institut max von laue · paul langevin · grenoble · france

ANNUAL REPORT 1982

Applications for the use of the ILL facilities

All research proposals have to be submitted to the Scientific Council for approval. The Council meets 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) 48.72.44 B. Maier
48.71.79 G. Briggs
48.70.41 K. Mayer-Jenkins (Secretary)
48.70.82 A. Taffut (Secretary)
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).

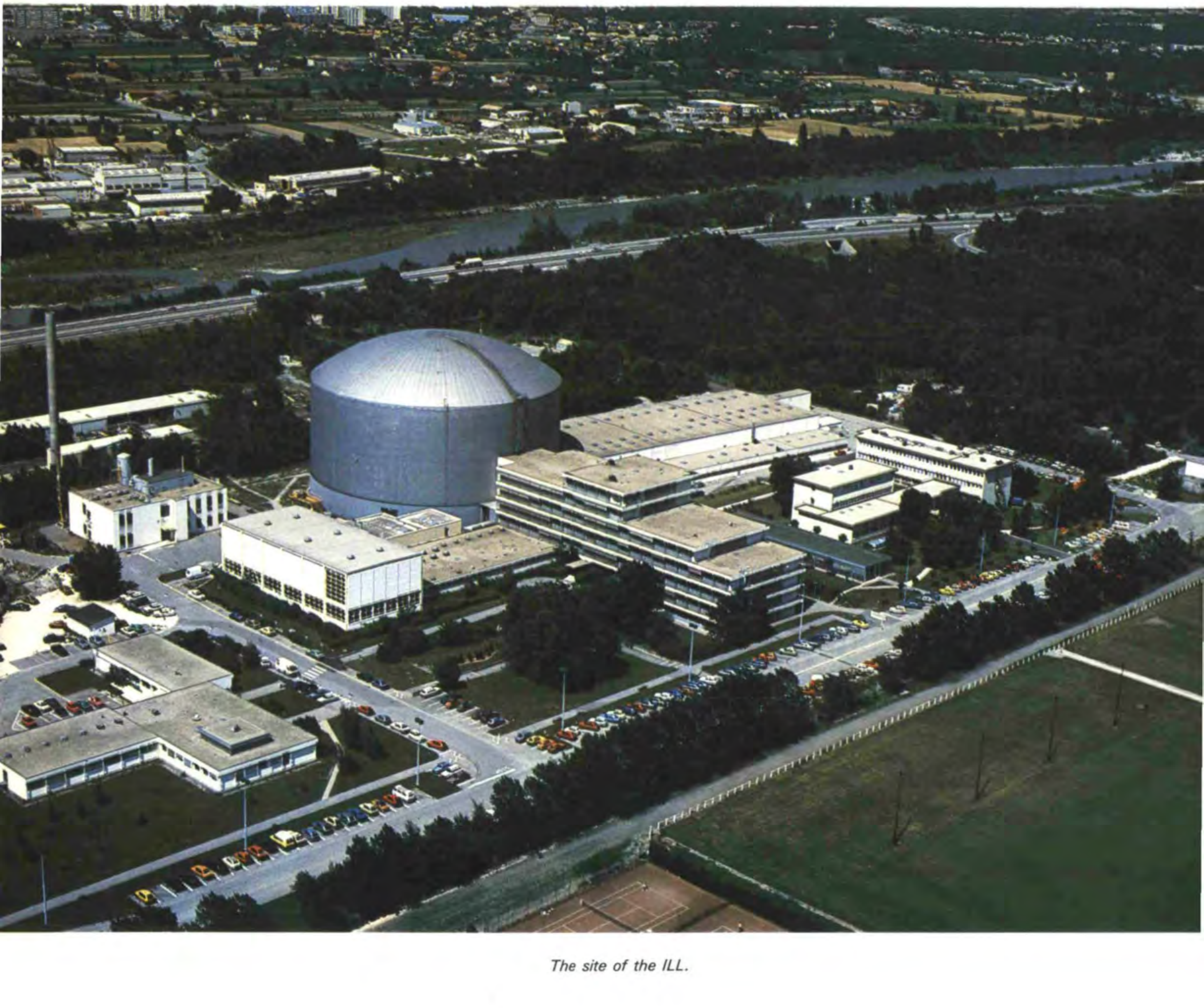
Commercially exploitable results

Visitors and ILL scientists may occasionally be involved in experiments which have possible commercial applications. If any scientist considers that this is the case, he should get in touch with the Scientific Secretary.

FRONT-COVER PICTURE:
Histogram of counts of the weakest reflection (051) from DKDP ($=KD_2PO_4$) on the Position Sensitive Detector Prototype D 19 A.

ANNUAL REPORT 1982

Institut von Laue . Langevin Grenoble . France



The site of the ILL.

CONTENTS

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 science. 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 the 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. On December 9, 1981 a protocol was signed by representatives from the three member countries which extended the life of the ILL until December 31, 1992.

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

- Kernforschungszentrum Karlsruhe GmbH, Germany
- Centre National de la Recherche Scientifique, France
- Commissariat à l'Energie Atomique, France
- Science and Engineering 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 Associates, the other two by the remaining Associates. A Scientific Council, nominated by the Associates, advises the Directors on the scientific programme and on practical aspects relating to its operation.

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

The purpose of the ILL thus differs from other research institutes in so far as it is a central facility created so that chemistry, solid state physics, fundamental and nuclear 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.

EXTERNAL ORGANISATION OF THE INSTITUT LAUE-LANGEVIN 1982

Great Britain	France	Germany

Associates of the Institut

Great Britain	France	Germany
SCIENCE AND ENGINEERING RESEARCH COUNCIL (SERC)	COMMISSARIAT A L'ENERGIE ATOMIQUE (CEA) CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)	KERNFORSCHUNGSZENTRUM KARLSRUHE (KFK)

Steering Committee
(at its last meeting)

Great Britain	France	Germany
Egginton - (SERC) Hobbis - (SERC) Leadbetter - (SERC) Ottewill - (Univ. of Bristol)	Cribier - (CEA) Horowitz - (CEA) Lehmann - (CNRS) Mercouroff - (CNRS)	Döll - (BMFT) Hofbauer - (BMF) Klose (Chairman) - KFK Simon - Max-Planck-Ges.

Audit Commission

Great Britain	France	Germany
Pettet Millington	Gouzien Racine	Binder Riess

Scientific Council
(at its last meeting)

Armbruster	- GSI Darmstadt	Fuller	- Univ. Keele	Ottewill	- Univ. Oxford
Benoit	- CNRS Strasbourg	Galy	- CNRS Toulouse	Rainford	- Univ. Southampton
Comes	- Univ. Paris-Sud, Orsay	Goodenough	- Univ. Oxford	Schmatz	- KfK Karlsruhe
Cowley	- Univ. Edinburgh	Hart	- King's Coll., London	Schofield	- AERE Harwell
Dachs	- HMI Berlin	Horner	- Univ. Heidelberg	Schult	- KfA Jülich
Drifford	- CEN Saclay	Joly	- CEN Saclay	Stuhrmann	- DESY, Hamburg
Ebel	- IBMC Strasbourg	Lemaire	- CEN Saclay	Villain	- CEN Grenoble
Enderby	- Univ. Bristol	Miller	- Univ. Oxford	Winter	- ILL
Fender	- ILL (Chairman)	Mills	- Univ. Reading		

SUBCOMMITTEES OF THE SCIENTIFIC COUNCIL

Fundamental and Nuclear Physics	Structural and Magnetic Excitations	Crystal and Magnetic structures		Liquids, Disorders and Defects in Mater.	Biochemistry	Chemistry: Large Molecules	Chemistry: Surfaces and Spectroscopy	Instruments
Lynn	Challis	Coles	Cheetham	Dupuy	Blundell	Charvolin	Conard	Gläser
Schult	**Cowley**	Day	Fischer	Durand	Chabre	Cotton	Ehrhardt	Nifenecker
Shotter	Hanke	Fuess	**Galy**	Enderby	**Fuller**	Hoffmann	Forstmann	Pepy
Signarbieux	Horner	Goodenough	Hahn	Hensel	Giège	Kilian	**Hüller**	Press
Specht	Lajzerowicz	**Lemaire**	Marezio	Schilling	Janin	North	Lassègues	**Rainford**
Vinh Mau	Lambert	Plumier	Pouget	**Schofield**	Miller	**Ottewill**	Mills	Renouprez
	Rainford	Prandl	Sim	Stewart	Nierhaus	Weill	Thomas	Schmatz
	Rossat-Mignot	Souletie		Suck	Sänger			Stewart
	Schmatz				Schulz			Steyerl
								Stirling G.

INTERNAL ORGANISATION OF THE INSTITUT LAUE-LANGEVIN AT 1.1.83

DIRECTORATE

Fender	Director
Ruppersberg	Co-Director
Winter	Co-Director

OFFICE OF THE SCIENTIFIC SECRETARY

Maier

SAFETY & HEALTH PHYSICS

Sallé

DELEGUE TECHNIQUE

Jacquemain

COLLEGES (College Secretaries)

College 2: THEORY
Becker

College 3: FUNDAMENTAL AND NUCLEAR PHYSICS
Schreckenbach

College 4: EXCITATIONS
Paul

College 5: CRYSTAL AND MAGNETIC STRUCTURES
Bouillot/Burke

College 6: LIQUIDS, DISORDERED AND DEFECT MATERIALS
Dianoux

College 8: BIOCHEMISTRY
Worcester

College 9: PHYS. CHEMISTRY/POLYMERS
Poinsignon/Oberthür

INSTRUMENT GROUPS

3 - AXIS SPECTROMETERS
Dorner - Stirling

INSTRUMENTS FOR FUNDAMENTAL AND NUCLEAR PHYSICS
Gönnenwein - Börner

DIFFRACTOMETERS
Brown - Lehmann

DIFFUSE SCATTERING AND TIME OF FLIGHT SPECTROMETERS
Beaufils/Janot - Mezei/Heidemann

MONOCHROMATORS
Freund

LIBRARY

Castets

SCIENTISTS' SECRETARIAT

Parisot

DEPARTMENTS

INSTRUMENT OPERATION DEPARTMENT
Gönnenwein

REACTOR DEPARTMENT
Franzetti

TECHNICAL DEPARTMENT
Faudou

DEPARTMENT OF COMPUTING
Rimmer

ADMINISTRATION
Grillo

Extension of the Intergovernmental Agreement on the I.L.L.

The extension of the Intergovernmental Agreement on the ILL until 31 December 1992 was signed by the Ambassadors of France and the Federal Republic of Germany as well as by a representative of the British Government in London on 9 December 1981.

Visits and events in 1982

Mr. William Shelton, British Parliamentary Under-Secretary of State of the Department of Education and Science (second from left) visited the ILL on 7July 1982. In the picture he is talking to Dr. B.E.F. Fender (ILL) and Dr. A. Leadbetter (Head of the Neutron Division of the Rutherford Appleton Laboratories; at the right).

On the occasion of the Spring meeting of the Scientific Council and to celebrate the 50th anniversary of the discovery of the neutron by Sir J. Chadwick the ILL lecture hall was named "Chadwick Amphitheatre". The "baptismal ceromony" was directed by Prof. T. Springer and his colleagues Dr. B.E.F. Fender and J. Winter.

Dr. B.E.F. Fender succeeded Prof. T. Springer as ILL Director on 1 October 1982.

Prof. H. Ruppersberg was appointed co-Director with effect from 1 October 1982.

The Scientific Council during the meeting of 15 October 1982.

On the open day of 27 March 1982 more than 950 guests from Grenoble and district visited the ILL premises and laboratories.

INTRODUCTION

director's report

I write this report on 31 December with a view from my office of a clear blue sky and the sun on snow-covered mountains. It is a holiday, but all the instruments are functioning over the New Year period and there are a good many ILL and visiting scientists who have interrupted their holiday to make use of scarce instrument time. The pressure on instruments is illustrated by the last round of applications to the Scientific Council in October, when 2243 days were allocated out of a total demand of 5724 days.

1982 has been a pivotal year for the Institut. In conjunction with the Instrument Sub-committee and the Scientific Council, we have taken substantial steps in planning for the new cold source to operate in 1986, so that the range of instruments and facilities we can offer in the latter half of the decade is now largely clear. 1982 has also been the first year in which there have been substantial unscheduled interruptions to the reactor operation. After more than ten years of remarkably reliable service much work has to be undertaken to renew vulnerable parts. The steps necessary will reduce the operating time for the reactor in each of the next three years but we can then expect to return to full operation in 1986. The modernisation programme launched in 1979 had as a major objective the redesign and reconstruction of the reactor face instruments. The first of the major new instruments are undergoing tests, and outline plans for improvements to the remaining instruments, although now funded by the normal budget, have been agreed during the year.

Second cold source

The approval of a new horizontal cold source at the end of 1981 aimed at building on the Institut's strengths in small angle scattering, high resolution spectroscopy and the application of polarised neutrons in solid state physics and elementary particle physics. It also implied a degree of specialisation appropriate to an era where there will be significant contributions around the world from pulsed sources. On of the major beneficiaries will be biologists so that it was appropriate that the year should begin with the European Molecular Biology Laboratory's antenna moving into its new building on the ILL site. The increased scientific interaction arising from close proximity has been strongly evident throughout the year and we are now deriving full benefit from the pioneering work of Andrew Miller and Bernard Jacrot as successive Heads of the outstation. One product of the enhanced collaboration is an agreement to build jointly a new diffractometer (DB 21) which will use the scattering contrast differences of H_2O and D_2O to elucidate (to 10-15 Å resolution) structural features of biological crystals (e.g. viruses) with very large unit cells up to 400 Å. However, nearly all the other main areas of science will benefit from the plans made during 1982. We have started planning an improved triple axis spectrometer (IN 14) which will cover both cold and thermal neutron ranges, which should make it an ideal instrument to study new systems where the lattice dynamics (or the magnetic behaviour) cannot be well predicted. Approval has also been given for the construction of an ultra-high resolution spin echo instrument. The existing instrument, IN 11, which will be further improved in 1983, gives the highest resolution of any neutron spectrometer — down to several neV — and is producing new results in fields as diverse as micelles and critical magnetic scattering. The aim of IN 14 will be to provide an improvement in energy resolution by a further order of magnitude, thus further narrowing the gap between the energy and momentum transfer ranges accessible by light scattering and NSE. Although the advantages of exploring polymer dynamics down to very small energy transfers are clear, so far the value of such studies in biology remains a tantalisingly open question.

The importance of small angle scattering studies for biology, as well as polymers, colloids and nucleation in metals and glasses, is of course fully established, and the competition for time on the small angle scattering machines has been fiercer than ever with many good projects having to be rejected. The first steps in defining a new low Q instrument for the second cold source have been taken and further consideration has been given to the transfer of IN 10 to the new source. Proton tunnelling spectroscopy is now a fully fledged field of study and IN 10 one of the most valuable instruments for physical chemists.

Detailed consideraition has also been given to the nuclear and fundamental physics programme. Mainly the experiments will be of the special beam type and may include a further search for neutron-antineutron oscillations; the investigation of angular correlations between the electron and antineutrino momenta and neutron spin by the study of free neutron decay as well as parity non-conservation of nuclear forces by the study of thermal neutron-proton interactions.

Reactor renewal programme

The unforeseen events in the reactor operation were the rupture of the suction pipe of the heavy water circulating system, and a small leak which developed in the H 12 beam tube IN 4. The former caused a halt of the reactor from 20 April to 30 June, the latter an interruption from 5 July to 27 July for the routine replacement of a new tube. The damaged section of the suction pipe is inspected regularly by television cameras and shows no sign of further deterioration. Tests on the beam tube show that the leak arose from a very fine crack a few centimetres from the end of the beam tube.

The first part of a revised programme of beam tube replacement has the approval of the safety authorities and will take place from February to May 1983. We plan to replace the remaining beam tubes in an extended shutdown lasting perhaps as long as 12 months, beginning mid-1984. During this period the damaged suction pipe will also be repaired, the new vertical cold source installed and the hot source replaced.

Modernisation programme

The end of 1982 sees the first substantial benefits from the modernisation of the reactor face instruments. The triple axis instrument IN 1 B on the hot source is being tested, as is the liquids diffractometer D 4 B. PN 8, the coincidence fission spectrometer which measures both the velocity and kinetic energies of correlated fragments in binary fission, is working and has achieved mass resolution of one on the lighter fragment.

Steady progress has also been made on other major projects: the diffraction instruments D 19 B, D 2 B, D 20 (to replace D 8, D 1 A and D 2); and the polarisation analysis instrument IN 20 (which will replace IN 2). Plans have been drawn up to considerably improve the flux on D 9 and IN 4.

Important advances have also been made on D 7 B where supermirrors are now used routinely for the analysis of neutron spin. Full polarisation analysis not only allows magnetic and nuclear contributions to be separated, it separates incoherent and coherent contributions and so allows the individual motions and collective motions to be separately studied. Pioneering studies on liquid sodium and on a molecular crystal have begun in what promises to be a whole area of exciting studies.

Scientific programme

The strength of the Institut's scientific programme is the variety provided by its many visitors. But the interaction with Institut scientists frequently shapes the particular direction of individual projects. Often this is through the instrumentation which is why I have laid emphasis on the instrumental progress and plans. Frequently, however, it arises from scientific discussions and collaborations with in-house scientists or from collaborations between visitors from different laboratories (often in different countries) which the ILL catalyses. Many examples are provided in the following pages, but striking examples are the UK-French-German-ILL collaborations, which have led to considerable advances in our understanding of magnetism of transition metals; the CERN/Padova/Rutherford Laboratory/ILL search for baryon violations which has placed a limit on the neutron-antineutron oscillation time of 10^6 secs.; and the Berlin-ILL collaboration on the mapping of protein distribution and shapes in ribosomes. Quantitatively the vigour of the Institut's scientific life is seen from the publications by ILL staff:

1978 :	300
1979 :	250
1980 :	375
1981 :	281
1982 :	340

Personnel

On 1 October 1982 Prof. T. Springer left the Institut to return to Jülich after 5 1/2 successful years as Assistant Director and then Director, and Prof. H. Ruppersberg succeeded him as the German Assistant Director.

Monsieur P. Nozières was elected to the French Academy of Science, Monsieur F. Mezei to the Hungarian Academy of Science, Monsieur C. Janot arrived in July as the Senior Scientist with an interest in metal physics and disordered systems.

College 7 has disbanded; College 6 now deals with defect and disordered materials as well as liquids and amorphous solids. The magnetic interests of College 7 are expressed in Colleges 4 and 5. The Technical and Computing Departments have been reorganised to allow the former to deal more readily with instruments and methods, and the latter to respond more easily to the changing balance between data acquisition and data treatment.

B.E.F. FENDER

bericht des direktors

Ich schreibe diesen Bericht am 31. Dezember 1982 und blicke dabei von meinem Büro aus auf einen klaren, blauen Himmel und sonnige, schneebedeckte Berge. Es ist Feiertag. Doch die Experimentiereinrichtungen des Instituts stehen deshalb nicht still. Eine beachtliche Anzahl der ILL-Physiker und der Gastwissenschaftler haben ihren Urlaub unterbrochen, um über die Neujahrstage wertvolle Messzeit zu nutzen. Wie gross die Nachfrage nach Messzeit an den Experimentiereinrichtungen ist, wird durch die letzte Sitzung des Wissenschaftlichen Rates im Oktober illustriert : Von insgesamt 5 724 beantragten Messtagen konnten nur 2 243 zugeteilt werden.

1982 ist für das Institut ein entscheidendes Jahr gewesen. In gemeinschaftlicher Arbeit mit dem Wissenschaftlichen Rat und dem Unterausschuss für Instrumentierung hat das Institut die Planung der neuen, voraussichtlich 1986 betriebsfertigen Kalten Quelle in beträchtlichem Masse vorangetrieben, mit dem Ergebnis, dass jetzt Typ und Anzahl des in der zweiten Hälfte der Achtzigerjahre zur Verfügung stehenden Angebots an Instrumenten und Einrichtungen weitgehend feststehen. 1982 ist auch das erste Jahr gewesen, in dem der Reaktorbetrieb durch unerwartete Unterbrechungen beeinträchtigt worden ist. Nach über 10 Jahren aussergewöhnlich reibungslosen Servicebetriebs kommt jetzt eine grosse Arbeitslast auf uns zu, da anfällige Reaktorkomponenten ausgewechselt werden müssen. Die in diesem Sinne zu ergreifenden Massnahmen werden einen reduzierten Reaktorbetrieb in den nächsten drei Jahren zur Folge haben ; jedoch wird der Reaktor aller Voraussicht nach 1986 wieder voll in Betrieb sein. Eines der Hauptziele des im Jahre 1979 begonnenen Modernisierungsprogramms ist es, die direkt am Reaktor befindlichen Instrumente neu zu konzipieren oder umzubauen. Die ersten dieser Experimentiereinrichtungen werden gegenwärtig erprobt. Für die übrigen Instrumente sind im Laufe des letzten Jahres Entwürfe für Verbesserungsvorschläge ausgearbeitet worden, welche allerdings jetzt über das Normalbudget finanziert werden.

Zweite Kalte Quelle

Ende 1981 ist die neue horizontale Kalte Quelle mit dem Ziel genehmigt worden, die Vorherrschaft des Instituts in der Kleinwinkelstreuung, der hochauflösenden Spektroskopie und der Verwendung polarisierter Neutronen in der Festkörper- und Elementarteilchenphysik weiter auszubauen. Dieser Beschluss bedeutet einen gewissen Grad an Spezialisierung, der sich in einer Epoche, wo Spallationsquellen weltweit bedeutsame Forschungsbeiträge erbringen, als durchaus notwendig erweist. Unter anderem profitieren davon hauptsächlich die Biologen und es war daher angemessen, das Jahr mit dem Umzug der Aussenstelle des European Molecular Biology Laboratory in das für es bestimmte neue Gebäude auf dem ILL-Gelände zu beginnen. Die geographische Nähe hat sich das ganze Jahr über fruchtbar auf die Zusammenarbeit der beiden Institute ausgewirkt, so dass die zukunftweisenden Arbeiten von A. Miller, dem ehemaligen Leiter des EMBL und seinem Nachfolger B. Jacrot jetzt ihre volle Wirkung erzielen. Ein Ergebnis dieser verstärkten, wissenschaftlichen Zusammenarbeit ist das gemeinsame Projekt zum Bau eines neuen Diffraktometers (DB 21). Mit Hilfe der Kontrastmethode H_2O/D_2O (bis zu einer Auflösung von 10-15 Å) sollen hier die strukturellen Eigenschaften biologischer Kristalle (z.B. Viren) mit sehr grossen Einheitszellen bis zu 400 Å untersucht werden. Jedoch werden auch nahezu alle übrigen wissenschaftlichen Hauptgebiete von den 1982 gefassten Plänen profitieren. So hat zum Beispiel die Planung eines verbesserten Dreiachsenspektrometers (IN 14) begonnen, das sowohl kalte als auch thermische Neutronenenergien umfasst, wodurch es wahrscheinlich zu einem idealen Instrument für die Untersuchung neuer Systeme werden wird, in denen die Gitterdynamik (oder das magnetische Verhalten) nicht sehr präzise vorausgesagt werden kann. Ebenfalls genehmigt wurde der Bau eines höchstauflösenden Spin-Echo Spektrometers. Das vorhandene Instrument, IN 11, das 1983 noch weiter verbessert werden wird, erzeugt die höchste, bis jetzt an einem Neutronenspektrometer erreichte Auflösung -bis zu mehreren Nano-Elektronenvolt- und es werden damit Ergebnisse auf so verschiedenen Gebieten wie Mizellen und kritische magnetische Streuung erzielt. Mit dem neuen Instrument soll eine Verbesserung der Energieauflösung um eine Grössenordnung erreicht und so der Abstand zwischen dem Energie- und Impulsübertrag noch verkleinert werden, welcher der Lichtstreuung und der Spinechomethode zugänglich ist. Obwohl die Vorteile der Untersuchung des dynamischen Verhaltens von Polymeren bis zu sehr kleinen Energieüberträgen bekannt sind, bleibt der Wert solcher Untersuchungen im biologischen Bereich bis jetzt noch eine drängende, offene Frage.

Die Bedeutung der Kleinwinkelstreuung für die Biologie sowie für Polymere, Kolloide und der Nukleierung in Metallen und Gläsern ist längst kein Geheimnis mehr und der Wettbewerb um Messzeit am Instrument für Kleinwinkelstreuung ist intensiver denn je, mit der Folge, dass viele gute Forschungsprojekte zurückgewiesen werden müssen. Die ersten Schritte zum Entwurf eines Spektrometers mit niedrigem Q-Bereich für die zweite Kalte Quelle sind bereits getan und Überlegungen zur Überführung des Instruments IN 10 an die neue kalte Quelle wurden angestellt. Die Proton-Tunnelspektroskopie ist nunmehr ein voll entwickeltes Forschungsgebiet. IN 10 wurde deshalb eines der wichtigsten Instrumente der Physikalischen Chemie.

Für das Forschungsprogramm der Kern- und Grundlagenphysik sind ebenfalls sehr ausfürliche Überlegungen angestellt worden. Es wird hauptsächlich spezielle Strahlexperimente betreffen : Eine eventuelle Fortsetzung der Suche nach Neutron-Antineutron-Oszillationen, sowie die Winkel- Korrelationen zwischen dem Elektron und den Anti-neutrino-Drehimpulsen und dem Neutronenspin mittels der Untersuchung des Zerfalls des freien Neutrons, und die Nichterhaltung der Parität von Kernkräften mit Hilfe der Untersuchung der Wechselwirkung von thermischen Neutronen und Protonen.

Erneuerungsprogramm des Reaktors

Die beiden unvorhersehenen den Reaktorbetrieb beeinträchtigenden Ereignisse waren ein Bruch im Ansaugrohr des Schwerwasserkreislaufs und ein kleines Leck im Strahlkanal H 12, der das Instrument IN 4 mit Neutronen versorgt. Das erste Ereignis verursachte einen Reaktorausfall vom 20. April bis 30. Juni 1982, das zweite eine Betriebsunterbrechung vom 5. bis 27. Juli 1982 zur Ausführung des Strahlrohrersatzes. Die beschädigte Stelle des Ansaugrohres wird nach jedem Reaktorzyklus regelmässig mit einer Fernsehkamera inspiziert und zeigt bisher keine Verschlimmerung des Schadens. Die soweit am Strahlkanal H 12 durchgeführten Untersuchungen haben ergeben, dass das Leck auf einen kleinen, einige Zentimeter vom Ende des Strahlrohres entfernt liegenden Riss zurückzuführen ist. Der erste Teil eines geänderten Strahlrohraustauschprogramms ist von den Sicherheitsbehörden genehmigt worden und wird anlässlich des von Februar bis voraussichtlich Mai 1983 vorgesehenen Reaktorhalts durchgeführt werden. Die restlichen Strahlkanäle sollen während eines langen voraussichtlich Mitte 1984 beginnenden und bis zu 12 Monaten dauernden Reaktorstillstands ausgetauscht werden. In diesem Zeitraum soll auch das beschädigte Sammelrohr repariert sowie die neue senkrechte Kalte Quelle und der Ersatz der Heissen Quelle installiert werden.

Modernisierungsprogramm

Ende 1982 wurden die ersten Erfolge der Modernisierung der direkt am Reaktor installierten Instrumente sichtbar. Das Dreiachsen-Spektrometer IN 1 B und das Flüssigkeitsdiffraktometer D 4 B beide an der Heissen Quelle werden gegenwärtig erprobt. PN 8, das Spaltprodukt-Koinzidenz-Spektrometer, das sowohl Geschwindigkeiten als auch kinetische Energien korrelierter Spaltprodukte bei der binären Spaltung misst, ist in Betrieb. Es sind damit Auflösungen an leichteren Spaltprodukten von 1 Masseneinheit erzielt worden.

Die Durchführung der anderen grösseren Projekte schreitet ebenfalls stetig voran : Die Diffractometer D 19 B, D 2 B, D 20 (als Ersatz von D 8, D 1 A und D 2), sowie das Dreiachsenspektrometer mit Polarisationsanalyse IN 20 welches IN 2 ersetzen wird. Überdies liegen Pläne zur Erhöhung des Neutronenflusses an D 9 und IN 4 vor. Bedeutende Fortschritte sind auch an D 7 B zu verzeichnen, wo jetzt routinemässig Superspiegel zur Analyse des Neutronenspins verwendet werden. Mit Hilfe der Polarisationsanalyse können nicht nur magnetische und nukleare Streuung voneinander getrennt werden, sondern auch kohärente und nicht kohärente Beiträge, was die getrennte Untersuchung individueller und kollektiver Spin-Bewegungen ermöglicht. Pionierarbeit wird auch seit kurzem mit der Untersuchung von flüssigem Natrium und eines Molekular-Kristalls geleistet, ein hinsichtlich seiner Forschungmöglichkeiten höchst vielversprechendes Gebiet.

Wissenschaftliches Programm

Die Stärke des wissenschaftlichen Programms des Instituts beruht auf der Vielfalt des von den Gastwissenschaftlern am ILL durchgeführten Experimentierprogramms. Doch trägt die Wechselwirkung mit den ILL Wissenschaftlern ebenfalls häufig entscheidend dazu bei, einzelnen Projekten eine bestimmte Richtung zu verleihen. Oft geschieht dies bei der Definition der Instrumentierung und deshalb habe ich auch gerade besonderes Gewicht auf instrumentelle Planung und Fortschritt gelegt. Häufig nimmt ein Projekt erst bei wissenschaftlichen Gesprächen und in der Zusammenarbeit mit ILL-Wissenschaftlern oder durch den Informationaustausch zwischen Gastforschern aus verschiedenen Laboratorien (und oft aus verschiedenen Ländern) Gestalt an, wobei das ILL als Katalysator wirkt. Dies wird auf den nächsten Seiten an zahlreichen Beispielen illustriert : Besonders eindrucksvoll ist die britisch-deutsch-französische Zusammenarbeit mit ILL-Wissenschaftlern, die zu entscheidenden Fortschritten in der Kenntnis des magnetischen Verhaltens in Übergangsmetallen geführt hat, sowie die gemeinsame Suche der Laboratorien CERN, Padua, Rutherford, ILL nach der Verletzung der Baryonenzahl, wobei für die Neutron-Anti-Neutron Oszillationszeit eine Grenze von 10^6 Sekunden erreicht wurde oder die Zusammenarbeit zwischen Berlin und dem ILL zur Ermittlung der Proteinverteilung und -gestalt in Ribosomen. Rein quantitativ gesehen zeigt die Anzahl der von ILL-Wissenschaftlern verfassten Veröffentlichungen die intensive wissenschaftliche Tätigkeit des Instituts :

1978 :	300
1979 :	250
1980 :	375
1981 :	281
1982 :	340.

Personalnachrichten

Am 1. Oktober 1982 hat Professor T. Springer das Institut nach fünfeinhalb erfolgreichen Jahren als stellvertretender Direktor und Direktor verlassen und ist nach Jülich zurückgekehrt. Herr Professor Ruppersberg hat als stellvertretender Direktor seine Nachfolge angetreten.

Herr P. Nozières wurde in die französische und Herr F. Mezei in die ungarische Akademie der Wissenschaften gewählt. Herr C. Janot übernahm im Juli seine Funktion als Senior Scientist, mit speziellem Interesse für Metall-Physik und ungeordnete Systeme.

Kollegium 7 ist aufgelöst ; Kollegium 6 hat davon den Bereich der defekten und ungeordneten Systeme in Werkstoffen sowie Flüssigkeiten und amorphe Substanzen übernommen, während Kollegium 4 und 5 die magnetischen Arbeiten von Kollegium 7 fortführen. Die technische und die Informatik-Abteilung sind umorganisiert worden, mit dem Ziel, der technischen Abteilung die Methodenentwicklung und den Instrumentenbau zu erleichtern, sowie der Informatik die Möglichkeit zu geben, flexibler auf Schwerpunktverschiebungen zwischen Datenerfassung und Datenverarbeitung zu reagieren.

B.E. FENDER

rapport du directeur

C'est avec sous les yeux le spectacle d'un ciel bleu sans nuages et du soleil sur les montagnes enneigées que j'écris ce rapport, ce 31 décembre. C'est la période des vacances de Nouvel An, mais tous les instruments continuent de fonctionner et bon nombre de scientifiques de l'ILL et des chercheurs invités ont interrompu leurs congés pour profiter d'un temps d'utilisation des instruments qui est denrée rare. Ce problème de temps d'utilisation des instruments apparaît en regardant les dernières propositions soumises au Conseil Scientifique, en octobre : seulement 2 243 jours ont été alloués pour une demande totale de 5 724 jours.

1982 a marqué pour l'ILL un tournant. En accord avec le Sous-Comité Instruments et le Conseil Scientifique, nous avons sérieusement avancé dans le programme de mise en route de la nouvelle source froide prévue pour 1986, de sorte que l'ensemble des instruments et des équipements qui seront disponibles dans la deuxième partie de cette décennie est maintenant bien défini. 1982 s'est également avérée être la première année pendant laquelle le réacteur aura connu des arrêts de fonctionnement importants non prévus. Après plus de 10 ans de fonctionnement remarquablement fiable, il faut maintenant entreprendre le remplacement des parties vulnérables. Les travaux nécessaires entraîneront une réduction du temps de fonctionnement du réacteur pendant les trois années à venir, mais on devrait revenir à un fonctionnement à temps complet en 1986. Le programme de modernisation lancé en 1979 avait pour principal objectif la reconception et la reconstruction des instruments situés près du réacteur. Des essais sont en cours sur les premiers des principaux nouveaux instruments. Les prévisions globales pour l'amélioration des autres instruments, bien que maintenant payés par le budget normal, ont été approuvés cette année.

Deuxième source froide

L'accord concernant une source froide horizontale a été acquis fin 1981, et permettra d'améliorer les capacités de l'Institut dans le domaine de la diffusion aux petits angles, de la spectroscopie à haute résolution, de l'application des neutrons polarisés à la physique de l'état solide et de la physique des particules élémentaires. Cela impliquera aussi un degré de spécialisation approprié pour une époque où d'importantes contributions provenant des sources à spallations vont apparaître dans le monde entier. Les biologistes en seront parmi les principaux bénéficiaires, il était donc normal que l'année commence avec l'emménagement de l'antenne du Laboratoire de Biologie Moléculaire Européen dans les nouveaux locaux sur le site de l'ILL. L'interaction scientifique importante due à cette proximité s'est fortement manifestée pendant toute l'année, et nous tirons maintenant grand bénéfice du travail de pionnier d'Andrew Miller et de Bernard Jacrot, responsables successifs de l'antenne. Un des fruits de cette collaboration accrue est la décision commune de construire un nouveau diffractomètre DB 21 qui utilisera les différences de contraste de diffusion de H_2O et D_2O pour déterminer (jusqu'à une résolution 10-15 Å) les caractéristiques structurelles des cristaux biologiques (par exemple des virus) avec des cellules élémentaires très grandes (jusqu'à 400 Å). Cependant, presque tous les autres domaines scientifiques principaux bénéficieront aussi des projets faits en 1982.

Nous avons commencé l'étude d'un spectromètre à 3 axes (IN 14) qui couvrira à la fois les gammes des neutrons froids et des neutrons thermiques, ce qui devrait en faire l'instrument idéal pour l'étude de nouveaux systèmes pour lesquels la dynamique de réseau (ou le comportement magnétique) ne peut être théoriquement prévue. L'approbation a également été donnée pour la construction d'un instrument spin-echo à très haute résolution. L'instrument actuel, IN 11, qui sera amélioré courant 1983, donne la plus haute résolution possible parmi les spectromètres neutroniques — jusqu'à plusieurs nanoélectron volts — et produit de nouveaux résultats dans des domaines aussi divers que les micelles ou la diffusion magnétique critique. IN 14 aura pour but d'obtenir un ordre de grandeur supplémentaire en résolution d'énergie ce qui réduira encore l'écart entre les gammes d'énergie et de transfert d'impulsion accessibles par diffusion de la lumière et par spin écho neutronique. Bien que les avantages de l'étude de la dynamique des polymères jusqu'à de très petits transferts d'énergie soient clairs, jusqu'à ce jour, l'intérêt de telles études en biologie demeure une question ouverte et bien tentante.

L'importance des études de la diffusion aux petits angles pour la biologie ainsi que pour les polymères, les colloïdes et la nucléation dans les métaux et les verres, est bien sûr tout à fait reconnue, et la compétition pour le temps de machines à diffusion aux petits angles a été plus sévère que jamais ; plus d'un bon projet a dû être ainsi refusé. Les premières réflexions ont été faites pour définir un nouvel instrument à faible Q pour la deuxième source froide et le transfert de IN 10 auprès de la nouvelle source a aussi été réexaminé. La spectroscopie d'effet tunnel des protons est maintenant un domaine d'étude bien établi, et IN 10 est l'un des instruments les plus précieux pour les physicochimistes.

Le programme de physique nucléaire et fondamentale a également été examiné soigneusement. Les expériences seront principalement du type faisceau spécial (S-experiment) et pourront comprendre : une nouvelle étude des oscillations neutron-antineutron, l'étude des corrélations angulaires entre les impulsions d'électrons, d'antineutrino et le spin neutronique par l'étude de la désintégration du neutron libre ; ainsi que la non-conservation de parité dans les forces nucléaires par l'étude des interactions neutron thermique-proton.

Programme de rénovation du réacteur

Les événements imprévus dans le fonctionnement du réacteur ont été : la rupture de la crépine du système de circulation d'eau lourde et une légère fuite sur le canal H 12 (IN 4). Le premier incident a causé un arrêt du réacteur du 20 avril au 30 juin, le deuxième une interruption du 5 au 27 juillet pour le remplacement standard du canal. La partie endommagée de la crépine est régulièrement contrôlée par des caméras de télévision et ne montre aucun signe d'évolution. Des essais ont révélé que la fuite du canal H 12 provenait d'une fissure très légère à quelques centimètres du bout du canal.

La première partie d'un nouveau programme pour le remplacement des canaux a obtenu l'approbation des autorités de sécurité et aura lieu de février à mai 1983. Nous projetons de remplacer les autres canaux pendant un arrêt prolongé qui pourrait durer jusqu'à 12 mois, commençant milieu 1984. Pendant cette période, la crépine endommagée sera également réparée, la nouvelle source froide verticale sera installée et la source chaude remplacée.

Programme de modernisation

La fin de 1982 aura vu les premières conséquences importantes dues à la modernisation des instruments situés près du réacteur. Des tests sont en cours sur l'instrument à 3 axes IN 1 B (utilisant les neutrons de la source chaude), ainsi que sur le diffractomètre à liquide D 4 B. Le spectromètre à fission de coïncidence PN 8, qui mesure la vitesse et l'énergie cinétique des fragments correlés dans la fission binaire, est en bon état de marche et a réussi une résolution de masse unité pour les fragments les plus légers.

Des progrès réguliers ont également été faits sur les autres projets importants : instruments à diffraction D 19 B, D 2 B, D 20 (en remplacement de D 8, D 1 A et D 2) ; et l'instrument d'analyse de polarisation IN 20 (qui remplacera IN 2). Une amélioration considérable du flux sur D 9 et IN 4 est prévue.

D'importants progrès ont également été faits sur D 7 B où des supermiroirs sont maintenant utilisés de façon régulière pour l'analyse du spin neutronique. Une analyse de la polarisation permet non seulement la séparation des contributions magnétiques et nucléaires, elle sépare aussi les contributions cohérentes et incohérentes et permet ainsi une étude séparée des mouvements individuels et des mouvements collectifs. De nouvelles études sur le sodium liquide et sur les cristaux moléculaires ont commencé dans ce qui promet d'être un tout nouveau domaine d'études intéressantes.

Programme scientifique

La rigueur du programme scientifique de l'Institut vient de ce qu'il est alimenté de façon très variée par ses nombreux visiteurs. Mais l'interaction avec les scientifiques de l'Institut détermine souvent l'évolution des projets individuels. Cela se produit d'ailleurs souvent par les améliorations des instruments et des techniques ; c'est pourquoi j'ai particulièrement souligné les progrès et les projets concernant les instruments. Fréquemment, cependant, c'est à partir de discussions scientifiques et de collaborations avec les scientifiques de l'ILL ou de collaboration entre les visiteurs des différents laboratoires (souvent de pays différents) que l'ILL donne à la science une valeur ajoutée. On en trouvera de nombreux exemples dans les pages suivantes, mais les exemples les plus significatifs sont les collaborations entre anglais, français et allemands, et des chercheurs de l'ILL qui ont entraîné des progrès considérables dans notre compréhension du magnétisme des métaux de transition, la recherche CERN/Padoue/Laboratoire de Rutherford/ILL des violations baryoniques qui a fixé une limite de 10^6 secondes au temps d'oscillation neutron-antineutron et la collaboration Berlin/ILL pour la représentation spatiale de la distribution et des formes des protéines dans les ribosomes. De façon quantitative, la vigueur de la vie scientifique de l'Institut se mesure par le nombre de publications faites par le personnel ILL :

1978 :	300
1979 :	250
1980 :	375
1981 :	281
1982 :	340.

Personnel

Le 1er octobre 1982, le Professeur T. Springer a quitté l'Institut pour retourner à Jülich après cinq années et demie de succès en tant que Directeur Adjoint, puis Directeur, et le Professeur H. Ruppersberg lui a succédé en tant que Directeur Adjoint allemand.

M. P. Nozières a été élu à l'Académie des Sciences française, M. F. Mezei à l'Académie des Sciences hongroise, M. C. Janot est arrivé en juillet en tant que Senior Scientist s'intéressant à la physique des métaux et aux systèmes désordonnés.

Le Collège 7 a été dissous. Le Collège 6 s'occupe maintenant des défauts et des matériaux désordonnés ainsi que des liquides et des solides amorphes. Les sujets magnétiques de l'ex-Collège 7 sont répartis dans les Collèges 4 et 5. Les Départements Technique et Informatique ont été réorganisés pour permettre au premier de s'occuper plus efficacement des instruments et des méthodes, et au second de répondre plus facilement à l'équilibre changeant entre l'acquisition et le traitement des données.

B.E.F. FENDER

1

INSTRUMENTATION

Introduction

During 1982, certain facets of the modernisation programme have been adapted to reflect both the concurrence and the increasing impetus of the beam tube replacement project. The decision was taken during the year to postpone the installation of the replacement vertical cold source because of the slight risk of damage to the thimbles H 1/H 2 and there have also been delays to the commissioning and instrument calibration tests of PN 8, IN 1 B and D 4 B. By the end of 1982 these instruments were approaching the end of this phase and will be scheduled when the scientific programme recommences in May 1983 after the 4 month shutdown of the reactor.

IN 20 monochromator drum has now been delivered and filled and together with the secondary spectrometer will be assembled and tested in the test hall before installation in the reactor towards the end of 1983.

Improvements to IN 11 to increase the data collection rate are in progress. A multiple detector bank, wide angle magnet and correction coils will be installed. D 7 has commenced operation in the polarisation analysis mode. 600 supermirrors for polarisers and analysers have been manufactured, tested and installed.

In the field of Ultra Cold Neutrons, the new external superthermal UCN source has been delivered and installed. Commissioning tests are now taking place to optimise the operational conditions and evaluate the performance.

Also in 1982 decisions were taken on instruments for the second cold source. Initially there will be a 3-axis spectrometer, small angle diffractometer for biological work, high resolution N.S.E. spectrometer and a nuclear fundamental physics beam position.

Important consideration has been given to the supply of ancillary equipment (magnets, cryostats and furnaces) to satisfy the increasing demand for "exotic" sample environments but requests for extreme temperatures can still only be satisfied with equipment operating under development conditions.

Significant progress has been noted during the year in the field of monochromator production and supply and certain aspects will be described in detail in the instrument operation section.

Finally, plans were made during 1982 for the change-over of the last two instruments on the CARINE system and towards the end of 1983, all instrument control and data collection will be effected by dedicated mini-computers.

Einleitung

Im Jahre 1982 mussten Teile des Modernisierungsprogramms aufgrund der Gleichzeitigkeit und der Dringlichkeit des Strahlrohr-Austauschprojekts neu geplant werden. Gegen Jahresmitte fiel die Entscheidung, den Einbau des Ersatzes der neuen vertikalen Quelle zu verschieben, da diese Arbeiten ein gewisses Risiko für die Strahlrohre H 1/H 2 bedeutet hätten. Ebenso ergaben sich Verzögerungen bei der Abnahme, Justierung und Eichung von PN 8, IN 1 B und D 4 B. Bei Jahresende näherte sich die Testphase dieser Instrumente ihrem Abschluss und aller Voraussicht nach werden diese Geräte zur routinemässigen Benutzung im Mai 1983 zur Verfügung stehen, wenn der HFR nach viermonatigem Stillstand seinen Betrieb wieder aufnehmen wird.

Die Monochromatortrommel für IN 20 wurde geliefert, mit Abschirmmaterial gefüllt, wird gegenwärtig in der Versuchshalle zusammen mit dem Sekundärspektrometer aufgebaut und getestet, und wird gegen Ende 1983 an seinem Strahlrohr H 13 installiert werden. An IN 11 werden gegenwärtig Verbesserungen zur effizienteren Datenerfassung vorgenommen, die die Installation einer Vielfachdetektor-Bank mit Weitwinkelmagnet und Korrekturspulen vorsehen. D 7 hat seinen Betrieb mit Polarisationsanalyse aufgenommen. Sechshundert Superspiegel zur Verwendung als Polarisatoren und Analysatoren wurden angefertigt, getestet und eingebaut.

Auf dem Gebiet der Ultrakalten Neutronen ist die Lieferung und der Aufbau der neuen, externen superthermischen Quelle zu erwähnen. Eichmessungen zur Optimalisierung der Betriebsbedingungen und zur Erfassung ihres Wirkungsgrades sind im Augenblick im Gange.

Im vergangenen Jahr wurde ebenso die Entscheidung zum Bau von Instrumenten an der zweiten kalten Quelle getroffen. Zunächst werden gebaut werden : Ein Dreiachsenspektrometer, ein Kleinwinkeldiffraktometer für biologische Arbeiten, ein hochauflösendes Spin-Echo-Spektrometer sowie eine Strahlposition für Experimente auf dem Gebiet der Grundlagen- und Kernphysik.

Grosses Gewicht wurde auf die quantitative und qualitative Verbesserung der Hilfsgeräte an den Instrumenten gelegt (Magnete, Kryostate, Öfen), um der steigenden Nachfrage nach "exotischen Probenumgebungen" gerecht zu werden. Nachfragen nach extremen Probentemperaturen konnten jedoch oft nur mit Hilfe von Geräten befriedigt werden, welche sich noch im Entwicklungsstadium befinden.

Beträchtlicher Fortschritt war im letzten Jahr auch auf dem Gebiet der Monochromatorproduktion zu verzeichnen. Gewisse damit im Zusammenhang stehende Aspekte sind im entsprechenden Abschnitt des Kapitels "Instrumentenbetrieb" beschrieben.

Abschliessend sei erwähnt, dass der Wechsel vom CARINE-System zu einem instrumenteigenen Rechner an den letzten beiden Geräten eingeleitet wurde und gegen Ende 1983 vollzogen sein müsste. Ab diesem Zeitpunkt werden somit die Betriebskontrolle und Datenfassung an allen Geräten von Kleinrechnern vorgenommen werden.

Introduction

En 1982, certains aspects du programme de modernisation ont été modifiés pour refléter l'importance croissante et le développement simultané du projet de remplacement des canaux. Il a été décidé au cours de l'année de reporter l'installation du remplacement de la source froide verticale en raison d'un léger risque d'incident sur les doigts de gant H 1/H 2. Des retards ont également eu lieu dans la mise en service et les tests d'étalonnage des instruments PN 8, IN 1 B et D 4 B. Fin 1982, cette phase était pratiquement terminée et les instruments sont prévus pour la reprise du programme scientifique en mai 1983 après l'arrêt du RHF de 4 mois.

Le tambour de monochromateur de IN 20 a été livré et rempli de matière de protection. Il sera monté et testé en même temps que le spectromètre secondaire dans le hall d'essais avant d'être installé dans le réacteur vers la fin 1983.

Des améliorations sur IN 11 portant sur l'augmentation du taux d'acquisition de données sont en cours. Un banc de détecteurs multiples, un aimant à grands angles et des bobines de correction ont été installés. D 7 a commencé son fonctionnement selon le mode d'analyse de polarisation. Six cents supermiroirs pour polarisateurs et analyseurs ont été fabriqués, testés et installés.

Dans le domaine des neutrons ultra-froids, la nouvelle source extérieure et superthermique a été livrée et installée. Des tests pour la mise en service sont actuellement en cours afin d'optimaliser les conditions de fonctionnement et d'évaluer la performance.

En 1982 également, des décisions ont été prises concernant les instruments à la deuxième source froide. Tout d'abord, il y aura un spectromètre à 3 axes, un diffractomètre à petits angles pour des échantillons biologiques, un spectromètre à spin-echo à très haute résolution ainsi qu'une position de canal pour des expériences en physique nucléaire et fondamentale.

Une importance prépondérante a été accordée à l'équipement auxiliaire (aimants, cryostats, fours) afin de satisfaire la demande croissante concernant des environnements "exotiques" d'échantillons. Cependant, pour faire face à la demande de températures extrêmes, du matériel étant encore en développement a souvent dû être utilisé.

Un progrès considérable a été noté dans le domaine de la production et de l'approvisionnement en monochromateurs. Certains aspects sont décrits en détail dans la section "Instrument Operation Department".

Finalement, des plans ont été faits en 1982 pour le transfert des deux derniers instruments su système CARINE sur un ordinateur en ligne. Vers la fin 1983, tout le contrôle d'instrument et toute l'acquisition de données seront effectués par des mini-ordinateurs directement reliés.

beam-time allocation and instrument statistics

Table 1 — The reactor has operated for 236 days (to 1 February 1983), Operating time which was affected by unscheduled shut-downs was recuperated by extending the reactor cycles to 1 February 1983. Experimental periods which were lost due to reactor faults have been rescheduled using instrument test times except in the few cases where special conditions applied.

Instrument	Scheduled Operating Time (days)	Coll. 3	Coll. 4	Coll. 5	Coll. 6	Coll. 7	Coll. 8	Coll. 9	Instrument test, experiment change-over and minor repairs	Comments
IN 1	0									Instrument installation and commissioning. Cf. D 4
IN 2	191		171			20			45	
IN 3	173		153					20	63	
IN 4	199		35		40	49		75	37	Four experiments lost due to urgent replacement of beam tube H 12
IN 5	199		25		4	57		113	37	
IN 6	185		11		31	40	5	98	51	
IN 8	74		74						60	In addition, 102 days backlog arising from instrument modifications, were scheduled in 1982
IN 10	200				21	59	9	111	36	
IN 11	194		21	5	16	36	36	80	42	Test time includes supermirror development
IN 12	180		143		14	23			56	
IN 13	165					46	19	100	71	Modifications made to Chopper supply system
D 1 A	190			163		13		14	46	
D 1 B	133			58	5	8		62	59	Additionally 44 days backlog due to electronic and multidetector malfunction, were scheduled
D 2	179			47	81	30		21	57	
D 3	218			218					18	
D 4	0									Instrument installation and commissioning. Cf. IN 1
D 5	184		14	122	20	28			52	
D 7	151				14	114		23	85	Extensive modifications and resulting instrument test
D 8	196			156			40		40	
D 9	183			177		6			53	
D 10	114		26	70	5	13			122	Instrument tests for spin-echo feasibility
D 11	188				1	41	65	81	48	
D 15	115			109					35	Instrument removed October 1982 prior to beam tube IH 4 exchange
D 16	134			14	8		45	67	102	Instrument and multidetector undergoing commissioning in available test time
D 17	195				6	20	88	81	41	
D 18	50			8				28	186	Final scheduling period. Instrument converted to special beam installation
PN 1	0									Instrument removed for beam tube exchange
PN 2	199	199							37	
PN 3	205	205							31	
PN 6	224	224							12	
PN 8	132	132								Commissioning experiments only

Table 2 — Special Beam Experiments carried out, in progress or under preparation during 1982.

In addition to the 35 permanently installed instruments the ILL is operating a number of special beam facilities (so-called S experiments). These are normally under the full scientific responsibility of external research groups and do not follow the usual scheduling procedure. Technical help and financial support is essentially provided by the external groups. Nevertheless, these facilities are also supported by the ILL to a limited extent and external groups are encouraged to submit proposals for such experiments.

Experiment Number	Beam Position	Proposed by	Title	Time Allocated
3-07-003/4	H 142	Heidelberg Stanford Univ.	Weak magnetism in decay of free neutrons. Neutrons lifetime determination without use of nuclear neutron capture data	2 cycles
3-07-002	H 142	ILL, Harvard, ISN	Further search for parity violation in neutron-proton capture	1 cycle
7-04-008	H 16	Berlin, Munich	Determination of range profiles and lattice positions	Long-term
3-05-009	H 17	Bonn Univ.	Magnetic bottle for neutron storage at external UCN source	Long-term
	H 17	Rutherford, ILL	Commissioning superthermal UCN source	3 cycles
3-12-13	H 18	CERN, Rutherford, Sussex Univ., Padua Univ.	Search for $N\bar{N}$ transitions	6 cycles
01-003	H 21	Braunschweig	Experimental determination of h/m	Long-term
3-13-45	H 22	Sussex Univ., ILL	Magnetic moments of excited states populated by neutron capture	21 days
3-13-46	H 22	Surrey Univ.	Fundamental aspects of neutron tomography	14 days
	H 22	Darmstadt, Bordeaux, Sussex Univ., Braunschweig, ILL	7 in-beam fission experiments; (n,α), (n,γ), (n,F) reactions	6 cycles
3-13-47	H 24	ISPRA	Dual polarized beams from perfect crystals	28 days
7-03-232	H 24	Stuttgart	Comparison of macroscopic & microscopic thermal expansion	6 cycles
5-16-140	H 24	Univ. of Hull, CENG	Spiral spin domains in Holmium	20 days
5-16-147	H 24	Strathclyde Univ.	Neutron topography of organic crystals	14 days
7-04-005	H 25	Munich Univ.	Determination of concentration profiles by (n,γ) and (n,p) reactions	Long-term
	H 25	Marburg Univ.	In-beam NMR	Long-term
3-03-008	IH 3	Sussex Univ., Harvard, Munich	Magnetic neutron bottle	Long-term
3-03-008	IH 3	Sussex Univ., Harvard Univ.	Search for EDM of the neutron	Long-term

new sources

Improved Vertical Cold Source

This re-designed cold source replaces the existing one and, by virtue of a re-entrant thimble penetrating to the centre of the D_2 moderator vessel, increases the intensity for all cold neutron guides by almost a factor of 2. The installation of a vertical neutron guide is planned which will deliver neutrons of 50m/sec to be decelerated by a Steyerl turbine for obtaining ultra-cold neutrons. The expected UCN flux will be much higher than presently available at PN 5.

The exchange of the vertical cold source by the above replacement was initially planned for Spring 1983. However, due to the possibility of disturbing the cold neutron guide noses, this exchange has been postponed until mid-1984 (in the frame-work of the long shut-down in 1984/85).

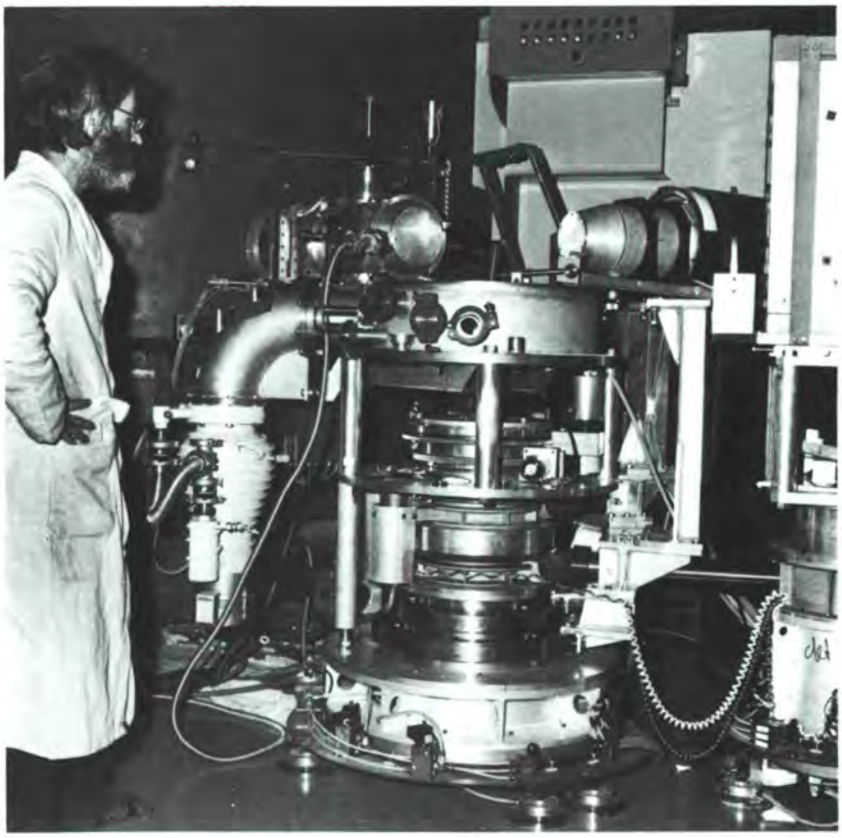
Liquid He UCN Source

The source has been operating since mid-1982. At its base temperature 0.5 K the detected UCN density is 1-1.5 UCN cm^{-3} and UCN life-times of 60 s have been achieved. This is in agreement with the predicted values taking into account the transmission losses (factor of ~ 10) in the Al membranes and in the guides. The development of less absorbing membranes is in progress.

Second Cold Source

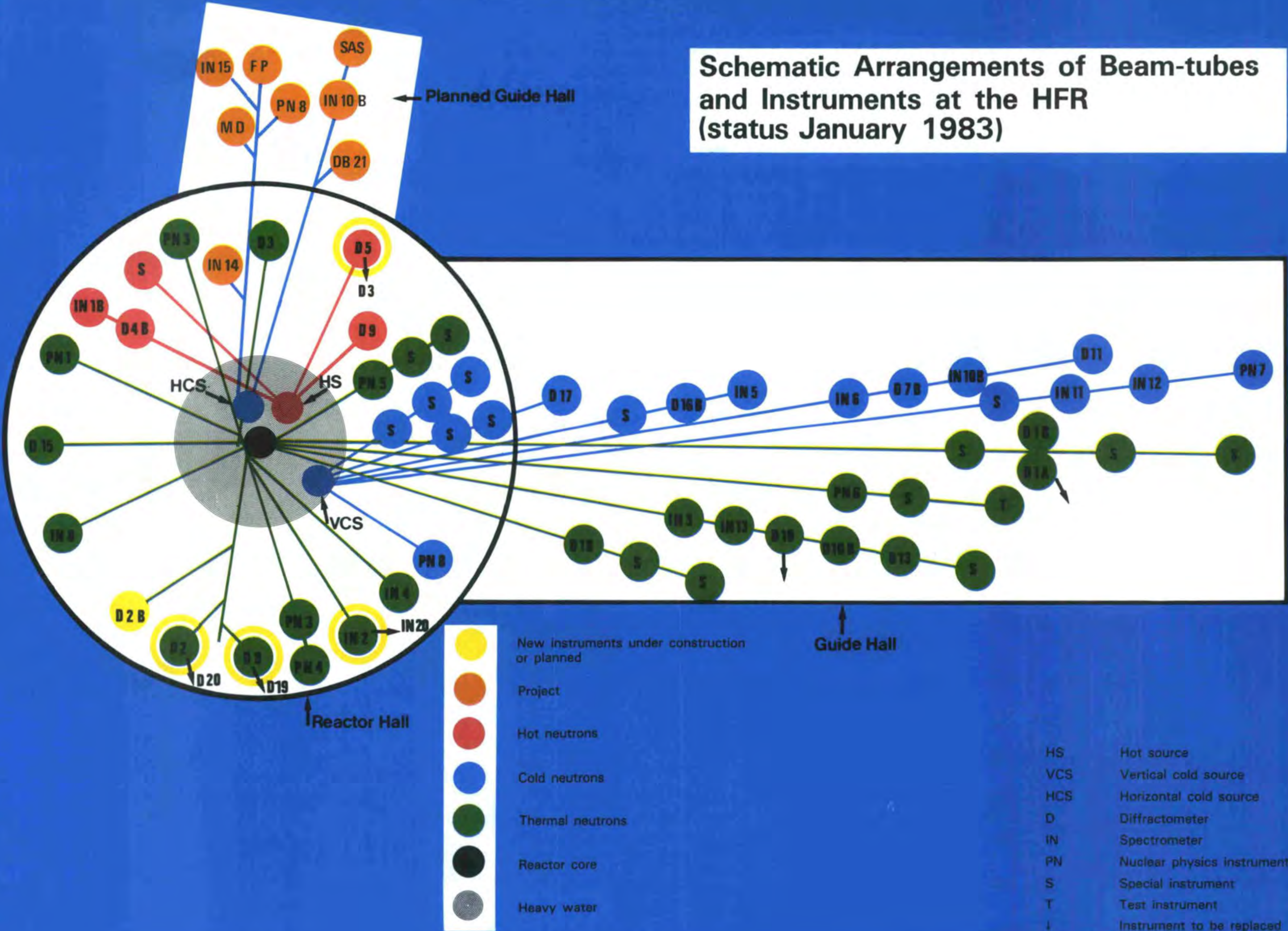
The beam position envisaged for this new source which is expected to be operational in 1985/86 is H 5, presently feeding D 3. It will be equipped with two guides, one being straight to allow for a substantial flux increase in the range 2-6 Å and the other curved for instruments requiring longer wave-lengths (up to 25 Å).

The design of the source is progressing to schedule. A mock-up has been successfully tested (see section of Reactor Department). The construction of the associated Guide Hall will commence in early 1983 and will be finished by 1984.



The new liquids diffractometer D4B is presently being tested and will be available to users as from Summer 1983

Schematic Arrangements of Beam-tubes and Instruments at the HFR (status January 1983)



INSTRUMENTS

OPERATIONAL

- D1A Two-axis (powders) ●
- D1B Two-axis (powders)
- D2 Two-axis (powders, single crystals) ●
- D3* Polar. n-diffractometer
- D4B Two-axis (liquids)
- D5* Polaris. analysis diffractometer
- D7B* Diffuse scattering facility
- D8 Four-circle diffractometer ●
- D9* Four-circle diffractometer
- D10 Four-circle diffractometer
- D11 Small angle scattering camera
- D13 Crystal testing facility
- D15 Mark VI diffractometer (single crystals)
- D16B Mark VI diffract. (multidetector for single crystals)
- D17 Small angle scattering camera
- D18 Neutron interferometer
- IN1B Three-axis spectrometer
- IN2 Three-axis spectrometer ●
- IN3 Three-axis spectrometer
- IN4 TOF spectrometer
- IN5 TOF spectrometer
- IN6 TOF spectrometer
- IN8 Three-axis spectrometer
- IN10B Backscattering spectrometer
- IN11* Spin-echo spectrometer
- IN12 Three-axis spectrometer
- IN13 Backscattering spectrometer
- PN1 Fission product spectrometer
- PN2 Conversion electron spectrometer
- PN3 Gamma-ray spectrometer
- PN4 Anti-compton spectrometer
- PN5 Ultra cold neutron source
- PN6 Fission product spectrometer
- PN7B* Polar. beam (fund. physics)
- PN8 Fission product coincidence spectrometer

* Polarized neutrons

NOT YET OPERATIONAL

- D2B ● Two-axis (high-intensity, high res., for powders), replacing D1A
- D20 ● Two-axis (high-intensity; for powders), replacing D2
- D19 ● Two-axis (multidetector; for single crystals), replacing D8
- IN20 ● * Three-axis spectrometer with polaris. analysis, replacing IN2

SECOND COLD SOURCE (HCS)

Approved instrument projects:

IN14	Triple-axis spectrometer
IN15	High resolution spin-echo spectrometer
DB21	Small angle diffractometer for biology
FP	Polarized beam for fundamental physics
MD	Multidetector test position

Approved transfers of instruments (final site not yet defined)

PN8	Fission product coincidence spectrometer
IN10B	Backscattering spectrometer

Other projects:

SAS	Small angle scattering instrument with low Q
	High resolution powder diffractometer

instrument projects at the second cold source (HCS)

The following projects were recommended by the Scientific Council.

New Triple-Axis Spectrometer

W.G. Stirling and R. Pynn.

That the ILL has made many outstanding contributions to different fields of scientific activity is due in no small measure to the existence of its excellent cold source. High fluxes of long wavelength neutrons have allowed studies, ranging from biology, through solid state physics, to fundamental physics, which would otherwise be extremely difficult (and are frankly not possible at other reactors). One of the advantages of such long wavelength neutrons is that they allow good energy resolution to be obtained. A particular effort has been made at ILL to develop instrumentation for neutron scattering with very good resolution in energy (e.g. IN 10, IN 11, IN 13). In general, however, this energy resolution is obtained at the expense of wavevector resolution or intensity, or often both. So, many studies in solid state science which require both good energy and wavevector resolution become extremely difficult on such instruments (e.g. studies of structural phase transitions, critical scattering, etc.). This is not the case for high-resolution three-axis spectrometers.

Although the triple-axis crystal spectrometer has been in use at neutron scattering laboratories for some twenty-five years, it remains one of the most valuable tools for detailed studies of the dynamical response of a sample. In particular, where controlled (and understood) resolution in both energy and wavevector are required, this type of instrument is still unchallenged. Indeed in many neutron laboratories, triple-axis spectrometers are the principal instruments used in condensed matter research.

At ILL, the cold neutron instrument IN 12 has permitted a wide range of low-energy experiments to be performed with excellent instrumental resolution. Similar (though less powerful) instruments now exist at several laboratories. It should be noted that experiments within the subject areas of Sub-committees 6 and 9 have been performed on IN 12, but the majority of IN 12 proposals have naturally been considered by Sub-committee 4. Although the 'load-factor' (time requested/time available) is not a number which necessarily describes completely the situation, IN 12 has always been substantially oversubscribed, with a load-factor of typically about 2.5. The provision of a new three-axis instrument on the horizontal cold source would help to alleviate this problem. In several respects the new instrument would be superior to IN 12 and would allow experiments to be performed which are at present extremely difficult or which require time on more than one instrument.

The instrument will provide a much improved flux between 2 Å and 4 Å — where IN 12 is penalised by the guide curvature — while being more than competitive at longer wavelengths. One can estimate flux gains, compared with IN 12, of order 10 at 2 Å, 2.6 at 4 Å and 2 at 6 Å.

Notice also that the new source should provide fluxes comparable to those of **thermal** beam tubes at around 3 Å. Thus we can reasonably expect to have an instrument with high incident flux between 2 Å and 6 Å, providing a uniquely flexible spectrometer. In particular, the **same instrument** can be used at the graphite filter wavelength of 2.35 Å **and** at high-resolution (Be-filter) wavelengths of greater than 4 Å. So the **dynamic range** of the instrument would be extremely wide, with incident neutron energies between about 20 meV and 2.0 meV available. Of course, this implies a correspondingly wide range of instrumental resolution.

The main design features of the proposed instrument will be very similar to the other three-axis instruments recently built or under construction (IN 1, IN 8, IN 12, IN 20).

Summary: The new three-axis instrument will be an extremely flexible instrument with a dynamic range and incident flux unmatched at any laboratory. A very wide range of **complete** measurements will be possible using this spectrometer. The provision of polarisation analysis will further extend the range of applications.

High Resolution Spin-Echo Spectrometer

F. Mezei.

The high resolution provided by the IN 11 NSE spectrometer opened up the possibility of investigation of a number of new phenomena, especially in small angle scattering. At the same time it also became clear that further improvement of the resolution would be a direct benefit in these studies. In particular, in the investigation of the dynamics of macromolecular systems, such as polymers, micelles and biological matter, the instrument is often used at the limit of its capabilities, and there is still a big gap between the energy and momentum ranges accessible to light scattering and to NSE. It is therefore proposed to build an improved energy and momentum resolution NSE instrument optimized for quasi-elastic small angle scattering work. (Note that at small angles the quasi-elastic linewidth and momentum transfer is often related by the classical $\Gamma = D q^2$ law, and thus the energy and momentum resolution should be improved in corresponding proportions).

The resolution of a NSE spectrometer is fundamentally limited by the inhomogeneities of the precession fields. In the case of solenoidal precession fields, which are a priori the best adapted to very high resolution work, the inhomogeneity can be reduced by about an order of magnitude with the help of the Fresnel coils, but no further improvement is being foreseen. Thus there are two ways left to improve resolution:

a) Increase of the neutron wavelength,
b) Increase of the dimension of the precession field coils.

The ultimate energy resolution is composed of 2 components, one depending on the statistical error $\delta\Gamma_S$ which happens to be independent of wavelength, the other on the systematic error $\delta\Gamma_i$ which scales with the wavelength as λ^{-2}.

Typical resolution figures in small angle scattering experiments on IN 11 are ($\lambda \simeq 8.5$ Å):
$\delta\Gamma_S \simeq 0.3$ neV $\qquad \delta\Gamma_i = 1.5 - 4$ neV.

Therefore an order of magnitude improvement of the systematic uncertainties is required to match the statistical accuracy. This can be achieved by using about 25 Å neutron wavelength, together with the desirable 3 fold simultaneous increase of the q resolution. As noted, the same result could also be obtained by increasing the physical dimensions of the spectrometer by a factor of 3 at constant wavelength. This latter solution is more expensive and technically more demanding, thus the use of longer wavelength is preferable if available. Allowing in addition for somewhat longer counting times than actually used and for a number of further minor improvements (better polarizer and analyzer, small multidetector, modestly bigger precession field magnets) it is reasonable to aim at about 20 times better energy resolution at $\lambda = 25$ Å than that of IN 11 at $\lambda = 8.5$ Å, which gives:

Energy resolution:

Statistical uncertainties	$\delta\Gamma_S = 0.2$ neV
Systematic uncertainties	$\delta\Gamma_i = 0.1 - 0.2$ neV
Momentum resolution	$\delta q = 0.0025$ Å^{-1}

Technically the use of long wavelength neutrons eases most of the design problems, such as neutron polarization and polarization analysis and the production of precession fields. In particular, the beam deflection achievable by a single super-mirror is sufficiently large ($> 4^\circ$) for a normal guide position (end position is not required). Also an optically focussing polarizer could be envisaged.

Small Angle Diffractometer for Biological Samples

A. Bentley, G. Bentley, M. Roth, D.L. Worcester

Biological macromolecules and materials often exist as a complex of two or more distinct chemical species. Some examples of these are chromosomes, consisting of protein and DNA, membranes, consisting of lipids and proteins, simple plant viruses, consisting of protein and RNA and some animal viruses, consisting of protein, lipids and DNA. Many of these macromolecular complexes, or fragments of them, have been crystallised and therefore are amenable to crystal structure analysis. Others are in ordered arrangements which produce Bragg diffraction "in vivo" (e.g. myelin membranes and retinal rod outer segments). In order to make a distinction between the different chemical species, such as protein and nucleic acid, a normal crystal structure analysis must be taken to a resolution better than 3.5-4.0 Å d-spacing. Because these molecules are large, this undertaking may be formidable or even technically impossible. For example, crystals of the nucleosome core particle (a basic structural unit of the chromosome) diffract to 5 Å d-spacing at best. This resolution is too low to distinguish between the protein and DNA components although such information would contribute to our knowledge of chromosome function.

Constrast variation with H_2O/D_2O mixtures using neutron diffraction is a very effective method of distinguishing different components within a macromolecule and thus provides a firm basis for structural interpretation. Contrast variation has now been applied to the single crystal study of the nucleosome core particle. These results show clearly the 3-dimensional shape of the protein and DNA even though the data extend only to 25 Å resolution. Very recent results on Satellite Tobacco Necrosis Virus show that the RNA is mainly localised in specific regions just inside the protein coat (G.A. Bentley, L. Liljas, U. Skoglund and T. Unge, unpublished results). Other crystallographic projects of this nature are currently in progress: Tomato Bushy Stunt Virus and the complex Aspartyl-tRNA synthetase/tRNA^{Asp}.

Experimental proposals have been submitted for several other interesting complexes: the glycoproteins transferrin and prothrombin fragment, as well as the membrane protein porin. Recently, crystals of the 50 S subunit of the ribosome particle (the site of protein synthesis in cells) have been grown and there is definite interest in undertaking a contrast variation study of this system. This would be a very important project for the future.

Neutron diffraction from rat sciatic nerve myelin membranes (180 Å repeat unit) has been measured for nerves labelled with deuterium "in vivo" (by dietary means) on choline groups of lipids and cholesterol molecules. These data, taken together with diffraction from unlabelled nerves, provide explicit locations for the deuterium atoms, and hence detailed structural information from only low resolution data. Studies of myelin membranes during application of high hydrostatic pressure has also been made possible by neutron diffraction facilities and has clarified the roles of charge neutralization and electrostatic potentials in establishing the native structure in nerves. Similar studies may be possible for other materials and crystals.

All these examples demonstrate growing interest and new experimental possibilities in the use of contrast variation, sometimes with deuterium labelling, in low resolution neutron crystallography, where the information provided would complement a higher resolution X-ray structure analysis or even make an important contribution in its own right.

None of the new research projects have yet been accepted due to lack of beam time on the only suitable ILL instrument, D 17. This instrument has been developed over the past 5 years to collect good quality data from ordered biological materials and crystals of biological macromolecules up to 15 Å d-spacing. However, it is not a dedicated instrument for such work, and the beam time allocated to biological diffraction is limited by demand for use of the instrument for small-angle solution scattering. On the basis of this experience with D 17, it is proposed to construct a dedicated biological diffractometer, which would be adapted to the particular needs of low resolution crystallography.

The crystals used are invariably small (less than one millimetre dimension), fragile, have very large unit cells (100 — 400 Å) and do not diffract strongly to high resolution. Data are collected to 15 Å, or at best to 10 Å d-spacing, which is approximately the limit of the usefulness of the contrast variation approach. At this low resolution, high accuracy of data is needed if the structure analysis is to proceed successfully.

The characteristic features of the new instruments will be the following:

Crystal sizes	: ~ 0.5 mm
Large unit cells	: a ~ 100 — 400 Å
Low resolution	: d-spacing ⩾ 15 Å
Optimum wavelength	: $\lambda = 8$ Å
Wavelength spread	: ~ 2.5 FWHM
Variable beam divergence	: from 0.6° to 2.3° FWHM
Variable detector-sample distance	: from 15 — 50 cm
Detector resolution	: ~ 1 mm
Probable type of the detector	: Scintillation detector based on the Anger γ-ray camera
Size of detector	: Ø = 20 cm
Number of data points per spectrum	: ~ 19 K

The instrument is expected to be built, developed and tested in collaboration with EMBL before mid-1984.

Fundamental and Nuclear Physics Beam

It has been agreed in principle that an end position on one guide of the Second Cold Source could be allocated to fundamental physics. The programme foresees the following installations:

Set-up for neutron-antineutron oscillations

This will be a continuation of the recent experiment carried out on H 18 which so far has revealed a lower limit of the neutron-antineutron oscillation time of 10^6s. With the new set-up oscillation times as high as 2×10^8s could be disclosed and it appears that it would be difficult to reach this sensitivity elsewhere in the world. The sizeable improvement will be due to the increased total neutron intensity (4×10^{11}n/s on the new source as compared to 10^9n/s on H18) and increased time of observation, viz. available flight path for the free neutron beam (about 30 m on the new source as compared to 3 m on H 18). The new set-up might well be the largest special beam apparatus ever to be proposed to the ILL. This project is a CERN-ILL-Padua-RAL collaboration. The experiment is expected to start in 1985 and to run until 1986/87.

Transfer of PN 8 (coincidence fission spectrometer) and polarized beam for fundamental physics

After the termination of the above experiment there will be two positions at this guide: one for the transfer of the coincidence fission spectrometer and the other for a polarized beam for fundamental physics.

The latter will serve mainly for the following experiments:

- Free neutron decay

The decay of the neutron into a proton, an electron and an antineutrino is the most elementary example of ß-decay. At least the basic features of parity non-conserving weak interactions responsible for ß-decay are well established, both theoretically and experimentally. The neutron lifetime is directly linked to the ratio of coupling constants for the vector and axial vector coupling. Presently two groups are undertaking measurements of the neutron lifetime at the ILL. Considerable effort has also gone into studies of angular correlations between the electron and antineutrino momenta and the neutron spin. The experiments proposed to the ILL and to be carried out at the new source aim at a higher precision. They could help to answer questions concerning:

a) the contributions to weak interactions other than just vector and axial vector coupling,

b) refinement of the theory induced by strong interaction (weak magnetism related to the conserved vector current hypothesis upon unifying weak and electromagnetic interactions),
c) time reversal invariance.

• Parity non-conservation of nuclear forces

Nuclear forces are mediated by the interchange of mesons like pions, rho-mesons etc. The strong interaction is known to conserve parity. Any contribution of the weak interaction to the nucleon-nucleon potential as expected on theoretical grounds would reveal itself through parity being violated. Experimentally the difficulty is to observe any effect of the weak interaction in the presence of the dominating strong interaction. Two different approaches have been followed in the past: either one looks into transitions strictly forbidden by parity selection rules or one is searching for a non-zero correlation between momentum and spin, i.e. a pseudo-scalar observable. All unequivocal confirmations of parity violation have come in the second category.

The importance of thermal neutron studies in this field was outstanding and work pursued at the ILL has largely contributed to it. It is quite evident that high cold neutron flux from the new second cold source combined with the highly efficient supermirror polarizers developed at the Institut will place the ILL in a unique position to engage in ambitious projects. The aim is to study parity violating nuclear forces in one of the most elementary nuclear systems, viz. the (n,p)-system. Theory shows that if weak interactions are taken into account the scattering amplitude for slow neutrons on protons will comprise three additional independent amplitudes. Therefore, three independent pieces of information are necessary to determine them and so far, the ILL proposals cover two of them. One proposal (by R. WILSON and B. HECKEL) is, in fact, a continuation of a long standing effort at the ILL (B. VIGNON, R. WILSON et al) and it is argued that possibly only the new facility will allow observation of a non-zero result. The experiment is to capture polarized neutrons in parahydrogen and to search for an asymmetry in the capture gamma-ray emission parallel and antiparallel to the neutron spin. The second proposal (B. HECKEL) concerns spin rotation in parahydrogen. Spin rotation (or neutron "optical activity") in nuclei is an effect which has been predicted some 20 years ago, but which has been proved to exist experimentally only very recently at the ILL. It is due to a neutron spin helicity dependence of the coherent scattering cross section.

Other Projects

One of the major aims of the Second Cold Source is to enhance the small angle scattering facilities. Consideration is being given to a new low-Q instrument of the D 11 type but with an extended Q-range. Discussions also continue on an improved IN 10 type backscattering spectrometer and on a high resolution powder diffractometer (proposal from Munich).

2

INSTRUMENT OPERATION DEPARTMENT

Einleitung

Die Abteilung Instrumentenbetrieb ist verantwortlich für den Betrieb und die laufende Verbesserung sämtlicher Experimentiereinrichtungen. Sie leistet insbesondere Gastforschern die notwendige technische Hilfe bei der Durchführung von Experimenten. Die Instrumente im engeren Sinn sind vier Instrumentgruppen zugeordnet, die für deren Weiterentwicklung zuständig sind. Die übrigen Gruppen der Abteilung entwickeln und bauen Vorrichtungen die mehreren Instrumenten gemeinsam sind (Monochromatoren, Probenumgebung) bzw. erbringen allgemeine Dienstleistungen (Zentrale Gruppe).

In der Monochromatoren-Gruppe wurden die Diffraktometer für γ-Strahlen neu konzipiert und an eine ^{137}Cs-Quelle angepasst, um Kristalle im γ-Strahl ziehen zu können. Die Anlage soll Anfang 1983 in Betrieb gehen. Es wurden weiterhin Anstrengungen unternommen, die Mechanik von Monochromatoren mit variablem Krümmungsradius zu verbessern. Prototypen dieser Monochromatoren wurden mit Cu-Kristallplatten ausgestattet. Testmessungen brachten die erwarteten Resultate. Der Test eines vom MPI für Metallforschung in Stuttgart gezogenen Be-Kristalls verlief vielversprechend. Weitere Untersuchungen wurden an interkalierten Graphitkristallen für Monochromatoren und an Saphir-Kristallen für schnelle Neutronenfilter angestellt.

Die Zentralgruppe kam auch im abgelaufenen Jahr den Anforderungen der Wissenschaftler an Dienstleistungen wie Versorgung mit Flüssiggasen, Wasser, Druckluft und Elektrizität, Wiedergewinnung von Abgasen und Kranbetrieb nach. Besondere Aufmerksamkeit galt wiederum allgemeinen Sicherheitsaspekten, Alarmsystemen, der Handhabung von Schadstoffen, Messungen des Neutronenuntergrundes, der unterbrechungsfreien Versorgung mit spannungskonstanter elektrischer Energie für empfindliche Instrumente, der Vorbereitung von Anweisungen und Massnahmen bei Zwischenfällen, usw. Die Zentralgruppe wirkte auch in erheblichem Umfang mit bei der Schaffung von neuen und der Verbesserung von bereits bestehenden Arbeitsbereichen, Laboratorien, Plattformen, Kabinen und Lagerungszonen, die direkt den Betrieb von Instrumenten oder speziellen S-Experimenten betreffen. Eine schwere Arbeitslast war zu bewältigen, als das Strahlrohr von IN 4 ausgetauscht werden musste. Weitere Aufgaben, die 1982 angegangen wurden, waren die Organisation der Zusammenarbeit mit der Reaktorabteilung während des für 1983 vorgesehenen längeren Reaktorstillstands, sowie die Demontage der Instrumente mit dem Ziel, freien Zugang zu den Strahlrohren zu bekommen. Die Zentralgruppe half auch bei der Vorbereitung von Postern und organisierte spezielle Fortbildungskurse.

In der Gruppe Probenumgebung wurden beträchtliche Anstrengungen auf die Beschaffung supraleitender Spulen verwandt. Zwei neue Spulen arbeiten nun im Routinebetrieb, eine mit 5 T am In-

Introduction

The Instrument Operation Department has overall responsibility for the operation and improvement of the instruments. It also provides necessary technical assistance to enable the visitors to carry out their experiments. The instruments are divided amongst four instrument groups which assure their operation and development. The other groups of the department provide facilities and expertise needed by all the instruments.

In the Monochromator Group the γ-ray diffractometers were dismantled and redesigned to accommodate a new ^{137}Cs source which will feed the inbeam crystal growth facility. The facility should become operational in early 1983. Efforts were made to improve the mechanics of monochromators with a variable radius of curvature. Prototypes of such monochromators were equipped with Cu crystal slabs and proved to perform as anticipated. Testing a Be-crystal grown by the MPI für Metallforschung in Stuttgart gave very promising results. Further studies went into intercalated graphite crystals for monochromators and sapphire crystals for fast neutron filters.

The Central Group continued to serve as the link between the demands of scientists and general services like supply of cryogenic fluids, water, compressed air, electricity, effluent recovery and crane operation. Again special attention had to go into general safety aspects, alarm systems, handling of hazardous materials, background measurements and shielding, supply of clean and uninterrupted electrical power for sensitive instruments, preparation of instructions and intervention plans in case of incident etc. An important role was played by the Central Group with the installation of new, and improvement of, existing working areas, laboratories, platforms, cabins and storage zones directly connected to the operation of instruments or special beam experiments. A heavy workload had to be faced when the thimble of IN 4 had to be exchanged. Organising the collaboration with the Reactor Department during the extended shut-down of the reactor scheduled in 1983 and dismantling instruments to give free access to the beam tubes had to be initiated in 1982. The Central Group also helped in preparing display posters and organised special training courses.

In the Sample Environment Group a major effort went into the supply of superconducting magnets. Two new magnets are now routinely operational, one with 5 T on instrument D 2 (horizontal field) and another with 10 T on instrument D 7. Some difficulties were encountered with a third magnet foreseen for instrument D 3. Finally a maximum field of 7 T had to be accepted. Delivery of this magnet is scheduled for the end of 1982. A further superconducting magnet has been ordered for the Triple Axis Group. The assembly is being tested at the factory and should become available shortly.

Introduction

Le Département Exploitation a la responsabilité générale de l'exploitation et de l'amélioration des instruments. Il fournit également l'assistance technique nécessaire pour permettre aux visiteurs de réaliser leurs expériences. Les instruments sont répartis en quatre groupes d'instruments qui assurent leur fonctionnement et leur développement. Les autres groupes du Département apportent aide et compétence à tous les instruments qui en ont besoin.

Dans le Groupe Monochromateurs, les diffractomètres à rayonnement γ ont été démontés et réaménagés pour s'adapter à une nouvelle source de ^{137}Cs qui permettra de faire pousser des cristaux dans le faisceau. Cet appareil devrait devenir opérationnel au début 1983. Des efforts ont été faits pour améliorer la mécanique des monochromateurs à rayon de courbure variable. Les prototypes de tels monochromateurs ont été équipés de plaques de cristal de Cu et ont fonctionné de la manière prévue. Des tests sur un cristal de Béryllium développé par l'Institut Max-Planck de recherche sur les métaux de Stuttgart, ont donné des résultats très prometteurs. D'autres études ont été consacrées à des cristaux de graphite intercalés pour monochromateurs, et à des cristaux de saphir pour les filtres à neutrons rapides.

Le Groupe Central a continué à assurer le lien entre les demandes émanant des physiciens et les services généraux, tels que l'approvisionnement de fluides cryogéniques, d'eau, d'air comprimé, d'électricité, la récupération des effluents et la manutention. Comme par le passé, une attention particulière a été accordée aux aspects de sûreté générale, aux systèmes d'alarme, à la manipulation de matériel présentant des risques, aux protections, aux mesures de bruit de fond, à l'alimentation ininterrompue de courant électrique stabilisé pour les instruments sensibles, à la préparation de consignes et de plans d'intervention en cas d'incident, etc. Le Groupe Central a joué un rôle important dans l'installation de nouvelles zones de travail et dans l'amélioration des zones existantes, des laboratoires, des plateformes, des cabines et des zones de stockage directement liées au fonctionnement des instruments ou des expériences spéciales. Il a fallu faire face à une lourde charge de travail lorsque le doigt de gant d'IN 4 a été changé. L'organisation de la collaboration avec le Département Réacteur pendant le long arrêt du réacteur programmé en 1983, et du démontage des instruments pour permettre le libre accès aux guides, a été engagée en 1982. Le Groupe Central a également apporté sa contribution dans la préparation de posters destinés à des expositions et a organisé des cours de formation spécialisée.

Dans le Groupe Environnement des Echantillons, un effort important a été consacré à la fourniture d'aimants supraconducteurs. Deux nouveaux aimants sont maintenant opérationnels de façon routinière, un de 5 tesla sur l'instrument D 2 (champ horizontal) et un autre de 10 strument D 2 (Horizontales Feld), eine zweite mit 10 T am Instrument D 7. An einer dritten für das Instrument D 3 vorgesehenen Spule traten technische Schwierigkeiten auf, und letztendlich musste ein Maximalfeld von 7 T akzeptiert werden. Die Lieferung dieser Spule ist für Ende 1982 geplant. Eine weitere supraleitende Spule wurde für die Drei-Achsen-Gruppe bestellt. Die Anlage wird momentan im Werk getestet und wird uns in Kürze zur Verfügung stehen.

In der zweiten Hälfte des Jahres 1982 stieg der Verbrauch an flüssigem Helium dramatisch an. Dieser Anstieg ist zurückzuführen auf die grössere Zahl an Experimenten bei niedrigen Temperaturen sowie die Einführung von Apparaturen, wie z.B. supraleitenden Spulen, mit hohem spezifischen Verbrauch. Es ist offensichtlich, dass der höhere Heliumverbrauch direkt die sowohl quantitativ als auch qualitativ gestiegene Nachfrage nach einer hoch-spezialisierten Probenumgebung widerspiegelt. Es ist zur Zeit nicht abzusehen, ob das Institut finanziell gesehen weiterhin in der lage sein wird, allen Anforderungen der Gastforscher nachzukommen. Andererseits liegt es bereits klar auf der Hand, dass es mit der verfügbaren Arbeitskraft in der zentralisierten Gruppe Probenumgebung unmöglich sein wird, die technische Unterstützung für den täglichen Betrieb aller Spezialapparaturen zur Probenumgebung zu gewährleisten.

A dramatic increase in liquid Helium consumption in the second half of 1982 is to be noted. This may be traced back both to a higher number of experiments run at low temperatures and to the introduction of devices, like superconducting magnets, with a high specific consumption. Obviously, the increase in Helium consumption directly reflects the increasing demands, both in quantity and quality, for a highly sophisticated sample environments. At the moment it is not clear how in the future the Institute will be able to cope with the visitors requests from a financial point of view. On the other hand, it is already evident that with the manpower available in the centralised Sample Environment Group it is impossible to supply the technical support for the daily operation of all special sample environment devices.

tesla sur l'instrument D 7. Un troisième aimant prévu pour l'instrument D 3 a occasionné quelques difficultés. Finalement, un champ maximum de 7 tesla a dû être accepté. La livraison de cet aimant est prévue pour fin 1982. Une autre bobine supra-conductrice a été commandée pour le Groupe Trois-Axes. L'ensemble est testé en usine et doit être disponible rapidement.

Une augmentation brutale de la consommation d'hélium liquide durant la seconde moitié de 1982 doit être mentionnée. Ceci peut être attribué à deux causes : un nombre élevé d'expériences réalisées à basses températures et à l'introduction de dispositifs, tels que les bobines supra-conductrices, avec une consommation spécifique élevée. L'augmentation de la consommation d'hélium est clairement le reflet de l'augmentation des demandes, aussi bien en quantité qu'en qualité, de même que celui d'un environnement des échantillons hautement sophistiqué. A l'heure actuelle, il est difficile de savoir si l'Institut sera capable à l'avenir de faire face aux demandes des visiteurs, au point de vue financier. D'autre part, il est déjà évident qu'avec la main d'œuvre disponible dans le Groupe centralisé de l'Environnement des Echantillons, il est impossible de fournir le support technique pour les opérations de routine de tout l'environnement des échantillons des dispositifs spéciaux.

instrument group fundamental and nuclear physics

PN1	:	Fission Product Separator (LOHENGRIN) on beam tube H 9.
PN2	:	Beta Spectrometer (BILL) on the vertical beam tube V 3.
PN3	:	Three Curved Crystal Gamma Spectrometers (GAMS 1, 2, 3) on the through-going beam tube H 6/H 7.
PN4	:	Ge(Li) Pair Spectrometer on the through-going beam tube H 7.
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 H23 L.
PN7	:	Cold Polarized Neutron Beam on neutron guide H142.
PN8	:	Fission Product Coincidence Spectrometer (COSI FAN TUTTE) on beam tube IH1.
H17	:	Cold neutron guide: liquid helium UCN-source.
H18	:	Cold neutron guide: search for neutron-antineutron transitions.
H22	:	Thermal neutron guide: neutron induced particle emission (H 22 D); γ-γ angular correlations (H22 F); neutron induced fission (H22 E).

PN1 fission product spectrometer "LOHENGRIN"

(H.R. Faust, R. Brissot, I. Gartshore, M. Taylor)

In 1982 the spectrometer LOHENGRIN was shut down in order to carry out a preventive exchange of the beamtube H 9. Technical reasons led to the decision to delay this exchange until spring 1983. During this year a considerable part of the spectrometer was dismantled, including parts of the casemates, the source changing facility, the deflecting magnet, and an important part of the vacuum system. All pieces have been inspected and, where necessary, repaired or replaced. In the condenser section of the spectrometer two new turbomolecular pumps have been installed to ensure a vacuum of better than 10^{-6} Torr after restart of the instrument.

The improvement of the stability of the high voltage to 10^{-6} continued in order to permit direct mass measurements (Giessen & ILL). To date the specifications have been met for the negative HT. The work on the positive part is continuing. It is also planned to install a reference voltage of 1000 V and a programmable divider for the control of the new high voltage facility by the instrument computer.

PN2 beta spectrometer "BILL"

(K. Schreckenbach, G. Colvin, G. Blanc)

In 1982 the beta spectrometer BILL was operational for about 90% of the reactor operating time. Approximately 20 different measurements were performed in atomic, nuclear structure and neutrino physics.
An important gain in sensitivity was achieved by the installation of a larger multi-wire proportional counter. Differing from the former 10-wire counter, the new counter is inclined by 45° relative to the beam axis and, with a length of 110 mm, covers almost all of the accessible part of the focal plane of the spectrometer. At present there are 32 wires mounted at a distance of 3.6 mm and separated by thin walls to confine scattering of low energy electrons. A 64 wire arrangement with a 1.8 mm wire distance has already been tested and aims at a further improvement of the position resolution.

The fast, epithermal and thermal flux at the in-pile target position of PN 2 was measured by the Groupe Dosimétrie, CENG. The epithermal flux was determined by the Cadmium ratio of In, Au and Co samples. To overcome self-heating problems of the Cd-containers the activations were performed at 6 MW reactor power. The following values were obtained:

φ_{th} (conventional) $= 3.16 \times 10^{14}$ n sec^{-1} cm^{-2} with 3σ error of 4%; epithermal Wescott factor $r\sqrt{T/T_0} = 3.8 \times 10^{-4}$, 3.4×10^{-4} and 2.3×10^{-4} for the In, Au and Co sample, respectively;

$\varphi_{fast} = 1.1 \times 10^{11}$n sec^{-1} cm^{-2}.

The spectrometer was calibrated for positrons and several measurements have already been performed with these anti-particles. The background of positrons from the target holder and backing was found to be 30 times smaller than that of electrons for a corresponding momentum setting of the spectrometer.

PN3 curved crystal gamma ray spectrometers "GAMS 1" and "GAMS 2/3"

(H.G. Börner, F. Hoyler, S.A. Kerr, M. Taylor)

In 1982 the bent crystal spectrometers were operational for about 75% of the reactor time. The loss of beamtime was due to a contamination of the source changing device with Tantalum originating from a metal target. It was found that Tantalum metal changes its structure when heated in a high neutron flux where Nitrogen is present at the level of only a few ppm, as in the Helium used to pressurize the beamtubes.

More than 10 different measurements were performed in order to study nuclear structure physics and special attention has been devoted to multiple capture of thermal neutrons in the rare earth region. In order to be able to disentangle such complex spectra a special effort has been made to further improve the resolution by more precise shaping of the targets and a best value of 0.5 arcsec has been obtained. This corresponds to a resolving power of $\Delta E/E = 4 \times 10^{-5}$ for a 200 keV γ-line measured in 5th order of reflection. (see fig. 1).

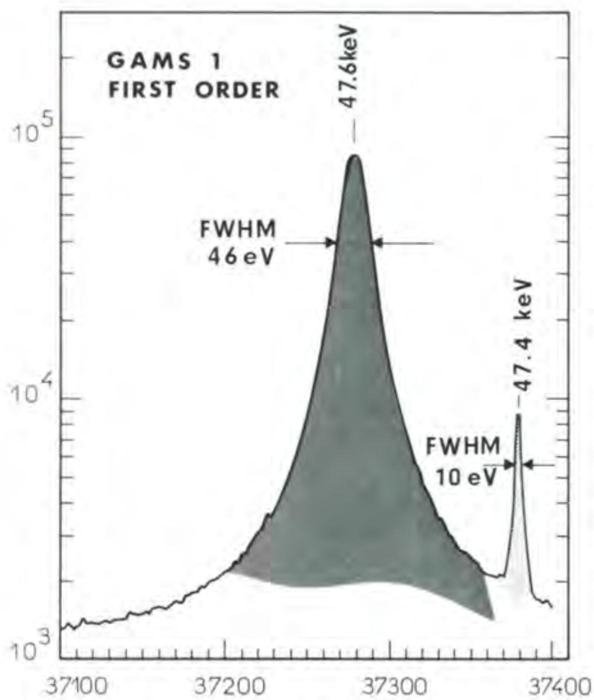


Fig. 1: Spectral range obtained from a ^{124}Dy target and measured by GAMS 1 showing peaks from a Kα-X-ray and a neighbouring γ-ray. The plot clearly demonstrates the high resolution of the spectrometer compared with the natural X-ray line width.

To further improve the energy-precision of GAMS 2/3 a sound insulating cabin has been constructed which entirely surrounds the instrument. Vibrational amplitudes in the interferometers (used for measuring the Bragg angles) have been reduced by approximately a factor of five.

A substantial improvement has been achieved in the PN 3 spectra analysis programs. A modular data treatment system based on a PDP 11/23 configuration has been adopted which allows data from the three spectrometers to be processed almost concurrently with the measurements.

PN4 Ge (Li) pair spectrometer

(S.A. Kerr, F. Hoyler)

More than 8 measurements of both singles and pair spectra have been taken during the year. As a complement to the bent crystal spectrometers a special effort was made to observe multiple neutron capture products by exploiting the advantage of odd-even mass differences which can be easily observed in the primary γ-ray spectra.

Work was continued on development of the data acquisition software by integrating this into the RT-11 F/B-system with PN 3.

PN5 ultra cold neutron source (UCN)

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

The ultra cold source has been used over the whole year in a time-sharing mode for the neutron electric dipole moment experiment, test measurements with the neutron microscope from TU Garching and for transmission measurements of neutron guides, neutron turbine blades and membranes.

PN6 on-line mass separator for thermally ionised fission products "OSTIS"

(B. Pfeiffer, U. Stöhlker, B. Nief)

The mass-separator OSTIS was running for most of the reactor time (85%) and 16 experiments have been performed. The reliability of the new indirectly heated high-temperature ion source has been further increased.

As a first application of the timing unit installed last year a multiscaling data acquisition sytem for half-life measurements was developed. The upgrading of both the separator and the acquisition system is continuing and a first on-line test of the negative ion source for halogens, developed by the University of Giessen, is imminent.

PN7 polarized neutron beam

(B. Heckel, O. Schärpf)

The PN 7 cold neutron beam has been equipped with a supermirror neutron polarizer since July 1981. A total of 4×10^9 neutrons/sec are transmitted by the polarizer, with a polarization of 97%, and a mean wavelength of 5.5 Å.

Two reactor cycles have been used in 1982 for testing and optimizing the superconducting neutron decay spectrometer PERKEO which has been installed by a Heidelberg-Argonne-ILL-collaboration. PERKEO will not only allow improved measurements on existing neutron decay parameters, but also an attack on hitherto inaccessible fundamental problems such as the weak magnetism in the decay of free neutrons. It should be noted that one day's measurement with PERKEO is equivalent to twenty years' run with earlier instruments !

The second experiment on PN 7 was the continuing investigation of the γ-ray asymmetry (A_γ) following neutron capture by protons (ISN & Harvard collaboration). In order to improve the sensitivity relative to the previous set-up, the liquid parahydrogen target is now fed by an on-line liquefactor, the efficiency of the two detectors (NE 235 scintillating oil) was improved, and a more symmetric set-up along the beam path should reduce the beam associated systematic effects.

PN8 fission fragment coincidence spectrometer "Cosi fan tutte"

(A. Oed, P.E.J. Perrin, R. Brissot, F. Gönnenwein, E. Aker, P. Geltenbort, T. Manning)

The set-up of the "second souffle" fission fragment spectrometer "Cosi fan tutte" was delayed by almost 6 months due to the beam-tube exchanges which became necessary on neighbouring instruments. The platform for mounting the apparatus on the inclined beam IH1 became accessible in July 1982. With considerable help from the technical services of the I.L.L. the mechanical, vacuum, electronic, counting gas supply and alarm systems were assembled in a fairly short time. First test measurements were run in September 1982. It then became apparent that some additional effort had to go into the radiation protection in order to reduce the background level on nearby instruments to an acceptable level. This work is still in progress. It seems that the major difficulties have now been overcome.

Measurements taken in November 1982 showed for the first time unambiguously that the major goal of Cosi fan tutte — a one-by-one mass iden-

PN 8, the new coincidence fission spectrometer "Cosi fan tutte", installed on the inclined hole IH1.

tification of fission fragments — had been achieved. In the present spectrometer fragment masses are determined in a rather straightforward way by measuring simultaneously the velocities and kinetic energies of fission fragments. The development and performance of the time-of-flight detectors (for the velocities) and ionization chambers (for the energies) have been described in more detail in preceding Annual Reports of the I.L.L. and some other publications. One of the first results as obtained for the thermal neutron induced fission of ^{235}Uranium on Cosi fan tutte is given in the figure.

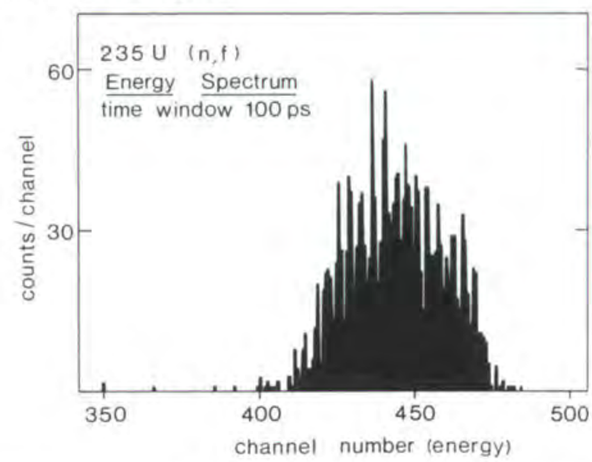


Fig. 2: Energy spectrum of fission fragments from thermal neutron induced fission of $^{235}U(n,f)$ with a time window of 100 ps set on the time-of-flight. The peaks in the spectrum correspond to individual masses ranging from 80 to 105 amu of the light mass wing of Uranium fission.

It shows the fragment energy spectrum of the ionization chamber for a fixed narrow time-of-flight window (width approx. 100 picosec) or corresponding velocity window. For a given velocity the discrete fission fragment mass spectrum should give rise to a discrete kinetic energy spectrum. This is indeed to be observed on the figure: each peak corresponds to a fission fragment mass. The peak-to-valley ratio (giving the mass resolving power) as found so far is roughly 2:1 for the light mass wing of fission fragments. Experiments are underway to improve these figures.

In the remaining test period the set-up of the instrument has to be completed. The first proposed and accepted experiment is expected to start in June 1983.

Special beam experiments

(P. Ageron, R. Brissot, B. Heckel, F. Hoyler, C. Jewell, S.A. Kerr, W. Mampe, O. Schärpf)

The neutron guides H 141, H 17, H 18 and H 22 were used for nuclear spectroscopy, fission and fundamental physics experiments.

On the S-3 B monochromatic 7 Å neutron beam (H 142, formerly S-43) the parity non-conserving (PNC) neutron spin rotation studies were continued. Targets of ^{139}La were studied.

The first superthermal ultra cold neutron (UCN) source has been installed in summer 82 at H 17. This UCN source has a 3 m long cryostat filled with liquid He-4 in which cold neutrons of $\lambda = 9$ Å are "down scattered" into the UCN region of $\lambda > 500$Å. The source has reached its base temperature of 0.5°K. A UCN storage time of 60 sec has been measured. The density of 1 – 1.5 UCN/cm^3 detected after a build-up time of 180 sec is lower than the actual density in the cryostat due to present imperfections of the extraction system. Further improvement should allow detection of the true density estimated to be ~ 20 UCN/cm^3.

The construction of the improved vertical cold source (VCS) is close to completion. The design of its associated vertical guide for extracting very cold and ultra cold neutrons has been completed. A technology of metallic guides with transmission identical to glass guides has been developed at Garching and the ILL. The fabrication of the guide and the associated "Steyerl" turbine has started at Garching.

At H 18 the beam of $\lambda = 20 \pm 10$ Å neutrons was used for the search of neutron-antineutron oscillations (CERN-PADUA-RAL-ILL collaboration). The target and detector geometry have been optimized and data were taken continuously over the year (during reactor operation and whilst shut-down). The total sensitivity for the oscillation period is now at the level of 10^6 sec. The apparatus has reached its optimum performance under the given conditions and data analysis is in progress. A second generation experiment is planned to be installed at the New Cold Source.

H 22 D and E were used for (n,α) cross section measurements and fission experiments, respectively. H 22 E is now equipped for operating with a continuous flow of gases such as butane or methane. A double torus ionisation chamber has been installed (TH Darmstadt, Bordeaux, ILL-collaboration) which allows the study of light charged particle accompanied thermal fission of

The new superthermal UCN source installed at H 17. The lower part shows the 3 m long He container in which UCN are produced. The vertical section houses the various cooling circuits.

^{235}U. This "DIOGENES" detector enables the measurement of masses, charges, energies and angles of the two fission fragments together with the light particle. This complete set of kinematic parameters combined with trajectory calculations will give new information about the scission configuration of fissioning nuclei.

On H 22 F the measurements of angular correlations of γ-rays after thermal neutron capture have been continued.

Co-Ordinator:
H. BÖRNER.

instrument group three-axis spectrometers

IN1	:	3-axis with beryllium-filter option on the hot beam tube H 8.
IN2	:	3-axis with a double monochromator on the thermal beam tube H 13.
IN3	:	3-axis spectrometer on the thermal guide tube H 24.
IN8	:	3-axis spectrometer on the thermal beam tube H 10.
IN12	:	3-axis spectrometer on the cold guide tube H 142.
IN20	:	3-axis spectrometer with polarised neutron option on thermal beam tube H 13.

Introduction

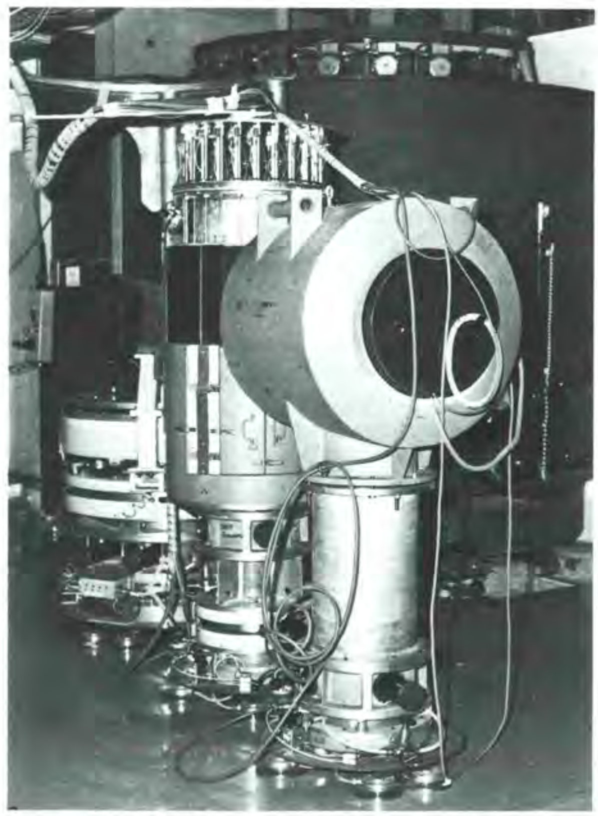
During 1982, the existing three-axis instruments (IN 2, IN 3, IN 12) operated normally whilst the modified IN 8 became operational at the beginning of the year and considerable progress was made on the new instruments IN 1 and IN 20. After deliberations by the Instrument Subcommittee, a three-axis instrument (IN 14) will be built on the new horizontal cold-source to be installed in 1985. This instrument should provide a wide range of incident wavelengths (≈ 2 Å to 6 Å) and be a particularly flexible spectrometer.

There have been relatively few changes in personnel. B. Dorner has joined IN 1 as second responsible and U. Steigenberger has replaced D. Cebula (who has returned to R.A.L.) as second responsible on IN 2 and IN 20.

IN1B hot source 3-axis spectrometer with Be filter option

(A. Kollmar, B. Dorner, H.J. Lauter, H. Jobic, P. Cross)

At the time of writing the "new" IN 1 has been completely assembled on site. The photograph shows a general view of the new IN 1 instrument. At present, all motors may be operated in the manual mode, but the SOLAR 16-40 computer has been connected and testing of the control programs is under way. A variable curvature Cu(220) monochromator has been tested in situ and significant flux gains compared to the previous instrument have been recorded. This monochromator is composed of 11 copper strips and is 20 cm high by 18 cm wide. Neutron tests have continued during the last cycle of 1982, although some time was devoted to tests of the new D 4 liquids spectrometer. It is intended to repeat some spin-wave measurements made on the old instrument to permit a more meaningful evaluation of the spectrometer's performance.



IN1B, the new triple-axis spectrometer on the Hot Source.

The Be filter detector, on loan from A.E.R.E. Harwell, was installed by the end of 1982. Design studies for a more sophisticated combined Be/pyrolytic graphite filter are well advanced.

IN2 thermal beam 3-axis spectrometer with double monochromator

(R. Pynn, U. Steigenberger, P. Flores)

At the end of September 1981 the H 13 beam-tube was replaced, resulting in a complete dismantling of IN 2. Fears that the subsequent performance of the instrument might have suffered have proved unfounded and this old, but very useful, spectrometer has since behaved well with no major breakdowns. No significant changes have been made to IN 2 in view of the imminent installation of IN 20, planned for mid 1983.

IN3 3-axis spectrometer on thermal guide

(D. Paul, H.J. Lauter, R. Arthaud)

As in previous years IN 3 operated satisfactorily with no major modifications. During the Spring shut-down in 1983 the electronics will be replaced with the new (IN 8/IN 1) modules and the instrument will be connected to a dedicated SOLAR 16-40 computer. Future modifications to the instrument will include the installation of a variable curvature monochromator system, with both copper and pyrolytic graphite crystals, and the provision of a single (5 cm diameter) ^3He detector as an optional replacement of the existing multidetector.

IN8 thermal beam 3-axis spectrometer

(R. Currat, B. Renker, A. Brochier)

The new version of IN 8, which had been assembled and partly tested during 1981, went into scheduled operation in January 1982. Because of the heavy pressure for beam-time some of the final tests and debugging had to be carried out in parallel with the experimental program. The new set-up, with central-drive step-motor units and a dedicated SOLAR 16-40 computer, is now fully operational.

A new 15-piece composite Cu(220) monochromator, prepared and assembled by the Monochromator Group, has been installed, thus completing the set of four interchangeable, vertically-focussing monochromators (pyrolytic graphite (002), Cu(111), Cu(220) and Ge(111)).

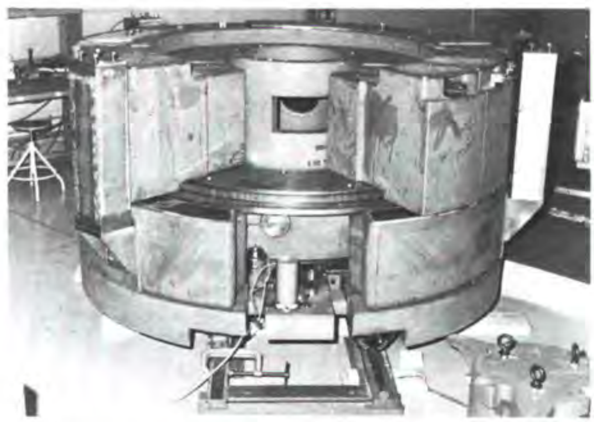
By the end of 1982 it is envisaged to instal, (i) a software package permitting the automatic exchange and alignment of the four monochromators, (ii) an automated control system for the polythene shielding blocks around the analyser, and (iii) a background terminal for on-line data treatment.

IN12 3-axis spectrometer on cold guide

(W.G. Stirling, K.A. McEwen, D. Puschner)

During 1982 there were no major modifications to IN 12 which continued to operate satisfactorily. Significant progress was made in the provision of equipment for neutron polarisation analysis experiments. A variable-curvature Heusler alloy analyser is now available; this device has a peak reflectivity of 73% at 4 Å for neutrons of the desired spin state and a measured polarising efficiency of above 95%. A Mezei-type spin-flipper and collimators within guide fields may also be mounted rapidly for polarised neutron studies.

A detailed design-study of an automatic (IN 8/IN 1) analyser block system is under way, with installation planned during 1983. The computer memory has been increased to 128 K permitting access to an extended library of programs.



The assembling of IN 20 in the test hall.
The picture shows the monochromator drum of the instrument.

IN20 thermal-beam 3-axis spectrometer with polarised-neutron option

(R. Pynn, U. Steigenberger, D. Cebula)

The monochromator drum of IN 20 was delivered on schedule in September 1982 and, at the time of writing, is being filled with paraffin wax. It is intended to mount this drum, at the end of 1982, on a specially designed test floor in the Hall d'Essais. The mechanical parts of the secondary spectrometer will then be connected to the drum, thus permitting tests of the electronics and computer system **before** the spectrometer is moved to the reactor face. A PDP 11/24 computer has been ordered to control the instrument. The motor-control electronics consists of slightly modified versions of the modules recently installed on IN 1 and IN 8. In conclusion, the design work for IN 20 is almost completed and most of the components are being fabricated.

Co-ordinator:
W.G. STIRLING.

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.
IN10	:	Backscattering spectrometer on cold guide H15.
IN11	:	Spin echo spectrometer on cold guide H141.
IN13	:	Backscattering spectrometer for short wavelengths on thermal guide H24.
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.

Introduction

The by now traditional experimental programme covering mainly magnetism, physical chemistry, metallurgy and biophysics was carried out successfully and with little perturbation. At the same time major reconstruction and improvement activity went on on a few instruments. The most notable achievement is the implementation of polarization analysis with ordinary resolution time-of-flight capability on a first set of 8 detectors on D 7 by using as many as 600 supermirrors. Thus, between IN 11 and D 7 polarization analysis is now available for the study of inelastic scattering effects in the whole energy domain from 0.05 µeV to 3 meV. The multidetector on D 16 is now fully installed and tested. Considerable effort has been devoted to the preparation of a reconstruction of IN 4, which is aimed at boosting the flux by about an order of magnitude. The experimental and numerical feasibility studies performed this year gave very positive results in this respect.

IN4 time-of-flight spectrometer

(A.P. Murani, H. Langel and H. Walter)

IN 4 operated satisfactorily during the first six months of this year with a few breakdowns attributed mostly to the aging electronics but also to Camac and computer system failures. The instrument however suffered a serious setback at the beginning of July when the H 12 beam tube was discovered to have developed a leak. Almost two reactor cycles were lost in the consequent instrument shut-down. After replacement of the beam tube and reinstallation of the spectrometer the normal experimental programme has been resumed from the middle of October.

Installation of a background chopper for the single monochromator option was completed in early January. Subsequent tests showed an excellent signal to noise ratio (improvement by a factor 3) with the background level even lower than for the normal double monochromator set-up. However, a fast neutron pulse originating during the open time of the background chopper still shadows 25% of the frame time. For the higher incident energies of 67 and 115 meV obtained with the C(004) and Cu(022) monochromators this represents an energy range of 15 meV permitting measurements in down-scattering to 50 and 100 meV, respectively. It would be possible to eliminate this unwanted fast neutron pulse with a new chopper having the combined functions of background and Fermi chopper.

IN5 multichopper spectrometer (TOF)

(F. Douchin, D. Kearley, J.P. Beaufils, S. Jenkins)

Thirty-two experiments and 3 tests were carried out on the spectrometer IN 5 in 1982, 50% of which were from the Chemistry subcommittee. Since the commissioning of IN 6, the instrument is used more for long incident wavelength measurements (50% of the time at $\lambda_0 > 10$ Å and a further 33% at 10 Å $> \lambda_0 >$ 6 Å). The use of wavelengths $\lambda_0 <$ 6 Å, i.e. in a zone where the performance of IN 6 is better, corresponds to small angle measurements or to the necessity of a direct comparison between the results obtained for two different wavelengths.

The use of the instrument has been facilitated by the preparation of a set of programs permitting the adjustment parameters to be set as a function of the desired characteristics and providing for a simplified "pre-treatment" of the results on the spot.

The 900° furnace (sample under vacuum) made for IN 6 is now also used on IN 5. A standard triple-axis type support also makes it possible to mount furnaces or the cryostats of the ILL sample environment group.

The development of magnetic bearings for choppers is continuing at KFA Jülich with a few months delay in the completion of the high speed prototype, due at the end of 1982. The motors decided on after simulation tests and production of a low speed prototype are hysteresis motors, which will permit automatic control of the whole range of speeds and wavelength of IN 5.

IN6 focussing time-of-flight spectrometer.

(A.J. Dianoux, M. Bée, Y. Blanc)

IN6 has been performing very satisfactorily during the year: in spite of the unscheduled reactor shut-down, 30 experiments will have been performed at the end of December. Only two instrument failures occured during this year: a breakdown of the chopper drive and a problem with a disk drive unit of the PDP-11 computer. A spare chopper drive is now available. The long lifetime of the chopper ball bearings is impressive: they have been performing without trouble for more than 18 months. In the two years of operation of the 337 detectors only one break-down has been observed at one detector. The reason was dust deposited on the high voltage connexions. During the reactor shut-down at the beginning of 1983 the dust shielding will be improved. The very high efficiency of the detector band permits to obtain reliable results in a very short time as shown on the figure 3.

The test of the curved slot chopper has shown that it is not very useful: its transmission is much smaller than the normal straight slot chopper. Furthermore the experiments carried out up to now did not require chopper speeds above 20 000 rpm. It has therefore been decided to replace the curved slot collimator by a straight one; this will provide a spare chopper in case of accidental break-downs.

During the year some improvements have been implemented: a new external memory to eliminate some occasional memory faults, a new cooling loop with Peltier cells permitting to obtain temperatures as low as −50°C at the sample, a new sample holder loaded from the top with precise angular positioning of the samples. At the beginning of December, a new evacuated sample box was installed. It will be possible to put a camera much closer behind the sample, thus leading to clearer pictures. Two collimators will reduce the background: a straight one will eliminate the tail of the small angle scattering from the beryllium filter, a radial oscillating collimator around the sample box will eliminate parasitic reflexions not coming from the sample area. The IN 6 control program has proved to be very simple to use by visitors, and very reliable. The transmission of the data to the PDP 10 central computer is now automatic.

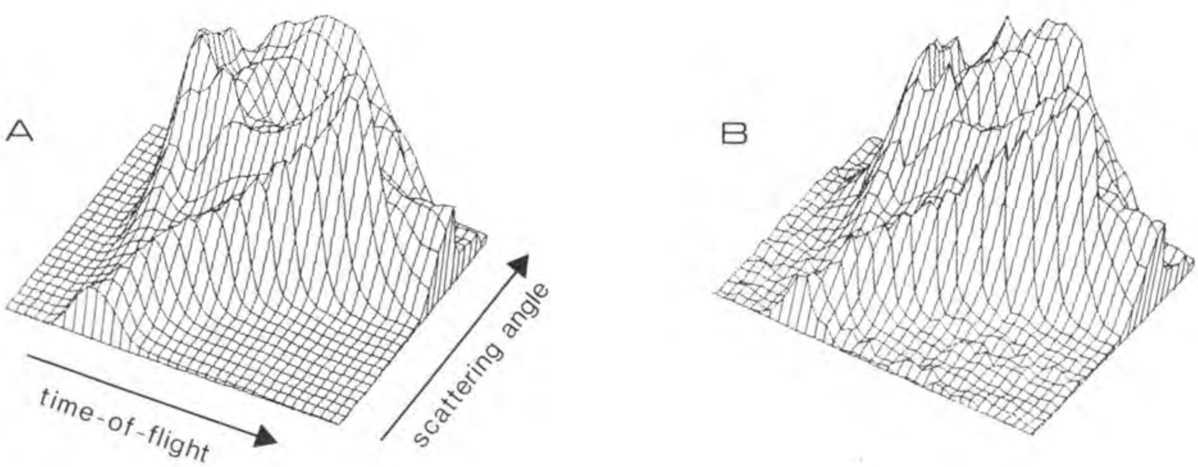


Fig. 3: Experimental (a) and theoretical (b) scattering law of polycrystalline FCC Lanthan at 293° K (counting time: 4 h). The theory uses 14 Born-von Karman parameters with interactions up to the 8th nearest neighbour (U. Buchenau, Jülich and N. Nücker, Karlsruhe). Run obtained on IN6.

IN10 backscattering spectrometer

(C. Poinsignon, A. Magerl, J. Bauchat)

The improvement to the new IN 10 spectrometer – installed during the long shut-down in 1981 – include the computer controlled movements of the analysers, the graphite deflector and the sample table. Recently the Doppler drive was mounted on a motorized support, thus permitting a more rapid and precise alignment of the monochromator.

The old instrument computer has been exchanged for a PDP 11/23. This together with improvements in the system software makes IN 10 now a very reliably running instrument.

In addition, the software has been extended. This improves on-line data inspection and facilitates the alignment of various instrument settings. A new acquisition system using microprocessors is currently being designed.

IN11 spin-echo spectrometer

(J.B. Hayter, F. Mezei, J.P. Varini)

The scientific programme of the instrument was about equally shared between chemistry type experiments (investigation of polymers, micelles, polyelectrolytes, biological matter, etc.) and studies in condensed matter physics (such as phase transitions, spin glasses, self-diffusion, phonon linewidth, etc.). This profile of the proposed experiments is rather stable over the past few years, as is the chronic overload on the instrument. At each Scientific Council the demand is about 3 times greater than the available beamtime, so that for example for one experiment it took as long as 4 years to total 3 weeks allocation necessary for a conclusion. This time is somewhat too long, even if the instrument has no competition elsewhere.

In some experiments performed this year special attention has been paid to exploring the ultimate resolution limits of the spectrometer. In the determination of the Lorentzian energy half width of quasielastic small angle scattering, 0.2 neV statistical accuracy can be very rapidly achieved at $\lambda \simeq 8$ Å. With the instrumental resolution broadening of about 15 neV, the systematic uncertainty, however, can be much bigger, especially if the scattering cross section changes very rapidly within the angular resolution of the instrument ($\sim 0.7°$). It was found that the systematic uncertainties represent typically 1-3 neV error to the measured linewidth, which appears to be just the level at which the internal motion of certain biological molecules manifests itself, as was observed for the first time in immunoglobulin this year.

Another highlight was the use of polarization analysis in the study of superparamagnetic liquids ("ferrofluids") with the help of a newly implemented software dedicated to the polarization analysis investigation of polyelectrolytes. This is the first time polarization analysis has been coupled with small-angle scattering to study these interesting systems. The technique provides a powerful means of following the detailed build-up of anisotropy as an external fields is applied, and allows a sensitive test of recent theoretical predictions.

The extension of IN 11 to a multiple detector system is nearing the end of the design stage. B. Sarkissian joined the group in Autumn this year and has been concerned with detailed calculations on the final magnet design.

IN13 backscattering spectrometer for short wavelengths

(A. Heidemann, I. Anderson, J.F. Barthélémy)

IN13 entered the phase of routine operation at the end of 1981. Since then the spectrometer has been running quite smoothly. Occasional system crashes of the instrument computer were eliminated more or less completely by some improvements of the RT 11 software and by the implementation of a standard DEC Camac controller. The PDP 11/34 was in addition equipped with a third terminal and a second disk drive. The memory was extended to 128 K.

The most delicate part of the spectrometer, namely the monochromator furnace, has been operating without any problem in a temperature range from −20 to 450°C. The second monochromator furnace which is, apart from some minor improvements, a copy of the first one, was assembled, tested and is, since the end of October, in operation on the spectrometer.

During the year 1982 numerous small improvements have been executed. The background level was reduced by the addition of extra shielding.

A complete set of data treatment programs is now available on the DEC 10 including raw data preparation (like CROSSX), display and fitting facilities.

The main object of the experiments carried out so far was the investigation of the Q-dependance of the incoherent scattering law $S_{inc}(Q,\omega)$ over a wide Q-range up to 5.5 Å^{-1} in a variety of systems such as molecular crystals (tunnelling, reorientation), metal hybrides (diffusion) and polymers. The measurement of the inelastic structure factors of tunnelling molecules or molecular groups like CH_3 in polycrystalline samples was for the first time successful due to the simultaneous availability of μeV-resolution and high Q-values on IN13.

D 7 diffuse scattering spectrometer

(O. Schärpf, F. Fujara, R. Rebesco)

At the beginning of 1982 a series of conventional diffuse scattering experiments were performed, all at 4.85 Å, as the bad mechanical construction of the first new monochromator did not allow the wavelength to be changed. After the unscheduled shut-down it finally became possible at the end of August to start experiments using polarisation analysis. For this reason a new detector bench was constructed, which allows 16 detectors to be set up on one bench and a special collimator in a vacuum box in front of those detectors for normal no-analyser arrangement. For polarisation analysis this box can be replaced by eight analysers in front of each second detector and guide fields acting simultaneously as collimators.

Each analyser contains 50 supermirrors. The direction can be adjusted by computer controlled synchronous motors with reversable motion. The 600 supermirrors 100 mm × 300 mm now needed for the analysers (in the final version it will be 1 800 mirrors and polarisers) were deposited on thin glass plates, assembled to analysers and tested individually for good performance (polarisation better than 94%, transmission better than 70%).

Six computer controlled current stabilized bipolar current sources were bought and are in use for spin flippers, spin turners and guide fields. For better resolution (ca. 70 μeV) than with the mechanical chopper and to gain intensity, a statistical flipper chopper between two supermirror polarisers was used, a set-up that also permits the use of detectors without analysers for TOF measurements with the same good resolution.

A totally new concept of programming had to be developed to deal with all these new possibilities. This concept is applied in cases where it is not required to take into account all possibilities of the machine or to call upon a programmer to implement new measuring or evaluation methods. For real research it must also be possible to implement easily completely unforeseen measuring techniques. The design and realisation of this is due to O. Schärpf. He chose as the programming language BASIC, which allows simple program development and simple direct display after evaluation directly on the machine during measurement. Cross-correlation of the pseudostatistical data during measurement and without interruption of the measurement and display of the results is possible as well as least square fits of the results using self-made matrix multiplication and inversion assembler programs for a BASIC array.

Experiments with spin analysis performed to date on D 7 are:

1. Separation of coherent and incoherent scattering by chlorine in the plastic phase of a molecular crystal C_2Cl_6.
2. Paramagnetic scattering with time of flight analysis in Cr(Fe 10%), $TmAl_2$, $Tb_{0.15}La_{0.85}Al_2$, $Tb_{0.02}La_{0.18}Al_2$ and Fe above the Curie point.
3. Separation of incoherent and coherent inelastic scattering in fluid sodium.
4. Measurements were also performed in a field of 16 kG with polarised neutrons without analysis using the mechanical chopper. For this reason the Al-windows in the chopper wheels were cut away to avoid the depolarising eddy currents.

D11 small angle scattering instrument

(P. Timmins, R. May, R. Oberthür, K. Ibel, P. Joubert-Bousson)

1982 has been a year of consolidation on D 11 with a number of improvements being made following the major modifications carried out the previous year.

The on-line data reduction facilities have been improved by the purchase of a hard-copy unit linked to the Tektronix 40.25 terminal. The DECNET system has been implemented allowing communication with the PDP-10 and other instruments, also speeding up the transfer of data to the PDP10. The memory has been expanded to 128 K.

The CAMAC electronics has been reviewed with a larger memory and closed loop units for step motor control. A new live-display unit was installed. A further expansion to 256 K of CAMAC memory will soon enable the time resolution required in the field of repetitive real time relaxation experiments.

A prototype automatic control of collimation change has been installed on the 5 m guide section making collimation change more rapid. An electronically controlled beam-stop is under construction and will soon be installed.

The scientific program continues to be very heavy with an average of almost four experiments per week and 2-3 times the available time requested. Several novel experiments have been carried out using new sample environments such as: myelin

A B

Fig. 4: Scattering from colloidal V_2O_5 in D_2O (12.5 mg/cm³) on the two-dimensional detector of D11.
(a) at rest: isotropic scattering pattern
(b) in a shear gradient (S = 500 s⁻¹): anisotropic scattering pattern.

under high pressure (Worcester & Braganza, ILL) polymers and colloids in a shear gradient (Lindner & Oberthür, ILL, see Fig. 4) and a magnetic alloy in a dilution refrigerator (Joffrin, Paris; Lyan, Maryland; Pynn, ILL; Ragazzoni, ILL).

control. The software programs for data acquisition and treatment are under review to increase their flexibility and make their use easier for inexperienced users. A television camera alignment system is being installed.

D16 high q-resolution, four-circle diffractometer in the range $0.05\ Å^{-1} < q < 2.5\ Å^{-1}$

(G. Zaccaï, S.A Wilson, L.F. Braganza, J.M. Reynal)

In its new configuration with small two-dimensional multidetector, D 16 has been in routine operation following the long shut-down this year. A number of experiments have taken advantage of the relatively large q-range available with good resolution. They include: Surface studies on graphite where the small angle region as well as the (002) graphite peak were of interest. Small angle studies on micelles, around the minimum q limit of the instrument. Powder diffraction from crystalline biological membranes ($0.1 < q < 1.2\ Å^{-1}$) where peaks separated by $0.02\ Å^{-1}$ were well resolved (wire spacing on the multidetector corresponds to $\Delta q = 3.5 \times 10^{-3}\ Å^{-1}$).

Improvements on the instrument have continued: the cooled Be filter is now under automatic refill control. The shielding around the monochromator housing and the instrument itself has been rebuilt, reducing the background to a very low level. Flight paths are under vacuum with automatic

D17 low-q high resolution spectrometer

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

A number of important improvements have been implemented in 1982. A new power supply has been installed for the velocity selector, which gives a better stability of rotation speed. The improved version of the sample changer has proven 100% reliable. The hard copy unit installed allows instantaneous output of displayed spectra. Faster data transfer to the PDP 10 main computer is assured by the new DECNET connection. In order to achieve better standardization throughout the Institut, the CAMAC controller has been changed. A number of modifications were made in order to facilitate the crystallographic work on this instrument. These include the installation of a faster and more accurate Eulerian cradle (HUBER) on a more rigid support providing perfect reproducibility of the alignment. The temperature control system of the sample has also been improved by using a stream of dry air.

Co-ordinators:
A. HEIDEMANN.
F. MEZEI.

instrument group diffraction instruments

D1 A	:	High resolution powder diffractometer on thermal guide H22.
D1 B	:	Two-axis diffractometer with multidetector on thermal guide H22.
D2	:	High flux 2-axis diffractometer with multidetector on thermal beam H11.
D2 B	:	Very high resolution powder diffractometer (in preparation).
D3	:	Two-axis polarized neutron diffractometer with lifting counter on thermal beam H5.
D4 B	:	Liquids diffractometer sharing hot beam H8 with IN1 B.
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 triple-axis spectrometer on thermal guide H24 (neutron spin-echo option).
T12	:	Neutron camera on thermal guide H23.
D15	:	Four-circle MK 6 diffractometer on inclined thermal beam IH4.
D18	:	Neutron interferometer on thermal neutron guide H25.
D19 A	:	2D multidetector for tests on thermal guide H24.
D20	:	High flux multidetector (in preparation).
S21	:	Double crystal diffractometer.
LI 4/5/7	:	X-ray laboratories.

Introduction

The instruments of the group have continued to function satisfactorily during the year. Parallel to this, developments are going as planned for the instruments connected to the H 11 project as reported below. The monochromator housings for the three instruments involved, D 2 B, D 19 B and D 20, have been designed, the tender to industry has been completed, and the group is now waiting for the decision on the fabrication of the shielding. The liquids diffractometer D 4 B has been completed, and during the year the rebuilding of one of the other instruments on the hot source, D 9, was decided upon.

Following the move of part of the group to the new computer building (ILL 19) the X-ray laboratories have been moved as well, and are now installed in the basement of the building connecting ILL 19 and ILL 20.

The group has, as usual during the year, received generous support from all services of the ILL, and we would hereby like to express our sincere thanks.

D1A high resolution powder diffractometer

(A.W. Hewat, A. Wright, S. Heathman)

The demand for the high resolution powder diffractometer continues to increase; nearly 10% of all ILL proposals are now for D 1 A, with an average of 3.5 days allocated to any one. With automatic programming of the temperature, two or more scans per day are now common, and often one hour scans at a series of temperatures are used to follow phase transitions. The installation of the new direct dialling telephone exchange means that it is now possible to interrogate and control D 1 A from remote home terminals at any hour of the day or night; the same remote terminal can also be used to process the data on the central computer. Apart from convenience, this should in future improve the efficiency by reducing machine or user errors. Some problems were experienced in 1982 with the electronics, which is now ten years old and reaching the end of its life.

D1 B two-axis diffractometer with multidetector

(J. Pannetier, P. Mangin, A. Dorn)

The instrument has continued to perform well under the Solar computer with few technical problems. The average time allocation has dropped to 3.8 days and is shared almost equally between colleges 5 and 9.

The dedicated furnace (up to 1200°C) has been fully tested and in now available as standard equipment. A translation table has been installed on the goniometer to facilitate the cryostat or furnace centering and minimize the loss of beam time during a change of configuration of the instrument. A new Eulerian cradle controlled by the instrument computer is presently under test and should be available soon for texture experiments.

A study of the implementation of super mirrors for neutron polarization was carried out; it was found that a polarization of 95% could be achieved at 2.52 Å with a reduction of flux of a factor 10.

D2 high flux two-axis diffractometer with multidetector

(J. Bouillot, J.L. Soubeyroux, P. George, J. Torregrossa)

D2 has continued to perform a large number of experiments in the field of magnetic alloys, intercalated surfaces, amorphous, liquids, and even gases. These experiments made use of the whole wavelength range and sample environment possibilities of the diffractometer.

The small number of test experimental days was mainly due to some instabilities of the new 64 cell multidetector. These problems are now completely solved.

The horizontal magnetic field cryomagnet is again available after having been more than one year out of use. A four-circle apparatus for texture studies is being set up and will be available in 1983.

D2 B very high resolution powder diffractometer

(A.W. Hewat, S. Heathman)

D2 B will be a much improved version of D 1 A, using 64 five-minute collimators and high pressure He 3 counters; many of these components were delivered in 1982. The PDP 11/24 computer will arrive early in 1983, and the electronics and mechanics, which are standard designs, will be available later that year. Il will then be possible to install D 2 B at the end of 1983 as planned.

D3 two-axis polarized neutron diffractometer with tilting detector

(F. Tasset, S. Burke, K. Ben-Saidane)

During the long reactor shut-down it became possible to find and repair errors in the computer system, which had hitherto reduced its efficiency. At the same time routines were set up for automatic restart, but as the instrument now functions satisfactorily, these have not been used. The transmission of data to the DEC 10 works well, and it is even possible to carry out data reduction on the DEC 10 from D 3. This allows a better optimization of measurement.

A new pumping unit for the cryostat has made it possible to reach temperatures of 1.35 K, and an improved sample holder now gives reproducible positioning in sample rotation of $\pm 0.02°$ inside the cold chamber. In addition crystal orientation using half-shutters has been automated, and a new DAC module produced at the ILL will soon allow limited automatic control of temperature.

The cabling of the instrument has been revised, especially with respect to the angular decoders, and in connection with this a dustproof cabinet has been purchased for holding the most sensitive part of the electronics.

D4 B two-axis liquids diffractometer

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

The D4 B instrument has been installed on the tanzboden. The first tests with neutrons were started in late November. One has observed as compared to D 4 a significant increase of flux at the sample, which amounts roughly to a factor of two to six depending on the monochromator focalisation, (at a wavelength $\lambda = 0.5$ Å). It is too early yet to assess the quality of the instrument in its highest flux configuration, but one may already claim that the results seem quite encouraging.

D5 polarized neutron spectrometer

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

As in previous years, D 5 was heavily over-subscribed particularly for experiments involving polarisation analysis. The spectrometer operated routinely throughout the year without major incident. Following the installation of the dedicated 11/34 computer emphasis has been placed on automation of the experiment. It is hoped shortly to install a sweep and field changing unit which will enable the incident neutron polarisation direction to be changed automatically.

Work on the development of improved neutron polarising monochromators has continued throughout the year.

D8 high flux four-circle diffractometer

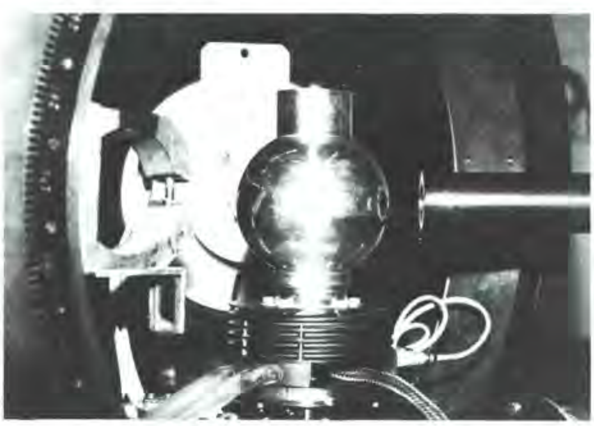
(S.A. Mason, G.J. McIntyre, J.R. Allibon, J. Archer)

D8 continues to run satisfactorily. Because the instrument will soon be replaced by the D 19 B multidetector diffractometer, only improvements in the electronics and software, common to D 9, were made, These include implementation of quicker, more flexible centring routines and changes to the software and hardware to allow programmed control of the temperature of the displex cryostat, and remote control of the instrument by telephone line.

D9 four-circle diffractometer with short wavelength

(M.S. Lehmann, W.F. Kuhs, J.R. Allibon, J. Archer)

The instrument has continued to function satisfactorily. More emphasis has been put recently on studies at temperatures above ambient, and this year a new four-circle furnace, constructed at the Kernforschungszentrum Karlsruhe, has been brought into operation and used successfully for several studies. The furnace is watercooled with a vacuum shield, and can operate up to around 1000°C with a long term stability of better than 0.5°.



New four-circle furnace (constructed at Kernforschungszentrum Karlsruhe) in operation on D9.

Remote control is now possible using a telephone line, and the instrument computer has also been connected to the DECNET system available at the ILL. This allows for almost instantaneous transfer of data to the central computer which permits early checking of the data and better planning of measurement.

Temperature control and variation for the displex cryostat has been brought under computer supervision. This allows automatic change for phase transition studies and a warning system in case of irregularities in cryostat behaviour.

During the year the reconstruction of the monochromator housing of D 9 has been extensively discussed, and at the autumn session of the Instrument Subcommittee the rebuild was recommended. The new instrument will be called D 9 B, and will still be a four-circle diffractometer, possibly with a small area detector. The monochromator will be nearer to the hot-source, and this should allow both a higher flux at the sample and better resolution for data at high momentum transfer. The wavelength change will be computer controlled, and this will allow for routine checking on secondary extinction. At present more detailed planning is under way, and it is hoped that the new instrument will be available shortly after the long shut-down in 1984-1985.

D10 high resolution four-circle triple axis spectrometer

(C. Zeyen, N. Lehner, R. Chagnon)

D10 worked well in all its different configurations (four-circle, two-circle, with and without energy analysis).

Experiments were mainly performed using the special four-circle He-cryostat, but also in the two-circle mode with a furnace, a cryomagnet and a pressure cryostat.

For studies with energy analysis, the resolution can now be adapted by using the standard ILL collimators before the analyser. A small rotation unit for the automatic change from the Cu 200 to the PG 002 monochromators is under construction. Using the four-circle He-cryostat the sample temperature can now be changed by the computer program, so that automatic measurements as a function of temperature are possible. An experiment on TmS at T = 3.6 K proved that measurements below 4.2 K are indeed possible.

While no scheduled experiments suffered from the reactor shut-down, the spin-echo tests planned for this year could not be performed.

D15 four-circle MK6 diffractometer

(P.J. Brown, S. Wilson, J.M. Reynal)

This year again, most of the experiments carried out on D 15 have exploited its capability to provide sample conditions of temperature, pressure or magnetic field which are difficult to achieve on the other four-circle diffractometers. This has meant that for most of the time the diffractometer has been used in the normal-beam configuration, the four-circle configuration with the two-stage displex refrigerator was used for just one experiment. The increased flexibility provided by the 11/34 computer and associated software has helped greatly with many of the experiments.

During the year D 15 acquired its own ILL "orange" cryostat with a specially extended tail to allow measurements with a detector elevation of up to 30°. The new ILL standard thermometry associated with this cryostat allows much greater reproducibility of temperature. The high temperature (2000°C) furnace designed for powder studies was used for two single crystal experiments. The experience gained has enabled the specifications for a high temperature "single crystal" furnace for D 15 to be established. We hope that such a furnace will be built during the coming year. A new half-shutter system with a high degree of stability and reproducibility has been designed and was installed in the spring. The use of this system enables a very much better centring of a sample held inside a cryostat or furnace.

In October D 15 was dismounted to enable the work of dismantling PN 1 in preparation for the long shut-down of 1983. During this shut-down the IH 4 beam tube, on which D 15 is located, will be replaced. The instrument should be re-installed and ready for scheduled experiments in June 1983.

D18 neutron interferometer

(U. Kischko, G. Schmid)

The instrument has continued to function satisfactorily this year. From next year the instrument will stop being routinely scheduled, and will from then on be considered as a special instrument.

The D19 A multidetector prototype.

D19A two-dimensional multidetector on neutron guide

(M. Thomas, R.F.D. Stansfield, M. Berneron).

For the first half of 1982, D 19 A was equipped with the small "fly's-eye" PSD of 64 × 16 cells. This configuration has been used to collect data from an organic crystal (Phthalocyanine = $C_{32}H_{18}N_8$) and an inorganic crystal (DKDP = KD_2PO_4) at room temperature. These experiments were performed using classical four-circle geometry with the aid of the control program LSD. The DKDP data was reduced to integrated intensities, on-line on a PDP 11/34, using the new program BRAGAI. The reduced data have been the subject of a detailed analysis, which was presented at the PSD workshop held at the ILL in October. The results are encouraging for the role of PSD's in the evaluation of accurate Bragg intensities.

In the second half of the year, a large vertically curved PSD of 512 × 16 cells was installed in place of the small prototype. After two months of tests by the detector group, the hardware was operational. Software methods are being extended for the big detector, in conjunction with progress towards defining an optimum strategy of data collection using normal-beam geometry. The need to process several million words of data per hour, on-line, exceeds the capacity of the present PDP 11/34, and a VAX 11/750 computer has been approved for delivery in early 1983.

The scientific program for D 19 A in 1983 includes three proposals from other laboratories and marks the start of a scheduled service to users.

D20 two-axis diffractometer with PSD at high counting rate

(P. Convert, J. Bouillot, J. Torregrossa)

The detailed design study of the mechanical part of the diffractometer is underway. The fast data acquisition system is under development. The 128 cell D 20 PSD prototype built by ILL (Jacobé), using ^3He gas, will be operational in early 1983. The technical tests of a 100 cell PSD prototype built by the Rutherford Laboraty, using a scintillation discrete element system, was performed at the ILL in December 1982. The decision to build the large D 20 detector based either on the gas or scintillation technique will be taken in January 1983.

X-ray laboratories

(A.N. Christensen, P.J. Brown, G. Schmid).

The X-ray laboratories were out of operation for part of the year while the move to the new location (room S 15 under the hall connecting ILL 19 and ILL 20) was made. The laboratory is now again operational and comprises a Siemens diffractometer, a precession and a Weissenberg camera. Improved microscope facilities are being set up at present, and work is under way installing an X-ray powder diffractometer.

Co-ordinator:
M.S. LEHMANN.

monochromator group

Instruments:

D13	:	Neutron double-crystal diffractometer on thermal guide H24
D13 C	:	Neutron double-crystal instrument on thermal guide H23
LI 2A	:	X-ray double crystal diffractometer
LI 2B	:	X-ray orientation unit
LI 3	:	Gamma-ray diffractometer
		Laboratory for crystal preparation

Status of the Instruments

No major modifications of the neutron and X-ray facilities were carried out in 1982. D 13 A was used for crystal characterisation and orientation and D 13 C served as usual for monochromator tests and for assembling multicrystal focussing systems. On the other hand, the three γ-ray diffraction units of LI 3 were completely dismantled and are being reconstructed in a different way in order to accommodate the fourth diffraction unit including the crystal growth furnace. Because of safety regulations the radioactive source had to be moved to a special building separated from the γ-ray laboratory. The installation of an alternative and complementary source (^{137}Cs) is envisaged which would feed the crystal growth facility and at least one of the other diffractometers used for in-beam plastic deformation

A new mechanical device for monochromators with variable radius of curvature has been developed which was applied to the design of the IN 1 B/D 4 B, IN 20 and D 20 monochromators (in collaboration with E. Schedler, Neckarsulm, Germany and the Mechanical Construction Group of the Technical Department). The procedure for the oriented transfer of the crystals has also been considerably improved.

Monochromator production and development

The prototype of the variable curvature monochromator for D 4 B/IN 1 B was equipped with Cu(220) slabs covering a surface of 400 cm². Both the reflectivity and the gain due to vertical focussing were as expected, corresponding to a total increase of flux by a factor of 4 to 5 with respect to the old IN 1 in the energy range from 100 to 300 meV. The mechanical support for the four-monochromator device has been constructed and the copper crystals (200, 220 and 311) are being mounted on three faces. The fourth system will be supplied later, probably also with copper crystals for high intensity and lower resolution work. Two analyser systems for variable curvature were equipped with Cu (200) and PG(002) crystals. The production of Heusler alloy crystals for the IN 20 monochromator and analyser has already started and the copper crystals for this instrument are in preparation. The copper raw material (undeformed) for IN 1 B/D 4 B and IN 20 was partly provided by the Kristall-Labor of the KFA Jülich, Germany

The in-beam controlled growth of copper crystals by means of a Bridgman furnace mounted on the γ-ray diffractometer was delayed due to the late delivery of the temperature control and to the subsequent modifications at the γ-ray laboratory. We hope to start operating this facility early in 1983. At about the same time we shall begin with γ-ray in-beam experiments on the improvement of pyrolytic graphite using a furnace which has been supplied by the firm Le Carbone Lorraine, Gennevilliers, France.

After a series of unsuccessful attempts to produce good quality beryllium single crystals of big diameter by means of the improved induction furnace a very encouraging result was recently obtained with the newly constructed light-weight furnace at the Max-Planck-Institut für Metallforschung, Stuttgart, Germany (S. Joensson, S. Stiltz). A 10 cm long crystal of 1 cm diameter has been grown without any subgrain boundary. The mean mosaic spread of this crystal as measured with γ-rays was 0.05°, distributed uniformly as shown by topography. We hope that this unique result will be reproducible also for bigger diameters.

The peak reflectivity of intercalated graphite (KC_8, d_{001} = 5.35 Å) is close to the theoretical value for a wavelength of 7.2 Å. This has been confirmed experimentally (r_p = 71% for a mosaic spread of 1.8°), and the preparation of other compounds with slightly different lattice constants (RbC_8, d_{001} = 5.65 Å) is under way for a composite monochromator where the lattice plane distance is varied. Such systems are of direct interest for a diffractometer to be designed for biology and for nuclear physics experiments. This development is carried out in conjunction with Ecole d'Electrochimie, INPG, Grenoble (A. Hamwi, P. Touzain).

Big sapphire crystals produced by the firm Pechiney Kuhlmann, Pont de Claix, France, have been examined with a view to their application as fast neutron filters. The relatively large and non-uniform mosaic spread makes them suitable only for work at fixed neutron energies below about 60 meV. Based on a general formula developed for calculating total cross-section MgF_2 has been discovered as a possible candidate which can be obtained as a big single crystal of a few seconds mosaic spread.

Co-ordinator:
A. FREUND.

sample environment group

Vacuum

Maintenance of the 470 Institute pumps:
- 700 Routine interventions.
- 360 Repairs, of which 150 major repairs.

Commissioning of new pumps:
- 12 Primary pumps.
- 2 Turbo-molecular pumps.
- 7 Roots pumps.
- 5 He pumps.

Assembly of 5 complete He pumping systems.

Approximately 650 leak tests have been performed in the laboratory (with helium leak detectors). Four weeks have been spent on various leak tests 'in situ', on the reactor systems and on the experimental devices.

Cryogenic fluids

Liquid Nitrogen:
396 550 l (+17%) at cost .45 F/l.

Liquid Helium:
- Consumption: 63 445 l (+70%).
- Average cost per litre: 19.5 F (+6%) including gas losses.
- Gas losses: 11 200 m³ (i.e. 24% of consumption), (19% in 1981).

Despite the reduced operation time of the reactor, there was a large increase in Helium consumption, due to the operation of superconducting magnets and to the increase of sample preparation experiments.

Cryogenics

Neutron experiments requiring low temperatures: 224.
Cryostat-days: 2 192.

Standard cryostats

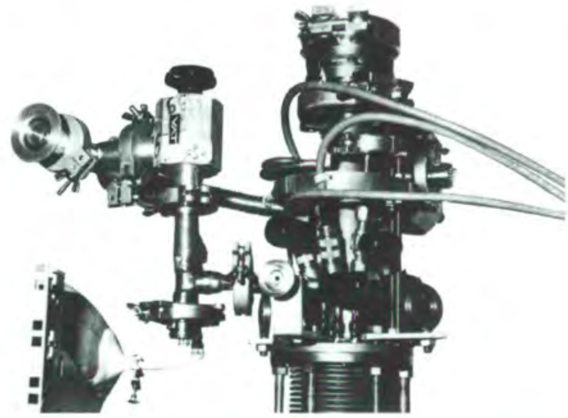
1 new standard cryostat has been developed and put into service for use with a conventional electro-magnet, having the same performances and reliability as the standard cryostat.

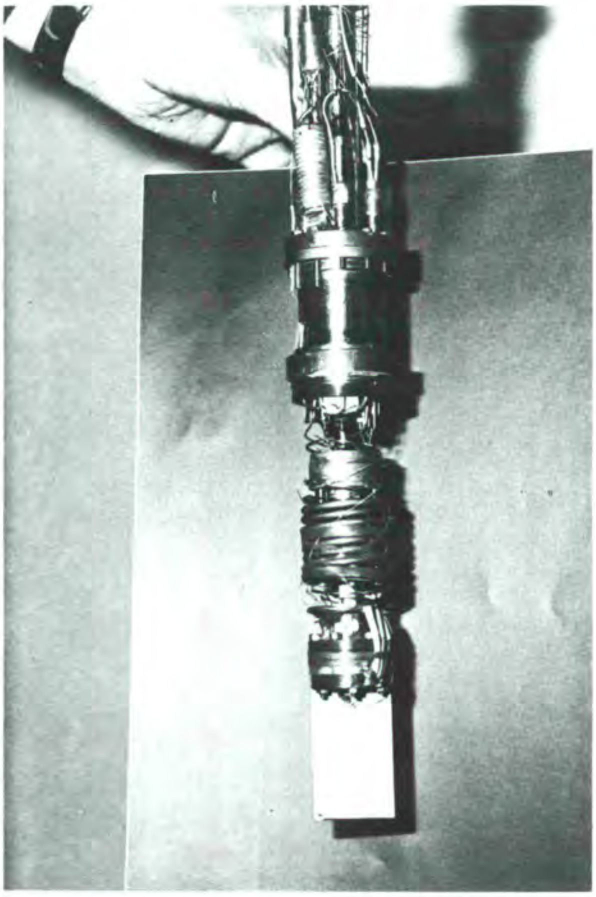
4 standard cryostats have been commissioned and put into service.

4 closed circuit 10 K machines have been mounted with the top loading ILL system.

Special systems

- The IN 1 Be-Filter (77 K), to be installed in the primary beam, has been studied, mounted and successfully tested out of the beam.
- The ultra-cold neutron source superfluid He at





Upper and lower structure of the new insert for the "pocket dilution refrigerator" which fits into a standard orange ILL ^{4}He cryostat.
Temperature range: 50 mK to 300 K.
Maximum sample can dimensions: 70 mm high, 38 mm wide.
The insert has been developed by K. Neumaier (Zentral-Institut für Tieftemperaturforschung der Bayerischen Akademie der Wissenschaften, Garching) in collaboration with the ILL Sample Environment Group.

.5 K has been commissioned and put into test operation for two months.

Very low temperatures

6 experiments have been conducted at very low temperature on IN 6, D 11 (2), IN 10, D 16, IN 2.

1 experiment has been unsuccessful, due to cold leak in the dilution heat exchangers.

A new dilution insert which can be operated in standard ILL cryostats has been successfully developed in collaboration with Dr. Neumaier, from Munich.

A temperature of 40 mK is achieved at the moment. Improved performances are expected in the near future.

The main problem in this field is, and will continue to be, the lack of staff. The only technician devoted to this domain cannot prepare and operate several systems simultaneously. The very low temperature systems are therefore not used as extensively as they could be.

Superconducting magnets

— The 10 TESLA vertical field magnet manufactured by I.G.C. has been delivered and tested at the ILL. This magnet, purchased for D 7, will enter into full service when the necessary alterations have been made to D 7 to accept it.

— The 6 TESLA computer controlled vertical field magnet system ordered by the 3-Axis Group has met with problems during manufacture, but should be tested and installed at the ILL early in 1983.

— The D2 5 TESLA horizontal field magnet has been tested and re-installed on its experiment after modification and repair at Oxford Instruments. This magnet is now back in full time service and has successfully functioned for several experiments.

— The D 3 THOR magnet system, (originally 10 TESLA) which was rejected during acceptance tests at the ILL as it did not reach its specified field, will now be delivered and tested at the end of 1982 with a nominal field of 7 TESLA.

There have been improvements over last years situation, but several problems still exist. Although devoted to an instrument, all these systems should operate also on other instruments when required. That would mean one 'operator' per superconducting magnet, which is impossible, with the present staff of only one technician.

Furnaces

—·70 (+8) experiments have used furnaces on loan from the Sample Environment Service. The increase in this field is in fact higher, as the experiments on instruments with their own furnace are now not included in this figure.

— After the satisfactory results obtained with the 2nd version of the 2 500°C furnace, a third version has been studied. One similar model, which is specially adapted to D 15, is being studied.

— The basis of a standard furnace for the Triple Axis instruments have been fixed.

— Major modifications have been carried out on the IN 4 furnace, and studied on S 6 furnace (again).

Temperature measurement and control

The new ILL microprocessor-based temperature controller has made progress as planned. A first series of six units are nearing completion and these will be installed on selected instruments during the long reactor shut-down at the beginning of 1983.

During the year the group has purchased three high-precision a.c. resistance bridges which enable us to measure and control temperatures in low-temperature furnaces to a precision of the order of 1 mK.

The replacement of Si diodes thermometers by calibrated Platinum and Carbon resistances has been continued and is nearly finished. The possible uses of Rhodium-Iron resistances have been studied and some will be mounted for test under real experimental conditions.

D. BROCHIER.

central group

During 1982 the group has been very actively involved in organising, defining, supplying and maintaining the general services required by the I.L.L. scientists and visitors in the carrying out of their experimental programmes. As in previous years this has included:

— The provision of cryogenic fluids (liquid Helium and Nitrogen), and some maintenance of dewars.
— The provision of general fluids (electricity, water, compressed air and gases, and effluent recovery).
— The definition, connection, regular testing and improving of instrument alarm and safety interlock systems.
— Provision and repair of gas regulators.
— The preparation of instructions for the supervision of dangerous experiments and materials, and the procedures to be followed in the event of any incident.
— Assistance with the installing and dismantling of special beam experiments particularly on the polarised beam PN 7 and the N-$\bar{N}$ experiments.
— Planning and organisation of shutdown work schedules.

The necessity to change the reactor thimble on IN4, involved the dismantling of the entire primary shielding, and the opportunity was taken to redesign and modify it, to facilitate any future dismantling.

Currently, preparations are well advanced for the long shutdown in 1983 during which a number of other reactor thimbles are to be changed. This has already involved the complete dismantling of D 15, and a large part of PN 1. The instruments D 2, D 8, IN 8, D 3 and part of H 6 will also be dismantled. The movement and safe storage of the large quantities of shielding and experimental equipment involved, has necessitated the construction of a specially adapted building for the shielding of D 15, and the purchase of a crane lorry.

The definition of the basic safety configuration 'Etat Fondamental' and intervention plans for all instruments have been virtually completed.

Design proposals and studies were carried out for:

— The new X-ray laboratory now installed and operational in the basement of ILL 19.
— The internal organisation of the new Experimental Hall.
— The T 12 Weissenberg camera instrument, including the automatic control.
— The modification of the Displex 1003 cryorefrigerators to make them compatible with ILL temperature controllers.

Following background measurements, modifications have been made to D 16, by the addition of hot formed curved polyethylene as developed for D 12 in 1981.

The installation of PN 8 lead to increased background levels, on the surrounding instruments, and after extensive studies, shielding improvements were made on PN 8 and IN 4. Shielding improvements have been carried out on a number of other sites including D 7, PN 3, PN 4 and S 21.

Special developments have included:

— The realisation of seamless spherical radiation shields.
— The examination of optimised γ and neutron shields for new miniature types of detectors developed by external laboratories.
— The study of new guide tube windows in graphite.
— The transformation of Lithium metal to Lithium fluoride.
— The production of a new beam shutter control box with the Reactor Electrical Group.

Improvements have been made in the experimental halls by the installation of an extra work platform for PN 1, the installation of electrically controlled interlocked doors on the airlock of the guide hall building, and the installation of a lightweight demountable cabin for S 21.

The future provision of clean, computer electrical supplies is being studied, and comparison being made between the choice of a centralised static invertor, or individual units on especially sensitive instruments. Test equipement has been installed to survey continuously the quality of the existing clean supply generator, particulary with regard to transient phenomena.

A new improved integrated water supply and alarm system has been defined and is under construction. It will permit the automatic closing of the supply and the shutting down of equipment, in the event of loss of flow or of a detected leak, and the transmission of an alarm to the Control Room via the SADI microprocessor.

The SADI system is now fully operational, and is being used for the surveillance of a number of instrument safety parameters including vacuum pressure, gas detection and elevation of temperature.

In collaboration with the Scientific Staff, display posters were prepared which have been used at a number of exhibitions in Britain, France and at the ILL. A three dimensional cut-away section of the Standard ILL Orange Cryostat has also been prepared for display purposes and for use in descriptive manuals.

Training courses were organised by the Department on Nuclear Physics sample environment techniques (cryostats, furnaces, magnets and high pressure), and in collaboration with the training section on Vacuum techniques. A course is planned on Cryogenic techniques. Visits were also organised to several local Research and Industrial organisations during the unscheduled extended shutdown of the reactor.

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: Structural and magnetic excitations
College 5: Crystal and magnetic structures
College 6: Liquids, disorders and defects in materials
College 8: Biochemistry
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. The College Secretaries are normally elected for a 2 year term and have regular meetings with the Directors and Senior Scientists to ensure the flow of information on all matters concerning the scientific activity of the Institut.

Einleitung

Die gesamte wissenschaftliche Tätigkeit des Instituts ist in Kollegien mit spezifischen wissenschaftlichen Interessen aufgeteilt.

Zur Zeit sind folgende Kollegien am Institut tätig :
Kollegium 2 : Theorie
Kollegium 3 : Grundlagen- und Kernphysik
Kollegium 4 : Strukturelle und magnetische Anregungen
Kollegium 5 : Kristallographische und magnetische Strukturen
Kollegium 6 : Flüssigkeiten, Unordnungen und Fehlstellen in Substanzen
Kollegium 8 : Biochemie
Kollegium 9 : Chemie.

Jedes Kollegium entspricht einem Unterrausschuss des Wissenschaftlichen Rates des ILL, der die Direktion in Fragen des wissenschaftlichen Programms berät. Die Kollegien prüfen als erste dem ILL unterbreitete Vorschläge zu neuen Forschungsvorhaben im Hinblick auf ihre technische Realisierbarkeit. Daraufhin werden sie den Unterausschüssen vorgelegt. Eine weitere Aufgabe der Kollegien ist es, zu einem reibungslosen Ablauf der Experimente beizutragen : Sie stellen den Gastforschern wissenschaftliche Hilfe vor Ort und beraten den Verantwortlichen der Experimentiereinrichtung und den Wissenschaftlichen Sekretär über die Zeiteinteilung für die Experimente an den verschiedenen Instrumenten. Die Sekretäre der Kollegien werden normalerweise für 2 Jahre gewählt, und halten mit der Direktion und den "Senior Scientists" regelmässig Sitzungen ab, um den notwendigen und alle wissenschaftlichen Tätigkeiten des ILL betreffenden Informationsfluss zu gewährleisten.

Introduction

L'ensemble de l'activité scientifique de l'Institut est réparti en collèges avec des intérêts scientifiques spécifiques.

La liste actuelle des collèges se compose comme suit :
Collège 2 : théorie
Collège 3 : physique fondamentale et nucléaire
Collège 4 : excitations structurelles et magnétiques
Collège 5 : structures cristallographiques et magnétiques
Collège 6 : liquides, désordres et défauts dans les matériaux
Collège 8 : biochimie
Collège 9 : chimie.

Chaque collège correspond à un sous-comité du Conseil Scientifique de l'ILL, qui conseille la Direction en matière de programmes scientifiques. Les collèges examinent d'abord la faisabilité technique des propositions de recherche soumises à l'ILL. Elles sont ensuite présentées aux sous-comités du Conseil Scientifique. Les collèges contribuent également au bon déroulement des expériences en proposant des collaborateurs locaux aux chercheurs invités, et en conseillant le responsable d'instrument ainsi que le Secrétariat Scientifique de la répartition du temps d'expérience sur les différents instruments. Les Secrétaires de Collège sont normalement élus pour 2 ans et se réunissent régulièrement avec la Direction et les "Senior Scientists" dans le but d'assurer une bonne circulation de l'information dans tous les domaines d'activité scientifique de l'Institut.

college 2
theory

Membership 1982

I. **ILL Members**
P. Nozières
P. Becker
H. Capellmann
B. Desplanques
R. Hasse
D. News
M. Roger
P. Schuck
H.J. Schulz
H.J. Sommers
J. Treiner
M. Uwaha
T. Ziman

II. **Thesis Students**
C. Comte
J. Bartel
U. Stroth

III. **Long term visitors**
S. Evangelou
G. Ghosh
J. Gunton
M. Hood
A. Hüller
I. Katz
P. Lindgaard
K. Makoshi
S. Noguera
R. Peierls
R. Prange
N. Read
J. Solyom
D. St James
K. Usadel
J. Winter
J. Yeomans

Introduction

Besides the research activities in condensed matter and nuclear theory, which will be summarized below, several points should be mentioned concerning the College.

Professor P. Nozières was elected to the French Academy of Sciences. The College has been in charge of organising the "General Colloquia" in the Institute (Becker, then Ziman). A workshop (CNRS contract) and an International Symposium (in honour of E.F. Bertaut) brought together experimentalists and theorists in the domain of electron density distribution in solids (Becker). The weekly theoretical seminar organized by Nozières has been quite successful and allowed for lively and controversial debates about new fields in Physics. Despite the replacement of two members (Capellmann and Schuck), the College composition has been quite stable this year, which resulted in an increase of scientific collaborations both internal and with experimentalists.

In the following we shall report about the major research subjects covered this year.

Scientific Activities in 1982

1. Magnetism and magnetic transitions

This field, one of the "classics" of ILL activities, exerts a significant attraction upon theorists, and allows for important joint studies with experimental groups.

a) ***Itinerant Magnetism***

Theory of itinerant magnetism in 3d metals and alloys, developed by Cappelmann (and Vieira) led to the persistence of short range magnetic order above T_c. Important joint studies with Brown, Ziebeck (ILL), Desportes and Givord, using polarised neutron scattering (Fe, Cr, MnSi) confirm this short range order and quantum fluctuations of magnetization density (MnSi). This collaboration opens a new field in the magnetism of metals.

b) ***Solid ^{3}He***

Roger, who proposed multiple exchange mechanism to interpret magnetism (and other observations) in solid ^{3}He, has further developed the theory for 3 and 4 particle exchange couplings, particulary as a function of particle density: with an interesting application to 2 D-Wigner solids. Theory seems to be ahead of experiments in this field, as diffraction at $T < 1$ mK is still under development. Roger and Glyde proposed a quasielastic neutron experiment, at $T \sim 10$ mK, showing that it would be a unique test for multiple (3 and 4 particle) exchange couplings.

Together with Gillon (ILL), Becker studied the influence of substituants on spin properties of radicals such as $^{R}_{R'}{>}NO$, explaining the apparent disagreement between neutron, ESR and theoretical predictions.

In collaboration with Bonnet (CENG) and Sfez (Paris), Becker proposed a simple model for interpreting "forbidden" magnetic reflections in YIG, in terms of covalent and superexchange interactions.

d) ***Spin glasses***

Quantum theory of induced moment spin glass has been developed by Sommers (with Usadel). The theory is extended to Spin 1 systems with uniaxial anisotropy (such as MnZn, CdMn). Sommers completed the derivation of Sompolinsky's dynamic mean field theory of spinglass, discussed its property of marginal dynamic stability and its relation to Parisi's replica solution.

Ziman and Salamon (visiting experimentalist) proposed a simple phenomenological model for lineshapes of ESR spectra for spin glass, based on a fluctuating random field.

Nozières clarified the nature of Onsager reaction field in spin glass, an applied this to the study of metastable states.

e) ***Spin-1 chains***

Ziman and Solyom undertook a study of Spin-1 chains for a Hamiltonian with site and exchange anisotropy (as in easy plane ferromagnetic chains). Study of finite chains (8, 7, 6) and use of renormalisation group enables a fair description of the phase diagram. Deviations from mean field model are quite marked.

f) ***Spin Dynamics***

Two close collaborations with College 4 developed in this domain. Lindgaard studied the dynamics of incommensurate phases (in Nd, Pr, $CeAl_2$) and of singlet-doublet systems. Hood calculated neutron polarisation effects for single magnons in a Heisenberg model and showed how polarisation analysis can distinguish between site and exchange anisotropy (application to $CsNiF_3$).

2. Phase transitions, critical phenomena and low dimension physics

There have been several crucial contributions in this most topical area of research.

a) ***Adsorbed layers on surfaces*** (such as Xe on Cu(110), Pb on Cu(110) or H on Fe(110) exhibit various phases, commensurate, incommensurate and disordered. The phase diagram has been successfully established by a theory of Schulz incorporating a dependance on the number of degenerate commensurate phases.

b) Newns and Makoshi studied the ***charge transfer associated with inelastic atom or ion collisions with a surface.*** Hasse, Ghosh and Schuck formulated a quantum theory of electron stimulated desorption of hydrogen or oxygen from metallic surfaces (quantum effects are related to the large imaginary part of the optical potential).

c) In order to understand how anisotropic quasi-one-dimensional super-conducting fluctuation effects decrease the critical temperature, Schulz developed a theory based on ***low energy phase fluctuations of the surperconducting order parameter,*** incorporating quantum effects. He also investigated how the long range part of the Coulomb interaction in quasi-one-dimensional conductors may lead to the possibility of metallic character to remain at $T = 0$.

d) If ***localisation effect with diagonal disorder*** (site energy) is well established in random mediums, the problem is more difficult for cases with off-diagonal disorder (exchange), relevant to magnetic excitations for example. Ziman performed a theory in such a case, first in one dimension, which has interesting singularities in transport and spectral properties. He then showed how one may map higher dimensional cases onto one dimension.

e) Solyom, during his 4 month stay, developed a theory of finite size scaling of first order transition within Potts model.

3. Quantum solids

Under the leadership of P. Nozières, important contributions have been achieved in this fundamental area. Besides the study of magnetism in ^3He discussed above:

a) Nozières and Comte completed a detailed study of ***exciton condensation in semiconductors,*** proposing a consistent theory to describe the competition between screening and pairing for Mott transition. Furthermore, Nozières and St James studied the competition between excitons and biexcitons in a boson liquid: there can be an easy transposition to superconductivity.

b) Uwaha (with G. Baym) developed a theory for ***sound attenuation in electron-hole liquids:*** the unexpectedly small effect in He is related to e-e collision process.

c) Nozières studied the ***thermodynamic formulation for crystallisation kinetics in ^4He,*** in collaboration with Castaing and Balibar: roughening transition, Kapitza resistance. Uwaha developed a quantum theory of crystal growth in ^4He (from bulk or on substrate) particulary concerning the crystallisation and Rayleigh waves. Nozières and Uwaha started a study of the inferfacial behaviour.

4. Other studies in condensed matter

a) Newns and Read, in the limit of large orbital degeneracy, developed a ***thermodynamic theory of intermediate valence impurities.*** More generally, they are interested in transport phenomena in mixed valence compounds. Collaborations are in progress with Schweizer concerning form factor measurements.

b) ***Charge Density in Solids.*** Collaborations of Becker with College V led to X-N studies in molecular crystals. In particular a recent study on short S...O non bonded interactions (with Lehmann and Cohen-Addad), both experimental and theoretical, leads to a new interpretation. Becker also developed a simple model for first order density matrix in ionic solids and metals with a few parameters being transferable to several experiments. Finally he completed some studies concerning the theory of extinction, especially for polarized neutrons: this multiple scattering process is still of major importance in interpreting integrated reflectivities.

5. Nuclear physics

In this domain, very active joint studies with College 3 and ISN are being developed, resulting in original contributions.

a) Several studies were performed in ***semi-classical nuclear theory*** (Schuck, Hasse, Ghosh, Winter). Semiclassical methods ($\hbar$ expansion, Fermi gas, or Landau theory, nuclear fluid dynamics in the long mean free path limit) were applied to nuclear properties (especially giant resonances, fission, level densities, rotations). Such methods lead to significant improvement over previous theories (inclusion of finite size effects and higher momentum transfers). Bartel, in completion of his thesis, also developed semi-classical calculations and compared the results with Hartree-Fock models (particulary in a spherical model of nuclei $^{16}O \rightarrow {}^{208}Pb$).

b) Schuck persued his work on ***Boson expansions in application to nuclear spectroscopy:*** microscopic derivation of the phenomenological parameters of Iachello's IBA-2 model.

c) In collaboration with College 3, work has been continued on a wavepacket description of ***Cold Nuclear Fission,*** where the low probability events will be obtained by quantum tunnelling from the fission valley through the ridge into the fusion valley (Hasse).

d) Desplanques (also with Noguera) analysed the relative importance of relativistic effects in the ***radiative capture of thermal neutrons by protons and parity violation in elastic scattering of thermal neutrons*** on heavy nuclei (in collaboration with Avenier and Heckel): for example compensation in $n + p \rightarrow d + \gamma$. Parity violation is also important when the probability of a nucleon to be at the surface is small.

e) Desplanques (with Mathiot) improved his ***theoretical description of magnetic form factors*** by including high momentum transfer components.

He also reproduced evidence of the absence of quenching of magnetic and Gamow-Teller transition due to excitation of the Δ resonance.

Concluding remarks

It is clear from the preceding section that for most of the problems of interest among the theory College, interactions with experimental teams inside and outside the Institute, either occured or will inevitably occur. Such collaborations, and also internal joint research within the College take time to develop and open out, and it is thus important that theorists can stay for several years at the Institute.

Secretary:
P. BECKER.

college 3
fundamental and nuclear physics

Members of the college

I. **Internal members**
M. Avenier
J. Bartel
H.G. Börner
F. Blönningen
R. Brissot
G. Colvin
B. Desplanques
H.R. Faust
F. Gönnenwein
B. Heckel
R.W. Hasse
F. Hoyler
K. Jewell
S.A. Kerr
W. Mampe
B. More
S. Noguera
A. Oed
J. Pannicke
P.E.J. Perrin
B. Pfeiffer
K. Schreckenbach
P. Schuck
M. Snelling
U. Stöhlker
U. Stroth
H. Weikard

II. **External members**
P. Liaud (Chambéry)
E. Monnand (CENG)
C. Ristori (CENG)

III. **Visiting members**
E. Aker (Karlsruhe)
P. Armbruster
M. Baldo Ceolin (Padua)
C. Botty (Rutherford)
J. Byrne (Sussex)
J. Chauvin (ISN)
H.G. Clerc (Darmstadt)
D. Dubbers (Heidelberg)
D. Engelhardt (Karlsruhe)
G. Fidecaro (CERN)
M. Fidecaro (CERN)
I. Förster (Köln)
P. Geltenbort (Tübingen)
R. Golub (München)
K. Green (Rutherford)
W.D. Hamilton (Sussex)
P. Heeg (Darmstadt)
P. Hermann (München)
E. Krüger (PTB Braunschweig)
K. Kügler (Bonn)
B. Leroux (Bordeaux)
J. Morse (Rutherford)
H. Nifenecker (CENG)
W. Nistler (PTB Braunschweig)
R. Olivier (ILL)
W. Paul (Bonn)
J.M. Pendlebury (Sussex)
G.H. Puglierin (Padua)
N. Ramsay (Harvard)
P. de Saintignon (ISN)
A. Steyerl (München)
G.P. Theobald (Darmstadt)
B. Vignon (ISN)
W. Weirauch (PTB Braunschweig)
R. Wilson (Harvard)

General summary

In 1982, research work in College 3 comprised the following studies:

1) ***Fission*** induced by thermal neutrons was studied at the cold neutron beam IH 1 and the neutron guide H 22 D. The parabola spectrometer LOHENGRIN was shut down in 1982, waiting for the preventive exchange of the correponding beam tube H 9 (see instrument group report).
At IH 1 the gross features of thermal neutron induced fission of isotopes with small fission cross-sections were investigated. The double torus ionisation chamber "DIOGENES" installed at H 22 E aimed at the study of the dynamics of the ternary fission process and the new instrument COSI FAN TUTTE (PN8) proved its high performance during the first test runs.

2) ***Nuclear structure*** studies were performed at the bent-crystal spectrometers GAMS, the beta-spectrometer BILL, the pairspectrometer PN 4 and the γ-γ correlation facility at H 22 F, using the (n,γ) reaction. At OSTIS, the beta-decaying fission products were investigated by β-, γ- and neutron spectroscopy.

Investigations at GAMS, BILL and the pair spectrometer included: test of the Interacting Boson Fermion Model (IBFM) on odd-A Hf, Ta and Pt isotopes; residual neutron-proton interaction in medium mass nuclei and actinides; systematic studies of even-even and even-odd deformed rare-earth nuclei for investigating the predictions of the Interacting Boson Model (IBM) and the coupling of vibrational states to Nilsson configurations respectively. Precise level energies up to the neutron capture state for ^{28}Al and ^{36}Cl were also investigated.

At the γ-γ correlation facility (H 22 F) spin and parities of nuclear levels and multipolarity mixing ratios were determined for various nuclei.

At OSTIS the main interest was focussed on nuclei close to the neutron numbers N = 60 and N = 90 in view of new regions of deformation.

Q_β values, half-lifes, γ-rays and delayed neutrons were measured to elucidate the nuclear properties. Neutron-rich isotopes of Sr, Y, Zr, Ce and Ba were compared with predictions of the IBM. With the new high temperature source very neutron-rich isotopes were observed.

3) In ***atomic physics*** the influence of the chemical bond on outer shell internal conversion electrons was studied at the beta-spectrometer BILL.

4) ***Parity violation*** in the weak nucleon-nucleon force was examined in two different experiments with polarized neutrons. A definite effect for the parity non-conserving (PNC) neutron spin rotation was observed in ^{139}La using the monochromatic beam S43. At PN 7 an experimental set-up was calibrated aiming at the determination of the asymmetry A_γ of the γ-emission from the polarized neutron capture of the proton.

5) ***Neutron decay*** experiments were performed to measure the neutron half-life (magnetic hexapole sphere at H 17) and parameters of the decay electrons from polarized neutrons (spectrometer PERKEO at PN 7) (see fig. 5).

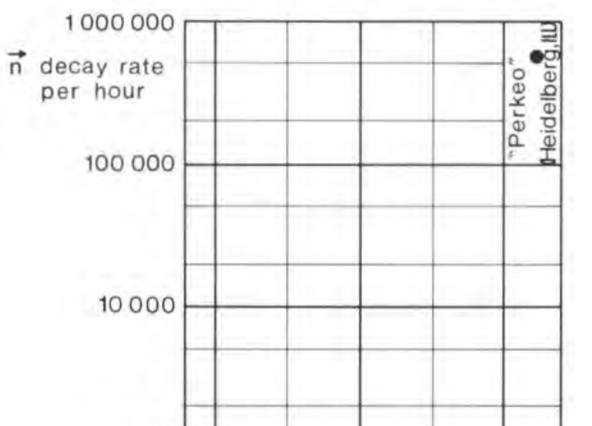


Fig. 5: Decay of polarized neutrons. The enormous gain in the observed polarized neutron decay rate by the spectrometer "PERKEO" at PN 7 is illustrated.

6) ***Ultra-cold neutrons*** (UCN) from PN 5 were used for a further search of the electric dipole moment (E.D.M.) of the neutron. A neutron microscope for UCN was tested at PN 5. The performance of a new superthermal UCN source was examined in detail at H 17.

7) ***The neutron-antineutron oscillation*** experiment at H 18 achieved a limit of 10^6sec for the oscillation period. The experiment searches for baryon number violation at a level of $\Delta B = 2$.

8) Further ***special beam experiments*** comprise a precise measurement of the fundamental constant ratio h/m_n at S50, (n,α) and (n,f) cross-section measurements at H 22 E, neutron activation analysis of geological material at PN 4, and the determination of the cumulative beta-spectrum from thermal neutron induced fission of ^{235}U and ^{239}Pu at H 22 D and H 22 F. The latter experiment aimed at the complemantary $\vec{\nu}_e$ spectrum, important for reactor neutrino experiments. An experiment at the BILL spectrometer searched for decay branches involving heavy neutrinos in the ^{64}Cu β^+ decay.

9) In ***theory*** the main work was focussed on the dynamics of cold fission events and parity violation in the weak nucleon-nucleon interaction.

In 1982, 107 proposals were submitted of which 86 were accepted.

Scientific trends and highlights in 1982

Thermal neutron induced fission

At IH 1 fission fragment energy measurements have been carried out for the fissionable isotopes ^{229}Th and ^{232}U. The fissioning events were recorded in a ΔE-E ionisation chamber identifying nuclear charges. Such measurements are the basis for testing models where the static properties in the fission process, such as shell and pairing corrections, are described.

The big double torus ionization chamber "DIOGENES" was set-up at the beam H 22 E and performed multi-parameter measurements of ternary fission. For each such event "DIOGENES" records kinetic energies, charges and emission angles of the fission fragments and the associated light particle. Since these light particles are emitted close to the scission point they carry information on the scission configuration.

The fission fragment coincidence spectrometer COSI FAN TUTTE (PN 8) proved its high performance in first measurements with ^{235}U targets. The present status of this instrument is summarized in the instrument group report.

Nuclear structure work

The nuclei $^{177,179}Hf$, $^{181,183}Ta$ and ^{195}Pt were investigated by (n,γ) at GAMS, PN 4 and BILL, testing the IBFM predictions for heavy nuclei close to the IBM O(6) limit. For ^{195}Pt the measurements, performed in collaboration with the Brookhaven National Laboratory, established a complete set of

Table 3.

Collaboration of College 3 with institutes and universities in 1982.

Fission

Darmstadt GSI
Darmstadt TH
Grenoble CEN
Grenoble University
Geel JRC
Gent
Bordeaux
Mainz
München
ISPRA
Tübingen
Lyon

EDM-Experiment

Sussex
Harvard
Oak Ridge Nat. Lab.
Rutherford Lab.

UCN research

Lancaster
Sussex
München

Nuclear Spectroscopy

Köln
Belgrade
Sussex
Glasgow
München
Manchester
Maryland
Giessen
Fribourg
Braunschweig
Göttingen
Mol
Brookhaven Nat. Lab.
Grenoble CEN
Livermore LL
Leningrad
Jülich KFA

$N\bar{N}$ transitions

Cern
Padua
Rutherford Lab.

Weak-nucleon-nucleon force

Spin rotation:
Harvard
Rutherford
Ispra
Sussex

$\bar{n}$ p capture:
Grenoble ISN
Harvard

Theoretical physics

Bordeaux
München
Lyon
Grenoble CENG
Grenoble ISN
Orsay IPN
Orsay CSNSM
Regensburg

Fundamental constants

Braunschweig PTB

n-decay

Bonn
Heidelberg
Argonne
Los Alamos

low spin, negative parity states up to $E_x = 1.5$ MeV (see fig. 6). Below 1 MeV eleven states with $J^\pi = 1/2^-, 3/2^-$ were identified and discussed in the frame of the IBFM. In this scheme a so-called multi-g supersymmetry was predicted recently. The present data seem to be the first detailed example for this new class of supersymmetries. Further detailed comparisons with the IBFM are in progress for the nuclei ^{181,183}Ta, where levels with spin up to 21/2 were observed in the (n,γ) reaction. ^{183}Ta has been reached by double neutron capture in a ^{181}Ta target due to the high neutron flux at the GAMS and BILL target positions. Data of high quality were obtained for ^{181}Ta, although only a small amount of the target nucleus ^{180}Ta was available (^{180}Ta is the rarest stable istotope !).

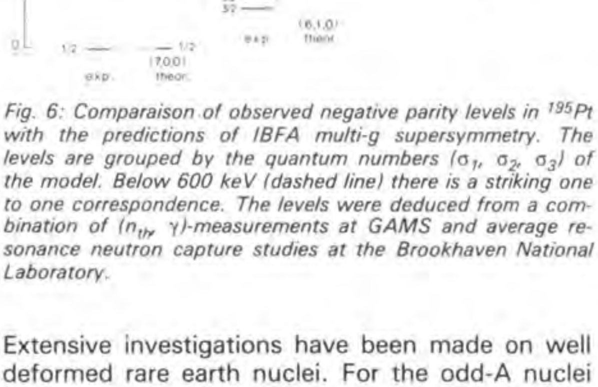


Fig. 6: Comparaison of observed negative parity levels in ^{195}Pt with the predictions of IBFA multi-g supersymmetry. The levels are grouped by the quantum numbers $(\sigma_1, \sigma_2, \sigma_3)$ of the model. Below 600 keV (dashed line) there is a striking one to one correspondence. The levels were deduced from a combination of (n_{th}, γ)-measurements at GAMS and average resonance neutron capture studies at the Brookhaven National Laboratory.

Extensive investigations have been made on well deformed rare earth nuclei. For the odd-A nuclei ^{161,163,165}Du and ^{153}Gd vibrational modes coupling to the Nilsson states were studied. The even-even nuclei ^{162,164,166}Dy and ^{154}Gd were measured up to $E_x = 2$ MeV revealing information on the relation between the geometrical model and the IBM. Two more details were investigated for the classical example ^{168}Er: (i) branching ratios from a likely candidate for the 2-phonon $K = 4^+$ γ-vibration, (ii) M1 admixtures for the γ-band to ground state band transitions via internal conversion electron subshell ratios. Both sets of ^{168}Er data permit again the testing of the IBM.

Detailed structure studies on odd-odd actinides were continued with ^{242,244}Am and ^{238}Np. The level structure of ^{244}Am could be explained by a model where the unpaired proton and neutron disturb only weakly the deformed core. Thus the n-p residual interaction can be well studied for this class of nuclei.

At the fission product mass separator OSTIS the on-set of deformation at neutron numbers $N = 60$ and $N = 90$ was investigated systematically, yielding detailled information on excited states populated by the β-decay or delayed neutron decay of the precursors. ^{99}Sr, ^{99,100}Y and ^{100}Zr were shown to be at the edge of a new region of deformation around $N = 60$, while a transitional character with shape coexistence was observed for ^{98}Sr. Studies on nuclei close to $N = 90$ were primarily performed for comparison with IBM predictions. Comprehensive decay schemes of ^{140}Ba and ^{142,148}Ce were established, and complement the systematic studies performed earlier on even-even Ba isotopes.

The measurements of β-delayed neutrons at OSTIS yielded interesting contributions to nuclear structure problems. Of special interest was the

Violation of the Parity Symmetry

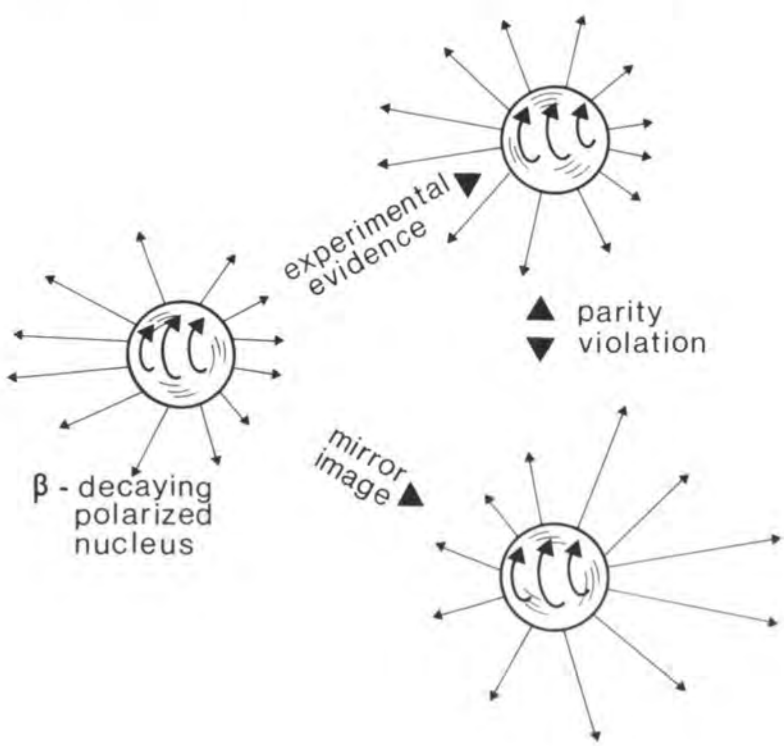
Physics aims at the understanding of the evolution in time and space of objects and their internal structure. In spite of the variety of their compositions and movements these objects obey well determined laws. In classical mechanics their properties are believed to be unchanged upon translation and rotation. They are also believed to remain unchanged by a spatial inversion and, taking also rotational invariance into account, by a reflection with respect to a plane. That property accounts for everyone's experience that the image of the world seen in a plane mirror represents another world but with the same characteristics. For that reason this symmetry is often called **mirror-symmetry.**

When nature displays some discrete symmetry, quantum mechanics implies in general that elementary systems should have this symmetry associated with certain eigenvalues π which for the mirror symmetry can be $+1$ or -1. These values correspond to the even or odd character of wave functions upon reflection with respect to a plane. Formally this means for $\pi = +1$: $\psi(-r) = \psi(r)$ and for $\pi = -1$: $\psi(-r) = -\psi(r)$. The quantum number associated with this reflection is called **parity** and as long as mirror symmetry holds, parity should be conserved.

The hypothesis that parity conservation may be violated has been introduced in modern physics by T.D. Lee and C.N. Yang, analyzing strange meson decay processes (1956). It was confirmed one year later by the famous experiment of C.S. Wu and coworkers on the β-decay of ^{60}Co. Nuclear states are known to be eigenstates of parity. In this experiment the nucleus was polarized defining an equatorial plane. With respect to this plane the measurement shows the surprising effect, that the decay electrons are preferentially emitted on one side of this plane. This effect is explained by the presence of a final state with **both** parities, +1 and −1, being mixed while only **one** of them is present in the initial state. It is thus indicated that there is violation of parity conservation ("parity violation").

The figure illustrates parity violation in the β-decay by comparing the experimental observation with the expectation of a mirror image of the process. The length of the arrows surrounding the spinning nucleus should indicate the intensity distribution of the emitted beta particles.

Since this discovery, parity violation has been observed in various processes. At the ILL the beta-decay of the polarized neutron is studied in this respect as well as processes concerning only nucleons (parity non-conserving spin rotation of neutrons passing through nuclear matter; asymmetry of γ-ray emission following the capture of polarized neutrons). For the latter class of experiments the parity conservation is believed to originate from the same process, but is more difficult to observe, since it is hidden by the presence of a strong parity conserving interaction being many orders of magnitude larger.



selective feeding of 0^+ excited states in even Sr isotopes from odd Rb precursors. Due to selection rules the existence of two excited 0^+ states in ^{94}Sr were proved for the first time. The availability of the high temperature source at OSTIS allowed to determine P_n values for Sr, Y, Ba and La isotopes. The surface ionisation source gave also first estimates for ^{100}Rb and ^{148}Cs. First tests were made with a new γ -delayed neutron coincidence technique to measure complete β-strength functions for the Cs precursors. The resulting systematics should show the influence of the $h_{11/2}$ proton orbital compared to the $g_{9/2}$ proton one in the case of the Rb precursors.

Determination of nuclear masses and half-lifes.

Two complementary approaches were continued at OSTIS to establish the systematics of mass excesses and neutron binding energies. Very neutron-rich low-yield isotopes in the mass chain A = 99 and A = 100 were studied by β- γ coincidence techniques applying a new efficient scintillator telescope. A rough estimate for the mass excess of ^{100}Rb was obtained for the first time. For the more abundant daughter nuclei closer to the valley of stability a hyper-pure Ge-detector was used to determine ß end point energies with higher accuracy.

γ-multispectra and both ß- and delayed neutron multiscaling techniques were used to measure half-lifes of nuclei obtained from the high temperature ion sources at OSTIS. The nuclei ^{101}Sr, ^{149}Ba, ^{152}Pr and ^{154}Nd are the most neutron rich isotopes of these elements observed till now.

Parity violation in weak nucleon-nucleon interaction.

The S 3 B (formerly S-43) monochromatic 7 Å neutron beam was dedicated for one week to the continuation of the parity non-conserving (PNC) neutron spin rotation studies. PNC neutron spin rotation proceeds through the contribution of the weak interaction to the neutron index of refraction. Targets of ^{139}La, 7.5 and 15 mm in length were studied. The PNC neutron spin rotation per unit length, $\varphi_{PNC}/1$, was measured to be : $\varphi_{PNC}/1$ (^{139}La) = $-$ $22 \pm 2 \times 10^{-5}$ rad/cm. The minus sign corresponds to a left-handed rotation of a neutron spin about its momentum, and the magnitude of the rotation is in good agreement with models that consider p-wave resonance enhancement of PNC effects.

The forward-backward asymmetry A_γ of the γ-ray angular distribution in the radiative capture of polarized neutrons by protrons is currently studied at PN 7. The parity violating contribution of the weak neutral current between nucleons is poorly understood, whereas the structure of the parity conserving forces is well known. The expected sensitivity of the present PN 7 experiment of 2×10^{-8} is in the region of most reliable theoretical predictions ranging from $A\gamma = 10^{-7}$ to 10^{-8}. The ability to achieve such a precision is unique to the polarized PN 7 beam due to its flux of $4 \times 10^8 \vec{n}$ $cm^{-2}sec^{-1}$. The capture rate in the liquid para-hydrogen target is 70% of the neutron beam intensity. The target is viewed by two 400 l liquid scintillator γ-detectors. The calibration of the apparatus has started using a strong γ-source.

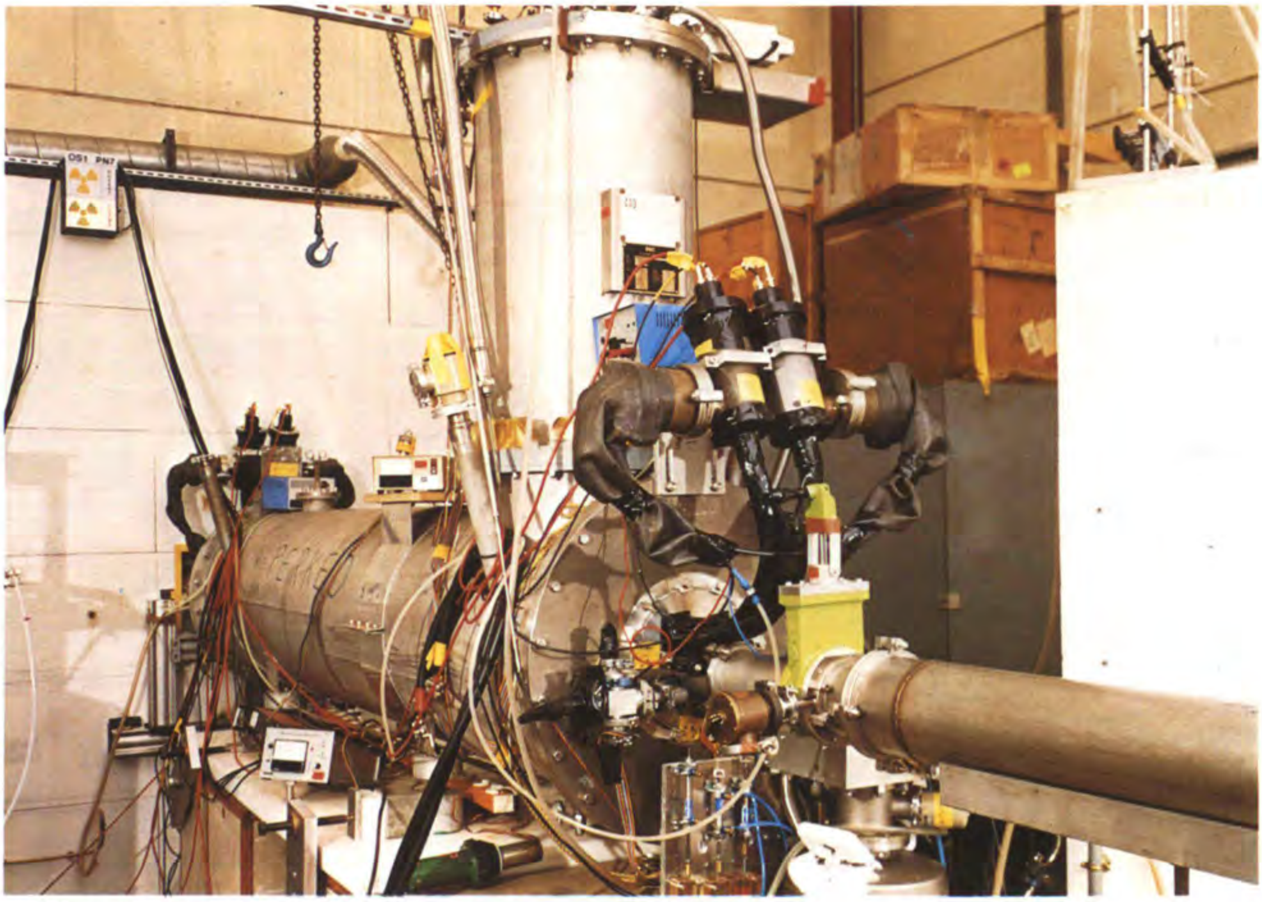
Properties of the neutron

The experiment at PN 5 to search for a neutron electric dipole moment (EDM) is based on the observation of the magnetic resonance of bottled UCN in a static magnetic field. One looks for a possible shift in the resonance frequency when an electric field is applied (reserved). The experiment has now entered into its first major data accumulation stage and has reached a sensitivity of 4×10^{-24} per day, limited primarily by the low UCN density. Current experimental parameters are : UCN polarisation 85%; UCN storage time 60-80 s; reversible electric field 11-12 kV/cm; reversible magnetic field 3-10mG; UCN counting rate $\sim 3 \times 10^4$/day. Efforts are under way to increase the electric field strength, the UCN storage time and to put into operation a higher density U.C.N. source (superthermal UCN source at H 17).

The most recent view on the PN5 platform, the experimental area for ultra cold neutrons. Left of the beam switch box (in the middle) one can see the "neutron microscope" (Garching / ILL collaboration); on the right is the EDM experiment (Sussex / RAL / ILL collaboration).

The magnetic hexapole sphere of W. Paul and coworkers (Bonn) stores UCN produced by down -scattering in superfluid ^4He and aims at a direct determination of the neutron life-time. The cryostat was tested on the H 17 neutron beam and special UCN detectors working at 1°K were developped. The cryostat is presently being modified in order to reach lower temperatures.

A neutron optical system similar to a conventional microscope has been designed and constructed by A. Steyerl and coworkers (TU München) and brought to the ILL for measurements. The adjustment appeared to be difficult due to the low counting rate on the present ultra cold neutron source PN 5. The work is still in progress.



PERKEO, the extremely efficient set-up at PN7 for measuring the neutron life-time (Heidelberg - ILL collaboration).

At PN 7 the superconducting neutron decay spectrometer PERKEO has been installed by the Heidelberg-Argonne-ILL collaboration. The spectrometer contains the decay electrons from a polarized neutron beam in a superconducting coil. Together with improved measurements of existing neutron decay parameters, the highly efficient spectrometer is able to look into hitherto not accessible fundamental problems such as "weak magnetism". This term can be measured via the energy dependance of the asymmetry of the decay electrons from polarized neutrons.

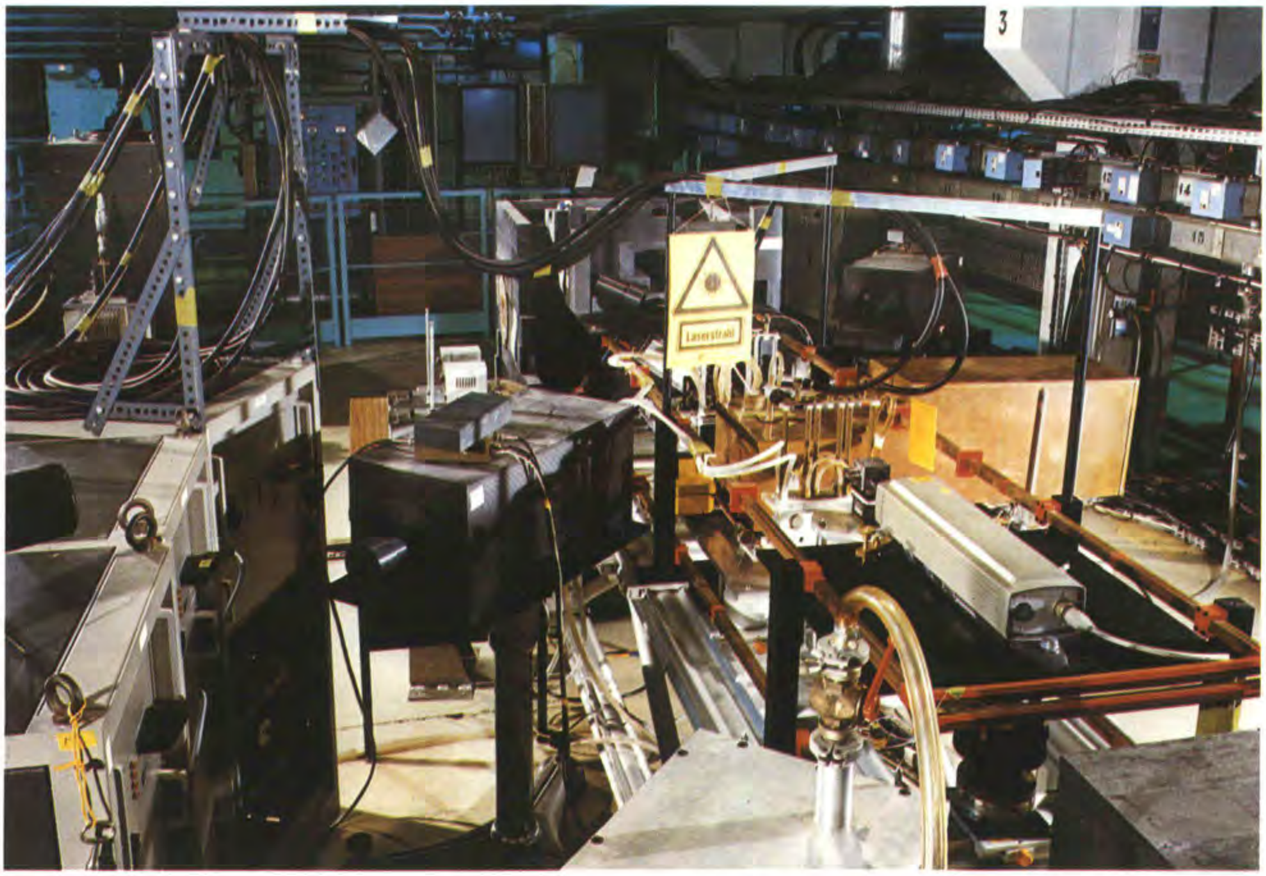
The neutron-antineutron ($n - \bar{n}$)oscillation experiment has reached a limit of of 10^6 sec for the oscillation period. This progress was primarily due to a background reduction by localising the tracks of each event. The $n - \bar{n}$ oscillation violates baryon number (B) conservation by $\Delta B = 2$. This violation is predicted in generalized grand unified theories treating leptons and baryons at the same level. A major improvement of the experimental performance is to be expected from a new generation experiment at the second cold source.

Special experiments

At the beam position H21 A the experiment for a precise determination of the fundamental constant ratio h/m_n was continued. The wavelength and the velocity of neutrons are measured simultaneously determining h/m_n by the de Broglie law. The velocity is measured by a special time-of-flight method in which the direction of the spin of polarized neutrons is modulated with a frequency of 750 kHz. The wavelength of the neutrons is determined by back-reflection from a perfect Si single crystal. At present an accuracy of 10^{-5} is achieved for h/m_n. An improvement by about one order of magnitude is expected by increasing the neutron flight path from 0.5 to 10 m.

At the H 22 D neutron guide systematic studies of (n_{th},p) and $(n_{,th},\alpha)$ reactions were continued. An accurate value of 115 $\pm$ 10 mb was determined for the $^{33}S\ (n_{th},\alpha)^{30}Si$ reaction cross-section, a value which is of importance for astrophysical calculations. New results on (n,α) cross-sections were also obtained for ^{39}K, ^{43}Ca, ^{101}Ru, ^{115}Sn and Cd_{nat}. In the reaction $^{65}Zn\ (n,\alpha)$ ^{62}Ni, transitions to the ground-state and first excited state in ^{62}Ni could be identified with reaction cross-sections of 1b and 0.8 respectively (preliminary values).

The analysis by neutron activation of the Hercynien intrusive rocks in the external French Alps was continued. Determination of the rare earth element concentrations displayed a bimodal magmatism in certain of the crystalline massifs. Work was also carried out on samples originating from ocean floor basalts from the Galapagos spreading centre (Pacific Ocean). Analysis has yielded the progressive differentiation from a tholeiite primary magma, and has shown that alteration (olivine to smectite) of the basalts, by interaction of seawater, has not appreciably changed the rare earth chemistry.



The experimental facilities for the high precision measurements of $\frac{h}{m_n}$ (PTB - Braunschweig).

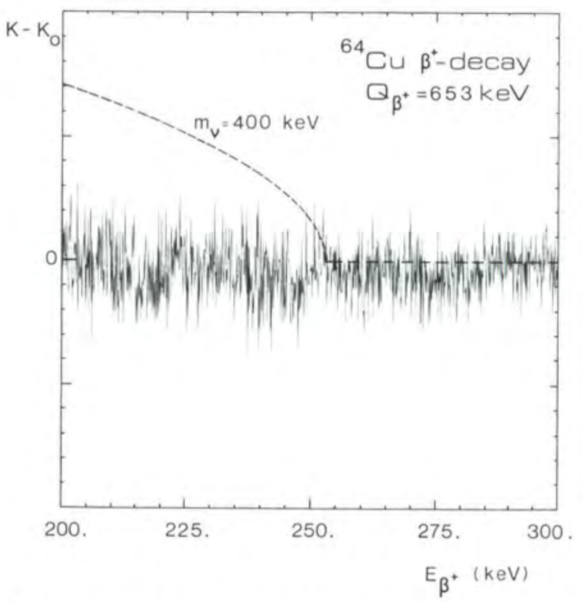


Fig. 7: Search for heavy neutrinos in the β^+ decay of ^{64}Cu (Q_β = 653 KeV), performed at the BILL spectrometer. The figure shows the difference of the Curieplot K of the measured spectrum and the Curieplot K_0 expected for an allowed β^+ decay (≡ straight line). The region from 200 KeV to 300 KeV is displayed containing about 2×10^8 events with a resolution of 150 eV. The dashed line shows the expectation for a superposed 2% branch with a 400 KeV neutrino mass. There is obviously no sign of such a branch in the displayed region (limit < 0.2%).

At the beta spectrometer BILL the β^+ spectral shape of the ^{64}Cu decay (Q_β + = 653 keV) was investigated for possible neutrino admixtures involving neutrinos in the mass range 50 keV to 500 keV. At energies $E_{\beta+} = Q_{\beta+} - m_\nu c^2$ distinctive deviations from an allowed beta-spectral shape are expected. To search for those deviations the spectrum was scanned with high statistics (total of 3×10^8 events) and a high resolution of about 200 eV. Limits of <1% were obtained for this exotic decay branch relative to the main β^+ decay. (see Fig. 7).

Theory

The theoreticians Schuck, Hasse and Bartel worked in collaboration with nuclear experimentalists on problems in fission. The problem of cold fission was tackled by computing semiclassical potential energy profiles with shell effects and running quantum mechanical wave packets from saddle to scission. It was found that a fraction of the probability tunnels throught the ridge resulting in compact and cold fission fragments. Kinetic energy distributions are then compared with experimental data. Odd-even effects in the fission product mass distribution are explained on the basis of a semiclassical pairing theory for largely deformed nuclei.

Seminars

In 1982, 28 seminars dealing with nuclear structure, fission, heavy ion, atomic and fundamental physics problems and with new experimental developments were held.

Secretary:
K. SCHRECKENBACH.

College 4
structural and magnetic excitations

Members of the College

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Stirling W.
Suck J.-B.
Vettier C.
Ziebeck K.
Zeyen C.

II. **External Members**
Filippini C.

General summary

The scientific activity of College 4 is mainly related to studies of lattice dynamics, magnetic and structural phase transitions and magnetic excitations. The majority of the experimental work is performed on the five triple axis spectrometers (TAS), i.e. IN 1, IN 2, IN 3, IN 8 and IN 12, with a few experiments being carried out on the time of flight (TOF) and diffraction instruments. Although, in the future, the percentage of TOF experiments should increase due to the inclusion of the excitations section of College 7 in College 4.

Prospects for the future of the TAS instruments are very promising. The return to operational status of IN 1 will allow the continuation of studies of excitations at high energy transfers, and the possible construction of a new cold source spectrometer (IN 14) would further strengthen studies of low energy excitations. Experiments which require some form of polarisation analysis are becoming very common. The construction of IN 20 will fulfill much of this demand. "Kits" already exist which permit polarisation analysis, at least a polarisation analysis of the scattered beam, to be carried out on IN 3 and IN 12.

Scientific trends and highlights in 1982

Phonons

The number of studies of lattice dynamics has declined slightly with respect to investigations of magnetic phenomena. There has also been a trend towards the study of phonons in compounds where the unusual dispersion curves are related to, or even the source of interesting physical phenomena.

It is often very informative to compare the phonon dispersion curves of a moderate or high T_c superconducting material with a low T_c, or even non-superconducting material of the same structure. Recently, crystals have been grown of some A 15 compounds and the phonon dispersion curves have been measured, e.g. $V_3Si(T_c = 17\ K)$, $Cr_3Si(T_c < 0.015\ K)$, although these measurements were limited by the small sample size. For the first time, it has been possible to grow large single crystals of $Mo_3Si(T_c = 1.3\ K)$. The acoustic and a large number of the optic phonon branches have been measured in this material, using the IN 8 TAS[1]. An initial interpretation of the experimental results is that the influence of electron-phonon coupling on the dispersion curves is rather strong.

Similar experiments are being attempted on some C 15 compounds in an attempt to relate the magnetic properties of $ZrZn_2$ and the superconductiong properties of ZrV_2 to the phonons of these substances.[2]

Structural phase transitions

The phase diagrams of modulated systems, as a function of temperature, pressure and ordering fields, continue to be extensively studied. When an applied field couples to a commensurate order-parameter the stability range of the corresponding commensurate structure is enlarged at the expense of the adjacent incommensurate phase. This type of situation is realised when modulated "ferroelectric" materials, such as thiourea $(Sc(ND_2)_2)$ or sodium nitrite $(NaNO_2)$, are subjected to a uniform electric field parallel to the polar axis. In $Sc(ND_2)_2$ the appearance of a field-induced lock-in phase with wavevector b*/8 was predicted[3] and has been experimentally confirmed.

Local contact duties for outside users are taken very seriously by the ILL's scientific staff. In the picture W. Stirling (on the right) is assisting R. Ward (University of Exeter) during a run on IN 3.

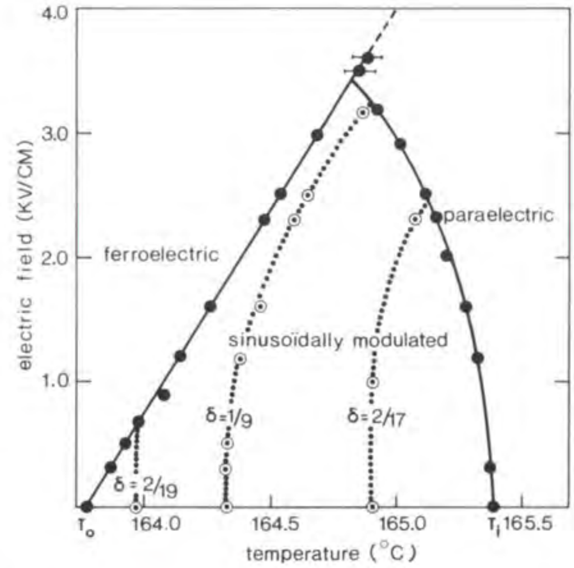

Fig. 8: Experimental phase diagram of Sodium Nitrite under an applied electric field (after correcting for Joule heating in the sample).

Figure 8 shows the (E,T) phase diagram of $NaNO_2$[4] which has recently been measured using the IN 8 T.A.S. The paraelectric-sinusoidal phase transition appears to remain continuous under an applied field, in contrast to the case of thiourea where tricritical behaviour is observed. Above the

Commensurate - incommensurate phases

In ordinary crystalline solids the atoms are periodically ordered with the identity period given by the unit cell. Such a crystal may be transformed into an incommensurate (or modulated) structure by freezing in the instantaneous atomic displacements corresponding to a single phonon mode, the wavelength of which is an irrational multiple of the initial lattice period. The resulting atomic configuration is non periodic in the direction of the modulation wavevector, since atoms located in different wavefronts are displaced by different amounts from their original (periodic) positions. As a consequence of the incommensurability between the modulation wavelength and the original periodicity the phase of such a static displacive modulation with respect to the periodic positions is arbitrary in the sense that none of the physical properties of the system are affected by a change of the overall phase.

Several classes of 1- or 2-dimensional conductors are known to exhibit (Peierls) instabilities with respect to an electronic charge-density modulation of wavedetector 2 kf, where kf is the conduction electrons' Fermi momentum. In such a case the charge density wave couples to a lattice distorsion of the same periodicity and gives rise to a modulated structure. Sliding the phase of the modulation does not cost energy but would transport charge. This mechanism has been proposed to allow for high conductivity at high temperature, yet not found in real crystals so far. Other examples of displacive modulations are encountered in insulators, as a result of competing interactions of different ranges.

The modulated quantity may also be a site occupation probability as in binary alloys, an orientational probability as in molecular crystals, the orientation or magnitude of magnetic moments as in helimagnets and spin-density wave systems.

From a diffraction standpoint modulated structures are characterised by additional Bragg reflections, the satellite reflections, corresponding to momentum transfers of the form $\vec{G} + m\vec{q}_0$ (m = 1,2,3...) where $\vec{G}$ is a reciprocal vector of the parent lattice and $\vec{q}_0$ is the wavevector of the modulation.

As far as inelastic scattering is concerned, new excitation branches are expected to appear, corresponding to fluctuations in the amplitude and phase of the static modulation. Of particular interest is the experimental observation of the phase-mode dispersion (phason branch), first identified by means of neutron scattering (cf. experiments 04-02-117 and 04-02-151).

triple-point, evidence for a direct paraelectric-ferroelectric transition line was obtained, although the position of the critical end-point could not be determined in the experiment.

Magnetic phase transitions

The dynamics of the critical fluctuations in iron have been reinvestigated using high resolution time of flight (TOF) and neutron spin echo (NSE) techniques.[5]. The results, at the Curie temperature T_c, confirm the validity of the power law relating the quasielastic linewidth of the critical scattering, Γ_q, to the momentum transfer, i.e. $\Gamma_q \alpha q^Z$, with Z = 2.5. This is valid for at least four orders of magnitude in energy, as demonstrated by figure 9, and is in agreement with the predictions of dynamical scaling theories. However, above T_c, no hydrodynamic behaviour, $\Gamma_q \alpha q^2$, could be found, which indicates a breakdown of dynamical scaling, possibly due to the influence of thermodynamic random forces. Both of these findings are quite surprising, and contradict recent speculations.

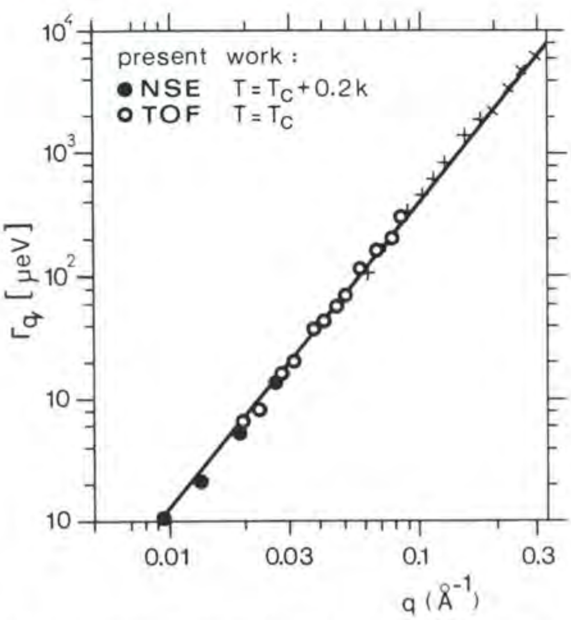

Fig. 9: Momentum dependence of the quasielastic linewidth of the critical scattering in iron at the Curie temperature. The crosses represent previous measurements using a triple-axis spectrometer.

Magnetic excitations

The study of magnetic excitations covers a wide range of materials and regions of interest. Studies of spin waves in 3d transition metals and compounds continue to shed light on the importance of itineracy and single particle modes on the magnetic excitations. Studies of certain iron alloys (CrFe, AuFe) have been begun with the aim of understanding the strong damping of the magnetic excitations at low temperatures. Quasi-one dimensional systems continue to be of widespread interest.

The nature of the magnetic excitations in longitudinally modulated magnetic systems has been a subject of theoretical interest for many years. Recently, using the T.A.S. IN 3 and IN 12, the first definitive observations of magnetic excitations in metallic neodymium have been made.[6] Neodymium exhibits a complex variety of modulated phases below T_n = 19.9 K . Figure 10 shows an example of how the well-defined excitations at 1.2 K broaden and soften with increasing temperature. Substantial energy broadening is also found for wavevectors approaching the magnetic satellite positions. The temperature and wavevector dependance of the excitations in neodymium provides a sensitive test for the available theories.

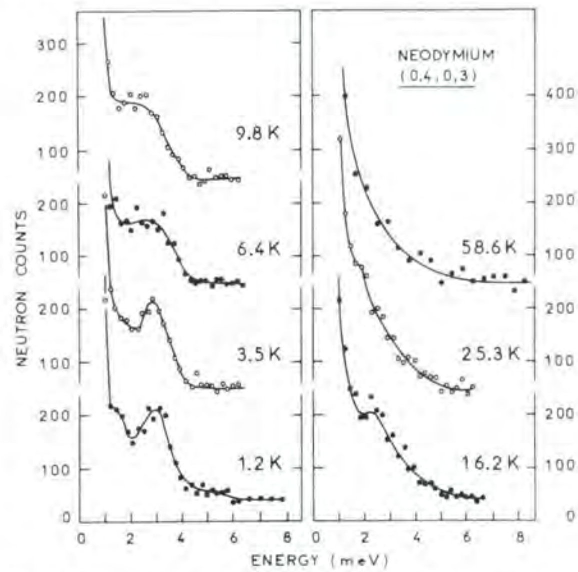

Fig. 10: Temperature dependence of the inelastic scattering at (0.4, 0, 3) in Neodymium.

The study of soliton modes in magnetic systems continues to be of experimental and theoretical interest. In magnetic chains, solitons may be regarded as travelling domain walls. An exhaustive study of the soliton regime has been performed on the 1d antiferromagnetic TMMC, $[(CD_3)_4NMnCl_3]$[7]. In antiferromagnetic chains, the dynamics can be studied by measuring the energy width of the staggered mode, which gives a measure of the rate of flipping of the magnetic sublattices resulting from the passage of the soliton. Experiments have shown that in very pure crystals the solitons travel freely along the chains, however with the addition of a small amount of magnetic impurities, the solitons behave diffusively, with a drastic slowing down of the fluctuations. Future work will be concerned with attempts to understand the phase coupling between solitons and magnons in more detail. In 1982, J.P. Brochet, M. Nechtstein and J. Rossat-Mignod received the "Prix Ancel" for condensed matter physics, for their contributions to the understanding of these problems.

The use of small angle scattering techniques on triple-axis spectrometers increased considerably in 1982. This technique has allowed measurement of the long wavelength magnetic excitations in amorphous systems, and for weak itinerant ferromagnetic systems in both polycrystalline and single crystal samples. For example, the first measurement of the magnetic excitations in the weak itinerant ferromagnet, Ni_3Al has been performed.

This system is particularly difficult to study by conventional neutron scattering methods since the low temperature magnetic moment is only 0.05 μ_B/Ni atom and the spin-wave stiffness is ~ 20 THz Å^2. Figure 11 presents an example of the data measured in this experiment. Although important corrections must be made to account for the influence of instrumental resolution, the spin wave scattering is clearly resolved in the raw data.

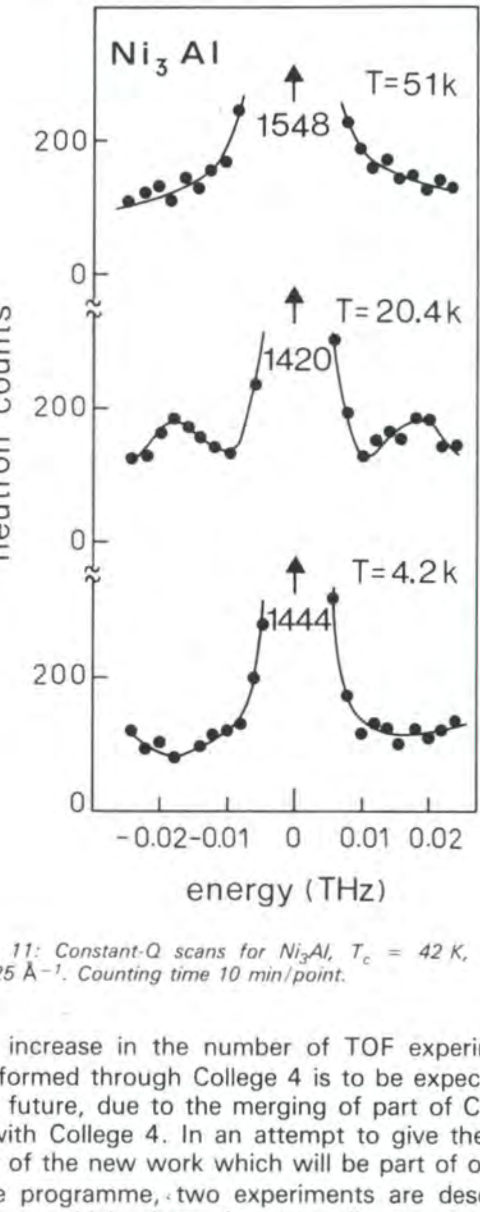

Fig. 11: Constant-Q scans for Ni_3Al, T_c = 42 K, |Q| = 0.025 Å^{-1}. Counting time 10 min/point.

An increase in the number of TOF experiments performed through College 4 is to be expected in the future, due to the merging of part of College 7 with College 4. In an attempt to give the flavour of the new work which will be part of our future programme, two experiments are described below, which although origionally scheduled by College 7, will be continued under the auspices of our college.

The longstanding problem of moment formation of magnetic impurities in non-magnetic host is difficult to resolve experimentally due to the exceedingly small magnetic cross-sections. The high flux of the TOF spectrometer IN 6 has made possible a study of the dilute alloy Pd 1% Ni, where the dynamical response shows strong wavevector and temperature dependence[8]. Isolated Ni atoms in Pd do not support a good local moment and appear to be well described by localised spin fluctuation theory.

The measurement of the TOF spectra of iron, using polarised neutrons and a fast, pseudorandom flipping technique on D 7, has permitted the first observation of the influence of the three spin correlation function[9]. This technique gives directly the difference spectrum between spin up and spin down scattering. Below T_c, neutrons scattered with annihilation and creation of spin waves appear separately in the detectors at +2.25° and − 2.25° respectively, as illustrated by Figure 12. Above T_c, the two processes appear together in the same detector, Figure 12, with an asymmetry in the intensity of the individual processes. This asymmetry disappears if the magnetic field direction is normal to the incident beam, and can be explained in terms of the three spin correlation functions.

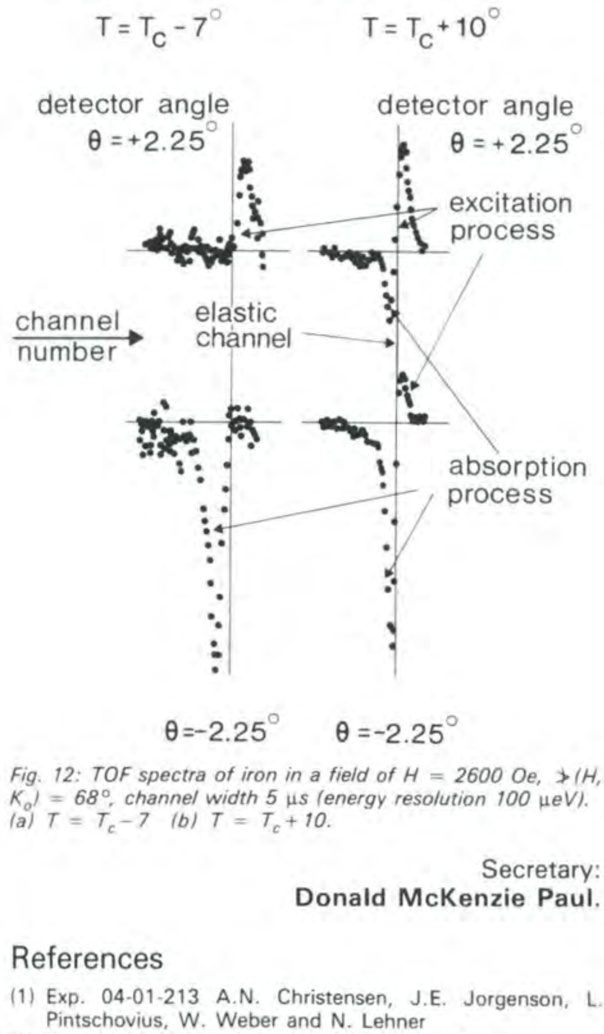

Fig. 12: TOF spectra of iron in a field of H = 2600 Oe, ∢(H, K_0) = 68°, channel width 5 µs (energy resolution 100 µeV). (a) T = T_c − 7 (b) T = T_c + 10.

Secretary:
Donald McKenzie Paul.

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(9) Exp. 07-01-246 A.I. Okorokov, A.G. Gukasov and O. Schaerpf.

college 5 crystal and magnetic structures

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K. Ziebeck

II. **Visitors**

Christiansen (Aarhus)

Table 4

Experiments accepted for execution in 1982.

Instrument	D1 A	D1 B	D2	D3	D5	D8	D9	D10	D15	D16	Total
Number of Experiments	49	16	11	17	11	18	20	8	11	2	163
No. of days	163	58	46	218	120	156	177	69	109	14	1130

General summary

In the past, the scientific interests of College 5 have been concentrated in one way or another on crystal and magnetic structures. As a result of the decision to discontinue College 7, this scientific base has been broadened during 1982 to include any problems dealing with the "static" properties of magnetic systems (e.g. small angle scattering, diffuse scattering in addition to crystallographic studies). As a result, proposals concerned with magnetism are now considered by two subcommittees: College 4 (dynamics) and College 5 (statics), rather than four subcommittes as in the past. Apart from allowing a more coherent assessment of research proposals this change has brought together ILL scientists whose interests lie in magnetism and should improve both the in-house scientific life and the scientific services we provide to visitors.

The experimental activity of College 5 in 1982 was somewhat increased compared to 1981, despite the unscheduled reactor shutdown earlier this year. The number of research proposals submitted to the College has remained essentially unchanged. Competition for beam time was severe, as usual.

Finally, we would like to express our gratitude to R. Lemaire, who retires as chairman of College 5(a) after a period of three years.

Scientific meetings

Two important scientific meetings, dealing with techniques of direct importance to College 5, were held at ILL this year: the "Workshop on position-sensitive detection of thermal neutrons" organized by J.B. Forsyth and P. Convert (11-12 Oct. 1982) and the "International Conference on the impact of polarized neutrons on Solid State Physics and Chemistry" organized by P.J. Brown (ILL), R. Lemaire (CNRS Grenoble) and J. Schweizer (CEN-G / ILL) (15-19 Oct. 1982).

Workshop on Position-Sensitive Detection of Thermal Neutrons

This workshop brought together some 120 scientists who have developed, used or intend to use position-sensitive detectors (PSD's) in neutron diffraction. Three main topics were covered by review talks: diffraction from liquids and powders (C. Riekel, Hamburg), small angle scattering (R. May, ILL) and diffraction from single crystals (B.P. Schoenborn, BNL). Hardware aspects were reviewed by A. Axmann (Berlin) and the application of PSD's to nuclear physics and medicine were described by G. Charpak (CERN) and F. Soussaline (Orsay). In addition to these reviews, poster sessions and a round table discussion chaired by R. Allemand (LETI) and G. Lander (ANL) allowed the participating scientists from 8 countries some opportunity for exchange of ideas and discussion.

A. Axmann inspecting an ILL multi-detector in the exhibition hall.

B. Schönborn during his lecture in the Chadwick Amphitheatre.

Interesting discussions took place during the poster sessions.

A souvenir picture from the International Conference on "The Impact of Polarized Neutrons on Solid State Physics and Chemistry".

International Conference on the impact of polarized neutrons on Solid State Physics and Chemistry

The purpose of this conference was to review the impact which experimental results obtained using polarized neutron techniques have had on the theoretical understanding of problems in solid state physics and chemistry.

Over 100 scientists from 12 countries attented this five day conference. The conference proceedings, which include 14 invited review papers and some 40 contributed papers, will be published in J. Physique in 1983.

More than 100 participants listened to the lectures.

Two colloquia dealing with the problem of charge, spin and momentum densities in solids were held at ILL. The second of these two day meetings was organized by P. Becker to mark the retirement of Prof. E.F. Bertaut (CNRS, Grenoble). Prof. Bertaut, amongst many of his scientific activities, was the founder chairman of the College 5 subcommitte.

This scientific activity at ILL was also reflected by the large attendance of members of College 5 at International Conferences in Japan and the "50th Anniversary of the discovery of the neutron" meeting in Cambridge.

Scientific trends and highlights

Magnetic Phases

Once again it is impossible to find a uniting theme to summarize the range of magnetic structures and magnetic phase transitions studied during 1982. Several of these investigations were noteworthy in that they stretched the limits of temperatures, pressures and magnetic fields available at ILL. The magnetic phase diagram of the metamagnet $FeCl_2$-$2H_2O$ was determined with great accuracy in applied fields up to 6 T in order to define precisely the position of the triple-point (Ferrimagnet-Antiferromagnet-Paramagnet) and multicritical points (first order — second order Ferrimagnet-Paramagnet, first order — second order Ferrimagnet-Antiferromagnet). It was found that only one of the multicritical points exists and lies sufficiently close to the triple point that both points may coincide. If so, this would represent a completely novel multicritical behaviour. The magnetic structure of single crystal TmS was determined at T = 3 K using the four circle diffractometer mode of D 10. The structure is similar to $CeAl_2$, being an incommensurate antiferromagnet with a modulation vector of the type $(1/2+\delta, 1/2-\delta, 1/2)$ and consists of 12 magnetic domains. It was a considerable technical achievement to reach such a low temperature whilst retaining full 4-circle geometry. The usefulness of a hot neutron beam for magnetic studies of materials containing Gd (or Sm) was demonstrated by a determination of the magnetic structure of single crystal Y Gd alloys using D 9. Here the magnetic phases (ferromagnet and helix) in the vicinity of the Lifshitz point could be investigated using natural Gd by working at short wavelength (λ = 0.4 Å) to minimize the absorption problem. In the case of absorbing $EuAs_3$ a successful structural study was made possible by a careful choice of sample geometry and the large magnetic moment of Eu. Finally, the value of neutron polarization-analysis in solving difficult problems encountered in magnetic structure determination was demonstrated by an investigation of the moment direction and possible multi-q nature of the compound PrAg.

Magnetization Density

The particular value of neutron diffraction in providing a highly accurate measure of the magnetization density in solids has been emphasized many times.

Magnetization density

The neutron is scattered in a magnetic material because of the interaction between its magnetic moment and magnetic fields in the material. In just the same way as for X-ray scattering one can define a structure factor. Thus the magnetic structure factor $\underline{M}(k)$ is given by

$$\underline{M}(k) = \int_{cell} \underline{M}(r) e^{i\underline{k}\cdot\underline{r}} dr$$

where $\underline{M}(r)$ is the intensity of magnetization, or **magnetization density** in the material and is the analogue of the charge density in the X-ray case. The principal difference between the X-ray and magnetic structure factors is that $\underline{M}(k)$ being the Fourier transform of a vector, is itself a vector. The intensity of magnetically scattered neutrons is not directly related to the magnetic structure factor, but to its projection on the plane perpendicular to the scattering vector. Thus the cross-section for magnetic elastic scattering of unpolarized neutrons is given by

$$\left(\frac{d\sigma}{d\omega}\right)_{\text{magn el.}} = |M_{\perp}(k)|^2$$

where

$$\underline{M}_{\perp}(k) = \hat{k} \times \underline{M}(\underline{k}) \times \hat{k}$$

The **magnetization density** in a material is due both to the intrinsic magnetic moment of electrons (the electon spin) and to the magnetic moment generated by moving electrons (orbital magnetization). In most materials, paired electrons generate equal and opposite magnetic moments so that the net magnetization density is everywhere zero, but in magnetic or magnetized matter some electrons are unpaired. In such cases the magnetization density due to electron spin reflects the spatial distribution of the unpaired electrons, but that due to their orbital motion is less simply interpreted.

As in previous years, studies of magnetization density have tended to follow two main themes: the determination of ground state wavefunctions and conduction electron contributions to the magnetization in systems such as $HoAl_2$, TmSe, CeNi, $CeIn_3$, $NpAs_2$ and SmZn, and the study of covalency in insulating materials such as Rb_2CrCl_4, $CrCl_3$ and $Fe(bpy)Cl_3$. A determination of the magnetic structure and spin density of antiferromagnetic CuO was performed. The other 3d transition metal oxides have been investigated extensively in the past and only the recent availability of a single crystal of CuO made this study possible. In common with other transition metal monoxides copper is octahedrally coordinated by oxygen, the octahedra being linked by sharing corners. In CuO, however, two of the six copper oxygen distances are 90% greater than the rest so the coordination approaches square planar. In the antiferromagnetic structure each oxygen has three close copper neighbours of one spin direction, and one close and two remote copper neighbours of the other spin direction. The projection of the spin density shown in the figure gives evidence for some spin transfer to the oxygen ions the sign of which corresponds to that of its three close copper neighbours (see Fig. 13).

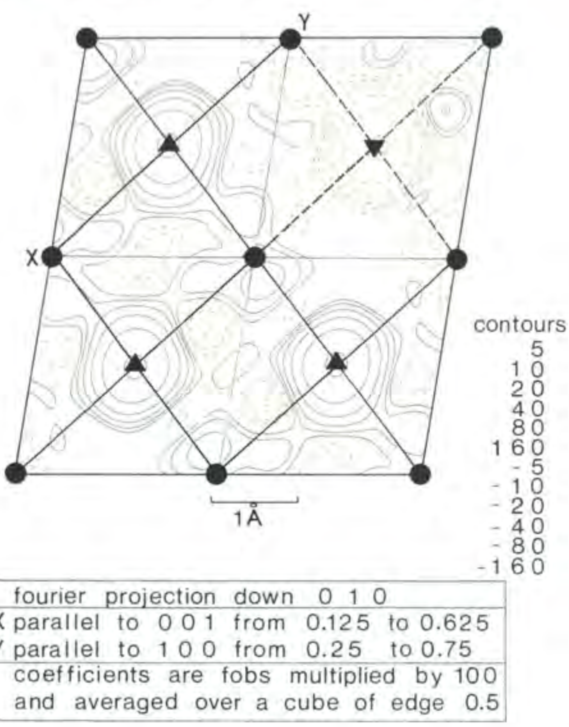

Fig. 13: Projection of the spin density in CuO down [010]. Black circles mark the positions of the oxygen atoms and triangles those of copper. The short bond directions are masked.

Analysis of data collected on the ionic actinide compound UCl_4 is in progress and the results should indicate the extent to which the Uranium 5 f electrons are involved in bonding. One of the rare structural studies of polycrystalline material using polarized neutrons was carried out this year using the D 1 B multidetector together with a supermirror bender polarizer. In this case the sample (Y_9Co_7) which is a magnetic superconductor cannot be prepared in single crystal form. The induced paramagnetic structure factors for a few reflections were measured to determine the magnetic moments on the three Cobalt sites.

Paramagnetic scattering

The unique ability to separate magnetic scattering from other scattering contributions provided by neutron polarization-analysis continues to be used with considerable success to investigate the fluctuating magnetization in paramagnetic materials. This technique has been used to study the paramagnetic scattering from the 3d metals Cr, Ni and Fe, whose magnetic properties are still not fully understood. For these materials there is no general agreement as which fluctuations ('amplitude' of the moment or 'angle' of the moment) are responsible for the transition between the magnetically ordered and paramagnetic states, or indeed on the nature of the paramagnetic state itself.

Polarized neutrons and polarization analysis have been used to investigate the paramagnetic scattering from a single crystal of Cr. The observed paramagnetic scattering, which was strongly peaked about (100) decreased rapidly in intensity as the temperature was increased from 1.18 T_N to 2.23 T_N and the characteristic wavelength for short range magnetic order decreased from 56 Å to 26 Å. Integration of the paramagnetic scattering indicated a temperature independent average Cr 'moment' of $0.1 \pm 0.05\ \mu_B$. This is at variance with currently accepted models for the antiferromagnetism of Cr which assume the Cr 'moment' to collapse to zero at the ordering temperature.

Similar investigations have been carried out on Ni and γFe. Results obtained for polycrystalline Ni reveal short range magnetic order at 1.15 T_c and suggest that the correlation length in Ni is larger than that in Fe at the same temperature relative to T_c. Further experiments using single crystal isotopically enriched Ni are planned. The paramagnetic scattering from fcc Fe at 1320 K is noteworthy in that the scattering is enhanced in the forward direction rather than at a finite Q value as may have been expected. (It has been generally accepted that γFe would be antiferromagnetic if the fcc structure could be retained at low temperature).

Structural transitions

Structural phase transitions, as in the past, hold a major place in the experimental activities of College 5. Data treatment using new techniques allow us to go further into this domain. As an example, a recently developed series expansion technique, the so-called quasi-momentum expansion of the harmonic probability density function, may give important information on the precursor effects taking place before the transitions. Such a study was successfully applied to the crystal structure of K_2SO_4 above and below its phase transition at 853 K on D 9. This experiment, which used a new, versatile 4-circle furnace (see instrument report D 9) has shown a 'precursor' behaviour of the set of oxygen atoms 70°C below the phase transition. The anharmonic third-order modification terms (Fig. 14) strongly suggest the splitting of this position in the high temperature phase.

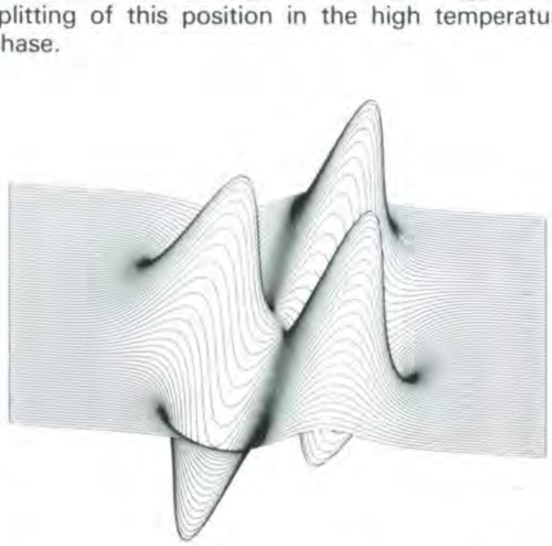

Fig. 14: Third order modification map of oxygen 1 in the low temperature phase of K_2SO_4 at 780 K (plane of the trifold splitting in the high temperature phase).

Incommensurate phases

These structures continue to represent an important volume of work within the College. The polymer concentration (P) dependence of the phase diagram and thermal expansion of PTS ($R - C \equiv C - C \equiv C - R'$ where $R = R' = CH_3 - C_6H_4 - SO_3 - CH_2$) was measured on D 8 (Expt. No 5-13-133) and D 10 (expt. No 5-16-119). Neutrons have to be used because X-rays affect P. PTS has an incommensurable phase in the temperature range 158 ~ 200 K. For small P, the low temperature and the incommensurable phases coexist over a temperature range of 1.5 K and a 1 K hysteresis was measured. With an increase of P critical scattering was observed over an increasing temperature range. The thermal expansion measured on D 1 B (Expt. No 5-21-159) shows a reorientation of the main expansion directions with P (Fig. 15). In the same domain the average structure of the modulated phase in Rb_2ZnCl_4 was determined on D 9 (Expt. No 5-15-208) and the commensurate-incommensurate structural transition of $ThBr_4$ was studied on D 9 and D 10 (Expt. No 5-15-209).

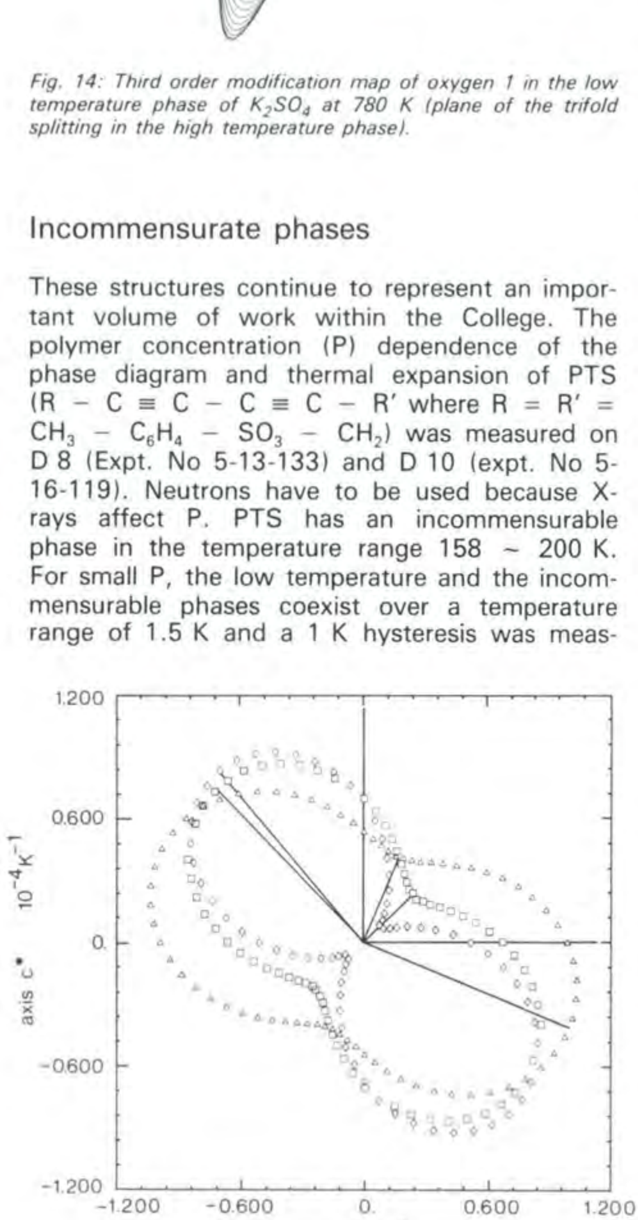

Fig. 15: Main expansion values in the ac plane of PTS:
◇ *monomer*
□ *P = 12%*
△ *P = 15%.*

Intercalates, Ionic conductors

Materials which can accept and release ions or small molecules are of prime interest for fundamental reasons and for obvious practical applications. A great number of experiments with such materials are performed by means of neutron scattering. In this field the intercalate compounds of graphite are of great interest, particulary as anisotropic synthetic metals. Recent improvements in the synthesis led to the preparation of intercalated samples based on natural graphite single crystals either with hydrogen or deuterium. Such a crystal of a deuterated potassium intercalated graphite has been measured on D 8 (Expt. No 5-13-123) and, although the crystal mosaicity was strongly anisotropic, the collected intensities are accurate enough to determine the three-dimensional structure.

Ionic conductors still remain an important field of research. As an example, the structure of cation exchanged $ND_4UO_2\ PO_4.\ 3D_2O$ (where N replaces one of the oxygen atoms in the water squares of $HUO_2PO_4.4D_2O$) was determined using D 1 A (Expt. No 5-21-156) and permits a better understanding of the different conductivity of these two compounds.

Organic-Metallic compounds, organic conductors

Studies of charge density in organo-metallic complexes were continued in several experiments on D 8. For instance, the Displex cryostat permitted low temperature intensity measurements of an interesting "triple-decker" sandwich compound $(C_5H_5)\ V\ (C_6H_6)\ V\ (C_5H_5)$ and of bis(π-allyl) nickel (Fig. 16). Both of these have low melting points (~ 0°C) and crystals of the latter tend to ignite in air, necessitating a difficult mounting procedure. For these reasons, the structure of this crystal has remained unknown for 20 years. All previous ab initio theoretical calculations, including the assignment of bands in the photo-electron spectrum have been based on the assumption of planar C_3H_3 groups. The study at − 170°C, however, revealed that the hydrogen atoms lie as much as 34° out of the plane of the allyl carbon atoms (Expt. No 5-14-138). The quasi one dimensional organic conductor TMA.TCNQI undergoes a transition at ~ 150 K which was found to be of the metal-insulating type associated with a Peierls-like lattice distortion. (Expts. No 5-12-172 on D 12 and No. 5-15-173 and 205 on D 8). This transition and the other two observed at 96 K and 65 K are due to transverse coupling between charge density waves and between TCNQ and iodine columns. The neutron diffraction contribution in this field is of importance because, iodine being a poor neutron scatterer, the organic sublattice scattering is predominant.

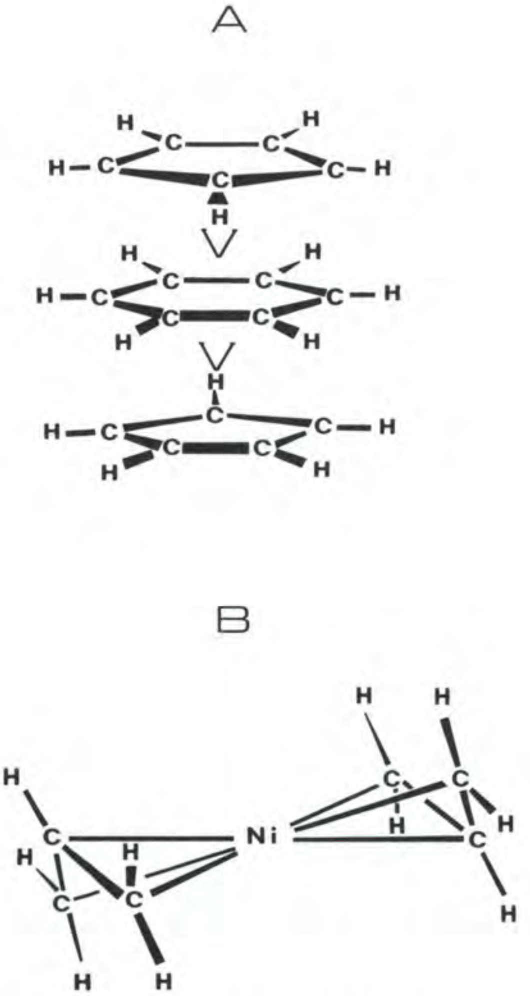

Fig. 16: Structure of $(C_5H_5)\ V\ (C_6H_6)\ V\ (C_5H_5)$ (A) and $(\pi\text{-}C_3H_5)_2Ni$ (B)

The structure of $MEM(TCNQ)_2$ below the spin-Peierls transition and the phase diagram under pressure was also investigated. Here, below the spin Peierls transition, there is a coupling between dimers of TCNQ each having a spin 1 to form a "quadramer-ized" phase in which the net spin of pairs of dimers is zero. One of the outstanding problems in this field of low dimensional organic conductors is whether a fully ordered magnetic phase can be established and its structure: this question remains open.

Electron-densities

Neutron diffraction measurements for combination with X-ray observations to obtain deformation electron densities is still a main activity in the College, and one of the areas where studies have concentrated over the last few year is the analysis of the region of short S...O contacts. The first compound studied has an S...O distance of 2.63 Å and no deformation density was found between S and O. This year, a compound (3-benzoylimino-4-methyl perhydro-1,2,4-oxathiazine) with an S...O contact of 2.26 Å was investigated. A small negative region was observed near S, and, more interestingly, the density aspects around the sulfur atom are completely different in the two compounds (Fig. 17). (Contour intervals are 0.1 e/Å and negative contours are dotted.) The largest deformation peak is near sulfur in a lone-pair region. In the compound with an S...O contact of 2.63 Å this peak is absent. Presently work (Expt. No 5-14-140) is in progress in collaboration with members of the theory College to explain this phenomenon.

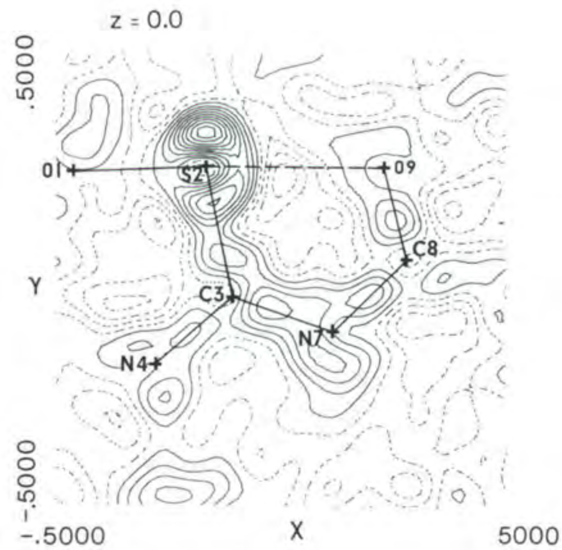

Fig. 17: Short S...O distances.
Section through the planar part of the molecule of 3-benzoylimino-4-methyl perhydro-1,2,4 oxythiazine containing S and O. This deformation density map shows the largest deformation near the S lone pair region. Contours are 0.1 e/Å^3.

Materials research

Properties of materials are always an important field of research for neutron experiments. For example, a kinetic investigation of the reaction of the solids $Ca_3\ Al_2O_6$, $Ca_5Al_6O_{14}$, $CaAl_2O_4$ and $Ca_3Al_{10}O_{18}$ $(CaAl_4O_7)$ with D_2O at temperatures from room temperature to 90°C was made on D 1 B (Expt. No 5-25-157). The phases with high aluminium content are found in high-alumina cement. The rate of reaction of the solids with D_2O decreased with decreasing temperature and increasing aluminium content. At temperatures above room temperature, the main hydration product was the hexahydrate $Ca_3Al_2O_6$. 6 D_2O, and, at room temperature, the decahydrate $CaAl_2O_4$. 10 D_2O was found. Studies on martensitic transformations in $Cu\text{-}Nb_3Sn$ multifilamentary superconducting wires (prestress) have been done on D 1 A (Expt. No 5-22-183 and 5-22-191). The results furnish direct evidence for a strongly anisotropic stress distribution. The compressive stress is not fully uniaxial as widely assumed, but it also exhibits radial components, suggesting a three-axial stress tensor.

Other interesting experiments were performed in College 5, such as the structure determination of mixed valency antimony (III, V) hexahalide and related salts (Expt. No 5-21-150), the measurement of interlayer distances in Bi_2Te_3 as a function of uniaxial and hydrostatic pressure (Expt. No 5-15-203 on D 15) which shows a clear decreasing of the inter-sandwich distances.

Seminars

As in previous years, a series of seminars dealing with topics of general interest to College 5 members provided an important part of the scientific life of the College.

Secretaries:
S. BURKE.
J. BOUILLOT.

The International Workshop on Position Sensitive Detectors from 11-13 October 1982 was a great success. A souvenir picture was taken on this occasion.

college 6
liquids, disorder and defects in materials

Members of the College

I. Internal members

Anderson I.
Bader B.
Bley F.
Burke S.
Cenedese P.
Chaix-Pluchery O.
Chieux P.
Cummings S.
Dianoux A.J..
Freilander P.
Fujara F.
Heidemann A.
Jahnel F.
Janot C.
Just W.
Kiese G.
Langel W.
Lartigue C.
Lauter H.J.
Magerl A.
Maret M.
Petry W.
Poinsignon C.
Pynn R.
Roth M.
Schärpf O.
Suck J.B.
Stirling W.G.
Trost W.
Van der Marel C.
Wright A.F.

II. External members

Cyrot F. (CRNS Grenoble)
Desré P. (ENS Electrochimie, St.-Martin d'Hères)
Dupuy J. (Lyon-Villeurbanne)
Jal J.F. (Lyon-Villeurbanne)
Volino F. (CRNS)

General summary

The operation of College 7 was discontinued in June 1982 and consequently three subjects have been integrated into College 6: defects and disorder in solids, in-beam experiments and diffusion in bulk material.

A great number of elastic and inelastic experiments have been performed on liquids and amorphous solids and one on gases. The non-availability of D 4 has considerably slowed down the research on the structure of disordered materials, although several experiments in this field were carried out on D 2. It should be noted that there is continuing interest in the study of disordered materials over a very wide range of momentum transfers, including SAS for obtaining a complete view of the structure at different scales.

Considerable progress was made in the field of polarization analysis on D 7. This technique, by means of the separation of spin flip and non-spin flip scattering, permits the line-width determination of coherent and incoherent scattering of liquid Na near the maximum of the structure factor. In this way it became possible for the first time to measure the de Gennes narrowing and to compare different scattering modes of fluids (Fig. 18, 19, 20).

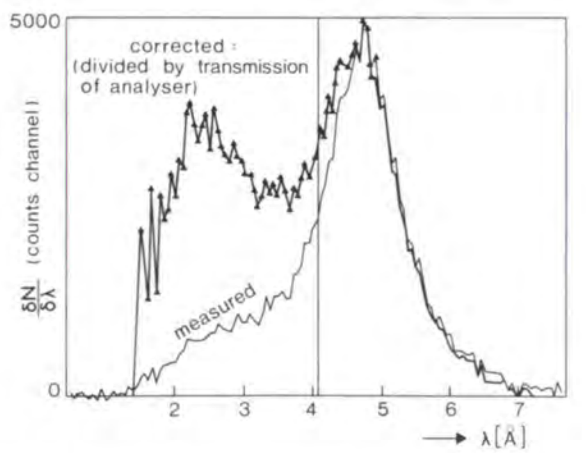

Fig. 18: Example of a measured TOF spectrum of the incoherent scattering by liquid sodium and the same spectrum corrected for the analyser transmission.

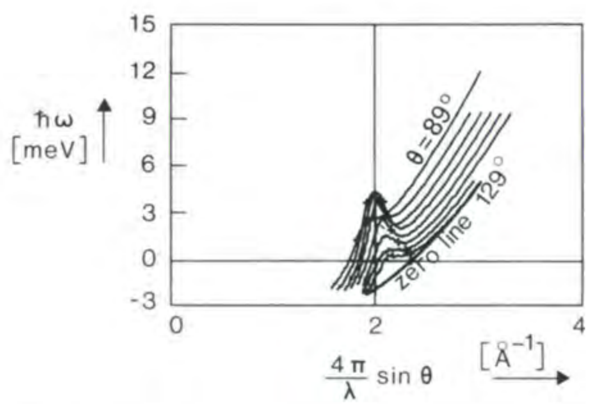

Fig. 19: Time of flight spectra of the coherent scattering on liquid sodium drawn as curves over the Q, ω plane corresponding to the Q, ω values of the time of flight spectra of the eight detectors at different scattering angles 2θ with polarisation analysis.

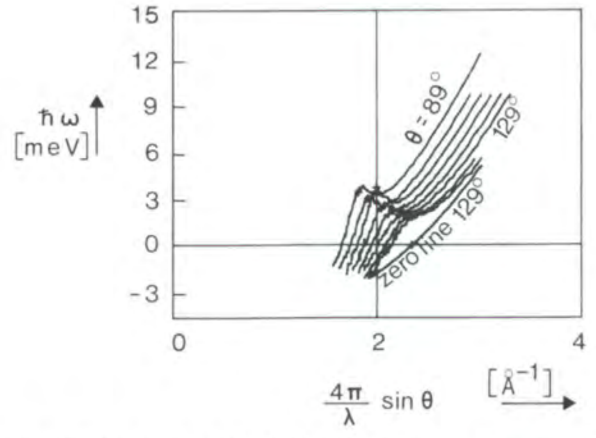

Fig. 20: The same as fig. 19 for the incoherent scattering on liquid sodium.

Scientific trends and highlights in 1982

Quantum liquids

Surface excitations have been found by inelastic neutron scattering on IN 12 and IN 6 in the systems of ^{4}He on grafoil (4-8 layers), Ne on graphon (2 layers) and ^{4}He on Ne coated graphon (1-12 layers). These excitations have no dispersion in the range of investigation and explain the anomalous high transition of phonons through a solid-liquid interface (Kapitza resistance). No influence on the intensity of the surface excitations for coverages of more than 5 ^{4}He layers was observed and the ^{4}He bulk excitations did not reveal any broadening as a function of coverage down to 5 adsorbed ^{4}He layers, which would have indicated a 2-dimensional behaviour (Surface roton). The cause of the excitations is thought to be the solid layers adjacent to the substrate.

The new liquids diffractometer D4 B at the Hot Source which will become routinely available to users in Summer 1983.

Gases and simple liquids

Diffraction measurements have been made on SF_6 gas at 15 bar and are shown in Fig. 21. The cross-section is dominated by the molecular form-factor over most of the Q-range which is shown as a solid line. Departures are seen at low Q-values which are due to inter-molecule interference and relate to the second structural virial cœfficient, $B_2(Q,T)$ which is a generalisation of $B_2(T)$. The data extracted for this region contain information on the orientationally averaged intermolecular potential.

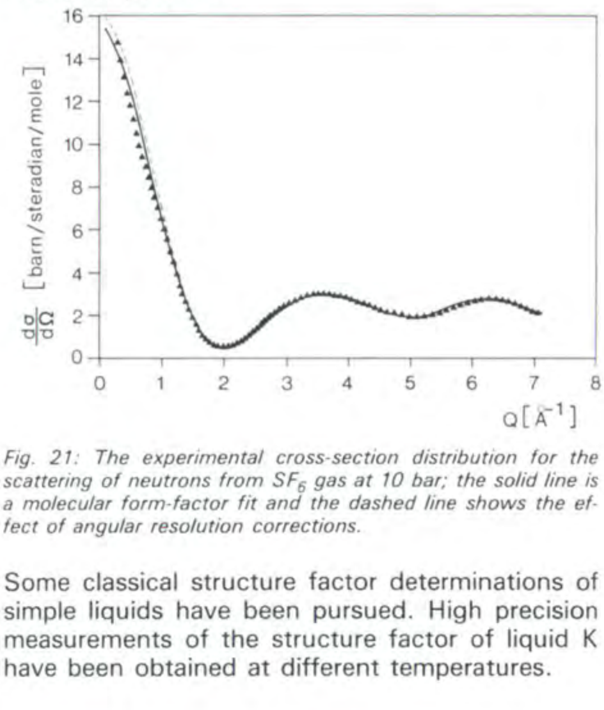

Fig. 21: The experimental cross-section distribution for the scattering of neutrons from SF_6 gas at 10 bar; the solid line is a molecular form-factor fit and the dashed line shows the effect of angular resolution corrections.

Some classical structure factor determinations of simple liquids have been pursued. High precision measurements of the structure factor of liquid K have been obtained at different temperatures.

Molecular liquids

The hydrogen/deuterium substitution is being increasingly used for investigations of the structure of molecular systems, since some of the difficulties linked with the Placzek correction have been overcome. A complete determination of all the partial pair correlation functions of liquid chloroform has been obtained. This will lead to a better understanding of the orientational correlation function, and, in particular, it will be of great interest for the hydrogen-bonded systems. A study on formamide has been completed. Another on methyl alcohol is in preparation. The H/D isotopic substitution was used to determine the three partial structure factors for liquid water.

Aqueous solutions

An intense activity of investigations has been going on in the field of highly concentrated aqueous solutions, not only in the area of the structure of hydrated ions, but also in the domain of the structure and dynamics of the water itself. Concentrated $ZnCl_2$ solutions have been investigated with respect to the dynamics of the water molecule as well as highly concentrated HCl solutions concerning the proton dynamics. The concentrated LiCl aqueous solution being a glass former has been investigated and nucleation and growth of the ice nuclei were studied above T_g and as a function of the thermal history (annealing) below T_g. The conditions for the crystallisation of cubic ice (I_c) and its transformation to hexagonal ice have been understood and controlled (see fig. 22).

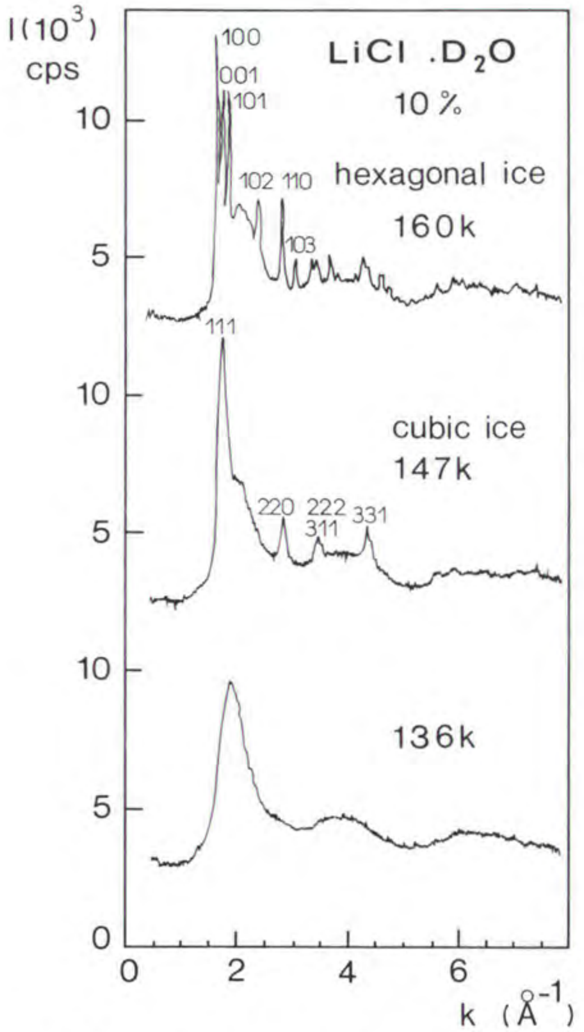

Fig. 22: Typical diffraction pattern of a 10% Li Cl.D_2O glassy sample at 136 K just after quenching. At 147 K the cubic ice is fully precipitated and at 160 K it is almost completely transformed to hexagonal ice. One notices at the highest temperature the permanence of the supercooled residual disordered structure.

Experiments have been carried out to study the hydration of more 'complex' ions eg. $(NO_3)^-$ in $NaNO_3$ solution, $(ND_4)^+$ in ND_4Cl solution. Results of the former investigation have been compared with those from X-ray diffraction, vibrational spectroscopy and quantum mechanical cluster calculations. Agreement is usually good except for the case of calculations for small cluster sizes not permitting a proper comparison.

In the latter case the comparison with molecular dynamics simulation is good. The discrepancy of the value of the hydration number may be due to the neutron diffraction experiment and the molecular dynamics simulation both being carried out at two different concentrations.

Glasses and amorphous materials

The study of the crystallisation processes in glasses and inorganic gels has revealed interesting results, both in the investigation of new materials and in the modelling of SAS data. The crystallisation of pure zirconia gel turns out to be an almost ideal system in that the scattering curves give a very good fit to a model of interacting soft spheres where the experimental intensity I(o) varies directly with the fitted particle volume for a constant volume fraction of crystallites.

A similar model can be fitted to the early stages of crystallisation of Cr^{3+}doped silicate glass, but the kinetics are more complex. The rate of change of intensity and crystallite size point to strong variations in the contrast between the precipitate and the matrix which may arise because of size dependent composition changes in the solid solution precipitate. These processes are associated with strong colour changes which are being investigated by optical absorption and laser line narrowing spectroscopy.

The investigation of the local order in amorphous metals by the isotopic substitution technique has continued, using polarized neutron diffraction ($Co_{81.5}B_{18.5}$) or combination of X-ray and neutron scattering ($Tb_{0.75}Cu_{0.25}$), ($Mg_{0.70}$ $Zn_{0.30}$). The isotopic substitution method has also been applied to the investigation of a rather complicated problem such as the distribution of Dy atoms in a sodium fluoroberyllate glass. On the other hand the long range order in metallic glass has been investigated in a search for dislocations (NiB) or quench induced anisotropicity (Pd Si). The origin of the small angle scattering behaviour of the metallic glasses is not yet fully understood and new interpretations are likely to be given such as the one proposed for the $Tb_{.75}$ $Cu_{.25}$ system where large domains are apparently created by a characteristic non-uniform distribution of impurity bubbles within the material.

A recent experiment on D 2 aimed at the study of photo-irradiation in As_2S_3 glass. Although the large magnitude of the effect has been demonstrated no quantitative results are available yet.

On the dynamical side, there has been an investigation of the dispersion of the collective density fluctuations near the first maximum Qp of the structure factor in a metallic glass Mg_{70} Mn_{30}. A non-zero minimum of these excitations has been found near Qp. The dependence of the observed peaks in the dynamic structure factor $S(Q,\omega)$ on heat treatment has been discussed and compared with recent computer simulations and model calculations.

Amorphous metals

Amorphous metals can be thought of in terms of disordered solid metals in which atomic short range order is very similar to that of the corresponding liquids. The interpretation of the properties of amorphous metals imposes a particular challenge since the understanding of crystalline solid has generally been based upon their crystal periodicity. Translational invariance does not exist in amorphous metals.

Amorphous metals can be prepared by a variety of methods:

1) Evaporation of metals in vacuum and condensation of their vapour on a cooled substrate
2) Sputtering, by which atoms are removed from a target under bombardement with energetic inert gas atoms
3) Chemical or electroless deposition
4) Electro-deposition
5) Rapid quenching from the liquid state (10^6 Ks^{-1}).

Amorphous alloys prepared by the latter method are the so-called metallic glasses or glassy metals. The main interests in amorphous metals were initiated by the special features in their basic properties due to the lack of long range order, but also by possible technical application based on outstanding mechanical, magnetic, electrical and chemical behaviours.

Pure amorphous metals are very difficult to obtain and transform into crystalline materials at very low temperature (~ 10 K). Binary or more complex alloys can be maintained in the amorphous state above room temperature. At present, the following families of amorphous metals are known: T-N; N-N; T_L-T_E; RE-N; RE-MN; RE-T_L and U-T where T is a transition metal, N is a polyvalent normal metal, T_L and T_E are respectively a late and an early transition metal, RE is a rare earth metal, MN is a monovalent noble metal and U is uranium.

Critical scattering of fluids

The solutions of metal in molten salts or in liquid ammonia have been studied for effects linked to the non-metal to metal transition. In the Rb-RbBr system a very strong disorder is produced by the introduction of the salt in the metal structure, while the salt-rich order is simply diluted by the addition of metal. A cross-over between mean field and critical indices has been confirmed, at a few degrees above the critical temperature for liquid-liquid phase separation in the Na-ND_3 system.

In-beam NMR spectroscopy

Studies of nuclear spin lattice relaxation in the liquid alloy systems Li-Bi, Li-Sn, Li-Pb have been performed by β-radiation detection in the temperature range from 850 K to 1550 K. The relaxation rate as a function of concentration and temperature deviates markedly from metallic behaviour near the compositions Li_3Bi, Li_4Sn and Li_4Pb. Comparison with Knigth shift and conductivity data show an increasing tendency of electron localization and compound formation in the series of alloy systems Li-Pb, Li-Sn to Li-Bi.

Defects and disorder in solids

A study of nucleation and growth of voids in Cu submitted to creep at temperatures above 400°C was done by neutron small angle scattering and is a continuation of a similar investigation on the formation of voids in Cu by fatigue in the same temperature range, which gave rather unique results on the kinetics of nucleation and growth of voids during this process. This is connected with the problem of failure of materials under fatigue. Neutron small angle scattering is a rather unique technique in this field because it makes it possible to determine separately both the nucleation rate and growth kinetics, in contrast to other techniques.

The study of oriented latent nuclear tracks in mica and polymers has been continued. These long linear defects created by energetic heavy ions in materials have been studied on D 11 at very low Q to find out whether these long, straight cylindrical defects may show properties analogous to neutron guides and also to investigate the fine structure of the defects.

The clustering kinetics in AlAgZn alloys has been studied for the first time by contrast variation. Demixion kinetics at room temperature has been determined in situ at D 17 on three samples containing ^{109}Ag, ^{107}Ag or natural Ag. The partial structure factors (S_{ZnZn}, S_{ZnAg}, S_{AgAg}) have been separated from the three sets of measurement. There is evidence of a unique type of Guinier-Preston zones enriched by Ag and Zn. The compositions of the zones and of the matrix have been determined, and are in good agreement with the calculated miscibility gap.

Precise measurements have been carried out to study the temperature dependence of the defect structure of doped calcium fluoride. The results permitted the establishment of systematic trends with dopant radius and with temperature in the defect cluster structure of the trivalent doped fluorite halides. Several studies of diffuse scattering in pure and doped superionic conductors have revealed the extent and nature of the short-range order existing in these phases.

Diffusion in bulk material

There is a continuing interest in the study of the diffusion mechanism of hydrogen in metals and alloys. Some of the most promising hydrides for applications are those based on $LaNi_5$. Quasi-elastic and inelastic scattering experiments were performed on these hydrides and have given a better understanding of the hydrogen diffusion mechanism. In particular the role of aluminium substitution on hydrogen dynamics has established a relation between the structure and the diffusion process. High resolution experiments on IN 10 in $LaNi_5H_6$ have shown that the diffusion cœfficient exhibits an anomalous concentration dependence. The existence of composite spectra at large momentum transfers is explained by the hydrogen diffusion in the presence of structural traps.

Other experiments have been carried out to study the diffusion of hydrogen in α-Yttrium hydride, which is an example of an hcp metal were the hydrogen has been shown to occupy both octahedral and tetrahedral interstitial sites, giving rise to the possibility of a complicated diffusion mechanism. Further measurements on single crystals are necessary to define the exact spatial diffusion mechanism.

Secretaries:
A. J. DIANOUX.
A. HEIDEMANN
(Former secretary of College VII).

college 8
and embl Grenoble: biochemistry

Members of the college

I. **At ILL**
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Chenavas P.
Cuillel M.
Devaux C.
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Lehmann M.S.
Mason S.
May R.
Oberthür R.
Roth M.
Smith J.
Timmins P.
Torbet J.
Wilson S.
Worcester D.L.
Zaccai G.

II. **At EMBL.**
Bentley A.
Bentley G.
Berthet C.
Boras F.
Cusack S.
Foote A.
Jacrot B.
Jesior J.C.
Leberman R.
Perkins S.
Schoot B.
Sgro J.Y.
Zulauf M.

Table 5

Instrument usage for biochemistry. The table shows the number of proposals and days of beam time (in brackets) considered at the two subcommittee meetings in 1982.

		D8	D11	D16	D17	IN5	IN6	IN10	IN11	IN13	Total
April 1982	requested	1(40)	31(77)	1(7)	9(86)	1(4)	1(4)	1(6)	4(39)	2(11)	49(274)
	allocated	1(40)	17(31)	1(7)	5(41)	—	—	—	4(16)	2(9)	30(144)
October 1982	requested	1(10)	21(63)	3(42)	9(113)	2(44)	5(24)	—	3(36)	2(13)	46(315)
	allocated	—	10(24)	3(36)	3(38)	1(5)	2(7)	—	2(13)	1(6)	22(129)

General summary

The ILL biology college and the Grenoble outstation of the European Molecular Biology Laboratory (EMBL) moved into the new joint EMBL/ILL building (ILL 20) in the first months of 1982. The consolidation of the facilities of the two groups has considerably improved the conditions and the support for biological experiments at ILL. Extensive biochemical equipment and instruments for centrifugation, X-ray and light scattering, electron microscopy and biochemical deuteration are now conveniently located close to the neutron scattering facilities. The dual support of biochemical experiments by EMBL and ILL has continued, with EMBL providing preparative facilities and physical methods other than neutron scattering, and ILL (and also to a lesser extent EMBL) providing assistance with the neutron scattering measurements, instrument operation and data evaluation. The basic research of both groups is also an important activity, and in many cases occurs in collaboration, either locally or with outside universities. Nearly all of the biological neutron beam experiments at ILL involve the scientific participation of one or several ILL or EMBL scientists. This has considerably helped to ensure the efficient use of neutron facilities and the success of the research projects.

Scientific trends and highlights of 1982

Small-angle scattering continued to be the dominant technique for biological experiments in 1982, but there was a substantial increase of beam usage for low-resolution crystallography, which utilized D 17 almost to the exclusion of biological small-angle scattering experiments. The Biology Subcommittee of the Scientific Council continued to emphasize several topics for long term commitment: the triangulation of the 50 S subunit of the E. Coli ribosome, chromatin, the structure of viruses, low resolution crystallography of multicomponent macromolecules, and water structure in macromolecules. Several other topics of particular interest, but shorter term nature, were allocated beam time and included several separate experiments on membranes.

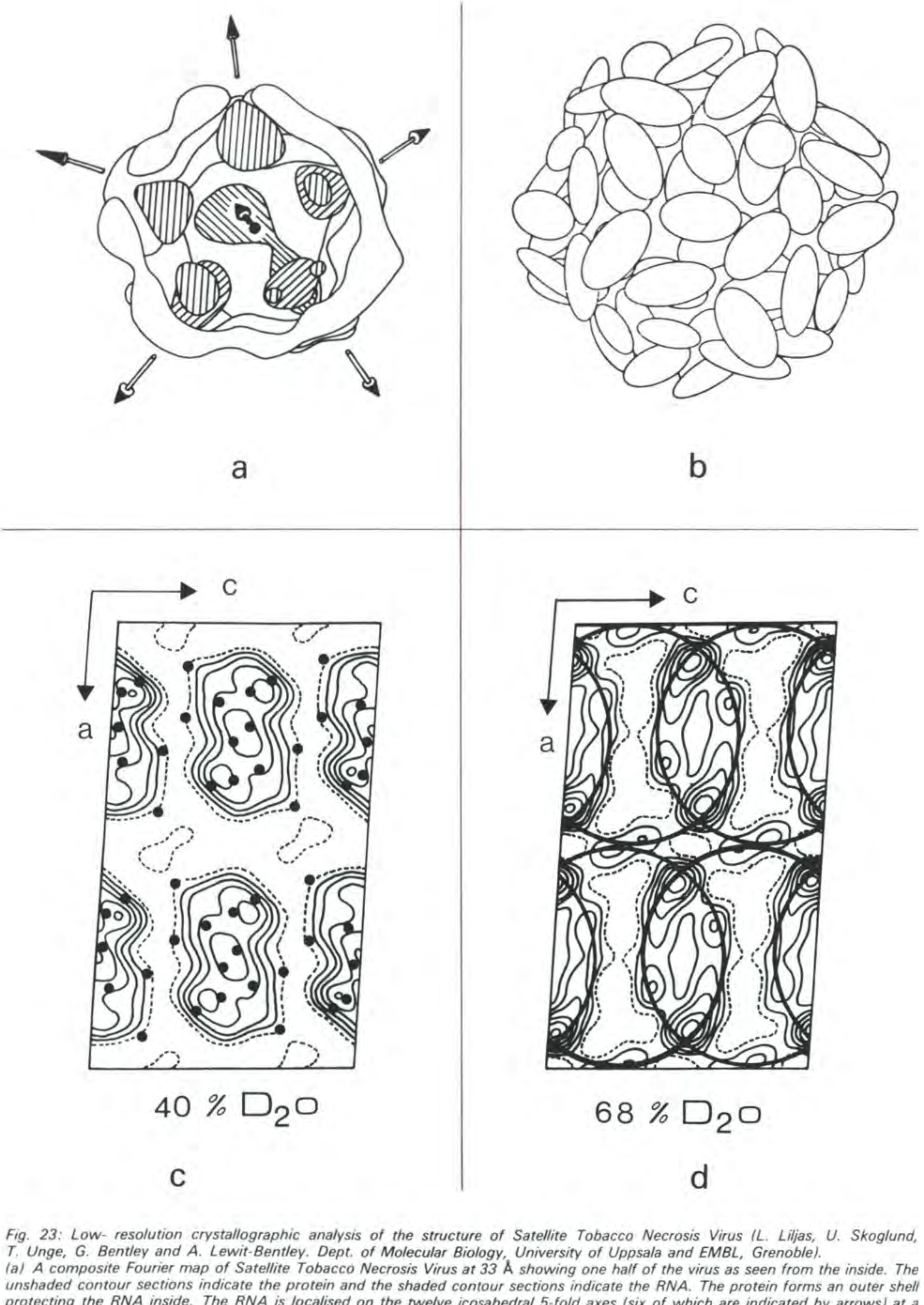

Fig. 23: Low- resolution crystallographic analysis of the structure of Satellite Tobacco Necrosis Virus (L. Liljas, U. Skoglund, T. Unge, G. Bentley and A. Lewit-Bentley. Dept. of Molecular Biology, University of Uppsala and EMBL, Grenoble).
(a) A composite Fourier map of Satellite Tobacco Necrosis Virus at 33 Å showing one half of the virus as seen from the inside. The unshaded contour sections indicate the protein and the shaded contour sections indicate the RNA. The protein forms an outer shell protecting the RNA inside. The RNA is localised on the twelve icosahedral 5-fold axes (six of which are indicated by arrows) at a mean distance of 55 Å from the virus centre (indicated by the black dot).
(b) Artists' impression of the protein "subunit" structure at low resolution.
(c) and (d) Contour maps obtained for 40% D_2O and 68% D_2O respectively. The 40% D_2O contrast (which shows RNA predominantly) was obtained by interpolation of 0%, 25%, 68% and 100% D_2O data. The circles are drawn about the virus centre with a radius (77 Å) to the positions of the protein subunit centres.

As in previous years, requested beam time for biological small-angle scattering experiments was much in excess of time available. Many good proposals had to be turned down or shortened because of this. The difficulty was accentuated however, by increasing use of D 17 for excellent projects in low-resolution crystallography. Altogether, less than half of the days requested on the small-angle scattering instruments D 11 and D 17 could be allocated. Installation of a multidetector on D 16 was completed during the year, and several experiments showed that this improvement made the instrument very useful for small-angle scattering as well as diffraction.

Low-resolution crystallography

Diffraction analysis of the structure of several large macromolecular complexes was made using D 17. Previous measurements of nucleosome crystals were continued. Extensive measurements were made of single crystals of Satellite Tobacco Necrosis Virus. Structural analysis at 33 Å resolution was completed using data sets for 0, 25, 68 and 100% D_2O (see figure 23 a-d) and shows clearly the separate locations of RNA and protein with RNA located preferentially on the 5-fold axes. Data to 16 Å resolution were collected for crystals in 0, 68 and 100% D_2O. The total number of reflections measured for the crystal in D_2O was 4276 with 1713 out of 2477 unique reflections having intensities greater than three standard deviations (Uppsala, EMBL, Grenoble).

Single crystals of the membrane protein matrix porin-detergent complex were briefly examined on D 17 and found to diffract to at least 25 Å resolution. Further measurements will be made on crystals of this integral membrane protein, structural analysis of which should show the nature of the transmembrane pore which it forms (EMBL Grenoble and Heidelberg, ILL, Basel).

Protein Crystallography

Analysis of neutron diffraction data to 1.4 Å resolution from a 20 mm^3 triclinic crystal of hen egg-white lysozyme at pH ~ 4.2 has shown that the side-chain of Glu 35 is protonated whereas Asp52 is not. This is as predicted by the reaction mechanism proposed by Phillips, Blake and others in the late 1960's. A further important result concerns the degree of protection of the H atoms of the backbone NH group against exchange with D_2O. At least 35 out of 126 such H's are more than 80% protected : most are in the helices formed by residues 8-15 and 25-35 and in the β sheet 40-60. In conjunction with solution NMR studies these amide exchange results can be used to assess fluctuations in the lysozyme structure and models of solvent penetration.

Chromatin

Studies of chromatin included experiments on the detailed structure of chromatin subunits and on the large-scale structure of native chromatin, metaphase chromosomes in particular. In the latter experiments, the differences between scattering curves obtained for different concentrations, ionic and pH conditions are directly analysed in terms of buffer-filled spaces which form in the compacted chromosomes, and provide information on the environmental factors influencing the high degree of structural organization (ILL, Munich).

E. coli 50 S Ribosomal Subunit

Measurements of the arrangements and 'in situ' sizes of the proteins in the large subunit of the E. coli ribosome continued. Five data sets on new inter-protein distances were collected, bringing the total number to ten. These are L 2-L 3, L 2-L 4, L 2-L 20, L 3-L 4, L 3-L 13, L 3-L 23, L 4-L 13, L 4-L 20, L 4-L 23, L 13-L 23. In addition, five more data sets for radii of gyration of proteins "in situ" were obtained . The proteins thus studied are L 2, L 3, L 4, L 13, L 20, L 22, L 23 (Berlin, ILL).

Virus Research

Work has continued on the low resolution structure of influenza virus (EMBL and Leiden). Measurements have shown that the A and B strains have very similar structures and that there are significant structural changes induced on lowering the pH to 5.0. These latter changes are likely to be important in understanding how the virus fuses with cell membranes during the infection process.

Studies on human adenovirus type 2 have resulted in a radial distribution of scattering length density from which the distribution of DNA and protein have been determined. Work on the whole virus was complemented by studies of mutants lacking part of the structure. In addition, X-ray studies made it possible to propose a model for the packing of the major coat protein in the capsid and also to observe some structural regularity in the nucleoprotein core. Further X-ray and E.M. studies are being carried out on crystalline preparations of the adenovirus fibre (ILL, EMBL, Grenoble, Lille).

Glycoproteins

Several glycoproteins were studied by small-angle neutron scattering in 1982. Alpha-acid glyco-protein was found to have an expanded structure in high salt (1 M NaCl) and a contracted form in more physiological conditions (0.2 M NaCl), as demonstrated by radius of gyration and contrast variation studies. The two structures could correspond to glycan chains extending into the solvent or folding back onto the surface of the protein core respectively (EMBL, ILL, Lille).

Several of the glycoproteins of human complement were studied by neutron small-angle scattering to determine molecular weights, radii of gyra-

Contrast variation

The scattering of radiation (of any kind) is due to fluctuations, or differences in scattering densities within the target. For neutron scattering, the scattering densities are sums of the coherent scattering amplitudes of the atoms in a unit volume. Studies of biological macromolecules by neutron scattering are usually made in an aqueous medium whose scattering density can be varied between that of H_2O and that of D_2O, with the scattering densities of all biological macromolecules falling (remarkably) between the two. The difference between the scattering density of the macromolecule and that of the aqueous solvent is the contrast, and can be varied by changing H_2O/D_2O mixtures. If the macromolecule has a uniform scattering density, changing the contrast changes the intensity, but not the angular distribution of the scattering (Babinet's principle). At zero contrast, the scattering densities of macromolecule and aqueous solvent are the same (hence matched) and there is no scattering. If the macromolecule is inhomogeneous, having components of different scattering density such as DNA and protein, the mean scattering density of the macromolecule determines the contrast. In this case, at zero contrast, the scattering vanishes at very small angles, but may be non-zero at larger angles. The aqueous scattering density can also be made to be the same as that of one component. The scattering is then completely determined by the structure of the other component. In this way it is possible to separately "see" the different components of a two-component complex.

Mathematically, the essential feature of contrast variation is that the Fourier transform of a hydrated structure is a linear function of the scattering density of the water. This is a consequence of the simple mathematical form of the Fourier transform which allows the target to be described as the sum of the aqueous component and the macromolecules. Such a Fourier transform is in general a complex number, and both real and imaginary parts are linear with the aqueous scattering density. At very small angles however, and for centrosymmetric structures, the Fourier transform is real, and therefore the square root of the scattered intensity is linear with the aqueous scattering density.

tion and "wide-angle" spectra. These were C 1, activated C 1, sub-component C 1 Q and the sub-unit complex C 1 r_2C 1 s_2. The data help to evaluate different models for the structures of these important components of the immune system (Oxford, Sheffield, CENG and EMBL, Grenoble).

Tryptophan Synthetase

Small angle scattering of trypophan synthetase and its subunits were made using reconstituted samples with one or the other of the two subunits deuterated. The enzyme is an $\alpha_2\beta_2$ complex with subunit molecular weights of 29,000 and 72,000 respectively. The data from samples with deuterated alpha subunits clearly show a substantial separation of the two subunits (Basel, ILL, EMBL, Grenoble).

Membranes

Structural analysis of purple membranes of 'Halobacterium halobium' was continued using 'in vivo' deuterium labelling of individual amino acids (Yale, ILL) and retinal (ILL, Argonne and MRC, Cambridge). Further samples were prepared by culturing Halobacteria in the presence of deuterated retinal obtained by mild oxidation of deuterated β carotene. These additional samples provided accurate diffraction data showing distinct intensity differences compared to the native in-plane diffraction. Difference analysis is now in progress.

Extensive studies of myelin membranes and multilamellar lipid vesicles were made during the year, to analyse the surprising finding that the membrane repeat unit of myelin increases with hydrostatic pressure (ILL). Diffraction analysis showed that this results from an increase in the cytoplasmic space in rat sciatic nerve, but that both cytoplasmic and extracellular spaces increase in myelin of the spinal cord, demonstrating a clear difference between the myelin membrane interactions from peripheral nerves and the central nervous system. Studies of lipid multilamellar vesicles of defined composition showed that the pressure effect is probably the result of disrupting salt bridges between acidic groups of lipids and basic groups of proteins. The response of spinal cord myelin was closely reproduced by vesicles containing phosphatidic acid and purified myelin basic protein. Measurements were also made on sciatic nerve of a mutant mouse (provided by N. Baumann of the Neurochemistry Laboratory, Hôpital de la Salpêtrière, Paris) which lacks myelin basic protein.

Water structure in Macromolecules

Experiments on the hydration of papain in ethanol-water mixtures and ribonuclease in glycerol-water mixtures were performed on D 11. The absolute intensity data show very little water associated with papain in ethanol-water mixtures, but 32% (w/w) associated water for ribonuclease in glycerol solutions. Radius of gyration data gave a measure of the location of the hydration shell (ILL).

Measurements of $tRNA^{Asp}$ have concentrated on the contribution to the total scattering of the hydration of counterions attracted to the negatively charged transfer RNA molecule. The data show nicely that this water is denser than bulk water, as expected for electrostriction of water molecules around the charged ions in the counterion cloud. No change of the structure of tRNA with ionic strength is observed but there is a redistribution of the ions (Strasbourg, ILL).

Inelastic Scattering

Molecular dynamics of lysozyme were studied on IN 13 and IN 6 for different conditions of hydration and inhibitor binding (Edinburgh, London, ILL). The inelastic difference spectra between lysozyme without and with saccharide inhibitors are always positive, consistent with a tightening of the Lys •G1cNAc and Lys • $(G1cNAc)_3$ complexes relative to free lysozyme. Partial frequency distributions have been derived for six mean scattering angles, and these show two principal features: a band structure between 300 and 700 cm^{-1} that does not depend significantly on Q_o, and a strongly Q_o – dependent band between 5 and 100 cm^{-1} the maxima of which shift from around 50 cm^{-1} ($Q_o \approx 2$ Å^{-1}) down to about 12 cm^{-1}) (≈ 0.4 Å^{-1}) while increasing in intensity. These preliminary results appear to indicate that at low Q_o, where the dynamics is sampled over distances in the 10 to 15 Å range, cooperative motions of the domain structure are seen ("hinge-bending mode"). The quasi-elastic difference broadenings, on the other hand, are rather different for the two inhibitors studied. Because of the slow decay of Lorentzian-like broadenings with increasing $h\omega$, small intensity differences due to "soft mode" changes in the near-inelastic region need to be analyzed very carefully. Measurements of the broadening for a number of lysozyme-inhibitor concentrations are required to separate these two effects.

Secretary:
D. WORCESTER.
Head of EMBL Outstation:
B. JACROT.

college 9
chemistry

Members of the College

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Hayter J.B.
Heidemann A.
Ibel K.
Jobic H.
Kearley G.
Kugler J.
Langel W.
Lauter H.J.
Lehmann M.
Lindner P.
Magerl A.
Marie P.
Oberthür R.C.
Pannetier J.
Pautrot P.
Pluchery O.
Poinsignon C.
Rawiso M.
Saubat B.
Thorel P. (CEN-Grenoble)
Volino F. (CEN-Grenoble)
Wright A.

Table 6

Instrument usage by College 9.
Proposed to and allocated by the Scientific Council in April and October 1982.

Instrument	Percentage use of instrument by Coll. 9	Proposed: number of experiments 9a	9b	Proposed: days of beam time 9a	9b	Proposed: days per experiment	Allocated: number of experiments 9a	9b	Allocated: days of beam time 9a	9b	Allocated: days per experiment	Percentage accepted: number of experiments	Percentage accepted: days of beam time
D1 A	6	5	—	24	—	4.8	3	—	9	—	3.0	60	38
D1 B	41	12	14	87	54	5.4	6	8	39	26	4.6	52	46
D2	13	5	—	30	—	6.0	3	—	19	—	6.3	60	63
D7	11	1	2	10	14	8.0	1	2	8	12	6.7	100	83
D11	44	3	91	8	181	2.0	2	47	3	70	1.5	52	39
D16	55	6	8	37	47	6.0	3	6	27	32	6.6	71	70
D17	38	—	80	—	156	2.0	—	40	—	67	1.7	50	43
D18	—	—	2	—	15	7.5	—	2	—	15	7.5	100	100
IN1	36	18	1	100	7	5.6	3	—	8	—	2.7	16	7
IN2	4	1	—	10	—	10.0	1	—	7	—	7.0	100	70
IN3	13	7	—	56	—	8.0	4	—	25	—	6.3	57	45
IN4	38	21	1	170	14	8.4	7	1	51	8	7.4	36	32
IN5	56	26	1	180	7	6.9	16	1	91	7	5.8	63	52
IN6	39	24	2	142	12	5.9	14	1	64	7	4.7	58	46
IN10	60	32	5	237	34	7.3	15	2	91	13	6.1	46	38
IN11	32	—	14	—	142	10.1	—	10	—	59	5.9	71	42
IN13	70	12	1	111	7	9.1	12	1	102	6	8.3	100	92
Sum or average:		173	222	1202	690	4.8	90	121	544	322	4.1	53	46

General summary

The separation of College 9 into two subunits 9a and 9b is now well established and has proved to be a reasonable decision:
9a is devoted to physical chemical problems of small molecules, including physisorbed, chemisorbed and intercalated compounds, and molecules in mesophases (liquid and plastic crystals).

9b deals with the physical chemistry of complex supermolecular structures and of large molecules, i.e. with colloids and polymers.

The instrument use in College 9 is similar to that of the new College 6 with some thematic overlap. The instrument use in Sub-college 9b is similar to that of College 8 with an overlap in the field of biopolymers and colloids of mainly physico-chemical interest.

Instruments of main interest in Sub-college 9a are the inelastic spectrometer IN 1, the time-of-flight instruments IN 4, IN 5, IN 6 and the backscattering spectrometers IN 10 and IN 13.

Instruments of main interest in Sub-college 9b are the small angle scattering instruments D 11 and D 17, and the spin-echo-spectrometer IN 11.

Instruments of common interest in College 9 are the powder diffractometers D 1 B and D 16.

Instruments of marginal interest in College 9 are the powder diffractometers D 1 A and D 2, the diffuse scattering instrument with polarization analysis D 7, the interferometer D 18 and the triple-axis instruments IN 2 and IN 3.

On average, the ILL Scientific Council was able to accept only half the proposed experiments, with only a limited possibility of reducing the beam time for each experiment (from an average of 4.8 days for a proposed experiment to 4.1 days for one accepted).

Instruments with a considerably faster turnover than average are the small angle scattering machines D 11 and D 17 with an average of 1.5 and 1.7 days per accepted experiment, whereas the other instruments have an average turnover of 6.0 days per accepted experiment in chemistry.

This leads to the other interesting feature, which is that most of the total beam time in College 9 is used by 9a, whereas the majority of the experiments are carried out in the frame-work of College 9b (cf. Table 6).

The enormous overload on IN 1 is due to the reconstruction of the instrument (IN 1 B), which for nearly two years has prevented any experimental activities with high energy transfer in chemical bond studies.

Since the end of 1982 for the first time in the history of the ILL the scientific in-house activity in the field of colloid and polymer science has reached a reasonable stage with 4 physicists and 3 thesis students mainly working in this field. If this number can be maintained at least over the next few years, several urgent projects could be carried through: a critical review of data handling for diffuse scattering at $Q > 0.2$ Å^{-1}, standard routines to estimate or correct for geometric and wavelength collimation influences on the diffuse scattering data, general programmes for model calculations of polymer conformation, development of new experimental techniques like neutron reflectivity for surface investigations or neutron scattering in non-equilibrium environments.

Scientific trends of 1982

Physisorption

Bi-dimensional phase studies benefit particularly from the use of neutron diffraction. Phase diagrams of H_2, D_2, and rare gases are now well documented. A new direction is opened by bi-dimensional phase diagram studies for CF_4 and C_2D_2 on lamellar halides such as $NiCl_2$ and PbI_2 where the appearance of plastic phases is noticed (Saclay).

Tunnelling spectroscopy

At room temperature a rigid methyl group, bound to the rest of a molecule X (or a surface, or a solid...), rotates almost freely (strictly speaking it is rotational diffusion) around the X-C axis. There is, however, an interaction between CH_3 groups and the surrounding such that certain orientations of the CH_3 are preferred. At lower temperatures, the CH_3 group freezes in one of these orientations. This situation can be described by saying that each H hydrogen atoms is localized in a potential well in which the H nucleus can oscillate, due to the molecular librations. At very low temperatures, even the librations are not excited, but tunnelling transitions are still possible and can be understood as follows: the spatial wavefunction of the methyl group is pretty much localised within the three potential wells. They extend, however, into the region between the potential minima (of the maxima of the potential) and there is a finite overlap with the spatial wavefunctions of the same group with an orientation changed by $\pm$ 120° (that is, with a given proton in one of the neighbouring wells...). This gives rise to a splitting of the rotational ground state, called tunnel splitting. Now, as one is dealing with homonuclear molecules or molecular groups, one has to observe the consequences of the Pauli principle. This necessitates taking the nuclear spin functions of the CH_3 group into consideration and implies symmetry requirements on the spatial and spin functions of the methyl groups. Consequently, transitions between spatial wave functions involving symmetry changes, necessitate a change of symmetry as for the spin function. For this reason it is obvious that such transitions cannot be mediated by phonons in a straight forward fashion. It involves, necessarily, a spin flip, and to stimulate it one has to use external probes capable of inducing spin flips. In practice, neutrons provide such a probe and they are an ideal tool to measure these transitions although the first evidence of the effect came from NMR. The wavefunction overlap is extremely sensitive to the shape of the potential near the top of the barrier between two wells. Tunnelling spectroscopy is therefore a unique tool to study this part of the potential and is complementary to libration spectroscopy which is more sensitive to the potential near its minima.

Quasi-elastic scattering from diffusion, tunnelling

The Q-dependence of the inelastic structure factors of tunnelling molecules, molecular groups and ions such as CH_4, $-CH_3$ and NH_4^+ has been studied with the thermal backscattering spectrometer IN 13. The results are in good agreement with recent theoretical prediction (Jülich, ILL). The rotational motions of NH_4^+ ions diluted in alkali halide lattices have been investigated on IN 5 yielding results which are consistent with a tunnelling model of a tetrahedron in an octahedral field (ILL). Tunnelling of NH_3 in solid $Ca(NH_3)_6$ has been measured on IN 6 in a wide temperature range exhibiting quasielastic broadening beside the tunnelling lines (Lille, ILL). A high resolution neutron scattering study has been made of a solid solution of CH_3D in CH_4 on IN 10 in order to obtain information about the energy states of the CH_3D molecules in the phase II structure. Free rotational and tunnelling transitions were observed (Oxford).

Rotational tunnelling of an H_2-D_2 mixture is used as a probe for electrical potential measurements and molecular interactions in lamellar compounds such as alkali intercalate graphite and lamellar silicates (Oxford).

With neutron quasielastic studies on solid protonic conductors, a new research field is being explored as mentioned in the College 5 report (cf. Annual Report, 1981) related to energy storage applications. The large scale of spectrometers available at the ILL makes it possible to investigate local fast motion and long range slow motions of protons in order to elucidate the proton transfer mechanism and its relation with protonic conductivity (Oxford, ILL).

Chemisorption and catalysis

The structure of chemisorbed layers has been well documented in the study of C_2H_2 adsorbed on Co_3O_4. The quantitative treatment of the Bragg peak modification induced by adsorption has been used from methods developed for physisorbed systems such as CH_4 on graphite. They are now applied to magnetic interaction studies at Co_3O_4 surfaces. The lattice site of electron transfer associated with chemisorption is identified for a spinel type oxide (Lille, ILL).

As previously mentioned, the additional delay of nearly one year in the rebuilding of IN 1 B had a very serious effect on the research programme of several teams, who were forced to give up their activities at the ILL. Nevertheless, catalytic property studies on zeolites, started on IN 1 B, can be developed with IN 6. The dynamics of aromatic hydrocarbons produced during the reforming of heavy oils in the porous network of zeolites is performed to elucidate the effect of catalytic properties and size selectivity for para-toluene against ortho-toluene synthesis in modenite frame-work.

A. Leadbetter (Head of the Neutron Division at the Rutherford Appleton Laboratories) is one of the prominent ILL users. On the picture he (on the right) is controlling a run at the IN6 spectrometer.

The motion of an alkyl chain grafted on silica carriers, which has been investigated by quasielastic scattering, can be described by a model of three-bond-jumps (Paris, ILL).

Molecular crystals and lamellar compounds.

The study of the dynamical behaviour of molecular plastic crystals was continued in order to investigate motions of increasing complexity, for example, in the investigations of hexamethylethane and hexamethyldisilane: each of the three motions corresponding to methyl groups (Me_3C-or Me_3Si-) or to the whole molecule was analysed over a wide temperature range. Similarly the internal and whole ion rotation study of the tetramethyl-ammonium ion in $[N(CH_3)_4]ZnCl_4$ was performed in relation to the set of four successive phase transitions between $-20°C$ and $30°C$ (Lille, ILL).

Lamellar compounds

Clays. Water dynamics in montmorillonite and vermiculite with different compensating cations (Na^+, Li^+, Ca^{2+}) have been investigated in two hydration states (one and two water layers). Adsorbed water anisotropy is also exhibited for those dioctahedral swelling clays (Birmingham, Orléans). Information about forces between charged lamellae has been obtained from an acoustic phonon study on a well crystallised vermiculite, saturated with different cations (Oxford).

Graphite intercalate compounds (GIC)

H_2 rotational tunnelling has been described for electrical potential measurements in alkali GICs (Oxford). Similar studies with H_2-D_2 mixtures were performed to prove H_2 dissociation. Crystallographic studies (Orléans, Nancy, Orsay) of $KC_8H_{2/3}$ monocrystals were performed to localize hydrogen in this GIC. Dynamic studies of the alkali ion in different stages of Rb and Cs GICs have been performed and show the influence of graphite modulation on the alkali mobility (Urbana, ILL).

Colloids

The continuing investigations of micellar systems with small angle neutron scattering (SANS) and neutron spin echo (NSE) has led to the speculation that the micelles might undergo a structural deformation during diffusion in concentrated solution. This is now being checked with chemically rigidified micelles, which should show the expected hydrodynamic behaviour of particles with constant spherical shape (Bristol, ILL).

The experimental results obtained with magnetic colloids (Bangor, Didcot) have challenged theoretical calculations for a model fluid of spherical particles with dipole moment (ILL), which can explain many of the experimental data.

Investigations on the internal structure of spherical micelles by isotope labelling of different parts of the constituent amphiphilic molecules with a combined use of D 11, D 17, D 16 and D 1 B are going on (Saclay, Orsay, Strasbourg), but progress will depend on a correct data handling at $Q \leq 0.2Å^{-1}$ (extraction of the coherent signal of the solute).

Interest is growing in the critical fluctuations of both uncharged and charged colloidal systems (Nancy, Grenoble, Saclay) and in lipid bilayers (Munich).

One promising new technique for the investigation of single liquid lamellae and interfaces is neutron reflectivity. It has now been applied for the first time to structural investigations of a single black film from a soap solution (Oxford, ILL) and could be an interesting tool for investigations of preferential adsorption of surfactants and polymers at interfaces.

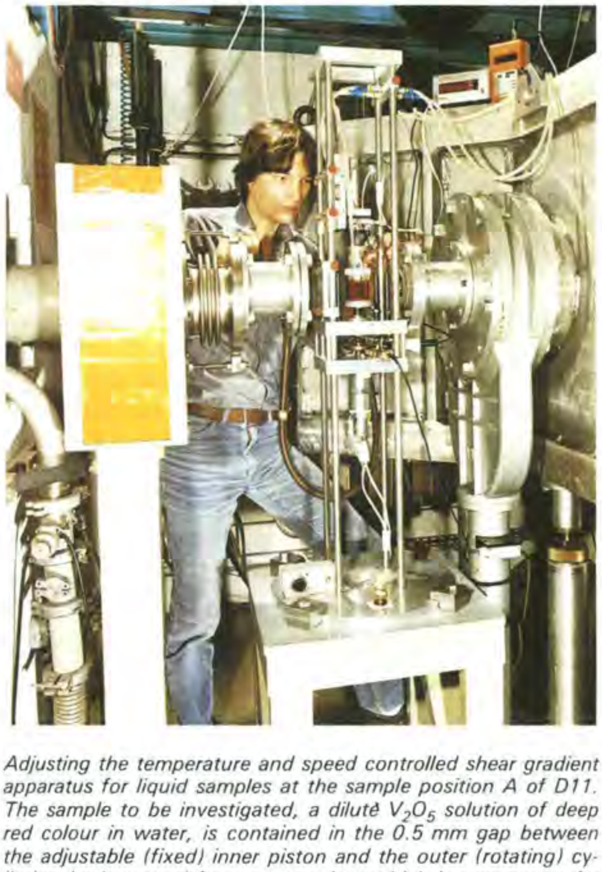
Polymers

Basic investigations are going on with partially labelled isotactic polystyrene (PS) in CS_2 solution (Strasbourg, ILL) to determine the local conformation of the chain from the scattering data. The main problem remains the data handling at $Q \leq 0.2$ $Å^{-1}$ and in particular the careful determination of the incoherent scattering of the solute, which is now attempted by polarization analysis on IN 1 and D 7.

Neutron interferometry for the determination of the refractive index increment (scattering contrast) of solutions with increasing solute concentration was extended to molecules dissolved in protonated solvents (Dortmund, ILL). This method has now reached such an accuracy that it can be used for coherent scattering length determinations of elements in soluble compounds.

Dynamic investigations on polymers focus on the transition from chain motion in concentrated solution to chain motion in the melt, and on the local mobility of the chain segment (Jülich, Mainz, London).

Using the results of early NSE experiments with PS in solution, conditions were found where a coil molecule should be deformed in a constant shear gradient. The first successful observation by SANS of such a shear deformation of a polymer coil in dilute solution is shown on Fig. 24 (Mainz, ILL).



Adjusting the temperature and speed controlled shear gradient apparatus for liquid samples at the sample position A of D11. The sample to be investigated, a dilute V_2O_5 solution of deep red colour in water, is contained in the 0.5 mm gap between the adjustable (fixed) inner piston and the outer (rotating) cylinder, both ground from quartz glass which is transparent for neutrons.
The spectra obtained with this sample on the 2D detector of D11 are shown on Fig. 24.

Several complex systems of polymers interacting with colloids have been investigated by various groups. It was found possible to describe the adsorption of polyoxyethylene (POE) on PS-latex beads by the polymer-segment concentration profile at the latex/water interface through Fourier-transform of the scattering data (Bristol). The investigation of the interaction of sodium dodecyl sulfate (SDS) with POE in dilute aqueous solution has led to the suggestion of a grape-like structure of a given number of spherical SDS mi-

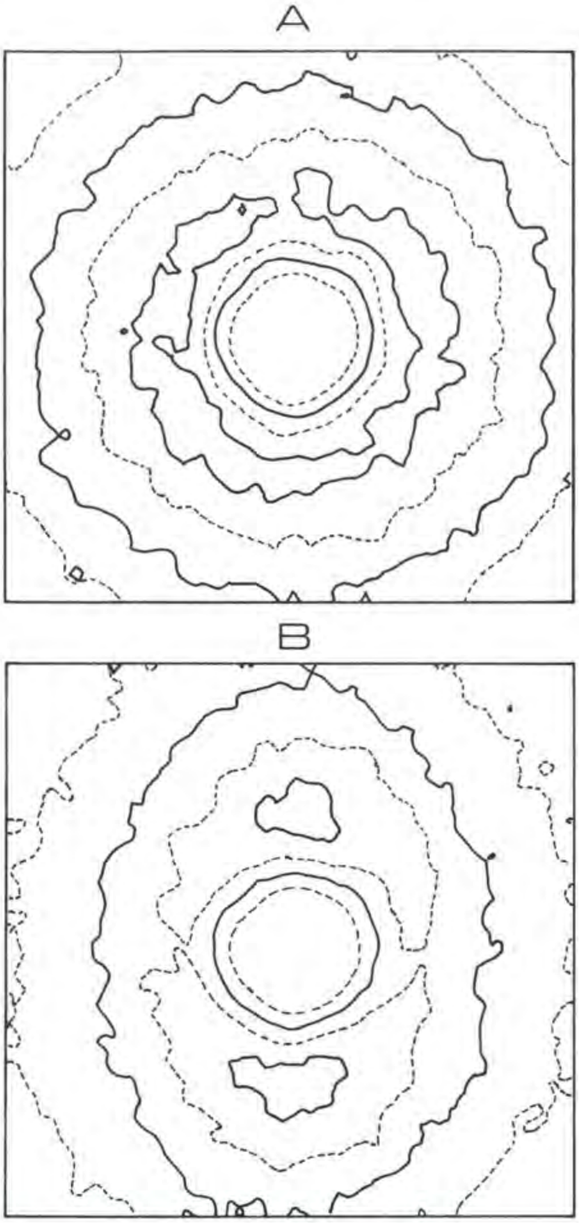


Fig. 24: Effect of a shear gradient on polymer conformation in solution. Lines of equal intensity on the 2 D-detector of D 11 for the SANS of d_8-PS (M_ω = 279000 g/mole) dissolved in oligostyrene/toluene (η = 0.2 Pa.s) after correction for detector efficiency and background substraction (sample-detector 10.7 m, wavelength 10 Å).
(a) at rest
(b) in a shear gradient G = 450 s^{-1}.

celles attached to each POE-chain, with several striking implications (Orsay, Strasbourg).

Highly ordered systems of pure block copolymers, invisible with light and scarcely visible with X-rays, are revealed by SANS, if one subchain is labelled (Strathclyde). A similar technique with labelled polychloroprene latex beads in the pure latex made it possible to follow the fate of such a bead by SANS at different stages during the processing of the material (Leverkusen, ILL), which was not possible with electron microscopy.

Workshop

A workshop on "Neutron Scattering and the Dynamics of Polymers" held at the ILL in March 1982, was organized under the auspices of College 9 by G. Weill (Strasbourg), L. Monnerie (Paris) and R. Oberthür (ILL). The meeting, attended by some 80 scientists, permitted a fruitful discussion of recent results obtained by neutron scattering and various other techniques.

Seminars

Some topics of more general interest covered by College 9 were reflected in ILL seminars given by E.W. Fischer (Mainz) on crystalline polymers, M. Mandel (Leiden) on polyelectrolytes and H.G. Zachmann (Hamburg) on synchrotron radiation in polymer research. In addition, several seminars of more specific interest were organized by College 9 with P. Pottier (Montpellier), K. Hahn (Mainz), M. Pons (Orléans), M. Benmouna (Tlemcen, Algeria), M. Bée (ILL), H.J. Lauter (ILL), F. Freund (Cologne), S.H. Chen (MIT), D. Tinet (Orléans) and H. Estrade (Orléans).

Secretaries:
C. POINSIGNON.
R. OBERTHÜR.

4

SECTIONS WITH SPECIAL TASKS

office of the scientific secretary

Organisation of Workshops and Conferences

In the period March 29-30, 1982 a workshop on "Dynamics of Polymers" has been held at the ILL. Is was organised by the Office in collaboration with R. Oberthür (ILL). About 80 experts discussed new developments in this field.

On October 11-13, 1982, the Office organised a "Workshop on Position Sensitive Detectors" in collaboration with P. Convert (ILL) and B. Forsyth (RAL). The workshop was attended by about 130 participants. It gave a state of the art of the development of multidetectors. The proceedings will be issued in Spring 1983 by Academic Press, Oxford.

An "International Conference on the Impact of Polarized Neutrons in Solid State Physics and Chemistry" was held at the ILL from October 15 until October 19, 1982. It was organised by the Office in collaboration with J. Schweizer (CENG), F. Tasset (ILL) and R. Lemaire (CNRS). More than 100 participants attended the lectures and poster sessions.

The proceedings of the Conference will be issued in Spring 1983 by Journal de Physique.

Preparations were started for the organization of the following workshops in 1983 :

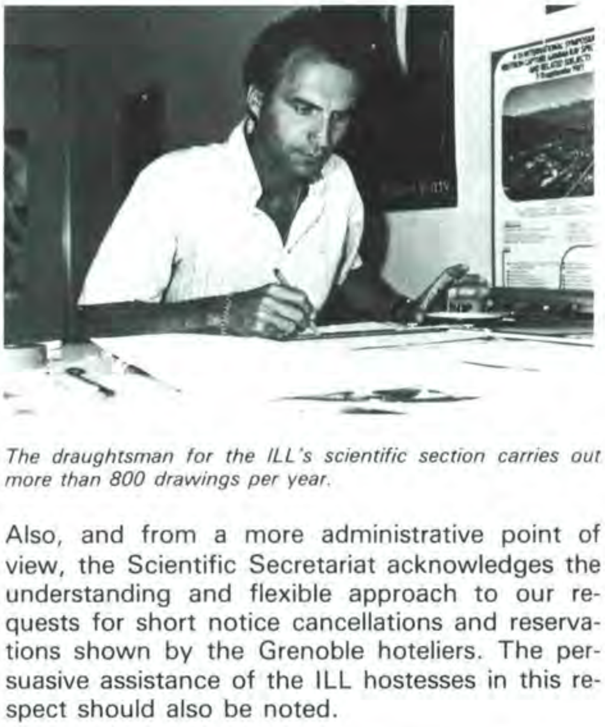
1. Workshop on "3d Metallic Magnetism" organized by K. Ziebeck (ILL) and D. Givord (CNRS) (25-26 March 1983).
2. Workshop on "Data Treatment for Studies of Concentrated Polymer Solutions and Colloids" organized by R.E. Ghosh, J.B. Hayter, R.C. Oberthür (29-30 March 1983).
3. Workshop on "The Use of Neutrons in Applied Chemistry" organised by J.P. Beaufils and J. Hayter (27-28 October 1983).
4. Workshop on "Fundamental Physics Experiments at Reactors" organised by F. Gönnenwein (in Autumn 1983).

Public relations

On March 27, 1982 the Office organised an Open Day at the ILL which has been a remarkable succes. More than 950 persons from the Grenoble population visited the Institut.

Instrument Operation

1982 proved to be a difficult year for the implementation of the scientific programme of the Institut. Perturbation and uncertainty due to faults which occurred in the reactor has meant cancellation at short notice of some 100 experiments. Subsequent inconvenience, both to the visitors themselves and to their associated experimental sample preparation programme, was largely minimised by their understanding of our difficulties and the efforts which were made to reschedule the experiments. That we were successful in maintaining the programme by compressing the remaining available time, was mainly due to the efforts of the instrument scientists, local contacts and technicians, a point which highlights once again, the extremely high level of serviceability we expect from our scientific instruments.



The draughtsman for the ILL's scientific section carries out more than 800 drawings per year.

Also, and from a more administrative point of view, the Scientific Secretariat acknowledges the understanding and flexible approach to our requests for short notice cancellations and reservations shown by the Grenoble hoteliers. The persuasive assistance of the ILL hostesses in this respect should also be noted.

The final reactor cycle originally foreseen for 1982 was delayed until 1 February 1983. On information presently available, the scientific programme will be continued next year on the basis of the following reactor cycles :

25 May to 14 June 1983
21 June to 4 August 1983
16 August to 29 September 1983
11 October to 24 November 1983
6 December to 23 January 1984
(interruption 23-28 December 1983)

Project office

The project Office assumes responsability for technical coordination, financial planning and budget control in the field of scientific capital investment in the normal budget and the execution of the modernisation programme.

The total expenditure in 1982 was 11 MF in the normal budget and 16.3 MF in the modernisation budget ; commitments not yet paid being 8.9 MF (October 31).

The projects in 1982, in an advanced stage are the following : IN 1B, D 4B, PN 8, D 19A. The fabrication begins for D 7B, IN 20 and the main orders for the H 11 project (D 19B, D 2B, D 20) are placed. Preliminary studies for IN 4B, DB 21 (the biological diffractometer to be constructed in collaboration with EMBL) are under way.

The instrument projects for the second cold source are under discussion.

The Project Office became connected to a management information system early this year, permitting access to some book-keeping data for analytic budget control, project cost survey and budget planning.

safety and health physics group

The main function of the Group has continued to be the monitoring of radioactivity around the installations and the measurement of risks at the working positions.

In particular the Group has assisted, in conjunction with the other departments and services of the ILL,

1) in the work necessitated by the repairs to the primary circuit of the Reactor in April ; this repair work involved dismantling and decontamination in particular of the heat exchangers, where there had been some contamination since 1977 ;

2) in changing the H 12 beam tube liner and work on the H 6 source manipulator ;

3) with health physics calculations on the future horizontal and vertical cold sources and on future instruments such as IN 20 and D 20 ;

4) with monitoring on commissioning of experiments IN 1 and PN 8 ;

5) on the safety study for the future buildings, in particular the future neutron guide hall and building ILL 21.

Also in 1982 the Safety and Health Physics Group computerized the records for radioactive sources and the despatch to the laboratories of origin of the dosimetry results for the guest scientists.

The Group also continued and expanded its work of informing all staff on health physics, with particular emphasis on the video film.

library

In 1982 the I.L.L. Library has succeeded, thanks to strong in-house support, in maintaining its rate of acquisition of books and its number of periodicals, despite the considerable increase in the price of scientific publications.

It has now 7300 books (490 acquisitions in 1982).

It handles 300 subscriptions to journals of which :

- 160 scientific titles
- 60 technical titles

are stored in the Library, the remainder being dispatched to other departments of the Institute.

The library continues to be point of attraction and interest for the users of the I.L.L. facilities.

1982 has marked the end of the computerisation process for some tasks of the library, in particular for :

- publications (about 350 registered for 1982 jointly with the Physicists' Secretariat),
- experimental reports collected for the Annex to the Annual Report (about 400 every year).

Library budget for 1982 : 442 KF.

The efficient organisation of the ILL's library by Mme Castets plays an essential part in the Institut's scientific activities.

secretariat of physicists

This secretariat is in charge of the typing of scientific publications and the mail of the ILL physicists and long-term visitors.

Typing of research proposals and reports (submitted to the Scientific Council) is also done by this section.

The secretariat is also involved in the preparation of the list of ILL publications for the annual report of the Institute in collaboration with the library.

The group contributes to the preparation of conferences and workshops and regularly sends reprints of the ILL publications for which there is a high level of demand from very many laboratories.

Due to the increase in the typing load, the introduction of a word processor for the secretariat is envisaged for the near future to permit a better service to be given to the scientists.

5

TECHNICAL DEPARTMENT

Introduction

Le département technique assume 2 missions fondamentales :

l'une, de caractère général est confiée au Service Fabrication, Aménagement et Entretien et couvre l'ensemble du site et de ses installations hors réacteur, y compris l'aménagement des dispositifs expérimentaux ;

l'autre, de support scientifique est assurée par le Service de Construction et de Maintenance qui, de l'étude à la réalisation, le montage et les tests est responsable de la partie mécanique des dispositifs expérimentaux.

Dans le cadre de la mission générale, l'année 1982 a été marquée essentiellement par l'installation de l'autocommutateur téléphonique et les travaux de définition du nouveau hall de guides lié à la source froide horizontale.

Dans le cadre de la mission de support scientifique, la première série d'instruments du programme de modernisation a été mise en service : IN 1 B, D 4 B, PN 8, et les structures essentielles du projet d'aménagement de H 11 étudiées et lancées en fabrication.

Introduction

The Technical Department has two principal functions :

The Production and Site Maintenance Group has a general function covering the entire site and the installations apart from the Reactor, including the equipment of the experimental instruments.

The Instrument Construction and Maintenance Group provides scientific support, and is responsible for the mechanical part of the experimental instruments from their design to the construction, assembly and tests.

As regards the general function, 1982 was mainly characterized by the installation of the telephone switchboard and the work of defining the new guide hall associated with the horizontal cold source.

Under scientific support, the first group of instruments in the modernization programme was commissioned : IN 1B, D 4B, PN 8, and the basic structures of the H 11 equipment project were designed and ordered.

Einleitung

Das Technische Departement ist für zwei wesentliche Aufgaben zuständig:

— die eine, mehr allgemeiner Art, ist der Abteilung Werkstätten, Infrastruktur und Gebäudewartung übertragen und erstreckt sich auf das gesamte Gelände und dessen Anlagen ausserhalb des Reaktors, einschliesslich Infrastruktur der Experimentiereinrichtungen.

— die andere, die wissenschaftliche Unterstützung, ist durch die Abteilung Konstruktion und Wartung gewährleistet, die vom Entwurf bis zur Ausführung, der Montage und den Tests, für den mechanischen Teil der Experimentiereinrichtungen verantwortlich ist.

Von den allgemeinen Aufgaben her gesehen, war das Jahr 1982 im wesentlichen geprägt von der Inbetriebnahme der Telefonvermittlung und der Planungsphase für die neue Neutronenleiterhalle im Zusammenhang mit der horizontalen Kalten Quelle.

Von der Aufgabe der wissenschaftlichen Unterstützung her gesehen, wurde die erste Serie von Instrumenten des Modernisierungsprogramms in Betrieb genommen : IN 1 B, D 4 B, PN 8. Ausserdem wurden die wesentlichen Teile des Projekts zur Infrastruktur H 11 entworfen und in Auftrag gegeben.

production and site maintenance group

1. General

The Group is active in three main areas :

— contribution to the technical and logistic support of the ILL scientific and general services ;
— maintenance in good condition, and as necessary extension of the buildings and general infrastructure of the ILL (excluding the Reactor) ;
— operation, maintenance and repairs of the general technical installations.

2. Production group and primary materials store

Mechanical and Sheet-Metal Workshops

With a staff of 4 and a fairly complete range of machining and welding equipment, these have contributed to :

— the construction of a considerable proportion of the experiments and their infrastructure,

— the equipment and maintenance work for the Reactor, laboratories and general technical installations.

The projects include vacuum pumps for PN 5, cryogenics and Reactor. Platforms for the installation of PN 1 and nuclear ventilation for ILL 21. Biological shielding for PN 8.

The Self-Service Mechanical and Sheet-Metal Workshops

A range of 15 machines is permently available to technicians from various groups doing small items on mechanical work of a very high quality.

Two permanent staff attached to this workshop also

— advise the users,
— carry out certain work themselves,
— maintain the stock of machine tools outside the main workshops.

The Primary Materials Store

Linked with the ILL general stores, this store is operated on behalf of and under the control of the Administration and Finance Department. One employee supplies materials in sheets and profiles to the (non-finished) dimensions requested by the users.

3. Design studies and construction project group

This group deals with new constructions and major changes to the general infrastructure and buildings. It does all or part of the associated design studies, deals with invitations to tender, selection of suppliers and supervision of the work carried out by outside firms.

The main jobs in 1982 were :

— a meeting room on the 1st floor of ILL 4, renovation of the 2nd floor conference room and installation of centralized air-conditioning, also shared with the Scientific Secretariat's computer
— installation of a central X-ray laboratory in ILL 19
— construction of an entrance and toilets for handicapped persons in ILL 4
— equipment of the decontamination building ILL 21 with contamination and conventional facilities
— construction of a lorry access lane at the entrance to the site and access for pedestrians at the corner of the ISN
— repainting of the 3 upper floors of ILL 4
— establishment of a test area for heavy experiments on the 1st floor of ILL 2
— equipment of a room for legally required archives in ILL 11
— reconstruction of the road ILL 7/ILL 11
— various equipment work for offices or laboratories.

In addition the initiation of design studies for the construction of the second guide hall (ILL 22) took place and orders were placed for engineering consultancy, supervisory organisation, surveyor, studies of the ground and supervision of the base. The invitation to tender for the roads and the base has been issued.

4. Building and instrument maintenance group

Description of duties

The group has 3 main fields of work.

a) Maintenance of the technical installations and the ILL's furniture and structures

The work in this field is essentially preventive, partly with the aid of specialized external firms, under maintenance contracts.

The recruitment in 1982 of a technician directly responsible to the group head has made it possible to start computerizing the list of equipment, to form the basis of a plan of preventive maintenance and stock management.

b) Equipment of buildings

In conjunction with the design studies and construction project group, the group carries out the majority of design studies and preparation of technical specifications and the follow-up of construction work (done by external firms) in the field of liquids, air-conditioning, handling, electricity and furniture.

c) Modifications to instrument positions

As a function of the requests from the Instrument Operation Department and the Project Office, and in conjunction with the Reactor and the Construction and Maintenance Group, this group organizes the preparation and assembly of the shielding and other facilities (electricity, handling, infrastructure) on new or existing instruments.

Principal jobs in 1982:

— Equipment of the hydrogen area behind PN 7
— Assistance in changing the H 12 beam tube liner and in dismantling preliminary to the replacement of the H 9, H 10 and IH 4 beam tubes
— Equipment of the γ-area in ILL 1
— Infrastructure for PN 8
— Transfer of the evaporator S 3
— Equipment of the liquid Helium experiment on H 17
— Handling equipment on IN 12 and on the liquid Helium experiment on H 17.

Facilities available

Apart from the use of external firms and other sections of the ILL, the group is mainly supported by its workshops :

— Maintenance and electrical workshop : 4 staff (after incorporation of the contract personnel)

— Maintenance workshop for general technical installations : general fluids, heating, sanitary, ventilation, air-conditioning, effluents (outside the Reactor), and lifting and handling equipment (5 Staff).

— General maintenance workshop : maintenance of buildings, general and technical furniture, ILL vehicules, all internal removals and a considerable proportion of the internal transport and handling (4 staff).

— Concrete prefabrication base. With the associated civil engineering equipment, this makes it possible to deal with particular requirements for experiments as regards shielding (ordinary or special concrete).

telephone

To satisfy its telecommunications requirements, the ILL installed its own telephone switchboard in 1982, making it independant of the network of the Centre d'Etudes Nucléaires de Grenoble.

Preparations for installation were spread over the first six months of 1982.

The switchboard is a SIEMENS EMS 12000 electronically controlled multi-line system, providing 525 internal lines, 300 of which can be reached by direct inward dialling. This provides a number of additional services for the ILL personnel, the most used being the centralized abbreviated numbering, which provides four-figure codes for numerous outside numbers.

The exchange consists of three switchboards and a computerized ILL directory. It is manned by operators from 8 a.m. to 6 p.m. on working days.

In parallel with the installation of this telephone system, work was carried out in association with the general operation on the renovation of the internal network, identification, updating and replacement of old equipment, and the installation of new lines required for new rooms or transfers of staff.

The new ILL switchboard installed in June 82 has considerably improved the efficiency of the Institut's telephone system.

Instrument construction and maintenance group

Within the Technical Department, this Group has two main functions :

— assistance with the design and construction of the instruments under the responsibility of the Project Office ;

— collaboration on the operation of instruments in the fields of inspection, measurement and maintenance.

Two additional fields were attached to this Group during 1982 :

— the mechanical workshop
— the special products workshop.

The design studies, internal and external mechanical construction work, assembly, tests, and measurements thus form a coherent whole. This coherence was reflected at the end of the year by the complete assembly on a platform in the workshop building of the new triple-axis spectrometer IN 20.

Design studies

These cover three working groups :

— The shielding group with the preparation of the tender documents for the new H 11 project : at the end of 1982 the design studies for all the main integrated components were completed and construction was started in Germany of the shielding assembly for D 19B-D 2B-D 20.

— The secondary spectrometers group with the completion of the optical equipment for D 4B-IN 1B-IN 1-Beryllium : at the end of 1982 this group completed the structural studies for IN 20 and started the design studies for the optical components of this instrument. In addition the design studies for D 19B, D 20 are in progress.

— The development group contributed to the definition of new mechanical components suitable for Eulerian cradles, superconducting coils for D 7B, and fast choppers possibly for IN 4B.

Production

The group has dealt with 270 sets of documents for outside industry.

The workshops have done a great deal of work with the Reactor in connection with difficult maintenance work. They also contributed to the sensitive construction work on variable curvature multiple monochromators. After D 7-IN 6 the new prototype will be used by IN 1 B. They have also made possible the construction of special new goniometers which can be motorized and coded.

The main external items concern IN 20 with the shielding supplied from the U.K., and also a multidetector prototype, and in the Grenoble area the supply of D 7 components suitable for polarized neutron experiments by supermirrors.

Assembly, tests

This group is still very active :

— work outside the group on behalf of the Equipment and Maintenance Group, for the scientists and for the Reactor Department ; these are essentially measurements of vibrations, temperatures, noise and dimensions ;

— assembly and test of the instruments and components produced by the Group : IN 1B, D 4B, IN 1-Beryllium, new projects for D 7, PN 8 and IN 4 ;

— loan of measuring equipment with instruction for the users.

6

REACTOR OPERATION DEPARTMENT

Introduction

Le rythme de fonctionnement habituel du réacteur a été perturbé, en 1982, à la suite de deux incidents qui ont affecté les structures du bloc-pile :

— rupture d'un secteur du collecteur de reprise de l'eau lourde dans le bidon réflecteur,

— perte d'étanchéité du nez du doigt de gant du canal H 12.

Le programme initialement prévu comportait six cycles totalisant 257 jours de fonctionnement ; la remise en état de l'installation à la suite des incidents a nécessité l'aménagement des cycles et la durée totale de fonctionnement a été réduite à 204 jours.

Einleitung

Zwei Zwischenfälle, die die Strukturen des Reaktorblocks betrafen, haben im Jahre 1982 den üblichen Funktionsrhythmus des Reaktors gestört:

Bruch eines Teiles des Ansaugtorus im Schwerwasser des Refektortanks.

Undichtigkeit der Nase des Strahlrohres H 12.

Das ursprünglich vorgesehene Programm belief sich auf 6 Zyklen von insgesamt 257 Betriebstagen. Die notwendigen Arbeiten an der Anlage nach den Zwischenfällen hatten eine Neuplanung der Zyklen, sowie eine Verkürzung der Gesamtbetriebsdauer auf 204 Tage zur Folge.

Introduction

The regular operation of the reactor was disturbed in 1982 following two incidents which affected the structures of the reactor block :

Breaking off of part of the heavy water suction nozzle in the reflector tank.

Failure of water tightness at the nose of the beam tube liner of beam H 12.

The original schedule for 1982 included 6 cycles totalling 257 days of operation ; the repairs following these incidents necessitated a change in the reactor cycles, reducing the total operating period to 204 days.

reactor operation 1982

Cycle 8/81

Operation from 5 January to 11 February 1982.

The schedule was respected and the cycle was completed without any notable incident.

Cycle 1/82

Operation from 23 February to 10 April 1982.

The initial cycle was prolonged by two days to compensate for a shut-down of 42 hours during the cycle necessitated by the replacement of a main pump of the heavy water circuit, when the vibration level became excessive.

Cycle 2/82

This cycle was initially programmed from 20 April to 3 June 1982, but was interrupted by two incidents.

The first, following the breaking off of the heavy water suction nozzle in the reflector tank, stopped the Reactor from 20 April to 30 June. The second incident was the discovery of a leak on the liner of beam-tube H 12 ; its replacement necessitated a further shut-down of the reactor from 5 to 27 July 1982.

Operation then resumed from 27 July to 16 August without any particular problem, but the fuel element was only partly used (24 days instead of 44), this element will be used again in 1983.

Cycle 3/82

Operation from 24 August to 10 October 1982.

The original cycle had to be prolonged by 3 days to allow for a reactor shut-down to replace safety rod n° 5.

This cycle was interrupted by 3 reactor shut-downs, including one with a Xenon poison-out. These shut-downs were due to voltage drops on the EDF supply network.

Cycle 4/82

Operation from 19 October to 2 December 1982.

The scheduled dates of this cycle were respected despite a 42-hour reactor shut-down following a voltage drop on the EDF network.

Cycle 5/82

This cycle commenced in 1982 and finished in January 1983.

The start-up was on 14/12/82, and the cycle was interrupted over Christmas from 23 to 28 December 1982, then continued normally until the end of January 1983.

An operational error during the start-up on 14/12/82 resulted in a brief shut-down, but the Reactor was immediately restarted.

Data for 1982

N° of days originally scheduled	257
actual n° of days of operation	204
N° of equivalent days of full power	200
actual operating time	56%
actual operating time in relation to time scheduled	79%
N° of fuel elements used	5
N° of fuel elements actually despatched for processing	5
N° of unscheduled shut-downs	10
including: brief shut-downs	5
shut-downs with Xenon poisoning	5

Analysis of unscheduled shut-downs

Intervention by operation staff	3
EDF power cuts	4
Mechanical reasons	3

The number of unscheduled shut-downs (10) is comparable with that of recent years, but the number of shut-downs with Xenon poisoning (5) is considerably higher than in 1981 ; this is the result of failures of equipment, which necessitated long shut-downs for repairs.

Despite the improvements to our installations for protection against EDF power cuts (no effect on the reactor operation when these cuts are shorter than 1.5 seconds), the unscheduled shut-downs due to EDF voltage drops amounted to 4 this year : this was due partly to a 220 KV loop being interrupted at certain periods,which results in longer power cuts if there is an interruption due to lightning ; in addition, a long power cut (1 h 35mn), due to a violent storm, interrupted the 220 KV supply on 7 November 1982.

operation of the sub-assemblies

Reactor block

Following the damage to the heavy water suction nozzle in the reflector tank, the complete circuit was equipped with sensors to indicate any unusual events and filters were installed to trap any new part likely to enter the circulation and damage the equipment. At each scheduled shutdown the interior of the reflector tank is inspected by a television camera to follow any changes in the internal structures of the reactor block.

The year was also marked by the replacement of the H 12 beam tube liner, at the nose of which a heavy water leak was detected ; three replacement beam tube liners have been made and a complete set of liners for the horizontal and inclined beam tubes has been ordered.

The leak detection circuits in the beam tubes have been tripled, and the electrode leak detectors have been replaced by new systems operating in 2/3 logic to close the associated safety valve.

The pneumatic control circuit for the safety valves has also been replaced and duplicated.

Following safety studies and tests to evaluate the consequences for the instruments, the beam tube liners previously under vacuum were filled with helium at 2 bars absolute.

Circuits

The piece of aluminium from the suction nozzle slightly damaged the impeller when it reached the reactor block, and necessitated the replacement of main pump n° 2 ; following this, filters were installed on the inlet side of the pumps to avoid repetition of this incident.

During the year the majority of the immerged rotor pumps were equipped with devices to monitor the wear of the graphite bearings.

On the heavy water circuit, a filter of large area and small grainsize was tested and found satisfactory, reducing the turbidity of the heavy water to below 5 mg alumina per litre.

New liquid effluent tanks were installed, permitting the temporary storage of effluents before transfer to the processing facility.

The Dam on the Drac was again consolidated and a second dam constructed 250 m downstream now limits the drop to which the ILL Dam is subject.

Detritiation plant

The detritriation plant operated only during the first three months of the year, processing 3 620litres of heavy water from one of the HARWELL reactors, 1 450 litres of heavy water from EL 3 at SACLAY, and 30 m³ of heavy water from the HFR. During this period approximately 20 000 curies of tritium were extracted.

Following this, the detriation plant was stopped and the refrigerator used for tests on the model of the future Cold Source, which will be installed in the H 5 beam tube liner (see photo).

Test set-up for the new Horizontal Cold Source.

Electricity

During 1982 a study was carried out for the replacement of the static inverters of the completely reliable 220 V production and distribution network. The old TCMS network, which had been gradually replaced by the ARC and NS networks has been disconnected and the static inverter removed.

The control unit for the instrument PN 3 has been completely rebuilt using an automatic programmable device.

Electronics

To augment the information received in the Control Room and, in particular, to improve the operation of the experimental instruments, SADI (Information Acquisition System) systems have been installed and connected to a control panel with teleprinter in the Control Room.

The information on the detritiation plant has also been combined on a SADI and relayed to the Reactor Control Room.

The TCMS system (Centralized Treatment of Measurements and Signals) has been equipped with a colour visual display unit permitting changes to be followed in real time, or changes in measurements arriving at the computer to be reconstituted. This will make it possible to reconstitute past events, the information being stored in the ILL Central Computer by means of a link also implemented this year.

A photocopy system has also been provided for this visual display unit.

Handling of fuel elements

The ILL received two new fuel elements in 1982 and forwarded five used elements for reprocessing in the USA. From the end of 1982 a new type of container will permit two fuel elements to be despatched at the same time.

The hot cell has been equipped with a cutting device, which has been used to take specimens from the beam tube liners H 8 and H 12 which were replaced during the year.

7

COMPUTING AND ELECTRONICS DEPARTMENT

Introduction

1982 has been a year of consolidation, of general improvements, and of planning for the future.

The new Central Computer, DEC 1091, completed its first years normal operation in October. After resolving some initial problems the system now runs smoothly with very few interruptions of service. The long reactor shut-down in spring disrupted, for a while, the normal pattern of use, but it is now clear that the workload is considerably higher than had been forecast, and some signs of saturation are appearing.

A number of projects are in hand to improve communications with and between computers. A computer network is being installed with the principal aim of facilitating data transfer to the DEC 10. By the end of 1982 about 20 instrument computers had been connected. In parallel with this, a hardware switching device will permit (for such equipment as is connected to it) any terminal to be linked to any computer.

Purely on the instrument control side (computers and electronics) one must particularly note
— implementation and testing of the rebuilt systems IN 1B, IN 8B
— work on data acquisition on D 19A, leading to the refined technical specification for D 19B's computer
— improvements to IN 6, IN 13 following their coming into general service
— major modifications on D 5, D 7, IN 10, IN 11.

Aside from its work on individual instruments, notably D 19A, the Data Treatment Group has been engaged in unifying formats for corrected data, to enable standard analysis packages to be used.

Specifically on the electronics side there is a clear movement towards the use of microprocessors, and better programming and test facilities are being introduced. The implementation of the DEC standard CAMAC controller continues.

With few exceptions reliability of instruments systems is good. This is a very fine achievement in view of the rapid increase in the amount of equipment in service.

In the detector area, the principal achievement was the delivery of the 8000 cell multidetector for D 19, after overcoming many technical problems. For the future, the relative merits of gas and solid state technologies for large area position sensitive detectors are being carefully reviewed.

The Management Information System, MISSILL, which was originally restricted to the automation of the Scientific Secretariat and related services for guest scientists, has widened its cover to include travel, radiation records and the Project Office.

Einleitung

1982 war ein Jahr der Konsolidierung, der allgemeinen Verbesserungen und der Planung für die Zukunft.

Im Oktober beendete der neue Zentralrechner DEC 1091 sein erstes Jahr im Normalbetrieb. Nach Beseitigung einiger Anfangsschwierigkeiten läuft das System nun reibungslos mit nur sehr wenigen Betriebsunterbrechungen. Der lange Reaktorhalt im Frühjahr unterbrach für eine Weile den normalen Betriebsablauf, aber es ist nun klar, dass der Rechenbedarf bedeutend höher ist als vorgesehen und erste Anzeichen der Sättigung sind zu erkennen.

Eine Anzahl von Projekten zur Verbesserung der Kommunikation mit und zwischen den Rechnern wurde angefangen. Ein Rechnerverbindungsnetz wird installiert mit dem Hauptziel, die Datenübermittlung zur DEC 10 zu erleichtern. Ende 1982 waren etwa 20 Instrumentenrechner angeschlossen. Parallel dazu wird ein Terminal-Netzwerk aufgebaut, das die Anwahl eines beliebigen Rechners von einem beliebigen Terminal aus ermöglichen soll.

Auf dem Gebiet der Instrumentsteuerung (Rechner und Elektronik) muss folgendes besonders beachtet werden :
— Inbetriebnahme und Test der neuerstellten Systeme IN 1B, IN 8B
— Arbeiten auf dem Gebiet der Datenerfassung für D 19A, die zur verfeinerten technischen Spezifikation für den D 19B-Rechner geführt haben
— Verbesserungen von IN 6, IN 13 nach ihrer Inbetriebnahme
— wesentliche Modifikationen an D 5, D 7, IN 10, IN 11.

Abgesehen von ihrer Arbeit an einzelnen Instrumenten, besonders D 19A, wurde die Datenerfassungsgruppe für die Vereinheitlichung des Formats korrigierter Daten herangezogen, um die Verwendung von standardisierten Analyseprogrammen zu ermöglichen.

Im Elektronikbereich ist eine klare Hinwendung zum Gebrauch von Mikroprozessoren zu verzeichnen ; Systeme zur Vereinfachung der Programmierung und von Tests wurden eingeführt. Die Standardisierung auf Camac-Controller der Firma DEC wurde weitergetrieben.

Abgesehen von wenigen Ausnahmen sind die Instrumentensysteme sehr zuverlässig. Angesichts der schnellen Erhöhung der Anzahl dieser System in Dauerbetrieb ist dies eine sehr gelungene Leistung.

Auf dem Gebiet der Detektoren bestand die Hauptleistung in der Fertigstellung eines 8000 Zellen-Multidetektors für D 19, nachdem viele technische Probleme gelöst werden konnten. Für die Zukunft werden die relativen Vorzüge der Gas — und Festkörpertechnologien für grossflächige ortsempflindliche Detektoren sorgfältig überprüft.

Das Management-Informationssystem MISSILL, welches ursprünglich auf die Automation des Wissenschaftlichen Sekretariats und auf damit verbundene Dienste für Gastforscher beschränkt war, wurde auch auf das Projektbüro und auf die Büros erweitert, die sich mit Dienstreisen und Strahlenschutz befassen.

Introduction

1982 a été une année de stabilisation, de perfectionnement général et de planning pour le futur.

Le nouvel ordinateur central DEC-1091 a terminé sa première année de fonctionnement normal. Après quelques problèmes pendant la première période, le système tourne maintenant de façon régulière avec très peu d'interruptions dans l'exploitation. Le long arrêt du réacteur au printemps a entraîné pendant un certain temps un ralentissement dans l'utilisation normale de la machine, mais il est clair à présent que la charge de travail est considérablement plus élevée que prévue et laisse apparaître déjà quelques signes de saturation.

Un certain nombre de projets sont en cours pour améliorer les communications avec les ordinateurs ainsi que les communications entre ordinateurs. L'installation d'un réseau d'ordinateurs est en cours, avec pour but principal de faciliter le transfert de données vers le DEC-10. Ainsi, fin 1982, environ 20 ordinateurs gérant les instruments ont été connectés. En parallèle, un dispositif aiguilleur permettra, quel que soit l'équipement qui lui est connecté, à tout terminal d'être relié à n'importe quel calculateur.

Uniquement du point de vue contrôle d'instruments (ordinateurs et électronique) on peut noter en particulier
— l'implantation et les tests de reconstruction des systèmes IN 1B, IN 8B,
— les travaux sur l'acquisition de données sur D 19A, conduisant à une spécification technique affinée sur l'ordinateur de D 19B,
— les améliorations d'IN 6, IN 13 suite à leur mise en route dans le service général,
— des modifications importantes sur D 5, D 7, IN 10 et IN 11.

En plus de son travail sur des instruments particuliers D 19A, le groupe de traitement des données s'est efforcé d'unifier les formats pour les données corrigées, de standardiser les logiciels d'analyse de données.

Du point de vue électronique, il y a précisément une nette tendance vers l'utilisation des microprocesseurs, pour lesquels on a amélioré la programmation ; des facilités de test sont en cours de développement. La mise en place du contôleur CAMAC au standard DEC suit son cours.

A part quelques exceptions, la fiabilité des systèmes d'instruments est bonne. C'est une excellente réussite étant donné l'accroissement rapide du nombre d'équipements dans le service.

Dans le domaine des détecteurs, le principal résultat a été la livraison d'un multidétecteur à 8 000 cellules pour D 19, malgré de nombreux problèmes techniques qui ont été résolus. Pour le futur, pour les détecteurs de grandes dimensions, les mérites relatifs des détecteurs à gaz et à scintillation font l'objet d'études comparatives.

Le système de gestion informatique "MISSILL", qui se limitait auparavant à l'automatisation du secrétariat scientifique et aux services ayant rapport avec les visiteurs scientifiques, a élargi son domaine pour inclure les missions, les enregistrements de radiation et le bureau des projets.

instrument control and data acquisition service (sciad)

This service is responsible for the construction, improvements and maintenance of instrument control systems, detectors and electronic equipment generally.

Summary of Instrument Control Systems at the end of 1982

In Routine Operation:

Carine 2: IN 2, IN 3
Nuclear physics mini-network: PDP 11/23 data concentrator.
PDP 11s on GAMS 1/PN 4, PN 2, GAMS 2/3.

Free Standing Systems:

PDP 11s (various): IN 4, IN 5, IN 6, IN 10, IN 11, IN 13, D 3, D 4, D 5, D 7, D 8, D 9, D 10, D 11, D 15, D 16, D 17, D 19A, PN 1.
Plessey Micro 1 or 2: D 1A, D 2, D 18, S 3A
Solar 16/40: IN 8B, IN 12, D 1B
Macamac: D 13A/B/C, S 3B.

Under development and test:

PDP 11/24: PN 8
Solar 16/40: IN 1B.

Under design:

IN 20, D 2B, D 19B, D 20.

New instruments

Of the three instruments being constructed on the new H 11 guide, D 2B, D 19B, D 20, the most straightforward is D 2B which will have a standard data acquisition chain and a PDP 11/24 computer.

D 19B has been the subject of extensive study, particularly in respect of data acquisition. The raw data will arrive at too high a rate (an 8000 word matrix every 4 seconds in the most extreme case) to follow the traditional procedure of transfer to the DEC-10 for subsequent treatment. The only realistic solution is to immediately reduce the raw data to integrated peak counts. Two alternative algorithms for doing this have been tried out on data derived from D 19A and D 17, both of which can simulate, albeit at a lower flux, the conditions expected on D 19B. The techniques are now understood, and indicate the need for an on-line computer considerably more powerful than those so far installed on instruments. Data inspection facilities on D 19B will include a VS 11 colour graphics terminal, which has been provisionally installed on D 19A. The 8000 cell multidetector was installed on D 19A in June and has since then been under evaluation.

D 20 is in a less advanced state. The choice of detector will depend on the evaluation of gas and solid state prototypes.

On PN 8, which uses commercially available 'Canberra' electronics, the principal contribution from the Department has been to provide facilities via the PDP 11/24 for live display and on-line treatment of data.

Rebuilt instruments

Within the Carine replacement project, work has continued to resolve the remaining control problems on IN 8B. For IN 1B the multiwire detector and all electronics are available, as is most of the software (being in large measure copied from IN 8B). For the associated project D 4B, the 64 × 16 cell multidetector is available with new faster logic. Control electronics is complete and the software has been improved.

On D 7B, in parallel with the new electronics, major revisions have been made in the software, which, at the request of the scientist responsible, now offers Basic as applications programming language. Support for the polarisation mode is in hand.

Other instruments

All instruments undergo continuous improvement, in the light of users reactions and changing requirements. Such changes usually necessitate modifications somewhere in the detection/control/data acquisition subsystems. It is only possible to mention here some of the more significant of these.

On two recently released instruments, IN 6 and IN 13, improvements have been made following initial operational experience. On IN 6 the control of incoming data during acquisition has been improved, and automatic data transfers to the DEC-10 is more reliable. It is hoped to make some of these features available on IN 4 and IN 5. On IN 13 the improvements relate mainly to control and read-out of temperature.

Improvements to the 4-circle diffractometer software package are especially effective, as this is available on so many instruments, including, now, D 2. Temperature control facilities on D 8 , D 9, D 10 have been redesigned.

IN 10 now has automated Doppler drive and remote temperature control. The new PDP 11/23 is running with an improved operating system and display facilities.

On D 5 a considerable amount of program development has been undertaken, some in connection with instrument modifications (cryoflipper, furnace) some improving the data handling, on which little had been done before the instrument acquired a PDP 11/34. Inelastic experiments are now fully supported.

D 11 and D 17 have a DEC CAMAC controller and largely rewritten program library and data transfer program.

Network studies

Design of the main ILL Computer Network has benefitted from two small networks already in operation. One provides the β- and γ-spectrometers (PN 2, GAMS 1/2/3, PN 4) with common data handling facilities, in particular a pen plotter to output the very complex spectra which are such a feature of these instruments. The other is an experimental prototype using DECNET and linking a number of computers within the Service. One should also note that the PDP 11/34 and PDP 11/23 which together control D 16 have been linked by DECNET. (The main Network project is described later).

Maintenance

ILL being an organisation with a service role, efficient maintenance of operational equipment is essential. This comprises scheduled preventive maintenance, prompt response to breakdowns, fault identification and repair. It is an activity to which less glamour attaches than research, design and implementation, so a special effort has to be made to assure the staff concerned that conscientiousness in this field is really appreciated by the management.

Whereas software, electronics and detector maintenance are usually the responsibility of whoever supplied it, computer hardware maintenance is handled by a Group established for that purpose. One has attempted to simplify their task by standardising equipment, but this is to some extent vitiated by rapid changes in technology which make new products financially and technically attractive, and by the Institut's purchasing rules. By way of example, there are 13 different types of memory and 6 different types of disc installed on the various PDP-11 computers. The sheer quantity of equipment is also increasing rapidly, the number of terminals having increased dramatically in recent years. The group is in addition responsible for cabling of computers and links. Apart from work for the Network, the whole Institut has been rewired for terminals.

Maintenance of detectors is also absorbing increasing amounts of time, especially with the installation of position sensitive detectors on many instruments.

Electronics development

Studies on the control of stepping motors continue, with the aim of having smoother acceleration.

Work on 'external' memories, which hold the instantaneous neutron counts for each channel, continues. Modules of 128 K 16-bit words are now in routine use, with a new microprogram-controlled display of contents.

Various projects are in hand for stabilised power supplies, frequency meters, alarms of emergency power supplies etc.

With the aim of improving efficiency of production and testing of electronic units, the Service has acquired a PDP 11/24 for development of CAMAC modules and supplier-independent microprocessor work, together with a development system specifically for Intel 16-bit microprocessor work.

Electronics loan service

A stock of portable electronic equipment is available on loan to scientists and technicians. All returned equipment is carefully tested, and if necessary repaired, before being reissued. The quantity of equipment necessary to assure a good service is always under review. In a research environment it is undesirable to have too rigid a system and the period of loans has to be flexible.

Detector development

Although the successul installation of the multidetector on D 19 has demonstrated that the traditional ILL gas detector design can be applied to large area position sensitive devices, it is clear that other technologies are being developed rapidly.

With its heavy load of maintenance work, the ILL Detector Group has no spare effort available to independently investigate alternative designs, and has opted rather to collaborate with other institutes. Facilities have been provided for the Rutherford Laboratory to test out their prototypes, including a small Anger camera which has been used on D 9. There is also collaboration with CERN and EMBL on gadolinium detectors.

Meanwhile it is believed that better resolution for He^3 detectors can be obtained by using new gas mixtures and more sophisticated electronic methods for position sensing.

central computer service

A year's experience with the system DEC-1091

After the shut-down of the DEC-1070 on 30 October 1981, all the scientific programs were transferred without any particular problems. There were simply a few difficulties in recovering some old files stored on 800 bpi magnetic tapes of the old system.

The environment

Several months passed before the environment of the Computer (air conditioning, electrical supply, arrangement of equipment in the machine room) reached a satisfactory stability. The installation of equipment continued until February: old DEC-1070 peripherals, network concentrators, final installation of the automatic fire extinguisher system. All these operations caused some disturbance to operations and affected the level of cleanliness of the rooms; at the end of February we had to arrange for a very thorough spring-cleaning of the machine room.

Operation of the DEC-1091 and its peripherals

The first eight months of operation were characterized by a system instability due to backplane problems in the CPU. These problems sometimes resulted in unexplained "crashes", sometimes identified as a CPU error.

Initial intervention work was carried out in February; some modifications to the wiring were effected after an examination of the junctions. The problems became more serious again in May and the CPU and backplane were replaced in June. Since then the system has operated satisfactorily.

Utilisation of the DEC-1091

This was greater than that anticipated for the first year. The number of terminals was increased progressively to about forty for all the scientists.

Until September there were certain variations in the load, but this was generally not critical. However, since September this load has tended to stabilize at a sufficiently high level to make response times non-negligible. The standard system parameters have so far been maintained, but it will be necessary to undertake a study of the influence of these parameters in order to give them values favouring the interactivity of the programs.

Operations

The conversion procedure for 800 bpi to 1600 bpi magnetic tapes started in 1981 was continued and completed in March 1982. This work was done with the aid of an operator provided by an external firm. A certain number of old tapes could not be completely recovered, but in general this operation was completed without the loss of any important files.

With effect from 1/1/82, following the reduction in working hours by one hour, the operator cover was reduced by half an hour per day (a quarter hour for each shift period) except for Mondays.

The employment of a half-time operator (external personnel until June and ILL employee from July) made it possible to provide supervision on Saturdays. At night and on Sundays the system operates in self-service mode.

With the aid of the SCIAD Maintenance Group the Operations Group dealt with the distribution and installation of new and old terminals.

For archiving of experimental data we reserve two 400 Megabyte disks for the storage of experimental data, to facilitate access to them; the first disk receives the data from the current reactor cycle, the second contains all the data from the preceding cycle. The Group has taken charge of the archiving of these data on tape.

System utilities

Certain problems appeared in the implementation of the monitor 701. Contacts were made with the DEC Remote Diagnosis Centre at Valbonne to resolve these problems. A certain number of corrections were made in the monitor code. In general the major work on this system concerned the integration of the network modules.

A new version of Fortran (version 6) has been installed and tested, but maintained as an experimental product because of its performance. This is an intermediate version between the existing Fortran and Fortran 77.

System or utility programs:

As every year part of the activity of the group has consisted of modifying and adapting certain utilities in accordance with the ILL's requirements.

A program for communication with other centres via magnetic tape is being rewritten. This product will make it possible to transfer experiment data in a general format accessible on all types of machine and using all types of Fortran, and to create tapes in a very conversational manner; it will therefore not require any particular knowledge of tape formats on the part of the user.

An archive file management program has been written and permits any user to interrogate a catalogue; he is thus informed quickly about all his files in the archive and where they are to be found.

A control program for the DEC-10 statistics file has been written and refined to permit us to produce more reliable statistics.

Principal purchases of equipment

Purchase of a model 1212, 79 cm BENSON plotter to replace the CALCOMP plotter.

Daisy wheel printer for very high quality typing.

8-colour TEKTRONIX flat-bed plotter.

A terminal switching concentrator for access to a number of computers.

This system will have the advantage of covering a certain number of terminals which will no longer be directly connected to a computer, but which can be connected to any of several computers by a single command to the switching device. Thus the scientists will have access to the DEC-10 from their instruments; certain DEC-10 terminals close to scientists' offices will be usable for access to instrument computers; the access to word processing systems will also be facilitated.

Computer network

(in collaboration with SCIAD)

During the first half of 1982 we connected new computers to the DEC-1091 in accordance with an ILL protocol developed in previous years and using asynchronous transmission lines. The number of computers thus connected has reached about twenty. In particular the Reactor Computer has been connected for archiving and analysis on the DEC-10 of all relevant information on the operation of the Reactor.

The decision to set up at ILL a new network of computers with a greater capacity and better communication facilities led to the choice of the DECNET standard and of the ILL protocol for systems not capable of supporting DECNET. Network concentrators installed at the beginning of the year provide communication channels with the DEC-10 by means of high speed synchronous lines; on the instrument side, each concentrator connects a certain number of computers by medium or high speed synchronous procedures.

Automatic transfer tasks for experimental data have been developed and refined both for the RSX systems operating in the DECNET environment and for the other systems operating in the ILL protocol environment. The DEC-10 developments concern the adaptation of the communication modules to the DECNET protocol of the other systems and the creation of communication tasks for dialoguing with similar tasks on other computers for the transfer of data and standard files.

Thus with the installation of this new communications standard the majority of the instrument computers have been gradually transferred to the new protocol starting in July 1982.

The instruments currently connected to the new Network are D 4, D 5, D 8, D 9, D 10, D 15, D 16, D 1B, D 19, IN 4, IN 5, D 11, D 17, D 7, IN 1B, IN 8, IN 12, PN 1. Only IN 13, IN 10, D 2, D 1A, IN 6, D 3, GAMS, and PN 6 are still connected with the old network.

Graphics

As last year an effort has been made to improve the transfer of graphical images to the DEC-10 peripherals.

A system of spoolers makes it possible to send the plot files produced from different libraries to the BENSON, VERSATEC, TEKTRONIX, the TEKTRONIX flat-bed plotter and the PRINTONIX matrix printer.

A GRASPL software has been written and tested for the control of the TEKTRONIX flat-bed plotter; this makes it possible to produce plots using standard libraries and from text available in standard files.

Improvement of the plot libraries; new subroutines available for 3-dimensional representation.

Mathematics

In 1982 new software was provided for the users in different fields:

EDA (exploratory data analysis) which implements a certain number of qualitative and quantitative statistical techniques, permitting an initial rapid analysis of results (both graphical and numerical).

ITPACK, which implements numerical resolution techniques of large sparse linear systems of equations by iterative methods.

RATFOR, which implements the preprocessor RATFOR permitting programs to be written in structured Fortran, while maintaining Fortran as input language.

MATLAB software, permitting the interactive use of the EISPAC and LINPAC libraries (calculation of eigenvalues and eigenvectors, and resolution of linear systems).

In 1982 some formal calculations connected with crystallography were finally completed. The results should appear in a monograph: linearisation table of products and powers of structure factors (of powers up to 4).

Finally, studies and experiments were carried out on the generation of random numbers on DEC-10 and PDP-11 (fundamental and effective periods, adequation test of χ^2, Knuth spectrum tests programmed with the aid of the BRENT multiple precision software, and using the preprocessor AUGMENT, portability, etc.).

Word processing

The purchase of a daisy-wheel printer has enabled certain scientists to increase their activity in the typing of scientific documents. Despite the shortage of software available on the DEC-10 for this work, this has shown the scientists' interest in this activity.

The service has also undertaken the preparation of technical documents on the computer. Thus the new DEC-10 user manual has been produced by two operators. Revisions of this manual will be easier in future.

data treatment group 'gratin'

The Data Treatment Group has a general role of surveying and advising on data treatment in general, and intervenes to resolve particular problems or to improve programs in specific areas. It suffered during the year from the departure of the engineer responsible for the nuclear physics area, a deficiency which it is hoped to remedy in the near future.

A primary strategy has been to define data formats for corrected data which permit a variety of instruments which are used in conjunction on many projects to share analysis programs even when raw data formats are necessarily incompatible. There is a general advantage which accrues, namely that of increasing the total number of paths for analysis. In addition it simplifies and increases the attraction of export of data at this stage for final analysis, or continued treatment. This year there has been considerable consolidation of this concept, especially amongst the Vercors group instruments, where the same experiment is frequently reperformed on several instruments, depending on resolution, and range requirements. An interactive program suite for powder diffraction instruments is now under preparation.

Secondly, by avoiding many attractive though system dependent extensions to the FORTRAN language, an increasing number of programs are being written to run under all the principal computer systems in use at ILL, and are hence often simple to adapt for external use. Combining both these characteristics a data fitting package has been assembled which should be of considerable general use, and already the kernel routines have been used extensively for analysis of both time-of-flight and data, and where in each case physicists have been able to build on the skeletal basis provided by the Group.

Data treatment schemes initially developed for the IN 6 spectrometer have been implemented on IN 4 and IN 5, and also on the Central Computer.

The work described earlier on D 19 A data reduction was in large part carried out by the Group. Graphics packages designed for that instrument have been generalised and made available on the DEC-10. During the studies on data reduction algorithms it became clear that a better understanding of statistical analysis techniques would be useful. A course on statistics given by an external lecturer was organised in collaboration with interested scientists. The Central Computer Service is assisting with the installation of new subroutines in this field.

management information system and office automation

An automated information service was first set up in 1980 to serve the Scientific Secretariat and the Library. Once this was in routine operation and the benefits evident, a large number of requests were received to provide facilities in other areas. During 1982, therefore, the service was extended to cover

Not only the experimental equipment and the HFR undergo a rejuvenation, also the efficiency of ILL's office work is continuously improved. The picture shows a specialist for office automation at work.

— travel costs (ILL staff and visitors)
— radiation dose records
— Project Office
— telephone directory

whilst many improvements were made to the original package.

The PDP 11/34 which runs the service is becoming heavily loaded, with 12 terminals attached and about 25 regular users. The new projects currently in hand,

— management of radioactive sources
— information relating to guest scientists
— sitewide information service

probably represent a limit to what can be handled with the present configuration.

A survey of office automation systems has been made, with particular reference to the typing of scientific papers. It is hoped to make a start with a small number of workstations in 1983.

8

ADMINISTRATION

Einleitung

Die Verwaltungsabteilung ist für die administrativen Aufgaben des Instituts zuständig. Sie unterstützt den Direktor, den wissenschaftlichen Bereich sowie alle übrigen Abteilungen und Dienste bei der Abwicklung ihrer Tätigkeiten und erbringt die dazu notwendigen verwaltungstechnischen Leistungen. Sie stellt sicher, dass die zur Verfügung stehenden Mittel richtig und wirtschaftlich genutzt und die entsprechenden Regelungen, Richtlinien und Anweisungen beachtet werden.

Die Verwaltungsabteilung ist in drei Gruppen aufgeteilt : Personalabteilung, Finanzabteilung, Sozialabteilung. Zur Verwaltungsabteilung gehören asserdem die betriebsärztliche Betreuung und das Übersetzungsbüro. Sie stellt das Sekretariat für den Lenkungsausschuss, bereitet seine Sitzungen sowie die der Unterausschüsse vor und führt seine Beschlüsse durch.

Das Jahr 1982 war für die Verwaltung insbesondere durch eine Reihe zusätzlicher Aufgaben im Personalbereich gekennzeichnet. Hierzu gehört zum einen die Übernahme von 35 bisherigen Leiharbeitnehmern auf ILL-Arbeitsverträge, die ohne Schwierigkeiten und in enger Abstimmung mit den bisherigen Arbeitgebern, den aufnehmenden Departments sowie den Sozialpartnern erfolgte. Die Eingliederung der verbleibenden 23 Leiharbeitnehmer ist für 1983 vorgesehen. Weiterhin war der umfangreichen neuen französischen Gesetzgebung auf vielen Gebieten des Personalwesens Rechnung zu tragen. Schliesslich konnten die Verhandlungen über die Änderung und Verlängerung des Betriebstarifvertrages im wesentlichen zum Abschluss gebracht werden.

Auf dem Finanzsektor wirkte sich der Reaktorstillstand vom Frühjahr 1982 durch nicht unerhebliche Mitteltransfers aus, die zwischen einzelnen Budgetkapiteln und Kostenstellen erforderlich wurden.

Die auch 1982 fortgesetzten Bemühungen um eine ausgewogene Beschaffungsaufteilung zwischen den drei Mitgliedsländern führten wiederum zu zufriedenstellenden Resultaten.

Introduction

The Administration and Finance Department deals with all administrative matters 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 provide the necessary administrative services. It ensures that the available resources are correctly and economically used and that the appropriate regulations, guidelines 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 and provides the Secretariat of the Steering Committee, prepares its meeting and those of its Subcommittees, and implements its decisions.

This year 1982 was characterized by a series of additional tasks in the personnel sector. One of these involved the transfer of 35 former contract staff to ILL contracts. This took place without difficulty and in close consultation with the previous employers, the departments receiving these employees, and the unions. The integration of the remaining 23 contract staff is scheduled for 1983. Moreover attention had to be paid to the comprehensive new legislation in France affecting many aspects of personnel administration. Finally, the negotiations on the amendment and extension of the Collective Agreement were essentially concluded.

In the finance sector the reactor shutdown in spring 1982 resulted in considerable transfers of funds becoming necessary between individual budget sections and cost-centres.

The continuing effort towards a balanced distribution of purchases between the three member countries again brought satisfactory results in 1982.

Introduction

Le Département Administratif et Financier est chargé de traiter les affaires à caractère administratif de l'ILL. Il a pour tâche d'apporter un soutien efficace au Directeur, au domaine scientifique et à tous les départements et autres unités de l'Institut afin de leur permettre d'exécuter leurs fonctions et d'accomplir les travaux concernant le domaine administratif. Il assure l'utilisation correcte et économique des moyens disponibles ainsi que l'observation des règlements, directives et instructions.

Trois groupes accomplissent les fonctions administratives : Service du Personnel, Service Financier et Achats, Service Relations Sociales. Le Département Administratif et Financier comprend également le Service Médical, le Bureau de Traduction et assure le Secrétariat du Comité de Direction, prépare ses réunions et celles de ses sous-comités, puis met en pratique ses décisions.

En ce qui concerne l'Administration, l'année 1982 a été caractérisée principalement par une série de travaux supplémentaires dans le domaine du personnel. Il s'agit entre autre de l'intégration de 35 régiels au personnel ILL, qui s'est réalisée sans difficulté et en accord étroit avec leurs employeurs respectifs, les Départements concernés de l'ILL et les partenaires sociaux. L'intégration des 23 autres régiels est prévue pour 1983. De plus il a fallu prendre en compte la nouvelle législation française, très fournie, concernant de nombreux secteurs de la gestion du personnel. Les négociations concernant la modification et la prolongation de la Convention d'Entreprise ont également pu aboutir à un accord.

Dans le domaine financier l'arrêt du réacteur au printemps 1982 s'est traduit par de nombreux transferts de crédits, qui se sont avérés nécessaires, entre chapitres et services budgétaires.

Les efforts, également poursuivis en 1982, pour parvenir à une répartition équilibrée des achats entre les trois pays membres, ont conduit à de bons résultats.

personnel

The personnel Section is responsible for recruitment, salaries, staff management, and the administrative aspects of external visits and guest scientists. It also deals with correspondence with the Social Security and the administrative work for the "Société Mutualiste" for ILL staff.

Staff

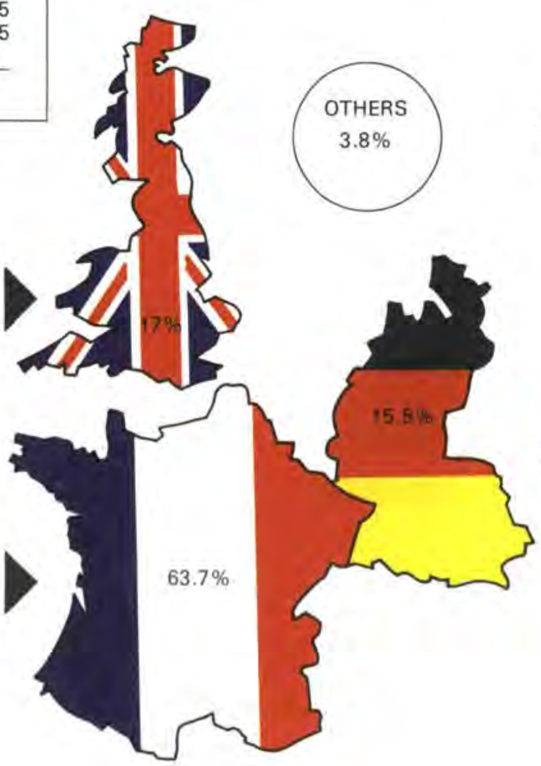
The ILL staff increased considerably in 1982, mainly because of the incorporation in the staff of 35 employees of external firms working at the Institut. This measure, indentical to that implemented at the CEA, and already envisaged in 1981 because of new French legislation, started on 01.06.82 and is expected to continue until 31.05.83 with the probable incorporation of 23 additional personnel in 1983.

Table 7: Staff changes in 1982

Categories	Position on 31.12.81	Changes in 1982 Recruitment	Departures	Difference + or −	Position on 31.12.82	Change % column 4 compared with column 2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Scientists	72	16	14	+ 2	74	19.44
2. Engineers	54	2	1	+ 1	55	1.85
3. Other "Cadres"	8.5	2	1	+ 1	9.5	11.76
4. Thesis students	27	8	5	+ 3	30	18.51
5. Technicians	162	7	3	+ 4	166	1.85
6. Others	110	32.5	2	+30.5	140.5	1.81
Total	433.5	67.5	26	+41.5	475	5.99

Table 8: Breakdown of staff by nationality and percentages by nationality within the staff categories.

STAFF AT 31.12.82	
U.K.	81
France	302.5
Germany	73.5
Others	18
	475



U.K	%
Scientists	27
Engineers	12.7
Other Cadres	31.6
Thesis Students	33.3
Non-Cadres Technicians	17.5
Non-Cadres others	8.5

FRANCE	%
Scientists	27
Engineers	71
Other Cadres	42.1
Thesis Students	33.3
Non-Cadres Technicians	72.9
Non-Cadres others	77.2

OTHERS	%
Scientists	11
Engineers	–
Other Cadres	–
Thesis Students	3.4
Non-cadres Technicians	1.2
Non-Cadres others	5

GERMANY	%
Scientists	35
Engineers	16.3
Other Cadres	26.3
Thesis Students	30
Non-Cadres Technicians	8.4
Non-Cadres others	9.3

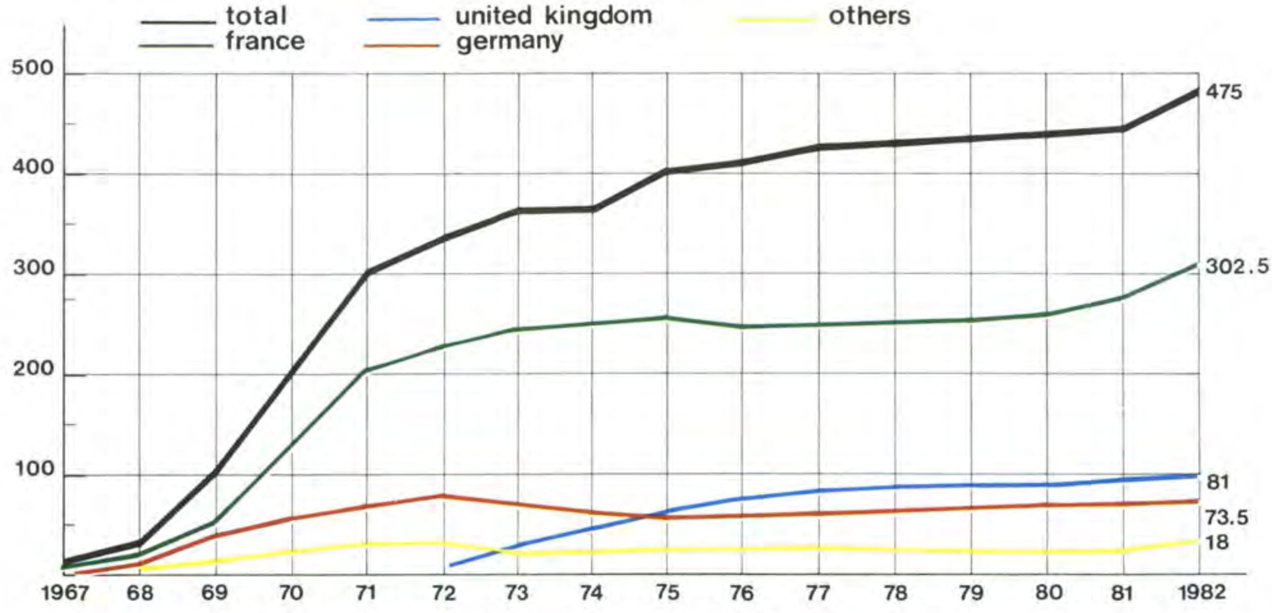


Fig. 25: The changes in staff by nationality from the foundation of the ILL until 1982.

Salaries

Individual pay increases at ILL (following the CEA) were limited to a total of 8% during 1982. These increases raised salary costs for 1982 by 5.2% in comparison with 1981. In addition, the increases already made duing 1981 raised 1982 costs by 5.9%, giving a total increase of 11.1%.

The percentage of the staff costs budget devoted to real growth (advancements, increases, social security charges, seniority) was 2.8%

The overall increase in the total payroll in 1982 was 13.9%.

Average Age

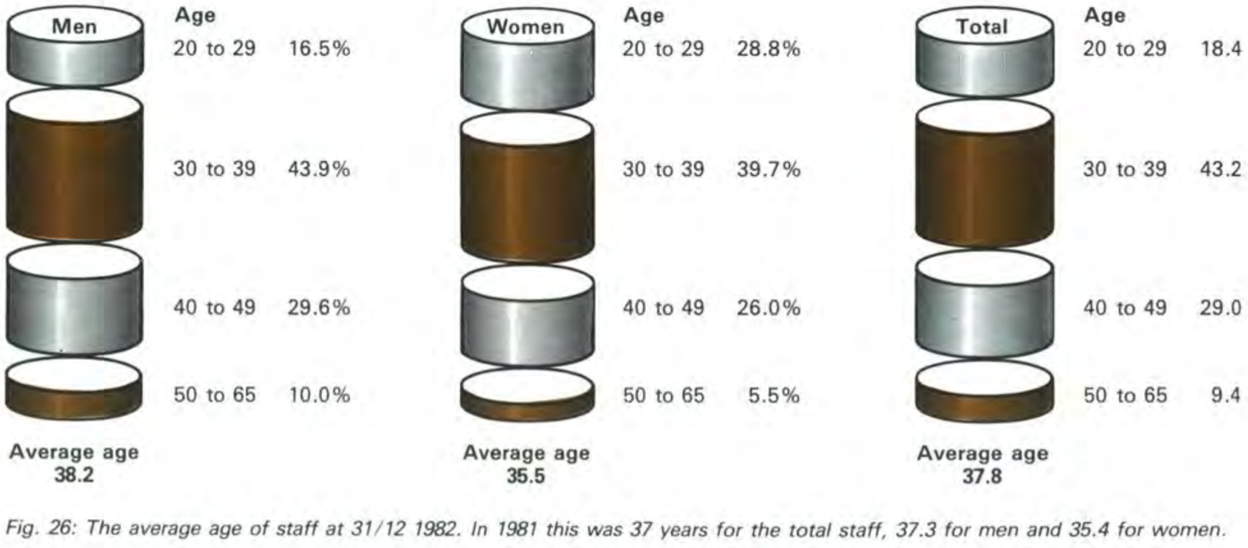


Fig. 26: The average age of staff at 31/12 1982. In 1981 this was 37 years for the total staff, 37.3 for men and 35.4 for women.

The Director presented medals for 25 years industrial service to 10 ILL staff members.

B.E.F. Fender with K. Arnal (left) and L. Bauchat (right).

Guest scientists

In 1982 the ILL received a total of 1 710 visitors. This number includes visits for:

Reactor use
Scientific Council
Workshops
Seminars
Sabbaticals

In comparison with 1981, with a total of 1 624 visitors, a slight increase of 5.3% is noted.

Fig. 27: Break-down of the number of guest scientists by nationality.

welfare

The Welfare Section ("Relations Sociales") deals with general services (reception, post, drivers, reprography, cafeteria) problems of new arrivals, settling-in of families, housing, schools, and staff training.

It also provides administrative support for the medical service and the welfare adviser.

General Services

In 1982 the receptionists welcomed nearly 1800 people to the ILL. The formalities are being computerized to make them quicker and simpler particularly for reactor users, and to ensure easier coordination of information within ILL.

The reprography workshop handled 310 different originals such as technical notes, scientific reports, theses and reactor cycle reports, and produced 4000 documents in bound format.

Reception and Settling-in of Families

Accommodation for Staff and Guest Scientists

At the end of 1982 the ILL had 14 furnished flats. During the year, flats were sublet to 52 different families or group of scientists, whose stays ranged from a few days to several months.

The quest for flats or houses to rent on the open market proved particularly difficult in 1982. The section was nevertheless able to assist 40 families.

Twenty loans (up to 30.11.82) have been provided for a total value of 751,650 francs under the "0.9%" law on aid for housing. The law has been made more flexible and now permits loans to be granted to all employees matched to their means and family responsibilities.

Schools

Numbers of children registered at the beginning of term in September 1982:

Ecole de la Houille Blanche :
(International Primary School)

— 59 children of English and German mother tongue, including 34 children of ILL staff and guest scientists

Collège d'Enseignement Secondaire et Lycée des Eaux Claires (Secondary Schools):

— 39 children of English and German mother tongue, including 18 children of ILL staff and guest scientists.

The ILL provides 9 teachers for these schools (including 6 part-time).

A financial contribution is required from non-French parents not associated with the ILL.

Staff Training

Language courses are still dominant:

approximately **75** persons attend FRENCH classes organized by the section each year. These courses are free to ILL staff and long-term guest scientists, and their spouses. They are also available, on payment, to scientists at CNRS or the Centre d'Etudes Nucléaires de Grenoble.

38 members of staff were enrolled in 1982 for various levels of advanced classes in ENGLISH.

There has been a revival of interest in GERMAN during recent months: 15 French and British staff have enrolled for beginners' or advanced courses, either daytime or evening classes.

About 80 staff participated in scientific and technical courses, mainly to improve their knowledge of their own field. The majority of these were on computing, micro-computers and programmable control devices. In addition a one-week course on vacuum techniques was organized in English for the benefit of British technicians at ILL.

There is good cooperation ont the preparation ot the Training Plan between the various ILL departments, the training sub-committee of the Works Committee and the training section.

The sum available for training amounts to approximately 1.4% of the total payroll.

Medical Service

Since the beginning of 1982 the medical service has been accommodated in larger, better designed rooms. New equipment (eye testing apparatus, oscillometer, etc) is now available to the works doctor and the nurse, which makes it possible to carry out detailed examinations at ILL, thus avoiding the need for staff to go elsewhere.

Depending on where they work, ILL staff and long-term guest scientists are required to attend one or two regular medical examinations per year, plus special examinations on the instructions of the works doctor (blood and urine tests, chest X-rays, electrocardiograms, etc.).

finance

Budget and Accounts

Introduction

The 1982 Budget was authorised with a provision for a 10% inflation rate, plus an additional reserve of 2%, and a further reserve of 1 million Francs to cover the exchange rate risk associated with the fuel element budget. Apart from staff costs, no real growth was possible for any of the headings of the operation budget. Several increases were in fact considerably higher than 10% (e.g. electricity, tax on nuclear installations). It was only possible to finance these by drawing on the 2% inflation reserve.

Since June 1982 the ILL Management, in accordance with French legislation, initiated the process of incorporating 58 contract personnel in the ILL staff. Of these 35 were incorporated in 1982 with the aid of a transfer of funds from the various user departments of the order of 1.78 MF to the staff costs heading.

The reduction in the number of reactor cycles to 5 (instead of 6) in 1982 made possible a number of savings, particularly on fuel elements and guest scientists, amounting to a total of approximately 2 MF, which was completely used to cover additional expenditure on the reactor.

In 1982 the total expenditure reached 212.5 MF excluding taxes (normal and modernisation programme budgets), 203.4 MF of which were financed by the Associates, and 9.1 MF by the ILL's own income.

Implementation of the 1982 budget

Normal Budget

For 1982 the normal budget provided for a total expenditure of 181.1 MF (excl. taxes), 175.3 MF of which was to be financed by the Associates' grants (fig. 28).

According to the provisional annual accounts to 31.12.82, expenditure in 1982 in comparison with 1981 was as shown in Table 9 below (excluding taxes).

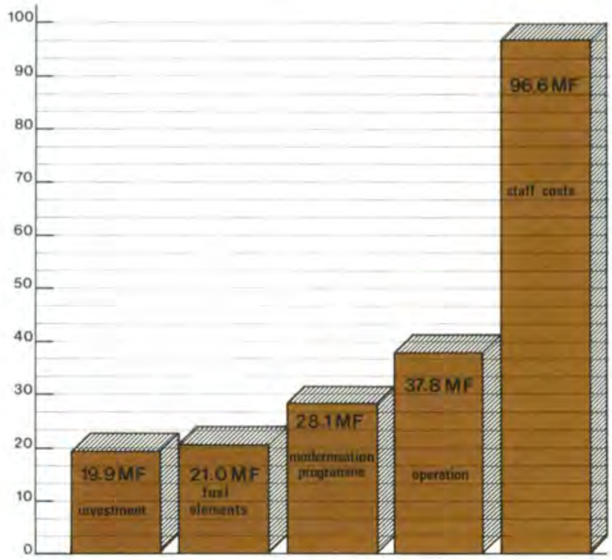


Fig. 28: Associates' contribution 1982: 203.4 Million F.

Table 9: Normal Budget. Comparison of expenditure in 1982 and 1981

	1981 MF	% of total	1982 MF	% of total
a) Operation				
Consumable materials	11.425	7.2	13.005	7.2
Fuel elements	18.841	11.9	20.879	11.5
Staff costs	82.191	51.8	96.449	53.2
Taxes	0.483	0.3	0.701	0.4
Long-term service and supply contracts	13.038	8.2	13.728	7.6
Other work, supplies and services from third parties	10.829	6.8	10.740	5.9
Transport, removal and travel expenses	1.248	0.8	1.600	0.9
Miscellaneous administrative costs	3.985	2.5	4.200	2.3
Total operation	142.040	89.5	161.302	89.0
b) Investments				
Buildings	0.429	0.3	0.485	0.3
Equipment (except experimental instruments)	3.146	2.0	4.596	2.5
Experimental instruments	9.927	6.3	11.038	6.1
Other investments	3.065	1.9	3.738	2.1
Total investments	16.567	10.5	19.857	11.0
Total expenditure	158.607	100.0	181.159	100.0
c) Income				
ILL's own income	5.452	3.4	5.827	3.2
Grants from Associates	153.155	96.6	175.332	96.8
Total income	158.607	100.0	181.159	100.0

In comparison with the preceding year, the operation expenditure increased from 142.0 MF to 161.3 MF (+13.5%). If staff costs and fuel elements are excluded from this comparison, there is a reduction in real terms of 2 MF (−5%) in operation expenditure in comparison with 1981, when the operation budget was increased by drawing on the investment budget in order to cover the expenditure due to a long reactor shutdown.

In 1982 investments have increased by 7% in real terms.

Modernisation programme budget

The complete modernisation programme planned to run from 1979 to 1985 was costed at 104.2 MF (at 1979 prices). At the end of 1982, 62% of the work had been done for 83.2 MF at actual prices (64.6 MF at 1979 prices).

The construction of a second guide hall, the replacement of a number of beam tubes, and the design and construction of the new horizontal cold source constitute the main investments initiated in 1982, which will be continued in 1983 to 1985.

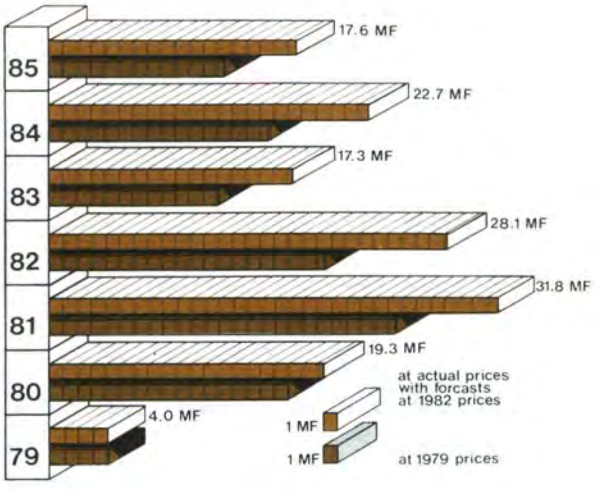


Fig. 29: The Modernization Programme.

The modernisation programme budget for 1982 was 31.4 MF, of which 3.2 MF was covered by ILL's own income and 28.1 MF by the Associates' grants.

Table 10: 1982 Budget for the Modernization Programme (excluding taxes)

	1982 MF	% of total
a) Operation		
Consumable materials and small equipment	0.370	1.3
Staff costs	3.429	12.2
Long-term service and supply contracts	0.434	1.5
Other work, supplies and services from third parties	3.539	12.6
Transport, removal and travel expenses	0.220	0.8
Miscellaneous administrative costs	0.230	0.8
Total operation expenditure	8.222	29.2
ILL's own income	−3.235	−11.5
Total operation	4.987	17.7
b) Investments		
Buildings	1.550	5.5
Experimental instruments	19.634	69.8
Other investments	1.964	7.0
Total investments	23.148	82.3
Total expenditure	28.135	100.0

ILL Budgets 1967-1982 and outlook for 1983-1987 (1982 prices)

The graphs of ILL budgets from its foundation (1967) show the various phases of the Institut's development.

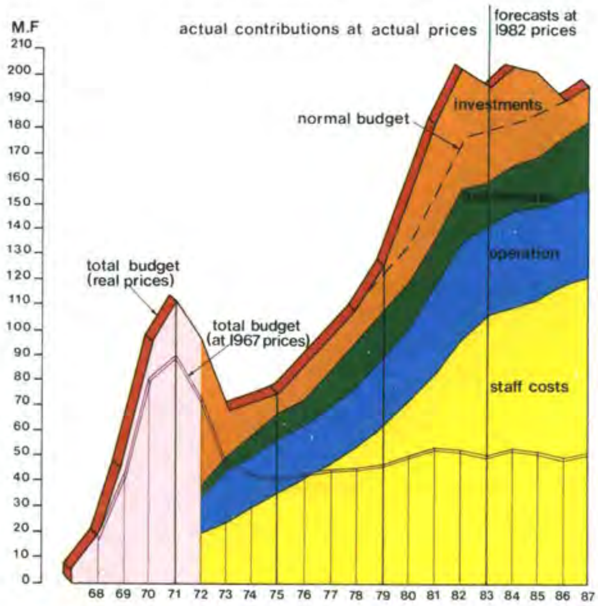


Fig. 30: ILL Budgets 1967 to 1987.

From 1967 to 1971 there was the construction phase for the buildings, the reactor and its associated installations, leading up to the reactor going critical in December 1971, which was followed by normal operation from 1972 to 1979. In 1979 the ILL's Associates decided to implement the modernisation programme.

The changes in the total budget deflated to 1967 prices show the increasing difficulties faced by the ILL in keeping the effects of inflation within the limits of its budget.

Purchasing

The peak of activity on the modernisation programme, and the preparations for the accelerated renovation of the reactor, led to a surge of major purchases in 1982. Particularly noteworthy were contracts totalling 2.4 MF for nuclear quality aluminium alloy (split between VAW Leichtmetall and the Péchiney group), 3.1 MF for replacement beam tubes (1.5 MF to Nukem, Hanau, and 1.6 MF to Neyrpic, Grenoble), 0.9 MF for an ultra-high vacuum evaporator (Electrotech, UK), and 2.4 MF for the shielding of the trio of new instruments on beam H 11 (Sigri Electrographit).

In September 1982 ILL was host to an exhibition of electronic equipment mounted by nine British firms. Mr. Alan Payne, Consul-General at Lyon, inaugurated the event.

As in previous years, the ILL made great efforts to ensure that technically competent British and German firms were invited to quote for all worthwhile orders. The European market, especially in engineering, remained fiercely competitive. From July domestic prices in France were first frozen, and subsequently rigorously controlled. Nevertheless, and despite unfavourable exchange rates for much of the year, German and British suppliers frequently quoted very keen prices. As a result, the distribution of ILL's "free" purchases in 1982 was as follows:

Table 11: Distribution of ILL's "free" purchases

"Free" means that a free choice of supplier was possible, excluding therefore the fuel cycle, electricity and small purchases of less than 30000 F.

	1982		1981 (for comparison)
	MF	%	%
France	11.0	40	49
Germany	7.9	29	15
UK	4.7	18	22
Other	3.5	13	14
Total	27.1	100	100

9

MISCELLANEOUS

experiments carried out at the i.l.l.

The following is the list of the experiments performed at the ILL in 1982 for which experimental reports were received before January 13, 1983. (It also includes some reports submitted in 1982 for experiments performed previously).

Please refer to the Annex of the Annual Report 1982 for a detailed study of the results.

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

COLLEGE 3 (Fundamental and Nuclear Physics)

03 01 100 — Study of light particles (d, t, Li, Be) emitted during neutron induced fission of ^{235}U. — PN1
Barreau G., Carjan N., Dien Q., Doan T.P., Leroux B. (Bordeaux).
Muetterer M., Theobald J.P., Sicre A. (Darmstadt).
Pannicke J. (ILL).

03 01 111 — Study of the light-charged-particles emitted in the thermal induced fission of ^{235}U. — PN1
Asghar M. (Alger).
Faust H.R., Pannicke J. (ILL).
Carjan N., Doan T.P., Leroux B., Barreau G., Sicre A. (Bordeaux).
Muetterer M., Theobald J.P. (Darmstadt).

03 02 134, 03 02 156 — Reinvestigation of low-lying states in ^{134}Cs. — PN2, PN3
Bogdanovic M., Simic J. (Beograd).
Boerner H.G., Brissot R., Barreau G., Kerr S., Schreckenbach K. (ILL).

03 02 156 — See 03 02 134

03 02 162 — See 03 02 163

03 02 163, 03 02 208 — High precision neutron capture gamma-ray and conversion electron measurement of ^{179}Hf. — PN2, PN3, PN4
Richter R., Haque A.M.I., Rascher R., Foerster I., Brentano P.V. (Koeln).
Boerner H.G., Kerr S., Brissot R., Schreckenbach K., Barreau G. (ILL).

03 02 163, 03 02 162 — High precision neutron capture gamma-ray and conversion electron measurements of ^{178}Hf. — PN2, PN3, PN4
Haque A.M.I., Richter R., Rascher R., Brentano P.V. (Koeln).
Boerner H.G., Schreckenbach K., Kerr S., Barreau G., Brissot R. (ILL).

03 02 178 — Conversion electrons in the ^{176}Lu (n, e,$^-$) ^{177}Lu reaction. — PN2
Brentano P.V., Haque A.M.I., Rascher R. (Koeln).
Boerner H.G., Schreckenbach K. (ILL).

03 02 204 — A detailed investigation of the structure of the odd mass Dy isotopes. — PN3, PN4
Egidy T.V., Hungerford P., Schmidt H., Balodis M., Prokofjev I.P. (Muenchen).
Kerr S., Boerner H.G., Schreckenbach K. (ILL).

03 02 205 — Level structure of the transitional nuclei ^{153}Gd and ^{154}Gd, studied with the (n, e$^-$) reaction. — PN2
Spits A.M.J., Van Assche P.H.M. (Mol.).
Greenwood R.C., Reich C.W. (USA).
Schreckenbach K., Colvin G. (ILL).

03 02 208 — See 03 02 163

03 02 218 — Evidence for a nonstatistical concentration of E1-strength in ^{238}U in the energy range 5.1 to 5.2 MeV. — PN3, PN4
Schumacher M., Zurmuehl U., Rullhusen P., Smend F. (Goettingen).

03 02 219, 03 13 012 — Instrumental neutron activation analysis of Galapagos Spreading Center basalts. — PN4
Oliver R.A., Kerr S. (ILL).
Vivier G. (Grenoble).

03 02 221 — Analysis of the beta$^+$ spectral shape in the ^{64}Cu decay in view of heavy neutrinos. — PN2
Schreckenbach K. (ILL).
Feilitzsch F.V. (Muenchen).

03 02 232 — Nuclear levels in ^{242}Am. — PN2
Kern J., Salicio J.L., Gasser M. (Fribourg).
Colvin G., Schreckenbach K. (ILL).
Hoff R. (Livermore).

03 02 241 — Instrumental neutron activation analysis of french alpine granites. — PN4
Oliver R.A., Kerr S. (ILL).
Vivier G. (Grenoble).

03 03 171 — Search for two octupole vibration states in ^{208}Pb. — PN2, PN4, H22F
Mariscotti M.A.J. (Buenos Aires).
Gelletly W. (Manchester).
Kane W. (Brookhaven).
Davidson W.F., Schreckenbach K., Warner D.D., Hungerford P., Kerr S.A. (ILL).

03 05 033 — Focussing of ultracold neutrons by a 2-mirror system at high magnification. — PN5
Herrmann P., Steyerl A. (Muenchen).

03 06 009 — Energy levels of ^{146}La populated in the beta-decay of ^{146}Ba. — PN6
Monnand E., Schussler F., Pinston J.A. (CEN-Grenoble).
Pfeiffer B., Jung G. (ILL).

03 06 010 — Half life measurements on gamma-lines of neutron-rich isotopes of mass A=100 and 148. — PN6
Muenzel J., Wollnik H., Jung G. (Giessen).
Pfeiffer B. (ILL).

03 06 013 03 06 026	Qß -measurements of highly unstable fission products in the mass region of M = 88 − 95 and M = 139 − 145. Bloennigen F., Jung G., Pfeiffer B. (ILL). Geisse C., Wollnik H. (Giessen).	PN6
03 06 016*	Time differential directional correlation of the 289-145 gamma-gamma cascade in Sr^{98}. Hamilton W.D., Robinson (Sussex). Snelling D. (Sussex/ILL). Pfeiffer B. (ILL).	PN6
03 06 017	Gamma ray coincidence and correlation measurements in ^{98}rubidium. Becker K. (Giessen). Wollnik H., Pfeiffer B., Jung B. (ILL).	PN6
03 06 021	See 03 06 028	
03 06 022	Energy levels of ^{99}Y populated in the beta-decay of ^{99}Sr. Monnand E., Schussler F., Pinston J.A. (CEN-Grenoble). Pfeiffer B. (ILL). Muenzel J. (Giessen). Lawin H. (Juelich).	PN6
03 06 025	Gamma-gamma coincidence measurements of neutron rich isotopes A = 148. Muenzel J., Jung G., Wollnik H. (Giessen). Pfeiffer B. (ILL).	PN6
03 06 026	See 03 06 013	
03 06 027	Qbeta-measurements of the ^{99,100}Sr isotopes using the mass separator OSTIS. Muennich F., Keyser U., Graefenstedt M., Pahlmann B. (Braunschweig). Pfeiffer B., Weikard H. (ILL).	PN6
03 06 028 03 06 021	P_n-values of short-lived Sr, Y, Ba and La precursors. Pfeiffer B. (ILL). Gabelmann H., Kratz K.L., Kronenburg M. (Mainz). Muenzel J. (Giessen). Crawford G. (Glasgow).	PN6
03 06 031	Gamma-spectroscopy on neutron-rich halogen isotopes from a negative ion source. Muenzel J., Wollnik H., Rabbel V. (Giessen). Stoehlker U., Pfeiffer B. (ILL).	PN6
03 06 032	Half-lives of extremely neutron rich strontium, barium, praseodymium and neodymium isotopes. Pfeiffer B., Stoehlker U. (ILL).	PN6
03 06 033	Half-life measurements of neutron rich isotopes in the mass region A = 147 - 152. Muenzel J., Stoehlker U. (Giessen). Pfeiffer B. (ILL).	PN6
03 06 034	Qß -measurements of ^{100}Rb and ^{100}Sr using the mass separator OSTIS. Muennich F., Keyser U., Graefenstedt M., Pahlmann B. (Braunschweig). Pfeiffer B., Weikard H. (ILL).	PN6
03 06 TES	Measurement of the absolute gamma-ray line intensities in the mass chains 144, 146, and 147 at the mass separator OSTIS. Denschlag H.O., Sohnius B. (Mainz). Pfeiffer B. (ILL).	PN6
03 13 007*	Level spins and gamma ray multipolarities in 147, 149 Nd and the decay of ^{149}Nd to ^{149}Pm. Hamilton W.D. (Sussex). More B., Snelling D.M. (Sussex & ILL).	H22F/S34
03 13 012	See 03 02 219	
03 13 016	The level structure of ^{124}Te and ^{126}Te. Hamilton W.D., Robinson S.J. (Sussex). Snelling D.M. (ILL).	H22F/S34
03 13 017*	The structure of ^{204}Tl and ^{206}Tl. Hamilton W.D. (Sussex). More B., Snelling D.M. (Sussex & ILL).	H22F/S34
03 13 018*	Magnetic moments of excited states populated in neutron capture. Snelling D.M. (ILL). Hamilton W.D. (Sussex).	H22F/S34
03 13 022	An experimental limit on production of axions in a fission reactor. Boehm F., Hahn A.A., Kwon H., Vuilleumier J.L. (Caltech). Feilitzsch F.V., Moessbauer R.L. (Muenchen).	B42
03 13 028 03 13 038	Systematic study of (n, α) and (n, f) reaction. Wagemans C., D'Hondt P., Allaert (Gent & Mol). Brissot R. (ILL). Emsallem A. (Lyon).	H22D
03 13 038	See 03 13 028	
03 13 039	Search for the two-step (n, γp) reaction in the ^{22}Na + nth system. Asghar M. (Alger). Emsallem A. (Lyon). D'Hondt P. (Gent). Wagemans C. (Mol).	S10
03 13 041	Investigation of the beta- and antineutrino spectrum of ^{239}Pu(nth, f) fission products. Keyser U., Muennich F. (Braunschweig). Weikard H., Faust H.R. (ILL).	H22

COLLEGE 4 (Inelastic Scattering in Simple Solids)

04 01 194	External and internal phonon modes in monoclinic TCNE (tetracyanoethylene). Chaplot S.L. (Edinburgh). Mierzejewski A. (Wroclaw). Lefebvre J. (ILL).	IN3
04 01 195	Phonons in the orientationaly disordered phase of C_2Cl_6. Prandl W. (Tuebingen). Gerlach P., Lefebvre J. (ILL).	IN2
04 01 201	High frequency optical phonons in K_2ZnF_4. Geick R., Strobel K., Rauh H. (Wuerzburg). Lehner N., Bouillot J. (ILL).	IN8
04 01 203	Lattice dynamics of cerium dioxide. Clausen K., Hayes W., Schnabel P. (Oxford). Bowen P., Hutchings M.T. (Harwell).	IN8
04 01 205	Optic phonons in LaS. Roedhammer P., Reichardt W. (Karlsruhe).	IN8
04 01 213	Phonon dispersion of Mo_3Si, an A15 structure. Christensen A.N., Jorgensen J.E. (Aarhus). Kress W., Weber W., Pintschovius L. (Karlsruhe).	IN8
04 01 214	Phonons in graphite intercalation compounds. Rosenman I., Simon C., Batallan F. (Paris). Lauter H.J. (ILL).	IN8
04 01 215	Molecular dynamics in imidazole. Link K.H., Grimm H., Stiller H. (Juelich). Dorner B. (ILL).	IN3

04 01 224	Measurement of the LA (001) phonon branch in KCP at 17 kbar. Renker B., Bernard L., Vettier C. (ILL). Comes R. (Orsay). Schweiss P. (Frankfurt).	IN3
04 01 226	Magneto-elastic interaction and acoustic phonon dispersion in CeF_3. Schaack G., Rauh H., Geick R., Kullmann W. (Wuerzburg).	IN2
04 01 228	Lattice dynamics of non-rigid molecules: biphenyl Cailleau H. (Rennes). Moussa F. (LLB, Saclay). Bouillot J. (ILL). Natkaniec I. (Cracow).	IN2, IN3
04 01 234	Inelastic N-scattering on N-irradiated quartz. Grasse D., Peisl J. (Muenchen).	IN2
04 01 235	Test experiment for diffuse inelastic n-scattering on resonant modes in irradiated fcc-metals. Urban R., Ehrhart P. (Juelich).	IN3
04 02 142	Study of the T-dependence of the $EG(T_{12})$ mode in $Nb_3Sn(V_3Si)$. Glaeser W., Mueller P. (Muenchen). Schweiss P. (Frankfurt). Renker B. (ILL).	IN8
04 02 146	Dynamics of the incommensurate phase of $NaNO_2$ and its precursors. Durand D., Denoyer F., Lambert M., Moudden A.H. (Orsay). Bernard L., Currat R. (ILL).	IN3
04 02 149	Structural phase transformations in Rb_2ZnCl_4. Quilichini M. (ILL). Joffrin C. (Saclay).	IN3
04 02 152 04 02 153	Phasons and amplitudons in biphenyl. Cailleau H. (Rennes). Moussa F. (LLB, Saclay). Bouillot J., Zeyen C. (ILL).	IN12, IN3
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04 02 164	Behavior of incommensurate $Ba_2NaNb_5O_{15}$ below room temperature. Schneck J., Toledano J.C., Errandonea G. (Bagneux). Currat R. (ILL).	IN2
04 02 174	Study of order parameter near the antiferroreorientational phase transition of partially deuterated p-terphenyl. Lechner R.E. (Berlin). Toudic B., Cailleau H. (Rennes).	D10
04 02 175	Temperature dependence of the phonon dispersion curves in $KTa_{(1-x)}Nb_xO_3$ near the quantum limit. Bilz H., Kress W. (Stuttgart). Rytz D. (Lausanne). Fontana M.D., Carabatos C. (Metz). Hoechli U.T. (Zuerich). Servoin J.L. (Orléans).	IN2
04 03 172	Spin-wave dispersion in partially ordered Ni_3 Mn. Blanckenhagen P.V., Lin C. (Karlsruhe). Hennion M., Hennion B. (LLB, Saclay).	IN1
04 03 174	Magnet excitations in the mixed metamagnets $Fe_pCo_{(1-p)}Cl_2$. Day P., Wood T.E. (Oxford).	IN2
04 03 185*	Low energy magnetic response of incommensurate chromium. Burke S.K., Ziebeck K.R.A., Stirling W.G. (ILL). Booth J.G. (Salford).	IN12
04 03 196	Magnetic excitations in CeB_6. Rossat-Mignod J., Effantin J.M. (CEN-Grenoble). Kunii S. (Sendai). Vettier C. (ILL).	IN8
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04 03 202*	Study of the crystal electrical field levels of the holmium ion in $HoNi_2$ and $HoCo_2$. Castets A., Gignoux D. (CNRS, Grenoble). Hennion B. (LLB, Saclay).	IN5
04 03 202*	Study of the crystal electrical field levels of the holmium ion in $HoNi_2$ and $HoCo_2$. Castets A., Gignoux D. (CNRS, Grenoble). Hennion B. (LLB, Saclay).	IN4
04 03 203	Dispersion of magnetic excitations in a Kondo lattice. Galera R.M., Pierre J. (CNRS, Grenoble).	IN2
04 03 204	Search for magnetic excitations in $USb_{0.85}Te_{0.15}$. Lander G.H. (Argonne). Rossat-Mignod J. (CEN-G). Stirling W.G. (ILL). Vogt O. (Zuerich).	IN8
04 03 208	Magnetic structure of single crystal praseodymium under uniaxial stress. McEwen K.A., Stirling W.G., Vettier C. (ILL).	IN2
04 03 209	Magnetic excitations in neodymium. McEwen K.A. (Salford ILL). Stirling W.G. (ILL).	IN3
04 03 212	Field effect on the phase transition of $NiBr_2$. Regnault L.P., Rossat-Mignod J. (CEN-Grenoble). Day P., Moore M., Wood T.E. (Oxford).	IN12
04 03 215	Magnetic excitations in $Rb_2Cr_{(1-x)}Mn_xCl_4$ mixed crystals. Kullmann W., Rauh H., Geick R. (Wuerzburg). Muenninghoff G. (Marburg). Lehner N. (ILL).	IN3
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04 03 226	Influence of vortex excitations on the renormalization of spin-wave in the 2d-XY helimagnet $BaCo_2(AsO_4)_2$. Regnault L.P., Rossat-Mignod J. (CEN-G).	IN12
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04 03 TES	Small-angle triple-axis test. Paul D.MCK. (ILL). Mitchell P.W. (Edinburgh).	IN12
04 04 082	Are scaling laws still valid in nickel near Tc? Mezei F. (ILL). Papoular R., Allain Y. (LLB, Saclay).	IN11
04 04 086	Lineshape and polarization analysis of the central peak for $CsNiF_3$ at small q_c and small energies. Steiner M. (Berlin).	IN11

04 04 088	Antiferromagnetic solitons in TMMC. Boucher J.P., Regnault L.P. (CEN-G). Mezei F., Bouillot J. (ILL).	IN11
04 04 094	Dynamical critical scattering from a two-dimensional easy-plane ferromagnet, Rb_2CrCl_4, in a magnetic field. Day P., Fyne P.J. (Oxford). Hutchings M.T. (Harwell).	IN12

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05 11 108	Precise structure determination of PdD_x at low temperatures. Ross D.K., Witchell D.G. (Birmingham). Carlile C.J. (Rutherford).	D10
05 11 110	4.2 K structure of [FeIII (bipyridyl)$_2$Cl$_2$] [FeCl$_4$]. Figgis B.N., Reynolds P.A. (Australia).	D15
05 13 102	Crystal structure of naphthazarin C at two temperatures. Herbstein F.H. (Haifa, Israël). Lehmann M.S. (ILL).	D8
05 13 109	Single crystal neutron diffraction on hydrogen uranyl phosphate hydrate (HUP). Fender B.E.F., Wright A.F., Fitch A.N. (ILL).	D8
05 13 111	Neutron diffraction study of [ReH$_7$ (PPr$^i_2$Ph)$_2$]. Howard J.A.K., Mead K. (Bristol).	D8
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05 14 134	Accurate Debye-Waller factor. Determination of Li_7H and Li_7D by neutron diffraction for electron density work. Vidal J.P., Vidal G. (Montpellier).	D9
05 14 136	Deformation density in salts of complex anions, magnesium sulfite hexahydrate, $MgSO_3.6H_2O$. Fuess H., Bats J.W., Elerman Y. (Frankfurt). Allibon J. (ILL).	D8
05 14 137	Low temperature structure of UCl_4 and $U(C_5H_5)_4$. Spirlet M.R. (Liège). Rebizant J., Kanaellakopoulos B. (Karlsruhe). Lander G.H., Stansfield R. (ILL).	D15
05 14 139	Electron deficient bond in $Na[Al_2Me_6H]$. Howard J.A.K. (Bristol).	D8
05 14 140	Charge density study of short S... O contact. Cohen-Addad C. (USM-Grenoble). Parkanyi L. (Budapest).	D8
05 14 145	Electronic deformation density in tetracyanoethane. Parfonry A., Declercq J.P., Tinant B., Legrand E., Van Meerssche M. (Mol.).	D9
05 15 181	Neutron powder diffraction study of the magnetic phase transition in $EuAs_3$. Chattopadhyay T., Schnering H.G.V. (Stuttgart).	D1A
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05 15 188	Modulated structure of quartz above the α-ß transition. Dolino G., Bachheimer J.P. (USM, Grenoble). Zeyen C. (ILL).	D10
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05 15 196	Crystallographic structure of deuterated MEM-(TCNQ)$_2$ at 5 K. Bloch D. (CNRS, Grenoble). Vettier C. (ILL). Oostra S. (Groeningen).	D10
05 15 197	Elastic properties of MEM-(TCNQ)$_2$ at high pressure. Bloch D., Voiron J. (CNRS, Grenoble).	D1A
05 15 201	Fluorine distribution in the fast ionic conductor ß – PbF_2. Schulz H., Bachmann R. (Stuttgart).	D9
05 15 203	Interlayer distances in Bi_2Te_3 as a function of uniaxial and hydrostatic pressure. Geick R., Rauh H., Kullmann W., Eichhorn G. (Wuerzburg). Steigenberger U., Lehner N. (ILL).	D15
05 15 204	Phase transition in $(CH_3NH_3)_2$ $(SnCl_6)$ (plus measurements on other compounds). Leadbetter A.J., Ward R.C., Clark J.W. (Exeter). Suga H. (Osaka).	IN5
05 15 204	Phase transition in $(CH_3NH_3)_2$ $(SnCl_6)$. Leadbetter A.J., Ward R.C. (Exeter). Richardson R.M. (Bristol). Suga H. (Osaka).	IN6
05 15 205	Phase transition in the 1D organic conductor TMA-TCNQ-I (1) Intermediate phase (2) Low temperature phase. Gallois B. (Bordeaux).	D8
05 15 206	Phase transition characterization in a new 1D-organic conductor: (I PENT DMA)-TCNQ-I. Gallois B., Gaultier J. (Bordeaux).	D8
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05 15 215	The temperature dependence of the ionic distribution in the protonic superconductor NH_4^+/H_3O^+8ß"-alumina. Thomas J.O. (Uppsala). Frase K.G. (Pennsylvania). McIntyre G.J. (ILL).	D9

05 15 219	Neutron diffraction study of the second order displacive phase transition in SnS. Chattopadhyay T., Schnering H.G.V. (Stuttgart).	D9
05 15 224*	Determination of the structure of hydrated iron fluosilicate in the incommensurate range. Pepy G., Chevrier G. (CEN-Saclay). McIntyre G.J. (ILL).	D8
05 15 225	Displacively modulated phases of PAMC. Depmeier W. (Genève). Mason S.A. (ILL).	D8
05 15 227	$(TMTSF)_2\ ClO_4$: mean structure at 7K. Comparative study with 300K and 125K structural data. Gallois B., Gaultier J. (Bordeaux).	D10
05 16 051	Photographic studies of neutron Laue diffraction related to phase transitions. Marmeggi J.C. (CNRS, Grenoble).	S42
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05 16 131	Chirality domains in single crystal Tb. Palmer S.B. (Hull). Baruchel J., Schlenker M. (CNRS, Grenoble).	S20
05 16 141	Neutron spin-echo mapping of saturation magnet. Distribution in Ga-YIG samples grown in various conditions. Baruchel J., Guigay J.P., Schlenker M. (CNRS, Grenoble). Daval J., Challeton D, (CEN-G).	IN11
05 16 143	The determination of the ground state p.d.f. of NH_4 in $(NH_4)_2SnCl_6$. Prandl W., Vogt K., Brueckel T. (Tuebingen).	D10
05 17 150	Magnetic and crystalline structures of Co-V alloys. Williams D.E.G. (Loughborough).	D15
05 17 153	Magnetic ordering in $EuAs_3$ at low temperature. Chattopadhyay T., Schnering H.G.V. (Stuttgart).	D15
05 17 156	Antiferromagnetism in cupric oxide, CuO. Forsyth J.B. (Rutherford). Brown P.J. (ILL).	D15
05 17 157	Magnetic phase transitions and multi-critical phenomena of $FeCl_2.2H_2O$. Hirte J., Weitzel H. (Darmstadt).	D10
05 17 159	Magnetic satellites in the incommensurate phase of $NiBr_2$. Day P., Moore M.W. (Oxford). Wilkinson C. (London).	D16
05 17 161	Investigation of the magnetic strucure of Gd-Y alloys. Palmer S.B., Bates S., Sousa J.B. (Hull).	D9
05 17 168	Magnetic phase transitions and multicritical phenomena of $CoCl_2.{}_2H_2O$. Hirte J., Weitzel H. (Darmstadt).	D10
05 17 173	Magnetisation and magnetic structures of the dilute metamagnets $Fe_pMg_{(1-p)}Cl_2$. Day P., Wood T.E., Moore M.W. (Oxford).	D15
05 17 174	Structural phase transitions and magnetic ordering in $K\ Mn_{(1-x)}Zn_xF_3$. Heger G., Geick R., Rauh H. (Karlsruhe). Lehner N. (ILL).	D10
05 17 175	Structure and magnetic moment arrangement of the distorted NiAs type structure $(Mn_{0.50}Fe_{0.50})_{1.20}Sb$. Reimers W. (CEN-Saclay). Treutmann W., Hellner E. (Marburg). McIntyre G.J. (ILL).	D15
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05 21 140	Metal exchanged zeolites. (Second preliminary report). Adams J.M., Haselden D.A. (Aberystwyth).	D1A
05 21 141	Profile refinement of zeolite complexes. Adams J.M., Haselden D.A. (Aberystwyth).	D1A
05 21 142	Neutron diffraction studies on synthetic and natural silicates. Cheetham A.K. (Oxford). Thomas J.M., Jefferson D.A. (Cambridge).	D1A
05 21 150	Structures of mixed valency antimony (III, V) hexahalide and related salts. Day P., Cheetham A.K., Prassides K. (Oxford).	D1A
05 21 152	Structural study of bismuth mobybdates. Goodenough J.B., Battle P.D., James D.A. (Oxford).	D1A
05 21 153	Structural determination and refinement of the molybdic acids $MoO_3.2D_2O$ and yellow $MoO_3.D_2O$. Dickens P.G., Crouch-Baker S. (Oxford).	D1A
05 21 154	Structural refinements of $Ni(OH)_2$ and gamma-NiOOH. Greaves C., Thomas M.A. (Birmingham).	D1A, D2
05 21 155	The structure of calcium amide, calcium imide, and solid solutions. Fender B.E.F., Cockcroft J.K. (ILL).	D1A
05 21 156	The structure of cation exchanged $HUO_2PO_4.4H_2O$. Fender B.E.F., Fitch A.N. (ILL).	D1A
05 21 159	Structural determination and refinement of $Li_{0.7}WO_3$ to determine lithium atom positions. Hibble S.J., Dickens P.G. (Oxford).	D1A
05 21 161	Structure determination of the ordered phases of the fast ionic conductors Cu_6PS_5Hal (Hal = Cl, Br, I). Kuhs W.F. (ILL). Konz W. (Freiburg).	D1A
05 21 164	Structure of the ordered form of hexagonal ice. Leadbetter A.J., Ward R.C., Clark J.W. (Exeter). Suga H. (Osaka).	D1A
05 21 168	Crystal structure determination of dehydraded dioptase, $CuSiO_3$. Breuer K.H., Mueller R. (Heidelberg). Eysel W., Fuess H. (Frankfurt).	D1A
05 21 173	Structure of the ordered vacancy compounds Nb_6C_5 and Ti_2N. Christensen A.C. (Aarhus). Novion C. De, Landesman J.P. (CEN-Fontenay).	D1A
05 22 117	Biphenyl-d_{10} at low temperatures. Natkaniec I. (Dubna). Pawley G.S. (Edinburgh).	D1B
05 22 138	The structures of $C_6F_6.C_6D_6$. Overell J.S.W., Pawley G.S. (Edinburgh).	D1A

05 22 183	Martensitic transformations in Cu-Nb_3Sn multifilamentary superconducting wires (prestress). Fluekiger R., Pintschovius L. (Karlsruhe). Muellner W. (Frankfurt).	D1A
05 22 189	High temperature neutron diffraction study of the order-disorder of vacancies in NbC_x. Novion C.H. de, Landesman J.P., Lorenzelli N., Alamo A. (CEN, FAR). Christensen A.N. (Aarhus).	D1B
05 22 191	Martensitic transformations in Cu-Nb_3Sn multifilamentary superconducting wires (prestress). Fluekiger R., Pintschovius L. (Karlsruhe). Muellner W. (Frankfurt).	D1A
05 22 194	A study of phase changes occurring in pure and magnesia-doped zirconia gels on heating from RT to 1100°C. Brett N.H. (Sheffield). Niepce J.C. (Dijon). Bouillot J. (ILL).	D1B
05 22 196	Phase transitions in ammonium thiosulfates $(NH_4)_2S_2O_3$. Teng S.T., Fuess H. (Frankfurt). Heathman S. (ILL).	D1A
05 22 211	Phase transitions and structures in Rb_2NaHoF_6. Ihringer J. (Tuebingen).	D1A
05 22 212	Structures of further mixed valency Sb (III, V) hexahalides. Day P., Cheetham A.K., Prassides K. (Oxford).	D1A
05 22 219	Study of the structural transformations preceding the dehydration of $Mg(OD)_2$. Niepce J.C., Ciosmak D. (Dijon). Bouillot J., Chaix-Pluchery O. (ILL). Freund F. (Koeln).	D1B
05 23 223	Magnetic and structural studies on mixed metal oxides. Cheetham A.K., Hope D.A.O. (Oxford).	D1A
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05 23 241	2D magnetic ordering of $NiCl_2$ islands intercalated into graphite. Flandrois S. (Bordeaux). Hewat A.W. (ILL).	D1B
05 23 247	Magnetic structure of $LiMnFeF_6$. Courbion G., Jacoboni C. (Le Mans).	D1A
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05 23 259	Magnetic ordering in $CeRu_2$. Fruchart D., Vaillant F., Rouault A., Flouquet J., Benoit A. (CNRS, Grenoble).	D1B
05 23 260	Magnetic structure of $CeMo_6S_8$. Chevrel R., Rossat-Mignod J., Quezel S. (CEN-Grenoble). Benoit A. (CNRS, Grenoble).	D1B
05 23 261	Magnetic structure of the reentrant superconductor $ErRh_{1.2}Sn_{3.6}$. Bertaut E.F., Hodeau J.L., Benoit A., Marezio M., Remeika J.P., Flouquet F. (CNRS, Grenoble).	D1B
05 23 264	Magnetic properties of iron surfaces. Barbaux Y. (Lille). Saubat B., Beaufils J.P., Schweizer J. (ILL).	D5
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05 23 276	Neutron diffraction reinvestigation of pyrite $MnSe_2$ magnetic structure. Plumier R., Sougi M. (CEN-Saclay).	D1A
05 23 277	Magnetic structure of $FeCl_3$ graphite intercalation compounds. Rosenman I., Batallan F., Simon C. (Paris). Vangelisti R. (Nancy).	D2
05 23 284	Neutron diffraction study of the tetragonal $NpCu_4Al_8$ and $ErFe_4Al_8$ intermetallic compounds. Kalvius G.M., Potzel W. (Muenchen). Gal J., Melamud M., Pinto M., Shaked H. (Negev). Caciuffo R. (ILL).	D1B
05 24 158*	Determination of hydration number from powder diffraction. Lehmann M.S. (ILL). Wilkins S.W. (Australia).	D1A, D2
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05 25 154	Study of the human ankle. Bacon G.E., Bacon P.J., Griffiths R.K. (Sheffield).	D1B
05 25 157	A kinetic investigation of the reaction of solids with water: $Ca_3Al_2O_6 + 6D_2O \rightarrow Ca_3Al_2O_6 6D_2O$. Christensen A.N. (Aarhus). Lehmann M.S. (ILL).	D1B
05 25 159	Thermal expansion of mixed monomer polymer crystals. Bertault M., Schott M. (Paris). Lefebvre J. (Lille). Aime J.P. (ILL).	D1B
05 31 066 05 35 060	1) Magnetic form factor of Eu^{2+} in EuS 2) Nuclear spin dependent scattering length of ^{153}Eu. Zinn W., Bohn H. (Juelich). Tasset F. (ILL).	D3, D15 D5
05 31 069	Study of the 25K NpO_2 phase transition by a neutron oscillation camera. Manes L., Rebizant J., Spirlet I. (Karlsruhe). Fournier J.M. (CEN-Grenoble). Bœuf A., Caciuffo R., Rustichelli F. (ILL & Ispra).	D12
05 31 074	Magnetic form factor of $GdAl_2$. Rainford B.D. (Southampton). Schweizer J., Osborn R. (ILL). Boucherle J.X. (CEN-G).	D5
05 32 121	Magnetisation density in vanadium metal. Brown P.J. (ILL). Forsyth J.B. (Rutherford).	D3
05 32 131	Magnetisation density in Co_2MnSi. Webster P.J., Town S.L. (Salford). Brown P.J., Ziebeck K.R.A. (ILL).	D9, D3
05 32 135	Magnetic form factor and spin distribution in UGa_2. Ballou R., Givord F., Lemaire R. (CNRS, Grenoble).	D3
05 32 137	Spin canting and magnetization density in the antiferromagnetic state of Fe_2SiO_4. Fuess H., Mueller R. (Frankfurt). Brown P.J. (ILL).	D15
05 32 141	Spin density distribution in ferromagnetic $Mn_{0.98}Fe_{0.11}Sb$. Reimers W. (LLB, Saclay). Hellner E., Treutmann W. (Marburg). Brown P.J. (ILL).	D3
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05 32 152	Spin density determination in ionic uranium systems. Spirlet M.R. (Liege). Rebizant J. (Karlsruhe). Stansfield R. (ILL). Lander G.H. (Argonne/ILL).	D3
05 32 154	Magnetization density in manganese orthosilicate Mn_2SiO_4. Fuess H., Lottermoser W. (Frankfurt). Brown P.J. (ILL).	D15
05 32 TES	Spin-flop phase transition and magnetic phase diagram of Rb_2MnCl_4. Kullmann W., Geick R. (Wuerzburg). Hirte J., Weitzel H. (Darmstadt).	D10
05 33 064	Measurement of charge distribution in europium systems via the spin-orbit (Schwinger) interaction. Forte M. (Ispra). Brown P.J. (ILL). Delapalme A. (LLB, Saclay). Lander G.H. (Argonne).	D5
05 34 065	Paramagnetic response in chromium. Booth J.G. (Salford). Brown P.J. (ILL). Capellmann H. (Aachen). Bland J.A.C. (Cambridge).	D5
05 34 080	Paramagnetic scattering from nickel. Capellmann H., Brown P.J., Ziebeck K.R.A. (ILL). Givord D., Deportes J. (CNRS, Grenoble). Cowlam N. (Sheffield).	D5
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05 TEST	Quantum effects in the structure of mixed crystals at low temperature. Naylor G., White J.W., Jackson I.P. (Oxford).	D1A

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06 01 071	Pressure dependence of the excitations in liquid ^3He. Pedersen K., Cowley R.A. (Edinburgh). Armitage J. (St. Andrews). Scherm R. (Braunschweig). Ragazzoni J.L., Stirling W.G. (ILL).	IN6
06 01 072	Systematic study of the linewidth of phonon excitations in superluid ^4He. Mezei F., Stirling W.G. (ILL).	IN12
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06 02 049	Diffusion retardation and long time behaviour in simple liquids. Glaeser W., Freudenberg U., Morkel C. (Muenchen).	IN6
06 02 053	Dynamic structure factor of liquid metals at high temperatures. Morkel C., Glaeser W., Bodensteiner T. (Muenchen).	IN4
06 02 054	Long time tail of velocity autocorrelation in simple liquids. Glaeser W., Gronemeyer C. (Muenchen).	IN5
06 02 057	Diffusion retardation in simple liquids. Glaeser W., Gaehler R. (Muenchen). Schaerpf O. (ILL).	D7
06 03 116	Self-diffusion in simple liquid binary alloys. Glaeser W., Gronemeyer C. (Muenchen).	IN6
06 04 026	Magnetic form-factor of the oxygen molecule. Dore J.C. (Kent). Schweizer J. (ILL/CENG).	D2
06 05 045	Small-angle scattering by supercooled water. Dore J.C. (Kent). Teixeira J. (ESPCI, Paris). Bosio L. (CNRS, Paris).	D17
06 05 048	Structure factor of chloroform. Bertagnolli H. (Wuerzburg).	D4
06 05 051	Diffraction studies of D_2O on spherisorb. Dore J.C., Wright C.J., Steytler D. (Kent).	D2
06 05 052	Polar group hydration using isotopic substitution. Neilson G.W. (Bristol). Finney J.L. (London). Cummings S. (ILL).	D2
06 05 053	Structural properties of carbon in liquid and amorphous systems. Neilson G.W. (Bristol). Cummings S. (ILL).	D2
06 05 061	Diffraction studies of D_2O on spherisorb. Dore J.C., Steytler D., Wright C.J. (Kent).	D2
06 06 009	Structural properties of molten salt/metal mixtures. Howe R.A., Newport R.J. (Leicester).	D4
06 06 015	The separation of collective modes in molten RbCl by isotopic substitution. McGreevy R., Mitchell E.W.J., Margaca F. (Oxford).	IN6
06 07 033	Small angle neutron scattering by electrolytic solutions in D_2O. Bellissent M.C., Wanderlingh F. (LLB, Saclay). Fontana M.P., Migliardo P. (Parma). Maisano G. (Messina).	D11
06 07 036	Diffusional dynamics and local structure in liquid electrolytes. Bellissent M.C., Kahn R., Wanderlingh F. (LLB, Saclay). Fontana M.P. (Parma). Migliardo P., Maisano G. (Messina).	IN6
06 08 053	Partial structure factors of $Ni_{64}B_{36}$ metallic glass. Cowlam N., Davies H.A., Guoan Wu. (Sheffield).	D4
06 08 073	Distribution of Dy in a sodium fluoroberyllate glass. Wright A.C., Etherington G. (Reading). Sinclair R.N. (Harwell).	D2
06 08 080	Small angle neutron scattering study of structural heterogeneities in $\alpha-Si:H$. Bellissent R. (Saclay, LLB). Chenevas-Paule A. (CEN-G, LETI).	D17
06 08 085	Neutron diffraction study of amorphous $Mg_{0.70}Zn_{0.30}$ alloy. Andonov P. (CNRS, Meudon). Chieux P. (ILL).	D2
06 13 000	Spin-lattice relaxation of ^8Li in the lithium-silicate glass $(SiO_2)_{0.67}(Li_2O)_{0.33}$. Ackermann H., Bader B., Doerr K., Freilaender P., Heitjans P., Kiese G., Stoeckmann H.J., Van der Marel C. (Marburg/ILL). Mueller-Warmuth W. (Muenster).	S6
06 13 000	^8Li spin-lattice relaxation in liquid alloys with compound-forming tendencies: Li-Bi and Li-Pb. Ackermann H., Bader B., Freilaender P., Heitjans P., Kiese G., Stoeckmann H.J., Van Der Marel C. (Marburg/ILL). Ruppersberg H. (ILL).	S6

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07 01 120*	Longitudinal spin fluctuations in Fe-Ni invar alloys. Komura S., Takeda T. (Hiroshima). Chamberod A. (CEN-G). Roth M. (ILL).	D17
07 01 205	Percolation in oxispinels. Fiorani D. (Roma). Nogues M. (Meudon). Tholence J.L. (CNRS, Grenoble). Murani A.P. (ILL).	D2
07 01 206	Spin glass phase in thiospinels. Nogues M., Gibart P. (Meudon, CNRS). Fiorani D. (Roma). Murani A.P. (ILL). Tholence J.L. (CNRS, Grenoble).	D2
07 01 216	Reentrant ferromagnetism in amorphous Fe-Ni alloys. Salamon M.B. (Urbana). Murani A.P. (ILL).	IN2
07 01 217	Small-angle scattering study of reentrant ferromagnetism in amorphous Fe-Ni alloys. Salamon M.B. (Urbana). Tholence J.L. (CNRS, Grenoble). Murani A.P. (ILL).	D11
07 01 224	Small angle scattering from the Chevrel phase superconductor $HoMo_6S_8$. Pynn R. (ILL). Lander G.H. (Argonne). Lynn J. (Maryland). Joffrin J. (Orsay).	D11
07 01 224 07 01 248	Small-angle scattering from the Chevrel phase superconductor YMo_6S_8. Lynn J. (Maryland). Pynn R., Lander G.H. (ILL).	D11
07 01 225	Magnetism and superconductivity in $Er_cLa_{(1-c)}Os_2$. Baberschke K., Luft H., Loewenhaupt M. (Juelich).	D2
07 01 227	Dynamical susceptibility of Pd 1% Ni. Burke S.K. (ILL). Rainford B.D., Lindley E.J., Moze O. (Southampton).	IN6
07 01 230	Spin wave dynamics of Au-Fe alloys close to the critical concentration. Murani A.P. (ILL).	IN5
07 01 231	Pressure dependence of spin dynamics in CeAg. Frick B., Loewenhaupt M. (Juelich). Debray D., Millet R. (CEN-Saclay).	D7
07 01 234	Onset of ferromagnetism in CuNi and AuNi alloys. Booth J.G. (Salford). Cywinski R. (Rutherford). Rainford B.D., Lindsay E. (Soton). Burke S.K. (ILL).	D11
07 01 239	Magnetic order in FeNiCr alloys. Blanckenhagen P.V., Majumdar A.K. (Karlsruhe).	D1B, D2
07 01 246	Experimental investigation of three spin correlation dynamics in Fe above T_c. Okorokov A.I., Gukasov A.G. (Leningrad). Schaerpf O., Fujara F. (ILL).	D7
07 01 248	See 07 01 224	
07 01 259	Relaxation time spectrum of the amorphous spin glass $Al_2Mn_3Si_3O_{12}$. Prandl W., Knorr K., Kabs M. (Tuebingen).	IN11
07 02 083	Spin dynamics of intermediate valence systems. Walter U. (Juelich). Holland-Moritz E. (Koeln).	IN4
07 02 090	Crystal field splitting of rare earths in amorphous Y-Cu alloys. Rainford B.D., Lee E., Begum R.J., Samadian V. (Southampton).	IN6
07 02 094	Linewidth of magnetic excitations in cerium intermetallics. Pierre J., Galera R.M. (CNRS, Grenoble).	IN4, IN5
07 02 095*	Crystal field in $CeRu_2$. Fruchart D., Wolfers P., Vaillant F. (CNRS, Grenoble). Murani A.P. (ILL).	IN4
07 02 096*	Pair interactions in intermetallic compounds. Berthier Y., Gignoux D. (CNRS, Grenoble). Devine R.A.B. (Miami).	IN4
07 02 097	Level splittings of dilute f-electron systems in the cluster regime. Furrer A., Vogt O. (Zuerich). Heer H. (Wuerenlingen). Murani A.P. (ILL).	IN4
07 02 098	Linewidth of magnetic excitations in cerium intermetallics. Galera R.M., Pierre J. (CNRS, Grenoble). Murani A.P. (ILL).	IN4
07 02 114	Crystal electric field transitions and superconductivity in La (Tm)Al_2. Frick B., Loewenhaupt M. (Juelich). Feile R. (Mainz).	IN6
07 03 209 07 03 234	Clustering in FeAl and related CoGa alloys. Booth J.G., Okpalugo D.E. (Salford). Cywinski R. (Rutherford).	D17, D11
07 03 210	Destruction of precipitates in Cu-Co single crystals during fatigue. Gerold V., Steiner D., Beddoe R.E. (Stuttgart). Kostorz G., Schmelczer R. (Zuerich).	D11
07 03 212	Anisotropic scattering associated with impurities in silicon - Separation of the elastic and inelastic scattering. Mitchell E.W.J. (Oxford). Stewart R.J., Dusic M., Messoloras S. (Reading).	D17
07 03 213	A study of precipitation in Fe-Cr-Al alloys. Stewart R.J., Dusic M., Messoloras S. (Reading).	D11
07 03 223	Photostructural changes in glasses. Rayment T., Elliott S.R. (Cambridge).	D2
07 03 224	Clustering kinetics in Al-Ag-Zn using isotopic contrast. Guyot P., Simon J.P., Livet F., Doumain B., Ghilarducci A. (INP, Grenoble).	D17
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07 03 235	The effects of irradiation on the precipitates in a nimonic PE16 alloy. Stewart R.J., Hull S., Messoloras S. (Reading).	D11
07 03 236	Radiation damage in a single crystal of Si. Mitchell E.W.J. (Oxford). Stewart R.J., Messoloras S., Pike B.C., Dusic M. (Reading).	D11
07 03 239	Comparative investigation of the local order in FeM alloys (M = Mn, Co, Al) by NMR and neutron diffuse scattering. Cadeville M.C., Pierron-Bohnes V. (Strasbourg). Mirebeau I. (CEN-Saclay).	D7
07 03 245	Temperature dependence of the defect structure of doped calcium fluoride. Catlow C.R.A. (London). Chadwick A.V. (Kent). Corish J. (Dublin).	D9

07 03 247	Low frequency fluctuations in $Ab_{(1-x)}An_x$ (anorthite). Frey F., Adlhart W. (Muenchen).	IN12
07 03 250	Small angle neutron scattering from oriented latent nuclear tracks. Albrecht D., Armbruster P., Spohr R. (Darmstadt).	D17
07 03 253	Study of the order-disorder transformations in the epsilon and teta phases and epsilon to teta in Mn-Al-C... L'Heritier P., Fruchart R. (E.N.S.I.E.-Grenoble).	D1B
07 03 264	Oxygen precipitation in dislocation free Czochralski grown silicon. Newman R.V., Stewart R.J., Messoloras S., Pike B.C. (Reading).	D11
07 03 270	Doping fluctuations at high concentration in Si. Mathiot D., Goeltz G., Pfister J.C. (CNET, Meylan).	D11
07 03 271	Study of grain boundary cavitation in copper subjected to high temperature creep. Weertman J.R., Yang M. (Evanston). Roth M. (ILL).	D11
07 03 273	A study of precipitation in Fe-Cr-Al alloys. Stewart R.J., Hull S., Messoloras S., Pike B.C. (Reading).	D17
07 03 275	Small angle neutron scattering from doped Al-Cu and NiAl-bronze. Booth J.G., Prince J.G. (Salford). Brunning C.D. (Harwell).	D17
07 03 276	Local displacements around D in Nb (from diffuse neutron scattering). Peisl J. (Muenchen). Dosch H., Dorner B. (ILL).	IN2
07 04 010	Investigation of (n, γ)-defects in cadmium by PAC. Haas H., Butt R., Menningen M. (Berlin).	H22F/S34
07 06 128	New elementary diffusion steps of hydrogen in niobium below 250K. Richter D. (Juelich). Wipf H. (Muenchen). Magerl A. (ILL).	IN13
07 06 133	Hydrogen in a metallic glass. Suck J.B., Kuenzi H.U., Rudin H., Guentherodt H.J. (Karlsruhe).	IN10
07 06 136	Optical mode in $LaNi_4Al$ and $LaNi_5$ hydrides. Achard J.C., Percheron-Guegan A. (Meudon, CNRS). Dianoux A.J., Tasset F., Lartigue C. (ILL).	IN4
07 06 140	Study of the reduction in mobility of hydrogen as a consequence of Al and Mn substitutions for Ni in $LaNi_5$ hydride. Achard J.C., Percheron-Guegan A. (Meudon, CNRS). Lartigue C., Dianoux A.J., Tasset F. (ILL).	IN10
07 06 141	H diffusion in hydrided interstitial stabilized alloys. Fruchart D., Anne M. (CNRS, Grenoble).	IN10
07 06 142	Study of residence times in Y/H. Ross D.K., Wilson S.K.P. (Birmingham). Bonnet J.E. (Orsay).	IN13
07 06 143	Q^4-broadening and one-dimensional diffusion in beta-NbH_x. Richter D., Hempelmann R., Alefeld B (Juelich).	IN10
07 06 144	Elementary jump process for fast diffusion of Co in ßZr. Vogl G. (Berlin). Heidemann A. (ILL).	IN10
07 06 145	Tunneling of hydrogen in NbO_xH_x. Wipf H. (Muenchen). Magerl A. (ILL). Richter D., Kehr K., Rush J.J., Rowe J.M. (Juelich).	IN13
07 06 146	Neutron spectroscopy on hydrogen tunnelling states in NbTi. Wipf H., Neumeier K., Richter D., Kehr K., Cannelli G., Cantelli R., Hempelmann R. (Juelich). Magerl A. (ILL).	IN10
07 06 158	Proton mobility in PbO_2 (α, ß). Boher P., Gavarri J.R. (Chatenay). Garnier P. (Paris).	IN5
07 06 161	Hydrogen back jumps in concentrated metal hydrogen systems. Richter D., Hempelmann R. (Juelich).	IN13, IN5
07 06 163	Diffusion of alkali atoms intercalated in graphite. Magerl A. (ILL). Zabel H. (Illinois).	IN6
07 07 039	Lattice dynamics of cerium dioxide. Hayes W., Clausen K., Schnabel P. (Oxford). Hutchings M.T. (Harwell).	IN3
07 07 045	Neutron scattering in Ag^+ and Na^+ ß aluminas. Gavarri J.R., Lucazeau G., Colomban P. (Paris). Dianoux A.J. (ILL).	IN5
07 07 046	Proton diffusion coefficient in ion-rich beta'' Al_2O_3, fast ionic conductor. Colomban P. (Palaisseau). Lassègues J.C. (Bordeaux). Baffier N. (Paris).	IN10
07 07 047	The structures of oxide ion conductors based on bismuth sesquioxide. Battle P.D., Talbot J.R.W. (Oxford).	D1A
07 07 048	Diffuse scattering study of pure and doped Bi_2O_3. Catlow C.R.A., Drennan J. (London).	D7
07 07 055	Structure determination of $Bi_{12}PbO_{19}$ and $Bi_{12}SnO_{19}$. Catlow C.R.A, Drennan J. (London).	D1A
07 07 059	Li-diffusion and lattice relaxation in the 1-D superionic-conductor beta-eucryptite ($LiAlSiO_4$). Renker B., Lehner N. (ILL). Bernotat H. (Muenster). Press W. (Juelich). Heger G. (Karlsruhe).	IN12

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08 01 030	Single crystal diffraction study of the nucleosome core particle. Finch J.T. (Cambridge). Lewit-Bentley A., Bentley G.A., Roth M., Timmins P. (ILL).	D17
08 01 034	Investigation of the lattice-like arrangement of neurofilaments and microtubules in intact giant axons. Eagles D., Wais-Steider C. (London). Torbet J. (MPI, Grenoble).	D17
08 01 036	Change, with age, of apatite orientation in human bones. Bacon G.E., Griffiths R.K. (Sheffield).	D1B
08 01 037	Test experiment on lysozyme (tortoise, human and hen). Blake C., Artymiuk P. (Oxford).	D8
08 01 041	Contrast variation on single crystals of satellite tobacco necrosis virus. Liljas L., Skoglund U., Unge T. (Uppsala).	D17

08 01 041 08 01 047	Contrast variation on single crystals of satellite tobacco necrosis virus. Liljas L., Skoglund U., Unge T. (Uppsala). Bentley G.A., Lewit-Bentley A. (EMBL, Grenoble).	D17
08 01 047	See 08 01 041	
08 01 048	Matrix porin: single crystal analysis of an integral membrane protein. Garavito R.M., Rosenbusch J.P., Bueldt G. (Basel). Timmins P., Zulauf M. (ILL).	D17
08 02 103	Structure and function of the 50S subunit from E. Coli ribosomes. Nierhaus K.H., Stuhrmann H.B., Lietzke R., Wurmbach P., Bartetzko A., Schulze H. (Berlin). May R. (ILL).	D11
08 02 109	Study of the molecular mechanism of translocation in protein biosynthesis. Serdyuk I.N., Spirin A.S., Baranov V.I. (USSR).	D11
08 02 110*	Solution structure and hydration of tRNA. Giege R. (Strasbourg). Oberthuer R., Zaccai G. (ILL).	D11
08 02 112	Conformational changes of RNA polymerase and DNA during transcription. Heumann H., Lederer H. (Martinsried). May R. (ILL).	D11
08 03 069 08 03 075	Neutron scattering studies of the structure of chromatin. Baldwin J.P., Carpentier B.G., Rattle H.W.E., Wyns L., Poland A. (Portsmouth).	D11, D17
08 03 075	See 08 03 069	
08 03 076*	Native structure of chromatin. Ibel K. (ILL). Bogenberger J. (Muenchen). Klingholz R. (Hamburg).	D11
08 03 076	Native structure of chromatin. Ibel K. (ILL). Bogenberger J., Fittler F. (Muenchen).	D11
08 03 076	Native structure of chromatin. Ibel K. (ILL). Klingholz R., Straetling W.H. (Hamburg).	D11
08 03 079 08 03 075	Neutron scattering studies of the structure of chromatin. Baldwin J.P., Carpentier B.G., Rattle H.W.E., Wyns L., Poland A., Staynov D., Dunn S. (Portsmouth).	D11
08 04 035	Molecular dynamics of d-proteins. Randall J. (Edinburgh). Middendorf H.D. (London).	IN5
08 04 040	Low-Q dynamics of d-proteins. Randall J. (Edinburgh). Middendorf H.D. (London).	IN11
08 04 044	High-Q dynamics of hydrated d-proteins. Randall J. (Edinburgh). Middendorf H.D. (London).	IN13
08 04 052	Molecular dynamics of enzymes. Randall J. (Edinburgh). Middendorf H.D. (London).	IN13, IN6
08 04 055	Hydrogen-bonding properties of amino acids and peptides. Randall J. (Edinburgh). Middendorf H.D. (London).	IN6
08 04 057	Dynamics of the photosynthetic membrane of rhodopseudomonas viridis. Furrer A., Haelg W., Muehlethaler K. (Wuerenlingen). Heidemann A. (ILL).	IN13
08 05 051 08 05 069	Phospholipid membranes. Bueldt G. (Basel).	D16
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08 05 084	The molecular weight and shape of mitochondrial ATP-ADP transport protein. Lauquin G., Block M., Vignais P. (CEN-G).	D11
08 05 TEST	Low resolution structural studies of cytochrome reductase by S.A.N.S. 1. The detergents and the enzyme-detergent complexes. Perkins S.J. (EMBL, Grenoble). Weiss H. (Heidelberg).	D11, D17
08 05 TEST	Low resolution structural studies of cytochrome reductase by S.A.N.S. 2. Cytochrome bc1 subunit-detergent complex & complex of subunits I and II. Perkins S.J. (EMBL, Grenoble). Weiss H. (Heidelberg).	D11, D17
08 06 014	Contrast variation studies on single crystals of tomato bushy stunt virus. Bentley G.A., Lewit-Bentley A. (EMBL, Grenoble). Timmins P. (ILL). Witz J. (Strasbourg).	D17
08 06 034	Structural studies of influenza virus. Mellema J.E., Krygsman P. (Leiden). Cusack S. (EMBL, Grenoble).	D11, D17
08 06 037	Conformation of viral RNA in solution. Jacrot B., Cusack S., Schoot B. (EMBL, Grenoble). Oostergetel G., Mellema J.E. (Leiden).	D11
08 06 045	The conformation of viral RNA in solution. Jacrot B., Cusack S., Mellema J.E., Schoot B. (EMBL, Grenoble). Oostergetel G. (Leiden).	D11
08 07 034	Domain structure of tryptophan synthase. Kirschner K., Simpson K. (EMBL, Grenoble). Ibel K., May R. (ILL).	D11
08 07 042	Study of alpha-acid glycoprotein by neutron scattering. Loucheux M.H. (Lille). Perkins S.J. (EMBL, Grenoble). Zong-Qi Li (Shanghai).	D11
08 07 049 08 07 055	Structure of the glycoproteins of component C1 of human complement by S.A.N.S. - studies on C1q, $C1r_2C1s_2$ and C1 and C1. Boyd J., Dwek R.A. (Oxford). Burton D.R. (Sheffield). Perkins S.J. (EMBL, Grenoble).	D11
08 07 054	Hydration of proteins. Lehmann M.S., Zaccai G. (ILL).	D11
08 07 055	See 08 07 049	
08 07 063	Internal organisation of the glycoproteins of component C1 of complement by small angle neutron scattering. Boyd J., Dwek R.A. (Oxford). Burton D.R. (Sheffield). Perkins S.J. (EMBL, Grenoble).	D11
08 07 066	Spatial arrangement of structural domains in tryptophan synthase. Kirschner K., Lane A. (Basel). May R. (ILL).	D11
08 07 TES	Internal organisation of the glycoproteins of component C1 of complement by small angle neutron scattering. Perkins S.J. (EMBL. Grenoble). Dwek R.A., Boyd J. (Oxford). Burton D.R. (Sheffield).	D11

08 08 009	Boron-loaded probes in physiology and oncology. Application of cold neutrons to studies of immune-body traffic and selective cell-inactivation in vivo. Larsson B., Thellier M. (Uppsala). Gabel D. (Bremen).	H17

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09 03 278	Quasielastic and inelastic scattering study of the $(CH_3NH_3)_2MnCl_4$ monoclinic phase. Couzi M., Mokhlisse R., Lassègues J.C. (Bordeaux).	IN4
09 03 282	Mechanism of hydrogen diffusion in HUP (hydrogen uranyl phosphate). Fender B.E.F., Wright A.F., Bernard L., Fitch A.N. (ILL). Howe A.T. (Leeds).	IN10
09 03 284	High resolution study of tunneling spectrum of CH_4 at very low temperature. Heidemann A. (ILL). Press W., Prager M. (Juelich). Lushington K., Morrison J. (Hamilton).	IN5
09 03 286 a	Rotational tunneling of NH_4^+ ions in $(NH_4)_{0.005}K_{0.995}$ Br. Morrison J., Lushington K. (Hamilton). Press W. (Juelich). Heidemann A. (ILL).	IN5
09 03 286 b	Rotational states of NH_4^+ in dilute solution in alkali halide lattices. Lushington K.J., Morrison J.A. (McMaster). Heidemann A. (ILL). Press W. (Juelich).	IN5
09 03 286	Energy states of CH_3D molecules in phase II of CH_4. Lushington K.J., Morrison J.A. (McMaster). Heidemann A. (ILL). Press W. (Juelich).	IN5, IN10
09 03 301	Tunnelling spectroscopy of rapidly tunnelling methyl groups. Clough S., Horsewill A.J. (Nottingham). Heidemann A. (ILL).	IN13
09 03 304	Anisotropic reorientation in substituted adamantanes and triethylenediamine. Amoureux J.P., Sauvajol J.L., Foulon M., Fontaine H., Garbi H. (Lille). Bee M. (ILL).	IN5
09 03 305	Molecular motions in incommensurate tetramethylammonium tetrachlorozincate. Amoureux J.P., Sauvajol J.L., Foulon M. (Lille). Marion G. (Pau). Lefebvre J., Bee M. (ILL).	IN5
09 03 307	Search for fine structure in the rotational tunnelling spectra of HD on $C_{24}Rb$ at low temperatures. White J.W., Gillibrand C. (Oxford).	IN13
09 03 308	Fluxionality in transition metal cluster compounds. Richardson R.M. (Bristol). Howard J. (Durham).	IN6
09 03 310	A quasielastic neutron scattering experiment on the diffusion of Li in LiAl. Heitjans P. (Marburg). Riekel C., Weppner W. (Stuttgart). Magerl A. (ILL).	IN10
09 03 312	Separation of the coherent and incoherent scattering of C_2Cl_6 by polarization analysis. Gerlach P., Prandl W. (Tuebingen). Schaerpf O. (ILL).	D7
09 03 314	Conformational dynamics of crown-ethers and cyclic alkanes. Besnard M., Fouassier, Lassègues J.C. (Bordeaux). Viovy J.L. (Paris, PCSM).	IN6
09 03 315	Reorientation in hexamethyldisilane and hexamethylethane. Fontaine H., Garbi H., Foulon M., Amoureux J.P. (Lille). Bee M. (ILL).	IN5
09 03 317	Rotational motions in trimethyloxosulfonium halides. Bee M., Jobic H. (ILL). Sourisseau C. (Thiais).	IN5, IN10
09 03 321	Rotational tunnelling in $(ND_4)_2$ $PdCl_6$ isotope effect and temperature dependence. Prager M., Press W. (Juelich). Heidemann A. (ILL).	IN10
09 03 327	Temperature dependence of methyl tunnelling in manganese acetate. Clough S., Horsewill A.J., McDonald P.J. (Nottingham).	IN10
09 03 335	Order-disorder effects in bromoform and iodoform. Leadbetter A.J., Ward R.C. (Exeter). Gunn M. (Rutherford). Matsuo T. (Osaka).	IN6
09 03 336	Excitations and relaxations in the disordered phase of tertiary butyl cyanide. Leadbetter A.J., Ward R.C. (Exeter). Richardson R.M. (Bristol). Stirling W.G. (ILL).	IN3
09 03 337	Rotational tunnelling of the ammonium ion in environments of low symmetry. Kearley G. (ILL).	IN13
09 04 279	Temperature dependence of a molecular mode expected to soften at the phase transition of N-nitrodimethylamine (DMN). Filhol A., Jobic H. (ILL). Rey-Lafon M. (Bordeaux).	IN4
09 04 280	The temperature dependence of the librational modes and of barriers to rotation. Howard J. (Durham). Tomkinson J. (Rutherford).	IN4
09 04 287	Determination of the low frequency modes in strained organic molecules. Jobic H. (ILL). Coulombeau C., Coulombeau Ch., Brunel Y. (USM-Grenoble).	IN4
09 04 289	Vibrational spectra of CH_4, CH_2D_2, CH_3D in $C_{24}Cs$. Trouw F., White J.W. (Oxford).	IN4
09 04 290	Methyl group torsion - rotation states. Clough S. (Nottingham).	IN3
09 04 296	Phonons in mixed valency antimony (III, V) hexahalide and related salts. Day P., Prassides K. (Oxford).	IN6

09 05 286	Molecular organization of two-dimensional layers of lipids and lipid mixtures. Knoll W., Schmidt G., Sackmann E. (Muenchen).	D11
09 05 299	Microemulsions. Robinson B.H., Dore J.C., Toprakcioglu C. (Kent).	D17
09 05 302	Water mobility in water containing polymers. Volino F., Pineri M. (CEN-Grenoble).	IN5
09 05 309	Microemulsions with non ionic surfactants. Ravey J.C. (Nancy). Buzier M. (Vandœuvre).	D17
09 05 310	Phase diagram of lecithin-cholesterol mixtures. Knoll W., Sackmann E., Schmidt G. (Garching).	D11
09 05 311	Critical concentration fluctuations in binary lipid alloys. Knoll W., Schmidt G., Sackmann E. (Garching).	D11
09 05 313	Magnetic colloids. Cebula D.J. (ILL). Charles S.W., Popplewell J. (Bangor).	D17
09 05 314	Dynamics of solutions of polynuclear ions. Ramsay J.D.F., Richardson R.M. (Harwell). Poinsignon C. (ILL).	IN10
09 05 316	Critical reflection to study black films and adsorption at the air-solution interface. Thomas R.K., Highfield R.R., Mingins J. (Oxford). Gregory D., Cummins P., Humes R.P. (Unilever). Hayter J.B. (ILL).	S3B
09 05 318 09 05 344	The structure of inorganic dispersions in nonaqueous media. Cebula D.J. (ILL). Markovic I., Ottewill R.H. (Bristol).	D17
09 05 325	Study of lyotropic nematic phases of amphiphilic molecules. Charvolin J., Hendrikx Y. (Orsay). Rawiso M. (ILL).	D17, D1B
09 05 326	Internal structure of micelles. Cabane B. (Orsay). Duplessix R. (Strasbourg). Zemb T. (Saclay).	D11, D17
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09 06 308	Alkyl on silica. Beaufils J.P. (ILL). Caude, Rosset R., Hennion M.C. (Paris, ESPCI).	IN5
09 06 317	Quasielastic scattering on the intercalation compound dimethylsulfoxide-kaolinite. Part 1: IN5 measurements. Weiss A., Meyer H., Becker H.O. (Muenchen). Poinsignon C. (ILL).	IN5
09 06 317	Quasielastic scattering on the intercalation compound dimethylsulfoxide-kaolinite. Part 2: IN10 measurements. Weiss A., Becker H.O., Meyer H. (Muenchen). Poinsignon C. (ILL).	IN10
09 06 368	The rotational tunnelling of CH_3D on graphite. Thomas R.K., Collinson S., Roser S.J. (Oxford).	IN13
09 06 370	The forces between clay platelets. Thomas R.K., Humes R.P. (Oxford). Cebula D.J. (ILL).	IN3
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09 06 383	H mobility in Mo and V bronzes. Estrade H., Tinet D. (Orléans).	IN10
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09 11 014	Etude de la conformation du xanthane et organisation des solutions aqueuses. Rinaudo M., Milas M. (CNRS, Grenoble). Duplessix R. (Strasbourg).	D17
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09 11 054	Cross over from Rouse relaxation to hydrodynamic interaction in concentrated polymer solutions. Richter D., Baumgaertner A. (Juelich). Ewen B., Stuehn B. (Mainz).	IN11
09 11 055 09 11 056	Segmental mobility of star shaped polymers in solution. Ewen B., Stuehn B. (Mainz). Richter D., Nerger K., Burchard W. (Juelich).	IN11, IN10
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09 12 006 A	Quasi elastic scattering by polyelectrolyte strong solutions. Matching with theory. Jannink G., Nallet F. (Saclay, LLB). Oberthuer R. (ILL).	IN10
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09 13 008	Structure of oriented crystalline polyethylene. Sadler D.M., Odell J.A., Barham P.J. (Bristol).	D17
09 13 009	Chain conformation in isotactic polystyrene crystallized near its melting point. Guenet J.M., Picot C. (Strasbourg).	D11, D17
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09 13 020	Molecular motion in uniaxially oriented PEO crystals. Fischer E.W., Rennie A., Ewen B. (Mainz).	IN10
09 13 027	Neutron powder diffraction on doped organic polymers. Haesslin H.W. (Basel). Riekel C. (Stuttgart).	D1B
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09 14 017	SANS characterization of chain deformation in plastically deformed amorphous polymers. Escaig B., Lefebvre J.M. (Lille). Picot C. (Strasbourg).	D11, D17
09 14 018 09 14 027	Polymer chain conformation in a rubbery network. Picot C., Herz J., Beltzung M. (Strasbourg).	D11, D17
09 14 020	Dimensions of a polymer chain in a crosslinked network. Richards R.W., Davidson N.S. (Glasgow). Maconnachie A. (London).	D11, D17

09 14 022	Conformation and interactions of isolated polymer coils in a shear gradient. Lindner P., Oberthuer R. (ILL). Kirste R.G. (Mainz).	D11
09 14 023	Conformation of chain molecules in oriented amorphous polymers. Higgins J.S., Maconnachie A., Muddle A.G. (London). Dettenmaier M., Kausch H.H. (Lausanne).	D11
09 14 026	Radius of gyration in anisotropically swollen gels. Geissler E., Hecht A.M. (Chambéry).	D11
09 14 026	Radius of gyration in anisotropically swollen gels. Geissler E., Hecht A.M. (Chambéry). Duplessix R. (Strasbourg).	D11
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09 14 029	Dimensions of a polymer chain in a crosslinked network. Richards R.W., Davidson N.S. (Glasgow).	D11, D17
09 14 030	Dopant distribution in polyantylene fibres of different texture. White J.W., Naylor G. (Oxford).	D2, D11
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09 15 018	Domain interface dimensions in block copolymers. Richards R.W., Thomason J.L. (Strathclyde).	D17
09 15 025	Investigation of single phase polymer mixtures. Higgins J.S., Carter A.J., Walsh D.J., Dodgson K. (London).	D11

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09 15 031	Domain morphology of styrene-isoprene block copolymers. Richards R.W., Thomason J.L., Edwards C.J.C. (Strathclyde).	D17
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09 15 060	Structure of some polymer + soap aggregates in water. Cabane B. (Orsay). Duplessix R. (Strasbourg).	D17
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and conferences

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Workshop on "Neutron Scattering and the Dynamics of Polymers" (82 OB 11 T) (organized by R.C. Oberthür)	I.L.L. March 29-30, 1982
Colloque sur les "Densités d'Electrons dans les Solides" en l'honneur de E.F. Bertaut (organisé par P. Becker)	I.L.L. 5-6 mai 1982
Workshop on "Position-Sensitive Detection of Thermal Neutrons" (organized by P. Convert and J.B. Forsyth) Proceedings to be published by Academic Press	I.L.L. October 11-12, 1982
International Conference on "The Impact of Polarised Neutrons on Solid-State Chemistry and Physics" Sponsored by the European Physical Society, la Société Française de Physique, the Institute of Physics, die Deutsche Physikalische Gesellschaft (organized by P.J. Brown, R. Lemaire, J. Schweizer) Proceeding to be published in Journal de Physique.	I.L.L. October 15-19, 1982

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Proceeding of the Fourth International Symposium on Neutron-Capture
Gamma-Ray Spectroscopy and Related Topics organised by the Institut Laue Langevin and held at the Institut des Sciences Nucléaires, Grenoble, France, 7-11 September 1981
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Rainer ANDERS	Doktorarbeit vorgelegt vor der Fakultät für Physik der Ludwig-Maximilians-Universität München, 7. Dez. 1981 Bestimmung des kritischen Exponenten η der Korrelations-funktion sowie der Exponenten ν und γ von Nickel aus einem Neutronenstreuexperiment.
Martine CUILLEL	Thèse de Doctorat d'Etat, Grenoble, 1981. Etude de la structure et de la morphogénèse du virus de la mosaique du brome.
Franz JAHNEL	Doktorarbeit vorgelegt vor der Technischen Universität München am 2. Juli 1982 und angenommen durch die Fakultät für chemie, Biologie und Geowissenschaften am 29. Juli 1982 Reichweiteverteilungen von ionenimplantiertem Bohr-10 in Metallen.

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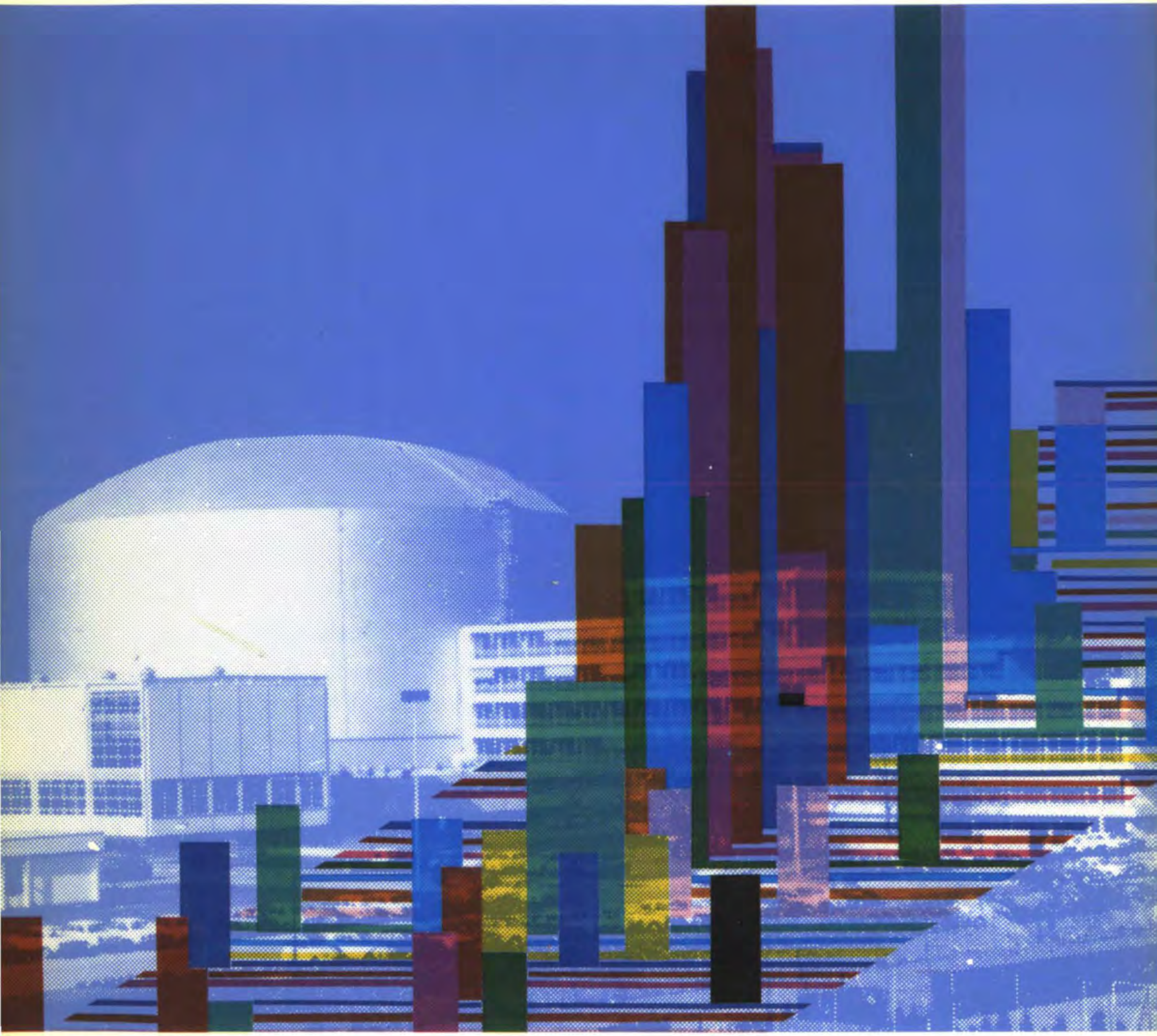

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