ILL

ANNUAL REPORT
1973

INSTITUT MAX VON LAUE - PAUL LANGEVIN

B.P. 156 Centre de tri - 38042 GRENOBLE Cedex - France - Tél. (76) 97.41.11

Application for use of I.L.L. facilities

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

B. MAIER
Institut Laue-Langevin
B.P. 156 Centre de Tri
38042 Grenoble Cedex
France

Tél. (76) 97-41-11 poste 82-44.

Appropriate forms are obtainable on request from this office.

The closing dates for acceptance of applications are as follows:

August 31
and February 15

All proposals are submitted to the Scientific Council for approval.

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

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

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GENERAL SURVEY

GENERAL SURVEY

1973 was the first full year of largely routine operation of the Reactor and its associated hot and cold sources. The Reactor was available as a neutron source for measurements 67% of the time, was shut down according to plan for 29.5% of the time for maintenance and technical modifications; for 3.5% of the time there were unscheduled shut-downs due to external circumstances.

In the work of the Institut there was further progress in the transition from the design and construction phase of the instruments to the operational phase, and a considerable number of spectrometers have come into routine scientific use. Modifications and extensions have been made to several of the instruments already in operation ; some of the changes permit new applications and others allow measurements to be carried out more quickly. Further work was done on instruments still in the construction phase and on planning for new equipment. In general satisfactory progress has been made on this design and construction programme, but there have been considerable delays in the completion of two instruments : the multichopper system IN5, which can only be operated for the present at reduced resolution, and the "LOHENGRIN", fission product spectrometer, where the high temperatures occurring at the source-holder made it necessary to redesign the holder for safety reasons.

A special study group has been formed to prepare a design study for a source of ultra-cold neutrons. Further project groups are preparing plans for new instruments proposed by users of our reactor and in some cases pressed for very vigorously. The most urgent problem in this group is an additional powder diffractometer. The use of the few

beams still free for further experimental facilities is being increasingly restricted by considerations of staff capacities and budget limitations. In this connection it is important to mention the need for continued capital investment for the occasional modification of the many existing instruments and the construction of some new ones even after all the present instruments are in full operation.

The continual commissioning of further instruments has led to a sharp increase in the number of experiments carried out.

In addition to research institutes quite a number of university departments in the three member countries have done experiments. 142 experiments completed in 1973 were divided among the following fields:

Solid State Physics	:	1396 instrument days (100 experiments on 13 instruments)
Chemistry	:	91 instrument days (7 experiments on 2 instruments)
Biology	:	229 instrument days (17 experiments on 4 instruments)
Metallurgy and Mineralogy	:	99 instrument days (12 experiments on 4 instruments)
Nuclear Physics	:	338 instrument days (6 experiments on 6 instruments)

The number of experiments accepted by the Scientific Council and still to be carried out is approximately 250 at present.

There are still great difficulties in obtaining or producing suitable monochromator crystals. A special monochromator group has been formed, which is to study monochromator crystals and which is intended to develop methods permitting the production of monochromator crystals with a suitable mosaic structure and monochromator crystals with focussing properties.

The internal organisation of ILL has been further adapted to the increasing experimental operation, particularly by the creation of Instrument Groups with Group Coordinators, by the establishment of a pool of engineers and technicians to help with the operation of the instruments, and by the creation of further service facilities for the rapidly increasing flow of external reactor users.

The new ILL Computer Centre (DEC 1070 and PDP 10 systems) has started operation. The transition from the IBM machine previously used to the new machine took place very smoothly, and the new machine does all it is required to do. Its use is continually increasing, and special attention is being paid to the improvement of existing programmes, particularly in connection with data processing and evaluation.

On 1st January 1973 the United Kingdom became the third full partner in ILL. The additional experimental programme was incorporated in the existing programme without any great difficulty. There were however some bottle-necks on instruments as regards the chemical neutron research programme. Particular efforts have been made to recruit qualified British staff.

The results of inflation are leading to a growth in staff costs which is particularly worrying, as in the long term this could lead to a limitation of capital investment.

The system of limited duration contracts, to which the entire scientific staff of ILL is subject, is giving rise to some serious problems and must be modified to some extent in the near future to ensure the continuous smooth operation of the costly instrumentation. In addition to the recruitment of a small number of Senior Scientists,

three of whom have already started work at the Institut, a limited number of "Staff Scientists" in posts without a time limit are to be employed in the future to ensure rational utilization of the available instruments, intensive cooperation with external users of the Reactor and continuous development of the expensive equipment.

The ILL's international links have been further extended. It has been necessary to apply very strict criteria in considering applications for research from laboratories outside the three member states, in view of the large number of applications from laboratories within the member states. The flow of long and short-term external visitors has nevertheless increased considerably.

In 1973 the ILL organised a number of scientific meetings. (see paragraph on publications, theses, experiments performed, conferences.)

The negotiations with the French education authorities were successfully concluded ; with the setting up of an experimental school with a largely international character, the school problem may be considered solved as regards elementary education, although experience must still be acquired with this school. It must however be pointed out that at present the salaries of the German and English teachers and for the intensive French lessons are being paid from ILL funds.

The total budget of the ILL in 1973 amounted to 59,400,000 FF. The number of staff completely paid from ILL funds was 371 on 31.12.73.

The following report gives a survey of the state of the ILL's experimental facilities and of the scientific work carried out in 1973, and of the main administrative features of the operation of the Institut. A second volume of this report gives more detailed descriptions prepared by the experimental staff of the individual scientific projects.

Grenoble, 3. 1. 1974

R.L. MÖSSBAUER

ORGANISATION OF THE ILL

STEERING COMMITTEE

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COLLEGE SECRETARIES

2 Theoretical physics
3 Nuclear physics
4 Pure crystals
5 Crystal and magnetic structures
6 Liquids, gases and amorphous materials
7 Imperfections
8 Biology
9 Chemistry

INSTRUMENTS

INSTRUMENT GROUP COORDINATORS

Three axis spectrometers
Special 3 axis spectrometers
Time of flight instruments
Crystallographic diffractometers
Diffuse scattering instruments
Powder instruments
Polarised neutron instruments
Monochromators
Nuclear physics instruments
Ungrouped instruments
Development of new techniques

REACTOR

TECHNICAL SERVICES

Construction
Electronics
Cryogenics
Radioprotection
Workshops

COMPUTING SERVICES

ADMINISTRATION

INSTRUMENTATION

INTRODUCTION

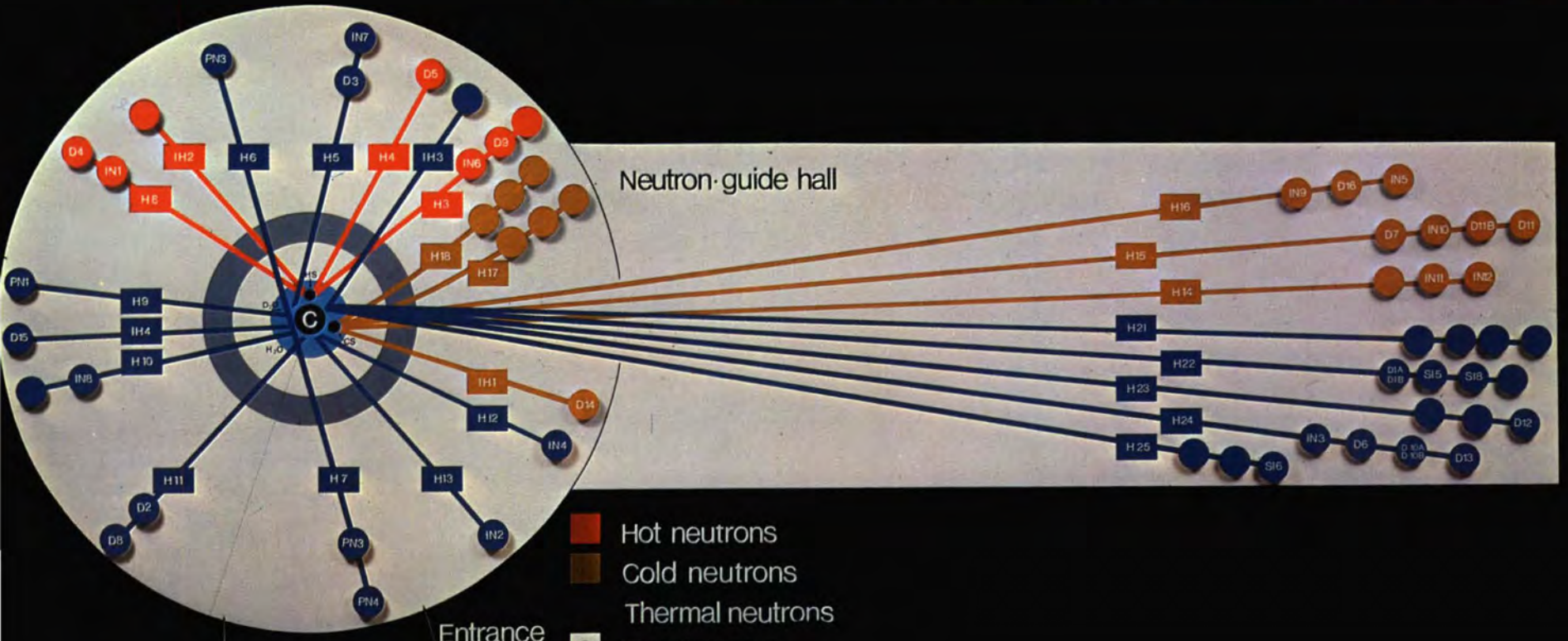
The long term planning of instrumentation at ILL must consider three or four types of experimental need ; the manufacture and installation of major multi-user instruments ; the continued improvement of such major instruments ; the provision of technical facilities to explore new techniques and the installation of special instruments for single experiments.

In this chapter we describe the progress on major instrument installation and amelioration, and the new technique development. The special experiments are reported in the Chapter of College Activities. The continued development of the instruments at ILL has demanded a new level of organisation for their planned improvement and for optimum utilisation. Each set of closely related instruments is treated as a coordinated group for matters of operation, close technical support and budget planning. The performance of existing instruments and progress in manufacture and installation of new instruments is therefore presented here in terms of these coordination groups. It is gratifying to note that major instruments of every planned type are now operating, and that experience is beginning to accumulate which permits critical comparison of our instruments with those in use at other centres. In almost every instrument which is operating routinely some points of dissatisfaction have been identified, and a steady programme of amelioration is being pursued. The most notable series of changes planned concern the improvement of crystal monochromators, for which a special development group has been set up, and a short initial statement of their programme is given in section 8 of this chapter.

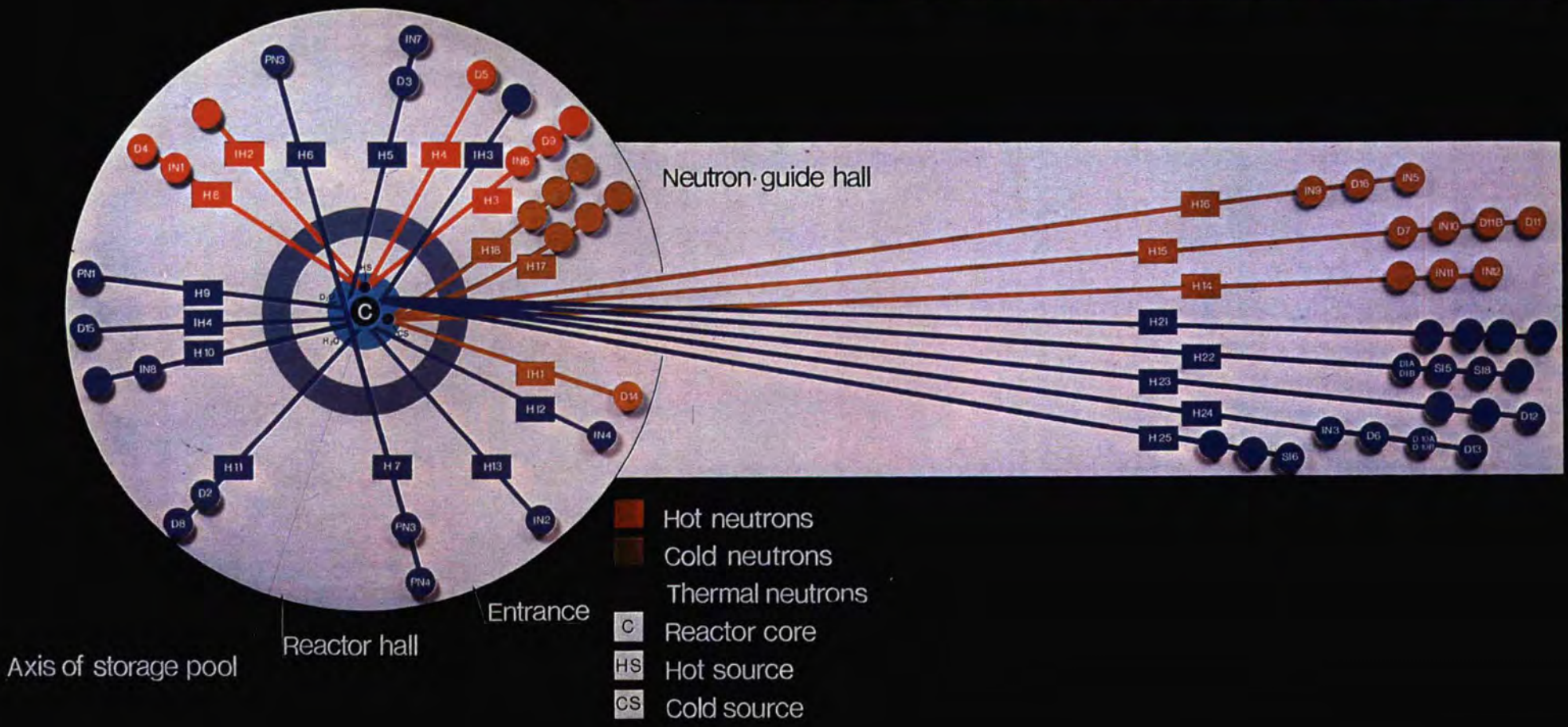
The use of γ-ray and neutron diffractometers to test and classify our monochromators, and to assist in the search for new suppliers of satisfactory crystals is important. In addition the decision to attempt construction of composite monochromators has been taken. The performance of large perfect crystals curved mechanically or thermally, and of crystals with a lattice constant gradient gives hope for the development of some specialised neutron focussing techniques.

The new technique development work reported in the last section refers to new types of polarising device and to the problem of production of "Ultra Cold Neutrons" with kinetic energies so low that they correspond only to the gravitational energy of a neutron at a height of a few tens of metres. It is becoming clear that the HFR is in many ways an ideal source for these technical developments, and that the space available in the neutron guide hall will permit very good experimental conditions for much of the work.

Beam tube arrangement and instruments at the HFR



Beam tube arrangement and instruments at the HFR



OPERATION STATISTICS FOR THE INSTRUMENTS (days used in 1973)

Instrument group		College 4	College 5	College 6	College 7	College 8/9	Comments
3 axis	IN1	66		6	32		-Operating: waiting time until August 1974.
	IN2	192		3		14	-Operating: waiting time until January 1975.
Time of flight	IN4	105		54	35		-Calibration tests completed. Low intensity (paired monochromators)
	IN5			(7)			-Operating at low speeds (rotors). Scheduled for experiments but with low resolution. Waiting time until January 1975. () = most experiments unsuitable for low resolution work.
	IN7	47			111		-Statistical chopper. Suitability of experiments to new techniques being studied.
Crystallography	D6					160	-Preliminary structure experiments. Programme ready for expansion.
	D8		74			69	-Routine operation and being scheduled fully.
Powder	D1A						-Instrument modification.
	D1B						-Modification in progress.
	D2	6	183	14	8		-Routine operation and being scheduled fully.
Polarized	D5		108	8	16		-Routine operation
Diffuse	D7				102		-Being scheduled for use with unpolarized neutrons.
	D11			2	108	77	-Fully operational.
Special 3 axis	IN3						-Selected experiments at completion of modifications.
	D10		136				-Routine operation.
Ungrouped	D4				129		-Routine operation

PROJECTS IN HAND

Instrument		Comments
3 axis	IN8	Constructed by ILL. Assembly continuing.
	IN12	Installation scheduled for end of 1974 but dependent on the progress of guide tube.
Time of flight		No new proposals have been approved.
Crystallography	D9	Constructed by ILL. Final modifications by early 1974.
	D15	Harwell MK VI- on inclined hole by March 1974.
	D16	Harwell MK VI- Installed on cold guide Nov. 1973. Final alignment now taking place (Dec. 1973).
High Resolution Powder Instrument		This instrument has still to be defined. Also some positional difficulties have to be resolved.
Polarized	D3	Being designed and manufactured by R.H.E.L. Installation scheduled by March 1974.
Diffuse	D11B	Manufacture by R.H.E.L.
	IN10	Installation in an advanced stage. Final modifications and tests March 1974.
Special 3 axis	IN6	Project frozen - awaiting outcome of final tests of IN3 and availability of technical effort.
Ungrouped	D12	Modified Laue technique. Photographic. Entering test period by December 1973.
	D14	Modified Laue technique. Television camera.
	IN9	Polarized beam. Polarized proton target
	IN11	Spin-echo spectrometer - under manufacture

INSTRUMENT GROUP 1

"CONVENTIONAL THREE-AXIS SPECTROMETERS"

This group includes the following instruments:

IN1 single monochromator instrument on the hot source (beam-tube H8)

IN2 double monochromator instrument on a thermal beam tube (canal H13)

IN8 single monochromator instrument on a thermal beam tube (under construction; to be installed on beam-port H10)

IN12 single monochromator instrument on a cold guide (under study; to be installed on guide H14)

All 4 instruments are (or will be) controlled by the CARINE system. Except for IN1, they make use of the tanzboden and air-pad technique.

IN1 - Single monochromator instrument on the hot source (D. Tocchetti)

This instrument was equipped (July 1973) with a new analyser-detector system. This, together with the addition of new shielding elements, resulted in a very significant improvement in the instrument performance (resolution and background). Thanks to the careful planning by the ILL Technical Services, these major modifications were carried out with minimal disruption to the instrument programme.

Since then, the instrument has been in continuous operation. Presently, the background - without sample - is about 1.8 counts/min.,

The monochromator used so far is a Cu crystal with a $[1\bar{1}0]$ vertical axis. Using the (111), (220) and (331) reflections, the energy range from 30 to 600 meV is covered, with some loss in intensity at the high and

low energy ends due to the asymmetrical transmission geometry. A new Cu crystal with a horizontal $[1\bar{1}0]$ axis, is currently being installed, where all 3 reflections will be available in symmetrical transmission geometry.

Pyrolytic graphite (002), Cu (220) and Be (11.0) have been used so far as analyser crystals. A composite PG (002) transmission crystal, on loan from Union Carbide, is currently being tested with promising results.

Minor improvements are planned in the near future (new detector, modification in the detector shielding, improved instrument control program, computer monitoring of sample temperature, Be monochromator).

Also, the installation of a cooled Be filter analyser on the instrument's second arm is scheduled for early 1974.

Recently a series of magnetic studies (γ-Mn, NiO, NiS) have been successfully completed. In γ-Mn, magnons have been measured with frequencies as high as 35 THz, thereby demonstrating the unique value of this instrument as a tool for studying high energy excitations.

IN2 - Double monochromator instrument on a thermal beam tube (E. Dorner)

This instrument has been in continuous operation since October 1972. The signal to background ratio is excellent due to the double monochromator unit. The background under measuring conditions is generally below 1 count/min. The lowest background recorded aside a phonon has been 0.3 count/min.

Some 12 experiments have been completed already. The first neutron scattering experiment performed at ILL was carried out on this instrument and results were accepted for publication in December 1972 ($CsNiF_3$).

Due to the excellent cooperation with the ILL Technical Services, there has been no major breakdown or interruption. Several minor improvements and modifications have been implemented during the course of 1973, among which:

- A heavy duty sample goniometer, with a free height of 60 cm between goniometer top and neutron beam level.
- Stronger motors and gears to move the tanzboden units.
- A digital millivoltmeter (for sample temperature monitoring), the output of which can be read and printed out by the computer.
- Improvements in the instrument control program and in the input routine. Data collected during experiments are now stored on a disc from which punched cards may be obtained by external users for processing at home.

Further improvements are in progress: new collimators and collimator mounts; a bench under the monochromatic beam to support monitor, filter and diaphragms; a cooled Be-filter; precise positioning of the shielding drum between the two monochromating crystals with a view to installing a collimator in the drum. Also, through collaboration with the Monochromator Group, some improvement in monochromator crystal quality will hopefully be achieved.

Finally, a second analysing system will be connected to the instrument during the spring of 1974.

IN8 - Single monochromator instrument on a thermal beam tube (R. Currat)

This instrument is presently under construction. Its installation on beam-port H10 will take place from January to April 1974. Tests will probably run through May and June. Because of its single monochromator design, the IN8 spectrometer is expected to have a higher flux than IN2, particularly at moderately high neutron energies (above 40 meV), thereby bridging the existing gap between useful energy ranges on IN1 and IN2.

During the design stage effort was directed at achieving:

- Proper shielding of the casemate in order to minimize the background level (which nevertheless is expected to be higher than on IN2)
- Fully automated monochromator exchange (without entering casemate), in order to insure continuous operation of the instrument.

IN12 - Single monochromator instrument on a cold guide (W. Stirling)

This instrument will be installed on a cold guide (H14) and is designed to operate at neutron energies lower than 15 meV. Below 8 meV it is expected to be more efficient than IN2. Also, because of the selective transmission of the guide, the problem of higher order contamination will be greatly reduced.

The instrument is still in the design stage. Installation is scheduled for the end of 1974.

Coordinator : R. Currat

INSTRUMENT GROUP 2

"SPECIAL THREE AXIS SPECTROMETERS"

This group includes the following instruments :

D10B 4 circle diffractometer at thermal guide H24

IN3 triple axis instrument at H24

D10B - 4 circle diffractometer at thermal guide H24 (W. Yelon)

D10B has been in routine operation since May 1973. With a Cu 111 monochromator the flux at the sample is 6.10^5 n/cm^2 sec. at 1.44 Å. 200 reflections can be measured per day with samples as small as 2 mm^2. Since September beamtime has been used to more than 90 %. Ten experiments have been completed including two at low temperature with the four circle cryostat, two diffuse scattering problems and one experiment at high pressure.

The completion of the third axis is foreseen for 1974. This will allow for the separation of the elastic component of the diffuse scattering or to use D10 as a triple axis instrument.

IN3 - Triple axis instrument at H24 (R. Scherm)

The installation of IN3 was essentially finished in the beginning of 1973, which allowed to do first test measurements to be carried out. Later on, however, many modifications and improvements had to be carried out as:

- Repairing and repolishing the floor.
- Stronger motors, additional air pads at the tables.

- Improvement of the monochromator shielding as well as analyzer and detector shielding.
- The optical system for fine positioning of the tables had to be completely rebuilt. It will be installed February 1974.

Since September 1973 IN3 is working (without optics) fully automatically without major failures. Measurements have been carried out to study the performance of curved crystals as monochromators and analyzers. Thermally bent CaF_2 crystals with 6 metre radius of curvature gave at 18 meV 50 % reflectivity and an effective mosaic spread of 0.15°. However, a considerable amount of development has still to be done before the curved crystals can be used as "standard equipment".

For the time being IN3 can operate as a standard spectrometer with Cu, graphite or Ge as monochromator or analyzers. A typical performance is : E_o = 18 meV, flux at the sample : 10^6 n/cm^2 sec., resolution (Vanadium scan) 0.32 meV.

Coordinator : R. Scherm

INSTRUMENT GROUP 3

"TIME OF FLIGHT"

This group covers the following instruments :

IN4	rotating crystal spectrometer
IN5	multi-chopper spectrometer
IN7	mechanical statistical chopper spectrometer
SI8	test assembly for electronic chopper

IN4 - Rotating crystal spectrometer (W. Drexel)

This instrument was constructed for ILL by GfK (Mr. Nücker). It is mounted on the thermal beam tube H12 (Reactor hall). It is in operation, open to outside use, subject to the acquisition of the instrument's own cryostat.

The assembly of the instrument on beam tube H12 was completed in December 1972 and calibration measurements were carried out from January to April 1973. Since then the instrument has operated completely satisfactorily with two (220) copper monochromators, one rotating and one stationary, and numerous measurements have been made, both for outside users and for ILL physicists (V, V_3Si, liquid Rb, naphthalene, various measurements of crystal field splitting). These measurements have given excellent results, but background scattering from the neighbouring neutron guides, which was considerable at small angles, had to be eliminated.

Since November 1973 the instrument has been operating with two graphite monochromators rotating in phase to transmit only one order at a time. This arrangement gives an excellent signal to noise ratio: 1500

at 16 meV with a 2 mm thick vanadium sample. Allowing for the duty cycle the intensity is the same as that of the 3-axis spectrometer IN2 (3×10^4 n/cm^2 sec at 16 meV). It has permitted new crystal field measurements, and neutron scattering on paraffinic chains in soap-water solution.

The instrument itself has had very few breakdowns and those originating in the data acquisition system and its interface are diminishing. The cryogenic equipment was very unsatisfactory in 1973, but the special cryostat for IN4 has been completed and is now under test at ILL. The main problem for all the crystal spectrometers remains that of the monochromator crystals. On IN4 the (220) copper crystals used for high incident energies have mediocre characteristics and it is essential to replace them. At low incident energies ($E < 50$ meV) the graphite crystals at present in position have a mosaic of 0.8°, which is too wide, and which involves the existence of very weak parasite peaks in the incident beam and a lower resolution. It is also necessary to replace these.

IN5 - Multi-chopper spectrometer (F. Douchin)

This instrument, mounted on the 'cold source' guide H16 (neutron guide hall) started operation with 3 choppers at medium speed (10,000 rpm) on 13.12.73. Opening it to complete external use still requires the availability of the fourth chopper and the improvement of the sample environment, filling the time-of-flight tank with He, and the possibility of full operation at high resolution, which depends on the delivery of mechanical spare parts (Spring 1974). Experiments and tests are continuing, for which R. Lechner has the scientific responsibility.

As regards assembly, work was done between January and April 1973 on the progressive adjustment of the 4 choppers, the control and safety electronics, the counters and interface with the computer (Nicole

system) the temporary improvement of the shielding of the secondary spectrometer (time-of-flight tank and detector support) and the installation of the first detectors.

In July and August work was done on the realignment of the junction guides (doubling of intensity), on the final adjustment of the chopper phasing electronics, on the complete installation of cooling and safety equipment, on the completion of the shielding for the secondary spectrometer (changed to obtain a background level of 10 to 15 counts/detector/hour), on the installation of the first 160 detectors (angular calibration) and on various improvements to the electronics and the data acquisition program. In addition the variable temperature cryostat specially designed for the instrument, and a preliminary furnace (400°C) were tried out.

In May 1973 the main calibration measurements on the instrument were started: phase determination, detector efficiency, background, intensity on the specimen, elastic and inelastic resolution, and the first part of the test experiment was carried out (quasi-elastic and inelastic scattering from NH_4Br). (Cf. ILL report ITR 26/73, Douchin, Lechner and Blanc, June 1973 and "IN5 Scientific Status Report", Lechner and others ISR 8/73). From September 1973 the instrument operated continuously with 3 choppers at first limited to 6000 rpm, then increased to 10,000 rpm in December, and the experimental programme began (experiments at low resolution, 4% in wavelength at 6 Å). The increase in speed in December now permits medium resolution experiments to be carried out (2.4% at 6 Å). In the meantime a double graphite monochromator has been tested. It can be used as a spare if a chopper fails.

The maximum speed (20,000 rpm), dependent on the delivery in May 1974 of mechanical spare parts, gives a total elastic resolution of 1.2% at λ_o = 6 Å.

The differential flux at the sample is 2.5 x 10^5 n/cm^2/sec at λ_o = 6 Å and at 6000 rpm. It must be divided by the reduction rate (overlap). Background is of the order of 15 counts/detector/hour (electronic noise 6 counts/detector/hour).

After a mechanical incident caused by a chopper ball bearing (operating under vacuum) (cf. ILL report ITR 12/73, F. Douchin and G. Gobert, June 1973), various checks and improvements in operation were carried out (cooling, acceleration and braking procedures, replacement of parts with excessive tolerances, etc.). ILL has also ordered two additional mechanical units necessary to obtain continuous operation of the experiment. Long-term operation tests are continuing satisfactorily, in order to evaluate the long term reliability of the components (3 months with 3 choppers at 6000 rpm, then at 10,000 rpm, then at the beginning of 1974 4 choppers at 10,000 rpm and over). All that part of the tests which could affect the running of the scientific programme will be transferred to a test platform (chopper No. 6) and will start in May 1974.

During the first half of 1974 it is planned to complete the major part of the commissioning of the instrument by

1 - the provision of two complete units (chopper, phased power supply), one intended to ensure continuity of operation of the experiment, the other to carry out the most critical tests outside the units in operation. An additional rotor will also be provided for the main choppers.

2 - definition of high-speed operation (reliability, starting procedure, etc.) after the above equipment has been provided.

3 - completion of the secondary spectrometer: shielding of the sample area, completion of the cryostat and the furnace, installation of all the

detectors (400), filling the time-of-flight tank with helium.

IN7 - Mechanical statistical chopper spectrometer (W. Drexel)

This instrument, loaned by GfK to ILL, is installed on thermal beam tube H5 (Reactor hall). It is operational, installation having been completed in March 1973. It has since been used for measurements of crystal field splitting and phonons (CuBe, RbI, Al_2O_3). The shielding will be reconstructed in 1974 to permit the simultaneous use of beam tube H5 by IN7 and D3. This operation will make it possible to use copper crystals for the double monochromator of the instrument, for measurements at high incident energy, which has so far been impossible.

In 1974 it is planned to add two more detectors to the existing detector bank.

SI8 - Installation of test for preliminary electronic chopper design (C. Berthet)

After its recent transfer to thermal guide H22 (neutron guide hall), this equipment has been used for tests of magnetic crystals (chopper-monochromators) and other elements necessary for the possible construction of a magnetic chopper spectrometer.

Installation after the transfer was simplified and considerably improved: reduction in background, accessibility, reliability of electromagnetic operation. (Pulses of 10 µsec, 1000 A at 1000 Hz). The magnetic circuit was entirely redesigned (3500 Oe pulsed field) and a new ferrite core is under test (December 1973). Parallel to this an attempt has been made to grow monochromator crystals type Fe_5LiO_8 or $Ni_{0.5}Fe_3O_4$ at the ILL, at very low cost (borrowed furnaces). The crystals obtained

are becoming steadily better but still need considerable improvements (dimensions, magnetic properties, etc.) (cf. ILL report by Mme Berthet Dec. 1973 "Electronic Chopper Monochromators"). The nickel crystal, in particular, has very good reflectivity considering its very small mosaic, well matched to the divergence of the neutron guides. An additional crystal sample has been loaned by the Chemistry Department of ORNL (USA). This department could if necessary provide ILL with a crystal. Operation with a nickel ferrite would in any case necessitate the use of the isotope Ni^{62}, which is relatively expensive.

Nothing has been planned as regards this installation, except the testing of crystals at present being grown or delivered. Subsequent development associated with the construction of a real statistical electronic chopper spectrometer is still at the design stage. Apart from the growth of crystals and the study of implantation, the development must include the adaptation of the modulator to a high duty cycle and the on-line computing facilities necessary for handling the correlation functions. In addition the same problem arises of the adaptation of the choice of experiments to the statistical method as for IN7.

Coordinator: F. Douchin

INSTRUMENT GROUP 4

"CRYSTALLOGRAPHIC INSTRUMENTS"

The following instruments form the group :

D6 Hedgehog-Diffractometer with 100 movable counters on the thermal guide H24

D8 Four-circle instrument on the thermal beam tube H11

D9 Four-circle instrument on the Hot Source (beam-port H3)

D12 Modified Laue Film Method on the thermal guide H23

D15 Four-circle instrument Mark VI on the inclined thermal tube IH4

D16 Four-circle instrument Mark VI on the Cold Source (beam-port H16)

In the group of crystallographic instruments three facilities produced scientific results by the end of 1973. We therefore state that these instruments (D6, D8, D12) are fully operational. We must mention also D10 which was used in the past entirely as a crystallographic four-circle instrument. It will however be converted to a triple-axis machine in 1974 and is therefore included in the group of special three-axis spectrometers (see report Group 2). Two other facilities (D9 and D16) are in an advanced stage of construction and will be fully operational in the first part of 1974. The installation of D15 however has not yet begun.

1 - Operational instruments

D8 - Conventional four-circle diffractometer (A. Filhol, M. Thomas)

The instrument shares the H11 beam-hole with the D2 powder

instrument. The installation which was started in September 1972 was completed during 1973. The in-pile collimation and the beam shutters required modification to allow the instruments D2 and D8 to work more independently. The installation of new collimators between the monochromator and the sample resulted in a considerable reduction in background. Several monochromators (Cu and Ge) were tested. The measured flux at 1.21 Å with Cu(200) (mosaic spread = 10', thickness = 10 mm, R_Δ = 15%) is 2 x 10^7 n/cm^2 sec. Due to the low take-off angle ($26° < 2\theta_M < 42°$) the resolution of the instrument is low at higher scattering angles (resolution curves for various experimental conditions are available as is a detailed report discussing the first set of data collected with D8). Factors limiting the speed of data acquisition are the velocity of the motors and the waiting time for the CARINE computer. Tests to attribute the time lost to these different sources are under way. Further improvements are planned to enable the instrument to be used more efficiently for protein crystallography. Four complete sets of data have been collected since the instrument became operational.

A. Filhol, M. Thomas and J. Vicat, The Present State of the D8 Diffractometer, ILL Report 1973.

D6 - The Hedgehog-Diffractometer (B. Klar)

The instrument is completed and a data set of 2000 reflections on a thymine-adenine base-pair has been collected. Due to the inhomogeneity of the mechanically bent copper monochromator the internal consistency of the data is not yet as good as it is with conventional instruments.

A good deal of work has gone into the conversion of data

acquisition and data reduction programs to the DEC 10 computer.

B. Klar, Dissertation, Universität des Saarlandes, Saarbrücken (1973).

D12 - The modified Laue film method (D. Hohlwein)

The instrument is installed at the end of a thermal guide tube. Considerable improvements in the installation and reducing the background have been achieved. A number of crystals have been tested (KCl, KH_2AsO_4, Insulin). It was shown that simultaneous registration of up to 80 reflections from a crystal of insulin is at present possible using a flat graphite monochromator. This crystal with a mosaicity of 0.8° produces a homogeneous angular wavelength spread of 7% for λ = 1.7 Å.

L14 - X-ray four-circle instrument (M. Thomas)

The X-ray four-circle facility worked without difficulties during the whole year. A low temperature device for temperatures down to liquid nitrogen was installed and proved to be fully operational for the solution of several structures.

2 - Instruments under construction

D9 - Four-circle instrument at the hot source
(M.S. Lehmann, H.D. Bartunik)

The construction of this instrument, started by A. Tippe, is partly completed. The shielding surrounding monochromator and detector has been defined and construction is under way. The "dancing floor" has been finished and the Eulerian cradle has been tested. Alignment

of the diffractometer is expected to take place in early 1974 and will be followed by the crystallographic tests using the neutron beam.

The diffractometer is expected to work with neutron wavelengths in the range 0.6 - 1.2 Å. Its main application is at present seen in the experimental determination of phases in medium size proteins by anomalous dispersion of ^{113}Cd (resonance 0.667 Å or 0.178 eV and ^{149}Sm (resonance 0.915 Å or 0.0976 eV). The diffractometer will be equipped with a Cu monochromator ([111] in transmission) and the expected flux is 10^7 n/cm^2 sec. This gives focusing and the best resolution for reflections with a d-spacing of about 2 Å in which case reflections from crystals with unit cells of 50-80 Å should be resolvable. The λ/n-contamination will be reduced by filters. The installation of a Bi crystal as a γ-filter is being considered. The monochromator take-off angle, $2\Theta_M$, can be continuously varied between 13° and 70°, automatic variation being possible within a range of about 12°.

The maximum accessible range for the sample take-off is approximately 50° for $2\Theta_M$ = 15° increasing with higher $2\Theta_M$ passing 90° for $2\Theta_M$ = 35°.

The equipment is also supplied with a dancing-floor analyzer table which is not expected to be used during the first measurements. Other monochromator crystals are contemplated to optimise the resolution conditions.

D16 - Classical four-circle instrument (Mark VI) at a cold neutron guide

(S. Wilson)

Two Mark VI instruments (sharing a common PDP-8E) will be installed by Harwell. One is on a cold source neutron guide tube. It

has a pyrolytic graphite monochromator and can work between ~2-5 Å, i.e. take-off angles between 30°-110) ($2\Theta_M$). To start with the wavelength will be fixed at 2.4 Å to enable the $\lambda/2$ component to be removed by a graphite filter. The flux will be about 2×10^6 n/cm^2 sec.

The instrument has available a helium cryostat which can replace the χ circle, and a lifting counter is then used to collect data in layer lines from an angle of -10° to +35°.

Alignment and testing is about to start, and the instrument should be available from the end of January 1974.

D15 - Classical four-circle instrument (Mark VI) on an inclined thermal beam hole (H. Dachs)

It will be controlled by the same PDP-8E as D16, and could share the cryostat-lifting counter facility. It will work at a fixed take-off angle of 90°, and be a high-resolution instrument with an estimated flux of ~5×10^6 n/cm^2 sec, for use in crystallographic investigations.

Detailed designs of the platform and shielding are completed, and the instrument should be installed in the Spring of 1974.

Coordinator: H. Fuess

INSTRUMENT GROUP 5

"DIFFUSE SCATTERING"

This group includes the following instruments :

D11A	small angle scattering
D11B	small angle and diffuse scattering
D7	diffuse scattering apparatus
IN10	backscattering device

D11A - Small angle scattering (K. Ibel)

The mechanical and data collection system are in reliable and problem-free routine operation ; more than three thousand spectra were taken in 1973. The detector position being at least 100 m from the core, the signal to background performance is excellent.

The instrument is highly productive : experiments on magnetic structure of superconductors, on polymer conformation in solution, and on precipitations in alloys have already led to publications in this first year of operation. An important review paper on biological macromolecules in solution will appear early in 1974 ; several publications in this field are in preparation. The outstanding properties of the camera were disclosed to the scientific community at the Third International Conference on X-Ray and Neutron Small Angle Scattering in September in Grenoble. Five invited papers and four others dealt with results obtained with this instrument. The generous layout and versatile construction have led to applications originally not envisaged, e.g. diffractometry on biological systems. Furthermore, it made possible a double chopper system for high resolution inelastic measurements at small angles. The

high incoming intensity permits observation of the radius of gyration at time rates less than a tenth of a second ; for the study of the hydrogen exchange in proteins a stop-flow apparatus was constructed which will be tested at the end of the year. Specifications for several accessories which meet specialized small angle scattering requirements have been established ; their execution is now in the hands of centralized technical services (cryostat for liquid He temperatures and high magnetic fields ; velocity selector for high resolution short wavelength monochromatization ; autonomous data acquisition system).

The instrument D11 is at least several years ahead of similar competitive ones.

D11B - Small angle and diffuse scattering (G. Kostorz)

Manufacture of this instrument is under way in close collaboration between Rutherford Laboratory and ILL. The big vacuum vessel has been ordered, and computer support will be provided by a PDP11/40 based system which will also incorporate D11A. Delivery of D11B is provisionally scheduled for January 1975.

D7 - Diffuse scattering apparatus (W. Just)

The instrument was completed for use with unpolarized neutrons. An electro-magnet with a suitable cryostat was made available so that the planned programme of magnetic impurity work could also be started. In the six experiments performed this year, the instrument proved to meet fully the expectations concerning experimental possibilities and performance.

IN10 - Backscattering device (A. Heidemann)

In the period from January 1 until December 1 in 1973 most of the mechanical parts of the backscattering spectrometer have been constructed and installed : The doppler drive with the monochromator crystal, the graphite crystal which deflects the backscattered neutrons, the neutron guide which leads the neutrons from the graphite crystal to the target, the Helium tight analyser container, the analyser and detector shielding and the detectors. The missing parts, the auxiliary chopper, the support for the analyser crystal plates and the paraffin shielding will be installed in December 1973 or January 1974.

In 1973 the data acquisition system which consists of a PDP11 computer, a Camac hardware and software have been developed and tested. The hardware is in operation. The connection between hard-and software will be made in December 1973. Intensity measurements with different monochromators have been performed. They are in satisfactory agreement with expected values.

The IN10 will be operational not before February 1974.

Coordinator : M. Roth

INSTRUMENT GROUP 6

"POWDER SPECTROMETERS"

This group includes the following instruments :

D1A two-axis high resolution diffractometer for powders and single crystals

D1B two-axis diffractometer with multidetector

D2 two-axis high flux diffractometer for powders and single crystals

D1A - Two-axis high resolution diffractometer for powders and single crystals (M. Steiner)

The construction and the initial tests carried out by P. Burlet were continued by M. Steiner. The use of the same monochromator crystal (Ge 311 and 111) for experiments D1A and D1B did not prove very suitable. A new improved protection was constructed in November with goniometer heads for two monochromators. D1A was kept at the same take off angle of 122°. The flux was improved (7.10^5 n/cm^2/s at 1.9 Å on the sample), but is still low ; this is the main drawback of the experiments carried out, the other being the high and variable background noise due to inadequate protection on the adjacent neutron guide.

New monochromators (Ge 533) are now being tried. Experiments requiring a high resolution and not too high a flux can now be carried out on the equipment. Such experiments were started at the beginning of November.

D1B - Two axis diffractometer with multidetector (P. Convert, M. Steiner)

The development of the whole facility (comprising tests of the multi-detector, programmes for the calibration and the actual measurement) started with Burlet, was continued during the first half of the year, and various experiments were carried out as a trial. The results are described in Note ILL ST 73/554 by J. Jacobe and P. Convert. The present multidetector has major homogeneity and response defects, together with parasitic counts due to localised internal flashes. The effects of this latter defect have been eliminated. As the equipment is nevertheless stable it can be used for preliminary tests until the arrival of another similar multidetector now being built as a free replacement for the present defective equipment.

The new monochromator shielding installed in November permits take off angles of 38 - 45°, and the D1A and D1B crystals are now different. Thus it will be possible to carry out tests using other monochromators, graphite in particular, in order to improve the flux on the sample, which was 5.10^5 n/cm^2/ s.

D2 - Two-axis high flux diffractometer for powders and single crystals (P. Burlet)

Under favourable conditions this equipment permitted routine operation throughout the year (it was used by 38 experimenters). Several improvements were made :

- Automation of the cryostat relative to the electromagnet.
- Set of trueing shims permitting rapid centring of all types of cryostats, furnaces, etc. in the neutron beam. Also a goniometer head

with two inclining movements can be adapted to this for adjustment of a cryostat containing a crystal sample.

- Installation of a partial shutter on the monochromatic beam to eliminate interference between D2 and D8 which are on the same reactor channel H11.

- Automation of the magnetic field.

An operating manual (item No. for ordering : ID 2/73) describes all the characteristics of D2 and the programmes for obtaining data using the CARINE system. This latter, which occasioned frequent stoppages at the start of the year, has operated fully satisfactorily since then.

Coordinator : P. Convert

INSTRUMENT GROUP 7

"POLARISED NEUTRONS"

This group includes the following instruments :

D5 Three-axis polarisation analysis neutron spectrometer

D3 Polarised neutron 2-axis diffractometer

D5 - Three-axis polarisation analysis neutron spectrometer

(J. Schweizer)

This complex instrument has been operational since the end of April 1973. Additional work has been necessary on important points to achieve the desired performance :

1) Modification of the in-pile collimator.
2) Improvement of the size of the FeCo monochromator by 5 x 5 cm.
3) Construction of a 3-crystal assembly permitting the use of Heusler alloy as a monochromator until larger crystals of this alloy become available.
4) Design and construction of numerous items of equipment for the polarisation guide fields and to reduce background noise.

Neutron operation is now satisfactory for the various forms in which this instrument may appear.

Performance is excellent as regards flux allowing for the fact that this type of instrument most often uses very absorbent crystals both in the monochromator position and on the analyser axis.

- Polarisation analysis in the case of small scattering cross-sections

A FeCo analysing crystal now permits polarisation analysis which is satisfactory in most cases.

However tests have shown that the use of 2 crystals of Heusler alloy of optimum dimensions would permit an increase in the counting rate by a factor of at least 5. The production of these crystals is a delicate operation undertaken jointly by CNRS Grenoble and ILL. These should be available in March 1974 and will permit some difficult studies in the best possible conditions.

- Programming for automatic operation

Three different programs are available, permitting easy use of the CARINE system for control of the instrument :

1) D5 program : conversational, rapidly learned, permits the user to develop and implement simply sequences of measurements not normally required.
2) Reno program : inspired by programs used for 4-circle diffractometers, this permits the completely automatic recording of flipping ratio R for a large number of Bragg reflections (spin map). Reno controls all the operations necessary in this type of study, optimises the measuring times, carries out a statistical treatment of the results and presents them in graph form. As almost all the routine jobs are thus loaded on the computer, this allows a great saving in time.
3) Rada program : permits the automatic angle setting necessary in studies of inelastic phenomena in general and allows the measurements suitable for polarisation analysis.

We now come to a technical difficulty resulting from the low disc store capacity of the CARINE system. As a result the use of the instrument is more critical. In addition the lack of computer support does not allow us to satisfy the urgent need for standardisation of program-user dialogues.

- Associated equipment

We have a thin-tailed cryostat permitting the temperature of liquid helium to be reached in a magnetic field. This cryostat has needed development, and is now operational with a 2-day filling period. A furnace for up to 800°C is operational.

- Conclusion

This instrument is noteworthy for more than one reason :

1) in position on the hot source of the ILL high flux reactor it permits the use of wavelengths down to 0.4 Å;
2) it is completely equipped for polarisation analysis and permits the separation of the different sections with good neutron diffusion properties (see paragraph on Polarisation analysis...);
3) its design at the level of the specimen axis, complemented by an appropriate program, permits very economical studies of monocrystals resulting in a considerable saving of time in the pre-measurement phase and during measurements;
4) The magnetic field on the specimen is a maximum of 19 kOe. A superconducting magnet now being made will permit a vertical field of 48 kOe.

D3 - Polarised neutron 2-axis diffractometer (F. Tasset)

B. Forsyth is responsible for the construction and commissioning of the entire project.

- Monochromator shielding

This instrument will be installed on beam tube H5 (thermal neutrons) which it will share with IN7. The monochromator shielding is completed, and will be installed at the end of February 1974. $Co_{92}Fe_8$ and Heusler alloy monochromators will be available in about April.

- Diffractometer

This has been made by Grubb-Parsons (Mark VI) and is at present being completed at Rutherford Laboratory. It is controlled by a PDP/40 computer. Delivery to ILL is planned for June 1974, and it should be in routine operation by the end of 1974.

- Cryogenics

A THOR helium cryostat will be supplied with the instrument. A superconducting cryostat has been ordered from Oxford Instruments. It is not part of the project, but will be for use on D3 and D5.

- Conclusion

This instrument,which is simpler than D5,should have a higher rate of data acquisition, and it will be used for polarised neutron studies which do not require polarisation analysis.

Coordinator : F. Tasset

INSTRUMENT GROUP 8

"MONOCHROMATORS"

At the beginning of the second half of 1973 a group of several scientists and technicians was set up at the Institut Laue-Langevin, the main purpose of this group being to study and develop neutron monochromators for the ILL diffraction instruments. This group has been allocated three instruments which complement each other in the study of the reflection properties of monochromator crystals, namely :

D13 Neutron double crystal diffractometer

LI2 Double crystal diffractometer for X-rays

LI3 Gamma diffractometer

There are two characteristic aspects of the operation of the group :

- Scientific aspect : Systematic research into the relation between defect structure and diffraction behaviour of imperfect crystals (density and arrangement of dislocations, curved crystals $\longleftrightarrow$ mosaic model, extinction theories, etc.) ; treatment of single crystals to improve the reflection properties (deformation, heat treatment) ; design and development of new types of monochromators (composite systems, crystals with a gradient in the lattice constant, focussing systems) ; improvement of test methods for monochromator crystals, etc.

- Centralised service : Collection of data regarding reflection properties, costs, sources of monochromator crystals, administration of a central budget for monochromators (from 1974), routine testing of single crystals, crystal orientation with neutrons and X-rays,

determination of lattice constants, etc.

These two aspects have dominated the work of the group, which consists of the following members :

Scientist	Main field of work
A. Boeuf	Construction of D13; study of monochromator crystals using neutrons; development of new monochromator systems.
A. Freund	Study of the defect structure of single crystals using X-rays and gamma rays; deformation of single crystals; new monochromator systems.
S.E. Rasmussen (visitor)	Beryllium single crystals.
F. Rustichelli	Construction of D13; bent monochromators; crystals with a gradient in the lattice constant; monochromatising crystal systems.
E. Schedler	Thermally-curved monochromator crystals, particularly for inelastic neutron diffraction instruments.
J. Schneider	Study of monochromator crystals using gamma rays and neutrons; calculation of relation between the two methods.
Technicians	
A. Hartmann	Measurements using the gamma diffractometer.
P. Detourbet	Construction and operation of D13.
A. Escoffier	Crystal growth (Cu, Cu (Ge)).
R. Hustache	Crystal preparation; X-rays.

The construction of a double crystal diffractometer for neutrons (D13) on the neutron guide H24 behind D10 was started in May 1973, and by August the first test of monochromator crystal measurements were being carried out (A. Boeuf, F. Rustichelli, P. Detourbet). The first crystal in each case is an almost ideal crystal, the distance between lattice planes being approximately the same as in the test crystal. The beam cross-section can be limited to 6 x 6 mm^2, thus permitting the study of relatively small volume elements of the sample crystal. The crystal surface is subdivided and scanned systematically. The quantities measured are the half-width of the rocking curve, the maximum reflectivity, and the integrated reflectivity. Typical rocking curves and the measured quantities corresponding to the individual volume elements are given in a test report. More than 50 crystals have been characterised in this way since the start of September 1973 (Cu, Be, Ge, pyrolytic graphite, ferrite crystals). Most of these monochromators used at the ILL have exhibited extensive spatial inhomogeneity of mosaic spread and of reflectivity. Whereas in small volume elements of Cu and Ge crystals a maximum reflectivity of about 50 % was attained (at $\eta \gtrsim 15'$ and $\lambda = 1.3$ Å), the integrated reflectivity dropped by more than half on integration over a large crystal volume.

For the gamma diffractometer Li3, N. Thillosen has developed with J. Schneider, a supplement to the electronic control system permitting automatic measurement of the rocking curves of adjacent volume elements in large crystals. In this way a study has been made of e.g. 56 volume elements in a 13 x 7 x 0.8 cm^3 Cu crystal. The data are obtained on punched tape. A computer program is now being developed, for determination of the overall diffraction behaviour from measured local properties of the sample. The wavelength dependence of the

diffraction behaviour is simulated. The degree of perfection of a large number of crystal samples was also tested on the gamma diffractometer (A. Hartmann).

In conjunction with the firm Cristal-Tec of Grenoble, an attempt was made to increase the diameter of Cu (Ge)-crystals with a lattice constant gradient, from 20 to 50 mm (F. Rustichelli, A.Escoffier, A. Boeuf). This however gave an undesirable radial Ge concentration gradient. An attempt is now being made to eliminate this effect through minimisation of the temperature gradient. A focussing system made up of curved Si plates has been constructed and this has proved satisfactory in tests (A. Boeuf, F. Rustichelli).

S.E. Rasmussen and J. Schneider studied the beryllium crystals available at the Institute and which exhibited a most unsatisfactory mosaic structure. Recently, however, Mme Faure (CENG) has succeeded in greatly reducing the substructure of Be crystals by suitable heat treatment. Testing of a cubic crystal of 1 cm^3 volume with neutrons and gamma rays gave a highly homogeneous mosaic structure ($\eta \gtrsim 3'$) and 60 % reflectivity. A corresponding treatment to improve the reflection properties of Be crystals already at the ILL appears desirable.

A. Freund studied the reflection properties of Cu single crystals, diameter 17 mm, deformed to various extents in an orientation lying in the middle of the standard triangle, using neutrons and gamma rays. The samples deformed between 2 % and 12 % exhibited a mosaic spread η of 13' to 80' which was also largely governed by the azimuth angle ϕ (turning about the diffraction vector $\langle 111 \rangle$), as was expected from the anisotropic dislocation distribution. In a single sample $\eta(\phi)$ varied by up to a factor of 3. The reflectivity was about 80 % of the theoretical value calculated for the ideal mosaic crystal. A

monochromator system is now being prepared where a large crystal is composed of a large number of small crystal blocks deformed in this way. The inhomogeneity of the mosaic structure can be largely avoided using this technique and careful adjustment of the blocks. Curved mosaic crystals could also be produced in this way. An attempt is also now being made to bend copper crystals elastically in parabolic form (A. Freund, D. Hohlwein).

E. Schedler, R. Scherm, W.D. Teuchert and D. Woods have further developed the method of thermally bent CaF_2 crystals as analysers on the Tanzboden spectrometer IN3. The maximum reflectivity of a crystal bent to 6 m curvature radius, and measuring 100 x 50 x 5 mm^3 was 50 % for k = 2.9 $\AA^{-1}$ neutrons. Measurement of a phonon in lead ($\vec{Q}$ = (0,0,2.6), ν = 1.26 THz) gave the resolution 0.044 THz.

In November 1973 A. Freund organised a Monochromator Seminar at the ILL, which was attended by scientists from various institutes. The aim of the Seminar was to survey the present status of monochromator technology and to coordinate future collaboration in this field. It included analysis of the present monochromator requirements of ILL, discussions of the characteristic reflection properties of various materials, and the possibilities for future improvement of these properties and for the design of focussing systems for elastic and inelastic neutron spectrometers. A detailed report of this seminar is being prepared and will be issued at the beginning of 1974.

Coordinator : A. Freund

UNGROUPED INSTRUMENTS

D4 - 2-axis instrument "liquid spectrometer" on the hot source (H. Egger)

The instrument worked continuously all the year, most of the time for external users.

There was some success in improving the performance of the instrument :

1 - Extremely large practically usable range of angles (2°-140°) by using vacuum around the sample.

2 - Very small second order contamination by using resonance filters. In all cases contamination of other orders of reflections are less than 10^{-3}.

3 - Rapid change from one wavelength to another with fixed monochromator, (almost always Zn 002) just by selecting with a filter the reflex 002 (and suppression of 004) or 004 (by suppressing 002 and 006).

This gives a range of K accessible with the Zn 002 reflection of 0.3 to 17$\mathring{A}^{-1}$ which can be extended with the Zn 004 to $\simeq 34 A^{-1}$.
A unit to get four different wavelengths (0.9, 0.7, 0.45 and 0.35 $\mathring{A}$) will be installed at the beginning of 1974.

A lot of work has been done to complete the additional equipment. A special vanadium furnace was installed which permits precise experiments up to 1000°C. Large pumps had been installed in order to cut down dead times of the instrument due to the pumping down times.

A large effort was made to get the necessary "good" containers for materials at high temperatures.

The problems with the machine are at the moment :

1 - It is only manually operating. Therefore one cannot always use the beam time in the optimum way.

2 - The data acquisition and handling system is insufficient. The acquisition of the data is done on a punched tape of a TTY. It was practically only this TTY (and the interface) which caused shut downs of the instrument. On the other hand there are too many errors on the punched tape, which have to be corrected in a very time-consuming way.

IN9 - Time of flight spectrometer with polarisation analyser. (P. Seyfert)

The time of flight spectrometer with polarisation analysis, IN9, is still under construction. Up to now the main effort has aimed at the assembly of the polarised proton filter and the preparation of a suitable polarized neutron beam.

The primary beam

The presently used installation is a double monochromator-like arrangement with a 0.8°-graphite crystal in the first position and a 0.18° Heusler alloy crystal in the second position. It provides a 95 % polarized neutron beam with a flux of 1.3 $10^5/cm^2$ sec. at $\lambda = 4.3$ Å. The beam section is 2.8 x 1.4 cm^2 (height x width). The Heusler alloy crystals were supplied by R. Perrier de la Bathie (Cristaltec)

Since July 1973 this beam arrangement has been used alternatively for testing preliminary set-ups of the spin-echo spectrometer of Mezei (IN11) on the one hand and the transmission characteristics of the polarised proton filter on the other hand. In the latter case a Mezei type spin-flip coil together with appropriate magnetic guide fields were placed between the polariser and the proton filter. In the final state of IN9 a single chopper system will be added which is already on hand at the Institute (except the mechanical shielding of the wheel).

The polarised proton filter

From an engineering point of view the polarised proton filter consists of four components : The magnet system, the cryostat, the microwave system and the LMN crystal.

The magnet system is operative. When analysed the field (H_o = 18.5 KG) varied by an amount of about 10G over the volume of the filter crystal. The previous users of this magnet at CERN had attained a field homogeneity of 10^{-4} over the same volume, which is a very acceptable value for our purposes. As soon as the appropriate HALL-probe arrives at the Institute (ordered several months ago) we will trv to recover the original field characteristics by additional shimming.

The design and the construction of the cryostat was completely carried out under the responsibility of P. Roubeau of the CEA Solid State Physics Department in Paris. The cryostat was tested in July 1973. A characteristic performance was a cooling power of 30 mW at a temperature of 0.70 K. This meets very well the expected requirement for attaining proton polarisation of 80 - 85 %.

The microwave system is ready. It was tested in August 1973.

We currently have at our disposal a rectangular-shaped LMN single crystal, 45 x 25 x 7 mm^3. This specimen was out of a large LMN single crystal grown at the chemistry lab of the SRC Rutherford High Energy Laboratory. We are very grateful to W.G. Williams and G. Stapleton for having provided us with this crystal. We finally seem to be successful in trying to grow LMN crystals at the Institute. We point out that the time needed for growing crystals of the required size is about three months.

During a first global test in December 1973 a proton polarization of about 45 % built up in the LMN crystal. In contrast to a comparatively poor spatial uniformity (relative variation of $\pm$ 20 % across the crystal area) polarization was found to be remarkably stable in time (1 % variation within 24 hours). We believe that this is an encouraging result for the beginning. The system will have to be carefully optimised. This might take several months. Its potential performance is thought to be stable production of 80 % proton polarisation.

Detectors and Data Acquisition System

For the purpose of the various test experiments mentioned in a previous section we have been using a rather elementary counting equipment (a ^{3}He detector, a monitor, a scaler-timer, a counter and a printout unit).

In the final state of IN9 the solid angle substended at the sample position by the LMN filter will be covered at the end of a 2 m flight path with 10 ^{3}He detectors (1 inch diam., 30 cm length). These detectors are in stock at the ILL and allocated to IN9. As far as the data

acquisition system is concerned no clear decision has been taken as yet. Two solutions are presently being discussed : The connection to the Nicole-system and the utilization of an autonomous system which would be shared with IN11. In any case there will be enough computing capacity allowing for operation of IN9 with a pseudo-statistically controlled spin-flipper (on-line calculation of the cross correlation function).

Final Remark

Inelastic neutron scattering experiments on the fully equipped polarisation spectrometer IN9 are estimated to need a minimum flux of about $10^5/cm^2$ sec. at the sample position. Assuming a 3 % duty cycle for the mechanical chopper this leads to a continuous beam of 3 $10^6/cm^2$ sec. Compared to this value the flux of the actually available beam at H16 is too low by a factor of 20 at least. We see no sensible chance to improve the performance of the equipment to that extent. The only possible solution seems to be the replacement of the present graphite-Heusler alloy system by a helicoidal slit velocity selector-polarisation filter (magnetic mirror, magnetic hexapole etc.) system. This modification implies the removal of IN9 to an end position of a cold-neutron guide. In fact we shall have the opportunity in summer 1974 to get on H14, thus sharing an intense polarised beam of about $10^7 n/cm^2 sec.$ (energy spread $\frac{\Delta E}{E} = 4\%$) together with IN11. The present arrangement at H16 is very convenient for the optimisation studies of the proton filter and will be used for this purpose in the meantime.

IN11 - Spin-echo spectrometer (F. Mezei)

The construction of the IN11 Spin-echo spectrometer has been decided by the Scientific Council in early 1973. This decision was preceded by a number of test experiments aimed at a demonstration of the high resolution capabilities of this novel inelastic scattering technique, and a set of preliminary studies have been made since then to collect experience for the final IN11 design. Some results of these studies are:

- measurement of Doppler Shift of neutron velocity in reflection from a vibrating graphite crystal with a resolution of 3×10^{-6} (corresponding to 2×10^{-8} eV) demonstrating the virtues of the spin-echo method, even in a simple improvised set up. (Note that these figures represent by far the best energy resolution ever achieved with neutrons.)

- set up of a simplified small scale version of IN11, which gives a 2×10^{-6} eV spectral resolution. This preliminary arrangement was mainly used to gain operational experience for the IN11 design. Furthermore, it made it possible to begin some test experiments in this new resolution range concerning the critical fluctuations in structural phase transitions.

- the use of the spin echo principle in transmission experiments on macroscopic magnetic structures has been worked out and tested (F. Mezei: Generalised neutron polarisation analysis; paper presented at the Magnetism Conference, Boston: 13 - 16 November, 1973.)

The full scale IN11 instrument is expected to be ready for test experiments by August 1974, and to be completely operational by the end of 1974.

NUCLEAR PHYSICS INSTRUMENTS

This group includes the following instruments:

PN1 mass spectrometer for unslowed fission products

PN2 beta spectrometer: BILL

PN3 bent crystal gamma-ray spectrometers

PN1 - Mass spectrometer for unslowed fission products: LOHENGRIN

(H. Schrader)

After the break-down of the mass spectrometer in September 1972, due to a bending of the source holder trolley associated with corrosion damage on mechanical parts of the beam tube, the whole source changing facility was demounted in January 1973. The corroded parts were replaced and a wider passage provided for the trolley inside the beam tube. In order to measure the deformation and the temperature of the front part of the trolley, several devices have been installed. After the reinstallation of the whole assembly in June 1973 the trolley showed, nevertheless, a reversible deformation of more than 5 mm, during 4.5 hrs of reactor operation at 57 MW, corresponding to a temperature of about 600°C in the front part of the stainless steel frame.

Therefore a new trolley with a titanium front part is under construction, which exhibits lower heating masses and a better dilation behaviour. The new trolley will be delivered by the end of January 1974 and could be installed in February 1974.

The tape transport system which is to be used at the collector of the spectrometer has been mechanically improved and connected to a computer control. The construction of an He-jet system has been started to concentrate rapidly the activity spread along the outlet slit of the parabola-spectrometer on a small source surface. The efficiency of a long counter for delayed neutron measurements has been investigated as a function of geometry and energy.

PN2 - Beta spectrometer: BILL (W. Mampe)

In 1973 the two magnets of the spectrometer were adjusted by photographing the electrons flying on different trajectories. The stabilization of the magnetic fields as well as the spectrometer electronics have been installed. Detector systems have been constructed and tested. The connection of the PDP-11 including hardware and software has been completed.

The remanence of the magnets has been studied and the demagnetization cycle fixed.

The instrument on the whole is in the testing and calibrating phase at the moment.

PN3 - Bent crystal gamma-ray spectrometers Gams II and Gams III (H.R. Koch)

The quartz crystal of Gams III has been bent in the same way as Gams II to a radius of 24 m. By variation of the distance of the crystals from the source a position was found where the resolution of both crystals is very satisfactory. The linewidths for a 412 keV radiation are 1.15 and 1.25 seconds of arc. Both spectrometers were ready to operate at the end of 1973.

J.P. Bocquet

DEVELOPMENT OF NEW TECHNIQUES

1 - Polarization of neutrons by reflection by mirrors (B. Hamelin)

The following studies and tests were carried out with the aim of designing a neutron guide with high polarisation ($p > 90\text{-}95\%$) and good reflectivity:

1-1 Tests using magnetic mirrors of thick iron cobalt (1.5 cm): results negative, the thicker sheets being more difficult to saturate magnetically than thin sheets (0.5 to 1 mm) of iron cobalt stuck on a rigid support and then polished.

1-2 Analysis and interpretation of the measurements made in 1972 on thin sheet mirrors; polarisation diminishes with the ratio of the angle of incidence to the wavelength. A model based on the hypothesis of an unsaturated layer (~100 Å) at the surface of the sheet gives results in accordance with experiment (1).

1-3 Tests on a thin layer (~1000 Å) of FeCo deposited on glass under a magnetic field, with an intermediate anti-reflective layer: results negative because of the inhomogeneous composition of the FeCo.
These tests will be continued in 1974.

2 - Polarisation of neutrons by magnetic deflection (B. Hamelin)

2-1 Development of a hexapole simulation programme by Monte Carlo methods. Investigation of the performance of a hexapole.

2-2 Design, assembly and experiments on a new type of "Stern-Gerlach" apparatus as polariser or analyser of neutron polarisation.

3 - Ultra-cold neutron source (P. Ageron)

The present design of the cold source and its guides does not permit the emission of sufficiently intense beams of very cold ($v < 100$ m/s) and ultra-cold neutrons ($v < 10$ m/s).
An installation capable of providing such neutrons was the subject of a preliminary project (2) covering:

- a comparison of the different possible sources in the HFR, including a modification of the existing cold source,

- a study of a source in an inclined beam, with a converter using beryllium cooled by liquid nitrogen, considered as the most practical short term solution.

Studies and measurements made at Garching (A. Steyerl) and at the University of Sussex (R. Golub, J.M. Pendelbury) contributed to this preliminary project and a development programme for 1974 was established with a view to achieving a definitive design.

(1) Hamelin - Feltin: Polarisation d'un faisceau de neutrons par miroir magnétique (polarisation of a neutron beam by magnetic mirror). Internal note ISR 5/73.

(2) P. Ageron, J.M. Astruc, J. Verdier: Preliminary project of an ultra cold neutron source at the high flux reactor. Internal note ISR 9/73.

P. Ageron

SCIENTIFIC ACTIVITIES

COLLEGE 1

"THEORY GARCHING"

I - Members of the College

Cheung T.H.	
Dieterich W.	
Fulde P.	
Hirst L.	
Hoenerlage B.	until 30 August 1973
Mais H. (D)	
Peschel I.	
Schmidt U.	until 30 September 1973
Selke W.	
Stollhoff G.	
Takayama H.	
Trinkaus H.	

Furthermore Mrs. K. Baker was a member of our group due to a grant by Deutsche Forschungsgemeinschaft and Dr. M.C. Leung due to a stipend from the Humboldt-Stiftung.

II - Visiting Scientists

Cullen J.	Naval Ord. Lab.	18.2 to 17.3.73
Aoi K.	FU Berlin	18.3 to 13.4.73
Hertz J.	Cambridge	16.4 to 16.5.73
Luther A.	Harvard	1.8 to 7.9.73
Fukuyama H.	Bell Tel. Lab.	25.8 to 2.9.73
Kehr K.	IFF Jülich	3.12 to 8.12.73

III - Scientific activities

As in the past, the activities and interests of the Theory group in Garching covered a wide field in 1973. Work was done in the following areas:

1 - Crystal fields in metals (Cheung, Fulde, Hoenerlage, Klenin, Peschel, Schmidt)

Two of our theoretical predictions have now been confirmed experimentally: the anticipated anomaly in the thermo-electric power of a metal with crystal field split impurities was found by Umlauf et al. (Phys. Rev. Letters 30, 1173 (1973)), and the effect of higher crystal field level on the linear shape of low-lying transitions was proved experimentally by Purwins et al. (Phys. Rev. Letters, submitted). Our new theoretical work dealt with quasi-elastic scattering near a Van Vleck magnetic phase transition. The excitation spectrum of a Van Vleck ferromagnet was also calculated, allowing for the complete level diagram. In addition the effect of phonons on the exchange-induced phase transition was studied and relevant experiments proposed. Finally it was demonstrated that superconductive tunnelling should be an unconventional method of measuring the crystal field level of magnetic impurities.

2 - Superconductivity (Dieterich, Fulde, Leung, Takayama)

The emphasis here was on superconductors in high magnetic fields. A review paper summarised the results which were obtained mainly from collaboration with the MIT Francis Bitter Magnet Lab. (Meservey, Tedrow). These concern thin Al layers in parallel fields and cover Zeeman splitting of quasi-particles, measurement of the order of phase transition, spin-orbit interaction, spin-dependent

tunnelling and fluctuations. The research was extended to superconductors with lamellar structure. The dynamic properties of type II superconductors with short mean free path lengths were also studied.

3 - Metals (Dieterich, Fulde, Mais, Peschel, Stollhoff, Takayama)

Considerable attention has been paid to the problem of quasi 1-dimensional metals. The Luttinger model has been studied and the susceptibility in this model calculated exactly. The results obtained are important for understanding the Peierls transition. The relationship between the Peierls temperatures and the magnetic field was also calculated.

Another problem concerned the electron-phonon interaction in strongly disturbed metals. As such a system is no longer translationally invariant, there is no momentum conservation in the electron-hole excitation by phonons. The consequences for the various electronic properties have been studied.

The relationship calculated earlier between the magnetic field and the speed of sound in A15 compounds was investigated with a view to determining the electronic density of states in the vicinity of the Fermi energy. The method has also been extended to other systems.

4 - Magnetism of rare earths (Hirst)

Some rare earths change their valency when high pressures are applied (Ce, Sm chalcogenide). A simple theory has been developed to explain such transitions as the alpha-gamma phase transition of Ce.

5 - Diffuse X-ray scattering (Trinkaus)

The X-ray diffraction gives an indication of defects in a crystal. A method was developed permitting the effect of distortions

on Huang scattering to be studied. Measurement of the Huang scattering thus permits defect symmetry to be studied where lattice symmetry is known.

This relationship is of great practical importance for the study of disturbed crystals. The present state of experiment and theory has been described in a short review paper.

6 - Surface effects (Baker, Fulde, Peschel, Takayama)

As a continuation of earlier work an investigation was carried out as to how far a long-term interaction could prevent the occurrence of surface magnetism in Van Vleck magnets. In addition, for the problem of the surface of transition metals, the energy of the various Hartree Fock solutions was compared and a study was made of the conditions under which the surface layer combines antiferromagnetically with the interior of the sample.

Secretary: P. Fulde

COLLEGE 2

"THEORY GRENOBLE"

I - Members of the College

Gaspard J.		until 31.10.73
Hölzl K.		
Iche G.		
Kugler A.		
Lovesey S.		since 1.7.73
Nozières P.		
Ranninger J.		
Schmid C.		
Villain J.		
Cyrot-Lackmann F.	CNRS	since 1.11.72
Dobrzynski L.	CNRS	since 1.11.72
Kress W.	T.U. Munich	since 1.10.72

II - Visiting Scientists

Natoli R.	CNEN, Casaccia	until 20.7.73
Weiss P.R.	Rutgers University	until 1.7.73
Zawadowski A.	Central Research Institute, Budapest	until 6.8.73
Solyom J.	Central Research Institute, Budapest	since 26.11.73

III - Scientific activities

The Grenoble theory college continues to have a scientific activity of its own going far beyond the field of neutron physics. This does not prevent frequent collaboration with the experimental colleges. Work within the college continues to be rather individualistic, and the variety of subjects covered makes any attempt at classification somewhat arbitrary. However the following main topics can be distinguished:

1 - Surfaces

Dobrzynski is interested in lattice properties: phonons and surface instabilities, bonding of two metals. F. Cyrot-Lackmann has studied the static aspect of the adsorption problem (bonding energy, density of states induced by the adsorbate) while G. Iche and P. Nozières are more interested in the dynamic aspect (friction force on a mobile impurity, application to desorption).

2 - Phase transitions

Important work by J. Villain on the idea of collective mode and of order parameter in one or two dimensional systems. Special mention should be made of a joint effort on applications of renormalisation group techniques to various problems (Kondo effect, etc.)

3 - Polymer dynamics

The exhaustive work of Schmid and Hölzl on modes associated with defects is at the application stage. A considerable number of results have been obtained by using symmetry to reduce the quantity of calculation work.

4 - Disordered systems

F. Cyrot-Lackmann and J.P. Gaspard have studied in depth the relationship between different methods in use in this type of problem. Their interest, which was originally confined to impurity bands of semi-conductors, now extends to amorphous materials and liquid metals.

Other more specific studies are difficult to allocate to a particular heading: phonons and their interactions in ionic crystals (Kress), magnons and their interactions in Heisenberg ferromagnets (Ranninger and Natoli), local field corrections in the dielectric constant in a free electron gas (Kugler), infrared singularities in the Raman diffusion of X-rays (Nozières), etc.

Even more than the work completed or in progress, it is important to stress the ideas "in the air" since this is the raison d'être of a group of theoreticians in a mainly experimental laboratory: martensitic transition in A15 compounds, dispersion and attenuation of phonons in liquid ^{4}He etc - there is no lack of ideas.

Most of the ILL theoreticians are associated with outside laboratories. In the Grenoble area, there are regular contacts with groups at CNRS, CENG and the University (theoretical seminars, etc.). On a wider scale, some members of the College have kept up a fruitful collaboration with their home laboratory.

There are some problems as regards the short-term development of the College. Next year four members will reach the end of their contracts, and the recruitment of new members is being considered: the present thinking is to give priority to high-level visitors coming for only a few months to bring some "fresh air" into ILL. In the coming

year, four or five visits of this type are planned. This type of collaboration is undoubtedly very enriching for the Institut, and is strongly defended. Nevertheless a certain minimum of "stable" theoreticians (for several years) is essential. Recruitment is difficult, as they must have a certain impact to ILL at large to justify their presence. This problem will have to be faced in the near future.

Secretary: P. Nozières

COLLEGE 3

"NUCLEAR PHYSICS"

I - Members of the College

Asghar M.		
Bailleul G.		
Bocquet J.P.	UER1, DRF CEN-Grenoble	
Börner H.		
Chauvin C.	DRF CEN-Grenoble	
Crawford G.		since September 1973
Dress W.B.	ORNL, Oak Ridge	
Gautheron J.P.	CEN-Grenoble	
Greif J.	temporarily at Dubna	since July 1973
Heck D.	GFK, Karlsruhe	
Henkelman R.	T.U.M. Garching	since July 1973
Jeuch P.		
Koch H.R.		
Liaud P.	UER1, ISN	
Mampe W.		
Miller P.D.	ORNL, Oak Ridge	
Moll E.	Balzers, Liechtenstein	since April 1973
Moussa A.	UER1, DFR CEN-Grenoble	
Perrin P.E.J.	DRF CEN-Grenoble	
Pinston J.A.		
Roussille R.		
Schrader H		
Schussler F.	DRF CEN-Grenoble	
Siegert G.		absent July - Nov. 1973
Steinberg R.	Rutherford Laboratory, ISN	
Vignon B.	CNRS, ISN	

II - Visiting Scientists

Chéry R.	IPN Lyon
Do H.P.	IPN Lyon

Emsallem A.	IPN Lyon
Hauser U.	P.I. Köln
Neuwirth W.	P.I. Köln
Pietsch W.	P.I. Köln

III - Scientific Activity

Nuclear physics at ILL is developing in several directions:

- Study of fission and fission products with the aid of the "Lohengrin" fission product spectrometer.
- (n,γ) spectroscopy by means of gamma diffraction spectrometers, an anti-Compton spectrometer and an electron spectrometer;
- Study of the basic properties of neutrons: measurement of the dipole moment;
- Test of time reversal invariance in the disintegration of polarised neutrons;
- Study of the (n_{th},α) reactions for medium heavy and heavy nuclei.
- Study of inter-atom and atom-molecule collisions by Doppler effect.

All these experiments are now operational, except for the "Lohengrin" spectrometer and the "BILL" electron spectrometer (W. Mampe and P. Jeuch). In (n,γ) spectroscopy the spectrum of $^{99}Tc(n,\gamma)$ has been studied with the aid of the GAMS I and anti-Compton spectrometers (H. Börner, D. Heck, H.R. Koch, J. Pinston, R. Roussille). The electric dipole moment of a neutron is at present being measured, the value at present obtained being $D = (0.34 \pm 1)\ 10^{-24}$ e.m. (W.B. Dress, P.D. Miller, P. Perrin).

The test to measure the time reversal invariance is also in progress, and the first results indicate a definite improvement in precision in comparison with earlier experiments (P.Liaud, R. Steinberg, B. Vignon).

Several cross-sections were measured for the (n_{th}, α) reaction resulting in new values for ^{151}Eu, ^{147}Sm and several isotopes of Yb (A. Emsallem, Do Hun Phnoc, R. Chéry: I.P.N. Lyon).

The use of the Doppler effect has made it possible to determine several characteristics of inter-atom collisions (the projectile is an atom of $^{7}Li^{*}$ produced by the reaction $^{10}B(n,\alpha)^{7}Li^{*}$). (U. Hauser, W. Neuwirth, W. Pietsch).

Finally an experiment performed at Cologne permitted the determination of the characteristics of a double ionisation chamber which will be connected to the "Lohengrin" spectrometer. (K. Sistemich (Jülich)in collaboration with P. Armbruster (Darmstadt) and M. Asghar, G. Bailleul, J.P. Bocquet, J.P. Gautheron, J. Greif, H. Hammers, H. Schrader, G. Siegert and E. Moll)

Secretary : J.P. Bocquet

COLLEGE 4

"PROBLEMS OF PURE CRYSTALS"

I - Members of the College

Almairac R.		
Berthet C.		
Castets A.		
Copley J.C.		since 1.11.73
Currat R.		
Dianoux A.J.		
Dorner B.		
Douchin F.		
Drexel W.		
Egger H.		
Funahashi S.	Japan Atomic Energy Research Institut	
Heidemann A.		
Hennion B.	CEN - Saclay	until 31.12.73
Hennion M.		until 31.12.73
Jex H.	Frankfurt	until 31.7.73
Kalus J.	T.U. Munich	
Kress W.	T.U. Munich	
Lechner R.E.		
Lovesey S.W.		
Meyer J.		
Parisot G.		
Ranninger J.		

Roth S.		until 31.11.73
Rustichelli F.		
Schedler E.		
Scherm R.		
Schlaak M.	D.F.G. Darmstadt	since 15.11.73
Steiner M.		
Stirling W.		since 1.7.73
Teuchert W.D.		
Tochetti D.		
Vettier C.		
Villain J.		
Volino F.		
Wagner V.	University of Würzburg	
Woods A.D.B.	Atomic Energy of Canada	since 24.5.73
Yelon W.B.		

II - Scientific Activity

In 1973, 23 experiments of College 4 were carried out (see Table). The following instruments were used :
IN1 (4 experiments), IN2 (13 experiments), IN3 (1 experiment, using flat crystals), IN4 (2 experiments), IN5 (2 experiments at low resolution), IN7 (2 experiments), D2 (1 experiment). Some of these experiments were performed while the respective instruments (IN1, IN3, IN5) were not yet completed and therefore operating with limited performance. The main activities have been in four different fields : lattice dynamics, phase transitions, magnetism and dynamics of disordered systems. Some of the experiments cover several of these fields simultaneously.

1 - Lattice dynamical models

Specific models were tested successfully for MgF_2, SiO_2 and for RbI by measurement of the phonon dispersion relations at room temperature. In the latter case the emphasis was on pressure effects. A breathing shell model was shown to be able to reproduce not only the phonon frequencies but also their pressure dependence at least up to 3 kbar. An attempt was also made to study the transition from zero to first sound in RbI by measuring the acoustic phonon branches at small q. Further lattice dynamical studies were carried out on CD_4 in phases I and II, on D_2O, Se, V_3Si and $KNbO_3$. In the case of V_3Si important changes in the acoustic part of the phonon density of states were found in the neighbourhood of the superconducting transition temperature. Part of the phonon studies in $KNbO_3$ and SiO_2 sought to explain the observed X-ray diffuse scattering. The latter was found to correspond to the "soft" regions of specific branches of the dispersion relations. Mode eigenvector determinations carried out for these provide a more detailed understanding of the diffuse X-ray streaks.

2 - Phase transitions

Several studies were undertaken with the purpose of shedding light on phase transformations. While an experiment on Cs at a first stage was limited to structure studies at very high pressure (up to 43 kbar) inelastic scattering studies were performed on several other substances. At the I/II phase transition of CD_4 critical slowing down was observed. This is the first non-magnetic observation of this kind in a solid. In SiO_2 the temperature dependence of the lowest acoustic branches was studied, in particular near the α/β-phase transition. The theoretical analysis of these temperature effects is not yet conclusive with regard to the question whether critical fluctuations near a first

order phase transition can be seen or not. The study of the linear conductor, $K_2Pt(CN)_4Br_{0.30} - xH_2O$, did not - as one might have expected - reveal a condensation of the anomalous (Kohn-Peierls) mode observed at room temperature. Instead, with decreasing temperature, increasing quasielastic scattering was observed to become critical near 80°K, which seems to correspond to the 3-dimensional phase transition.

3 - Magnetism

Spin waves were studied in Ca_2MnO_4 and in antiferromagnetic γ-Mn. In Ca_2MnO_4 special attention was paid to the temperature dependence of magnon energies near the transition from 2-dimensional to 3-dimensional order. In the case of γ-Mn magnon dispersion curves were measured up to 140 meV using for the first time incident neutrons of up to 600 meV (IN1)! Further magnetic studies were performed on antiferromagnetic $KCoF_3$ (Co^{2+} - excitons) and on $Ni_{1-x}V_x$ and similar alloys (measurement of stiffness constant D).

4 - Dynamics of disordered systems

Three types of substances were studied :

a) in α-AgI, a solid electrolyte, where Ag^+-ions have a very high mobility, the translational diffusion of these ions was studied for the first time with neutrons aiming at the geometry and the time dependence of the single particle motion.
b) in CD_4, a plastic crystal, the diffusion of the orientational correlation of molecules was found to be anisotropic. The observed quasielastic scattering related to the single molecule reorientation suggests that the molecules rotate in an extremely shallow potential.
c) In phases I and II of the ammonium halides NH_4Br and NH_4I, which exhibit dynamical disorder of the molecular orientation, a study of

rotational diffusion of these ions was started. Whereas for phase I in both cases quasielastic scattering was clearly separated from elastic incoherent scattering, for phase II this was possible only in the case of NH_4Br. These results yield rotational correlation times and information on the potential in which the ions rotate.

Secretary : R.E. Lechner

COLLEGE 5

"CHEMICAL AND MAGNETIC STRUCTURES"

I - Members of the College

Bartunik H.	since 1.3.73
Burlet P.	
Convert P.	
Dachs H.	since 1.10.73
Filhol A.	
Fuess H.	
Hewat A.	since 1.10.73
Hohlwein D.	
Klar B.	
Lehmann M.	since 1.6.73
Mason S.	since 1.6.73
Schneider J.	
Steiner M.	
Tasset F.	
Thomas M.	
Wilson S.	since 1.9.73
Wolfers P.	
Yelon W.	

II - Visiting Scientists

Duc T.	CNRS Grenoble	
Fender B.E.F.	Oxford	until 1.8.73
Lajzerowicz J.	University of Grenoble	
De Novion H.	CEN - Fontenay aux Roses	since 1.10.73
Plant J.	University of Sheffield	since 1.11.73
Rasmussen S.E.	University of Aarhus	since 1.9.73
Schweizer J.	DRF CEN-Grenoble	

III - Scientific Activities

1 - General Remarks

The centre of scientific activity was shifted in 1973 from the technical development and building up of the instruments to real experimental work. About 40 studies have been carried out in the last twelve months ; most of them are completed from the experimental side but in nearly all cases data evaluation is still in progress. The present report cannot pretend to give an extensive survey of all these activities but aims to show some typical experiments in the different fields. The reader is referred to the second volume of this ILL report for a detailed examination of all the results. Besides the experimental activity the college discussed as well the development of new instrumentation, especially for high-resolution powder work and neutron protein crystallography. Workshops were held on the study of zeolites and actinide compounds and on extinction problems.

The experimental activity may be subdivided into three main

fields : chemical structure, magnetic structure and spin density work.

2 - Chemical structure work

2-1 - Inorganic structures (Powders)

Structure work on powder samples was carried out on the D2 diffractometer. Let us report in first place the somewhat unusual work of Bacon, Cowlam (Sheffield) and Hohlwein on graphite inclusions in steel. The aim of the experiment is to detect differences in the graphite deposited after various degrees of heat treatment. The neutron measurements concern a dynamic state and are carried out at 600°C. The experiment is not yet completed but first results show that the small variation of the lattice parameter of graphite in steel can be detected by neutron diffraction. The authors were furthermore able to consider some of their procedures for accurate wavelength and lattice parameter determination.

Experiments were carried out by Fender, Cheetham and van Dreele (Oxford) on non stoechiometric rare-earth hydrides ($CeD_{2.5}$, $LaD_{2.3}$ and $PrD_{2.3}$). Runs were also made on a niobate block structure and on palladium hydride. Successful profile refinements were carried out on the ordered rare-earth compounds and the block structure has been used to assess the effects of resolution on the refinement of complex structures.

Wedgwood (Harwell) and Burlet studied the protactinium oxides PaO_2 and Pa_2O_5 and determined the scattering length of Pa^{231} to $b_{Pa} = (1.30 \pm 0.2) \cdot 10^{-12}$ cm. The aim of an investigation by Jones and Yerkess (Bradford) is an accurate determination of C-C bond-length in tetragonal dicarbide structures. Patterns were recorded on $Y_xHo_{1-x}C_2$

(five samples) showing the tetragonal CaC_2 structure. It is hoped that refinement will reveal the variation in C-C bond length with composition. Another series of samples were $U_{0.75}R_{0.25}C_2$ (R = La, Ce) and $U_xTh_{1-x}C_2$ (with x = 0.5, 0.3). Both families showed lines additional to those expected for the tetragonal CaC_2 structure.

2-2 - Inorganic structures (Single crystals)

The study of the crystal structure of a complex of $FeCl_3$ and DCN (deuterated cyanic acid) by Daran (Toulouse), Fuess and Yelon gave evidence of nitrogen bond to iron (Fe-N-C-D-chains) in contrast to the normally observed iron-carbon binding (Fe-C-N chains). The position of the deuterium atom was determined.

The study of uranium-glimmer (metatorbernit), a natural mineral (Rothbauer and Joswig, Frankfurt; and Knorr) allowed the location of the hydrogen positions and some estimates on the bonding scheme including hydrogen bridges. Other single crystal studies were done by Bartl (Frankfurt) and Mason on $4PbO \cdot PbSO_4$ and by Bartl and Yelon on Scolezite; by Durif, Masse (CNRS, Grenoble) and Fuess on $BaNH_4P_3O_9 \cdot H_2O$, by Mason on Hg-acetamide, by Ferraris, Catti (Torino) and Filhol on $CaHPO_4$ and by Vettier and Yelon on the high pressure phase of $FeCl_2$. The data collection on all these experiments is completed but data evaluation is still in progress.

2-2-1 Defect studies by diffuse scattering

Two experiments on diffuse scattering were made, one on V_4C_3 is almost complete, the other one on a spinel by Patrat, de Bergevin, Brunel (CNRS, Grenoble) and Yelon will be reported next year. The purpose of the measurement on V_4C_3 by Sauvage (Genève) and Yelon, was to confirm that the diffuse scattering observed on electron diffraction

patterns from V_4C_3 was due to short-range ordering of carbon vacancies. Continious scans in regions between Bragg peaks were registered and the intensity showed a maximum located very close to the mid-points. From these observations short-range order parameters of the carbon vacancies were derived.

3 - Organic and biological structures

The structure of the base-pair 1-methyl-thymine-9-methyl-adenine has been measured on the D6 facility by Klar.

The structural parameters were refined with 403 independent reflections to an agreement factor of R = 0.13. The resulting parameters confirmed the model proposed by Hoogsten from X-ray diffraction data and showed no significant difference compared with independent neutron diffraction measurements on a conventional instrument at Brookhaven.

Preliminary measurements were made on insulin crystals by Fuess and Mason on the four circle diffractometer D8, in order to determine the optimal conditions for a complete high-resolution determination of the three-dimensional molecular structure of a protein. Therefore the resolution of the instrument was studied at four different wavelengths. The intensity for the strongest reflection was 500c/sec under the best conditions. The peak to back-ground ratio for this reflection was 20:1. The background is however still too high for most reflections to allow a high resolution study with the present equipment. Considerable modifications to the instrumentation are needed before a full set of data can be collected.

At D12 about 80 reflections on insulin were recorded simultaneously on a single film by the modified Laue-film-method by Hohlwein.

The data were processed with a photodensitometer and attempts will be made to obtain structure amplitudes from the data. The determination of the molecular and crystal structure of cadmium-histidine dihydrate by anomalous dispersion on Cd^{113} was started by Bartunik and Fuess.

Several complete data sets were collected on the four-circle X-ray diffractometer by groups from the CENG and CNRS, Grenoble University, University of Lyon and CNRS de Bellevue. Some of these data sets were collected at liquid nitrogen temperature.

4 - Magnetic structures

Among the various studies on magnetic structure determination mostly done on D2 we cite especially the work of Burlet and Burlet (DRF CEN-Grenoble) on manganese-acetate ($Mn(CH_3COO)_2\ 4H_2O$) and of Steiner and Dachs on $CsNiF_3$. Both studies deal with systems which are ordered in one or two dimensions and in three dimensions at a lower temperature.

The magnetic transition temperature in $Mn(CH_3COO)_2.4H_2O$ has been determined on single crystals following the temperature dependence of magnetic reflections. Above the magnetic transition temperature T_N = 3.18 K the compound orders two-dimensionally. The three-dimensional order in the absence of a magnetic field is antiferromagnetic. The magnetic unit cell is twice the crystallographic one in the a direction and consists of ferrimagnetic sheets in (011) which are coupled antiferromagnetically. Under the application of a magnetic field, the compound becomes ferrimagnetic.The phase diagram of $CsNiF_3$ for $1.9\ K < T < T_N = 2.7\ K$ was determined in an external field. The phase

transition is always continuous. The critical scattering connected with the magnetic phase transition is centered around the position of the magnetic Bragg reflections. The critical scattering was found to be similar everywhere on the phase separation line ($H \neq 0$) and $T_N(H = 0)$: under the influence of a small magnetic field only domain reorientation processes were observed.

Other experiments were carried out on solid solutions of $NiTiO_3$ - αFe_2O_3 and Co_2TiO_4 - $CoFe_2O_4$ by Hubsch and Marnier (Nancy), by Boller (Vienna) on manganese disilicide ($MnSi_{1.743}$). New fields of interest in magnetic work are opened up by the work on actinide compounds where some preliminary measurements were done ($NpAs_2$ by Wolfers, and PaO_2 by Wedgwood (Harwell) and Burlet). The study of PdF_2 by Hoppe, Paus and Müller (Giessen) and Fuess shows antiferromagnetic ordering in compounds of 4d transition elements where little is known about the magnetic behaviour.

A study of the antiferromagnetic domain structure in $KCoF_3$ by neutron polarography was done by Schlenker (CNRS, Grenoble). The data show that this kind of study is feasible with neutrons and gave already interesting results.

Dance (Bordeaux) took powder diagrams of $CrVF_5$ and $CrTiF_5$. The magnetic structure derived from theoretical calculations was proven and refined for the compound $CrVF_5$.

The field and temperature dependence of nuclear and magnetic reflections were studied on single crystals of $DyVO_4$ by Will and Schäfer (Bonn).

The (100) magnetic peak disappears in a field higher than 2.5 KG; this means the formerly described magnetic structure breaks down in a field of this strength. The (200) nuclear reflections seem to increase at the same field which should be correlated to a ferromagnetic order or a domain rearrangement.

5 - Spin and electron density and form-factor measurements

These experiments are carried out by using diffraction of neutrons, X-rays and γ-rays. One technique consists of combining precise X-ray and neutron diffraction measurements to obtain results on the distribution of valence electrons. Rees (Strasbourg) and Yelon collected neutron data on $Cr(CO)_6$ at liquid nitrogen temperature. The results of this study will be compared with the results obtained on $Cr(CO)_3C_6H_6$.

The study of the compound $Co(NH_4)_2(BeF_4)_2.6H_2O$ by Vicat (CNRS-Grenoble Filhol and Thomas served as the final test of the D8 facility. 3400 reflections were collected in two months, corresponding to one month of real measuring time due to various failures. An optimization was effectuated for reflections with Bragg angles smaller than 30 degrees. The optimization gave ratios of $\sigma(F^2)/F^2$ better than 3.10^{-2}. Out of the 3400 reflections measured 1200 had to be rejected for several reasons (badly registered due to electronics failures, unobserved reflections, reflections registered several times). Data refinement is still in progress, the R-factor is at present R = 0.06. The aim of the experiment is to combine the neutron results with the X-ray results of Vicat in order to find the electron distribution between the various atoms. A study of the same kind was done by Tippe (Neuherberg) and Dietrich (Berlin) on $Li\text{-}C_2H_5$ at 77K. It will be combined with the X-ray data already published.

Schneider has developed the method of measuring absolute structure factors with short wavelength gamma-radiation. However, before results from neutron and gamma work can be combined further work has to be done on the extinction problem.

The other technique used to obtain this kind of information is the polarized neutron technique where several investigations were carried out at the D5 facility.

Schweizer and Tasset have processed their data on the ferromagnetic alloys YCo_5 and Y_2Co_{17} which were first studied on the DN2 at CENG and completed at the D5. The magnetic moment distribution in the map of YCo_5 allowed the separation of the various contributions within the unit cell. The interpretation of the form factor curve for the two crystallographic sites of Co showed that the anisotropy of the localised spin density of the cobalt is very important.

The magnetic moments in the different magnetic sites of Y_2Co_{17} were calculated. The existence of a polarisation of the conducting electrons in the zones of the unit cell with high proportion of localised moments was shown. Boucherle (DRF CEN - Grenoble) and Schweizer collected data on $NdAl_2$ in order to establish a spin-density of neodymium. Bonnet, Delapalme (DRF CEN-Grenoble), Fuess and Tchéou (DRF CEN - Grenoble) studied the magnetic form factors for the two different iron ions in yttrium iron garnet (YIG).

Magnetic structure factors were collected for about 200 reflections. Both the magnetic moments and the magnetic form factors were derived for the two sites. The magnetic moments at room temperature (3.75 μ_B and 3.70 μ_B for octahedral and tetrahedral site respectively) are considerably lower than those found by other methods. The magnetic form factor for the octahedral site is in good agreement with theoretical calculations for the free ion but there is a marked deviation of the form factor curve of the tetrahedral site from the calculated value.

The magnetic moment distribution shows clear evidence of moment density (result of uncancelled moments transferred from the two sites) on the oxygen ions.

6 - Extinction with γ-diffraction

The conventional corrections for extinction are based on the assumption of a homogeneous distribution of the crystal mosaic. Measurements by Schneider at the γ-diffractometer show, however, that this assumption is nearly never fulfilled. The developement of a diffraction theory for inhomogeneous mosaic crystals was considered but did not appear promising. An experimental criterion was formulated and tested which allows a decision as to whether diffraction of 412 KeV γ-rays by a real crystal may be described reasonably well with Darwin's model. For diffraction with various degrees of extinction the calculation should always give the same mosaic distribution.

7 - Programs and new instrumentation

The main effort in programming was made by Duc who worked on the X-ray system and on programs for the application of direct methods.

Lehmann did work on a method for precise determination of peak and background. Data reduction programs were developped by Filhol, Fuess and Wilson. The amelioration of the measuring programs for D8 and D10 was continued by Filhol and Yelon in cooperation with Barthélemy and Kaiser from the computer group.

The proposition to build a high resolution powder diffractometer was extensively discussed in the college. Several solutions (a third instrument at the H11 channel between D2 and D8, a considerable modification of D1A or a back-scattering time-of-flight instrument) were envisaged, but no final decision was taken.

Secretary : H. Fuess

COLLEGE 6

"LIQUIDS GASES AND AMORPHOUS MATERIALS"

I - Members of the College

Bellissent R.		
Chieux P.		
Copley J.		since 1.11.73
Cyrot-Lackmann F.	CNRS	
Derrien J.		
Dianoux A.J.		
Douchin F.		
Drexel W.		
Egger H.		
Gaspard J.P.		
Hamelin A.		
Heidemann A.	University of Munich	
Hervet H.	Collège de France	
Higgins J.		since 1.7.73
Howells W.S.		since 19.9.73
Knoll W.		
Kugler A.		
Lechner R.		
Marti C.		
Ranninger J.		
Scherm R.		
Seyfert P.		
Stirling G.		
Volino F.	Guest professor at the Physics Department of the National Engineering University, Lima, Peru (August to October, 1973).	

II - Scientific activity

Introduction

During 1973 two spectrometers used in the College have become operational for experiments: at the beginning of the year the spectrometer D4 (diffractometer for liquids at the hot source) and in the middle of the year IN4 (time-of-flight spectrometer for thermal neutrons). For this reason the majority of experiments have been to determine the short range order in gases under pressure, molecular liquids, liquid alloys and amorphous semiconductors.

The College is divided into three groups corresponding to their members' main field of activity:

- Structure of liquids and amorphous materials

The instrument used most is the diffractometer D4, which has proved to be very satisfactory for studies of molecular liquids, due to its very wide range of momentum transfer (0.4 to 34 $\AA^{-1}$).

- Quantum liquids

Several experiments on He^4 and He^4-He^3 mixtures have been prepared and will be carried out at the beginning of next year when the cryogenic problems have been solved and the desired spectrometer is available.

- Dynamics of liquids and amorphous materials

Several studies on the dynamics of liquids have been prepared. These studies are on simple liquids, liquid metals, molecular liquids, liquid crystals and amorphous substances. Some experiments have been carried out this year.

Experiments

Sixteen experiments have been carried out this year, and the results are satisfactory. Three experiments have been delayed, in all cases due to a deficiency in the performance of the instrument in relation to its technical specifications. These experiments must be redone when the instrument has achieved its specified preformance.

Apart from carrying out their experiments and assisting outside users, the members of the College have been involved in improving spectrometers already in routine operation (D4, IN4) and in developing two others (IN5 and IN9). There has been a special effort on the processing of data: both for diffraction and inelastic scattering, the measurements must be corrected for several effects before they can yield any usable results.

Some examples of experiments carried out

1-Structure of liquids

The greatest number of studies have been in this field this year. H. Ruppersberg (University of Saarbrücken) has studied lithium-lead alloys in their liquid phase. These experiments have shown that the proposed interpretation of X-ray diffraction curves was correct: there are correlated concentration fluctuations in the binary liquid. The diffraction of neutrons is very favourable in this case because Li and Pb have scattering amplitudes of different sign.

Mme Dupuy and J.Y. Derrien (University of Lyon I and ILL) have started their studies of ionic liquids (molten salts) with KCl The use of KCl with enriched ^{35}Cl and ^{37}Cl has made it possible to obtain diffraction curves showing very noticeable differences: this gives hope

that it will be possible to calculate the partial structure factors with good precision. The radial pair distribution functions will then be compared with those obtained by a Monte-Carlo method for a particular ionic pair potential.

J.E. Enderby, R.A. Howe and W.S. Howells (University of Leicester) measured the scattered intensity from saturated solutions of $NiCl_2$ in D_2O. Using two mixtures of Ni isotopes they were able to extract the partial structure factor a_{Ni-Ni}.

Their results tend to prove that in a concentrated solution, ions are ordered in a lattice-like manner. The same result was found for solutions of NaCl in D_2O.

P. Chieux (ILL) has begun the structural study of metal-ammonia solutions with a precise determination of the structure factor of ND_3. Measurements of ^7Li-ND_3 solutions at different concentrations showed a peak corresponding to the distance between the layers of tetrahedra of the solid compound $Li(ND_3)_4$.

In the field of molecular liquids J.C. Dore and J.M. Clarke (University of Kent), R. Régis and R. Parreins (University of Paris-Sud) have studied respectively the structure of liquid nitrogen and of carbon tetrachloride. With the very good statistics of the measurements it is hoped that the radial distribution functions will be determined very accurately.

2 - Dynamics of liquids

Few experiments on the dynamics of liquids or of amorphous materials were carried out this year, as the spectrometers were not yet operational or became operational late in the year.

J. Suck (GfK-Karlsruhe) used IN4 to measure the time-of flight spectrum of liquid rubidium. The evaluation of the results has not yet been completed.

Some experiments on mesomorphic phases (liquid crystals) have started with the chopper spectrometer IN5. This instrument is still operating at low chopper speed, and the shielding to reduce the background has not yet been completed, so that the instrument has not been used at optimum performance. These experiments have been carried out by A.J. Dianoux, H. Hervet, R.E. Lechner and F. Volino (ILL).

- Study of the nematic phase of PAA

Three samples have been studied; one deuterated on the benzene rings, the second on the methyl groups, and the normal sample. Considerable differences were observed in the time-of-flight spectrum. This indicates very different motions between the various parts of the molecule and permits the spectrum to be assigned. In particular the contribution of the methyl groups occurs mainly in the inelastic region.

- Study of the different mesomorphic phases of TBBA

The time of flight spectra have been obtained in the six phases. Surprisingly the differences between the spectra of the different phases are not very marked (except for the crystalline phase). It also appears desirable to carry out selective deuterations in order to obtain more detailed information on the dynamics.

- Study of a soap-water system

The different phases of the potassium laurate/heavy water system have been studied at different temperatures with the spectrometer IN4. The aim of this preliminary study is to compare the motions in

the different phases (micell phase and lyotropic phases) and to check the results obtained by nuclear magnetic resonance.

Secretary: A.J. Dianoux

COLLEGE 7

"IMPERFECTIONS"

I - Members of the College

Ackermann H.	Univ. of Heidelberg	since 1 April 1973
Bletry J.		
Burlet P.		
Devismes N.	CEN-Grenoble	
Drexel W.		
Dubbers D.	Univ. of Heidelberg	since 1 April 1973
Fender B.	Univ. of Oxford	
Freund A.		
Goeltz G.		
Grupp M.	Univ. of Heidelberg	since 1 April 1973
Ibel K.		
Iche G.		
Jaccarino V.	Univ. of California	since 1 September 1973
Jeandey C.		
Just W.		
Knorr K.		
Kostorz G.		
Livet F.		
Lovesey S.		since 1 July 1973
Marti C.		
Mathieu J.		
Mezei F.		
Nozières P.		
Parisot G.		
Pataud P.		
Radhakrishna P.		
Roth M.		
Roth S.		
Rustichelli F.		
Schneider Jochen		
Schneider Julius		

Schweizer J.	DRF CEN-Grenoble	
Stirling W.		since 1 July 1973
Tasset F.		
Thorel P.		
Villain J.		
Wagner V.	Univ. of Würzburg	

II - Scientific Activities

1 - Introduction

This report represents only a short survey of the scientific activity of the College members. A more detailed description of the experiments performed and their results are given in the second volume of the ILL annual report and publications are listed in a special chapter of this volume. However, as almost all experiments performed in 1973 have been carried out in collaboration between ILL-physicists and users from outside institutes, the following picture of the activity describes all the different kinds of experimental work done on the ILL neutron spectrometers in College 7 rather adequately.

The instruments mainly used were D7, D11 and IN4, but also some time was requested for measurements on D2, D5, IN2 and IN7. The number of 42 new experiments proposed in 1973 which have all been discussed in College meetings, is about the same as the total number of proposals submitted before 1973. Several seminars at the ILL have already been held and are planned for the next year in order to coordinate the activity of different groups working in the same fields of research, e.g. lattice gas in metals, rare earth alloys, Invar, precipitations in Al based alloys, etc.

2 - Magnetic Impurities - Magnetism of Alloys - Spin Waves

Neutron small angle and diffuse scattering experiments have been carried out on the system $Ce_{1-x}Tb_xRu_2$ by K. Ibel, W. Just and S. Roth on the instruments D7 and D11 in order to study the coexistence of magnetic order and superconductivity. The order of the Tb-spins at x = 20% has been found to be of the spin glass type both above and below the transition temperature. The results suggested a more extensive study of spin glasses, and preliminary experiments on clusters in AuFe alloys are in progress at D11. An account of the results will be published later by K. Ibel, F. Mezei, P. Radhakrishna, B. Rainford (Imperial College, London), and S. Roth.. W. Just presented a review on "Magnetic Diffuse Scattering of Neutrons" at the Meeting of the Institute of Physics, London, December 1973. M. Roth, G. Göltz and A. Chamberod (DRF-CEN-Grenoble) performed small angle scattering experiments on a Ni-Fe 30-70 alloy in order to get information about the concentration and magnetisation fluctuations in this system. The results have to be analysed and further measurements will be made.

P. Radhakrishna, together with F. Livet, studied the spin density in single crystals of Ni containing 2% Ti using polarised neutrons (D5). The analysis of the results is in progress. He continued the collaboration with the CNRS - "Centre de recherches sur les très basses températures" on interactions in magnetic alloys, using resistivity measurements of the systems CuMn, AuFe, AuMn, PtCo, and NiV at temperatures below the ordering temperature, where new features of the resistivity appeared. P. Pataud performed at the same laboratory magnetisation measurements on the alloy VFe. The cryostat and the magnet for measurements on D7 which are necessary in order to extend the results, are now being tested.

V. Wagner investigated together with B. Hennion (CEN-Saclay) and D. Tocchetti magnetic excitations in mixed crystals of NiO with other transition metal oxides in the antiferromagnetic phase by inelastic neutron scattering at IN1. The measurements on NiO-30% CoO are not yet complete but so far have been successful. In addition the infrared technique has been applied to this substance whereby the single ion anisotropy of the impurity ions has been determined. Other spin wave studied have been carried out by W.G. Stirling, P. Radhakrishna and E. Walker (University of Geneva) on the system PdFe using the instrument IN2. Well-defined magnon groups were not observed. However, some inelastic scattering occurred and the work on this alloy will be pursued at higher concentrations of Fe.

F. Mezei continued the development of the spin echo technique and performed both calculations and test experiments in order to prepare the design of the full scale instrument IN11. He tested this method with a white neutron beam, studied the homogeneity necessary of the magnetic field and demonstrated the capabilities of the method both in a high resolution ($\Delta E = 2 \times 10^{-8}$ eV) and in a reduced scale operating mode ($\Delta E = 5 \times 10^{-6}$ eV) by real experiments. Furthermore he tested a hexapole type neutron polariser and obtained satisfactory results (100% virtual polarisation).

3 - Metallurgy - Non-Magnetic Impurities - Dislocations

In this field of research much work has been done on Al based alloys. G. Kostorz studied the chemical composition of clusters in $Al_{1-3x}Mg_xZn_{2x}$ on D11 in collaboration with V. Gerold and G. Kralik (MPI für Metallforschung, Stuttgart) which will be continued. The combination of X-ray and neutron small angle scattering yielded the Mg concentration in the precipitates and the matrix of 28 at.% and 7 at.% after ageing at

20°C and similar results after ageing at 60°C. G. Kostorz participated in experiments on the decomposition of Al-alloys on D7 and D11 (C.D. Clark, S. Messaloras, E.W.J. Mitchell, R.J. Stewart - University of Reading). Furthermore he studied homogenised and air quenched technically pure AlSi alloys with 0.4 - 1.2 at.% Si. These samples were prepared for the Cold Source Research Programme (in collaboration with SBT-CENG). Alloys for low temperature irradiation with fast neutrons and for subsequent mechanical property and annealing measurements were to be as homogeneous as possible. D11 was used to verify the absence of measurable Si clustering following the slow quenching method used and no evolution of the small angle scattering was measurable for ageing times of 15 min to 21 days at room temperature.

M. Roth finished the data analysis of small angle neutron scattering on Al Mg alloys and deduced the size, number and Mg-concentration of the Guinier-Preston zones present in these alloys. This work has been done in collaboration with M. Bernole, R. Graf, P. Guyot and J.M. Raynal. Further small angle scattering experiments and measurements of superstructure reflections (at D2) on Al Mg polycrystalline alloys, performed together with A. Daugier (University of Poitiers) in order to study order-disorder transformations in the G.-P. zones have still to be analysed and to be completed by other measurements. The publication of results concerning G.-P. zones in AlCu single crystal alloys (with J.M. Raynal, University of Rouen) and of the investigations of the phase separation in Na_2O, SiO_2 glasses (with J. Zarzycki, University of Montpellier) is in progress. Furthermore M. Mendes and M. Roth developed Fortran routines for desmearing measured small angle scattering profiles.

Other small angle and diffuse scattering experiments have been performed by W. Just and E. Seitz (KFA Jülich) on PbBi alloys (D7 ;data

analysis in progress) and by B.E.F. Fender, J. Nawrocki (Oxford University) and G. Kostorz on defect clusters in the fluorite structure (D11; feasibility study, showed that measurements of differential cross sections in the millibarn region are possible).

Much work has also been done on the dislocation structure in magnetic and non-magnetic single crystals. An orientable sample-support controlled by the computer system NICOLE and a magnet have been installed at D11. Ni and Fe single crystals have been studied by neutron small angle scattering. The analysis of experimental results obtained up to now is in progress and further measurements will be done. This work is performed by G. Göltz in collaboration with H. Scheuer, W. Schmatz (KFA Jülich) and H. Kronmüller and A.A. Seeger (MPI für Metallforschung, Stuttgart). In June 1973 A. Freund finished his thesis work on the diffraction of X- and γ-rays by copper single crystals with different dislocation densities. In the framework of this study a high resolution double crystal X-ray diffractometer has been built which works in a wide range of Bragg angles, from 3° up to 89.9° also using wavelengths out of the continuous X-ray spectrum. The aim of the investigation was to determine the lattice tilts (mean misorientation angle η) and strains ($\frac{\Delta a}{a} = \varepsilon$) introduced by different amounts of dislocations and to study the relation between the mathematical mosaic model and the real defect structure of an imperfect crystal. A resolution of 0.05 seconds of arc for η and of 10^{-7} for ε has been obtained. As a function of the dislocation density the lattice tilts increased much faster than the lattice strain, thus revealing the non-statistical distribution of the spacings between dislocations and the signs of the Burgers vector. The wavelength dependence of the integrated reflecting power has been measured in a range $0.03\ \text{Å} < \lambda < 1.66\ \text{Å}$ using the γ-diffractometer built by Jochen Schneider

and a set of wavelengths selected out of the continuous X-ray spectrum. It has been shown for the first time that the same crystal may reflect like a perfect or an ideally imperfect crystal depending on the wavelength of the radiation used in the diffraction experiment. Precise values for the form factors of Cu derived from perfect crystal data (X-rays), as well as those obtained from γ-ray measurements for which the crystal behaved like an ideal mosaic crystal, agreed to better than 1% with recent theoretical results. An application of Zachariasen's extinction theory to 10% - 20% extinguished reflections, did not give the correct values for the form factors because primary extinction has been present. Jochen Schneider succeeded in increasing the integrated reflecting power for γ-rays of 0.03 Å by bending elastically a CaF_2 single crystal and demonstrated that there has been 20% primary and only 3% secondary extinction present in the unbent sample. A new and more refined bending mechanism has been constructed which allows systematic investigations with the 158 keV and 412 keV gamma radiation.

4 - Crystal Field Studies

K. Knorr has performed experiments on the crystal field splittings in metallic rare earth compounds by inelastic neutron scattering in collaboration with W. Drexel, P. Morrin, J. Pierre (CNRS Grenoble) and J. Rossat-Mignod, and P. Chamard-Bois (DRF-CEN-Grenoble) using the time-of-flight instruments IN4 and IN7. Results have been obtained on the systems ErX (X=Cu Ag,Zn), R.E.Rh (R.E. = Ho, Er, Tb, Tm) and quite recently on $NdSn_3$, $NdPb_3$. The results for HoRh are already published: the complete crystal field level scheme has been deduced from well resolved transitions, and field parameters have been obtained which deviate considerably from point charge estimates.

5 - "In-beam" - Experiments: NMR Spectrometer SI6 and Mössbauer Experiment SI5

Starting in April 1973 an in-beam NMR spectrometer (SI6) for activated β- and γ-emitters has been built by H. Ackermann, D. Dubbers and M. Grupp (University of Heidelberg) which became operational in September 1973. SI6 is suited for the measurement of relaxation times and NMR signals of radioactive, polarised target nuclei, produced by capture of polarised neutrons. The nuclear polarisation is monitored by the radioactive decay. For target activation a beam of polarised thermal neutrons (polarised by a magnetic mirror) is available; $P > 80\%$, $I \approx 5.10^7$ polarised neutrons/cm^2 sec at the target 50 x 5 (to 10) mm^2 cross-section. The target temperature can be varied between 4 and 1000 K. Pertinent data of the other components are: electro magnet (ϕ 25 cm, 10 kW), rf-field (quartz synchronised up to 100 MHz, 20 W) two β-detectors (10 x 10 cm^2 scintillator telescopes) three γ-detectors (500 cm^3 NaJ scintillators). CAMAC electronic and a NOVA computer are used for data acquisition and control of the experiment.

The following experiments on NMR and relaxation of neutron activated short lived nuclei have been carried out together with P. Heitjans and H.-J. Stöckmann (University of Heidelberg):

a) Self diffusion and nuclear spin relaxation of Li^8(0.8s) in Li^7 metal: If the correlation time for the atomic motion is of the order of the reciprocal Larmor frequency the longitudinal relaxation time T_1 passes through a characteristic minimum. Such minima and their broad transition regions into the Korringa line have been investigated between 0.1 - 7 kOe.

b) Study of electric field gradients and defects in fluorides:

- In cooperation with K. Recker (Bonn) and K. Wanczek (Frankfurt) electric field gradients in $KZnF_3$ and $NaMgF_3$ single crystals have been investigated by irradiation of a broad band modulated rf field. Extension to other fluorides is under way.

- In MgF_2 it was found from measuring width and height of NMR signals that the ^{20}F (11s) nuclei recoiled by the capture γ-radiation (E_{rmax} = 1.2 keV) are almost completely stopped by replacement collisions on normal lattice sites in an undisturbed environment.

C. Jeandey finished experiments on Hf-compounds using the "in-beam" Mössbauer apparatus (SI5) installed at H22 since October 1972. By changing somewhat the experimental setup he succeeded recently in also using Fe^{57} for in-beam operation, in collaboration with M.Cjzjek (Karlsruhe). The alignment of non-cubic defects in $FeAl_3$ between 80 and 300 K and the migration of interstitials in FeAl between 600 and 1000 K is studied.

6 - Miscellaneous activities

K. Ibel collaborated with G. Alefeld, H. Schefts and N. Stump (TU München) on experiments at D11 examining the behaviour of H and D as lattice gas in metals. It turned out that in contradiction to conclusions from previous experiments a critical scattering can be observed.

G. Kostorz terminated the evaluation of the enhanced plasticity effects in superconductors based on experiments carried out at Argonne National Laboratory.

P. Thorel continued feasibility studies for experiments on vortex lines in type II superconductors to be performed on the instruments IN11 (spin-echo) and D11. The design of the cryostat and the super-conducting magnet has been completed.

P. Chieux, K. Ibel, G. Kostorz and M. Roth served as members of the local committee for the 3rd International Conference on X-ray and Neutron Small Angle Scattering, Grenoble, September 5 - 8, 1973.

Secretary : A. Freund

COLLEGE 8/9

"PHYSICAL BIOCHEMISTRY / PHYSICAL CHEMISTRY"

I - Members of the College

Arndt U.	M.R.C. Cambridge	until 31 August 1973
Bartunik H.		since June 1973
Chenavas P.		
Dianoux A.		
Duée E.		
Fuess H.		
Gilmore D.		since 1 November 1973
Haas J.		
Higgins J.		since 1 July 1973
Hölzl K.		
Ibel K.		
Jacrot B.	on leave September 1973 - June 1974	
Klar B.		
Lajzerowicz J.	Univ. of Grenoble	
Lehmann M.		since 1 June 1973
Mason S.		since 1 June 1973
Mathieu J-P.	ILL and DRF CEN - Grenoble	
Peterlin-Neumaier T.		
Peticolas W.	ILL and Univ. of Oregon	since 1 September 1973
Schmid C.		
Stirling G.		
Stuhrmann H.	Univ. of Mainz	until 28 February 1973

II - Visiting Scientists

Fender B.	Inorganic Chemistry Laboratory, Oxford, April-September 1973
White J.	Physical Chemistry Laboratory, Oxford, February-April 1973

III - Scientific Activities

The dominating interests of the College have been small angle scattering from large molecules, biological crystallography, and polymer dynamics. Experimentally, most work has been carried out on the small angle scattering instrument D11. Stuhrmann (now returned to Mainz) has carried out an extensive series of measurements on aqueous solutions of macromolecules with molecular weights from about one hundred to several millions. The contrast variation technique, where the solvent scattering-length density is varied by using different H_2O-D_2O mixtures, has been developed for separating the shape scattering from the scattering of the internal solute structure. An international programme (Mainz, Manchester, Saclay, Strasbourg) on the conformation of bulk polymers has been fostered by the Institut, co-ordinated by Higgins. The long-disputed hypothesis that in the bulk the molecule is an unperturbed gaussian chain has now been unambiguously confirmed. In addition, work has started on small angle scattering from polymers in solution (Saclay). Biological problems investigated on D11 in collaboration with Ibel have included the study of low-density lipoproteins (Basel, Gif), diffraction by tobacco mosaic virus (Heidelberg), and DNA structure (Paris).

Considerable effort has been devoted to the development of instruments for investigating the crystal structure of biological materials. Two conventional four-circle diffractometers, D8 and D16, have now been commissioned, and measurements have started on 2-Zn-insulin (Fuess, Mason). The four-circle diffractometer on the hot source, D9, which will utilize the anomalous scattering technique for phase determination, is currently being installed (Bartunik, Lehmann). Two instruments are based on the "Modified Laue Method", D6 with 100 movable detectors (Klar), and D12 with photographic detection (Hohlwein). A full

structure analysis on a base-pair of thymine-adenine has been carried out on D6 while preliminary experiments on insulin were done on D12. A television detector system, D14, is being developed for the study of fibres and biological single crystals (Arndt, Gilmore).

In polymer dynamics, Schmid and Hölzl have continued and extended their theoretical calculations on defect modes in polyethylene. Experimentally, a study of phonon dispersion in a single crystal of polyoxymethylene has been carrried out by White (Oxford) in collaboration with Currat on the triple-axis spectrometer IN2 ; both transverse and longitudinal acoustic modes were identified.

The application of neutron scattering techniques to the study of synthetic and biological polymers and macromolecules. Following a recommendation of the Scientific Council, the College organized a one-day "Workshop" at the ILL on 10 October 1973 attended by over 50 scientists from France, Germany and the U.K. Lectures covered polymer structure and dynamics, small angle scattering by large molecules in solution, and structural studies of biological materials.

Secretary : G.C. Stirling

REACTOR SERVICE

OPERATION OF THE REACTOR DURING 1973

In 1973 the Reactor did not start up until 24 January. The last cycle in 1972 was interrupted on 15 December for a general check of how well-shielded the beam tubes were and to provide them with a neutral atmosphere, to ensure that there was no recurrence of corrosion incidents such as the one in which the source transporter of beam H9 was damaged.

This major work continued until 24 January 1973.

I - Operation timetable

1 - Cycles N7 and N8 - at 57 MW

These two cycles passed without any incidents worthy of note, finishing on 2 March.

2 - Cycle N9

This cycle started on 5 March at 57 MW nominal power, and finished on 3 April at 40 MW as a result of damage to a main pump in the primary circuit (part of the electric motor destroyed).

3 - Cycle N10

This cycle started at 40 MW until 23/5/73 and finished on 30/5/73 at 57 MW after the pump motor had been replaced.

4 - Annual shut-down 30 May to 4 July

This shut-down was utilised for various maintenance jobs, for

installing experiments and for improving the cooling of the main pump bearings to avoid a recurrence of the incident of 23 March.

5 - Cycles N11 to N17

These cycles at 57 MW passed without serious interruption and lasted until 22 December. They were only interrupted by three unscheduled 48-hour shut-downs (due to a strike, a relay incident on the cold source and human error on activity measure counters).

II - Consumption of fuel elements and integrated power

The consumption of fuel elements was 5.3, corresponding to 12,426 MWd and equivalent to 218 days at full power.

The actual operation figures were :

- 245 days operating (including about 200 at 57 MW).
- 13 days of unscheduled stoppages.
- 107 days of planned shut-downs for installation, maintenance and changing fuel elements.

This can be converted into percentages :

- gross percentage of operation during the year : 67 %
- real percentage of operation in relation to the programme : 94,7 %

III - General conclusions drawn from operation in 1973

A study of this first year of operation gives rise to the following comments :

1 - Difficulties of continuous operation including operation during the school summer holiday period.

As a result of these difficulties a sixth shift team has been recruited, which will start work in the first half of 1974.

2 - Prolonged difficulties in the starting up of the detritiation works, which should finally take place in 1974. Continuous operation should stop the rapid increase in the proportion of tritium in the heavy water.

3 - Very good reliability of the Reactor sub-units, particularly the hot and cold sources.

Despite the incidents on the heavy water pumps, which were responsible for a long period of operation at reduced power, and the persistent difficulties due to the poor quality of the cooling water obtained from the river Drac, the proportion of outages has been only about 5 %, which may be considered as low for a first year of normal operation.

TECHNICAL SERVICES

TECHNICAL SERVICES

SCIENTIFIC SUPPORT

1 - Construction and Maintenance Section

Four sectors of activity have been developed in the Mechanical Construction Section: Design studies and industrial manufacture - Assembly and testing - Installation - Technical Assistance. The main jobs have been:

- -conversion of IN1, IN3, D7, D1A and B
- -completion of D8, IN5, IN10
- -special equipment for IN2, IH1, SI5
  preparation of new instruments:
  D9, D13, D16, He3 being installed
  IN7 - D3, IN8, IN2B, IN6 to be installed shortly,
- -study of the possibilities of construction of IN11, IN12 and D11B and modification of D4, D10, ultra cold neutrons,
- -technical assistance on IN5, D5, D7, D11, IN7, IN3,S13 ,SI4 , SI4,
- -development of special equipment : air-bearing rotating tables for heavy loads, targets and furnaces,
  choppers and velocity selectors ,
- -additional shielding necessitated by the reduction of background noise,
- -initiation of the construction by industry of neutron guides for beam tube H14
- -construction and equipping of the test platform.

2 - Electronics section

The first half of 1973, like the year 1972, was occupied by the installation of further first generation experiments and their systematic improvement. The number of operational experiments set up in conjunction with the sections "process computer software" and "design and construction of experimental equipment" increased to 23.

The main emphasis of work in the second half of the year was on the second generation of experiments (D3, D9, D11B, D14, IN6, IN8, IN9, IN11, IN10, IN12) and work to be caught up with on inventories the completion of maintenance contracts and documentation. The following point should be particularly noted:

2-1- Neutron detectors and multidetectors

The neutron detector developments (3He gas detector) carried out jointly by the ILL Electronics section and the Company LMT, proved to be very successful. At present there are 600 3He detectors of various designs in operation at ILL. They have practically no sensitivity to gamma radiation. The values for their background (reactor not operating are between 3 and 15 counts per hour).

Experience with the operation of the multidetectors of experiments D11 and D1B led to the decision to develop new multidetectors to operate in the proportional range. Parallel with this development, which is being carried out jointly with LETI and LMT, ILL is developing a new encoder logic, which should permit considerably higher counting rates (dead time: 1 μ sec) and should prevent encoding errors.

2-2 - Computer Interfaces

a) Nicole

An interface for the Nicole computer system has been developed at ILL (ITR 18/73). This interface uses the standard channel of TR 86, a standard Telefunken modem, and the ILL Camac system controller, which had already been developed for Nicole system experiments. The interface permits block transfers to the memory of the TR 86 under control of the program. With the aid of buffer stores near the experiment any of the existing experiments at ILL could be connected to the TR 86. This interface will be used at the Dusseldorf University hospital for intensive monitoring of seriously ill patients.

b) PDP 11

The ILL interface for the PDP 11 was completed by the direct memory access.

The Camac interface for the PDP 11 permits an economic solution of real time problems typical of many ILL experiments. This is achieved by the consistent utilisation of the properties of the PDP 11, which make special allowance for the solution of real-time problems.

2-3 - Experimental electronics

The experimental electronics of the CARINE and NICOLE systems were extended by the automation of additional control functions and by the connection of analog captors (temperature, magnetic field, etc.). In this connection 15 different Camac and NIM modules were developed in the past year. Work has started on the documentation on the experimental electronics. It is also intended to produce a brief catalogue of the ILL developments.

2-4 - Service and maintenance

Any failures occurring on experiments are given highest priority by all engineers and technicians of the electronics section. The technicians in the section are responsible for particular experiments, in the construction of which they themselves played an important part.

There are also responsibilities for units such as interfaces, detectors, nucleonics, NIM scalers, CAMAC scalers, digital voltmeters. This network of responsibility for systems and units has proved extremely satisfactory and has led to a systematic improvement in experiment reliability. Time failures attributable to electronics faults should be only a small percentage of the measuring time on completed experiments. Maintenance and repair contracts have been signed for the large numbers of measuring instruments and equipment supplied by industry. To a large extent the ILL makes use of the existing CENG contracts. Instruments where this is not possible are maintained by technicians in the electronics section.

3 - "Cryogenics - Vacuum" Section

3-1- Vacuum equipment

Current maintenance of 200 vacuum pumps, including 150 primary, 40 secondary and 10 special (Roots). Repair of 60 pumps, including 20 which were contaminated.General technical assistance, particularly on the de - tection of leaks (more than 1000 helium tests). Inauguration of a loan service (primary and secondary pumps, gauges etc.) which made more than 100 loans during the year.

3-2 - Cryogenic liquids and gases

Installation and commencement of operation (February 1973) of the distribution of gaseous nitrogen in the reactor by recompression at 150 b of the evaporated gas in the 6000 l liquid nitrogen tank.

Liquid nitrogen : consumption from 1.1. to 30.11.73 :131,917 litres.

Liquid helium : consumption from 1.1. to 30.11.73 : 11,297 litres.

min. monthly consumption: 300 l

mean monthly consumption: 1000 l

max. monthly consumption: 1900 l

Rate of loss of gas: 26 %

Extension of the system for recovering helium gas (D1B, H17, SI6, etc.)

3-3 - Cryostats

In operation on 1.1.1973 : 6

In operation on 31.11.1973 : 14 (9 allocated
(5 for general use

The number of cryostats in operation is still very inadequate (by a factor of 4 in comparison with organisations equivalent to ILL). This involves a considerable increase in work to ensure the rapid rotation of cryostats and their adaptation to specific problems.

Thirteen additional cryostats, ordered in July 1973, should have been delivered by the 31.12.1973. If delivery delays are not too great and if these instruments can start operating quickly, the situation will be eased to some extent in the coming months.

A contract for design and construction of a dilution cryostat was awarded on May 1973 to the Research centre on very low temperatures at CNRS. This has now been completed and is at present in the test phase.

TECHNICAL SERVICES

TECHNICAL SUPPORT

1 - Production, Fittings and Maintenance Section

1-1 - Mechanical

a) Main workshop

Our workshops have carried out approximately 8700 hours of work, permitting 350 major requests for work to be dealt with, divided as follows: 40 for the Reactor, 50 various for general needs, 260 for the drawing office and the physicists.

A number of very interesting mechanical engineering jobs should be mentioned: angular modules for IN6, prototypes of pneumatic gonio - meters and rotating tables, stop-flow system for D11, work on high speed choppers, various collimators, source carrier and tape unroller for Lohengrin. However, as in 1972, the workshops had a definite predominance of small jobs, to modify or adapt items used in experiments - 80 % of the requests were for work of less than 20 hours, often urgent. These jobs make it difficult to plan work of technical interest, particularly in the boiler-making and welding shop.

b) Self-service workshop

This workshop equipped with 3 lathes and 3 milling machines of medium quality, permits technicians and experimenters to do minor machining work and small production jobs themselves. An average of 12 employees used this workshop 40 to 42 hours per day, the equivalent of 6 full-time employees.

c) Various workshops

For shielding requirements around the experiments the following work has been done;

- Production of 750 m2 of flexible panels of polyethylene or boron carbide.

- Filling the shielding with paraffin, lead, boron carbide, polyethylene.

- Development of a process for producing and machining panels of compacted enriched lithium fluoride.

As regards the general needs of the Institute this year has seen the production section take over the control and operation of the metallurgical raw materials store including supplying the dimensions requested by many users.

1-2 - Fittings and maintenance

During the year 400 requests for work and 580 for handling jobs were handled. The main activities of this group were:

a) Design and coordination of work on all new buildings and associated work (building ILL17 for the physicists, boiler-making shop and raw materials store, computing centre, 15 offices in building ILL4, hydrogen laboratory)

b) Provision of all or part of the associated fittings (liquids, technical equipment and furniture)

c) Provision of all connections to liquid circulation systems and related work, for experiments and at the request of the physicists.

d) All handling and transport within the Institut and in some cases outside.

e) Maintenance of technical installations outside the reactor, partly by our own efforts and partly by external contracts.

f) Ensuring that installations comply with current safety regulations.

g) Cleaning and general maintenance of buildings, green spaces and roads (by external contract).

2 - Safety and Radioprotection Section

2-1 - General Safety

a) Ascertaining the needs and arranging for the work necessary to fulfil legal and safety requirements. E.g. sound insulation of the reactor and boiler-making workshops. Device for isolating the superheated water system in case of leaks. Fire protection for the hot cell.

b) Extension of the remote alarm system

Fire detection in new buildings or rooms (ILL17, basement of ILL4 etc.)

Smoke detection in the technical galleries.

Detection of opening of access doors to certain rooms (electronics laboratory, technical galleries, etc.)

c) Checking conformity with French regulation in collaboration with official bodies:

of electrical installations (decree of 14 Nov. 1962)

of lifting and handling equipment (decree of 23 Aug. 1947)

of equipment under gas or steam pressure (decree of 18.1.43 and 2.4.26 respectively).

of installations covered by the law of 19 Dec. 1917 on dangerous premises (storage of inflammable or toxic products).

d) Periodic calibration and maintenance of hydrogen detectors permanently operating on equipment (cold source, detritiation, hydrogen laboratory) and of portable explosimeters.

e) Health and safety committee :

Secretariat of the committee, cooperation with the departments concerned, implementation of their requests, minutes, relations with the Inspecteur du Travail, etc.

f) Internal Safety Commission

Safety analyses, preparation of meetings, minutes, contact with those responsible for applying the commission's recommendations.

g) Liaison with CENG emergency services (FLS, SPEE, SMT). Periodical checks on extinguishers, preparation of plans for emergencies, staff training exercises on first-aid equipment, etc.

h) Watchkeepers

Organisation and supervision of watchkeepers. Setting up an ILL watchkeeping staff.

i) Miscellaneous

Measurements of noise, toxicity, etc. . Supervision of dangerous handling operations. Records of incidents. Control of individual protection equipment and of some materials (FLi, alcohols etc.). Maintenance of records required, etc.

2-2 - Radioactivity protection

a) Laboratory work

Analyses connected with the operation of the Reactor and the detritiation installation. Monitoring the radioactivity of heavy water and tritium. Acquisition of equipment (portable spectrometer) for work on the spot.

b) Technical assistance to physicists in measuring and defining the fittings necessary for reducing the background noise near the experimental equipment and improving the safety of the beams.

c) Modifications and improvements to the tritium detection system in the detritiation building.

d) Dosimetry of staff and environment.

Control of films: 4630 films were distributed, including 950 to non-ILL personnel (visiting scientists, staff of outside firms). 720 environment films were placed in areas where there is a risk of irradiation.

e) Control and storage of radioprotection materials.

In 1973 the following were installed on experiments:

lead: 35 tons in 5 kg blocks

polyethylene: 300 m2 in panels and 800 1kg blocks

borated polyethylene: 600 kg

paraffin: 20 tons in pellets

cadmium: 250 m2 in panels 0.7 and 1 mm thick

boron carbide: 300 m2 in panels

lithium fluoride: 100 kg (natural); 2kg (enriched)

f) Hot cell

Report of safety and facilities with a view to cutting the fuel elements.

g) Monthly records of waste materials and monitoring of liquid and gaseous effluents before disposal. Radioprotection records of the cycle of irradiated fuel elements.

h) Control and treatment of waste in collaboration with the corresponding CENG department. Control, storing and monitoring of radioactive sources.

i) Practical work

Preparation and implementation of all work in radioactive environments. Decontamination work. Maintenance of equipment for emergencies (masks, breathing apparatus, clothing, etc.). Periodic calibration of detector systems. Checking biological shielding, alarm systems, etc.

j) Development of shielding material

Compacted FLi, B_4C, etc.

COMPUTING SERVICES

COMPUTING SERVICES

1 - Introduction

The Computing Services Department was created in September 1973 and consists of the two previously existing groups, Calcul Scientifique (now called Central Computer Group) and Informatique. Thus the electronic data processing and control for all aspects of the experimental programme, namely instrument control, data acquisition, reduction and analysis is identified as a single unit.

This report covers the activities of the two groups during the whole year.

2 - Informatique

The Informatique Group is responsible for designing, implementing and maintaining the control and data acquisition systems for automated instruments. During the year the load on many of these systems has risen to something approaching full operational conditions. This has therefore constituted the final testing phase, and has also been the time when instrument responsibles and other regular users have been learning how to interact with the system. In these circumstances it was natural that the failure rate was initially rather high, but as a result of the efforts made by the members of the Group to remedy the defects, and increasing familiarity on the part of the users, the reliability has steadily improved and all instruments are now receiving satisfactory service.

The Group consists of three sections corresponding to the three types of computer system, namely Telemechanique T2000 (CARINE 1,2 and 3), Telefunken TR86 (NICOLE 1 and 2) and DEC (several of models PDP 11/20 and 11/40)

2.1 CARINE Systems

CARINE 1 has been operating throughout the year and handles its full capacity of six instruments (namely D2, D5, D8, D10, IN1, IN2) with good reliability. CARINE 2 has been used for instrument control since April but so far only three of its instruments have reached the stage of using the control facility (D1A, D1B, IN3).The role of off-line support, for hardware and software testing and development, which was carried out by CARINE 2 until April, has since been transferred to the newly installed system CARINE 3.

Work carried out by the team (in addition to its underlying responsibility for software and hardware maintenance) has concentrated on making better use of the peripheral devices and providing additional and more standardised software packages for the users.

2.2 NICOLE Systems

NICOLE 1 supports five instruments (D7, D11, IN4, IN5, PN1) and apart from PN1, whose programs are still under test, the control and data acquisition facilities are fully available. NICOLE 2 is used in off-line mode for testing and development work.

At the beginning of October the NICOLE team took over from Telefunken the task of hardware maintenance of the TR86 computers, software maintenance having already been their responsibility. Considerable effort has been put into making access to the system more

convenient for the users, including preprogrammed sequences of control operations. A user manual has been produced.

2.3 DEC Systems

Three PDP 11/20 computers are now in use for the control of instruments D6, SI4, PN2/PN3. These use an operating system designed at the Institut, which is compatible with DEC software. This operating system also forms the basis for three 11/40 systems being introduced to control instruments IN10, D14, D3 (The D3 instrument system is being supplied by the Rutherford Laboratory but the software is being written to conform with the Institut design.)

2.4 New Systems

A design study has been undertaken for the new instrument D11B. It had originally been envisaged that this would be controlled by NICOLE, but it is now decided that it should be on a PDP11-based system which will eventually support D11A also.

3 - Central Computer (Calcul Scientifique)

The major event during the year has been the installation of the DEC System 10, giving the Institut for the first time its own general computing facility.

Until August, the Institut continued to rely on external computers, principally an IBM 360/50 at CENG and a 360/91 at Saclay, both under a contract with CISI. In spite of valuable help from the CISI engineers this manner of working presented some difficulties since the 360/50 was resource limited, whilst use of the 360/91 frequently involved the transportation of magnetic tapes to Saclay. Nevertheless

7000 jobs were processed during the 6 months up to August 15 when the CISI contract was terminated.

The System 10 was delivered in May, installation and hand-over trials being finished by the beginning of July. In preparation for handover members of the group had received training from DEC both in the USA and Europe, and had been ensuring that all necessary library subroutines would be available. A set of routines for handling the experimental data from the CARINE and NICOLE systems was also prepared.

Serious use by Scientists started about the middle of August and the work load has grown rapidly as a result of the high reliability of the system, the ease of access from terminals and the simplicity of the operating system. Up to the end of the year a total of 17000 jobs had been processed, the rate of usage having risen steadily to reach 1200 jobs/week in December. The system is currently operated for 15 hours/day Monday-Friday, and 4 hours on Saturday if there is sufficient demand.

Of the current load, 65 % originates from Colleges 3-9 (Experimental Sciences), 25 % from College 2 (Theory), the remaining 10% coming from Service Groups and outside users (ISN and CNRS).

System-10 receives from CARINE and NICOLE (by means of manually transferred magnetic tapes) 10 Million words/month of experimental data, principally from instruments D7, D8, D10, D11 and IN4. To make the most recently acquired data readily available on a permanently mounted disc, whilst retaining reasonable access to less-recent data is a problem to which the systems group has given considerable attention. There is a smaller amount of data from the PDP-11 based instruments which is transferred on DEC-tape (i.e. non-standard

magnetic tape). Standard system subroutines for accessing this data have been provided. Routines have also been provided in connection with use of graphic terminals and the graph plotter.

The Group continues to give advice to scientists on mathematical problems, programming techniques and languages and facilities available on System-10. They also give assistance in debugging programs. Visiting scientists are helped to transform their experimental results into a format compatible with the facilities at their own institute. A Users Guide has been produced in order that new arrivals can become acquainted with the system without having to fully digest the DEC manuals.

ADMINISTRATION

ADMINISTRATION

The number of ILL staff increased from 348 to 371 between 1 January and 31 December 1973.

I - They are divided as follows by function and by nationality:

1 - by function

Theoretical physics Grenoble	8
Theoretical physics Garching	11
Experimental sciences	85
Operation of experimental equipment	30
Reactor	75
Scientific support	54
Computing services	26
Technical support	33
Management and scientific assistance	14
Administration	35
Total	371

2 - by nationality, comparing 1972 and 1973

	French		German		British		Others		Total	
	72	73	72	73	72	73	72	73	72	73
Physicists Engineers and "Cadres"	56	57	42	40		16	20	13	118	126
Ph.D. Students	21	18	14	10		1	3	2	38	31
Non-Cadres	167	182	22	19		9	3	4	192	214
Total	244	257	72	69	0	26	26	19	348	371

II - External staff, stagiaires, language teachers, vacation students

French	21
German	9
British	3
Others	7
Total	40

III - Salaries and charges

The gross total of salaries paid by 30.12.73 is 17,746,000 F. The corresponding "social"charges are 6,740,000 F.

The increase in these charges in 1973 is due to the "ceiling" of the Sécurité Sociale being raised by 11.5 %, and to the inclusion from 1 July 1973 of staff who are members of I.R.R.A.P.R.I. in the additional superannuation scheme of I.P.R.I.S.

IV - Repayments in addition to the Sécurité Sociale

The ILL "Mutuelle" fund made payments in 1162 cases amounting to a total refund of 117,741.02 F.

In 77 cases I.R.R.A.P.R.I. repayments were made amounting to a total refund of 16,421.38 F.

V - The number of guest scientists is as follows :

1 - Guest scientists whose expenses were paid :

	Number	NATIONALITIES			
		F	G	B	O
1 year or more	17	3	11	1	2
3 months to 1 year	6	1	2	1	2
less than 3 months	112	23	54	18	17
Totals	135	27	67	20	21

2 - Guest scientists whose expenses were not paid

	Number	NATIONALITIES			
		F	G	B	O
1 year or more	15	5	2	3	5
3 months to 1 year	4	2	-	1	1
less than 3 months	107	21	19	47	20
Totals	126	28	21	51	26

VI - Visits

685 official travel visits were made by ILL staff.

Average cost per journey: 706 F.

400 expense payments made to guest scientists, candidates, members of the Scientific Council.

VII - Staff representation

In March 1973 elections were held earlier than foreseen for the Comit d'Entreprise and the Délégués du Personnel. A joint list was submitted for the first time by the CGT and CFDT. As a result of the votes cast, half the seats were allotted to the joint CGT - CFDT list and the other half to the SILLG (ILL Union).

Representatives of the staff were received by representatives of the Steering Committee on 20 June at Gif-sur-Yvette and on 14 December in Grenoble, and by the members of the Subcommittee on Personnel Questions on 10 August. They were particularly insistent on the questions of representation of the staff in the Steering Committee, on the question of the payment of Ph.D. students, and on the importance of discussions on the collective agreement specifically for ILL.

At its meeting on 14.12.73 the Steering Committee decided to admit representatives of the staff as obervers from its next meeting on.

On 11 October the ILL had its first strike (more than 75 % of staff on strike). The origin of this was a strike to demonstrate solidarity with the staff of CENG, but it developed towards specifically ILL demands for an ILL salary agreement because CEA had failed to reach an agreement in 1973,and claims on behalf of employees on shift work.

VIII - Training

The sum of 175,000 F was devoted to training. This represents enrolment fees for courses, etc. and payments to language teachers.

IX - Housing

Assistance to staff in the purchase of accommodations has been given through the Personnel Department. This included :

- 22 loans totalling 24,200 F through the Comité Inter-professionel du Logement des Alpes Françaises (Use of funds amounting to 0.9 % of ILL salaries)
- 5 direct loans from I.R.R.A.P.R.I. amounting to 86,000 F
- 4 loans from the BNP amounting to 795,000 F, guaranteed by I.R.R.A.P.R.I.

In addition 18 furnished flats are now available for the use of guest scientists, and we have found 42 flats or houses for ILL staff.

X - School problems

The ILL Management has been in contact with the Inspection d'Académie and with the University for the organization of an "experimental" primary school. This school includes French, British and German children. At present there are 41 non-French pupils, of whom

- 30 are children of ILL staff
- 11 { are children of employees of the Max-Planck-Institut
  { are children who have attended classes at the Ecole Clémenceau

The German and British teachers are for the moment paid by ILL.

There are difficulties at the secondary education level because of the small number of pupils involved (5 in 1973, 7 in 1974). Contacts are continuing with the headmasters of the Lycées and with the Inspection d'Académie.

Finance

In the financial sector the processing of information has been improved so that in future expenditure under the Budget can be shown by instruments and cost centres. At the same time accounting has been adapted to the reorganization in the scientific and technical areas.

In the implementation of the Budget considerable difficulties again arose in the practical application of the budget rules, which necessitated numerous transfers of funds to adjust the estimates to the actual expenditure.

Revised budget rules have been submitted to the Steering Committee, but have not yet been unanimously approved by all members.

After the dissolution of the project group any matters pending, including the settlement of the "devis total" were transferred to the Institut. Agreement was reached in the Steering Committee on the distribution of orders for the actual building of the reactor and related financial questions.

The store attached to the Purchasing Office has been further extended. Only articles specific to the Institut are kept there, in order to minimise the amount of capital committed.

Cooperation on purchasing problems with CENG, GfK - and in the year under review with SRC for the first time - continued to be indispensable for ILL. The support of the associates was particularly valuable to ILL on differences of opinion and on problems of the interpretation of contracts.

PUBLICATIONS

THESES

EXPERIMENTS PERFORMED

CONFERENCES

PUBLICATIONS

1973

(by authors, in alphabetical order)

1 - Publications in Scientific Journals

I.L.L. Grenoble

H.J. STÖCKMANN[x] H. ACKERMANN D. DUBBERS[x] M. GRUPP[x] P. HEITJANS[x]	Elektrische Quadrupolwechselwirkungen von ^{20}F in MgF_2 - Einkristall. [x]Un. Heidelberg, Germany	Z. Physik (in print)
K. SISTEMICH[x] P. ARMBRUSTER[xx] M. ASGHAR G. BAILLEUL J.P. BOCQUET[xxx] J.P. GAUTHERON[†] J. GREIF H. HAMMERS H. SCHRADER G. SIEGERT E. MOLL[††]	Eine Ionisationskammer zur Bestimmung der Kernladung von Spaltprodukten [x] KFA, Jülich, Germany [xx] GSI, Darmstadt, Germany [†] Accélérateurs, CEN-Grenoble, France [xxx] UER1 - St. Martin d'Hères and DRF, CEN-Grenoble, France [††] Present address : Balzers AG, FL-9496 Balzers, Liechtenstein	GSI-Report Darmstadt (1973) (in print)
M. ASGHAR	(See H. HAMMERS and E. MOLL)	
G. BAILLEUL	(See M. ASGHAR, H. HAMMERS and E. MOLL)	
J. BLETRY	Etude des Trempes Ultrarapides à partir de l'Etat Liquide dans des Appareils à Pistons et à Saut de Ski.	J. of Physics D : Appl. Phys. 6, 256 (1973)
J.P. BOCQUET	(See M. ASGHAR, H. HAMMERS and E. MOLL)	
A. BOEUF[x] F. RUSTICHELLI[x]	Composite Focusing Neutron Monochromator System. [x]I.L.L. Grenoble, France and C.C.R. Euratom, Ispra, Italy	Nucl. Instr. and Methods 107, n° 3 429-435 (1973)

Underlined names are in alphabetical order

A. BOEUF* F. RUSTICHELLI*	Confronto di Reflettività Neutroniche a Varie Lunghezze d'Onda Tra Cristalli Perfetti e Cristalli Curvi di Si. *I.L.L. Grenoble, France and C.C.R. Euratom, Ispra, Italy	Réunion de la Société Italienne de Physiqu 59ème Congrès Nat. à Florence 30 Oct.-30 Nov. 1973 Boll. S.I.F. 99 (197
K.P. BOHNEN K.H. FISCHER*	Non-Existence of a $T^{-1/2}$ Singularity in Transport Properties of Simple Kondo Alloys. * KFA, Jülich, Germany	J. of Low Temperature Phys. 12, 5/6 (Sept. 1973
Paulette BURLET* Paul BURLET E.F. BERTAUT**	Structure Magnétique en Champ Appliqué Nul de l'Acétate de Manganèse Tétrahydraté $Mn(CH_3COO)_2$, $4H_2O$. (Oct. 1973) * DRF CEN-Grenoble, France **C.N.R.S., Grenoble, France	Solid State Comm. (in print)
R. CURRAT	The Efficiency of Vertically Bent Neutron Monochromators	Nucl. Instr. and Methods 107, 1, p. 21-28 (1973)
R. CURRAT R. COMES* B. DORNER E. WIESENDANGER**	Inelastic Neutron Scattering in Orthorhombic $KNbO_3$. *Phys. des Solides, Fac. des Sciences, 91 - Orsay, France **Lab. f.Festkörperphysik, Zürich, Schweiz	The Third Int. Meeting on Ferroelectricity Edinburgh, Scotland Sept. 10-14, 1973 J. Phys. C.(in prin
F. CYROT-LACKMANN* M.C. DESJONQUERES** J.P. GASPARD	Local Densities of States on Adsorbates on a Narrow Band Solid. **Lab. de Microscopie Ionique Fac. Sciences, Rouen, France	J. Phys. C. (in print)
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L. HIRST	Theory of 4 f substances under high pressures	J. Phys. Chem. Solids (in print)
P. HOLZER J. KELLER P. FULDE	Superconductors with crystalline-field split impurities : tunneling density of states	J. Low Temp. Phys. (in print)
B. HOENERLAGE	Spin-phonon coupling in Van Vleck paramagnets	Z. Physik 260, 403 (1973)

M. KLENIN I. PESCHEL	Excitation spectra of ferromagnets with crystal fields	Phys. Kond. Materi 16, 219 (1973)
A. LUTHER I. PESCHEL	Single particle states, Kohn anomaly and pairing fluctuations in one dimension	Phys. Rev. B (in print)
H. PEISL H. TRINKAUS	Analysis of X-Ray distortion scattering : A method to study point defects and their clusters	Comments on Solid State Physics V 16, 167 (1973)
I. PESCHEL	Zur Möglichkeit von Oberflächen-Magnetismus in Systemen mit weitreichender Wechselwirkung	Z. Physik 265, 245 (1973)
H. TAKAYAMA K. MAKI	Theory of dirty type II superconductors	J. Low Temp. Phys. 12, 195 (1973)
H. TAKAYAMA	Electron-phonon interaction in disordered metals	Z. Physik 263, 329 (1973)
H. TRINKAUS	Über die Streuung von Röntgen-Strahlen an Kristallen mit statistisch verteilten Defekten	Z. Naturforschung 28a, 980 (1973)

2 - Internal Scientific Reports

P. AGERON J.M. ASTRUC J. VERDIER*	Preliminary Project of an Ultra Cold Neutron Source at the H.F.R. (Sept. 1973) * CEN-Grenoble, France	ISP-9/73
J.M. ASTRUC	(see P. AGERON)	
A.J. DIANOUX	(See R. LECHNER)	
F. DOUCHIN	(See R. LECHNER)	
B.E.F. FENDER	High Resolution Powder Diffractometers - Working Party Report, Part A. (Fender, Fuess, Steichele, Wedgwood Willis) - April 1973	ISR-3/73
H. FUESS	Neutronenbeugung und Kristallchemie Möglichkeiten eines mittelgrossen Reaktors. (Séminaire donné à l'Université Technique de Berlin, le 7 Mai 1973)	ISR-2/73
J.P. GAUTHERON	(see H. HAMMERS)	
Y. GLAIZE	(see H. HAMMERS)	
J. GREIF	(see H. HAMMERS)	
B. HAMELIN	Polarisation d'un Faisceau de Neutrons par Miroir Magnétique (49 Fe 49 Co 2V) (Mars 1973)	ISR-5/73
H. HAMMERS J.P. GAUTHERON* Y. GLAIZE J. GREIF	Mesures de Températures dans le Canal H9. Méthode utilisée et résultats. (Dec. 1973) * Accélérateurs, CEN-Grenoble, France	ISR-10/73
H. HERVET	(See R.E. LECHNER)	

R.E. LECHNER F. VOLINO A.J. DIANOUX F. DOUCHIN H. HERVET [x] G.C. STIRLING	The Multichopper IN5 Scientific Status Report (June 1973) [x]Collège de France, Paris	ISR-8/73
S.W. LOVESEY	Magnon Renormalization in $FeCl_2$ an Anisotropic Two-Dimensional Ferromagnet	ISR-4/73
J. KALUS[x] E. SCHEDLER	The Use of a Multicounter for the Measurement of Phonons with a Three-Axis Spectrometer (Sept. 1973) x Un. München, Germany	ISR-6/73
J. KALUS[x] E. SCHEDLER	A Pseudo-Curved Neutron Monochromator (Sept. 1973) xUn. München, Germany	ISR-7/73
Jochen SCHNEIDER	Examen de Monocristaux en Vue de leur Utilisation comme Monochromateurs pour la Diffusion des Neutrons. (Colloque "Caractérisation", Toulouse, 2-3/4/1973)	ISR-11/73
G.C. STIRLING	(See R.E. LECHNER)	
F. VOLINO	(See R.E. LECHNER)	
B. YELON	Reports on Curved Crystal Tests - D10 (April 1973)	ISR-1/73

3 - Internal Technical Reports

B. AMRHEIN R. TAFFUT	Tiroir GRE (Nov. 1973)	ITR-27/73
B. AMRHEIN	G L R (Nov. 1973)	ITR-28/73
B. AMRHEIN R. TAFFUT	Remarques sur la Programmation pour Dépannage plus Rapide. (Nov. 1973)	ITR-29/73
U. ARNDT	D14 - Single Crystal Neutron Diffractometer (July 1973).	ITR-13/73
A. AXMANN Y. LEFEBVRE	Utilisation du Système de Comptage FHC pour les Systèmes NICOLE et CARINE (Avril 1973)	ITR-9/73
A. AXMANN J.C. FALAISE	The Hardware of the Experiments Connected to the Multiuser System CARINE. General Description (Sept. 1973)	ITR-16/73
A. BARTHELEMY W. KAISER M. LE SOURNE M. TAESCHNER P. DARIER* A. VINIT* J.J. GIROD*	CARINE - A Multi-User Real-Time System for Control and Data Acquisition of Neutron Beam Experiments. (Proceedings of the Int. Computing Symposium Davos, Switzerland, 4-7 Sept. 1973, p. 291-8) *LETI, CEN-Grenoble, France	ITR-15/73
C. BERTHET	Electronic Chopper Monochromators (Dec. 1973)	ITR-33/73
Y. BLANC	(See F. DOUCHIN)	
A. BRESSON	Dispositif Optique pour Positionnement de Tables "Tanzboden" (Oct. 1973).	ITR-19/73
A. BRESSON	Pin Photodiode Amplifier and Level Dectector. (Oct. 1973).	ITR-22/73
A. BRESSON	Pseudo Random Generator.(Oct. 1973).	ITR-23/73
A. BRESSON	Preamplificateur Optoélectronique (Oct. 1973)	ITR-24/73
A. BRESSON	Asservissement Angulaire par Interféromètre de MICKELSON. (Oct. 1973)	ITR-25/73

F. DOUCHIN G. GOBERT	IN5 Spectrometer "Multichopper" Detailed Technical Report on Mechanical aspects and maintenance.(June 1973)	ITR-12/73
F. DOUCHIN R.E. LECHNER Y. BLANC	The Multichopper IN5 Technical Status Peport, June 1973.	ITR-26/73
W. ERTEL R. KLESSE	Untersetzer für 16-Kanäle.	ITR-5/73
W. ERTEL	Time-of-flight unit - Beschreibung	ITR-7/73
W. ERTEL	Time-of-flight-unit - Bedienungsanleitung.(Jan. 1973)	ITR-8/73
J.C. FALAISE	(See A. AXMANN)	
J.C. FAUDOU	Eléments de Conduite des Réacteurs (Sept. 1973)	
G. GOBERT	(See F. DOUCHIN)	
W. KAISER	(see A. BARTHELEMY)	
R. KLESSE	CAMAC-Systemkontroller für das Rechnersystem NICOLE. (May 1973)	ITR-1/73
R. KLESSE J. MAIWALD	CAMAC-PARALLEL-Input-Register, Mai 1973	ITR-3/73
R. KLESSE	CAMAC-Derandomizing-Input-Module. (Camac Bulletin, n° 9, Nov. 1973)	ITR-4/73
R. KLESSE J. MUNNIER	Module "Commande de Relais" (Mai 1973)	ITR-6/73
R. KLESSE J. MUNNIER	Testeur manuel de Branche CAMAC (Mai 1973)	ITR-11/73
R. KLESSE P. SCHURMANN	CAMAC - Variable Frequency Divider. (Oct. 1973)	ITR-17/73
R. KLESSE	CAMAC - Systemkontroller zum Anschluss an den Standardkanal des TR-86. (Oct. 1973)	ITR-18/73

R. KLESSE	(See P. ERTEL, J. MUNNIER and P. SCHURMANN)	
G. KOZMANN *	Shaping filter state-equations for power-low noises. x Budapest	ITR-10/73
R.E. LECHNER	(see F. DOUCHIN)	
Y. LEFEBVRE	Connexion de l'Expérience D14 à un Calculateur PDP 11/40. (Déc. 1973)	ITR-30/73
Y. LEFEBVRE	Connexion de l'Expérience IN-10 à un Calculateur PDP 11. (Mars 1973)	ITR-31/73
Y. LEFEBVRE	Note Technique. PN3 - GAMS 1 Modification du Hardware. (Avril 1973)	ITR-32/73
Y. LEFEBVRE	(See A. AXMANN)	
M. LE SOURNE	(see A. BARTHELEMY)	
J. MAIWALD	(see R. KLESSE)	
J. MUNNIER	CAMAC - Interrupt Request Register Oct. 1973)	ITR-20/73
J. MUNNIER	Compteur Binaire 12 Bits. (Oct. 1973)	ITR-21/73
J. MUNNIER	(see R. KLESSE)	
P. SCHÜRMANN R. KLESSE	CAMAC - Schrittmotorsteuerung.	ITR-2/73
P. SCHÜRMANN	(See R. KLESSE)	
M. TAESCHNER	(See A. BARTHELEMY)	
R. TAFFUT	(See B. AMRHEIN)	

4 - Instrument Description

P. BURLET P. CHAGNON P. CONVERT	Spectromètre D2 - Manuel d'Emploi (Oct. 1973)	ID-2/73
A. TIPPE	Users Guide to the Spectrometer D10 (Feb. 1973)	ID-1/73

THESES

P. FELIX — Thèse de 3ème Cycle : Mars 1973 (Orsay)

Etude par la Diffusion des Rayons X des Corrélations Associées aux Transitions de Phase dans les Boracites.

A. FREUND — Promotion : Mai 1973 (München)

Untersuchung des Einflusses von Versetzungen auf die Beugung von Röntgen- u. Gammastrahlen an Kupfereinkristallen.

B. KLAR — Promotion : Juni 1973 (Saarbrücken)

Entwurf, Realisierung und erste Erprobung eines neuartigen Neutronen-Einkristalldiffraktometers mit 100 beweglichen Zählrohren.

Jo. SCHNEIDER — Promotion : März 1973 (Hamburg)

Ein Beitrag zur Messung von Strukturfaktoren an nicht perfekten Einkristallen mit Hilfe eines Gammastrahlen-Diffraktometers.

EXPERIMENTS PERFORMED AT ILL

1973

The following is simply a list of the experiments performed at ILL in 1973. Please refer to the Annex to the Annual Report for a detailed study of the results.

College 3

Spectre du ^{99}Tc (n,γ) GAMS1

H. Börner, D. Heck, H.R. Koch, J. Pinston, R. Roussille (ILL).

Mesure du moment dipolaire du neutron

W.B. Dress, P.D. Miller (ORNL Oak Ridge), P. Perrin (DRF CEN-Grenoble).

Test de l'invariance du renversement du temps, dans la désintegration du neutron polarisé SI1

P. Liaud (Université de Grenoble), R. Steinberg (Rutherford Laboratory), B. Vignon (CNRS-Grenoble).

Study of (n_{th},α) reaction of medium and heavy nuclei.

A. Emsallem, Do Huu Phuoc, R. Chery (IPN Lyon), M. Asghar (ILL).

Nuclear Doppler shift investigations of atom-atom and atom-molecule collisions

M. Hauser, W. Neuwirth, W. Pietsch (PI Köln).

Chambre d'ionisation pour la mesure des pertes d'energie

K. Sistemich (KFA Jülich), P. Armbruster (GSI Darmstadt), M. Asghar, G. Bailleul, J.P. Bocquet, J.P. Gautheron, J. Greif, H. Hammers (ILL), E. Roth (KFA Jülich), H. Schrader, G. Siegert (ILL).

College 4

04 01 000	Dispersion in ZnO B. Dorner, W. Drexel, R. Currat, G. Duesing (ILL) W. Vegener (CEN-SCK Mol, Belgium), K. Thoma (Darmstadt).	IN2
04 01 001	Phonons in MgF_2 R. Almairac (ILL), C. Benoit (Montpellier)	IN2
04 01 004	Lattice dynamics of the hexagonal D_2O-Ice B. Renker (Karlsruhe), A.D.B. Woods (Atomic Energy of Canada and ILL), J. Revelli (Orsay)	IN2
04 01 005	Acoustic phonons in $TiSe_2$ J.D.N. Checke (CNRS Grenoble), W.G. Stirling, B. Dorner (ILL).	IN2
04 01 007	Phonons in Se R. Scherm, W.D. Teuchert (ILL), F. Landwehr (Würzburg).	IN3
04 01 010	The phonon frequency distribution of V_3Si B.P. Schweiss (Karlsruhe), W. Drexel (ILL).	IN4
04 01 015	Phonon dispersion curves in InP and InAs G.F. Alfrey, P.H. Borcherds (Birmingham), D. Woods (ILL).	IN2
04 01 018	Binding forces in naphthalene. Frequency distribution of naphthalene W. Drexel (ILL), I. Natkaniec (Dubna).	IN4
04 01 020	Phonon dispersion of RbI at long wave-lengths J. Daubert, A. Loidl, M. Müllner (Frankfurt)	IN7

04 02 003	Microscopic Gruneisen parameters in rubidium iodide O. Blaschko, G. Ernst (Univ. of Vienna), G. Quittner (SGAE Vienna), W. Kress (Munich and ILL), R.E. Lechner (ILL).	IN2
04 02 007	Anomalie de Kohn-Peierls dans les conducteurs unidimensionnels $K_2Pt(CN)_4\ Br_{0.30} - xH_2O$ B. Renker, L. Pintchovius, H. Rietschel, W. Glaser (Karlsruhe), R. Comès, Liebert (Orsay), W. Drexel (ILL).	IN2
04 03 001	Anisotropic softening of dispersion branches in Quartz approaching the α-β phase transformation B. Dorner (ILL), K.H.W. Bauer, H. Jagodzinski (Munich), H. Grimm (KFA Jülich).	IN2
04 03 002	Inelastic neutron scattering in orthorhombic $KNbO_3$ R. Currat, B. Dorner, D. Tocchetti (ILL), R. Comès (Orsay), E. Wiesendanger (Zürich).	IN1 IN2
04 03 003	Soft modes and inelastic critical scattering at phase transitions in solid CD_4. W. Press, A. Hüller, H. Stiller (KFA Jülich), W.G. Stirling, R. Currat (ILL).	IN2
04 03 006	Diffraction experiment on Cs under pressure D.B. McWhan (CNRS and Bell Labs), G. Parisot (ILL) D. Bloch (CNRS-Grenoble).	D2
04 04 001	Co^{+2} excitons in antiferromagnetic fluorides G. Parisot (ILL).	IN1
04 04 002A	Damping of one-dimensional spinwaves in $CsNiF_3$ M. Steiner, B. Dorner (ILL).	IN2
04 04 003	Spin waves in Ca_2MnO_4 and their temperature dependence R. Almairac (ILL), F. Moussa (CEN Saclay), G. Ollivier (DRF CEN-Grenoble).	IN2

04 04 005	Spin waves in Ni alloys D. Tocchetti (ILL), B. Hennion (CEN-Saclay and ILL)	IN1
04 04 011	Spin waves in antiferromagnetic γ-manganese M.W. Stringfellow, M.T. Hutchings, R.D. Lowde (AERE Harwell), B. Hennion (CEN-Saclay and ILL), D. Tocchetti (ILL).	IN1
04 05 001	Rotational diffusion in ammonium halides R.E. Lechner, F. Volino (ILL).	IN5
06 02 006	Quasi-elastic and inelastic scattering of cold neutrons from silver iodide K. Funke (Göttingen), J. Kalus (Munich), R.E. Lechner (ILL).	IN5
	Phonons in $MgZn_2$ K. Feldmann (Dubna), B. Dorner (ILL).	IN2
	Magnetic excitation in ErHo B. Dorner, W. Drexel (ILL), G. Paul (Kensington Australia and ILL), A.D.B. Woods (Atomic Energy of Canada and ILL).	IN2
	Neutronenstreuexperimente an Al_2O_3 am statistischen chopper des Instituts Laue-Langevin, Grenoble H. Bialas, H.J. Stolz (Heidelberg).	IN7

College 5

05 01 001	Electron density in C_2H_5Li A. Tippe (Neuherberg), H. Dietrich (Berlin).	D10
05 01 003	Hydrogen bonds in manganese acetate Paul Burlet, A. Filhol, M. Thomas (ILL), Tran Qui Duc (CNRS-Grenoble), Paulette Burlet (DRF CEN-Grenoble).	D8

05 01 004	Structure determination of a coordination compound formed by iron trichloride dissolved in liquid deuterium cyanide ($Fe^{III}_{1-x} Fe^{II}_{x} Cl_{2.68} (DCN)_3$) with x = 0.48. J. Daran (Toulouse), H. Fuess, W. Yelon (ILL).	D10
05 01 005	Crystal structure of $4PbO.PbSO_4$ H. Bartl (Frankfurt), S.A. Mason (ILL)	D10
05 01 006	Crystal structure of metatorbernit (uranium glimmer) R. Rothbauer, W. Joswig (Frankfurt), K. Knorr (ILL).	D10
05 01 010	Crystal structure of $BaNH_4P_3O_9.H_2O$ A. Durif, R. Masse (CNRS-Grenoble), H. Fuess (ILL).	D10
05 01 013	Structure of the plastic phase of SF_6 A. Dianoux (ILL), P. Rigny (Saclay)	D2
05 01 018	Measurement of diffuse scattering in V_4C_3 M. Sauvage (Geneva), W. Yelon (ILL).	D10
05 01 027	Phase transition and structure of C_2D_2 E. Sandor, E. Arzi, K. Koski (London).	D2
05 01 028	Electron density in $Cr(CO)_6$ B. Rees (Strasbourg), W. Yelon (ILL).	D10
05 01 029	Lattice parameters measurements on Fe-C-Si alloys G.E. Bacon, N. Cowlam (Sheffield), D. Hohlwein (ILL)	D2
05 01 030	Neutron diffraction studies of rare earth and actinide metal dicarbides D.W. Jones, T. McColm, R. Steadman, J. Yerkess (Bradford).	D2
05 01 035	Diffuse scattering in $MgO.Al_2O_3$ G. Patrat, F. de Bergevin, M. Brunel (CNRS-Grenoble), W. Yelon (ILL).	D10

05 01 038	Crystal structure of scolezite H. Bartl (Frankfurt), W. Yelon (ILL).	D10
05 01 039	Hydrogen bonding in $CaHPO_4$ G. Ferraris, M. Catti (Turin), A. Filhol (ILL).	D8
05 01 041	Structure of the high pressure phase of $FeCl_2$ C. Vettier (ILL and CNRS-Grenoble), D. Bloch (CNRS-Grenoble), W. Yelon (ILL).	D10
05 01 048	Crystal and molecular structure of Hg-acetamide S.A. Mason, H. Fuess (ILL).	D8
05 01 053	Information über die Lage der ungeordneten Silberatome K. Funke (Göttingen), J. Kalus (Tübingen).	D2
05 01 000	Electron density in $Co(NH_4)_2(BeF_4)_2.6H_2O$ T. Vicat (CNRS Grenoble), A. Filhol, M. Thomas (ILL).	D8
	Determination of the crystal structure of dipropylacetic (DPA) and tripropylacetic (TPA) acid derivatives C. Cohen-Addad (Univ. Grenoble)	R X Siemens
	Crystallographic structures of nitroxide free radicals A. Capiomont, B. Chion, J. Lajzerowicz (Univ. Grenoble).	R X Siemens
05 02 003	Determination of the magnetic structure of Cu_2FeGeS_4 by neutron diffraction W. Wintenberger (CNRS Grenoble and DRF CEN-Grenoble), Paul Burlet (ILL).	D2
05 02 005	Magnetic structure of PdF_2 R. Hoppe, D. Paus, B. Müller (Giessen), H. Fuess (ILL).	D2

05 02 006 Magnetic structure of $Mn_{27}Si_{47}$ ($MnSi_{1,743}$) D2

H. Boller (Vienna).

05 02 007 Solutions solides $NiTiO_3$-Fe_2O_3 D2

G. Marnier, J. Hubsch (Nancy), Paul Burlet (ILL).

05 02 008 Solutions solides Co_2TiO_4-$CoFe_2O_4$ D2

J. Hubsch, G. Marnier (Nancy), Paul Burlet (ILL).

05 02 010 Magnetism in $Mn(CH_3COO)_2,4H_2O$ D2

Paulette Burlet (DRF CEN-Grenoble), Paul Burlet (ILL).

05 02 011 Linear chain antiferromagnetism in Tanol (a free radical nitroxide) D2

J. Lajzerowicz, A. Capiomont (Univ. Grenoble).

05 02 012 Magnetic order in NdB_6 D2

R.Naslain (Bordeaux), M. Pernet (CNRS Grenoble), Paul Burlet (ILL).

05 02 018 Der Einfluss eines aüsseren Magnetfeldes auf die Magnetischen Strukturen von $DyVO_4$ und $TbPO_4$ D2

W. Schäfer, G. Will (Bonn).

05 02 020 Magnetic phase diagram of $CsNiF_3$ D2

M. Steiner and H. Dachs (ILL).

05 02 026 Facteur de forme du Nd dans $NdAl_2$ D5

J.X. Boucherle, J. Schweizer (DRF CEN-Grenoble).

05 02 027 Etude de la solution solide $UFe_{0.75}Cr_{0.25}O_4$ D5

P. Wolfers (ILL et CNRS Grenoble), M. Bacmann, E.F. Bertaut (CNRS-Grenoble).

05 02 028 Metamagnetic behaviour in Ho_2O_2S D5

J. Rossat Mignod, J. Schweizer, Y. Abbas (DRF CEN-Grenoble).

05 02 029 Polarized neutron determination of magnetic moments and magnetic form factors of Fe^{+3} in yttrium iron garnet D5

M. Bonnet, A. Delapalme, F. Tcheou (DRF CEN-Grenoble), H. Fuess (ILL)

05 02 030 Magnetic structure studies on $MnFe_2O_4$ D1A

H. Vincent (CNRS Grenoble), M. Steiner (ILL).

05 02 034 Structure of Pa_2O_5 and PaO_2 D2

F.A. Wedgwood (Harwell), Paul Burlet (ILL).

05 02 035 Magnetization density in $FeSO_4$ D5

J. Brown (Cambridge), B. Forsyth (Rutherford).

05 02 036 Magnetic form factor of $BiFeO_3$ D5

B.E.F. Fender, A.Jacobson (Oxford).

05 02 037 Measurement of intensity of diffuse peak in the diffraction pattern of $Mn_{0.90}Au_{0.10}$ as function of temperature D2

G.E. Bacon, N. Cowlam, L. Gillott (Sheffield), D. Hohlwein (ILL).

05 02 040 Magnetic moment in non-stoichiometric NiS D2 D5

J. Coey, R. Brusetti (CNRS Grenoble), A. Kalel (Tunis), H. Fuess (ILL), J. Schweizer (DRF CEN-Grenoble).

05 02 042 Structure magnétique de $NpAs_2$ D2

P. Salmon, J.M. Fournier (DRF CEN-Grenoble), P. Wolfers (ILL, CNRS Grenoble).

05 02 043 Search for orbital superlattice in CoS_2 D2

B. Forsyth (Chilton), M. Cyrot (CNRS-Grenoble)

05 02 044	Antiferromagnetic domains of $KCoF_3$ by neutron polarography M. Schlenker (CNRS-Grenoble), J. Baruchel (DRF CEN-Grenoble and CNRS-Grenoble).	D2
05 02 048	Magnetic structure of $CrVF_5$ and $CrTiF_5$ J.M. Dance (Bordeaux), H. Dachs (ILL).	D2

College 6

06 01 003	Catalysis A. Renouprez (Villeurbanne), R. Stockmeyer (Jülich), D. Tocchetti (ILL).	IN1
06 02 003	Dynamics of liquid Rb J.B. Suck, N. Nücker (Karlsruhe), W. Drexel (ILL).	IN4
06 03 001 004	Structure of amorphous semiconductors AsSe and SeTe G. Tourand (Saclay), R. Bellissent (ILL).	D4
06 03 002 003	Studies on metal-ammonia solutions in the non-metal to metal transition region P. Chieux (ILL). Structural studies of metal ammonia solutions P. Chieux (ILL).	D4 D11
06 03 006	A neutron diffraction determination of the partial distribution functions of liquid potassium chloride J.Y. Derrien, J. Dupuy (Univ. of Lyon).	D4
06 03 007	A neutron diffraction investigation of liquid LiPb alloys H. Ruppersberg (Saarbrücken).	D4
06 03 009	Structure factor of ^{36}Ar gas H. Egger (ILL), H. Fredrikze (Delft).	D4

06 03 010	Structural studies of simple molecular liquids by thermal neutron scattering - I - application to CCl_4 R. Regis (Orsay), R. Parreins (Montpellier).	D4
06 03 011	Measurements of the coherent scattering functions near the first quasi-reciprocal lattice point in SiO_2 A.G. Leadbetter (Bristol), P. Seyfert (ILL).	IN4
06 03 013 019	Structure of liquid binary alloys P. Lamparter, S. Steeb (Stuttgart), W. Knoll (ILL)	D4
06 03 014	The structure factor of liquid nitrogen J.C. Dore, J.H. Clarke (Canterbury), H. Egger, P. Chieux (ILL).	D4
06 03 016	Structural studies of aqueous solutions J.E. Enderby, R.A. Howe, W.S. Howells (Leicester)	D4 D2
06 03 017	Study of amorphous metallic alloy Co-P by neutron scattering J. Dixmier, F.J. Sadoc (Orsay), J. Bletry (ILL).	D2
06 03 018	Separation of coherent and incoherent scattering contributions from D_2O using polarized neutrons J.C. Dore, J.H. Clarke (Canterbury).	D5

College 7

07 01 001	Distribution of magnetic moments in dilute ferromagnetic alloys P. Radhakrishna, F. Livet (ILL), J. Schweitzer (DRF CEN Grenoble).	D5
07 01 005	Spin fluctuations in PdNi P. Radhakrishna, M. Bernasson (ILL), H.G. Purwins (Geneva).	D7 IN4

07 01 006 — Neutron experiments concerning the coexistence of ferromagnetism and superconductivity — D2 D5 D7

S. Roth, K. Ibel, W. Just (ILL).

07 01 011 05 022 — Neutron scattering from AuFe alloys — D11

B.P. Coles, B. Rainford, A.P. Murani (London) K. Fischer (Jülich), P. Radhakrishna, F. Mezei, K. Ibel, S. Roth (ILL).

07 02 001 — Crystal field in RERh (RE = Er, Ho, Tm, Tb) — IN7

R. Chamard-Bois, J. Rossat-Mignod (DRF CEN-Grenoble) K. Knorr, W. Drexel (ILL).

07 02 002 — Crystal field in Er X (X = Ag, Cu, Zn) — IN7

K. Knorr, W. Drexel (ILL), P. Morin, J. Pierre (CNRS Grenoble), J. Rossat-Mignod (DRF CEN-Grenoble).

07 02 003 — Crystal field in $NdSn_3$, $NdPb_3$ — IN7

P. Lethuillier, J. Pierre (CNRS Grenoble), K. Knorr (ILL).

07 02 004 — Crystal field and spin phonon interaction in heavy rare earth metals — IN4

S. Hüfner, J. Pelzl (Berlin), K. Knorr, W. Drexel (ILL).

07 02 005 — Crystalline electric field in $RE_{0.01}Y_{0.99}Al_2$ and $RE_{0.01}La_{0.99}Al_2$ — IN4

H.G. Purwins (Geneva), K. Knorr, W. Drexel (ILL).

07 03 001 — Study of Guinier-Preston zones in Al-Mg alloys — D11

J.M. Raynal (Rouen) M. Roth (ILL).

07 03 003 — Disorder scattering on lead single crystals doped with bismuth — D7

W. Just (ILL), E. Seitz, W. Schmatz, G. Bauer (KFA Jülich)

07 03 004 — Chemical composition of Guinier-Preston zones in Al Mg Zn alloys — D11

V. Gerold, G. Kralik (MPI Stuttgart), G. Kostorz (ILL).

07 03 006 009	Magnetic small angle scattering of neutrons in cold-worked nickel K. Ibel, G. Göltz (ILL), A. Seeger, M. Wilkens, H. Kronmüller (MPI Stuttgart), H. Scheuer, J. Schelten, W. Schmatz (KFA Jülich).	D11
07 03 010	Defect structure in non-stochiometric compounds and solid solutions B.E.F. Fender, A.K. Cheetham, R. van Dreele, C.G. Titcomb (Oxford), H. Fuess (ILL).	D2 D7
07 03 011 015	Study of defects in crystals and precipitations in alloys E.W.J. Mitchell, G.D. Clark, R.J. Stewart, S. Messoloras, P. Poncet (Univ. of Reading).	D11 D7
07 03 012	Phase separation in SiO_2-Na_2O glasses M. Roth (ILL), J. Zarzycki (Montpellier).	D11
07 03 018	Chemical dismiscibility and magnetic disorder scattering on the system (Mn,Fe) WO_4. Ch. Klein (Tübingen), H. Dachs (ILL).	D7
07 04 002	Nuclear magnetic resonance and relaxation of neutron activated short lived nuclei H. Ackermann, D. Dubbers, M. Grupp (Heidelberg and ILL), P. Heitjans, H.J. Stöckmann (Heidelberg)	SI6
07 05 001	Coherent inelastic neutron scattering study of local and in-band modes in Cu Be and Cu Mg S. Bednarski (Swierk), J. Natkaniec (Dubna).	IN4
07 05 004	Magnetic excitation in NiO-CoO V. Wagner, D. Tocchetti (ILL), B. Hennion (CEN-Saclay and ILL).	IN1
07 06 001	Energy levels of hydrogen and deuterium in metals H. Stump (Jülich), G. Alefeld (Munich).	D11 IN4
07 06 004	Deuterium as lattice gas in niobium G. Alefeld, H. Schefts, N. Stump (Munich), K. Ibel (ILL).	D11

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08 01 001	Preliminary measurements on 2Zn-insulin H. Fuess, S.A. Mason (ILL).	D8
08 01 002	Neutron diffraction study on 1 methyl-thymine-9-methyl adenine B. Klar (ILL).	D6
08 02 001	Structure of ferritin in aqueous solution E. Duée (ILL), H. Stuhrmann (Mainz).	D11
08 02 003	Chromatin in solution S. Bram (Institut Pasteur), K. Ibel (ILL).	D11
08 02 004	DNA: solutions and fibre diffraction S. Bram (Institut Pasteur), K. Ibel (ILL).	D11
08 02 005	Determination of the basic small angle scattering functions of DNA by contrast variation in H_2O/D_2O mixtures H. Stuhrmann, R. Oberthür (Mainz), K. Ibel (ILL).	D11
08 02 006	The structure of lysozyme in solution H. Stuhrmann (Mainz), H. Fuess (ILL).	D11
08 02 007	Molecular scattering length density distribution from contrast variation H. Stuhrmann (Mainz).	D11
08 02 008	Structure of fibrinogen in aqueous solution H. Stuhrmann (Mainz), G. Marguerie (DRF CEN-Grenoble).	D11
08 02 010	The basic scattering functions of the glucose oxidases notatin and nigerin H. Stuhrmann (Mainz).	D11

08 02 011	Neutron diffraction of solutions of low density lipoproteins of human plasma V. Luzzati, L. Mateu, C. Sardet, A. Tardieu (Gif sur Yvette), H. Stuhrmann (Mainz and ILL).	D11
08 02 012	Quaternary structure of enzyme complexes W. Hoppe, R. May, P. Stockel (Munich), K. Ibel (ILL)	D11
08 02 014	Bacteriophage PM2: structure and hydrogen exchange R.M. Franklin, D. Schneider (Basel), K. Ibel (ILL).	D11
08 03 001	Neutron diffraction at small angles on tobacco mosaic virus E. Mandelkow, K.C. Holmes (Heidelberg), H. Fuess, K. Ibel, B. Jacrot (ILL).	D11
08 05 001	Membrane vesicles H. Eibl (Göttingen), K. Ibel (ILL).	D11
08 05 002	Dynamics of paraffinic chains in a soap-water system A. Dianoux (ILL), P. Rigny (CEN-Saclay), J. Charvollin (Orsay).	IN4
08 05 004	Molecular structure of nerve myelin D.L. Worcester (King's College, London), K. Ibel (ILL).	D11
09 01 001	Neutron diffraction from dilute and semi-dilute polymer solutions as a function of temperature J.P. Cotton, B. Farnoux, G. Jannink (CEN-Saclay), J.S. Higgins (ILL).	D11
09 01 002	Neutron diffraction of solutions of γ-aminobutyric acid and sodium dipropyl acetate in D_2O C. Cohen-Addad (Univ. de Grenoble), H. Stuhrmann (Mainz and ILL).	D11

09 02 002	Polymer chain configuration in the bulk	D11
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09 02 005	Polymer configuration	D11
	R.G. Kirste, W.A. Kruse (Mainz).	
09 04 006	Lattice dynamics of polyoxymethylene	IN2
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09 04 011	Quasielastic scattering on polyethylene	IN5
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09 06 001	Small angle scattering on catalysts	D11
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CONFERENCES AT ILL

IN 1973

- Symposium on "Nuclear Physics experiments at the ILL" (March 1973)

- Workshop on "Neutron studies on Zeolites" (March 1973)

- Workshop on "Hydrogen impurities in transition metals" (April 1973)

- Properties of one-and two-dimensional systems (May 1973)

- Symposium on "Spin waves in metals" (May 1973)

- Workshop on "Neutron diffraction on Actinides" (May 1973)

- Workshop on "The application of neutron scattering for the study of synthetic and biological polymers and macromolecules" (October 1973)

- Symposium on "The present state of investigation of Quartz" (November 1973)

- Discussion meeting on "Neutron monochromators" (November 1973)

- Discussion meeting on "Invar" (December 1973)