



# rapport annuel 1976

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 :

B. MAIER  
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.

The general regulations of the ILL and all information necessary for carrying out an experiment at the HFR will be sent to the applicants upon acceptance of their proposals.

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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Vue de Grenoble vers le massif de Belledonne. Au premier plan l'ILL.

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	same members						

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COLLEGE 7 : IMPERFECTIONS	A. Heidemann
COLLEGE 8 : BIOCHEMISTRY	J. Zaccai
COLLEGE 9 : CHEMISTRY	S. Howells

## INSTRUMENT GROUPS

3 AXIS SPECTROMETERS  
(B. Dorner)  
NUCLEAR PHYSICS INSTRUMENTS  
AND SPECIAL BEAM EXPERIMENTS  
(T. v. Egidy)  
DIFFRACTOMETERS  
(J. Brown)  
DIFFUSE SCATTERING AND TIME  
OF FLIGHT SPECTROMETERS  
(B. Jacrot)  
MONOCHROMATORS  
(A. Freund)

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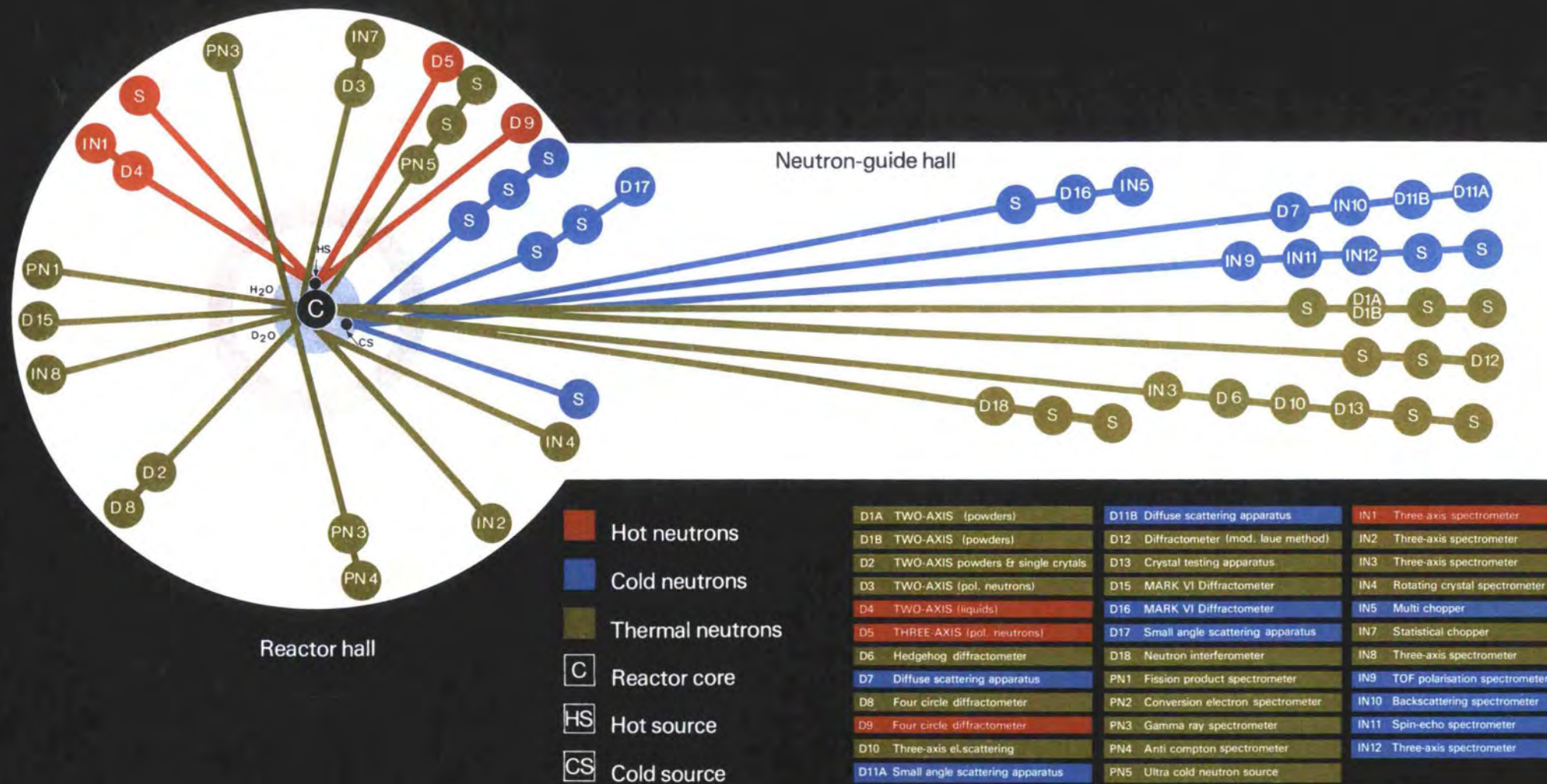
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# beam tube arrangement and instruments at the H.F.R. of the I.L.L.



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

# l'institut max von laue-paul langevin

L'institut Max von Laue - Paul Langevin (ILL) de Grenoble a été créé officiellement en janvier 1967 par la signature d'un contrat entre les gouvernements de la France et de la République Fédérale Allemande. Le but était de mettre à la disposition de l'ensemble des scientifiques des pays membres une source de neutrons unique en son genre et utilisable dans divers domaines tels que la physique de l'état condensé, la chimie, la biologie, la physique nucléaire et la physique des matériaux. La construction de l'institut et de son réacteur à haut flux fut réalisée conjointement par la France et l'Allemagne, les capitaux investis s'élevant à 335 millions de francs français. Le réacteur divergea en août 1971 et atteignit pour la première fois sa pleine puissance de 57 MW en décembre 1971. L'année 1972 vit la mise en service des sources froide et chaude, des premiers dispositifs expérimentaux et marqua le commencement du programme expérimental. Le 1er janvier 1973, le Royaume-Uni devint le troisième partenaire associé à parts égales de l'institut, apportant sa quote part à l'investissement total. Une nouvelle convention fut alors signée en juillet 1974 par les ministres compétents de chacun des trois pays membres. Aux termes de la loi française l'ILL est une société de droit civil. Les trois pays sont représentés par les organismes suivants :

- «Gesellschaft für Kernforschung mbH Karlsruhe», Allemagne
- Centre National de la Recherche Scientifique, France
- Commissariat à l'Energie Atomique, France
- «Science Research Council», Royaume Uni.

Ces associés sont représentés par un comité de direction qui fixe les règles générales de gestion de l'ILL. L'institut a à sa tête un directeur et deux directeurs adjoints, tous trois nommés pour une période de cinq ans. Le directeur est nommé à tour de rôle par le partenaire allemand ou britannique, les deux directeurs adjoints par les associés n'ayant pas désigné le directeur. Un conseil scientifique, dont les membres sont nommés par les associés, conseille le directeur dans l'élaboration du programme scientifique et sur les problèmes pratiques liés à sa réalisation.

L'ensemble des scientifiques utilisateurs de l'ILL est représenté dans huit sous-comités du conseil scientifique. Ils se réunissent deux fois par an pour choisir parmi les projets de recherche qui leur sont soumis, ceux qui seront réalisés sur les appareils de l'ILL. Un autre sous-comité du conseil scientifique est chargé des questions d'instrumentation et sert de lieu de rencontre entre l'ILL et ses utilisateurs extérieurs.

Le but de l'ILL diffère ainsi fondamentalement de celui de la plupart des autres instituts de recherche. Il constitue une facilité centrale créée de telle sorte que les spécialistes en chimie, physique, biologie et métallurgie appartenant aux laboratoires des pays membres puissent utiliser cette puissance unique de techniques neutroniques pour attaquer leurs problèmes sur un plus large front. Concevoir et faire fonctionner les instruments, aider les utilisateurs extérieurs à mener à bien leurs expériences, telles sont les tâches principales des chercheurs ILL. L'utilisation expérimentale des instruments par le personnel ILL est soumise aux mêmes règles d'approbation que celles appliquées aux équipes extérieures.



#### Des Secrétaires d'Etat visitent l'ILL

En 1976 les Secrétaires d'Etat, responsables de la recherche dans deux des trois pays membres, ont visité l'Institut. En janvier, Monsieur Fred Mulley, Secrétaire d'Etat britannique pour l'Education et la Science a passé un jour à l'ILL au cours duquel il a visité le réacteur et s'est entretenu avec quelques membres du personnel. Le 4 mars, Monsieur le Dr. Volker Hauff, Secrétaire d'Etat parlementaire allemand, visitait le réacteur ainsi que le hall d'expérimentation.

Sur les photos on peut voir Monsieur Mulley dans la zone contrôlée du réacteur puis Monsieur le Dr. Hauff à qui l'on présente le spectromètre à trois axes IN2.



# introduction

## CONSIDERATIONS GENERALES SUR LES ACTIVITES DE L'INSTITUT EN 1976

L'ILL, en sa qualité d'institution centrale, a plusieurs importantes fonctions à remplir. Parmi ses principales attributions figurent :

1. La mise à la disposition de tous les laboratoires et instituts de recherches des trois Etats membres des faisceaux de neutrons de son réacteur à haut flux, et la réalisation, à l'aide de ceux-ci, d'un vaste programme d'essais et d'expériences, en collaboration étroite entre des utilisateurs du réacteur venant de l'extérieur, et son propre personnel.
2. La mise au point d'appareillages de technique avancée permettant aux faisceaux de neutrons d'être utilisés avec des possibilités de mesures améliorées et ouvrant la voie à de nouveaux domaines d'application.
3. La constitution d'un forum, permettant en permanence un échange intensif d'expériences entre les collaborateurs scientifiques travaillant sur les différentes installations de recherches en service à l'ILL.

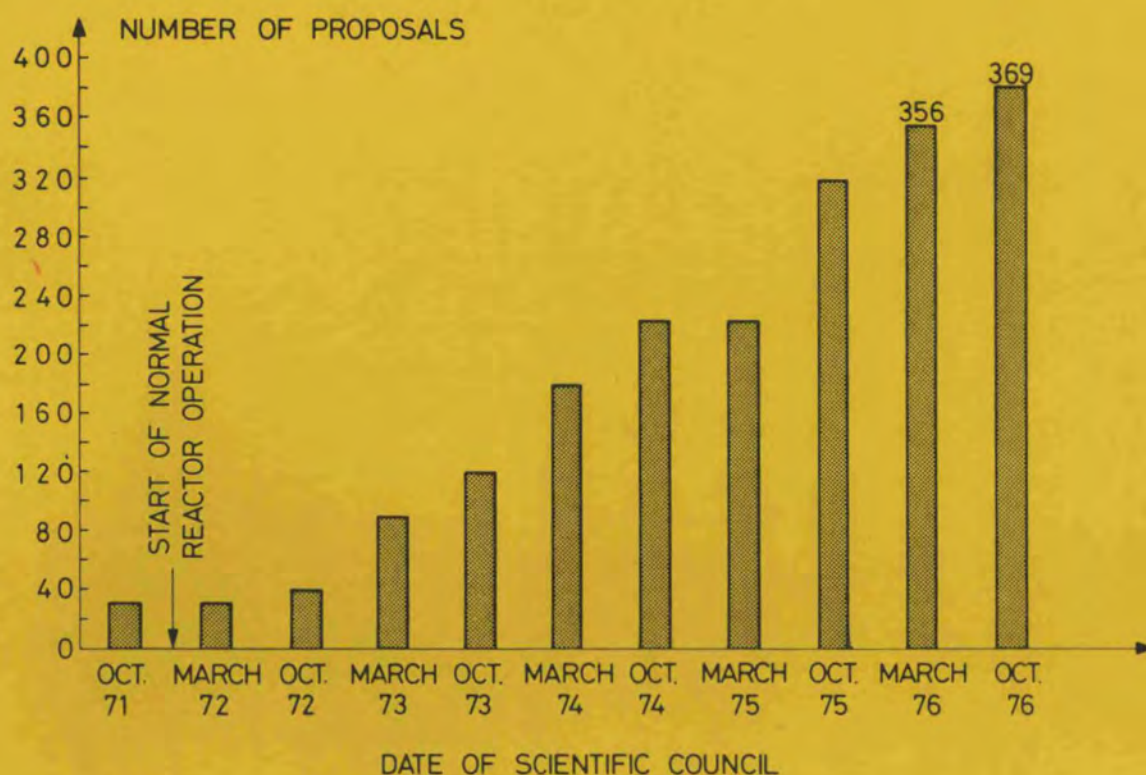


Fig. 1

Evolution du nombre des propositions soumises en fonction des réunions du Conseil Scientifique.

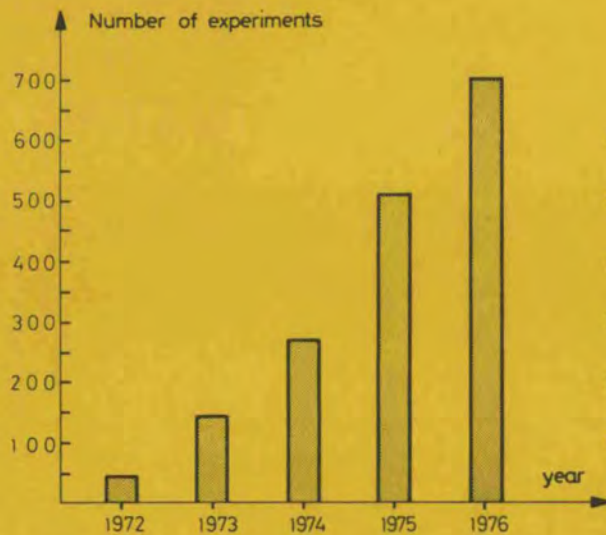


Fig. 2 a)  
Evolution du nombre d'expériences effectuées à l'I.L.L. pendant les 5 premières années du fonctionnement du réacteur.

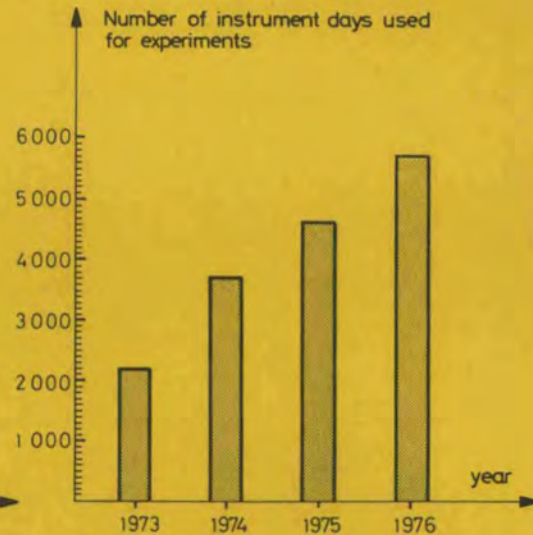


Fig. 2 b)  
Développement du nombre de jours d'utilisation des appareils pendant les premières années de fonctionnement du réacteur.

On a pu continuer en 1976 à mener à bien ces tâches importantes dans des conditions relativement satisfaisantes. Une priorité absolue a été en l'occurrence donnée à la réalisation du programme d'essais approuvé par le Conseil Scientifique, une fois de plus, ce qui, sur le plan des effectifs, soulève des problèmes dans une proportion croissante eu égard à la mise en service de nouveaux appareils et au manque de techniciens.

Les temps de mesure demandés sur les différents spectromètres à neutrons et sur les faisceaux de neutrons directement utilisés continuent à être en augmentation, ainsi que le montre la figure 1. Les Sous-Commissions du Conseil Scientifique ont de plus en plus tendance à accorder un temps de mesure plus important à un nombre d'expériences plus restreint, pour avoir l'assurance que les expériences acceptées pourront être effectivement menées à bonne fin.

En 1976, 696 expériences ont été entreprises, avec la participation de 981 collaborateurs scientifiques appartenant à 178 laboratoires différents répartis dans 21 pays. La réalisation de ce programme d'essais, aussi astreignant que vaste, n'a été possible que grâce à la contribution personnelle intense apportée par les collaborateurs scientifiques et techniques de l'Institut, et aussi grâce au fait qu'il a été possible, durant cette période de 1976 encore, de faire fonctionner le réacteur avec une régularité particulièrement satisfaisante.

Le tableau ci-après donne une vue récapitulative d'ensemble du programme de mesure scientifique réalisé en 1976, en fonction des différents domaines de travail et appareillages concernés.

PROGRAMME EXPERIMENTAL DU 1er JANVIER AU 31 DECEMBRE 1976

Principaux domaines scientifiques concernés	Nombre de jours d'utilisation des appareils	Nombre d'expériences	Nombre d'appareils mis à contribution
Biologie	255	75	5
Chimie	356	80	10
Structures cristallines	767	82	10
Structures magnétiques	624	70	9
Liquides et substances amorphes	607	75	11
Diffusion diffuse	340	66	8
Phonons	512	65	8
Magnons	118	13	5
Transitions de phase	229	25	11
Physique nucléaire	845	75	5
Essais scientifiques etc...	364	70	22
Total	5 017	696	28

Expériences pour le développement des monochromateurs et des instruments (y compris D13)	546	105
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Outre la réalisation du programme de mesures expérimentales, la mise au point de nouveaux instruments et de nouvelles techniques de mesure s'est poursuivie dans le cadre des disponibilités en personnel et financières existantes, et dans certains cas en étroite collaboration avec d'autres laboratoires de recherches des trois Etats membres. La mise en service imminente du nouvel appareil à faible dispersion angulaire D17 devrait permettre d'éliminer très prochainement, sur le plan expérimental, un goulot d'étranglement particulièrement sérieux. Les travaux entrepris sur la source de neutrons ultra-froids PN 5, sur le spectromètre spin-echo IN 11, sur le spectromètre à trois axes IN 12 et sur l'interféromètre à neutrons D 18 en sont à un stade avancé. On a commencé l'élaboration de projets pour un certain nombre de spectromètres à neutrons, dont quelques-uns de technique avancée. Parallèlement aux travaux sur les spectromètres proprement dit, on a poursuivi les

travaux de recherches portant sur la mise au point d'installations auxiliaires instrumentales, qui revêtent une importance déterminante pour une exploitation rationnelle du réacteur. D'importants progrès ont été réalisés dans ce domaine, particulièrement au niveau de la mise au point de puissants monochromateurs, de polariseurs de spin et d'analyseurs. Les travaux sur les détecteurs de neutrons à sensibilité de position ont également poursuivi leur progression.

L'année 1976 également s'est caractérisée par un excellent coefficient d'exploitation pour le réacteur. Le réacteur a fonctionné durant 98,9 % du temps disponible global. Au cours de l'exercice considéré, il ne s'est produit aucun incident de caractère nucléaire, qui aurait pu être préjudiciable au bon état de fonctionnement du réacteur. Aucun collaborateur n'a été exposé à un taux de radiations supérieur à la limite annuelle tolérée.

La charge de travail imposée à l'ordinateur central de l'ILL (système 1070, PDP 10) se rapproche du maximum que celui-ci est capable d'absorber. Le traitement direct des données mobilise une fraction toujours plus importante du temps de calcul global disponible, au détriment du temps qui peut être consacré à des travaux de recherches proprement dits. Etant donné que l'évolution scientifique de l'Institut peut être, à longue échéance, sérieusement affectée par la limitation de la capacité de travail de l'ordinateur, il faudra, dans un avenir pas tellement éloigné, trouver une solution aux problèmes d'ordinateur de l'Institut.

L'élaboration d'un projet et le choix d'un nouveau système d'ordinateur pour remplacer le système 'Nicole' dépassé, ont occasionné un travail important, qui a cependant pu être achevé pour la fin de l'année. La réalisation du nouveau système pourrait demander deux années de travail, auquel cas on prévoit un déroulement des opérations de mesures expérimentales exempt de perturbations au niveau des spectromètres concernés.

Les efforts entrepris pour instaurer une rationalisation au sein de l'Institut se sont poursuivis. Une fois encore, on est parvenu, par des regroupements de personnel, à renforcer, de façon extrêmement modeste, le groupe de techniciens disponible pour les travaux expérimentaux. Mais les réserves cachées de l'Institut sont maintenant pratiquement épuisées. Les groupes préposés aux instruments ont été réorganisés dans le but d'une part d'aboutir à une utilisation rationnelle des collaborateurs techniques par la création de groupes suffisamment importants, et d'autre part de rendre possible un contact direct entre des collaborateurs scientifiques et les chefs de groupes nouvellement mis en place.

Le budget global de l'ILL s'est monté, en 1976, à 89,9 millions de francs, pour un effectif de 397 personnes (à la date du 31 Décembre 1976).

Plusieurs groupes d'études de projets s'occupent des orientations futures possibles de l'Institut. A cet égard, il convient en particulier de citer les études concernant l'augmentation des installations d'expérimentation existantes par le recours à des neutrons froids, par exemple en apportant des modifications au système guide neutrons actuel, ou en prévoyant une seconde source froide.

Les travaux d'établissement des données et documents, qui doivent servir de base aux gouvernements des trois Etats membres pour la décision à prendre sur la durée de reconduction des activités de l'Institut, battent leur plein. Une commission à vocation technique, chargée de donner une estimation conforme à la réalité de la durée de vie du réacteur, s'occupe de l'élaboration d'un rapport, qui fera état des études technologiques applicables courantes. Parallèlement à ces travaux, des prévisions sont en préparation sur le programme de recherches à long terme de l'ILL, avec la participation simultanée de collaborateurs scientifiques de l'ILL et d'utilisateurs du réacteur venant de l'extérieur.

La réalisation pratique de l'énorme programme d'expériences et du programme de mise au point des appareils devient de plus en plus difficile à mener à bien par suite de l'existence de goulots d'étranglement qui concernent à la fois le personnel et les équipements. Un certain nombre d'appareils donnent des signes de fatigue résultant de phénomènes de vieillissement, qui constituent pour l'avenir un sérieux motif de préoccupation. Il existe également de sérieux problèmes au niveau des stocks de pièces de rechange et du personnel chargé des réparations, en raison de la situation financière de l'Institut. Les conséquences d'une dotation relativement trop faible en moyens de recherches et d'investissement, mesurée au niveau de l'ensemble de l'exploitation, se font de plus en plus sentir. En 1976, on n'a pu mettre en service qu'un seul nouveau spectromètre, à savoir le D 17. Les travaux de mise au point entrepris sur deux autres spectromètres (le spectromètre 'hérissou' D 6 et le système multidétecteurs-caméra de télévision D 14) ont été interrompus, pour assurer une plus forte concentration des moyens existants sur les plans des finances et du personnel. On a dû ralentir dans des proportions draconiennes les travaux de mise au point sur d'autres spectromètres et toute une série d'autres projets, pour des raisons financières. Une telle situation peut, pour autant qu'elle se prolonge encore, avoir de très sérieuses répercussions sur la qualité du programme scientifique et sur la place de tout premier rang à laquelle l'Institut était parvenu à accéder dans son temps d'existence relativement court.

Le rapport qui va suivre donne une vue d'ensemble de la situation des installations expérimentales de l'ILL et des travaux scientifiques effectués en 1976, ainsi que des principales activités administratives et techniques de l'Institut.

Un second volet de ce rapport a été consacré à une description plus détaillée des différentes expériences effectuées.

Grenoble, le 3 janvier 1977

R.L. Mössbauer



Sculpture d'Ipoustéguy à l'ILL.

# instrumentation

## introduction

The instrument construction programme continued vigorously in 1976, subject to the limits of finance and staff. Only one new instrument was finished but four should be completed in 1977. The development of a number of instruments at the ILL since the start of normal reactor operation is shown in Figure 3, which also reflects the fact that the number of instrument positions is approaching saturation. This is particularly true for instruments which need cold neutron beams. There is a growing demand in this area and the only alternatives open, apart from constructing another cold source (which is being studied in connection with the long-term scientific future of the ILL), are to increase the utilisation of existing beams and to shut down some instruments.

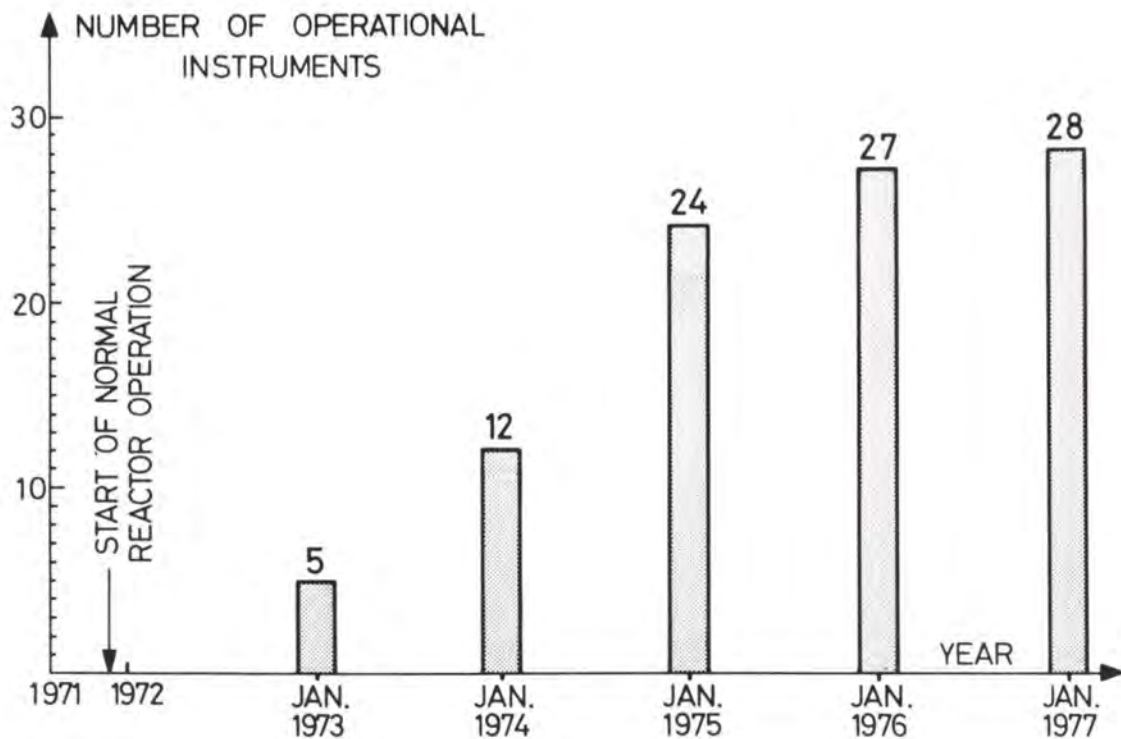
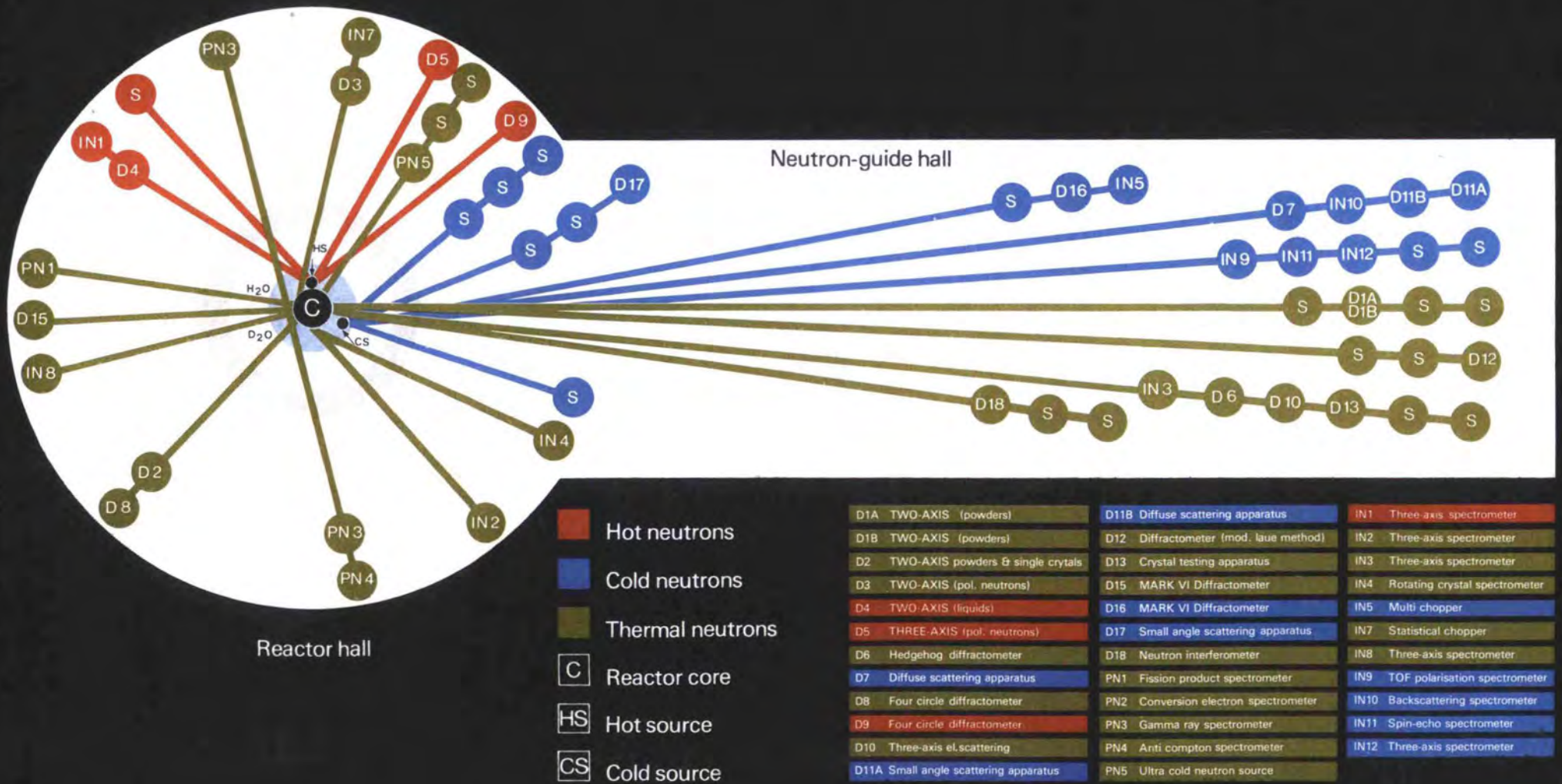


Fig. 3  
Development of the number of operational instruments.

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



D Diffractometer

IN Spectrometer for Inelastic Neutron Scattering

PN Nuclear Physics Instrument

S Special Beam Instrument

The operation of the instruments has been generally satisfactory because of continuous investment in them, although many instruments are now showing the effects of having been designed and built for approximately five years. For example, the speed of movement of many instruments suffers, not only because of crowding on the central control computers CARINE and NICOLE, but also because of the mechanics used. Delays due to the computers have been reduced by re-arrangements and by giving some instruments into dedicated computer control, and the new NICOLE replacement will help in this respect. A new type of mechanical drive is being developed for IN12.

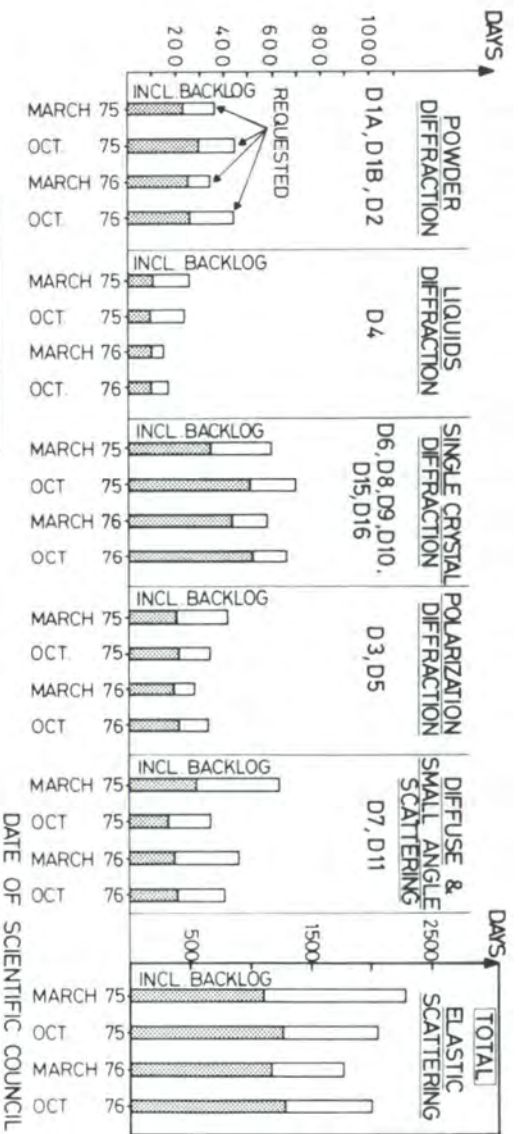
New instrument groups were formed in 1976 in order to facilitate improvements and operation of the existing machines. Each group is headed by a Senior Scientist and assisted by a Group Co-ordinator, and in some cases an Engineer has been attached to a new group. The Central Group, created in 1975, has continued to work well, but because of the considerable lack of technicians, many of the members of it have had to work for long periods attached to given instruments during 1976.

The demand for time on instruments at the ILL has continued to increase and Figure 4 shows a breakdown of the requested and allocated days on different instruments during 1975 and 1976. The pattern shows a strong interest in all areas, with particularly high over-subscription in the inelastic scattering and nuclear physics areas. In addition to the growth of scheduled experiments, an increased

number of test experiments has been encouraged in response to requests from a number of Subcommittees of the Scientific Council. On some instruments definite periods of time for test experiments have been set aside and these also give some flexibility for experiments on samples which deteriorate rapidly etc.

One area which has grown considerably is the area of special beam experiments. These experiments usually stay at the ILL for many months and some of the activities going on are summarised in the tables which follow. It is expected that this class of experiment will grow and, as a result, special funding arrangements may have to be made since the cost for each experiment is much greater than for the other types of experiment at the ILL.

New instruments at present in the planning stage meet both the criterion of innovation from the point of view of technique, and satisfaction of demand in the most over-loaded areas. The ILL will continue this policy of instrument development and some of the details are summarised in the annexed tables.



NOTA : ACCEPTED

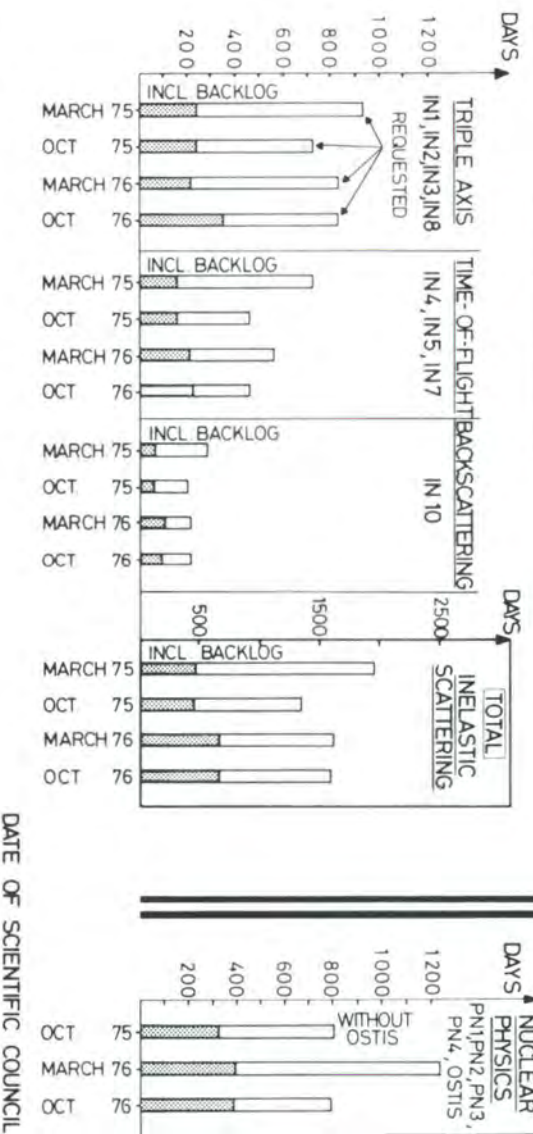
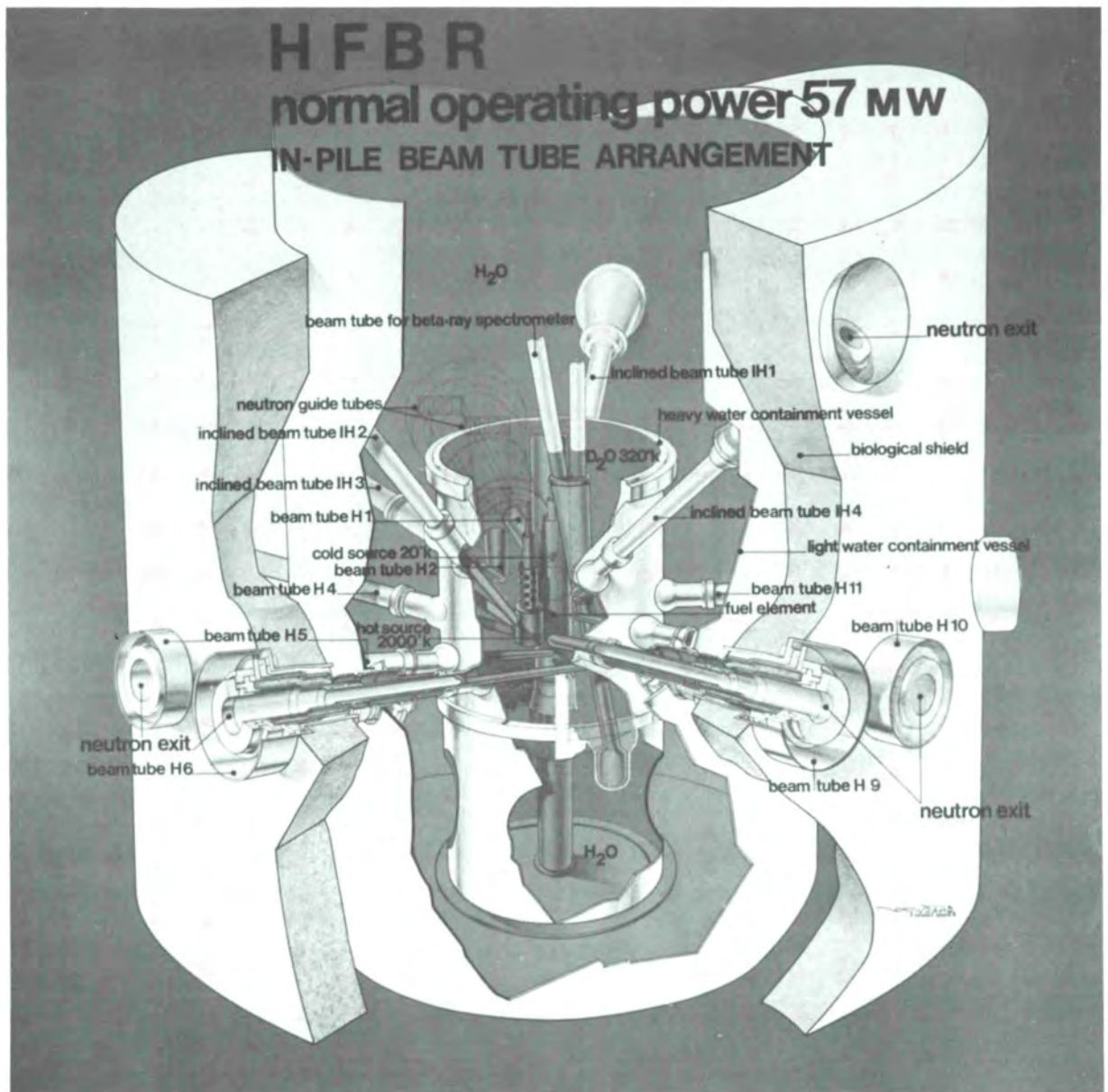


Fig. 4  
Development of the number of instrument days used for experiments during the last 2 years of reactor operation.



A cutaway view of the reactor and some of the associated beam tubes

## INSTRUMENT OPERATING STATISTICS

THE REACTOR HAS OPERATED FOR 262.4 DAYS DURING THE YEAR

(5.1 days were recuperated by

Instruments	Total operating time (days)	Loss of beam time (days)	Coll. 3	Coll. 4	Coll. 5	Coll. 6	Coll. 7	Coll. 8	Coll. 9	Internal test, feasibility and instrument improvement experiments.
IN1	231.1	31.3		73.1		25.8	53.6		48.8	29.8
IN2	234.9	27.5		180.7		21.9	22.8		7.5	2.0
IN3	203.0	59.4		115.4		47.6	22.8			17.2
IN4	233.7	28.7		60.8		31.9	82.8		39.7	18.5
IN5	212.8	49.6		22.8		85.3	34.2		69.5	1.0
IN7	127.2	135.2					8.7		14.0	104.5
IN8	231.6	30.8		188.3		6.9	12.3		6.4	17.7
IN10	224.7	37.7		36.6		31.3	47.7	17.5	74.4	17.2
D1A	254.9	7.5			201.1		3.0		6.3	44.5
D1B	247.5	14.9			129.7	14.7			47.7	55.4
D2	241.9	20.5			150.2	43.8				47.9
D3	190.7	71.7			171.7					19.0
D4	249.7	12.7				220.9			6.0	22.8
D5	237.3	25.1		16.2	127.3	58.2				35.6
D6										
D7	179.2	83.2		2.7	10.0	133.7				32.8
D8	211.7	50.7			81.8			121.1		8.8
D9	232.7	29.7			159.9			19.9		52.9
D10	231.0	31.4		10.3	165.7		5.0			50.0
D11A	233.1	29.3			6.3	19.0	59.3	94.9	43.2	10.4
D11B										
D12										
D13	244.5	17.9								244.5
D15	98.7	33.2			94.1					4.6
D16	171.9	90.5			60.7			87.2	3.0	21.0
D17										
PN1	210.0	52.4	185.0							25.0
PN2	230.0	32.4	220.0							10.0
PN3 (G1)	237.8	24.6	231.8							6.0
PN3 (G2/3)	172.2	90.2	160.2							12.0
PN4	48.3		48.3							
PN5										

(JANUARY TO DECEMBER 1976)

3.7 DAYS WERE AFFECTED BY UNSCHEDULED SHUT-DOWNS

(extending the operating cycle)

Comments
Instrument out of commission for modifications until 7/2/76
Loss of beam time includes chopper and guide replacement
Instrument modification and uprating in progress. Delays due to counter housing manufacture difficulties.
18.0 days of effective beam time lost due to a computer fault
Loss of beam time includes 14 days for installation of new shielding
Instrument modifications and tests continued until September 1976
Loss of beam time includes changing instrument mode to polarised neutrons
Loss of beam time mainly due to control computer (CARINE) difficulties
Test time includes commissioning of 4 circle closed loop cryostat
Continuation of instrument test and calibration programme
14 approved experiments carried out - Instrument to be fully scheduled from January 1977
61 experiments carried out - crystal mosaic spread, reflectivity, topography, etc.
Full scheduling commenced 21/6/76
During 1976 this instrument was out of commission for 1.5 reactor cycles - modifications
Programme of commissioning experiments in progress
Operational time includes decay measurements during shut down period. Loss of beam time includes 21 days for source changing modifications
Loss of beam time includes 1 reactor cycle for PDP-11 replacement and 21 days for source changing modifications
Use restricted by experimental requirement and positioning of PN3 (G.1)
Installation proceeding-commissioning w.e.f. April 1977.

TABLE II - PROJECTS IN PROGRESS (1976)

IN12	Conventional triple axis spectrometer on a cold neutron guide. Completion of the monochromator assembly and Tanzboden was effected during 1976 and it is expected that preliminary evaluation experiments will commence in October 1977.
IN9	Time-of-flight spectrometer with polarized proton filter. The development of this instrument re-commenced in May 76 after being moved to a permanent position taking a waste beam from IN10. Polarization by the filter is 90% with a transmission of 45% and 3% for parallel and anti-parallel spins respectively. Electronic stability and reliability have been increased during 1976 following the loan of equipment from the Rutherford Laboratory. Development work is continuing.
IN11	During 1976 work continued to complete the mechanical installation of this instrument. Software and computer control requirements were also completed. Tests were continued during the year on the development of polarised beam benders and the final version resulting from this work will be installed in February 1977. Consequently the first spin-echo tests will commence in the Spring of 1977.
D11B	This small angle and diffuse scattering spectrometer is mechanically operational. Detectors and electronics linked to the PDP 11/40 have been successfully tested and software development has continued. Cryostat and sample changer, developed by ILL/ Rutherford Laboratory, have been tested. Further extensive tests are continuing.
D18A	The construction of this neutron interferometer continued during the year. An X-ray beam has been incorporated into the design and will be used for alignment purposes. The instrument will be operational during the course of 1977.
PN5	The installation of this ultra-cold neutron source continued during the year. The external guides have been tested and the in-pile section is ready for installation. The completed facility should be ready in May, 1977 and will have 3 measuring positions.

TABLE III - PROJECTS UNDER DEFINITION

IN10B	The scientific and technical definition of this instrument is now complete. Experimental conditions envisaged are as for the present IN10. Further progress on this project is dependent upon the budgetary situation.
IN13	This backscattering spectrometer with an energy range up to 200 ueV is now fully defined. Further progress on this project is also dependent upon the budgetary situation.
D18B	Polarised neutron version of the neutron interferometer.
IN5B	This proposal, for a new high resolution time-of-flight spectrometer, was submitted to the Instrument Subcommittee of the Scientific Council in October 1976. Work is continuing on the scientific definition and siting of this instrument.

TABLE IV - SPECIAL PROJECTS

Polarisation Devices	Development work on new techniques for producing polarised neutrons has been concentrated in two areas : supermirror polarisers and polarising beam benders. With the former device, a polarisation efficiency of better than 99% has been achieved, whilst the joint ILL/Rutherford Laboratory project to construct a polarised beam bender for IN11 has resulted in the successful testing of the prototype version. The manufacture of two definitive benders for IN11 is almost complete.
D19 (multidetector)	Construction of this 2-dimensional multidetector was started in 1976 after feasibility studies in mid-1975. With 512 horizontal and 16 vertical elements in high pressure $^3\text{He}$ gas it will have good resolution and efficiency at relatively short wavelengths, and will be used for high resolution protein crystallography as well as for biological and chemical problems.  With its own data collection and processing system, D19 will be used from early 1978 as an autonomous unit on the existing diffractometers D8, D9 and D16.
Monochromators	During 1976 maximum effort was concentrated on monochromators for long wavelength neutrons, resulting in the production of Ge and Si crystals showing considerable improvement. In addition, the anisotropic mosaic spread can be controlled during production. A joint project by the M.P.I., Stuttgart and ILL to develop and produce good quality Beryllium single crystals was commenced during the year and has already shown promising results.

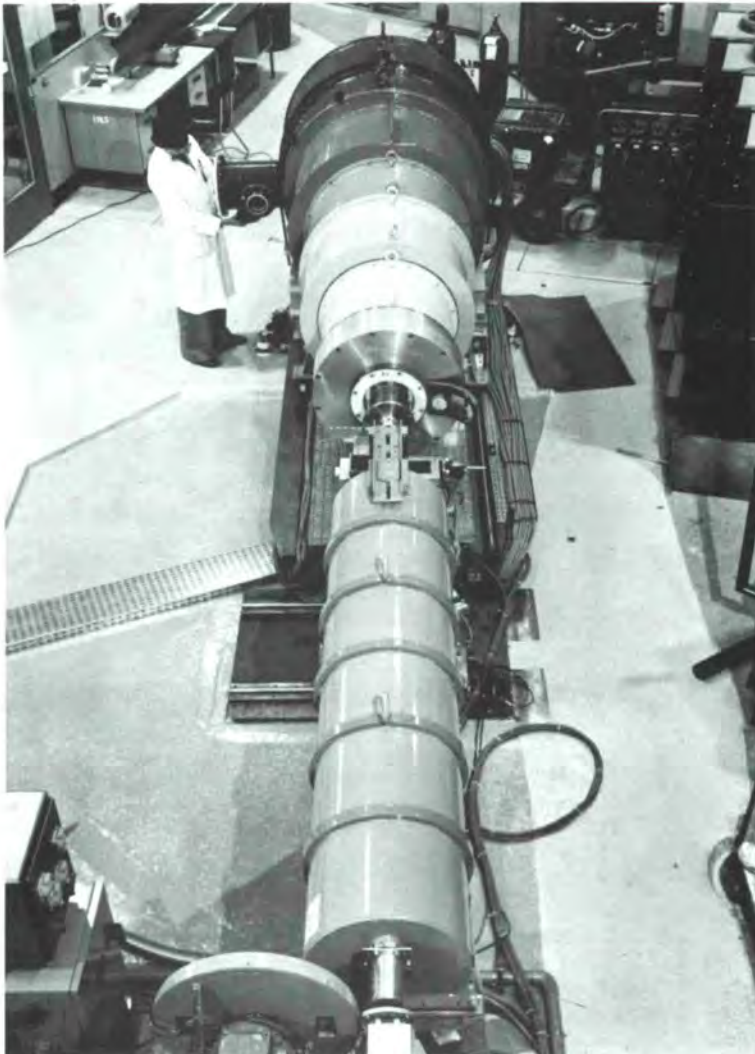
TABLE V - SPECIAL EXPERIMENTS

Instrument	Beam Position	Experiment Number	Title
S 4	H 18 L	03-03-010	Magnetic moment of the neutron
S 6	H 25 U	07-04-002A	In-Beam N.M.R.
S 10	H 22 W	{ 03-03-052	(n, p), (n, $\alpha$ ) in n-deficient nuclei
		{ 03-03-053	(n, $\alpha$ ), (n, $\gamma$ $\alpha$ ) in medium and heavy nuclei
		{ 03-03-054	(n, $\alpha$ ), (n, f) of heavy isotopes
S 13	H 17 U/M	06-02-009	He surface
S 20	H 24 W	07-03-045	Neutron Topography
S 21	H 24 W	05-01-100	High precision lattice parameters
S 22	IH 3	03-03-008	Neutron bottle (ultra cold neutrons)
S 23	IH 3	03-03-007	Neutron Storage ring (ultra cold neutrons)
S 25	H 22 M	03-03-011	Protein content in seeds
S 28	H 23 L	03-03-015	Isotope separator - OSTIS
S 30	H 25 M	03-04-001	Concentration profiles by (n, $\alpha$ ) and (n, p) reactions
S 32	H 14 (special)	01-003R	h/m determination
S 33	H 14	03-03-018R	ga/gv from free $\beta$ -decay
S 36	H 14	03-03-037	Parity violation in $^{114}\text{Cd}$ and $^{118}\text{Sn}$ , etc.
S 37	H 18	03-03-038	Neutron half life
		{ 03-03-054	(n, $\alpha$ ) and (n, f) of heavy isotopes
S 38	IH 1	{ 03-03-055	Mass distribution for $^{231}\text{Pa}$ , $^{237}\text{Np}$ (n, f) reaction
		{ 03-03-060	Emission of 2 light particles in $^{235}\text{U}$ (n, f)
S 39	H 22 W	03-03-056	One and two phonon decay in n + $^3\text{He}$ capture
S 31	H 22 U	{ 03-03-058	$\gamma$ -directional distribution from oriented nuclei
		{ 03-03-059	$\gamma$ - $\gamma$ directional correlation after n-capture
S 40	No beam requirements	03-05-001	Neutrino cross-section and neutrino oscillations
S 41		03-05-002	PNC effects in polarised neutron optics
S 42	H 25 W	5-16-51	Change of domains in $\alpha\text{Fe}_2\text{O}_3$

## instruments which became operational in 1976

### THE LOW- $q$ , HIGH RESOLUTION SPECTROMETER D17

D17 is a 2-axis spectrometer, with multidetector, for scattering experiments in the scattering vector ( $q$ ) range  $5 \cdot 10^{-3} \text{ \AA}^{-1}$  to  $1.0 \text{ \AA}^{-1}$ , requiring high resolution. It is thus designed for studying high order diffraction peaks of large periodical structures. It can also be operated as a classical small angle scattering spectrometer and will take in charge part of the small angle scattering experiments currently carried out on D11, an apparatus, up to now, heavily overloaded.



D17 : new small-angle scattering instrument

D17 is equipped with a LETI BF<sub>3</sub>-multidetector, 64 x 64 cm<sup>2</sup> in area, with 16000 counting cells each 5 x 5 mm<sup>2</sup>, in a planar X, Y arrangement. This detector is positioned 3 m from the sample and can be rotated around the sample from 0° to 90° from the incident beam direction. The detector can also be placed at 1.5 m from the sample. The incident beam as well as the scattered beam are in vacuum, except for a few centimetres around the sample.

The apparatus is installed at the exit of the cold neutron guide H17 with a beam cross-section size of 3 x 5 cm<sup>2</sup>. Because of the rather strong curvature of the H17 guide, the range of available neutron wavelengths is restricted to 7.5-30 Å. The beam monochromatization is made by velocity selectors. A first selector already running gives a wavelength resolution  $\Delta\lambda/\lambda$  of 10%. A 4% selector will be available in January 1977.

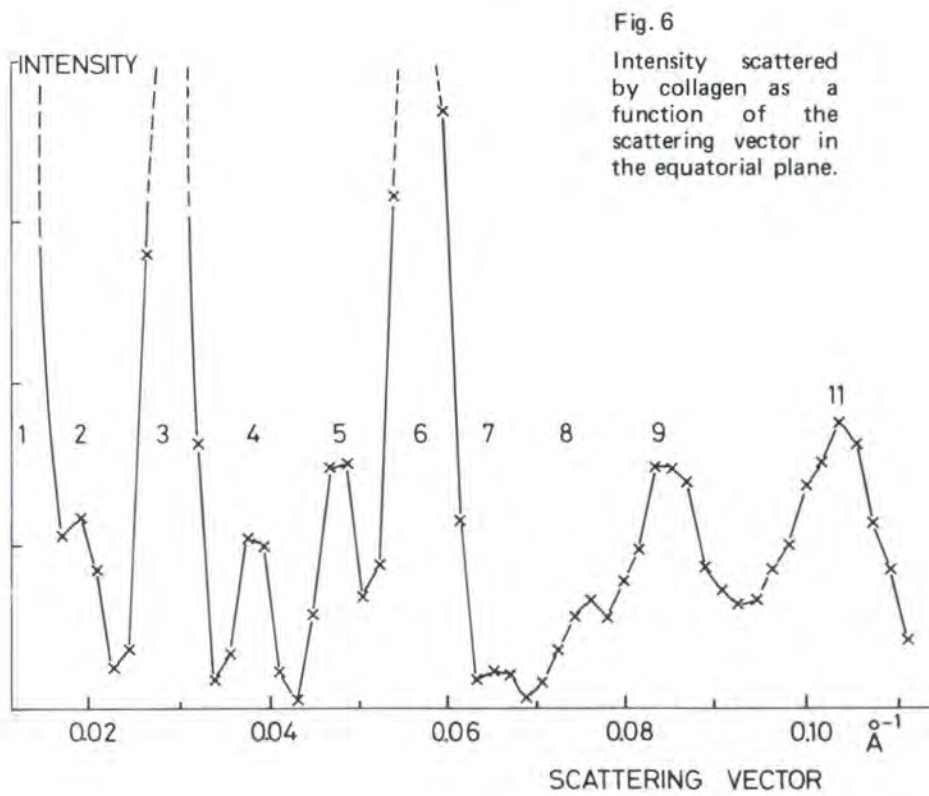
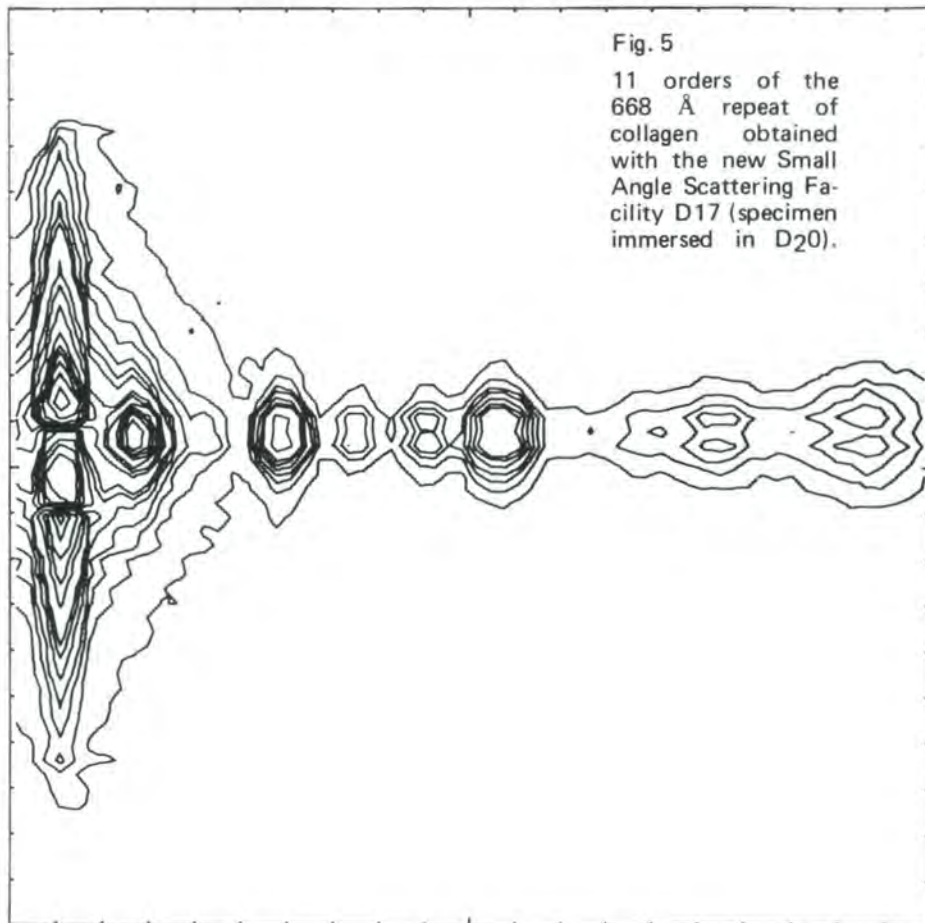
The q resolution  $\Delta q$ , of the apparatus is in a first approximation simply proportional to  $q \cdot \Delta\lambda/\lambda$  at high scattering angles. At low angles, q depends on the collimation of the incident beam. A lowest reasonable limit is nevertheless  $2 \times 10^{-3} \text{ \AA}^{-1}$ . The divergency of the incident beam can be varied between  $2 \cdot 10^{-2}$  rad. and  $5 \cdot 10^{-3}$  rad.

Some ancillary equipment is available : a sample table with a 360° monitored rotation, and a monitored translational sample changer ; a cryostat (4 K to 150 K) with a vertical magnetic field (0 - 20 KOe) ; a chopper allows easy wavelength calibrations and eventually some time-of-flight analysis of the scattered beam, with low energy resolution.

D17 is equipped with a PDP11-40 computer for controlling the experiments and collecting the data. Some data reduction treatment and display are possible on measured spectra. The computer is programmed in FORTRAN.

D17 will be operational for external users in Spring 1977. Some preliminary experiments have shown that the available intensity on the sample at 12 Å is very similar to that at D11 for the same collimation, and is higher for longer wavelengths.

To exemplify the resolution and the possibilities of the apparatus, Figures 5 and 6 show the scattering pattern and equatorial intensity obtained after 1 h measurement with the 10%  $\Delta\lambda/\lambda$  resolution on a sample of aligned collagen/D<sub>2</sub>O fibres. Collagen has a highly crystalline one-dimensional periodical structure with a period of repeat of 668 Å. Peak overlapping due to  $\Delta\lambda$  smearing appears beyond the 7th order of diffraction.



## instrument group

### \\three-axis spectrometers//

IN1	:	on the hot source (beam tube H8)
IN2	:	on thermal beam-tube H13
IN3	:	on guide tube H24
IN8	:	On thermal beam-tube H10
IN12	:	under construction on cold guide H142.

During the year 1976 the instruments IN1, IN2 and IN8 have been in continuous operation, while the construction of IN12 was in progress. As a result of the new instrument group structure, the spectrometer IN3, with much improved capabilities, is now part of the three-axis group.

No major modifications to the other existing instruments was undertaken. It is generally felt that a significant move towards improved instrument performance should begin with the replacement of the present Carine system ; but so far the outlook has been rather unpromising.

Nevertheless, an effort at simplifying the control hardware through a more systematic use of stepping motors is currently underway and will be implemented on IN12.

#### IN1 – HOT SOURCE 3-AXIS

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

Over the past year, considerable improvements to the radiation safety aspects of the instrument have been completed, with the installation of two  $^6\text{LiF}$  beam shutters and a displaceable beam-stop.

Essential maintenance work has included the replacement of the cables to the monochromator table and the installation of a new motor to rotate the monochromator drum (both items have been the source of frequent instrument break-downs in the past). As a result variable  $E_0$  scans no longer present mechanical problems.

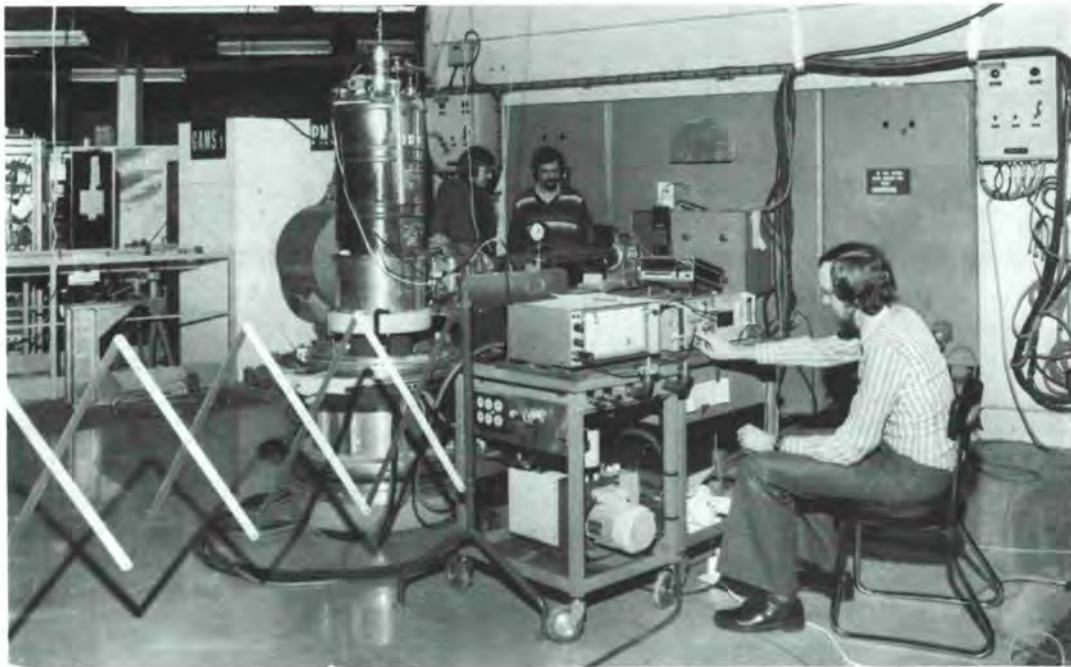
We have acquired a good beryllium crystal which is frequently used as an analyser. The beryllium filter analysing system continues to operate satisfactorily and has been used during approximately a third of the available beam time.

Some users would like to see the possibility of improved incident energy definition at the obvious expense of intensity. This would be achieved if higher take-off angles  $2\theta_M$  were available : however, the corresponding modification would not only affect IN1 itself but also the use of D4 and this for a considerable length

of time. Such a step will therefore require a careful discussion and a scientific choice.

#### IN2 — THERMAL BEAM 3-AXIS WITH A DOUBLE MONOCHROMATOR (B. Dorner, R. Ghosh, and B. Fitzgerald)

Apart from the usual Carine problems, IN2 has been running satisfactorily all year. It is used more and more in the fixed incident energy (14 meV), up-scattering mode with pyrolytic graphite as monochromator and analyser crystals. Since it is well adapted for the study of low-frequency excitations, an important fraction of the experiments performed on the instrument have to do with dynamical studies near phase transitions. For soft phonon mode measurements the large range of available scattering angles around the sample table is often very useful.



Changing sample temperature on IN2

For the future a project for a new version of the instrument sharing the H13 beam with a new back-scattering machine (IN13) is presently under study.

#### IN3 — FOCUSING TRIPLE AXIS SPECTROMETER ON THE GUIDE TUBE H24 (R. Scherm, V. Wagner)

At the end of 1975 IN3 has been shut down for 4.5 months to undergo a major reconstruction (G. Gobert, M. Laroumagne, R. Ritter).

As a result of this overhaul the position is as follows :

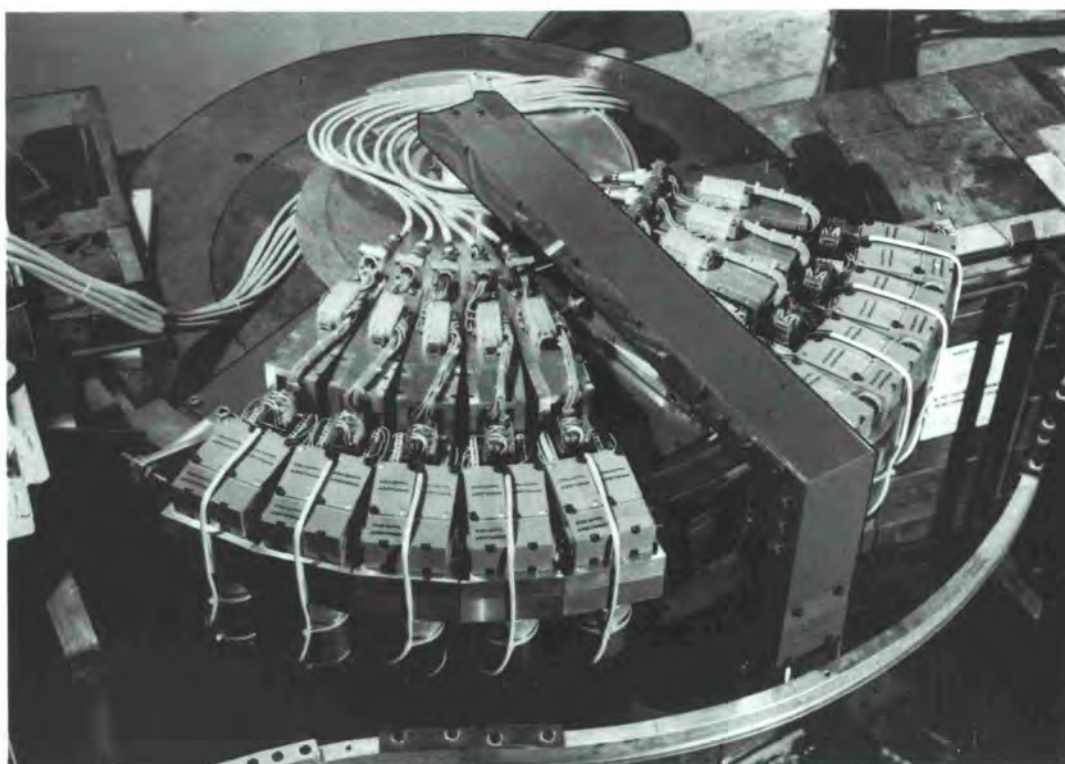
1. Precise, backlash compensated positioning of the angles.
2. On an optical bench system collimators, filters, diaphragms, monitors and the neutron camera can be placed quickly and reproducibly without any need for realignment.
3. Mylar foil collimators, purchased from the Rutherford Lab. give excellent transmission.
4. A newly designed analyzer shield using Gd-painted curtains allows the detector to sweep its full angular range automatically with no one needed to rearrange shielding blocks.
5. In October 76 the automatic monochromator shielding was installed (H. Beaujard, G. Gobert, P. Tardif). Finally now even IN3 can vary the incident energy automatically.
6. A new vertically curved Cu111 monochromator has been installed (A. Freund, H. Hustache) : it has increased the flux by a factor 2.5 :

$E_i$	Cu111	Graphite 002
1.2 THz	—	$8.5 \times 10^5$
3.5	$0.27 \times 10^7$	$1.5 \times 10^7$
5.3	$0.55 \times 10^7$	$2.0 \times 10^7$
8.4	$1 \times 10^7$	
10.0 THz		

7. Last but not least new programs (F. Reichl, P. Rice, W. Kaiser, V. Wagner) have been written to perform faster and partially automated alignment procedures.

IN3 resumed scheduled operation on February 7 1976. Thanks to the modifications described above, the spectrometer has become a very versatile instrument. Resolution can be adapted quickly to the experimental needs both in the classical and focusing mode of operation. The time wasted for alignment is reduced to a few hours.

Except for the steady complaints about the slowness and frequent breakdowns of the Carine computer and electronics the instrument is now operating very satisfactorily.



Monochromator assembly on IN3

#### IN8 — THERMAL BEAM 3-AXIS

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

IN8 has been in high demand all year because of its high flux and low background, particularly in the medium energy transfer range (5 to 15 THz).

The instrument is now fully equipped with graphite and beryllium filter supports on the incident and scattered beams. Improvements to the monochromator-drum drive unit, sample goniometer and beam stop are underway.

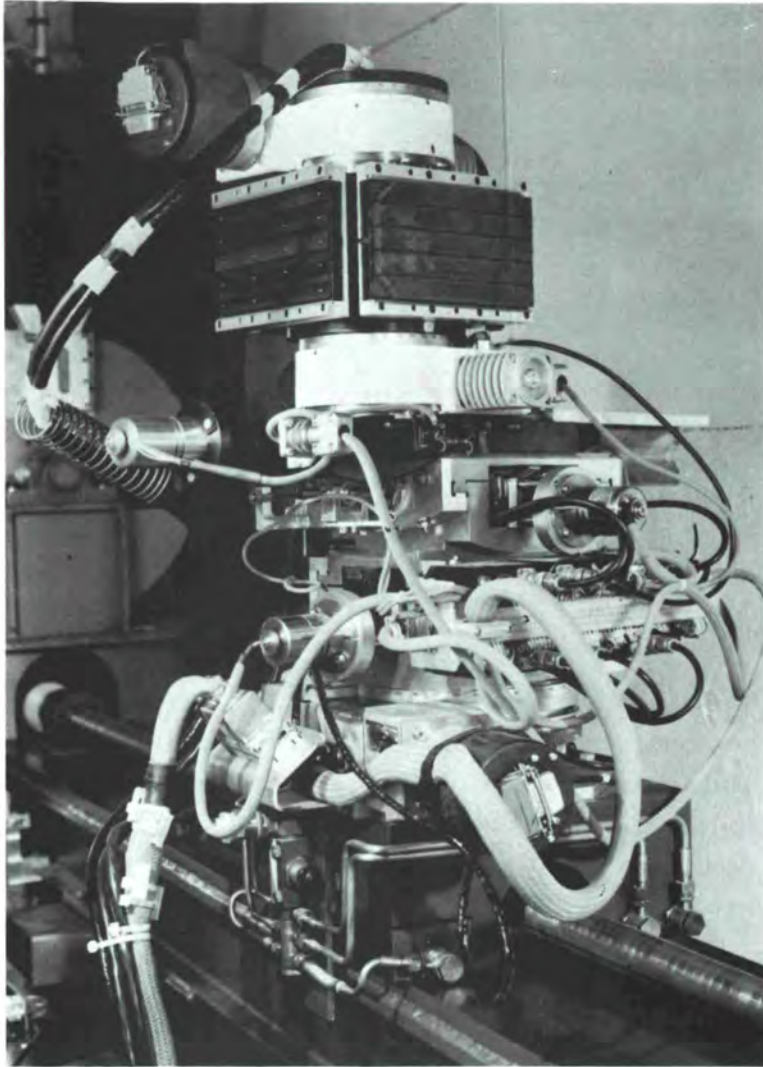
A variable vertical curvature device installed at the monochromator position has been tested using a 15-piece pyrolytic graphite assembly. The flux gain, as measured on a small sample, is a factor of 2.5 at all attainable incident wavelengths (1.5 to 4 Å). Similar developments are in progress using Copper and Germanium crystals.

#### IN12 — 3-AXIS ON A COLD GUIDE

(W. Stirling)

Construction of this instrument is under way with the monochromator to be assembled and in position during January 1977. First tests of the complete machine are scheduled for Summer 1977, although the shortage of electronic staff may hinder the final commissioning. It is unlikely, therefore, that IN12 can perform scheduled experiments next year.

Co-ordinator : R. Currat



IN8 : Monochromator assembly with the variable vertical curvature apparatus.

## instrument group "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 : Double monochromator + Fermi chopper spectrometer on the thermal beam tube H15.
  - IN9 : Polarized proton filter on cold guide H14
  - IN11 : Spin echo spectrometer on cold guide H14.
- } fully operational

### IN4 – ROTATING CRYSTAL SPECTROMETER

(J. Suck, C. Carlile)

The instrument was operational throughout the year performing 32 experiments in 1976.

While last year the shielding of the spectrometer building was completed, in 1976 considerable effort was made to reduce the background coming from the instrument's own beam : the flight path is now covered with Cd ; scattering from the cryostat was reduced. The background coming from gas scattering within the secondary spectrometer was partially improved by a beam stop nearer to the sample. To reduce the background further, it is planned to install coarse Cd collimators in front of the detectors.

The installation of a lifting table now allows the installation of heavy equipment on the sample site. Two furnaces (670 K with good temperature homogeneity and  $T < 2000$  K) will soon be available. The control of the cryostat has been further automated.

A new Fermi chopper was installed and tested up to 15000 RPM. Flux and resolution have been studied for the graphite and Cu monochromator ; a comparison of the performance of the rotating crystal with the Fermi chopper is under way.

To overcome the intensity problems the addition of new detectors is planned for 1977.

### IN5 – MULTICHOPPER SPECTROMETER

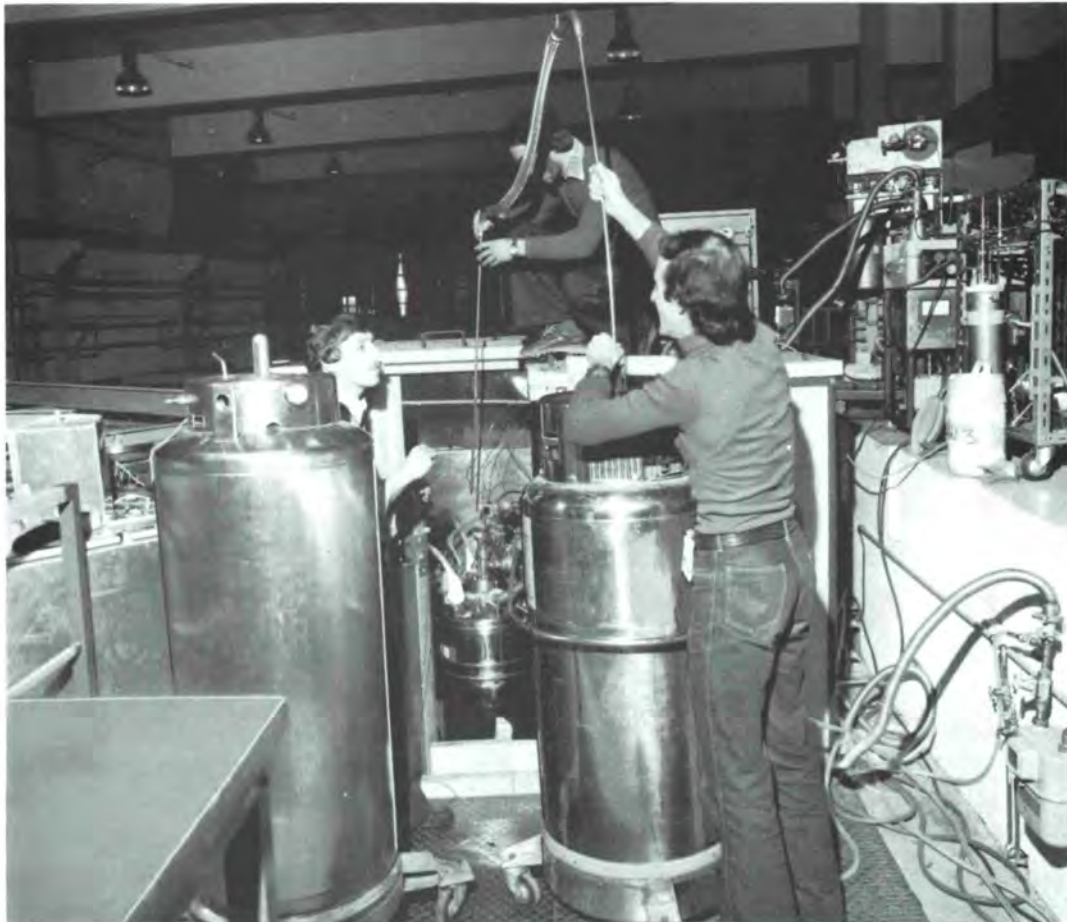
(R. Lechner, A. Dianoux, F. Douchin)

After a series of tests the IN5 choppers have been running regularly and reliably at 15000 RPM since April 1976. Tests are continuing in order to allow quick changes of the chopper speed. This would allow the user to rapidly adapt wavelength and resolution to physical problems. The range of stable operation of chopper 3 has been extended down to 1666 RPM. This permits the use of

$\lambda = 15 \text{ \AA}$  to achieve 5  $\mu\text{eV}$  resolution at  $Q < 0.8 \text{ \AA}^{-1}$ .

The flux at the sample increased by 30% as a consequence of a realignment of the neutron guides between the choppers. The cause of the misalignment (unstable supports ?) will be investigated.

IN5 is presently working with 400 detectors. The installation of a second series of 400 more is foreseen. Detector supports and shielding have been delivered and improved cabling has been developed. Problems arose with the insulating ceramics ; delivery of all detectors has been delayed until 1977.



Filling the  $^3\text{He}$  cryostat on IN5

To improve background scattering a He filled sample box has been built. It can accommodate different cryostats and furnaces as well as several samples which can be brought by means of a new sample lift.

The instrument was in full operation throughout the year with a total of 44 experiments of an average duration of 5 days. The NICOLE data acquisition system has been working very efficiently.

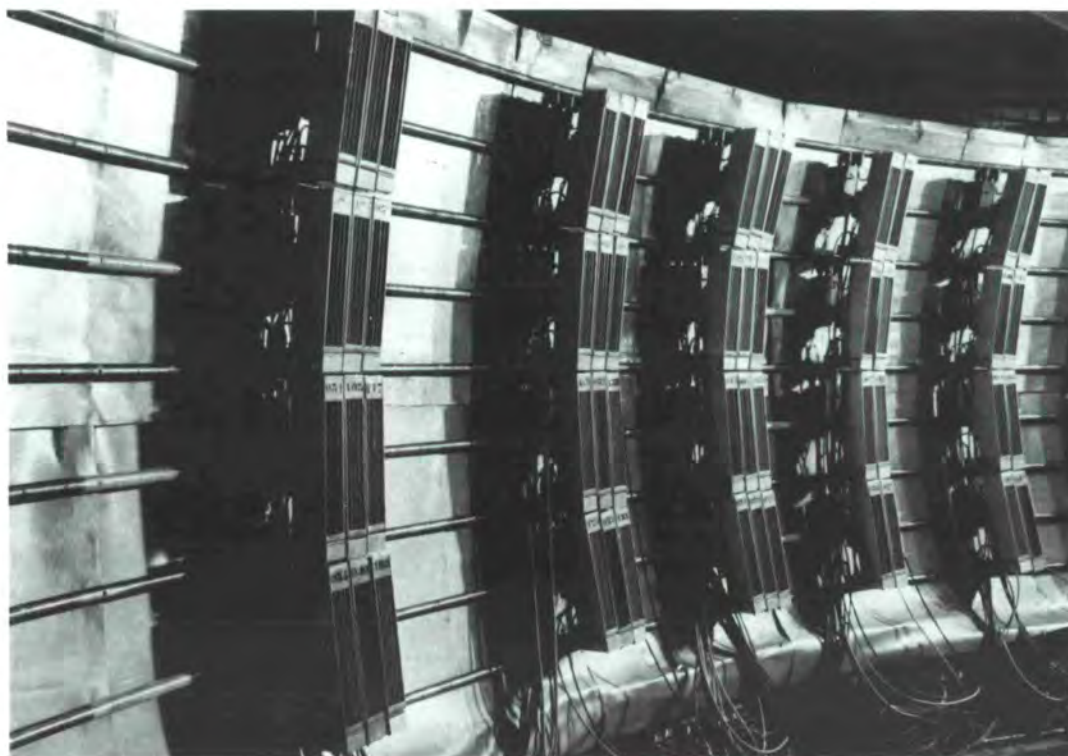
The only major drawback concerning continuous operation is power failures

during the summer period. It is hoped that in 1977 a safe power supply will become available.

The need for a flexible choice of  $\lambda$  and resolution may be illustrated by the following table.

chopper speed	use 1976	$\lambda$ -range	% use 1976
6000 RPM	10%	3 – 6 Å	38%
10000	34%	6 – 10 Å	57%
12500	6%	10 – 11 Å	5%
15000	50%		

Further development is intended to push towards higher resolution (20000 RPM) and easier variation of the chopper speed. It is hoped that the planned new TOF spectrometer "IN5 bis" will relieve IN5 in the  $\lambda < 6 \text{ \AA}$  region while IN5 will be used even more at long wavelengths.



Banks of detectors on IN5

## IN7 – DOUBLE MONOCHROMATOR + FERMI SPECTROMETER

(A.P. Murani)

The modified IN7 spectrometer (consisting of a graphite double monochromator and a single box of He<sup>3</sup> counters ; area : 15 x 30 cm, flight path : 2.35 m) has been used for a few scheduled experiments but mainly for tests and experiments by scientists in Grenoble (CNRS and ILL) and visitors coming to ILL for experiments on other instruments. Because of the limited detector area the experiments take rather long periods and consequently the demand for the instrument has been limited - in particular proposers of experiments transferred from IN4 have asked to be delayed until the new counter bank is installed. The latter will increase the detector area by a factor of 6, the maximum possible within the tight limits of the available space. It is hoped to complete the installation by the spring of next year.

## IN9 – POLARIZED PROTON FILTER

(G.T. Jenkin, D. Feltin, J.L. Ragazzoni)

Work has continued on the optimization of the spin filter for the proposed inelastic instrument IN9.

The apparatus became operational again in May, after it had been moved to a position to use the waste beam from IN10. Neutrons were only available when the transparent doppler machine was used. A Heusler crystal in a compact samarium magnet was obtained as polarizer/monochromator, and a beryllium filter bought to eliminate  $\lambda/2$  for ( $\lambda : 3 - 5 \text{ \AA}$ ). The shielding of the polarizer required considerable attention.

A new cavity has been made for the filter to minimize the presence of He<sup>3</sup> in the neutron beam, while at the same time retaining the high polarization in the hydrogen of the filter. This design has been found to work very well (see ILL publication 76J237T). The 90% polarization enables an estimated transmission of neutrons of 45% and 3% for the spins parallel and antiparallel, with allowance for imperfect polarization from Heusler.

The electronics have been radically improved during the year, with the loan of a Rutherford Laboratory N.M.R. system allowing accurate monitoring of nuclear polarization and stabilization of magnetic field. The microwave frequency is now phase locked to a crystal controlled frequency synthesiser enabling a high polarization in the filter stable to 1% to be held for 2 weeks. Mains failure is the limiting factor.

An experiment with the old D1B multidetector has not allowed any observation of a small angle scattering pattern, eliminating one area of doubt about this type of filter.

The detailed design of the inelastic instrument is now being undertaken.

## IN11 – SPIN ECHO SPECTROMETER

(J. Hayter and F. Mezei)

For most of the year IN11 continued to run in its mirror-testing mode, evaluating supermirrors and a prototype polarising beam-bender (see section on "Development of new techniques").

The design of IN11 was based on the assumption that a long-wavelength polarisation analyser would be built which was nearly 2 orders of magnitude smaller and lighter than any existing at the time (early 1974). The excellent performance of the polarising bender now makes this a reality. In the first instance, the machine will use a 50 x 30 mm<sup>2</sup> cross-section bender as polariser, and a 50 x 40 mm<sup>2</sup> bender as analyser, both being 200 mm long.

Since October, the machine has been converted back to its original configuration for spin-echo operation. The final 5 m section of guide has been mounted between the velocity selector and the polariser position, tests have been concluded on the magnet control electronics, and the sample-access walkway has been installed.

Co-ordinator : R. Scherm

# instrument group

## \\diffuse scattering//

This group includes the following instruments :

On the cold guide H15

- D7 : Diffuse scattering spectrometer
- D11A : Small angle scattering spectrometer
- D11B : Small angle and diffuse scattering spectrometer
- IN10 : Backscattering spectrometer.

On the cold guide H16

- D16 : Four circle Mk6 diffractometer

On the cold guide H17

- D17 : New small angle and diffuse scattering spectrometer.

### 1. — APPARATUS IN FULL OPERATION

#### D7 — DIFFUSE SCATTERING SPECTROMETER

(W. Just, P. Radhakrishna)

The instrument was running with unpolarized neutrons for the first three reactor cycles of this year. In June polarized neutrons were installed again, using the Heusler alloy  $\text{Cu}_2\text{AlMn}$  as polarizer at about 5 Å. A dynamical spin flip mode was put into service and is available now as an option to conventional spin flip methods. In this mode the incoming neutron spins are flipped up and down in pseudo-statistical sequence ; the scattered neutrons are registered in 127 time channels per detector. The raw spectra can be cross-correlated on-line (NICOLE) and the result displayed at any time during a measurement. This option represents a powerful means in diffuse magnetic scattering of discriminating inelastic spin-independent scattering processes.

#### D11A — SMALL ANGLE SCATTERING SPECTROMETER

(K. Ibel, J. Haas)

The reliability of the D11A-system, of utmost importance with regard to the large number of users and the tight experimental programme, could be further increased. The transfer of the detector is now more easily possible by means of a stable movable crane, the sample area being serviced now by a jib crane. The manual of the instrument is now available in its fifth revised edition. A description has been published in J. Appl. Crystallography Vol. 9, Part 4, August 1976, page 296.

## IN10 – BACKSCATTERING SPECTROMETER

(A. Heidemann, S. Howells)

A step motor control system was installed which allows the driving of the step motors of the sample and the graphite goniometers via the PDP11 computer. A new small analyser consisting of seven concentric analyser circles was put into operation. Seven  $Q$  values between  $0.07 \text{ \AA}^{-1}$  and  $0.32 \text{ \AA}^{-1}$  can be measured simultaneously. The system was used for the study of polymers, membranes, liquid crystals and hydrogen in metals. A third Doppler drive which is transparent and "fast" ( $v < 3 \text{ m/s}$ ) is under construction. The state of the spectrometer can now be controlled by telephone. Apart from a severe breakdown in June/July where 70% of one reactor cycle was lost due to a memory fault, the machine was operating satisfactorily.

## D16 – FOUR CIRCLE Mk6 DIFFRACTOMETER

(G. Zaccai, S. Wilson)

This year, D16 has been used for studies on partially oriented samples such as biological membranes and clays in strictly controlled temperature and relative humidity environments, as well as for studies on single crystals where a long wavelength was required, for example to examine the dependence of extinction on wavelength.

An effective increase of a factor of ten in intensity has been achieved, where large samples have been available, by the installation a 15 cm diameter counter and high transmission mylar collimators with an angular divergence of  $0.2^\circ$  in  $2\theta$ , corresponding to a few hundred Angstroms resolution in real space. The cross-sectional area of sample which can now be illuminated by the neutron beam is  $3 \times 5 \text{ cm}^2$ .

The flexibility of data collection program on the PDP8 (shared by D15) has been improved by the acquisition of extra core memory. The curved multidetector under construction (D19), will be compatible for use on D16.

## 2. – APPARATUS UNDER CONSTRUCTION

### D11B – SMALL ANGLE AND DIFFUSE SCATTERING SPECTROMETER

(G. Kostorz, G. Goeltz)

After installation of the new vacuum components, D11B has been mechanically operational since November 1975, serving as vacuum vessel for D11A experiments. Detectors and electronics have been linked to the PDP11/40 computer, and the data acquisition path has been tested successfully. Software development has continued for D11B (detector array) and D11A (multidetector), and several programs for data acquisition and on-line data reduction are available. Others are progressing, with emphasis on user-oriented display programs. The link between PDP11 and the central PDP10 computer has been established and tested. A cryostat for diffuse scattering experiments and a five/eight position, computer con-

trolled sample changer including a rotational drive have been developed at the Rutherford Laboratory in collaboration with I.L.L. These items have been tested for short periods, and the corresponding software is available. More extensive tests are necessary and will take place in 1977. The still unsatisfactory shielding situation on the IN12 side of the instrument will be improved subsequently.

#### D17 - SMALL ANGLE AND DIFFUSE SCATTERING SPECTROMETER

(M. Roth, P. Timmins).

The installation of the new small angle and diffuse scattering machine D17 was completed during this year. The main parts of the spectrometer are a velocity selector, a chopper for TOF analysis, a special collimator system, a step motor controlled sample table (sample changer), a multidetector ( $64 \times 64 \text{ cm}^2$ ,  $128 \times 128$  elements) and a PDP11/40 computer. First tests of the instrument showed that the performance is as expected. The intensity at  $11 - 12 \text{ \AA}$  is very similar to that of D11. It is interesting to note the relatively high flux of long ( $12 - 25 \text{ \AA}$ ) wavelength neutrons. Further tests and studies are necessary until March or April 1977. Then the spectrometer will be available for external users. Studies of the use of polarized neutrons on the machine are in progress.

Co-ordinator : A. HEIDEMANN

## instrument group \\diffraction instruments//

This group was formed in November 1976 by an amalgamation of the groups powder diffraction (co-ordinator P. Convert), crystallography (A. Hewat) and polarized neutrons (F. Tasset/J. Brown). The special diffractometer D10 was also included, while the cold neutron diffractometer D16 left for the neutron diffusion group. The group now includes the following instruments.

- D1A : High resolution powder diffractometer on thermal guide H22.
- D1B : Multidetector on thermal guide H22.
- D2 : High flux 2-axis diffractometer on thermal beam H11.
- D3 : Two-axis polarized neutron diffractometer with lifting counter on thermal beam H5.
- D4 : Liquids diffractometer on hot beam H8.
- D5 : Three-axis polarization analysis spectrometer on hot beam H4.
- D6/D19 : Modified Laue/2D multidetector tests on thermal guide H24.
- D8 : High flux four circle diffractometer on thermal beam H11.
- D9 : Four circle diffractometer on hot beam H3.
- D10A/B : Four circle three-axis diffractometer on thermal guide H24.
- D12 : Neutron cameras on thermal guide H23.
- D15 : Four circle Mk6 diffractometer on inclined thermal beam IH4.
- D18 : Neutron interferometer on neutron guide H25.
- LI4/5/7 : X-ray laboratories.

Most of these machines have passed the initial stages of construction, testing and modification and are fully scheduled for experiments. Emphasis on technical improvements is now centred on two main areas : firstly to widen the range of sample environment, and secondly to increase the speed and ease of data collection.

Neutron diffraction still has an enormous potential for development in these two areas. Because neutrons are more penetrating than X-rays, more sophisticated refrigerators, cryostats, furnaces and pressure cells are possible : most of the diffractometers have seen major improvements in this area in 1976, and more are planned for 1977. These improvements, although perhaps "conventional" by normal ILL standards, open up quite new possibilities for crystal structure research : it becomes possible to "force" a structure rather than simply accept it as it is. We can then hope to understand "why" as well as "what" it is.

Increase in the speed and ease of data collection is perhaps only a question of

economics : but then so is the construction of a high flux reactor. Many of the diffractometers have recently seen a dramatic increase in effective intensity, as much as an order of magnitude. And this for a relatively small investment in new monochromators, especially focusing monochromators, in mechanics and collimators, and in new detectors, especially multidetectors and data acquisition systems.

#### D1A – HIGH RESOLUTION POWDER DIFFRACTOMETER

(A.W. Hewat)

D1A has operated routinely with its new high efficiency collimator bank (Nucl. Instr. Methods 137, 463). Wavelengths between 1.2 Å and 5.7 Å can now be selected by simple rotation of a single squashed germanium monochromator. A prototype focusing monochromator has been shown to concentrate the beam from 150 mm to 15 mm with a corresponding order of magnitude intensity gain, and a definitive version will be installed early in 1977. This monochromator, using the new ILL technique for producing anisotropic mosaic spread in squashed Ge, will give a choice between 1.1 Å, 1.38 Å and 1.9 Å, and will be especially useful for the high pressure techniques being developed with the CNRS Grenoble Laboratory.

#### D1B – TWO-AXIS DIFFRACTOMETER WITH MULTIDETECTOR

(P. Convert/J.L. Buevoz from 1.9.76 with P. Thorel until 31.8.76)

The instrument has worked satisfactorily all the year. For kinetic experiments, the dead time between two measurements has been reduced (about 1 second with Carine 3). However the Carine system is not adapted and reduces the possibilities of D1B : it is impossible to compare two diagrams on the instrument. It is now obvious that it is practically impossible to control an experiment without a new system allowing for immediate data comparison, and eventually primary data evaluation. More and more short experiments are performed for characterisation of samples to be used on other ILL instruments. In 1977, increase of the flux and facilities to change the wavelength are planned.

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

(K.R.A. Ziebeck)

Throughout 1976 D2 continued to operate efficiently. Improvements to the detector shielding and that of the environment of D2 have minimised the background. The introduction of four mylar sollers before the detectors has increased the detected flux and ensured that the line shapes of the four detectors are uniform and consistent. These small innovations when coupled with an increased "take off" angle on the monochromator have improved both the flux and the resolution. The instrument remains a versatile variable wavelength 2-axis spectrometer.



D1B : set-up for a kinetic experiment

### D3—TWO-AXIS POLARIZED NEUTRON DIFFRACTOMETER

(J. Brown and F. Tasset)

D3 has been in high demand during 1976. It has been used for the determination of magnetic scattering amplitudes from a wide range of materials, mostly ferromagnetic, antiferromagnetic and paramagnetic phases. The commissioning of the 4.8 T asymmetrically wound cryomagnet early in the year has increased its range of application considerably. Experiments can now be done in fields of up to 4.8 T at temperatures between 1.5 K and 400 K.

A suite of programs is now available on the DEC-10 computer which allows rapid evaluation of the data, and this can lead directly from the D3 dectapes to a magnetisation density map (see figure 7).

### D4 — TWO-AXIS "LIQUIDS DIFFRACTOMETER" ON THE HOT SOURCE

(P. Chieux and W. Knoll)

D4 has been fully operational and almost trouble free during 1976. New single crystal sapphire sample holders for use at high temperatures represent a major improvement. As well, improved protection has reduced the instrument background to one half its former value. Priority in 1977 has been given to improving the effective intensity and we expect to have soon a multidetector working routinely on this diffractometer at a wavelength near 0.5 Å.

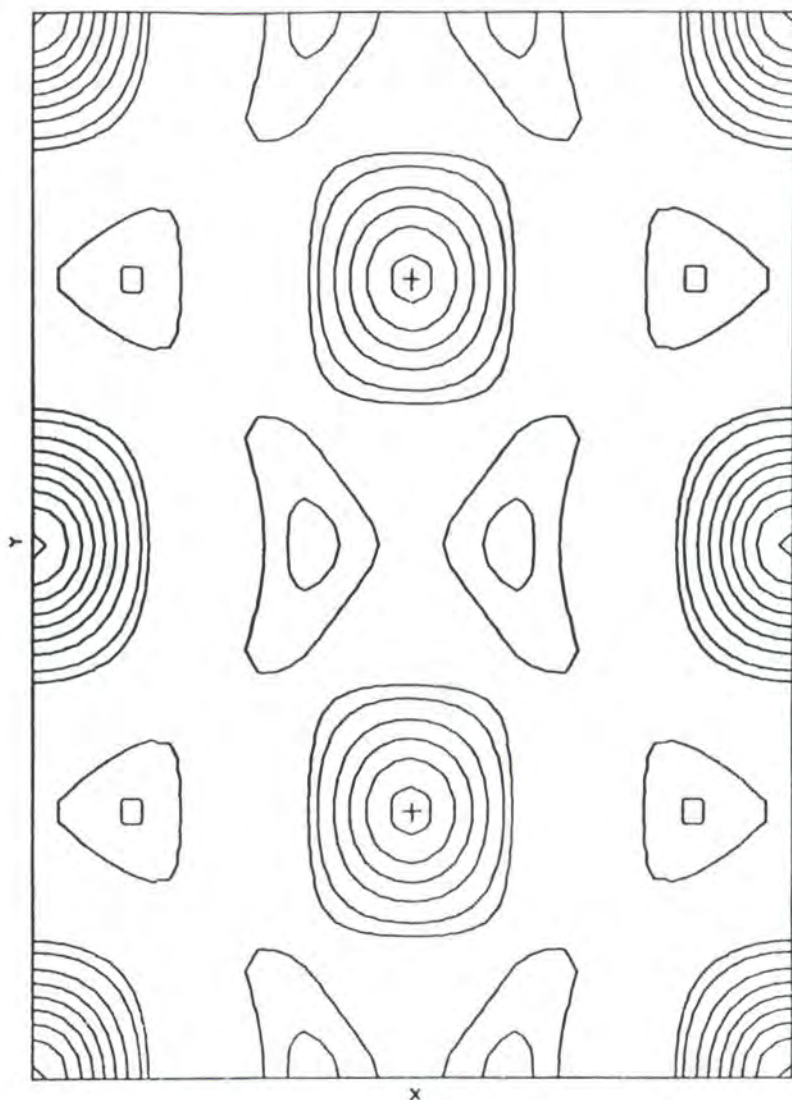


Fig. 7  
Projection of the paramagnetic magnetization in URh<sub>3</sub> on the |110| plane.

#### D5 – THREE-AXIS POLARIZATION ANALYSIS SPECTROMETER

(J. Schweizer)

D5 has been used either for magnetic form factor measurements (mostly on single crystals, but also on powders and amorphous materials) or in the polarization analysis setting to separate cross-sections (magnetism, coherent/incoherent scattering from liquids). Many experiments have used the cryomagnet which provides a vertical 4.8 T magnetic field. Advantage has been taken of the hot source in experiments where, besides extinction problems, wavelengths smaller than 0.50 Å allowed the study of elements which are very absorbing at higher  $\lambda$ , (e.g. samarium). This type of experiment will probably continue (with gadolinium, etc.) since with such short wavelengths no special isotope is needed.

A horizontal electromagnet with a large gap is expected to be available towards the end of 1976. On the one hand, it will allow measurements at large K (access

angle  $\pm 50^\circ$ ) with a 10 K0e horizontal field : on the other hand, using an extra Helmholtz coil in the polarization analysis setting, it will allow a direct comparison of cross-sections with the field vertical or horizontal ( $H//k$  and  $H \perp k$ ) without modifying the sample environment.

#### D6/D19 – MODIFIED LAUE/2D-MULTIDETECTOR TESTS

(S. Wilson)

The "hedgehog" diffractometer has undergone a series of tests and has been shown to very largely meet the design specifications of its constructor, B. Klar. A full report has been prepared. It has also been confirmed that to make it a routinely operating instrument would require a considerable expenditure to replace the 100 movable detectors, which are not sufficiently homogeneous and whose positioning motors are too slow. Instead we propose to make a technological jump directly to a two dimensional position sensitive detector (D19) which, after development on D6, will be used as a self-contained system on diffractometers such as D8, D9 and D16.

#### D8 – HIGH FLUX FOUR CIRCLE DIFFRACTOMETER

(S. Mason/C. Riekel from 1977)

The flux at the sample has been further increased to  $8 \times 10^7$  n/cm<sup>2</sup>/sec with a new ILL Cu(200) monochromator. For special applications, such as protein crystallography,  $2 \times 10^8$  n/cm<sup>2</sup>/sec can be obtained from pyrolytic graphite, but only at the expense of resolution. To match this higher flux, a new control system, based on the PDP 11/40 calculator originally used by D14, will be implemented in 1977. A new Fortran program system (ILL report 76B270T) common to D8, D9 and D10 has already simplified and speeded up data collection.

The Displex closed cycle refrigerator, identical with that on D9, now operates routinely at temperatures above 45 K, with the sample usually protected by vanadium or aluminium cans. This, together with the high flux, greatly extends the range of problems possible, so that now a structure can be studied at different temperatures in an acceptable time.

#### D9 – FOUR CIRCLE DIFFRACTOMETER WITH SHORT WAVELENGTHS

(M. Lehmann)

D9 on the hot neutron source has relatively good flux ( $3 \times 10^6$  n/cm<sup>2</sup>/sec) at wavelengths much shorter than usual (0.5 to 0.8 Å). This wavelength can be varied continuously because the  $\alpha_2$  collimator moves on air cushions between the water-filled lips of a novel monochromator protection. D9 is unique for work with high spatial resolution on moderately large structures and the short wavelength also makes it interesting where extinction might otherwise be a problem. New monochromators, especially beryllium being developed at the ILL, should increase the flux, and operation will also be speeded by mechanical improvements to the counter support.

D9 was the first diffractometer to be equipped with a closed cycle refrigerator operating down to 45 K, and this has proved very popular. In 1977, we hope to have developed a gas flow furnace operating at up to 800°C, again with full three dimensional geometry.



Eulerian sample-orienting cradle on diffractometer D9.

#### D10A/B – FOUR CIRCLE THREE-AXIS DIFFRACTOMETER (C. Zeyen)

Since May 1976 a new vertically focusing composite copper monochromator has been in operation. The flux at the sample position was thus increased from  $10^6$  to  $2 \cdot 10^7$  n/cm<sup>2</sup>/sec.

This allowed for the observation of a number of small effects in the field of diffuse, critical, and Huang scattering. The data acquisition rate increased dramatically so that now the spectrometer is severely handicapped by the slow time-sharing Carine computer system.

This year the flexibility of the 4-circle Helium-cryostat with the analyzer was shown to be particularly useful in a variety of problems such as 6 low temperature structure determinations, 3 diffuse scattering problems, and 2 critical scattering studies.

From June 1977 a new more accurate Eulerian cradle with a new type of Helium flow cryostat for temperatures as low as 2.5 K will be available. A new epithermal counter shielding is expected to further reduce the background.

#### D12 – NEUTRON CAMERAS

(D. Hohlwein A. Wright from 1977).

Neutron film techniques are of exciting interest for a variety of applications stretching from protein crystallography to magnetic structures, structural transitions and critical scattering. In these fields the neutron Weissenberg and Precession cameras can often provide an astonishing contrast as well as a supplement to the information available from their X-ray counterparts. The modified Laue camera uses a bent Cu monochromator to select a 7% band of wavelengths so that many reflexions can be excited simultaneously : this compensates to some extent for the lower flux of neutron sources.

In 1976 a cryostat attachment was implemented, extending the operating temperature of the cameras down to 1.5 K. In 1977 a refrigerator will allow faster operation at temperatures above 10 K, which will be especially interesting for work on phase transitions.

#### D15 – FOUR CIRCLE DIFFRACTOMETER ON AN INCLINED BEAM

(M. Thomas)

This instrument became available for scheduling early in 1976, and since then has worked reliably. In the lifting counter mode, the X-circle can be replaced by large cryostats and magnets working down to 1.5 K as on its sister machine D3 ; it is then useful for work on magnetic structures and critical scattering. In 1977, the lifting counter will be computer controlled and extra core is being implemented on the PDP8 calculator (shared with D16) to permit more sophisticated programming. In the four circle mode of operation, programs have been written for avoiding blind spots due to the large X-circle. In 1977 this X-circle will carry a two-stage refrigerator, which will permit temperatures down to 10 K with full three dimensional geometry.

#### D18A – NEUTRON INTERFEROMETER

(W. Bauspiess)

This instrument is under construction at the thermal guide H25 following successful operation of a prototype machine (S12) in the same position. The instrument is designed to perform Bragg-diffraction interferometry as well as high resolution double crystal diffraction work. A built-in X-ray tube will serve as wavelength standard and a stable source of high intensity for crystal alignment. The instrument will be operational (in a semi-automatic mode) in 1977.

On the prototype setup (S12) the measurement of scattering lengths of solid samples has been further developed, to a degree where the resolution ( $\Delta b_c/b_c \sim 10^{-3}$ ) is mainly determined by sample parameters. A standard data evaluation program is available.

Polarization effects have been investigated in the case of simultaneous phase shift and spin rotation of the neutron wave. As predicted, the polarization oscillates when the phase of the neutron wave is shifted continuously (e.g. by rotating any non-magnetic sample), even if the magnetic field applied to one partial beam is not changed. Test experiments on gases and magnetic samples have been started.

#### LI4/5/7 – X-RAY LABORATORIES

(M. Thomas, J. Reynal and J. Brown)

These machines are used for preliminary crystal alignment and for crystal structure measurements complementing the work on the neutron diffractometers. LI 4 is a four circle automatic (PDP 8) Siemens X-ray diffractometer with a nitrogen cryostat. In 1976 the paper tape data collection system was replaced by a simple "silent" magnetic tape terminal, which permits direct transfer to the central DEC-10 computer. LI 5, which is used for photographic measurements and crystal alignment, is being modified to make it safer for the large variety of potential users at the ILL : the original generator has been replaced by a new Philips generator with automatic safety shutters.

Co-ordinator : A.W. Hewat

## instruments for nuclear physics

This group includes four large spectrometers (PN1-PN4) with internal targets at very high neutron flux. They have excellent resolution. The facility for ultra cold neutrons (PN5) and most of the special experiments have recently been allocated to this group.

- PN1 : Mass Separator for Unslowed Fission Products (LOHENGRIN) on beam tube H9
- PN2 : Beta Spectrometer (BILL) on the vertical beam tube V3
- PN3 : Three Curved Crystal Spectrometers (GAMS 1, 2, 3) on the through going beam tube H6/H7
- PN4 : Ge Anti-Compton and Pair Spectrometers on the through going beam tube H6/H7
- PN5 : Ultra-Cold Neutron Source on the inclined beam tube IH3
- S1 : Gamma Asymmetry Spectrometer on neutron guide H142L
- S4 : Magnetic Moment of the Neutron on neutron guide H18L
- S10 : Neutron Induced Particle Emission on neutron guide H22W
- S14 : Time Reversal Invariance on neutron guide H142L
- S16 : Ternary Fission on inclined beam tube IH1
- S28 : On-Line Mass Separator for Thermally Ionized Fission Products (OSTIS) on neutron guide H23L
- S30 : Concentration Profiles by Neutron-Induced Particle Emission on neutron guide H25M.

In addition 6 short-term experiments have been set up on neutron guides.

### PN1 — MASS SEPARATOR LOHENGRIN FOR UNSLOWED FISSION PRODUCTS

(H. Schrader)

The very high demand for this instrument continued in 1976. During 70% of the scheduled reactor operating time 23 visitor experiments were carried out ; 7% of the time had to be used for instrument tests and 23% of the scheduled operating time was lost due to instrument failures or reactor shut-downs. Some 5-year-old instrument components, the Nicole on-line computer and the shortage of technicians for maintenance caused some problems. After a continuous running time of 2.5 years the Uranium sputtered from the targets onto the surrounding materials now causes a fission product background of 3%. Therefore special developments are now being tested to reduce this background. The tests will be continued in 1977. A new exit slit was constructed which offers more flexibility for experiments and corresponds better to the experimentally determined focal line.

Measurements were performed to determine fission yields by scanning, by registration of  $\gamma$ -lines with known absolute intensity and by the collision X-ray method.

In addition, a new technique for deducing yields by comparing  $\gamma$ -spectra from OSTIS and LOHENGRIN was tested. At OSTIS a  $\beta$ -decay chain has one definite starting point whereas at LOHENGRIN there are many starting points due to the nuclear charge distribution in fission. In nuclear spectroscopy on neutron rich fission products, major results have been obtained on  $\gamma$ -decay schemes,  $\beta$ -end point energies and delayed neutron emission probabilities of 15 nuclei.

#### PN2 – BETA SPECTROMETER BILL

(K. Schreckenbach)

During 1976 the beta spectrometer BILL was running continuously for 90% of the time without any major break-down. 17 nuclei have been investigated to provide information on the nuclear structure of these isotopes and on the atomic structure. For instance, the unparalleled resolution allowed the determination of neutron binding energies with a precision of  $10^{-5}$  (80 eV error on 8 MeV). The precision of the spectrometer was further increased by temperature stabilisation of the magnets, resulting in a better linearity above 2 MeV. The detectors are now mounted in such a way that they can be adjusted for optimum resolution without breaking the vacuum. A new air-tight target changing facility was constructed, which made it possible to use  $\alpha$ -active or toxic targets or materials that would otherwise be oxidised in contact with air. This improvement extends considerably the range of interesting targets to be studied with BILL.

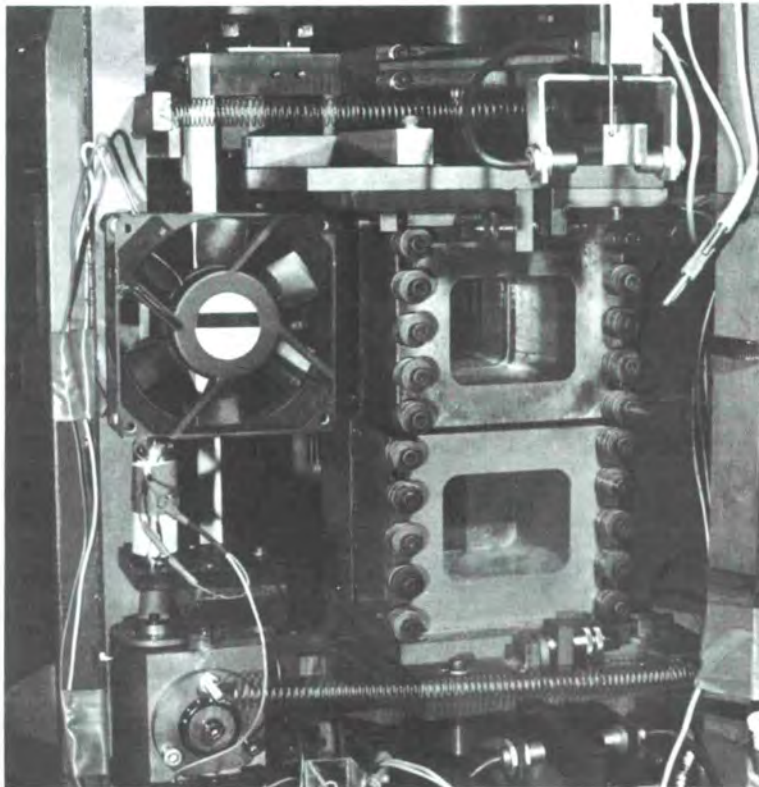
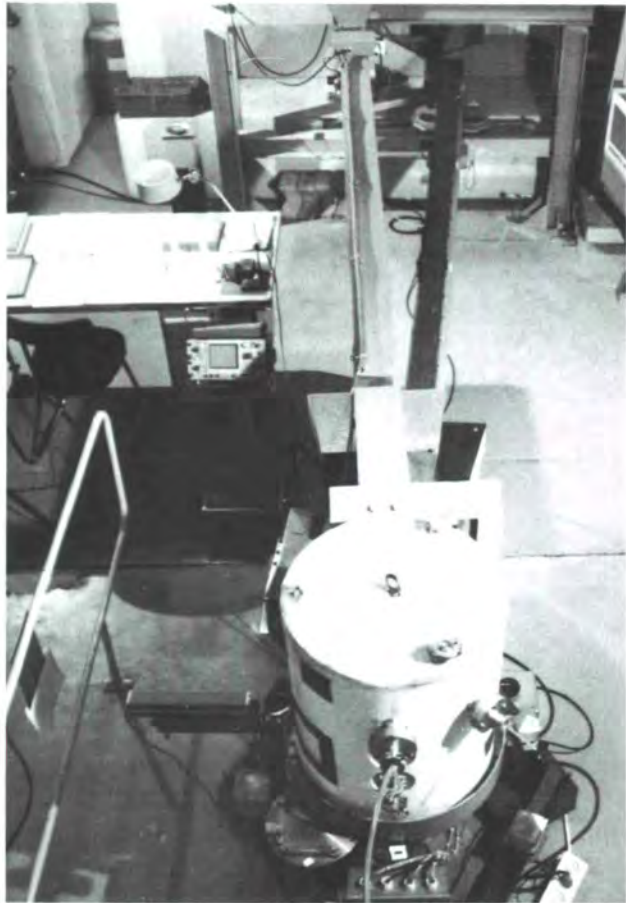
#### PN3 – CURVED CRYSTAL SPECTROMETERS GAMS 1 AND GAMS 2/3

(H. Börner, W.F. Davidson)

In 1976 the GAMS 1 spectrometer was operational 85% of the time. For the GAMS 2/3 spectrometers this figure is 15% lower due to a computer break-down. Spectra of  $\gamma$ -rays following neutron capture in 12 different targets were studied. On the technical front several improvements were made to the spectrometers and their associated data collection systems. The reliability of the data collection was greatly improved by assigning a separate PDP11/40 computer for control of the GAMS 2/3 spectrometers. At GAMS 1 automation systems for remote-controlled tilting of the main quartz crystal about the beam axis and for adjusting the control crystal onto the reference  $\gamma$ -beam have been developed and have reached the commissioning stage. At GAMS 2/3, in order to augment the transmission of lower energy  $\gamma$ -rays, an 8 m long evacuated tube has been installed.

A concomitant improvement in source techniques has led to the achievement of better line resolutions. For instance a line width of better than 0.7 sec of arc can be attained on the 24 m spectrometer. In fifth order of diffraction this corresponds to about 45 eV FWHM on the well known 411 keV  $\gamma$ -line in  $^{198}\text{Hg}$ . An interesting development is the growing interest in the study of transuranium and other actinide nucleides. Consequently modifications to the H6/H7 through-tube for the introduction of  $\alpha$ -emitting targets were carried out first of all in prototype fashion for a  $^{248}\text{Cm}$  target. More permanent modifications to enable the safe introduction of further  $\alpha$ -emitters are currently in progress.

View of the GAMS 2/3 curved-crystal spectrometers. The white cylindrical housing in the foreground contains the quartz crystals. The two arms in the background are the Soller collimators down which the diffracted rays pass.



Interior view of the cylindrical housing showing the two curved quartz crystals and their clamping blocks. They share a common vertical axis of rotation.

## PN4 – Ge ANTI-COMPTON AND PAIR SPECTROMETERS

(D. Warner)

The Ge pair-spectrometer was fully operational throughout 1976. However, the 10-year-old electronic system caused some problems, resulting in failure 15% of the time. Useful data have obtained with a resolution of 5 keV at 7.7 MeV. The data analysis software has been extended and improved considerably.

The operation of the Ge anti-Compton spectrometer was delayed by difficulties in manufacturing a suitable Ge-crystal. Now these problems have been solved with the advantage that the crystal supplied has a 50% higher efficiency and is of intrinsic rather than Li drifted Ge. The spectrometer should become operational by the end of 1976 with improved specification.

## PN5 – ULTRA-COLD NEUTRON SOURCE

(P. Ageron)

Construction and installation of the ultra-cold neutron source has progressed during 1976. The out-of-pile guides have been tested and the in-pile part is ready for mounting. The inclined beam tube IH3 made it necessary to build a platform of about 100 m<sup>2</sup> which is 5 m above the ground floor. This platform provides space for the shielding which is currently under installation, and for three measuring positions. The installation of the ultra-cold neutron source should be completed in March 1977. The expected neutron flux is about  $n/cm^2/sec$  for neutron velocities below 6 m/sec and 10000  $n/cm^2/sec$  in the velocity range between 10 and 20 m/sec.



Ultra-cold neutron source during construction

#### S1 – GAMMA ASYMMETRY SPECTROMETER

(B. Vignon)

The experimental set-up already described in the 1975 ILL annual report was fully operational and used without any significant modification.

#### S4 – MAGNETIC MOMENT OF THE NEUTRON

(W. Mampe)

The set-up to measure the electric dipole moment of the neutron has been transformed to allow a precision measurement of the magnetic dipole moment of the neutrons. A beam of slow neutrons ( $\approx 100$  m/sec) undergoes the same magnetic resonance as a beam of protons from a stream of flowing water. In this way the exactly known magnetic moment of the proton is directly compared to that of the neutron, increasing the precision of the latter by two orders of magnitude.

#### S14 – TIME REVERSAL INVARIANCE

(B. Vignon - Collaboration ISN Grenoble and Sussex University)

To look for a possible violation of T invariance in electromagnetic processes, a detector arrangement of six NaI crystals (3" x 3") was installed which can register 8 relevant angular correlations simultaneously. With a fast electronic system count rates of  $2 \times 10^5$ /sec (above a threshold of 200 keV) could be handled at a desired energy resolution of 10%. The performance of the set-up described and the electronic stabilisation permitted a statistical accuracy of  $3 \times 10^{-5}$  to be obtained in two months.

#### S28 – ON-LINE MASS SEPARATOR OSTIS FOR THERMALLY IONIZED FISSION PRODUCTS

(K.D. Wunsch)

In October and November 1975 OSTIS was installed successfully on neutron guide H23. Since the beginning of 1976 this mass separator worked in a very reliable way, fully benefiting from the high neutron flux. As a consequence there was a very high demand for this instrument. The separator beam was available 73% of the scheduled reactor operating time for 14 different proposals ; 7% of the time was used for instrument tests and modification. The remaining 20% were lost due to instrument failures or reactor shut-downs.

The separator, built by the University of Giessen, is equipped with a variety of detectors in a heavily shielded area. Devices for ion and  $\beta$ -counting are available. A Ge(Li) and an intrinsic Ge detector are connected to the instrument. This basic set-up allows yield and half-life determination,  $\gamma$ -ray spectroscopy,  $\beta$ -end point determination with very high precision, and an indirect measurement of delayed neutron emission to ground and excited states. A second Ge detector and four different neutron detectors have been provided by visitors to measure

$\gamma\text{-}\gamma$  coincidences, delayed neutron emission probabilities or the kinetic energy spectra of the delayed neutrons with three different methods. Important results have been obtained for nuclei far from stability.

During the annual shut-down, the first einzellens was replaced by a quadrupole doublet increasing the intensity of OSTIS by at least half an order of magnitude. Now extremely neutron-rich isotopes like  $^{98}\text{Rb}$  and  $^{147}\text{Cs}$  are also available for investigation in 1977.

The experimental set-ups of S10, S16 and S30, consisting mainly of the appropriate detectors in their reaction chambers with the necessary shielding and pumping, are not complex technical installations, and are therefore not described here in detail. For scientific results of these and of all other instruments mentioned above, see the section of College III in this volume and in the Annex to the Annual Report.

Co-ordinator : G. Siegert

# instrument group \\monochromators//

The group includes the following devices :

- D13A : Neutron double-crystal diffractometer on thermal guide H24
  - D13B : High precision neutron double-crystal diffractometer on H24
  - D13C : Neutron single crystal orientation unit on H23
  - LI2 : X-ray double crystal diffractometer
  - LI3 : Gamma-ray diffractometer
- Laboratory for crystal orientation and preparation.

## 1 – INSTRUMENT DEVELOPMENT

The mechanical tests of the high resolution diffractometer D13B being completed this instrument is now ready for installation on H24. The double-crystal orientation unit D13C is also prepared for installation on H23 in January 1977. As the other instruments of the group are working satisfactorily no major modifications have been performed in 1976. As also in earlier years many routine tests of the perfection of single crystals prepared for neutron monochromatization as well as for experiments scheduled on other ILL instruments were carried out in 1976.

## 2 – DEVELOPMENT OF MONOCHROMATOR MATERIALS

Whereas in the year 1975 monochromator crystals for thermal neutrons have been developed successfully (Cu, NbD), in this year we succeeded to improve considerably monochromator crystals for long wavelength neutrons (Ge, Si). The in-beam control of the mosaic spread of these crystals on the  $\gamma$ -diffractometer during their plastic deformation at high temperature made it possible to find out more rapidly the optimum deformation parameters i.e. temperature, pressure, orientation and dimension of the crystals and increased the reproducibility of the reflecting properties. It has now become possible to produce Ge and Si monochromators with a mosaic spread ranging from some minutes of arc to several degrees distributed in a homogeneous way. In addition the mosaic spread is highly anisotropic because of the special dislocation arrangement. Thus it is possible to vary the mosaic spread during an experiment by simply turning it about an axis normal to the reflecting planes. Fig. 7 shows the variation of the neutron (111) rocking curve width  $\beta$ , the mosaic spread  $\eta$  and the neutron peak reflectivity  $r$  as a function of this rotation (angle  $\phi$ ). Fig. 8 represents the rocking curves with minimum and maximum width using the same crystal of  $3 \times 3 \times 1 \text{ cm}^3$  (reflection geometry). The anisotropic mosaic spread also has a special advantage for vertical focusing where the vertical mosaic spread can be made several times smaller than the horizontal one.

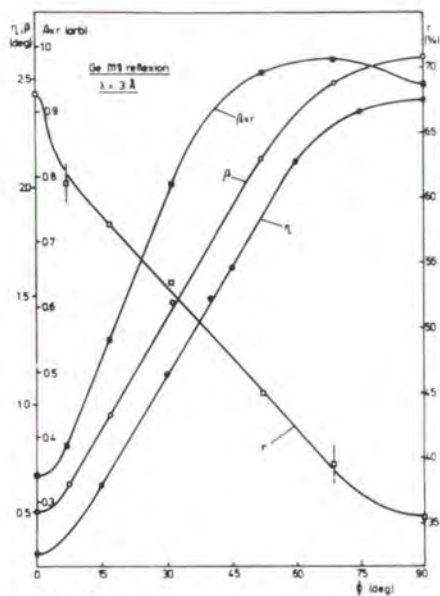


Fig. 8  
Variation of the neutron (111) rocking curve width  $\beta$ , the mosaic spread  $\eta$  and the neutron beam reflectivity  $r$  as a function of the rotating angle  $\phi$

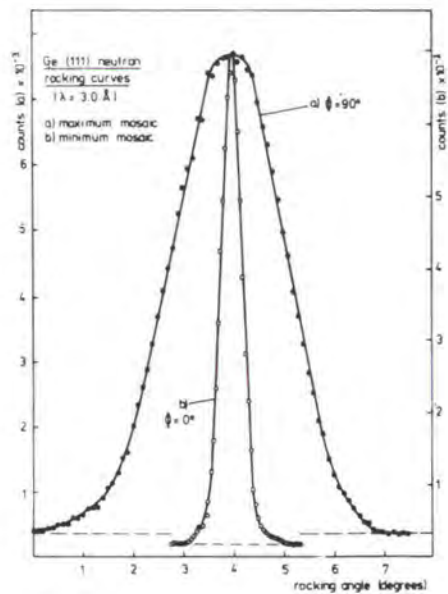


Fig. 9  
Rocking curves with minimum and maximum width using the same crystal of  $3 \times 3 \times 1 \text{ cm}^3$  (reflection geometry).

A new series of ten Cu-(Ge) crystals has been grown and tested, the best were used to improve the performance of the monochromatizing neutron lens for IN3. In collaboration with the Max-Planck-Institut in Stuttgart, Germany, the development of good-quality Beryllium single crystals has been started and first results are promising. These crystals will be of special use for high-energy neutron monochromators where improvements are still to be made.

### 3 – COMPOSITE SYSTEMS AND BENT CRYSTALS

Several vertically focusing composite monochromators have been produced such as 20 Cu lamellae glued in a well-oriented way in a frame for vertical focusing on D10 where the overall gain in flux at about the same resolution was about a factor 20 due to the improved reflectivity, the well-adjusted mosaic spread and the focusing effect. The vertically focusing system on IN3 yielded a factor 2.5 in flux. IN8 has been equipped with a device allowing the variation of the radius of vertical focusing. In order to increase still further the spatial homogeneity of the mosaic structure large monochromator crystals are now routinely composed of several smaller pieces.

### 4 – DIFFRACTION STUDIES OF IMPERFECT CRYSTALS

Neutron section topographs have proved to give valuable information on the large-scale defect structure of deformed and undeformed samples. This technique

permits a mapping of crystal inhomogeneities and is a complementary tool for studying defect structure in single crystals observed on an angular scale by rocking curve measurements. The help of Drs. Schlenker and Baruchel is gratefully acknowledged. Other investigations on the more microscopic defect structure of imperfect crystals have been started using electron microscopy and X-ray topography. This work is performed in collaboration with the University of Oxford and is especially concerned with the relation between the neutron diffraction properties and the defect structure of imperfect crystals. The investigation of the diffraction characteristics of curved Si crystals have been continued. In particular several reflectivity measurements have been performed and interpreted by a simple model previously developed. The neutron space condensation due to an asymmetrical cut (Fankuchen effect) was observed on curved crystals and a design of a focusing monochromator for D8 has been worked out.

Co-ordinator : A. Freund

# development of new techniques

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

- The progress of the construction of the UCN source (PN5) is described with the instruments for Nuclear Physics.
- The experimental set-up for VCN (very cold neutrons) selection has been used for :
  - the measurement of the gain of a liquid parahydrogen convertor : about 30 for neutrons  $10 \text{ m/s} < V < 50 \text{ m/s}$  compared to room temperature moderators.
  - the measurements of the transmission of VCN (velocity around 20 m/s) by different neutron guides : about 50% for a straight 6 m long, 6.7 cm diameter electropolished stainless steel guide, about 65% for a curved 6.8 m long, 7 x 7 cm section nickered glass guide.

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

Preliminary calculations with the 2 dimensions transport code DOT 3, using the method (M. Livolant and al. Cryogenics, February 1969) of two overlapping thermal groups (cold and room temperatures) indicate that a cavity, inside the present HFR cold neutron source, would enhance by a factor of 2 the cold neutron flux in the guide tube direction. More detailed spectrum calculations are in progress.

## 3. — POLARISATION OF NEUTRONS

### 3.1 — Supermirror Polariser (F. Mezei and P. Dagleish)

Multilayer thin-film optic techniques have been used to produce neutron mirrors with higher critical angles than are possible with conventional mirrors. Such "supermirrors" are formed from bilayers successively evaporated with an appropriate thickness gradient. The use of alternating magnetic and non-magnetic materials to form the bilayers permits such a mirror to be polarising.

The figure 10 shows results for two such supermirrors, both using Fe and Ag as the bilayer components. The polarising efficiency is better than 99%.

### 3.2 — Polarising Beam Bender (J.B. Hayter (I.L.L.) and J. Penfold, W.G. Williams (Rutherford Laboratory)).

The joint Rutherford Laboratory - I.L.L. project to build a polarising beam bender (ultra-compact multi-channel polarising guide) culminated in summer 1976 with the successful production of a prototype bender of cross-section  $5 \times 30 \text{ mm}^2$  and 180 mm length.

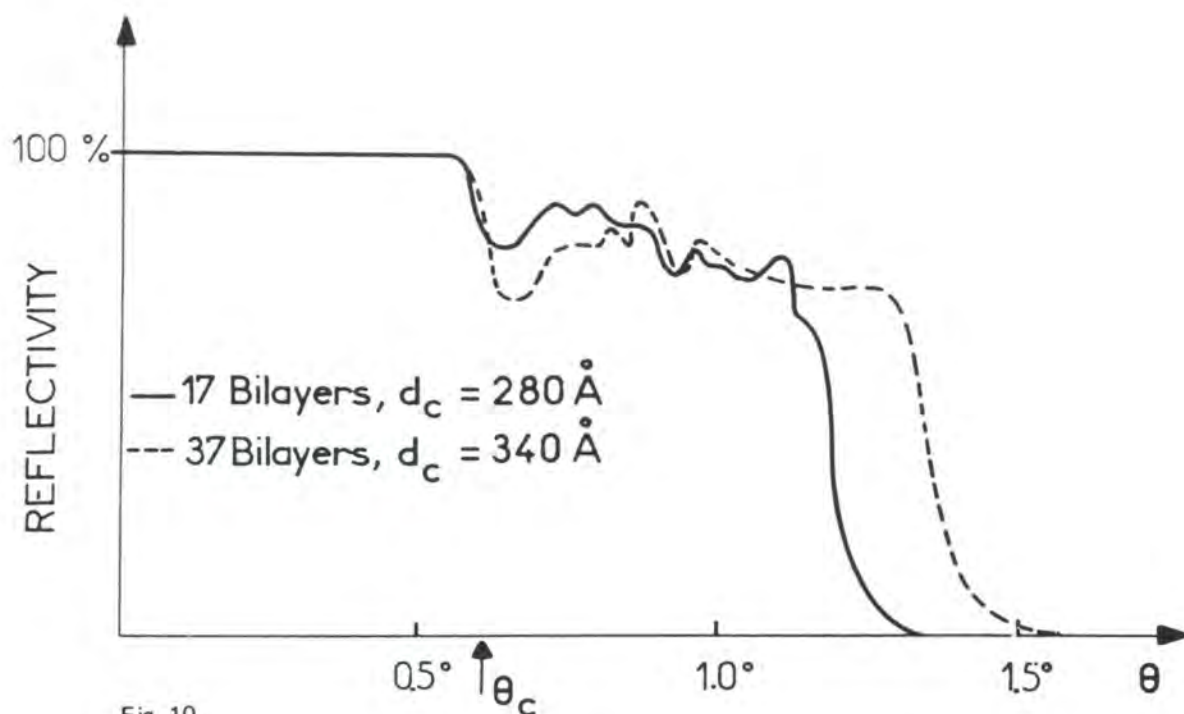


Fig. 10

Reflectivity versus incident angle for Fe-Ag supermirrors ( $\theta_c$  is the critical angle for a simple Ni mirror). The structure in the curves results from interference effects in the multilayer system.

Designed to operate above  $6 \text{ \AA}$ , the bender had a polarising efficiency  $> 95\%$  for a spectrum centred on  $7 \text{ \AA}$  and with  $\Delta\lambda/\lambda = \pm 20\%$ . Transmission was  $41\%$  for the (+) spin-state.

Construction of two benders (polariser and analyser) for IN11 is now almost complete. These will have cross-sections  $30 \times 50 \text{ mm}^2$  and  $40 \times 50 \text{ mm}^2$ , respectively. Both will be  $180 \text{ mm}$  long, with radius of curvature  $6500 \text{ mm}$ , giving a beam deflection of  $1.5^\circ$ .

# colleges

## introduction

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

The following is the current list of colleges :

- College 2** : Theory
- College 3** : Fundamental and Nuclear Physics
- College 4** : Excitations
- College 5** : Structures
- College 6** : Liquids, gases and amorphous materials
- College 7** : Impurities
- College 8** : Structural 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 1976 experimenters came to I.L.L. from these research centres or universities



## college 2

### «theory»

#### I - MEMBERS OF THE COLLEGE

Burkhardt T.W.	(From Oct. 1976)
Derrida B.	(From Oct. 1976)
Eisenriegler E.	(From Oct. 1976)
Fogedby H.C.	
Gautier F.	(From Oct. 1976)
Hinkelmann H.J.	
Iche G.	(To April 1976)
Loveluck J.M.	
Lovesey S.W.	
Nozières P.	
Schuck P.	(From May 1976)
Southern B.W.	
Trammel G.	(To July 1976)
Word R.	(To Aug. 1976)
Young P.	

#### II - VISITING SCIENTISTS

Balcar E.	(Atominstitut Vienna)
Beal-Monod M.T.	(Orsay)
Hubermann B.A.	(Xerox, Palo Alto)
Kagan Y.	(Moscow)
Lewis J.W.E.	(Rutherford Lab.)
Licciardello D.	(Birmingham Univ.)
Ring P.	(Munich Univ.)
Schofield P.	(Harwell)
Sherrington D.	(London Univ.)

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

#### III - SCIENTIFIC ACTIVITIES

The Theory College has experienced another year of flux in its membership, although, this year, primarily an influx, which has resulted in a situation which promises to be comparatively stable, at least for the next two years. However, some flexibility has been retained, in that two positions are occupied by one-year visitors on leave of absence : E. Eisenriegler, from Jülich, whose recent work has been concerned with one-dimensional conductors, in particular, aspects related to the electron-phonon interaction, and the possibility of incommensurate phase transitions ; and F. Gautier, from Strasbourg, who has worked extensively in the theory of alloys, in particular, magnetic alloys. In view of the difficulties experienced in attracting French and German theorists to spend longer periods at the ILL, it is intended to continue this practice of encouraging long-term visitors on leave of absence from their home institutions.

During the year, the Senior member of the Theory Group, P. Nozières, took up a chair at the University of Grenoble. Happily, he continues to spend a large fraction of his time at the ILL and to take a strong interest in the well-being of the Theory Group.

Besides the long-term visitors, mentioned above, there are a further three new members of the Theory College : B. Derrida, who will work with Nozières ; T.W. Burkhardt, whose field of interest is phase transitions and critical pheno-

mena ; and P. Schuck, the first nuclear theorist to join the College, but who should be joined by a second in a few months time.

Without being exhaustive, some of the major areas of interest of the Theory College can be summarized as follows :

- Phase transitions and critical phenomena are being studied by real-space renormalization group methods. The problems under investigation include the spin-glass problem (Southern and Young), other models which include the possibility of tricritical points and first-order phase transitions (Burkhardt), and the effect of surfaces and finite thickness on critical phenomena (Burkhardt and Eisenriegler). Renormalization group methods have also been applied, in recent work by Lovesey, to study departures from hydrodynamic behaviour in low-dimensional fluids : further work related to the theory of fluids is being done by Derrida, who is considering a model, of the Lorentz-attractor type, which describes some aspects of turbulence.
- In the field of many-body theory, one-dimensional conductors are continuing to receive attention by Hinkelmann, who has studied the optical properties of such systems, while Fogedby has applied the field-theoretic techniques, which he developed to study the dynamics of the one-dimensional electron gas to the Wolff model of an almost magnetic impurity in a non-magnetic host. Nozières has also continued his work on magnetic impurities, to consider more realistic models, including the possibility of orbital degeneracy.  
Work on many-body theory now includes the study of nuclear matter, by Schuck, who is also conversant with the application of such techniques in solid-state physics, providing our lone nuclear theorist with a desirable overlap with other members of the College.
- The study of the specifically many-body aspects of magnetic impurities is now supplemented by Gautier's much more wide-ranging interest in alloys, recent work including a study of thermodynamic properties of transition metal alloys, which is of relevance to neutron scattering experimentalists in this field, and to other experimental and theoretical work being done in Grenoble.
- The investigation of static and dynamic fluctuations in paramagnets and, in particular, the case of one-dimensional magnets, has continued (Loveluck and Lovesey) with a study of paramagnets in a magnetic field ; the theoretical study is being complemented by a computer simulation for Heisenberg magnets, and a projected experiment at the ILL adds further interest.
- A new interest is the study of superionic conductors (Hinkelmann and Hubermann) which has led to a collaboration in an experimental investigation (Hinkelmann and J.B. Suck).
- Nozières and collaborators have studied several topics which refuse the Procrustean bed of the above groupings : with Iche, the study of Brownian motion in the quantum regime was completed, culminating in the thesis of G. Iche ; various problems arising from previous work on chemical desorption were examined ; and a study of terrestrial magnetism has been commenced.

Finally, the group has greatly benefited from the visits, both long and short term, listed above. G. Trammel, spending his sabbatical year at the ILL, informed us, in several provocative seminars, of his rather fundamental work on subjects from gamma-ray lasers to the limits of microscopy ; D. Sherrington interacted with the work on spin glasses, and the visit of D. Licciardello prompted an on-going study of the application of rescaling methods to the electron localization problem : contributions to computer simulation studies on spin dynamics in one-dimensional magnets, and on short-wavelength collective modes on liquids, were made by E. Balcar and J. Lewis, while B.A. Hubermann stimulated work on superionic conductors, and P. Schofield continued work with Lovesey on density fluctuations in small particles.

Secretary : J.M. Loveluck

## college 3

### «fundamental and nuclear physics»

#### I - MEMBERS OF THE COLLEGE

Almeida J.	(I.S.N.)
Asghar M.	
Balestrini S.	(Giessen and California)
Berko S.	(Brandeis)
Blachot J.	(CENG)
Bocquet J.P.	(CENG)
Börner H.	(Jülich)
Braumandl F.	
Casten R.	(Brookhaven)
Cavaignac J.F.	(I.S.N.)
Charvet J.L.	(I.S.N.)
Crançon J.	(CENG)
Davidson W.F.	
Decker R.	(Giessen)
Diggory A.F.	
Do Huu Phuoc	(Lyon)
von Egidy T.	
Emsallem A.	(Lyon)
Greene J.	(Harvard)
Guet C.	
Hawerkamp K.	
Hetzelt M.	
Hungerford P.	
Jeenicke E.	(I.S.N.)
Jung G.	
Kaiser W.	
Koglin E.	
Larysz J.R.	
Mampe W.	
Monnard E.	(CENG)
Moussa A.	(CENG)
Namenson A.	(Washington)
Perrin P.E.J.	(CENG)
Pinston J.A.	
Ribon P.	(Saclay)
Ristori C.	(CENG)
Robson J.	(McGill)
Roussille R.	
Scharman P.	(Sussex)
Schrader H.	
Schreckenbach K.	
Schussler F.	(CENG)

Schuck P.	
Sellam R.	(Grenoble)
Siegert G.	
Vignon B.	(I.S.N.)
Warner D.	
Wünsch K.D.	(Giessen)

#### II - VISITING SCIENTISTS

Alexeev V.	(Leningrad)
Andersson G.	(CERN)
Armbruster P.	(GSI Darmstadt)
Clark D.D.	(Cornell)
Clerc H.G.	(Darmstadt)
Crawford G.I.	(Glasgow)
Denschlag H.O.	(Mainz)
Forte M.	(ISPRA)
Gelletly W.	(Manchester)
Hamilton W.D.	(Sussex)
Hoff R.W.	(Livermore)
Kienle P.	(Munich)
Klein T.	(Melbourne)
Kratz K.L.	(Mainz)
Leroux B.	(Bordeaux)
Löbner K.E.G.	(Munich)
Miller P.	(Oak Ridge)
Nifenecker H.	(Saclay)
Pendlebury J.	(Sussex)
Prokofjev P.	(Riga)
Ramsay N.	(Harvard)
Sheline R.K.	(Florida)
Signarbieux C.	(Saclay)
Sistemich K.	(Jülich)
Smith K.	(Sussex)
Smither R.K.	(Argonne)
Van Assche P.	(Mol)
Wilson R.	(Harvard)
Wollnik H.	(Giessen)
Yoccoz J.	(Paris)

### III - SCIENTIFIC ACTIVITY

Altogether 93 experiments were done in 1976, on Lohengrin (23), BILL (17), GAMS 1, 2, 3 plus Anti-Compton and Pair spectrometers (12), OSTIS isotope separator (14) and external beams (15).

#### A - EXPERIMENTS PERFORMED WITH EXTERNAL TARGETS

1. The experiment on alpha-particle accompanied fission of  $^{236}\text{U}$  was completed. The post-neutron fragment mass was determined from single fragment energy and time-of-flight measurements. About  $10^5$  correlated events were collected. Good fragment mass resolution and precise  $\alpha$ -particle angular distribution were achieved (ILL, CEN-Grenoble, Saclay, Bordeaux).
2. The fragment energy correlations for the odd-even  $^{237}\text{Np}$  thermal neutron induced sub-barrier fission have been measured with 2 surface barrier silicon detectors. The aim is to compare the fragment mass distribution of an odd-odd fissioning system ( $^{238}\text{Np}$ ) - not measured up to now - with the well known mass distributions of even-even fissioning systems such as  $^{236}\text{U}$ . About  $1.2 \times 10^5$  correlated events were recorded. Data are being analysed at present (ILL, CEN-Grenoble, Gent, Mol).
3. The work done on the OSTIS isotope separator was as follows : the delayed neutron emission probability ( $P_n$ ) values were determined for  $^{94-96}\text{Rb}$  and  $^{143-145}\text{Cs}$  isotopes from simultaneous neutron and beta measurements. High quality delayed neutron energy spectra for the  $^{93-97}\text{Rb}$  isotopes were measured with  $^3\text{He}$  ionization chambers. The BNG mode, where the delayed neutron following  $\beta$ -decay feeds different excited states of the final nucleus, was studied directly using a coincidence technique ; the partial probabilities of neutrons going to the different excited states of the final nucleus were obtained for the  $^{93-96}\text{Rb}$  isotopes. High precision ( $\geq 6$  keV)  $Q_\beta$  - values of the  $^{88,89,90,92,93}\text{Rb}$  isotopes were obtained with an intrinsic germanium detector.  
The level schemes of  $^{143}\text{La}$  and  $^{143}\text{Ba}$  were established from  $\gamma$ -ray spectra and  $\gamma$ - $\gamma$  coincidence work. Furthermore, neutron, beta and  $\gamma$ -ray measurements helped to determine with a good precision the half-lives of the different accessible Rb and Cs isotopes (Giessen, ILL, CEN-Grenoble, Mainz, Glasgow, Orsay, Los Alamos).
4. The population and the decay of the 116 ns half-life shape isomer in  $^{236}\text{U}$  following the thermal neutron capture by  $^{235}\text{U}$  was studied with a Ge(Li) diode and an inner shell vacancy (ISV) detector. The ISV detector helps to separate the fission events from those when there is no fission. The data analysis is not complete yet. (Cornell, Munich, ILL, ISPRA).
5. The charged particle reactions such as  $(n, \alpha)$  and  $(n, p)$  induced by thermal neutrons, have been carried out on targets of  $^{129}\text{Xe}$ ,  $^{77}\text{Se}$ ,  $^{155}\text{Gd}$ ,  $^{167}\text{Er}$ ,

$^{177}\text{Hf}$ ,  $^{58}\text{Ni}$ ,  $^{59}\text{Ni}$ ,  $^{61}\text{Ni}$ ,  $^{209}\text{Bi}$ ,  $^{132}\text{Cs}$ ,  $^{125}\text{Xe}$  and  $^{127}\text{Xe}$ . The last three neutron deficient nuclides were produced at the ISOLDE facility at CERN. Moreover, thermal neutron induced fission cross sections of  $^{232}\text{Th}$ ,  $^{231}\text{Pa}$  and  $^{237}\text{Np}$ , and the ternary fission to binary fission ratio (LRA/B) values were obtained for  $^{231}\text{Pa}$  and  $^{237}\text{Np}$ . (ILL, Lyon, CERN, Gent, Mol, Gothenburg).

6. The neutron binding energy of  $4025.2 \pm 0.6$  keV for  $^{137}\text{Xe}$  was determined using the  $^{136}\text{Xe}(n, \gamma)^{137}\text{Xe}$  reaction. The target was Xe gas enriched to 91.2% in  $^{136}\text{Xe}$  (Studsvik, ILL).
7. A measurement of the asymmetry in the radiative neutron-proton capture has been performed using polarized cold neutrons on a parahydrogen target. The result,  $A_\gamma = (0.6 \pm 2.1) \times 10^{-7}$ , is in agreement with values predicted by various theories of the weak interaction. (Harvard, I.S.N.).
8. The magnetic moment of the neutron is being measured using the split coil technique. Although the measurement is not yet finished with all the necessary checks, the data obtained up to now give hope for an improvement of the precision of the previous value by a factor of  $\approx 100$ . (Harvard, ILL, Sussex, Oak Ridge, CEN-Grenoble).
9. The Fresnel diffraction of neutrons of wave-length  $\lambda = 4.33$  Å produced by single domain walls in a ferromagnetic foil was observed. This verified the spinor nature of the rotation of fermions (neutrons) by showing that an odd number of  $2\pi$  rotations leads to a minus sign in the amplitude of the wave function. (Melbourne, ILL).
10. The work to determine the concentration profiles by  $(n, \alpha)$  - and  $(n, p)$  - reactions has been continued. Absolute  $^6\text{Li}/\text{cm}^2$  and  $^{10}\text{B}/\text{cm}^2$  concentrations were determined (Munich, Berlin).

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

1. The isotopes studied with the  $(n, e)$ -reaction with the beta spectrometer BILL were  $^{56}\text{Mn}$ ,  $^{80,82}\text{Br}$ ,  $^{114}\text{Cd}$ ,  $^{115}\text{In}$ ,  $^{122,124}\text{Sb}$ ,  $^{147}\text{Nd}$ ,  $^{155}\text{Sm}$ ,  $^{168}\text{Er}$ ,  $^{162,164}\text{Dy}$ ,  $^{174}\text{Yb}$ ,  $^{190}\text{Os}$ ,  $^{196}\text{Pt}$ ,  $^{200}\text{Hg}$ ,  $^{198}\text{Au}$ , and  $^{249}\text{Cm}$ . The Q-values after neutron capture in  $^{114}\text{Cd}$  and  $^{200}\text{Hg}$  will be determined to an accuracy of about 60 eV. In the case of  $^{147}\text{Nd}$ , precise values of multipole mixing ratio  $M_1/E_2$  have been obtained for transitions up to 100 keV. The  $\beta$ ,  $\gamma$  and octopole vibrational states were identified in  $^{239}\text{U}$ . (ILL, Argonne, Brookhaven, Leningrad, Livermore, Lyon, Manchester, Washington).
2. Nuclides studied with the  $(n, \gamma)$  reaction with GAMS 1, GAMS 2/3, Anti-Compton and Pair spectrometers were  $^{44}\text{Ca}$ ,  $^{80,82}\text{Br}$ ,  $^{155}\text{Sm}$ ,  $^{122,124}\text{Sb}$ ,  $^{168}\text{Er}$ ,  $^{162,164}\text{Dy}$ ,  $^{174}\text{Yb}$ ,  $^{191,193}\text{Os}$ ,  $^{196}\text{Pt}$ ,  $^{235}\text{U}$  and  $^{249}\text{Cm}$ . In the case of  $^{44}\text{Ca}$  about 70  $\gamma$ -ray transitions were observed below 1.5 MeV. Moreover, the various types of data led to a level scheme of  $^{80}\text{Br}$  with 55 levels up to an excitation energy of 1.5 MeV and to a level scheme of  $^{82}\text{Br}$  with 37

levels up to 1.3 MeV. A comparison between the 411.8 KeV  $\gamma$ -ray in  $^{198}\text{Hg}$  and the 511 keV annihilation line gave the energy of the  $^{198}\text{Hg}$   $\gamma$ -ray as  $411.805 \pm 0.005$  keV. The  $^{249}\text{Cm}$   $K_{\alpha}$  x-ray energies were determined to be  $K_{\alpha 1} = 109.271 + 0.005$  keV and  $K_{\alpha 2} = 104.583 \pm 0.005$  keV. (Preliminary value). (ILL, Argonne, Belgrade, Brookhaven, ISN, Jülich, Leningrad, Livermore, Lyon, Manchester, Mol, Washington).

3. The mass separated fission products from Lohengrin were used in different ways to study nuclear spectroscopy of neutron rich nuclei and to get information on the fission process itself. Decay schemes from  $\gamma$ -ray and  $\gamma$ - $\gamma$  coincidence data were constructed for  $^{131}\text{Sn}$ ,  $^{136}\text{Te}$ ,  $^{145}\text{Ce}$ ,  $^{145}\text{La}$ ,  $^{145}\text{Ba}$ . The  $Q_{\beta}$ -values for 19 nuclides with an accuracy of  $\geq 100$  keV were determined from the  $\beta$ - $\gamma$  coincidence work. The  $\gamma$ -rays in the final nuclei reached by delayed neutrons were studied for mass chains 85, 94 and 135 with a Ge(Li) detector. The delayed neutron work on other mass chains was continued. The Z-yields as a function of fragment kinetic energy of mass chains 133 and 134 were studied by measurement of  $\gamma$ -rays. The work on mass yields, and Z-yields in the light fragment group of  $^{235}\text{U}$  thermal neutron fission with several direct methods was continued.

The energy loss of fragments in different gases was studied with different ionization chambers. A large ionization defect in the specific ionization was observed with argon gas in the chamber. A few experiments to test different experimental techniques were carried out on the separator, as for instance the collision X-rays for the identification of the nuclear charge in the heavy fission fragment group. (ILL, Brunswick, CENG, Darmstadt, Dublin, Giessen, Glasgow, Ispra, Jülich, Mainz, Saclay).

Secretary : M. Asghar

## college 4 «excitations»

### I - MEMBERS OF THE COLLEGE

Castets A.	(CNRS)
Coey J.	(CNRS)
Copley J.R.D.	
Currat R.	
Dorner B.	
Escribe C.	
Fitzgerald W.	
Fogedby H.	
Ghosh R.	
Jenkin G.	
Lechner R.E.	
Loveluck J.	
Lovesey S.W.	
Parisot G.	
Pynn R.	
Rossat-Mignod M.	(CENG)
Scherm R.	
Southern B.	

Stirling W.G.	
Suck J.B.	
Villain J.	(CENG)
Wagner V.	
Young P.	
Ziebeck K.	

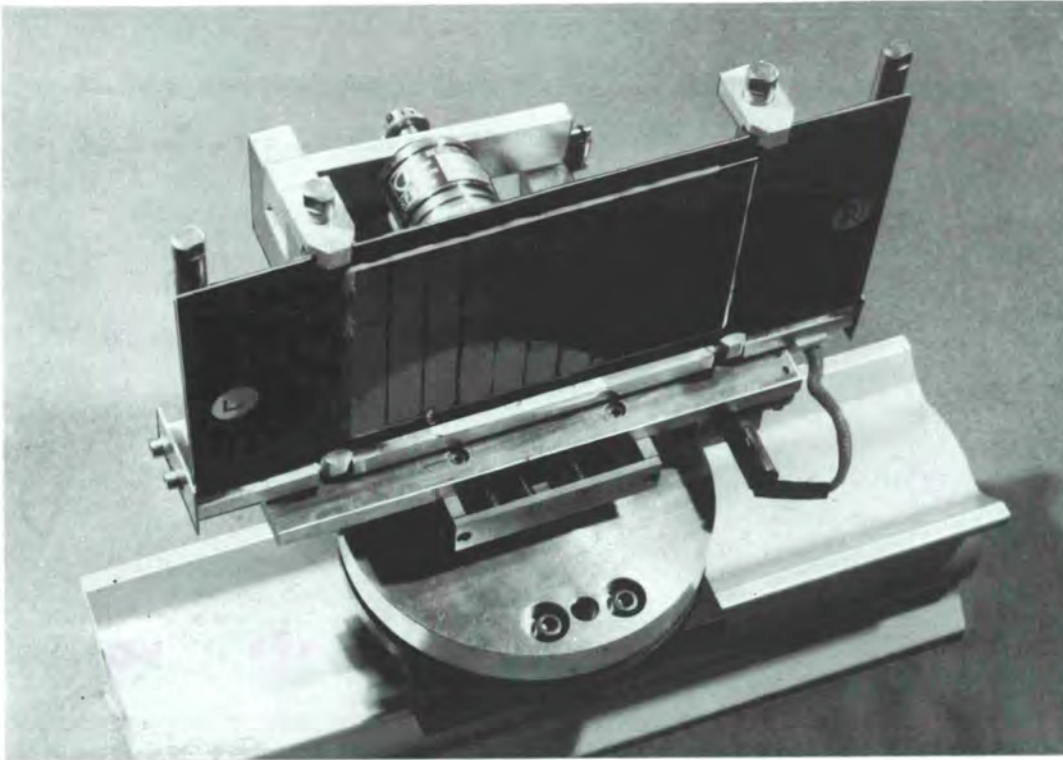
### II - VISITING SCIENTISTS

Axe J.D.	(BNL)
Eisenriegler E.	(KFA)
Grimm H.	(KFA)
Holden T.M.	(CRNL)
Joffrin C.	(Léon Brillouin)
Koehler W.C.	(ORNL)
Lowde R.D.	(AERE)
Nicklrow R.	(ORNL)
Paul G.	(U. New South Wales)
Woods A.D.B.	(CRNL)

### III - SCIENTIFIC ACTIVITIES

Although the scientific work of College 4 involves use of a wide range of instruments including the time-of-flight spectrometers IN4 and IN5 and the back-scattering spectrometer IN10, it is certainly the case that the study at I.L.L. of elementary excitations in condensed matter is centred on the group of triple axis crystal spectrometers (T.A.S.). Of these instruments, IN1, IN2 and IN8 operated in a reasonably reliable manner during 1976, while IN3 was largely rebuilt and now operates most satisfactorily. The existence of the high-flux machine IN8 has allowed many studies hitherto impossible or at best extremely difficult. Unfortunately, the "CARINE" computer-control system continues to give problems and leads to considerable losses of instrument time. The new cold-source instrument, IN12, is under construction and first tests are planned for the summer of 1977.

In March and October of 1976, the members of Subcommittee 4 - "Excitations" - considered a total of 98 proposals ; this represents an increase of 40% over the figure for 1975. Of this total, the Subcommittee allocated instrument time to



Variable curvature monochromator for IN3

67 proposals, 32 of which were in the category "phonon dispersion and lattice dynamics" (04-01), 15 in "anharmonic effects and phase transitions" (04-02), and 20 in "magnetic excitations" (04-03). The largest increase compared with the year 1975 is in the first of these categories. Table VIa lists by category the numbers of proposals submitted and accepted.

Table VIa

Number of proposals submitted to the meetings of the Subcommittee "Excitations" in 1976.

Category	March		October	
	Submitted	Accepted	Submitted	Accepted
04-01	28	19	20	13
04-02	11	8	8	7
04-03	15	8	16	12

Table VIb

Instruments used for experiments in the College "Excitations" (September 1975 - September 1976).

Instrument	IN1	IN2	IN3	IN4	IN5	IN8	IN10	D5	D7	D10
N <sup>o</sup> of experimental periods	10	21	12	10	4	24	3	1	1	1

During the past year, approximately 60 distinct College 4 experiments have been performed, many of which used several periods on one or more instruments. Table VIb gives a breakdown of these experimental periods by instrument. As mentioned above, it is obvious that College 4 experiments make particular use of triple axis instruments, and that the newest spectrometer, IN8, has moved rapidly to a prominent position.



Transferring liquid helium to the cryostat on IN8

With such a large number of experiments it is obviously impossible to discuss each one individually and so, as in previous reports, we have chosen several examples to illustrate the type of work at present being performed.

The study of "conventional" phonon dispersion curves continues to be of interest. Measurements have been completed of the dispersion curves of the molecular crystal urea<sup>1</sup> and detailed model calculations have been performed. Acoustic modes have been observed in both crystalline and smectic phases of the liquid crystal TBBA<sup>2</sup>, while several groups have worked on quasi-two-dimensional materials such as HgI<sub>2</sub><sup>3</sup>, TaS<sub>2</sub><sup>4</sup> and NaOD<sup>5</sup>.

There has been increasing interest in the effects of electron-phonon interactions, exemplified by an elegant experiment on polysulphur nitride (SN)<sub>x</sub><sup>6</sup> in which a sample composed of 12 tiny aligned single-crystals was used to study an anomaly in a longitudinal phonon branch ; it is probable that this difficult experiment would have been impossible on any ILL T.A.S. other than IN8. Similarly a Kohn anomaly and non-commensurate superlattice has been observed in the layer compound TaS<sub>2</sub><sup>4</sup>. The [001] and [100] phonon dispersion curves are shown in Figure 11. Again, IN8 was used, this time with 7 oriented crystals of total volume < 0.01 cm<sup>3</sup>.

As in past years, many proposals were concerned with the dynamics of structural phase transitions. The now more-or-less standard "central peak" has been observed near the phase transition in the improper ferroelectric RbH<sub>3</sub>(SeO<sub>3</sub>)<sub>2</sub><sup>7</sup>, as well as a Brillouin zone-boundary soft-mode. A study has been started of the dynamics of the second-order ferroelectric phase transition which occurs in the material K(TaNb)O<sub>3</sub><sup>8</sup> ; as well as a central peak and damped optic mode there is evidence of an acoustic-optic mode interference. Other work involving the study of anharmonic effects has been that on mode Grüneisen parameters in Potassium<sup>9</sup>, involving accurate frequency-shift determinations at pressures up to 4 kbar. The pressure dependence of zone boundary phonons in Selenium<sup>10</sup> has been used to improve the understanding of the nature of bonding in such semimetallic crystals. The time-of-flight spectrometers IN4 and IN5 were used by several groups to make phonon density-of-states measurements or to study quasielastic broadening effects. For dhcp Lanthanum<sup>11</sup> the phonon density of states has been determined at 4.2 K and room temperature ; using this data in conjunction with tunneling results, information can be obtained on the frequency dependence of the electron-phonon coupling in such superconductors. As part of an investigation on "fast-ion" conductors using several instruments<sup>12</sup>, the quasielastic scattering from PbF<sub>2</sub> and SrCl<sub>2</sub> has been investigated on IN5 ; in the latter compound there are indications of a broadening, attributable to cation diffusion.

Turning now to studies of magnetic materials, we find that the T.A.S. on the hot-source, IN1, still offers an almost unique tool for the study of high energy

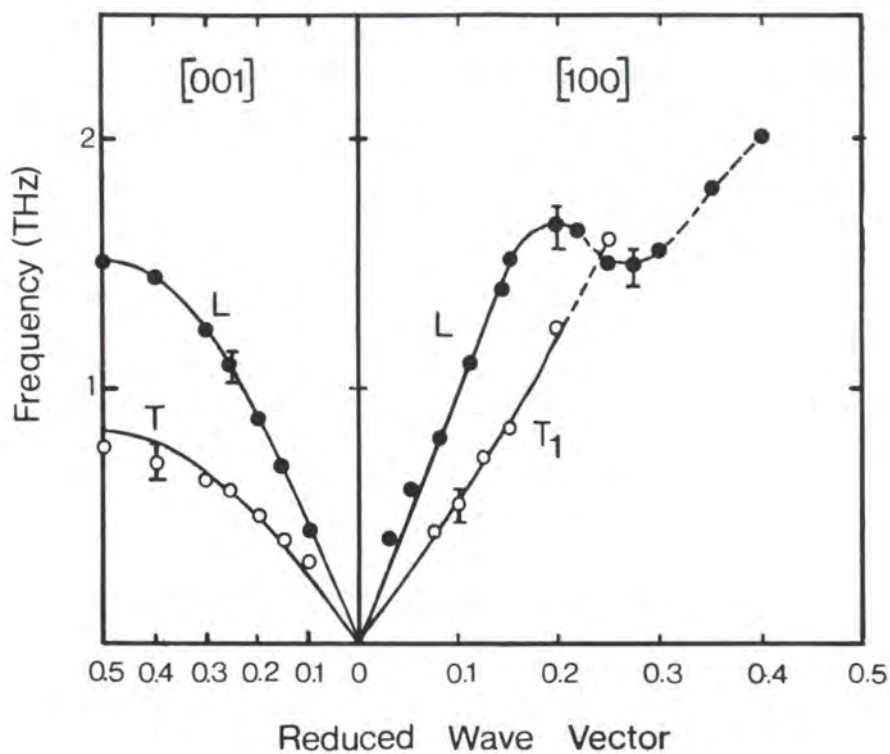


Fig. 11  
 Room temperature acoustic phonon dispersion curves of  $\text{IT}_2 - \text{TaS}_2$ . The phonon anomaly in the  $[100]$  L branch has the same wave-vector component as the non-commensurate distorted lattice (Instrument : IN8/IN2).

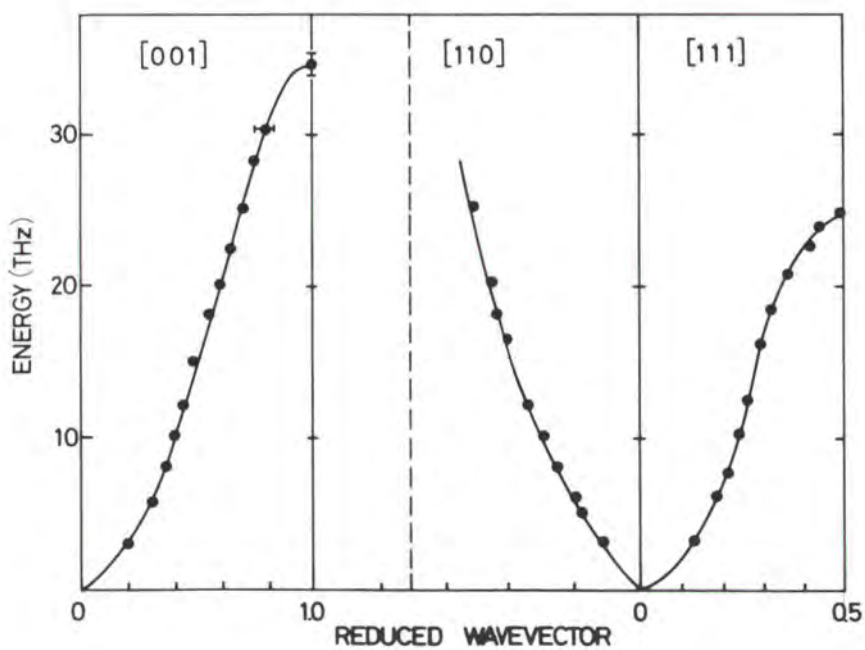


Fig. 12  
 Room temperature spin-wave dispersion curves of  $\text{Fe}_3\text{Si}$ . (Instrument : IN1).

magnetic excitations. For example, the room temperature, spin-wave spectrum of the ferromagnetic, intermetallic material  $\text{Fe}_3\text{Si}$ <sup>13</sup> has been measured out to the zone boundaries - see Fig. 12 - where the excitations have an energy of about 30 THz ( $\sim 124$  meV). The exchange interactions can thus be determined for this substance which has different moments on the different iron sites. Another experiment necessitating relatively high energy transfers was that on longitudinal excitons in antiferromagnetic  $\text{KCoF}_3$ <sup>14</sup>. Reasonably good energy resolution was needed for this experiment as, at a general wavevector, up to 4 distinct peaks were visible between 4 and 14 THz, i.e. a phonon and three exciton branches.

Use was made of the other T.A.S. instruments for many other magnetic experiments. For example, by application of a uniaxial stress of 500 bar, a monodomain sample of  $\text{CoO}$ <sup>15</sup> was obtained, thus allowing the first observation of well-defined magnetic excitations in this antiferromagnet. Previous work on a multi-domain sample produced only extremely broad neutron groups. Another antiferromagnetic material recently investigated is  $\text{CoCl}_2$ <sup>16</sup> where there are 2 low energy excitations arising from the splitting of the degenerate antiferromagnetic modes by the anisotropic crystal field.

A technically novel experiment on a very similar system is the study of magnon-phonon hybridisation in  $\text{FeCl}_2$ <sup>17</sup> using polarisation analysis. For this experiment the IN8 T.A.S. was equipped with a Heusler alloy analysing crystal, magnets and guide fields, so that a separation of "spin-flip" and "non-spin-flip" scattering could be made. Another inelastic scattering experiment involving polarized neutrons was part of the study of  $\text{Pd}_3\text{Fe}$ <sup>18</sup> carried out using the D5 spectrometer. In this case, a polarized incident beam and conventional (Cu) analyser were used to separate magnon and phonon contributions to the observed inelastic scattering. The above two experiments may lead to a wider use of polarized neutrons in inelastic scattering investigations at I.L.L.

It would be inappropriate to close this report without extending the thanks of College 4 members to S.W. Lovesey who retired from the position of College Secretary in April after 2 years of extremely efficient service to the College.

Secretary : W.G. Stirling

## EXPERIMENTS CITED ABOVE

1. 04-01-013A : Lefebvre, Fouret, Currat
2. 04-02-018A : Doucet, Levelut, Lambert, Porquet, Dorner
3. 04-01-040 : Prevot, Bellmann, Dorner
4. 04-01-078 : Ziebeck, Dorner, Stirling, Schöllhorn
5. 04-01-006 : Bleif, Dachs, Grimm
6. 04-01-067A : Pintschovius, Currat
7. 04-03-029 : Grimm, Fitzgerald, Stiller
8. 04-02-030A : Courdille, Joffrin, Ziolkiewicz, Currat
9. 04-02-015 : Meyer, Dolling, Scherm, Paureau, Vettier, Kalus
10. 04-02-016C : Teuchert, Meyer, Wendel
11. 04-01-021 : Nücker, Suck
12. 04-01-055 : Dickens, Lechner
- 04-03-020R : Dickens, Hayes, Hutchings, Ghosh
13. 04.04.052 : Forsyth, Ziebeck
14. 04-03-030 : Parisot, Satya-Murthy
15. 04-04-040R : Wagner, Geick, Ronzaud
16. 04-03-035 : Escribe, Ziebeck
17. 04-03-034 : Ziebeck, Escribe
18. 04-03-035 : Holden, Smith, Cowley, Stirling

## college 5 «structures»

### I - MEMBERS OF THE COLLEGE

Aldebert P.  
Bartunik H.D.      T.U. Munchen  
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Burger N.  
Cheel V.  
Convert P.  
Croset B.  
Feld R.  
Filhol A.  
Fitzgerald W.  
Freund A.  
Givord D.  
Gregory A.  
Hermann-Ronzaud D.  
Hewat A.W.  
Hohlwein D.  
Jenkin G.  
Klar B.  
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Nunes A.C.

Overs T.  
Parisot G.  
Radhakrishna  
Riekkel C.  
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Soubeyroux J.L.  
Tasset F.  
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Thorel P.  
Timmins P.  
Wilson S.A.  
Wolfers P.  
Wright A.  
Zeyen C.  
Ziebeck K.

### II - VISITING SCIENTISTS

Cooper Malcolm J.      Univ. of Warwick  
Lander G.      Argonne  
Fuess H.      Univ. of Frankfurt  
Schneider J.R.      H.M.I. Berlin

### III - SCIENTIFIC ACTIVITIES

During 1976, the four-circle Mark VI diffractometer D15 became available for scheduling, and has substantially reduced the load on D2, D8 and D10. Development of D6, the multi-counter diffractometer ("hedgehog") using the modified Laue method, and of D14, the television camera scintillation detector, was halted for lack of resources. However, the first complete structure determination has been reported from D12, the photographic neutron diffraction apparatus, and recently a He cryostat has been fitted to much extend the range of materials studied on this apparatus. As well, planning has begun for D19, a new area detector system which will serve a wide range of users from those interested in kinetics of solid state reactions to those studying protein structure. Experiments are now beginning on the neutron interferometer D18, where it is possible for example to measure scattering lengths or study neutron waves in magnetic fields. The scheduled instrument group now includes three powder diffractometers, two polarized neutron diffractometers, three single-crystal diffractometers, D12 and the quasi-elastic scattering 4-circle diffractometer D10. Each of these has

unique properties, and taken together with the special instruments S20 and S21, and LI2 and LI3 (the  $\gamma$ -diffractometer) referred to elsewhere, constitute a powerful tool for research using diffraction techniques. For its successful functioning, the ILL will continue to depend on close cooperation with users as is well illustrated by the study on D10 of the phase diagram of  $\text{CsMnCl}_3\cdot 2\text{D}_2\text{O}$  in skew magnetic fields using a superconducting magnet and a cold Eulerian cradle. Below we summarize some other recent results.

High-resolution neutron powder diffractometry has much enlarged the range of substances whose structural phase transitions may be followed. Work has been possible on the influence of pressure on ferroelectric  $\text{KH}_2\text{PO}_4$ , the structure of uranium and its oxides at high temperature, and the structure of naphthalene at 25 kbar. Hydrogen bromide, methanol and ammonia have been examined at low temperature. Work on resorcinol shows that it is now possible to refine meaningfully as many as 140 structural parameters from a neutron powder pattern. The linear multidetector D1B remains uniquely versatile. Suspected phase transitions may be verified in a matter of hours or even minutes, and the courses of solid-state reactions are now routinely followed by recording changes in the diffraction pattern of the system. Further, new results are being obtained in studies of the diffraction from mono- and bilayers on surfaces e.g. Kr/graphite or Ar/ $\text{MnI}_2$ . Detailed studies of magnetic structure continue : thus  $\text{FeU}_2\text{S}_5$  orders antiferromagnetically at about 250 K, the uranium atoms having a small ferromagnetic component. Below 30 K, the uranium orders progressively and modifies the magnetic moments of the iron atoms. On D1B also, several phase transitions of rare-earth oxides have been followed in the temperature range 1800 to 2500°C.

Several studies bearing on extinction in single crystals have been completed. Work on yttrium iron garnet has shown that by measuring flipping ratios it is possible to scale directly structure amplitudes measured at different wavelengths. This promises to be a powerful technique for the future. In another study, plastically-deformed single crystals of Cu were examined on the  $\gamma$ -diffractometer and also with short-wavelength neutrons. A "peanut-shell" shaped mosaic distribution accounts successfully for both the  $\gamma$  and neutron results whereas a conventional ellipsoidal model does not. Hot neutrons were also indispensable for the location of interstitial F atoms in several disordered phases of  $\text{YF}_3$  enriched  $\text{NaYF}_4$ . The electron density in the short symmetrical hydrogen bond in sodium hydrogen acetate was studied at 90 K by combination of accurate X-ray and neutron diffraction data. The effect of neglect of T.D.S. in such work is now being investigated.

Much work on phase transitions has been completed, including correlation of the structure of the improper ferroelectric  $\text{RbH}_3(\text{SeO}_3)_2$  with the dynamic properties of the crystal ; and very precise measurements in the critical temperature region for several ferroelectrics using the S21 instrument. The high flux, low background,

and high resolution of D10, operating in the 3-axis mode, made possible the first neutron observation of Huang scattering in neutron-irradiated MgO and  $\gamma$ -irradiated  $^6\text{LiF}$ .

Polarized neutron diffraction continues to provide new results. A study on D3 of the magnetization density in partially ordered  $\text{Au}_4\text{V}$  shows that the moment is confined to the vanadium sites and hence confirms that vanadium atoms in contact do not have a moment. Experiments on  $\text{CoF}_2$  show that a single  $180^\circ$ -domain antiferromagnetic crystal can be produced under the combined action of pressure and magnetic field. Thus the magnetization distribution of both the magnetoelastic moment and the covalent moment can be determined. An experiment on  $\text{SmCo}_5$  has shown the feasibilities of studying natural samples (not isotopically depleted) containing Cd, Gd, Sm, etc. by using wavelengths below  $0.5 \text{ \AA}$  on D5. The spin density of the N-O free radical in a single crystal of tanol suberate, the first known purely organic ferromagnet, has been studied. In conclusion we mention the study of the scattering of polarized neutrons from dynamically polarized protons in hydrated lanthanum magnesium nitrate. It has been shown conclusively that the polarization within the sample is inhomogeneous, possibly due to temperature or microwave field gradients in the crystal.

Secretary : S.A. Mason

## college 6

### «liquids,gases and amorphous materials»

#### I - MEMBERS OF THE COLLEGE

Besnard M.  
Bellissent M.C.  
Blétry J.H.  
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Chieux P.  
Copley J.  
Dianoux A.J.  
Heidemann A.  
Higgins J.  
Hilton P.

Howells W.S.  
Jal J.F.  
Klein M.  
Knoll W.  
Lechner R.  
Lovesey S.  
Marti C.  
Poncet J.F.  
Scherm R.  
Suck J.B.  
Volino F.  
Wright A.

#### II - SCIENTIFIC ACTIVITIES

As a general trend we might say that 1976 has been characterized by the development of some highly successful programmes of which a short review is given below. On the other hand there is a non negligible amount (say about 25%) of experiments performed at the limits of either the present state of the theory or of the technique. Unless significant breakthroughs are made, these are often not reported but they are nevertheless characteristic of the actual scientific effort ; a few titles : collective excitations in general, inelastic or quasielastic studies of superionics, glasses, amorphous systems, molecular liquids, binary alloys, extreme temperature or pressure conditions, critical phenomena.

Two meetings have been organized. In March, an informal gathering of all the users working on binary alloys was the occasion to define priorities and to develop a general framework for research in the field. This should be considered as a main success considering the omnipresent dilemma between specific metallurgical problems and general scientific interest. In October, the week of the Scientific Council, a workshop on ionic systems clarified the experimental difficulties to be overcome and reassessed the priorities in this area. Both meetings should be considered extremely fruitful for the promotion of closer collaboration among users, defining priorities and drawing guidelines for instrumental developments. We hope in the future to systematically hold meetings in the different scientific areas covered by the College.

## 2.1 — Quantum liquids

The programme of work on the excitations in liquid helium has continued during the past year. Although liquid  $^4\text{He}$  is certainly one of the most studied of materials, neutron measurements can still produce valuable information. Using the IN5 spectrometer, a high-resolution measurement has been made of the small- $Q$  phonon dispersion curve in superfluid  $^4\text{He}$ . Since long wavelength neutrons (6 to 8 Å) could be used, giving improved energy resolution and smaller wave-vectors than hitherto possible ( $\sim 0.07 < Q \text{ (Å}^{-1}\text{)} < 1.0$ ), a direct observation of the anomalous dispersion was made. In a second experiment, the pressure dependence ( $0 < p \text{ (bar)} < 20$ ) of the dispersion curve has been investigated. Another high resolution measurement, this time using the IN3 instrument, was the accurate determination of the roton energy at the saturated vapour pressure. By comparison with Raman scattering measurements it has been possible to verify the existence of a two-roton bound-state and to define its binding energy.

Finally, a study has been made of the excitations in thin films of superfluid  $^4\text{He}$ . In a first experiment, graphite powder was used as substrate. Excitations could be observed in films of 3 layers and thicker. A second experiment used oriented "papyex" as substrate. As with the first experiment, no appreciable change occurred in the roton energy compared with bulk helium.

Turning to the lighter isotope  $^3\text{He}$ , measurements have been made at improved resolution of the excitation spectra of several mixtures of  $^4\text{He}$  in  $^3\text{He}$ . The figure 13 shows the excitation spectrum of a 6% ( $^4\text{He}$ ) mixture. The particle-hole continuum and single phonon-roton dispersion curve merge at about  $1.7 \text{ Å}^{-1}$ ; it is not possible to say definitely whether the continuum is below the roton curve, but it certainly deviates from a strict quadratic dispersion.

## 2.2 — Liquid metals

A large programme which complements previous inelastic experiments has now been completed on liquid Rubidium and should improve our understanding of liquid metals. The structure factor has been measured with an increased accuracy over a large  $k$ -range, the main peak of the structure factor itself being investigated over a temperature range from 450 K to 1400 K which corresponds to a density variation from 1.42 to 0.98 g/cm<sup>3</sup> i.e. approaching the critical conditions. The pressure derivative of  $S(Q, \omega)$  has been successfully obtained and will allow models of the triplet correlation function to be tested.

## 2.3 — Binary alloys

Previous work on Li alloys using the Bhatia and Thornton formalism and the

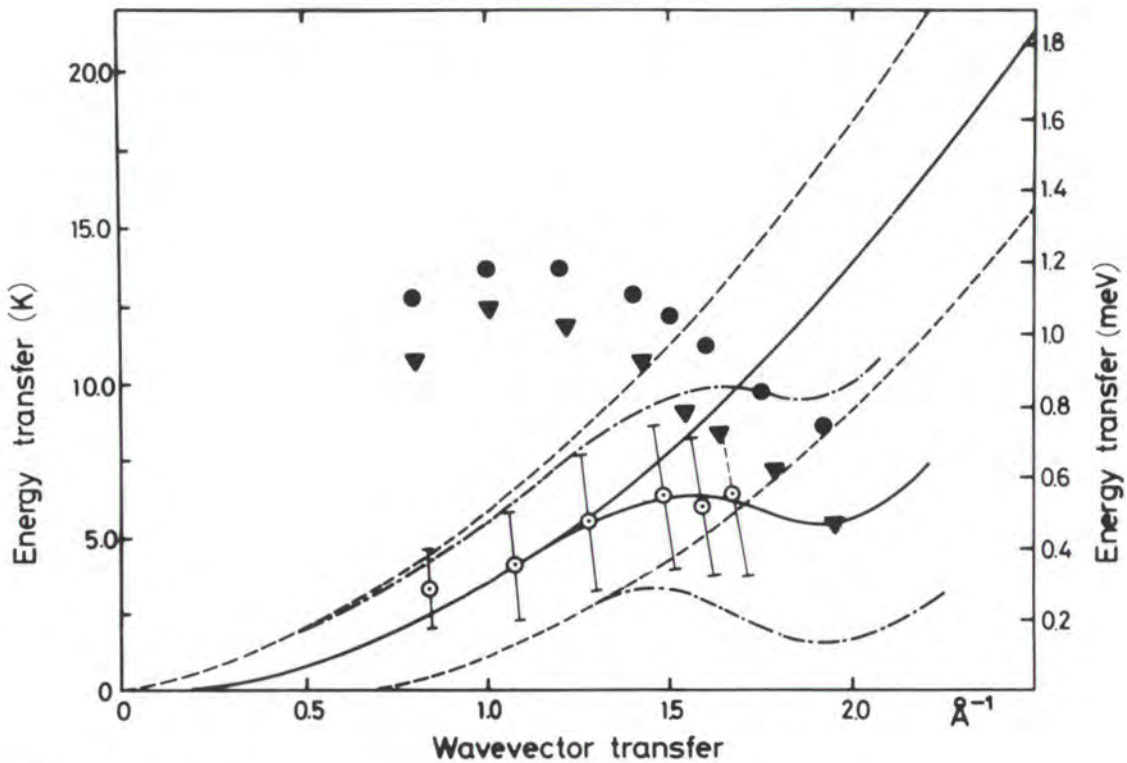


Fig. 13

Experimental and theoretical excitation of 6%  $^3\text{He}$ - $^4\text{He}$ . The closed circles are the positions of the phonon-rotor peaks, the triangles show where these peaks reach the background level, while the open circles give the positions and widths of the particle-hole continuum peaks.

"zero alloy" technique has been extended to a detailed study of the Li-Ag and Li-Na systems.

Segregation effects are investigated in detail for some binary systems such as Al-Sn.

New single crystal sapphire containers, successfully tested in the case of Fe-C (5% C) will probably open the way to the study of higher melting point alloys.

#### 2.4 — Magnetic form factor

The interest in magnetic form factors of simple fluids has been sustained. Depending on experimental conditions several approaches are now being used in order to separate magnetic from nuclear scattering : polarization analysis (liquid iron), isotopic substitution (liquid iron) comparison between similar systems (nitrogen versus oxygen gas). Moreover small angle scattering attributed to spin fluctuation has been observed in liquid iron.

#### 2.5 — Molecular liquids

By a systematic study of molecular liquids in the high  $k$ -range and at several

wavelengths (or incident energies) a deeper understanding of the inelasticity corrections as well as better values of the intramolecular structure factor has been reached. This has a direct effect on the quality of the intermolecular structure factor determination and comparison with new theoretical approaches such as the RISM model is very promising.

## 2.6 – Molten salts

The work on partial structure factor determination of molten halides was successfully extended to RbCl and CuCl. The available statistical accuracy seriously limits further development of the isotopic substitution method and an increased data collection rate such as provided by the multidetector technique is necessary. Critical fluctuations were observed near the liquid-liquid demixing point in the system K in molten KBr. The system seems to behave classically even at temperatures very close to  $T_c$ .

## 2.7 – Ionic solutions

Continuing progress has been made in the use of isotopic substitution to investigate concentrated ionic solutions in  $D_2O$ . Solvation effects have been investigated as a function of concentration for the Nickel ion in  $NiCl_2$  and the Chloride ion in NaCl. Preliminary work as a function of temperature and especially pressure also allows very interesting quantitative information on solvation to be obtained in these cases.

## 2.8 – Mesophases

Incoherent neutron quasi-elastic scattering of different smectic phases in powder or aligned sample suggest that the accepted model for local order in these phases is not very adequate. The work has therefore focused on well defined experiments especially in the smectic C and A phases. Using extensively the Elastic Incoherent Structure Factor (EISF) it was shown that the neutron results do not support the existence of an orientational ordering around the long axis as predicted by numerous microscopic theories. Moreover in the smectic A phase, the picture of molecules arranged perpendicular to the smectic plane seems to be incorrect and this is investigated in more detail.

Similar experiments using the EISF concept have proved to be a powerful tool to distinguish between different types of rotational motion in plastic adamantane. The smectic C - smectic A transition has been accurately investigated. The tilt angle and its corresponding critical exponent  $\beta$  were followed by a method based on rocking curves.

Secretary : P. Chieux

# college 7

## «impurities»

### I - MEMBERS OF THE COLLEGE

Blétry J.  
 Carlile C.J.  
 Escribe C.  
 Freund A.  
 Goeltz G.  
 Grupp M.                      Univ. of  
    Heidelberg

Hayter J.  
 Heidemann A.  
 Heitjans P.                    Univ. of  
    Heidelberg

Just W.  
 Körblein A.  
 Kostorz G.  
 Mezei F.  
 Murani A.  
 Parisot G.  
 Radhakrishna P.  
 Roth M.  
 Schweizer J.                C.E.N.G.  
 Stirling W.G.

Suck J.  
 Thorel P.  
 Wagner V.                    Univ. of  
    Würzburg

Young A.P.  
 Zeyen C.  
 Ziebeck K.

### II - VISITING SCIENTISTS

Anders R.                    (Stierstadt,  
    München)  
    (March 76)

Fujara F.                    Univ. of  
    Heidelberg  
    (May 1976)

Hicks T.                    Lucas Heights,  
    Australia

Söffge F.                    Univ. of  
    München

### III - SCIENTIFIC ACTIVITIES

Out of 99 proposals submitted to the subcommittee in March and October 67 were accepted. A total of 67 experiments concerning this college were carried out in 1976. The instruments used were IN1, IN3, IN4, IN5, IN7, IN10, D7 and D11A. The small angle and diffuse scattering spectrometers D11B and D17 are now in the test phase. They should become operational in 1977 and will then reduce the load on the heavily demanded machines D11A and D7. Present areas of research interest in the college fall into three categories :

1. Mixed magnetic systems,
2. Defects and disorder in solids,
3. Diffusive motion in solids.

A great effort was concentrated on the investigation of spin glasses. Diffusion and dynamics of superionic conductors is a field of increasing interest.

#### 1. Mixed magnetic systems

Magnetic diffuse scattering of unpolarized neutrons with energy analysis was studied to determine the spin-spin correlation function in space and time for several systems exhibiting various unusual magnetic properties, namely Kondo, intermediate valence and spin glass behaviour. In the rare earth Kondo alloys  $\text{CeLaAl}_2$  and  $\text{CeYAl}_2$  and the "Kondo compound"  $\text{CeAl}_2$  the concentration and temperature dependence of the quasielastic and inelastic line width of the crystal field split  $\text{Ce}^{3+}$  ions was investigated. From the data an increase of the Kondo temperature from  $\text{CeLaAl}_2$  to  $\text{CeAl}_2$  and to  $\text{CeYAl}_2$  was inferred. In the intermediate valence compound  $\text{CePd}_3$  an abnormally large and almost temperature independent quasielastic line width and a reduction of the total magnetic cross section was observed indicating only 0.5 electrons in the 4 f shell. In the classical spin glass system AuFe the existence of two species of magnetic moments with different sizes and relaxation rates above the freezing temperature was deduced from inelastic neutron scattering. (M. Löwenhaupt, E. Holland-Moritz (KFA Jülich), F. Steglich, H. Scheuer (Universität Köln), W. Just (ILL)).

Measurements of the dynamics of spins in a Cu 8 at. % Mn alloy (A.P. Murani (ILL), J.L. Tholence (CRTBT)) show no evidence of critical slowing down normally associated with a second order phase transition which is predicted for spin glasses by some recent theories. Also, the temperature of the maximum in the susceptibility is found to be dependent on the time constant of measurement, the neutron scattering data (time constant  $\sim 10^{-11}$ s) yielding a significantly higher value compared with that obtained by the conventional ac susceptibility technique (time constant  $\sim 10^{-2}$ s).

The temperature dependence of the hyperfine interaction on the vanadium sites in  $\text{V}_3\text{O}_7$  was studied on IN10. A phase transition at 5.2 K was detected (A. Heidemann (ILL), K. Kosuge (Kyoto)).

#### 2. Defects and disorder in solids

Small angle scattering from  $\overline{\text{AlZn}}$  was investigated at high temperature and after aging at room temperature to study the supposed changes in decomposition mechanism from spinodal to nucleation-and-growth. An interparticle interference peak of the Al-6.8 at % Zn alloy aged at 133°C was observed at very small angles (D. Allen, R. Stewart (Reading), P. Guyot, G. Laslaz (Grenoble), M. Roth, G. Kostorz (ILL)).

The study of irradiated GaAs has been terminated and the results are available in a thesis by S. Gupta (S. Gupta, E.U.J. Mitchell, R. Stewart (Reading) G. Kostorz (ILL)). The anisotropy of neutron small angle scattering after fast neutron irradiation of a single crystal was attributed to the shape of

the displacement cascades.

A programme on Ni based high temperature alloys has been started. The small angle scattering caused by precipitates was studied as a function of aging temperature and time, and uniaxial stress as an additional parameter (R. Miller, R. Stewart (Reading), G. Kostorz (ILL)).

The small angle scattering from faceted voids in  $\beta'$ -NiAl was studied further. Model calculations are under way to interpret the results (J.E. Epperson (Stuttgart), G. Kostorz (ILL)).

3. Diffusive motions in solids

The study of hindered diffusion of hydrogen in Nb by quasielastic neutron scattering on IN10 was continued. Despite some experimental effort the predicted translational tunnelling motion could not yet be detected (D. Richter, T. Springer (KFA Jülich)).

The single particle motion in single crystalline Na was investigated on a microscopic scale by quasielastic neutron scattering on IN10. In general the results are compatible with the model of  $\langle 111 \rangle$  - jumps for mono-vacancies but there are also characteristic differences which are probably caused by the motion of divacancies. Further work is in progress (A. Seeger (MPI, Stuttgart), G. Goeltz, A. Heidemann (ILL)).

4. In-Beam NMR spectrometry

Studies of the electronic structure and atomic diffusion in LiMg, LiAg and LiCd alloys were performed on the in-beam NMR spectrometer (S6, Heidelberg group) by measuring the temperature dependence of the spin-lattice relaxation time  $T_1$  of  $^8\text{Li}$ .

An information meeting on hydrogen in metals (organized by W. Just, T. Springer) took place on January 23, 1976 at the ILL. The aim was to gather the various groups which have used the HFR facilities for investigations on hydrogen metal systems, in particular the aspects of self-diffusion, lattice vibrations, structure and density fluctuations. The general aspects were : Relation between local modes and the activation energy for diffusion, the influence of the strain field on local density fluctuations of the dissolved hydrogen atoms, diffusion in the presence of traps, direct hydrogen-hydrogen interaction, physical aspects of hydrogen storage in rare earth compounds and in Mg alloys. At the end of the meeting and after a general discussion, the different groups sketched their future programme, in particular at the ILL reactor.

Secretary : A. Heidemann

## college 8

### «structural biology»

#### I - MEMBERS OF THE COLLEGE

at I.L.L.

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Haas J.

Ibel K.

Jacrot B.

Mason S.A.

Torbet J.                    Euratom

Timmins P.

White J.W.

Zaccai G.

at the E.M.B.L. outstation :

Berthet C.

Gabriel A.

Hulmes D.J.S.            EMBO Fellow

Lindley H.

Miller A.

Ngo Tri H.

Tocchetti D.

White S.W.                EMBO Fellow

#### II - SCIENTIFIC ACTIVITY

Of the 72 proposals submitted to the Biology Subcommittee of the Science Council for the two six-month periods of 1976, 53 were accepted. Most were for low angle scattering work using D11A, but there were proposals, as well, for D8 (protein single crystal), D16 (membranes) and IN5, IN10 (inelastic studies). The subcommittee continued the principle of test time on instruments for quick experiments to see whether or not more elaborate studies of a system were warranted. It proved to be very successful, with most test experiments leading to well formulated proposals which were subsequently accepted.

In the low angle field, the long term studies on the structure of ribosomes and chromatin are continuing, their progress emphasized by the publications in each subject. In particular, it has been shown that in both the 50s and 30s ribosomal subunits the RNA is located towards the core of the particle with the protein more to the outside. In the chromatin nucleosomes, it has been shown that the protein is located towards the core with the DNA on the outside. The first studies on spherical viruses are now completed. They showed a strong correlation between protein RNA interpenetration and stability in those viruses. The work on the retinal rod outer segment membranes has also been completed and published this year. Using contrast variation, the rhodopsin was found to span the bilayer with small changes in its position on bleaching. Another interesting study, which shows the unique advantage of neutrons for certain structures, is the one on calcified tendon. Calcified tendon is essentially made up of collagen and a calcium mineral. Whereas with X-rays, calcium strongly dominates the scattering, with

neutrons, its contribution is comparable to that of collagen. This study located the mineral relative to the collagen in the structure. It is the first example of the successful use of contrast variation in a noncentrosymmetric system. The sensitivity of the neutron technique is clearly demonstrated in a study which has been started this year on aminoacyl-t-RNA-synthetases and their interactions with t-RNA. Complex formation between the enzymes (molecular weights between  $1 \times 10^5$  and  $2 \times 10^5$ ) and the t-RNAs (molecular weights  $\sim 2.5 \times 10^4$ ) and subsequent dissociation as the stoichiometry is varied have been followed by observing the changes in scattering in solvent conditions where only the enzyme contributes and where both the enzyme and the nucleic acid contribute.

A number of inelastic experiments have been performed in 1976 but it is premature, as yet, to comment on their results except to say that they show the technique to be worth pursuing.

In the single crystal field : At their March meeting, the subcommittee strongly backed protein crystallography as a long term project at the Institut, and demanded that an area-sensitive detector be developed to speed up data collection. In the meanwhile, the work on lysozyme is continuing on D8. Preliminary tests (on D17) on virus crystals (unit cell dimensions  $\sim 400 \text{ \AA}^3$ ) to estimate the feasibility of a low resolution study to locate the nucleic acid core have been very promising.

An important event in college life, this past year, has been the installation of the Biochemistry Laboratory under the responsibility of B. Jacrot. It is small but well equipped with, amongst other equipment, a spectrophotometer kindly provided by the E.M.B.L. It has greatly enhanced the quality of experiments on the beams, by allowing last minute sample preparations and controls under much improved conditions. The college has a close and excellent collaboration with the E.M.B.L. outstation, and it is hoped that now long term visitors will be attracted to the Institut for biological work.

Secretary : G. Zaccai

## college 9

### «chemistry»

#### I - MEMBERS OF THE COLLEGE

Aldebert P.	
Bartunik H.	
Besnard M.	
Bomchil G.	
Carlile C.	
Chauvin C.	CENG
Chieux P.	
Dianoux A.	
Duée E.	CENG
Fitzgerald W.	
Ghosh R.	
Guillermet J.	
Hayter J.	
Higgins J.	
Haas J.	
Howells S.	
Ibel K.	
Jacrot B.	
Jenkin G.	
Lajzerowicz J.	Univ. de Grenoble
Lehmann M.	
Leslie M.	
Lovesey S.	

Mason S.	
Mathieu J.P.	CENG
Mezei F.	
Nunes A.	
Osborne H.	CENG
Perry C.	MPI, Grenoble
Riekel C.	
Rustichelli F.	
Schmidt G.	
Tabony J.	
Timmins P.	
Tomkinson J.	
White J.	
Wright A.F.	
Volino F.	
Zaccai G.	

#### II - VISITING SCIENTIST

James D.	(University of Queensland, Australia)
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#### III - SCIENTIFIC ACTIVITIES

During the past year 100 experiments have been carried out by this College on 13 different instruments. The most heavily used instruments continue to be :

D1B	6	experiments	39	days
D11	21	experiments	38	days
IN1B	9	experiments	29	days
IN4	8	experiments	33	days
IN5	20	experiments	49	days
IN10	26	experiments	69	days

A meeting of the European groups studying polymers was held again this year at Strasbourg in May. Results on small and wide angle neutron scattering as well as quasielastic neutron scattering were presented.

In polymer mixtures values of  $R_g$  have been measured both in the middle and at

the edge of the compatibility range (Mainz group).

For polymer solutions, it is now possible to describe the whole temperature-concentration system by a universal function and the predictions for the critical region have been confirmed experimentally (Saclay group).

Work on block polymers in solutions with varying contrast factors has measured the classical parabolic variation of  $R_g$  (apparent) with contrast for a number of systems. Inelastic scattering from n-alkanes ( $n\text{-C}_{33}\text{H}_{68}$ ) has shown that there is quasielastic scattering in the C modification. The translational component of the motion is not controlled by the flip-flop process but by an additional kind of motion unknown up to now in which the time constant is  $1.3 \times 10^{-8}$  sec. (Fischer, Ewen and Richter, Jülich).

In the field of molecular dynamics, the year was marked by the successful measurement of tunnelling spectra in two different systems using the IN10 backscattering spectrometer. The spectrum for the  $\text{NH}_4^+$  ion in  $\text{NH}_4\text{ClO}_4$  showed five pairs of side peaks whose positions could be measured as a function of temperature

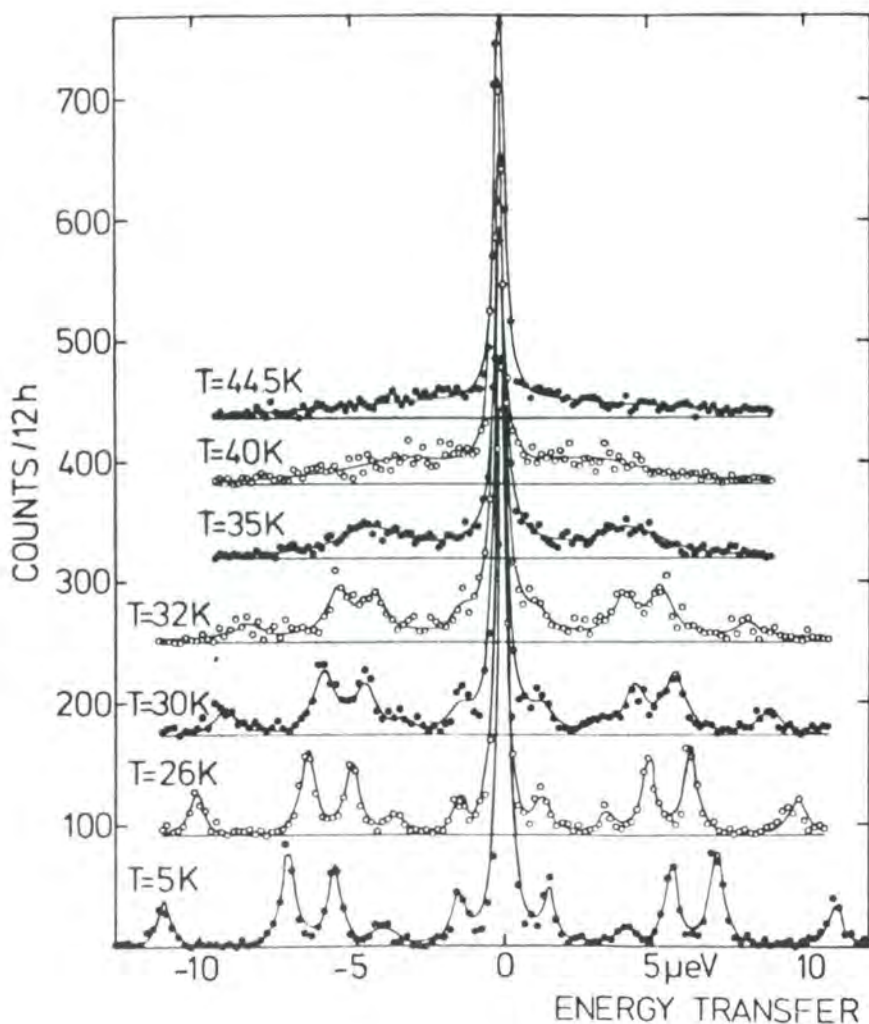


Fig. 14  
Tunnelling spectrum  
of  $\text{NH}_4\text{ClO}_4$  as a  
function of temper-  
ature measured on  
IN10.  
(Alfeld, Hüller,  
Prager and Press,  
Jülich).

(see Fig. 14). The energy level scheme has been unambiguously determined and the intensities established the degeneracies (Jülich group). The spectrum for dimethyl diacetylene (hexadiyne) showed a single pair of peaks corresponding to the lowest torsional level at  $\sim 1 \mu\text{eV}$ . Again, as the temperature increased the side peaks eventually merged into the central quasielastic peak (Oxford group).

Work continues on the structure and dynamics of adsorbed species. The system  $\text{NH}_3$  on graphon has been measured on D1B and IN10 and shows that the gas clusters around certain active sites with properties reminiscent of the liquid state. Varying the temperature of the sample produces a solid-liquid transition, close to that of bulk  $\text{NH}_3$ , which is associated with the rapid diffusion of the  $\text{NH}_3$  molecule.

Experiments on the IN1B Beryllium filter spectrometer concerned the supported catalyst Pt-zeolyte and the powder Pt black. Results from the zeolyte indicate the breaking of Si-O-Si bonds by atomic hydrogen, while the Pt black results appear to be similar to those from the Pd-H system (Durham and Lyon groups).

Other experiments on IN1B include vibrational studies of some bisbiacetate salts, which confirm the infra-red measurements, and some hydrogen bihalides, where the energy transfers were higher than previous measurements.

Work on IN4 concerning the internal torsional modes of methyl rotors has led to very well resolved spectra and the confirmation of previous results (Durham group).

Secretary : Spencer Howells

## european molecular biology laboratory, grenoble

The E.M.B.L. Grenoble Outstation was started in September 1975. The *raison d'être* of the Outstation is the High Flux Beam Nuclear Reactor at the Institut Laue-Langevin. The purpose is twofold, viz. to provide a compact yet comprehensive biological/biochemical laboratory which will be useful to scientists carrying out scheduled experiments at I.L.L. and to initiate a programme of research which involves the application of neutron scattering to problems of biological interest. The E.M.B.L. is in the grounds of the C.E.N.G., some 300 m from the Neutron Guide Hall. In January 1977 the gate through the C.E.N.G. security fence will be operable by the I.L.L. magnetic cards.

The service aspect of E.M.B.L. will be run in close collaboration with I.L.L. The intention is to provide a laboratory where visitors can carry out last minute specimen preparation or specimen assay both before and after neutron experiments. Internal or external I.L.L. users are invited to use the E.M.B.L. facilities and, if required, E.M.B.L. staff will provide whatever assistance may be necessary for the successful completion of neutron experiments on biological materials. A list of the equipment available can be obtained from the E.M.B.L. office (ext. 3237). Since the I.L.L. schedule is known well in advance, it is requested that prospective users of the E.M.B.L. give two weeks notice so that staff have adequate time to ensure that the appropriate equipment is working in the correct configuration. Some E.M.B.L. equipment is actually situated in the I.L.L. under the supervision of Dr. B. Jacrot.

The research programme is at present confined to biological fibres, primarily connective tissue and muscle. It is clear from recent work that the amino-acid sequence of the collagen molecule, which is determined directly by the order of nucleotides in the D.N.A. coding for collagen, in turn determines the axial shift (of 670 Å) which occurs between neighbouring molecules when they self-assemble into collagen fibrils. The small-angle X-ray and neutron diffraction patterns can also be related to the molecules of known amino-acid sequence staggered by 670 Å with respect to each other. The one-dimensional character of these biological fibres has permitted an understanding of the structure of a native animal tissue (tendon) to virtually amino-acid resolution in one-dimension. This is being used as a basis for interpreting the structure of modified connective tissue such as bone, cartilage and aorta wall.

Exploratory studies are also being carried out by A. Miller (E.M.B.L.), J.W. White (I.L.L.) and collaborators on the inelastic scattering of neutrons and light by

biological fibres. These measurements of molecular dynamics give information about the microscopic elastic moduli of the molecular components and, of course, these are precisely the aspects of biological fibres which are related to their structural role in biomaterials.

A project has been started by H. Lindley (E.M.B.L.) to determine the amino-acid sequence of the rod portion of the myosin molecule of muscle. This should, by analogy with the collagen work, provide the basis for analysis of the axial intermolecular contacts in myofilaments which can be supplemented by similar kinds of studies on the structure and dynamics of muscle.

The staff of the E.M.B.L. consists of five scientists and seven technicians and research assistants. Further appointments remain to be made and will probably broaden the research programme.

A. Miller

# services techniques

## bureau des projets

1. En liaison étroite avec les coordinateurs des groupes d'instruments, le Bureau des Projets a assuré la préparation, la gestion et le contrôle du budget d'investissement consacré à l'activité expérimentale :
  - 1.1 29 appareils en fonctionnement ont bénéficié d'améliorations, parmi lesquels 12 ont subi des modifications essentielles, que ce soit pour améliorer les conditions d'emploi ou élargir la gamme des mesures (augmentation du nombre des détecteurs de IN5, refonte de IN7, améliorations de D10, etc . . .), ou pour satisfaire à des normes de sécurité (nouveau générateur X de LI 5), ou encore pour réduire le bruit de fond neutronique d'ambiance comme ce fut le cas sur D16.
  - 1.2 En parallèle, ont été financés partiellement cette année le nouveau spectromètre à diffusion aux petits angles D17, le trois axes IN12, l'interféromètre à neutrons D18 et la nouvelle source de Neutrons Ultra Froids.
2. Sur le plan technique, outre la coordination et le suivi de la construction des nouveaux appareils précédemment cités, le Bureau des Projets a apporté son support aux scientifiques pour la préparation des avant-projets des instruments à haute résolution comme IN10B et IN13 ou du spectromètre à temps de vol IN5B.
3. Dans le cadre de l'amélioration d'équipements généraux le Bureau des Projets a défini, coordonné et financé une campagne de mesures destinée à préciser les caractéristiques des matériaux de protection utilisables pour réduire le bruit de fond neutronique.

Enfin le Bureau des Projets s'efforce de définir et préciser l'ampleur des modifications d'appareils ou équipements nouveaux à prévoir pour permettre aux scientifiques de travailler à l'ILL sur des isotopes émetteurs dans des conditions de sécurité acceptables.

## service de construction et de maintenance mécanique

Les activités du Service se sont manifestées à la fois dans le domaine des dispositifs

nouveaux, dans celui de la maintenance des dispositifs en fonctionnement et dans la recherche d'améliorations pour de meilleures conditions d'exploitation des dispositifs. Dans ce sens, on s'oriente vers une plus grande souplesse, une plus grande rapidité de fonctionnement et une extension de la normalisation des composants qui, jusqu'ici, a donné d'excellents résultats.

#### 1. Nouveaux instruments :

- en cours d'étude, de construction, d'installation : D18A, IN12, PN5 (Ultra Cold Neutrons), D13C
  - terminés : IN7, IN11, D17, S13
2. Compléments d'équipement sur : D1B, D4, D9, D11A, D11B, IN8, PN2
  3. Gros travaux de transformation ou de maintenance sur : D1A, D2, D3, D5, D7, D9, D10, IN1, IN3, IN5, IN9, IN10, D16, guides de neutrons IN5 et IN10, et guide de répartition de H16.
  4. Installation des Instruments spéciaux : S4, S12, S25, S28, S29, S30, S31
  5. Mise en place de nouveaux guides de neutrons : D18, IN11, PN5
  6. Aménagements : Plate-forme de circulation IN11/IN12, coffrets d'obturateurs, casemate pour essais bruit de fond
  7. Essais de dispositifs mettant en œuvre des technologies nouvelles :
    - enceinte haute pression pour multidétecteur
    - collimateur aérostatique (Poisson)
    - positionnement piézoélectrique
    - Labyrinthe d'étanchéité différentielle

Par ailleurs, l'assistance technique a continué à se développer par la fourniture de matériels standard et par le prêt d'instruments de mesure et de contrôle.

## section sécurité et radioprotection

### SECURITE GENERALE

1. **Etudes de sécurité dans le cadre de la Commission Interne de Sécurité (CIS)**  
Analyses de sûreté et examens des dispositifs expérimentaux utilisés pour l'irradiation d'échantillons de forte radiotoxicité, par exemple : OSTIS, PN2, PN3 (expérience avec  $^{244}\text{Cm}$ ), D5 (expérience avec  $^{242}\text{Pu}$ ), S10 (cibles d'uranium).
2. **Définition des prescriptions nécessaires à l'amélioration des conditions de travail et la protection du personnel**
  - Mesures de nuisances
  - Mesures de bruit et d'éclairement dans la salle du PDP 10, dans le bâtiment conduits des neutrons
3. **Animation du Comité d'Hygiène et de Sécurité (CHS)**

- Examen des postes de travail, bilan et enquêtes sur les accidents du travail, rapport annuel à l'Inspecteur du travail . . .
4. **Prévention des accidents**
    - Visite de sécurité dans les installations, essais systématiques des systèmes de détection (incendie, inondation, explosimètres . . .)
    - Extension et amélioration du réseau de téléalarmes (dans le réacteur, le bâtiment ILL11)
    - Etude et réalisation d'une installation d'extinction automatique des filtres de la ventilation du réacteur
    - Etude d'une détection fumée adaptée aux locaux des calculateurs
    - Respect de la réglementation française concernant les vérifications et épreuves périodiques des appareils à pression de gaz, des installations électriques, des appareils de manutention. . .
  5. **Formation et information du personnel**
    - Séances de formation et de recyclage pour le personnel sur les aspects pratiques et réglementaires des appareils de levage et de manutention.
    - Entraînement du personnel au maniement d'appareils de premier secours.
  6. **Maintenance et vérification du matériel d'intervention**
    - Extincteurs, appareils respiratoires, équipements de protection individuelle . . .
  7. **Suivi des échantillons dangereux**
    - Assistance des physiciens pour le contrôle et le stockage de ces échantillons
  8. **Aspects techniques du gardiennage**
    - Mise au point du système automatique de contrôle des accès dans le réacteur
    - Extension du système à l'entrée hall piscine

## RADIOPROTECTION

1. **Radioprotection dans les installations et autour des expériences**
  - Contrôles quotidiens des protections et des échantillons irradiés, balisage, information et assistance auprès des physiciens et des techniciens
  - Contrôle et étalonnage périodiques (chaque cycle) des chaînes de surveillance collective (réacteur et détritiation)
2. **Analyses en laboratoire**
  - Spectrométrie  $\gamma$  d'échantillons liquides et gazeux liés au fonctionnement des installations nucléaires (analyses de routine et préventives) circuits  $D_2O$  et  $H_2O$ , huiles de pompes à vides, canaux . . .
  - 600 analyses sur des échantillons liquides. 300 sur des prélèvements gazeux.
  - Analyses par scintillation liquide : 3500 échantillons analysés en 1976 (circuits  $D_2O$  et  $H_2O$ , effluents liquides, huiles des pompes, urines, frot-tis. . .)

3. **Dosimétrie du personnel**
  - Attribution et gestion des films, exploitation des résultats.  
6000 films délivrés en 1976. 5000 films individuels et 1000 films de dosimétrie de zone.  
1200 films délivrés à des agents extérieurs à l'ILL (chercheurs-invités et entreprises)
  - Mise en place pour les agents non directement affectés et l'ambiance d'une dosimétrie par thermoluminescence.
4. **Préparation, suivi et contrôle des interventions en milieu actif**
  - Tous travaux de décontamination
5. **Contrôle et surveillance des rejets d'effluents radioactifs liquides et gazeux**
  - Analyses avant et pendant les rejets, bilans mensuels, liaison avec le Service concerné du CENG pour les aspects de surveillance du site
6. **Tri, conditionnement et gestion des déchets radioactifs solides et liquides avant leur transport et leur traitement au CENG.**
7. **Assistance radioprotection envers les problèmes d'exploitation du réacteur**
  - Etude DRG : contamination de surface des plaques de l'élément combustible
  - Source de démarrage : optimisation d'irradiation de la source
  - Mesures de la stabilité du flux neutronique
  - Analyse de la dérive des chambres de puissance
  - Analyse des conséquences radiologiques en cas d'accident à la détritiation
8. **Assistance radioprotection envers l'exploitation des expériences**
  - Etude d'aménagement des locaux et des dispositifs expérimentaux pour travaux sur produits de haute radiotoxicité (transuraniens), laboratoire  $\alpha$ , cellule pour canal  $\beta$ , appareils de physique nucléaire PN2, PN3 . . .
9. **Assistance radioprotection auprès du Bureau des Projets**
  - Participation à la définition des protections autour des nouveaux dispositifs expérimentaux
  - Essais sur les matériaux usuels de protection afin de définir leur efficacité sur le plan de la radioprotection ( $\gamma + n$ ) et du bruit de fond ( $n_{th}$  et  $n_{epith}$ )
  - Analyse par activation des structures du dispositif UCN afin de mieux cerner les aspects corrosion et protection
  - Mesures de bruit de fond (Commission Bruit de fond)
10. **Formation et éducation du personnel en radioprotection**
  - Séances d'information hebdomadaires pour tout le personnel
11. **Permanences de sécurité**
  - Assistance du Chef de quart pendant les nuits et le week-end
  - Contrôles systématiques des lieux de travail, inspections et recherche de la contamination dans toutes les installations
  - Interventions à la demande soit du chef de quart (installations du réacteur), soit des physiciens (dispositifs expérimentaux).

# services fabrications mécaniques aménagement et entretien

## FABRICATIONS MECANIQUES

1. Les ateliers principaux de mécanique et chaudronnerie ont assuré, avec les mêmes moyens que l'année précédente, environ 10.000 heures de travail réparties sur 300 demandes, soit environ 80 % pour les besoins des expériences, 10 % pour le réacteur et 10 % pour les besoins généraux.  
Les réalisations les plus marquantes concernent une importante contribution à la création de nouveaux instruments ou à la modification de ceux existants, selon détails fournis au chapitre du «Service de Construction et Maintenance Mécanique».
2. L'atelier «libre service» a vu, comme par le passé, la fréquentation permanente d'une dizaine de techniciens qui, sous contrôle d'un ouvrier professionnel, ont assumé eux-mêmes leurs travaux de fabrications mécaniques. Bien que d'importance limitée du fait des moyens disponibles, la qualité des réalisations s'est sensiblement élevée cette année et apporte une contribution importante aux travaux nécessités par les expériences.
3. L'atelier «produits spéciaux» a continué à assurer, avec un agent, la fabrication et la mise en œuvre des matériaux de radioprotection habituels (polyuréthane au carbure de bore, plaques de fluorure de lithium fritté, etc. ...)
4. Le magasin général «matières premières» est resté exploité par un seul agent pour tous les besoins de l'Institut.

## aménagement et entretien

Les activités de cette section se sont exercées dans les domaines suivants :

1. Etude des projets, passation des commandes, surveillance des travaux confiés aux entreprises extérieures pour travaux neufs ou importants, travaux d'entretien et de modifications aux installations existantes.  
Ces travaux portent sur 1,4 Mio F environ et 50 firmes environ. Les réalisations essentielles sont :
  - le nouveau poste de garde à l'entrée du site
  - le local SPR pour triage et stockage des déchets actifs
  - l'installation d'une cellule de relèvement du cosinus  $\emptyset$  pour améliorer le rendement des installations électriques et l'alimentation secourue (150 KVA) des ordinateurs.
2. Réalisation de tout ou partie des travaux d'aménagement complémentaires correspondants.
3. Réalisation pour les expériences - et sur demande des physiciens - des branchements aux réseaux de fluides et petits aménagements complémentaires annexes.
4. Manutentions et transports à l'intérieur de l'ILL et partiellement vers l'extérieur.

5. Maintenance et réparation des installations techniques générales en partie par agents ILL et en partie par entreprises extérieures. Ce secteur d'activité a représenté en 1976 une surcharge considérable de travail du fait du vieillissement général de certaines installations (ascenseurs, monte-charges, ponts roulants, conduites de fluides ou d'effluents).
6. Mise en conformité des installations avec les règlements en vigueur et travaux visant à améliorer les conditions de sécurité en général.
7. Nettoyage et entretien général des bâtiments, espaces verts et voirie par contrats extérieurs.
8. Gestion et entretien du mobilier général de tout l'Institut.



Nouveau poste de garde à l'entrée du site de l'ILL.

# services exploitation du réacteur et des instruments

## fonctionnement du réacteur en 1976

Le programme de fonctionnement, établi en décembre 1975, avait prévu 6 cycles en 1976.

La périodicité de marche (démarrage le mardi, arrêt le jeudi) a été conservée dans la mesure du possible.

### ANALYSE DU FONCTIONNEMENT

#### RESUME DES CYCLES

- Cycle 1-76 : — Démarrage Réacteur le 6/1/76.  
Arrêt le 19/2/76.  
Ce cycle s'est déroulé sans incident notable.  
A noter, toutefois, une évacuation du hall expérimentateurs le 18/2/76 due à une légère contamination atmosphérique (1/100 CMA) par suite d'une fuite sur PN1.  
Aucune contamination de personnel n'a été observée.
- Cycle 2-76 : — Démarrage Réacteur le 2/3/76.  
Arrêt le 15/4/76.  
Fonctionnement sans incident notable, sauf une chute de barres suivie d'un redémarrage immédiat. A signaler une légère contamination du hall piscine, suite à une manipulation de source du canal  $\beta$  (PN3) (1er mars 1976). Trois personnes ont subi une légère contamination externe ( $< 1\ 000$  c/s). Un incident identique s'est reproduit le 8 avril 1976 (contamination externe de deux opérateurs).
- Cycle 3-76 : — Démarrage Réacteur le 27/4/76.  
Arrêt le 10/6/76.  
Aucun incident de fonctionnement notable, sauf deux chutes de barres suivies de redémarrage immédiat.
- Cycle 4-76 : — Démarrage Réacteur le 22/6/76.  
Arrêt repoussé au 8/8/76, pour récupérer 48 heures perdues en cours de cycle.  
Ce cycle a été marqué par une série de chutes de barres suivies, pour la plupart, de redémarrages immédiats, sauf en ce qui concerne l'arrêt du 4 au 8 juillet entraîné par la rupture d'une cana-

lisation d'eau de refroidissement.

Les chutes de barres ont eu pour cause principale les nombreuses baisses de tension EDF dues aux orages.

Cycle 5-76 : — Démarrage Réacteur le 17/8/76.

Arrêt le 2/10/76.

L'arrêt a été repoussé de 2 journées pour récupérer un arrêt suivi d'empoisonnement Xenon.

Ce cycle a, lui aussi, été marqué par quelques chutes de barres par suite de baisse de tension du réseau EDF.

A signaler, en outre, un incident de contamination du hall expérimentateurs provoqué par une fuite sur le dispositif PN1 Lohengrin, survenu le 27 août 1976. Le niveau de contamination atmosphérique à l'intérieur du hall a atteint 0,2 CMA ( $2.10^{-7}$  Ci/m<sup>3</sup>). Le hall a été évacué pour une durée de 5 heures environ. 25 personnes ayant présenté une contamination externe (< 300 c/s) ont dû être dirigées vers la douche.

ARRET ANNUEL POUR MAINTENANCE DU 2/10 au 4/11/76.

Cycle 6-76 : — Démarrage Réacteur le 4/11/76.

Arrêt le 18/12/76.

Aucun incident notable.

#### BILAN 1976

— Nombre de jours programmés initialement	266 réduits à 264 jours
— Nombre de jours de marche effective	262,4 j.
— Pourcentage de marche effective	71,8 %
— Pourcentage de marche effective par rapport à la marche prévue	99,3 %
— Nombre d'éléments combustibles utilisés	6
— Nombre d'éléments combustibles envoyés en retraitement	0
— Nombre de chutes de barres ou arrêts imprévus*	28
. dont arrêt de courte durée	26
. dont arrêt avec empoisonnement Xénon	2

\* Dans ce total, on a comptabilisé tous les incidents ayant entraîné le déclenchement du circuit de sécurité (en dehors des périodes d'essai). Cette définition englobe un nombre de cas plus grand que celle retenue en 1975.

## ANALYSE DES CAUSES D'ARRET OU CHUTES DE BARRES

– Sur intervention d'exploitation	5
– Electronique, contrôle, électrotechnique	7
– Décrochage des barres de sécurité	6
– Coupure alimentation E.D.F.	9
– Cause mécanique	1

## ANALYSE DES CAUSES D'ARRET

On retrouve, encore, une statistique assez comparable à celle observée en 1975.

### a/ Barres de sécurité

L'ensemble des barres de sécurité a pu être remis au cours du 2ème semestre, en l'état considéré comme optimum. Toutefois, les études se poursuivent pour tenter de définir une solution de rechange au cas où de nouvelles perturbations seraient observées.

b/ La période particulièrement orageuse de l'été 76 a eu une forte influence sur la fréquence des chutes de barres. Toutefois, des progrès décisifs semblent avoir été faits en fin d'année sur les points les plus sensibles aux coupures de courant de courte durée (Source Froide et système de pressurisation de l'eau lourde).

c/ Il faut remarquer que malgré un chiffre total de chutes de barres comparable à celui de 1975, le nombre des arrêts prolongés du fait de l'empoisonnement Xénon a décru de 8 en 1975 à 2 en 1976.

## FONCTIONNEMENT DES SOUS-ENSEMBLES

Les sources froide et chaude ont continué comme les années précédentes à fonctionner parfaitement.

L'usine de détritiation de l'eau lourde a fonctionné très correctement. Le soutirage du tritium a été mis en service normal. La mise en marche de cette installation est modulée pour maintenir l'activité du tritium de l'eau lourde au-dessous de 3 Ci/l.

– Les quantités d'eau traitées sont (pour 76) RHF	57 000 litres
– La quantité de tritium extraite	76 000 curies
– La quantité de tritium expédiée vers Marcoule	57 000 curies

Aucun sous-ensemble n'a posé de problème grave en 1976. On peut signaler, toutefois, une montée d'activité de certaines zones du circuit eau lourde qui serait susceptible de poser des problèmes difficiles si elle venait à s'aggraver.

D'autre part, la question du retraitement des éléments combustibles pourrait poser un problème difficile si elle n'était pas réglée avant septembre 1977.

D'autres problèmes identiques se poseraient en ce qui concerne l'évacuation du tritium au cas où notre correspondant à Marcoule cesserait toute activité en ce domaine.

## PRINCIPAUX TRAVAUX ET AMENAGEMENTS EN 1976

### ELEMENTS COMBUSTIBLES

Dans l'hypothèse du retraitement des E.C. aux U.S.A., une nouvelle méthode de découpe a été mise au point. D'autre part, des études ont été menées à bien pour vérifier la possibilité d'allongement du cycle de fonctionnement par augmentation de la charge en uranium des E.C. Aucune décision n'a été prise à ce sujet.

### EAU LOURDE

Un ensemble permettant l'épuration de l'eau lourde par distillation (débit 50 l/h) a été installé. Sa mise en service se poursuit.

### CIRCUITS DE REFROIDISSEMENT INTERMEDIAIRES

L'élimination des boues déposées par l'eau de rivière dans les circuits a constitué un travail long et fastidieux et a retardé le raccordement des expériences. Néanmoins, ce problème a été pratiquement réglé. Le réseau est de plus en plus étendu et fonctionne correctement.

### ELECTRICITE – CONTROLE

Le deuxième calculateur est entré progressivement en service au cours de l'année 1976. Certaines difficultés sont encore subsistantes mais en voie de règlement. La mise en service des nouvelles machines à écrire s'est avérée de plus en plus indispensable, au vu de la fréquence des défaillances des machines actuelles. Cette opération est en cours.

Les chambres d'ionisation chargées du contrôle du Réacteur ont dû être remplacées en cours d'année. Les difficultés rencontrées devant ces opérations conduisent à prévoir la mise en place d'un nouveau système de positionnement de ces chambres.

### VENTILATION EFFLUENTS

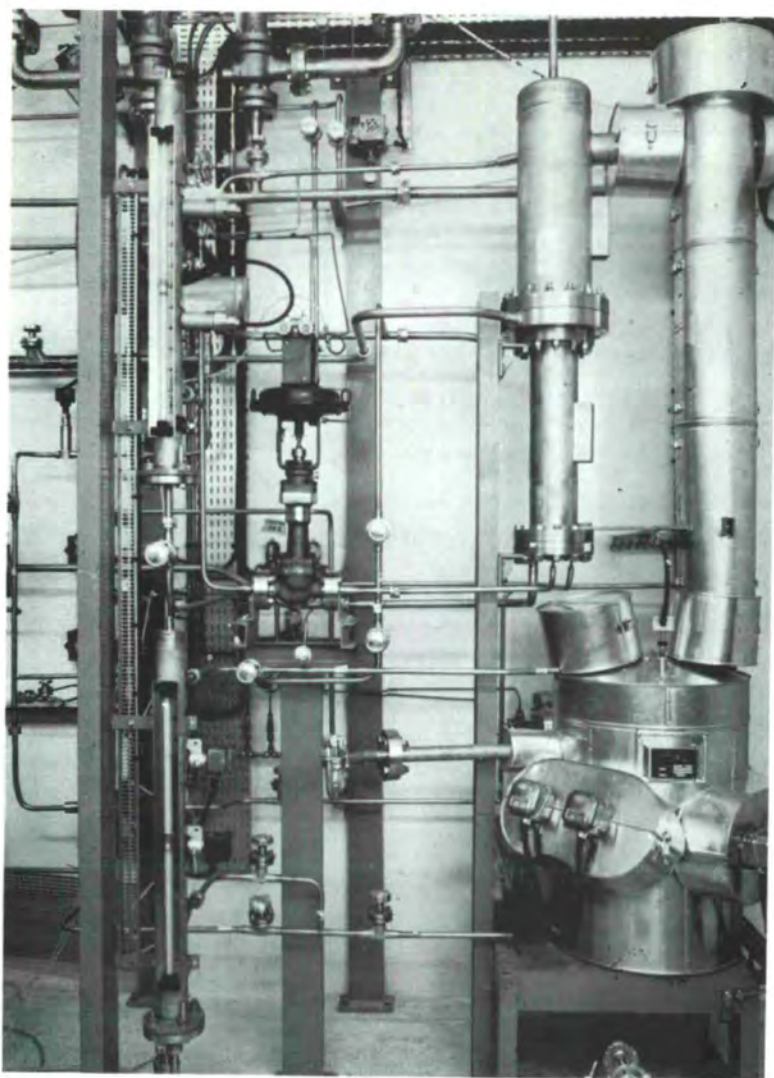
Les incidents de contamination des halls rencontrés en cours d'année ont conduit à améliorer le réseau d'effluents gazeux afin d'éliminer certains problèmes rencontrés dans la liaison entre la sortie des expériences et le réseau général.

### BARRES DE SECURITE

Les modifications apportées aux cinq barres de sécurité ont permis d'éliminer complètement le problème de l'accrochage des barres. On peut espérer que la stabilité de la tenue en accrochage sera satisfaisante grâce aux réglages rigoureux qui ont été effectués. Une solution de rechange est toutefois à l'étude.

### ALIMENTATION REGULEE DES CALCULATEURS

Un ensemble tournant de 180 KVA permettant de supprimer les coupures de courant de courte durée dans l'alimentation des calculateurs scientifiques, a été mis en place et essayé. Son raccordement est prévu pour fin 1976.



Nouveau distillateur  
d'eau lourde.

# service environnement des échantillons

## 1 – SECTION VIDE

- Maintenance du parc comprenant :
  - . 198 pompes primaires
  - . 45 pompes secondaires
  - . 39 groupes spéciaux
  - . 17 pompes à air
  - . 2 Roots Hibon à air
  - . 4 Hélitests
- 560 interventions, dont 175 réparations importantes.
- 550 tests hélium pour les usagers extérieurs au service.

Le travail de maintenance des pompes à vide est de plus en plus lourd en raison, d'une part du vieillissement du matériel, d'autre part, et surtout, de la contamination radioactive croissante de certaines pompes ( 1/3 du parc). L'effectif actuel permettra de plus en plus difficilement de faire face aux besoins.

## 2 – FLUIDES CRYOGENIQUES

### 2.1 – Azote liquide

Consommation de 324 000 litres (+30 %) à 0,43 F le litre.

### 2.2 – Hélium liquide

Fourniture par le CENG.

Consommation de 41 250 l (+17,5 %).

Coût moyen du litre, pertes comprises : 10 F.

Gaz fourni en libre service : 3 000 m<sup>3</sup>.

Pertes de gaz : 6 000 m<sup>3</sup> (20 %).

A noter le doublement des pertes de gaz par rapport à l'année précédente, dû pour moitié au mauvais fonctionnement de la récupération et pour moitié à la négligence des utilisateurs.

Si le niveau de ces pertes devait encore augmenter, le principe de la fourniture d'hélium en libre service devrait être réétudié.

Dans un proche avenir, le retour du gaz au CENG se fera par une ligne haute pression de 1 750 m. L'économie réalisée sur le transport des cadres de bouteilles devrait amortir cette ligne en 2 ans.

### 3 — CRYOSTATS

#### 3.1 — Exploitation courante

9 nouveaux cryostats ayant été mis en service, le parc effectif est maintenant de 43 cryostats, dont 10 couvrent la gamme 1,5 à 300 K et 17 sont affectés en permanence à des instruments déterminés.

En raison des conditions d'emploi très dures auxquelles ce matériel est soumis (transports fréquents, changement d'utilisateurs, méconnaissance par certains utilisateurs des règles les plus élémentaires), le taux de réparation et d'obsolescence augmente rapidement.

Les 156 demandes de prêt (+ 20 %) ont été satisfaites, avec, toutefois, quelques difficultés.

La disparition et le départ de 2 agents du Service ont causé des difficultés certaines et ont, au moins pour un temps, diminué la qualité du service rendu.

#### 3.2 — Développement

Le cryostat à température variable 1,5 – 300 K, avec accès de l'échantillon par le haut, léger, compact et à très longue autonomie (5 jours) développé fin 1975 a été testé avec succès en utilisation réelle. Il semble répondre particulièrement aux besoins propres à l'ILL et présente des avantages relativement contradictoires tels que, par exemple, grande vitesse de variation de température permettant de faire rapidement des mesures à des températures différentes sans délai inutile entre les points, et stabilité suffisante pour des mesures de phénomènes critiques ( $\leq 0,01$  K). Tous les utilisateurs l'ayant eu en mains ont manifesté le souhait de s'en voir attribuer un.

Le corps de ce cryostat sera donc, vraisemblablement, pris comme standard des futurs cryostats ILL. Il ne faut cependant pas perdre de vue qu'il existe, maintenant, sur le marché, des machines frigorifiques en circuit fermé, très fiables et permettant de descendre à des températures de 8 à 10 K. Ces machines ne consomment aucun fluide cryogénique et leur prix est ainsi amorti en moins de 2 ans. Afin de limiter l'augmentation des dépenses de fluides cryogéniques, voire même de les diminuer, il est important que l'ILL dégage les crédits nécessaires pour acheter ces machines en quantité suffisante.

#### 3.3 — Très basses températures ( $T < 1$ K)

Tout développement est actuellement bloqué en raison du décès de M. PRATI. On peut espérer que son remplacement au cours du premier semestre 1977 permettra de mettre en service un instrument à utilisation générale d'ici la fin de l'année.

### 4 — FOURS

L'exploitation de routine est maintenant normalement assurée. Des besoins spéciaux (très grande stabilité ou très haute température) sont apparus et les développements nécessaires sont en cours, le plus souvent en collaboration très étroite avec les physiciens concernés.

## service exploitation des instruments

Les techniciens et les ingénieurs de ce Service, qui sont maintenant au nombre de 43, ont pour mission de fournir un soutien technique aux appareils en service, et ont de ce fait continué à être surchargés, surtout en raison de l'insuffisance de l'effectif en techniciens. Le volume d'assistance technique requis étant supérieur à ce que ce Service pouvait assurer, on a dû réduire le coefficient d'utilisation de certains appareils, ce qui a obligatoirement entraîné le refus de prendre en charge un certain nombre d'expériences.

Au cours de l'année, on a procédé à des réorganisations qui avaient pour but de rassembler l'assistance technique en des groupes plus importants pour arriver à une meilleure efficacité. Quatre groupes 'appareils' et trois 'groupes de service' (groupe monochromateurs, chimie et central) ont été constitués, une équipe chargée des halles d'expériences a été ajoutée au Groupe Central, et le groupe Circuits du réacteur a entrepris de prendre en charge, par l'intermédiaire du Groupe Central, tous les travaux en rapport avec les circuits d'eau de refroidissement et d'effluents radio-actifs.

Ce service a contribué dans une proportion importante à l'installation de la plateforme pour les équipements à neutrons ultra-froids, D17, D18, IN9, ainsi qu'aux travaux de modification de la protection de D16.

Au titre des attributions du Groupe Central, ses agents ont apporté leur concours à l'optimisation de D15 et IN11, à la poursuite des travaux de mise au point de polariseurs multi-couches, à l'adaptation d'une micro-balance sur un cryostat, à la mise au point d'un système d'ultra-vide pour l'étude des surfaces, à la mise au point et à l'expérimentation, en collaboration avec le Service Contrôle des Instruments et Acquisition des Données, d'un nouveau multi-détecteur, et aux études en matière de sécurité pour l'irradiation d'un échantillon de PU<sup>242</sup> p. Une étude d'un laboratoire équipé pour la manipulation de certaines matières particulièrement dangereuses, par exemple des éléments transuraniens, a été menée à bien et ce projet est présentement en discussion.

La normalisation du fonctionnement des obturateurs de faisceaux dans le Hall des Guides de Neutrons a été terminée, tout comme l'implantation d'un circuit mémoire servant à indiquer l'état actuel et l'état immédiatement antérieur de chaque obturateur de faisceau secondaire. Il s'ensuit qu'en cas de fermeture de l'obturateur principal, l'équipe de quart peut maintenant faire redémarrer des expériences dans un laps de temps particulièrement réduit.

On a mis à profit l'arrêt annuel du réacteur pour peindre tout le sol et toutes les surfaces en béton exposées à la vue dans le Hall des Guides de Neutrons, pour réduire les problèmes de poussières. Le sol des zones expérimentales de IN10, D7, D1B et du Canal Technique, a également été modifié, étant donné que le revêtement plastique qu'il comportait jusqu'à présent s'avérait incapable de résister au choc thermique découlant de projections accidentelles d'azote liquide.

# services informatique

## introduction

Au cours de l'année 1976, ces Services n'ont fait l'objet d'aucune modification importante, pas plus sur le plan de l'organisation que sur le plan technique, et cette année s'est principalement caractérisée par des problèmes liés à des insuffisances d'effectifs et des restrictions budgétaires.

Les instruments sont maintenant utilisés de façon plus intensive que durant les premières années de fonctionnement, et certains équipements commencent à présenter des signes de vieillesse. Il s'ensuit que l'entretien et le remplacement de systèmes existants sont devenus l'activité prédominante.

L'ordinateur central DEC Système 10 continue à assurer les calculs scientifiques, y compris l'analyse des données et leur archivage, mais il n'a pas été possible d'augmenter la configuration en proportion de la demande, et cet état de choses a conduit à des difficultés considérables.

Il n'en demeure pas moins que tous les membres du Département se sont montrés conscients des problèmes de l'Institut et ont bien collaboré à maintenir tous les systèmes en fonctionnement.

## 1 service contrôle des instruments et acquisition des données

Ce service assume la responsabilité des mises au point, des améliorations et de l'entretien des équipements électroniques, des dispositifs électroniques de commande des instruments, des systèmes informatiques des instruments et des détecteurs de l'ILL.

### 1.1 -- Systèmes CARINE

[ CARINE 1 : D1A, D1B, D2, D5, D8, D9

CARINE 2 : D1O, IN1, IN2, IN3, IN8

CARINE 3 : unité de réserve ; pour les travaux d'essais et  
de mise au point ; utilisation individuelle par D1B ou D8 ]

Des améliorations techniques apportées à un certain nombre de diffractomètres ont fait ressortir le fait que la longueur des temps de réponse de l'ordinateur constituait actuellement le principal goulot d'étranglement au niveau de nombreuses

expériences. Pour que les instruments à trois axes n'aient pas à souffrir de ces problèmes, on les a regroupé sur CARINE 2, et le système de réserve, CARINE 3, est affecté soit au D1B soit au D8 (qui sont les instruments imposant habituellement les exigences les plus rigoureuses), lorsqu'il n'est pas fait appel à son concours par ailleurs.

La possibilité d'utiliser des micro-processeurs pour accélérer les éléments électroniques est à l'étude. Mais l'entretien des systèmes électroniques existants occupe à plein temps le personnel dont on dispose, et la réalisation pratique de modifications importantes ne sera pas chose facile.

Les travaux d'unification des logiciels d'application se sont poursuivis, mais ont dû être souvent délaissés au profit de travaux visant à résoudre des problèmes d'entretien plus urgents.

## 1.2 — Systèmes NICOLE

[ NICOLE 1 : D7, D11A, IN4, IN5, PN1

NICOLE 2 : unité de réserve ; pour essais et mises au point ]

Compte tenu de la décision de procéder au remplacement de NICOLE par un système plus moderne et offrant davantage de souplesse, les travaux de développement de ces systèmes se limitent maintenant à de simples modifications au niveau du support des instruments, en particulier du polariseur de neutrons et des caches mobiles tournants sur le D7.

L'alimentation protégée, qui a été mise en place à la fin de l'année, devrait améliorer la fiabilité dans des proportions considérables. Au cours de l'année 1976, la principale cause de dérangement de ces systèmes a en effet résidé dans des pannes de courant provoquées par les orages, qui ont été très fréquents au cours de l'été.

## 1.3 -- Systèmes PDP -- 11

D3, D6, D8, D11A/B, D14, D17, IN10, 1N11, PN2, PN3, LI7, S4.

Le PN2 (BILL) a été doté d'un petit PDP 11/10, ce qui le rend indépendant vis à vis du PN3, et fonctionne maintenant dans des conditions satisfaisantes. Les trois spectromètres GAMS, qui composent le PN3, ont continué à poser des problèmes d'interférences, et il a donc fallu mettre en place un petit PDP 11/04 pour pouvoir séparer les GAMS II et III du GAMS I. Cet équipement fonctionne maintenant dans de bonnes conditions.

L'abandon du projet de caméra Arndt D14, a rendu disponible un petit PDP 11/40. Celui-ci, après différentes adjonctions, sera affecté au D8, instrument qui, retiré de CARINE, aurait le plus d'avantage à bénéficier d'un meilleur temps de réponse.

Le système équipé d'un PDP 11/40, destiné au D17, est entré en service en septembre. Il présente plusieurs caractéristiques nouvelles et originales, dont les équipements de contrôle des données en ligne satisfaisants et un circuit de transmission directe des données à l'ordinateur central. L'assimilation de la manipulation de ces équipements demandera un certain temps pour en tirer le maximum d'efficacité. Un système équivalent prévu pour équiper le D11A/B était prêt pour les essais à la fin de l'année.

Au niveau des systèmes déjà opérationnels, des efforts considérables ont été mis en oeuvre pour le D3 et l'IN10 en rapport avec les modifications apportées aux instruments. Pour l'IN10 et le GAMS 1, on a mis au point un module qui engendre des signaux acoustiques en fonction de l'état opérationnel du système, et qui a été raccordé sur le réseau téléphonique. Ceci permet aux collaborateurs scientifiques de vérifier l'état de fonctionnement de leur appareil à n'importe quel moment, en adressant simplement un appel téléphonique à l'Institut.

#### **1.4 — Autres systèmes d'instruments**

Pour arriver à un certain niveau d'automatisme dans l'acquisition des données pour l'IN9 au cours de ses essais de réalisations pratiques, on a mis en place un système utilisant un micro-processeur INTEL 8080. C'est la première fois qu'un tel système est installé dans ces conditions à l'ILL, et son fonctionnement est observé avec beaucoup d'intérêt.

Le système assurant la commande du D15 et du D16 continue à causer des problèmes, particulièrement au niveau de l'interface entre les équipements électroniques et le calculateur PDP 8/E. Pour le nouvel interféromètre D18A, il n'existe pour l'instant pas de ressources disponibles pour un ordinateur de commande mais la partie électronique est bien avancée.

#### **1.5 Equipements électroniques en général**

Ce groupe assure des prêts et des réparations de dispositifs de mesure et de commande électroniques au niveau de l'ensemble de l'Institut. La demande à cet égard est en augmentation croissante, et il devient difficile de la satisfaire de façon continue. L'entretien essentiel de cet équipement demande maintenant tellement de temps, qu'il en reste très peu pour la mise en oeuvre de nouveaux modules.

#### **1.6 — Détecteurs**

De nouvelles batteries de détecteurs, dotés des équipements électroniques correspondants, ont été installées sur l'IN7, D11B et IN9. Le nouveau détecteur à bi-dimensionnel a été monté sur le D17, et son système à logique ultra-rapide a également été installé sur le D11A.

On s'est mis d'accord sur une spécification pour un multi-détecteur uni-dimensionnel portable (type banane) qui pourra être utilisé sur des appareils du genre D8, D9, D16, et la réalisation pratique a commencé.

Les travaux pour la fabrication de détecteurs à des fins de contrôle se sont également poursuivis.

Le projet de caméra Arndt D14, est maintenant abandonné.

### 1.7 — Entretien des calculatrices

Eu égard à l'augmentation des coûts des prestations d'entretien, l'ILL a passé un nouveau contrat avec DIGITAL EQUIPMENT CORPORATION (DEC) aux termes duquel toutes les calculatrices entretenues par cette firme (PDP-10, quatre PDP 11/20 et deux PDP8) sont prises en charge par les techniciens résidents DEC suivant une priorité déterminée par l'ILL. Il s'ensuit que lorsque des pannes simultanées se produisent, il peut s'écouler un temps très long avant que l'une d'elles puisse être réparée. On étudie la possibilité d'entretenir les PDP 11/20 par des techniciens de l'ILL (comme c'est le cas pour les 9 autres PDP 11) étant donné que l'équipe d'entretien et dépannage est maintenant bien familiarisée avec les équipements DEC et opère avec une grande efficacité.

Le nombre de pannes signalé en dehors des heures normales de travail semble être en régression. Les utilisateurs habituels de ces systèmes se familiarisent avec leurs particularités individuelles et sont souvent en mesure soit de résoudre par eux-mêmes des problèmes d'importance mineure, soit de savoir comment procéder pour éviter qu'ils ne se produisent.

## 2 service calcul scientifique

Le volume des données expérimentales transmises à l'ordinateur central DEC System 10 est pour le moment stabilisé à environ 200 M mots/an. Ceci traduit le fait qu'il n'a pas été mis de nouveaux instruments en service.

La demande en temps d'unité centrale continue à augmenter cependant, au fur et à mesure que les collaborateurs scientifiques apprennent à utiliser des programmes d'analyse et de correction plus élaborés. L'unité centrale a fonctionné durant 3200 heures en 1976, ce qui représente une augmentation de 25 % de son coefficient d'utilisation par rapport à l'année 1975. Ce chiffre ne reflète cependant pas le volume réel de la demande étant donné que le système se trouve saturé durant la majeure partie du temps où il se trouve sous le contrôle des opérateurs. Pour pallier à cette saturation, les collaborateurs scientifiques ont reçu l'autorisation de faire fonctionner eux-mêmes cette machine la nuit et durant les week-ends, mais on ne considère pas qu'il s'agisse là d'une solution satisfaisante.

Dans une telle situation, le personnel préposé à la conduite de cet équipement doit faire preuve de beaucoup de fermeté en refusant l'accès aux personnes non autorisées. Mais étant donné le grand nombre d'expériences qui sont maintenant effectuées par des groupes de travail mixtes composés d'agents de l'ILL et de chercheurs invités, il est difficile d'établir et de faire appliquer à cet égard des règles réalistes.

Il est également à déplorer que des restrictions budgétaires aient empêché, en 1976 d'accroître la configuration de l'ordinateur central et d'agrandir la salle machine. On se pose maintenant sérieusement la question de savoir si le système sera en mesure d'absorber les charges de travail futures qui lui seront imposées, et qui seront représentées par exemple par les liaisons directes avec le D11 et le D17, et les quantités de données supplémentaires qui découleront de l'utilisation plus poussée de multidétecteurs.

Les adjonctions apportées sur le plan du matériel ont été les suivantes :

- 1 commande de disque (il y en a maintenant 7 au total)
- 1 traceur de courbes électrostatique 'Versatec' (fonctionnant non connecté à l'unité de traitement)
- 1 terminal graphique Tektronix 4010 (maintenant 2 au total)

Le personnel de l'ordinateur central répartit son temps entre deux grands secteurs d'activité : travaux de mises au point du système, et aide aux utilisateurs. Nous pouvons citer dans le premier cas :

- Introduction d'un nouveau logiciel fourni par DEC
- Logiciel pour terminal à cassettes
- Logiciel pour imprimante électrostatique
- modifications au niveau des structures d'archivage de données expérimentales, rendues nécessaires par la transmission directe de données en provenance du D11 et du D17.

En ce qui concerne l'aide apportée aux utilisateurs, l'aspect le plus positif que l'on ait en l'occurrence enregistré est que les problèmes relatifs aux bandes de données destinées aux chercheurs invités ont été pratiquement résolus. Il est maintenant très rare que l'on reçoive des rapports de ces personnes se plaignant d'éprouver des difficultés de lecture ou de compréhension des données. Des améliorations ont également été apportées dans les domaines de l'analyse numérique, en particulier grâce à un meilleur générateur de nombres au hasard, et à l'introduction d'un logiciel permettant la manipulation des nombres dans n'importe quel degré de précision souhaité.

Au cours de l'année, on a entrepris, pour le compte du Service des Relations Sociales et des Chercheurs Invités, le transfert dans le Service Calcul Scientifique d'une série de travaux concernant les missions et la formation permanente réalisés jusqu'alors par une firme extérieure. Les programmes correspondants fonctionnent correctement, et leur exploitation a été confiée à des membres de ce service.

# administration

Le département «Administration» comprend le Service du Personnel, le Service des Relations Sociales et le Service Financier.

Le projet de Convention d'Entreprise tenant compte de la situation spécifique de l'ILL a abouti fin 1976 à un accord entre la Direction et les syndicats. Ce projet est à présent soumis à l'approbation du Comité de Direction.

## personnel

Les tâches de plus en plus importantes et complexes en matière de gestion du personnel ont amené le Service du Personnel à une restructuration interne, afin d'augmenter son efficacité et d'éviter au maximum les lourdeurs administratives.

L'effort de recrutement en Grande Bretagne a été poursuivi afin d'arriver à un meilleur équilibre des nationalités. Il est à signaler également l'effort entrepris en matière de mutation et promotion internes.

### I SITUATION DE L'EFFECTIF

Catégories	Situation au 31.12.75	Mouvements en 1976		Différence + ou -	Situation au 31.12.76	Fluctu- ations % col. 4 par rapport col. 2
		Embauches et fluctua- tions internes	Départs et fluctua- tions internes			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Scientifiques	73	16	16	-	73	22
2. Cadres tech- niques et administratifs	54	4	--	+ 4	58	-
3. Collabora- teurs tempor. de thèse	29	11	15	-4	25	52
4. Techniciens	139	9	6	+ 3	142	4
5. Autres Catégories	100	6	7	-1	99	7
Total	395	46	44	+ 2	397	11

Les mouvements importants de personnel sont, comme pour les années précédentes, essentiellement dus au personnel scientifique ayant des contrats à durée limitée.

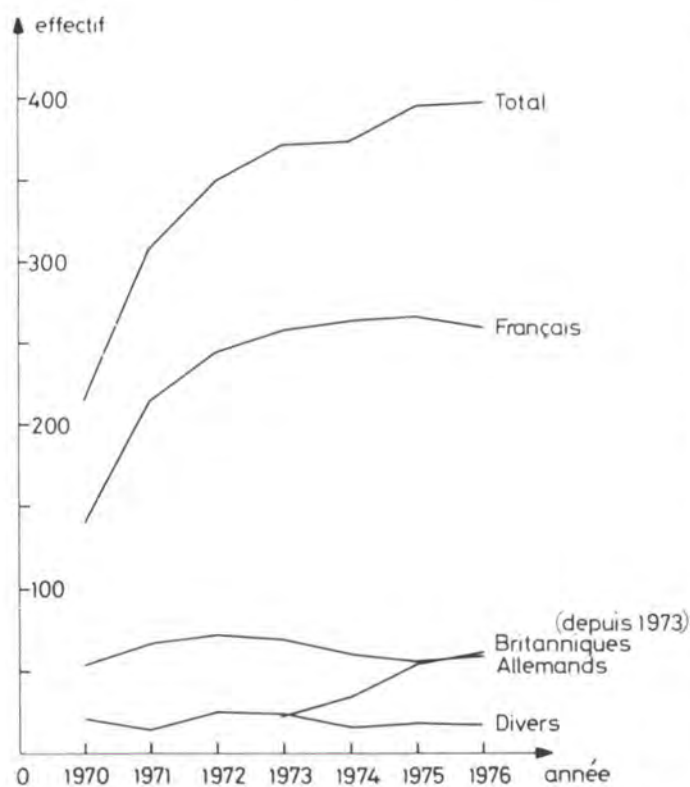
\* Pourcentage du personnel ILL qui a quitté l'Institut en 1976, par comparaison avec l'effectif au 31.12.1975.

## II REPARTITION PAR NATIONALITE : 1973, 1974, 1975, 1976

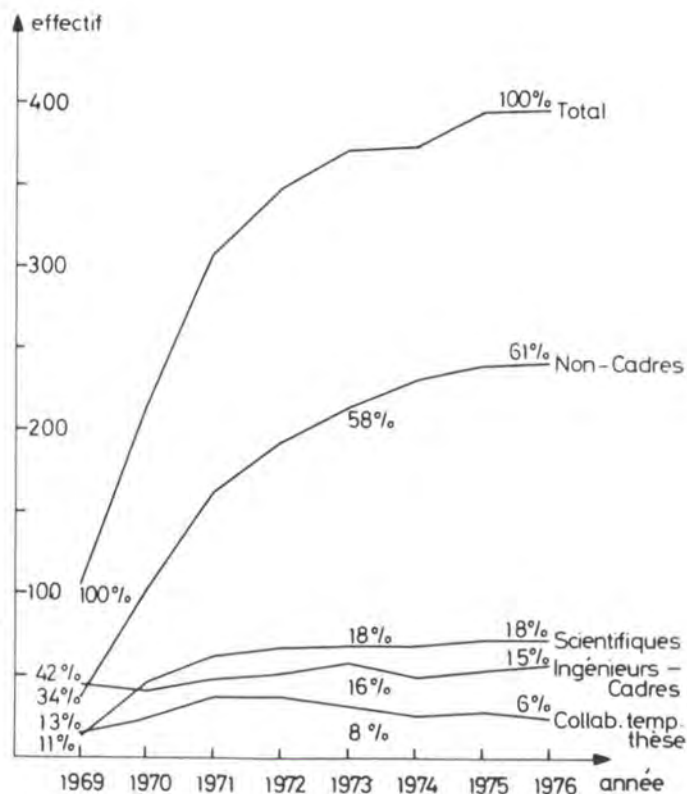
Catégories	Français				Allemands				Britanniques				Divers				Total			
	73	74	75	76	73	74	75	76	73	74	75	76	73	74	75	76	73	74	75	76
Scientifiques	19	18	17	17	25	26	22	21	7	13	22	22	17	11	12	13	68	68	73	73
Cadres et Ingénieurs	38	35	38	40	15	9	11	11	5	5	5	7	-	-	-	-	58	49	54	58
Collaborateurs temp. de thèse	18	15	15	9	10	7	5	9	1	2	7	7	2	2	2	-	31	26	29	25
Non-Cadres	182	195	196	193	19	18	18	19	9	14	21	25	4	3	4	4	214	230	239	241
Totaux	257	263	266	259	69	60	56	60	22	34	55	61	23	16	18	17	371	373	395	397
Variations		+6	+3	-7		-9	-4	+4		+12	+21	+6		-7	+2	-1		+2	+22	+2

- 1) Français : légère diminution en 1976 (-7)
- 2) Allemands et Britanniques : augmentation en 1976 (+4 et +6)

Evolution de la répartition du personnel par nationalité de 1970 à 1976



Evolution de l'effectif Représentation de chaque catégorie



## V – PERSONNEL PAR CATEGORIE ET NATIONALITE AU 31.12.1976

EFFECTIF TOTAL : 397

Français 259

Allemands 60

Britanniques 61

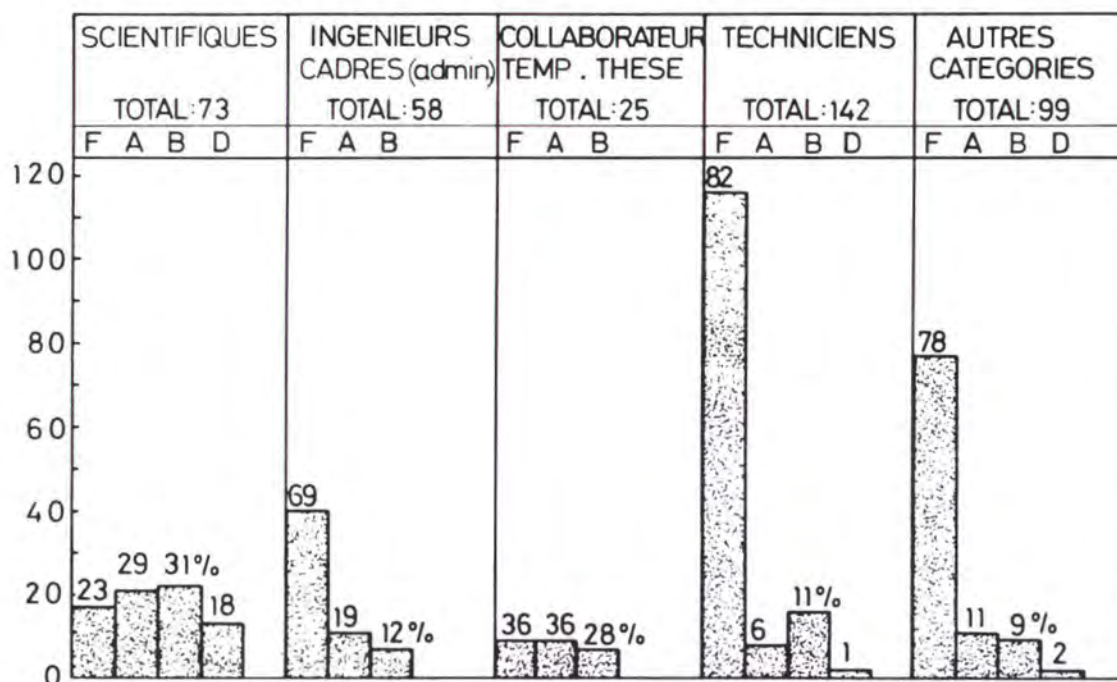
Divers 17

F : Français

A : Allemands

B : Britanniques

D : Divers



Déséquilibre évident entre Français et Allemands et Britanniques dans les catégories Ingénieurs, Techniciens et autres.

Après dissolution du syndicat ILL, deux syndicats français restent représentés en 1976.

Lors du 2ème tour des élections de Délégués du Personnel, Collège Cadre, deux candidats hors listes syndicales, ont été élus (1 titulaire et 1 suppléant).

Le Comité d'Entreprise, conformément à ses attributions, a participé à la vie active de l'ILL, notamment par l'intermédiaire de ses diverses commissions (formation, amélioration des conditions de travail, Mutuelle, etc. . . ).

Il a pu également donner fréquemment son avis sur les questions financières et techniques.

# chercheurs invités · relations sociales formation

(Tous les chiffres donnés sont arrêtés au 30.11.76)

## CHERCHEURS INVITES

Au cours de l'année 1976 nous avons enregistré :

– 1344 passages de Chercheurs Invités.

A ceci s'ajoute la gestion des Chercheurs Invités de longue durée (28).

Dépenses 1976 = 2 050 000 F.

Cette somme comprend les frais de voyage et indemnités journalières pour les utilisateurs du réacteur, les chercheurs invités pour des expériences à long terme, séminaires et les réunions du Conseil Scientifique.

## SERVICE MEDICAL

a) La surveillance médicale du personnel et des Chercheurs Invités s'est effectuée suivant les risques encourus.

Ainsi en personnel directement affecté (c.a.d. travaillant en zone contrôlée plus de 200 heures par an), nous avons eu :

– 180 agents I.L.L.

– 33 chercheurs invités.

Ces personnes sont convoquées deux fois par an pour les prélèvements et analyses nécessaires et visite médicale, qui s'effectue au Service Médical du Centre d'Etudes Nucléaires de Grenoble – Ont été suivis, une fois par an, par le Médecin du Travail exerçant dans les locaux de l'I.L.L.

Agents I.L.L.	: Non directement affectés :	124
	Non affectés :	95
Chercheurs Invités	: Non directement affectés :	116

Les Chercheurs Invités qui remettent, lors de leur arrivée, un certificat médical attestant leur aptitude à travailler sous rayonnements ionisants, sont dispensés de ces visites.

b) 20 accidents de travail ont été, à ce jour, déclarés à la Sécurité Sociale dont :

– 6 accidents ayant entraîné au total 99 jours d'arrêt de travail.

– 3 accidents de trajets.

- c) Arrêts de travail pour maladie, maternité, etc. . .  
 Au 30 Novembre 1976, nous relevons :  
 98 arrêts de travail (13 cadres, 85 non-cadres), représentant 1666 jours d'absence, soit un pourcentage d'absence de 1,75 % par rapport au nombre d'heures de travail théorique correspondant.  
 Le plus grand nombre d'arrêts de travail se situe en Avril – Mai et Septembre.  
 A noter cette année, 4 maladies graves de longue durée, reconnues comme telles par la Sécurité Sociale, entraînant l'application de l'article 29.1 du Statut du Personnel (maintien de la rémunération sous déduction des indemnités journalières de la Sécurité Sociale pendant toute la durée de la maladie).
- d) Sécurité Sociale et Société Mutualiste du Personnel I.L.L.  
 Au 30 Novembre 1976 : 6170 feuilles de maladie ont été contrôlées, complétées par le Service et transmises à la Sécurité Sociale pour liquidation. ( 5.580 décomptes en 1975 et 4.967 en 1974).
- La Société Mutualiste est intervenue pour le règlement de 4.715 décomptes de remboursements complémentaires à la Sécurité Sociale pour un montant de 210.343 F au 30.11.76.
  - Des conventions ont été passées avec les hôpitaux et cliniques de la région, aux termes desquelles les agents, membres de la Société Mutualiste du Personnel I.L.L., n'ont aucun frais à déboursier - à l'exception de dépenses personnelles - lors d'une hospitalisation qu'il s'agisse d'eux-mêmes, d'un conjoint ou d'un enfant, - sur présentation d'une attestation de «prise en charge» délivrée par la Société Mutualiste : 197 prises en charge ont été délivrées à ce titre en 1976.
  - A noter que des remboursements complémentaires sont effectués par l'I.R.R.A.P.R.I., (Caisse de Retraite des Cadres et Assimilés) en particulier pour des remboursements en radiographies, hospitalisations médicales du personnel participant à cette Caisse de Retraite auprès de laquelle nous avons souscrit un contrat de prévoyance.
  - 218 dossiers ont ainsi été transmis représentant 39.095 Francs de remboursements.

#### QUESTIONS SCOLAIRES

La moyenne du nombre d'enfants non-français accueillis à l'école de la Houille Blanche a été de 42 pour l'année scolaire 1975-76. Elle se situera à 50 pour l'année 1976-77.

Nous sommes en relations avec Hewlett-Packard – Ugine-Carbone – et Thomson qui envoient des enfants du personnel non-français, moyennant versement d'une participation financière.

Au lycée des Eaux Claires fonctionnent une classe de 6e et une classe de 5e expérimentale, suivant les mêmes principes qu'à la Houille Blanche (1 heure d'enseignement par jour dans la langue maternelle aux non-français ; tout le reste du programme étant celui de l'Education Nationale Française).

Il n'est pas encore décidé si la Direction du Lycée est d'accord pour poursuivre l'expérience au delà de la classe de 5e, en raison d'une part de faible nombre d'enfants concernés (8 à 10 dans chaque classe) et des orientations décidées en fin de 5e.

#### QUESTIONS DE LOGEMENTS

Des aides à l'accèsion à la propriété sont intervenues

- par l'intermédiaire du C.I.L.A.F. (comité interprofessionnel du logement collecteur de fonds de 1 % pour la région).
- 22 prêts pour une valeur totale de 253.000 Francs. Ces versements sont effectués dans le cadre de la loi de 1956, réglementant l'obligation des employeurs de consacrer 1 % des salaires brut à l'effort de construction.
- auprès de l'I.R.R.A.P.R.I. – 3 prêts directs pour une valeur de 81.000 F.
  - 3 cautions données pour des prêts sollicités auprès de la Banque Nationale de Paris.
  - 2 dossiers refusés.

#### FORMATION PROFESSIONNELLE CONTINUE

L'année 1976 est marquée par un travail d'étroite collaboration du Service et la Commission Formation du Comité d'Entreprise.

Le souci commun a été :

- d'étudier un système d'enseignement plus structuré dans le domaine linguistique.
- c'est ainsi en particulier qu'une convention a été passée avec le C.U.E.F.A. (Centre Universitaire d'Education et Formation des Adultes) dans les locaux duquel se déroulent maintenant l'enseignement de l'anglais : les agents I.L.L. bénéficient des moyens audio-visuels importants de ce Centre, encadrés par des enseignants formés à l'enseignement des adultes.
- de trouver dans la région Grenobloise des organismes valables susceptibles de répondre aux nombreuses demandes de formation professionnelle.
- d'élargir le champ des formations générales, en recherchant des sujets d'intérêt réel : sont ou vont être réalisées dans ce cadre des formations en économie - éducation du consommateur - études des institutions en France par exemple.

Les différentes formations représentent :

- environ 30 % par les actions linguistiques.
- près de 50 % par les actions professionnelles.
- un peu moins de 20 % par les actions générales.

# service financier

## 1 — BUDGET ET COMPTABILITE

Le budget autorisé pour l'année de référence prévoyait des dépenses d'un montant total de 89,5 M. F. Sur ce montant 1,4 M. F. devait être couvert par des recettes propres à l'Institut, tandis que les contributions des Associés étaient prévues pour un montant de 88,1 M.F.

En ce qui concerne les dépenses totales évaluées dans le budget, le règlement transitoire a dû - comme pour l'année précédente- être appliqué encore cette fois, d'après lequel les gouvernements compétents autorisent les Associés à approuver pour l'Institut, jusqu'à ce qu'un nouveau règlement contractuel soit en place, un budget plus élevé par rapport aux dispositions financières de l'accord intergouvernemental du 19 juillet 1974.

Entre temps la révision formelle de ces dispositions financières a eu lieu. La version modifiée de l'accord intergouvernemental, qui annule la clause en vigueur jusqu'à présent relative au plafond du budget annuel, a été signée le 27 juillet 1976. La modification correspondante du contrat de la Société a été faite le 23 août 1976.

Par rapport aux dépenses totales prévues dans le budget 1976, d'un montant de 89,5 M. F., le solde suivant résulte de l'arrêté des comptes provisoire 1976 :

### a) Frais de fonctionnement

	1976 (x 1000)	% du total	1975 (x 1000)	% du total
Matières et matériels consommables	6.270	7,0	5.940	7,8
Elements combustibles	9.900	11,0	9.800	12,8
Frais de personnel	41.856	46,55	36.100	47,1
Taxes	97	0,1		
Travaux, Fournitures et Services Extérieurs à long terme	7.400	8,2	8.570	11,2
Autres Travaux, Fournitures et Services Extérieurs	5.623	6,3	5.380	7,0
Frais de mission, déménagements et transports	950	1,0	800	1,0
Frais divers de gestion	2.800	3,1	2.350	3,1
Total frais de fonctionnement	74.896	83,25	68.940	90,0

b) Investissements

Bâtiments	230	0,25	400	0,5
Aménagements (sauf dispositifs expérimentaux)	1.100	1,20	1.000	1,3
Dispositifs expérimentaux	8.857	9,9	4.100	5,3
Autres investissements	4.810	5,4	2.200	2,9
Total investissements	14.997	16,75	7.700	10,0
Total dépenses	89.893	100,00	76.640	100,0

c) Recettes

Recettes internes	1.794	2,0	1.700	2,2
Contribution des Associés	88.099	98,0	74.940	97,8
Total recettes	89.893	100,00	76.640	100,0

Les dépenses totales provisoires de l'année de référence n'étaient donc inférieures que de peu à ce qui avait été évalué dans le budget. Les recettes propres à l'Institut ont évolué de façon moins satisfaisante que prévu. Quelques contrats attendus concernant la détritiation d'eau lourde n'ont malheureusement pas été conclus.

- 1.1 Les dépenses de fonctionnement ont augmenté par rapport à l'année précédente, passant de 68,9 M. F. à 74,9 M. F. (+ 8,7 %). Ce taux d'augmentation ne devrait dépasser que faiblement l'augmentation générale des prix pour l'année de référence. Les principaux écarts par rapport aux dotations sont à signaler principalement au poste «Frais de mission et de séjour pour les utilisateurs du réacteur», où les dépenses sont supérieures de 40 % environ à ce qui était initialement prévu. Ces dépenses supplémentaires sont essentiellement dues à une extension du fonctionnement pour les utilisateurs.
- 1.2 Par rapport à l'année précédente, les dépenses d'investissement sont passées de 8,7 M. F. à 16,75 M. F. (+ 92 %). Pour des raisons de clarté il faut cependant signaler que dans ces dépenses sont compris 3,1 M. F. destinés à l'achat d'une installation pour le calcul scientifique, et qu'il faut donc considérer comme une dépense unique, ne se répétant pas annuellement.

Dans le domaine de la comptabilité la procédure d'information a été améliorée afin de rendre compte plus tôt aux services chargés de la gestion des crédits de la situation des dépenses et des engagements pris.

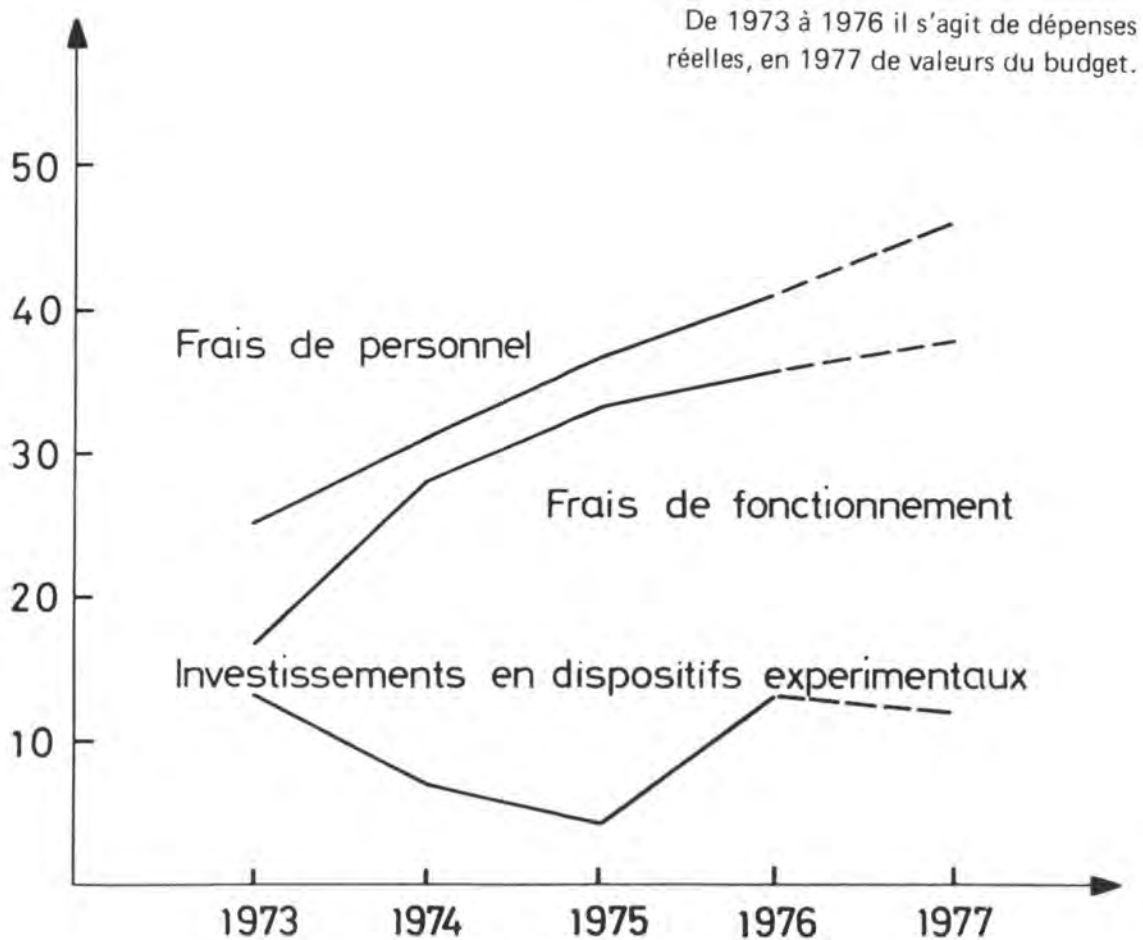
### 3 — ACHATS

Le service des achats a traité 5.538 commandes au cours de l'année de référence, contre 3.930 en 1975. Tous les achats ont été exécutés en étroite collaboration avec les services techniques et scientifiques.

De nouveaux succès sont à signaler pour cette année en ce qui concerne les efforts qui ont été faits pour atteindre un meilleur équilibre dans la passation des commandes entre les trois pays partenaires. La part des contrats passés en Grande-Bretagne et en RFA a évolué comme suit :

	1976		1975	
	F	%	F	%
Volume des contrats	26 231 243	100,0	20 096 199	100,0
Part :				
— France	16 493 089	62,9	12 951 198	64,4
— RFA	6 594 704	25,1	6 206 736	30,9
— Grande-Bretagne	3 143 450	12,0	938 265	4,7

### 2 — EVOLUTION DES DEPENSES 1973-1977



Un évènement douloureux a marqué cette année 1976. La mort tragique, causée par un accident d'avion, de deux de nos collaborateurs :

M. Jean-Paul Giraud

M. Gabriel Prati.

Un fils de M. Giraud a également trouvé la mort dans cet accident. Les deux disparus travaillaient à l'ILL depuis des années où ils jouissaient de l'estime de tous.

I.L.L. PUBLICATIONS 1976

(References arranged by Code Number)

Example of Code Number : 76 A 08

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

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

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## LIST OF THESES

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- 76I17 G. ICHE, Thèse de Doctorat d'Etat, Grenoble (Février 1976). Description "Stochastique" de la Désorption. Equation de "Fokker Planck" Quantique.
- 76P19 J.C. PARLEBAS, Thèse de Doctorat d'Etat, Strasbourg (Février 1976). Effets des Interactions entre Impuretés sur la Structure Electronique et les Propriétés Magnétiques des Métaux Nobles ou de Transition.
- 76J30 P. JEUCH, Doktorarbeit, München (Feb. 1976). Anbau und Justierung des Konversionselektronen-Spektrometers BILL und Messung von Konversionselektronen nach Neutroneneinfang an  $^{233}\text{Th}$ .
- 76M153 Jürgen MEYER, Doktorarbeit, München (July 1976). Wechselwirkende Phononen in Kalium.
- 76G155 G. GÖLTZ, Doktorarbeit, Stuttgart (June 1976). Magnetische Kleinwinkelstreuung von Neutronen an Versetzung in verformten Eiseneinkristallen.
- 76P175 P. PATAUD, Thèse de Doctorat d'Etat, Grenoble (June 1976). La Diffusion des Neutrons de Grande Longueur d'Onde appliquée à l'Apparition du Magnétisme dans les Alliages Métalliques Désordonnés.
- 76P223 T. PETERLIN-NEUMAIER, Doktorarbeit, München. Untersuchung von nichtperiodischen Bewegungen in Teilkristallinem Polyäthylen mittels hochauflösender Neutronenspektroskopie.
- 76L225 F. LIVET, Thèse de Doctorat d'Etat, Grenoble (Oct. 1976). Contribution à l'Etude du Magnétisme des Alliages de Métaux de Transition par la Diffusion des Neutrons.
- 76R259 R. ROUSSILLE, Thèse de Doctorat d'Etat, Grenoble (Oct. 1976). Etude des Niveaux Excités de Trois Isotopes de Néodyme de Masse Impaire 147, 149, 151Nd.
- 76B407 H. BORNER, Doktorarbeit, München (December 1976). Bestimmung des Termschemas von  $^{239}\text{U}$  durch hochgenaue Messung von  $\gamma$ -Strahlungen nach Einfang thermischer Neutronen.
- 76G408 M. GRUPP, Doktorarbeit, Heidelberg (December 1976). Defects in  $\text{CaF}_2$  Following the Thermal Neutron Capture Process  $^{19}\text{F}(n, \gamma) ^{20}\text{F}$  and Relaxation by Intrinsic Anion Self-Diffusion in  $\text{CaF}_2$ .

CONFERENCES AT I.L.L. IN 1976

Information Meeting on Hydrogen in Metals (organized by T. Springer and W. Just)	January 1976
Meeting on Binary Alloys (organized by P. Chieux and A. Guinier)	February 1976
Workshop on "Special Diffraction Methods" (organized by B. Klar and S.A. Mason)	March 1976
Structure and Dynamics of Liquids with Ionic Interactions (organized by J.R.D. Copley, and J.E. Enderby)	October 1976

## EXPERIMENTS PERFORMED AT I.L.L. 1976

The following is a list of the experiments performed at I.L.L. from January 1 to October 1 1976 for which reports have been received up to January 10 1977.

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

COLLEGE 3	03 01 026	Irradiation of photoemulsions with fission products	PN1
03 01 007B	Nuclear charge distribution of heavy mass region fission products at variable kinetic energies (Chain 133) H. Braun, Z. Alfassi, H.O. Denschlag, W. Faubel, G. Fischbach, T. Izak-Biran, G. Paffrath, T. Tamai (Mainz) H. Schrader, G. Siegert (I.L.L.)	J. Greif (Giessen) G. Siegert, C. Chauvin (I.L.L.)	PN1
03 01 007B	Nuclear charge distribution of heavy mass region fission products at variable kinetic energies (Chain 134) W. Faubel, H. Braun, H.O. Denschlag, T. Izak-Biran, J. Leuthner, H. Meixler, G. Paffrath, T. Tamai (Mainz) H. Schrader, G. Siegert (I.L.L.)	03 01 027B0 Delayed-neutron spectroscopy of Rb precursors with <sup>3</sup> He ionization chambers K.L. Kratz, H. Ohm, M. ZendeI (Mainz) J. Crançon, C. Ristori (CENG) K.D. Wuensch (Giessen) M. Asghar (I.L.L.)	S28
03 01 008B	Q $\beta$ -measurements in mass chains of short-lived fission products. H. Hawerkamp, F. Münnich, R. Stippler (Braunschweig) R. Decker, B. Pfeiffer, W. Wollnik (Giessen) E. Monnard, F. Schussler (CENG) J.P. Bocquet, H. Schrader (I.L.L.)	03 01 030 03 03 028 Decay properties of short lived Cs and Rb fission products, specially: Q $\beta$ values of neutron rich nuclei K.D. Wuensch, R. Decker, H. Wollnik, J. Muenzel, G. Jung, S. Balestrini (Giessen) G. Siegert, E. Koglin (I.L.L.)	S28
03 01 016B	Spectroscopy of the short lived fission products <sup>136</sup> Te and <sup>131</sup> Sn. J. Blachot, J.P. Bocquet, E. Monnard, F. Schussler (CENG)	03 01 030R Mass yields from <sup>235</sup> U(n <sub>th</sub> , f) as a function of kinetic energy and ionic charge H. Wohlfarth, W. Lang, H.G. Clerc, K.H. Schmidt (Darmstadt) H. Schrader (I.L.L.)	PN1
03 01 016B	Spectroscopy of the short lived fission products <sup>147</sup> La and <sup>147</sup> Ce J. Blachot, J.P. Bocquet, E. Monnard, F. Schussler (CENG) B. Pfeiffer (Giessen) H. Lawin, K. Sistemisch (Jülich)	03 01 031R Nuclear charge yields of the fission products from <sup>235</sup> U(n <sub>th</sub> , f) as a function of the kinetic energy. H.G. Clerc, W. Lang, W. Wohlfarth, H. Dann, K.H. Schmidt (Darmstadt) H. Schrader (I.L.L.)	PN1
03 01 018A0	Investigation of the emission probability of delayed neutrons, P <sub>n</sub> , of individual nuclei. The alkaline activities are obtained by the Ostis facility. C. Ristori, J. Crançon (CENG) K.D. Wuensch (Giessen) M. Asghar (I.L.L.) K.L. Kratz, W. Rudolph, H. Ohm (Mainz)	03 01 034A Nuclear charge distribution and Q $\beta$ values measured with very high mass resolution of Lohengrin W. Kaiser, G. Siegert (I.L.L.) J. Greif (Giessen)	PN1
03 01 025A	Nuclear charge distribution of fission products G. Siegert, W. Kaiser, T. von Egidy (I.L.L.) H. Wollnik, G. Fiedler, G. Geisl, K. Munzenberg, J. Greif, H. Ewald, P. Armbruster (Giessen)	03 01 046 Mass yield measurement and determination of the average energy distance of the decay chain to the stable end product G. Siegert, W. Kaiser (I.L.L.) H. Wollnik (Giessen).	PN1
		03 02 004 Level Structure of <sup>80</sup> Br Do Huu Phuoc, R. Chery (Lyon) Pn3-Group, PN2-Group (I.L.L.) D. Heck (Karlsruhe) H.R. Koch, H. Seyfarth (Jülich)	PN1, PN2 PN3, PN4

03 02 005R 03 02 031	Energy levels of $^{122}\text{Sb}$ and $^{124}\text{Sb}$  V.L. Alexeev (Leningrad) W. Davidson, J.A. Pinston, K. Schreckenbach (I.L.L.)	PN2, PN3	R.F. Casten, D. Warner, J.A. Pinston, H. Boerner, W. Davidson (I.L.L.) A. Namenson (Washington)	
03 02 006	Nuclear spectroscopy $^{232}\text{Th}(n, \gamma)^{233}\text{Th}$  P. Jeuch (I.L.L.)	PN4	03 02 038 Conversion electron studies of $^{190}\text{Os}$  M. Macphail (Manchester) K. Schreckenbach, R.F. Casten (I.L.L.)	PN2
03 02 009	Measurement of the $^{154}\text{Sm}(n, \gamma)^{155}\text{Sm}$ and $^{154}\text{Sm}(n, e)^{155}\text{Sm}$ spectra  R.K. Smither (Argonne) A. Namenson, PN2-Group, PN3-Group (I.L.L.)	PN2, PN3 PN4	03 03 012 Observability of $2\pi$ rotations. (Fresnel diffraction of neutrons)  A.G. Klein, G.I. Opat (Melbourne)	Special S26
03 02 018	The nuclear level structure of $^{172}\text{Yb}$ and $^{174}\text{Yb}$  J. Larysz (Manchester)	PN2, PN3 PN4	03 03 019 Determination of the neutron binding energy of $^{137}\text{Xe}$  B. Fogelberg (Nyköping, Sweden)	Special Set-up
03 02 024	X-rays from double K vacancies in $^{233}\text{U}$ atoms ; X-ray energies from Th, Pa, and U ; $\gamma$ -lines from $^{232}\text{Th}(n, \gamma)^{233}\text{Th}$ .  J.P. Desclaux, H. Boerner, K. Schreckenbach, P. Jeuch, W. Davidson, J.A. Pinston (I.L.L.)	PN3	03 03 020 Determination of concentration profiles by $(n, \alpha)$ - and $(n, p)$ - reactions  R. Henkelmann, K. Mueller, M. Lindner (München) J.P. Biersack, P. Mertens (Berlin)	Special Set-up
03 02 027	High precision measurements of level width, level energies and Auger electrons of atomic shells  K. Schreckenbach (I.L.L.)	PN2	03 03 022 Beta +Neutron +Gamma ray decay mode of isotopes of rubidium and caesium  G.I. Crawford, S.J. Hall, J.D. Kellie (Glasgow) M. Asghar (I.L.L.) R. Decker, K. Wuensch (Giessen)	S28
03 02 028	High precision measurement of Q-values and primary transition energies in the thermal neutron capture process  F. Braumandl, K. Schreckenbach (I.L.L.)	PN2	03 03 024 Time of flight spectrometer capable of determining the velocity of recoil nuclei from delayed neutrons  P. Paris (CNRS, Orsay) H. Wollnik, K. Wuensch (Giessen)	S28
03 02 029	M subshell ratios of pure E2 transitions in the rare earth region  W. Gelletly (Manchester) K. Schreckenbach, R. Casten (I.L.L.)	PN2	03 03 044 Gamma ray spectroscopy with the mass separator OSTIS  J. Blachot, J.P. Bocquet, E. Monnard, F. Schussler (CENG) K. Wuensch, E. Koglin (Giessen) B. Fogelberg (Nyköping, Sweden)	S28
03 02 030	Level structure of $^{249}\text{Cm}$ by neutron-capture, gamma-ray measurements  R. Hoff, T. von Egidy, W. Davidson, K. Schreckenbach, H. Boerner, D. Warner (Livermore, USA and I.L.L.)	PN2, PN3	03 03 044 Gamma ray spectroscopy with the mass separator OSTIS and LOHENGRIN  J. Blachot, J.P. Bocquet, E. Monnard, F. Schussler (CENG) K. Wuensch, B. Pfeiffer (Giessen) H. Lawin, K. Sistemisch (Jülich)	PN1, S28
03 02 033	Study of the levels of $^{196}\text{Pt}$ with particular emphasis on the excited $K = 0$ bands  R.F. Casten, K. Schreckenbach (I.L.L.)	PN2	03 03 052 Low energy neutron induced $(n, p)$ - and $(n, \alpha)$ - reactions in neutron deficient nuclides  G. Andersson (Göteborg, Sweden) M. Asghar (I.L.L.) A. Emsallen (Lyon) E. Hagberg, B. Jonson, Tidemand-Peterson (CERN)	S10
03 02 034	Study of levels and transitions in $^{191}\text{Os}$ : systematics of low lying Nilsson orbitals and fragmentation of Nilsson strength at higher energies.	PN3		

03 03 053	( $n_{th}$ , $\omega$ )- and ( $n$ , $\gamma\omega$ )- reactions on medium and heavy nuclei M. Asghar (I.L.L.) R. Chery, A. Emsallen (Lyon)	S10	04 01 066	Anharmonic effects in orthorhombic $\text{KNbO}_3$ A.M. Quittet (Paris) C.H. Perry, H. Buhay (Boston) R. Currat (I.L.L.)	IN8
03 03 054	Study of ( $n$ , $\omega$ )- and ( $n$ , $f$ )- reactions for several heavy isotopes M. Nève de Mevergnies, C. Wagemans (Mol) A.J. Deruytter, P. D'Hondt (Gent, Belgium) A. Emsallen (Lyon) M. Asghar (I.L.L.)	S10	04 01 067	Phonon dispersion of polysulfur nitride, $(\text{SN})_x$ L. Pintschovius (Karlsruhe)	IN8
			04 01 071	Constantes élastiques de NiS à la transition métal-non métal R. Brusetti, J.M.D. Coey (CNRS Grenoble) C. Escribe, G. Parisot (I.L.L.)	IN3
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04 01 013A	Phonons dans l'urée deutériée J. Lefebvre, R. Fourret (Lille)	IN8	04 01 072	Phonon density of states in gallium L. Bosio, R. Cortes (CNRS Paris) J.B. Suck, J.R.D. Copley (I.L.L.)	IN4
04 01 038	Phonons in beta-gallium L. Bosio, R. Cortes (Paris) J. Copley, W. Teuchert (I.L.L.)	IN2	04 02 007A	Giant Kohn anomaly in KCP B. Renker, L. Pintschovius (Karlsruhe) R. Comes (Orsay)	IN8
04 01 040	Phonons in the layered structure $\text{HgI}_2$ G. Schwab, B. Prevot, M. Sieskind (Strasbourg)	IN3	04 02 016C	Pressure dependence of zone boundary phonons in selenium W.D. Teuchert, J. Meyer (I.L.L.) H. Wendel (Stuttgart)	IN8
04 01 041	Phonon dispersion in cerium deuterides P. Vorderwisch (Berlin) S. Hautecler (Mol) G.G. Libowitz (Morristown)	IN3	04 02 018A	Etude des modes de phonons sur le TBBA J. Doucet, A.M. Levelut, M. Lambert, P. Porquet (Orsay) B. Dorner (I.L.L.)	IN2
04 01 042R	Phonon anomalies in TiN W. Kress, H. Bilz, P. Roedhammer (Stuttgart) A. Christensen (Aarhus) W.D. Teuchert (I.L.L.)	IN8, IN1	04 02 019A/B	Anharmonic phonons in CuCl H. Hennion (Gif) B. Prevot (Strasbourg)	IN2
04 01 044	Lattice vibrations in some layer crystals ; Measurements on $\text{Sb}_2\text{Te}_3$ H. Burkhard, P. Grosse (Aachen) V. Wagner (I.L.L.)	IN8	04 02 021	Pressure dependence of phonon energies in Naphtalene J. Kalus, Schmelzer (Bayreuth)	IN8
04 01 047	Dynamics of Kr adsorbed on graphite J.P. Coulomb, M. Bienfait (Marseille) C. Marti (Paris) P. Thorel, B. Croset (I.L.L.)	IN4	04 02 022R	Structural phase transitions of boracites R.J. Nalms, F.R. Thornley (Edinburgh)	IN8
04 01 049	Study of the phonon modes of $\text{TaS}_2$ K.R.A. Ziebeck, B. Dorner, W.G. Stirling (I.L.L.) R. Schoellhorn (Münster)	IN8	04 02 026	Lattice dynamics of KCN J. Daubert (Münich) W. Dultz (Regensburg) A. Loidl (Frankfurt) K. Knorr (Tübingen)	IN2
04 01 055	Quasielastic scattering from $\text{PbI}_2$ and $\text{SrCl}_2$ M.H. Dickens (Oxford and Harwell)	IN5	04 02 030	Second order phase transition of KTN (Ferroelectric) J. Courdille, J. Joffrin, S. Ziolkiewicz (Paris)	IN2
04 01 060	Lattice phonons of AgBr in the premelting regime W. van der Osten (Paderborn)	IN2	04 02 032	Investigation of ferroelastic phase transition in $\text{Sb}_5\text{O}_7$ W. Prettl, C.R. Becker (Regensburg) V. Wagner (I.L.L.)	IN3

04 03 014	Elastic-diffuse scattering in RbI under pressure (complementary measurement) O. Blaschko, G. Ernst, G. Quittner (Wien)	D7	04 04 040R	Magnetic excitations in antiferromagnetic CoO D. Ronzaud (C.N.R.S. Grenoble and I.L.L.) V. Wagner (Würzburg and I.L.L.) R. Geick (Würzburg)	IN8
04 03 015A	Allotropic (martensitic) phase transformation and the polytype structure of cobalt F. Frey, H. Jagodzinski, W. Prandl (München)	D10	04 04 043	Spin wave dispersion in $Pd_{0.5}Fe_{0.5}$ W.G. Stirling, K. Ziebeck, P. Radhakrishna (I.L.L.)	IN8
04 03 020R	Temperature dependence of phonon excitations in the fast-ion conductor $SrCl_2$ M.H. Dickens, W. Hayes (Oxford) M.T. Hutchings (Harwell)	IN8	04 04 050	Magnetic in MnSi Y. Ishikawa, M. Kohgi (Tohoku) D. Bloch (CNRS Grenoble) P. Radhakrishna (I.L.L.)	IN2
04 03 023	Lattice dynamics of KCN J. Daubert (Garching) K. Knorr (Mainz) W. Dultz (Regensburg) R. Currat (I.L.L.)	IN8	04 04 051	Dynamic spin correlations of 2-dimensional Heisenberg AFM : $Rb_2MnCl_4$ and $(CD_3ND_3)_2MnCl_4$ V. Wagner (Würzburg and I.L.L.) U. Krey (Regensburg) N. Lehner (Karlsruhe)	IN3
04 03 025A	Soft phonon and central peak in $RbCaF_3$ R. Almairac (I.L.L.) B. Hennion (Saclay) J. Nouet, M. Rousseau (Le Mans)	IN2	04 05 005A	Quasielastic neutron scattering from NaOH J.G. Smit, H. Dachs (Berlin) R. Lechner (I.L.L.)	IN4
04 03 030	Anisotropic exchange and orbital effects in K $CoF_3$ via the dispersion of high energy longitudinal excitons G. Parisot (I.L.L.) M.T. Hutchings, N.S. Satya-Murthy, W.J.L. Buyers (Harwell)	IN1	04 05 013	Quasielastic scattering from $\alpha AgI$ G. Eckold, K. Funke (Göttingen) R.E. Lechner (I.L.L.)	IN5
04 03 041	Investigation of the magnetic excitation spectrum of nearly 1D AF $CsLnBr_3$ and $CsCoCl_3$ R. Weber, W. Breitling (Konstanz) V. Wagner (I.L.L.)	IN3	<b>COLLEGE 5</b>		
04 04 002A	Spin waves in finite ferromagnetic chains : an inelastic neutron scattering investigation of $CsNiF_3$ (2% Mg) M. Steiner (Berlin) B. Dorner (I.L.L.)	IN2	05 01 006R	The crystal structure of a 1Tc chlorite W. Joswig (Frankfurt)	D8
04 04 023A	Investigation of the hyperfine splitting in $V_3O_5$ and $V_4O_7$ by inelastic neutron scattering A. Heidemann (I.L.L.) K. Kosuge (Kyoto)	IN10	05 01 015A	Etude structurale in situ de l'oxyde $Fe_{1-x}Zn_xO$ Carel, Gavarrri, Grammond, Weigel (Paris)	D2
04 04 026R	Inelastic neutron scattering from an ionic ferromagnet M.J. Fair, P. Day (Oxford) M.T. Hutchings (Harwell)	IN2	05 01 064B	Sublattice ordering in $\beta'$ -sialons G.E. Bacon, N. Cowlan (Sheffield)	D2
04 04 029A	Spin waves in $Pd_3Fe$ A.J. Smith, R.A. Cowley (Edinburgh) W.G. Stirling (I.L.L.)	IN1	05 01 076A	Structure of krypton and nitrogen layers on graphite C. Marti, P. Thorel, B. Croset (I.L.L.)	D1B
			05 01 076	Structure of krypton layers on graphite C. Marti, P. Thorel, B. Croset (I.L.L.) J.P. Coulomb (Marseille)	D1B
			05 01 078	Huang-scattering from point defects in MgO H. Peisl, B.v. Guérard, N. Stump (München)	D10

05 01 079A	Investigation of anorthite by clastic and inelastic neutron scattering (diffuseness) H. Jagodzinski, W. Prandl, F. Frey (München)	D10	05 01 110	H. $\beta$ -alumina B.C. Tofield, A.J. Jacobson (Harwell)	D1A
05 01 079B	Investigation of anorthite (CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub> ) by neutron scattering (structure determination) H. Jagodzinski, K. Kalus (München)	D10	05 02 092A	Magnetic properties of manganese perovskite. Studies at high temperature D. Fruchart (CNRS Grenoble) P. L'Héritier (I.N.P. Grenoble)	D1B, D2
05 01 080A	The phase transformation in K <sub>2</sub> SnCl <sub>6</sub> H. Jagodzinski, W. Prandl, H. Boysen (München)	D7	05 02 094A	SDW in Cr-Pd K. Ziebeck, R. Chagnon (I.L.L.) J.G. Booth (Salford)	D2
05 01 080B	The phase transformation in K <sub>2</sub> SnCl <sub>6</sub> H. Jagodzinski, W. Prandl, H. Boysen (München)	D1A	05 02 099	Helical antiferromagnetism in Ni <sub>2</sub> (Mn <sub>x</sub> Al <sub>2-x</sub> ) P.J. Webster, R.M. Mankikar (Salford)	D1A
05 01 087	Investigation of the ordering mechanism of intermediate plagioclase feldspars in the course of the annealing process W. Joswig, M. Korekawa (Frankfurt)	D16	05 02 104	Study of the antiferromagnetic metallic phase in the NiS <sub>2-x</sub> Se <sub>x</sub> mixed compounds with pyrite structure G. Krill, F. Gautier (Strasbourg)	D2
05 01 093A	Intercalation velocities in chalcogenides C. Riekel (I.L.L.) R. Schoellhorn (Münster)	D1B	05 02 113	Laue method under magnetic field for simultaneous observations J.C. Marmeggi (CNRS Grenoble)	D13, S20
05 01 094 05 01 094A	Two dimensional structure of adsorbed layers on lamellar halides F. Millot, Y. Larher (Saclay) B. Croset, P. Thorel, C. Marti (I.L.L.)	D1B	05 03 003A	Study of the variation with temperature of crystal and molecular structure of some organic semiconductors : the charge transfer complexes of TCNQ (tetracyanoquinodimethane) J. Gaultier (Bordeaux) P. Delhaes (CNRS Bordeaux) A. Filhol, C. Zeyen (I.L.L.)	D10
05 01 096	Precise neutron diffraction study of BaTiO <sub>3</sub> R. Schollmayer, K.F. Fischer (Saarbrücken)	D9, D10 D16	05 03 011	[C <sub>5</sub> H <sub>5</sub> Fe(CO) <sub>2</sub> ] <sub>2</sub> A. Mitschler, B. Rees (Strasbourg)	D9
05 01 103	Etude cristallographique de l'oxyde Pb <sub>3</sub> O <sub>4</sub> entre 240 et 5 K Weigel, Gavarrri (Paris)	D1A	05 04 001	Spin density in ferromagnetic chromium bromide P. Radhakrishna (I.L.L.)	D3
05 01 104	Neutron diffraction topographic observation of Cu-decorated dislocations and twin-boundaries in Si single crystals H. Tomimitsu (Japan) C. Zeyen (I.L.L.)	D10	05 04 012	Piezo-magnetic effects and spin density in CoF <sub>2</sub> P. Radhakrishna (I.L.L.)	D3
05 01 105	Study of the A $\rightleftharpoons$ H and H $\rightleftharpoons$ X crystalline transitions of the lanthanum sesquioxide P. Aldebert (I.L.L.) J.P. Traverse (Odeillo)	D1B	05 04 021	Polarization analysis of NaO <sub>2</sub> W. Kaenzig, M. Ziegler (Zürich) H.G. Smith (Oak Ridge) P. Fischer (Würenlingen) J. Schweizer (I.L.L.)	D5
05 01 108	High-pressure powder diffraction from KD <sub>2</sub> PO <sub>4</sub> and KH <sub>2</sub> PO <sub>4</sub> N.S.J. Kennedy, R.J. Nelmes (Edinburgh)	D1A	05 04 026	Internal metamagnetism in ThCo <sub>5</sub> D. Givord (I.L.L.) J. Laforest, R. Lemaire (CNRS Grenoble)	D3
			05 04 031	An investigation into the use of standards in polarization analysis experiments and measurements of multiple scattering vanadium F.F. Freeman, B.H. Meardon, W.G. Williams (Rutherford) J.C. Dore (Kent)	D5

05 04 032	Covalency in $K_2ReCl_6$ F.A. Wedgwood (Harwell) J.B. Forsyth (Rutherford)	D3	5 17 29	The spin-flop transition in $CsMnCl_3 \cdot 2D_2O$ in skew magnetic fields, and the effect of a magnetic field on the one-dimensional order	D10
05 05 015	Investigations on S-H...S hydrogen bridges: Di(p-chlorophenyl) dithiophosphinic acid B. Krebs, G. Henkel (Bielefeld) S.A. Mason (I.L.L.)	D8	5 23 13B	Satellites in MnSi and FeGe C. Wilkinson (London) J.B. Forsyth (Rutherford) M. Roth (I.L.L.) D. Bloch (CNRS Grenoble)	D11A
05 05 016	The high pressure structure of naphthalene G.A. Mackenzie, G.S. Pawley (Edinburgh)	D1A	05 23 76B	Study of the $Mx, (UX_2)_n$ system ( $X = S, Se, M = 3d$ metal) P. Wolfers (I.L.L. and CNRS Grenoble) H. Fillion (CNRS Grenoble)	D1B
05 05 018	Crystal structure of $(C_3H_7NH_3)_2MnCl_4$ at low temperatures with special respect to hydrogen positions J. Felsche, W. Depmeier (Konstanz)	D9	5 24 23B	Ammonia-d <sub>3</sub> on graphon R.K. Thomas, T.D. Trewern (Oxford) J.W. White (I.L.L.)	D1A
5 11 1R	Localisation des fluors en excès dans la solution solide à structure fluorine $NaYF_4-YF_3$ . Etude de la composition $NaYF_4-30\% YF_3$ soit $Na_{0,412}Y_{0,588}F_{2,176}$ L. Pontonnier (CNRS Grenoble)	D9	<b>COLLEGE 6</b>		
5 11 1R	Localisation des fluors dans la solution solide $NaYF_4-YF_3$ à structure fluorine. (Etude de la composition $NaYF_4 + 15\% YF_3$ ) L. Pontonnier (CNRS Grenoble)	D9	06 01 009B	Molecular motions in liquid crystals A.J. Leadbetter, R.M. Richardson, D.H. Bonsor, J.C. Frost (Exeter) C. Carlile (I.L.L. and Rutherford)	IN5, IN10
5 14 39	Electron density studies in calcium formate $Ca(HCOO)_2$ H. Fuess (Frankfurt) N. Burger (I.L.L. and Frankfurt)	D8	06 01 023	Neutron quasi-elastic scattering study of rotational motions in the smectic C, H and VI phases of terephthal-bis-butyl-aniline (TBBA) F. Volino (I.L.L. and Montpellier) A.J. Dianoux (I.L.L.) H. Herve (Paris)	IN5
5 15 14A	Study of a phase transition in N-Nitrodimethylamine Lascombe, Rey Laffont (Bordeaux) A. Filhol (I.L.L.)	D10	06 01 023	Self-diffusion and undulation modes in a smectic A liquid crystal. A high-resolution neutron-scattering study. A.J. Dianoux, A. Heidemann (I.L.L.) H. Herve (Paris) F. Volino (I.L.L. and Montpellier)	IN10
5 16 24	Neutron diffraction from hydrated clay minerals and graphitic oxide D.J. Cebula, R.H. Ottewill, R. K. Thomas (Oxford) J.W. White (I.L.L.)	D16	06 01 032	Phonons dans l'adamantane-d <sub>16</sub> J.D. Damien, R. Fouret, J. Lefebvre (Lille)	IN2
5 16 24	Neutron diffraction from clay/water systems D.J. Cebula, R. H. Ottewill, R.K. Thomas (Oxford) J.W. White (I.L.L.)	D16, D11	06 02 010D	Inelastic scattering from $^3He-^4He$ mixtures R.A. Cowley, P.A. Hilton (Edinburgh) W.G. Stirling, R. Scherm (I.L.L.)	IN5
5 16 24	Neutron diffraction from hydrated clay minerals D.J. Cebula, R.H. Ottewill, R. K. Thomas (Oxford) J.W. White (I.L.L.)	D11	06 02 015A	Optic modes in a molten salt G. Dolling (Chalk River) J.R.D. Copley (I.L.L.)	IN1
			06 02 016R	Low momentum transfer excitations in superfluid helium J.R.D. Copley, W.G. Stirling, R. Ghosh, J.S. Higgins (I.L.L.)	IN5

06 02 031	Surface effects on neutron scattering in He <sup>4</sup> films J. Joffrin, B. Lambert, D. Salin (Paris)	IN3	06 03 072	Pressure dependence studies of aqueous solutions J.E. Enderby, R.A. Howe, G.W. Neilson (Leicester) I. Page (Harwell)	D2
06 03 006C	Structural analysis of molten CuCl at 500°C W. Knoll, P. Chieux (I.L.L.) S. Eisenberg, J.F. Jal, J. Dupuy (Lyon)	D4	06 03 075R	Scattering law for vitreous silica at high Q values R.N. Sinclair (Harwell) A.C. Wright (Reading)	IN1
06 03 007C	Concentration fluctuations in liquid Li-Na alloys H. Ruppersberg (Saarbrücken)	D4	<b>COLLEGE 7</b>		
06 03 013R	Structure of liquid binary alloys with segregation tendency in the system Al-Sn S. Steeb (Stuttgart) W. Knoll (I.L.L.)	D11A	07 01 026A	Origin of the coercivity in the Ce (Co, Cu) <sub>5</sub> intermetallic compounds, spherical crystal study B. Labulle, C. Petipas (Rouen) J. Laforest (CNRS Grenoble) R. Lemaire (Grenoble) M. Roth (I.L.L.)	D11
06 03 16E	Aqueous solutions J. Enderby, A. Howe, G.W. Neilson, A.K. Soper, S. Cummings (Leicester)	D4	07 01 028B	Magnetic diffuse scattering from Co-Ga and related alloys J.G. Booth, R. Cywinski, J.G. Prince (Salford)	D11
06 03 18C	The structure factor for liquid bromine J.C. Dore, G.W. Stanton (Kent)	D4	07 01 036A	Freezing of spins in binary alloys A.P. Murani (I.L.L.) J.L. Tholence (CNRS Grenoble)	IN5
06 03 23	Neutron scattering study of methyl group rotation in solid para-azoxianisole (PAA) H. Hervet (Paris) A.J. Dianoux, R.E. Lechner, F. Volino (I.L.L.)	IN5	07 01 037A	Magnetic diffuse scattering in Au-Fe alloys A.P. Murani (I.L.L.) B.R. Coles (London)	D11
06 03 036	Structural study of the nonmetal to metal transition of K in molten KBr by small angle scattering J.F. Jal, J. Dupuy (Lyon) P. Chieux (I.L.L.)	D11	07 01 038A	Critical magnetic scattering on a system with continuously variable magnetic anisotropy K. Stierstadt, F. Soeffge (München)	D11A
06 03 042A	Structure factor of acetonitrile M. Zeidler, H. Bertagnolli (Karlsruhe)	D4	07 01 040	Magnetic excitations in FePt <sub>3</sub> D. Bloch (CNRS Grenoble) P. Radhakrishna (I.L.L.) M. Kohgi, Y. Ishikawa (Japan)	IN1
06 03 058	Neutron scattering in molten Au-Co alloys at small momentum transfer S. Steeb (Stuttgart) W. Knoll (I.L.L.)	D11A	07 01 043	Freezing of spins in Pd-Mn alloys A.P. Murani (I.L.L.)	D11
06 03 060A	Fe-C melts S. Steeb, M. Weber (Stuttgart)	D4	07 01 045	Relaxation rates in kondo systems M. Loewenhaupt (Jülich) F. Steglich (Köln)	D7
06 03 066R	Critical opalescence at short wavelengths J.L. Rivail (Nancy)	D11A	07 01 051	Ordering in (La <sub>2</sub> O <sub>3</sub> ) <sub>1-x</sub> (CeO <sub>2</sub> ) <sub>x</sub> solid solutions C. Bouysset, G. Bacquet (Toulouse)	D7
06 03 071	Structure factor of liquid chloroform P. Chieux (I.L.L.) D. Leicht, M.D. Zeidler (Karlsruhe)	D4	07 02 003B	CF in Van Vleck paramagnets PrX <sub>3</sub> K. Knorr (Mainz) A.P. Murani (I.L.L.)	IN4
			07 02 011A	Kondo side bands in CeAl <sub>3</sub> and related pseudo-binaries K. Knorr (Mainz) A.P. Murani (I.L.L.) K.H.J. Buschow (Eindhoven)	IN4

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