

Institut von Laue · Langevin Grenoble · France



Annual Report 1979

Applications for the use of ILL facilities

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

February 15 and August 31.

The completed research proposal forms should be sent to :

The Office of the Scientific Secretary
Institut Max von Laue - Paul Langevin
156 X
38042 Grenoble Cedex
France
Tel. : (76) 97.41.11 Ext. : 82.44 Telex : 320621 F

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

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

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

FRONT-COVER DESIGN :

based on a three-dimensional display of the counting rates obtained from polystyrene latex (SLJG4 in 90 % D₂O ; 0.5 % w/v ; mean diameter 1320 Å) on the Small Angle Scattering Camera D11. (R.H. Ottewill, J.W. Goodwin, N.M. Harris)



Annual Report 1979

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External Organisation of the Institut Laue-Langevin 1979

Associates of the Institut

Great Britain

SCIENCE RESEARCH COUNCIL
(SRC)

France

COMMISSARIAT A L'ÉNERGIE ATOMIQUE
(CEA)

CENTRE NATIONAL DE LA RECHERCHE
SCIENTIFIQUE (CNRS)

Germany

KERNFORSCHUNGSZENTRUM
KARLSRUHE (KFK)

Steering Committee (at its last meeting)

Hobbis - (SRC)
Enderby - (Univ. of Bristol)
Beattie - (SRC)
Eggington - (SRC)

Winter - (CNRS)
Roux - (CNRS)
Horowitz - (CEA)
Pascal - (CEA)

Huber - (Univ. Erlangen)
Hofbauer - (BMF)
Schött - (BMFT)
Klose (Chairman) - (KFK)

Audit Commission

Mead
Millington

Gouzien
Auffret

Riess
Dorn

Scientific Council (at its last meeting)

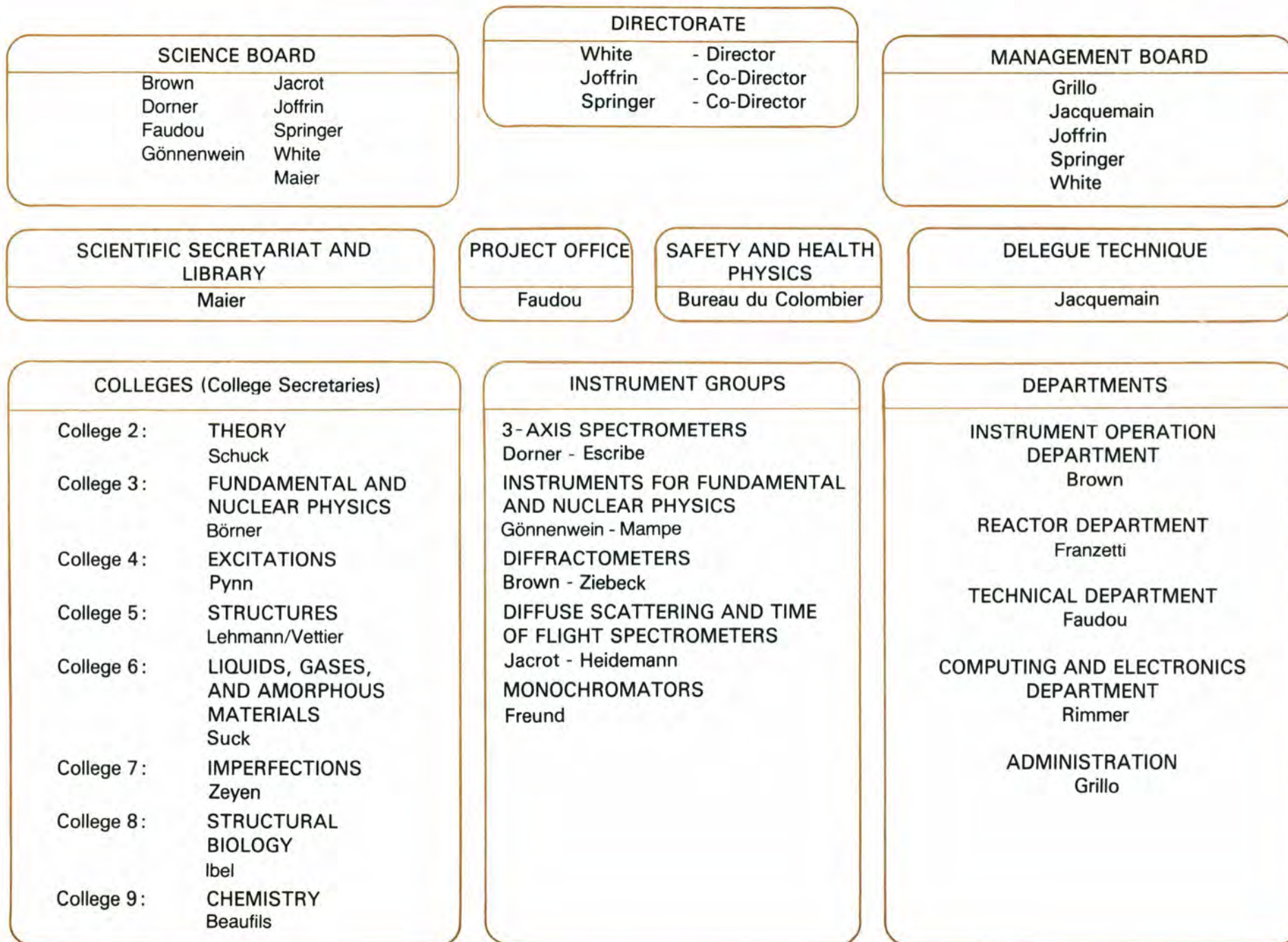
Bertaut	— CNRS Grenoble	Faissner	— TH Aachen	Mitchell	— Univ. Reading
Blow	— Imperial College	Fender	— Univ. Oxford	Rigny	— CEN Saclay
Challis	— Univ. Nottingham	Fulde	— MPI Stuttgart	Schelten	— KFA Jülich
Coles	— Imperial College	Gläser	— TU München	Stiller	— KFA Jülich
Comes	— Fac. Sc. Orsay	Guinier	— Univ. Paris Sud	Stuhrmann	— DESY Hamburg
Dachs	— HMI Berlin	Kienle	— TU München	Wegner	— Univ. Freiburg
Ebel	— Strasbourg	Leadbetter	— Univ. Exeter	White	— ILL - Chairman
Elliott	— Univ. Oxford			Yoccoz	— IN2P3. Paris

SUBCOMMITTEES OF THE SCIENTIFIC COUNCIL

Nuclear Physics	Excitations	Crystal Physics and Magnetism	Crystal Structure Determination	Liquids	Imperfections	Biochemistry	Phys. Chemistry	Instruments
Faissner Gizon Leroux Lynn Sandars Schult Smith	Coles Comes Fulde Landwehr Schofield Villain	Dachs Delapalme Goodenough Lemaire Prandl Wilkinson	Dachs Galy Lucas Milledge Pawley Rees von Schnering	Cowley Cyrot Götze Hansen Mitchell Powles Ruppertsberg Zeidler	Alefeld Elliott Gautier Kleitz Rainford Saada Schmatz	Blow Fuller Holmes North Parello Stuhrmann Tardieu Wittmann Witz	Ballard Bienfait Brenig Higgins Kirste Leadbetter Menzel Monnerie Ottewill Renouprez Rivail Schelten Stiller Weill Weiss	Armbruster Dachs Farnoux Forsyth Gläser Rainford Rossat-Mignot Schmatz Windsor

Internal Organisation of the Institut Laue-Langevin at 1.12.79

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The Institut Max von Laue- Paul Langevin

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

The ILL is a non-trading company under French civil law. The three countries are represented by the following Associates :

- Kernforschungszentrum Karlsruhe GmbH, Germany (formerly GfK)
- Centre National de la Recherche Scientifique, France
- Commissariat à l'Energie Atomique, France
- Science Research Council, United Kingdom.

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

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

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



Professor and Mrs P. Ewald unveiling portraits of Max von Laue and Paul Langevin on the occasion of the hundredth anniversary of the birth of Max von Laue.



The ILL Open Day on the 19th May 1979 has been an outstanding success. The picture shows a group of pupils from Grenoble High Schools receiving information on health physics problems.



Dr Axel Herbst, the German Ambassador in France and Frau Herbst (both in the centre) during their visit at the ILL on October 12, 1979, shown here by the IN2 spectrometer with Dr Dörner (second from right), a Senior Scientist at the ILL.



Sir Nicholas Henderson, the British Ambassador in France (at right) and Mr Howard E. Rigney, British Consul General at Lyon, with Dr J. White (centre).

Introduction

Rapport du directeur

Dans son évolution scientifique depuis 1967, l'Institut est passé de la phase de la construction et du premier fonctionnement du réacteur (1967-1972) à celle de la mise en route des instruments et à l'installation d'une fonction de service orientée vers les utilisateurs (1972-1976). Pendant cette période, une diversité croissante de demandes scientifiques pour les faisceaux de neutrons et les instruments spécifiques à ILL a été constatée. Au cours de la période 1976-1980, il s'en est suivi que, devant l'augmentation constante des demandes en matière de neutrons, une préoccupation essentielle de la Direction devait être de trouver un équilibre entre l'ancienne pratique consistant à explorer de nouveaux domaines à l'aide d'expériences courtes et le besoin de mesures " en profondeur " dans les domaines scientifiques considérés comme prometteurs sur la base des expériences passées. Afin de maintenir cet équilibre, certains domaines ont été favorisés quant au temps de faisceau et aux ressources qui leur ont été attribués par le Conseil Scientifique, tandis qu'en même temps, une continuité d'accès était assurée pour une large gamme d'études nécessitant l'utilisation des neutrons. L'autre trait essentiel des 4 dernières années fut la ré-émergence d'un programme de développement dans le domaine des techniques et des appareillages neutroniques. Ce programme qui constitue une part importante de la vie scientifique propre de l'ILL, trouvera son expression tangible dans le " Deuxième Souffle ". Il s'agit d'un programme de modernisation décidé par le Comité de Direction de l'Institut lors ses réunions de Mai et Octobre 1979, pour une somme de 104 MF (valeur monétaire 1979) et qui doit se réaliser pendant la période 1979-1984. Le budget supplémentaire de modernisation pour 1979 a permis un démarrage rapide de ce programme.

Dans le programme normal, nous avons encore constaté une forte demande en ce qui concerne le temps sur les instruments et ce dans tous les domaines d'activité durant 1979 (fig. 1). Le nombre des propositions du Conseil Scientifique, lors des 2 sessions de ce Conseil, a atteint les chiffres records de 470 en Mars et de 459 en Octobre. La qualité de ces propositions s'est constamment améliorée au cours des années et la tâche des sous-comités chargés de la sélection en est rendue extrêmement difficile. Afin d'éviter la division du temps disponible en très petites fractions, les sous-comités ont reçu de la part de la Direction des directives tendant à accorder une allocation de temps suffisante pour permettre, si possible, de terminer les expériences lors de la première tentative. Du fait du fonctionnement amélioré des instruments au cours des 2 dernières années, ceci est devenu possible pour de nombreuses expériences. De plus, la politique consistant à donner une préférence spéciale à certains secteurs et programmes scientifiques commence de porter ses fruits. On peut donner à titre d'exemple pour l'année 1979, la recherche des oscillations de neutrino, les expériences avec des neutrons ultra-froids, la détermination des densités d'aimantation des électrons paramagnétiques par la diffusion des neutrons polarisés, la structure des solutions ioniques, les phénomènes de surface et la détermination de la structure tri-dimensionnelle des particules de nucléosome. Des rapports supplémentaires sur ceci et sur d'autres domaines d'intérêt spécifiques à ILL peuvent être trouvés dans les rapports des Groupes d'Instruments et des Collèges.

Au cours de l'année 1979, le réacteur a bien fonctionné, un total de 260 jours ayant été utilisés sur un maximum possible de 264 jours ; la seule perte de temps importante a été causée par le changement d'une pompe principale dans le circuit de refroidissement d'eau lourde.

On attend pour Mars 1980 les résultats des études sur l'évolution des propriétés mécaniques des parties fortement irradiées du réacteur, et des préparations sont en cours pour le changement préventif d'un doigt de gant lors de l'arrêt prolongé du réacteur prévu pour 1981. En 1979, nous avons eu un rapport rassurant d'un groupe de travail assisté du Professeur W. Schilling (Jülich) et

du Dr R.S. Nelson (AERE, Harwell) concernant l'évolution de l'aluminium dans la source froide sous l'effet de radiation et du cyclage thermique qui résulte du fonctionnement normal. Le remplacement des nez de conduits, actuellement en cours de préparation, aura lieu à l'occasion d'un arrêt du réacteur d'une durée de 2 à 3 mois prévu pour le printemps 1981. Une conséquence de ce long arrêt est que le long arrêt d'Octobre 1980 sera supprimé permettant de ce fait d'augmenter le temps de faisceau affecté aux expériences au cours de l'année 1980.

Deux nouveaux instruments (IN12 et D18) et un, entièrement reconstruit (D10) ont été mis en service en 1979. De plus, la construction des instruments IN6, IN13, D19, IN1+, D4+ et D1B s'est poursuivie. Des projets détaillés furent élaborés et la construction devrait bientôt commencer pour le pré-projet de PN8 (spectromètre à produit de fission : "Cosi fan tutte") et pour l'analyseur de polarisation de supermiroirs pour D7, le spectromètre de diffusion diffuse. Les projets de développement comprennent la reconstruction de D16 pour les expériences de diffraction à haute résolution sur les monocristaux biologiques à grandes mailles ainsi que le projet H11 qui doit produire 3 nouveaux instruments : un diffractomètre à poudre à très haute intensité, un diffractomètre à poudre à très haute résolution et un diffractomètre pour monocristaux avec multi-détecteur. Les projets pour l'amélioration du conduit H15 et de ses instruments IN10, D11 de même que les projets relatifs aux neutrons polarisés sur D3/D5 ont atteint un stade d'étude avancé. Les caractéristiques des instruments ci-dessus, seront décrites dans des sections ci-après de ce rapport.

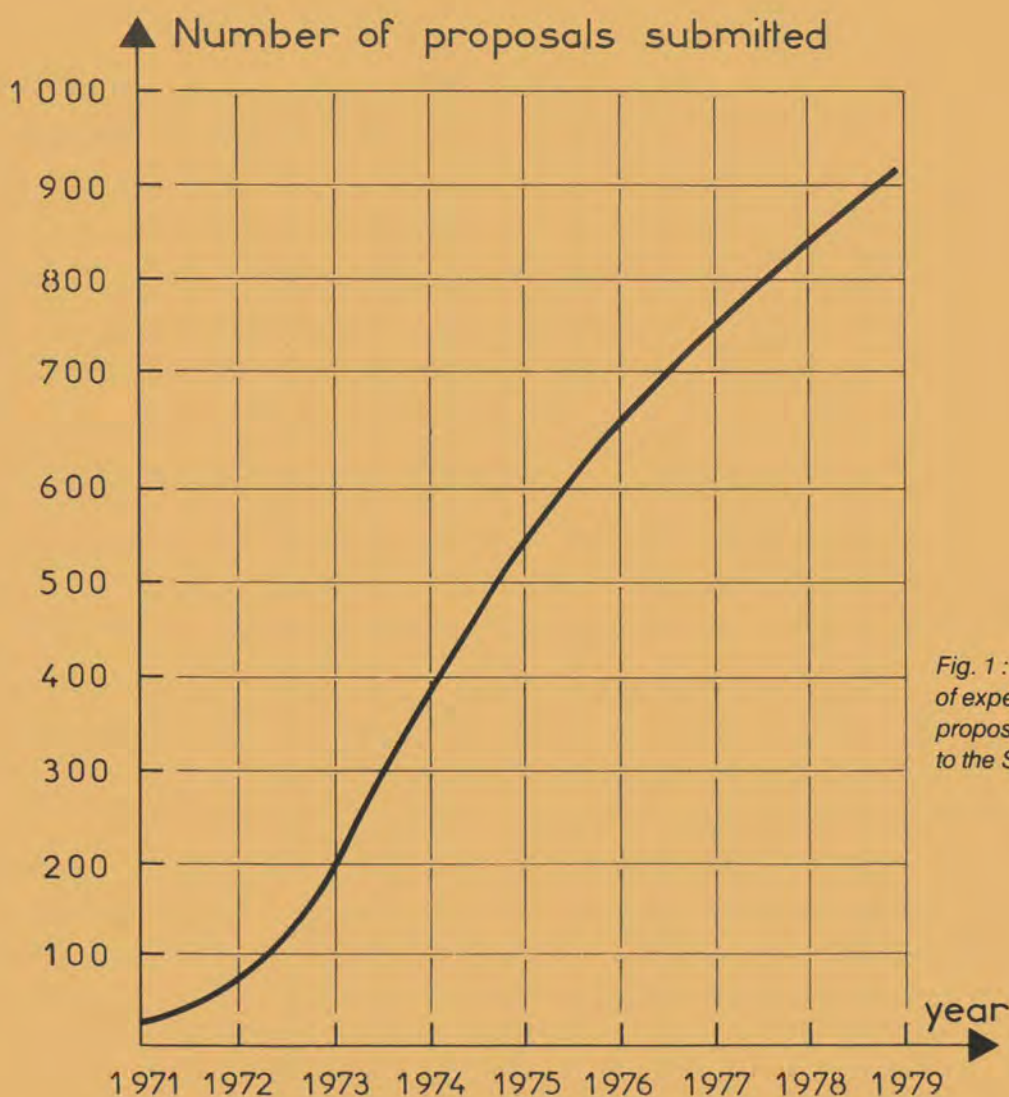


Fig. 1 : Development of experimental proposals submitted to the Scientific Council.

Une amélioration notable dans le domaine du traitement des données pour les instruments du type temps-de-vol, diffraction et physique nucléaire a été réalisée grâce à un effort important en 1979, et ce afin de permettre un contrôle plus direct des expériences en cours. Avec le remplacement prochain de CARINE, et l'installation de nouvelles lignes directes entre ordinateurs d'instruments et processeur central, de nouvelles améliorations sont à espérer. Les efforts dans le domaine de la programmation seront renforcés en 1980, grâce à du personnel extérieur assistant les équipes en place, et grâce à des contrats de développement tel que celui passé avec AERE, Harwell / Rutherford Laboratory relatifs aux programmes de traitement de données pour les appareils à trois axes.

Toujours afin de fournir une base solide aux projets d'instruments prévus dans le cadre du "Deuxième Souffle", une importance particulière a été accordée au développement des nouvelles techniques neutroniques. En Octobre, l'évaporateur pour la production des supermiroirs (S3) a commencé de fonctionner de façon entièrement automatique et a produit un premier ensemble de supermiroirs. La production régulière est maintenant assurée et des essais systématiques dans le but d'améliorer les caractéristiques des miroirs produits sont en cours. Des miroirs d'essai pour la radiation synchrotron ont également été produits, et ont été testés à LURE (Orsay). Les premières supermiroirs sont à présent utilisés sur le spectromètre reconstruit D10 ; d'autres fourniront un bon polariseur pour l'expérience de résonance magnétique nucléaire en faisceau S6, et seront utilisés pour obtenir un analyseur de polarisation de grande surface pour le spectromètre de diffusion diffuse D7. Il existe déjà d'autres "clients" pour les supermiroirs, et la fabrication d'un prototype de guide de neutrons utilisant des supermiroirs commencera au début de 1980. Pour les neutrons chauds, l'obtention de petits cristaux de beryllium de distribution mosaïque adéquate représente un succès important. Avec ceux-ci, il sera déjà possible de fabriquer un monochromateur pour IN1⁺. En améliorant la technique de croissance, on espère produire des cristaux encore plus grands en 1980. Dans le cadre du programme de collaboration entre l'ILL, le CNRS de Grenoble, le Physikalisch-Technische Bundesanstalt à Brunswick, et l'Atomic Energy Research Establishment (AEK Riso), une quantité importante de cristaux d'alliage d'Heusler de bonne qualité a été obtenue. Ils seront utilisés pour la fabrication des futurs monochromateurs et analyseurs polarisants. Ceci et le développement des supermiroirs mentionnés ci-dessus, préparent la voie aux futurs spectromètres à analyse de polarisation, qui seront installés à ILL au cours de l'année 1980.

Egalement, dans le domaine des techniques neutroniques, la décision a été prise de construire une source de neutrons ultra froids externe utilisant l'⁴He liquide à 0.7 °K pour produire des densités élevées de neutrons ultra froids dans un volume fermé. Le projet consistant à remplacer la source froide actuelle par une source de meilleur rendement, a atteint le stade de la construction.

TABLE I

EXPERIMENTAL PROGRAMME JANUARY TO DECEMBER 1979

	BIOLOGY	CHEMISTRY	CRYSTAL STRUCTURE	MAGNETIC STRUCTURE	LIQUIDS AND AMORPHOUS	DIFFUSE SCATTERING	PHONONS	MAGNETIC EXCITATIONS	PHASE TRANSITIONS	NUCLEAR PHYSICS	SCIENTIFIC TEST AND FEASIBILITY EXPERIMENTS	TOTAL
INSTRUMENT DAYS	322	746	582	596	518	573	230	310	642	1060	489	6068
NUMBER OF EXPERIMENTS	18	197	64	69	71	100	26	28	70	76	155	937
NUMBER OF INSTRUMENTS INVOLVED	8	13	10	11	11	14	7	8	13	6	21	31
MONOCHROMATOR AND INSTRUMENT DEVELOPMENT EXPERIMENTS (INCL. D13)											456	
											124	

Director's report

In its scientific evolution since 1967, the Institut has passed from construction and first reactor operation (1967-1972) to instrument commissioning and installation of the user oriented service function (1972-1976). During this period a growing range of scientific demands for the neutron beams and the unique instruments at the ILL was identified. It has followed naturally that, during the period 1976-1980, when demand for neutron facilities continuously increased, a major pre-occupation of the Direction has been to find a balance between the past practice of exploring new areas with shorter experiments and the need for "in depth" measurements in scientific areas shown to be of high promise by past experiments. To achieve this balance certain areas have been favoured in beam time and resources allocated by the Scientific Council, whilst at the same time assuring continuity of access for the broad range of studies needing neutrons. The other major feature of the past four year period has been the re-emergence of an instrument and neutron technique development programme. This is now an important part of the ILL's own scientific life which will find tangible expression in the "Deuxième Souffle". This modernisation programme was agreed by the Steering Committee of the Institut at its meetings in May and October 1979 at a cost of 104 MF (value 1979) to take place in the period 1979-1984. The supplementary modernisation programme budget for 1979 has allowed a quick start to the programme.

In the normal programme there has again been a high demand for instrument time in all sectors of activity during 1979 (Figure 1). The number of proposals at the Scientific Council reached an all time record in the March (470) and October (459) rounds of the Scientific Council. The quality of the proposals has continually improved over the years and the job of sub-committees in making the selection is now extremely difficult. In order to avoid the effect of cutting available time into very small pieces, sub-committees have been given guidance by the Direction to allow enough time for experiments to be finished, if possible, in the first attempt. This has become possible for more experiments due to improved performance of instruments during the last two years. In addition, the policy of giving special preference to certain scientific sectors and programmes has begun to show positive results. Examples from 1979 are the search for neutrino oscillations, ultra cold neutron experiments, determination of paramagnetic electron magnetisation densities by polarised neutron scattering, the structure of ionic solutions, surface phenomena and the determination of the 3-dimensional structure of nucleosome core particles. Further reports on these and other areas of special interest to the ILL will be found in the Instrument Group and College reports.

The reactor worked well during 1979, a total of 260 days being available out of the possible maximum of 264. The only major loss of time was due to the need to change a main pump in the heavy water cooling circuit.

The results of studies on the evolution of the mechanical properties of highly irradiated parts of the reactor are expected in March 1980 and preparations are being made for preventive change of a beam tube thimble in the long reactor shutdown foreseen for 1981. During 1979 we had a reassuring report from a group assisted by Prof. W. Schilling (Jülich) and Dr R.S. Nelson (AERE, Harwell) on the evolution of the aluminium in the cold source under radiation and the thermal cycling resulting from normal operation. Preparations are now well advanced for the change of the guide tube noses in the 2-3 month shutdown foreseen for the Spring of 1981. A consequence of this long shutdown is that the long shutdown of October 1980 will be suppressed, thereby giving more beam time for allocation of experiments during the year 1980.

Two new instruments (IN12 and D18) and one completely rebuilt instrument (D10) came into operation during 1979. In addition, the construction of the instruments IN6, IN13, D19, IN1*, D4* and D1B was continued. Detailed designs were made, and construction should begin soon on the pre-project for PN8 (cosi fan tutte fission product spectrometer) and the supermirror polarisation analyser for the diffuse scattering spectrometer D7. Development projects include the reconstruction of D16 for high resolution, large unit cell, biological single crystal diffraction experiments, the H11 project to produce three instruments, an extremely high intensity powder diffractometer, a very high resolution powder diffractometer, and a multidetector single crystal diffractometer. The projects for improvement of the H15 guide and its instruments IN10, D11 and the D3/D5 polarised neutron projects are also in an advanced stage of study. The characteristics of the above instruments will be found in later sections of this report.

A noticeable improvement in the data treatment facilities at the time-of-flight, diffraction and nuclear physics instruments has been produced through a major effort during 1979 to allow better control of an experiment whilst it is in progress. The CARINE replacement, coupled with the installation of more direct lines from the instrument computers to the central processor, can be expected to give further improvements. Program developments in this area will be reinforced during 1980 by the attribution of external programming help to existing teams and by continuing development projects such as that with the AERE, Harwell/Rutherford Laboratory for a suite of triple axis data treatment programs.

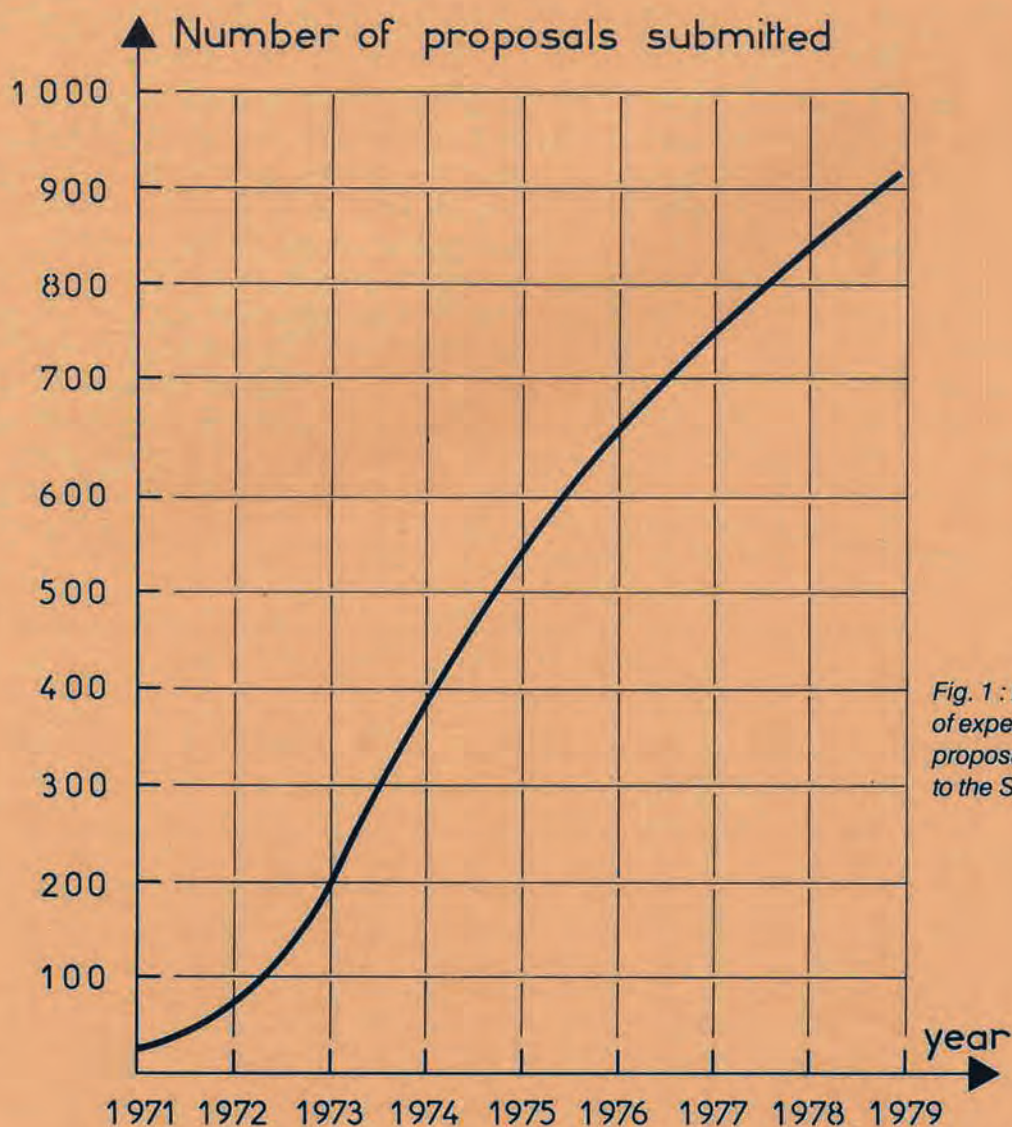


Fig. 1 : Development of experimental proposals submitted to the Scientific Council.

Consistent with producing a solid basis for new instruments in the "Deuxième Souffle" programme, strong emphasis was again given in 1979 to the development of new neutron techniques. The supermirror evaporator (S3) began to work under completely automatic computer control in October and produced the first batch of supermirrors. Regular production is now assured and systematic experimentation to improve the mirror characteristics is underway. Trial mirrors for synchrotron radiation have also been produced and tested at LURE (Orsay). The first supermirrors are now in use on the rebuilt D10 spectrometer ; others will provide a good polariser for the in-beam nuclear magnetic resonance experiment S6, and will be used to make a large supermirror polarisation analyser for the D7 diffuse scattering spectrometer. Other "customers" for the supermirrors are already apparent and a programme will start in early 1980 for the test production of supermirror neutron guides. For hot neutrons the successful growth of small beryllium crystals of suitable mosaic texture has been an important step forward. Already with these it will be possible to make up a mosaic monochromator for IN1* using our own beryllium crystals. It is hoped to extend the technology of growth to produce even larger crystals during 1980. In a collaborative programme between the ILL, the CNRS (Grenoble), the Physikalisch-Technische Bundesanstalt at Braunschweig, and the Atomic Energy Research Establishment (AEK Risø), a large quantity of high quality Heusler crystals have been produced for making the next generation of polarising monochromators and analysers. This and the supermirror developments above, paves the way for polarisation analysis spectrometers to be installed at the ILL during the 1980's.

Again in the field of neutron techniques, the decision has been made to construct the external ultra cold neutron source relying upon liquid ^4He at 0.7°K to produce high densities of ultra cold neutrons in a confined space. The project to replace the present cold source by one with improved performance has gone to the construction stage.

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												124

Aluminium in der kalten Quelle unter Bestrahlung und Wärmebeanspruchung bei Normalbetrieb. Die von Herrn Prof. W. Schilling (Jülich) betreute Gruppe erstellte einen beruhigenden Bericht über die Zuverlässigkeit dieses grundlegenden Bestandteils unseres Reaktors. Die Vorbereitungen zum Austausch der Frontstücke der Neutronenleiter während der vorgesehenen Reaktorpause von 2 - 3 Monaten im Frühjahr 1981 sind mittlerweile gut vorangeschritten. Die Folge ist, dass die für Oktober 1980 geplante grössere Reaktorpause entfällt und somit mehr Zeit für Experimente in diesem Jahr zur Verfügung steht.

Zwei neue Instrumente (IN12 und D18) sowie ein komplett neu angebautes instrument (D10) wurden 1979 in Betrieb genommen. Ausserdem wurde der Bau der Instrumente IN6, IN13, D19, IN1+, D4+ und D1B fortgesetzt. Für das Projekt PN8 (Cosi fan tutte) und den D7 Analysator aus Polarisations-Superspiegeln wurden Detailpläne erstellt und der Bau sollte bald begonnen werden. Die Entwicklungsprojekte schliessen die Modifikation von D16 (hohe Auflösung, biologische Streuexperimente an Einkristallen mit grossen Einheitszellen) und das H11 Projekt zum Bau von 3 Instrumenten, nämlich 2 Pulverdiffraktometern mit grosser Neutronenintensität bzw. hoher Auflösung und einem Einkristalldiffraktometer mit Multidetektor ein. Auch die Projekte zur Verbesserung des Leiters H15 und der dazugehörigen Instrumente IN10, D11 sowie des Umbaus der Geräte für polarisierte Neutronen D3 und D5 befinden sich in fortgeschrittenem Stadium. Die Kenndaten der oben erwähnten Instrumente können den nachfolgenden Kapiteln dieses Berichts entnommen werden.

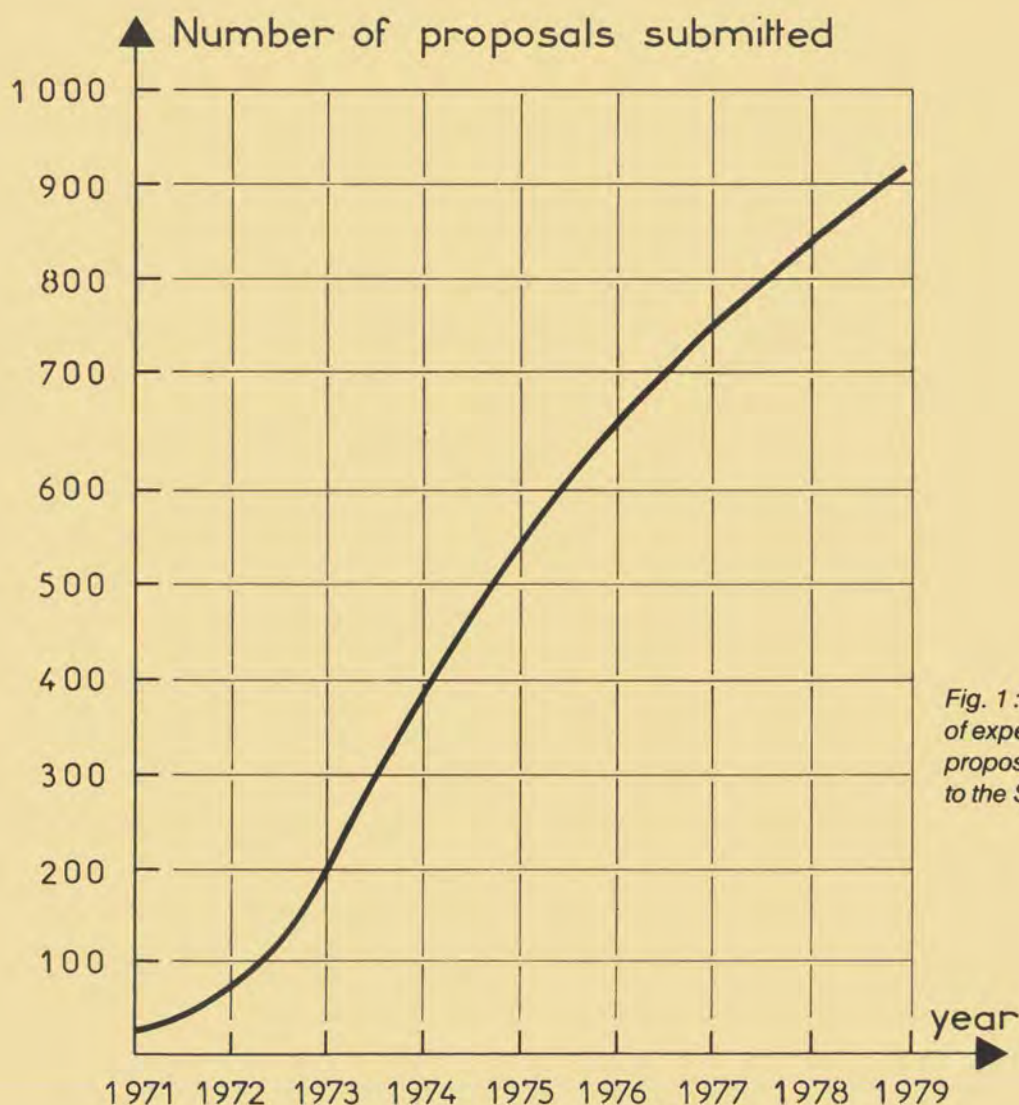


Fig. 1 : Development of experimental proposals submitted to the Scientific Council.

Bericht des Direktors

Im Rahmen der wissenschaftlichen Entwicklung des ILL reichten sich an die Phase der Konstruktion und der Inbetriebnahme des Reaktors (1967-1972) 4 Jahre der Instrumentenentwicklung und des Aufbaus des Dienstleistungssystems für Benutzer (1972-1976). Während dieser Periode war eine rasch zunehmende Vielfalt von eingereichten Anträgen für Neutronenstrahlzeit und den Instrumenten zu verzeichnen. Als in der darauffolgenden Periode (1976-1980) die Anzahl der Versuchsvorschläge weiter zunahm, war es eine ganz natürliche Folge, dass die Direktion des ILL sich um einen Ausgleich zwischen den beiden Praktiken bei der Zuteilung von Messzeit bemühte, nämlich der Zuteilung von kurzen Messzeiten für Tests auf neuen Gebieten und der Notwendigkeit von tiefergehenden Messungen auf Gebieten, die aufgrund vorangegangener Experimente als vielversprechend gelten. Um diese Balance zu halten, wurden bestimmten Gebieten mehr Strahlzeit und mehr Mittel vom Wissenschaftlichen Rat gewährt, wobei jedoch darauf geachtet wurde, dass die grosse Vielfalt von Projekten auf dem Gebiet der Neutronenforschung weiterhin Zutritt zum Hochflussreaktor hat. Das andere bemerkenswerte Kennzeichen der letzten 4 Jahre war die Schaffung eines Entwicklungsprogramms für Instrumente und Neutronentechniken. Dieses stellt heute einen wichtigen Teil der eigenen wissenschaftlichen Aktivität des ILL dar und findet seinen konkreten Ausdruck im Erneuerungsprogramm des ILL. Dieses Modernisierungsprogramm ist vom Lenkungsausschuss des ILL auf seinen Sitzungen im Mai und Oktober 1979 beschlossen und mit einer Investitionssumme von 104 MF (Geldwert 1979) für den Zeitraum 1979-1984 ausgestattet worden. Dieses zusätzliche Budget hat es erlaubt, das Erneuerungsprogramm bereits im Jahre 1979 zügig in Angriff zu nehmen.

Das laufende Programm des ILL wurde in diesem Jahr wieder durch die gleichbleibend starke Nachfrage nach Messzeit geprägt. Die Zahl der in diesem Jahr eingereichten Versuchsvorschläge erreichte für beide Sitzungen des wissenschaftlichen Rates eine Rekordhöhe (470 bzw. 459). Aufgrund der steigenden Qualität der Versuchsvorschläge wurde die Aufgabe der Unterausschüsse zusehends schwieriger, eine gerechte Auswahl zu treffen. Zur Vermeidung von zerstückelten Messperioden, wurde den Unterausschüssen von der Direktion empfohlen, ausreichende Messzeiten für den befriedigenden Abschluss eines Experiments zu genehmigen. Als Folge der erhöhten Leistungsfähigkeit der Instrumente wurde dieser Richtlinie in den meisten Fällen Rechnung getragen. Überdies zeigt die Zuteilung von mehr Messzeit für bestimmte wissenschaftliche Bereiche, d.h. bestimmten Experimenten und Programmen, erste positive Ergebnisse. Diese Politik erlaubt, aus der grossen Vielfalt der vorgelegten Anträge besonders vielversprechende Bereiche oder Forschungsvorhaben auszuwählen. Beispiele sind die Untersuchungen zu Neutrino-Oszillationen, Experimente mit ultra-kalten Neutronen, die Bestimmung von paramagnetischen Elektronen-Magnetisierungsdichten durch polarisierte Neutronenstreuung, Strukturuntersuchungen an ionischen Lösungen, Oberflächenphänomene und die Bestimmung der 3-dimensionalen Struktur von Nukleozom-Teilchen. Weitere Einzelheiten über diese und andere Bereiche, die für das ILL von besonderem Interesse sind, können den Berichten der Instrumenten-Gruppen und der "Colleges" entnommen werden.

Mit 260 von 264 möglichen Betriebstagen war der Reaktorbetrieb im Jahre 1979 sehr zufriedenstellend. Der einzig nennenswerte Zeitverlust wurde durch das Auswechseln einer Hauptpumpe im Schwerwasserkühlkreis verursacht. Die Untersuchungsergebnisse über die Veränderung der mechanischen Eigenschaften von den einer starken Bestrahlung ausgesetzten Reaktorteilen werden für März 1980 erwartet und schon jetzt werden Vorkehrungen für die vorsorgliche Erneuerung der Strahlrohrnasen während des für 1981 geplanten langen Reaktorstillstands getroffen. Das Jahr 1979 brachte ebenso eine befriedigende Stellungnahme zur Veränderung von

Eine bemerkenswerte Verbesserung der Datenverarbeitungssysteme und den Flugzeitgeräten, Diffraktometern und Kernphysikinstrumenten hat im Jahre 1979 zur besseren Kontrolle der Experimente während ihres Ablaufs geführt. Der Ersatz des CARINE Rechners zusammen mit der Installation von mehr direkten Verbindungen zwischen Instrumentrechnern und dem zentralen Datenverarbeitungssystem sollte die Leistungsfähigkeit der Instrumente weiter verbessern. Programmentwicklungen in diesem Bereich werden 1980 verstärkt gefördert werden, d.h. den bestehenden Programmiergruppen soll Unterstützung von aussen gewährt werden, besonders zur Weiterführung von Entwicklungsprojekten, wie z.B. für eine Reihe von Datenverarbeitungsprogrammen an den Dreiachsengeräten in Zusammenarbeit mit AERE-HARWELL / RL.

Um für neue Instrumente im Erneuerungsprogramm eine solide Grundlage zu schaffen, wurde 1979 wiederum die Entwicklung der Neutronentechnik in den Vordergrund gestellt. Im Oktober funktionierte die Aufdampfanlage zur Herstellung von Superspiegeln (S3) erstmals unter völlig automatischer Rechnerkontrolle und erzeugte den ersten Satz von Superspiegeln. Die routinemässige Produktion der Spiegel ist somit sichergestellt ; darüberhinaus werden gegenwärtig systematische Versuche unternommen, die Spiegeleigenschaften weiter zu verbessern. Auch für Synchrotronstrahlung wurden Versuchsspiegel hergestellt und für LURE (Orsay) getestet. Die ersten Vorrichtungen dieser Art wurden bereits beim Aufbau des Spin-Echo-Test-Experiments an dem modifizierten Spektrometer D10 verwendet. Ebenso erwartet man, dass sie einen guten Polarisator für das Experiment zur kernmagnetischen Resonanz S6 sowie einen grossen Polarisationsanalysator für das Spektrometer für diffuse Streuung D7 abgeben. Eine Erweiterung des Kundenkreises für die Superspiegel ist absehbar und Anfang 1980 soll ein Programm zur Herstellung von Neutronenleitern aus Superspiegeln beginnen. Ein grosser Fortschritt auf dem Gebiet der heissen Neutronen bedeutete das erfolgreiche Züchten von kleinen Beryllium-Kristallen mit der gewünschten Mosaik-Breite. Allein mit diesen wird es möglich sein, einen Mosaik-Monochromator für IN1 zu erstellen. Man hofft jedoch, im nächsten Jahr die Technologie der Kristallzucht so zu verbessern, dass noch grössere Kristalle erzeugt werden können. Im Rahmen einer Zusammenarbeit zwischen ILL, CNRS (Grenoble), Physikalisch-Technischer Bundesanstalt, Braunschweig und Atomic Energy Research Est. (AEK Risø) wurde eine bedeutende Anzahl von Heusler-Kristallen hoher Qualität erzeugt. Diese sollen das Ausgangsmaterial für die nächste Generation von Polarisations-Monochromatoren und Analysatoren darstellen und zusammen mit den oben erwähnten Superspiegeln das Aufstellen von Spektrometern zur Polarisationsanalyse in den 80iger Jahren ermöglichen.

Im Bereich der Neutronentechnik wurde der Bau einer ultrakalten Neutronenquelle ausserhalb des Reaktors beschlossen. Diese soll mit flüssigem ^4He bei 0,7 K betrieben werden und hohe Intensitäten ultrakalter Neutronen in einem umschlossenen Raum erzeugen. Das Projekt, zum Ersatz der bestehenden kalten Quelle durch eine leistungsfähigere, befindet sich nunmehr im Konstruktionsstadium.

J.W. WHITE.

	BIOLOGY	CHEMISTRY	CRYSTAL STRUCTURE	MAGNETIC STRUCTURE	LIQUIDS AND AMORPHOUS	DIFFUSE SCATTERING	PHONONS	MAGNETIC EXCITATIONS	PHASE TRANSITIONS	NUCLEAR PHYSICS	SCIENTIFIC TEST AND FEASIBILITY EXPERIMENTS	TOTAL
INSTRUMENT DAYS	322	746	582	596	518	573	230	310	642	1060	489	6068
NUMBER OF EXPERIMENTS	18	197	64	69	71	100	26	28	70	76	155	937
NUMBER OF INSTRUMENTS INVOLVED	8	13	10	11	11	14	7	8	13	6	21	31
MONOCHROMATOR AND INSTRUMENT DEVELOPMENT EXPERIMENTS (INCL. D13)											456	
											124	

The Deuxième Souffle

The "Deuxième Souffle" - modernisation programme - is designed to make improvements in the basic neutron facilities and instruments of the ILL which have not been possible during the last five years due to insufficient money in the normal investment budget of the Institut. The new investment will support developments in four main areas :

- (i) The Reactor and Neutron Sources
- (ii) New Instrumentation and neutron techniques
- (iii) Computing
- (iv) New buildings including a laboratory shared with the European Molecular Biology Organisation.

(i) Reactor and Sources

Seven years of operation (1972-1979) have shown that the High Flux Reactor operates very reliably and that its life can be estimated as at least a further 15-20 years. A programme to study the evolution of the reactor materials under the high ambient fluxes was started three years ago and will be continued. It is not economically feasible to augment the basic reactor flux appreciably so the major developments will be in the use of improved sources in the heavy water reflector.

The present liquid deuterium cold source will be replaced by an improved design allowing cold neutron flux gains of about a factor of 2x for all the cold neutron guides whilst at the same time giving the possibility to extract an ultra cold neutron beam with an estimated intensity of $2 \cdot 10^3/\text{cm}^2 \text{ sec}$ by means of a vertical guide and cold neutron turbine. This factor of 150x above all other sources should allow novel experiments in neutron optics, elementary particle physics and surface physics.

A second cold source based on liquid hydrogen is foreseen for one of the present thermal beam holes. This source should give an optimum flux in the 2Å to 5Å region which lies between the maxima of the liquid deuterium cold source and thermal neutron beam spectra. The source may eventually feed a guide tube system made of supermirror guides*.

The present cold source and cold neutron guides have in recent years created unique possibilities for experiments at the ILL, in particular, in the fields of polymer research, chemistry and biology. The demand for cold neutrons is increasing. The second cold source will allow novel instruments to be installed to meet demands in these fields as well as for intense polarised beams for fundamental physics experiments. The completion of the above changes to the cold and ultra cold neutron sources will allow Grenoble to offer the best available continuous beam intensities for neutron wavelengths between about 0.7 Å and 500 Å.

Supermirrors are devices whereby the critical angle for total external reflection at a surface is effectively increased by factors of about three times by depositing alternating layers of increasing thickness of two materials with different neutron scattering lengths. This technology is at present being used to produce neutron polarising mirrors - for guides it would give greater intensities through increased solid angle of acceptance.

(ii) **New Instruments and Neutron Techniques**

An important aspect of the modernisation programme is to replace instruments where efficiency and scientific interest has been overtaken by events during the last seven years as well as to provide the extremes of sample environment, temperature, pressure, magnetic field etc. required in modern experiments. During 1978/79 a programme to prepare new techniques - supermirrors, neutron optics, special monochromators, spin echo, multidetectors - was given budgetary priority and has provided a basis for the new instruments to be constructed.

The ILL will make only a slight net increase in the total number of instruments during the modernisation programme since replacement of existing instruments is a primary point of policy. Table II lists the presently planned actions in the field of instrument construction.

A general guide line will be to ensure complementarity between the new instruments built at the ILL and those foreseen at national facilities in the three countries, such as new reactors and spallation sources. Some of the areas where the intense continuous neutron beams from our reactor are likely to retain their superiority are in polarised neutron diffraction and neutron spin polarisation analysis ; high resolution inelastic scattering and spin echo spectrometry, nuclear and fundamental physics.

High resolution spectrometers have always been a speciality of the Institut. The high resolution time-of-flight and back-scattering spectrometers have been in routine use since 1975. The spin echo instrument recently became operational and new spectrometers using the back-scattering and time-of-flight (with time focussing) principles are under construction. The application of the spin echo technique to a three axis spectrometer and a diffractometer for separating the thermally diffuse scattering will be implemented on new instruments if current tests show this to be feasible.

(iii) **Computing**

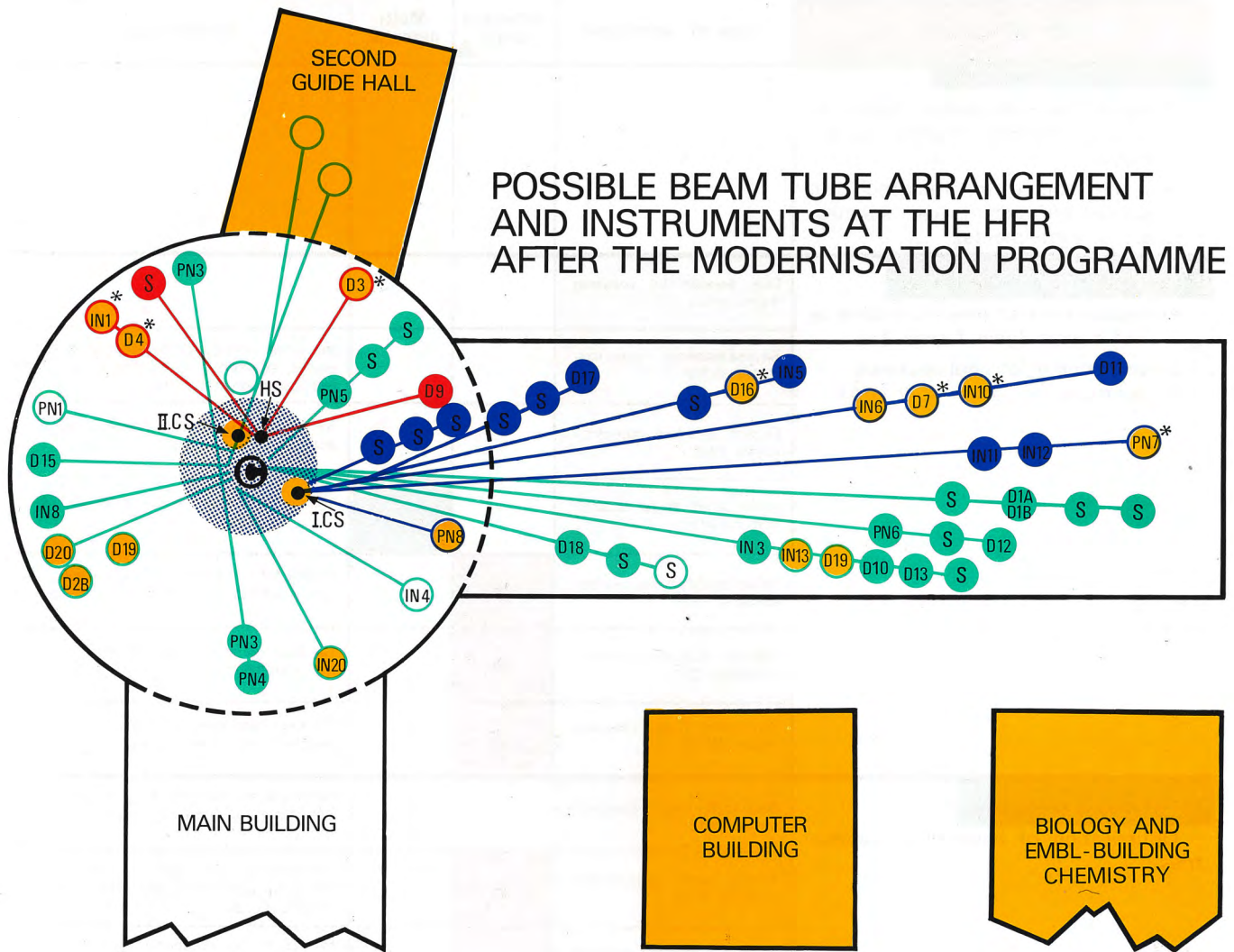
Since one cannot expect to greatly increase the reactor power and hence the basic flux at the high flux reactor, one can imagine that, by adding multidetectors and more powerful computing facilities, the neutrons will be more effectively used.

Both the process computers for instrument control and the Institut's central computer are to be replaced. The aim of the programme is to equip each spectrometer and diffractometer with its own mini-computer so as to increase the efficiency of the instruments and permit partial data reduction as the experiment proceeds. In particular, the central computer (PDP-10) must be replaced in 1980 after eight years of operation. The large data flow arising from modern measuring methods (multidetectors, on-line data reduction etc.), and the high demand for computer time to perform subsequent data treatment, require an immediate, considerable increase in capacity for the new computer system in comparison with the existing PDP-10. The new computer system will allow data treatment at the autonomous instrument computers and also rapid transfer to the central machine.

MAJOR DEVELOPMENTS OF NEUTRON SOURCES AND INSTRUMENTS

Type of neutrons	Type of instrument	Polarised beam	Multi detector	Primary use
A. Ultra Cold Neutrons				
a) Liquid He moderator (EDM of neutron, neutron physics experiments). b) In-pile source for replaced cold source (diffraction and spectroscopy experiments).				
B. Cold and Cool Neutrons				
a) Replacement of present source by cold source (gain factor 2) b) New source for cool neutrons (optimum flux at $\lambda = 2-5 \text{ \AA}$)	Flux benefit for existing instruments.			
	Backscattering spectrometer IN10 ^x			for small energy changes (e.g. quasi-elastic scattering in liquids, liquid and molecular crystals, etc.).
	Fission product spectrometer PN8.			for primary fragment masses and α -accompanied fission.
	(New small angle scattering facility).			mainly for biological experiments.
	Polarized beam for nuclear physics PN7 ^x .	▲		mainly for fundamental physics such as parity violation experiments, etc.
	Diffuse scattering spectrometer D7 ^x .	▲		for disorder scattering of magnetic and non-magnetic nature.
	(Spin-echo 3 axis spectrometer IN14).	▲		for very high resolution of phonon and magnon line width measurements.
C. Thermal Neutrons				
Optimisation of beam tube geometries.	Backscattering spectrometer IN13.			for physical chemistry (e.g. single particle motions, such as jump rotations, tunnelling, etc.).
	3-axis with polarization analysis IN20.	▲		for inelastic polarized neutron scattering to separate nuclear and magnetic contributions.
	Polarized thermal neutron diffractometer D5 ^x .	▲		for study of magnetic properties of crystals with polarisation analysis.
D. Hot Neutrons				
Optimisation of beam tube geometries.	Polarized hot neutron diffractometer D3 ^x .	▲		for study of magnetic properties of crystals using classical polarised neutron technique.
	Hot neutron 3-axis spectrometer IN1 ^x .			for inelastic scattering with large energy changes.
	Hot neutron liquids diffractometer D4 ^x .			for structure investigations of liquids, gases and amorphous materials.
Exploitation of multidetectors and computers.				
E. Cold Neutrons				
	Mark VI diffractometer D16 ^x .			for diffraction of large unit cell crystals, e.g. viruses.
	TOF spectrometer IN6.			for TOF quasi- and inelastic scattering (selected scans) using large area detector.
F. Thermal Neutrons				
	Powder diffractometer D2B.			for high resolution, high intensity powder diffraction.
	Powder diffractometer D20.			for high intensity powder diffraction for kinetic and surface studies.
	Pseudo 2-dimensional multi-detector D19.			prototype, for fast data collection in large molecule crystallography.
G. Development Project				
Multi-detector of 400 000 cells.	(Multi-cell detector).			prototype.
H. Computers				
a) Increase of computing power of central computer. b) Equipment of each instrument with a « mini-computer ». c) Computer control of sample environment.				

POSSIBLE BEAM TUBE ARRANGEMENT AND INSTRUMENTS AT THE HFR AFTER THE MODERNISATION PROGRAMME



- Hot neutrons
- Cold neutrons
- Thermal neutrons
- Effect of the renewal programme
- Instrument future under discussion
- C Reactor core
- HS Hot source
- ICS First cold source
- ICS Second cold source
- D Diffractometer
- IN Spectrometer for Inelastic Neutron Scattering
- PN Nuclear Physics Instrument
- S Special Beam Instrument

Instruments remaining un modified

- D1A TWO-AXIS (powders)
- D1B TWO-AXIS (powders)
- D2 TWO-AXIS powders & single crystals
- D8 Four circle diffractometer
- D9 Four circle diffractometer
- D10 Three-axis el. scattering
- D11 Small angle scattering apparatus
- D12 Diffractometer (mod. laue method)
- D13 Crystal testing apparatus
- D15 MARK VI Diffractometer
- D17 Small angle scattering apparatus
- D18 Neutron interferometer
- PN1 Fission product spectrometer
- PN2 Conversion electron spectrometer
- PN3 Gamma ray spectrometer
- PN4 Anti compton spectrometer
- PN5 Ultra cold neutron source
- IN2 Three-axis spectrometer
- IN3 Three-axis spectrometer
- IN4 Rotating crystal spectrometer
- IN5 Multi chopper TOF
- IN8 Three-axis spectrometer
- IN11 Spin-echo spectrometer
- IN12 Three-axis spectrometer

New instruments

- D2B High intensity - high resolution two-axis for powders
- D19 Pseudo 2 dim. detector
- D20 High intensity two-axis for powders
- IN6 TOF + large area detector for selected scans
- IN13 Backscattering instrument with large momentum transfer
- IN14 Spin-echo 3-axis spectrometer
- IN20 3-axis with polarisation analysis
- PN8 Fission product spectrometer

Improved instruments

- IN1* 3-axis spectrometer
- IN10* Back scattering spectrometer
- D3* Polarised neutron diffractometer
- D4* 2-axis spectrometer for liquids
- D5* Thermal neutron pol. analysis diffractometer
- D7* Diffuse scattering instrument
- D16* Mark VI diffractometer
- PN7* Pol. beam for nuclear physics

(iv) **New Building and the Biology/Chemistry Programme**

New buildings for the central computer, a second guide hall and a major construction together with the European Molecular Biology Laboratory (EMBL) will be made.

The new laboratory will house the Grenoble outstation of the EMBL, as well as the biology and chemistry groups of the ILL. Its construction recognises the growing use of neutron scattering experiments for chemistry and biology in such areas as the structure determination of multienzyme complexes, plant viruses, connective tissue and membranes, polymer structure and dynamics, chemisorption, physisorption, high resolution molecular spectroscopy of solids and liquid crystals. The new building will provide a focus for European activity in molecular biophysics and chemistry.

The plan shows, approximately to scale, one possible model of the geographical changes associated with instrument and building construction foreseen in the next five years.

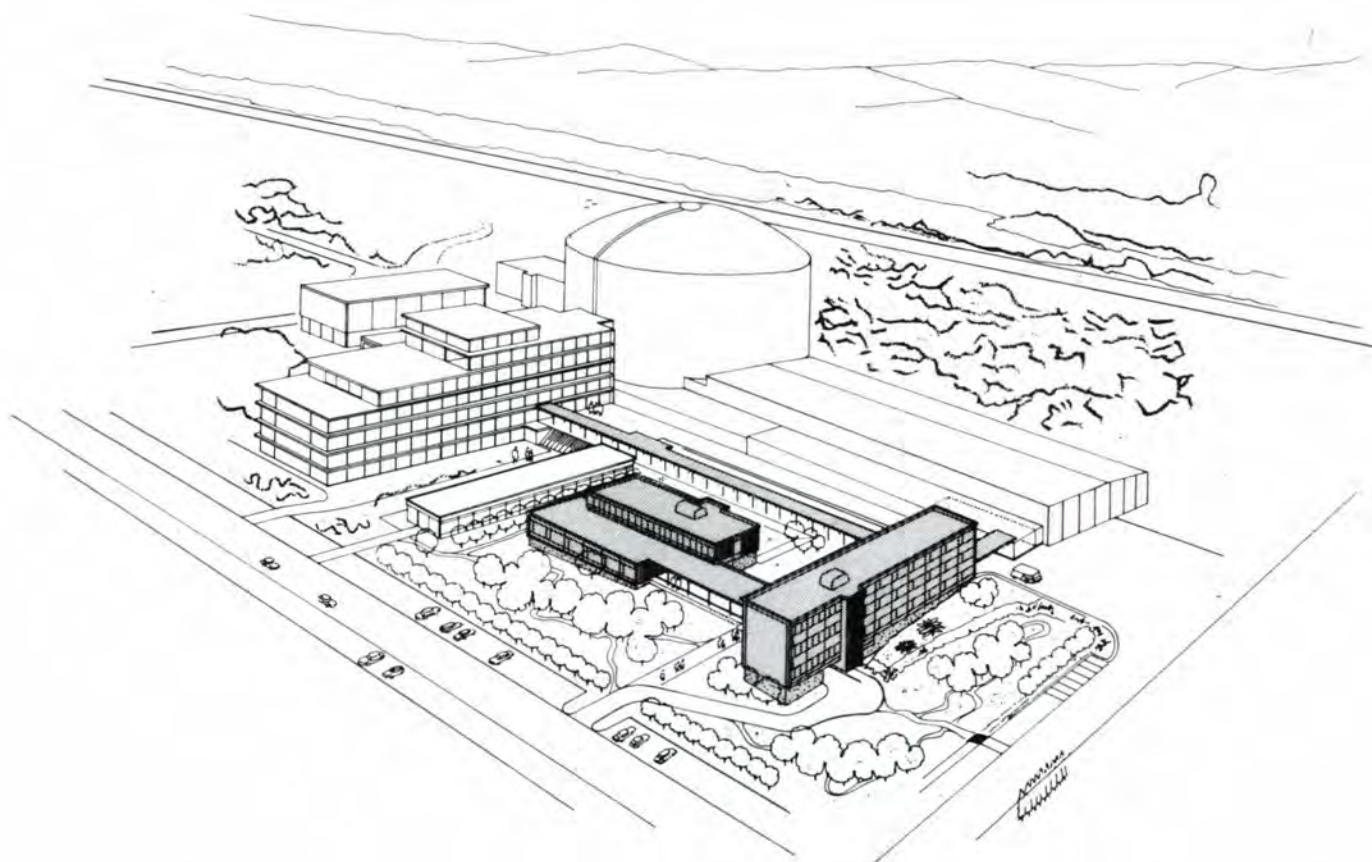


Fig. 3 : Possible arrangement of the ILL buildings after the modernization programme. The shaded parts represent the new building foreseen in the renewal programme.



Instrumentation

Introduction

The investments made during 1978 and 1979 through the agency of the restructured instrument groups have continued to show their effects by improved instrument operation. The statistics of time lost on a number of typical instruments over the last four years are shown in Table III. The noticeable continuing trend of improvements reflects the installation of new electronics and mechanics in a number of instruments, the installation of dedicated mini-computers at instruments as opposed to the old CARINE and NICOLE systems, and the beneficial effects of the reorganised instrument group structure since 1978. Finance for the instrument groups was maintained as a budgetary priority during 1979 and will continue to be so in 1980 to ensure adequate care of the large number of instruments which are not in the "Deuxième Souffle" programme.

At the level of electronics and instrument control, the NICOLE replacement was completed in 1979 by the transfer of the instruments IN5, IN4 and PN1 to dedicated computers. The installation of suitable "soft-ware" for easy data reduction whilst experiments are in progress is in progress for former NICOLE instruments. The CARINE replacement continues and this year new computers have been placed on the D1B multidetector powder diffractometer, D9 short wavelength single crystal diffractometer, and the D10 multi-purpose and low temperature single crystal diffractometer. Dedicated computers have been ordered for the diffractometers D2 and D5 and the 3-axis machines IN1 and IN8. These will be installed in the first part of 1980. The instrument operating statistics for 1979 are given in Table IV.

It will be remembered that, in order to prepare for the "Deuxième Souffle" instrumentation, high priority was given in 1978 to develop new neutron techniques. This trend was continued in 1979 with also the phased start of a number of new instrument constructions and major instrument rebuilds as the year progressed. Facilitated by money available in the special modernisation programme budget 1979, and some money from the normal budget, it was possible to begin constructing the new IN1 hot source three axis spectrometer and the associated improved D4 liquids diffractometer. These instruments will use curved monochromators and eventually beryllium crystals, perhaps producing flux gains respectively of the order of 5-30 times at the sample. Table V shows the projects in progress during 1979 and Table VI shows projects under definition. The "Deuxième Souffle" projects for 1980-81 are listed in Table VII. All projects are approximately on schedule except for the D19 multidetector for which a worrying delay due to electronic faults has occurred. A new modification of the elements in the multidetector and of the associated logic, expected to be working by late January 1980, should clear these difficulties. No such problems have been encountered for the one-dimensional multidetectors which will be installed on the D4 liquids diffractometer and the D16 high resolution biological diffractometer during 1980.

TABLE III : TIME LOST DUE TO TECHNICAL PROBLEMS (DAYS).

Year	1976	1977	1978	1979
Reactor operating days	262.4	257	262.6	260
D1A diffractometer	7.5	24.2	14.8	11.3
D8 diffractometer	50.7	36.3	25.4	18.5
D11 S.A.S.	29.3	25.5	32.6	24.5
IN2 3-axis	27.5	30.3	40.1	18.9
IN5 T.O.F.	49.6	37.7	24.4	5.1
IN8 3-axis	30.8	64.4	49.7	62.0

INSTRUMENT OPERATING STATISTICS

**THE REACTOR HAS OPERATED
4 DAYS WERE AFFECTED BY
(ZERO 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
IN1	215.8	44.2		54.2			29.8	
IN2	241.1	18.9		213.6				
IN3	233.5	26.5		151.7		33.3		
IN4	220.4	39.6		22.0		23.0	53.5	
IN5	254.9	5.1		5.8		24.0	84.1	15.9
IN8	198.0	62.0		176.6		10.1		
IN10	231.8	28.2		16.9		13.2	40.6	21.5
IN11	216.8	43.2		16.0	7.0	83.5	12.0	15.0
IN12	111.0			73.6		20.5		
D1A	248.7	11.3			182.2		12.0	
D1B	241.2	18.8			120.3	13.0	12.5	3.5
D2	234.9	25.1			159.8	44.5		
D3	225.4	34.6			180.2			
D4	249.9	10.1			6.0	131.9		
D5	238.7	21.3		21.0	140.5		15.0	
D7	215.0	45.0			6.6		171.8	
D8	241.5	18.5			178.4			41.8
D9	237.8	22.2			202.9			
D10	40.7						17.0	
D11	235.5	24.5			2.0	16.0	54.4	75.2
D12	191.7	68.3		31.6	90.5		15.0	
D13	116.0							
D15	226.0	34.0			179.5			
D16	248.3	11.7			30.9		40.5	141.3
D17	241.0	19.0			5.0	15.0	43.5	57.0
PN1	164.5	95.5	143.5					
PN2	210.0	40.0	189.0					
PN3 (G1)	258.5	1.5	237.5					
PN3 (G2/3)	258.5	1.5	237.5					
PN4	56.5		53.4					
PN5								
PN6	227.0	33.0	198.0					

(JANUARY TO DECEMBER 1979)

FOR 260 DAYS DURING THE YEAR
 UNSCHEDULED SHUT-DOWNS
 EXTENDING THE OPERATING CYCLE)

Coll. 9	Internal test, feasibility, and instrument improvement experiments	Comments
102.7	29.1	Tests of Be filter and new TAS analyser
	27.5	
4.5	44.0	
90.5	31.4	Problems with T.O.F. unit
114.1	11.0	
	11.3	Loss of beamtime includes 44 days mechanical + electronical overhaul
109.9	29.7	
67.7	15.6	34.5 days lost due to computer faults
	16.9	Commissioning experiments completed. Full scheduling commenced 21-6-79.
7.2	47.3	
37.3	54.6	
21.5	9.1	
	45.2	Cryogenic improvements (cryomagnet, cryoflipper)
	12.0	
	62.2	
5.6	31.0	
	21.3	
	35.9	
	23.7	Spin echo conversion and tests
62.1	24.8	
	54.0	33 days - repairs to collimation system
	116.0	23 short term experiments
	46.5	
8.0	27.6	
93.0	27.5	
	21.0	Electrical repairs, breakdown of source changing facility
	21.0	
	21.0	
	21.0	
	3.1	Use restricted by experimental requirement and positioning of PN3 (GI)
		Two long term experiments (EDM, storage ring)
	29.0	

TABLE V - PROJECTS IN PROGRESS

IN6	<p>High intensity time-of-flight spectrometer in the λ range 4.1 to 5.9 Å. It will have three focussing monochromator crystals (pyrolytic graphite) 20 cm high ; a Fermi chopper ; 2 metre flight path ; 400 elliptical ³Helium detectors covering 4 m². The monochromator and beryllium filter assembly have been installed and the mobile support for the secondary spectrometer constructed. The secondary spectrometer is in an advanced state of construction and will be installed in the early part of 1980. Commissioning tests will occur during Spring/Summer 1980 and full operation in the latter part of the year.</p>
IN13	<p>This is a back-scattering spectrometer on a thermal guide operating at 2.2 Å. The monochromator zone and three-walled neutron guide have been installed on the H24 guide. Tests on a prototype furnace for scanning the monochromator lattice parameter were carried out successfully in 1979 and led to the design of a control system with faster sweep rates for the incident energy. The machine should be installed in early 1980 and first test experiments occur during the summer of 1980.</p>
D19	<p>A complete diffractometer assembly has been constructed on the H24 guide and is under test. The large D19 multidetector (pseudo-two dimensional) has been certificated by the Bureau des Mines and is in the final stages of electronic testing. From December 1979 to June 1980 a smaller multidetector (64 wires) will be used for practical tests of the data acquisition and data treatment systems. The philosophy of the data acquisition system for single crystal experiments is being worked out by a group from Queen Elizabeth College, London, in conjunction with an in-house team who have been programming the multidetector on D17 for data acquisition on virus and other biological single crystals.</p>
IN1B	<p>This new hot source 3-axis machine will be a "no compromise" instrument using to the maximum the short wave length neutrons available from the ILL hot source. The design has now been completed and the instrument will cover a wide range of momentum transfers. In conjunction with the development of mosaic single crystals of beryllium during 1979 the instrument should have the highest attainable resolution with good intensity for hot neutrons using classical techniques. The instrument is expected to be installed in the long shutdown of Spring 1981. The instrument will be used in a time-sharing mode with the new liquids diffractometer D4.</p>
D4B	<p>To make the best use of the beam from the ILL hot source, an optimum monochromator drum has been constructed for IN1B and D4B. By the use of a multidetector and from the use of curved monochromator crystals, along with the improved monochromator to core distances, factors of up to 30 times might be obtainable for the effective beam intensity on the new liquids diffractometer. This makes time sharing with the 3-axis machine a reasonable possibility.</p>
IN8B	<p>The extensive rebuild of the IN8 3-axis spectrometer, applying the use of a dedicated computer and the new electronics and shaft drive systems developed for IN12, is almost complete. The instrument should run again in January 1980.</p>
<p>Polarised Neutron Projects</p>	
Monochromators	<p>We expect more than 1000 cm² of good Heusler crystal to be available for the ILL in 1980 as a result of developments in the manufacture involving the Physikalische Technische Bundesanstalt at Braunschweig, the CNRS and CEA in Grenoble, and the ILL. In collaboration with the Nuclear Physics Institute of the Academy of Sciences, Leningrad, an attempt is also being made to grow large single crystals of ⁵⁷Fe. Crystals from these two projects would be used for the new generation of classical polarisation analysis machines to be constructed at the ILL.</p>

S3 Evaporator	The S3 evaporator worked under full computer control for the first time in October 1979 and is now routinely producing supermirrors of good quality for the variety of projects requiring them at present under study at the ILL. Because of the intensive use of the IN11 spin echo spectrometer, the foreseen availability of the IN11 beam for systematic observation of the supermirror during production has not been possible. A study is being made to find an alternative site for the evaporator where continuous monitoring can be performed. Tests are also being made with the evaporator to see if mirrors suitable for synchrotron radiation can be produced.
D10	The D10 instrument has been completely reconstructed in 1979 and tested in its classical operating mode. Provision has been made for installing high field electromagnets and supermirrors or Heusler crystals to allow the spin echo tests, the first phase of which should be completed by January 1980. The initial series of experiments has been performed with the newly-produced supermirrors as the polariser and analyser.
D7	In early 1980 a supermirror polariser will be installed on D7 and some changes made in the instrument to allow the increased intensity available from the focussing monochromator, recently installed, to be used. A second project is the construction of an analysing polarisation analysis detector bank to be added to the present D7 instrument to allow tests of the use of polarisation analysis in diffuse magnetic scattering. The supermirrors for this analysing detector are at present under production with the S3 evaporator.
Generalised Polarisation Analysis	Successful tests were carried out during 1979 to make general polarisation analysis of scattered neutrons using a superconducting foil analyser. This work is described further in the Diffraction Group report.
	Neutron Sources
PN5 (UCN's)	Continued encouragement is being given to external groups to use the ultra cold neutron flux from the PN5 source. Present experiments include the storage of ultra cold neutrons in magnetic hexapole and copper bottles and development of apparatus for measuring the upper limit of the neutron electric dipole moment in collaboration with the Harvard and Sussex groups.
Liquid Helium UCN Source	A decision has been taken to construct an ultra cold neutron source at the guide H17 which will work by the downscattering of approximately 10 Å neutrons in highly pure liquid helium-4 at about 0.7° K. The source will be operated to store the ultra cold neutrons for periods which may be as long as 100 seconds, thereby producing ultra cold neutron densities of the order of 100 times greater than are presently available for the electric dipole moment experiment. It can be expected that this experiment will also lead to studies of the very small cross-section effects for very slow neutron scattering. The source should be installed in early 1981.
Replacement of the present Cold Source and possible UCN Source in pile	Design studies have been completed for the replacement of our present cold source by one with a re-entrant cavity, thereby giving possibly factors of 2 times greater flux to the cold neutron guide tubes. This source also has the possibility for extracting an ultra cold neutron flux vertically. This flux may be 100 times that presently available. A decision to construct this second ultra cold neutron source will await the results of experiments using the liquid helium ultra cold neutron source and further developments at PN5.

TABLE VI - PROJECTS UNDER DEFINITION (NORMAL BUDGET)

IN10	An improved secondary spectrometer has been defined for the existing IN10 instrument. This will allow greater flexibility of operation and efficient change of the analysing system to accommodate the increasing variety of samples presented to this instrument. It will be a preparatory change for the major changes associated with the installation of IN10B.
H15 Guide Reconstruction	A study is in progress for the reconstruction of the H15 cold neutron guide which feeds the instruments D7, IN10 and D11. By the modification of the guide shielding it should be possible to provide additional space needed for the construction of IN10B, to reduce the radiation hazards associated with change in the velocity selector for D11, and to allow fast change in the resolution of the D11 small angle scattering machine which is becoming more and more necessary as the sophistication of experiments with that instrument increases. The changes will also allow the installation of an eventually rebuilt D7 (D7B, if this option is finally chosen in 1980).

TABLE VII - PROJECTS UNDER DEFINITION (DEUXIEME SOUFFLE)

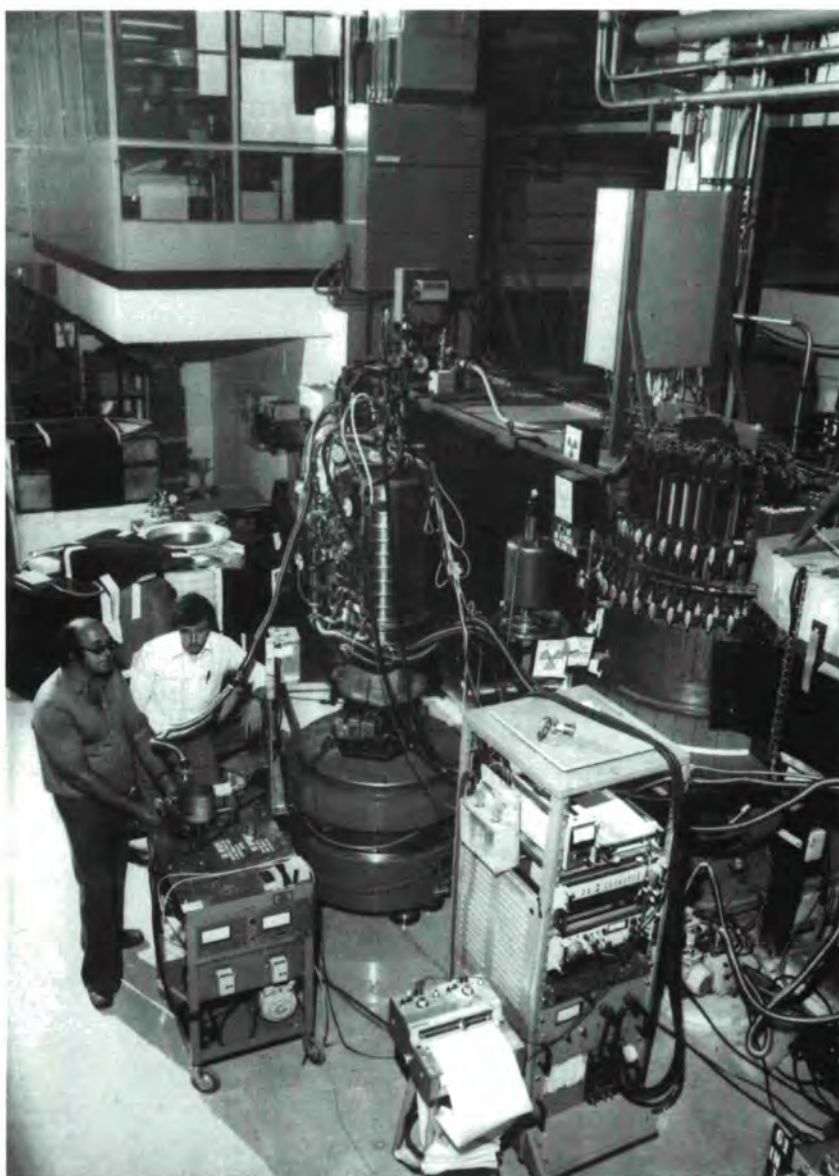
PN8 (Cosi fan tutte)	Design studies are now advanced on the special ionisation chamber detector needed for cosi fan tutte which is a fission product coincidence spectrometer. It is expected to decide at the Scientific Council in March 1980 whether the technically stringent conditions for the realisation of PN8 will allow construction to go ahead.
D16	This is an extensive reconstruction of the existing D16 cold neutron 4-circle diffractometer. The machine will have a dedicated computer, multidetector and optimised monochromator to allow the discharge of the D17 small angle scattering machine for work on large unit cell single crystals, particularly single crystals of virus and multi-enzyme complexes.
H11 Project	<p>This is a major project for the reconstruction of the D2/D8 instruments on the H11 beam port of the high flux reactor. The D8 position will be prepared to receive the D19 multidetector single crystal diffractometer after tests on the H24 guide position, perhaps in early 1981. The present D2 position will be developed to take two powder diffractometers :</p> <p>The first, D20, will be a very high intensity powder diffractometer using a focussing monochromator and an enlarged aperture on the H11 hole (which is one of the most intense holes of the high flux reactor).</p> <p>The second, D2B, will be a high intensity, very high resolution, powder diffractometer which may have again an intensity of about 10 to 30 on the present D1A instrument. When D2B is successfully functioning, D1A will be closed.</p>
IN10B	A detailed study has been made of a new Doppler drive system for the IN10 spectrometer. The rebuilt spectrometer will be called IN10B and by using the "Bauer wheel" should have an energy scan of the order of 10 to 50 times the present IN10 scan. It will, however, retain the energy resolution of IN10 (approx. 1 micro-electron volt) and work in the same range of momentum transfer.
Polarisation Projects	
D3/D5	Studies are in hand to allow the installation of the polarised neutron diffractometer, D3, on a hot source position which is almost certain to be that of the present D5 polarised neutron 3-axis machine. Because of the strong pressure for polarised neutron 3-axis experiments, an alternative site for the D5 instrument is under study. A considerable optimisation of the flux on both types of instrument can be expected from this move which logically follows the developments of interest in the neutron programme for polarised neutron work.

D7	A study for the extensive reconstruction of the D7 diffuse scattering spectrometer, especially involving the use of polarisation analysis, is in hand. The study will only be taken to a detailed stage when more information is available from the test experiments using the new D7 polarisation analysis facility expected to be available in 1980 early 1981.
IN20	It is proposed to rebuild IN20 on a thermal beam with a single crystal monochromator. The monochromator and analyser systems will be built in such a way that the polarised beams can be produced and analysed so the instrument would be capable of making polarisation analysis for 3-axis spectrometry. The instrument would, nevertheless, be available to meet the strong demand for classical 3-axis spectrometry at good resolution.
D13C	Improvements to this diffractometer are necessary to allow the systematic testing and mounting of crystals produced in the polarised neutron programme.
	Special Projects
Monochromators	<p>Progress continues in the systematic installation of plastically deformed germanium, silicon and copper monochromators further to the experimental requirements of different instruments at the ILL. In this way considerable gains in usable neutron flux have been obtained at several instruments. This project will take several years to implement.</p> <p>During 1979 crystals of beryllium of cm² size showing the correct mosaic texture for good monochromators have been produced. The beryllium programme has been reinforced following the success to allow both the mounting of composite monochromators based upon these small crystals and also the growth of much larger single crystals during 1980.</p> <p>As mentioned above, special projects for growing Heusler crystals and ⁵⁷Fe crystals are going ahead to give a firm foundation for the ILL's programme of polarisation analysis in the 1980's.</p>
Optimised Shaft Control	The system of shaft movements and computer control at the IN12 instrument has proved remarkably satisfactory. It is now being implemented under the modernisation programme budget at other 3-axis machines. In addition a system involving a loop has been developed during 1979 suitable for the control of diffractometer shafts, and this will be tested and if successful implemented in the 1980's.
Replacement of Guide Noses	Suitable glass for replacing that in the guide tube noses has been found and subjected to irradiation tests in the reactor. A continuous check of the evolution of the present guide tube noses is being kept and it is expected that the programme for the replacement of guide noses could be carried through in the long shutdown which is now foreseen to take place in the Spring of 1981. Approximately three months of shutdown may be required to effect this change.

Instruments which became operational in 1979

Three-axis spectrometer IN12

This triple axis spectrometer has been designed to operate at incident neutron wavelengths of between 2.3 Å and 6.3 Å. It has been installed on a cold neutron guide and became operational during 1979. The instrument is most suitable for high resolution, small energy and small momentum transfers experiments such as low frequency dispersion curves in molecular crystals, some soft-mode system studies, magnetic excitations and quantum and normal liquids.



IN 12 : The new 3-axis spectrometer on a cold neutron guide.

Right of centre : monochromator shielding and Be filter.

Centre : sample table with superconducting magnet cryostat.

Left of centre : analyser and detector units.

A single crystal monochromator (normally pyrolytic graphite) is used with a large range of Bragg angles and as the doubly-bent neutron guide has a cut-off for wave-lengths of less than 2 Å, higher order contamination is normally not troublesome up to about 4 Å. At this wavelength and

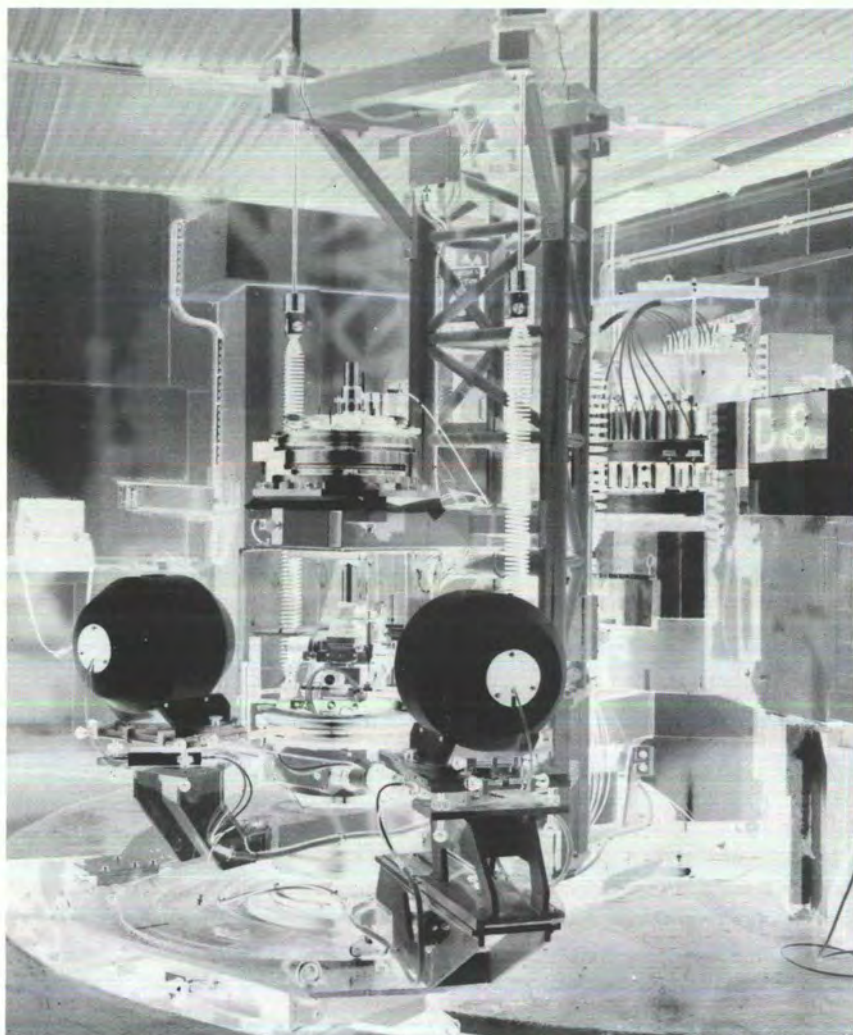
above, a cooled Beryllium filter may be used. A variable curvature graphite monochromator has been installed in order to utilise the full available vertical beam height for spatial focusing on to small samples. With 30' collimation, the flux at the sample position is about $5 \times 10^6 \text{ n cm}^{-2} \text{ s}^{-1}$ at a wavelength of 4 Å.

IN12 has been fitted with new central drive units allowing simultaneous positioning of the shafts and is controlled by a dedicated SOLAR 16/40 computer. Novel user-dialogue programs have been developed in order to simplify operation.

The combination of long wavelength and high sample flux should allow measurements to be made which were hitherto impossible at the ILL.

Double crystal diffractometer D18 for neutron interferometry

The D18 diffractometer is an instrument especially designed to extend the range of neutron optical experiments to investigations of perfect crystals and interferometry with thermal neutrons. It has been installed at the thermal neutron guide H25.



*The instrument lay-out
of the new neutron
interferometer D18.*

The central part of the instrument is a cast-iron "neutron optical bench" rigidly connecting two goniometers for very precise orientation of monochromator and interferometer crystals. A third goniometer is installed on the bench, to carry – optionally – an auxiliary monochromator crystal.

The instrument is built on a platform that can be rotated about the monochromator axis for selection of a suitable wavelength. The diffractometer bench is suspended from springs, to ensure the vibrational isolation necessary for neutron interferometry.

Two ^3He - detectors of 5 cm diameter are used for detection of the interfering beams, while several smaller detectors monitor neutron flux and crystal alignment. An X-ray beam is available for crystal orientation and wavelength calibration.

A 6800 microprocessor controls variation of sample parameters, crystal alignment, and data output to cassette tape.

The high angular sensitivity of this instrument makes it especially suited for investigations of diffraction by almost perfect crystals ; it was specifically designed for measurements with perfect-crystal interferometers.

The interferometer provides two widely separated coherent neutron beams, following a ray path similar to the Mach - Zehnder optical interferometer. The beam handling (splitting, deflection, and recombination) is done by successive Bragg reflections in perfect crystals, cut out of a perfect silicon crystal as a set of plane parallel plates, resting on a common base.

The intensity distribution between the outgoing beams is determined by the relative phase shift of the two coherent beams.

This phase shift is, for example, induced by the insertion of a sample into one beam. Its measurement allows a precise determination of the coherent forward scattering length density of the sample, with a typical relative error of 10^{-3} .. 10^{-4} .

Studies of sample composition and inhomogeneities (e.g. H in Nb) are also possible, and first experiments have shown the feasibility of phase contrast imagery, using photographic detection techniques (Gd converter).

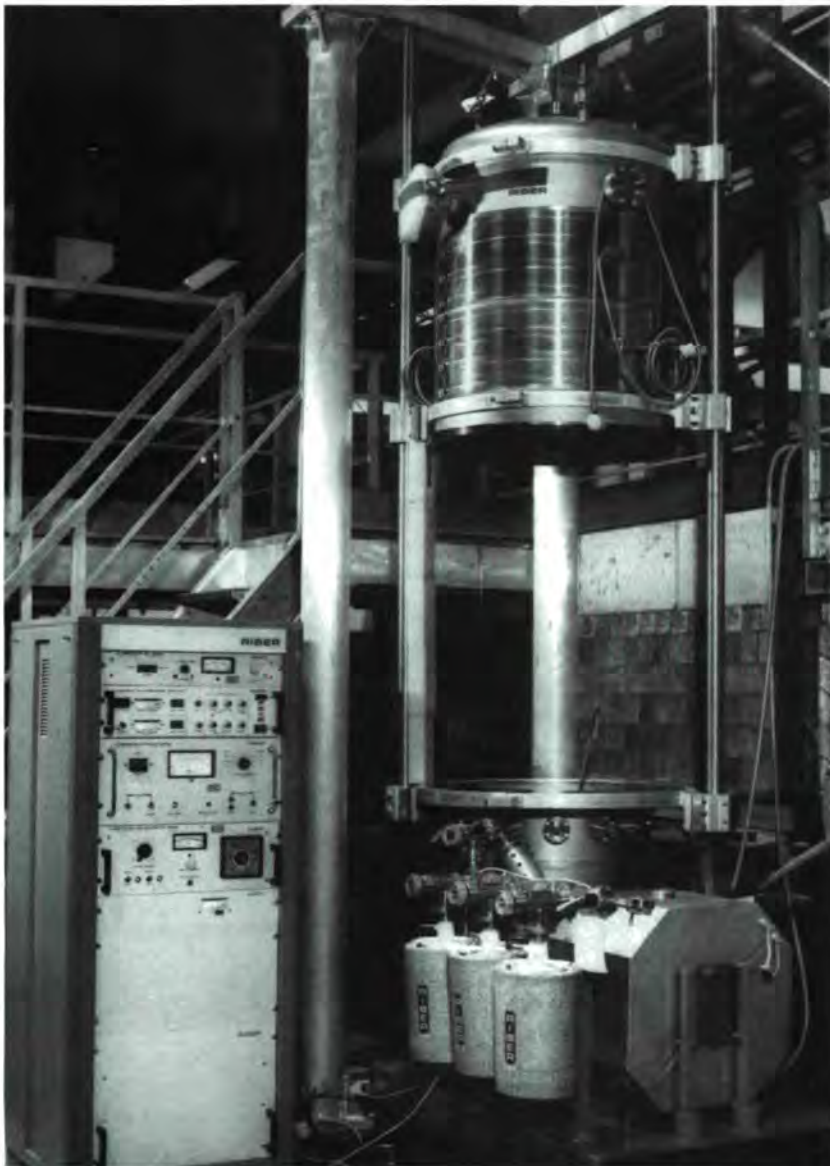
The wave propagation phenomena within the perfect crystal, as treated by the dynamical theory, can be examined for different types of interferometers, aiming at improvement of interference contrast and imaging quality.

The study of spin dependent phase shifts, occurring in magnetic samples or magnetic fields applied to the interfering beams will be continued. Beam polarization is easily achieved by combining the birefringence in a prismatic magnetic field with the high angular resolution of the interferometer setup.

Evaporator S3 - procedures presently available

S3 is an evaporator which uses an electron gun with four crucibles in ultra high vacuum for the production of thin films. It is controlled by a PDP11 type mini computer using BASIC as the programming language under the RT11 foreground/background system. The 5 KW electron gun allows the evaporation of very high melting point materials, e.g. tungsten, which has made possible the production of a multilayer (31) monochromator for long wave length X-rays. The large distance between source and substrate of 900 mm renders possible the simultaneous production of five multilayered devices of 20 cm \times 20 cm. Bake out heaters outside the bell-jar, and quartz lamps inside provide very efficient substrate surface cleaning, and coupled with the ability to deposit many layers very rapidly under computer control allows excellent layer definition. The three sorption pumps, an ion getter pump and titanium sublimation pump help maintain cleanliness by providing a totally oil free vacuum of better than 10^{-9} torr. A quartz crystal oscillator placed in the evaporant stream measures the thickness during production with a resolution of ± 0.5 Å. Electron beam intensity (and thus deposition rate), liquid nitrogen cooling, titanium pump operation, to-

gether with the surveillance of critical parameters (pressure, cooling water flow etc.) are all under the control of the computer, thus obviating the need of human intervention during the whole deposition process. The program is semi-intelligent in that it learns from previous experience the best



The photograph shows the evaporator S3, the new facility for the production of supermirrors for polarized neutrons.

method for achieving the required layer thickness. The advantage of the BASIC language is that the operator can halt the program in the middle of the production, make changes of parameters, on the program itself, and then continue where required. All these possibilities are in fact used in the present production of super mirrors. Super mirrors must be produced in a high magnetic field, and owing to the proximity of S3 to IN11 spin echo spectrometer (an instrument extremely sensitive to magnetic fields) we are now hindered in production by the fact that the two instruments cannot be used simultaneously. If this were not the case a production of two evaporations per week would be easily achieved. Another difficulty also involves IN11 : It was not yet possible to use the polarised neutron beam of IN11, because almost all measurements since the commissioning of S3 have until now been small angle scattering measurements, which make impossible the simultaneous use of the neutron beam. Otherwise it would be possible to investigate the full neutron reflection characteristics of the mirrors during their production and thus dynamically optimise them. It is believed that forthcoming work on IN11 will enable investigations of this nature to be carried out. Until now it was only possible to tests some mirrors after the production using D10 with an unpolarised beam of a wave length of 2.5 Å and later with a partly polarised beam of 3.5 Å.

New experimental techniques

Focussing neutron optics with Fresnel devices

A) Image Formation by a Concave Reflecting Fresnel Zone Mirror using ULTRA COLD NEUTRONS (UCN)

G. Schütz, A. Steyerl (T.U. München) and W. Mampe (ILL)

Following a proposal by A. Steyerl and G. Schütz a reflecting Fresnel zone mirror has successfully been used for image formation with UCN.

The zone mirror, 1 cm in diameter, focal length of 50 mm, was designed for UCN with wavelengths from 600 Å to 800 Å. 50 zone rings producing constructive interference of the reflected waves in the image plane were obtained by electroplating nickel (680 Å) on a concave glass lens. Appropriate compensation of the chromatism of an ordinary diffracting zone plate by the chromatic effect of gravity on UCN, gives an achromatic focussing device for the indicated range of relatively large wavelengths.

The neutrons arising horizontally from the UCN source (PN5) traversed a 2×10 mm² slit (object) and were reflected by a plane mirror in a vertical direction, onto the zone mirror. The real image produced by this zone mirror was scanned by a BF₃ detector with an 2×10 mm² entrance slit. The distance between the object and the zone mirror and between the latter and the image plane could be varied. Applying geometrical optics to these distances, magnifications from 1 to 10 were obtained where the image had the theoretical line shape.

These results give sufficient encouragement to continue the work, the eventual aim being the construction of an UCN interferometer or neutron microscope.

B) Neutron Beam Focussing with Fresnel Zone Plates

A.G. Klein, G.I. Opat, P. Kearney (all Univ. Melbourne)
R. Gähler (Univ. Bayreuth)

It was successfully demonstrated that a slow neutron beam can be focussed by a Fresnel Zone Plate. Using a 10 m-long optical bench set up on the beam line H 18, and a prism monochromator, a beam of 20 Å neutrons with a wavelength spread of ± 0.5 Å illuminated an entrance slit of 50 microns width. This slit was imaged by a Fresnel Zone Plate of 2.5 m focal length, giving a sharp image limited only by chromatic aberration.

The Zone Plates, produced in Melbourne by means of photo-lithography on a Silicone substrate, are of the phase-reversal type, i.e. alternate zones give a 180° phase shift to 20 Å neutrons by passing them through a 2.4 micron-thick layer of Copper (see Fig. 4 and 5).

The image was produced at 1 : 1 magnification and was scanned by a counter located behind a 30 micron exit slit. Although object and image distances could not be varied with this set-up, focussing experiments were carried out by varying the incident wavelength via the monochromator prism angle. The sharpest image was obtained at the design wavelength of 20 Å, and the broadening of the image at other wavelengths was consistent with the calculated change of focal length with wavelength.

Further experiments are being planned using cylindrical Zone Plates, aligned with the slit directions, in order to achieve higher intensities.

Reference

A.G. Klein and G.I. Opat : Proc. int Workshop on Neutron interferometry. ILL Grenoble, 1978 (O.U.P., in press).

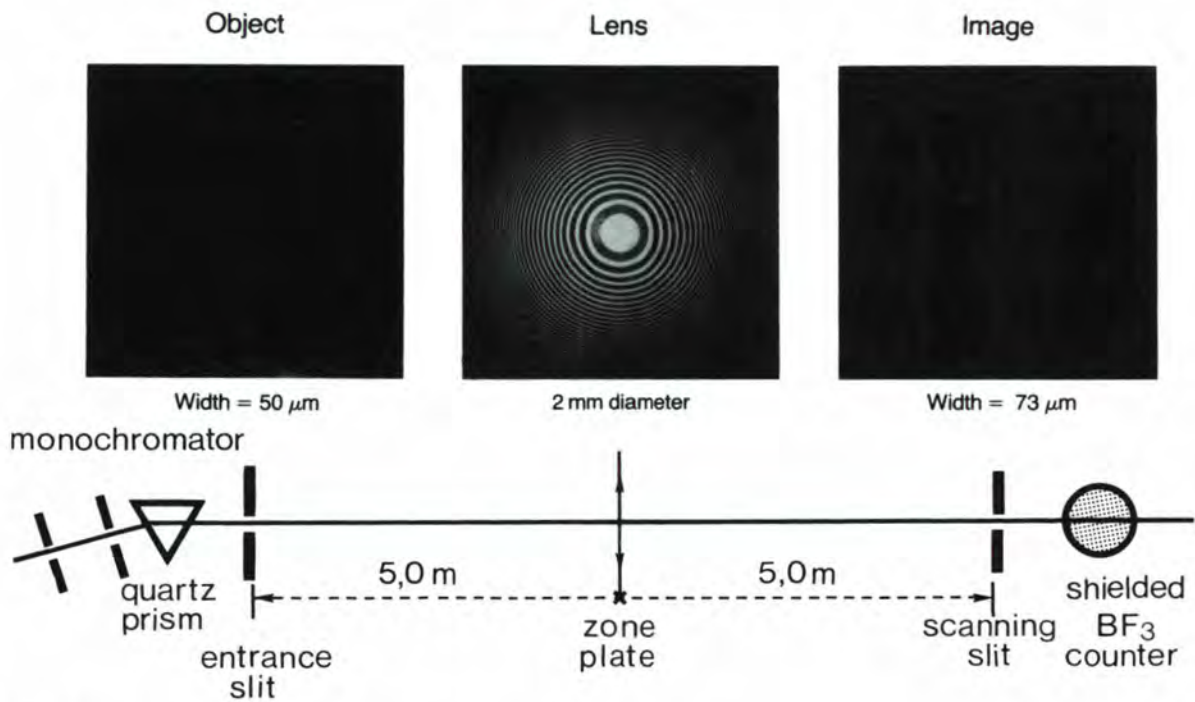


Fig. 4 : Fresnel zone plate acting as an imaging lens for 20 \AA neutrons

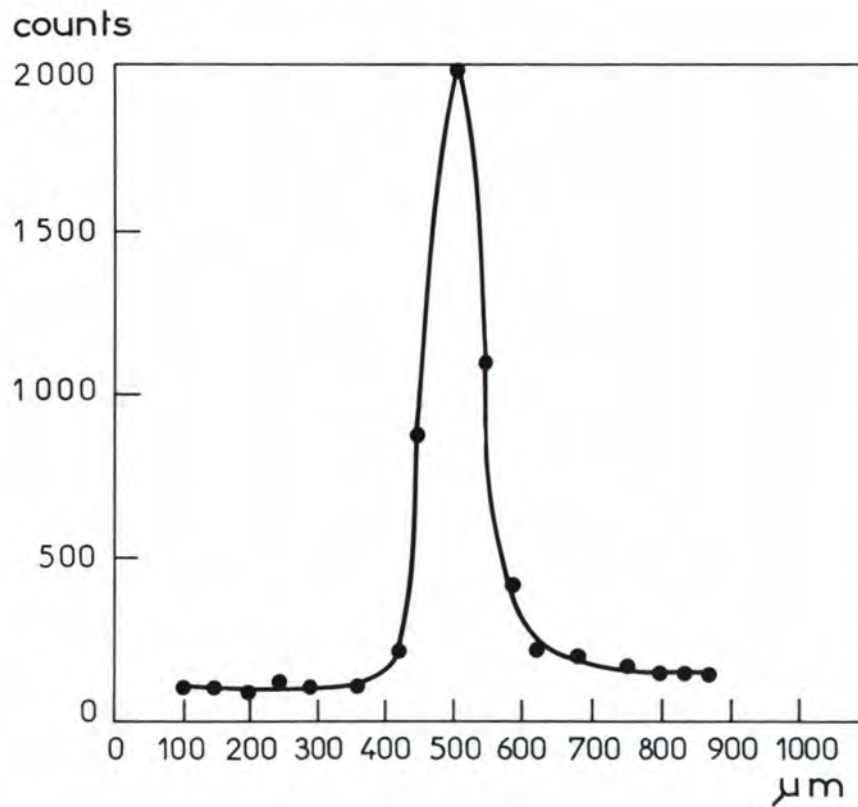


Fig. 5 : Image of $50 \mu\text{m}$ entrance slit at a distance of 10 m.

2

**Instrument
operation
department**

Introduction

The instrument operation department has overall responsibility for the operation and improvement of the instruments and for enabling the visitors to carry out their experiments. The instruments are divided between four instrument groups which assume responsibility for their operation and development. The other groups of the department provide facilities and expertise needed by all the instruments in the diverse domains implied by their names. The central group as well as ensuring the smooth operation of common facilities in the experimental halls, has the particular task of ensuring coordination between the instrument groups and the reactor department and security services.

INSTRUMENT GROUPS

Fundamental and Nuclear Physics

Three-axis spectrometry

Time-of-flight, high resolution and diffuse scattering

Diffraction

OTHER GROUPS

Monochromator Group

Central Group

Sample environment group (contribution not received)

Instrument group Fundamental and nuclear physics

PN1	:	Fission Product Separator (LOHENGRIN) on beam tube H9
PN2	:	Beta Spectrometer (BILL) on the vertical beam tube V3
PN3	:	Three Curved Crystal Gamma Spectrometers (GAMS 1, 2, 3) on the through going beam tube H6/H7
PN4	:	Ge(Li) Anti-Compton and Pair Spectrometers on the through going beam tube H7
PN5	:	Ultra-Cold Neutron (UCN) Source on the inclined beam tube IH3
PN6	:	On-Line Mass Separator for Thermally Ionized Fission Products (OSTIS) on neutron guide H23L
PN7	:	Cold Polarized Neutron Beam on neutron guide H142
H17	:	Cold neutron guide : liquid helium UCN source (in preparation), magnetic storage of UCN (in preparation), cancer research experiments
H18	:	Cold neutron guide : determination of the neutron charge (S37)
H22	:	Thermal neutron guide : neutron induced particle emission (S10) ; γ - γ angular correlation (S34) ; neutron induced fission (S51)
H142B	:	Polarized monochromatic (7 Å) neutron beam (S43)
IH1	:	Very intense neutron beam tube : neutron-induced fission (S16, S38)
base- ment	:	Neutrino experiments (S40)

PN1 - fission product separator "lohengrin"

(H. Schrader, J. Mougey, J.-M. Gandit, J. Gowman)

During 1979 the mass separator was operational for 170 days (65 % of the reactor time). The beam time has been used for 12 experiments in collaboration with external research groups (146 days) and 24 days for test measurements, mainly concerning the improvement of the high voltage generator stability, which is now about 5×10^{-5} (at 2×200 kV).

A main loss of beam time (one reactor cycle) was caused by malfunction of the source changing facility. Therefore, a complete revision of a number of moving mechanical parts in the channel was started in collaboration with the reactor service. The security devices became operational in November giving the possibility of moving the source trolley by hand back to a safe position in case of a power failure.

During the reactor cycle of March/April α -emitting targets were used successfully for the first time. A final version of the waste container for α -emitting targets will be completed by the end of 1979, allowing measurements of most of the fissile transuranium targets in the separator.

Continuous effort has been spent on the installation and the software of a PDP 11/34 as a replacement of the "Nicole" on-line computer system. A basic version of programs for data acquisition should be available at the beginning of 1980.

PN2 - beta spectrometer "Bill"

(K. Schreckenbach, H. Faust, G. Blanc)

In 1979 the electron spectrometer BILL was working continuously for about 85 % of the reactor time. Experiments in nuclear and atomic physics were performed on more than 25 different targets.

In a special study (^{208}Pb) a sensitivity of $5 \mu\text{barn}$ partial neutron cross section was achieved at 5 MeV by multiscanning the region of interest. It was proved that this procedure provides excellent spectra even at counting rates as high as 10^7 counts per channel.

A position sensitive electron detector of the avalanche type is currently under construction and should increase the sensitivity of the spectrometer significantly by covering five times more of the focal plane than the present multi-wire counter.

PN3 - curved crystal gamma spectrometer "Gams 1" and "Gams 2/3"

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

The γ -background measured in the source control system was significantly lowered by new shielding at the exit of the H7 beam tube. Even for weak monitoring γ lines the target position can now be determined with high precision. In addition experiments like Delbrück scattering can be performed under more favorable conditions.

The data acquisition system now allows an automatic photopeak stabilization for the γ -ray detector during the measurement. For low energies the stabilization includes the photopeaks from all five crystal reflection orders independently while at energies higher than 100 keV the stabilization is monitored by the photopeak from γ -rays of the first order of reflection.

The software system at the PDP11 control computer has been further developed. The foreground job controls the experiment and has an overlay structure (80 k program in 8 k memory). The background mode uses a Tektronix system.

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

(D.D. Warner, G. Barreau, C. Hofmeyer)

The Ge(Li) pair spectrometer was operational for the whole year. Instead of the anti-compton spectrometer mode a new 10 % efficiency Ge(Li) detector was used, which provides, besides high efficiency, an excellent intrinsic peak to compton ratio. This detector is shared with special beam experiments. The replacement of the 15 years old multi-channel analyser was started. A new system will be based on a computer, where part of the peripherals will be shared with PN2 and PN3.

PN5 - ultra cold neutron source

(P. Ageron, W. Mampe, A. Beynet)

In 1979 the advantage of the UCN switch box guiding the neutrons to 3 different experimental areas was fully used for the first time. 3 long term experiments could be installed independently and measurements were made in a beam time sharing mode (Electric dipole moment of the neutron, Neutron Storage Ring, Bottle experiment, Neutron optics). At least 2 experiments were running simultaneously all through the year.

The external guide with its radiation shielding, the switch box and the shutter system were joined together on prolonged rails in order to make the access to the in-pile window area easier. During the annual reactor shut down the entire guide system was cleaned or replaced in parts and the vacuum system revised in order to regain the original UCN flux which was deteriorating with time.

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

(B. Pfeiffer, P. Hungerford, G. Jung, B. Nief)

In 1979 the mass separator "OSTIS" was operational for about 90 % of the reactor time. Beam-time was highly demanded and 15 experiments were performed.

The following technical improvements were implemented during the year : I) The vacuum system of the mass spectrometer was separated from the ion source. II) A new auto adjusting source changer was constructed and is now operational. III) A new ion source was developed at the University of Giessen and installed at OSTIS in November. This source is designed for temperatures up to 2500°C and will be able to ionize I, Br, Ba, Sr and the rare earth elements. Thus a new field of isotopes will be open for nuclear spectroscopy at the separator.

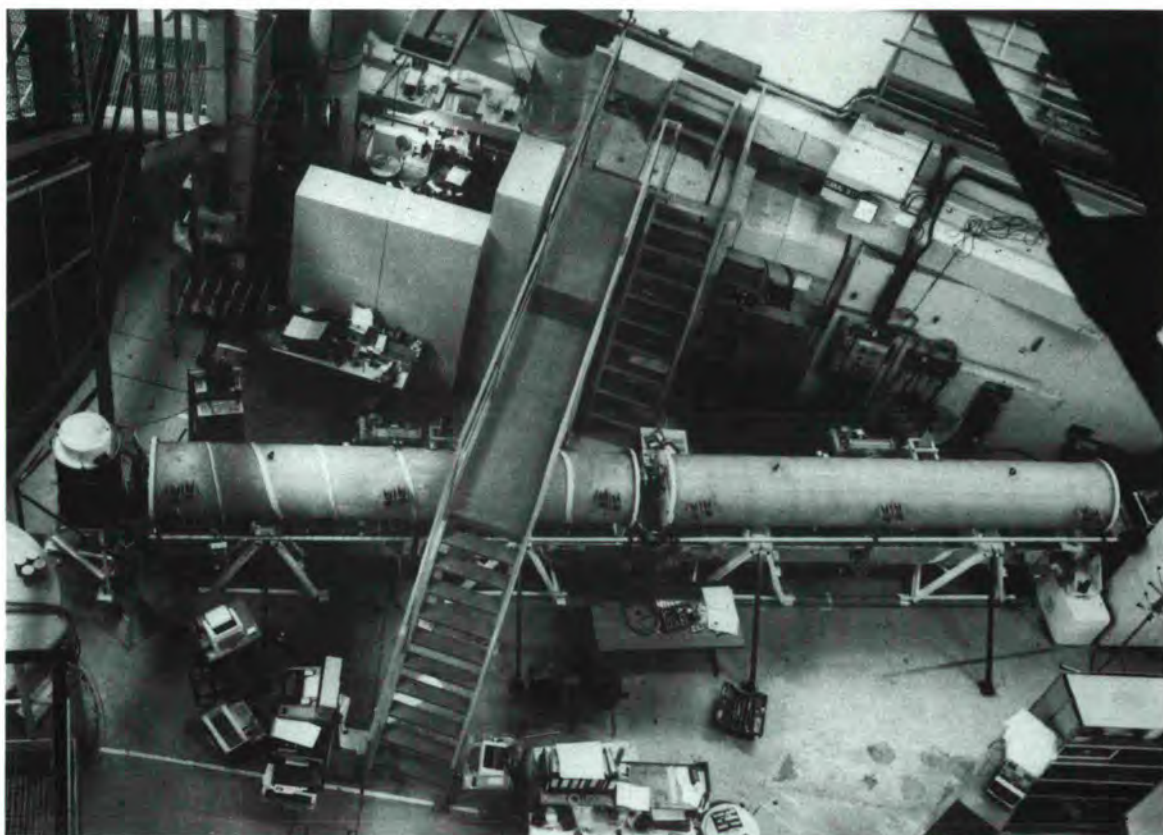
PN7 - polarized neutron beam

(B. Vignon, W. Mampe, B. Nief)

The high intensity polarized neutron beam with a low background, unpolarized flux of $1.4 \times 10^9 \text{ n.cm}^{-2}.\text{sec}^{-1}$, peaked at about 5 Å, was used continuously in 1979 for fundamental physics experiments. The first 5 reactor cycles were allocated to an experiment searching for asymmetry of the emitted gamma radiation after capture of polarized neutrons in deuterium. The last cycle of this year is being used to search for parity violating spin rotation of the neutron during its passage through a tin sample. During the set up of this experiment the polarized neutron flux has been remeasured as $< 3 \times 10^8 \text{ n/sec}$ (integrated flux over the beam area) at the target position.

Special beam experiments

(G. Barreau, R. Brissot, J.F. Cavaignac, P. Hungerford, W. Mampe, P.E.J. Perrin, F. von Feilitsch, B. Vignon, D.D. Warner, B. Nief)



Experimental arrangement for the measurement of the electric charge of the free neutron. Monoenergetic cold neutrons (20 Å) enter the system from the right hand side through a slit. During their subsequent flight path through two 5 m tubes they pass through a high electric field. A precise lense placed between these two tubes focuses the neutrons onto the exit slit in front of the detector (black box at left) (Gähler).

The neutron beams H18, H22 and IH1 were used continuously and successfully throughout 1979 for nuclear spectroscopy, fission and fundamental physics experiments. On H17 cancer research and studies for the new ultra cold neutron (UCN) source have been performed. A new position has been created on H14.

At H18 an experiment searching for an upper limit of the electric charge of the neutron was performed and finished in 1979. Experiments in neutron optics are currently underway.

The neutron flux at H17 has been increased by a factor of 10 to the new value of 3×10^9 n.cm⁻² sec⁻¹ on 5×3 cm² by prolonging the neutron guide to the target position. An experimental arrangement was set up to measure the upscattering losses of UCN in superfluid, ultra pure helium-4. A cryostat for the production of this helium-4 ($< 10^{-12}$ He-3) was constructed at Lancaster University and transferred to the ILL.

The final design of the new superfluid helium UCN source, at H17, has been completed and the order for its construction will be given at the end of 1979 to an industrial firm.

Furthermore H17 has been equipped for a new field of research. A group from Upsala started with cancer studies and the results are encouraging for a continuation in 1980.

The new beam position H142B, providing polarized monochromatic neutrons, became operational in 1979. This beam is characterized by a polarized flux of 10^5 n.cm⁻².sec⁻¹ and a wavelength of 7 Å with a spread of a few percent. Synthetic mica was used as the monochromator. With these characteristics initial measurements of neutron optical spin rotations in ¹²⁴Sn and natural Sn were possible with an error of several parts in 10^5 .

The multiparameter acquisition system for nuclear and fundamental physics was equipped and tested with soft-ware for two parameters, including list-mode output to a magnetic tape. An extension to 4 parameters is foreseen.

The neutrino experiment (cross section, beam oscillations) placed in the basement, became operational this year. A detailed description is given in "College 3" of this Annual Report.

“Cosi fan tutte” project at IH1

(P.E.J. Perrin, A. Oed)

On 1st September 1979, a preproject study on “Cosi fan tutte” was started. Based on recent detector developments (time-of-flight, ionization chambers with high energy resolution), this new instrument is intended to survey systematically mass, charge and energy distributions of fission fragments as well as neutron and light charged particle emission during the fission process. This facility will be complementary to Lohengrin. Two physicists were recruited (temporary contracts) to build the instrument.

Co-ordinators : W. MAMPE, K. SCHRECKENBACH

Instrument group

Three-axis spectrometers

IN1	:	3-axis with beryllium-filter analyser option on the hot source (beam tube H8)
IN2	:	3-axis with a double monochromator on the thermal beam tube H13
IN3	:	Focussing 3-axis spectrometer on the thermal guide tube H24
IN8	:	3-axis spectrometer on the thermal beam tube H10
IN12	:	3-axis spectrometer on the cold guide H14

Introduction

During 1979 the instrument IN12 became a fully operational ILL instrument, and has been fully scheduled since May.

A modernisation programme was started for the IN8 and IN1 spectrometers, involving automatic control by individual minicomputers, the Solar 16-40, as used successfully on IN12. In addition the use of new drive modules with independent encoders should give these renovated instruments IN8B and IN1B a much improved long term reliability.

Similar improvements are under consideration for the IN2 and IN3 instruments.

The spectrometers in the three-axis group have functioned without problem throughout the year, except for IN8 where a one cycle shutdown was foreseen for the end of the year to carry out some improvements.

IN1 - hot source 3-axis with beryllium-filter analyser option

(J. Tomkinson (until Nov. 1979), H.J. Lauter and S. Andrew)

The IN1 spectrometer has performed satisfactorily throughout the past year. The new 3-axis analyser/detector arm with the detector moving within the analyser protection, will be installed during November 1979. The new system which is equipped with boron-coated Rutherford Lab. collimators, is expected to yield a significant improvement in signal-to-noise ratio, in the 3-axis mode of operation.

An intensity gain has been achieved by increasing the effective area of the monochromator. A further gain is expected from the installation of a beam stop of smaller size, now under construction, which will allow shorter sample-to-analyser distances to be used.

The beryllium-filter analyser system has been equipped with a new multidetector, resulting in an improvement of the signal-to-noise ratio, in the 3-axis mode of operation.

IN2 - thermal beam 3-axis with a double monochromator

(B. Dorner, C. Joffrin and P. Florès)

IN2, the oldest ILL instrument, has operated continuously since fall 1972. It has performed quite reliably although somewhat slowly due to the well-known deficiencies of the tanzboden-drive system and of the CARINE computer.

In view of the growing interest in the use of polarised neutrons in inelastic work and as part of the current modernisation programme it is envisaged to rebuild IN2 as a single-monochromator instrument with the option to use a polarising monochromator crystal.

There were few changes or improvements to the existing set-up during the past year. A RL-type Soller Collimator was installed in the drum between the two monochromator crystals. This collimator was especially designed to fit the limited drum aperture. The flux improvement was about 30 % for a 60' - collimation.

IN3 - 3-axis on a thermal guide

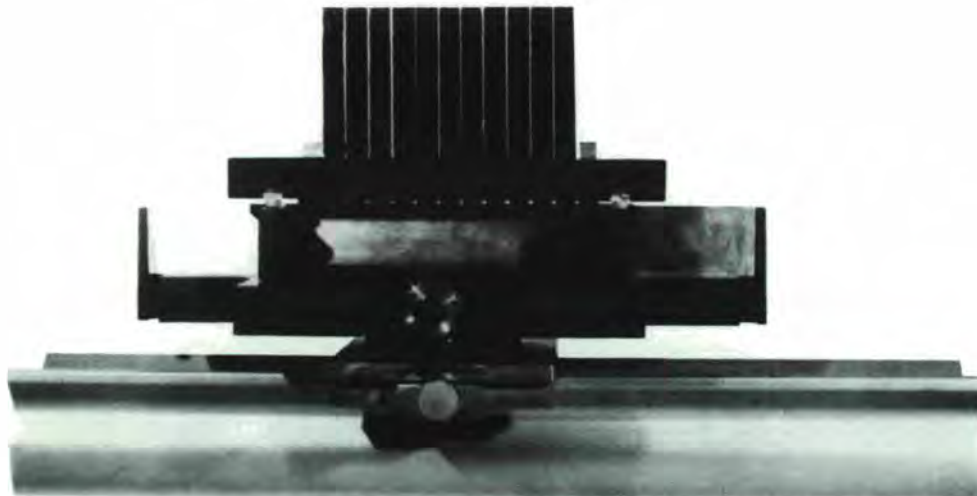
(J. Lefebvre, H. Kraxenberger and B. Wanzel)

Because of the tight collimation inherent to the neutron guide, IN3 is best suited for experiments requiring a high resolution in the intermediate incident energy range (5 to 30 meV).

A modification to the existing monochromator shielding blocks has resulted in some flux improvement as well as an increase in the available range of monochromator Bragg angles. The lowest accessible $2\theta_M$ value is now 32° , corresponding to an incident energy of 24 meV using PG(002) and 60 meV using Cu(111).

A new tanzboden control unit has significantly reduced the spectrometer positioning time.

A new horizontally curved analyser has been built and successfully used for optic phonon and tunnelling mode measurements. The new mechanical design allows for a quick exchange of analyser crystals (PG, Ge), a simplified alignment procedure and a low background (no extraneous material in the beam path).



The curved analyser of the 3-axis spectrometer IN3.

IN8 - thermal beam 3-axis

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

The IN8 spectrometer continues to be in high demand due on the one hand to the flux and signal-to-noise ratio and on the other to the wide range of incident energies accessible.

The variable, vertically-curved monochromators PG(002) and Ge(111) give an increase in flux of 2.5 and thus are used regularly.

The collimators before and after the sample have been replaced by RL-collimators giving an appreciable increase in flux, especially for small collimations (10', 20').

The first part of the planned improvements was started during the annual shutdown, and will continue until the end of the year. This concerns the monochromator turret assembly where the wiring, motors and support materials have been modified to eliminate radiation damage and limit the activation levels, and the installation of a more robust mechanical drive for the monochromator drum incorporating an independent encoder system.

IN12 - cold source 3-axis

(W.G. Stirling, J. Bouillot, P. Florès and R. Pratt)

After initial tests, IN12 became a regularly scheduled instrument in May of 1979. Since this time the spectrometer has worked well, with only minor mechanical and electronic problems.

The new "central-drive" system employed on IN12 has now been used for six months of continuous running and has behaved well allowing fast, accurate, simultaneous positioning. The step-motor control electronics and dedicated SOLAR 16-40 computer permit an efficient use of the neutron beam-time, with typically 4-5 seconds of lost time between counting positions. Considerable program development has been carried out. Simultaneous on-line control and some data processing is now possible. In the near future an instrumental resolution program will be made available on the SOLAR computer.

Many different types of experiments have been performed, normally with incident wavelengths between 4 and 5.5 Å, giving instrumental resolutions in the range 0.03 THz (120 μeV) to 0.01 (40 μeV) THz. The ultimate energy resolution is about 0.005 THz (≈ 20 μeV). Excitation energies as low as 0.005 THz (≈ 20 μeV) have already been measured.

Co-ordinator : R. CURRAT

Instrument group

Time-of-flight, high resolution and diffuse scattering

- IN4 : Time-of-flight spectrometer on thermal tube H12
- IN5 : Multichopper spectrometer on cold guide H16
- IN6 : Focussing time-of-flight spectrometer on cold guide H15
(under construction)
- IN10 : Backscattering spectrometer on cold guide H15
- IN11 : Spin echo spectrometer on cold guide H14
- IN13 : Backscattering spectrometer for short wavelengths on thermal
guide H24 (under construction)
- D7 : Diffuse scattering spectrometer on cold guide H15
- D11 : Small angle and diffuse scattering spectrometer on cold guide H15
- D16 : Four circle MK 6 diffractometer on cold guide H16
- D17 : Low-q-high resolution spectrometer on cold guide H17

IN4 - time-of-flight spectrometer

(J.-B. Suck, R. Richardson, A.P. Murani, H. Walter)

30 experiments from Colleges 4, 6, 7 and 9 have been performed on IN4 in 1979. After the major change of the secondary spectrometer in October 1978, the primary spectrometer has been improved and the data acquisition system was replaced this year.

The old Nicole 1 system has been replaced by a new data acquisition system with a front-end computer (PDP 11/34) linked to, but independent of, a central computer (PDP 11/55) ; 128 K external memory, CAMAC control electronics ; one fixed and one mobile disk ; a printing terminal, a display terminal and a plasma display. This system is much more versatile than Nicole 1 : a record of the experiment is a printed ; up to 16 parameters of the experiment can be checked by the front-end computer ; automatic data transfer is now possible, and an initial assessment of the current measurement including background subtraction allows decisions to be made during the experiment.

A major effort has been put into improving the stability of the data acquisition system : the connection of the detector boxes to the spectrometer and the one to the data acquisition system have finally been uncoupled, considerably reducing the wear of the electrical connections. All cables connecting the detectors at the spectrometer with the TOF-unit have been replaced. More powerful 6 V and 24 V supplies for the detectors have been installed. The connection board between the detector cables and the TOF-unit has been replaced by one which allows one to read out the detector positions and the splitting of each detector box in subspectra with the front-end computer. In addition to this, the data acquisition system has been put on the ILL stabilized ARC power supply.

4 boxes, each with six 15 cm long He³ counters, have been installed in order to achieve better momentum transfer resolution at the lowest scattering angles.

The door between the primary and the secondary spectrometer has been changed during the October shut down. The new door contains a horizontal (double monochromator) and an inclined (38.25 degrees for single monochromator) flight path for the monochromatic beam. The primary spectrometer for the single monochromator option will be installed during 1980. (See ILL report N° 79SU35T).

To improve the background conditions for low angle experiments and the resolution of the spectrometer a 40 minutes Rutherford collimator can now be installed in the monochromatic beam. It has already been used successfully in several experiments. A small background chopper can now be used behind the collimator position to reduce the background in the monochromatic beam and to suppress second order contamination in certain cases.

The horizontal geometry furnace has been improved which allows experiments now with temperatures up to 2000 K to be performed.

IN5 - multichopper spectrometer

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

The spectrometer performance has improved compared to last year. This was mainly due to the continuous effort of the instrument technician who has taken full responsibility for the functioning of the spectrometer especially handling and preparation of cryostats and furnaces and operation of the 1200 detectors.

Preventive maintenance of the chopper ball bearings has been very effective (only one shut down during the whole year). An arrangement has been made for the maintenance of the Ispra built electronic chopper drives until they are replaced.

36 experiments have been carried out this year, coming from 5 different colleges, mainly 7 and 9. This shows the large domain of science covered by this instrument, with emphasis on adsorbed phases, spin glasses and superionic conductors. A sizeable part of the experiments used an incident wavelength between 4 and 6 Å where IN6 should be superior in flux and intensity. The improvements initiated last year were completed during the October shutdown 1979. The new variable temperature Helium cryostat (ILL built) and the new furnace (400°C) allows simultaneous mounting of three samples with a very low temperature gradient. A manually activated electric sample changer allows measurement of spectra of three different samples without dismounting. Computer control of this sample changer is planned for the future. The change over from Nicole to the PDP11/34 took place without problem. Progressive development of new programs already some on-line calculations such as scale transformation from time of flight to energy transfer, summation, subtraction and normalization of spectra etc. The PDP11/55 concentrator has only been for data transmission.

The 800 mobile detectors (between 11° and 134°) are now all mounted. Their positioning for each experiment is a considerable task.

400 extra shorter detectors have been mounted in fixed positions between 1.9° and 9°. It is planned to carry out a systematic check of the time dependence of the detector efficiencies on the instrument computer.

During the next three years the present chopper ball bearings will be progressively replaced by electronically controlled magnetic bearings. This will allow the use of the nominal maximum speed of 20 000 r.p.m. thus improving the elastic energy resolution by a factor 4/3. The choice of the energy resolution will become independent of the other instrument parameters as foreseen in the original IN5 project.



View of the detector bank of IN5 consisting of 1200 He³ counter tubes. On the right the new small angle detectors.

IN6 - focussing time-of-flight spectrometer

(A.J. Dianoux, J.P. Beaufiles, Y. Blanc)

The design of the spectrometer was finished in September 1979. During the October shut-down, the monochromator system has been installed on site and its operation has been tested. All the parts between the monochromator and the sample position have been put in place as well during this time. The tests on the time-focussing principle await the final delivery of the chopper system.

In January 1979 the focussing of the monochromator was tested and found to be satisfactory : the intense part of the beam at the sample position is only 4 cm high compared to the 20 cm height of the neutron guide. At a wavelength of 5.1 Å, the rocking curve of one monochromator has a full width at half maximum of 50 minutes of arc, corresponding to a $\Delta\lambda$ of 0.09 Å. Using the assembly of three monochromators the flux at the sample position was found to be 3.3×10^7 neutrons/s.cm² at 5.1 Å.

During these tests the losses suffered by the instruments on H15 behind IN6 were measured. The result was a loss of flux between 2 and 3 % for D7, IN10 and D11. For D11, in the wavelength band from 10 to 18 Å, the loss was about 4 %.

The spectrometer should be completed by May 1980. Some test experiments are foreseen between June and September and the instrument should be fully operational after the October shut-down.

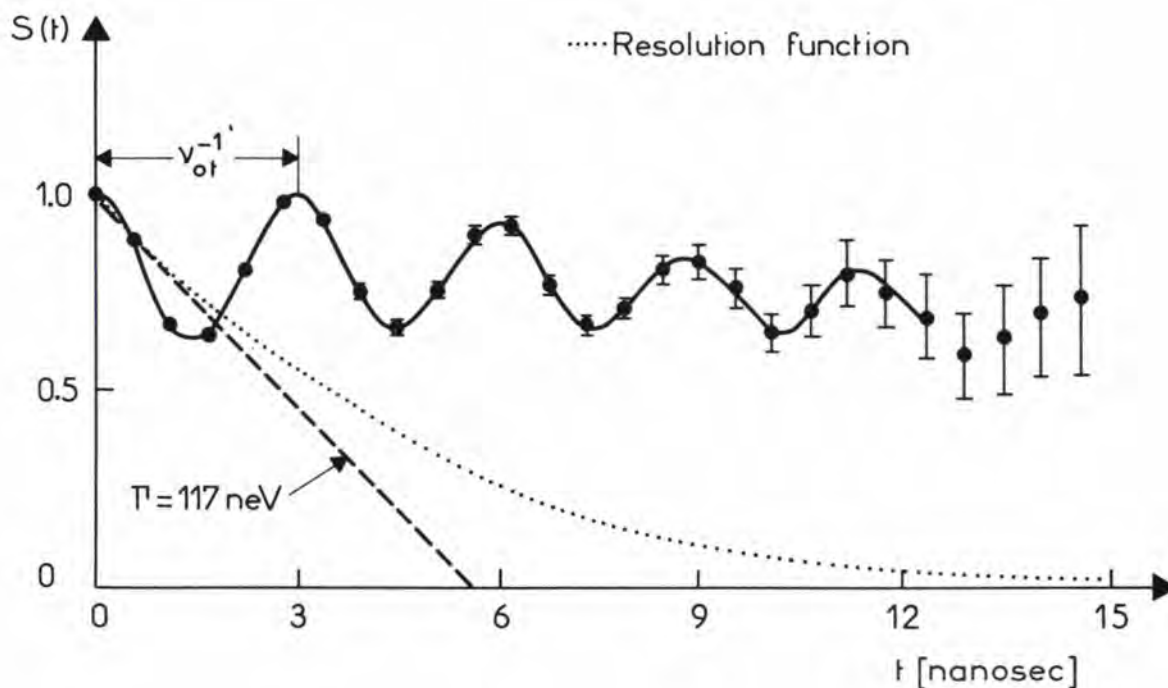


Fig. 6 : Deconvoluted spectrum in t -space of a tunnelling CH_3 group in Ni acetate at 4K measured on IN10. Tunnelling splitting is $1.4 \mu\text{eV}$.

IN10 - backscattering spectrometer

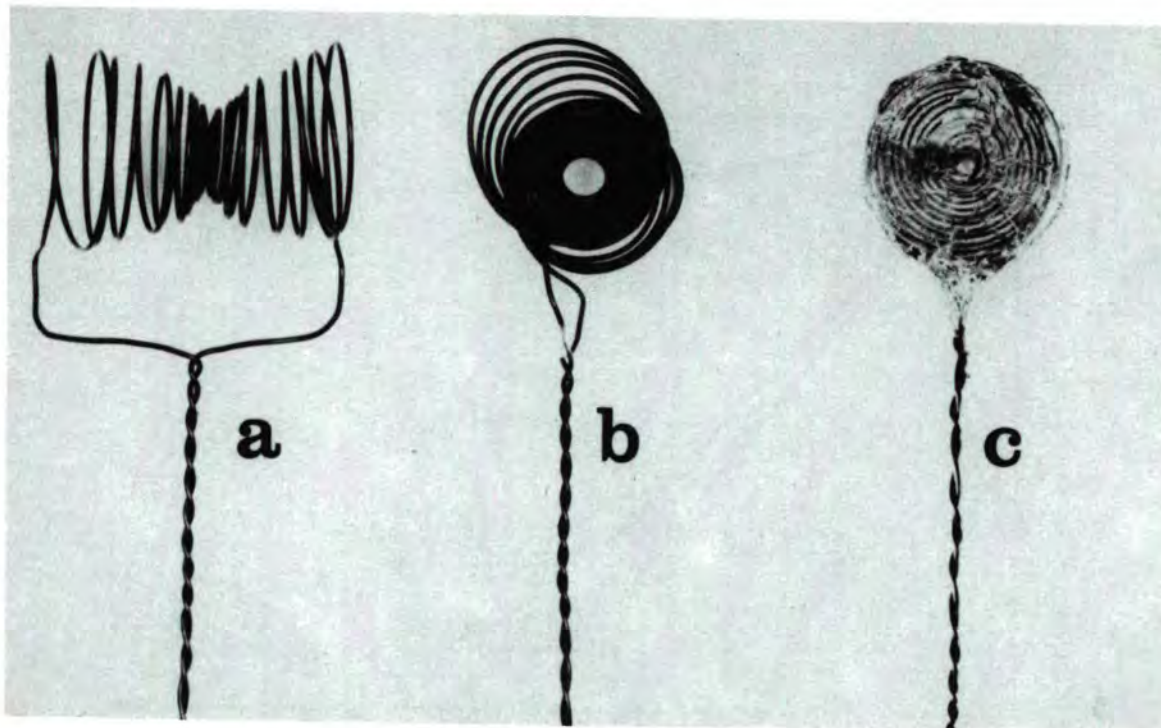
(A. Heidemann, G. Jenkin, C. Poinsignon, J. Bauchat)

The highlights among the 32 experiments performed in 1979 were the study of the dynamics of an amorphous spin glass (Tübingen), the pressure dependence of tunneling motions of CH_3 groups in molecular crystals (Nottingham and Oxford) and the first measurement of the tunnelling spectrum of fully deuterated methane (Jülich, ILL).

A continuous effort was made to improve the spectrometer. A Tectronix display was connected to the instrument computer. A lifting and rotating device for the sample cryostats and furnaces was installed. The detector supports were replaced by a new system which makes the adjustment of the detectors easier. A set of four new Silicon (111) analysers became available for the momentum transfer range between 0.3 and 0.7 \AA^{-1} . A pneumatic Doppler drive is in development. A first project study was made for a velocity drive for energy transfers up to meV values. Germanium monochromators were tested. Energy transfers between 150 and $180 \mu\text{eV}$ can now be measured with an energy resolution of $0.5 \mu\text{eV}$ (FWHM). The design study for the new analyser system was started at the end of 1979. Among some software improvements a computer program became available (S. Howells, Rutherford Laboratory) which deconvolutes IN10 data using fast Fourier transformation. A typical result is shown in fig. 6.

IN11 - spin-echo spectrometer

(J. Hayter, F. Mezei, P. Vanderbeke (until 31.7.1979))



Neutron Spin-Echo "Lollipop" correction coils. (a) and (b) show 2 views of the expanded coil. (c) is an Al covered coil. The coils are placed perpendicular to the beam on the magnetic axis of IN11 to correct for the off-axial field integral in homogeneities. The form shown in (a) and (b) provides a practical bi-linear approximation to the quadratic Fresnel spiral form suggested by Mezei. In use the coil is held flat by an aluminium foil (c) which gives the characteristic form of the lollipop. Using these coils the resolution of IN11 is improved by an order of magnitude at the cost of only a few percent loss in intensity (Hayter, Nicholson, Penfold, Richter).

The installation of the supermirror polariser/analyser system was completed in 1979 following delivery of new mirror-mounting mechanics and two new solenoid magnets. The precession fields in each arm now extend over 2m, giving 50 % higher resolution than was previously available at a given setting. A new velocity selector has been installed and tested, and gives the calculated performance ($\Delta\lambda/\lambda = 9\%$). The control system has been complemented by the addition of a dual Plessey disc, and a low-cost editing/display terminal has been added using a television set with a Thomson-CSF character-generating micro-circuit. The Tectronix graphics terminal now shares a hard-copier with IN10 and D7, and users may have hard-copy graphics of analysed experimental results within a few minutes of completing a run. The PDP-11/20 central processor is now showing its age (nearly 10 years), however, and a number of breakdowns were experienced during the year ; a suitable replacement processor is being studied.

The technique of spin-echo spectrometry has continued to evolve, and new methods of improving magnetic line-integral homogeneity have been tested.

The figure 7 indicates the consequent improvements in resolution since May 1978.

The general theory of spin-echo integral transform spectroscopy, and in particular inversion of the transforms, has also been extended and tested experimentally.

Experiments were performed on a wide variety of systems, including polymers in solution, interacting micelles, spin-glasses, haemoglobin and superfluid ^4He . A workshop on neutron spin-echo, held during the Science Council week in October, attracted more than 60 participants.

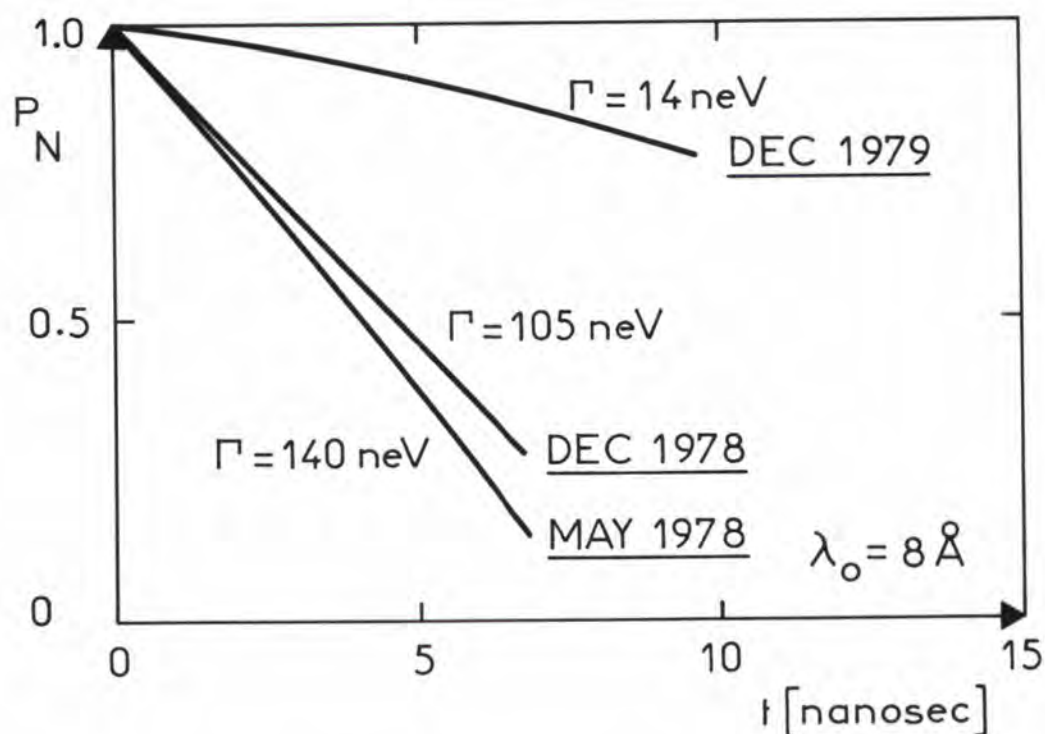


Fig. 7 : IN11 performance improvements. The spin echo polarisation is plotted vs Fourier time for a standard elastic scatterer. In a perfect machine the polarisation would remain constant at unity. Γ corresponds to the HWHM of a Lorentzian resolution function on a conventional spectrometer.

IN13 - backscattering spectrometer for short wavelengths

(J.L. Buevoz, A. Heidemann, I. Anderson, J.F. Barthelemy)

The installation of the primary spectrometer, i.e. the monochromator and deflector system was finished in February 1979. First tests with neutrons started in March 1979. TOF measurements showed that the $\lambda/2$ contamination was only 4 %. Extrapolating the flux results from the provisional set up, i.e. a small monochromator crystal with an area of $2 \times 2 \text{ cm}^2$ and a flat deflector, to the final configuration a total flux at the sample position of about 10^4 neutrons / s. cm^2 at $\lambda = 2.23 \text{ \AA}$ was estimated for a monochromator Bragg angle of 89° . This would be about the same flux as on IN10 for neutrons with $\lambda = 6.27 \text{ \AA}$. Temperature scans on IN13 as well as measurements on the γ -diffractometer were used to test the performance of various CaF_2 crystals in order to define the thickness and surface quality of the monochromator and the analyser crystals. The final monochromator crystals were installed in the October shut-down 1979. The 3000 analyser crystals (size $2 \times 2 \times 0.2 \text{ cm}^3$) were ordered in September. The support for the curved graphite deflector was constructed and the assembly tested with neutrons on D13. The specifications concerning quality of alignment were not fulfilled (B. Hamelin, Int. Report). Therefore a new support was developed by the monochromator group (Ritter, Hamelin). Tests showed the expected good performance.

The monochromator furnace was mounted and thermal tests started in July. The furnace worked well between 150 and 450°C . Below 150°C the cooling rate was too slow. Therefore the interior of the furnace was redesigned. Tests are planned for January 1980. The furnace was linked to the instrument computer. The automatic temperature control worked very well. The software controllers allowed a temperature stability better than 0.03°C to be achieved and temperature gradients to be reduced to less than 0.5°C at 500°C .

The final set up of the secondary spectrometer, i.e. the chopper, the sample table, the analyser system, the multidetector and shielding was defined at the end of 1978 and design work started early in 1979.

The delivery of all parts will be finished in April 1980. Some improvements of the monochromator area to be installed in spring 1980 will facilitate access to the monochromator furnace.

The electronic hardware was defined, ordered and most of the modules have already been delivered and tested. The multidetector, consisting of 40 individual He^3 counter tubes and its associated electronics, was ordered and will be mounted in early 1980.

Progress was made in the development of the instrument software especially in the design of the furnace control programs. Work to produce data handling programs started at the end of 1979.

An ILL standard helium sample cryostat has been ordered and should be available for the first tests of the complete spectrometer, scheduled for the end of 1980.

D7 - diffuse scattering spectrometer

(W. Just, R. Rebesco)

Working conditions and reliability were greatly improved by the replacement of the old chopper by a new one running in vacuum. In addition, this new chopper - a development of the "bureau d'études" (B. Mathieu, H. Just, G. Gobert) - has a maximum speed of 11 000 r.p.m.

The new standardized data format for time-of-flight instruments (R. Ghosh) was adopted on D7. Thus a variety of extremely useful programs for data handling and treatment became available. The link to the concentrator, PDP 11/55, is operating permanently now and offers powerful support for rapid data analysis.

During the October shut-down the beam distribution area was modified, in particular the guide tubes of IN10 and D11, in preparation for the installation of the new focussing monochromator of D7, which will use nearly double the height of the present primary beam. The new monochromator itself will be installed in the middle of 1980.

The LETI step motor drive unit was replaced by CAMAC modules. Each motor is now driven and controlled by a separate CAMAC module and amplifier.

Studies were started for a new secondary spectrometer including a multi angle polarisation analysis device (O. Schärpf).

D11 - small angle and diffuse scattering spectrometer

(G. Göltz, R. Duplessix, P. Timmins, P. Joubert-Bousson)

Most of the work started in 1978 has now been completed. The automatic sample changer which operates in the cloche is operational and may be installed when needed. The D11B apparatus is now working and in addition to the information from D11A the contents of the 32 D11B counters are also available.

The program for controlling the experiment and acquisition of data has been completely redefined in order to improve its versatility, its modular structure giving the user the possibility of introducing his own experiment control program.

A new detector has been installed. Its improved electronics will allow increased counting rates. The design of the detector housing is such that a vacuum is produced only in front of the detector thus substantially reducing the time for changing the detector from one position to another. An automatic control gives a much more precise adjustment of the beamstop.

D16 - four circle MK6 diffractometer

(G. Zaccai, S.A. Wilson, M. Cruz)

Plans and design work for the improved configuration of D16 have been completed in 1979 and, all going well, it should be ready for normal scheduling at the end of 1980. The area multidetector has 64 x 16 cells covering 10° x 5° at 1 metre from the sample. It can be positioned with its long axis vertical or horizontal. The path between sample and detector will be shielded and evacuated to reduce background to a negligible level. A dedicated computer will be purchased to control the diffractometer as well as perform crystallographic data treatment and cope with the large data turnover of kinetic experiments. Improvements are also foreseen for the flight path between monochromator and sample with a more efficient beryllium filter, better shielding and flexible collimation systems.

The aim is to achieve in D16 a low-background, high flux, high angular resolution diffractometer in the wavelength range 4 Å to 10 Å.

Experiments on D16 in 1979 include studies of model and natural biological membranes, from which reflections to ~ 6 Å (a relatively high resolution) can be obtained from lattice spacings which lie between 50 Å and 100 Å. Improvements in the preparation of these samples, especially relating to the specific deuteration of components, have made the neutron technique increasingly useful in the determination of membrane structure. Clays and liquid crystals have been studied. Like membranes, they form lamellar structures with large unit cells which are often sufficiently well-ordered to give high resolution reflections. The adsorption of helium 3 and helium 4 on graphite

has been studied. Interesting results have been obtained from a study of the diffuse scattering in palladium-deuterium.

D17 - low-q-high resolution spectrometer

(M. Roth, A. Lewit-Bentley, G.A. Bentley, M. Cruz)

During the past year, some experiments making new use of D17 have been carried out successfully : inelastic scattering experiments using the chopper. The resolution available is about 100 μeV . However, it is only possible to perform low-energy transfer measurements because of problems with frame overlap. It is now possible to use polarised neutrons on D17 as well, though not on a routine basis.

In October 1979, during the reactor shut-down, the working area around the instrument was completely rearranged and a new cabin built to improve working conditions for both D17 and D16 users. A new collimator was built with an adjustable length and simple and accurate repositioning. It is equipped with sapphire windows which produce extremely low background. The vacuum vessel with a sample changer which allows temperature control is now working. The positioning of the sample changer can be directly read and controlled by the computer.

A new instrument running program has been written which can be used both for low angle scattering and for single crystal data collection.

Co-ordinators : A.HEIDEMANN
F. MEZEI

Instrument group

Diffraction Instruments

- D1A : High resolution powder diffractometer on thermal guide H22
- D1B : Two axis diffractometer with multidetector on thermal guide H22
- D2 : High flux 2-axis diffractometer on thermal beam H11
- D3 : Two-axis polarized neutron diffractometer with lifting counter on thermal beam H5
- D4 : Liquids diffractometer on hot beam H8
- D5 : Three-axis polarization analysis spectrometer on hot beam H4
- D8 : High flux four circle diffractometer on thermal beam H11
- D9 : Four circle diffractometer on hot beam H3
- D10 : Four circle three-axis diffractometer on thermal guide H24
- D12 : Neutron cameras on thermal guide H23
- D15 : Four circle Mk6 diffractometer on inclined thermal beam IH4
- D18 : Neutron interferometer on neutron guide H25
- D19 : 2D multidetector to be installed for tests on thermal guide H24
- LI 4/5/7 : X-ray laboratories
- S20 : Neutron diffraction topography
- S21 : High resolution double crystal spectrometer

introduction

As indicated in the list opposite the group is responsible for a comprehensive range of diffractometers and thus provides experimental facilities for very diverse scientific interests. The heavy demand of previous years, for experimental time on the diffractometers was maintained and the group was again responsible for one third of the experiments carried out at the ILL. Apart from D10 which underwent a major rebuild and the completion of D18, all the group's instruments operated routinely throughout the year.

The group's priority project, that of replacing Carine by dedicated computers, has now been achieved with the exception of D5 which should receive its own computer during 1980. During the annual shut down, control of D2 was successfully transferred to a PDP11 (LSI11) using the same system and programs as available on D1A. A similar configuration will shortly be installed on D4 greatly improving data handling with the multidetector. However, the implementation of the SEMS computer for control of D1B has been subject to delays over the last two years and D1B will remain on Carine until the beginning of 1980.

Progress on the D19 project has been hindered by the heavy demand placed on the multidetector group. Initial tests of the multidetector on the guide H24 are not expected to commence before January 1980. In the same month the small multidetector consisting of 64 cells is expected to be installed on D2. The proposed replacement of D2/D8 by the 4 circle multidetector diffractometer D19 and the high flux 2 circle multidetector diffractometer D20 and the new high resolution powder diffractometer D2B on canal H11, has been accepted by the Scientific Council. The project will now pass into the development stage. Discussions are now in progress concerning the rebuilding of D5 on a thermal beam tube and a proposal will be submitted to the instrument sub-committee in early 1980.

Throughout the year the group has been helped by the technical department of the ILL and we would like in particular to thank A. BARTHELEMY, R. CHEVALIER, J. JACOBÉ, LE SOURNE and Y. LEFEBVRE of SCIAD, G. GOBERT of SCM and the office of the Scientific Secretariat for their part in the successful outcome of many of the group's projects.

D1A : high resolution powder diffractometer

(A.W. Hewat, C. Vettier, S. Heathman)

The first full year of operation with the Plessey MICRO-1 computer, commissioned in 1978, saw a number of important improvements to the control and data acquisition of D1A. Since the LSI-11 based system is compatible with the PDP-11 systems on D8/D9/D10, similar programs are available on all these diffractometers. MICRO-1 computers have now been installed on S13, D18, D2 and D4 as well so that again common hardware and software can be used. Single crystal measurements and display programs, as well as powder programs, have thus become available on D1A ; the data can be plotted while the experiment is running, or transferred directly to the main computer for immediate analysis. These facilities allow rapid decisions to change the course of the experiment if necessary. The computer has also meant a significant increase in the speed and reliability of the diffractometer. Up to four complete diagrams have been collected in a single day, and with programmable temperature control, implemented at the end of 1979, this will mean that the study of structures as a function of temperature will become common. New programs have also been implemented on the main computer, aiming at pattern indexing and direct solution of completely unknown structures. Several such unknown structures were solved in the course of the year, with a success rate of about 50 %, which we expect to improve. D1A now has its own high pressure cells, and almost all experiments are performed at low or high temperature or pressure, or a combination of these conditions.

Despite the increased speed of the diffractometer, demand for D1A time continues to exceed that available by a factor of two, and this justifies further technical improvements. These will mean another order of magnitude increase in effective intensity and a doubling of the resolution to maintain our position with respect to the new powder diffractometers being implemented on pulsed sources. Such extensive improvements will mean the eventual replacement of D1A by a new machine, D2B, a project which was approved by the Science Council in October 1979, and should be completed by 1981.

D2 high flux two-axis diffractometer

(C. Marti, G. Bomchil, P. George)

During the annual shut down the Carine computer control of D2 was replaced by a dedicated Micro 1 system from the British firm Plessey. The new computer based on the large scale integrated circuit version of the PDP 11 (LSI - 11) provides a powerful means of on-line supervision and data reduction. The system and control programs are the same as those used on D1A ; this permitted a very rapid conversion without disruption of the user programme.

D1B - two-axis diffractometer with multidetector

(P. Convert, G. Bomchil, R. Chagnon)

The instrument has given very satisfactory service during the year. Amongst the wide range of experiments performed several have been carried out at very low temperatures (down to 10 mK) using a dilution refrigerator (Benoit & Flouquet, CNRS Grenoble).

Several important modifications to the instrument are in the construction and design stages and some of these will be completed in the first half of 1980. They should increase the precision of D1B and make it easier to use. The more important changes planned are outlined below.

— The new Solar based data acquisition system is now under test with the old multidetector in a position behind D1B on the guide. It should be connected to D1B at the beginning of 1980.

— A focussing GE(111) monochromator is being constructed by the monochromator group. During the long shut down the necessary building work was carried out to enable a rail to carry the multidetector and the anchorage points for a small crane, to be installed. The crane itself and the motors to allow automatic control of the multidetector 2θ will be put in during 1980.

D3 two-axis polarised neutron diffractometer with tilting detector

(F. Tasset, K. Ben-Saidane)

A full experimental program was carried out on D3 during 1979. Experiments to determine magnetisation densities were made on wide variety of systems. Some experiments which are worthy of note are, the first determination of the form-factor of Neptunium made on a crystal of Neptunium oxide whose volume was only $\sim 1 \text{ mm}^3$, determination of the paramagnetic form factor of technetium in which the moment to be measured was only $9 \times 10^{-4} \mu\text{B}$ per atom, and a study of YNi_3 in which sufficient data to give the density distribution was obtained in only 12 days.

Minor improvements have been made to the cryogenic systems including an improved automatic filling system for liquid nitrogen with an autonomy of more than a week. A device for ensuring exact centring of the sample in the superconducting magnet cryostat is gradually being evolved in the light of experience, the current model gives centring to better than 0.5 mm. D3 is now the last instrument using the old ILL RTS11 software system. Plans for a change to the RT11 DEC supported system are being made and to enable this change to be made a Plessey dismountable disc unit has been installed.

D4 - two-axis liquids diffractometer

(P. Chieux, S. Cummings, A. Hawes)

Better facilities are now available for checking the position and alignment. In addition new slits have been made to allow transmission measurements on cylindrical samples. A development which will be appreciated by many users, is a new software package for faster processing of the raw data from the multidetector. A mini computer of the type micro 1 has been delivered and should be available for data acquisition and processing before the end of 1979.

D5 - three-axis polarisation analysis spectrometer

(K.R.A. Ziebeck, J. Schweizer, A. Perkins)

D5 functioned normally throughout the year. The demand for the instrument has significantly increased so that the time requested now exceeds the time available by a factor 3. Many of these experiments require polarisation analysis and at present D5 remains the only spectrometer in Europe which has this facility. However, it is evident that most polarisation analysis experiments would be better carried out if D5 was situated on a thermal source. Proposals are currently being discussed to build a new polarised neutron diffractometer with polarisation analysis on a thermal reactor beam hole. Developments on the instrument have been concentrated on improvement of the polarisation analysis facility. A. Perkins who is responsible for the engineering and technical improvements to the machine has maintained a high level of innovation and is responsible for the reliability of operation.

The difficulty of scheduling experiments involving the D3/D5 superconducting magnet should be reduced by the addition of a second cryomagnet. The new cryomagnet which should arrive in December 1979 will provide a vertical field of 10T but with a reduced vertical access of $\pm 5^\circ$.

The new Fe⁵⁷ monochromator is currently undergoing tests on the diffractometer. It is hoped to install it as the polariser next year simultaneously with improvements to the monochromator protection. In addition, a preliminary investigation of palladium Heusler alloys has suggested several systems superior to the current Cu₂MnAl monochromators.

D5 remains connected to Carine and is now the only instrument in the diffraction group without a dedicated computer. A PDP 11/40 has been ordered and is now expected to arrive at the end of December.

The priority task for 1980 will be the implementation of a new control and data acquisition system coherent with that operating on D3.

D8 - high flux four circle diffractometer

(S. Mason, J. Allibon, C. Riekel until 1-3-79 and J. Pannetier from 1-5-79)

With the installation of the LSD diffractometer control system on D9 and D10 the three diffractometers D8, D9 and D10 once again have very similar operating systems. The LSD system was developed at the ILL over many years after consultation with users and implemented under the RSX 11-M time sharing system by A. Barthelemy, P. Rice and C. Turfat.

Several independent programs run routinely in parallel with LSD, typically the data reduction program COLL5, and the program for automatic transfer of raw data directly to the control computer via an asynchronous line. An instruction manual, for the parts common to D8 and D9, is available on disc for up dating and printing. Owing to the ease of use of LSD, and particularly to the outstanding technical support of J. Allibon, users are now able to concentrate on the scientific part of their experiment.

D9 - four circle diffractometer with short wavelengths

(M.S. Lehmann, R. Feld, J. Allibon)

The instrument has continued to operate well. An important improvement in efficiency was obtained by the installation in April of a dedicated computer (PDP 11/34). High priority was given to making the control system and programs essentially identical to those available on D8 and D10 and therefore the period lost in its implementation was minimised. Since then, program development has continued and the instrument has been linked to the PDP-10 central computer by a teletype line. Because of the shorter response time of the new system, the data collection rate has improved in some cases by more than 50 %.

Further improvements to the crystal mounting within the displex cryostats have been made using a new design. The installation of a very small area detector is being planned.

D10 - high resolution four circle three-axis spectrometer (with spin echo option)

(C. Zeyen, N. Lehner, I. Bailey)

During the first eight months of the year the reconstruction of the standard four circle diffractometer with analyser was completed. At the same time the magnets and their computer control for the spin-echo option were tested. The instrument is now controlled by a PDP 11-34 computer and uses a similar system and programs to those available on D8/D9. Following the annual shut down D10 has operated with :

- a) automatic monochromator shielding (continuous wavelength change possible).
- b) computer controlled movement of the monochromator crystal.
- c) new precision Eulerian cradle.
- d) constant flow cryostat which goes to 4.2 k and is mounted on the Eulerian cradle, computer controlled temperature regulation system. A complete experiment on the incommensurate phase transitions of biphenyl has already been done using this new cryostat and its temperature stability and flexibility was demonstrated.
- e) three disc units, one for the system and programs and two for data.

Extended tests of the spin echo technique using super mirrors have started and should be completed in early 1980.

D12 - neutron camera

(A. Wright, S. Heathman)

The helium temperature Weissenberg camera has been fitted with a mobile lift for rapid and precise removal and replacement of the cryostat. This enables sample centring and orientation to be made optically at room temperature with the cryostat tail and radiation screens removed. A goniometer head to allow crystal orientation in the cryostat at helium temperatures is under development. Remote manipulation at the top of the cryostat will provide crystal adjustment of $\pm 5^\circ$. Mechanical tests of the goniometer are to begin in December 1979.

D15 - four circle MK6 diffractometer

(S. Wilson, J.M. Savariault to 30-9-79, J.M. Reynal and W.J. Fitzgerald from 1-12-79)

The past year has demonstrated the usefulness of both the Displex 2-stage refrigerator and the second wavelength option of $\sim 0.86 \text{ \AA}$.

Considerable effort has been expended to improve the mechanical accuracy of the diffractometer when the Displex refrigerator is being used, and to improve the low temperature performance of the refrigerator itself.

Several experiments under pressure have been carried out on D15 during the year. They have served to demonstrate the unflexibility of the PDP8 based control system.

In the coming year we look forward to the purchase and installation of D15's own dedicated computer. This will bring the control system into line with D8, D9, and allow more efficient use of the machine. It is also hoped to start studies of a less restrictive mounting of the Displex than the present Eulerian cradle, with the idea of reducing the extent of the blind regions and facilitating the initial alignment of the crystal.

D18 - neutron interferometer

(M. Schlenker, W. Bauspiess, U. Kischko, G. Schmidt)

Although it had not reached its final configuration, D18, the two-axis diffractometer for neutron interferometry went into operation and was used for experiments in 1979, under the control of its microprocessor only. It was connected to a MICRO-1 dedicated minicomputer during the October 1979 reactor shutdown, and the system is now being tested. The third axis set up, for fine control of the wavelength, is mechanically ready ; its connection is planned very soon.

D19 - multidetector for single crystal studies

(M. Thomas, C. Wilkinson, M. Berneron)

The computer and electronics are installed at the old D6 position on the thermal guide H24. The diffractometer has been assembled but delays in receipt of the multidetector and logic have held up tests of resolution and the development of software.

LI 4/5/7 - x-ray laboratories

(P.J. Brown, G. Schmidt)

Although seriously lacking in scientific and technical support, facilities continued to function in 1979.

S20 - neutron diffraction topography

(M. Schlenker, J. Baruchel)

The apparatus for topographical studies was reconstructed after modification to the guide H24, and was ready for use after the annual shut down.

S21 - high resolution double crystal spectrometer

(C. Zeyen)

Modification of the thermal guide H24 has necessitated the reconstruction of the spectrometer. A new monochromator shielding has been built and the instrument should be in operation during 1980.

Co-ordinator : K.R.A. ZIEBECK

Monochromator group

D13A : Neutron double-crystal diffractometer on thermal guide H24

D13C : Neutron single crystal orientation and test instrument on guide H23

LI 2A : X-ray double-crystal diffractometer

LI 2B : X-ray crystal orientation unit

LI 3 : Gamma-ray diffractometer

Laboratory for single crystal preparation

Introduction

Many of the new instruments planned for the 2nd souffle and plans for upgrading existing instruments are based on the possible increases in effective flux offered by advances in monochromators. Each monochromator is now composed of many individual crystals and consequently the work involved in production has enormously increased. During 1979 efforts have been made to improve the efficiency with which some of the time consuming production tasks can be carried out and these are described in the instrument reports. Additionally B. Hamelin and R. Ritter have been loaned to the monochromator group from the central group and temporary part-time help for crystal preparation has been available from A. Rubio.

Instruments

D13A

(A. Bœuf, F. Rustichelli)

D13A was rebuilt in March after the modification of the H24 guide tube. A new monochromator shielding was installed for better protection against γ -radiation and a reduced neutron background. After this D13A was used in the usual way for testing single or multiple crystal monochromators, aligning procedures and for various other special experiments of the "do-it-yourself" type. Furthermore, D13A worked in the "travelling" mode, i.e. the whole sample and detector unit with the corresponding electronics was transported to the D19 sample site for analysing the performance of the D19 focusing monochromator.

D13C

(A. Freund, B. Hamelin, R. Hustache)

D13C was used mainly for assembling multichromator focusing analyser and monochromator systems. A special orientation device has been built for this purpose which permits precise crystal alignment followed by glueing without losing the crystal orientation. The glueing is performed on crystal supports with either fixed or variable curvature. The large number of crystals to be aligned necessitates an automation of the alignment procedure which is under way. In addition, the crystalline perfection of large Beryllium and Heusler alloy single crystals was investigated on D13C by means of neutron topography.

LI 3

(A. Freund, B. Hamelin, A. Escoffier, A. Bœuf)

The γ -ray diffractometer LI 3 has been equipped with an automatic control for stepwise scanning of the mosaic spread of single crystals as a function of crystal translation and/or rotation about the diffraction vector. The PET 2001 computer used for this control of the experimental programme performs at the same time a first data reduction and analysis calculating parameters such as mosaic spread, reflectivity, homogeneity of the defect distribution in the crystal volume scanned and crystal curvature. A double furnace has been constructed for in-beam experiments on the γ -ray diffractometer of pyrolytic graphite intercalation compounds. As usual LI 3 served routinely for the in-beam controlled production of the mosaic spread in Ge and Si single crystals by plastic deformation at high temperatures. The intrinsic mosaic structure of many imperfect single crystal specimens has been determined and experiments on the domain structure of phase transitions were continued.

Single crystal laboratory

(A. Freund, B. Hamelin, R. Hustache, A. Rubio)

The laboratory for single crystal preparation equipped with a spark erosion machine, diamond and wire saws and a grinding and polishing machine has been moved into a larger and better adapted room allowing for better ventilation. Here the large number of crystals to be cut also needs automation of the orientation and cutting processes which is already being undertaken.

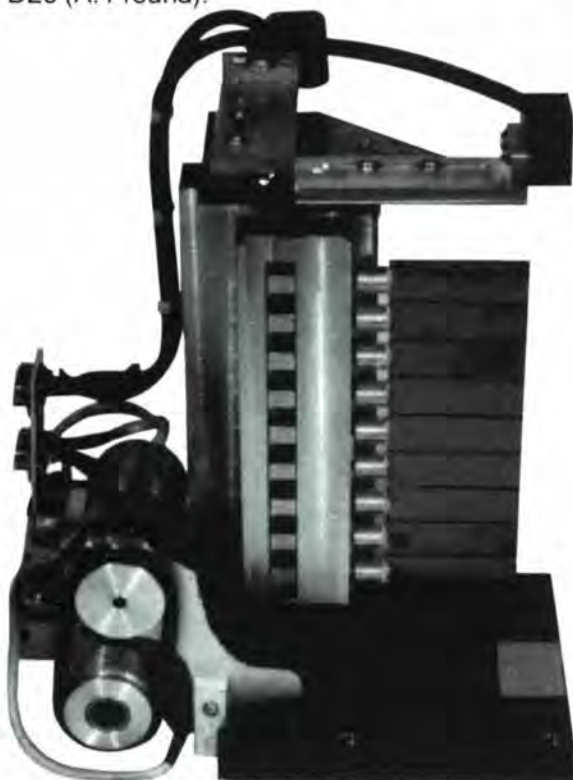
Basic studies of monochromator and filter materials

Whereas the production of Cu, Si and Ge monochromator crystals with any desired isotropic or anisotropic mosaic spread is straightforward and may be improved only with respect to the success rate, Be crystals still need development. In conjunction with the Max-Planck-Institut für Metallforschung, Stuttgart (S. Jönsson) and the firm Leybold-Heraeus, Hanau (F. Aldinger) an attempt has been made to improve the quality of the as-grown crystal perfection of zone-refined Be ingots. Whereas increasing the number of zone passes and annealing close to the phase transition did not show a significant effect the design of a new rf-coil for curving the solid-liquid interface gave positive results. In parallel with this study the production of a composite Be monochromator for the new IN1 has started (A. Freund, M. Hoecker).

The joint project with the PTB Braunschweig (R. Scherm, E. Krüger) and the CNRS Grenoble (R. Perrier de la Bathie, E. Bernardo) on the production of Heusler alloy single crystals as polarising monochromators or analysers continued during the year. Many large ingots have been crystallised and several rods are being cut into plates for the special thermal treatment required in order to produce the desired mosaic spread and polarisation efficiency which are determined on D13A (A. Freund, R. Pynn).

The feasibility study of expanded pyrolytic graphite as long wavelength neutron monochromator is going on in collaboration with the ENS Electrochimie, Grenoble (A. Hamwi, P. Touzain). An in-beam diffraction analysis of the intercalated graphite on the γ -ray diffractometer during the diffusion process clearly showed an increase of the mosaic spread correlated to the formation of different compounds to an extent which may be tolerable for certain applications. At present the influence of uniaxial pressure is being investigated (A. Bœuf, C. Riekell).

Results of recent measurements obtained at the PTB Braunschweig (R. Scherm, F. Friedrich) showed that cooling below 77 K has practically no effect on the filter characteristics of Si perfect crystals. Therefore, the application of such Si filters as proposed in the literature will be limited to neutron energies lower than about 100 meV. Studies of the angular distribution of the elastically scattered neutrons are planned at the sites where a Si filter will still be of use, i.e. PN8, IN1, D4, D20 (A. Freund).



The new modular crystal support system allowing variation of the radius of curvature of a monochromator.

A first and simple theoretical approach to the problem of neutron diffraction by bent mosaic crystals has been developed. The corresponding predictions have been compared with a number of published data and results recently obtained on D13A (A. Bœuf, R. Coppola, F. Rustichelli).

Monochromator production

All monochromators and analysers produced this year and almost all future constructions are focussing having either fixed or variable radius of curvature. This has led to the development of a modular crystal support system permitting a variation of the radius of curvature. The photograph above shows this system where each crystal has an individual axis of rotation and is turned by a lever system controlled by a stepping motor. The performance of a prototype has been tested successfully and IN13 has been equipped with such a device replacing the flexible plate technique which had been found to give unsatisfactory results. Also the IN3 curved analyser consisting of a flexible steel plate-pyrolytic graphite sandwich was replaced by a new bending device developed by H. Kraxenberger.

A composite pyrolytic graphite monochromator with fixed vertical and variable horizontal radius of curvature has been mounted for IN6. The 3x7 graphite strips cover a surface of 300 cm². Thirty silicon (220) lamellae with anisotropic mosaic spread have been prepared and assembled for the D19 vertically focussing monochromator 15 x 10 cm² in dimensions. The beam analysis at D19 confirmed the precise orientation of the monochromator elements. The vertically focussing D10 monochromator has been dismantled and completely reconstructed in order to cover the new beam height of 12 cm. At the same time the radius of curvature was changed according to the new D10 specifications. Sixty germanium crystals have been prepared and mounted on the new IN3 analyser device for horizontal focussing. The in-situ testing of the focussing efficiency is under way. A second analyser system has been equipped with pyrolytic graphite. Finally, the IN13 deflector device with variable radius of curvature using nine graphite lamellae has been finalised.

(A. Freund, B. Hamelin, R. Hustache, R. Ritter)

Co-ordinator : A. FREUND

Central group

The Central Group is responsible for the two experimental halls, and for the routine provision of general services to the experiments, in particular the distribution of cryogenic fluids.

The group works in close collaboration with the other Departments and Services of the ILL but especially with :

- (1) The Technical Department and Bureau des Projets to ensure the optimum implantation of the new instruments, the "amélioration" of the operating and working conditions of the existing instruments and the reduction of the neutron and gamma background levels.
- (2) The Reactor Department to ensure the provision of specialised services for the efficient and safe operation of the instruments, particularly concerning the surveillance of the experimental installations outside normal working hours.
- (3) The Radioprotection Service and Reactor Department in analysing the safety aspects of scientific proposals, and ensuring the safe installation and operation at the time of carrying out the experiment.

In addition to the routine work, members of the group have worked on, or collaborated in the following projects :

- Background shielding problems and coordination of modifications on H24, IN1, IN13, D11, IN4, IN6, IN12, IN8, S51, S34, PN7, D3, H14, D18, OSTIS, NEUTRINOS, H17.
- Production of sintered B_4C , as replacement in certain cases for LiF.
- Radiation damage effects on electrical cables.
- Modification of PN1 to allow the study of ^{239}Pu and ^{233}U .
- Design and construction of an automatic device for PN2 to allow the separation of the active target from its support and its introduction into a leak-tight shielded container.
- Production of composite monochromators for the following instruments :
 - IN6 (fixed curvature pyrolytic graphite)
 - D19 (fixed curvature silicon with anisotropic mosaic spread)
 - D10 Reconstruction of copper monochromator
 - IN3 (variable curvature pyrolytic graphite and fixed curvature Germanium with anisotropic mosaic)
 - D2 (fixed curvature Germanium with anisotropic mosaic)
 - IN13 (variable curvature, 2.5 metres to infinity, pyrolytic graphite)
- Design and construction of a new system (fan type) for varying the curvature of a monochromator.
- Modification of protection and control system of D13C, to permit the orientation and assembly of composite monochromators.

- Construction and testing of several small (64 x 16) high pressure Helium multidetectors, of the same geometry as that under construction for D19 (512 x 16 cells), permitted a redefinition of the D19 design. A small multidetector with disymmetric geometry (as chosen for D19) is under construction.
- Modification and installation of 8 cell detector on IN1.
- Design and construction of special sample holder with quartz windows, fine angular adjustment and gas shroud for D11.
- Adjustable mounts for Displex units on D8, D9, and D15.
- Design and construction of a Displex cooled sample chamber for X-ray diffraction.
- Installation of replacement micro suspension balance, and the construction and testing of a new system for measuring adsorption isotherms using a continuous gas flow.
- Operation and final testing of the S3 supermirror production instrument, to the state where supermirrors may now be produced.
- Preparation of display of photographs of equipment used on the instruments.

The following reports have been written :

- (1) Cooling to 10 K on a 4 circle diffractometer by means of a two stage cryorefrigerator (in publication), FILHOL, REYNAL, SIMMS and THOMAS.
- (2) A 0° C to 250° C thermostatically controlled sample mount for neutron single crystal diffraction, SIMMS and TIMMINS (in draft form).
- (3) An adjustable curved multicrystal monochromator using a " Fan type system ", HAMELIN, RITTER, SIMMS, FREUND (in draft form).
- (4) Ralentissement de protons et des tritons dans les mélanges d'hélium et d'argon, de krypton ou de xénon. Ralentissement des particules alpha et des ions lithium dans le trifluore de bore enrichi (¹⁰B) et dans l'argon, FELTIN (internal report).
- (5) Simulation d'un multidétecteur en atmosphère gaseuse, FELTIN (internal report).

D.A. WHEELER

3

Colleges

Introduction

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

The following is the current list of colleges :

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

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

College 2 Theory

Members of the college

Bartel J.	
Aslangul C.	since 1/10/79
Fogedby H.	to 1/10/79
Haldane F.D.M.	
Loveluck J.M.	
Sherrington D.	to 1/10/79
Southern B.W.	to 1/9/79
Schuck P.	
Bengtsson R.	to 1/10/79
Lovesey S.W.	to 1/9/79
Hüller A.	to 1/9/79
Quentin P.	since 1/7/79
Maki K.	since 1/10/79
Jancovici B.	since 1/9/79
Saint James D.	since 1/10/79

Visiting scientists

Balcar E.
Chuin Sin Tat
Gerling R.
Iwasaki S.
Kolb D.
Lavis D.
Ring P.
Vallieres M.
Trammel G.
Stinchcombe R.

General summary

In 1979, the Theory College continued to put its main effort into the study of various problems in both condensed matter physics and nuclear theory. The membership of the College underwent considerable changes again this year. Five people left the Institute (Fogedby, Sherrington, Southern, Bengtsson, Hüller) and five new theorists arrived (Aslangul, Quentin, Maki, Saint-James, Jancovici).

Scientific activities in 1979

The Theory College has continued to pursue several well established interests (e.g. critical phenomena, spin glasses, static and dynamic properties of one dimensional magnetic systems, valence instabilities, Kondo effect, semi-classical theories of the nucleus). The new members of the Theory College have introduced some new activities (e.g. diamagnetism of electrons and surface currents, quantum statistical mechanics of solitons, static and dynamic Hartree-Fock studies of the nucleus). Several short term visitors during the year have proved to be very stimulating and kept the College informed of recent developments in other fields. The Theory College and its visitors have participated in the seminars on theoretical physics, organized by P. Nozières, which provide an important link between the College and the theorists from all the other scientific establishments in the Grenoble area. The weekly ILL-seminars, intended for a wide scientific audience, have been organised this year by D. Sherrington and D. Haldane.

P. Nozières gave a series of lectures on Brownian motion intended for the physicist community of Grenoble.

The major activities in 1979 can be summarized as follows :

Kondo effect

D. Haldane pursued his interest in the (two impurity) Kondo problem and the Anderson lattice. P. Nozières finished work on the Kondo effect in real metals, taking into account the influence of degenerate orbitals and the crystal field.

Spin dynamics of the Heisenberg chain in a magnetic field

The study of the spin dynamics of the Heisenberg chain in a magnetic field was continued by J. Loveluck. He also investigated the crossover and scaling in a one dimensional classical planar magnet in an applied field. The thermodynamic properties of this system were calculated.

Spin glasses and dilute magnets

Work on spin glasses was continued by D. Sherrington. He developed a mean field theory for conventional spin glasses to give a heuristic explanation of the occurrence of induced moment spin glass phases, such as those found in ScTb at intermediate concentration. Critical properties of random and dilute magnets were studied by R. Stinchcombe. In particular a scaling theory of pure low dimensional anisotropic magnets was worked out.

Solitons

Solitons and magnons in the classical Heisenberg chain were studied by H. Fogedby using the inverse scattering method. From the action-angle variables it turned out that the Hamiltonian of the continuous Heisenberg chain was a completely integrable system possessing an infinite number of constants of motion. The theory of the quantum statistical treatment of solitons was set up and studied by K. Maki.

Renormalization group studies

B. Southern and D. Lavis studied the two dimensional bonded lattice fluid model on a triangular lattice which was introduced by Bell and Lavis to describe the anomalous properties of water, using real space renormalization group methods. A simple model which exhibits both spin glass and percolation behaviour was investigated by B. Southern, P. Young and P. Pfeuty using Migdal's recursion relations. Finally, an optimal truncation procedure in renormalization group calculations was set up by T. Burkhardt and B. Southern.

Transition from electron-hole plasma to Bose condensate of excitons

Using a method close to the BCS-method for the description of super-conductivity, P. Nozières and C. Comte have been trying to describe the transition from the electron-hole plasma to the condensation of excitons in a semiconductor. The wave function which is used is also applicable to the attractive Hubbard model.

Nuclear physics

P. Quentin has looked for a new phenomenological force to describe static and dynamic properties of the nucleus. He has also continued to work on the adiabaticity of collective nuclear motion. The semiclassical treatment of nuclear pairing properties was continued by R. Bengtsson and P. Schuck. It was found that for realistic nuclear forces the pair potential was surface peaked. The rotating liquid Fermi drop was studied by M. Durand and P. Schuck, while the self consistent determination of liquid drop densities was continued by J. Bartel. A new semiclassical method was set up to solve the Coulomb problem by R. Bhaduri et al. Ring, Iwasaki and Schuck showed how "nuclear field theory" was related to other boson expansion techniques.

College Secretary : P. SCHUCK

College 3

Fundamental and nuclear physics

Members of the college

I. INTERNAL MEMBERS

Avenier M.
 Barreau G.
 Blakeway S.
 Börner H.G.
 Brack M.
 Brissot R.
 Davidson W.F.D.
 Von Egidy T.
 Faust H.
 Gönnenwein F.
 Hawerkamp K.
 Jung G.
 Koglin E.
 Mampe W.
 Mougey J.
 Oed A.
 Perrin P.E.J.
 Pfeiffer B.
 Quentin M.
 Schrader H.
 Schreckenbach K.
 Schuck G.
 Vuilleumier J.-L.
 Warner D.D.

III. VISITING SCIENTISTS

Armbruster P.	(Darmstadt)
Böhm F.	(Pasadena)
Von Brentano P.	(Köln)
Byrne J.	(Sussex)
Caitucoli F.	(CENG)
Crancon J.	(CENG)
Daniel H.	(München)
Forte M.	(ISPRA)
Gähler R.	(Bayreuth)
Gelletly W.	(Manchester)
Golub R.	(Sussex)
Greene J.	(Harvard)
Hahn A.	(CALTECH)
Hamilton D.	(Sussex)
Hart R.	(ISN)
Hoff R.W.	(Livermore)
Heckel B.	(Harvard)

II. EXTERNAL MEMBERS

Blachot J.	(CENG)
Bocquet J.-P.	(CENG)
Cavaignac J.-F.	(ISN)
Von Feilitzsch F.	(Munich)
Hofmeyer C.	(A.E.B. South Africa)
Hungerford P.	(Giessen)
Mehmed E.	(ISN)
Monnard E.	(CENG)
Pinston J.-A.	(CENG)
Ristori C.	(CENG)
Schussler F.	(CENG)
Tokunaga Y.	(Jülich)
Vignon B.	(ISN)

Kern J.	(Fribourg)
Koang D.H.	(ISN)
Kwon H.	(CALTECH)
Leroux B.	(Bordeaux)
Lieb K.P.	(Göttingen)
Mac Mahon T.	(Manchester)
Mossbauer R.	(München)
Mariolopoulos G.	(CENG)
Nazarenko V.	(Leningrad)
Nifenecker H.	(CENG)
Paul W.	(Bonn)
Pendlebury J.	(Sussex)
Ramsey N.	(Harvard)
Schult O.	(Jülich)
Smith K.	(Sussex)
Trinks U.	(Bonn)
Wagemans C.	(Mol)

General summary

The scientific activities of College 3, as in previous years, were centred around the following areas :

- 1) The fission process-which was studied with the mass-separator LOHENGRIN and the neutron guides IH1, H22D and H22E. In these experiments mass and charge distributions of fragments from fission induced by neutron-capture into various actinide nuclei were determined and isomer formation as well as α -particles accompanying fission were studied.
- 2) Nuclear structure - where studies were carried out on the high precision spectrometers GAMS (bent crystal-spectrometers used for measurements of secondary γ -rays) and BILL (conversion electron-spectrometer), on the pair and anti-Compton spectrometers PN4, on the angular correlation apparatus installed at the H22F position and on OSTIS. Nuclear spectroscopy of fission products was carried out on LOHENGRIN and on the on-line-separator OSTIS.
- 3) Fundamental Physics - where experiments involving the search for neutrino oscillations, the study of parity violation in the n-d-capture and in n-optical activities, and the investigation of fundamental properties of the neutron were carried out.
- 4) Special experiments - where nuclear methods were applied to biomedical problems ; Quantum electrodynamic effects (Delbrück scattering) were studied by use of strong γ -sources, and the theory of electromagnetic interaction was tested by measurement of the photoelectric effect.

In 1979, a total of 107 proposals were submitted, of which 87 were accepted.

Scientific trends and highlights in 1979

Nuclear fission experiments

MASS SEPARATOR LOHENGRIN

During this year the investigations of the $^{235}\text{U}(n_{\text{th}},f)$ and $^{233}\text{U}(n_{\text{th}},f)$ systems have been extended.

$^{235}\text{U}(n_{\text{th}},f)$:

Measurements of kinetic energy distributions around the symmetric fission mass $A = 118$ were continued. Initial results indicated that the valley in the graph most probable energy vs. mass number A was about 4 to 5 MeV lower than normally referred to in the literature. The individual kinetic energy distributions of mass number 108 and 110 were considerably broadened (FWHM ~ 20 MeV).

The studies of nuclear charge yields and isomeric ratios were extended to masses $A = 99, 102$ and from 138 to 142. Final results on the measurement of nuclear charge yields in the light fission masses as a function of kinetic energy (from 38 to 108 MeV) covering all elements from As ($Z = 33$) to Mo ($Z = 42$) have been published.

$^{233}\text{U}(n_{\text{th}},f)$:

Mass and nuclear charge distributions were measured. The distribution at very high kinetic energies (~ 112 to 114 MeV, so-called cold fission) showed two dominant mass peaks at $A \approx 90$ and $A = 100$. In the case of $A = 100$ this could be interpreted as a pair of $^{100}\text{Zr} + ^{134}\text{Te}$. The odd-even structure in the fragment distributions of the $^{233}\text{U}(n_{\text{th}},f)$ system looks quite similar to the one in the $^{235}\text{U}(n_{\text{th}},f)$ system.

FISSION STUDIES USING SPECIAL ARRANGEMENTS

Two neutron guides (IH1 and H22) were used to complement the studies of the fission process.

- At H22E charge distributions of fission products have been obtained by use of a ΔE -E telescope ionization chamber and solid-state detector). This system was calibrated by determination of the response function to a given Z of fission fragments. This was achieved by measuring in coincidence with an X-ray detector (for Z-identification) using the ^{235}U (n_{th}, f) reaction. Subsequently the ^{229}Th (n_{th}, f) system has been investigated. Data evaluation is currently in progress.
- In view of the high neutron flux available at IH1, experiments concentrated on fission studies with very low cross section : Angular distributions of light particles emitted in ternary fission of ^{235}U and a systematic survey of mass and energy distributions of fragments in ^{226}Ra , ^{237}Np , ^{241}Am and ^{243}Am (n, f) reactions. Newly developed fission fragment detectors (cosi-fan-tutte pre-project) were tested.
- At H22D a detailed study of the energy distribution and emission probabilities of light charged particles (α , p and ^3H) accompanying fission of ^{235}U and ^{239}Pu was performed. Very interesting results were obtained using an unshielded ΔE -E telescope detector. For low alpha-energies a deviation from a pure gaussian shape was observed. The proton spectra on the contrary showed a gaussian distribution. In this context the behaviour of the low energy part for other light charged particles emitted during ternary fission is very important since this may yield information on the emission mechanism itself. For Tritons additional measurements are needed. These observations have to be tested for other nuclei, such as ^{237}Np and ^{241}Am .

Nuclear spectroscopy

CONVERSION ELECTRON SPECTROMETER BILL, BENT CRYSTAL SPECTROMETERS GAMS 1, 2/3, PAIR AND ANTI-COMPTON SPECTROMETERS, ANGULAR CORRELATIONS

The aim of the complementary measurements with these spectrometers is the study of nuclear forces by use of thermal neutron-capture which can be achieved by various approaches.

- The study of nuclei in the transitional region was continued by measurements of ^{195}Pt , ^{197}Pt and ^{199}Pt . The level order of the odd neutron coupled to a collective core permits the determination of the shape of the core. It is very interesting to apply the IBF approximation which is now available for odd nuclei.
- The conversion electron decay of the odd-odd nucleus ^{110}Ag has been measured. Multiplet assignment will give insight into the residual interaction between the odd proton and the odd neutron. The experiment will be continued in 1980 by measurements of secondary γ -rays.
- In ^{114}Cd a possible shape coexistence is currently under investigation. This shape coexistence has been predicted by various models.
- Possible candidates for EO-transitions depopulating a two phonon octupole vibration in ^{208}Pb have been detected and can serve as a crucial test of the picture of collectivity in this nucleus.
- The studies of nuclei in the actinide region are being continued. Conversion electron spectra of ^{236}U , ^{237}U and ^{244}Am and γ -ray transitions in ^{238}Np were investigated. The level scheme of ^{227}Ra , which was measured before has now been well established below 1MeV and interpreted in terms of the Nilsson model.
- In the region of light nuclei the γ -decay scheme of ^4K has been studied very thoroughly. The data interpretation is in process.

NUCLEAR SPECTROSCOPY OF FISSION PRODUCTS

The program concerning the study of neutron rich isotopes far from stability line included the following activities :

- On LOHENGRIN the systematic study of decay energies was extended to mass chains $A = 136$ to 139 and $A = 149$ to 150 . Previously unknown Q_{β} -values of ^{136m}I , ^{138}I , ^{139}I , ^{149}Ce and ^{150}Ce were published.
- On OSTIS the measurements were concentrated on the investigation of level systematics which gave information on the nuclear structure of transitional nuclei :
- Extensive conversion electron measurements led to the determination of spins and parities of excited states. The assignment of excited O^+ -states in $^{96,98}\text{Sr}$ and ^{98}Zr were of special interest. The first excited O^+ -state in ^{98}Sr was found to be at 215 keV which is the lowest one known in even-even nuclei. This is an indication for shape co-existence.
- Half life measurements by γ -multispectra techniques revealed isomerism in the ^{98}Rb and $^{144,146}\text{Cs}$ -decay.
- The experiments with the on-line angular correlation system were extended to ^{146}Ba , $^{142,144}\text{Ce}$ and $^{92,94,96}\text{Sr}$. In the case of the even Ba-isotopes a comparison with the predictions of the IBA-model was performed.
- The use of a newly developed β -spectrometer in conjunction with a Ge (HP)-detector enabled the high energy part of the β -spectrum to be determined with considerably improved quality, and thus the determination of Q -values with high precision.
- With delayed neutron-gamma-coincidence measurements the experimental β^- -strength functions for Rb-isotopes could be determined, showing well separated resonances which revealed nuclear structures effects in contrast to present purely statistical concepts.

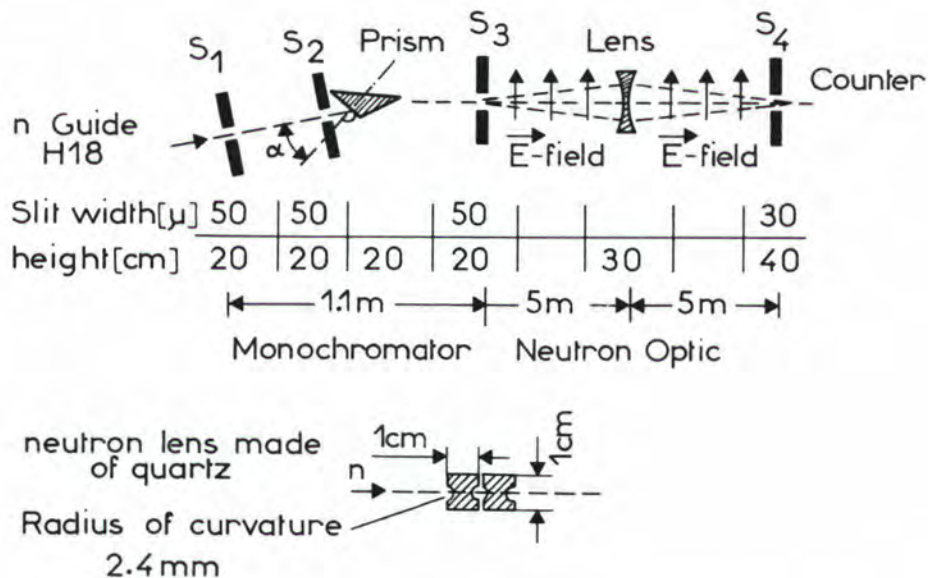


Fig. 8 : The neutron optics system for the experiment on the electric charge of the neutron (Gähler, Univ. Bayreuth).

Fundamental physics

FUNDAMENTAL PROPERTIES OF THE NEUTRON

- **Electrical charge of the neutron** (Bayreuth, ILL)

A neutron optics system (consisting of a glass prism monochromator, a slit system defining the beam divergence, and a focussing quartz lens, (fig. 8) was installed at the 20 Å neutron guide H18. It was tried to detect a shift of the neutron image in the focal plane of the optics as a function of the polarity of a strong transversal electric field applied along the 10 m neutron flight path. No shift was measured within the experimental precision limits. The upper limit to the neutron charge was pushed down by \sim two orders of magnitude to some 10^{-20} electron charges. A final value will be obtained after completion of the data evaluation.

- **Search for an electrical dipole moment of the neutron (EDM)** (Sussex, Harvard, ORNL, Rutherford, ILL)

The set-up of the experiment using ultra cold neutrons for the search of an EDM has made good progress. The final 5-fold Mu-metal shield was installed. The measured value and homogeneity of the field meet the design specifications. The improvement of the UCN-storage time has lead to a narrower resonance line (see also fig. 9). The development of high performance UCN-polarizers is in progress. The final Beryllia-Beryllium confinement vessel is under preparation.

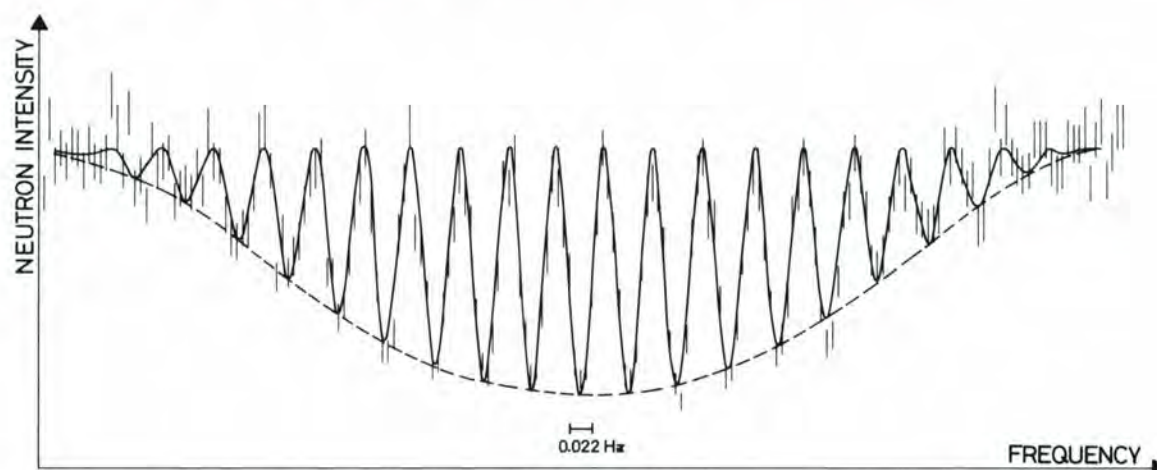


Fig. 9 : Magnetic resonance pattern obtained with UCN. (The lines are drawn to guide the eye).

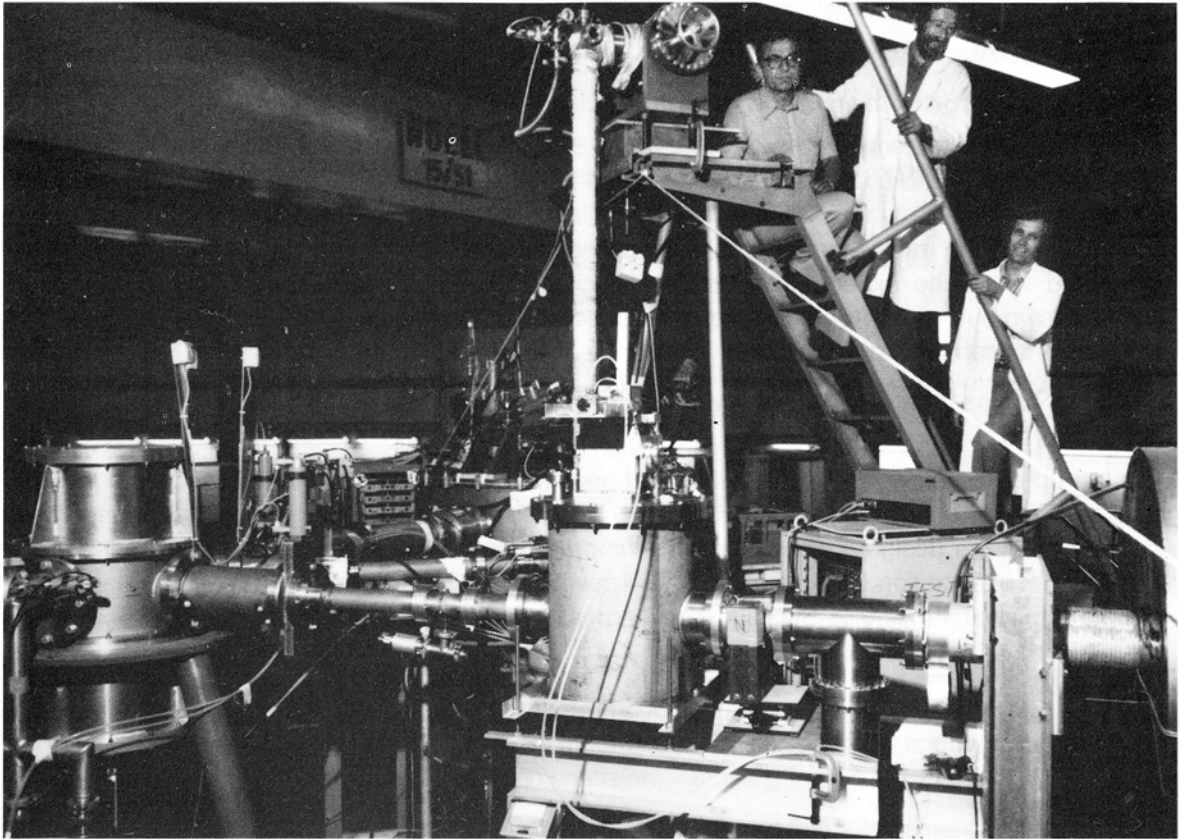
- **UCN-storage times in material bottles** (ILL)

For fundamental physics experiments at ILL, it is important to achieve longer storage times of ultra cold neutrons in bottles.

Different bottle materials have been studied. The storage time in a copper bottle could be pushed, for the first time, close to the theoretical limit. The measurements using different surface cleaning methods in a bakable ultra high vacuum system confirm that surface impurities are responsible for high experimental UCN reflection loss rates. The experiments are being continued with low absorption cross section materials such as Beryllium.

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

The losses in the superconducting magnetic ring storing neutrons in the velocity range between 10 and 20 m/s were studied in detail. It was concluded that the useful phase space volume demanded a stronger UCN source in order to perform a neutron half life measurement with a precision of about 1 % or better.



Installation at the UCN source PN5. On the left the UCN "switch box" distributing UCNs to three different experiments. An UCN switch (in the centre) guides neutrons to the EDM experiment ; behind is the vertical ultra high vacuum UCN storage bottle with its vacuum pump at the top.

A magnetic superconducting hexapole sphere for UCN storage is under construction at the University of Bonn and will be installed in the beginning of 1980 on a 10 Å neutron beam using the principle of UCN production by downscattering of 10 Å neutrons in liquid Helium to fill the sphere. Thus avoiding the resonance losses of the storage ring it is hoped that a lifetime measurement can be performed using this new magnetic bottle.

- Production and storage of ultra cold neutrons in liquid Helium
(ILL, Lancaster University, University of Sussex)

In 1977 the first successful measurement of UCN produced by down scattering of 10 Å neutrons in commercial liquid helium was carried out. This experiment is now being repeated using ultra pure Helium-4 ($< 10^{-12}$ He-3). Whereas in the previous experiment only the production rate was measured the aim now is to obtain information on the upscattering losses of UCN in liquid He as a function of temperature ($> 1.1^\circ$ K). The ultra pure He 4 was produced at ILL in a special cryostat built at Lancaster University. The measurements will continue until the end of 1979.

- Focussing optics with ultra cold neutrons (Munich, ILL)

The first optics experiment with ultra cold neutrons was performed. A concave (1 cm diameter) zone mirror was successfully used to produce an image of a 2 mm wide entrance slit. By application of the laws of geometrical optics different magnifications (up to 10) were obtained. The experiment was prepared by the group led by A. Steyerl in Munich.

STUDIES OF PARITY VIOLATION

- **Spin rotation experiment** (Rutherford, Harvard, Euratom (Ispra), Sussex)

Two experiments are in progress to measure a coherent parity violation (optical rotation) in the interaction of polarized neutrons and matter. This effect is expected from the parity violating part of the weak interaction. The first experiment, using samples of ^{124}Sn and Sn (natural) should be sensitive to the nucleon-nucleon weak interaction in the presence of resonant enhancement. A final error of less than 10^{-6} radian/cm is anticipated. Such a result is well within the theoretical predictions based on certain nuclear models. The apparatus for a second experiment, which will employ a long Bi sample, is currently under construction. This apparatus should be capable of detecting rotations which are comparable in size to those expected from the neutron-electron weak neutral current interaction.

- **Weak interaction in the neutron-deuteron-system** (ISN, Harvard, ILL)

In recent years the weak nucleon-nucleon coupling has been investigated at the polarized neutron beam PN7. The asymmetry of the spatial distribution of the photon emitted after n-capture with respect to the polarization of the neutron gives directly information on the weak interaction.

During 1979 the asymmetry in the n-d-capture was studied. The present status of the experiment indicates an effect which is much larger than theoretical predictions. This result has to be validated by additional tests comprising a study of background events, beam stability and stability of the data acquisition system.

- **Neutrino oscillations** (Caltech, ILL, ISN, Technical University Munich)

As a first step in the investigation of neutrino oscillations a detector was constructed which allows the measurement of the positron energy spectrum of the neutrino induced inverse beta decay of the proton. This detector is located at a distance of 8.5 m from the reactor core. Test measurements performed with part of the detector working were successful. The energy resolution (of positrons) is better than 18 % and the signal to background ratio is > 1 above 1.5 MeV (the positron energies range up to 6 MeV).

The complete detector is now operating and extensive background studies were performed during the annual shut down of the reactor. The proper measurement has now been started, yielding a rate of ~ 1.5 neutrinos per hour. Several months of acquisition are necessary to get a final result.

Special experiments

- **QED-EFFECTS IN PHOTON SCATTERING** (Göttingen, ILL)

The investigation of Delbrück scattering (elastic scattering of photons in the Coulomb field of nuclei) offers a new possibility for testing the predictions of quantum electrodynamics (QED).

The measurements carried out during the last year at ILL by use of a ^{140}Ce γ -source showed that photon scattering experiments were feasible at the H7 position of PN3. The aim was to fill the data gap between 3 and 7 MeV and to test the interpretation of the discrepancy between experiment and lowest order Delbrück theory observed at 2.75 MeV. Good agreement was found between experiment and lowest order Delbrück theory in the 4 to 5 MeV range. This is in line with the supposition that the effects of Coulomb correction might decrease when increasing the photon energy from 2.75 MeV to 4-5 MeV.

- **PHOTOELECTRIC EFFECTS** (Manchester, ILL)

To verify the theory of electromagnetic interaction at relativistic energies, measurements on the photoelectric effect were completed by the investigation of the angular distribution of photo electrons in the energy range 1-10 MeV. These experiments, reported for the first time, were performed on the beta spectrometer BILL, covering angles from 3° to 45° . The measured distribution disagreed with Sauter's high energy formula and favoured a recent calculation by Tseng et al (1978).



The exposure of rat intestine to neutrons at the H17 guide tube (B. Larsson, Uppsala and H. Börner, ILL).

- NEUTRON CAPTURE IN BIOLOGICAL SPECIMENS (Uppsala, ILL)

Cultivated hamster cells and exteriorized segments of rat intestine have been exposed to 10 Å neutrons at the H17 guide. Via doping with different amounts of Boron or Lithium the experimental conditions were chosen so as to emphasize effects of charged particles following the n-capture process. The aim was to relate observed impairment of reproductive capacity to structural changes of DNA in cells affected by densely ionizing particles.

Seminars and workshops

In 1979, the Fundamental and Nuclear Physics College organized a workshop : " Nuclear Spectroscopy of Fission Products ", held on 21-23 May. It was attended by about 80 participants. 34 papers were presented.

Additionally 38 seminars dealing with nuclear structure, fission, heavy ion collisions, atomic and fundamental physics and new experimental developments were given.

Secretary : H. BÖRNER

College 4 Excitations

Members of the college

I. EXPERIMENTALISTS, I.L.L.

Bouillot J.
Burke S.
Currat R.
Dorner B.
Escribe C.
Fitzgerald W.
Ghosh R.
Jenkin G.
Joffrin C.
Kollmar A.
Kraxenberger H.
Lauter H.J.
Lefebvre J.
Lehner N.
Pynn R.
Stirling W.G.
Suck J.-B.
Vettier C.
Ziebeck K.

II. THEORETICIANS AND EXTERNAL

Castets N. (CNRS)
Loveluck J.
Rossat-Mignod M. (CENG)
Villain J. (CENG)

General summary

Experiments carried out in College 4 are concerned with collective magnetic and mass-density fluctuations and with phase transitions which involve these densities. As in previous years the study of phonons, magnons and structural phase transitions are roughly equally popular, while magnetic phase transitions receive less attention. Most of the experiments are performed on three-axis spectrometers, although some use is made of diffractometers (D5, D10), time-of-flight spectrometers (IN4, IN5) and high resolution instruments (IN10, IN11). Until recently four three-axis machines have been available ; IN1 on a hot source and IN2, IN3 and IN8 on thermal sources. Usually IN1 is about 40 % oversubscribed, IN2 and IN3 about 50 % oversubscribed and IN8 can barely accept 50 % of the experiments which are proposed for it. The recent commissioning of the cold-source, three-axis spectrometer IN12 has not changed this situation significantly but has encouraged a large number of proposals for experiments which have, until now, been beyond the capabilities of ILL equipment. During the first six months of operation IN12 has performed well and has demonstrated the advantage of several design features not incorporated on the other three-axis machines. Spectrometer positioning is faster, user interaction with the control teletype is less frustrating and the dedicated Solar 16-40 computer permits initial, on-line data reduction.

The data reduction and resolution programs available on IN12 have been produced as part of a contract which ILL, Harwell and Rutherford Laboratory have initiated with the Polytechnic of Central London. Under the terms of this contract a consistent and coherent suite of resolution and data-handling programs is to be produced for use in conjunction with three-axis spectrometers. It is hoped that this project will increase the efficiency of the usage of ILL spectrometers and will allow users to leave the Institut with three-axis data which has been properly corrected for the effects of instrumental resolution.

In addition to improving the usefulness of its classical three-axis machines the College is looking forward to innovations which will be made possible by the approval of the Deuxième Souffle. For example, a project to produce a large, vertically-focussing, Heusler alloy monochromator is well under way. Such a polarising monochromator, which will facilitate numerous magnetic scattering experiments, will probably be installed on a three-axis spectrometer in the near future. In addition, the rebuilding programs for IN1 and IN8 are well advanced and plans are being discussed both for the installation of IN3 on an end-guide position and the refurbishment of one of the Institut's oldest instruments IN2. All of these reconstruction projects should benefit considerably from experience gained during the construction of IN12.

Scientific trends and highlights of 1979

Anyone who has compared the phonon spectra of, for instance, two f.c.c metals will agree that they are very similar. Sometimes however, marked differences in the physical properties of isostructural compounds lead one to expect differences in their phonon spectra. For example, although NbO and $\text{Nb}_{0.8}\text{Ti}_{0.2}\text{C}_{0.1}\text{N}_{0.9}$ have the same basic structure, the former compound has a low superconducting transition temperature (T_c) while the latter displays an unusually high T_c of $\sim 17\text{K}$. Whilst some differences between the phonon spectra of these materials have been observed (1) the correlation between the phonon and superconducting properties is not yet clear. A completely different physical effect was expected to cause discrepancies between the phonon spectra of CeSn_3 and LaSn_3 . Whilst they are isostructural, these materials differ because CeSn_3 is a mixed-valence compound and LaSn_3 is not. The difference between these ionic radii of the Ce^{3+} and Ce^{4+} ions is about 10 % and the fluctuations between these states might be expected to effect the phonon frequencies. In fact, the measured differences between the dispersion curves of these materials (2) are small and are apparently unrelated to the intermediate valence properties.

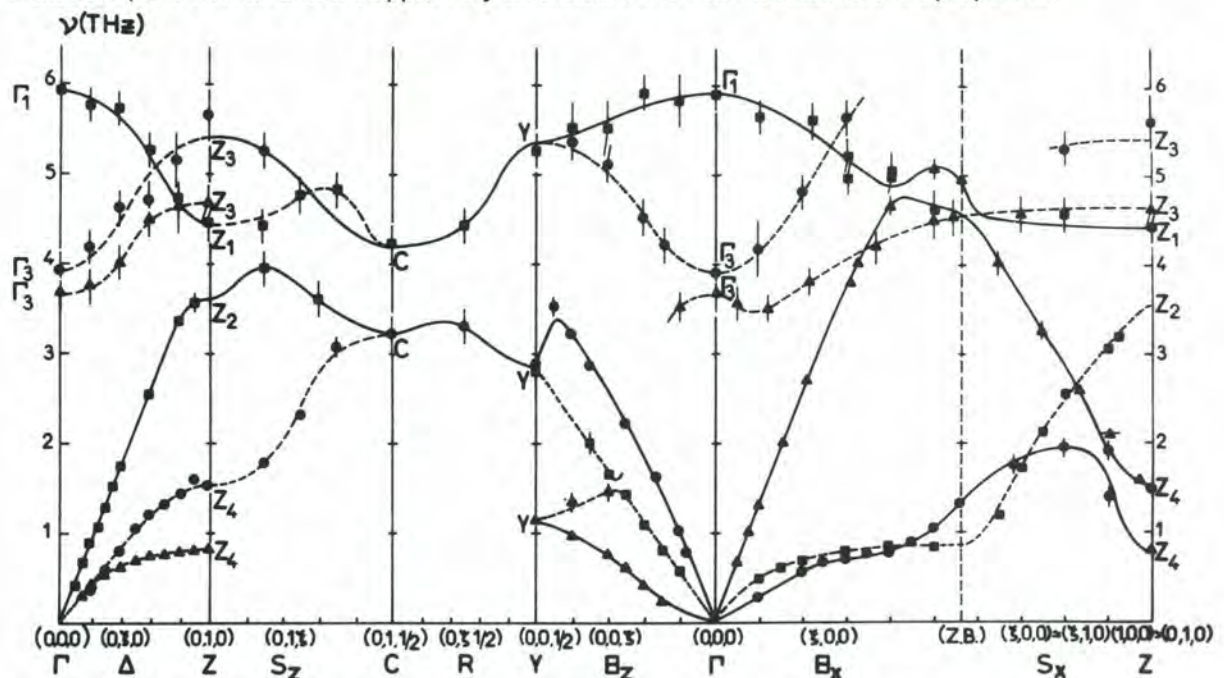


Fig. 10 : Measured phonon dispersion curves of β Gallium.

This year measurements of the phonon frequencies of the metastable β -phase of gallium were completed (Fig. 10). For this measurement (3), the single crystal sample was grown in situ on the IN8 spectrometer. Liquid gallium was cooled to -16°C to give a sample consisting of several misorientated crystallites. Subsequent annealing yielding a single crystal in equilibrium with the liquid phase. To determine the crystal orientation a linear multidetector was used to locate Bragg reflections.

A goniometer mounted inside the sample cryostat then allowed the desired scattering zone to be moved to the horizontal position. During the measurements the utmost care had to be exercised to prevent the metastable β phase from reverting to the stable α form. Even the vibrations produced by the step motors driving the sample table proved too violent to be tolerated by this fragile sample!

Among the first experiments performed on IN12 was a measurement which apparently located (4) the hitherto illusive "phason". This excitation, proposed many years ago by Overhauser (5), is expected to occur in incommensurably modulated structures (6). In two such phases of biphenyl, modes which have the expected behaviour have been found. The measured excitations form a branch whose frequency, zero at the satellite wavevectors, increases linearly with wavevector at a rate which is less than half that of an acoustic phonon. Another possible candidate for the observations of phasons is thiourea, which will soon be measured on IN12. Hitherto, experiments with thiourea (7) have concentrated on an exploration of its phase diagram. A new phase had been found to be stable in a narrow temperature interval between the incommensurable and the (low-temperature) ferroelectric phases. This phase is unusual in that the modulation wavevector is a remarkably small fraction (1/9) of a reciprocal lattice vector of the high-temperature structure.

Biphenyl and thiourea are both insulating materials. In contrast, TTF-TCNQ, another incommensurably modulated system, was once (falsely) lauded as a high-temperature superconductor. A series of experiments with high-pressures (up to 0.6 GPa) and small crystals ($\sim 1\text{mm}^3$) have recently been performed with TTF-TCNQ (8, 9). It has been shown that the Fermi wavevector changes essentially linearly with pressure and approaches the value $b^+/3$ at $P \sim 1.7\text{GPa}$ (b^+ is the reciprocal lattice vector in the chain direction of this quasi unidimensional conductor). The commensurability of the Fermi wavevector at $\sim 1.7\text{GPa}$ probably explains the first order nature of the transition observed by conductivity measurements in this pressure region. The detailed phase diagram deduced from the neutron measurements (Figure 11) does not agree however with that deduced from conductivity measurements. The discrepancies cannot be explained on the basis of existing theories of the phase transitions of TTF-TCNQ.

An incommensurable modulation, of magnetic rather than structural character, has been found to occur in uniaxially stressed praseodymium metal (10). Below about 10K and at zero stress a weak central peak is observed at a reduced wavevector of 0.11 in the direction Γ -M. This peak persists but its intensity does not diverge as uniaxial stress is applied. Rather, a magnetic satellite peak develops at a neighbouring wavevector ($\vec{Q} = (0.127, 0, 1)$) and coexists with the central peak. The origin of the latter peak is not yet clear. The fact that the exchange coupling in Pr is close to the value required for magnetic ordering results, via the hyperfine interaction, in an enhancement of the nuclear susceptibility. This in turn is expected to cause ordering of the combined electron-nuclear spin system at very low temperatures. A recent experiment, performed on IN2 at a temperature of 28mK (see photograph) has demonstrated this effect (11).

For obvious reasons the study of elementary excitations has tended to focus on linear excitations for which harmonic theories provide at least a lowest-order interpretation. A break with this tradition has been the recent interest in soliton modes. It was shown theoretically by Mikeska (12) that, in a one-dimensional, planar ferromagnet subjected to a magnet field in its easy plane, the soliton modes ought to cause a zero frequency peak in the fluctuation spectrum. Such a peak was subsequently observed in CsNiF_3 (13). On IN12 a central peak has recently been observed in the one-dimensional, planar antiferromagnet TMMC (14). The wavevector and energy widths of this peak have the exponential dependence on H/T (H is magnetic field and T the temperature) predicted by soliton calculations. In addition, for $H/T \gtrsim 8\text{ kOe/K}$, the measured soliton density agrees well with a recent calculation carried out at ILL by LOVELUCK (15).

Another non-linear magnetic excitation has been observed in FeI_2 (16) in which a two-magnon excitation has been observed in addition to three non-degenerate magnon branches. The latter excitations tend to disappear as the temperature is increased and have essentially disappeared at 8.3K (magnetic ordering temperature 9.3K). However, the two-magnon branch persists.

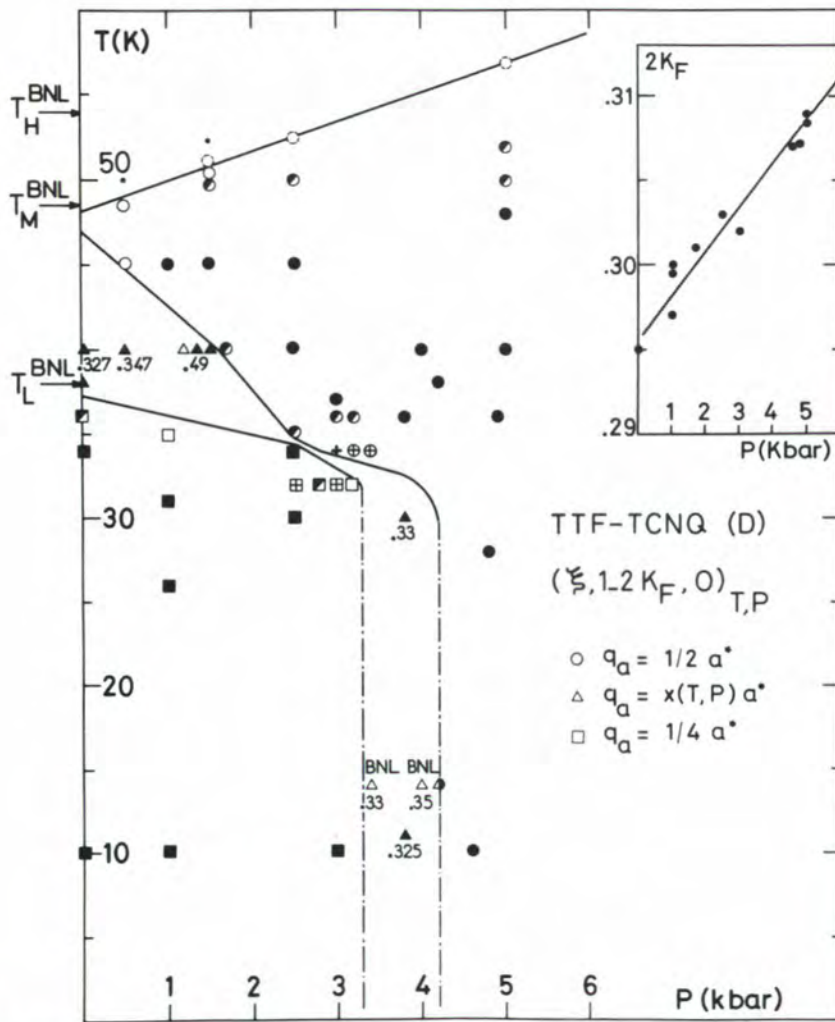
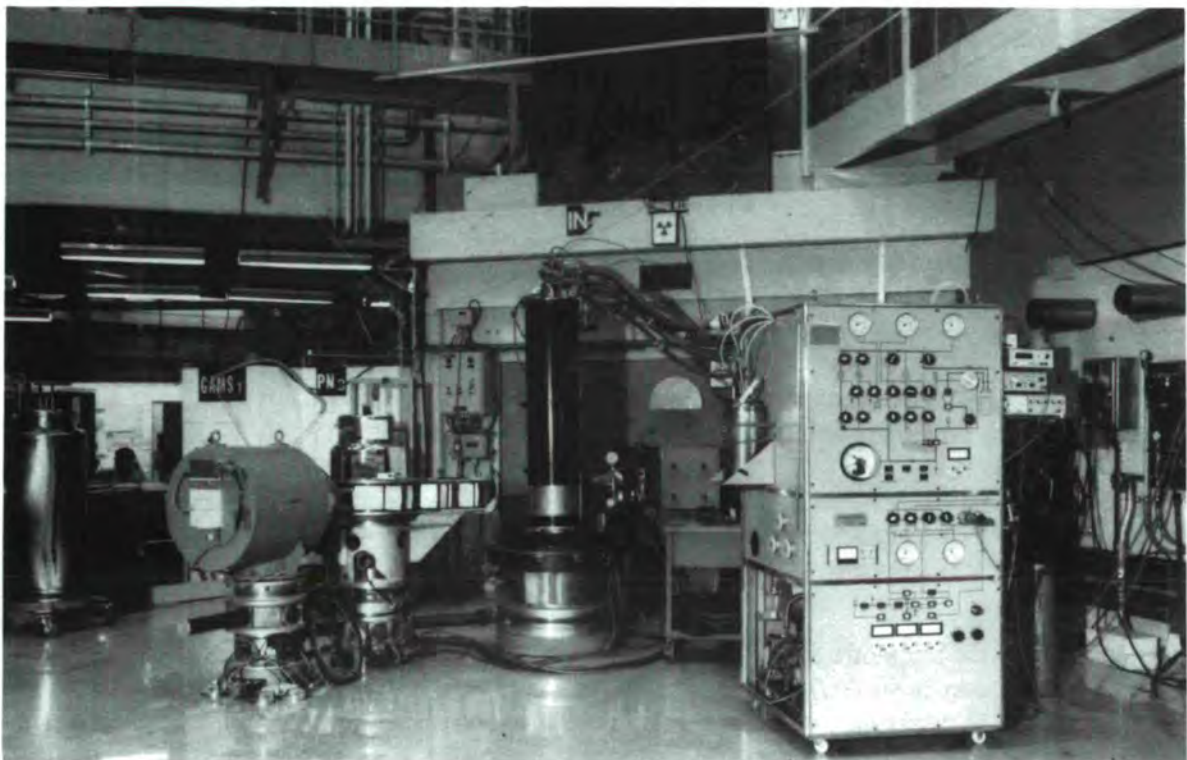


Fig. 11 : Phase diagram deduced from neutron measurements of the longitudinally (b^+) polarized lattice modulations of TTF-TCNQ.

The dilution refrigerator being used on IN2 for the experiment N° 04-03-108 (Incipient soft mode in Pr at millikelvin emperature) by McEven et al.



Workshops and seminars

In April this year a workshop was held on the contribution of neutron inelastic scattering to some current problems in metallic magnetism. Topics discussed included transition metals and their alloys, rare-earths and anomalous rare-earths and actinides. Some 70 scientists from 6 countries attended this two day workshop which was notable for the level and extent of the discussions which it prompted on a wide range of topics.

During the year the group has held regular weekly meetings which have served to keep members abreast of scientific developments both inside ILL and at other reactor centres.

Secretary : R. PYNN

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College 5 Structures

Members of the college

Aime J.P.	Paris
Aldebert P.	Toulouse
Bornchil G.	
Boucherle J.X.	CENG
Brown P.J.	
Cheel V.	Oxford
Convert P.	
Croset B.	Marseille
Feld R.	
Filhol A.	CNRS/Bordeaux
Freund A.	
Fruchart D.	CNRS/Grenoble
Gardner P.	London
Gillon B.	Paris
Givord D.	CNRS/Grenoble
Gregory A.	Frankfurt
Hewat A.W.	
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Lehner N.	
Leslie M.	
Marti C.	
Mason S.	

Pannetier J.	
Riekkel C.	
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Thorel P.	CENG
Timmins P.	
Tran Qui Duc	CNRS/Grenoble
Trost W.	
Vettier C.	
Vicat J.	CNRS/Grenoble
Wilson S.	
Wolfers P.	CNRS/Grenoble
Wright A.	
Zeyen C.	
Ziebeck K.	

Visitors

Tellgren R.	Uppsala
Wilkinson C.	London

TABLE VIII

EXPERIMENTS ACCEPTED FOR EXECUTION IN 1979 BY SUBCOMMITTEE 5

	D1A	D1B	D2	D3	D5	D8	D9	D10	D12	D15	Other	Total
N° of experiments	30	27	17	15	12	17	18	4	5	13	11	169
N° of days	158	119	142	196	141	169	183	30	73	176		

General summary

The experiments carried out by the college covered a wide range of subjects within structural and magnetic investigations on both powders and single crystals. The distribution of applications was, however, relatively unchanged from the preceeding year. The table shows the experiments accepted by the sub-committee 5 for execution in 1979 for the instruments most used by the college. As can be seen from the table these instruments are all in the diffraction group, and this facilitates the assignment of suitable instruments for experiments, and likewise guarantees close contact between the technical and scientific staff responsible for the experimental programme. The number of proposals submitted has increased, and it was decided to transfer some of the proposals mainly concerned with chemical subjects to college 9. This was tried at the October meeting of the scientific council for proposals connected with key-number 05-24 which is "structures of adsorbates and intercalated compounds", and as these changes seemed to work satisfactorily, 05-24 will in the future be called 09-07.

At the first scientific council of 1979 there were more than 100 proposals which were treated in two sub-committees. It has been practice for the college secretary to delegate some of the preparatory work to "experts" within the college, and this approach was normalised by the election of a deputy college secretary in a field complementary to that of the college secretary. The new system was partially tried out for the October council and worked well.

It has been a general trend in the proposals to make measurements as a function of some experimental variable such as temperature or pressure, which has increased the number of individual sets of measurements within each accepted proposal. Parallel to this the members of the college have been engaged in developing the automation of this type of study. A good part of this work involved continuing the transfer of instruments to individual computers and the development of software and documentation. At present only two instruments used by the college (D1B, D5) remain on the CARINE computer. The improved reliability of the control computers for the single crystal instruments, as well as the increased speed, was used to improve the quality of the measurements. Under the old computer system a common procedure was to measure one of a set of symmetry related reflections. This was not satisfactory when high precision observations were required. This approach has now been abandoned and several symmetry related reflections are measured. An interesting extension to the range of accessible temperatures was obtained for work on the instrument D1B by the use of a dilution refrigerator, constructed and owned by a group at the CNRS, Grenoble. Temperatures below 10 mk can be used.

The discussions, started during 1978, within the diffraction group and the college concerning the application of area detectors in powder and single crystal studies, have led to a project for rebuilding the instruments around the beam-port H11. This project, which includes a high resolution powder diffractometer (D2B), a "one and a half" dimensional detector for single crystal work (D19) and a diffractometer with a large detector with high counting rate capacity (D20) received approval at the October council, and is now being discussed in detail. Finally, the members of the college have also been heavily engaged in the considerations concerning the purchase of a new central computer.

Scientific trends and highlights in 1979

Electron densities

The tendency in the charge density studies has been towards the study of heavier atoms, either in the examination of the charge density in covalent bonds involving second row atoms (sulphur), or in the study of the environment of metal atoms in metal coordination complexes. Neutron diffraction data for these purposes have been collected on compounds such as α -P₄S₃, CaSO₄, Fe₂SiO₄ and Cu₂O. Within the college further consideration was given to the density in H₂O₂ where the absence of positive deformation density in the oxygen-oxygen bond was found very puzzling. It is generally assumed that covalent bonding will lead to charge accumulation between the atoms, and various arguments support this idea. These arguments are however, built on assumptions that might not always hold. In particular for bonds between electron rich atoms repulsions might prevent the build-up, and in this case the distortion that takes place would mainly occur in regions around the atoms, orthogonal to the bond axis. Indeed, several recent studies (notably of N-O bonds) have supported these ideas.

Hydrogen atom positions

The location of hydrogen atoms has occupied a good part of the instrument time on several diffractometers. On the one hand there has been a growing interest in the determination of metal hydrogen bonds. One example was the study of [HRu₆(CO)₁₈] [Ph₄A₅], where the hydrogen atom

was found embedded in the cavity of a metal octahedra. On the other hand hydrogen bond studies, in connection with structural phase transitions, have grown in demand, and here one of the centres of interest has been dimers of carboxylic acids. The dimer formation consists of the two acid groups being hydrogen bonded, forming an eight member ring (often around a centre of symmetry). There has often been spectroscopic evidence that the hydrogen bond system has a temperature dependent disorder. However, diffraction studies of several compounds have not revealed such a disorder, but have, in some cases, indicated other types of packing disorder.

Structural phase transition

Analysis of single crystal data on the α to β transformation in quartz, which takes place at 573°C , showed that the model, which till now has best described available X-ray data, did not hold for the neutron data. In the earlier model both oxygen and silicon atoms moved to special positions (6j and 3e in the spacegroup $P6_222$). The new data were best explained by assuming a disorder for the oxygen atom around the 6j position, and in order to keep regular SiO_4 tetrahedral a corresponding small disorder in the Si was assumed. The figure 12 shows a stereoplot of the unit cell content. Neutron powder refinement has continued to be used extensively for the study of phase transitions, in particular those associated with properties such as ferroelectricity and ionic conductivity. New programs, implemented at ILL by Shirley and Pawley, were used to index and refine D1A neutron powder patterns from completely unknown structures. For example, the abrupt changes in the ionic conductivity of Na_2UBr_6 have been explained by two structural transitions in which the Na ion first becomes free to move between equivalent holes, and the UBr_6 unit then enters a state of hindered rotations. Diffraction patterns resulting from such hindered rotations were explained with the aid of a cumulant expansion in terms of Kubic harmonics by Taylor in Sydney. Similar techniques were used by Athee and Kurki-Suonio in Helsinki to explain order-disorder transitions in materials such as CsPbCl_3 .

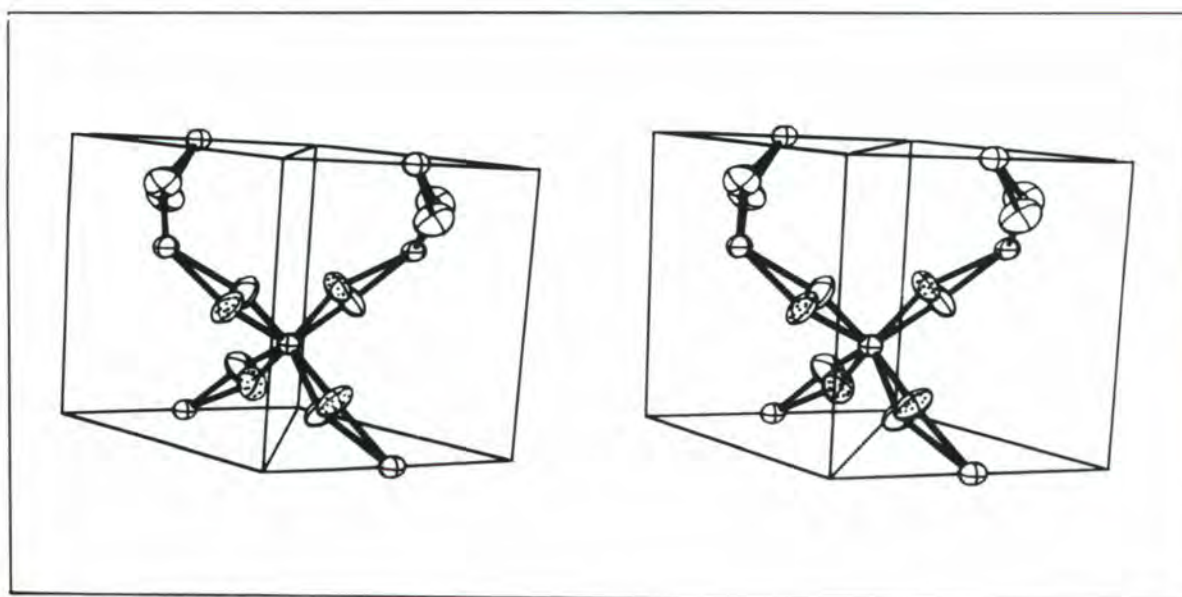


Fig. 12 : Stereo-view of the unit cell content of β quartz at 590°C . Small atoms are silicon, large atoms are oxygen. The ellipses enclose the region where atomic density is higher than 50 %, and indicate in this way the average thermal motion and disorder. In the present case the oxygen distribution is represented by two half-atoms. Dotted oxygen atoms correspond to one position of the SiO_4 tetrahedra, and the motion of the tetrahedra can be described as a screw motion along an axis through silicon and approximately orthogonal to the plane of the figure.

Magnetic phase transitions

Recently, emphasis has been put on magnetic phase transitions. In particular, interest has been given to the nature of such transitions in the presence of an applied field such as uniaxial stress or hydrostatic pressure. For example, the critical behaviour of MnO was investigated as a function of volume (hydrostatic pressure) and symmetry (uniaxial stress). Comparisons of the observed measurements led to an explanation of the driving mechanisms of the first order transition. Similarly for MnAu₂, where pressure induces first order transition from an incommensurate helical phase to a commensurate ferromagnetic phase, a Lifshitz point may then be found in this system. In relation to phase transitions, magnetic ordering has been monitored as a function of pressure for systems such as CeAl₂ and UN.

Polarisation analysis of diffuse scattering

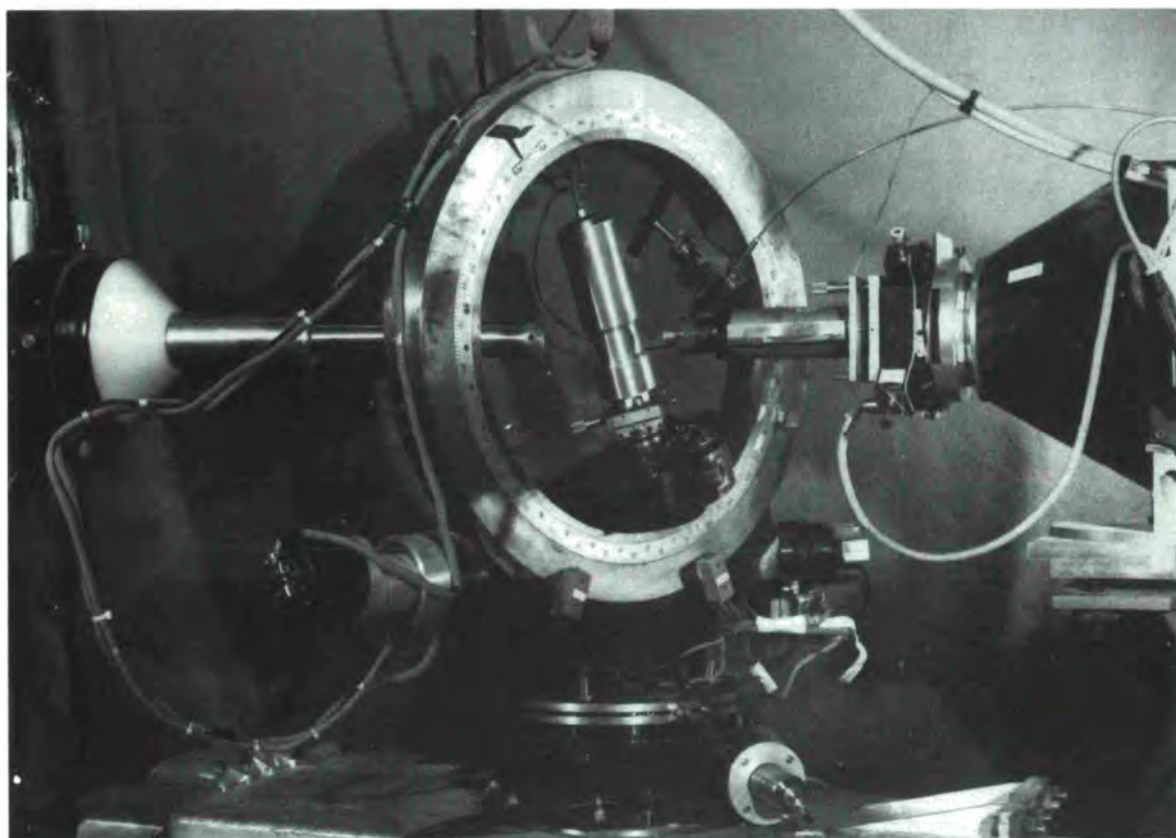
During the year development of methods of polarisation analysis for the study of diffuse paramagnetic scattering has continued. Developments of the instrument D5 has been done to give better resolution and more reproducible scattering geometry. In these experiments an unambiguous separation of the diffuse magnetic scattering was obtained from the difference in the spin cross-section for neutrons polarised parallel and perpendicular to the scattering vector. The work on MnSi was completed and experiments started on the weak ferromagnet Fe₂Ce. The magnetism in this compound was thought to be analogous to that in iron, but the addition of cerium reduced the Curie temperature to 230K making the paramagnetic region more accessible. Fe₂Ce differed from MnSi in that the paramagnetic scattering peaked in the forward direction ($q = 0$). The scattering was consistent with clustering of localised spins. Results for α -Mn, thought to be an itinerant anti-ferromagnet, were analogous to the those for MnSi. α -Mn showed a relatively strong paramagnetic response peaked at non-zero wave vector with an important inelastic component. These results lend support to the idea of local exchange split bands persisting into the paramagnetic region. More recently the polarisation analysis technique was used successfully to separate effects due to magnetic and nuclear correlations in alloy systems such as CuMn, NiMn, CrFe, CrCo.

Magnetisation density

Studies of the magnetisation densities in very weakly magnetic materials have continued. These experiments exploited the high flux of polarised neutrons available at the diffractometer D3 and the high fields available from a superconducting magnet. During the year an experiment to study the diamagnetic magnetisation in graphite showed that the scattering in the 100, 110 and 101 reflections was less than .025 of that in the forward direction given by magnetisation measurements. This implied a magnetisation density with less than 10 % variation throughout the unit cell. Experiments to measure the paramagnetic form factor of technetium were successfully completed. The results showed that the paramagnetic moment in this 4d element arose from "atomic like" 4d electron wave functions and were predominantly orbital in character. An experiment carried out on the conducting phase of the layered chalcogenide NbSe₂ provided information on the spatial distribution of conduction electrons in this compound. Magnetism resurgence in the Y-Ni alloys were investigated ; in particular it was shown that magnetism in YNi₃ arose essentially from the 3d Ni electrons.

Pressure effects

Pressure effects on crystallographic structures and interatomic distances have received growing interest. One should mention the studies of KDP and more recently TTF-TCNQ (tetra-thiafulvalenium tetracyanoquinodimethane). Neutron single crystal studies of the structure of TTF-TCNQ were carried out on the four circle D8 at pressures up to 5 Kbars. The pressure cell made of aluminium alloy had previously been used for simple structure work on D10. Absorption corrections were taken into account which allowed position determination with the same accuracy as at zero pressure. Such studies could easily be extended to other materials in the same range of pressure.



Four circle diffractometer D8 equipped with a pressure cell at 5 kbars. He-gas is used as the pressure transmitter.

Neutron interferometry

Preliminary considerations show that it should be possible, using unpolarised neutrons, to image ferromagnetic domains by phase contrast in the neutron interferometer, providing the reference beam is subjected to a magnetic field. On the interferometer D18 such neutron phase contrasts revealed images of simple ferromagnetic domains in a specimen of Fe-3 % Si. The expected contrast reservals were observed in preliminary experiments :

- a) by inversion of the reference magnetic field
- b) by change of the reference magnetic field value
- c) when a nuclear phase shifter (an aluminum plate) is inserted

When no reference beam is used, thus reverting effectively to 2-crystal interferometry, no contrast is observed between domains, but domain walls are visible ; the diffraction effects involved in this case are only very crudely understood at present.

Neutron topography

The unique possibilities of neutron diffraction topography for direct visualisation and characterisation of antiferromagnetic domains were further exploited, using the special instrument for neutron topography S20.

For NiO, earlier work has enabled to directly see T (or \bar{q}) domains. Then, on specimens featuring large and simple S domains an unexpected effect occurred of contrast between S domains on topographs made using either nuclear reflections of neutrons or X-rays. This was shown to be a consequence of the interplay of magnetostriction with crystallographic twinning of the plate surface. Understanding this effect has made it possible to reveal the S domains directly, using magnetic reflections of neutrons, and to rule out one of the two possibilities encountered in the literature for the spin direction, viz $\langle 110 \rangle$.

Seminars

The college arranged weekly meetings in collaboration with the diffraction group. During the past year a good proportion of these meetings were used to discuss scientific and technical aspects of the proposed new instruments for the second souffle. Time was also given for the thesis students to report on their work. Finally, members of the groups, as well as visitors, have given talks on subjects such as structural phase transition studies by powder methods, calculations of electrostatic potentials from diffraction data and the application of synchrotron radiation.

Several members of the college gave lectures on "Physics with neutrons" during a workshop organised by Société Française de Physique.

Secretaries : M. LEHMANN
C. VETTIER

College 6

Liquids, gases and amorphous materials

Members of the college

Angell A.	(vis. from Purdue Univ.)	Hilton P.	
Bletry J.	(Univ. of Grenoble)	Lovesey S.W.	
Chieux P.		Poncet P.F.J.	
Cummings S.		Pynn R.	
Cyrot F.	(CNRS Grenoble)	Stirling W.G.	
Desre P.	(Univ. of Grenoble)	Suck J.-B.	
Dianoux J.A.		Volino F.	(CNRS Grenoble)
Dupuy J.	(Univ. of Lyon)	Wright A.F.	

General summary

The diffraction and inelastic neutron scattering experiments performed on liquids and amorphous systems this year covered all the fields included in this College. No experiments were made on gases. The general trend towards more investigations of amorphous materials, mentioned last year for the first time, continued this year. Nearly a third of the experiments proposed dealt with amorphous samples.

Of the diffractometers used by the College, D4 had the heaviest overload : about three times more time was requested for experiments than was available for allocating in spite of the fact that exceptionally 210 days were given to the user programme. Several possibilities to change this unsatisfactory situation are under discussion at the moment. A similar problem arose for experiments requesting the small angle scattering facility D11. For inelastic neutron scattering experiments the time of flight spectrometers IN4 and IN5, and especially the new cold neutron triple axis spectrometer IN12, were heavily overloaded. As neutron scattering experiments on disordered systems in most cases have to be absolute measurements with very good statistics to enable interpretation of the results, i.e. long measuring times are needed, College 6 especially suffers from short time allocations on these instruments. This explains the large number of continuation and resubmitted proposals. About 60 experiments were carried out this year.

In April 1979, 33 proposals were discussed by the Subcommittee of the Scientific Council of which 20 proposals were continuations or resubmissions. For 28 of these proposals time was allocated. For October 1979 the corresponding numbers are 38, 23 and 31. A serious problem arises from the loss of several college members, who have left the Institute, which puts a heavy load of local contact duties on some of the remaining scientists.

Scientific trends in 1979

Quantum liquids

Zero-sound excitations have been observed at 20 mK in liquid ^3He using the t-o-f spectrometer IN5. The frequencies of these excitations are in good agreement with the results obtained at ANL. For the first time the finite line width of these excitations could be measured.

Using the new cold neutron triple axis spectrometer IN12 the roton ("Landau") parameters of ^4He have been redetermined at 50 mK. Due to the good resolution of the instrument the Landau parameters could be determined with better accuracy than was previously possible.

Measurements of adsorbed ^4He on the surface of exfoliated graphite showed a very dense solid first layer and a less dense solid second layer at 600 mK. From the (10)-reflection of the triangular structure a nearest neighbour distance of 3.54 Å was found in the second layer. No nucleation of ^4He on graphite into the bcc-phase could be detected even if bulk ^4He has a bcc-lattice under the same external conditions. In the dense liquid above the nucleated ^4He layers the surface roton was studied in inelastic neutron scattering experiments.

Monatomic liquids

The dispersion of collection excitations in liquid lead near its triple point has been determined for momentum transfers between 0.4 and 1.2 Å⁻¹. For higher momentum transfers ($Q > 0.6 Q_{\text{Peak}}$) no peaks at finite energy transfers could be separated from the quasielastic scattering.

The investigation of the structure factor of fluid Rb at temperatures up to the critical point was completed this year.

Binary alloys

The temperature dependence of the short range order in LiPb and LiMg was studied. A strong decrease of the short range order in LiPb and a weaker effect in LiMg with increasing temperature was found.

For the first time the temperature dependence of the dynamical structure factor $S_{cc}(Q, \omega)$ related to the concentration fluctuations was measured. The scattering law of LiPb shows a very strong broadening with temperature indicating a fast decay of the concentration fluctuations with increasing temperature.

Molecular liquids

DCI was studied as a continuation of the investigations of simple molecular liquids. The programme on the determination of the partial structure factors of water was continued. The inelasticity corrections cause major problems for these experiments. In the investigations of more complicated molecular liquids the partial structure factors of methylene chloride were determined by systematic isotopic substitution and combination of neutron and X-ray diffraction results.

Molten salts

A very drastic change of the static structure factor of K was found after the addition of 10 % KCl to pure K. These studies will be continued during 1980.

Aqueous solutions

The extensive programme on the investigation of the structure and dynamics of aqueous solutions has continued. The partial structure factors of the Cl-ions in NiCl_2 and in CaCl_2 dissolved in D_2O and the hydration shell around the Li-ion in LiCl solutions were determined. For NiCl_2 the pressure dependence of the static structure was also studied. It was found that the hydration shell was unaffected by pressures up to 1.5 K bars. Using the back-scattering spectrometer IN10 a third diffusion coefficient intermediate between that of the hydrated cation (known from tracer experiments) and that of free water could be determined in concentrated NiCl_2 solutions. This diffusion coefficient was attributed to the water in a second hydration shell around the Ni-ion. For LiCl no such second hydration shell could be found.

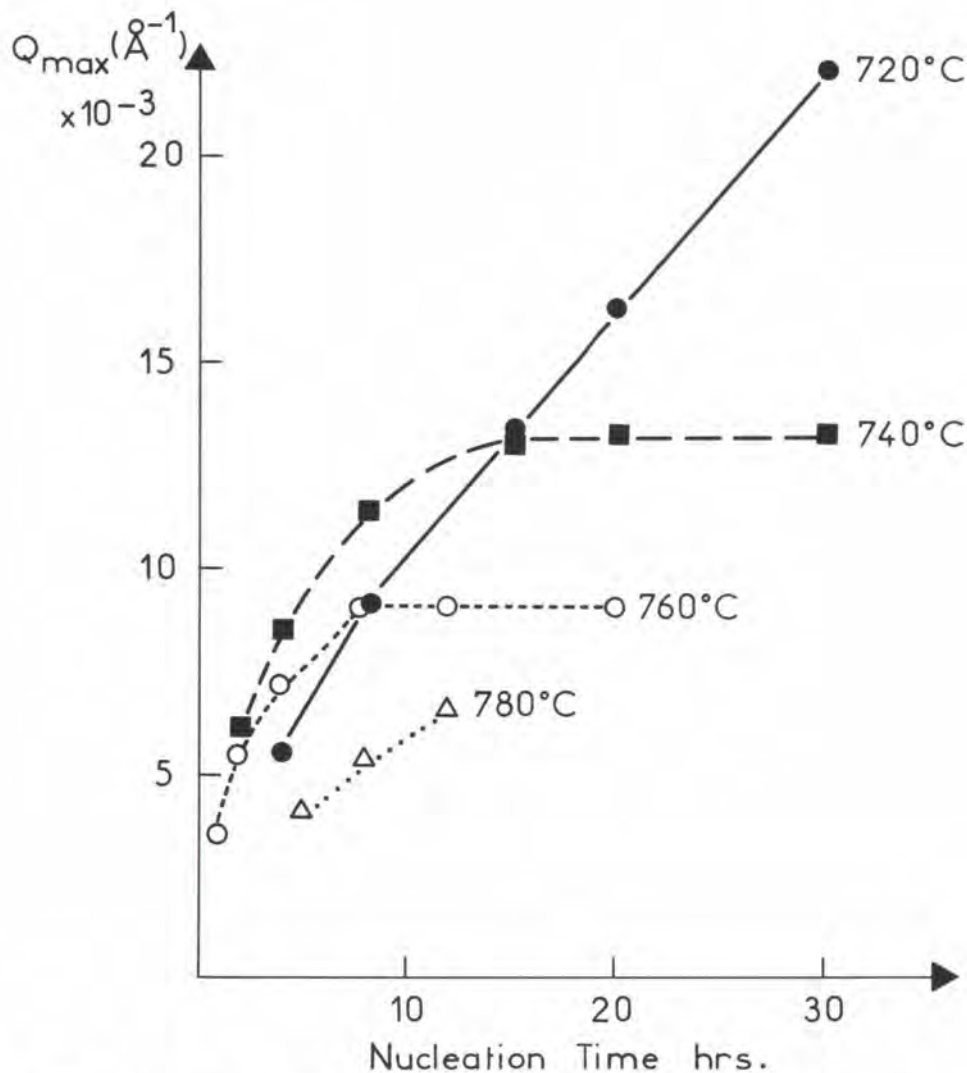


Fig. 13 : Study of nucleation process in glasses near the glass transition temperature. The figure shows the variation of the interparticle interference peak. Maximum (Q_{max}) with nucleation conditions. Interparticle distance (\AA) $\sim 2\pi/Q_{max}$. Crystallisation = 1 hr at 835°C.

Amorphous systems

The dependence of the atomic structure of amorphous Selenium on the thermal history of the sample was studied with good accuracy. A tendency towards stronger ordering could be detected on ageing of the sample.

The composition dependence of the structure factor, the partial structure factors, and especially the Fe-Fe correlation function in amorphous FeB was studied for Fe-concentrations between 18 and 22 at. %. No change of the Fe-Fe correlation function with concentration could be detected.

The extensive programme on the investigation of nucleation processes in glasses near the glass transition temperature was continued. Some of the results were : unexpected long times, until saturation of nucleation was achieved (see Fig. 13), and linear dependence of the growth rate on the interparticle distance at high nucleation densities.

For the first time the scattering law of an amorphous metal ($\text{Cu}_{46}\text{Zr}_{54}$) was determined. Compared with the corresponding polycrystalline sample a strong intensity increase at low frequencies could be detected in the scattering law (see Fig. 14). As a consequence of these low lying modes the generalized frequency distribution of the amorphous metal had a slope $\sim \omega^{3/4}$ for energies between 4.7 and 7 meV, whereas a Debye behaviour was found for the polycrystalline sample in this energy region.

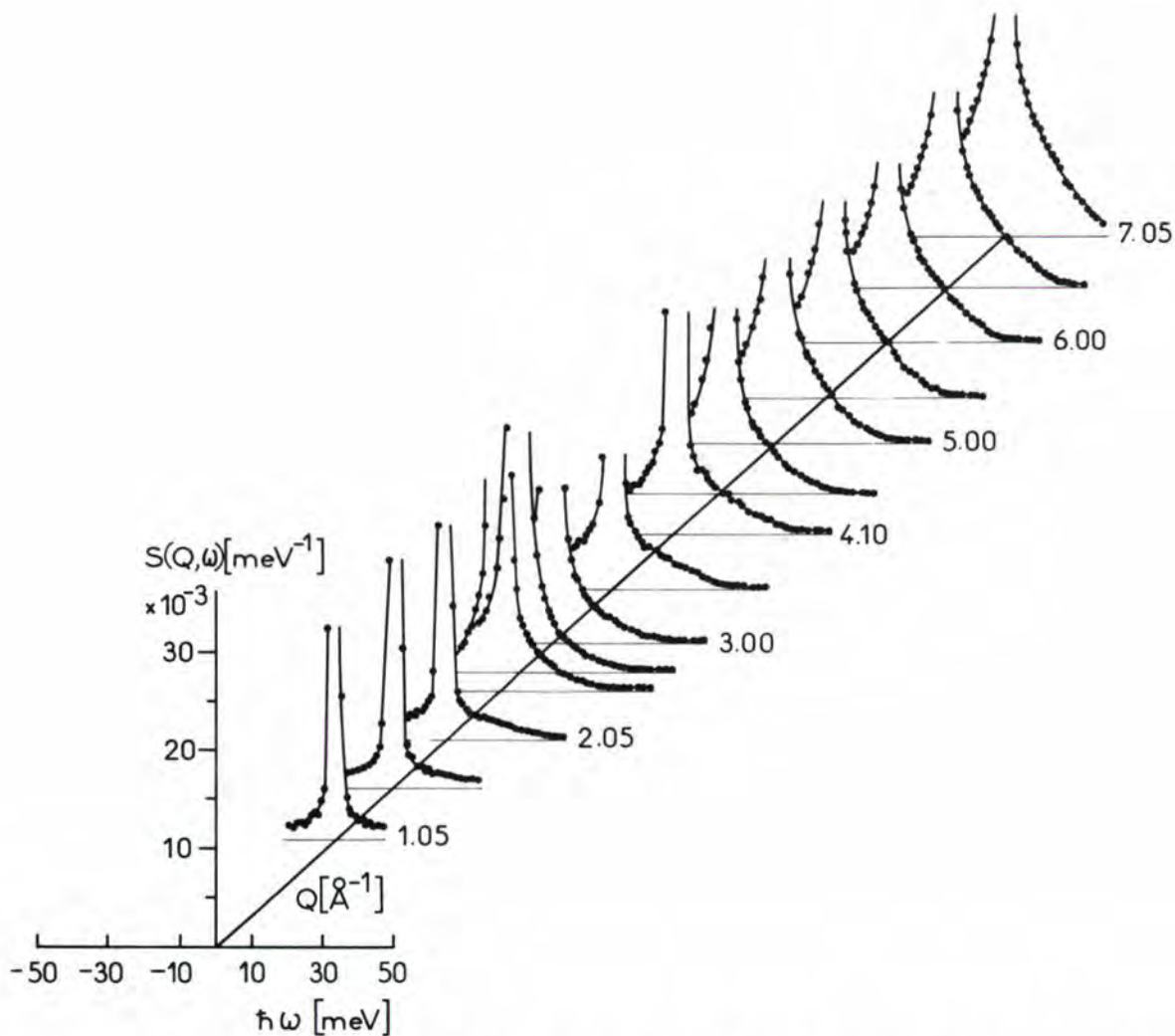


Fig. 14 : The symmetrized scattering law of the amorphous metal $\text{Cu}_{.46}\text{Zr}_{.54}$ measured at room temperature with IN4. The elastic line is not shown in the figure.

Liquid crystals

The average self-diffusion coefficients have been measured in the smectic A, nematic and isotropic phases of TBBA. The results could be satisfactorily described by a simple model for self-diffusion in the smectic A and the nematic mesophases.

A self consistent analysis of NMR, spin echo, and quasielastic neutron scattering measurements of translational diffusion in the smectic A and nematic mesophases of EABAC was completed. The structure of the smectic A and B mesophases of IBPBAC could be determined using a special new furnace. The intensities were used to refine rotational and translational order parameters.

Seminars and workshops

Several seminars of a general type and some special seminars for College 6 dealt with subjects covered by this college.

In October 1979, a workshop on "Neutron Scattering from Amorphous Metals" was held at the ILL. This brought together for the first time many of the groups working in this new field (more than 60 participants from 5 countries). Atomic structure, magnetic structure, atomic dynamics and nucleation processes were discussed in 19 papers presented at this meeting.

Secretary : Jens-Boie SUCK

College 7 Imperfections

Members of the college

Anders R.		Just W.	
Bletry J.		Kiese G.	(Univ. of Marburg)
Buttler W.	(Univ. of Marburg)	Mezei F.	
Cenedese P.	(C.T.T.)	Murani A.P.	
Dorner B.		Roth M.	
Escribe C.		Schaerpf O.	
Freund A.		Scheuer H.	
Goeltz G.		Stirling W.	
Heidemann A.		Suck J.-B.	
Heitjans P.	(Univ. of Marburg)	Wright A.	
Hewat A.		Zeyen C.	
Jahnel F.	(T.U. Munich)	Ziebeck K.	
Jenkin G.			

General summary

As in the past the activities of the Imperfections College ranged over a wide variety of different topics. Subjects recently introduced such as spin glasses and superionic conductors have been growing fast. Several groups were engaged in studying rather complicated magnetic problems, for example, the study of spin correlations in amorphous materials using neutron polarization analysis on D5. This actually created a problem regarding available beam time on this machine, which this year was most heavily demanded in our college and at the ILL as a whole. It is hoped that with the development of supermirrors, which is making fast progress, other machines (f. ex. D7) will soon be equipped with polarization analysis facilities. Another problem for College 7 has been to obtain sufficient beam time on the small angle machine D11. Direct competition with the biology and polymer sectors slows down the normal development of such important subjects as metallurgy in direct connection with practical technological problems such as precipitates and creep deformation in modern alloys.

Nearly all the diffraction, triple axis and TOF instruments of the house are used by College 7 experiments as well as a few special set-ups (altogether 19 ! different instruments).

The number of proposed experiments in the April meeting was 71, and 47 were given beam time. At the October meeting 46 experiments out of 70 were given beam time.

Reports on the activities of the special beam instruments S30 (concentration profiles of light isotopes by (n,α) and (n,p) nuclear reactions) and S44 (channelling and blocking experiments) were given at the April meeting. For the October Subcommittee meeting a new member in the field of superionic conductors was appointed which was of great help given the increasing demand in this field.

Scientific trends and highlights in 1979

The scope of College 7 activities being extremely broad we can only pick out a few main subjects where important contributions were made this year.

Spin glasses

Direct measurements of the time dependent spin correlation function $S(K,t)$ were performed for a Cu-Mn spin glass over nearly 3 decades of time in the range $10^{-12} < t < 10^{-9}$ sec. using, for the first time, a combination of neutron spin echo and polarization analysis techniques. The results showed most clearly the particular dynamics of spin glasses, namely a behaviour which can be best described by a broad spectrum of relaxation times evolving continuously with decreasing temperature, and extending to very long times at temperatures around and below the spin glass freezing temperature.

In the one dimensional spin glass FeMgBO_4 it was shown for the first time that neutron diffraction data, taken over a large Q-range, allow an extensive study of spin pair correlation in an insulating spin glass. Two distinct regimes were defined. Below T_f the spin correlations showed saturation reflecting the spin glass state. Above T_f there was a gradual decrease of the correlations with increasing temperature typical for 1D-short range order. Another important result was the first experimental evidence of a helical ground state in one dimensional systems.

In CuMn the atomic correlations were separated from the magnetic ones using polarization analysis on D5. A crossover from a short range order regime at low Mn content to clustering at above 50 % Mn was observed. The magnetic scattering was of particular interest because of the spin glass behaviour of the magnetic moments in CuMn alloys. The magnetic correlations were found to be very tenacious, persisting to well above room temperature. It is thus not valid to simply raise the temperature to room temperature to attempt a separation of atomic and magnetic scattering, underlining the unique value of polarization analysis in the study of disordered magnetic materials.

Magnetic impurities

Dynamics of Fe impurities in antiferromagnetic Cr were isolated for the first time. Using D7, quasi-elastic scattering was observed and interpreted as the paramagnetic-like relaxation of clusters of Fe impurities which appeared to be only weakly coupled to the antiferromagnetic spin density wave. This surprising observation was in agreement with the observation of spin glass like behaviour coexisting with antiferromagnetism as deduced from bulk susceptibility measurements and confirmed by the theoretical arguments of Friedel and Hedman.

Kondo / Intermediate Valence systems

The dynamical properties of rare earth ions involving either a stable 4f-configuration, a Kondo-type groundstate or a mixed valence state were investigated, by measuring the dynamical susceptibilities of Ce-ions diluted in the non-magnetic matrixes LaAl_2 , YAl_2 , ScAl_2 with inelastic magnetic neutron scattering over a wide temperature and concentration range. Mainly the low temperature properties revealed drastic differences for the three systems investigated. (Korringa shape, residual quasi-elastic linewidth, crystal field splitting).

Correlated with an increasing lattice pressure, the zero temperature spin fluctuations of the Ce-moments increased when using LaAl_2 , YAl_2 and ScAl_2 as matrixes. To explain the anomaly in the crystal field splitting, a coupling of the electronic system to the phonon system was taken into account.

In-beam NMR spectroscopy

A systematic study of point defects induced by the recoil of neutron activated ^{20}F in the alkaline earth fluorides MgF_2 through BaF_2 was carried out. From the ^{20}F NMR spectra at different temperatures below RT, annealing steps and the corresponding activation enthalpies were obtained. As part of a continued programme on the dynamic and structural properties of Li alloys the ^8Li -spin relaxation by conduction electrons in liquid Li-Na, Li-Mg and Li-Pb was studied over nearly the full concentration ranges. The results reflected a pronounced tendency to compound formation in the case of Li-Pb. In the intercalation compound LiC_6 in-beam measurements on ^8Li (jointly with conventional NMR on ^7Li) gave first results on the conduction electron and diffusion induced spin-lattice relaxation. (Heidelberg, now Marburg group).

Diffusion in bulk materials

The atomic jump processes involved in self-diffusion in high-purity sodium single crystals were studied by means of quasi-elastic neutron scattering using the IN10 backscattering spectrometer. In the temperature range between 323 K and the melting temperature (370.9 K) the dependence of the quasielastic linewidth on the momentum transfer was measured in the major crystallographic and in various non-symmetry directions. The results were compared with theoretical curves calculated for various mono- and divacancy mechanisms of diffusion including nearest- and non-nearest-neighbour jumps of individual vacancies. Spatial and temporal correlation effects of the atomic jumps were fully incorporated into the calculations.

The investigation of thermal behaviour of implanted boron distributions in silicon (10^{16} cm^{-2} , 120 keV) was one focal point of the measurements of both (n, α)-instruments for depth profiling (S30) and channelling-blocking measurements (S44).

A lot of effort both with experiments and Monte-Carlo simulations has also been put into the understanding of the 50 K phase transition in the PdD_x system.

Secretary : C. ZEYEN

College 8 Biology

Members of the college

AT ILL

Bentley G.
 Chauvin C.
 Chenavas P.
 Cuillel M.
 Devaux C.
 Dianoux J.
 Haas J.
 Ibel K.
 Jacrot B.
 Lehmann M.
 Lewit-Bentley A.
 Mason S.
 May R.
 Roth M.
 Timmins P.
 Wilson S.
 Zaccai G.

AT EMBL

Berthet C.
 Boras F.
 Cusack S.
 Jesior J.C.
 Miller A.
 Perkins S.
 Schoot B.
 Simpson K.
 Tocchetti D.
 Zulauf M.

VISITING SCIENTISTS

Engelman D.M. (Yale University, New Haven, USA)
 Li Zong Gi (Institute of Biochemistry, Shanghai, China)
 Rogan P.K. (Johns Hopkins University, Baltimore, USA)

General summary

The college's scientific activity is the investigation with neutrons of substances which are relevant to life sciences. The main interest is the determination of the structure of biological molecules and molecular complexes, with emphasis on the low resolution analysis of two-component structures by low angle solution scattering, where the use of heavy and light water allows a wide exploitation of the contrast variation method. Diffraction studies on partially ordered systems and low and high resolution single crystal studies are also of importance. The scope of the college includes studies on the dynamics of biological systems.

TABLE XIX
PRINCIPAL INSTRUMENT USAGE BY COLLEGE 8 :
NUMBER OF SUBMITTED AND ACCEPTED PROPOSALS (OCTOBER 1979)

	D 11	D 17	D 16	D 1B	IN 5	IN 10	IN 11
submitted	30	8	4	1	2	2	2
accepted	21	4	3	0	1	1	1

Scientific trends and highlights of 1979

Low angle solution scattering

Quantitatively, the largest part of the work was with low angle solution scattering : the number of accepted biological projects on the neutron small angle camera D11 was 20, with a mean allocation of 2 days beam time for each proposal in a six month period. The disproportion between requested time and time available for allocation was striking.

The importance of neutron small angle scattering on biological systems traditionally relies on the differences in scattering length densities of proteins on one hand and nucleic acids or lipids on the other. The variation of the scattering length density of mixtures of heavy and light water enables one to match out one or the other component in composite systems (contrast variation). This permits the investigation of their relative position as well as the structural features of one component. A typical example is the study of the interaction of the Lac-repressor with DNA. The arrangement of nucleic acids and proteins in viruses remains an attractive application of neutron small angle scattering ; very useful results were obtained recently with the study of the Semliki Forest Virus. Conformational changes and aggregations of enzymes which interact with tRNA, such as aminoacyl tRNA synthetases, can be studied by matching out the nucleic acid. Successful experiments have been performed on isolated walls of **Staphylococcus aureus** which enabled the location of one of its components, teichoic acid.

Increased effort has been spent on studies of composite systems which have been reconstituted using in vivo deuterated components. Effectively, more than half of the time on D11 is now spent on experiments of this kind. An extensive program has been started, in collaboration with the Max-Planck-Institut für Molekulare Genetik in Berlin and with the European Molecular Biology Laboratories in Hamburg and Grenoble, for the measurement of the relative distances of the proteins within the multi-protein complex of the 50 S subunit of the ribosome. Other remarkable examples are the determinations of the relative arrangements of subunits in RNA polymerase and in BF 1 ATPase. Preliminary experiments were carried out to locate the different histones in the chromatin subunit, the nucleosome. The sensitivity of the interference function, which is due to two deuterated subunits, has led to the investigation of conformational changes in RNA polymerase due to the binding of the apoenzyme with the σ -factor. The study of the low resolution structure of the aggregate which consists of two ribosomal elongation factors will take advantage of the possibility to specifically deuterate one of the proteins. The reconstitution of high molecular weight chromatin with deuterated histone H 1 will help to elucidate the role of this histone in the formation of higher order structures.

The use of the small angle camera D 11 at the smallest angles available at this instrument has been neglected somewhat in the field of biological structures, as compared with polymer science and metallurgy. Initial experiments aiming at the ultrastructure of chromatin in metaphase chromosomes showed the feasibility of neutron diffraction.

Low resolution crystallography

Low resolution crystallography was done on the small angle camera D 17, on single crystals of nucleosome core particles and virus single crystals. The neutron crystallography of nucleosomes can be regarded as a highlight, because it allows one to visualize the conformation of the DNA around the histone core within a three-dimensional ordered array (see Fig. 15).

The higher relative resolution which may be achieved with D 17 allowed the location of cholesterol, choline, lipids and proteins in the sciatic nerve membrane. For this, deuterated components were incorporated into the myelin via the diet of laboratory rats. The position of the deuterium in the membranes was obtained by a Fourier difference analysis of the labelled and unlabelled samples.

Medium resolution crystallography

The work on the Single Counter Diffractometer D 16 using cold neutrons was directed to the elucidation of membranes and membrane-protein systems. A series of experiments allowed us to determine the conformation of several selectively deuterated phospholipids and their segmental disorder along the bilayer normal. Very useful results have been obtained with the purple

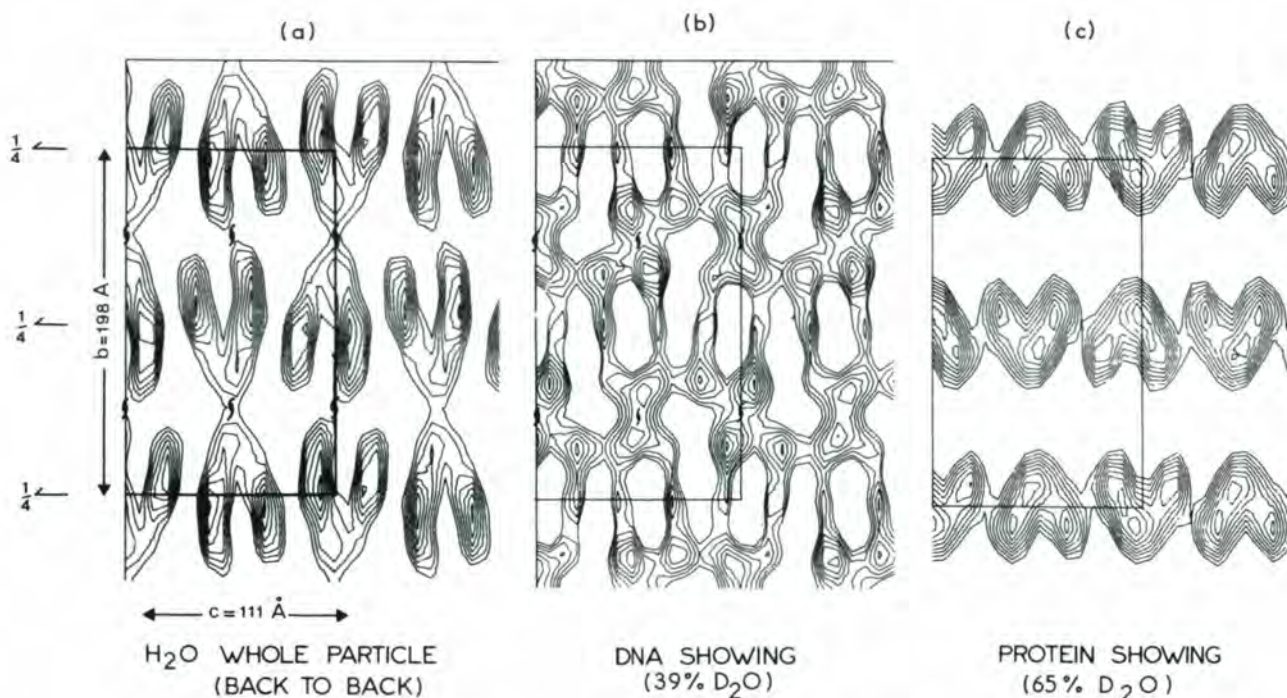


Fig. 15 : Single crystal diffraction study of the nucleosome core particle using contrast variation (Bentley G.A., Finch J.T., Lewit-Bentley A., Timmins P.A.).

The nucleosome core particle is the basic repeat unit of chromatin, consisting of roughly equal parts of protein and DNA.

Variation of H_2O/D_2O contrast, used frequently in solution scattering has now been applied to single crystal diffraction at low resolution.

Data have been collected on D17, which was adapted for crystallography from crystals soaked in :

- H_2O buffer (a)
- 39 % D_2O - where DNA dominates the scattering (b)
- 65 % D_2O - where protein dominates the scattering (c)

In the case of centrosymmetric reflections, the structure factor is a linear function of contrast. Thus, if we can establish phases of centrosymmetric reflections in one contrast, we can derive then for any other contrast.

Using this principle, projection maps were calculated for the three contrasts. Phases used were obtained from previous X-ray and E.M. work, but the neutron results showed that one of these was incorrect.

The maps shown were calculated with the final set : the series is consistent and confirms the model of a protein core with a superhelix of DNA wound around it.

Fig. 16 : Model of Alfalfa mosaic virus suggested by neutron scattering studies. The RNA loosely packs the shaded area.

membrane of **Halobacterium halobium**. Neutron studies have shown that the proton pathway does not have a bulk water pocket associated with it. Test experiments on samples which contained one single species of deuterated amino acids showed that such labels can be localized very well in the structure. This should be of assistance in unambiguously determining the high resolution structure of the purple membrane protein with its known primary structure.

High resolution crystallography

Work continued to determine the structure of the lysozyme molecule and surrounding water. The 1.4 Å data on a partially deuterated crystal were supplemented by measurements of the reflections to 1.8 Å spacing on an undeuterated crystal.

Molecular dynamics

Inelastic experiments were performed using the Spin Echo Instrument IN 11. They were aimed at the observation of low frequency collective motions in large biological structures.

These fundamental modes were expected to lie in the range 10^6 to 10^9 Hz. Inelastic scattering was clearly observable in this domain with haemoglobin and at present, efforts are directed towards the distinction between translational diffusion, rotational diffusion and the collective internal motions ("breathing" modes).

College Secretary : K. IBEL

College 9 Chemistry

Members of the college

I. INTERNALS MEMBERS

Aime J.P.
Aldebert P.
Beaufils J.-P.
Bomchil G.
Chenevas P.
Chieux P.
Croset B.
Dianoux J.
Duplessix P.
Ghosh R.
Hayter J.
Harris N.
Hässlin H.
Ibel K.
Jacrot B.
Jenkin G.
Jobic H.
Joffrin J.
Lauter H.-J.
Lehmann M.
Leslie M.
Marti C.
Mason S.
Pautrot P.
Poinson C.
Soubeyroux J.L.
Tabony P.
Tomkinson J.
White J.
Writhe A.

II. EXTERNAL MEMBERS

Heitjans (Universität Marburg)
Thorel P. (CNRS)
Volino F. (CNRS)

General summary

The principle feature of college 9 activity is the study of complex chemical systems such as polymers, multi-component systems (e.g. micelles), intercalation compounds and surfaces. Thus long preliminary work is often entailed before any meaningful results can be obtained - determining to which part of the system the result appertains or separating several contributions to the same data.

This explains why the fields of interest vary constantly, as the chemists explore new areas. This continual evolution can be seen by changes in the keyword system. This year there were two important modifications. Surface structure studies are now in college 9 (previously in 5) and polymer studies have been subdivided as follows :

- 1) Homogenous systems (dilute and concentrated solutions, gels, amorphous solids)
- 2) Polyelectrolytes
- 3) Semi-crystalline solids
- 4) Deformed systems (stretched or compressed polymers - stretched or swollen networks)
- 5) Heterophase systems (polymer blends, block copolymers, ionomers)

TABLE X
PRINCIPLE INSTRUMENT USAGE BY COLLEGE 9

Instrument	Time Requested (days)	Time Allocated (days)	Number of Experiments
D11	137	60	43
D17	128	90	46
IN1	151	88	15
IN4	212	92	17
IN5	164	89	18
IN10	152	115	19
IN11	146	67	8

A comparison of the table with last years figures (Annual Report 1978) shows a considerable increase in the demand for D11 and D17 time. This is due to studies on micelles as well as on polymers. Similarly the demand for IN1 (Be filter) has noticeably increased. It is used to study complex systems (e.g. catalysts) rather than vibrations themselves.

The demand for quasi-elastic instruments has remained constant, due in part to IN11 being fully operational, and used for polymer and micelle work. Quasi-elastic instruments are mainly used for tunnelling and physisorption studies.

Scientific trends and highlights of 1979

Polymers

The work in this field is the most typically "chemical" of the college : Small angle scattering experiments are performed on a great variety of samples differing by the chemical conditions of the their preparation. This is because conformation is determined by a number of interactions and only varying the " physical parameters " (q.T...) is not enough to separate their contributions. As a consequence the research programmes are spread over several years. However, one can see that the progress made in mastering selective isotopic substitution permits improvements in the separation of intra - and inter - molecular interactions.

Micelles

To study the properties of each micelle separately, it is necessary to remove the contributions from intermicellar interactions. These interactions are always important because the concentration cannot be set lower than the critical micellar concentration, but, being essentially of an electrostatic nature involving well defined charges, they can be calculated. An analytical expression of the effect of these interactions has been obtained and the first experiments performed on well known systems give hope for a decisive progress thereby.

Spectroscopy

There have been important developments in tunnelling spectroscopy this year. For the first time the isotopic effect on tunnelling transitions was observed (CD_4). Several studies on the influence of pressure on tunnelling were carried out. The theory was confirmed in the cases of CD_4 and of

sodium acetate under pressure. It appears, however, that the shape of hexadiyne molecules creates special interactions, where the simple theory does not work. In addition it has been observed with hexadiyne that tunnelling can still be observed at 50°K under a pressure of 4.6 k Bars, whereas it has completely disappeared for the same temperature at atmospheric pressure.

Physisorption

It is now clear that the determination of bidimensional structures by differential diffraction (difference between diffraction patterns with and without adsorbate) is an indispensable complement to the measurement of isotherms to establish phase diagrams. This method allows not only a characterisation of phases but also a precise measurement of transition points and the determination of the nature of the transition.

This method has now been extended to more complex adsorbed molecules, whose position with respect to the surface can be determined, and to adsorbents other than graphite, close to heterogeneous catalysts. It appears to be an irreplaceable tool for the investigation of oxide surfaces, which are reduced under vacuum in electron diffraction measurements, and thus cannot be studied by the latter method.

The study of rare gases on graphite however is still continuing because some features appeared in the phase diagrams which can only be explained by the presence of defects, and they have yet to be identified.

Multilayer adsorption and the competition between adsorption and tridimensional condensation is of increasing interest. The variety of adsorbates being investigated is very large, from superfluid He to water.

The movements of translation, rotation and vibration are still being studied by all spectroscopy methods, including tunnelling.

Chemisorption and catalysis

The activity in this field is growing, the main results being obtained for the moment by vibration spectroscopy. To treat the data each vibration has to be assigned to a definite mode. This is difficult for complex molecules chemisorbed or bound in coordination compounds which are liable to act in homogeneous catalysis. One way of surmounting this difficulty is to compare many species showing similarities. However, in the case of neutrons it is possible to fit a theoretical spectrum calculated from a force field to the experimental spectrum. It is then possible to study systems close to actual catalytic ones such as benzene on nickel already covered with hydrogen.

Intercalation compounds

Work continues actively in this area, in structural studies (college 5) as well as in spectroscopic aspects (diffusion, rotation, tunnelling). It has proved very fruitful to control electrochemically the preparation of such compounds, allowing the observation of phases which, otherwise, would be missed. This opens the path to many other studies where this technique can be used.

Seminars

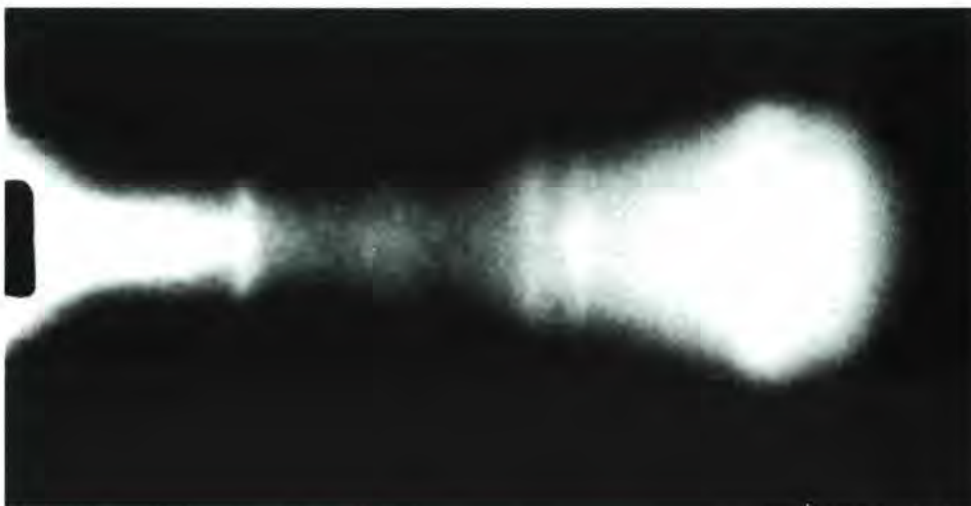
Professor H. Tom Diecke (Hamburg) gave a lecture on coordination compounds in homogeneous catalysis. Doctor H. Knozinger (Munich) gave a lecture on the chemisorption properties of alumina. In addition the college had several meetings devoted to the presentation of recent work by its members.

Secretary : J.P. BEAUFILS

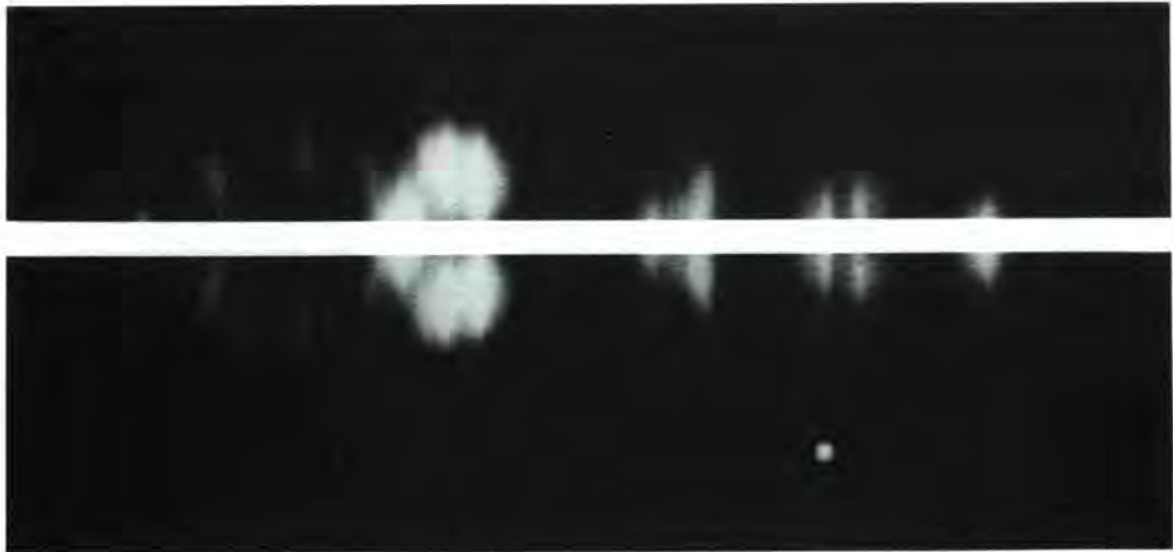
European molecular biology laboratory, Grenoble

The EMBL Outstation is now established as a compact laboratory specialising in structural molecular biology and using techniques which are grouped around neutron scattering. The ILL neutron facilities are, of course, central to the laboratory but ancillary techniques such as X-ray scattering, light scattering, electron microscopy and image processing, spectrophotometry as well as fairly comprehensive biochemistry facilities are also available. This means that the laboratory is able to be centred on biological problems and the harnessing of physical and chemical methods for biological research. This attempt to integrate neutron methods into the molecular biologists' armoury of techniques allows neutrons to make a more effective impact on biology than a unilateral concentration on neutron methods alone. The equipment at the Outstation is such that it could be readily adapted to almost any type of research activity in molecular biology based on neutron methods.

The research programme on connective tissue has resulted in a better established model for the molecular arrangement in collagen. *Nature* **282**, 878 (1979). This model is based on the medium-angle X-ray diffraction pattern. Since this pattern was first published, some 15 different models have been proposed. All of these models relied only on measurements of the R-values of the X-ray reflections. The new model in which the collagen molecules are quasi-hexagonally packed and inclined to the fibril axis, not only predicts the R-values of the reflections better than the other models, but also accounts for their Z-values and intensities. A calculated I (R, Z) map has been photowritten by the Optronix instrument and compares well with the observed new-equatorial X-ray pattern. Neutron scattering and X-ray scattering have been used to investigate how other molecular species interact with collagen to produce the variety of connective tissues. The location of inorganic apatite crystals in developing bone-like tissues was determined in this way (*J. Mol. Biol.* **134**, 430 (1979)). Now the more difficult task of investigating collagen-proteoglycan interactions in tissues such as cartilage and intervertebral disc is underway. The X-ray data from both of these tissues has been greatly improved even in the last year by both conventional X-ray methods and by synchrotron radiation at EMBL Hamburg. Interpretation of the results is being



Observed medium-angle X-ray diffraction pattern of native tendon.



X-ray diffraction pattern calculated from the quasi-hexagonal model of collagen and photowritten on the Optronix P1001.

carried out. More recondite tissues, such as dog-fish egg-case, which illustrate the versatility of collagen are being studied. A neutron study with Helen Muir et al (Kennedy Inst., London) on protein-polysaccharide interactions is also underway.

As a complement to these structural studies on connective tissues, Brillouin scattering has yielded new values for the elastic modulus of collagen and bone. For dry collagen a 3-D analysis of the phonons meant that values for the five elastic constants could be determined. Apart from the longitudinal modulus, this is the first time that these values have been measured and it is now possible to insert experimentally determined parameters into the formulae devised by materials scientists for the mechanism whereby apatite crystals stiffen collagen to form bone. Since our first publication on Brillouin scattering by biological materials several other groups have started similar studies on nucleic acids and other biomaterials. (*J.Mol.Biol.* **135**, 39, (1979).

As foreseen in an earlier Annual Report the in-house research topics are diversifying. The installation of the deuteration laboratory was a step in this direction. A considerable Outstation effort goes into the multi-group project on the molecular arrangement in the 50 S ribosome subunits. Studies on chromatin continue and a new involvement has developed in studies on the membranes ATP-ase F1 complex. Some 8 groups are now being supplied with deuterated cell fragments or biochemicals. An NMR method is being developed to assay the extent to which cells and macromolecules are deuterated.

Research also continues on the amino-acid sequence of the rod portion of the myosin molecule. Since several myosin species co-exist in the same muscle fibre (as demonstrated by immuno-chemical techniques) purification of these species would seem advisable before sequence work is carried out.

Isoelectric focussing in granulated gels shows several bands at the heavy chain position. This technique is now being used routinely in order to accumulate material from these bands.

Fragmentation of myosin heavy chain by either chemical or biochemical methods gives peptides of very similar properties. In particular those from the rod region are highly insoluble and show a strong tendency to aggregation.

After many trial experiments on these peptides, using all the known conventional methods, isoelectric focussing appears to be by far the most promising one.

At present optimising conditions are being sought for the separation of complex mixtures of peptides from the rod region of myosin.

A joint project with J. Mellema et al (Leiden) on the structure of the alfalfa mosaic virus has been particularly successful. The bottom component of this virus has the shape of a truncated cylinder with hemispherical ends (see Fig. 16). It is 560 Å long and 180 Å in diameter. The capsid is an open hexagonal net of protein but nothing was known about the RNA position and it was this which first stimulated the neutron work. This firmly established that the RNA is in the interior of the particle where it is rather loosely packed. X-ray and neutron studies on an icosahedral particle formed by the capsid protein alone has confirmed the icosahedral symmetry and the high quality diffraction data has permitted the construction of models for both this particle and the bottom components of the virus. This model is being tested and refined by further studies designed to investigate the mode of RNA packing.

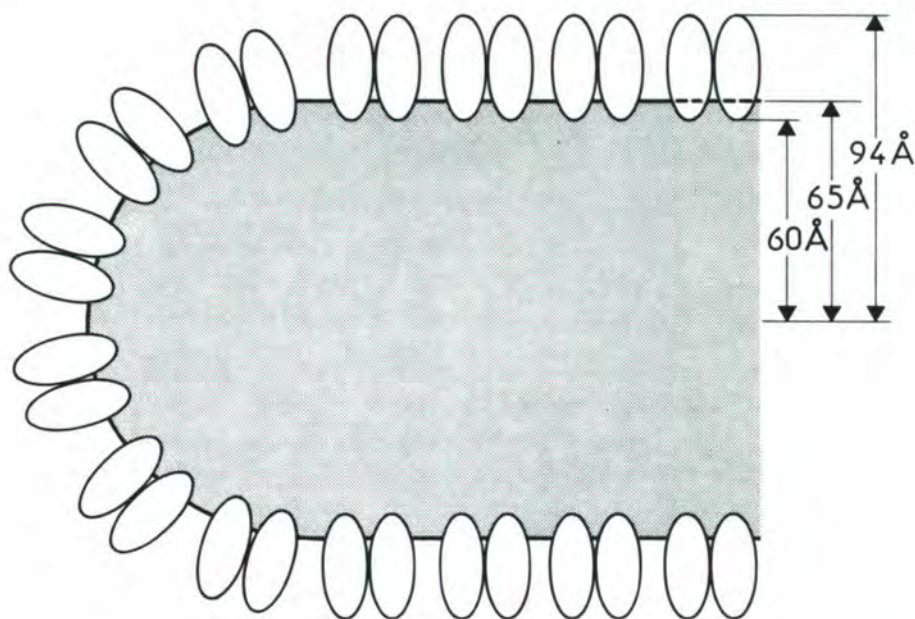


Fig. 16 : Model of Alfalfa mosaic virus suggested by neutron scattering studies. The RNA loosely packs the shaded area.

Another joint project which exploits the power of neutrons in investigating protein-nucleic acid interactions is with R. Lebermann et al (EMBL, Heidelberg) on the Elongation Factor, an important constituent in protein biosynthesis on the ribosome. EF-Tu has been examined by small-angle neutron scattering in solution and compared with the ternary complex EF-Tu-GTP-a.a.-tRNA. By the contrast variation technique a sensitive search can be made for conformational changes in either Tu or -tRNA during ternary complex function. This project is being extended to include studies on the interaction between the elongation factors Tu and Ts and the results should complement the results from the major ribosome project.

A new technique which has been introduced into the laboratory this year is photon correlation spectroscopy. This is being used in research on the structure of a membrane protein and on the kinetics of virus assembly. However a big attraction of the new equipment is that it can be used to monitor aggregation in preparations of macromolecules. This can be done extremely rapidly - in minutes or even seconds - and it may well become a routine preliminary of specimen checking before the more lengthy X-ray or neutron experiments on solutions of macromolecules.

There has been some demand from the ILL Biology Sub-Committee and from EMBL in-house projects for an X-ray solution camera. This is now under construction and should be available in Spring 1980.

We have enjoyed collaboration with at least a dozen ILL scientists, including the present Director, on our various projects and we hope that this collaboration will deepen when we are able to move to the new building on the ILL site in 1981. The new location will make it easier for visiting neutron users to take advantage of the EMBL facilities.

In summary there is an active research program here using neutrons and related techniques in a range of topics in structural molecular biology of proteins, protein-nucleic acid interactions and protein-polysaccharide interactions. A new project with H. Weiss et al. (EMBL, Heidelberg) on a membrane protein will extend this to protein-lipid interactions. All the facilities here are available to ILL scheduled users.

A. MILLER

Experimenters came to the ILL from these research centres or universities in 1979



4

Sections with special tasks

Project office

1979, with the first projects connected with the modernisation programme, has confirmed the essential role played by the Projects Office in :

- planning of requirements as regards staff ;
- co-ordination and follow-up of work under the investment budget and the associated financial organisation ;
- contribution to the establishment of preliminary projects for new instruments or for major modifications (preliminary studies, layout plans, estimates, and forward planning).

This task requires permanent contact with the different technical and scientific support groups at the ILL. For this reason the number of staff has been increased by two additional engineers with a good knowledge of the scientific aspects of the work in progress or at the planning stage.

Computerisation of the technical and financial management of the projects under study in the final months of the year should avoid any supplementary personnel whilst allowing still further progress towards a better distribution of the investment expenditure in the three countries.

The new instruments IN12 (on cold neutrons) and D18 (neutron interferometer) were put into operation in 1979. The Nicole replacement has been completed with the majority of instruments being connected to individual computers. PN1, IN4 and D7 are undergoing operational tests.

Considerable progress has been made on instruments under construction : new computer for D1B, D19, IN13, IN6, IN1B and IN8B, D4B, D13C etc. which are due to come into operation in 1980 or 1981 (IN1B, IN8B, D4B), and for the replacement of Carine with the purchase of five new computers.

Amongst new projects initiated in 1979, we may mention :

- major modification to instruments on beam tube H11 encompassing the future projects D20, D19, D1B ;
- major modification to D16 which will help somewhat to relieve the work-load on the small-angle scattering instruments ;
- general study of the possible new geometry of the reactor beam tube thimbles ;
- study of silicon or bismuth filters in order to improve the beams of the new instruments (IN1, PN8, beam tube H11) ;
- major modifications to D7 with polarisation analysis ;
- project for the new instruments PN8 for fission product analysis.

safety and health physics section

Monitoring of radioactivity around the facilities and nuisance measurements at places of work have clearly constituted the main work of the section. In cooperation with other groups at the Institut, the following measures have been undertaken :

- Preparation of a folder entitled " General Regulations on Safety and Radioprotection " containing the updated ILL regulations on pressure equipment, transport of dangerous materials, supply of radioactive sources, etc.
- Definition of methods and use of facilities to limit the activity of the radioactive effluents discharged into the river.

In addition the " special effluents " system shared by CENG and ILL, and used for this type of effluent, is now operational.
- Project to improve the radioactivity monitoring of the detritiation plant for heavy water.
- " Hot " changing rooms at the entrance to the reactor, permitting a stricter control of access to the restricted areas.
- Assistance with Safety analysis connected with modifications to the facilities, to experimental instruments under study, and to dangerous samples used at the ILL ; advice on the proposed equipment of the computer and biology buildings.

Other points to be noted :

A continuation of efforts to inform all staff on Safety problems, with the use of documentary films.

- A considerable increase in the number of dosimetry films supplied to visitors and Guest Scientists at ILL (approximately 1000 additional films).
- A considerable reduction in the integrated radiation dose for all staff during the annual reactor shutdown in October 1979. This result is particularly associated with the decontamination of the heat exchangers in the primary circuit undertaken last year.



The Director of the ILL Dr J.W. White (on the left) and the Head of the Reactor Department M.F. Franzetti making an inspection of the reactor pool during the October 1979 shutdown. Maintenance work can commence on this platform (normally submerged in the lightwater shielding) only a few days after shutting down the HFR and draining the water. Despite the close proximity to the reactor core (4.5 m) the radiation level is extremely low (10 - 15 mR/h).

5

**Technical
department**

Introduction

For the Technical Department, more than for other fields of activity at the ILL, 1979 has been a year of transition with the approach of the implementation of the modernisation programme.

For the section responsible for maintenance of the installations and fittings, a pooling of resources is necessary for two reasons : the general aging of the installations (on average 7 years old), which has become even more apparent with the increase in safety requirements, and the extension and rearrangement of the buildings and instruments in order to improve the conditions of "scientific life" at the ILL.

For the mechanical design and construction section, an increase in both the number of designers and draughtsmen and in the installation and testing teams must be such as to meet the needs for major modifications and improvements to the instruments themselves and their environment.

Mechanical construction and maintenance section

Organisation - Activities

The Technical Construction Section has two main fields of activity :

Design studies, relations with firms

The increased volume of design studies concerning modifications, additional equipment or new apparatus, has compelled us to resort to the increased use of outside personnel. We have been able to collect all our design personnel provisionally in the same place, which has improved and facilitated contact with the scientists, but the small area available limits efficiency and the extension of this kind of co-operation.

Assembly and testing

The activity can be broken down into the following areas :

- installation of apparatus on various sites ;
- maintenance ;
- management of stocks of spares ;
- inspections ;
- tests and measurements.

The current investment effort for the inspection and measurement group allows us to use very efficient equipment for measuring vibration phenomena and for the dimensional and positioning checks.

New instruments and projects

New instruments commissioned : D18, IN12.

New instruments awaiting completion : IN6, IN13, D10B, D19, S3, S21. It should be noted that the monochromator zones of these instruments have been completed.

New instruments under study : IN1B, IN8B, IN5B, new in-pile part of neutron guides H1 - H2.

Instruments which have undergone modifications or to which further equipment has been added :

- D7 - new chopper, modification of the monochromator zone ;
- D11 - new mobile support for the multi-detector ;
- IN1 - new analyser-detector shielding assembly ;
- D1B - new mobile outgoing beam-detector assembly ;
- D10 - lead shielding with mobile automatic sectors ;
- IN11 - new selector working under vacuum (5 % resolution).

Fields of activity

- Extension of the use of labyrinth frictionless seal systems ;
- Extension of the use of new modules with direct encoding for parts on air cushions for the 2θ and ω movements. This use is seen at its best with the appearance of the new flat goniometers able to accommodate large cryostats and electro-magnets ;
- Improvement of the environment of the shared neutron guides ; shutters, pumping facilities ;
- Amongst new techniques, improvement of support systems, and sealing of choppers and selectors, improvement of supports using inflatable skirt air cushions whose lifting height is under complete control ;
- As regards maintenance : maintenance of a stock of modular structural components, tables, goniometers and step motors.

Section for manufacturing, building and instrument maintenance

Manufacturing

The main mechanical engineering workshops (5 staff) and sheet-metal workshops (5 staff) permit the ILL, with its own facilities, to make a considerable part of the items required for experiments or for their infrastructure. 13,500 hours of work (i.e. approximately 75 % of time available) have enabled us to satisfy 475 recorded requests for work (210 for mechanical engineering, 265 for sheet-metal). The time taken for this work ranged from a few hours to approximately 700 hours for the biggest jobs. 4,650 hours (i.e. approximately 25 % of available time) have been devoted to small non-recorded jobs, for which there was no design, generally urgent and which represent the second function of the main workshops.

The percentage of time allocated to jobs is as follows : 79 % for experiments and their infrastructure, 10 % for work connected with the reactor, 11 % for all general needs. The experiment jobs are generally based on the designs of the Construction and Mechanical Maintenance Section for intervention work on the experimental instruments, and on the designs of the Fittings Section for the projects connected with the infrastructure of the instruments.

The most important jobs were :

- in mechanical engineering : $2 \pm 20^\circ$ goniometers for IN8 and IN12 (700 hours), numerous jobs for cryostats (IN10 amongst others), multidetectors for D11 and D18, housing for IN6, furnace and detector for IN13.
- in sheet-metal : casemate door for IN13, Neutrino shielding (680 hours), platform IN4, equipping of D19, platform IN6, casemate door IN4 (500 hours), shielding D11. The two former sheet-metal workshops were combined in the spring and this has resulted in a noticeable increase in the efficiency of this field of activity.

The “self-service” workshop - mechanical engineering (2 staff) continues to complement ideally the main workshops. It is still used daily by 8 - 10 technicians with enough personal experience in mechanical engineering to carry out themselves their small turning, milling and assembly jobs. The quality and precision of the parts produced is proof of the experience of these employees and of the usefulness of this arrangement. An improvement in the resources available to the users has been achieved by the repair or replacement of the oldest machines. A second employee (external) has been taken on full-time in this workshop with the dual function of maintaining in good order the whole stock of different tools in use outside the main workshops and of carrying out the machining work requested by the experimental technicians so as to reduce their work-load. A self-service sheet-metal and welding workshop has been set up this year but its location is provisional, as it is hoped to find a better solution.

The “special products” workshop has continued, with one part-time employee, to be responsible for the production and installation of health physics material or normal neutron absorbents. The work is in the form of moulding, sintering, glueing and painting. An effort has been made this year to reduce the use of FLi⁶ enriched lithium fluoride, the supply and processing of which causes difficulties.

The “primary materials” store is operated by one employee from the production section controlled by the Administration and Finance Department. It forms part of the ILL general stores.

Building and instrument maintenance

The fittings group (4 staff) is mainly responsible for :

- design studies of new projects or of fittings for existing installations in the fields of the general infrastructure, buildings and instruments ;
- requests for quotations, selection of firms and follow-up of the work ;
- design studies for ensuring the conformity of the general technical installations with the regulations in force and others intended to improve safety and working conditions ;
- organisation of the general furniture for the whole of ILL ;
- organisation of the maintenance contracts with external companies for : cleaning of buildings and roads, upkeep of lawns, maintenance of lifts, overhead cranes, handling and lifting equipment, air conditioning installations, etc. ;
- maintenance work on buildings, roads and drains ;
- organisation of installations for town water, high voltage electricity, telephone equipment, general heating ;
- improvement of general technical installations, distribution of fluids and the updating of corresponding plans ;
- the main projects for 1979 have been :
 - reconstruction of the cafeteria, provision of an "after-hours" kitchen/dining-room for the scientists, reconstruction of the sheet-metal workshop, reconstruction and equipping of the storage building ILL11, installation of a rented, prefabricated building of 10 offices behind ILL1, conversion of offices into single rooms in ILL4, shower in ILL7 ;
 - on the instruments can be mentioned : new door for IN4, cable ducts and small cranes D1B, assistance in the adjustments of guides H22 and H24, and the modifications to D17, IN6, D7, improvement of shielding D5 - S40 ;
- the main studies have been on :

project for biology and computer buildings in collaboration with the architect, reconstruction of the medical service, research into "in-house" solutions for extensions to workshops and offices, preparation for the repainting of the inside of the steel dome of the reactor, preparations for repairing the floor of the reactor experimental hall.

The electrical installation and maintenance workshop (5 staff) is in charge of the maintenance, improvement and installations of low voltage supply networks and lighting. Only major installation jobs are carried out by outside firms following design studies prepared by this group. The percentage of time allocated for jobs carried out is the following :

- 10 % - new jobs
- 71 % - modification to existing installations
- 17 % - repairs
- 2 % - preventive maintenance

The handling and general maintenance workshop (5.5 staff) is responsible for :

- maintenance of general technical and sanitary installations, service vehicles, furniture, door frames and locks ;
- small installation jobs or improvements in these fields ;
- all removals within ILL ;
- a large part of internal transport and handling ;
- organisation of facilities for events in the life of ILL (committees, visits, seminars, elections etc.).

The time allocated for these jobs is divided up as follows :

- 34 % - handling, transport, removals
- 14 % - new jobs
- 22 % - modification to existing installations
- 15 % - repairs
- 15 % - preventive maintenance

The year 1979 has emphasized the necessity of further increasing the resources of the fittings group and the general maintenance and handling workshop.



**Reactor
operation
department**

Reactor operation in 1979

The system of operation used since 1975 has been continued in 1979.

The six cycles originally planned total 264 days operation ; each cycle of 44 days operation is followed by a 12-day shut-down during which the fuel element is changed and maintenance of the installations is carried out ; in addition, there is a shut-down of approximately five weeks in October to permit major maintenance and modification work to be carried out.

Actual timetable

Cycle 1/79 Commenced 3 January, ended 16 February. The scheduled dates were maintained. The cycle was however interrupted four times by shut-downs followed in each case by an immediate restart.

Cycle 2/79 Commenced 27 February, ended 12 April. The scheduled dates were maintained and there were no incidents during the cycle. A leak of boron trifluoride should be noted on a counter in tests on beam tube H 23, which necessitated the temporary evacuation of the neutron guide building. This incident had no effects on the staff.

Cycle 3/79 The original timetable (24/4 to 7/6) was postponed as a result of a strike and the cycle commenced on 2 May and ended on 16 June. The postponement made it possible to maintain the planned rhythm and to recover the lost operation time. The only incident in this cycle was due to disturbances on the electricity mains network, which caused a shut-down followed by a poison-out which closed down the reactor for 46 hours ; the cycle was prolonged by 2 further days to make good the time lost.

Cycle 4/79 Because of the delay on the previous cycle, this cycle was also postponed by 2 days and run from 21 June to 3 August. During this cycle the failure of a main heavy water pump resulted in operation at 3/4 nominal power for 90 hours.

During this period of operation with a single main pump, inadequate cooling of this pump resulted in an emergency shutdown. The reactor restarted immediately, but stopped again two days later to permit replacement of the faulty pump (shutdown for 40 hours).

Cycle 5/79 Commenced 16 August, ended 29 September. The scheduled dates were maintained.

There was no incident of note during the cycle, apart from a brief shut-down followed by an immediate restart, due to a disturbance on the EDF electricity supply network.

Annual shut-down from 29 September to 6 November

The work planned was completed on schedule.

The following items are particularly worthy of note : checking the natural convection valves of the reactor block, the internal examination of the reactor block by means of a television camera, the addition of a valve directly at the output of the heavy water circuit on the control rod, the replacement of the connectors for the start-up detectors, the installation of a new compressor on the "air rod" circuit, etc.

Cycle 6/79 Commenced 6 November, ended 20 December. The scheduled dates were maintained.

During the cycle, a sudden drop in the flow of the River Drac resulted in insufficient cooling for the reactor, causing an emergency shut-down. The situation was quickly restored, and the reactor restarted during the following hour.

A second shut-down, followed by an immediate restart, was caused by the failure of the electronic control system for the control rod.

Data for 1979

— Number of days originally scheduled	264
— Actual number of days of operation	260
— Actual operating time (Equivalent days at full power)	254.8
— Actual operating time in relation to time scheduled	98.5 %
— Actual operating time (percentage of year)	71.2 %
— Number of fuel elements used	6
— Number of fuel elements actually despatched for reprocessing	9
— Number of unscheduled shut-downs	11
— Number of shut-downs with Xenon poisoning	1

Apart from the slight postponement of cycle 3/79, the continuity of the reactor operation can be regarded as satisfactory. The number of unscheduled shut-downs with Xenon poisoning has decreased considerably in comparison with 1978 (4 in 1978, 1 in 1979).

Analysis of unscheduled shut-downs

The number of "Chutes de barres" (unscheduled shut-downs) is comparable with the 1978 figure (8 in 1978, 10 in 1979). However, long shut-downs due to Xenon poisoning have considerably decreased (7 in 1977, 4 in 1978, 1 in 1979). This is apparently connected with an improvement in the safety rod circuits, and also to the fact that the unscheduled shut-downs occurred early in the cycle.

The only shut-down followed by Xenon poisoning was due to a storm causing numerous successive disturbances of the mains supply resulting in particular in failure to restart due to the cold source.

Operation of the sub-assemblies

Heavy water circuit

Commissioning of a circuit making it possible to supply the detritiation plant with heavy water from a distillation unit, thus considerably reducing the gamma activity.

Replacement of one of the main heavy water pumps because the vibration level of the bearings had become abnormal.

Electricity

The emergency accumulators for the electrical supply system for the computers (A.R.C.) were tested and operation commenced. These should make it possible to bridge all mains supply cuts.

Irradiation facilities

The irradiation tube V4 was dismantled and the corresponding aperture in the reflector tank was closed with a blanking plate : the tube will be used for metallurgical studies of highly irradiated material.

Nuclear Physics Instrument H9 : emergency manual control operational for movement of the source holder trolley.

Safety rods

Replacement of the upper part of safety rod n° 2 and of the whole of safety rod n° 5 (absorbant + upper part).

With effect from this year, the frequency of replacement of rods will be accelerated (3 instead of 4) in order to avoid the problems due to poor adherence of the nickel coatings. The replacement of the last rod which had been in the reactor for three years resulted in a dramatic reduction in the Silver 110 content of the heavy water.

Reactor control panel

Replacement of the old period meters for the start-up channels by new more reliable units.

The installation and development of the new computer (TCMS) have continued throughout the year.

Fuel elements

Nine used fuel elements have been dispatched to SAVANNAH RIVER (USA) for reprocessing, so that the complete backlog has now been eliminated.

Dam on the Drac

The rock-fill dam providing cooling water for the reactor subsided in 1977 as a result of the excessive removal of construction materials downstream, and repairs were undertaken in October 1977 to fill a gap and consolidate the whole dam.

After the floods in the Autumn of 1977, the situation appears to be deteriorating again and further repairs will probably be necessary at the beginning of 1980.

Detritiation plant

Modifications were effected on the input and output circuits in order to facilitate the processing of heavy water from other organisations.

Heavy water processed in 1979		Tritium extracted
H.F.R.	60 000 litres	85 000 curies
SACLAY (EL 3)	7 000 litres	26 000 curies
HARWELL (DIDO)	9 700 litres	120 000 curies

During the year 200 000 curies of tritium were dispatched to COGEMA/Marcoule ; it is also intended to return to HARWELL the tritium extracted from their heavy water.

7

**Computing
and electronics
department**

Instrument control and data acquisition service

This Service is responsible for the construction, improvements and maintenance of instrument control systems, detectors, multidetectors and general electronic equipment.

The assignment of instruments to control systems at the end of 1979 was as follows :

IN ROUTINE OPERATION :

CARINE systems (using Télémécanique T2000 computers)

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

PDP 11 network (11/55 concentrator ; 11/34 on each instrument) D7, IN4, IN5.

Free-standing systems :

PDP 11's (various types) : IN10, IN11, D3, D8, D9, D10, D11, D17, PN2, PN3 (GAMS 1), PN3 (GAMS 2/3)

Plessey Micro 1 : D1A, D2, D18, S3

Others : IN12 (Solar 16/40), D15/D16 (PDP 8)

UNDER DEVELOPMENT AND TEST

To be attached to PDP 11 network : IN6, PN1
Free-standing systems PDP 11/34 : IN13, D5, D19
Plessey Micro 1 : D4, PN4
Solar 16/40 : IN1, IN8, D1B

Change-over from centralised to individual control systems

1979 was marked by a continuation of the installation of dedicated computer systems on the instruments.

The centralised system NICOLE has been shut-down. Of the three instruments that were still connected to it at the start of 1979, IN4 and IN5 are now linked to the PDP 11 network, and PN1 is temporarily using a multichannel analyser, prior to going on the network early in 1980.

On the other centralised systems CARINE 1 and 2, three instruments (D2, D9 and D10) have come off in 1979, leaving only 6 of the original 11 instruments. Of these 6, 4 are in the process of being changed over, their computers having already been delivered. It is planned to shut down the CARINE systems in 1981.

Other improvements (existing instruments)

IN1.	New DC motor modules
IN3.	New DC motor modules
IN4.	Complete rewiring and additional detectors
IN5.	Additional detectors and new amplifiers
IN8	New DC motor modules
D4.	Being equipped with a Plessey Micro 1, in anticipation of multidetector, to be installed in 1980.
D8.	PDP 11/40 being replaced by PDP 11/34
D10.	Rewiring and new DC motor controllers, in association with installation of spin-echo option.
D11.	New multidetector installed
PN2 (GAMS 1).	Fundamental improvements to window control and stabilisation system.
PN5.	In operation with a NIM control system.

Several instruments now have direct links to the DEC-10 (see under Central Computer Service)

New instruments

IN12 is now in routine operation, the first system to use a SOLAR 16/40.

The control system for D18 (a Micro 1 linked to a Motorola M6800 microprocessor) is working and being used on preliminary instrument tests.

The control system for D19 (PDP 11/34) is also operational, but technical problems with the detector have delayed complete instrument tests.

S3, the evaporator for the production of supermirrors has come into operation under the control of a Micro 1.

Work continues on the installation of IN6 and IN13.

Studies, prototypes and long-term developments

The principal achievements to be noted here are.

- a prototype controller to automate temperature scans over a wide range of temperatures.
- tests with small (64 x 16 cells) two dimension multidetectors.
- feasibility studies for a fast linear 2000 cell detector and its data incrementation system (proposed for a new instrument, D20).
- study of data acquisition system for the new instrument PN8.

Maintenance

Despite the fact that the older electronics and computer systems are being replaced as quickly as possible by equipment of a modern modular design, the growth in the amount of equipment in use is creating a serious maintenance problem. The Service's underlying philosophy has been to undertake maintenance by its own staff for the standard lines of equipment and to have maintenance contracts to cover non-standard lines of equipment. However under the constraints of almost fixed operational budget and staff numbers it is proving increasingly difficult to provide the desirable level of service in this area. A review of the general maintenance problem is in progress.

Central computer service

Operations

The DEC System 10 Central Computer provides a general computing service for ILL scientists, and a data inspection service for visitors performing experiments at ILL.

The system has been running at the limit of its capacity for several years and a more powerful replacement is urgently needed. Because of the replacement project (discussed below) there was no new investment in the System during 1979.

The only significant operational change during the year has been a decision to allow the machine to run unattended overnight to process batch work. Although there was initially some concern about possible safety problems, the procedure has so far worked without incident. With batch work now concentrated at night, the daytime can be devoted to terminal support.

New releases of DEC software are still installed as they become available. The System is now running under Version 6.03 A of the TOPS-10 Operating System.

Data handling

The gradual replacement of the centralised instruments data acquisition systems NICOLE and CARINE by individual mini-computers which normally do not have magnetic tape units, has led to a demand for these to be provided with links to the DEC-10, since otherwise data can only be transferred indirectly, by sending disc packs to the PDP 11/55, for example. Such links have been in operation for D11 and D17 for some time.

The DEC-10 does not have enough access ports to enable all instruments to be provided with their own line. Furthermore, such an arrangement is unnecessary since each instrument only transmits data at the end of a run or experiment, and most instruments have much lower data acquisition rates than D11 and D17.

A multiplexer has therefore been developed to enable several instruments to have access via the same port. By this means, the instruments D1A, D2, D8, D10, IN12 have been provided with a direct connection.

The new experimental data base, which was introduced in 1978, has benefited from further improvements.

General support for users

Support for users falls into two categories :

- creation of new utilities and additions to program libraries, and implementation of new mathematical software to provide facilities in general demand.
- advice and assistance on programming techniques and debugging at an individual level.

In respect of the second of these, the Service recognises the more efficient use of scarce resources that can be achieved by better programming techniques but is naturally limited in the amount of effort it can make available.

Replacement of the DEC-10

Work on the project to replace the DEC-10 has continued throughout the year.

The Steering Committee raised several questions of a rather fundamental nature concerning the type of computing carried out at ILL and the most efficient means of providing the necessary resources, and set up a Commission of external experts to look at these and related problems. The opinion of the external users was also solicited.

It has been confirmed that although the appearance of "mega-mini" computers now offers the possibility of distributed data processing systems, there are particular reasons why ILL should preserve a Centralised computing service. For example there is a need to provide permanent operational and software support in the presence of a very high throughput of short-term visitors and a relatively high turnover of contract scientists.

On the technical side a bench mark (involving both batch and time-sharing work) has been prepared and run on several of the machines offered. This has given more precise information on the relative performances of the various machines than could be gathered from the manufacturers own literature.

A more difficult point concerns the conversion effort that would be needed if one were to change to a manufacturer other than DEC. Again, the peculiar position in which the Institut finds itself, with a large number of programs being made available for visitors with only limited support available, and the need to maintain a continuing service, appears to make conversion a more difficult problem than at normal research centres and universities, where users are generally using the computer for their own research.

At the time of writing the choice of computer was still under discussion.

Other activities

The use of computers as general office and management aids is currently experiencing rapid growth, and the Department is investigating whether such systems could be introduced to advantage in the Institut.

The Central Computer has been used for several years to record travel costs and other statistics connected with official visits.

This year an autonomous data-base system has been set-up for the Scientific Secretariat, putting on file all experiment proposals and decisions of the Scientific Council.

The possible introduction of similar systems for other Services is under examination.

The decision of the Administration Department to have the salaries and accounts run from interactive terminals connected to the CISI network has also involved the Computing Department in additional work in preparing for the change-over.



Administration

Introduction

The Administration Department is responsible for dealing with the matters arising in this field at the ILL. It is required to give effective support to the Director, the scientific area, and all departments and other units in the Institut in carrying out their functions, and to perform the necessary services in the administrative field. It ensures that the available resources are correctly and economically used and that the appropriate regulations, guide-lines and instructions are observed.

The administrative functions are carried out by three groups - personnel, finance and " Relations Sociales " (welfare). The Administration Department also includes the medical service and the translation office. It also provides the Secretariat of the Steering Committee, prepares its meetings and those of its Subcommittees, and implements its decisions.

Personnel

The Personnel Section is responsible for the recruitment, administration and payment of the ILL staff. It is responsible for studies and analyses in connection with personnel, some of which are selected this year.

Staff

The tables below show staff numbers for 31.12.79 and the breakdown of staff by category and nationality.

ILL staff numbered 421 on 31.12.79. This represents an increase of 4 in comparison with 31.12.1978.

TABLE XI
STAFF SITUATION

Categories (1)	Position on 31.12.78 (2)	Changes in 1979		Difference + or - (5)	Position on 31.12.79 (6)	Change % column 4 compared with column 2 (7)*
		Recruitment and internal changes (3)	Departures and internal changes (4)			
1. Scientists	74	30	27	+ 3	77	40.5 %
2. Technical and administrative " Cadres "	58	4	3	+ 1	59	5.2 %
3. Thesis students	29	9	8	+ 1	30	27.6 %
4. Technicians	147	7	4	+ 3	150	2.72 %
5. Others	109	4	8	- 4	105	7.6 %
TOTAL	417	54	50	+ 4	421	11.99 %

* Percentage of ILL staff who left the Institut in 1979 in comparison with staff numbers for 31.12.78

A considerable fluctuation (11.99 %) in comparison with 1978 (7 %) should be noted, still due mainly to the limited-term contracts of Scientific Staff and thesis students, although an increase in mobility has been noted in other categories.

In comparison with 1978, there has been an increase in German (+ 2) and French (+ 4) staff, no change in British staff, and a reduction in staff of other nationalities (- 2).

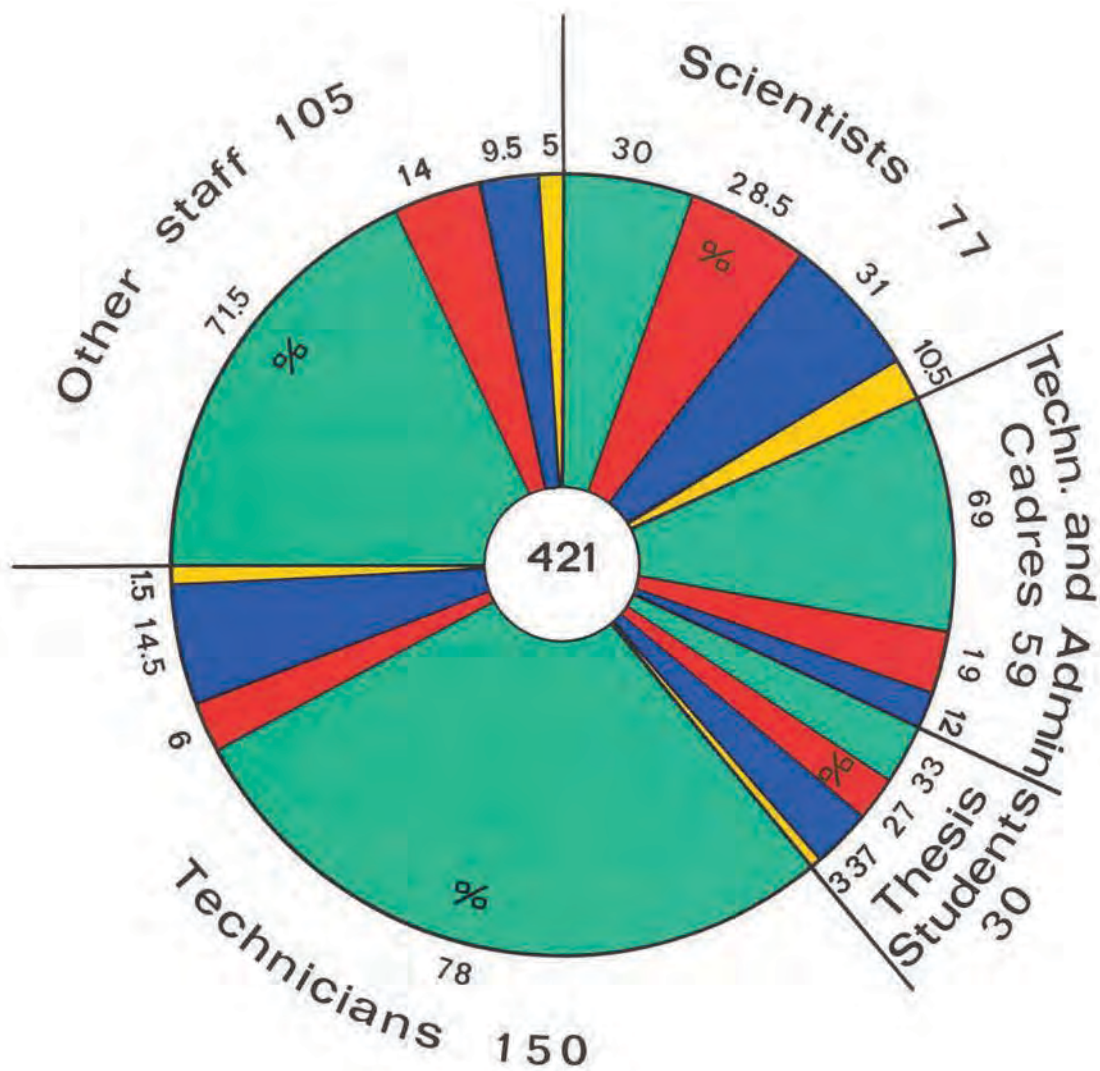


Fig. 17 : Break-down of staff by nationality.

Salary changes

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

The 1979 Salary Agreements signed at the CEA caused a salary increase of 11.72 %, of which 0.42 % of the payroll is for an improvement in purchasing power, mainly for the lower paid categories.

Adjustments are envisaged at the beginning of 1980 if the official price index for 1979 should be higher than the increases granted for the maintenance of purchasing power.

Age structure

After allowing for the numerous changes in 1979, the average age has only increased by 2 months (36 years 7 months instead of 36 years 5 months in 1978). The average age of the Scientists has increased from 36 years 4 months to 36 years 5 months.

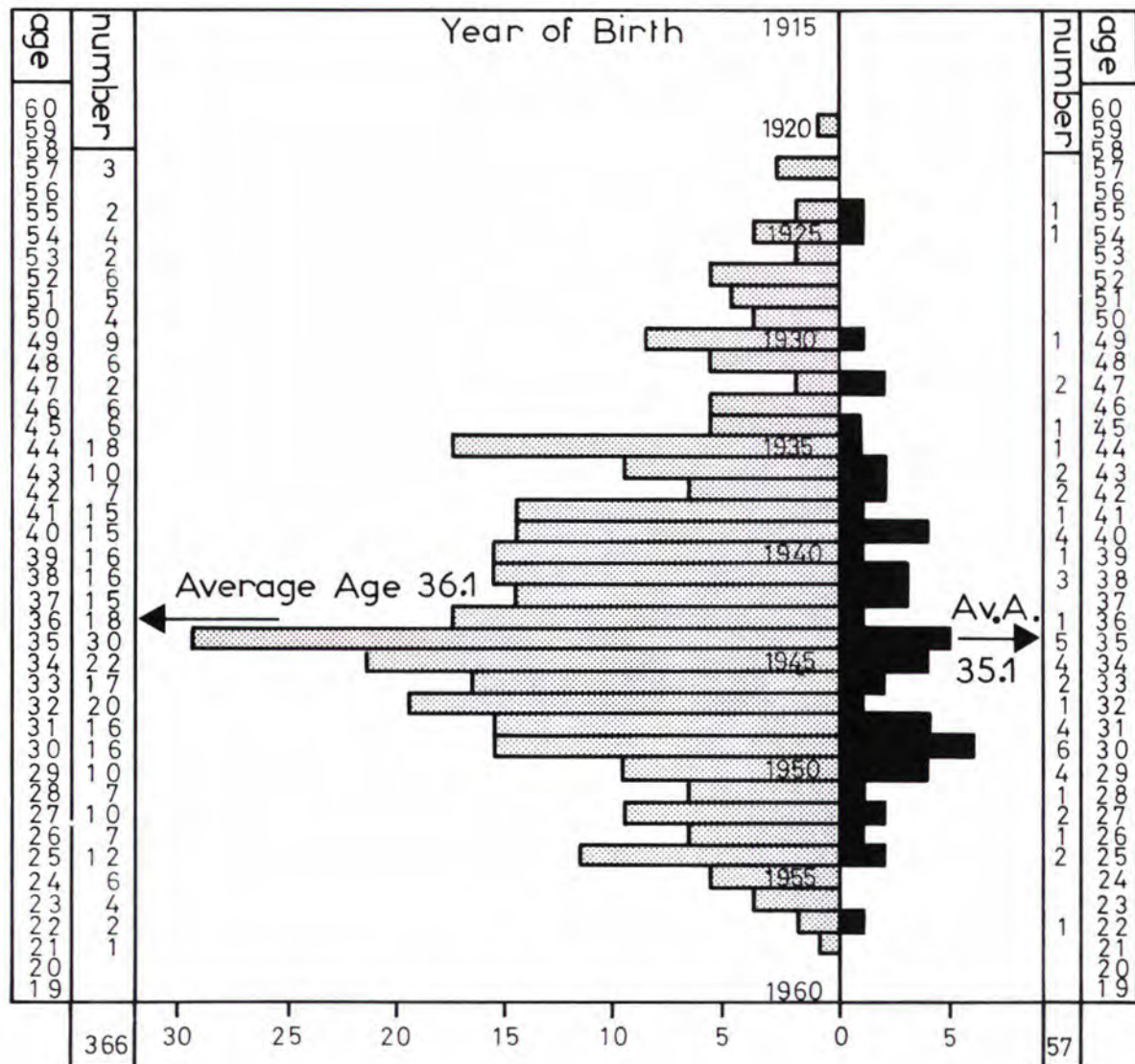


Fig. 18 : Age structure of the ILL.

Seniority of ILL staff

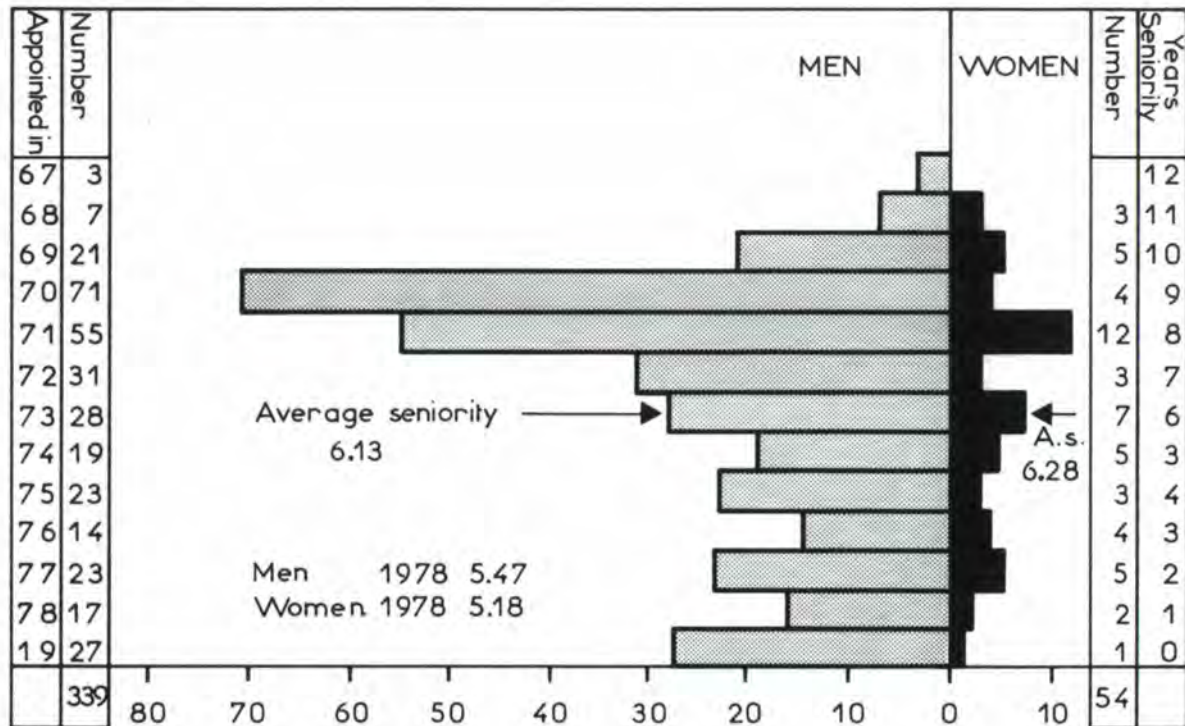


Fig. 19 : Seniority of ILL staff.

Staff representation

- Three Union branches :
CGT, CFDT, FO
- Works committee (Comité d'Entreprise) :
Number of representatives :
"Annexe I" : 2 members (1 CFDT, 1 FO)
2 substitutes (1 CFDT, 1 FO)
"Annexe II" : 4 members (1 CFDT, 2 CGT, 1 FO)
4 substitutes (2 CFDT, 1 CGT, 1 FO)
Allocation 1979 : 3 % of the payroll
- Committee on Health and Safety (C.H.S.) : 6 representatives
- Staff representatives (Délégués du Personnel) :
"Annexe I" : 3 members (2 CFDT, 1 FO)
3 substitutes (2 CFDT, 1 FO)
"Annexe II" : 4 members (2 CFDT, 1 CGT, 1 FO)
4 substitutes (1 CFDT, 2 CGT, 1 FO)
- Management/Union Careers Commission :
Six representatives + 4 substitutes.

Relations between management and unions

Major points on negotiations :

- a) Signature of an agreement on 27 April 1979 on the situation of shift staff, which included among other points a commitment by the Management to request permission from the Associates to open negotiations on earlier retirement for shift staff. At its meeting on 12 December 1979 the Steering Committee gave its approval on the opening of these negotiations.
- b) The decision of the Steering Committee at its meeting on 26 October 1979 to prolong the life of the ILL until at least 1990 made it possible to resume negotiations in November 1979, which had been interrupted in February 1979, on changes in the present system of classification and promotion of ILL staff.

Budget and accounts

In 1979 the ILL initiated the financing of the first investments under the Programme of Modernization. The financial report below shows the budget authorized for normal operation and the grants under the Programme of Modernization for 1979.

The normal budget authorized for the year 1979 provided for total expenditure amounting to 124.8 million francs, of which 3.4 MF were to be covered by the ILL's own income, and 121.4 MF by the Associates' grants. (These figures include 202 341 F brought forward from 1978, and a sum of 856 000 F for additional income).

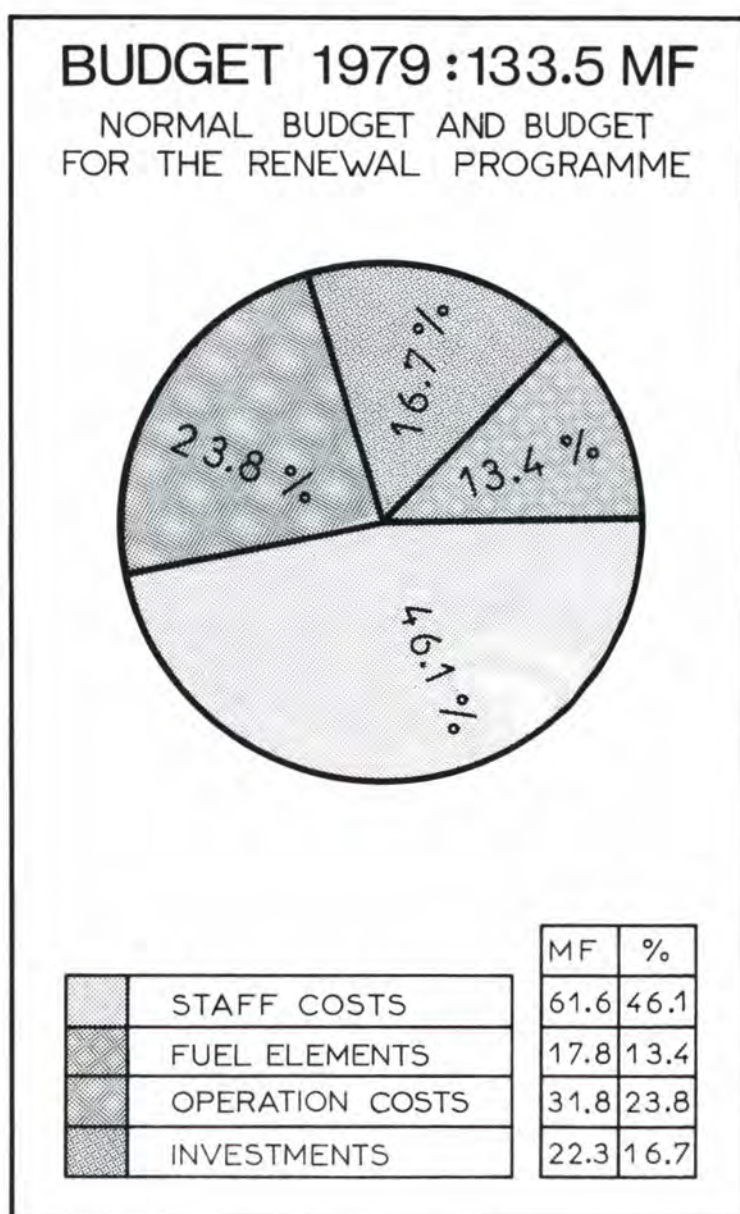


Fig. 20 : The budget 1979.

The provisional annual accounts for 1979 for actual expenditure, in comparison with the actual expenditure in 1978 (excluding taxes), are as follows :

TABLE XII - COMPARISON OF EXPENDITURE IN 1979 AND 1978

	1979 (x 1000 F)	% of total	1978 (x 1000 F)	% of total
a) Operation				
Consumable materials and small equipment	8 260	6.6	7 367	6.6
Fuel elements	17 738	14.3	17 651	15.7
Staff costs	61 650	49.6	54 192	48.2
Taxes	277	0.2	274	0.2
Long-term service and supply contracts	10 016	8.0	9 084	8.1
Other work, supplies and services from third parties	7 880	6.3	5 800	5.2
Transport, removal and travel expenses	979	0.8	862	0.8
Miscellaneous administrative costs	<u>3 538</u>	<u>2.8</u>	<u>3 145</u>	<u>2.8</u>
Total operation	110 338	88.6	98 375	87.6
b) Investments				
Building	320	0.3	396	0.4
Equipment (except experimental equipment)	1 910	1.5	2 039	1.8
Experimental equipment	9 510	7.6	8 886	7.9
Other investments	<u>2 500</u>	<u>2.0</u>	<u>2 555</u>	<u>2.3</u>
Total investments	14 240	11.4	13 876	12.4
Total expenditure	124 578	100.0	112 251	100.0

TABLE XIII - COMPARISON OF INCOME IN 1979 AND 1978

	1979 (x 1000 F)	% of total	1978 (x 1000 F)	% of total
c) Income				
ILL's own income	3 400	2.7	2 602	2.3
Grants from Associates	<u>121 400</u>	<u>97.3</u>	<u>109 647</u>	<u>97.7</u>
Total income	124 800	100.0	112 249	100.0

The operation expenditure increased from 98.4 MF to 110.3 MF (+ 12 %) in comparison with the previous year. This increase was spread over the whole operation budget, particularly the staff costs budget.

The investment expenditure also increased in comparison with the previous year, from 13.9 MF to 14.2 MF. In particular, the Institut completed in 1979 the northward extension of the Neutron Guide Building. The increase in the budget figure for equipment is due mainly to various installations and fittings in the technical and Reactor areas.

The budget authorized in 1979 for the Programme of Modernization amounts to 8.7 MF, of which 0.7 MF are covered by the ILL's own income and 8.0 MF by the contributions of the Associates. In addition, the sum of 2.0 MF of the investment funds has been frozen. This is for the budget for the purchase of the new central computer. The budget figures for the Programme of Modernization for 1979 are as follows :

TABLE XIV - PROGRAMME OF MODERNIZATION 1979

	1979 (x1000 F)	% of total
a) Operation		
Consumable materials and small equipment	45	0.6
Other work, supplies and services from third parties	875	10.9
Transport, removal and travel expenses	80	1.0
Miscellaneous administrative costs	90	1.1
Total operation expenditure	1 090	13.6
ILL's own income	— 702	— 8.8
Total operation	388	4.8
b) Investments		
Buildings	200	2.5
Experimental equipment	5 412	67.7
Frozen	2 000	25.0
Total investments	7 612	95.2
Total expenditure	8 000	100.0

Development of the budgets (1974-1979) and planned budget for 1980

The budget situation in 1979 and 1980 is particularly difficult as regards operation expenditure because of the inflation rate of approximately 11 - 12 % in 1979 which is higher than anticipated in the budget, and which affects staff costs, and supplies and services from third parties, and also increases the cost of investments.

The continual improvements in the field of health physics and general safety entail above average staff and financial requirements, and this trend will continue to increase in future.

The ILL does its best to meet these increased requirements within the Associates' financial limitations by making economies and increasing efficiency.

MILLION F

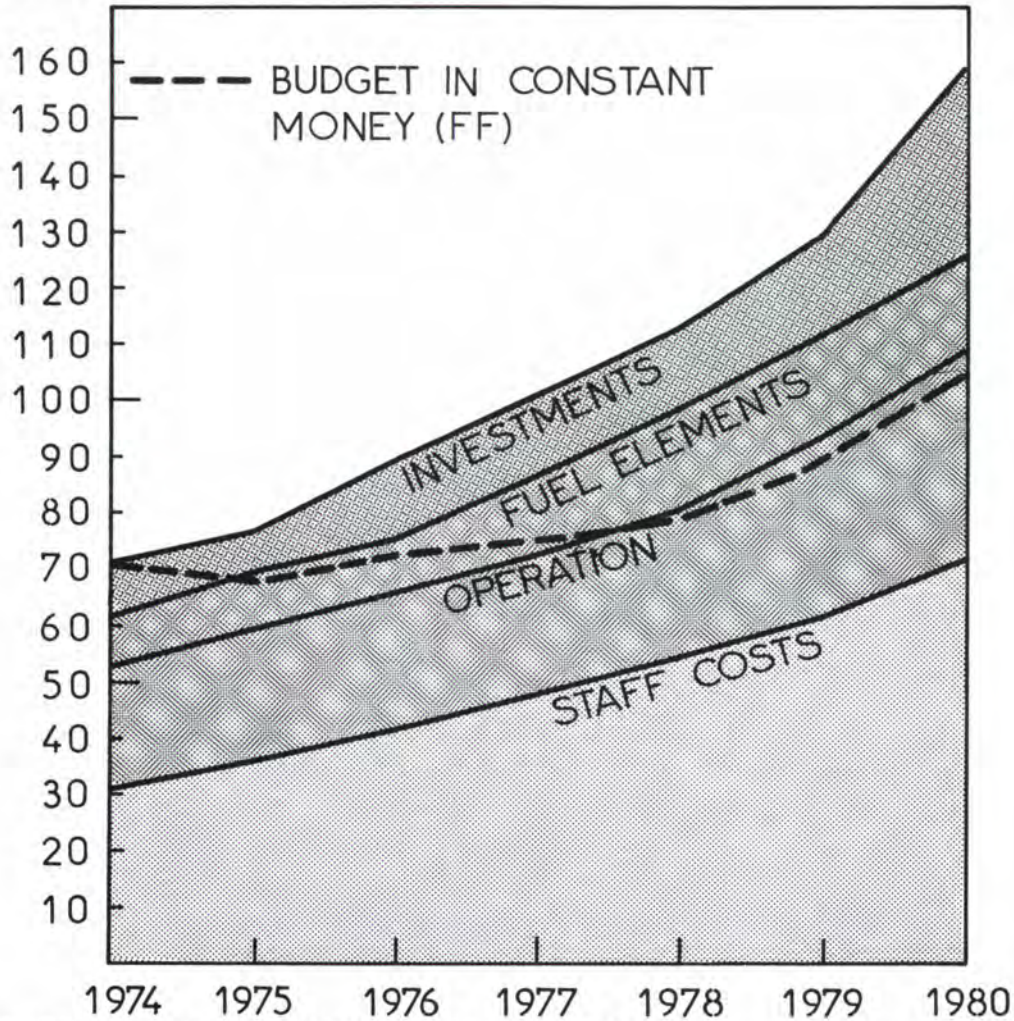


Fig. 21 : Spending of the budget (1974-1979). Planned budget for 1980.

Purchasing

During the year approximately 6000 orders and contracts (in comparison with 5 764 in the previous year were processed.

The major invitations to tender in 1979 included :

Purchase of 10 fuel elements	11,707 000 F
Purchase of 25 kg Uranium 235/93 %	5,260 700 F
Purchase of 4 process computers	583 000 F
Change-over of Administration data processing	490 000 F
Purchase of raw glass for the partial replacement of neutron guides	330 000 F
Purchase of replacement absorbers for the Reactor safety rods	1,100 000 F
Construction of an ultra cold neutron source with liquid Helium	727 000 F
Design and construction of a new vertical cold source	1,140 000 F
Equipment of the quadruple chopper system of spectrometer IN5 on magnetic bearings, including electronics	1,380 000 F
Reconstruction of the mechanical part of instrument IN1	1,305 000 F
Invitation to tender for a new central computer	approx. 10,000 000 F
Construction of a new Biology building and Computer building	approx. 10,000 000 F

The geographical distribution of orders by value is shown in the following table :

**TABLE XV
GEOGRAPHICAL DISTRIBUTION OF ORDERS
INCLUDING FUEL ELEMENTS**

	1979 (x 1000 F)	% of total	1978 (x 1000 F)	% of total
Total orders	47 134	100	44 462	100
Distribution :				
France	26 558	56.3	20 169	45.4
Germany	9 592	20.4	8 189	18.4
U.K.	2 034	4.3	2 239	5.0
Others	8 950	19.0	13 865*	31.2

* incl. purchase of 48 kg uranium through COGEMA

**TABLE XVI
GEOGRAPHICAL DISTRIBUTION OF ORDERS
EXCLUDING FUEL ELEMENTS**

	1979 (x 1000 F)	% of total	1978 (x 1000 F)	% of total
Total orders	29 799	100	24 134	100
Distribution :				
France	20 600	69.1	15 100	62.6
Germany	3 476	11.7	2 689	11.1
U.K.	2 034	6.8	2 239	9.3
Others	3 689	12.4	4 106	17.0

Relations sociales

(Figures up to 30 November 1979)

This section deals in particular with the reception of staff and Guest Scientists, the administrative aspects of medical and social problems, travel, training and general services.

Reception

New arrivals (new staff and Guest Scientists) are assisted with their problems of finding suitable accommodation, dealing with formalities as regards residence permits, work permits, customs, removals, etc.

In connection with reception, the arrangements for German and British children at the " Houille Blanche " European school and in the " international " sections of the " Lycée des Eaux-Clares " should be mentioned. The contacts with the local education authorities have been continued : a number of reports have been prepared by the ILL and submitted to the appropriate departments of the Ministry of Education. These requests are in support of official status as an experimental school for the primary school and of the international sections at the Lycée, with a view to the setting up of an international baccalauréat at Grenoble.

Work in the medical and social fields

Medical group

The following medical examinations have been carried out :

338 regular visits for ILL staff and long term Guest Scientists working regularly in restricted areas

139 regular visits for ILL staff

105 medical examinations on recruitment for applicants and scientists coming for more than 2 weeks without a certificate of fitness.

30 examinations following return from sick leave of more than 3 weeks, industrial accident or leave without pay

33 examinations requested by ILL staff.

In collaboration with the Departmental Blood Transfusion Centre, two blood donor sessions have been organized : 100 persons gave blood.

Social Security and Société Mutualiste group

The table below shows the changes during the last 3 years in the number of items submitted for reimbursement by the Social Security, the corresponding number of reimbursements by the Société Mutualiste and " prises en charge " for hospitals, etc. : the increasing number of these " prises en charge " is due to the fact that the Société Mutualiste is continuing to sign agreements with hospitals, laboratories, and radiologists, etc. These agreements permit staff to obtain treatment or analysis as required by their state of health without financial worries : in fact these agreements enable staff to avoid payment of charges outstanding after the Social Security has paid its share ; the Société Mutualiste obtains reimbursement from APPI for affiliated staff.

TABLE XVII
ITEMS SUBMITTED FOR REIMBURSEMENT BY THE SOCIAL SECURITY
AND THE SOCIÉTÉ MUTUALISTE

Year	Number of cases			Reimbursements by APRI
	Social Security	Société Mutualiste	Prises en charge	
1977	6 380	4 675	305	271
1978	6 892	5 293	447	278
1979	6 867	5 412	505	393

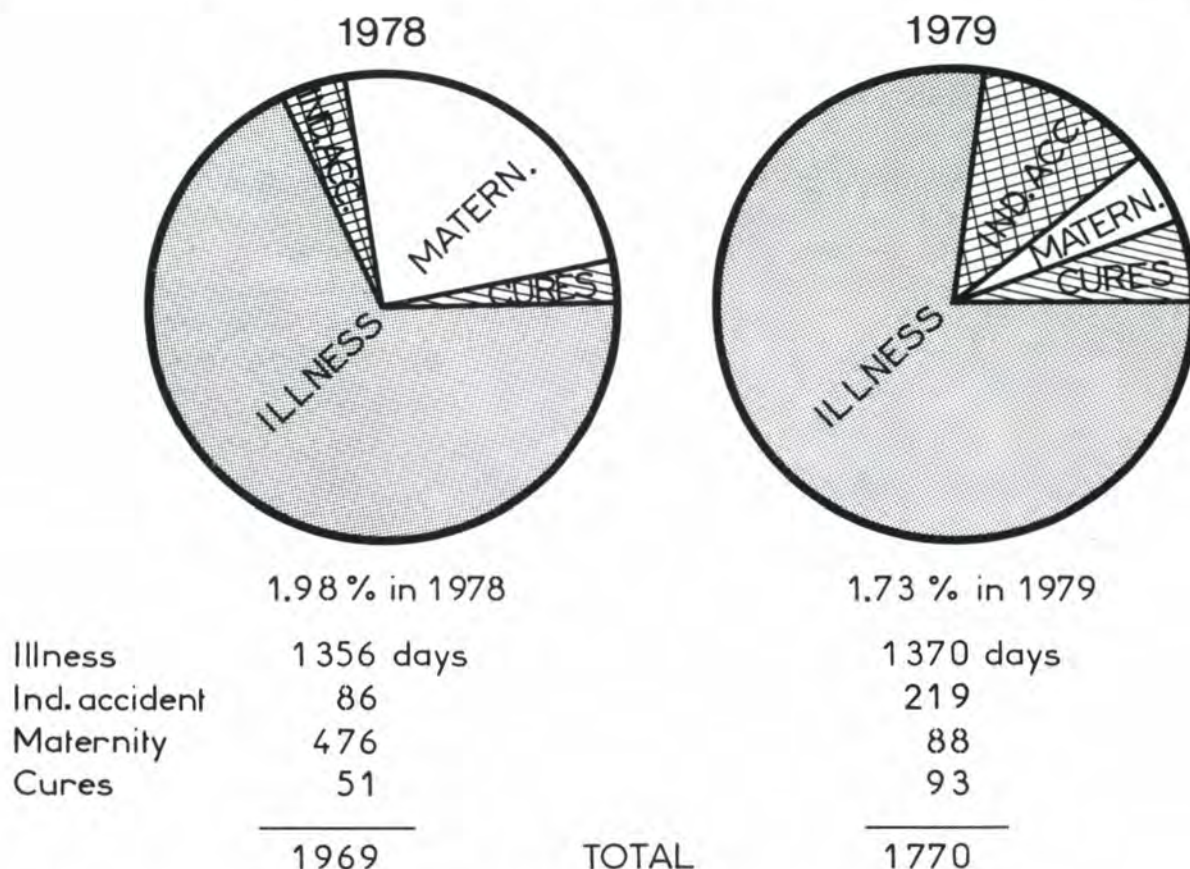


Fig. 22 : Sick leave with medical certificate, % hours sick leave out of total working hours.

Fig. 22 shows the percentage for 1978 and 1979 of sick leave in relation to the theoretical number of working hours and the breakdown by reasons : illness, maternity, industrial accidents, thermal cures. A net reduction in the number of days' sick leave due to industrial accident may be noted. There has also been a reduction in cures and maternity leave.

Assistance for housing

Nine requests for loans were agreed for an average sum of 26 000 F, totalling 233 750 F (for reimbursement free of interest in 10 years). Between January 1972 and the end of 1979, 109 ILL staff have bought property with the aid of the " 1 % " fund for housing assistance, as follows :

Cadres : 24 Non-cadres : 85

TABLE XVIII
ILL SCIENTISTS' VISITS, BY NATIONALITY AND COUNTRY VISITED,
DURING 1979

Visits in France	Visits in Germany
52 French = 177 days	11 French = 65 days
2 German = 10 days	27 German = 159 days
10 British = 42 days	5 British = 29 days
4 Others = 27 days	1 Other = 16 days
<hr/>	
68 visits = 276 days Average cost/visit = 701,-F	44 visits = 272 days Average cost/visit = 1892,-F
Visits in the U.K.	Visits outside member countries
4 French = 24 days	7 French = 69 days
3 German = 9 days	15 German = 305 days
26 British = 190 days	8 British = 88 days
3 Others = 14 days	5 Other = 54 days
<hr/>	
36 visits = 237 days Average cost/visit = 1930,-F	35 visits = 506 days Average cost/visit = 2555,-F

Visits by ILL Scientists

Table 18 shows Scientists' visits by nationality and country visited. It should be recalled that the scientists have an individual annual allowance of 2 750 F for visits. As may be expected, contacts are to a great extent with the country of origin.

As regards visits outside the Member countries, these include one six month visit by a German scientist to Oak Ridge (in exchange, an American Scientist from Oak Ridge will pay a long-term visit to ILL in 1980), visits of one week to one month to the United States (Boston, Los Alamos, Hamilton University) and attendance at conferences (NATO at Geilo, Norway, Neutrinos at Bergen, etc.)

Visitors

The table below shows the number of visits to ILL by scientists (reactor users, scientists attending workshops, staying for a sabbatical year or coming to give seminars), classified by laboratory of origin.

TABLE XIX
NUMBER OF VISITING SCIENTISTS DURING 1979

Scientists from laboratories in	France	Germany	U.K.	Others	TOTAL
With reimbursement	275	357	299	71	1002
Without reimbursement	212	149	123	147	631
Total	487	506	422	218	1633

NOTES :

- 1 - The figures quoted for British coming via the intermediary of the SRC are in accordance with data known at 30.09.79.
- 1 - In 1979, 7 Soviet scientists from the Institutes of Gatchina and Kurchatov have spent periods at ILL totalling 154 days.

Staff training

During the first six months of 1979, 294 staff attended 8613 hours of training. These may be broken down as follows :

- 2 281 hours language studies
(French, German, English)
- 5 378 hours technical studies
- 954 hours general or cultural studies.

The French courses organized by the ILL cover foreign Scientists working at ILL, but also at the Centre National de la Recherche Scientifique (CNRS) and the Centre d'Etudes Nucléaires de Grenoble (CENG).

As regard technical studies, preference is given to " basic courses " on subjects such as electrical engineering, electronics and micro-processors.

A crystallography course has been organized for the instrument operation technicians : this included a theoretical part given by staff of the Grenoble IUT de Mesures Physiques (College of Technology for Physics measurements) and a practical part at the ILL under the responsibility of an ILL Scientist. This experiment seems to have been beneficial and should be repeated.

British or German staff have requested technical training in their country of origin, for obvious reasons of language. For example staff have attended computing and management courses at DEC in Reading and SRC respectively.

In 1979, 4 staff spent two-month periods working abroad :

- 1 technician at HMI in Berlin,
- 1 secretary at Desy, Hamburg,
- 1 reactor technician at Harwell,
- 1 senior technician in the construction and maintenance section at Leeds University (tribology laboratory).

These visits permit a more thorough knowledge of the German or English language and encourage contacts between laboratories working on subjects of common interest. The ILL would like to have visits from British and German staff in exchange, under the same conditions, but has had very little success in this field to date.

EXPERIMENTS PERFORMED AT THE ILL IN 1979

The following is a list of experimental reports relating to experiments carried out at the ILL up to September 30, 1979. These reports are published in full in the Annex to the Annual Report for 1979, which also includes the Author Index for this list.

(Reports received after January 15, 1980 will be published in the Annex to the Annual Report for 1980).

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

COLLEGE 3

03 01 070	Decay energies of heavy fission products. Berg H., Keyser U., Pahlmann B., Muennich F. (Braunschweig) Hawerkamp K., Pfeiffer B., Schrader H. (ILL) Monnard E. (CEN-G)	PN1	03 02 088	Investigation of the integral β^- -spectrum of $^{235}\text{U}(n_{th},f)$ -fission products. Hawerkamp K., Schreckenbach K., Siegert G., Egidy T.V. (ILL) Keyser U., Muennich F. (Braunschweig)	PN2
03 01 075	Search for unidentified isotopes. Koglin E., Siegert G., Pfeiffer B. (ILL) Greif J. (Giessen)	PN1	03 02 100	Measurements of the angular distribution of the photoelectric effect as a function of photon energy. Blakeway S., Schreckenbach K., Faust H.R. (ILL) Gelletly W. (Manchester)	PN2
03 01 077	Search for unidentified isotopes. Koglin E., Pfeiffer B., Siegert G. (ILL)	PN1	03 02 102	Two-phonon octupole vibration in ^{208}Pb . Mariscotti M.A.J. (Argentina) Gelletly W. (Manchester) Davidson W.F., Schreckenbach K. (ILL)	PN2
03 01 TEST	Test of a foil detector. Siegert G. (ILL)	PN1	03 02 103	The structure of the lowest octupole band in ^{236}U . Faust H.R., Egidy T.V. (ILL)	PN2
03 11 038	SEE 03 11 042		03 02 105	Level scheme of ^{41}K up to 10 MeV with the $^{40}\text{K}(n,\gamma)^{41}\text{K}$ reaction. Barreau G., Boerner H.G., Warner D.D., Egidy T.V. (ILL) Daniel H. (Munich & ILL) Lieb K.P. (Goettingen) Rascher R. (Koeln)	PN3, PN4
03 11 039	Nuclear charge distribution of heavy mass region fission products at various kinetic energies and ionic charge states (chain 136, $\text{U-}^{235}(n_{th},f)$). Faubel W., Braun H., Denschlag H.O., Erten H.N., Meixler H., Poersch W., Sehr R., Sohnius B. (Mainz) Schrader H. (ILL)	PN1	03 02 114	Study of nuclear levels in ^{238}Np . Kern J., Drissi S., Strassmann W. (Fribourg) Boerner H.G. (ILL)	PN3, PN4
03 11 041	SEE 03 11 042		03 02 119	Determination of the deuteron binding energy. Schult O.W.B. (Juelich) Boerner H.G., Faust H.R., Schreckenbach K. (ILL)	PN3
03 11 042	Mass and nuclear charge distribution from thermal neutron induced fission of ^{233}U (light fission fragments) Quade U., Rudolph K. (Munich) Armbruster P., Theobald J.P., Mutterer M., Clerc H.G., Lang W. (Darmstadt) Schrader H. (ILL)	PN1	03 02 120	Detailed level structure of ^{36}Cl and ^{40}K studied with the (n,γ) reactions. Daniel H., Egidy T.V. (Munich & ILL) Boerner H.G., Barreau G. (ILL) Hofmeyr C. (Pelindaba) Lieb K.P. (Goettingen)	PN3, PN4
03 11 046	Nuclear charge distribution of heavy mass region fission products at various kinetic energies and ionic charge state of the fragments (chain 139, $^{235}\text{U}(n_{th}, f)$). Braun H., Denschlag H.O., Faubel W., Poersch W., Sehr R., Sohnius B. (Mainz) Schrader H. (ILL)	PN1			

03 02 123	Study of low-spin states in ^{75}Se and ^{77}Se . Tokunaga Y., Schult O.W.B. (Juelich) Barreau G., Boerner H.G., Faust H.R., Hofmeyr C., Warner D.D. (ILL)	PN2, PN3, PN4	03 03 125	Spectroscopy of ^{96}Rb β^- -delayed neutrons in coincidence with γ -rays depopulating excited states in the final nucleus ^{95}Sr . Schroeder A., Kronenburg, Heigenhauser, Kratz K.L., Gabelmann (Mainz) Jung G., Pfeiffer B. (ILL) Monnard E. (CEN-G)	PN6
03 02 124	Conversion electrons in the $^{109}\text{Ag}(n,e^-)^{110}\text{Ag}$ reaction. Mac Mahon T.D., Mitsunari T. (London) Faust H.R. (ILL)	PN2	03 03 131*	$\gamma\gamma$ -ray directional correlation measurements in even - A cerium isotopes. Scott S.M., Hungerford P. (ILL/Sussex) Warner D.D., Jung G. (ILL) Hamilton W.D. (Sussex)	PN6
03 02 TEST	Response function measurement of an intrinsic germanium detector at the conversion electron spectrometer BILL. Decker R., Wuensch K.D. (Giessen) Siegert G. (ILL)	PN2	03 03 133	High precision Q_β measurements using a magnetic sector field and a hyperpure Ge-detector. Bloenningen F., Rehfield D., Wollnik H. (Giessen) Pfeiffer B., Jung G., Koglin E. (ILL)	PN6
03 03 008	Search for the electric dipole moment of the neutron. Smith K. (Sussex), Harvard, ORNL, Munich, CEN-G, RHEL, ILL	S22	03 03 137	Low lying O^+ excited states in the light even-even nuclei $^{94-96-98}\text{Sr}$ and ^{98}Zr . Schussler F., Monnard E., Pinston J.A. (CEN-G) Pfeiffer B., Jung G. (ILL)	PN6
03 03 083	Non-statistical effects in β -delayed neutron decay of the 2,7 half life isotope ^{94}Rb . Kratz K.L., Schroeder A., Ohm H. (Mainz) Jung G., Wuensch K.D. (Giessen)	PN6	03 03 139	Gamma-gamma directional correlation measurements in even A cerium isotopes. Hamilton W.D. (Sussex) Scott S.M., Hungerford P. (Sussex/ILL) Michelakakis E. (Sussex) Warner D.D. (ILL)	PN6
03 03 101	Gamma and electron spectroscopy of low yield fission products with the mass separator OSTIS (Parts 1 & 2). Schussler F., Monnard E., Pinston J.A. (CEN-G) Jung G., Pfeiffer B. (Giessen/ILL)	PN6	03 03 140	Gamma-ray coincidence and correlation measurements in even mass rubidium isotopes (2nd part). Jung G., Pfeiffer B. (ILL) Alquist L.J., Wollnik H. (Giessen) Hamilton W.D. (Sussex) Hungerford P., Scott S.M. (Sussex/ILL)	PN6
03 03 109	Study of (n, α)- and (n,f)-reactions for several heavy isotopes. Wagemans C. (Mol & Gent) D'Hondt P., Deruytter A., De Clercq A. (Gent) Emsallem A. (Lyon) Asghar M. (ILL)	S10	03 03 143	SEE 03 03 125	
03 03 113	Gamma-ray directional correlation measurements using a polarized target. Hamilton W.D. (Sussex)	H22	03 03 146	Search for symmetric fission in the thermal neutron induced fission of low Z-actinides. Wagemans C. (Mol) D'Hondt P., Deruytter A. (Gent) Caitucoli F., Perrin P. (CEN-G)	S16
03 03 122	Q_β measurements of very neutron-rich Rb isotopes using the mass separator OSTIS. Muennich F., Keyser U., Hawerkamp K. (Braunschweig) Jung G., Pfeiffer B. (ILL) Bloenningen F., Decker R., Muenzel J. (Giessen)	PN6	03 03 148	Study of (n, α) - and (n,f)-reactions for several heavy isotopes. Wagemans C. (Mol) Deruytter A., De Clercq A., D'Hondt P. (Gent) Emsallem A. (Lyon) Barreau G. (ILL)	S10
03 03 123	Conversion electron measurements. Schussler F., Pinston J.A., Monnard E. (CEN-G) Pfeiffer B., Jung G. (ILL) Vanklinken J. (Groeningen)	PN6	03 04 005	Determination of lattice location of light atoms by (n, α) reactions. Biersack J.P., Fink D., Lauch J. (Berlin) Henkelmann R., Mueller K., Jahnel F. (Munich)	S44
03 03 124	Gamma-ray coincidence and correlation measurement in even mass rubidium isotopes (1st part). Jung G., Pfeiffer B. (ILL) Wollnik H. (Giessen) Hamilton W.D. (Sussex) Hungerford P., Scott S.M. (Sussex/ILL)	PN6			

03 05 001	Neutrino oscillations. Boehm F., Hahn A.A. (Caltech) Kwon H., Vuilleumier J.L. (ILL) Cavaignac J.F., Koang D.H., Vignon B. (ISN, Grenoble) Feilitzsch F.V., Moessbauer R.L. (Munich)	S40	04 01 111	Dispersion des ondes acoustiques dans $C_{10}D_{16}$. Damien J.C. (Lille) Lefebvre J. (ILL)	IN2
03 05 003	Search for coherent parity violating effects in neutron interactions with matter. Byrne J., Pendlebury J.M. (Sussex) Dress W.B., Miller P.D. (ORNL) Forte M. (Euratom, Ispra) Green K., Greene G.L. (RHEL) Heckel B., Sumner T.T. (ILL) Ramsey N.F. (Harvard)	S43 PN7	04 01 115	Natural acoustical rotary power. Dorner B., Joffrin J. (ILL)	IN2
03 05 006	SEE 03 05 018		04 01 116	Phonons in adsorbed layers. Croset B., Marti C., Pynn R. (ILL) Thorel P. (CEN-G)	IN8
03 05 017	QED effects in photon scattering. Schumacher M., Smend F., Rullhusen P. (Goettingen) Boerner H.G. (ILL)	PN3	04 01 117	Librons in TTF-TCNQ. Debray D., Kahn R., Decker D (LLB, Saclay) Weger M. (Jerusalem)	IN5
03 05 018	Search for parity violation. Avenier M. (ILL) Cavaignac J.F., Koang D.H., Vignon B. (ISN, Grenoble) Hart R., Wilson R. (Harvard)	PN7	04 01 118	Phonon anomalies of intermediate valence systems. Holland-Moritz E. (Koeln) Pintschovius L. (Karlsruhe)	IN3
03 05 020	Neutron beam focusing with Fresnel zone plates. Klein A.G., Opat G.I., Kearney P. (Melbourne) Gaehler R. (Bayreuth)	H18	04 01 119	Lattice dynamics of Cu-Zn-Al martensite. Gobin P.F., Guenin G. (INSA, Lyon)	IN2
COLLEGE 4			04 01 120	Relation between lattice dynamics and static omega phase formation in β' NiAl. Moss S.C., Ortiz C. (Madrid)	IN2
04 01 038	Phonons in β -gallium. Bosio L., Cortes R. (CNRS Paris) Copley J. (ILL) Teuchert W.D. (Munich)	IN8	04 01 122	High frequent optical phonons in $KMnF_3$. Geick R., Lehner N., Strobel K., Rauh H. (Wuerzburg) Stirling W.G. (ILL)	IN1
04 01 076	Metal-to-semiconductor transition in cerium deuteride. Vorderwisch P. (Berlin) Hautecler S. (Mol)	IN1	04 01 126	Phonon dispersion of the niobium- titanium-carbo-nitride $Nb_{0.8}Ti_{0.2}C_{0.1}N_{0.1}$. Roedhammer P. (Konstanz) Pintschovius L. (Karlsruhe) Christensen A.N. (Aarhus)	IN8
04 01 086	Dimethylacetylene. Batley M. (Macquarie) Owen M. (Oxford)	IN3	04 01 129	Investigation of anharmonicity in PdD_x and PdH_x (test experiment). Burger J.P. (Orsay) Pepy G. (Saclay) Weinzierl P., Blaschko O., Klemencic R. (Wien)	IN8
04 01 088	Phonons in cadmium. Chernyshov A., Romyantsev A. (Moscow) Dorner B., Pynn R. (ILL)	IN2	04 01 130	Lattice dynamics of naphthalene. Kalus J., Schmelzer U. (Bayreuth) Dorner B. (ILL) Pawley G.S. (Edinburgh) Sheka E.F., Bokhenkov E.L. (Moscow) Natkaniec I. (Dubna)	IN8
04 01 108	Phonon anomalies in transition metal nitrides: NbN. Christensen A.N. (Aarhus) Dietrich O.W. (Roskilde) Kress W. (Stuttgart) Teuchert W.D. (Munich)	IN8	04 01 139	Measurement of optical modes in cubic $BaTiO_3$. Bouillot J., Escribe C. (ILL)	IN1
04 01 110	Diffuse librational scattering from deuterated adamantane. Damien J.C. (Lille) Windsor C.G. (Harwell)	IN4	04 01 140	SEE 04 01 122	
			04 01 141	Lattice vibrations in Li_3N . Kress W. (Stuttgart) Grimm H., Press W. (Juelich)	IN8

04 01 149	Phonons dans le β -gallium. Bosio L., Cortes R. (CNRS, Paris) Teuchert W. (Munich) Copley J. (ILL)	IN8	04 02 077	Low frequency modes in the plastic phase of NaOD. Bleif H.J., Kabs M., Dachs H. (Berlin)	IN2
04 01 150	Phonons in RbCN. Ehrhardt K.D. (Juelich)	IN3	04 02 078	Scattering in plastic deuterated pivalic acid. Longueville W., Fontaine H., Marion (Lille) Lefevre J. (ILL)	IN2
04 01 157	Dispersion of phonons in $^{114}\text{CdPt}(\text{CN})_6$. Kaemper M., Weiss A., Meyer H. (Munich)	IN2	04 02 080	Pressure dependence of phase transitions in TTF TCNQ. Comes R., Megtert S. (Orsay) Pynn R., Vettier C. (ILL)	IN8
04 02 45A	Study of commensurate \rightarrow incommensurate phase transition in thiourea. Moudden A., Denoyer F., Lambert M. (Orsay) Fitzgerald W. (ILL)	IN2	04 02 083	Critical neutron scattering near the 193K and the 50K phase transitions in RbCaF_3 . Rousseau M., Ridou C. (Le Mans) Almairac R. (Montpellier) Bouillot J. (ILL)	IN12
04 02 050	Hg_2Cl_2 . Benoit J.P., Hauret G., Luspain Y., Cao-Xuan-An (Orsay)	IN3	04 02 089	Incommensurability (?) in the vicinity of the 273 °K phase transition of $\text{SO}_4\text{LiND}_4\beta$. Debeau M., Quilichini M. (DRP, Paris) Joffrin C., Pynn R. (ILL)	IN2
04 02 059	Inelastic neutron scattering study of the 300 °C ferroelastic transition in barium sodium niobate $\text{Ba}_2\text{NaNb}_5\text{O}_{15}$. Schneck J., Toledano J.C. (Bagneux) Joffrin C. (ILL)	IN2	04 02 090	High pressure study of incommensurate phase in thiourea. Moudden A., Denoyer F., Lambert M. (Orsay) Currat R., Vettier C. (ILL)	IN2
04 02 065	High pressure study of charge density waves in TTF-TCNQ. Megtert S., Comes R. (Orsay) Garito A.F. (Philadelphie) Pynn R., Vettier C. (ILL)	IN8	04 02 092	Incommensurate phase transitions in biphenyl. Cailleau H., Meinel J., (Rennes) Moussa F. (LLB, Saclay) Zeyen C.M.E., Bouillot J. (ILL)	IN12
04 02 066	SEE 04 03 094		04 02 093	Critical dynamic in p-terphenyl with high energy resolution. Cailleau H., Meinel J. (Rennes) Zeyen C.M.E., Heidemann A., Mezei F. (ILL)	IN11
04 02 068	Acoustic phonon dispersion in Mo_6Se_8 . Schweiss P. (Frankfurt) Renker B. (Karlsruhe) Flueckiger R. (Genève)	IN3	04 02 094	Structural phase transition in La_3Se_4 . Knorr K., Loidl A., Feile R. (Mainz) Luethi B. (Frankfurt)	IN3
04 02 069	Soft mode behaviour in heavily reduced SrTiO_3 . Baeuerle D., Wagner D. (Osnabrueck)	IN3	04 03 034	Polarisation analysis. Brown P.J., Escribe C., Ziebeck K.R.A. (ILL)	IN8
04 02 070	SEE 04 02 065		04 03 036	Magnetic response in chromium. Booth J.G. (Salford) Ziebeck K.R.A., Escribe C. (ILL)	IN8
04 02 071	High frequency mode density in TTF-TCNQ. Almairac R., Benoit C., Galtier M., Montaner A., Préfaut (Montpellier)	IN1B	04 03 043	Spin waves in disordered $\text{Pd}_{0.5}\text{Fe}_{0.5}$. Stirling W.G., Ziebeck K.R.A. (ILL)	IN1
04 02 074	Polymerization of a single crystal diacetylene: PTS. Aime J.P., Lefebvre J. (ILL) Pouget J.P. (Orsay) Schott M. (GPS, Paris)	IN2	04 03 061	Lattice dynamics and phonon-magnetic exciton hybridization in Tbp. Knorr K., Loidl A., Luethi B., Feile R. (Mainz)	IN3
04 02 076	Soft mode in biphenyl. Cailleau H., Meinel J. (Rennes) Moussa F. (Saclay, LLB) Zeyen C.M.E. (ILL)	IN2	04 03 071	Excitations in CrCl_3 . Ziebeck K.R.A., Escribe C. (ILL)	IN2
			04 03 074	Magnetic excitations in nickel. Mook H. (ORNL) Tocchetti D. (ILL)	IN1

04 03 077	Spin waves in HoCo ₂ . Castets A., Gignoux D. (CNRS, Grenoble) Hennion B. (LLB, Saclay)	IN8	COLLEGE 5			
04 03 081	Magnetic excitation in Fe ₂ . Petitgrand D., Hennion B. (LLB, Saclay) Escribe C. (ILL)	IN2		05 02 092	Non collinear magnetic structure Mn ₄ N. Fruchart D., L'Héritier P. (CNRS, Grenoble) Givord D., Convert P. (ILL)	D18, D2 D3
04 03 082	Test of gypsum (CaSO ₄ ·2H ₂ O)- Monochromator and -Analyser at IN10. Steiner M., Kakurai K., Knop W. (Berlin)	IN10		05 11 61	Crystal structure of hydrogen beta alumina. Tofield B.C. (Harwell) Newsam J.M. (Oxford)	D9
04 03 085	Magnetic excitations in uniaxially -stressed, single-crystal praseodymium. Macewen K.A. (Salford) Vettier C. (ILL & CNRS)	IN3		05 11 073	β-quartz. Wright A.F., Lehmann M.S. (ILL)	D1A, D9
04 03 087	Spin waves in helical dysprosium. Crangle J. (Sheffield) Ziebeck K.R.A. (ILL)	IN8		05 11 075	Average and superstructure of ε-(C ₃ H ₇ NH ₃) ₂ MnCl ₄ . Depmeier W. (Geneva) Mason S.A. (ILL)	D8
04 03 089	Optical branches and the temperature dependence of the magnetic excitation spectra of Pt ₃ Mn. Paul D.Mack., Cowley R.A. (Edinburgh) Stirling W.G. (ILL)	IN1		05 11 076	Thermal motion in beryllium. Larsen F.K. (Aarhus) Brown P.J., Lehmann M.S. (ILL)	D9
04 03 094	Direct determination of exchange parameters in the tetranuclear cluster [Cr ₄ (OH) ₆ (NH ₃) ₁₂] ⁶⁺ . Furrer A. (Wuerenlingen) Guedel H.U. (Bern) Murani A. (ILL)	IN4		05 12 067	Structure of the pivalic acid plastic phase. Longueville W., Fontaine H. (Lille)	D8
04 03 095	Magnon dispersion in Pd ₂ MnIn _{1-x} Sn _x . Webster P.J., Mankikar R.M. (Salford) Ziebeck K.R.A. (ILL)	IN8		05 12 069*	Hydrosilylation catalysts: neutron diffraction study of [Pt ₂ P ₂ Si ₂ O ₆ C ₃₀ H ₇₄]. Howard J.A.K., Spencer J.L., Stone F.G.A. (Bristol)	D8
04 03 102	Excitation in the ferromagnetic linear chain RbFeCl ₃ . Petitgrand D., Radhakrishna P., Hennion B. (LLB, Saclay) Escribe C. (ILL)	IN3, IN12		05 12 072	Study of the structural disorder in TMA, TCNQ ^{2/3} , (I ₃) _{1/3} . Filhol A., Gaultier J., Dupuis P., Watkins D. (Bordeaux)	D12
04 03 107	Magnetic excitations in the actinide compound uranium arsenide. Lander G.H. (Argonne) Stirling W.G. (ILL)	IN8		05 13 036*	Localisation of H bonded to a metal in hepta-molybdenum [HMo(CO) ₂]P(CH ₃) ₃ I ₄ ⁺ . Poilblanc R. (Toulouse)	D8
04 03 115	Magnetic excitations in Eu _x Sr _{1-x} S. Maletta H., Zinn W. (Juelich)	IN2		05 13 078	Structural investigation of perhydrates. Adams J.M., Ramdas V. (Aberystwyth)	D1A
04 03 117	High resolution measurements of the soliton peak for CsNiF ₃ at small q _c and low energy transfer E. Steiner M., Kakurai K., Dachs H. (Berlin) Kjems J.K. (Riso)	IN10		05 13 080	Etude par diffraction neutronique des composés Mn ₂₃ Y ₆ D _x . Fruchart D., Commandre M., Sauvage D. (CNRS/CEN-G) Sénateur J.P. (INPG)	D1B
04 03 TEST	Solitons in the one-dimensional antiferromagnet TMMC. Boucher J.P., Rossat-Mignod J., Regnault L.P., Renard J.P. (CEN-G)	IN12		05 13 081	Hydrogen bonds in succinic acid. Leviel J.L. (CEN-G, DRF)	D8
04 04 063	Dynamical critical scattering from a two-dimensional, easy-plane, ferromagnet: Rb ₂ CrCl ₄ . Day P., Hutchings M., Janke E. (Oxford)	IN12		05 13 083	Neutron diffraction study of 2-(2'-chlorobenzoylamino)thiazoline. Cohen-Addad C. (Grenoble)	D8
				05 13 084	Structural Study of [HRu ₆ (CO) ₁₈] ⁺ [Ph ₄ As] ⁺ . Raithby P., Lewis J. (Cambridge) Mason S.A. (ILL) Rouse K.D. (AERE Harwell) Nelson W.J.H. (London)	D8
				05 13 087	Location of hydrogen atoms in K ₃ Na(H ₂ P ₂ O ₇) ₂ . Dumas Y., Lapasset J. (Montpellier) Vicat J. (CNRS, Grenoble)	D9

05 13 091	Low temperature neutron diffraction study of N-H-N bond in homo-conjugated cations BHB^+ . Rozière J., Belin C. (Montpellier)	D9	05 15 114	Neutron diffraction study of ferroelectric $RbHSeO_4$ (90 K). Rozière J. (Montpellier)	D9
05 13 095	Localization of hydrogens in NH_4AlF_6 . Fourquet J.L., De Pape R. (Le Mans)	D9	05 15 115	High-resolution (direct space) studies of atomic distribution functions associated with structural phase transitions: $SrTiO_3$ and $CsPbCl_3$. Nelmes R.J., Hutton J. (Edinburgh)	D8
05 14 040	The crystal structure of hexakis-pyridine N-oxide cobalt II perchlorate by neutron diffraction and an examination of the electron density distribution using X-ray and neutron data. Brown R.K., Wood J.S. (Massachusetts) Lehmann M.S. (ILL)	D8	05 15 117	Etude de la structure basse température du chloranile en fonction de la température. Baudour J.L., Cailleau H. (Rennes)	D15
05 14 092	Determination of very accurate thermal and positional parameters in TiO_2 (Rutile). Gonschorek W. (Aachen) Feld R. (ILL)	D8	05 15 119	Domain distribution in $RbCaF_3$. Jex H., Muellner M. (Frankfurt)	D15
05 14 093	Low temperature neutron diffraction experiment with a view to determining charge density distribution. Chattopadhyay T.K., Schnering H.G.V. (Stuttgart) Lehmann M.S. (ILL)	D9	05 15 122	Structural investigation of the anharmonic behaviour of the ions in the Cu^+ ionic conductor Cu_6PS_5Br . Kuhs W.F. (Freiburg) Heger G. (Karlsruhe)	D9
05 14 096	Electron density study in anhydrite $CaSO_4$. Will G., Kirfel A. (Bonn)	D9	05 15 125	Pressure dependence of the structure of TTF-TCNQ. Filhol A., Bravic G., Gaultier J. (Bordeaux) Comes R., Vettier C. (ILL)	D8
05 14 100	Deformation density in formates: sodium formate. Fuess H., Bats J.W. (Frankfurt)	D9	05 15 126	SEE 05 12 072	
05 15 081	Etude de la dilatation thermique du KH_2PO_4 au voisinage du point tricritique. Bastie P., Vallade M. (USM, Grenoble) Meister H. (Euratom, Ispra) Vettier C., Zeyen C. (ILL)	S21	05 15 127	Structure analysis of PTS monomer. Schott M., Bertault M. (Paris, ENS) Williams J.O. (Aberystwyth) Aimé J.P. (ILL)	D8
05 15 099	Lifshitz point in $MnAu_2$. Bloch D., Voiron J. (CNRS, Grenoble) Rossat-Mignod J. (CEN-G, DRF) Vettier C. (ILL)	D1A	05 15 129	An accurate determination of the pressure dependence of the structures of tetragonal KH_2PO_4 and KD_2PO_4 . Nelmes R.J., Meyer G.M., Macintyre G.J. (Edinburgh)	D15
05 15 106	An accurate determination of the pressure dependence of the structure of KH_2PO_4 . Meyer G.M., Nelmes R.J. (Edinburgh)	D15	05 16 051	Neutron Laue diffraction. Marmeggi J.C. (CNRS, Grenoble)	S42
05 15 111	An accurate determination of the temperature dependence of the structure of tetragonal KD_2PO_4 . Meyer G.M., Nelmes R.J. (Edinburgh)	D8	05 16 101	Secondary extinction effects above 1 Å. Rouse K.D., Cooper M.J. (AERE, Harwell) Wilson S.A. (ILL)	D16
05 15 112	High-resolution structural study of cubic $Cu_3^{11}B_7O_{13}Cl$. Nelmes R.J., Meyer G.M. (Edinburgh)	D8	05 16 102	Neutron phase contrast imagery in the interferometer. Schlenker M., Graeff W. (ILL) Bonse U., Bauspiess W. (Dortmund)	D18
			05 16 104	Vacancy ordering in tetragonal niobium nitride, $\gamma-NbN_{0.78}$. Christensen A.N. (Aarhus) Lehmann M.S. (ILL)	D9
			05 16 105	Temperature dependence of the diffuse streak system in K_2SnCl_6 . Prandl W., Hohlwein D., Ihringer J. (Tuebingen)	D12

05 17 115	Magnetic structure of the low temperature phase of NiBr ₂ . Day P. (Oxford) Ziebeck K.R.A. (ILL)	D12 D15	05 22 107	SnF ₂ : study of phase transitions. Pannetier J., Denes G. (Rennes)	D1A
05 17 117	Magnetic structure of the antiferromagnetic phase of (Ti _{1-x} V _x) ₂ O ₃ (x = 0.80 and x = 0.90). Schlenker C., Marezio M., Pernet M. (CNRS, Grenoble)	D15	05 22 108	Structural phase transitions in KCaF ₃ . Nouet J., Bulou A. (Le Mans)	D1A
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07 03 129	Neutron inelastic scattering study of structurally disordered $ZrO_2 \cdot Y_2O_3$ Perry C.H., Feinberg A. (Evanston) Currat R. (ILL)	IN1	07 06 086	Local mode frequencies of hydrogen dissolved in hcp metals/Optical phonon frequencies for hydrogen-metal systems. Ross D.K., Carlile C.J., Khoda-Bakhsh R., Anderson I.S. (Birmingham)	IN1B
07 03 136	Voids and crack nucleation in fatigued copper single crystals. Kettunen P.O., Lepisto T. (Tampere) Kostorz G. (Stuttgart) Goeltz G. (ILL)	D11	07 06 089	SEE 07 06 086	
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07 06 094	Diffusional broadening of host-lattice atoms in the presence of diffusion of impurity interstitial atoms (System VD_x). Wipf H., Magerl A. (Garching)	IN4		Stuhrmann H. (Hamburg)	
07 06 097	Hydrogen diffusion in Mg_2Ni . Prandl W., Buchner H., Knorr K., Toepler J.M. (Stuttgart)	IN10	08 02 072	SEE 08 02 064	
07 07 009	Proton motion in superionic conductor H^+ (H_2O) _n β alumina. Baffier N., Colombari P. (Paris)	IN5 IN10	08 03 002	Neutron scattering studies of chromatin. Baldwin J.P., Bradbury E.M., Carpenter B.G., Boulter E.M., Poland G.A., Read C. (Portsmouth)	D11
07 07 017	Anisotropy of Ag^+ ion diffusion in α -AgI single crystals. Funke K., Hoeh A. (Goettingen)	IN5	08 03 002	Neutron scattering studies of chromatin. Baldwin J.P., Carpenter B.G., Thorne A., Sibbet G., Read C., Bradbury E.M., Kneale G.G. (Portsmouth)	D11
07 07 019	Antifluorite structured Li^+ electrolytes. Steele B.C.H., Catlow C.R.A., Brah A.S. (London)	D1A	08 03 032	DNA higher order structure in solution. Bram S. (California)	D11
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- BLETRY J. Thèse de Doctorat d'Etat, Université Scientifique et Médicale et Institut National Polytechnique de Grenoble (Mars 1979). Diffraction des Neutrons Polarisés par les Phosphures de Cobalt Amorphes. Interprétation par des Modèles Structuraux Applicables aux Métaux et Alliages Liquides.
- BRAUMANDL F. Doktorarbeit, Technische Universität München (Dez. 1978) Präzisionsmessungen von hochenergetischen Konversions-elektronenlinien und Bestimmung von Neutronenbindungsenergien.
- BURGER N. Doktorarbeit, Johann Wolfgang Goethe-Universität Frankfurt (März 1979). Strukturen, Elektronendichteverteilungen und magnetische Eigenschaften der Formiate des Calciums, Kupfers und Zinks.
- DERRIDA B. Thèse de Doctorat d'Etat, Université Paris-Sud (Novembre 1979). Effets du désordre et de la frustration dans les systèmes magnétiques. Propriétés critiques des bifurcations de transformations unidimensionnelles.
- FELD R.H. Doktorarbeit, Universität Marburg (Oktober 1979). Die Elektronendichteverteilung in α -Oxalsäuredihydrat -eine Röntgen und Neutronenbeugungsuntersuchung bei tiefen Temperaturen.
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- ROBERT A. Thèse de Docteur-Ingénieur, Université Scientifique et Médicale de Grenoble (Juin 1979). Spectrométrie de Neutrons Rapides par Détecteurs Semi-Conducteurs à Lithium 6 dans le Réflecteur d'une Pile Piscine à Eau Légère.

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- CHAUVIN C. Thèse de Doctorat d'Etat, Université de Grenoble (Mars 1979)
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- MÜLLER K. Doktorarbeit, Technische Universität München (1979). Die
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- PFEIFFER B. Doktorarbeit, Justus-Liebig-Universität Giessen (1978). Die
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- SOEFFGE F. Doktorarbeit, Ludwig-Maximilians-Universität München
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WORKSHOPS ORGANIZED BY THE I.L.L. IN 1979

- Workshop on « The Contribution of Neutron Inelastic Scattering to some current Problems in Metallic Magnetism ».
(organized by W.G. Stirling, I.L.L. and J. Villain, C.E.N.-Grenoble) I.L.L.
2-3 April 1979
- Workshop on « Nuclear Spectroscopy of Fission Products »
(Organized by G. Barreau, B. Pfeiffer, H. Schrader, G. Siegert, T. von Egidy, D.D. Warner, I.L.L. and J. Blachot, J.P. Bocquet, J. Crançon, E. Monnard, H. Nifenecker, J.A. Pinston, C. Ristori, F. Schussler, C.E.N.-Grenoble)
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(organized by F. Mezei, I.L.L. Grenoble) I.L.L.
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BROT C.	79BR168	CODDENS G.	79ME271	DEMAZEAU G.	79DE137	
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		COPPOLA R.	79BO259	DIANOUX A.J.	79DI015T 79DI017T 79DI110	
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CANDY J.P.	79RE144	CURRAT R.	79DA180			
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		DACHS H.	79CU322	DUEE E.D.	79BE281	
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ACKNOWLEDGEMENTS

The Institut Laue-Langevin wishes to thank
all contributors to the compilation of the

ANNUAL REPORT 1979

Edited by Shirley Grant.
Compiled by the Scientific Secretariat and Library.

Lay-out and styling
Roger David - Graphiste - Grenoble

Printed in France by Dardelet 911274 Grenoble

Photographs by :

Alsthom-Atlantique, Studio A2C, A. Bresson, B. Hamelin



Annual Report ILL 1979