a large vacuum vessel around the sample, and improvement of the protection around the monochromatic beam just before the sample.

Tests of the first prototype of 10' collimator (built by the Rutherford Laboratory) have been performed and have given very good results. The 4 definitive collimators will be installed at the beginning of next year.

D4 – TWO-AXIS "LIQUID SPECTROMETER" ON THE HOT SOURCE

(H. Egger until 31.7.75, P. Chieux and W. Knoll from 1.8.75)

For all the year 1975 the instrument has been fully operational and practically free of failure. A few modifications have however been implemented for the convenience of the users. A "Silent" teletype with "mini-cassettes" has been installed for data acquisition thus avoiding the cumbersome paper tapes. The furnace assembly has been modified for quicker mounting and faster replacement of the vanadium heating element ; its installation has now become an easy one-man job. Finally the removal of the Zn monochromator often requested for work in the H8 casemate has been made more practical and safer.

Co-ordinator : P. Convert.

instrument group 7

«polarized neutron instruments

This group has two instruments :

- D5 : Three axis polarization analysis neutron spectrometer on the hot beam H4
- D3 : Two axis polarized neutron diffractometer with a tilting counter for use in normal beam geometry on the thermal beam H5.

GENERAL

D3 became available for scheduled experiments in March 1975 and has shown since then that it is a very fast and efficient instrument for collection of polarized neutron data from magnetic crystals in the "classical" mode. The availability of D3 means that D5 can be used more regularly for experiments which exploit its special features of polarization analysis and access to short wavelength polarized neutrons.

The cryomagnet which will enable experiments to be done on either D5 or D3 in fields of up to 4T at temperatures down to 15K was delivered during the summer. It will be in almost continuous demand for scheduled experiments on D5 and D3 during 1976.

D5 has been in continuous use for a very wide range of experiments during 1975. During the year improvements have been made to the polarizing monochromators and to the D5 software package on Carine.

D3 – TWO-AXIS POLARIZED NEUTRON DIFFRACTOMETER

(see general chapter "Instrumentation")

D5 – THREE-AXIS POLARIZATION ANALYSIS NEUTRON SPECTROMETER



The new polarised neutron two-axis diffractometer D3.

A new Heusler alloy Cu_2MnAl monochromator has been installed during the year. This crystal is $50 \times 50 \times 14$ mm in size and has been installed in the same magnet gap as the Co Fe monochromator.

The monochromators can be exchanged by simply translating the magnet. The flux obtained by using the Heusler monochromator is a factor four greater than that obtained from the Co Fe crystal but a $\sin \theta/\lambda$ value for the same wavelength is half as large.

The flux increase has necessitated the installation of additional lead shielding around the beam.

The Carine program for general use in controlling D5 has been re-arranged to give a significant saving of time when setting up an experiment.

Co-ordinator : J. Brown.

instrument group 8 «monochromators»

Instruments belonging to this groupe :

- D13A : Neutron double-crystal diffractometer on thermal guide H24
- D13B : High resolution neutron double-crystal diffractometer on H24
- D13C : Neutron single-crystal orientation unit on H23
- D18A : Neutron Interferometer on H25
- LI2 : X-ray double crystal diffractometer
- LI3 : Gamma-Ray diffractometer
X-ray orientation device.

1. Instrument Development

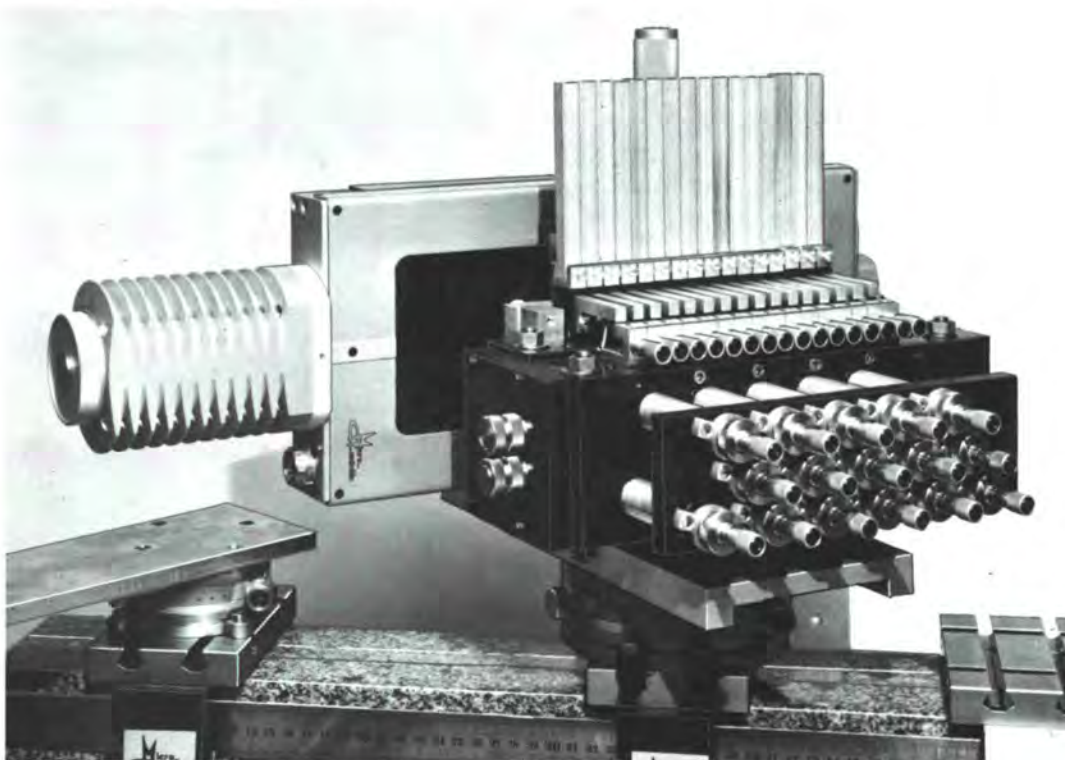
The x and z translation tables of the neutron diffractometer D13A are now step motor controlled. An automatic test of large single crystals on many points of its surface is possible due to special electronics controlling these step motors. Also the orientation of the elements of composite monochromator systems or of bent crystals can be checked automatically. The construction of the high resolution diffractometer D13B has been completed and tested. The reliability of the "inchworm" driving system has to be improved before this instrument will be operational. The data output of D13A, LI2 and LI3 can now be collected by magnetic tape cassette recorders and transferred more conveniently to the DEC computer system. Also in 1975 diffraction profiles, lattice constants and reflectivities of many neutron monochromators and samples have been measured routinely, e.g. 800 rocking curves on pure and deuterated niobium. A modification of the γ -ray diffractometer now also allows the use of the γ -radiation for Compton scattering experiments. The final installation of D13C depends currently on budgetary decisions, the plans having been completed. A report on D18A is given in the chapter on special instruments.

2. Development of monochromator materials

In 1975 the main effort has been concentrated on the production of copper and niobium monochromator crystals with well-controlled and uniform mosaic structure. The special cold-working procedure of initially nearly perfect, large copper crystals as well as the deuteration of niobium yielded fairly reproducible results. The mosaic spread can be varied at will between 5' and 90' for copper and between 15' and 70' for niobium. It turned out that Cu is

the better material for small and medium mosaic spread whereas NbD should be used at large mosaic spread ($\geq 30'$) and for especially high energy neutrons. Some data : nine NbD samples (13 mm diam. x 50 mm), all prepared for a mosaic spread of $30'$ at the T.U. Munich, had a mean width of the 45 measured neutron rocking curves of $31.3'$ with a mean standard deviation of $\sigma = 7.7'$. The absolute reflectivity determined in transmission geometry was about 35% for the 110 reflection and $\lambda = 1.5 \text{ \AA}$.

Twenty copper crystals ($5.0 \times 5.5 \times 50 \text{ mm}^3$) were cut out of a plate deformed for a mosaic spread of $15'$. The mean width of the rocking curves measured on these samples was $12.1'$ with $\sigma = \pm 2.0'$. The peak reflectivity reached 73% in reflection geometry at $\eta = 11'$, $\lambda = 1.5 \text{ \AA}$, 200 reflection, crystal thickness 5 mm. Under the same conditions Be does not perform better. The instruments equipped with newly developed Cu monochromators were D2, D8, D9, D10, D15, IN8. In the case where this corresponded to a change of the monochromator, the neutron flux at the sample increased by at least a factor 2 at more or less the same resolution.



Orientation device for assembling composite monochromator systems

3. Composite Systems and Bent Crystals

The construction of an orientation device for assembling composite flat, singly or doubly curved monochromator systems has been completed. This device is shown in the photograph equipped with 16 crystals each $10 \times 10 \times 100 \text{ mm}^3$. The crystals can be adjusted independently to better than $1'$ parallel to a given orientation about horizontal and vertical axes. A set of Cu

(Ge) crystals with different lattice spacings has been assembled and tested on D13A in order to obtain a focussing neutron lens. Preliminary tests of the system on IN3 are promising. The production of composite vertically and/or horizontally focussing NbD, Cu and Ge monochromators on the orientation device are in progress.

4. Diffraction Studies of Imperfect Crystals

Neutron white beam topography has been used on D13A for investigating several types of crystals, e.g. Fe_3Si , Al_2O_3 , etc. revealing coarse subgrain structures or inclusions in large samples. This non-destructive technique turned out to be very useful for selecting crystal regions out of as-grown crystal rods before cutting. Model calculations for the interpretation of neutron diffraction properties of bent perfect crystals such as Si and Ge were successful. Experimental and theoretical studies of the real optimum thickness of neutron monochromators as a function of mosaic spread and wavelength are under way. The work done at the I.L.L. in the past few years on the X-ray, γ -ray and neutron diffraction properties of imperfect "mosaic" crystals with special application to neutron monochromators has been summarized in a review article (I.L.L. publication 75F236S).

Co-ordinator : A. Freund.

instruments for nuclear physics

The instruments allocated to this group are given in the following list. The first three spectrometers have unparalleled mass or energy resolving power in their domain.

- PN1 : Mass Separator for Unslowed Fission Products (LOHENGRIN) on beam tube H9
- PN2 : Beta Spectrometer (BILL) on the vertical beam tube V3
- PN3 : Curved Crystal Spectrometers (GAMS 1, 2, 3) and
- PN4/PN4A : Ge Anti-Compton and Pair Spectrometers on the through going beam tube H6/H7
- S1 : Gamma Asymmetry Spectrometer on neutron guide H14
- S28 : On-Line Mass Separator for Thermally Ionized Fission Products (OSTIS) on neutron guide H23.

PN1 – MASS SEPARATOR LOHENGRIN FOR UNSLOWED FISSION PRODUCTS

(H. Schrader)

The construction and the tests of Lohengrin were completed in mid 1974. These tests showed a very satisfactory performance of Lohengrin, which in turn contributed to a high demand for the facility. Therefore no major modification was made on the separator in order to allow continuous operation of Lohengrin in 1975. In that period 39 experiment runs on 22 different proposals and 4 test runs have been made. The separator beam was available for 243 days corresponding to a working efficiency of about 94% and to an average of about 6 days/run, including a set-up and calibration time of the order of 1 to 2 days/run. The instrument is only equipped with standard detectors, including a second Ge(Li)-detector since December 1975. Therefore more complicated detector devices were brought by visitors, e.g., a TOF spectrometer (TH Darmstadt), Ge(Li)-detectors with coincidence electronics (University of Mainz and CENG), a computer analyser Inter-technique Multi 20 (CENG), an ionization chamber with 4-parameter data collection system (Euratom Ispra), etc.

Important results have been obtained on nuclear charge yields of ^{236}U -fission (see report of College 3 and Annex to the Annual Report).

For high resolution work it could be shown that the stability of the deflection voltage ($\sim 500,000$ V) is in the order 3×10^{-5} . However, due to other instabilities the very high mass resolving power $A/\Delta A \sim 15,000$ already achieved in 1974 could not be attained again. Further efforts will be made to improve the resolution. For spectroscopy on fast decaying radioactivities a multi-capillary gas-jet transport

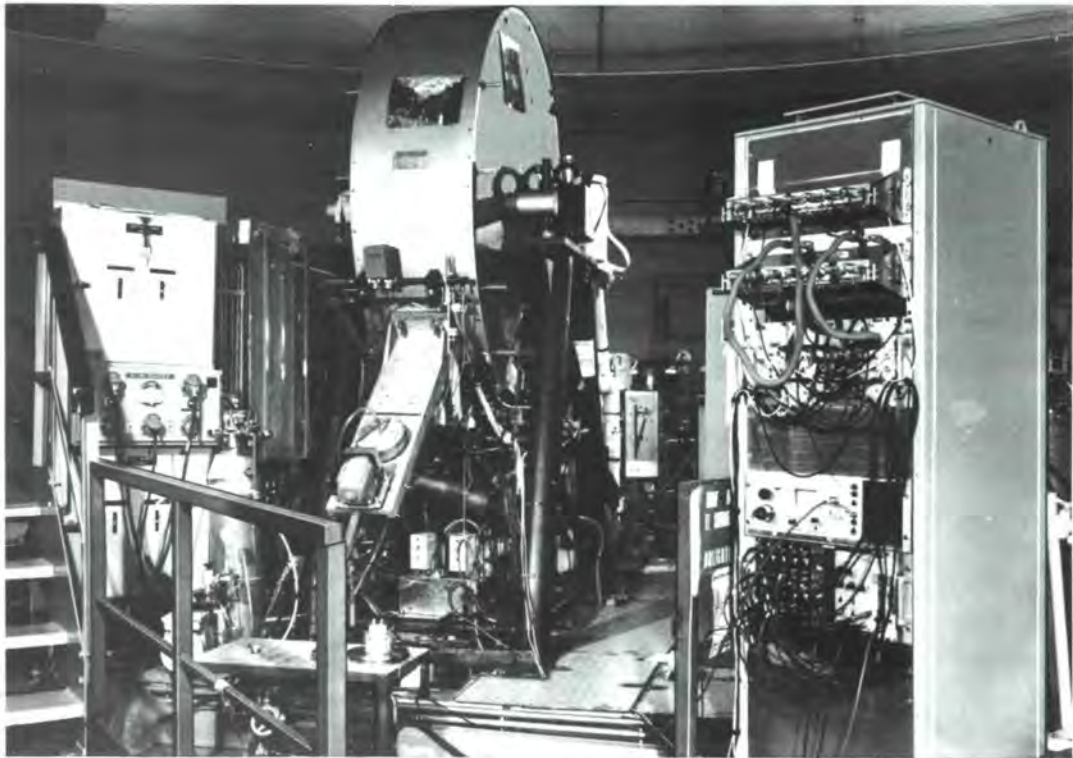
system came into operation. It has about 80% transport efficiency for most of the fission products (except rare gases and halogens) down to half-lives of 1 s. It has been tested successfully for γ -spectroscopy, Q_{β} - and P_n - measurements.

PN2 – BETA SPECTROMETER BILL (K. Schreckenbach)

In 1975 parallel to the measurements on eleven isotopes the stability and linearity of the field stabilization have been improved. In addition, a better energy reproducibility of the measurements has been achieved. The general features of the beta spectrometer have been determined as the following :

1. The best measured momentum resolution of $\Delta p/p = 8 \times 10^{-5}$ (at 300 keV) makes this instrument the most powerful of its kind. A remarkable resolution of 3×10^{-4} is obtained for routine measurements, i.e., 30 eV at 50 keV and 1.6 keV at 5 MeV.
2. The sensitivity could be increased using a new multiwire detector for energies down to 17 keV. The smallest measurable partial cross section for the (n,e^-) reaction has been proved to be 15 mbarn at 20 keV, 0.3 mbarn at 400 keV and 0.01 mbarn at 7 MeV for one normal run. For transition of particular theoretical interest the sensitivity can still be increased by repeated scanning in this region.

Due to these remarkably good features, the instrument is suitable for measurements with more information in nuclear physics and even open for measurements in atomic and solid state physics.



The conversion electron spectrometer BILL (PN2), with its 276° deflecting magnet

PN3 – CURVED CRYSTAL SPECTROMETERS GAMS 1 AND GAMS 2/3

(H. Börner, W. F. Davidson)

All three curved crystal spectrometers were operational during 1975 so that it was possible to carry out complete and reliable measurements on 11 different isotopes. The following improvements to these instruments were carried out, principally during reactor shut-down periods.

1. Considerable improvements were made to the photopeak stabilization system such that the five windows in the pulse height distribution coming from the NaI detectors now satisfactorily follow the γ -energies given by the five reflection orders from the curved crystal.
2. The interferometer system with which angular positions are measured was modified so that occasional readjustments can now be carried out during a measurement in a simple fashion. Such readjustments are necessary from time to time due to changes in the performance of the lasers.
3. The pressure inside the GAMS 2/3 interferometer box has been stabilized and the base plate strengthened, both of these enabling angle measurements of higher reliability.
4. The cave housing the NaI detectors of GAMS 2/3 has been lined with Pb to suppress natural γ -activity coming from the concrete by a factor of 3. The reliability of the GAMS 2/3 collimator positioning was also improved.

PN4/PN4A – Ge ANTI-COMPTON AND PAIR SPECTROMETERS

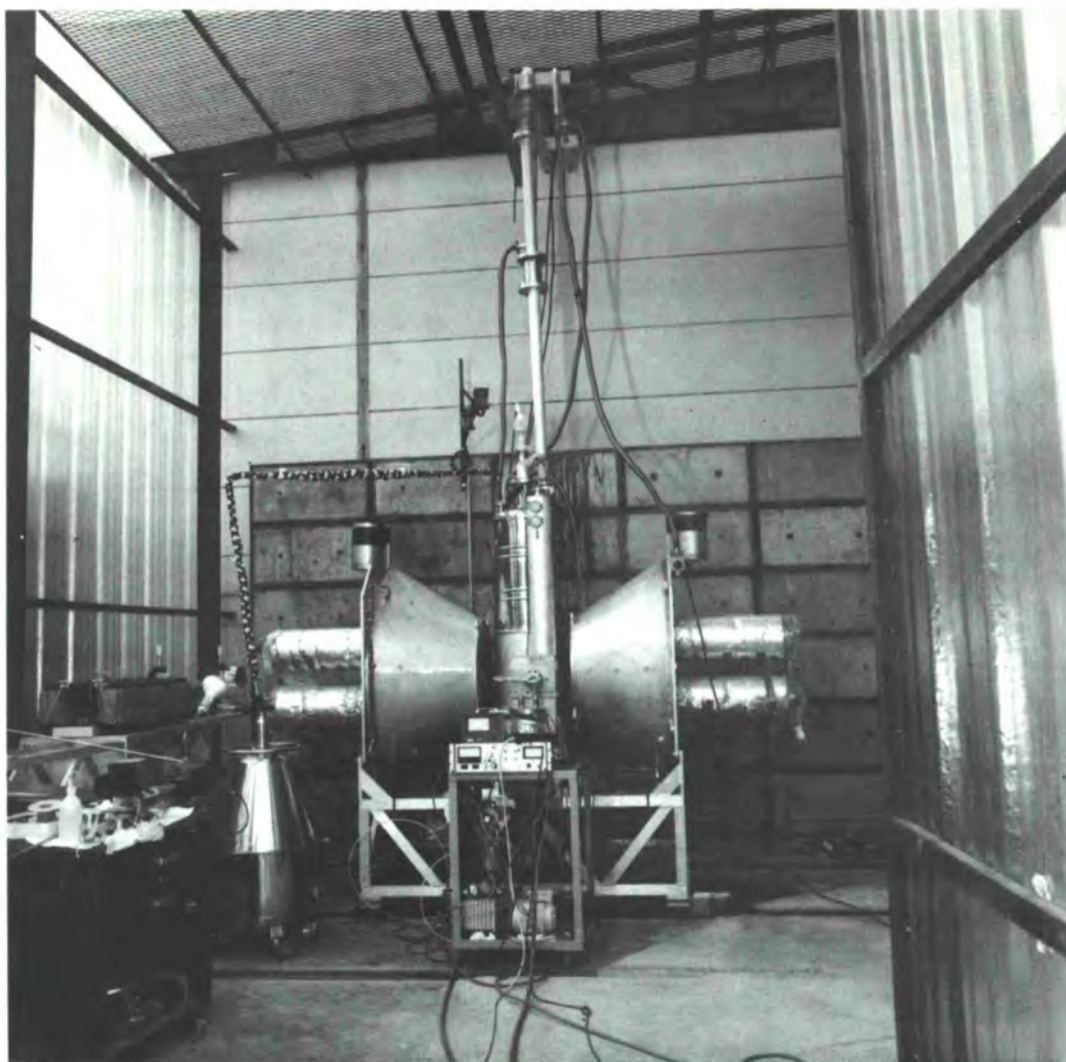
(D. Warner)

A break-down in 1974 and the withdrawal of the former instrument responsible by GfK did not allow for a full operation of the detectors in 1975. The pair spectrometer has now been set up again and the anti-Compton spectrometer should be fully operational in 1976.

S1 – GAMMA ASYMMETRY SPECTROMETER TO DETECT WEAK INTERACTION IN NEUTRON PROTON CAPTURE

(B. Vignon ; collaboration of Harvard University and ISN, Grenoble)

The installation of S1 was completed in 1975. Two large scintillation counters (1 m^3 of liquid scintillator) have been set up to view a target of 50 litres of liquid hydrogen. The beam guide to the target has been completed and the gamma background originating from other experiments as well as from S1 itself was reduced by thorough shielding. The safety precautions for the liquid hydrogen demand a naturally ventilated cabin which in turn made it necessary to stabilize the temperature of the detection system ($+ 0.1^\circ\text{C}$). The experiment was fully operational in November 1975 and data is currently being collected.



The set-up of the Gamma Asymmetry Spectrometer S1 outside the neutron guide hall

S28 – ON-LINE MASS SEPARATOR OSTIS FOR THERMALLY IONIZED FISSION PRODUCTS (Rb AND Cs) ON NEUTRON GUIDE H23

(K. D. Wunsch)

The separator installed on a neutron guide tube at the Munich Research Reactor was improved and modified for remote control. This allowed for a completely shielded installation of an important fission source in the neutron guide hall. No increase in the background of fast neutrons could be detected there. Ostis, however, can deliver Rb and Cs fission products now at about 100 times higher intensity which makes nuclei which are very far away from stability available for investigation.

Co-ordinator : G. Siegert.

H14 construction group

Formed to prevent problems of congestion from the installation of five new instruments on or near the cold guide H14, this group aims at self-destruction, the instruments becoming part of normal co-ordination groups once they are in operation. During 1975 considerable progress has been made towards this goal, and in particular S1 (Gamma Asymmetry Spectrometer) is now in routine operation as a Nuclear Physics instrument.

Instruments at present in the group are :

- IN9 : Time-of-flight polarisation analysis spectrometer
- IN11 : Spin-Echo spectrometer
- IN12 : Cold neutron three axis spectrometer
- D11B : Small-angle and diffuse scattering spectrometer.

The H14 group should cease to exist by about the end of 1976, when all of these instruments will be either in routine operation (IN11, D11B) or in the final stage of construction (IN9, IN12).

IN9 – TIME-OF-FLIGHT POLARISATION ANALYSIS SPECTROMETER

(P. Seyfert)

In 1975, it was decided to concentrate entirely on the final development of the polarised proton filter, and in this connection a remarkable break-through was achieved.

A completely redesigned microwave cavity allowed the proton polarisation, previously never better than 0.6, to routinely approach 0.9, slightly higher than the design specification for the instrument. The measured flipping ratio for the partially polarised beam of 4.3 Å neutrons (average polarisation 0.90) varied between 8 and 10 across the face (30 x 30 mm²) of the LMN single crystal. The overall transmittance of the system, including the (polarised) 7 mm thick LMN crystal, a thin layer of ³He gas and the aluminium walls of the cavity and cryostat, was 0.22 for an unpolarised 4.3 Å neutron beam.

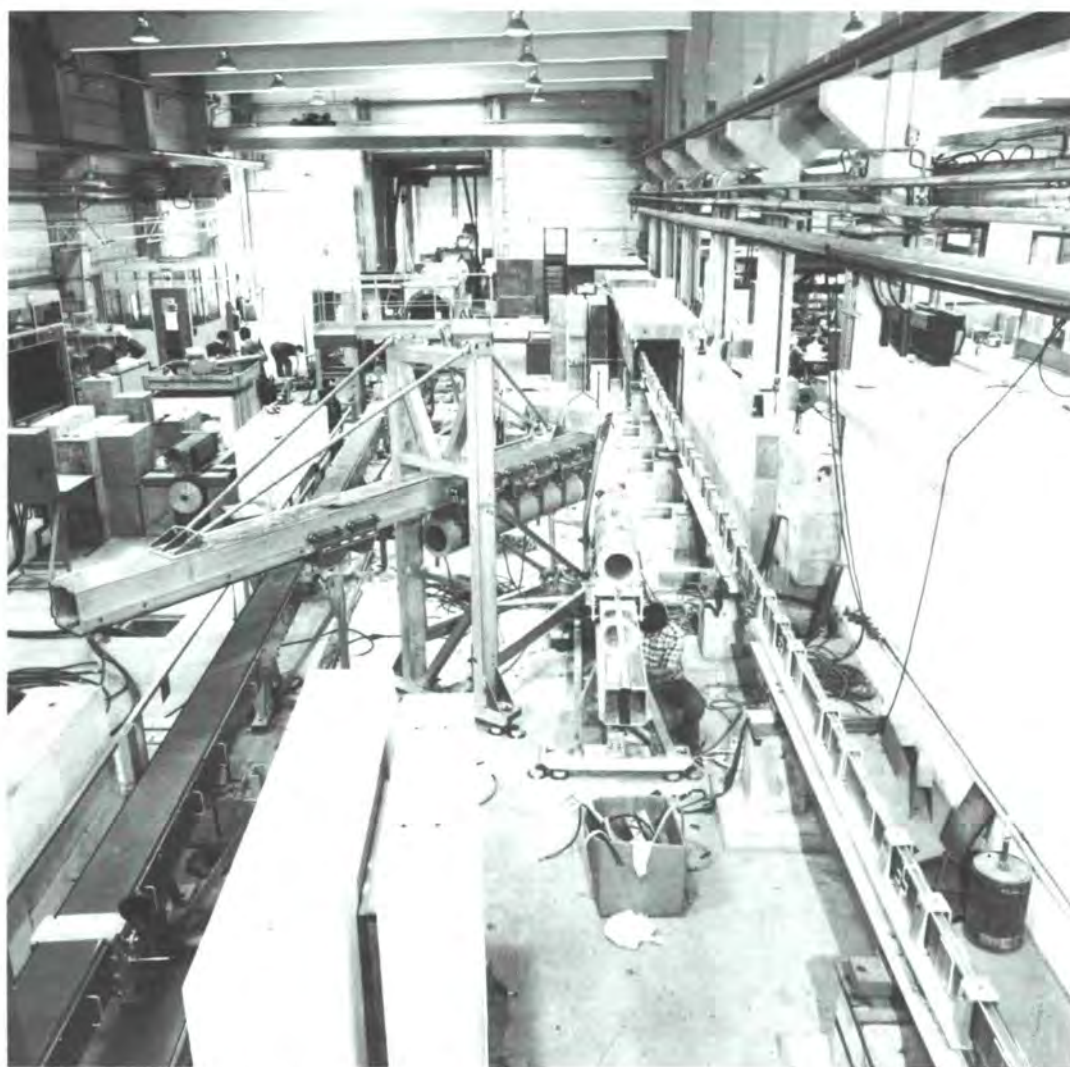
The apparatus proved to be reliable and the proton polarisation could be continuously controlled over extended periods. In one 11-day run, the only serious interruption was due to external influences (mains electricity failure during a thunderstorm).

Construction of D17 has meant the loss of the H16 beam previously used for tests on the filter, and it has been transferred to a position where it can use the residual beam of the IN10 monochromator to continue testing. . A very compact 2.8 kOe magnet has been developed for this purpose (Carlile, Hayter, Seyfert) to allow a

polarised beam to be taken directly from a middle guide position without interfering with the other beams. The magnet construction, using rare-earth polymeric magnets, offers the general possibility of using polarising crystal monochromators in situations where size or weight is critical.

IN11 – SPIN-ECHO SPECTROMETER (J. Hayter and F. Mezei)

All phases of the installation of IN11 (mechanical, electronic and computing) have gone ahead on schedule, and commissioning tests are at present taking place. The many design problems posed by this unique machine, and especially those associated with its need for a non-magnetic environment, have been overcome very smoothly by the I.L.L. technical services involved. The machine is running under full PDP-11 computer control, using a software package built around the DEC RT-11-F/B operating system. The software (G. Messoumian) allows the machine control programs to be written in Fortran, giving the flexibility necessary for rapid evolution of the mode of operation of the machine.



The installation of the new spin echo spectrometer IN11 beside its neutron guide H14.

The spectral transmission of the 45 m vertically s-bent guide (designed by P. Ageron for IN11) and the helical velocity selector have been measured by time-of-flight spectrometry, and performance is as calculated.

Development of a new and compact broad-band polariser/analyser system for IN11 is continuing on two fronts :

- (a) A sophisticated new type of multi-layer polarising mirror coating is being developed by F. Mezei. This will allow an increase in the beam divergence accepted by the mirrors.
- (b) The I.L.L.-Rutherford Laboratory project to build a polarising beam-bender is well advanced (Hayter, Penfold, Sutherland and Williams). Final tests on the iron-cobalt coated plastic films involved have been performed using the IN11 installation, modified to provide 1 mm wide polarised beam at 7 \AA , with 30 seconds of arc divergence and with simultaneous time-of-flight spectral analysis. Construction of the first pair of polarising benders is planned for early 1976, using iron-cobalt coatings ; these may be later modified to take advantage of the new films being developed by Mezei. Scientific commissioning of the machine is expected to be complete at the end of 1976.

IN12 – COLD NEUTRON THREE-AXIS SPECTROMETER (W. G. Stirling)

A final decision to construct this instrument has now been taken, after a reappraisal of the possible positions (guide H142 or inclined hole IH1), and the H142 position has been retained. The original mechanical design has been considerably refined to produce a more compact, faster moving machine.

The marble "tanzboden" will be laid in December 1975, the monochromator assembly installed and tested by autumn 1976, and first operation is expected by the end of 1976.

D11B – SMALL-ANGLE AND DIFFUSE SCATTERING SPECTROMETER

(G. Kostorz)

The in-beam components of D11B and related services were installed during the October shut-down. A new gate valve in front of the first detector position now separates the D11B diffuse scattering bank from the long tube containing the D11A multidetector. A new vacuum control system was installed to serve the four different vacuum chambers of D11A/B. The platform above and shielding around the modified sample area (including a chopper 1-3 m in front of the sample positions) are in position, except on the side facing IN12. A design study to complete this shielding has been initiated, and the platform will be modified in December 1975 to allow easier access to the H14 instruments. (Further details appear in the Instrument Group 5 report).

Co-ordinator : John Hayter.

development of new techniques

1. — ULTRA COLD NEUTRONS (UCN) (G. Germain, P. Ageron)

- The principles of this project have now been decided and it is at the stage of detailed design studies, supplies and placing of contracts for construction, partly at Rutherford Lab. for the part inside the pile and partly at I.L.L. for the part outside the pile and the safety facilities. The installation in the pile is planned for the next annual shut-down about October 1976.
- The experimental set-up, permitting the selection of very cold neutrons emerging from a converter placed on a neutron beam, has been used to eliminate certain doubts about the project, particularly the influence on the performance of the converter :
 - of the temperature of water between 20 and 100°C
 - of the presence of a zircaloy or aluminium membrane between the converter and the guide. As production proceeds, it will also permit the checking of the transmission of the neutron guides before their insertion in the pile.
- This same set-up has been used for the measurement of the gain due to the low temperature converters :
 - of solid moderators (polyethylene, Beryllium, graphite, mono and polycrystalline ice) at temperatures varying between 4 and 300°K (gain of the order of 2 to 3 measured for thicknesses of 2,5 cm).
 - of liquid hydrogen at 20°K in para- and ortho forms (measurement in progress).

2. — STUDY OF COLD NEUTRON SOURCES (A. Robert, P. Ageron)

The transport code DOT 3, two dimensional and with energy multi-groups, has been used at I.L.L. for the study of problems of rethermalization.

In particular it has been used, under contract with the Hahn-Meitner-Institut (Berlin) to study the thermalization by hydrogen in a complicated geometry and with an environment of materials other than heavy water in unlimited dimensions : vacuum, graphite, beryllium, ordinary water. It will be possible to use this for the study of a new cold source or of an improvement of the performance of the present cold source.

3. — POLARISATION OF NEUTRONS

3.1 — Polarisation by thin Fe-Co film with antireflecting layers on glass substrate (B. Hamelin, P. Ageron)

Polarising mirrors have been produced at CENG by depositing on a thin glass base

an anti-reflecting layer of 73% titanium and 26% gadolinium, then of a polarising layer of 50% iron and 50% cobalt, in a field between 500 and 1000 gauss, a polarisation higher than 95% has been measured, practically independent of the angle of incidence and of the wave-length of the neutrons.

It will be possible to use them for making a small polarising guide of the SOLLER type if their transmission proves sufficient.

3.2 — Multilayer Polarisers (F. Mezei)

Successive evaporations of layers of a magnetic and a non-magnetic material on a glass substrate can give a synthetic crystal with excellent polarizing efficiency, as suggested by the Brookhaven group (Schoenborn, Kjems). This idea has been checked on a few test multilayers made in the Central Research Institute for Physics in Budapest, with promising results. Consequently, a development project has been initiated to establish an automated procedure for the production and investigation of these and more sophisticated ¹ evaporated multilayer polarisers. Concrete results are expected by March 1976.

3.3 — Polarising Beam Bender

(J.B. Hayter (I.L.L.) and J. Penfold, W.G. Williams, J.C. Sutherland (Rutherford Laboratory).

The joint Rutherford Laboratory - I.L.L. project ^{2,3} to build a polarising beam bender has progressed on two fronts: bender technology has been refined, and work has continued on optimising the quality of the iron-cobalt films evaporated on the plastic substrate. Production of the first polarising bender (a microguide bending a $2 \times 3 \text{ cm}^2$ beam through $1.2 \times$ line-of-sight over 15 cm) is projected for spring 1976.

The spin-echo machine IN11 has been adapted to permit very accurate tests of polarisation vs reflecting angle (incident beam 1 mm wide collimated to 30 seconds of arc, with mean wavelength 7 \AA) with simultaneous time-of-flight diffraction. This has permitted a careful neutron optical study of the thin films, and we have been able to observe Fresnel interference fringes from the films (nominal thickness $d = 1000 \text{ \AA}$) beyond the total reflection cut-off⁴. Figure 8 shows a typical set of such fringes, measured on a film of magnetised iron-cobalt. The mirror cut-off is at $(\Theta/\lambda)_F$. Simple optic theory predicts fringes when $2d [(\Theta/\lambda)^2 - (\Theta/\lambda)_F^2]^{1/2} = N$ ($N = 1, 2, 3, \dots$), and gives a test-fit thickness of $d = 879 \text{ \AA}$. The bulk polished glass substrate gives a mirror reflection below $(\Theta/\lambda)_G$, and a comparison of intensities either side of this cut-off gives a direct measure of the beam polarisation reflected from the iron-cobalt ($> 99\%$ in this case).

The effect offers interesting possibilities for extending the divergence accepted by thin-film mirrors compared with back mirrors.

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1. Mezei, F., submitted to Communications on Physics.
2. Sutherland, J.C. and Wroe, H., "a stocked film bender for cold neutron

beams" Rutherford Laboratory report RL-75-063 (1975).

3. Penfold, J. Sutherland, J.C., Williams, W.G. and Hayter, J.B., "Preliminary measurements on the polarisation of cold neutron beams by total reflection from magnetised cobalt : iron thin films", Rutherford Laboratory report RL-75-112 (1975).
4. Hayter, J.B. and Penfold, J., Work in progress.

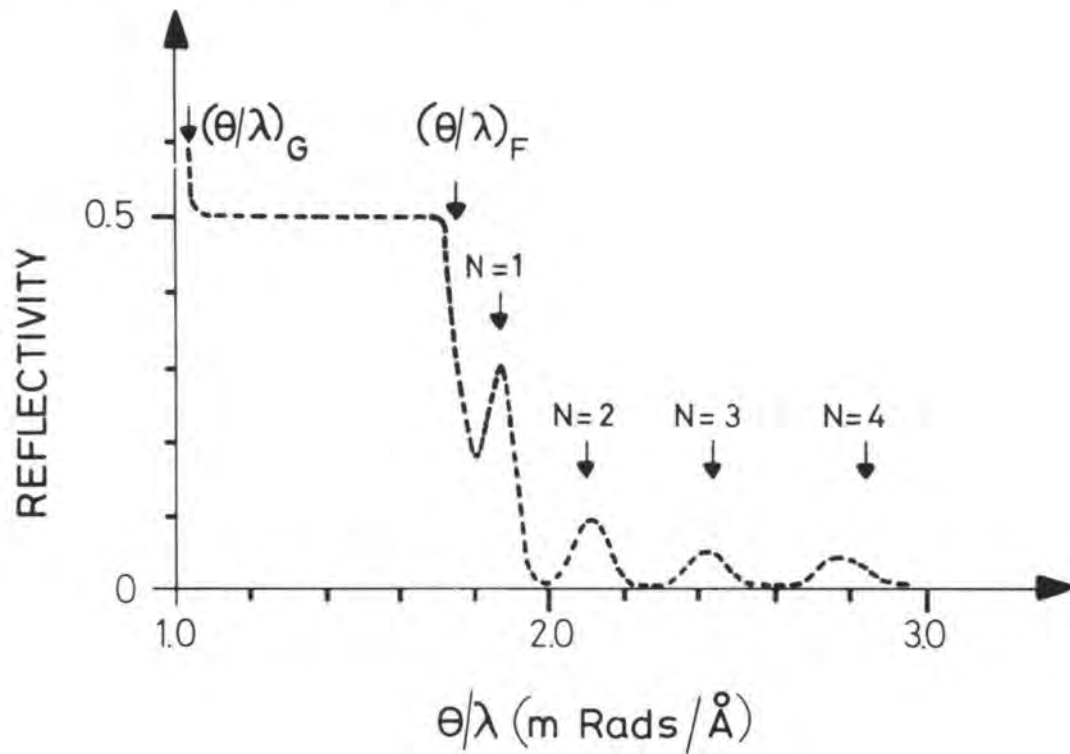


Fig. 8 : Measured neutron interference fringes from a thin-film iron-cobalt mirror. Arrows show positions calculated from elementary optic theory.

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** : Inelastic Scattering in Simple Solids
- College 5** : Crystallographic and Magnetic Structures
- College 6** : Liquids, gaseous and amorphous Materials
- College 7** : Imperfections
- College 8** : Biology
- College 9** : Chemistry

Each College corresponds to a Subcommittee of the Scientific Council of the I.L.L., which advises the directors on the scientific programme. New research proposals submitted to the I.L.L. will first be examined by the Colleges with respect to their technical feasibility and then be presented to the Council. 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.

In 1975 experimenters came to I.L.L. from these research centres or universities



college 2 «theory»

I - MEMBERS OF THE COLLEGE

Desclaux J.P.	(to Nov. 1975)
Desjonquères M.C.	(to Oct. 1975)
Fischer K.	(to Sept. 1975)
Fogedby H.	
Hinkelmann H.J.	
Iche G.	
Kaefer K.	
Loveluck J.	(since July 1975)
Lovesey S. W.	
Nozières P.	
Ranninger J.	(to Oct. 1975)
Rietschel H.	(to Sept. 1975)
Southern B.	(since Oct. 1975)
Trammel G.	(since Oct. 1975)
Young A.P.	(since Oct. 1975)
Word R.	(since Oct. 1975)

II - VISITING SCIENTISTS

Hüller A.	(Jülich)	
Beeby J.	(Leicester)	1.7 to 31.8.75
Schofield P.	(Harwell)	15.7 to 15.8.75
Weaire D.	(Heriot Watt)	11.8 to 30.9.75
Thorpe M.	(Yale)	1.6 to 30.6.75
Kawasaki K.	(Kyoto)	1.9 to 10.9.75
Kosterlitz M.	(Birmingham)	1.9 to 30.9.75
Solyom J.	(Budapest)	1.10 to 30.10.75

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

III - SCIENTIFIC ACTIVITIES

The Theory College is still in a transition period, with an unusually large turnover in 1975: five departures in the fall, compensated only in part by the arrival of three new members from the U.K. During the coming year, the vacant positions will be used for long term visits. Professor Trammel is spending his sabbatical with us, together with a student of his. We expect D. Sherrington (Imperial College) for six months.

Prospects for 1976 are now taking shape, and it appears that we shall quickly saturate our nominal staff of twelve physicists. In order to meet the needs of College 3, it has been agreed to hire two nuclear theorists who should help in keeping the experimentalists in touch with current work. In order to avoid undue isolation, we want these people (i) to be in close contact with the nearby theory group of the "Institut des Sciences Nucléaires", (ii) to be able to cooperate with their solid state colleagues. The solution of this problem is on the way.

The rest of the theory college is concerned with various solid state or many body problems, and we are actively engaged in the recruitment of new members, trying to maintain a balance between "applied theory" (of direct use to experimentalists) and more general work. We want to maintain high standards of quality, and, as far as possible, to balance the contribution of the three member countries. Unfortunately, the latter problem is not easily solved. In the spring, a search for theorists in the U.K. has provided a large number of applicants ; many of them were quite outstanding. It seems that in the present situation, we shall have no difficulty in attracting good theorists from the U.K. at the postdoctoral level. On the other hand, the prospects for French and German theorists are not as bright ; the finite contracts that the I.L.L. can offer certainly act as a deterrent as compared to what potential candidates can expect in their own institution. We expect to find in both countries a few first rate applicants, but a balanced situation is unlikely to be achieved.

We plan every year to keep a couple of positions vacant for senior visitors who can spend a year at the I.L.L. Also, we have had this year, mostly due to the initiative of S. Lovesey, a program of summer visitors which has proved very stimulating and useful to everybody. We feel the I.L.L. is an ideal place for such a program, and we expect to renew it regularly.

Traditionally, the work of theorists is mostly individualistic, and it is hard to classify it into well defined topics. A few guidelines may nevertheless be identified.

- A large effort has been devoted to one dimensional conductors : by Rietschel and his student Kaefer (Frölich instability, influence of interchain coupling) ; by Hinkelmann who is interested in polaronic effects in linear chains, and by Fogedby who has formulated another treatment of the Tomonaga model by means of a functional analysis technique. The structure of a renormalization group approach has been examined (Nozières, Solyom), and possible "strong coupling" behaviour at low temperature has been considered.
- K. Fischer has been working actively on spin glasses, and the subject is now pursued by Southern, who joined the College in October, and who is an expert in this field. There is still some work done on the Kondo effect (Nozières).
- The activity on surfaces has been pursued and extended. Besides the work of M.C. Desjonquères on the electronic structure, a good deal of work has been devoted to the theory of desorption rates (Iche, Nozières). The latter problem has led indirectly to the establishment of a genuine quantum theory of the Brownian motion of a heavy particle, which will form the core of Iche's thesis.
- The properties of low dimensional magnetic systems has been studied further by Loveluck and Lovesey, in close connection with the experimentalists of I.L.L. Independently, Lovesey is beginning an extensive study of neutron scattering of small spherical particles.
- Finally, with the arrival of Loveluck and Young, we now have two specialists of percolation theory, which opens new avenues to the work of the College.

Secretaries : J.M. Loveluck
P. Nozières

college 3

«fundamental and nuclear physics»

I - MEMBERS OF THE COLLEGE

Almeida J.
Asghar M.
Assche P. v. (Mol)
Bailleul G.
Blachot J. (CEN-Grenoble)
Bocquet J.P. (CEN-Grenoble)
Börner H. (KFA-Jülich)
Braumandl F.
Crançon J. (CEN-Grenoble)
Davidson W.F.
Decker R. (Giessen)
Diggory A.F.
Do-Huu-Phuoc (INP-Lyon)
Emsallem A. (INP-Lyon)
Greif J. (Giessen)
Guet C. (CEN-Grenoble)
Jeuch P.
Jeenicke E. (ISN-Grenoble)
Kaiser W.
Larysz J.R.
Mampe W.
Monnard E. (CEN-Grenoble)
Moussa A. (CEN-Grenoble)
Namenson A. (Washington D.C.)
Perrin P E J (CEN-Grenoble)
Pfeiffer B. (Giessen)
Pinston J.A.
Prokofiev P. (Riga)
Ristori C. (CEN-Grenoble)
Roussille R.
Schrader H.
Schreckenbach K.
Schussler F. (CEN-Grenoble)
Sellam R.
Siegert G.
Vignon B. (ISN-Grenoble)
Warner D.
Wünsch K.D. (Giessen)

II - VISITING SCIENTISTS

Armbruster P. (GSI Darmstadt)
Clerc H. G. (Darmstadt)
Egidy T. v. (Munich)
Fiedler G. (Giessen)
Fogelberg B. (Studsvik)
Forte M. (Ispra)
Gelletly W. (Manchester)
Hamilton W.D. (Sussex)
Kienle P. (Munich)
Morrison J. (Birmingham)
Reich C.W. (Idaho Falls)
Rudstam G. (Studsvik)
Pendlebury M. (Sussex)
Schuck P. (Munich)
Schult O. W. B. (Jülich)
Talbert W.L. (Ames/Iowa)
Wollnik H. (Giessen)

III - SCIENTIFIC ACTIVITY

Within the College 81 experiments have been performed in 1975, one of them completely unsuccessful. At the same time 10 experiments accepted by the Scientific Council are in preparation. Of these 81 experiments 20 were done on special set ups and 61 by the three large spectrometers. At the mass separator for fission products LOHENGRIN 39 experiments were performed, of which 4 were test runs. The remaining 35 experiments were carried out in the fields of nuclear fission (14), nuclear spectroscopy (18) and interaction of heavy ions with matter (3). The beta spectrometer BILL and the curved crystal spectrometers GAMS 1, 2, 3 recorded radiation from 11 isotopes.

A - EXPERIMENTS PERFORMED WITH EXTERNAL TARGETS

The simple process of neutron proton capture was studied by two experimental set ups.

1. The gamma asymmetry spectrometer seeks an asymmetry in the neutron proton capture due to weak interactions. In December the accuracy in the measurement of asymmetry was of the order of 10^{-6} . This figure is constantly improving and should reach $4 \cdot 10^{-7}$ in March 1976.
(J.F. Cavaignac, E. Jeenicke, B. Vignon, Richard Wilson - Harvard University, Institut des Sciences Nucléaires).
2. Measurements on the 2γ -decay in the n-p capture were repeated by an improved method. After preliminary data processing it seems that the cross section for two γ -decay is much smaller than the previous value of $350 \pm 50 \mu\text{b}$.
(W.B. Dress, C. Guet, P. Perrin - Oak Ridge, I.L.L., CENG).
3. Systematic studies of the (n, α) reaction have been carried out on 13 medium and heavy nuclei (^{77}Se , ^{95}Mo , ^{123}Te , ^{129}Xe , ^{145}Nd , ^{155}Gd , ^{161}Dy , ^{163}Er , ^{167}Er , ^{176}Lu , ^{181}Ta , ^{232}Th and ^{238}U). (M. Asghar, A. Emsallem, R. Chery, P. D'hondt, C. Wagemans - I.L.L., Lyon, Gent, Mol).
4. The alpha accompanied fission of ^{236}U is currently being studied to measure the mass and energy dependent angular correlation between the alpha particle and the fission fragment. This should give information on the scission configuration. A preliminary analysis of the data shows that the FWHM of the overall angular distribution is only $18 \pm 1^\circ$.
(C. Guet, P. Perrin, R. Bertholet - I.L.L., CENG).

B - EXPERIMENTS PERFORMED WITH INTERNAL TARGETS BY THE THREE LARGE SPECTROMETERS BILL, GAMS AND LOHENGRIN.

1. For the Beta spectrometer BILL the following eleven isotopes were used as targets for the (n, e^-) reaction : ^{79}Br , ^{81}Br , ^{99}Tc , ^{146}Nd , ^{150}Nd , ^{163}Dy , ^{167}Er , ^{171}Yb , ^{173}Yb , ^{232}Th , ^{238}U . In the decay of ^{100}Tc the multipolarity of the hindered 172.15 keV transition was definitely determined as a pure M1 transition by resolving the subshells. Also several E1 multipolarities were detected, which should be a great help in finding the unknown negative parity states.
Even for targets with cross sections of about one barn, (^{146}Nd , ^{150}Nd) crucial multipolarities were determined.

A reliable level scheme of ^{233}Th could be established. There 4 members of the $1/2^+$ β -vibrational band were determined. The decoupling parameter of this band and the strong $E0$ admixture to the $M1$ transitions to the ground state band are of great theoretical interest.

2. With the two curved crystal spectrometers GAMS 1 and GAMS 2/3 the (n, γ) reactions were measured from the following targets : ^{43}Ca , natural Ca, ^{81}Br , ^{130}Ba , ^{150}Nd , ^{153}Eu , ^{159}Tb , ^{171}Yb , ^{183}W . In addition a sandwich source of $^{197}\text{Au} - ^{181}\text{Ta} - ^{63,65}\text{Cu}$ was used and the reaction $^{10}\text{B} (n, \alpha) ^7\text{Li}^*$ was studied. As can be seen from the corresponding list for BILL three of the above nuclei were studied also with that spectrometer. In addition four nuclei mentioned under BILL had already been studied in 1974 with GAMS.

As an example ^{151}Nd was measured with GAMS, BILL and a Ge-Pair-spectrometer. The level structure has been established as below 1.6 MeV and revealed interesting results. Stable deformation is observed for ^{151}Nd in contrast to ^{147}Nd and ^{149}Nd measured with GAMS in 1974. Five rotational bands have been found, based on Nilsson states.

The sandwich source $^{197}\text{Au} - ^{181}\text{Ta} - ^{63,65}\text{Cu}$ was used to compare two primary wavelength standards (the 511 keV annihilation line and the $K_{\alpha 1}$ Röntgen line) to the 411.8 keV γ -line from ^{198}Au which is used most frequently for precise energy calibrations. A new value of $E = 411.805 \pm 0.005$ keV was found and an attempt will be made to achieve even greater precision.

For most of the other isotopes the data evaluation is complete and the results are currently being interpreted. The most difficult case is ^{153}Eu where several thousand lines exist below 1 MeV due to single, double and triple neutron capture.

3. Mass separated fission products from LOHENGRIN were mainly used to do nuclear spectroscopy on neutron rich nuclei and to yield information on the fission process.

In the domain of nuclear spectroscopy $^{14}\text{Q}_\beta$ values were measured for fission products in the mass range 90 to 100. γ -spectroscopy was done in the mass ranges 96 to 105, 136, 137 and 145 to 150. Three new isomers have been found in $^{96, 97, 98}\text{Y}$ and for two μ sec isomers already known a correct mass assignment could be made. Also the work on delayed neutron emitters was continued successfully. Energy spectra of delayed neutrons were taken with a ^3He counter and with time of flight equipment. Further excited levels could be found which were populated by delayed neutron emission.

The fission process was investigated by LOHENGRIN in recording the yields as a function of mass and kinetic energy. In addition the nuclear charges of the fission fragments were determined depending on the above parameters. In the light group a ΔE Si-detector and a carbon absorber (together with time of flight to measure the remaining energy) were used. The results show many interesting structures due to proton and neutron pairing and due to the $N = 50$ neutron shell. The influence of the latter was separated into that due to the fission process and that due to neutron evaporation.

In the heavy group radioactive decay properties were used to deduce the nuclear charge distribution for some especially interesting masses around the doubly magic nucleus $^{132}_{50}\text{Sn}^{82}$. An attempt to use photographic emulsions to measure nuclear charge distributions failed mainly due to background and sensitivity problems.

MISCELLANEOUS

The reaction $^{10}\text{B}(n, \alpha)^7\text{Li}^*$, used by the GAMS spectrometers and by a special set up can contribute to applied research. With GAMS the Doppler spectrum of the recoiling excited $^7\text{Li}^*$ was measured. This permits detection of the influence of outer shell electrons (chemical state of the target atoms) via the stopping process. GAMS is especially suited for this type of experiment due to high energy resolution and low background. Consequently one can measure the effect more precisely and in a larger amount of elements and chemical compounds than with Ge-detectors. This will allow exact charge (electron) shifts in chemical compounds to be stated. In another set up the ion implantation profiles of ^{10}B in silicon were measured. The energy distribution of α -particles originating from the above reaction was used to determine the depth distribution of the implanted ^{10}B . Both methods, in contrast to others, can be applied down to extremely low ^{10}B concentrations.

Secretary : G. Siegert.

college 4 «excitations»

I - MEMBERS OF THE COLLEGE

Almairac R.	Pynn R
Brown J.	Radhakrishna P
Castets A.	Ranninger J
Coey J.	Rossat-Mignod M.
Copley J.	Rustichelli F.
Currat R.	Schedler E.
Dianoux A.J.	Scherm R.
Dreyfus B.	Southern B.
Dorner B.	Stirling W.G.
Douchin G.	Suck J.B.
Fitzgerald P.	Teuchert W.D.
Ghosh R.	Thorel P.
Grimm H.	Villain J.
Heidemann A.	Volino F.
Iche G.	Wagner V.
Jenkin G.	Young P.
Lechner R.E.	Zaccai G.
Loveluck J.	Ziebeck K.
Lovesey S.W.	
Meyer J.	
Murani A.	
Nunes A.	
Parisot G.	

II - VISITING SCIENTISTS

Dolling G.	(Chalk River)
Hüller A.	(Jülich)
Lowde R. D.	(Harwell)
Mook H.	(ORNL)
Shirane G.	(BNL)
Smith H.	(ORNL)

III - SCIENTIFIC ACTIVITIES

A total of 69 proposals were considered by the Subcommittee Excitations at the meetings held in March and October, 1975. The Subcommittee recommended the acceptance of 46 proposals, and 40% of these proposals were for time to complete, or continue, experiments. The duration of a College 4 experiment has been found to be typically 10-12 days.

The three axis instrument IN8 is operational, and it should be scheduled routinely in the second half of 1976. The addition to IN8 of a polarization analysis facility is currently being investigated. A three axis instrument on a beam guide from the cold source, denoted IN12, should be operational early in 1977. A beryllium monochromator, loaned to the I.L.L. for a short period by Oak Ridge National Laboratory, was incorporated in IN1 for measurements of the dispersion of magnetic excitations in Mn and Ni at energy transfers up to 180 meV.

The current distribution of scientific interests in the College can be inferred from the following breakdown of proposals accepted in 1975. There are broadly three main headings, namely :

Number of proposals accepted	
phonon dispersion	15
anharmonic effects and phase transitions	16
magnetic excitations	15

Some work which has traditionally been considered by the Subcommittee Excitations is of interest principally to chemists, and this has now been transferred to College 9. This modification of the activities of the College is the outcome of a general appraisal of the scientific activities of the Colleges carried out in preparation for the March 1976 meeting of the Science Council and its Subcommittees.

The 9th Annual Symposium on Phonons in Solids, organised by R. Currat and B. Dorner from the I.L.L., was held at Pelvoux. Some 60 scientists attended the Symposium.

In making a summary of the scientific activity of the College in 1975 it is not possible, in the space available, to do justice to all experiments performed. Hence, we use the format adopted in the previous report, and illustrate the scope and nature of the scientific activities by summarising briefly the main conclusions of a few experiments. Reports on all experiments carried out in 1975 are given in an Annex to the Annual Report.

An experiment, and theoretical interpretation by Bialas, Kappus, Stolz and Weis, has shown that sapphire is essentially ionic in nature, and not molecular, as had been assumed in several previous studies. The experiment entailed the measurement of phonon dispersions along two principal symmetry directions, using IN1, and data for the $(\xi \xi \xi)$ direction are shown in the accompanying figure. The interpretation was in terms of a rigid ion model with 2-body interactions between contiguous ions ; the inclusion of 3-body interactions did not lead to a significant improvement between theory and experiment. The maximum phonon energy measured in this experiment was 108 meV.

The lattice dynamics of several quasi-two-dimensional compounds have been studied. For example, Cheeke, Dorner and Stirling have obtained fairly complete results for the low frequency transverse modes of the transition-metal dichalcogenide, $TiSe_2$. Less complete data was obtained for the longitudinal modes.

college 5 «structures»

I - MEMBERS OF THE COLLEGE

Aldebert P.
Bartunil H.D. T.U. München
Brown P.J.
Cheel V.
Convert P.
Coulomb J.P. CNRS Marseille
Croset B.
Filhol A.
Fitzgerald B.
Freund A.
Hewat A.
Hohlwein D.
Klar B.
Lehmann M.S.
Leslie M.
Mason S.A.
Nunes A.C.
Parisot G.
Radhakrishna
Riekel C.
Ronzaud D.
Schneider J.
Schweizer J. CEN-Grenoble
Tasset F.
Thomas M.
Thorel P.
Timmins P.
Wilson S.A.
Wolfers P.
Zeyen C.
Ziebeck K.

II - VISITING SCIENTISTS

Coppens P. Univ. of Buffalo
Forsyth J.B. NBRU Rutherford
 Lab.
Fischer K. Univ. Saarbrücken
Klein A.G. Univ. of Melbourne
Smith H.G. Oak Ridge Nat. Lab.

III - SCIENTIFIC ACTIVITIES

The scientific activities of College 5 are mainly oriented towards the determination of ordered structures by elastic neutron scattering. The interest shown in these structures is mainly focused on their atomic, molecular or magnetic arrangement and in many cases on their dependence on external parameters like temperature and pressure. The information yielded by these investigations serves a large variety of neighbouring fields of science in solid state physics and chemistry, and to some extent in mineralogy, material sciences and biochemistry.

During 1975 the number of machines mainly used by College 5 has been increased by the instruments D3 and D9. D3 is a polarized neutron diffractometer installed in the reactor hall. It can be equipped with magnets and cryostats and has very sophisticated computerized instrument control. Its main use is the measurement of magnetisation densities, where it can replace D5, leaving D5 more time for the polarisation analysis mode. It is expected that the high flux will enable magnetisation density studies to be made with useful accuracy on weakly magnetic materials. D9 is a four-circle diffractometer installed on the hot source. It provides very short neutron wavelengths (down to 0.50 Å) and thus poses interesting questions about the depth to which reciprocal space can be explored, and about the use of anomalous scattering for direct phase determination. The quality of the instrument has been demonstrated by a structure measurement on α -glutamic acid, which ended with an R-value of 2.6% and typical estimated standard deviations on the atomic positional parameters of 0.001 Å.

Besides these two "main-line" instruments two special instruments, S20 and S21 went into operation during 1975: S20 has been designed for topographic investigations of defects and domains in single crystals. It was financed by the Laboratoire de Magnétisme du CNRS and is operated by physicists from this laboratory. First experiments on this machine concerned anti-ferromagnetic domains in NiO and gave very satisfactory results. S21 is a neutron high-resolution double-crystal arrangement designed for precise investigations in the critical region around phase transitions, equipped with cryostats allowing for temperature homogeneities better than 10^{-3} K. This instrument was designed and financed to a large extent by Euratom, Ispra. The experiments performed until now showed e.g. the co-existence of both paraelectric and ferroelectric phases in KDP near the transition and allowed a direct measure of the order parameter via the shear angle.

Apart from these more spectacular novelties a continuous effort has been undertaken to improve the methodological background, on which all experiments rely. Besides the more technical aspects mentioned elsewhere in this report progress has been obtained with regard to the treatment of absorption and especially of extinction where the use of recent theories lead to a deeper understanding of this phenomenon which uncorrected may falsify the interpretation of neutron intensity measurements.

Remarkable methodical progress has been obtained for the phase determination by anomalous dispersion, which has been tested on Cd-histidin with the 2 wavelength procedure. About 100 phase angles were determined experimentally, the mean square precision of which was in the order of 10° for the not too weak reflections.

This corresponds to a "figure of merit" of 98%. Another interesting advance has been obtained by using the photographic Weissenberg technique on D12 for the investigation of intercalated compounds like $\text{NbS}_2(\text{C}_5\text{H}_5\text{N})_{0.5}$. The superstructure reflections, which are due to the pyridine intercalated between the NbS_2 sheets, allowed the space group to be determined and the structure to be solved. The interesting and somewhat unexpected feature of this structure is that the planes of the pyridine molecules seem to be perpendicular to the NbS_2 sheets with the nitrogen atom midway between the sheets. It should be mentioned in this context that the modified Laue Method also available on D12 has been used to obtain 2000 intensities in 15 hours from a histidine derivative. The data were extracted by scanning the resulting 30 films with an automatic densitometer and permitted an erroneous hydrogen position given in the X-ray literature to be corrected.

In the preceding sections some examples of research were given in the context of continuing or new developments. The developments complement the more strictly scientific work which represents about $\frac{2}{3}$ of the activities of the College. The following paragraphs are devoted to this part of the scientific activities: a major part of these activities can be entitled "phase transitions". The investigations are oriented towards studies of effects of external parameters on structural changes or the establishment of order. A very important external parameter is the temperature and two investigations at opposite ends of the temperature scale should be mentioned: in the first example the aim was to see an anti-ferromagnetic phase transition in tanol which needed the use of a dilution cryostat operating in the temperature range near 0.1°K . The second investigation concerned the dependence of the polymorphism of zirconia on temperatures up to 2500°C . In between the two temperature limits a large variety of structural changes on phase transitions has been investigated with both powder and single crystal techniques. They concern e.g. re-orientations of the KCN molecule on cooling. This study was complicated by the formation of domains at the phase transition, which had to be reduced by applying an uniaxial stress during the measurement. Other examples are investigations of ferroelectric materials which often exhibit problems of pseudosymmetry, or the observation of valence changes in cerium compounds on application of isotropic pressure up to 30 kbar. Another aspect of phase transitions is the ordering of magnetic moments at low temperatures. The observation of these phenomena is a typical application of neutron diffraction due to the interaction between the neutron spins and the ordered system of magnetic moments. Examples are investigations of uranium and actinide compounds in order to get some information about their electronic structure, or experiment on DyMn_2O_5 which are expected to complement the information obtained by magneto-electric effects. Another example was the observation of quasielastic scattering near the phase transition of diluted CsNiF_3 which could be interpreted in terms of the temperature dependence of the correlation length along the magnetic chain.

As a last application of neutron diffraction to a subject related to phase transitions one should mention the observation of the intercalation velocity of NH_3 into TaS_2 by means of the D1B multicounter diffractometer, where this chemical reaction could continuously be followed.

Similar experiments are progressing on adsorbed gas layers on the surfaces of solids like exfoliated graphite. These investigations will be of importance for the understanding of heterogeneous catalysis.

Another important part of the activities of College 5 is the very precise determination of crystal structures. Recently low temperature neutron data of a pyridine derivative were collected and then combined with corresponding X-ray data. "X-N" difference electron density maps have subsequently been calculated and showed an unusual and quite interesting lone pair electron density at the nitroso group, which is situated orthogonal to the N-O bond axis. This field will in future become increasingly important as it yields information which up till now was very difficult to obtain.

The survey of research made by this College cannot be concluded without mentioning protein crystallography. A substantial series of measurements on triclinic lysozyme started in the second half of this year and has already shown very promising results : 5000 reflections including all of those to a resolution of 2.8 Å have been measured already and almost all had observable intensities. This is very encouraging because one did not expect to see so many reflections from a 5 mm³ protein crystal with an elementary cell of 27 x 32 x 34 Å³. Data processing is under way and it is hoped that by this kind of investigation neutron crystallography will be able to furnish valuable information on enzyme structure, which is not accessible to X-radiation.

Secretary : B. Klar

college 6

«liquids,gases and amorphous materials»

I - MEMBERS OF THE COLLEGE

Besnard M.
Bellissent M.C.
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Higgins J.
Howells W.S.
Jal J.F.
Knoll W.
Lechner R.
Lovesey S.
Marti C.
Murani A.
Poncet P.F.
Scherm R.
Seyfert P.
Volino F.

II - VISITING SCIENTISTS

Enderby J. (Univ. of Leicester)
Dore J. (Univ. of Kent)

III - SCIENTIFIC ACTIVITIES

During the year 1975 the number of spectrometers used by the College has significantly increased, since experiments have been performed on the following machines IN1, IN2, IN4, IN5, IN8, IN10 and D1A/B, D2, D4, D5, D7, D11A. Moreover many experiments have been carried out on several machines. This was already the case for inelastic studies on IN4, IN5, IN10 for example or on IN1, IN2 but is also becoming the rule for liquid elastic studies where very often one wants to cover a "k" or "Q" spectrum as large as possible from D4 to D11 or for some part of the work use the high flux of D2, the polarisation analysis of D5, the flexibility of D1B or have a close look at the low Q part of the spectrum on D7. We are also beginning to see some studies crossing the border elastic-inelastic, for example, investigation

of some structural aspects of the phases on D1B or of the mesophases on D11, investigation also of inelastic properties of simple liquids like N_2 at very high Q on IN1 in order to gain a better understanding of the inelastic effects in structural work.

As a whole the picture of the college has not been modified since last year and the same classification scheme of research areas has been kept and will be reviewed in the following lines. We should however emphasize that many experiments have been completed at least as they were originally conceived and we are beginning to enter a new area where cooperation among the users to overcome the increasing pressure for beam time, to redefine the priorities, and to set up more ambitious long term programs in close collaboration with the instrumental development will hopefully prevail.

3.1 — Structural investigations

3.1.1 — Liquid metals

Few experiments have been completed in this field, most of them being under difficult experimental conditions, as the pressure dependence of the scattering law for liquid Rb by Egelstaff's team. Eder and Kunsch have studied on D4 the structure factor of liquid aluminium up to 850°C in order to investigate the discontinuity reported for the viscosity at 775°C . There is no evidence for a previously reported shoulder on the main peak of $S(k)$.

3.1.2 — Liquid binary alloys

When isotopes are available the isotopic substitution technique allows a complete determination of the partial structure factors of a binary alloy, and several teams are working along those lines. P. Desré and M.C. Bellissent are continuing their work on Ag-Ge and Al-Si and W. Knoll and Steeb on Al-Sn and Fe-C. On this last system a strong small angle scattering has been detected on D4 independently of the isotope. This is of interest for the cast iron technology where the nature of these melts being of segregation or of compound type is of great importance.

For the Li-alloys which H. Ruppertsberg is studying on D4 isotope substitution is often not feasible. Special attention has therefore been given to the "zero alloys" where only the concentration fluctuations are observed in the Bhatia and Thornton formalism. This gives information on the short range order in these alloys. In the Li-Ag system, preference for unlike nearest neighbours has been observed as for Li-Pb. The Na-Li alloy has also been investigated successfully above the critical temperature of immiscibility. This "zero alloy" technique seems to be now a well established approach for binary alloys studies.

A better understanding of the - if they exist - clustering processes in the liquid is often desired for these systems and several trials have been made on D11. Among these P. Chieux has completed the structural investigation of the non-metal to metal transition in the Li- ND_3 system. The correlation length for concentration fluctuations is quite significant (about 30 \AA a few degrees above T_c for liquid-liquid

immiscibility) and extend in the temperature and concentration scale in qualitative agreement with the thermodynamic properties.

3.1.3 — Molecular liquids

The systematic study for absolute structure factor determination of simple molecular liquids has been pursued by J. Dore and coworkers. The liquid N_2 and Br_2 systems have been carefully inspected on D4 for small discrepancies found between X-ray and neutron as well as between linac and reactor data. The experimental determination of the magnetic scattering for liquid Oxygen as well as the spin incoherent scattering for liquid D_2O was made by polarisation analysis on D5. Finally R. Sinclair has studied the dynamic properties of liq. N_2 at high Q values on IN1, which has a direct impact on the static approximation.

at high Q values on IN1. which has a direct impact on the static approximation.

More complicated molecules were also investigated such as hexafluorides by Regis and Parreins or acetonitrile (CD_3CN) by Zeidler and coworkers for which absolute measurements were made on D4 and the intramolecular parameters were verified to be very close to the gas phase values, the intermolecular term showing orientational correlation effects which will be further studied.

3.1.4 — Amorphous materials

The single most important work in this field is the determination by J. Blétry of the three partial interference functions of binary amorphous ferromagnets using a polarized neutron technique. This was performed initially on Cobalt Phosphorus alloy. However analogous polarized neutron experiments have been performed on amorphous iron-phosphorus ferromagnets in order to determine the localization and mean square fluctuations of the atomic magnetic moments, the shape of the iron magnetic form factor and the arrangement of phosphorus atoms in transition metal phosphorus alloys.

In a quite different and more applied work B. Fender and A. Wright have successfully studied on D11 the precipitation processes in a glass ceramic with added TiO_2 and are presently trying to produce a plausible mechanism for the critical stages of the phase separation in this glass.

3.1.5 — Ionic solutions

It is now clear that a combination of high neutron fluxes and the use of separated isotopes as proposed by J. Enderby will enable new insights to be gained into the structural nature of ionic solutions. The experiments so far have given the number of molecules in the hydration shell around the substituted isotopes. In the case of Nickel chloride solutions the Ni-Ni partial structure factor has been reached and shows an ordering of the Nickel ions in a quasi-lattice manner at concentrations from saturation down to 1.6 molar. For the chlorine atoms in Na Cl solutions the ordering is less defined.

Very strong ordering effects have also been detected by P. Chieux in solutions of metals in Ammonia.

3.1.6 — Molten salts

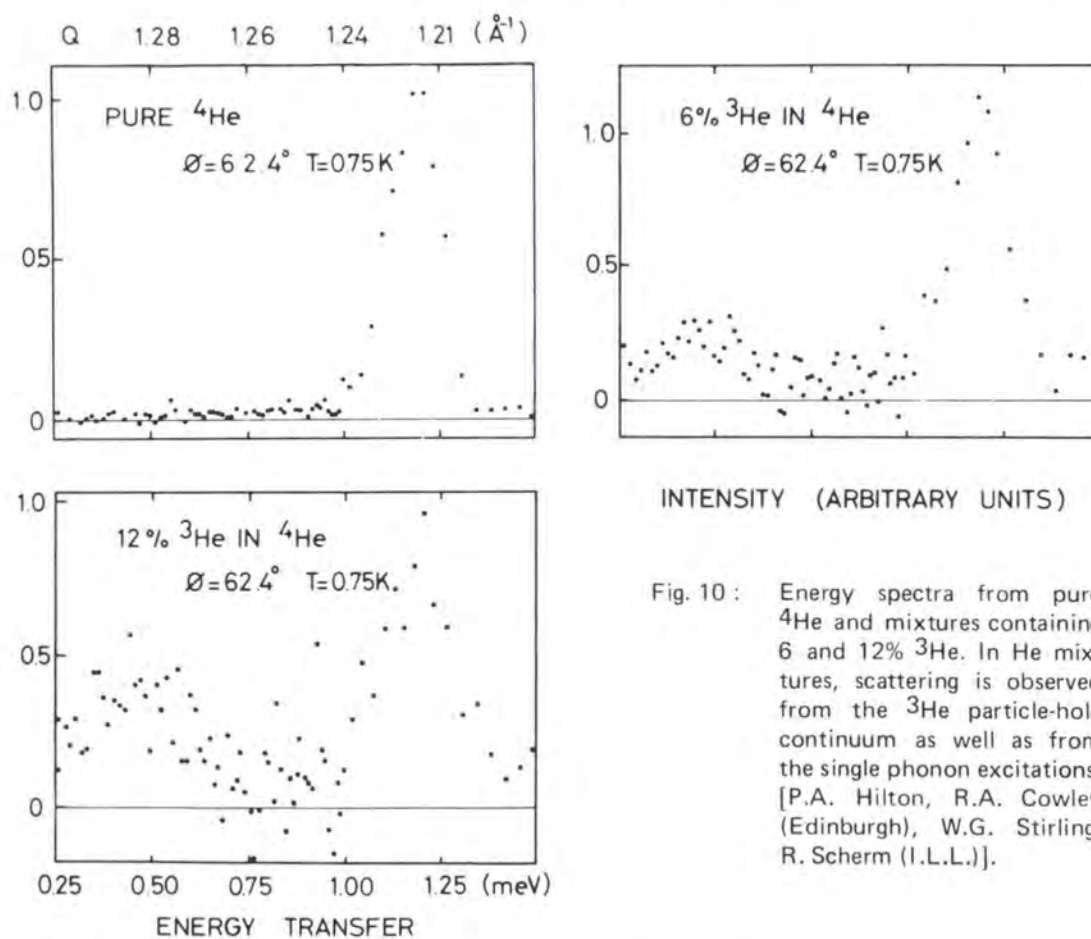
The previous experiments by Mme Dupuy and J.Y. Derrien on Ag Cl showed the importance of chemical bonding in this system at $510^\circ C$. The experiment was

repeated with chlorine substitution at 900°C and showed further reduction of the first coordination number. This is in agreement with mass spectrometry measurements in the vapour where a trimer species was observed and contrasts with the Cu Cl neutron data.

3.2 — Inelastic studies

3.2.1 — Liquid helium

The highly successful experiment on liquid Helium 3 has been pursued by R. Cowley, P. Hilton, R. Scherm and W. Stirling. The broad spectrum without any well defined excitations has been confirmed. The maxima of the spectra are at energies of less than 1.0 meV for wavevectors below 1.8 \AA^{-1} but then increase in energy to 3.0 meV at the largest wavevector transfers. A theory of the scattering from liquid ^3He based on the continued fraction method gives a good account of the experimental results. Further experiments have been performed at mixtures of 6, 12, 25 and 50% ^3He in ^4He . Whereas the 50% mixture resembles very much pure ^3He , at low concentrations the scattering consists of well defined roton excitations with energies very close to those of pure ^4He plus an extra peak.



INTENSITY (ARBITRARY UNITS)

Fig. 10 : Energy spectra from pure ^4He and mixtures containing 6 and 12% ^3He . In He mixtures, scattering is observed from the ^3He particle-hole continuum as well as from the single phonon excitations. [P.A. Hilton, R.A. Cowley (Edinburgh), W.G. Stirling, R. Scherm (I.L.L.)].

3.2.2 — Simple gases

The pressure derivative of the scattering law already investigated by P. Egelstaff's team on nitrogen was extended to krypton. The data appear to be of sufficient quality to derive Q dependent virial coefficients and hopefully extract the term involving the 3-body potential.

3.2.3 — Mesophases

This year again has seen an intense activity in this field and significant progress has been made in the understanding of the random motions of the different parts of the molecules in these phases.

The data obtained on the crystalline phase of TBBA are discussed by A. Dianoux, H. Herve, R. Lechner and F. Volino in terms of rotational motion of the butyl chain extremities, especially the last methylene and methyl groups. Methyl groups in solid PAA have also been shown to undergo random rotational motion around their 3-fold axis and rotations about other molecular axes on the same time scale can be excluded.

As far as the smectic H Phase of TBBA is concerned, the supercooled smectic-H shows partial orientational ordering of the molecules while in the titled B smectic-H the phenyl rings do not have a strongly preferred orientation.

High resolution work in collaboration with A. Heidemann on IN10 on the smectic H, C and A phases of TBBA is analyzed in terms of translational motion.

Leadbetter and coworkers have studied the components of the diffusion tensor parallel and perpendicular to the direction of magnetically aligned smectic A and nematic samples of EABAC. Except for the smectic A in parallel orientation the data are also consistent with simple translational processes. As far as the reorientational motion of the molecule is concerned no evidence for motion has been found yet in the solid.

On the other hand the S_E and S_B phases for D - PBABC seem to be disordered and are checked for a 180° jump model.

3.2.4 — Miscellaneous

Several other successful inelastic experiments must be reported. A. Leadbetter and P. Seyfert have studied on IN4 coherent scattering function of vitreous silica to determine by comparison with the polycrystalline cristobalite the true energy-broadening of the excitations in the glassy state. The full scattering function is now being established by interpolation of the observed data ; this will give access to the widths of excitation at constant Q.

An experiment on the well known catalytic system of chemisorbed hydrogen on Nickel was made on IN1 by Renouprez, Stockmeyer and coworkers. Two peaks were observed at 120 and 140 meV whose position and relative intensity was independent of the surface coverage. This is partially explained if the proton vibrates inside of potential whose minimum is correlated to the motion of the binding atoms. Theoretical calculations are however needed to interpret completely the observed data.

R. Lechner has completed a study of the sulphur liquid-liquid phase transition between the S_g phase and the S_n phase. Sizeable effects concerning the quasielastic linewidths and intensity were detected.

Secretary : P. Chieux.

college 7

«imperfections»

I - MEMBERS OF THE COLLEGE

Blétry J.
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Freund A.
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Iche G.
Just W.
Kostorz G.
Livet F.
Lovesey S.
Mezei F.
Murani A.
Nozières P.
Parisot G.
Pataud P.
Radhakrishna P.
Roth M.
Rustichelli F. ISPRA
Schneider J.
Schweizer J. CENG
Seyfert P.
Stirling W.
Suck J.
Thorel P.
Wagner V. Univ. Würzburg
Young A.P.
Zeyen C.
Ziebeck K.

II - VISITING SCIENTISTS

Söffge F. Univ. München,
Fischer K. KFA Jülich
Cohen J.B. Northwestern
 Univ. Illinois
 U.S.A.

III - SCIENTIFIC ACTIVITIES

In the past year 73 experiments concerning this college were carried out on the various instruments : 17 on magnetic impurity systems, 16 on crystalline electric field problems, 19 dealing with metallurgy and non-magnetic defects, 4 on defect modes and 17 on the physics of hydrogen dissolved in bulk metals.

On the metallurgical side the study of decomposition mechanisms continued with experiments on Al Zn (D. Allen, R. Stewart (Univ. of Reading), G. Kostorz (I.L.L.) and Al Mg (M. Bernole (Univ. Rouen), M. Roth (I.L.L.)) where effects of ageing, size and concentration of Guinier-Preston zones could be determined. Precipitates were shown to exist in Ce(CoCu) (hexagonal structure) upon annealing which are connected with the large enhancement of the magnetic hysteresis. The precipitates seem to be rod-like and oriented closely parallel to the c-axis (Laforet, Lemaire (CNRS, Grenoble), Collin (Ecole des Mines, Paris), Labulle, Petitpas (Univ. Rouen), M. Roth).

Radiation damage due to fast neutron irradiation was studied by small angle scattering on various systems. Al Si showed no precipitation after irradiation, surface contributions to small angle scattering were revealed, however (G. Kostorz). Strong increase of scattering upon ageing was observed with GaAs which had been irradiated with fast neutrons (E.U.J. Mitchell, R. Stewart (Univ. of Reading), G. Kostorz).

Neutron and X-ray small angle scattering have been combined for the tie-line determination in Al Mg Zn-alloys. Absolute X-ray and neutron intensities for an Al Zn -standard were in very good agreement (J.E. Epperson, V. Gerold (MPI Stuttgart), G. Kostorz). Small angle scattering was observed in CuAl alloys as well as in quenched and annealed stoichiometric NiAl where it was related to void formation (J.E. Epperson, G. Kostorz).

Magnetic diffuse scattering of polarized long wavelength neutrons from dilute alloys of nickel (NiTi, NiCu) and iron (FeV, FeMn) was studied. In combination with magnetization studies the moment on the individual atoms, the magnitude of the disturbance in the matrix and the degree of short range order were determined (F. Livet, P. Radhakrishna, P. Pataud, R. Tournier (CRTBT, Grenoble)). Utilizing gravitational fall of neutrons it was possible to separate elastic and inelastic components of the scattering in Cu Mn spin glasses (A.P. Murani, G. Göltz, K. Ibel) in the small angle scattering region. Although rather coarse, these results nevertheless demonstrate clearly the applicability of the Néel picture (blocking of superpara-magnetic particles) to the freezing of spins in these binary alloys. Further corroboration for this model is provided by recent measurements on some Au Fe alloys (A.P. Murani) where the freezing temperatures (sharp discontinuities) observed are found to be q-dependent in contrast to the expected unique "transition" temperature in some recent theories of spin glasses.

The spin relaxation rate of the Kondo-system Cu Fe was deduced from the diffuse quasielastic magnetic scattering of unpolarized neutrons. The experimental results agree well with theoretical calculations of Götzke and Schlottmann for the dynamical susceptibility of a Kondo-system (M. Löwenhaupt (KFA Jülich), W. Just (I.L.L.)).

The change of the spin correlation lengths with temperature very close to the Curie point ($T-T_c/T_c = \tau \sim 10^{-2}$), a cross-over temperature of $\tau_{\Delta} \sim 7 \cdot 10^{-4}$ and a critical exponent of $\Phi \sim 1.6$ were determined in an experiment on a Ni single crystal whose anisotropy was varied by applying a variable stress (F. Söffge, K. Stierstadt (Univ. München), G. Göltz, K. Ibel (I.L.L.)).

In the mixed anti-ferromagnetic $Ni_{1-x}Co_xO$ a detailed study has been started on the zone centre magnon modes in order to examine the anisotropy of a system which changes from an easy-plane to an easy-axis-anti-ferromagnet with increasing Co-concentration (V. Wagner, I.L.L.)

Hydrogen diffusion was studied by quasielastic scattering in the system $\alpha-NbH_{0.004}$ with 0.7 at % nitrogen impurities for various temperatures in order to investigate the trapping of H in the vicinity of a dissolved N atom. Typical trapping times are several 100 times larger than the mean rest time of a H atom an undisturbed interstitial site (D. Richter, J. Töpler (KFA Jülich), A. Heidemann (I.L.L.)). With the recently installed chopper at D11 a very strong inelastic contribution of a local mode at 78 meV in Nb(D) could be detected (N. Stump, W. Münzing (Univ. München), K. Ibel (I.L.L.)).

S19, a special set up for the study of vortex line structures, is now available which will help to continue with experiments originally planned for D11 where they suffered from restricted measuring times (P. Thorel).

Thermal self-diffusion of fluorine in CaF_2 was studied by measuring the temperature dependence of the ^{20}F spin-lattice relaxation time for different magnetic fields and crystal orientations on the in-beam NMR spectrometer (S6). Furthermore, the technique of decoupling unlike nuclear spins by applying a second radio frequency field was successfully tested: The resultant strong narrowing of the NMR-lines of the probe nuclei can be used to resolve small hyperfine fields due to defects (Heidelberg Group).

Secretary : W. Just.

college 8

«physical biochemistry»

I - MEMBERS OF THE COLLEGE

Bartunik H.	
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Higgins J.	
Haas J.	
Ibel K.	
Jacrot B.	
Lajzerowicz J.	Univ. Grenoble
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Mason S.	
Mathieu J.P.	I.L.L. & DRF CENG
Miller A.	E.M.B.L.
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Riekel C.	
Roth M.	
Rustichelli F.	ISPRA
Schmidt G.	
Stirling G.	I.L.L & NBRU
Timmins P.	
White J.	
Wilson S.	
Zaccai G.	

II - SCIENTIFIC ACTIVITY

In June 1975, College 8/9 split into two : College 8, Biology and College 9, Chemistry. Neutron scattering from biological structures came of age at the Institute. There are about eight I.L.L. scientists whose main activity is in the field, and with the E.M.B.L.* outstation nearby, this number is growing. E.M.B.L. will extend our facilities with a well-equipped biochemistry laboratory, an X-ray diffraction laboratory and an electron microscope. The next few years, therefore, promise a stimulating environment for biological research at the reactor.

Why study biological materials by neutron scattering ? It is a rare and expensive technique. A brief answer is possible : the very large difference between the scattering powers of hydrogen and deuterium. Biological materials are predominantly made up of a few elements (C,H,O,N,P. . .) and they are always bathed in water. Contrast variation by mixing H₂O and D₂O solvents (a relatively non-perturbing trick compared to contrast variation with X-rays where sugars are used to change the solvent electron density) and selective deuteration (often using sophisticated biochemistry) allow structural components such as protein and nucleic acid which are barely distinguishable by X-ray scattering to stand out quite boldly in a neutron scattering picture. These are techniques which are now developed and being used to help elucidate some rather complex structures.

The ribosome is the organelle responsible for protein synthesis in the cell. It is itself made up of protein and RNA components and its structure is now yielding to patient experimentation by a number of groups using different techniques, including neutron scattering (Berlin, I.L.L., Louvain, Mainz, Munich, Paris).

Scientists from Paris and Portsmouth are studying the structure of chromatin, the complex of protein (histone) and DNA in the genetic store of eukaryotic cells, the chromosome. Neutron scattering is at the moment the most powerful tool for this study.

Small RNA plant viruses are being observed in a collaboration between I.L.L. and Strasbourg. The localization of RNA in the spherical protein capsid under varying conditions is starting to throw light on the relation between stabilising forces and virus structure.

The above are long-term projects, but progress is tangible ; this year, there have been publications on chromatin and the virus study while several papers on the ribosomes are now in preparation.

* E.M.B.L. : European Molecular Biology Laboratory.

Membranes, muscle and connective tissue are mainly made up of protein (and lipid for membranes). The contrast between components is similar for neutrons and X-rays but neutron scattering retains the unique advantages of contrast variation by varying H₂O/D₂O in the solvent and selective deuteration.

Photo receptor membranes from retinal rod outer segments have been examined (Grenoble, Harwell, London) and results suggest interesting changes in the rhodopsin position in the lipid bilayer upon bleaching.

The lipid bilayer is a major component of all membranes and a fair effort is in progress to establish its structure to a high resolution. It is an interesting system which strongly depends on temperature, water concentration and chemical composition. Selective deuteration is used (Basel, Gif-sur-Yvette, I.L.L.).

Contrast variation is also providing valuable information on the distribution of proteins in vertebrate striated muscle, which, combined with X-ray data, is used to test model predictions (Harwell, London, Louvain).

Collagen is the major constituent of connective tissue. It is a protein complex with several levels of organisation : molecules, fibrils, fibres. The neutron structure is observed and the role of water is studied by fast kinetic experiments involving H-D exchange (E.M.B.L., I.L.L., Oxford). Fast kinetics was developed to study the H-D exchange in proteins to assess the accessibility of sites to the solvent and eventual conformational changes (I.L.L., Mainz).

We did not make an exhaustive list of all the work in the college but the above gives a good indication of activities in what might be termed low and medium resolution investigations. Many other interesting experiments are in progress (groups from Basel, Bristol, Edinburgh, Heidelberg, I.L.L., London. . .). In all, the turnover for these experiments is quite high and to some extent this is a disadvantage as each group then finds itself with strictly limited time.

In a very different type of study, single crystal protein crystallography, an I.L.L. group has this year initiated data collection from a crystal of lysozyme. Lysozyme is low molecular weight (14600) enzyme with a known X-ray structure. The neutron study will establish precise coordinates for H atoms, indicate which are accessible for exchange and show the configuration of bound water. The crystal is giving an exceptionally good diffraction pattern and data has now been collected in H₂O and D₂O solvents to a resolution of 2.8 Å. Ultimately 1.8 Å will be reached.

The College activities this year have been varied and exciting. Many groups have come to the reactor with the fast turnover on D11 responsible for most experiments. D16 was used for experiments using oriented samples requiring a larger angular range and good resolution, while the protein crystallography is on D8 and D9. Next year D17 will be working. Interest is starting to be shown in the use of inelastic neutron scattering (IN5, IN10, IN11) and we hope to have more to say about that a year from now.

Secretary : G. Zaccai.

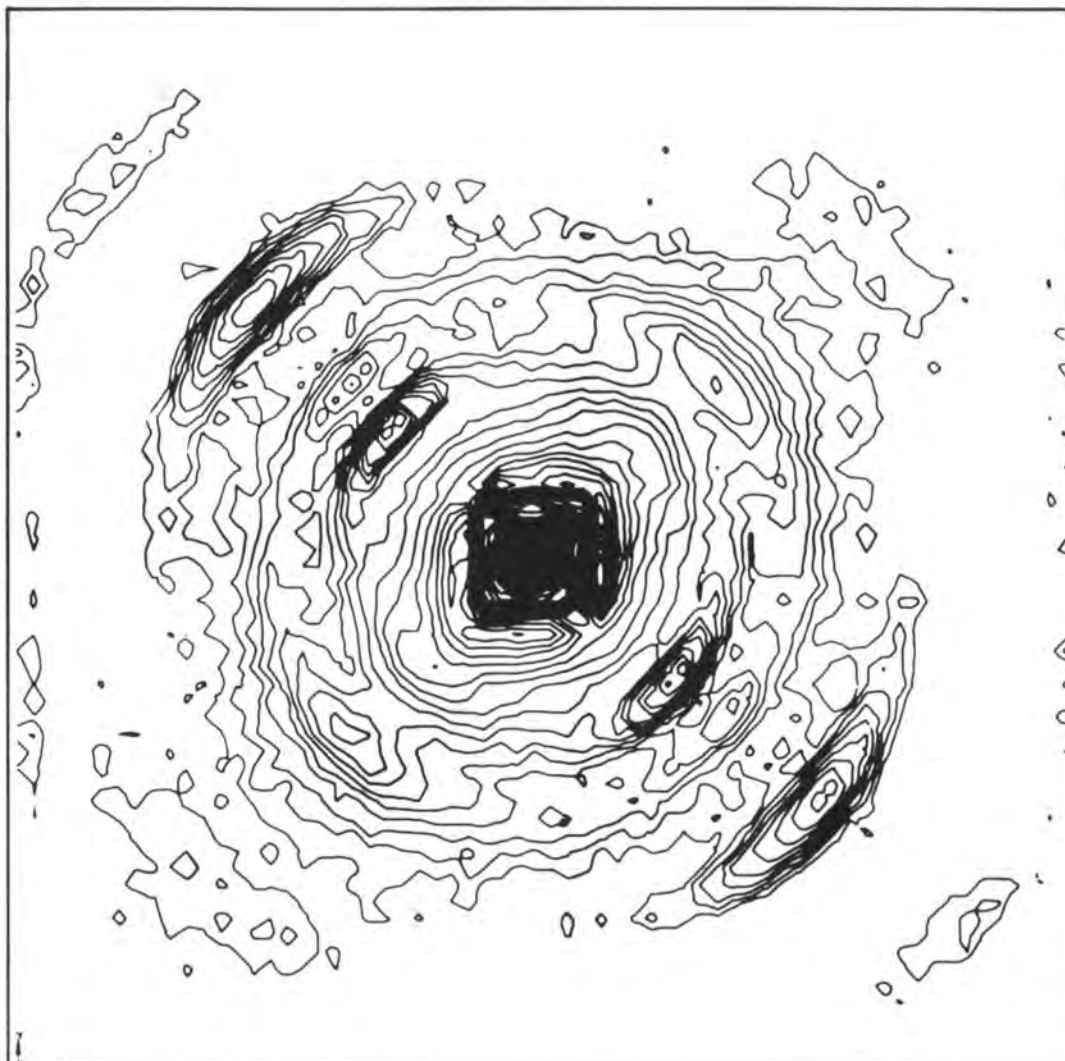


Fig. 11 : Neutron Scattering by Collagen.
Collagen is the main fibrous protein in vertebrate connective tissues, e.g. bone, skin, tendon and cartilage. The fast data acquisition rate possible on D11 allows one to observe the kinetics of H/D exchange in time scales of less than one second ; revealing information on the fibrillar structure of collagen. The picture shows the diffraction pattern obtained with a rat's tail tendon. Exp. 08-03-003C by A. Miller, EMBL Grenoble ; J.W. White, I.L.L. ; J. Haas, I.L.L.

college 9 chemistry

I - MEMBERS OF THE COLLEGE

Aldebert P.
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Carlile C.
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Chieux P.
Dianoux A.
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Higgins J.
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Mason S.
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Neumaier T.
Nunes A.
Osborne H. CENG
Pynn R.
Riekel C.
Rustichelli F.
Schmidt G.
Timmins P.
Tomkinson J.
White J.
Volino F.
Zaccai G.

II - GENERAL

In spring 1975, College 8/9 decided to separate into two distinct colleges as a result of the continually increasing expansion of interest in chemistry and biochemistry at the I.L.L. Within chemistry alone, the range of topics has expanded to include inorganic and physical organic as well as physical chemistry, and college 9 has now adopted the more general title of "Chemistry". The growing range of interest was also reflected in the expanded scientific sub-committee membership for the October meeting, where 55 proposals were considered, compared with 31 in March. Altogether, 41 experiments were carried out this year under the auspices of the college. New proposals for the main machines of interest (IN4, IN5, IN10 and D11) now request 2 to 4 times the machine time available.

In October, a Chemistry Information Meeting was held during Science Council week. This highly successful meeting, organised by J. Higgins, presented a wide range of invited speakers covering Molecular and Crystal Spectroscopy, Layer Structures and Surfaces, Disordered Crystals and Chemical Reactions.

III - SCIENTIFIC ACTIVITIES

The separation of chemistry from biochemistry provided an appropriate occasion to re-assess the evolving interests of the college. Present areas of interest fall into four broad categories :

1. Structural studies of polymers.
2. Dynamics of polymers.
3. Molecular dynamics in solution, solid-state, multi-component liquid crystalline and colloidal systems.
4. Disordered structures and dynamics of adsorbed molecules.

1. Polymer Structure

Once again, the small angle scattering apparatus D11 was the primary instrument used in this area. Groups from Strasbourg, Saclay, Mainz, Bristol and Manchester have studied the conformation of polymers in solution, gels and non-equilibrium states (e.g. the time-dependent properties of stretched bulk polymers). The studies in solution show an unexpected dependence of the radius of gyration on $C^{-1/2}$, where C is the concentration of polymer chains in solution.

There has been increased emphasis this year on studies of dissolved polymers in θ -Solvent conditions, and bulk polymers undergoing mechanical stress ; both of these areas have important ramifications in applied as well as pure research.

A meeting of all the European groups using neutron small-angle scattering to study polymers was held at Strasbourg in June. After presentation of results, a joint program of research was agreed upon, in order to make best use of the limited neutron time available. This collaborative effort slightly eased the pressure on D11, but the new apparatus D17 is needed more than ever if a reasonable experimental program is to be maintained in this field.

2. Polymer dynamics

Several feasible models are available for the low energy segmental motion of polymer chains in dilute solution. The model calculations predict different power laws for the Q -dependent broadening of the quasielastic scattering, and hence may be tested provided measurements can be made over several decades of momentum-transfer variation in the low- Q region. The experiments thus rely heavily on the continuous use of the high resolution spectrometers IN5 and IN10. Using complementary results from these two machines, the groups at Strasbourg, Saclay and Manchester have distinguished between different models of polymer motion in several regimes.

The Manchester group has also clearly demonstrated the effect of cross-linking on low energy segmental motion in rubbers and gels, the liquid-like properties of the bulk polymer becoming solid-like in a cross-linked gel.

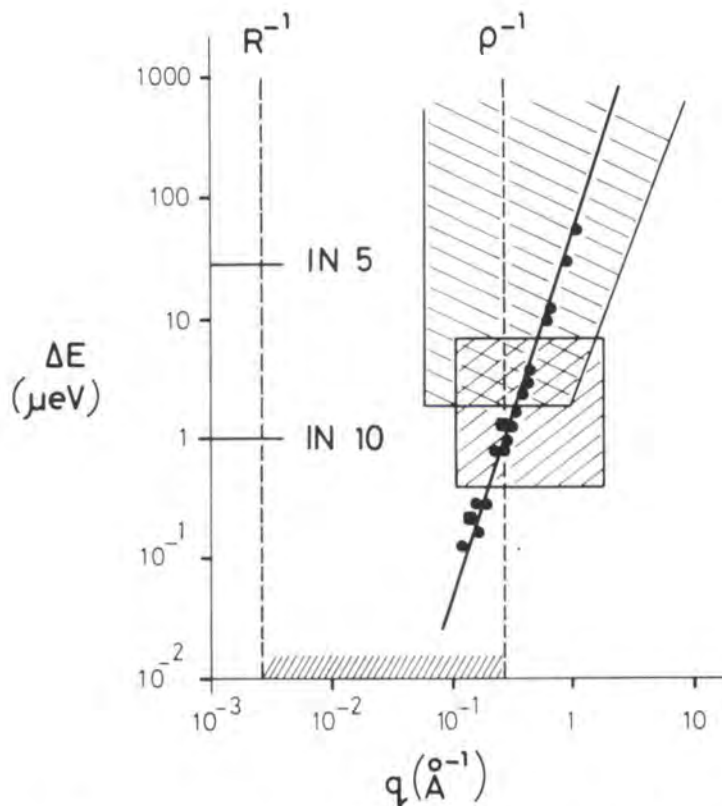


Fig. 12 : Diagram showing, in the q -range of interest, the energy resolution (FWHM) required for the study of the diffusive motion of segmental polymers, together with the regions accessible with IN5 and IN10. The points result from model-fitting the experimental scattering characteristics of polytetrahydrofuran in solution ; straight line follows a q^3 (Zimm) law, predicted in the region $R^{-1} < q < \rho^{-1}$. (I.L.L.-Manchester-Saclay-Strasbourg group).

3. Molecular dynamics

This wide-ranging field covers inter- and intramolecular motions at time-scales ranging from 10^{-9} to 10^{-13} seconds, and makes extensive use of IN5 and IN10 (diffusive motions) and IN4 and IN1B (inelastic spectroscopy). A cross-section of topics studied this year includes tunneling motions (Jülich) ; motions in liquid crystals (Exeter, Oxford) ; rotator phases in aromatic thiols (Bordeaux) ; and spectroscopy of molecules and ions in host lattices (Durham). The Oxford group is continuing its study of chemical reactions, and has shown that in the trifluoroacetic acid-water system there is quasielastic scattering which cannot be accounted for by centre-of-mass diffusion or rotational diffusion based on measurements of the rotational correlation times (NMR and light scattering). Diffraction measurements from trifluoroacetic acid in null H_2O/D_2O mixtures have been used to obtain partial structure factors, in an attempt to resolve the complex species in these solutions.

4. Adsorbed molecules

Advantage is now being taken of the sensitivity of many instruments on the high flux reactor to study the structure and dynamics of adsorbed species, for example in intercalates or surface-adsorbed films. Work on intercalation compounds has been extended this year to studies of the diffraction, kinetics of formation and inelastic scattering from C_8K and its compounds with hydrogen, though it still remains to be shown whether the included hydrogen is in atomic or molecular form.

The Oxford groups have also studied NH_3 adsorbed on graphon or intercalated in layer structures. Strong diffraction patterns from NH_3 on graphon show that the ammonia does not wet the surface. The melting of the microcrystalline clusters is at present being studied, along with related systems showing greater and less degrees of wetting.

This is an area of great applied interest, especially in catalysis, and is one of the College's fastest growing areas of research. Studies are at present being undertaken by numerous groups from the three member countries to observe hydrogen, aromatic and aliphatic molecules on both metallic and non-metallic (zeolite) surfaces.

Secretary : John Hayter.

technical services

SCIENTIFIC SUPPORT	Construction and maintenance Project office
TECHNICAL SUPPORT	General Safety Radioprotection Workshops, maintenance and fittings

scientific support

MECHANICAL CONSTRUCTION AND MAINTENANCE SECTION

All four sectors :

- design studies and industrial relations
- assembly and testing
- installations
- maintenance

of the section have been continuously active.

The major works are listed below :

- (1) Conversion of : IN3, IN9 (in progress), IN10, D1A, D13, D2, D7, D8, D12, D13, S4, S8, S13
- (2) Additional installations connected with the improvement of background conditions : IN4, D11A, S1, S10, PN3
- (3) Other additional installations : PN2
- (4) New instruments
 - studies of the possibilities of construction or conversion of : IN7, S12, D18, extension of H21
 - studies : IN12 (floors), D17, D18, ultra-cold neutrons
 - assembly, testing or installation in progress : IN12 (floors), D17, S27, IN11
 - installations completed : IN8, D3, D9, D11B, D15, S16, S19, S20, S28, S26.
- (5) Major maintenance work on : IN1, IN2, IN5 (construction of choppers 5 and 6), D5, D10, D11A, D16.
- (6) Installation of a new neutron guide at the exit of H17, and of short sections of guide between IN12 and S1, and between IN10A and IN9.

(7) Technological developments :

- prototype labyrinth for leak-proofing shafts of machines rotating at high speed
- prototype support for neutron selector drum.

There has been further development in the fields of technical assistance and loan of material to other departments. These are mainly for vibration and temperature measurements and checks by optical measurements.



Recent extension to the neutron guide building

PROJECT OFFICE

1. Within the framework of its general function of management and control of the investment funds for the experimental instruments, the Project Office contributed greatly in 1975 to the choices which made it possible, despite a strict budget, to make the best adaptation of the scientific equipment at I.L.L. to the necessities of a heavy scientific programme.
2. The Project Office was concerned in the preparation of projects and coordinated the construction and installation work :
 - of the new small angle scattering instrument D17 which is scheduled to start operation in spring 1976, only one year after the decision to construct
 - of the spin-echo spectrometer IN11
 - of the fission product spectrometer OSTIS
 - of the new diffractometer D15 on an inclined beam.

3. For 1976 the Project Office is preparing :
 - the construction of IN12
 - the installation of the ultra-cold neutron source
 - the installation of the new neutron interferometer D18
 - feasibility studies for an experiment on parity violation in capture (n, p) in the throughgoing beam-tube.
 - optimization of conditions of use of beams as regards equipment and background noise.

technical support

SAFETY AND RADIOPROTECTION SECTION

GENERAL SAFETY

1. Commission Interne de Sécurité
Study of the following experimental instruments : SI 16 (on beam tube H1), SI1, OSTIS (on H22), D4, IN1, D1B (irradiation of ^{244}Cu samples). Ultra-cold neutron source (preliminary study).
2. Health and Safety Committee (CHS)
Preparation and minutes of meetings, following-up action required by the CHS, investigations and reports on accidents, reports to the factory inspector, etc.
3. Improvement of working conditions and protection of staff
Lighting in the reactor control room, measurements of noise and ultrasonic frequencies in the neutron guide building.
4. Remote alarm network
Extension of fire detection in new buildings, monitoring access to the neutron guide building. Maintenance and systematic testing of equipment.
5. Checking and maintenance of first aid equipment (extinguishers, individual protection equipment, breathing masks, goggles, anti-noise helmets, etc.)
6. Training of staff
10 information meetings on :
the dangers of electric currents, risks to the eyes, the danger of fire and means of extinguishing, the use of handling equipment. Practical exercises.
7. Study of particular technical problems associated with the safety of the installations
Floorloads permissible in certain areas, particularly in the reactor buildings.
8. Study and implementation of the system for control of access to the reactor and to the detritiation building.
9. Control of entry to site
Supervision and training of watchkeepers. Instructions, updating of emergency plans, replacement of the perimeter fence, liaison with the CENG emergency services, etc.

RADIOPROTECTION

1. Dosimetry of staff (control of dosimeter films and evaluation of the results)
 - 5000 individual dosimeter films including 1000 for non-I.L.L. staff.
 - 800 dosimeter films were used for dosimetry of the environment.
 - Study of the adoption at I.L.L. of thermoluminescence dosimetry.
2. Laboratory analyses
 - Gamma spectrometry associated with the operation of the reactor and detritiation.
 - Daily analyses on liquid and gaseous samples.
 - Checking for tritium by liquid scintillation (various samples, urine, etc.).
3. Radioprotection around the experiments
Daily checks on the biological shielding and irradiated specimens, barriers, information and assistance to experimenters, particularly the guest scientists.
4. Periodic checking and sampling (every cycle) of the radioprotection monitoring circuits, reactor and detritiation.
5. Preparation and checks on building sites and emergency work in a radioactive area
Decontamination work.
6. Checks and monitoring of liquid and gaseous radioactive effluents
Control before and during disposal of waste, monthly summary, liaison with CENG who monitor the site.
7. Control and treatment of liquid and solid radioactive waste before their transport and treatment by CENG.
8. Training of staff
Weekly information meetings for new arrivals at I.L.L.
Instruction of permanent staff (10 meetings in 1975).
9. New projects
Assistance on radioprotection and protection against background noise in the equipping of new instruments (guides H141 and 142, H17, D17, IN11, D11B, S20, S27, etc.).
10. Measurements and background noise analysis
In association with the commission on background noise : measurements near IN4, D2, D8, IN8, D15, D14, OSTIS, etc.
11. Collaboration with the reactor department on a number of studies
 - activation of structures, study of the aging of materials and the problems raised by their replacement.
 - analysis of safety on the radiological consequences of an accident
 - evaluation of waste, during normal operation and in case of an accident
 - fuel element, link detection, contamination of surface with uranium.
12. Safety checks
Checks on working areas for contamination in all the installations.

PRODUCTION, FITTINGS AND MAINTENANCE

1. The mechanical engineering and sheet metal workshops carried out approximately 10,700 hours of work which covered 345 major requests for work, divided as follows :
275 for the experiments, 35 for the reactor, 35 for general requirements.
The most noteworthy jobs were :
Construction of the mechanical part of IN11 (beams, truck, trolley, polariser, etc.) system and orientation of monocrystals, prototypes of pneumatic turning table and liquid bearing, collimator on pneumatic chuck for D9, collimators for IN2, vacuum flight tube for D17, multi-collimator and diaphragms of D1A.
2. The "self service" workshop continues as in the past, and under the supervision of a mechanic with skills in several trades has been used regularly by about 10 technicians doing a number of minor machining and adjustment jobs on accessories for experiments.
3. The "special products" workshop, with one employee, produces radioprotection materials such as polyethylene or boron carbide panels, lithium fluoride scintillators, refills with paraffin, polyethylene, etc.
4. The operation and control of the general store "primary materials" continues to be operated by one employee.

FITTINGS AND MAINTENANCE

The main activities of this group (8 staff) cover :

1. Design studies, placing orders, checking work given to outside firms for new work or major maintenance. This work amounted to 900,000 F and about 15 firms. The most important were : repair of the superheated water network, construction of new laboratories (chemistry, crystal metallurgy, precision engineering), and the construction of 8 offices and the receptionists' area.
2. Part or all of the associated fitting and equipment work.
3. Connections to liquid networks and minor associated work for the experiments on request of the physicists.
4. All handling and transportation within the I.L.L. and to some extent outside.
5. Maintenance of the general technical installations (outside the reactor) partly by I.L.L. staff, and partly by outside contracts.
6. Ensuring that installations conform with the appropriate safety regulations.
7. Cleaning and general maintenance of buildings, green spaces and roads by external contracts.

reactor operation and instrument support services

reactor operation in 1975

The reactor operation schedule was modified from the beginning of 1975, in particular by the elimination of the shutdowns in the middle of the cycles. As a result each cycle lasts 44 days of continuous operation (complete consumption of 1 fuel element) followed by a 12-day shutdown.

If there is an unscheduled shutdown, the operating time lost can be made up by delaying the date of the next shutdown by not more than 3 days, the shutdown period being correspondingly reduced.

A total of 6 cycles of 44 days were scheduled, with an annual shutdown for maintenance from 30 September to 5 November.

ACTUAL TIME TABLE

- Cycle N31 : – commenced 7 January, ended 20 February 1975.
From 12 February until the end of the cycle, it was necessary to reduce power to 45 MW (failure of a main heavy water pump)
- Cycle N32 – commenced 4 March - end of cycle delayed until 19/4 at 08 hours, to compensate for a 40 hour shutdown due to a fault in the safety circuit.
- Cycle N33 – commenced 29 April at 08 hours, ended 12 June at 08 hours. No incident.
- Cycle N34 – commenced 24 June at 08 hours, shutdown delayed until 9 August (14 hours).
This cycle was interrupted by two shutdowns each of approx. 40 hours : on 14/7 failure of a main pump and on 30/7 due to incorrect operation on a purification circuit.
- Cycle N35 – commenced 19 August at 12 hours, ended 30 September at 8 hours. It was necessary to interrupt this cycle for 36 hours to change a faulty safety rod.
A second shutdown (of 44 hours) occurred on 14 September as a result of an E.D.F. power cut.
It was impossible to make up the time lost by these shutdowns because this would have involved shortening the annual shutdown for maintenance.

- Cycle N36 — commenced 5 November, ended 24 December at 14 hours. Up to 18 November, power was maintained at 45 MW because of a fault on a main D₂O pump which was repaired and recommenced operation on 21/11.
A shutdown of 53 hours between 16/12 and 18/12 was caused by release of the safety rods.

OPERATION OF THE SUB-ASSEMBLIES

- a) The operation of the cold and hot sources continued to give complete satisfaction.
b) The operation of the detritiation plant has reached a stable situation :
quantity of heavy water from the HFR treated : approx. 44 000 l.
number of curies of tritium extracted from HFR : approx. 56 000 Ci.

DATA FOR 1975

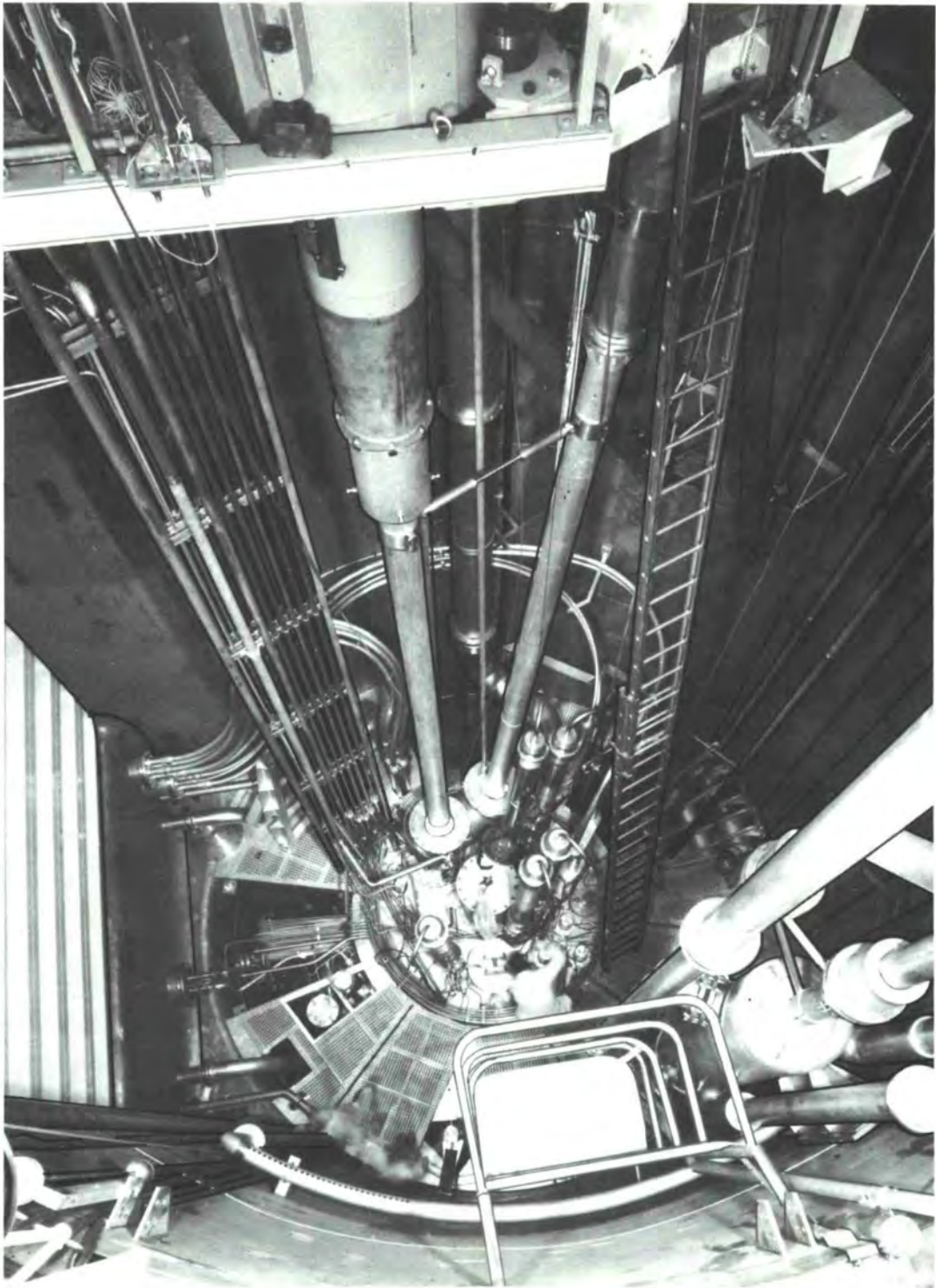
	1975
— number of days operation originally scheduled	262
— actual number of days of operation	257
at normal power	236.5
at 0.8 normal power	20.5
(provided that there are no unforeseen incidents between 8 and 22 December 1975)	
actual operating time (% of year)	70.5%
actual operating time in relation to time scheduled	98%
— number of fuel elements used	6
— total number of unscheduled shutdowns	25
. including short shutdowns (< 0.5 h)	17
. with poison-out	8
— including intentional to permit work	2

CAUSES OF THESE UNSCHEDULED SHUTDOWNS

— human intervention (operation)	7
— human error	3
— miscellaneous (electronics, control, electrical engineering)	4
— release of safety rods	7
— EDF power cuts	4

ANALYSIS OF INCIDENTS

There are no particularly noteworthy incidents to be mentioned, but the causes of systematic incidents are given.



Reactor swimming pool (empty)

- a) Safety rods
Despite the preventive modifications in the upper part of the safety rods, a number of releases of rods have been observed. A thorough study should lead to modifications which will be incorporated in 1976 and should eliminate this problem.
- b) Heavy water pumps
The repeated incidents on the bearings of these pumps have frequently necessitated operation at reduced power (0.8 normal power). The technical solution to this problem seems to have been achieved in November 1975.
- c) Continuity of operation
A considerable effort has been made to eliminate the systematic causes of unnecessary releasing of the safety rods and to improve the possibility of a rapid restart after an unscheduled shutdown.

MAJOR WORK AND MODIFICATIONS IN 1975

FUEL ELEMENTS

The completion of the Klein casket for transporting whole fuel elements to Marcoule has made it possible to send 7 elements for reprocessing in 1975. An eighth will be sent to Marcoule at the end of December.

HEAVY WATER

To solve the problems encountered with the various heavy water pumps it appears necessary to develop preventive maintenance and control systems and to purchase a complete main pump replacement sub-assembly.

COOLING CIRCUITS

The intermediary circuit cooling system started operation in November and should give complete satisfaction after the removal of the deposit left in these circuits by the river water previously used.

ELECTRICAL CONTROL

The usefulness and necessity of the computer control, associated with the problem of maintenance of the computer used at present, has led to the purchase of a second computer which will function in parallel with the existing one. Installation scheduled for the beginning of 1976.

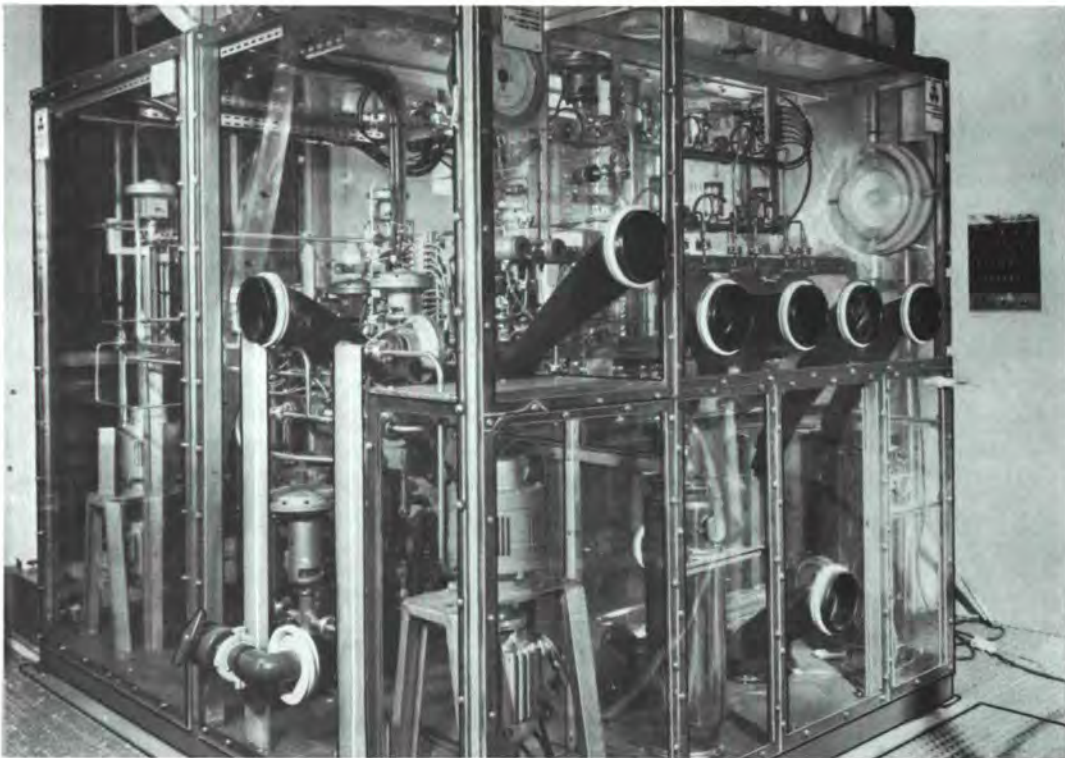
VENTILATION AND EFFLUENTS

The gaseous effluents from detritiation are now connected to the main chimney of the reactor.

Improvements have been made to the system and the discharge area to eliminate the risks encountered in September 1975.

SAFETY RODS

- a) The tests of a safety rod modified to reduce the risk of unnecessary releases should be completed early in 1976 and eliminate this difficult problem.
- b) The absorbent element of BS4 has been removed and replaced by a new absorbent (without emptying the heavy water). This revealed that the absorbent elements do not seem to have suffered any damage after more than the equivalent of 680 days of full power. The systematic replacement of the other absorbent elements may therefore be delayed.



Glove box in the detritiation plant

sample environment section

1 — VACUUM

- Maintenance of 295 pumping systems
 - . 245 primary groups
 - . 35 secondary groups
 - . 20 special groups
- 480 interventions, of which 170 were serious repairs
- 100 loans of vacuum systems.

2 — CRYOGENIC FLUIDS

2.1 — Liquid Nitrogen

Consumption : 252 000 litres (0.43 F/litre)

10% more than in 1974. This should be compared to the increase of 71% observed for the previous year.

2.2 — Liquid Helium

Consumption : 35 113 litres ; 29% more than in 1974. This should be compared to the increase of 145% observed for the previous year.

Minimum weekly consumption : 199 litres

Maximum weekly consumption : 1,227 litres

Gas losses : 2,577m³ (10%)

Mean cost per liquid litre (including losses and transportation) : 8.25 F.

The efficiency of the Helium recovery is satisfactory. Any improvement would cost more than the cost of the recovered gas.

It should be noted that the gas recovered in a single year

21.198 m³ x 18 F = 381,564 F

saves more money than the investment needed for the recovery (~ 300,000 F).

3 — CRYOSTATS

3.1 — Current operation

34 cryostats are now functioning operationally. 17 of them with special geometrics and/or special performances are permanently attached to specific instruments. 17 cryostats, of which only 6 are full range variable temperature, are operated in a pool, loaned upon request.

Every request for a loan (125) was satisfied. Each cooling for starting an experiment is done by the section which thus gives to the user a working apparatus.

There is a continuing increase in requests for loans of full range variable temperature cryostats. One must increase the number of this kind of apparatus to avoid a crisis next year.

3.2 — Very low temperatures

As the experiment S13 did not become operational during 1975 the dilution fridge has been used on D1B for diffraction measurements of antiferro-magnetic powders, specifically rare earth garnets (Dy-Ga-G, Yb-Ga-G), and an organic compound (Tanol).

The apparatus has worked very satisfactorily at temperatures well below the design figure of 100 mK even under the far from ideal working conditions in the neutron



New cryogenics laboratory

guide hall (vibrations, electro-magnetic noise etc.) - 65 mK were maintained for a long period and 55 mK in one shot mode.

The main problem for neutronic powder measurements is the thermal contact between the mixing chamber and the sample. The chosen method has been to immerse the sample in an He₂ bath attached to the mixing chamber.

3.3 — Development

A full range (1.5 → 300 K) variable temperature cryostat, with top access sample, light, small, with a very large holding time and easy to operate, has been developed during the last 6 months. The preliminary tests have shown performances in agreement with calculations. This cryostat will now be tested in routine operation. If the users find this apparatus advantageous, it could be considered as a prototype for future cryostats.

4 — HIGH PRESSURES AND LOW TEMPERATURES

There is constant cooperation with the High Pressure laboratory (M. Bloch and M. Poreau). Neutron diffraction measurements under hydrostatic pressures up to 4 kbar, at temperatures between 1.8 and 300 K are now standard facilities. On the other hand, quasi hydrostatic high pressures, up to 40 kbar, developed by M. Poreau and M. Bloch, have also been used at low temperature for neutron diffraction.

5 — FURNACES

Due to the increase in the number of people in the team we have been able to start routine operation of furnaces and associated apparatus (vacuum systems, electronics controllers). A number of modifications have already been carried out, but others remain to be done in order to ensure the normal operation of the existing systems. The numerous requests of users for help have demonstrated the necessity for this new service.

instrument operation section

During 1975 this section, which provides the technical support for all operational instruments, increased in number by 6 to 37, whilst in the same period the number of supported instruments either operational, undergoing tests, or in advanced planning stage increased to more than 50. The instrument technicians were under great pressure due to the frequent number of experimental changes (sometimes quite complicated) required at short notice, and also to the number of new instruments being installed and existing instruments being modified. An important part was played in the installation of D9, D3, IN8, D11B, D15 and IN11, and in the major modifications made to D7, IN3, and IN7.

Under a newly instituted procedure with the Project Office each new instrument before being accepted as operational is subjected to a reception procedure, which includes the preparation of a detailed dossier with full plans, technical descriptions and list of necessary spares, and an examination of Safety and Radioprotection aspects. During the year the procedure for D3 and D9 was completed whilst that for D15 and D16 is currently being finalised.

In order to improve the facilities available to the Service a small central laboratory is being equipped with test and measuring equipment, and a workshop has been established in the Neutron Guide Hall. A small Chemical Preparation Laboratory has been set up for the users of D11, and also a General Preparation area. Because of the increasing number of Proposals to study hazardous materials, an examination has been made of a suitable "Hot Laboratory" which will be located in the Reactor Experimental Hall early in 1976.

The changeover of the experimental cooling water circuit from river water to a closed loop circuit took place during the annual Reactor shutdown, but the definitive connection of all instruments has been delayed due to the large amount of foreign matter deposited in the pipework under the previous system.

computing services

INTRODUCTION

A major organisational change occurred during the year when the Electronics Group (of Technical Services) and the Informatique Group (of Computing Services) were merged to form the Instrument Control and Data Acquisition Service.

This new Service has a structure which reflects the various instrument control systems, in recognition of the fact that maintenance and modifications to existing systems now constitute the greater part of the workload. By the end of the year the new organisation had become effective and was providing a very efficient service to the experimentalists, thanks to the cooperation of the staff in accepting the necessary changes.

The most notable feature of 1975 has been the considerable growth in the amount of data collected from the computer-controlled instruments, an increase of about 80% compared with 1974. This has put considerable pressure on the Central Computer Service, which has had to handle the increased load with no additional staff and only a limited increase in resources.

1 – INSTRUMENT CONTROL AND DATA ACQUISITION SERVICE

This Service is responsible for developments, improvements and maintenance for the I.L.L. electronics equipment, instrument control electronics, instrument computer systems and neutron detectors. It also supplies software support for instrument control computers. Moreover, there is a continuing requirement to develop new techniques and methods in order to support new instruments and increase the efficiency of existing ones.

1.1 – CARINE systems [CARINE 1 : D2, D5, D8, D10, IN1, IN2
CARINE 2 : D1A, D1B, D9, IN3, IN8
CARINE 3 : stand-by, test and development]

At the instrument level D9 is now operational and IN8 has come on-line.

On the hardware side a new disk has been installed and a phased replacement of the original teletypes by more reliable models has started. A link to the System-10 Central Computer has been installed and preliminary hardware tests have been done. The overall reliability has remained good, but faults have arisen in the memory and disks.

Some major software improvements have been implemented. The operating system has been revised to give faster response and the support programs for the diffractometers have been reorganised. The equivalent project for the triple-axis machines is in progress.

1.2 — NICOLE Systems [NICOLE 1 : D7, D11A, IN4, IN5, PN1
NICOLE 2 : stand-by, test and development]

Although the performance of the NICOLE system has been better, on average, than in 1974 it still gives cause for concern and its maintenance consumes much scarce technical manpower. In consequence a decision has been taken to replace it. An outline hardware configuration using individual computers for each instrument has been drawn up. Implementation will commence in 1976.

Principal improvements during the year have been the installation of a CAMAC interface for IN5 and the handling of polarised neutrons on D7.

1.3 — PDP-11 System [D3, D6, D11A/B, D14, D17, IN10, IN11,
PN2/3, LI7, S4]

On the established instrument systems, running under the I.L.L. operating system RTS-11, there have been further software improvements. IN10 now has a data link to the System-10 and improved control facilities. On the PN2/3 (BILL/GAMS) system it has become apparent that the 200 m unibus extension is not really viable. It has therefore been decided to acquire a separate computer to provide independent control for BILL.

The PDP-11/20 (operating under RT11) for IN11 is now operational, and was supporting the instrument in its test phase at the end of the year. This computer cannot now be used to control IN9, since the latter is being installed on a different beam tube.

A small PDP-11/10, on loan from Harvard University has been installed on S4. Implementation of the PDP-11/40 for D11A/B (using the operating system RSX-11D) is continuing. A similar system is being constructed for D17.

1.4 — Other Systems

The two Mark VI diffractometers D15 and D16 are controlled by a PDP-8E. Some difficulties have been encountered with the electronics since this system, acquired from Harwell, does not follow I.L.L. standards.

The low data rate instruments D4, D13, LI2, LI3 have been fitted with cassette tape units (in place of paper tape punches) to improve their data acquisition handling.

1.5 — General Electronics

Considerable effort has been put into studying ways of improving the CARINE control electronics. Several modifications have been incorporated and the possibility of complete replacement is under review.

Computer-controlled cryostat temperature devices and vapour deposit equipment are being developed.

1.6 — Detectors

Development work is now very much oriented towards multidetectors. The neutron camera (D14) has been set up for tests. New multidetector logic has been developed, as well as new amplifiers which can be used both for multidetectors and conventional detectors. Neutron tests on a resistive wire multidetector have been performed, and a He^3/BF_3 station has been installed in order to permit filling of multidetector prototypes.

A crossed wire neutron detector, intended to serve as a localising monitor for flux distribution measurements, has been tested, as was a TV camera facing a Li-scintillator. This latter device facilitates orientation and quality checks on single crystals. Both systems can be used for neutron beam alignment work.

The 400 He^3 detectors on IN5 are now fully installed.

1.7 — Maintenance

The maintenance of everything except the PDP-11/20 and PDP-8 computers continues to be carried out by in-house technicians. In view of the many special features of the Institut's equipment this provides the most comprehensive support service possible. The problem of having a suitable expert immediately respond to a call for assistance outside normal working hours still creates difficulties, owing to the large number of different types of hardware and the lack of sufficient staff to permit shift-working.

2. — CENTRAL COMPUTER SERVICE

The amount of experimental data transferred to the DEC System 10 Central Computer has increased from 101M words in 1974 to 183M in 1975. Although most of this data is not analysed in depth at I.L.L. it has nevertheless generated a significantly increased workload. Usage of the central processor has increased from 1980 hrs to 2560 hrs (30% growth), coming from 36 000 time-sharing sessions and 29 000 batch-jobs.

Unfortunately this has happened at a time when there have been no additional staff available, and with first priority being to support the external user it has not been possible to provide the desired level of assistance to in-house staff. In the absence of operator cover the computer is given over to scientists who have received elementary operator training. It is to be hoped that this situation can be resolved in 1976.

More satisfactorily, as a result of discussions with visitors concerning their home computer installations, the Central Computer staff are now better able to supply data tapes in an easily readable format. As a result, there has been a sharp drop in the number of reported cases of visitors having data-reading problems.

The configuration of the System 10 has been enhanced during the year by the following additions :

- 32K words of main memory (making a total of 160K)
- 2 disk drives (total now 6)
- handler for 8 terminal lines (total now 24)
- 1 cassette terminal
- 1 display terminal with hardcopy unit.

These additions have enabled reasonable response and turn-around times to be maintained and permit some links to instrument control computers.

The principal system programming activities have been :

- incorporation of new and modified facilities offered by DEC
- introduction of direct access to the experimental data files
- improved management of magnetic tapes
- software for new types of terminal
- better support for graphics
- preparation for the high-speed links to D11 and D17.

Whilst the staff also try to find time to deal with general requests for assistance and advice, very little effort is available for writing programs for individual users.

It is now clear that additional investments in manpower and resources will have to be made in the area of post-experiment data handling if one is to extract the maximum of useful information from the raw data.



Computer terminal on D3

administration

The Administration department comprises the Personnel and Finance Branches of the Institut concerning which detailed information, including statistical charts, is given below.

In the Personnel Branch a re-organisation of staff and responsibilities took place in the early months of the year. Responsibilities, until then attributed to one Head of Branch, were divided, for practical purposes, into two distinct sections, Personnel Section and Social Relations Section, with a responsible officer for each.

Workload pressures in other areas were somewhat alleviated by exercising as far as possible the policy of internal transfer of staff from one Department to another. During 1975 negotiations continued between the management and trade unions in preparing the collective agreement to eventually replace the present "Statut du Personnel", and progress has been achieved.

personnel

The following table gives details of the increase in the effective strength between 31 December 1974 and 31 December 1975, taking into consideration the normal elements of recruitment and cessations of duty.

I STAFF SITUATION

Categories (1)	Position on 31. 12. 74 (2)	Changes in 1975		Difference + or - (5)	Position on 31. 12. 75 (6)	Changes * column 2 compared with column % (7)
		Recruit- ment and internal changes (3)	Depart- ures and internal changes (4)			
1. Scientists	68	19	14	+ 5	73	21
2. 'Cadres' and Engineers	49	8	3	+ 5	54	6
3. Thesis Students	26	11	8	+ 3	29	31
4. Technicians	133	12	6	+ 6	139	4
5. Others	97	8	5	+ 3	100	5
Total :	373	58	36	+ 22	395	10

The percentage fluctuations shown in the last column of the table indicate that the significant turnover of staff is restricted to the scientists who have limited contracts. The remaining personnel sectors are relatively stable.

* The percentage of I.L.L. personnel which in 1975, in comparison with the effective strength on 31 December 1974 have left the Institut.

II - BREAKDOWN OF STAFF BY NATIONALITY 1973, 1974, 1975

Categories	French			German			British			Others			Total		
	73	74	75	73	74	75	73	74	75	73	74	75	73	74	75
Scientists	19	18	17	25	26	22	7	13	22	17	11	12	68	68	73
'Cadres' and Engineers	38	35	38	15	9	11	5	5	5	—	—	—	58	49	54
Thesis Students	18	15	15	10	7	5	1	2	7	2	2	2	31	26	29
Non-Cadres	182	195	196	19	18	18	9	14	21	4	3	4	214	230	239
Total	257	263	266	69	60	56	22	34	55	23	16	18	371	373	395
Changes		+6	+3		-9	-4		+12	+21		-7	+2		+2	+22

The above table reflects the following trends, by nationalities :

- (1) French : a small increase over the 2 years (+ 9)
- (2) German : a slight decrease attributable to a combination of the end of contracts for Scientists and resignations by engineers for career reasons (- 13)
- (3) British : serious recruiting efforts to improve geographical distribution of staff achieved a significant increase (+ 21).

The geographical distribution of the effective strength on 31 December 1975 is given below :

III - STAFF BY CATEGORY AND NATIONALITY ON 31. 12. 1975

	French	German	British	Others	Total
Scientists	17	22	22	12	73
'Cadres' and Engineers	38	11	5	—	54
Thesis Students	15	5	7	2	29
Technicians	115	8	14	2	139
Others	81	10	7	2	100
Total :	266 (67%)	56 (14%)	55 (14%)	18 (5%)	395 (100%)

The table reflects the recruiting efforts exercised in the British sector which has enabled the British contingent to increase whereas the departure of a number of German personnel has diminished their overall strength.

Below is a table which details the effective strength by categories, since 1969 and shows the percentage representation of each category.

IV - DEVELOPMENT OF STAFF

Year	Total I.L.L.		Scientists		'Cadres and Engineers		Thesis Students		Non-Cadres	
	No	%	No	%	No	%	No	%	No	%
1969	106	100	12	11.32	44	41.51	14	13.21	36	33.96
1970	210	100	45	21.43	40	19.05	23	10.95	102	48.57
1971	307	100	61	19.87	48	15.64	37	12.05	161	52.44
1972	348	100	67	19.25	51	14.66	38	10.92	192	55.17
1973	371	100	68	18.33	58	15.63	31	8.36	214	57.68
1974	373	100	68	18.23	49	13.14	26	6.97	230	61.66
1975	395	100	73	18.48	54	13.67	29	7.34	239	60.51

It is evident that since 1971, apart from thesis students, the percentage representation by categories remains fairly constant.

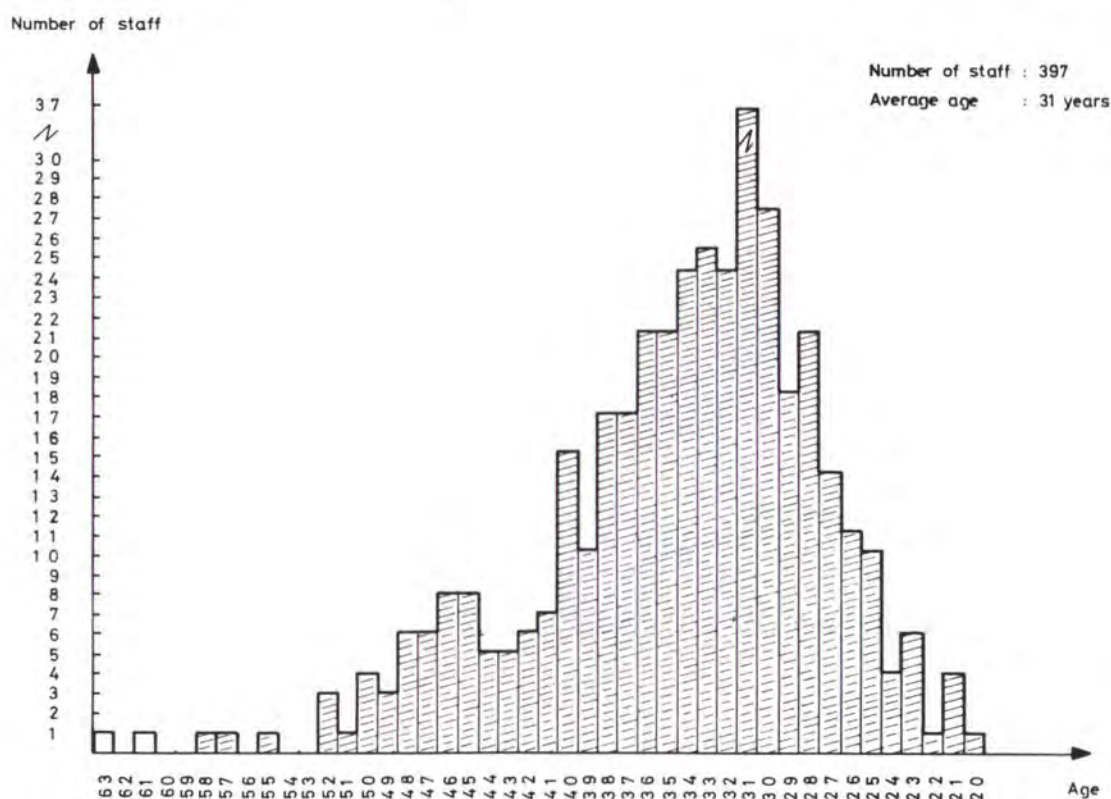


Fig. 13 : Age Structure of I.L.L. Staff on 31.12.1975

Compared with the average age of 34 years 2 months as on 31 December 1974 the average has decreased to 31 years due to the recruitment of a number of personnel in low age groups in the non-scientific brackets.

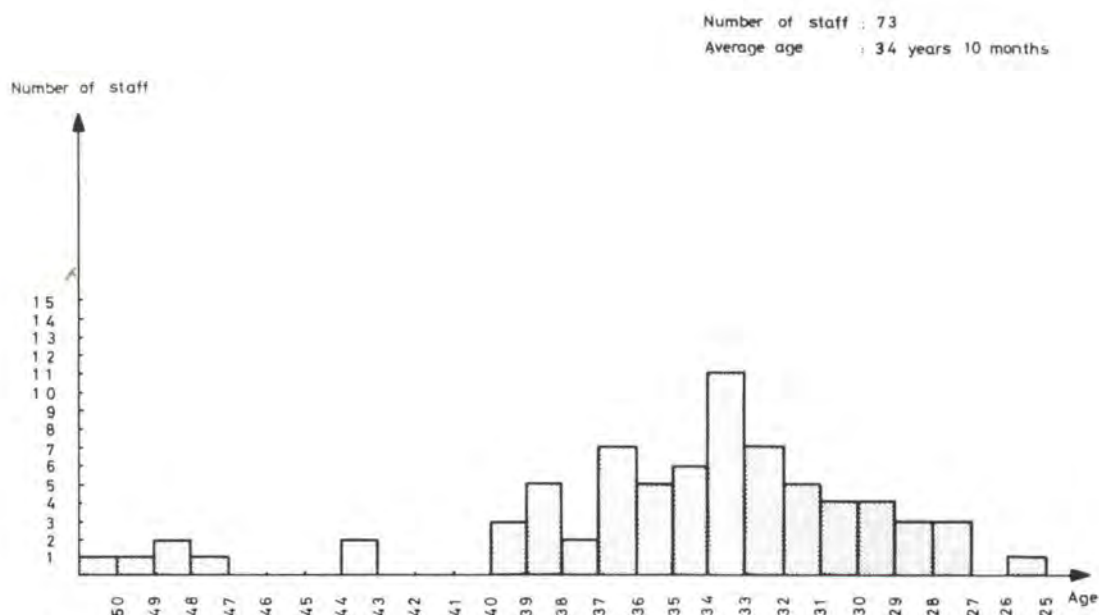


Fig. 14 : Age Structure of Scientists on 31. 12. 1975

Since 1974 the average age group of scientists has fluctuated by an increase of one year due to the replacement of departed personnel by new recruits of a slightly higher age group.

As the I.L.L. functions as a French company, it has representation of two national trade unions and one Institut union with members of different nationalities.

In compliance with the French law, a certain amount of the staff costs of the Institut is allocated to a Comité d'Entreprise (Works Committee). The members are elected biennially and represent a cross-section of the Institut's staff members ; the numbers are related to the complement. The mandate of this committee is co-operation with the management in maintaining and improving general working conditions of the Institut, and to act in a consultative capacity on financial and technical matters. The committee financially supports the I.L.L. supplementary insurance scheme (Société Mutualiste) and organises activities in the 'oeuvres sociales' field, such as sports, holiday schemes, training and culture.

The funds attributed to the Comité d'Entreprise are allocated, in accordance with French legislation, from the Institut's budget.

social relations and guest scientists

TRAVEL COSTS

a) Guest scientists

In 1975 almost 1200 visits by guest scientists from 136 different laboratories were recorded (783 visits in 1974). Some of these visitors came more than once.

Travel costs for these guest scientists are now handled by computer, as are those for I.L.L. staff. The statistics on these will be studied and utilized at I.L.L. in conjunction with the Scientific Secretariat and Computing Services. We think that we shall be operational at the end of the first quarter of 1976.

Expenditure 1974 : 1,070,000 F

Expenditure 1975 : approx. 1,450,000 F

The following table shows the distribution of guest scientists up to 30 November 1975.

b) I.L.L. staff

980 visits were made during the year at the total cost of 620,000 F.

MEDICAL SERVICE

I.L.L. staff and guest scientists remaining more than six months who work in the restricted area more than 200 hours per year are supervised by the medical service of the adjacent nuclear studies centre (CENG). All other staff have medical examinations at I.L.L. Since November 1975 there has been medical supervision at I.L.L. of scientists staying from 15 days to 6 months : those concerned have so far willingly agreed to these examinations.

– in 1975 19 industrial accidents were reported to the Social Security, including 12 accidents not involving absence from work and 7 accidents with a total of 83 days away from work.

No serious accidents were reported.

– 118 absences from work were recorded for illness, maternity, health cures (20 for Cadres, 115 for non-Cadres) representing a total of 2 064 days of absence from work.

SOCIAL SECURITY AND SUPPLEMENTARY REFUNDS

A total of 5 580 cases were submitted to the Social Security after checking and providing additional information (4 967 in 1974).

The "Mutuelle" then provided additional refunds : a total refund of 172,290 F for 4 800 cases (3 546 in 1974).

IRRAPRI (superannuation fund for 'Cadres') received from us requests for additional refunds in 194 cases, which resulted in a total refunded of 25 745 F.

"SOCIETE MUTUALISTE"

French legislation provides for the possibility of establishing within organizations a "Société Mutualiste" whose main aim is to provide refunds additional to those of the Social Security.

The Statutes of the Society for I.L.L. were prepared by a working group of I.L.L. staff in collaboration with an official representative. The General Meeting to establish the Society was held on 13 February 1975 and the provisional Administrative Council was set up on that date.

The Statutes were approved by the Préfecture of the Isère Department, so that the Society officially came into existence on 1 July 1975.

Since that date the Society has operated independently. It is financed by the Comité d'Entreprise, which provides one third of its budget for this purpose, and by subscriptions from members.

The main advantage of the establishment of this Society is that I.L.L. staff are rapidly admitted to hospitals and clinics in the area, on presentation of their membership cards. They have no costs (apart from personal expenditure) as the Society reimburses the hospital or clinic direct at established rates.

SCHOOLING

The "Ecole de la Houille Blanche" now takes approximately 50 children of the staff or of associated organizations. The system seems to have overcome its teething troubles and to be operating to the satisfaction of all concerned.

The children in the sixième experimental class at the Lycée des Eaux Claires in the school year 1974/75 were distributed among different cinquième classes in September 1975.

A new sixième class was organized in September 1975 in better conditions than the previous year, as it includes non-French children (the great majority German) well integrated in French life. In March a decision will be taken whether or not to continue this experiment at the secondary level.

HOUSING

Assistance in the purchase of houses or flats was obtained from several organizations :

- 16 loans totalling 185,000 F from the Comité Interprofessionnel du Logement, using the 1% housing assistance funds provided for under French law.
- 8 direct loans from the 'Cadres' superannuation fund for 148,000 F
- 7 loans guaranteed by the 'Cadres' superannuation fund from the Banque Nationale de Paris.

TRAINING

This includes languages, technical and general training :

- (1) language courses representing approximately 63% of total training time.

I.L.L. organizes (frequently in collaboration with CNRS) English, German and French courses. Non-French newcomers are recommended to go to the University for intensive French courses.

The question of exchanges between French and non-French technicians arises increasingly. It is desirable to find methods - preferably involving tuition - which would permit I.L.L. staff to work for several months in German or British Laboratories and to receive non-French technicians in Grenoble. The "Social Relations" section intends to consider this question more thoroughly in the next few months.

- (2) technical training : this represents 27% of training time and is given by specialised organizations.
- (3) general training : this represents 9.50% of training time : an effort should be made in this field to permit I.L.L. staff to attend interesting courses in insufficiently known areas (public speaking, economics, etc).

OTHER VISITORS

In addition to scientists visiting I.L.L. to do experiments, brief visits were also arranged for a considerable number of other scientists and groups from universities, schools and other organisations from several countries.



New reception area

GUEST SCIENTISTS - with travel expenses paid

	No of Visitors	Nationalities			
		French	German	British	Others
1 year or more	4	—	4	—	—
3 months - 1 year	10	1	4	—	5
less than 3 months	482	128	229	63	62
	496	129	237	63	67

GUEST SCIENTISTS - without travel expenses

	No of Visitors	Nationalities			
		French	German	British	Others
1 year or more	17	3	4	6	4
3 months - 1 year	23	5	4	7	7
less than 3 months	475	114	94	148	120
	515	122	102	161	131

finance

1 — BUDGET AND ACCOUNTS

The Budget approved for 1975 provided for a total expenditure of 78.0 million Francs. Of this 1.2 million Francs were to be covered by the I.L.L.'s own income, while the contributions of the Associates were set at 76.8 million Francs. Because of the general increase in price levels observed particularly during 1974 it was necessary to request grants from the Associates 5 million Francs higher than the maximum normally allowed for under the intergovernmental agreement of 19th July 1974 for the year 1975 (approx. 71.8 million Francs). The governments of the three countries have authorized the Associates to make available these additional funds to the Institut.

The following is the actual expenditure according to the provisional accounts for 1975, in comparison with the total estimated expenditure of 78.0 million Francs :

a) Operation

	1975 (x 1000)	% (of total)	1974 (x 1000)	% (of total)
Consumable materials and small equipment	5,940	7.8	5,559	7.9
Fuel elements	9,800	12.8	8,987	12.9
Staff costs	36,100	47.1	31,696	45.1
Long-term service contracts	8,570	11.2	7,186	10.2
Others work, supplies and services from third parties	5,380	7.0	5,443	7.7
Transport, removal and travel expenses	800	1.0	870	1.2
Miscellaneous administrative costs	2,350	3.1	1,825	2.6
Total Operation	68,940	90.0	61,566	87.6

b) Investments

Buildings	400	0.5	871	1.2
Equipment (except experimental equipment)	1,000	1.3	1,044	1.5
Experimental equipment	4,100	5.3	5,218	7.5
Other investments	2,200	2.9	1,549	2.2
	7,700	10.0	8,682	12.4
Total expenditure	76,640	100.0	70,248	100.0

c) I.L.L.'s own income	1,700	2.2	2,399	3.4
Grants from Associates	74,940	97.8	67,849	96.6
	76,640	100.0	70,248	100.0

The provisional total of expenditure for 1975 was thus 1.4 million F less than estimated in the Budget. Furthermore the I.L.L.'s own income was 1.7 million F in comparison with the anticipated figure of 1.2 million F, so that the grants not utilised in 1975 amounted to 1.9 million F.

If however allowance is made for two major contracts (replacement of the 'Nicole' process computer system - 1,500,000 F - and replacement of beam tube liners -

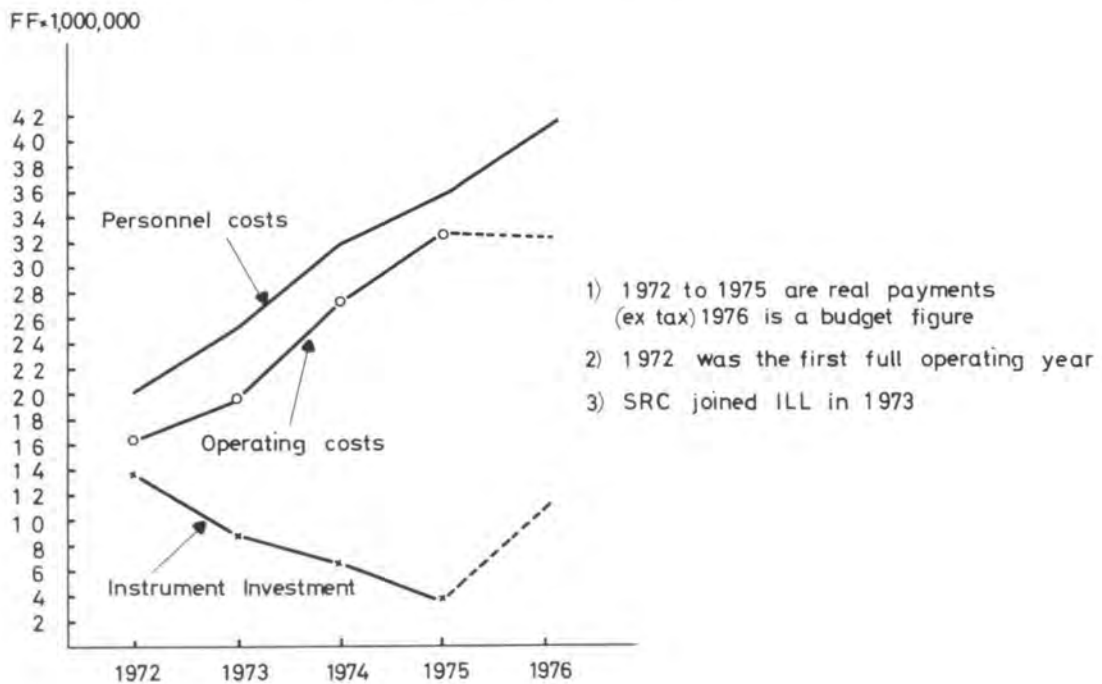
250,000 F) which for technical reasons can only be placed in 1976 but are to be financed from funds authorised for 1975, the Budget approved for 1975 was fully utilised apart from a balance of 150,000 F.

1.1 In comparison with the previous year the Operation Expenditure increased from 61.6 million F to 68.9 million F (+ 11.9%). This rate of increase is only slightly higher than the general inflation rate in the same period. It should however be pointed out that in 1975 the Institut was not required to pay payroll tax, which resulted in a saving of approximately 1.7 million F on operation expenditure.

1.2 The investments expenditure fell in comparison with the previous year from 8.7 million F to 7.7 million F (– 11.5%). The budget difficulties led to a slowing down of extension programme, particularly in the field of experimental equipment.

In the accounts field an improved reporting system was developed in 1975, which regularly informs all departments handling money on the state of expenditure categories, cost centres and projects ; in all three cases the actual values are compared with the estimated figures.

2 — EXPENDITURE TRENDS 1972 TO 1976



3 — PURCHASING

In 1975 3 930 purchase orders - in comparison with 4 126 in 1974 - were handled by the purchasing section. There is close cooperation with the technical and scientific areas on all purchases. The technical coordination by the Project Office has proved particularly helpful for purchasing with investments in the field of experimental equipment.

The first successes in our efforts to achieve a better equilibrium in the placing of orders among the partner countries were achieved in 1975. The proportion of orders placed in Britain and Germany increased as follows :

	1974		1975	
	F	%	F	%
Volume of orders	24,072,400	100.0	20,096,199	100.0
Distribution				
— France	20,201,719	83.9	12,951,198	64.4
— Germany	3,360,799	14.0	6,206,736	30.9
— U.K.	509,882	2.1	938,265	4.7

Finally efforts were made during the year to conclude a larger number of covering orders, to reduce the number of small orders (between 100 and 300 F).

I.L.L. PUBLICATIONS 1975

(References arranged by Code Number)

Example of Code Number : 75 A 217

75	stands for the year the paper was published
A	stands for the first letter of the first author's name
217	is the serial number of registration.

The letters T and S behind a code number indicate that this report is an INTERNAL TECHNICAL and SCIENTIFIC report respectively.

These reports are kept in the I.L.L. Library.

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C.M.E. ZEYEN, H. MEISTER, Third European Meeting on Ferroelectricity EMF-3, Zürich, Sept. 22-26, 1975. Order Parameter of the KDP Ferroelectric Phase Transition measured by Neutron Diffractometry.

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- 75Z55 Claude M.E. ZEYEN, Thèse de Doctorat d'Etat, München (Juin 1975). Untersuchung des Phasengemisches im Kritischen Temperaturbereich des Ferroelektrischen Phasenuberganges von KD_2PO_4 mit Hilfe der Neutronenstreuung.
- 75A82 Robert ALMAIRAC, Thèse de Doctorat d'Etat, Montpellier (Octobre 1975). Dynamique du Fluorure de Magnésium.
- 75B97 Gilles BAILLEUL, Thèse de Docteur-Ingénieur, Grenoble (Juin 1975). Spectrométrie de Produits de Fission sur le Séparateur de Masse Lohengrin.
- 75G99 Jean-Pierre GASPARD, These de Doctorat d'Etat (Juin 1975). Contribution à l'Etude de la Densité d'Etats Electroniques des Systèmes Désordonnés.
- 75M100 Jean-Paul MATHIEU, Thèse de Doctorat d'Etat, Grenoble (Juin 1975). Etude des Défauts dans les Solides
I. Conséquences Chimiques associées aux Phénomènes Nucléaires (Réaction (n, γ) et capture K).
II. Déshydratation du Chlorate de Baryum Monohydrate.
- 75E114 Anne ERMOLIEFF, Thèse de Doctorat d'Etat, Grenoble (Septembre 1975). Diffusion Brillouin dans la Glace Hexagonale. Contribution à l'Etude de la Transition Subie par la Glace Hexagonale à Pression Atmosphérique.
- 75T173 Francis TASSET, Thèse de Doctorat d'Etat, Grenoble (Mars 1975). Etude par Diffraction de Neutrons Polarisés de la Densité d'Aimantation du Composé Intermétallique YCo_5 et des Composés Voisins.
- 75V182 Christian VETTIER, Thèse de Doctorat d'Etat, Grenoble (Septembre 1975). Etude de Systèmes Magnétiques à Deux Dimensions $FeCl_2$ et $FeBr_2$.
- 75T199 Wolf-Dieter TEUCHERT. Thèse de Doctorat d'Etat, Würzburg (Novembre 1975). Phonons in Trigonal Selenium.
- 75T311 Pierre CONVERT, Thèse de Doctorat d'Université, Grenoble (Décembre 1975). Multidétecteurs à une et deux Dimensions pour Neutrons Thermiques. Apports et Perspectives en Diffraction et Diffusion des Neutrons.

CONFERENCES AT I.L.L. IN 1975

Meeting on Experimental Aspects of Charge Density Studies (organized by P. Coppens and B. Klar)	February 1975
Neutron Capture Information Meeting and Workshop (organized by M. Asghar)	March 1975
Information Meeting and Workshop on Liquid Dynamics (organized by S. W. Lovesey and J.R.D. Copley)	March 1975
Meeting on Extinction Problems (organized by P. Coppens and H. Fuess)	May 1975
Symposium on Phonons in Solids (organized by B. Dorner and R. Currat)	October 1975
Chemistry Information Meeting (organized by Julia Higgins and J.W. White)	October 1975

EXPERIMENTS PERFORMED AT I.L.L. 1975

The following is a list of the experiments performed at I.L.L. from January 1 to December 31 1975.

Please refer to the Annex to the Annual Report for a detailed study of the results.

* Experiment commenced or carried out during 1975 without submitted report

** Experiment carried out, report available, results not yet publishable.

COLLEGE 3		03 01 022*	Test of glass detectors Siegert (I.L.L.) Fiedler, Greif (Giessen)	PN1
03 01 003	Fission detectors Finch (Dublin) Forte (Varese, Ispra)	PN1		
03 01 005	n- γ coincidences Crançon, Ristori (C.E.N.G.)	PN1	03 01 023	He-jet (test run) Schussler (C.E.N.G.) Wollnik, Pfeiffer, Weitzel (Giessen)
03 01 006	Measurement of delayed neutron energy spectra by time of flight techniques Crawford, Asghar (I.L.L.) Kellie, Hall (Glasgow)	PN1	03 01 024*	Investigation of secondary electron emission induced by mass separated fission fragments from "Lohengrin" Clerc (Darmstadt)
03 01 007	Nuclear charge distribution of the heavy mass region fission products as a function of kinetic energy and ionic charge state. Denschlag, Paffrath, Faubel, Braun (Mainz) Siegert, Schrader (I.L.L.) Blachot (C.E.N.G.)	PN1	03 01 025	Nuclear charge distribution of mass separated fission products (1) at the mean kinetic energy (2) as a function of kinetic energy Siegert, Greif (I.L.L.) Wollnik, Fiedler (Giessen)
03 01 008	$Q\beta$ -measurements Decker, Wollnik (Giessen)	PN1	03 01 026*	Nuclear charge distribution of mass separated fission fragments recorded with nuclei emission Siegert, Greif (I.L.L.) Wollnik, Fiedler (Giessen)
03 01 010	Search for μ sec fission fragments isomers in ^{235}U Bachot, Monnard, Schussler (C.E.N.G.) Sadler, Sistemich (Jülich) Bocquet, Pfeiffer (I.L.L.)	PN1	03 01 027	Delayed neutron spectra following decay of bromine and iodine isotopes Kratz, Rudolph, Ohm (Mainz) Asghar (I.L.L.)
03 01 013*	Ionization chamber Armbruster (Darmstadt) Sistemich (Jülich)	PN1	03 01 029	Studies of short lived fission products in the mass region $A \sim 100$ Kaffrel, Tittel, Trautman (Mainz)
03 01 014	Search for μ sec fission fragment isomers in ^{235}U Bocquet, Pfeiffer (I.L.L.) Monnard, Schussler (C.E.N.G.)	PN1	03 01 030	Mass yields from ^{235}U (nth, f) as a function of K.E. and ionic charge (about $40\mu\text{g}/\text{cm}^2$ UO_2 target) Clerc (Darmstadt) Schrader (I.L.L.)
03 01 016	Study of E_γ , I_γ , $T_{1/2}$ of the fission fragments delivered by Lohengrin Bocquet, Pfeiffer (I.L.L.)	PN1	03 01 031	Nuclear charge yields from the fission products from ^{235}U (nth, f) and ^{233}U (nth, f) as a function of K.E. Clerc (Darmstadt) Schrader (I.L.L.)
03 01 017	4π β -counting or collision X-rays Wollnik (Giessen)	PN1	03 01 034	Nuclear charge distribution and $Q\beta$ -values measured with high mass resolution Greif (Giessen) Siegert (I.L.L.)
03 01 018	Investigation of the emission probability of delayed neutrons P_n of individual nuclei Asghar (I.L.L.) Kratz, Rudolph, Ohm (Mainz)	PN1		
03 01 020	γ - γ coincidence in mass chains $A \approx 100$ -105 Monnard (I.L.L.) Trautman, Kaffrel, Tittel (Mainz)	PN1		

03 01 036*	Spectroscopy of mass chain 148,149 for praseodymium, cerium and lanthanum Pinston, Roussile (I.L.L.)	PN1	01 002	Bragg diffraction interferometry with thermal neutrons Bonse (Dortmund) Rauch (Vienna)	D18 SI12
03 02 001*	$^{43}\text{Ca}(n, \gamma) ^{44}\text{Ca}$ Ratynski (Swierk)	PN3 PN4			
03 02 002*	$^{153}\text{Eu}(n, \gamma) ^{154}\text{Eu}, ^{176}\text{Lu}(n, \gamma) ^{177}\text{Lu}$ Gizon (I.S.N. Grenoble) Pinston (I.L.L.)	PN3	COLLEGE 4		
03 02 004	$^{81}\text{Br}(n, \gamma) ^{82}\text{Br}$ Chery, Do hu Phuoc (Lyon)	PN3 PN4	04 01 002R	Phonon dispersion of niobium carbide Pintschovius (Karlsruhe)	IN1
03 02 006	Neutron capture conversion electrons of ^{233}Th Egidy (München)	PN2	04 01 004*	Lattice dynamics of D_2O ice Renker (Karlsruhe) Drexel (I.L.L.)	IN1
03 02 013	Co-operative $^{183}\text{W}(n, \gamma)$ study Greenwood, Reich (USA) Davidson, Boerner (I.L.L.)	PN3	04 01 006*	Critical scattering from the NaOH phase transition at 240°C Dachs, Steiner (Berlin)	IN2
03 02 014	Doppler shift measurements of collision cross-section of ^7Li (method IDSA) Haüser (Köln)	PN3	04 01 012A	Librons and para-librons in solid H_2 Stiller (Jülich)	IN5
03 02 015*	Measurements of γ -ray standards Van Assche (Mol)	PN3 PN4	04 01 021A*	Phonon density of states of lanthanum Search for temperature dependent phonon softening Nuecker, Reichardt (Karlsruhe)	IN4
03 02 016	Study of Nilsson states in ^{161}Tb following double neutron capture in ^{159}Tb Heck (Karlsruhe) Davidson (I.L.L.)	PN3 PN4	04 01 022A*	Dispersion of optical phonon branches in Al_2O_3 Weis (Heidelberg)	IN1
03 02 017	A study of MI admixtures in γ -band intra-band transitions Gelletly (Manchester)	PN2	04 01 024R	Interplanar bonding in Bi_2Te_3 from phonon dispersion curves Wagner (I.L.L.)	IN3
03 02 018	Study of excited $k = 0^+$ bands in ^{172}Yb and ^{174}Yb Gelletly (Manchester)	PN2	04 01 025	Phonon dispersion in AgBr Van der Osten (Darmstadt)	IN2
03 03 004	Asymmetry in radioactive neutron-proton capture due to weak interactions Jeenicke (Harvard) Vignon (I.S.N. Grenoble)	SI	04 01 027	Phonon dispersion in the layer structure compounds $\text{PbI}_2, \text{CdI}_2$ Harbeke (RCA, Zürich)	IN2
03 03 006	Search for the electric dipole moment of the neutron Dress, Miller (USA - Oakridge) Perrin (C.E.N.G.)	S4	04 01 032	Zero sound and transition to first sound in NaF Daubert (Frankfurt)	IN3
03 03 009	2γ -decay in n-p capture Dress (USA - Oakridge) Perrin (C.E.N.G.)	S24	04 01 033	Elastic constants of metallic and semi-metallic NiS Coey, Brusetti (C.N.R.S. Grenoble)	IN4
03 03 016	α -accompanied fission of U^{236} Asghar (I.L.L.) Signarbieuse Perrin, Leraux (C.E.N.G.)	S16	04 01 039*	Density of states functions of KCP Renker, Gompf (Karlsruhe)	IN4
03 03 025	($n\text{th}-\alpha$) and ($n\text{th}-\gamma$) reactions on medium and heavy nuclei Asghar (I.L.L.) Ensallem, Chery (Lyon)	SI10	04 01 040	Phonons in the layered structure HgI_2 Schwab, Prevat, Sieskind (Strasbourg)	IN3
03 03 026	Study of ($h-\alpha$) reaction on several heavy isotopes Asghar (I.L.L.) Neve de Mevergnés (Mol) Deruyter (Gent, Belgium)	SI10	04 01 043	Phonon dispersion in GeS Zeyher, Kress, Biltz (Stuttgart)	IN3
			04 02 009R	Stress induced energy shifts of phonons in silicon Kalus (Tübingen) Lüscher, Prechtel (Garching)	IN2
			04 02 010	Shift of phonon energies with temperature in Na Kalus (Tübingen) Lüscher (Garching)	IN4
			04 02 012*	Phonon spectra of La_3In and La_3Ti Drexel (I.L.L.) Knorr (Frankfurt)	IN4

04 02 014*	Neutron investigation of phonon spectrum of intercalated NbSe ₂ Cheeke (C.N.R.S. Grenoble)	IN2	04 04 011A	Generalised susceptibility of f.c.c. manganese Lowde (Harwell) Hennion (Saclay) Tocchetti (I.L.L.)	IN1
04 02 015	Mode Grüneisen parameters of K Meyer (I.L.L.)	IN2 IN3	04 04 013*	Spin wave dispersion and width measurements of nickel sulphide Lowde, Hutchings (Harwell)	IN1
04 02 016	Pressure dependence of zone boundary phonons in Se Teuchert (I.L.L.)	IN3	04 04 017A*	Spin waves in Fe ₅₁ Rh ₄₉ Castets (I.L.L.)	IN1
04 02 018	Soft excitations and phase transition in TBBA Lambert (Orsay)	IN2	04 04 024	Hyperfine splitting in holmium and terbium. Investigation by inelastic spin-flip scattering Heidemann (I.L.L.)	IN10
04 02 019	Unusual line shape of some strongly anharmonic phonons in CuCl Pick (C.N.R.S. Paris)	IN2	04 04 028*	Stoner excitations in Fe and Ni Mezei, Lovesey (I.L.L.)	IN1
04 02 020	Possible soft modes in Cu ₃ Au Cohen (USA)	IN2	04 04 029	Spin waves in Pd ₃ Fe Cowley, Smith (Edinburgh)	IN1
04 03 008*	Critical scattering Yelon, Lechner (I.L.L.)	D10	04 04 032	Magnetic and diffuse scattering in the solid and molten paramagnet MnF ₂ , KMnF ₃ , RbMnF ₃ Jaccarino, Copley (I.L.L.)	IN4
04 03 009A	Acoustic phonons anomaly due to the Jahn Teller phase transition in TbVO ₄ Smith (Essex)	IN2	04 04 043	Spin wave dispersion relations in concentrated alloys of FePd Radhakrishna (I.L.L.) Walker (Geneva)	IN2
04 03 015R	Investigation of the allotropic phase transformation in cobalt by inelastic neutron scattering Frey, Jagodzinski, Prandl (ünchen)	IN3	04 04 045	Magnon and phonon dispersion and magnon-phonon interaction in FeO Carabatos, Kugel (Metz) Hennion, Pepy, Moussa (Saclay)	IN1
04 03 017	Neutron scattering at the ferroelectric phase transition in SbSi Harbeke (RCA, Zürich)	IN2	04 04 046A 046	Magnons in FeS Hutchings, Lowde (Harwell)	IN1
04 03 018*	Behaviour of the structure phase transition in TmAsO ₄ as a function of temperature and external field Becker (Karlsruhe) Gehring (Oxford) Steiner (Berlin)	IN2	04 04 047*	Magnetic excitations in induced moment systems Rainford (Imperial College)	IN2
04 03 019	Softening of the phonon dispersion in invar type Fe ₃ Pt alloy Ishikawa (Univ. Tohoku) Wohlfarth (Imperial College) Tajima (I.L.L.)	IN2 IN3	04 05 003*	Molecular reorientation matrices in solid and liquid phases in molecular compounds Lassier (Nice)	IN5
04 03 020R*	Phonons at high temperature in BaF ₂ and SrCl ₂ Dickens (Oxford)	IN2 IN1	04 05 004	Molecular rotation in adamantane Lechner (I.L.L.) Iff (Jülich)	IN5
04 03 021*	Investigation of central component of SrTiO ₃ Alefeld (Jülich)	IN10	04 05 005	Critical scattering at the phase transition at 240°C in NaOH Dachs, Steiner (Berlin)	IN5
04 03 022	Critical dynamics in P. Terphenyl Meinzel (Rennes)	IN2	04 05 010A	Study of rotational diffusion in plastic crystals Lechner, Heidemann (I.L.L.)	IN10
04 03 025	Study of 193K phase transition in RbCaF ₃ Rousseau (Mans)	IN2	04 05 011A 011	Rotational motions in NH ₄ Cl Töppler, Richeter, Alefeld (Jülich)	IN10
04 04 002	Influence of the finite length of the ferromagnetic chains on the damping of spin waves in CsNiF ₃ (Mg) Steiner (Berlin) Dorner (I.L.L.)	IN2	04 05 012	Quasi-elastic scattering from β-AgI Funke (Göttingen) Kalus (Tübingen)	IN10
04 04 010A	Disordered magnetic systems Cowley (Edinburgh)	IN1	04 05 019	Rotational motions in solid H ₂ Stiller (Jülich)	IN3
			04 05 020*	Inelastic and quasi-elastic neutron scattering by NH ₄ in RbI Smith (I.L.L.)	IN5

COLLEGE 5			05 01 083*	Cation distribution in olivines Riekel (I.L.L.) Weiss (München)	D2
05 01 007*	Structure of malachite $\text{Cu}_2(\text{OH})_2\text{CO}_3$ Schüster, Zigan (Frankfurt)	D8			
05 01 015	Defect structure of wustite Carel (Rennes)	D2	05 01 084	Structural studies on layered dichalcogenides and intercalated compounds Riekel (I.L.L.) Fender (Oxford) Schöllhorn (München)	D2
05 01 044	Investigation of the domain structure of plagioclase feldspars Korekawa, Joswig (Frankfurt)	D16	05 01 089*	Neutron diffraction of lanthanide silicide alloys $\text{Ln}_5\text{Si}_3\text{C}_x$ $x = 0.1$ to 2.0 Jones, Steadman (Bradford)	D2
05 01 046*	Structure determination of samarium acetate by anomalous dispersion Duc (C.N.R.S. Grenoble)	D8	05 01 091	Phase transformation and structure refinement in aluminium phosphate and silica Wright, Meardon (I.L.L.)	D2
05 01 047 47A	Structure of Cd histidine dehydrate by anomalous dispersion. Bartunk, Fuess (I.L.L.)	D8	05 01 092	Refinement of the TiSe_2 structure Schöllhorn (Münster) Riekel (I.L.L.)	D8
05 01 060R	Structural transitions in ferro-electric $\text{Na}_x\text{K}_{1-x}\text{NbO}_3$. Neutron powder profile analysis Ahtee (Helsinki)	D1A	05 01 093	Intercalation velocities in chalcogenides Riekel (I.L.L.) Schöllhorn (Münster)	D1B
05 01 062*	Profile refinement of the structure of hydrogen bonded materials $\text{NH}_4\text{H}_2\text{PO}_4$, $\text{NH}_4\text{H}_2\text{AsO}_4$ and KH_2PO_4 phase transitions Hewat (I.L.L.)	D1A	05 01 094*	Two dimensional structure of adsorbed layers on lamellar halides Lahrer (Saclay)	D1B
05 01 064 64A*	Powder diffraction patterns of β sialons Bacon (Sheffield) Jack (Newcastle)	D2	05 01 096	Neutron diffraction study of BaTiO_3 Schollmayer, Ehes, Fischer (Saarbrücken)	D9, D10 D16
05 01 067	Structure of the $\text{Li}(\text{ND}_3)_4$ compound Debaecker (Lille) Chieux (I.L.L.)	D1B	05 01 097	Structure analysis of several phases in CsPbX_3 ($X = \text{Cl}, \text{Br}$) Harada, Hirotsu (Japan)	D1A
05 01 068	Study of manganese acetate tetrahydrate Burlat, Bertaut (C.E.N.G.)	D2	05 01 098	CePd_3 under high pressure Vairon (C.N.R.S. Grenoble)	D2
05 01 069* 074	Low temperature phases of $\text{NaH}_3(\text{SeO}_3)_2$ and $\text{RbH}_3(\text{SeO}_3)_2$. Temperature and isotope effect on the disorder KHCO_3 and KDCO_3 Tellgren (Uppsala)	D1A	05 01 099	Temperature dependence of lattice parameters in MnF_2 and KMnF_3 Jaccarino (USA) Dorman (Darmstadt)	D1A
05 01 072	Single crystal neutron diffraction study of the hydronium ion $(\text{HgO}_4\text{-H-HgO}_4)^{3+}$ in a hydrogen hexacyanoferrate (II, III) hydrate Haser (Marseille)	D8	05 01 100	Phase mixing in $\text{KM}_2\text{P}_2\text{O}_7$ and $\text{KD}_2\text{P}_2\text{O}_7$ Zeyen (I.L.L.) Meister (Euratom)	SI21
05 01 073	Ordered defects in fluorine deficient system $\text{LaF}_3/\text{CaF}_2$ Cheetham (Oxford)	D1A	05 01 101	UO_2 at high temperature Aldebert, Hewat (I.L.L.) Willis (Harwell)	D1A
05 01 075/76*	Delocalisation of CO_2 and krypton in zeolite. Structure of krypton layers on graphite Marti (Paris)	D1B	05 01 105*	Study of the $\text{A} \rightleftharpoons \text{H}$ and $\text{H} \rightleftharpoons \text{X}$ crystalline transitions of the lanthanum sesquioxide Aldebert (I.L.L.) Traverse (Odeillo)	D2
05 01 078*	Huang scattering from point defects in MgO and from deuterium in niobium Peisl (München)	D10	05 02 002	Magnetic properties Mn_3SnL Fruchart (C.N.R.S. Grenoble)	D1B
05 01 079 80	Elastic diffuse scattering by anorthite near phase transition in K_2SnCl_6 measurement of the critical scattering Jagodzinski, Prandl (München)	D10	05 02 011/ 011A	Linear chain antiferromagnetism in Tanol (a free radical nitroxide) Lajzerowicz (C.N.R.S. Grenoble)	D1B D2
05 01 082	Extinction effects in SrF_2 over an extended wavelength range Wilson (I.L.L.)	D9	05 02 025	HoCO_2 magnetic problems Schweizer (I.L.L.)	D5
			05 02 033	Spin density of the free radical NO Schweizer (I.L.L.)	D5, D10

05 02 055A	Magnetic domains in cubic FeGe and MnSi Wilkinson (London)	D11	05 02 084	Magnetic structure at 4.2 K of $\text{CaCu}_3\text{Ti}_4\text{O}_{12}$ Collomb (C.N.R.S. Grenoble)	D1B
05 02 056A*	Paramagnetic scattering from Fe with polarisation analysis Vallera, Windsor (Harwell)	D5	05 02 087	Determination of magnetic moment direction in AuMn by polarization analysis Bacon (Sheffield)	D5
05 02 058*	Magnetic structure of CrB_2 Guy (London)	D10	05 02 088*	Magnetic study $\text{Co}_3\text{U}_2\text{O}_8$ Bacman (C.N.R.S. Grenoble)	D1B
05 02 061*	Solid Solutions $\text{NiTiO}_3 - \alpha\text{Fe}_2\text{O}_3$ Marnier (Nancy)	D1B	05 02 089	Structural and magnetic properties of arsenides and phosphides of transition metals Fruchart (C.N.R.S. Grenoble)	D1B
05 02 062*	Solid Solutions $\text{CoTiO}_4 - \text{CoFe}_2\text{O}_4$ $\text{Co}_{2-x}\text{Zn}_x\text{TiO}_4$ Hubsch (Nancy)	D1B	05 02 090*	Magnetic properties of the ordered spin $\text{Mn}(\text{TiMn})\text{O}_4$ Vincent (C.N.R.S. Grenoble)	D1B
05 02 063	Magnetic structure determination of NiS_2 Gautier (Strasbourg) Robert, Langis, Plumier (Saclay)	D2	05 02 091*	Determination of the Fermi length of curium and of the magnetic structure of curium metal at low temperature. Fournier (C.E.N.G.)	D1B
05 02 064*	Temperature dependence of correlation length in the one dimensional Ising ferromagnet $\text{Co}(\text{Py})_2\text{Cl}_2$ Kuntz, Kalus (Tübingen)	D2	05 02 092*	Magnetic properties of manganese perovskite mobility of metalloid at high temperature Fruchart (C.N.R.S. Grenoble)	D1B
05 02 065/* 065A	Investigation of DyPO_4 at 1.5 to 3.4°K in an external magnetic field Shibuya (Tübingen) Dachs (Berlin)	D1A D5	05 02 093	The magnetic structure of DyMn_2O_5 Wilkinson (London)	D2
05 02 066	Magnetic and structural phase transition in DyCrO_4 Dachs, Steiner (Berlin)	D2	05 02 094	Magnetic phase diagram for Cr-Pd and Cr-Pt systems Booth (Salford)	D1A
05 02 067A	Q.E.S. from $\text{Cs}(\text{Ni}_{0.95}\text{Mg}_{0.05})\text{F}_3$ and CsNiF_3 Steiner (Berlin)	D2	05 02 095	Critical behaviour of CoO under stress Bloch (C.N.R.S. Grenoble)	D1A
05 02 069	Magnetic structure and structure refinement of $(\text{FeOOH})\text{HP}$ Pernet (Grenoble)	D2	05 02 096	Magnetic structure of Tb at very high pressure Bloch (C.N.R.S. Grenoble)	D1A
05 02 070	Possible tricritical behaviour of MnO with uniaxial stress Steiner (I.L.L.)	D1A	05 02 111*	Spiral magnetic properties in MnP type structure Wilkinson (London)	D5
05 02 072	Magnetic structure of Zn_{13}Mn Bacon (Sheffield)	D2	05 02 114*	Neutron diffraction study of normal spinel $\text{Cu}_2^{1+}\text{In}_2^{1+}\text{Cr}_2\text{S}_4$ at $T \geq T_N$ Forsyth (Didcot) Plumier, Sougi (Saclay)	D2
05 02 076A	Magnetic structure in the compounds $\text{M}_x(\text{UX}_2)_n$ $n = 1, 2, 8$ Wolfers (I.L.L.)	D1B	05 03 003A	Variation with temperature of crystal and molecular structure of organic semiconductors charge transfer complexes of TCNQ Gauthier, Delhaes (Bordeaux)	D10
05 02 077**	Refinement of the magnetic structure of Fe_3Se_4 Lambert, Wintenberger (C.E.N.G.)	D1A	05 03 004R	Electron density study of ethyl lithium Dietrich (Berlin)	D10
05 02 078	Magnetic structure and refinement at 4.2 K of UCr_2O_6 Collomb, Gondrand (C.N.R.S. Grenoble)	D2	05 03 006	Liquid helium study of the electron distribution in p-nitro-pyridine N-oxide Coppens (USA)	D10
05 02 079	Magnetic structure and refinement of the high pressure phase of Mn_3O_4 Chenavas (I.L.L.) Collomb (C.N.R.S. Grenoble)	D2	05 03 007A	The nature of the metal-metal in dichromium tetra-acetate dihydrate Coppens (I.L.L., USA)	D10
05 02 082	Critical elastic neutron scattering in the uniaxial dipolar ferromagnet GdCl_3 Kützler (Darmstadt) Knorr (Frankfurt)	D10	05 04 001	Magnetic moment density in ferromagnetic CrBr_3 using polarized neutrons. Radhakrishna (I.L.L.)	D3
			05 04 002*	Magnetisation density distribution in FeBO_3 Forsyth (Rutherford) Brown (Cambridge)	D3

05 04 004	Magnetic moment distribution in UC (and UN) Wedgwood (Harwell) de Novion (C.E.N.G.)	D3	05 05 001	(H ₂ O) ₂ inclusion in cyclodextrin Sänger (Göttingen)	D6
05 04 006	Form factor of cerium in the CeAl ₂ compound Barbara, Rossignol (C.N.R.S. Grenoble) Boucherle (C.E.N.G.)	D5	05 05 002	Hydrogen bonds and thermal motion in pyrodoxine hydrochloride Bacon (Sheffield)	D8
05 04 008	Separation of covalent and orbital effects in neutron scattering from FeF ₂ J. Brown (I.L.L.)	D5	05 05 004*	Powder diffraction from polyacetylenes White (I.L.L.)	D2
05 04 009	Magnetic structures and form factor of the alkali superoxides Smith (I.L.L.)	D5	05 05 008	Comparative study of histidine hydrochloride monohydrate by film and diffraction methods Hohlwein, Fuess (I.L.L.)	D8
05 04 010A	Polarized neutron study of terbium iron garnet (Tb ₃ G) Bonnet, Delapalme (C.E.N.G.)	D1A, D5	05 05 010*	Powder profile analysis of urea-d ₄ Mason, Lehmann (I.L.L.)	D1A
05 04 011A	Spin density measurements in cerium compound Radhakrishna (I.L.L.)	D1A	05 05 011*	Study of a phase transition in N-nitrodimethylamine Ray-Lafon, Lascombe (Bordeaux)	D10
05 04 012	Piezomagnetic effects and spin density in CoF ₂ Radhakrishna (I.L.L.) Bloch (C.N.R.S. Grenoble)	D3	05 05 013	Structure determination of N-benzol-D1 leuciglycine ethylester Timmins (I.L.L.)	D9
05 04 014	Polarized neutron studies of the weak ferro- magnetism in Fe ₃ (PO ₄) ₂ ·4H ₂ O Forsyth (Rutherford)	D3	05 05 016*	Powder diffraction study of the pressure induced phase transition in naphthalene Pawley (Edinburgh)	D1A
05 04 015*	Electron delocalisation for Mn ²⁺ with D ₂ O and ND ₃ as ligands Fender (Oxford) Forsyth (I.L.L.)	D3	COLLEGE 6		
05 04 017	Spin density wave versus helical spiral in Mn ₃ Si Forsyth (Rutherford)	D3	06 01 003	Study of the chemisorption of hydrogen and hydrocarbons Renouprez (Villeurbanne)	IN1
05 04 018*	P.N. diffraction from dynamically polarized n neutrons White (I.L.L.) Jenkins, Mortimer (Oxford)	D3	06 01 006A	Quasi elastic neutron scattering in nematic PAA and its partially deuterated derivatives Hervet, de Gennes (Collège de France)	IN5
05 04 020	Comparison of charge and spin density on an N-O free radical Brown, Schweizer (I.L.L.)	D10	06 01 009R 009A	Molecular motions in liquid crystal Leadbetter, Temme (Bristol)	IN5 IN10
05 04 022	Magnetic moment distribution in the ionic ferromagnet RbCrCl ₂ Day (Oxford)	D3	06 01 013* 013B	The sulphur liquid-liquid phase transition Lechner (I.L.L.)	IN5
05 04 023	Asphericity of the distribution of magnetic electrons in alloys of Fe (FeV) 20%V Radhakrishna (I.L.L.)	D3	06 01 014	Dynamics of molecular motions in liquid cyclopropane Lascombe, Bernard (Bordeaux)	IN5
05 04 024	Magnetic structure and spin density distri- bution in Fe ₂ MnSi Brown, Ziebeck (I.L.L.)	D3	06 01 016	Collective motions in smectic A phases Hervet, de Gennes (Collège de France)	IN10
05 04 025*	Critical scattering and the super structure of magnetite at the Verwey transition Shirane (USA)	D5	06 01 017 018	Diffuse scattering in the crystalline and smectic phases of TBBA Elastic diffraction in smectic B phase Doucet, Levelut, Lambert (Orsay)	IN5 IN10
05 04 029*	The magnetic structure and spin density distribution in Au _n V Brown, Ziebeck (I.L.L.)	D3	06 01 019	Measurement of D and D _⊥ through nematic- smectic A transition Dasannacharya (Jülich)	IN5
05 04 030*	Measurement of form factor in actinide com- pounds by paramagnetic scattering Wedgwood (Harwell) de Novion (Fontenay)	D5	06 01 020*	Micelle shape in the concentrated region Hervet, Dianoux (I.L.L.)	D11A
			06 01 021	Quasi elastic neutron scattering from liquid crystalline TBBA Hervet (Collège de France) Volino, Rustichelli (I.L.L.)	IN5
			06 01 022*	S.A.S. from impure cyclohexane in its plastic phase Volino (I.L.L.)	D11A

06 02 010 010B	Excitations in liquid ^3He and $^3\text{He}/^4\text{He}$ mixtures Cowley (Edinburgh) Schem (I.L.L.)	IN5	06 03 048* 048R	Small angle scattering from carbon study of porosity in H.T.R. graphite Mildner (Rutherford) Willis, Martin (Harwell)	D11A
06 02 012R*	Superionic conductors Stirling (Didcot) Fender (Oxford)	IN5	06 03 051*	The structure of molten RbCl Wright, Poncet (I.L.L.)	D4
06 02 014A	Pressure derivative of scattering law of Kr and Rb Egelstaff (Guelph)	IN4	06 03 052*	Titanium clustering in silicate glasses Fender (Oxford) Wright (I.L.L.)	D11A
06 02 015R	Optic modes in a molten salt Copley (I.L.L.)	IN1	06 03 054*	Separation of nuclear and magnetic scattering of neutrons from liquid oxygen Dore (Univ. of Kent)	D5
06 02 022	Feasibility study of molecules in liquids Group V elements Lamparter (Stuttgart) Egger (I.L.L.)	IN1	06 03 056*	Magnetic scattering from liquid Fe Enderby (Leicester)	D5
06 03 002A	Structure studies of metal ammonia systems Chieux (I.L.L.)	D4	06 03 057	Static factor for liquid rubidium Howells, Copley (I.L.L.)	D4
06 03 007A	Determination of distance correlated concentration fluctuations in liquid alloys Ruppersberg (Univ. of Saarland)	D4	06 03 060*	Structure of iron-carbon melts Steeb, Weber (Stuttgart)	D4
06 03 008A*	Structural properties of AgGe liquid alloys Desre, Bellissent (ENSEEG Grenoble)	D4	06 03 061*	Structural studies of bromine and phosphorous structure factor of liquid DBr Dore (Kent, I.L.L.)	D4
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