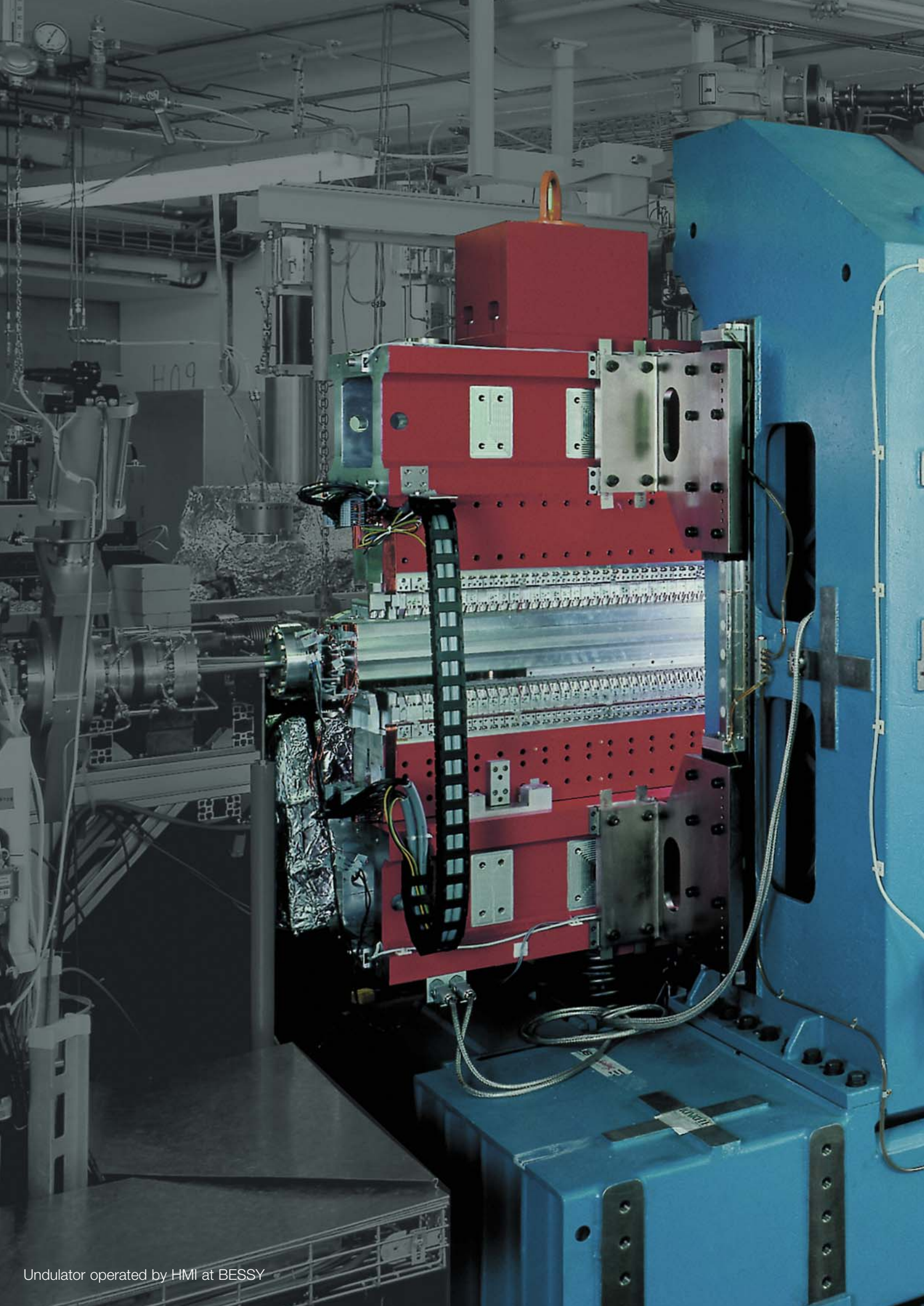
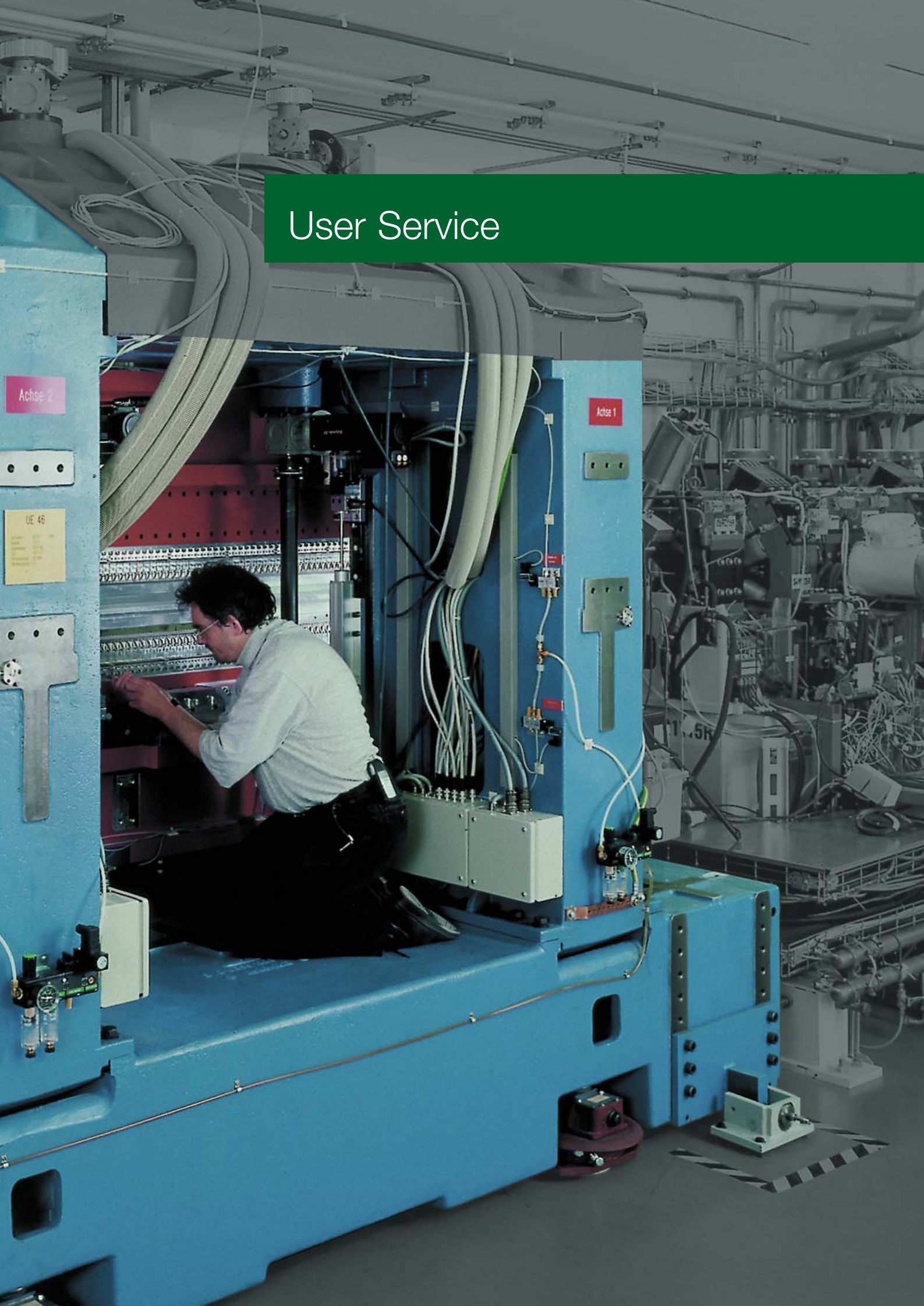
Annual Report 2003

User Service



Undulator operated by HMI at BESSY

User Service



BENSC Operation

Director: Prof. Ferenc Mezei

It is the mission of the Berlin Neutron Scattering Center (BENSC) to develop and operate the scientific instruments at the Berlin research reactor BER II. About 70 % of the beam time at the most important instruments is made available to external scientific user groups from all over the world.

On a **regional and national scale** BENSC performs a principal task of the Hahn-Meitner Institute:
Service for research groups from
- German Universities
- other public funded research institutions.

The relevant duties assigned to BENSC cover a broad range from contributions to scientific education up to performance of high ranking scientific research. An aim of increasing importance is
- scientific and technical support for industrial applications

On the **international scale** BENSC plays an important role in the round of European research centres. The growing international importance of BENSC is underlined by the fact that the number of short-term guest scientists from abroad exceeds the number of German visitors (see table 1). The European use of BENSC is stimulated by substantial support from the European Commission.

Profile of BENSC

The profile of BENSC is characterized by the exceptionally wide range of the **instrumentation**, which allows experiments to be performed in many areas ranging from basic to applied research. Several advanced BENSC instruments provide neutron intensities and resolutions competitiv with the best available worldwide, including those operating at high flux reactors. Most of the instruments have the option of using polarized neutrons.

Allocations 2003 for short-term projects	accepted projects	allocated days
D - Univ.	34	252
D - other	30	222
EU + Assoc + CH	76	526
RU + UA	14	93
USA, CAN, AU, JP	10	199
	164	1292

Table 1: Allocations of BENSC beam time for short term projects

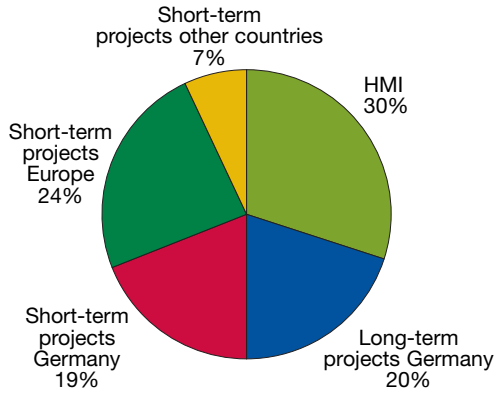


Fig. 1: Distribution of the BENSC instrument-time

Examples for unique advanced instrument options are, e.g.,
- the polarized neutron option SANSPOL
- the multidetector option the time-of-flight spectrometer NEAT
- the spin-echo instrument (SPAN) with the wide-angle NSE option
- the flat-cone diffractometer
- and especially the sample environment.

The leading role of BENSC for **sample environment at extreme conditions** is accepted worldwide: Experiments can be performed over a very large range of temperatures and/or magnetic fields. The temperature range for routine use is $15\ \mathrm{mK}$ to beyond $1200\ \mathrm{K}$; and magnetic fields up to $17\ \mathrm{Tesla}$ have been made available to routine user operation. The unique Cryostat ($1.5\ \mathrm{K} < T < 300\ \mathrm{K}$) with a split pair superconducting magnet and a vertical field up to $17\ \mathrm{Tesla}$ is the world's leading magnet system in a neutron scattering facility and up-to-now available only at BENSC.

The advanced instrumentation and the unique sample environment capabilities attract renowned research groups Europe- and world-wide, and even from other powerful neutron sources. Four examples of highlight results from external user groups are included in the Scientific-Highlights Section of this Report.

BENSC User Service

The BENSC user services provided for scientists of German universities and other national and international research institutions include

- Allocation of beam time to individual (short term) projects of external groups on the basis of peer reviewing by an international user committee and extensive scientific and technical support for the preparation, the experiments and the data evaluation. Logistic support and travel support for young researchers is provided.
- Long-term scientific and technical projects on the basis of co-operation agreements.

An amount of at least 50 % of the beam time of the 14 most important instruments operated by BENSC is reserved for individual scientific projects; up to 20 % of the beam time would be made available for long-term co-operation projects.

Long-term co-operations

Long-term co-operation projects are primarily in the interest of the respective co-operations partners; but they also increase the manpower at BENSC and broaden the capacities for scientific support to the external users. In the path breaking field of soft matter research for instance, which formerly was not a core field of HMI's own scientific program, BENSC has established close collaborative links with the Institute of Biochemistry, TU Darmstadt; Institut für Physikalische Biologie, Univ. Düsseldorf; Iwan-N.-Stranski Institute of the TU Berlin; Max-Planck Institute of Colloids and Interfaces in Golm/Potsdam.

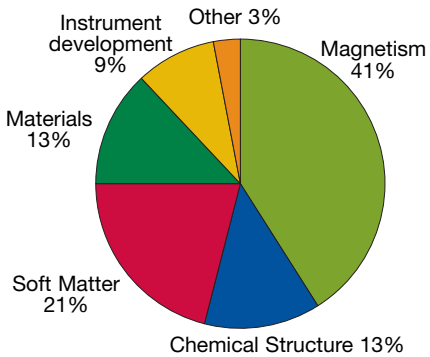


Fig. 2: Fractions of Experimental Reports in HMI-B595 listed by field of science

The most important long-term co-operation partners from the region of Berlin-Brandenburg are:

- Stranski-Laboratorium der Technischen Universität Berlin (Prof. G.H. Findenegg)
- Max-Planck-Institut für Kolloid und Grenzflächenforschung, Golm/Potsdam, (Prof Dr. H. Möhwald)
- Technische Universität Berlin, Institut für Werkzeugwissenschaften und -technologie, Metallphysik, (Prof. W. Reimers)
- Technische Fachhochschule Berlin, (Prof. W. Treimer)

Other national long-term co-operation partners in 2003 are

- Institut für Kristallographie, Universität Tübingen (Prof. J. Ihringer)
- Max-Planck-Institut Festkörperforschung, Stuttgart (Prof. B. Keimer)
- Institut für Biochemie, Technische Universität Darmstadt, (Prof. N. Dencher)
- Institut für Physikalische Biologie, Universität Düsseldorf, (Prof. G. Büldt)
- Institut für Festkörperphysik, Technische Universität Dresden (Prof. M. Loewenhaupt)
- FB Materialwissenschaften, Technische Universität Darmstadt, (Prof. H. Hahn)
- Institut für Festkörperphysik, Technische Universität Darmstadt, (Prof. H. Wipf)

Individual short-term research proposals of external users

It is the key issue of the BENSC user service to provide external groups with beam time and intensive scientific support for individual scientific experiments. This service is meant for both German groups and the international scientific community. The inclusion of new applications for beam time is decided by an internationally composed Scientific Selection Panel. For 2003, more than 165 short-term projects of external users have been accepted by the panel (see table 1).

Co-operation with Industry

The support for industry is mainly based on co-operation agreements, where the partners provide the samples and in return profit from the highly specialized know-how of the BENSC staff and from the advanced analytical methods available at BENSC, with use of neutrons and with complementary use of X-ray or synchrotron radiation. Major co-operation partners in 2003 have been

- MTU Aero Engines GmbH, München
- MTU Friedichshafen GmbH
- Ford Forschungszentrum Aachen GmbH
- Walter AG, Tübingen
- DaimlerChrysler AG, Stuttgart/TUM-Tech GmbH München

Extension of BENSC User Service to HMI instruments at BESSY

To promote complementary use of neutrons and synchrotron radiation, especially in materials science, HMI had initiated an EFRE-supported refurbishment project for the synchrotron source BESSY, including the development and installation of two new insertion devices for the BESSY ring. One of the insertion devices, the Undulator UE46, is operational already since 2002; with full user service at the (PGM-) beam line for magnetic nanostructures and magnetic films in 2003. The use of this beam line is detailed in table 2.

	weeks	
HMI in-house research	11	30 %
External Users under BENSC	4	11 %
External Users under BESSY	7	19 %
BESSY in-house research	15	40 %

Table 2: Distributuion of 2003 experiment time for the UE46-PGM beam line at BESSY

The second insertion device, a 7T Wiggler, has been installed in 2003 (see News-Report on page 110) and will serve two beam lines:

a. white beam for the Materials Science Diffractometer (Residual Stress and Texture Analysis)
b. monochromatic beam for Resonant Magnetic Scattering and High-resolution Diffraction.

The commissioning phase for these two beam lines will start in summer 2004.

BENSC – A European neutron facility, Support from the European Commission for Access to BENSC

The remarkably high number of guest scientists from member countries of the European Community have been stimulated by successfully applying for funds from the programs of the European Commission to support the transnational access to large scale research infrastructures. The EU funding for BENSC and users of BENSC under the Access action of the 5th Framework Programme (FP5) of the EU added up to 2,1 Mio €.

Some relevant numbers for FP5 support are:

4 years (2/2000–12/2003),
330 projects,
700 visits of European users,
2213 neutron instrument days delivered.

The EU-support will be continued under forthcoming FP6: For the 4 years period 2004–2007 BENSC will receive more than 2,3 Mio € for European access and for joint instrument development actions.

An analysis of the distribution of the beam time allocation for EU users demonstrates that a high number of users does not only come from countries which do not have a national research neutron facility, such as Italy, Spain or Greece. Strong user contingents also come from the UK and France to take advantage of options which are not available at their national neutron facilities or at the leading European reactor neutron source, the ILL in Grenoble.

Scientific results of the external users at BENSC

The scientific interim reports on most recent experimental results provide rapid dissemination of the BENSC users' results. The reports are published annually under the label of *BENSC EXPERIMENTAL REPORTS*, and the year 2003 Volume, HMI-B 595 (ISSN 0936-0891), is distributed to all users of BENSC in May 2004 as CD ROM and/or in printed form. The reports for 2000 through 2004 are also available on the BENSC internet pages.
(http://www.hmi.de/bensc/report2003/start_en.htm)

This rapid distribution of results is complemented by oral and poster contributions to national and international conferences. Publication in internationally renowned peer reviewed journals normally follows the experiments with a delay of 1 to 2 years. Since as a rule at least one collaborating BENSC scientist is among the authors the year 2002 publications of external users are included in the publication lists of the departments SF1, SF2 or SF3. A complete compilation of the year 2003 publication lists for all BENSC users and BENSC staff members is included in the a.m. volume *BENSC EXPERIMENTAL REPORTS 2003*, HMI-B595, May 2004. The majority of the BENSC publications has an external user as principal author, and a remarkably high fraction is published in high ranking journals (see table 3).

Journal **Impact Factor** (2002)	**Journal**	**Number** of BENSC publications 2003 with external user as principal author
30,40	**Nature**	3
7,232	**Phys. Rev. Letters**	2
6,201	**J. Am. Chem Soc**	1
4,207	Appl.Phys. Lett.	1
4,064	Biochemistry	1
3,912	FEBS Lett.	1
3,751	Macromolecules	1
3,327	**Phys. Review B**	8
3,248	Langmuir	5
3,048	Carbon	1
2,986	Phys. Review A	1
2,683	J. Mat Chem	1
2,4 - 1,4	Phys. Review E, J. Appl. Phys., Faraday Disc., Chem Phys., J. Appl. Cryst., Polymer, Macromol. Biosci., J. Phys.: Cond. Mat., Eur. Phys. J. B, etc.	30

Table 3: Number of external BENSC users' 2003 printed publications in high ranking journals, based on results of experiments under BENSC User Service

NAA-Laboratory and Irradiation Service at BER II

D. Alber, G. Bukalis, B. Stanik, A. Zimmer
HMI, SF6

The laboratory for neutron activation analysis (NAAL) at the reactor BER II provides radiation services for universities, scientific institutions and industry. Typical fields of applications are:

- Trace elements analysis with neutron activation analysis (NAA) for example in biology, medicine, geology and archeology. Certification of reference materials.
- Irradiation experiments, such as isotope production for medical applications, sources for Mößbauer spectroscopy and production of tracers for industrial applications.

The operation and further development of the irradiation devices at BER II and of the NAA measuring systems are a central task of the department SF6.

Irradiation devices

Four irradiation devices are available for different applications.

DBVK: rotatable irradiation device in the reactor core
DBVR: rotatable irradiation device in the Be-reflector of the reactor core
TBR: dry irradiation device outside the Be-reflector
SRT: fast rabbit system

DBVK and DBVR are used for long term irradiation experiments. Up to nine aluminum containers can be irradiated simultaneously.
Short time irradiation experiments are carried out by means of TBR and SRT.

Status 2003

- The fast rabbit system SRT was not in use in 2003, due to man-power problems. The control system as well as the acquisition system has to be renewed.
- The work for upgrading the in-core position DBVK is still in progress.
- Planning of the renewal of the control units of DBVK and DBVR.

Device	$\Phi_{thermal}$ [1/cm²s]	Φ_{fast} [1/cm²s]	Containers
DBVK	1,5E+14	4,3E+13	9*
DBVR	7,5E+12	1,9E+10	9
TBR	3,4E+12	2,2E+10	1
SRT	4,4E+11	3,9E+10	1

*Temporarily restricted to 4

Irradiation experiments 2003

A total of 1969 samples were irradiated in 2003. 71 % of the 185 irradiation experiments, were performed with the DBVK or DBVR. With these devices it is possible to irradiate up to 24 samples simultaneously in one aluminum container. About 60 % of the irradiation experiments and the analysis of samples was done for external users.

Internal users

Most of the internal users are from the Dept. SF6, but irradiation and analyses were also performed for users from depts. SF1, SF2, SF3, and SE5.

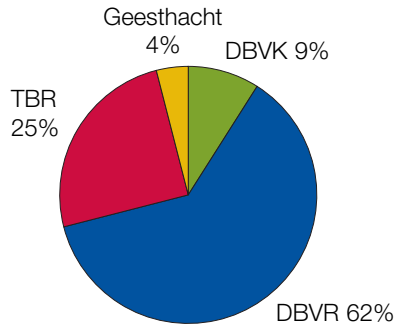
External users

Universities:
FU Berlin
HU Berlin
University Dresden
University Hamburg
University Karlsruhe
University Leipzig
TU München
University München
University Mainz
University Zürich
University Modena
University Lausanne

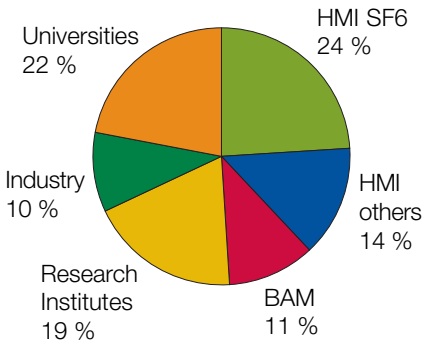
Research Institutes:
BAM, Berlin
GSF, Neuherberg
IIF, Leipzig
DGKC, Bonn
IZW Institute of Zoo Biology and Wildlife Research, Potsdam

Industry:
TruTec Process Diagnostics
Pilkington Deutschland AG

Utilisation of the Irradiation Devices



2003 Irradiated Samples



ISL Operations and Developments

Scientists: H. Homeyer, P. Arndt, W. Busse, A. Denker, W. Pelzer, C. Rethfeldt, J. Röhrich
Operators: J. Bundesmann, R. Grünke, G. Heidenreich, H. Lucht, E. Seidel, H. Stapel

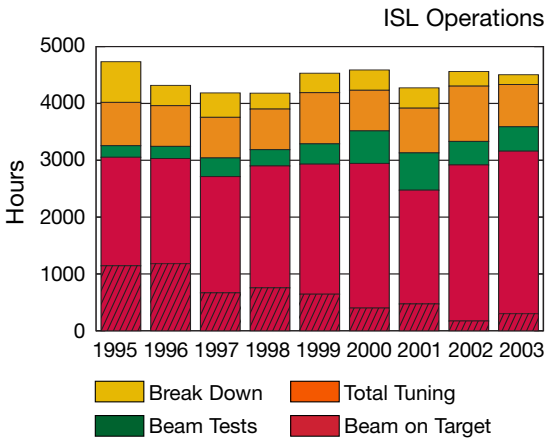


Fig. 1: ISL Operations since 1995: ISL has managed to operate the facility with an average of 3000 hours of beam-time on target. The hatched parts are low energy (Van-de-Graaff) beams. It can be observed that the demand for high energy beams and the reliability (less breakdowns) increased and the total tuning time stays relatively constant, which is due to the fact that the number of users with different beam settings increased. In addition, high levels of beam quality were asked for by many users.

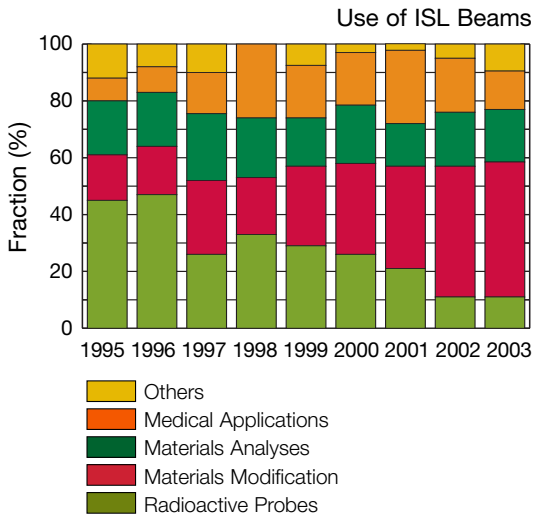


Fig. 2: Use of ISL ion beams. Materials modifications have become the largest part of research and development at ISL.

The ion-beam laboratory ISL offers ion-beams from various accelerators and accelerator combinations with energies ranging from some tens of eV to several hundred MeV dedicated to the application of ion-beam techniques. Internal and outside users study the basics of the interaction of ions with solids. They modify and analyse materials with ion beams and they perform radiotherapy of eye tumours with fast protons in a joint venture with university clinics. Users have at their disposal 15 different irradiation areas equipped with specific instrumentation.

ISL operations went rather smoothly in 2003. As seen in Fig. 1 the time for unscheduled downtimes reached a new all-time low. Simultaneously the production of high energy beams within the scheduled operation time of 4300 hours climbed to a new all-time high of nearly 3000 hours. Several reasons contributed to this excellent outcome:
I) improved operations of the ion source for Au ion beams which have become the most attractive beam used in 2003,
II) better reproducibility for the phase matching between the RFQ and the cyclotron, resulting in shorter tuning times,
III) training of the operators and
IV) a larger demand for high energy proton beams, providing an effective use of the time between therapy sessions either for high-energy PIXE or radiation hardness testing.

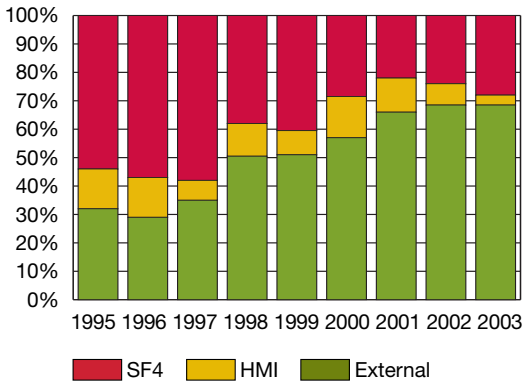


Fig. 3: ISL's development into a user facility. External users including proton therapy use more than 2/3 of the beam-time.

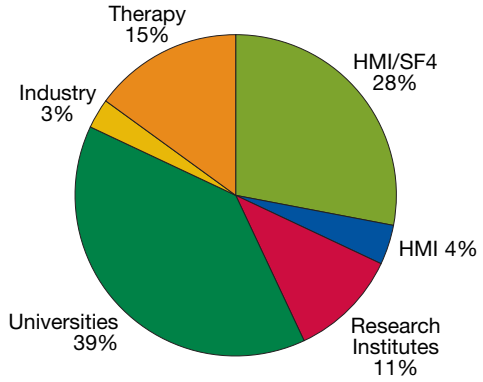


Fig. 4: Origin of ISL Users: The university share has again increased. This is due to their active involvement in the materials modification programme.

Any user has access to the ISL via a programme advisory committee, which meets annually, and decides on the applications for beam time solely on the basis of the proposals' scientific merit. 41 different projects (27 in 2002) involving more than 100 (70 in 2002) scientists received beam time in 2003. In total, more than 80 projects are active at ISL. At its annual meeting, the programme advisory committee accepted 41 proposals, 24 new ones and 17 addenda to running experiments.

Materials analysis in 2003 used exclusively fast ions, either heavy ions for ERDA or protons for high-energy PIXE. They used an almost constant share of beam time (see Fig. 2). Eye tumour therapy was performed at 9 therapy blocks, however, the medical applications used less beam time than 2002 for research work, reflecting changes in personnel. The most active field, concerning new proposals as well as amount of beam time is materials modification and ion-solid interaction.

The amount of beam time used by external users was again more than 2/3 of the overall time (see Fig. 3). Looking at the origin of the users, the universities increased once more their share, due to the on-going trend in the scientific programme towards ion-beam modification of materials.

The set-up of new target stations was pursued, and three of them went into operation in 2003: two of them are dedicated to interaction of ions with solids and one is to recoil implantation.

The tendency of using lightest and heaviest ions available consisted. The most requested beam was gold, now used for nearly one third of the overall beam time. In addition, so-called cocktail beams, ions with the same charge/mass ratio and the same velocity, have been produced: 2 MeV/u Ne/Ar and 3.5 MeV/u Kr/Xe. We assume an increasing demand for these cocktail beams, as they will allow rapid changes of the ion species and therefore the energy deposition.

Besides the installation of new target stations, most of the development was to increase the reliability of the facility in general. The quadrupole power supplies in the extraction beam line have been exchanged. The set-up of the new platform for the injection into the RFQ continued. When this platform is in operation, we expect a reduction of tuning times, as the ECR-source can be prepared parallel to a running experiment.

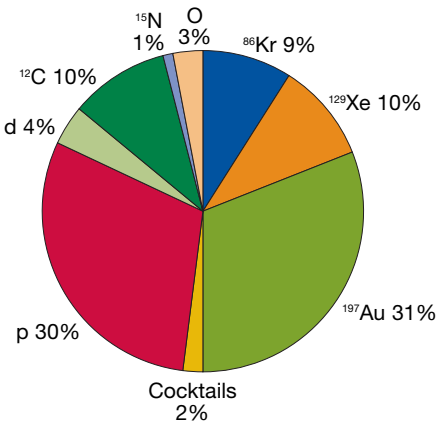


Fig. 5: Fast ion beams used at ISL: in 2003, most of the beam time used either the lightest or the heaviest ions available. In addition, so-called cocktail beams have been produced.