Survey of the Neutron Scattering Community and Facilities in Europe

Contents

August 1998

Preface

The 1994 Nobel Committee's citation to the Physics prize winners Cliff Shull and Bert Brockhouse can be paraphrased as *neutron scattering reveals where atoms are and what atoms do.* In this respect neutrons are a unique probe of the structure and dynamics of solids and liquids. Indeed, neutron scattering underpins the whole of condensed matter science and technology, from chemistry to biology and from fundamental physics to engineering.

A measure of the success and ever increasing popularity of neutron scattering has been provided by a recent Analytical Report commissioned by the OECD Megascience Forum. This report, prepared by the late Professor T Riste, indicates that the multidisciplinary neutron scattering community is expected to grow from an estimated 4000 beam users in OECD countries in 1993 to over 7000 in the year 2000. However, the report also points to a marked decrease in the number of neutron beam facilities over the same period. For example, of thirty reactor based neutron sources currently operating in OECD countries fewer than ten will still be operational in the year 2010. Moreover, only four spallation neutron sources (two in the USA, and one each in Japan and the UK) operate at present. By 2010 these sources will be, on average, over 25 years old and thus approaching the end of their working life.

The continuing development of neutron scattering, in both science and engineering, must therefore be viewed against a backdrop of a decreasing number of ageing neutron sources on the one hand, and a rapidly growing demand for neutron beams on the other. A reduced supply of neutrons for research and industry appears to be inevitable.

In this context the European Science Foundation (ESF) and the Council of the European Spallation Source Project (ESS) jointly launched, in 1994, a collaborative three year programme to investigate and evaluate the scientific and technical case for a third generation major neutron source for basic and applied condensed matter research in Europe.

As part of this extensive evaluation of the scientific impact of, and prospects for, neutron scattering methods and facilities in Europe the ESF commissioned a survey of European neutron scattering. Since 1995 this task has been undertaken on behalf of the ESF, by the European Neutron Scattering Association (ENSA) firstly under the Chairmanship of Professor Dieter Richter and more recently under the Chairmanship of Professor Albert Furrer.

Preface

In 1995 ENSA questionnaires were circulated by the national ENSA delegates, to the respective national neutron scattering communities in order to assess current neutron beam usage. Preliminary results of this survey of the European neutron scattering community has appeared as an appendix to the ESF/ENSA report *Scientific Prospects for Neutron Scattering with Present and Future Sources.*

In a second survey questionnaires were circulated directly to the European neutron facilities to obtain statistics and information on the provision of, and access to, neutron beam instrumentation within Europe.

The results of these independent surveys are collated and presented in this report. From the combined surveys, which represent 13 European neutron facilities and some 4000 members of the European neutron scattering community, there emerges a remarkable and crucial insight into the tremendous vitality, significance and breadth of European neutron scattering science.

Professor Robert Cywinski,
Vice Chairman of ENSA
University of St Andrews,
Scotland

1. The ENSA Survey of the Neutron Scattering Community

The principal aims of the ENSA questionnaire, circulated in 1995 to members of the European neutron scattering community, were to evaluate:

- the scientific and technological base of the European community;
- the scale of neutron beam usage by members of the community;
- the nature of neutron beam usage by members of the community;
- the perceived impact and development of neutron scattering science.

The first three of these evaluations have been successfully completed, as will be seen in later sections of this report.

Those questions which were formulated to evaluate the impact and development of neutron scattering produced subjective responses of such diversity that a coherent evaluation was precluded. This result, in itself, is testimony to the tremendous breadth of the European neutron scattering community.

In total 1026 questionnaires were circulated by the delegates to ENSA from the member countries. The mode of circulation of the questionnaire and the mode of response varied from country to country. Whereas some returns were made by individual scientists, others were made on behalf of whole research groups or institutes. Across Europe a total of 506 completed questionnaires were returned, representing the activities of some 2029 neutron scattering scientists and research staff. Almost 65% of the 3548 European neutron beam users known in 1995 were thus represented in the survey.

Since the ENSA survey was completed the European neutron scattering community has continued to grow in line with the OECD Megascience Forum Analytical Report. A re-evaluation of the community indicates that ENSA now represents 4400 neutron scatterers (see Appendix II).

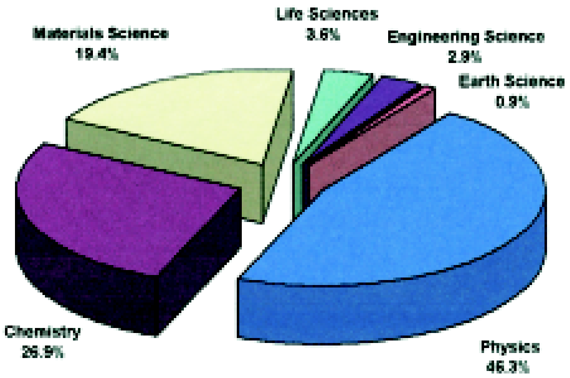
Table 1. Summary of the circulation of the ENSA questionnaire by country

Country	Scientists involved in neutron scattering[1]	Questionnaires distri-buted	Questionnaires returned	Scientists represented by the survey
UK	1200	219	43	400
Germany	800	400	74	600
France	600	150	23	487
Switzerland	300	52	34	201
Netherlands	160	39	15	142
Spain	150	60	13	147
Italy	130	27	18	116
Hungary	80	14	8	69
Sweden	68	20	7	68
Denmark	30	11	9	30
Austria	20	33	8	20
Norway	10	1	1	10
TOTAL	3548	1026	506	2290

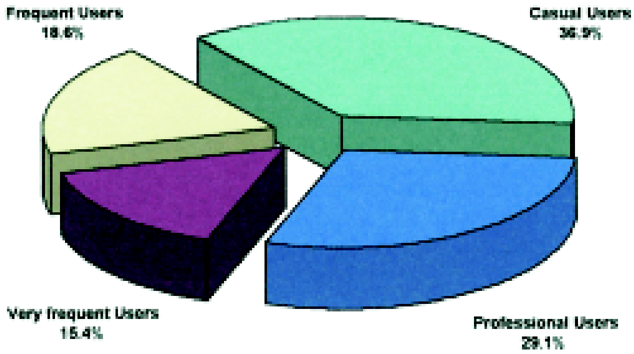
[1] Corresponding to the number of members in national neutron user organisations

2. Results of the ENSA Survey of Neutron Users

2.1 European neutron scattering community by discipline



2.2 European neutron scattering community by usage



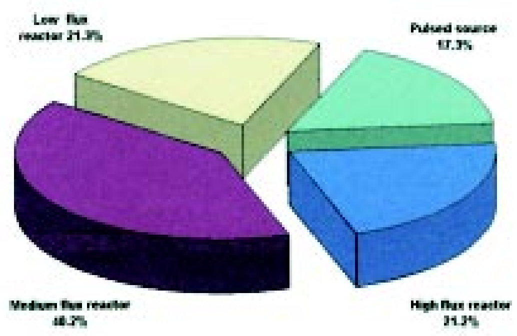
- Professional user: Neutron scattering constitutes between 75% and 100% of research programme.

- Very frequent user: Neutron scattering constitutes between 50% and 75% of research programme.

- Frequent user: Neutron scattering constitutes between 25% and 50% of research programme.

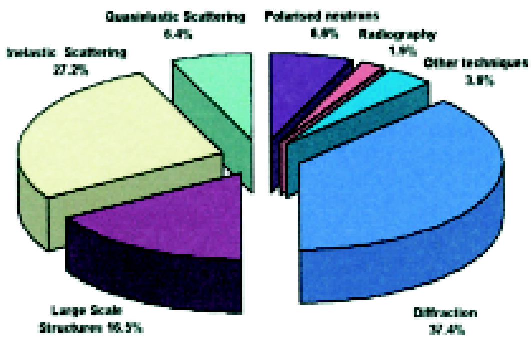
- Casual user: Neutron scattering constitutes less than 25% of research programme.

2.3 European neutron beam usage by source type

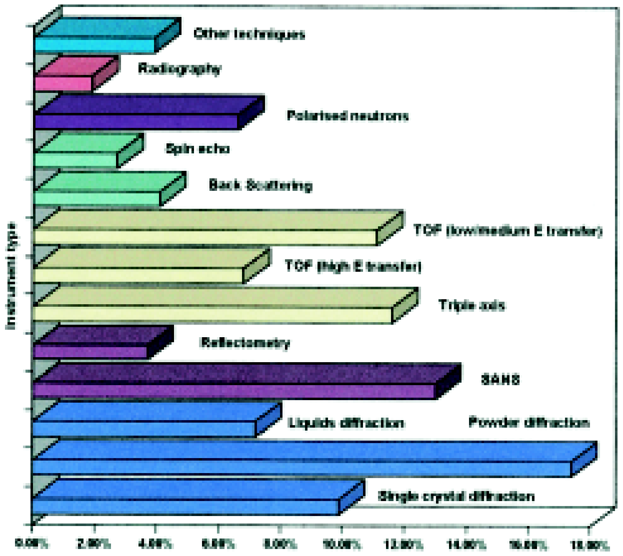


- Low Flux Reactors: $n_{th} \leq 10^{14}$ n.cm^{-2}.s^{-1}
- Medium Flux Reactors: 10^{14} n.cm^{-2}.s^{-1} $< n_{th} < 10^{15}$ n.cm^{-2}.s^{-1}
- High Flux Reactors: $n_{th} \oplus 10^{15}$ n.cm^{-2}.s^{-1} (Principally ILL)
- Spallation Sources: principally ISIS

2.4 Neutron beam usage by technique



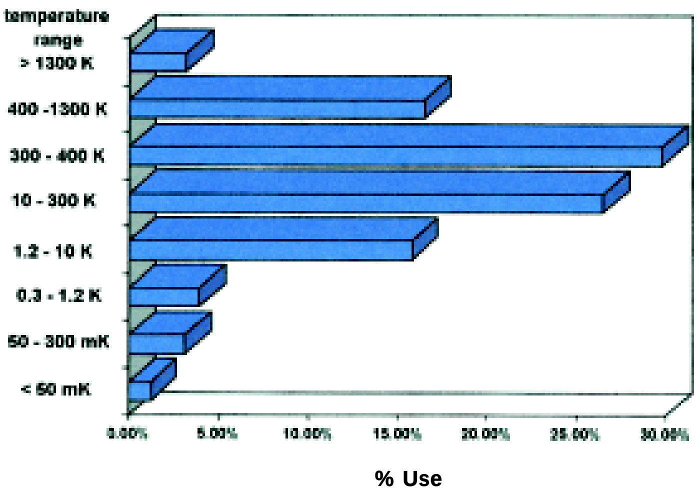
2.5 European neutron beam usage by instrument type



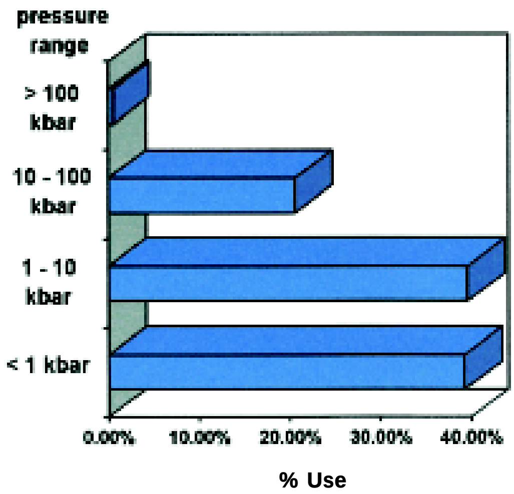
● **Note:** Instrument type is colour coded according to technique as in 2.4

2.6 Sample environment

2.6.1 Sample environment: temperature



2.6.2 Sample environment: pressure



- **Note:** Usage is expressed as a percentage of those respondents who use high pressure facilities routinely (ie approx 15% of respondents)

2.7 Subjective responses

2.7.1 Most important scientific question in the respondent's field

The request for respondents to cite the most important scientific question in their own field produced almost as many answers as respondents. Although there was no true consensus, the responses included:

- Understanding high temperature superconductors and design of new High T_c structures;
- Link between magnetic structures and macroscopic magnetic properties;
- Correlation of material properties with structural features;
- Understanding catalytic reactions;
- Understanding and control of redox processes;
- Dynamics and structures of polymer systems;
- Fast ion transport in glasses/polymers/biomaterials;
- The nature of first order and continuous phase transitions;
- Collective dynamics in liquids;
- Structural/property relations in nanostructural material;
- Internal stresses in engineering materials.

2.7.2 Most important neutron experiment in the respondent's field

The request for respondents to cite the most important neutron experiment in their field again failed to provide a consensus. The most frequently occurring answer proved to be *"my last experiment"*! The development of particular instrumental methods and neutron techniques were heavily cited, for example:

- Triple axis spectrometry by Brockhouse;
- Moon, Riste and Koehler's development of polarisation analysis;
- Development of Neutron Spin Echo by Mezei;
- Isotopic substitution methods (Enderby).

Other notable, multi-cited experiments included:

- Shull and Wollan's determination of antiferromagnetic structures;
- High T_c structure determination;
- Spin dynamics in High T_c materials (Rossat-Mignod);
- Measurements of the conformation changes in biological macromolecules;
- Dynamics of polymer melts (Richter).

2.7.3 The requirements for additional neutron beam time

The current European Neutron Scattering community expressed a need for additional neutron beam time at High Flux Reactors and Spallation Sources amounting to an increase in demand of 78%. A need for a further 18% of beam time at Medium and Low Flux reactors was also identified.

If this additional beam time were made available on average approximately 25% of beam users would move up one user category as defined in section 2.2

Responses indicated that the additional beam time would be used in some cases to extend neutron studies along existing lines, or to perform more systematic studies than are currently possible. However it was also clear from the responses that new studies would be initiated, for example:

- The examination of larger molecules;
- The execution of more difficult experiments (eg more dilute systems);
- Real-time kinetic studies;
- Greater use of polarised beam methods.

2.7.4 Research on the next generation high intensity neutron sources

The question *"what research would be carried out today if a next-generation high intensity neutron source was available"* again provided a wide range of answers. However some consensus was achieved with the most frequent answers being:

- Real time, kinetic structural studies;
- Reaction kinetics;
- Studies of very small samples;
- Studies of samples at extreme dilution;
- Measurements over wider energy range at higher resolution;
- Phase diagram studies of complex structures as a function of more than one variable (pressure, temperature, field etc);
- Real time small angle neutron scattering.

2.7.5 Further comments

Respondents were provided the opportunity to make further comments. Those received included:

- Frequently, too little beam time is given to complete an experiment at the larger facilities.
- There is a need for instrument optimisation and development at all sources.

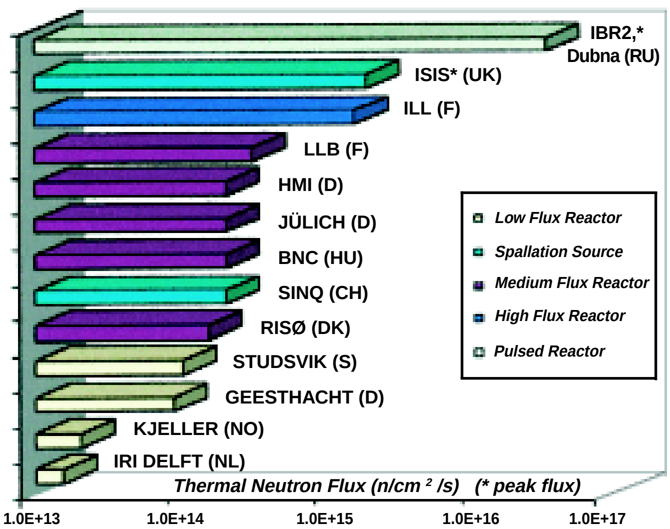
3. The ENSA Survey of European Neutron Facilities

The ENSA survey of European Neutron Scattering facilities was carried out over the period 1996/1997. Thirteen European neutron sources were requested to provide details of the nature of the neutron source, instrumentation, modes of access for national and international users, scale of financial support, points of contact and sources of information at the facilities.

The completed questionnaires from each of the thirteen facilities have been included in Appendix I of this report and should provide a useful guide to European neutron facilities for current and prospective neutron beam users.

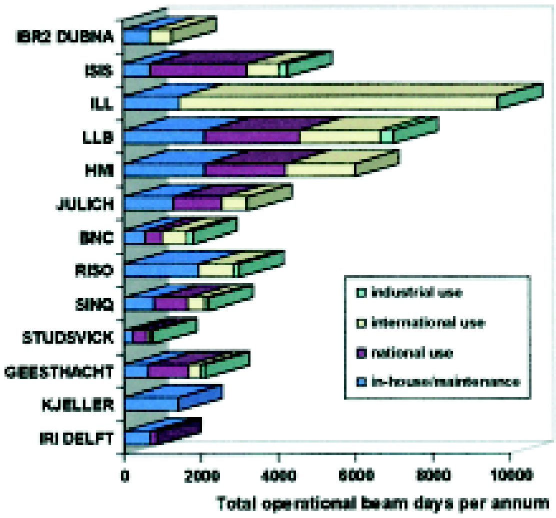
Russia was not a full member of ENSA at the time of the survey of neutron users. The Russian community is thus not represented in the preceding sections of this report. To facilitate comparisons between the ENSA surveys of neutron beam users and facilities the IBR2 Facility (Dubna, Russia), unless explicitly mentioned, has therefore been excluded from much of the following statistical analysis:

For convenience each of the European neutron beam facilities have been categorised according to their source type and flux, using the same definitions as in section 2.3.



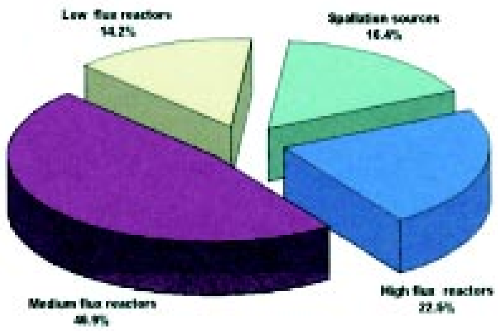
4. Results of the ENSA Survey of Neutron Facilities

4.1 Operational neutron beam days per annum

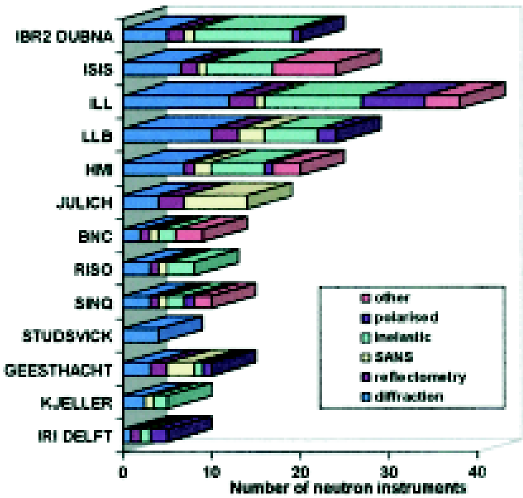


The total number of operational beam days per annum is the product of the annual operational days of the facility runs, multiplied by the total number of instruments at the facility. In total, the combined European neutron facilities offer almost 43,000 beam days per annum distributed over 198 neutron instruments.

Excluding the IBR2-Dubna facility from the analysis and accounting only for those neutron instruments which are available to the general user, the *provision of neutron beam time* according to the source type closely reflects the distribution of *neutron beam usage* estimated from the ENSA survey of the neutron community (section 2.3). The definition of source type is given in section 2.3

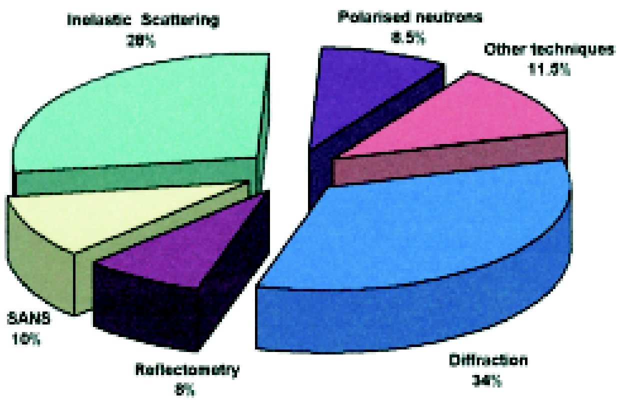


4.2 Availability of neutron instrumentation



The 173 neutron instruments available to the wider European neutron scattering community (and for the present purpose excluding those at IBR2-Dubna) have been classified according to neutron technique. The resulting distribution closely reflects the distribution of neutron beam usage by technique as assessed in the ENSA survey of the community and presented in section 2.4.

In the present statistical we have grouped quasielastic scattering and inelastic scattering together, whilst separating reflectometry and small angle neutron scattering from the "large scale structures" category. Otherwise the categories are as defined in section 2.4



5. Conclusions and Summary

A detailed statistical breakdown of the results of the ENSA survey of the European Neutron Scattering Community has been presented in section 2 of this report. In this section we shall provide a synopsis of the principal results, and propose the conclusions that may be drawn from them.

- Only minor regional variations in the nature and extent of the use of neutron beams are evident in the responses to the survey.

Conclusion 1:
The statistical data presented here can be taken as representative not only of the European neutron scattering community, but also of the individual national communities.

- Physicists constitute almost one half (46.3%) of the European neutron scattering community. Chemists and materials scientists are also well represented, and together constitute a further 46.3%. Life, engineering and earth scientists comprise less than 8% of the total neutron scattering community.

Conclusion 2:
The existing neutron scattering community must take a proactive role in encouraging life, engineering and earth scientists to make use of neutron beam techniques. It is clear that these disciplines, and indeed industry, have much to gain from an increased utilisation of neutron beam techniques in areas as diverse as pharmacology, strain scanning, mineralogy etc.

- Almost 37% of the European neutron scattering community classify themselves as Casual Users, ie less than 25% of their research programmes involves the use of neutron beam techniques. Indeed only 44.5% of the community devote more than half of their research effort to neutron scattering.

Conclusion 3:
More than half of the users of European neutron scattering facilities employ neutron beam techniques as only one component of a wider research programme. This emphasises the important role of neutron scattering as an enabling technique which underpins a broad condensed matter science base.

- Medium flux reactors account for 40.2% of the European neutron beam usage. Low flux reactors account for 21.3%, High Flux Reactors (principally ILL) for 21.2% and Spallation Sources (principally ISIS) for 17.4%.

Conclusion 4:
The two major European neutron sources, ILL and ISIS, together account for a total of almost 40% of all neutron beam usage.

5. Conclusions and Summary

- Neutron diffraction is the most widely used neutron technique accounting for 37.4% of beam usage. Large scale structure determination (small angle scattering and reflectometry) accounts for a further 16.5%. Inelastic and quasi-elastic scattering together account for 33.6%.

Conclusion 5:
Over one half of neutron beam studies in Europe focus upon structural determination. One third of all studies focus upon dynamics.

- Questions on the principal scientific and technological problems and on the most important neutron experiments to date in the respondent's field of research produced almost as many answers as respondents. There was little over all consensus, although repeating themes (eg High temperature superconductivity) were identified.

Conclusion 6:
European neutron scattering science is as diverse as condensed matter science itself.

- While the European neutron scattering community expressed a need for a further 18% of beam time at Medium and Low Flux Reactors, a further 78% of beam time is required at the High Flux Reactor and Spallation sources. This latter figure is broadly in-line with estimates by ISIS and ILL of an over-subscription factor of approximately two for beam time. This beam time would largely be used to extend existing experimental programmes

Conclusion 7:
There is an identified need, based on existing demand, for at least a doubling of available beam time on High Flux Reactor and Spallation neutron sources.

- When asked to highlight research opportunities on a next generation high intensity neutron source the majority of respondents identified new experimental techniques that would best make use of the proposed high neutron flux, eg real-time kinetic studies; measurements on very small samples or at high dilution; detailed maps of material properties in complex parameter space; high resolution studies.

Conclusion 8:
The European neutron scattering community is well aware of the scientific and technological opportunities afforded by the next generation neutron source. It is already planning novel and exciting experiments that will best utilise the characteristics of such a source.

A statistical analysis of the results of the ENSA survey of the European neutron scattering facilities has been presented in section 4 of this report. Detailed information on the individual facilities is provided in Appendix I. Several conclusions can be drawn from this statistical analysis, particularly when considered together with that of the survey of neutron

- On average, ISIS and the medium flux sources provide approximately 25% of available beam time for international use, often as a consequence of EU funding or major international collaborations. Low flux reactors are used primarily for in-house or national programmes. ILL is the only truly international facility, offering 85% of available beam time to international users.

Conclusion 9:
The European neutron scattering programme relies heavily upon, and benefits from, the provision of both national (ie home-based) and international facilities.

- Industrial use accounts for approximately 44 beam days per annum at high flux sources, 95 days at medium flux sources and 13 days at low flux sources.

Conclusion 10:
There is a small but very significant industrial interest in neutron techniques.

- It can be assumed that an average neutron scattering experiment can be accomplished in 5 days at the high flux ILL and ISIS facilities, in 8 days at medium flux sources and in 10 days at the low flux sources. Considering only those beam days available to (national and international) users external to the facilities we can estimate approximately 2400 experiments are performed per annum at ISIS and ILL, while a further 2000 per annum are performed at low and medium flux sources.

Conclusion 11:
ISIS and ILL, the major state of the art facilities in Europe, account for over half of all neutron scattering experiments performed within Europe by users based outside the facilities, thus emphasising the efficiency of these sources.

- Using the statistics available from the ENSA survey of users it can be estimated that approximately 3200 of the 3548 European neutron beam users are based outside the facilities. Assuming that each neutron scattering experiment is carried out by a team of two scientists, it can be further estimated that on average a team might expect to carry out only 1.5 experiments per year at a high flux source (ie ISIS or ILL) and a further 1.25 experiments at a low or medium flux sources.

Conclusion 12:
The beam time available to users in Europe is sufficient for each experimental team to perform on average fewer than three neutron scattering experiments per year. This cannot adequately support a healthy neutron programme.

5. Conclusions and Summary

- Increases in the European neutron scattering community since the ENSA survey of users (see Appendix II) have already reduced the average number of experiments per annum to approximately 2 per scientific team. The number of users is predicted to continue increasing.

Conclusion 13:
A major new high flux neutron facility is desperately needed.

Summary

The ENSA surveys of the European neutron scattering community and of the European neutron facilities have provided a remarkable and self consistent insight into the nature and extent of neutron scattering science within Europe. Although neutron scattering is often perceived as a specialist tool employed principally by physicists, it emerges as a widely applicable technique which underpins a broad and vibrant condensed matter science base incorporating not only physics but also chemistry, materials science, life sciences, earth sciences and engineering. Moreover the majority of European neutron scatterers use the technique as only one component of a much wider research programme. This further emphasises the vital role that neutron scattering assumes in underpinning European condensed matter science.

A picture has also emerged of a desperate shortage of neutron beam time within Europe. Even without the predicted increase in the number of neutron beam users and the inevitable decrease in the number of neutron sources, the average scientific team can expect on average only two or three neutron experiments each year. Such limited access to the neutron facilities is insufficient to sustain, let alone develop, healthy research programmes.

Both of the ENSA surveys presented here provide a clear indication of the vital role of the high flux neutron sources, ie ILL and ISIS, within Europe and, moreover that the future of neutron scattering science within Europe is intimately linked to the construction of a new major high flux facility. Such a project must be considered as a matter of great urgency.

6. Acknowledgements

I gratefully acknowledge the Chairman on ENSA, Professor Albert Furrer, for preparing the ENSA questionnaire on neutron beam usage, and the ENSA committee members (Appendix III) for providing the collated questionnaire returns from their respective national neutron scattering communities. I am also grateful to Dr Susan Kilcoyne of St Andrews University for her help in compiling the final statistics on the ENSA survey of the European neutron scattering community.

I should also like to thank the representatives of the European neutron scattering facilities listed in Appendix I for providing the detailed information about their respective neutron sources, and Professor Fabrizio Barrocchi for his help with the statistical analysis of the data presented by the facilities.

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Appendix I

A Guide to European Neutron Facilities

Budapest Neutron Centre (Hungary)

1. Source and instrument details

Facility: Budapest Neutron Centre

Type: Reactor

Flux: 2.0×10^{14} n/cm^2/sec

Operational days/year: 200 (approx)

Total number of instruments: 9

Number of instruments available to external users: 9

Type of instruments available to external users:
1 powder/liquid diffractometer
1 single crystal diffractometer*
1 SANS
1 reflectometer*
2 3-axis spectrometers
2 Neutron/gamma radiography
Prompt gamma activation analysis

* Under construction

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 30%
(b) national use 25%
(c) international use 35%
(d) industrial use 10%

% beam time available for:
(a) long term projects 25%
(b) individual experiments 55%
(c) urgent experiments..................... 20%

3. Proposal submission and experiment selection process

Dates for proposal submission: June 15/ November 15

Dates for selection process: July/December

Related scheduling periods:
August-December/January-June

Address for application forms:
Dr BORBELY Sándor, KFKI Building 10, 1525 Budapest, Pf 49, Hungary
E-mail: Borbely@power.szfki.kfki.hu

4. Financial

Formal international collaborations
LLB Saclay (BA); RAL ISIS (EU-PECO); PSI Switzerland (BA); PNPI Gatchina (GF); NPI Prague (BA); FLNP Dubna (GF); Univ.Wien (GF); NPI Sofia (GF); HMI Berlin (EU-PECO); NIST Gaithesburg (GF)

BA= Bilateral Institute Agreement GF= Government Level Framework Agreement

Source and degree of financial support for external users
(a) *national users*
National Fund for Scientific Research
(b) *international (European) users*
Via formal international collaborations

Charges for industrial beam use (per beam day)
650 ECU (negotiable)

5. Further information

Contact name: Dr Laszlo Rosta

Contact address: Budapest Neutron Centre, KFKI Building 10, 1525 Budapest, Pf 49, Hungary
Telephone: +36-1 395 9165
Fax: +36-1 395 9165
Email: borbely@power.szfki.kfki.hu
WWW page: http://www.iki.kfki.hu/nuclear

Further information for potential users:

The 10MW research reactor was restarted after an essential refurbishment in 1993. 2 thermal beam and 1 neutron guide positions are free and the cold source is under construction. International collaborating research groups are invited to install new instruments.

Geesthacht (Germany)

1. Source and instrument details

Facility: FRG-1

Type: Swimming Pool Cold Neutron Source

Flux: 8.7 x 10^{13} n/cm^2/sec

Operational days/year: 210

Total number of instruments: 10

Number of instruments available to external users: 10

Type of instruments available to external users:
1 four circle texture diffractometer
2 residual stress diffractometers
2 SANS
2 reflectometers
1 TOF spectrometer for basic research
1 Double crystal diffractometer for high resolution SANS
1 3-dimensional polarisation analysis diffractometer

Polarised neutrons available on 5 instruments

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 30%
(b) national use 50%
(c) international use 15%
(d) industrial use 5%

% beam time available for:
(a) long term projects 20%
(b) individual experiments 60%
(c) urgent experiments..................... 20%

3. Proposal submission and experiment selection process

Dates for proposal submission:
Any time

Dates for selection process:
Within 4 weeks of submission

Address for application forms: Reinhard Kampmann, Institut für Werkstofforschung, Abtlg. Wfn Neutronen-streuung, GKSS - Forschungszentrum, 21502 Geesthacht, Germany

4. Financial

Formal international collaborations
St Petersburg Nuclear Physics Institute, Gatchina, Russia

Source and degree of financial support for external users
(a) national users
From Universities only:
GKSS Fund for Cooperation, reimbursement of travel (economy class) and accommodation (guesthouse or hotel)
(b) international (European) users
As for national users

Charges for industrial beam use (per beam day)
Depending upon instrument and support required

5. Further information

Contact name: Reinhard Kampmann

Contact address: Institute for Materials Science, Div. Wfn-Neutronscattering, GKSS Research Centre, 21502 Geesthacht, Germany
Telephone: +49 (0) 4152 87 1316 / 2503
Fax: +49 (0) 4152 87 1338
Email: reinhard.kampmann@gkss.de
WWW page: http://www.gkss.de

Further information for potential users:

A brochure *Instrumentation at the Research Reactor FRG-1 Geesthacht* is available. It contains application forms and information on financial support for external users.

Hahn-Meitner Institute (Germany)

1. Source and instrument details

Facility: BER II, BENSC

Type: Swimming pool reactor

Flux: $2x10^{14}$ n/cm^2/sec

Operational days/year: 250

Total number of instruments: 24

Number of instruments available to external users: >17

Type of instruments available to external users:
2 powder/liquid diffractometers
3 3-axis spectrometers
4 single crystal diffractometers
1 quasielastic spectrometer
1 membrane diffraction
2 TOF (MET)
2 SANS
1 spin echo
1 reflectometer
1 neutron interferometer
1 β–NMR
1 cold source

NB: For many instruments options include polarisation, high fields, high pressures and low temperatures

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 35%
(b) national use 35%
(c) international use 30%
(d) industrial use .... <5%

% beam time available for:
(a) long term projects 20%
(b) individual experiments 70%
(c) urgent experiments .... <10%

3. Proposal submission and experiment selection process

Dates for proposal submission:
15 March /15 September

Dates for selection process: May/November

Related scheduling periods:
July-December /January-June

Address for application forms: BENSC, Office of the Scientific Secretary, Hahn-Meitner-Institut, Glienicker Str 100, 14109 Berlin, Germany. Download from the Web at http://www.hmi.de/grossgereate/bensc/BENSC-form.html

4. Financial

Formal international collaborations
European Commission (TMR/LSF); PNPI Gatchina; ILL; ISIS; Risø; ANSTO (Australia)

Source and degree of financial support for external users
(a) national users
BENSC funds assist in travel, subsistence and on-site accommodation. Preference is given to young researchers from German Universities. Neutron beam facilities are free of charge.
(b) international (European) users
For EU member state groups free access is provided until 2000 under the TMR/ LSF programme of the European Commission. There is a peer review selection procedure for the inclusion of new projects.The grant covers reimbursement of travel, accommodation and subsistence as well as free use of BENSC facilities and scientific and technical support.

Charges for industrial beam use (per beam day)
on request

5. Further information

Contact name: Dr Rainer Michaelsen

Contact address: BENSC Scientific Secretary, Hahn-Meitner-Institut, Glienicker Str 100, 14109 Berlin, Germany
Telephone: +49 30 8062 2304 / 3043
Fax: +49 30 8062 2523 / 2181
Email: michaelsen@hmi.de
WWW page: http://www.hmi.de/

Further information for potential users:

The BENSC brochure with technical descriptions of the instruments and sample environment as well as the annually distributed “BENSC Experimental Reports” are available from the BENSC office on request.

Updated versions of the instrument descriptions are provided on the WWW.

IBR2 Dubna (Russia)

1. Source and instrument details

Facility: IBR-2

Type: Pulsed Reactor

Flux: 3 x 10^{16} (thermal n in core)

Operational days/year: 2500h/year

Total number of instruments: 12

Number of instruments available to external users: 12

Type of instruments available to external users:
4 powder/liquid diffractometers
1 single crystal diffractometer
1 SANS
2 reflectometers
1 quasi-elastic spectrometer
2 TOF (MET)
1 spin echo

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 55%
(b) national use
(c) international use 45%
(d) industrial use

% beam time available for:
(a) long term projects 30%
(b) individual experiments 45%
(c) urgent experiments..................... 10%
(d) maintenance, reserve etc 15%

3. Proposal submission and experiment selection process

Dates for proposal submission:
16 October/16 May

Dates for selection process:
30 January/15 September

Related scheduling periods:
February-June/October-February

Address for application forms: Scientific Secretary, Frank laboratory of Neutron Physics, Joint Institute for Nuclear Research, 141980 Dubna, Moscow Region, Russia

4. Financial

Formal international collaborations
HMI (Berlin); FZ (Rossendorf); FHIZP (Saarbrucken); ILL (Grenoble); GKSS (Geesthacht); TU (Darmstadt); KFA (Julich); LLB (Saclay); Univ. of Leipzig; IK (Karlsruhe); TU (Braunschweig); RAL (UK); Beijing University (China); Trondheim University (Norway)

Source and degree of financial support for external users
(a) *national users*
Russian National Programme: "Condensed Matter Investigation by Neutrons"
(b) *international (European) users*
Budget of the Joint Institute for Nuclear Research

Charges for industrial beam use (per beam day)
n/a

5. Further information

Contact name: Dr Vadim Sikolenko

Contact address: Frank Laboartory of Neutron Physics, Joint Institute for Nuclear Research, 141980 Dubna, Moscow Region, Russia
Telephone: +7-09621-65096
Fax: +7-09621-65882
Email: sikolen@nf.jinr.dubna.su
WWW page: http://nfdfn.jinr.dubna.su/

Further information for potential users:

User Guide and Annual Report are available on request.

Institut Laue Langevin (France)

1. Source and instrument details

Facility: ILL

Type: 58MW High Flux Reactor

Flux: 1.5 x10^{15} n/cm^2/sec

Operational days/year: 225

Total number of instruments: Approximately 43 including test and development

Number of instruments available to external users: 36

Type of instruments available to external users:
5 powder/liquid diffractometers
7 single crystal diffractometers
2 SANS*
3 reflectometers*
5 polarised neutron instruments*
2 Nuclear Physics
6 3-axis spectrometers
2 backscattering spectrometers
3 TOF (MET)
2 spin echo
2 Fundamental Physics

*some double counting

NB: 7 of the above instruments are operated and supported by Collaborative Research Groups (CRGs)

2. Beam allocation

% beam time normally used for:
(a) in-house use/maintenance etc 10-20%
(b) national use
(c) international use 80-90%
(d) industrial use 0.1%

% beam time normally used for:
(a) long term projects .... <5%
(b) individual experiments .... >95%
(c) urgent experiments..................... ~0.5%

3. Proposal submission and experiment selection process

Dates for proposal submission: 15 February / 31 August

Dates for selection process: April / October

Related scheduling periods: July-December / January-June

Address for application forms: Scientific Coordination Office, ILL, BP 156, 38042 Grenoble Cedex 9, France

4. Financial

Formal international collaborations
Member countries:
France, Germany, UK, Spain, Switzerland, Austria, Italy

Source and degree of financial support for external users:
(a) national users
n/a
(b) international (European) users
Travel and subsistence for users from member countries:
normally 1 person per experiment, or two if from different laboratories
or for training students

Charges for industrial beam use (per beam day)
Depends on instrument

5. Further information

Contact name: Dr H Büttner

Contact address: Scientific Coordination Office, ILL, BP 156,
38042 Grenoble Cedex 9, France
Telephone: +33 4 76 20 7179
Fax: +33 4 76 48 3906
Email: buttner@ill.fr
WWW page: http://www.ill.fr

Further information for potential users:

Information about ILL is available on the World Wide Web.

IRI Delft (Netherlands)

1. Source and instrument details

Facility: IRI Delft

Type: 2MW light water swimming pool

Flux: 1.5 x 10^{13} n/cm^2/sec

Operational days/year: 170

Total number of instruments: 5

Number of instruments available to external users: 5+2*

Type of instruments available to external users:
2 powder/liquid diffractometers*
1 reflectometer
1 small angle scattering spectrometer*
1 TOF (MET)
2 polarised neutron instruments

*instruments located at ECN Petten

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 80%
(b) national use 20%
(c) international use
(d) industrial use

% beam time available for:
(a) long term projects 75%
(b) individual experiments 20%
(c) urgent experiments..................... 5%

3. Proposal submission and experiment selection process

Dates for proposal submission: no formal selection process

Contact one of the following:
M Th Rekveldt (Head of Polarised Neutron Group);
I M de Schepper (Head of Neutron Scattering Group) or
A A van Well (Coordinator of Neutron Beam Facilities)
at
Interfacultair Reactor Institut, Delft University of Technology, Mekelweg 15, 2629 JB Delft, The Netherlands

4. Financial

Formal international collaborations
None

Source and degree of financial support for external users
(a) national users
No financial support
(b) international (European) users
No financial support

Charges for industrial beam use (per beam day)
NGL 4000

5. Further information

Contact name: Dr A A van Well

Contact address: Interfacultair Reactor Institut, Delft University of Technology, Mekelweg 15, 2629 JB Delft, The Netherlands
Telephone: +31 15 2784738
Fax: +31 15 2786422
Email: VanWell@iri.tudelft.nl
WWW page: http://www.iri.tudelft.nl

Further information for potential users:

The neutron beam facilities are available to outside (Dutch and foreign) users mainly on a collaborative basis.

Note that some instruments are located at ECN Petten.

IRI has no paying industrial users. There exists some collaborative projects with industrial partners, eg Philips (recording materials) and DSM (dendrimers). Here the industrial partners supply the samples.

ISIS (United Kingdom)

1. Source and instrument details

Facility: ISIS

Type: Pulsed Spallation Source

Flux: 2.5 x 10^{16} n_{fast} / sec

Operational days/year: 175

Total number of instruments: 18 neutron + 5 muon + 1 neutrino

Number of instruments available to external users: 24

Type of instruments available to external users:
3.5 powder diffractometers
1 single crystal diffractometer
1 SANS
2 reflectometers
1 Cold neutron test VESTA
1 Single crystal alignment ALF
5 muon instruments
1 neutrino facility
1 3-axis spectrometers
1.5 quasielastic spectrometers
4 TOF spectrometers
1 eV spectrometer
1 strain/pressure diffractometer

- ISIS operates at 200µA in 0.4µs pulses at 50Hz

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 0/15%
(b) national use 60%
(c) international use 20%
(d) industrial use 5%
% beam time available for:
(a) long term projects 50%
(b) individual experiments 40%
(c) urgent experiments..................... 10%

3. Proposal submission and experiment selection process

Dates for proposal submission:
April 16 /October 16

Dates for selection process: First week of June / First week of December

Related scheduling periods: Sept to Jan / April to August

Address for application forms: ISIS User Liaison Office, Building R3, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX
Fax: +44 (0)1235 445103
Email: uls@isise.rl.ac.uk
WWW page: http://www.isis.rl.ac.uk/

4. Financial

Formal international collaborations
TMR programme of EU for neutrons and muons
Italy, Sweden, Netherlands, Spain, Germany, Australia, Japan
India, USA, Switzerland

Source and degree of financial support for external users
(a) *national users*
Access via research council funding (EPSRC, BBSRC, NERC)
(b) *international (European) users*
International collaborations
TMR Programme
Director's discretion

Charges for industrial beam use (per beam day)
on application

5. Further information

Contact name: ISIS University Liaison Office

Contact address: Building R3, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX
Telephone: +44 (0)1235 445592
Fax: +44 (0)1235 445103
Email: uls@isise.rl.ac.uk
WWW page: http://www.isis.rl.ac.uk/

Further information for potential users:

Information about ISIS is available on the World Wide Web.

Jülich (Germany)

1. Source and instrument details

Facility: FRJ-2 Jülich

Type: Dido reactor

Flux: 2×10^{14} n/cm^2/sec

Operational days/year: 200

Total number of instruments: 16

Number of instruments available to external users: 15

Type of instruments available to external users:
2 powder/liquid diffractometers
2 single crystal diffractometers
2 SANS
1 double crystal diffractometer
3 3-axis spectrometers
1 quasielastic spectrometer
1 TOF (MET)
2 backscattering spectrometers

1 β-NMR

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 40%
(b) national use 40%
(c) international use 20%
(d) industrial use

% beam time available for:
(a) long term projects .... n/a
(b) individual experiments .... n/a
(c) urgent experiments..................... n/a

3. Proposal submission and experiment selection process

Dates for proposal submission: no formal selection process

Informal proposals to:
Professor Dr D Richter, Forschungszentrums Jülich GmbH, Institut für Festkörperforschung, Postfach 19 13, 52425 Jülich, Germany

4. Financial

Formal international collaborations
None

Source and degree of financial support for external users
(a) national users
Financial support available
(b) international (European) users
No financial support

5. Further information

Contact name: Professor Dr D Richter

Contact address: Forschungszentrums Jülich GmbH, Institut für Festkörperforschung, Postfach 19 13, 52425 Jülich, Germany
Telephone: +49-2461161 2499
Fax: +49-2461161 2610
Email: d.richter@kfa-juelich.de
WWW page: http://www.kfa-juelich.de

Further information for potential users:

Jülich welcomes national and international users on a collaborative basis. Some of the instruments are operated by CRG university groups, who in general are also open for national and international collaborations.

Kjeller (Norway)

1. Source and instrument details

Facility: JEEP II

Type: D_2O moderated 3.5% enriched UO_2 fuel

Flux: $2x10^{13}$ n/cm^2/sec

Operational days/year: 280

Total number of instruments: 5

Number of instruments available to external users: 5

Type of instruments available to external users:
2 powder/liquid diffractometers
1 single crystal diffractometer*
1 SANS
1 3-axis spectrometer*
1 quasi-elastic spectrometer (TOF)

*The 3-axis instrument may be used as a single crystal diffractometer

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc
(b) national use
(c) international use
(d) industrial use

all facilities are used by local staff in collaboration with students from the Universities of Oslo and Trondheim (NTNU)

% beam time available for:
(a) long term projects
(b) individual experiments
(c) urgent experiments

see above

3. Proposal submission and experiment selection process

Dates for proposal submission:
No special dates

Dates for selection process:
No special dates

Address for application forms:
Professor A Skjeltorp, Physics Department IFE, Box 40, 2007 Kjeller, Norway

4. Financial

Formal international collaborations
None

Source and degree of financial support for external users
(a) national users
None
(b) international (European) users
None

Charges for industrial beam use (per beam day)
n/a

5. Further information

Contact name: Dr O Steinsvoll

Contact Address: Physics Department, IFE, Box 40, 2007 Kjeller, Norway
Telephone: +47 63 80 60 79
Fax: +47 63 81 09 20
WWW page: http://www.ife.no/departments/physics/index.html

Further information for potential users:

Information about JEEP II is available on the World Wide Web.

Laboratoire Léon Brillouin (France)

1. Source and instrument details

Facility: LLB

Type: Reactor

Flux: 3.0×10^{14} n/cm²/sec

Operational days/year: 250

Total number of instruments: 28

Number of instruments available to external users: 24

Type of instruments available to external users:
6 powder/liquid diffractometers
2 single crystal diffractometers
1 Strain diffractometer
1 Texture diffractometer
3 SANS
3 reflectometers
5 3-axis spectrometers
1 TOF (MET)
1 spin echo
1 polarised neutron instrument

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 30%
(b) national use 35%
(c) international use 30%
(d) industrial use 5%

% beam time available for:
(a) long term projects 30%
(b) individual experiments 50%
(c) urgent experiments..................... 20%

3. Proposal submission and experiment selection process

Dates for proposal submission: September

Dates for selection process: November

Related scheduling periods: January to December

Address for application forms: Laboratoire Léon Brillouin, CEA-saclay,
91191 Gif-sur-Yvette Cedex, France

4. Financial

Formal international collaborations
KFK Karlsruhe (Germany) ; KFK Wien (Austria); INFM (Italy); PNPI Gatchina (Russia); European Union (Large Scale Facilities)

Source and degree of financial support for external users
(a) national users
CNRS/CEA: 100%: support for accepted proposals
(b) international (European) users
LSF (European Union): 100% support for one researcher and one student,
limited to 10% of beam time available

Charges for industrial beam use (per beam day)
5000-15000 French Francs

5. Further information

Contact name: Mrs Claude Rousse

Contact address: Laboratoire Léon Brillouin, CEA-saclay, 91191 Gif-sur-Yvette Cedex, France
Telephone: +(33 -1) 69 08 52 41 / 54 17
Fax: +(33 -1) 69 08 82 61
Email: rousse@bali.saclay.cea.fr

NFL Studsvik (Sweden)

1. Source and instrument details

Facility: NFL Studsvick

Type: 50MW reactor

Flux: $>10^{14}$ n/cm^2/sec

Operational days/year: 187

Total number of instruments: 4 (5 in early 1998)

Number of instruments available to external users: 4 (5 in early 1998)

Type of instruments available to external users:
1 powder diffractometer
1 liquids diffractometer
1 single crystal diffractometer
1 Residual stress diffractometer
1 TOF (MET) scheduled for early 1998

2. Beam allocation

% beam time available for:

(a) in-house use/maintenance etc	30%
(b) national use	50%
(c) international use	15%
(d) industrial use	5%

% beam time available for:

(a) long term projects	30%
(b) individual experiments	40%
(c) urgent experiments	30%

3. Proposal submission and experiment selection process

Dates for proposal submission:
1 Dec/1 April /1 Aug (for LSF programme only)

Dates for selection process: Decisions before 1 Jan /1 May/1 Sept (LSF only)

Related scheduling periods: January-April / May-August / September-December

Address for application forms:
Dr R McGreevy, NFL Studsvik, S-611 82 Nyköping, Sweden

4. Financial

Formal international collaborations
EC LSF programme (Framework IV) joint user programme with Risø

Source and degree of financial support for external users
(a) national users
Travel and subsistence for students.
(b) international (European) users
EC LSF programme:
Travel and subsistence for 2 users per experiment, some funds for specialised technical items.

Charges for industrial beam use (per beam day)
30-40kSEK

5. Further information

Contact name: Dr R McGreevy

Contact address: NFL Studsvik, S-611 82 Nyköping, Sweden
Telephone: +46 155 221831 (Secretary 221830)
Fax: +46 155 263001
Email: mcgreevy@studsvik.uu.se
WWW page: http://www.studsvik.uu.se

Further information for potential users:

Information available on the World Wide Web.

Risø (Denmark)

1. Source and instrument details

Facility: DR3 steady state

Type: Pluto reactor

Flux: 1.5 x 10^{14} n/cm^2/sec

Operational days/year: 300

Total number of instruments: 8

Number of instruments available to external users: 8

Type of instruments available to external users:
1 powder diffractometer*
2 single crystal diffractometers*
1 texture diffractometer*
1 residual stress diffractometer
1 SANS
1 reflectometer
3 3-axis spectrometers

*the powder diffractometer, one single crystal and the texture diffractometer can only be used on an alternating basis

2. Beam allocation

% beam time available for:

(a) in-house use/maintenance etc ..	65%
(b) national use	
(c) international use	30%
(d) industrial use	5%

% beam time available for:

(a) long term projects	No fixed ratios: Only 20% of beam time is formally allocated
(b) individual experiments	
(c) urgent experiments	

3. Proposal submission and experiment selection process

Dates for proposal submission:
1 April /1 August /1 December

Dates for selection process:
15 May /15 September /15 January

Related scheduling periods:
Jun - Sept / Oct - Jan / Feb - May

Address for application forms: TMR Access to Large Scale Facilities FYS 108, Risø National Laboratory, DK-4000 Roskilde, Denmark

4. Financial

Formal international collaborations
EC Access to Large Scale Facilities

Source and degree of financial support for external users
(a) national users
No financial support
(b) international (European) users
EC-TMR Access to Large Scale Facilities: Covers travel and subsistence for European Users (for up to 20% of total beam time)

Charges for industrial beam use (per beam day)
24000 Dkr (approx)

5. Further information

Contact name: Prof Kurt N Clausen

Contact address: Condensed Matter Physics and Chemistry Dept, FYS 108, Risø National Laboratory, DK-4000 Roskilde, Denmark
Telephone: +45 4677 4704
Fax: +45 4677 4790
Email: kurt.clausen@risoe.dk
WWW page: http://www.risoe.dk/fys/lip.html

Further information for potential users:

See the advertisement in Neutron News, and the World Wide Web page.

SINQ (Switzerland)

1. Source and instrument details

Facility: SINQ

Type: Steady Spallation Source

Flux: 2.0 x 10^{14} n/cm^2/sec

Operational days/year: 220

Total number of instruments: 10

Number of instruments available to external users: 10

Type of instruments available to external users:
2 powder diffractometers
1 single crystal diffractometer
1 SANS
1 reflectometer
2 3-axis spectrometers (one for polarised neutrons)
1 TOF (cold neutrons)
Radiography
Prompt gamma analysis

2. Beam allocation

% beam time available for:
(a) in-house use/maintenance etc 35%
(b) national use 40%
(c) international use 20%
(d) industrial use 5%

% beam time available for:
(a) long term projects 65%
(b) individual experiments 25%
(c) urgent experiments 10%

3. Proposal submission and experiment selection process

Dates for proposal submission: Starting in 1998

Dates for selection process: Spring and Autumn (details to follow)

Related scheduling periods: January to June, July to December

Address for application forms: Secretariat, Laboratory for Neutron Scattering, ETH Zurich and Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland

4. Financial

Formal international collaborations
BMBF (Germany)

Source and degree of financial support for external users
(a) national users
Support available on request
(b) international (European) users
support available on request

Charges for industrial beam use (per beam day)
actual cost (not yet decided)

5. Further information

Contact name: Professor Dr Albert Furrer

Contact address: Laboratory for Neutron Scattering
ETH Zurich and Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland
Telephone: +41-56-310 20 88
Fax: +41-56-310 29 39
Email: albert.furrer@psi.ch
WWW page: http://wwwl.psi.ch/www_lns_hn/welcome_SINQ.html

Further information for potential users:

A guide describing SINQ instruments and the details of the application procedure will be available in early 1998.

The European Neutron Scattering Community

The Analytical Report on neutron scattering commissioned by the OECD Megascience Forum predicted an increase in the size of the international neutron scattering community from 4000 in 1993 to over 7000 by the year 2000.

Commensurate with this predicted growth, and also reflecting the increased membership of the European Neutron Scattering Association, the number of European neutron beam users represented by ENSA has increased markedly since the initial ENSA survey of the European neutron scattering community.

Table AII.1. Size of the European national neutron scattering communities

Country	Number of Users 1995 ENSA Survey	Number of Users 1997 Re-evaluation
Austria	20	60
Belgium		20
Czech Republic		30
Denmark	30	30
Finland		10
France	600	600
Germany	800	1100
Hungary	80	80
Italy	130	130
Netherlands	160	160
Norway	10	20
Poland		50
Portugal		10
Russia		350
Slowakia		10
Slowenia		10
Spain	150	150
Sweden	68	80
Switzerland	300	300
United Kingdom	1200	1200
TOTAL	3548	4400

The ENSA Committee

The European Neutron Scattering Association, ENSA, is an affiliation of national neutron scattering societies and committees which directly represent neutron beam users. The overriding purposes of ENSA are to provide a platform for discussion and a focus for action in neutron scattering and related topics in Europe.

ENSA was inaugurated in 1994 under the Chairmanship of Professor D Richter. The current national delegates to the ENSA committee are:

ENSA Executive Board

Professor Dr A Furrer	Switzerland	*ENSA Chairman*
Professor R Cywinski	UK	*ENSA Vice-Chairman*
Doctor B Lebech	Denmark	*ENSA Secretary*

ENSA Committee

Professor Dr P Fratzl	Austria	Email: fratzl@pap.univie.ac.at
Professor R Vacher	France	Email: rene@ldv.univ-montp2.fr
Professor Dr D Richter	Germany	Email: d.richter@kfa-juelich.de
Professor L Rosta	Hungary	Email: rosta@power.szfki.kfki.hu
Professor F Barocchi	Italy	Email: barocchi@fi.infn.it
Doctor A A Van Well	Netherlands	Email: a.a.van.well@iri.tudelft.nl
Doctor O Steinsvoll	Norway	Email: olav@ife.no
Professor Dr A Sztytula	Poland	Email: szytula@if.uj.edu.pl
Dr A V Belushkin	Russia	Email: belush@nf.jinr.ru
Professor J Colmenero	Spain	Email: wapcolej@sc.ehu.es
Professor L Borjesson	Sweden	Email: borje@fy.chalmers.se

In addition, invited observers to the ENSA committee include representatives nominated by:

Affiliated national neutron scattering groups (eg Belgium, Czech Republic, Portugal)
The major European neutron scattering facilities
Projects for new European Sources
The European Science Foundation (currently represented by Dr H U Karow)

For further information on ENSA see *http://www.studsvik.uu.se/ensa/ENSAhome.htm* or contact:

Professor Dr Albert Furrer
ENSA Chairman
Lab. for Neutron Scattering
ETH Zurich and PSI
CH-5232 Villigen PSI
Switzerland
Tel: +41-56-310-20-88
Fax: +41-56-310-29-39
Email: albert.furrer@psi.ch

Professor Bob Cywinski
ENSA Vice Chairman
School of Physics
University of St Andrews
St Andrews KY16 9SS
Scotland
Tel: +44-1334-463104
Fax: +44-1334-463108
Email: rc@isise.rl.ac.uk

Dr Bente Lebech
ENSA Secretary
Risø National Laboratory
PO Box 49
DK-4000 Roskilde
Denmark
Tel: +45-4677 4705
Fax: +4677 4790
Email lebech@risoe.DK

Further reading

Scientific Prospects for Neutron Scattering with Present and Future Sources
An European Science Foundation (ESF) Exploratory Workshop in collaboration with the European Neutron Scattering Association (ENSA).
Held with Additional support from EC/TMR and ILL, in Autrans, France in January 1996.

ISBN 2-903148-90-2

The ENSA Survey of the European Neutron Scattering Community
Neutron News Vol 7, No 3, p35 (1996)

Proceedings of the First European Conference on Neutron Scattering ECNS'96
Proceedings of an international conference organised by ENSA and held in Interlaken, Switzerland in October 1996.

Physica B Vols 234-236 (1997)

ESS: A Next Generation Neutron Source For Europe
Volume I The European Spallation Source
Volume II The Scientific Case
Volume III The ESS Technical Study

The scientific case and technical feasibility study for the European Spallation Neutron Source, published in 1997.

Volume I	ISBN:	090 237 6 500
		090 237 6 551
Volume II	ISBN	090 237 6 500
		090 237 6 608
Volume III	ISBN	090 237 6 500
		090 237 6 659

IREG Strasbourg - Dépôt légal : septembre 1998 - N° d'ordre 982343