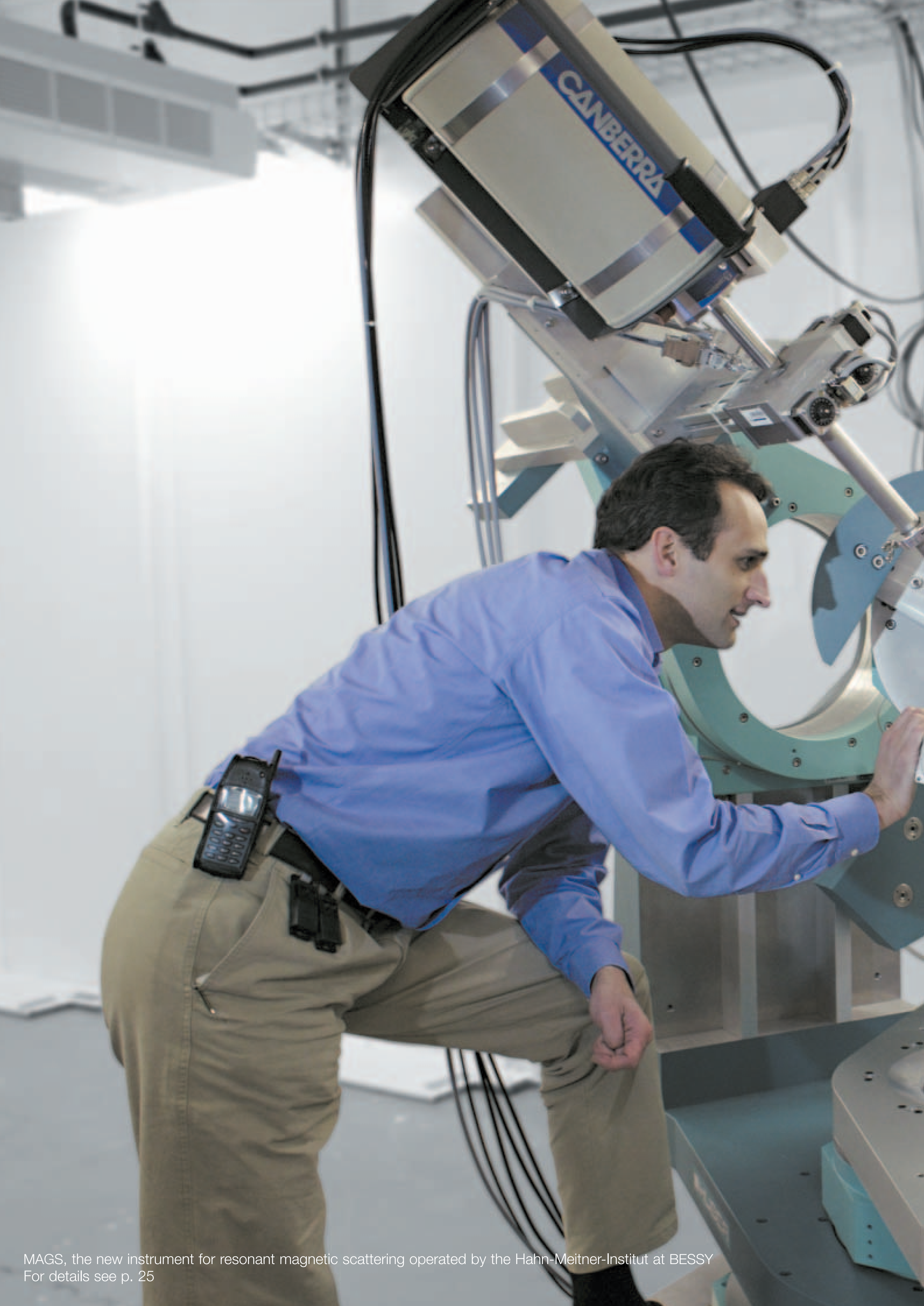


MAGS, the new instrument for resonant magnetic scattering operated by the Hahn-Meitner-Institut at BESSY
For details see p. 25

User Service

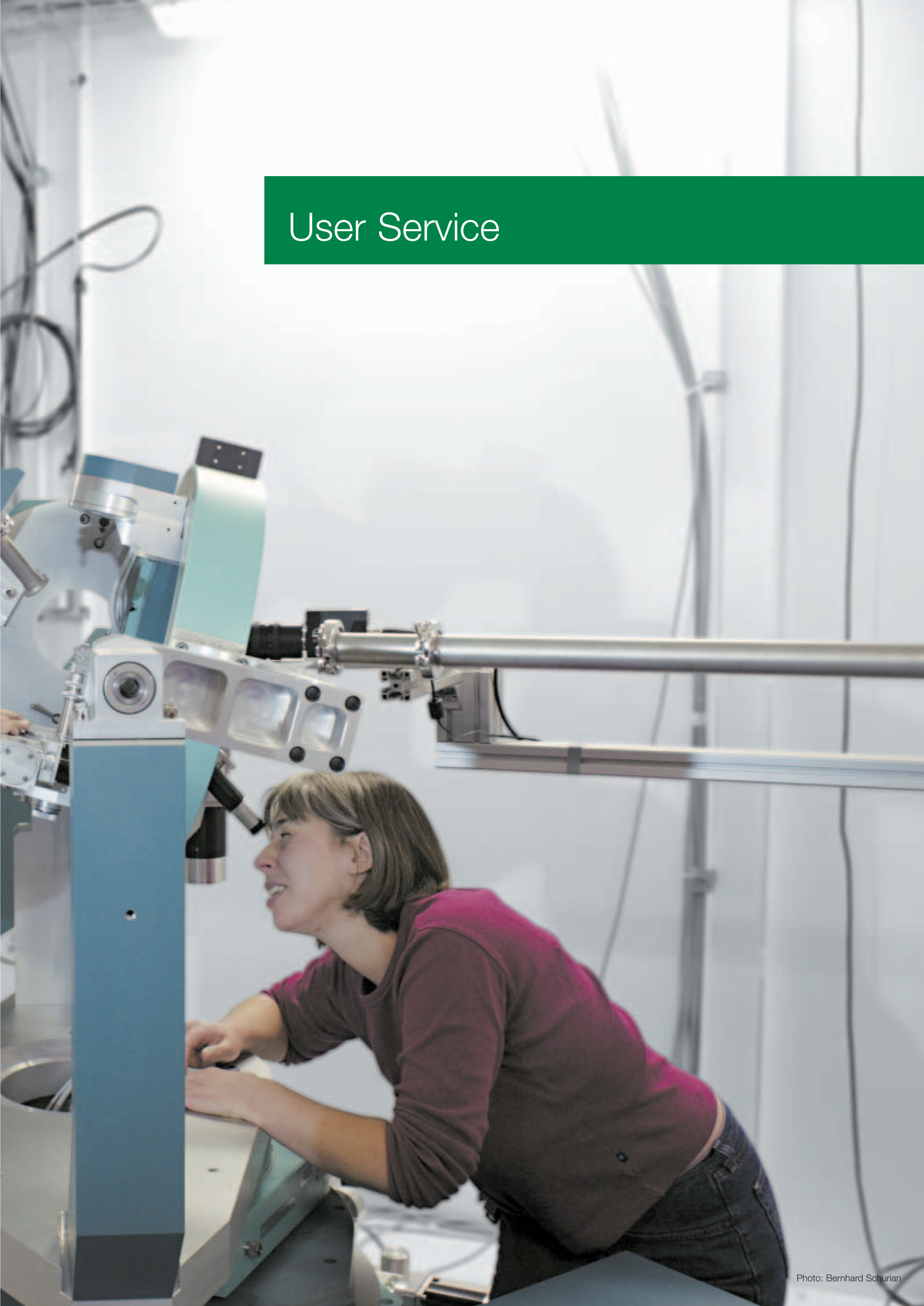


Photo: Bernhard Schurian

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. BENSC is open to both, the national and the international user community, whereby about 70 % of the beam time is available to external users: 20 % for long term collaborating groups from German universities and other research institutions and 50 % for peer reviewed short term projects.

Allocations 2004 for short-term projects	accepted projects	allocated days
Germany	34	212.5
EU + Assoc + CH	68	508
RU	5	71
USA, AU, JP	11	94.5
	116	886

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

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 competitive with the best available worldwide, including those operating at high flux reactors. Most of the instruments have the option of using polarized neutrons. 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 30 mK to beyond 2000 K; magnetic fields up to 17.5 Tesla have been made available to routine user operation. At present, two magnetic cryostats operated at BENSC ($1.5\,K < T < 300\,K$) with split pair superconducting magnets and vertical fields up to 17.5 Tesla are the world's leading magnet systems for neutron scattering.

Detailed descriptions of all essential BENSC neutron scattering instruments are available – and updated – on the BENSC Webpage: http://www.hmi.de/bensc/instrumentation.

A colour printed version (brochure HMI-B 577) has been published in March 2001 and is available on request.

BENSC puts special emphasis on sample environment under extreme conditions: high fields, high pressure, high, low and ultra low temperatures. The sample environment group has published a detailed technical handbook on BENSC sample environment. The handbook is updated continuously and available on the internet under http://www.hmi.de/bensc/sample-env/home.html

Extension of BENSC User Service to HMI instruments at BESSY

To promote complementary use of neutrons and synchrotron radiation, the Hahn-Meitner-Institut had initiated an upgrade project for the synchrotron source BESSY including the development and installation of two new insertion devices.

The HMI UE46 undulator provides polarized soft X-rays with, by orders of magnitude, worldwide highest brightness and flux density. The undulator is operational since 2002, with full user service at the PGM-beamline for magnetic nanostructures and magnetic films. The delivery of the high field magnet for the reflectometry option is now expected for 2005. The use of this beam line is detailed in table 2.

	weeks	
HMI in-house research Structural Research	13	36 %
HMI in-house research Solar Energy Research	1	3 %
External Users under BESSY and BESSY in-house research	22	61 %

Table 2: Distribution of 2004 experiment time for the UE46-PGM beam line at BESSY

The second insertion device, a 7 T-Wiggler, went operational in 2004. The Wiggler provides X-rays for two beam lines:

a) White beam for the Materials Science Diffractometer EDDI
b) Monochromatic beam for Resonant Magnetic Scattering and High-resolution Diffraction (MAGS). The user service at the Wiggler beam lines will start in April 2005. (See p. 25 for details.)

New Neutron Guide Hall
The construction of the new neutron guide hall advanced in big steps. With the foundation ceremony for the building already held on December 8, 2003 due to the relatively mild winter 2003/2004, the progress had been very quick, and with the end of the year the new hall was completed. See p. 12 for further information.

It is foreseen that the Wide-Angle Spin-Echo Instrument V5 will move from the old hall to the new hall. Other planned – and fully financed – instruments in the new hall are VSANS – High resolution SANS, equipped with a novel focusing technique – and EXED – Extreme Environment Diffractometer equipped with TOF-monochromatisation. The experiment site for EXED is in addition foreseen for the project of a 25 T high field magnet.

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 Hahn-Meitner-Institut's own scientific programme, 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.

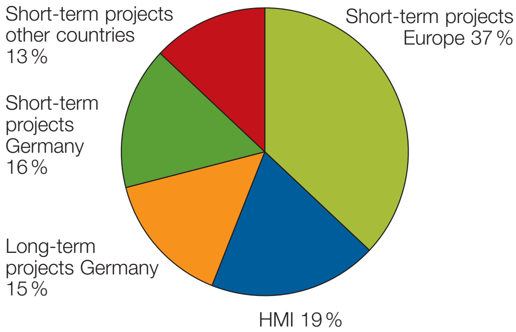


Fig. 1: Distribution of BENSC instrument time

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 2004, more than 110 short-term projects of external users have been accepted by the panel (see table 1). The number is lower than in 2003 because of the 3-months-shut-down of the research reactor BER II at the end of the year, required for the replacement of cold neutron guide 4 in connection with the BENSC upgrade project Neutron Guide Hall II.

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.

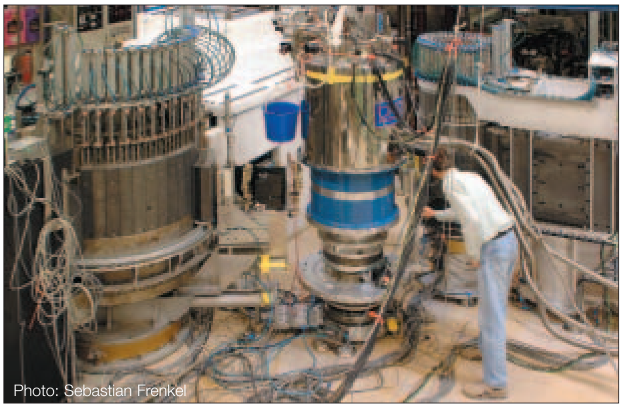


Fig. 2: The triple axis spectrometer FLEX

Support for European Access to BENSC from the European Commission
Right from the start of BENSC user operation in 1993, the access of European research groups to BENSC has been generously supported by the European Community under framework programmes FP3, FP4, and FP5 of the European Commission – with the values of the BENSC access grants increasing from contract to contract.

The EU support is available for groups from European Member States as well as for groups from the Associated States. Within the 4 years of the FP5 contract period under the *Access to Research Infrastructures* action of the *Improving Human Potential Programme* (IHP), formally ending in February 2004, BENSC delivered a mean annual amount of roughly 550 instrument days to the European research groups, distributed to ~80 different projects/year with a total of ~175 visits/year.

The successful European Access to BENSC actions are now continued under the 6th EU Framework Programme (FP6) in a slightly modified contractual situation: BENSC is now a partner in the ***Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy (NMI3)***. NMI3 brings together 23 partners from 14 countries, including 11 research infrastructures, together with other interested organisations. The most important branch of NMI3 includes 12 different access activities offering European users approximately 5000 beam days of access to 150 instruments at different facilities, with support for travel and subsistence. Under NMI3 BENSC will serve for a minimum access of 1040 instrument days.

In the first year (reactor operation period Jan.–Sept. 2004) under NMI3, BENSC delivered already 480 instrument days for European users. A total of 117 individual users from 55 groups from 14 countries have been involved, the majority of these EU supported users, 72 individual researchers, were new users.

Scientific results of 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 2004 volume, HMI-B 601, is distributed to all users of BENSC in May 2005 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/user-info/reports.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 2004 publication lists for all BENSC users and BENSC staff members is included in the a.m. volume *BENSC EXPERIMENTAL REPORTS 2004*, HMI-B601, May 2005. The majority of the BENSC publications have an external user as principal author, and a remarkably high fraction is published in high ranking journals.

The impact of BENSC to the national neutron user community has been demonstrated at the *Deutsche Neutronenstreutagung 2004 Dresden*, *September 2004*, *1.–4*. At this meeting, a third of all contributions reported on results of experiments at BENSC: 34 % of the talks, and 32 % of the posters. The majority of these BENSC contributions have been presented by external users. For three specific scientific fields, *Magnetism*, *Biological Systems*, and *Materials* the BENSC partition scored the 50 % level.

Four examples of highlight results from external user groups are included in the Scientific-Highlights Section of this Report.

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 BER II provides irradiation services for universities, scientific institutions and industry. Typical fields of applications are:

- Trace elements analysis by means of 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 scientific and 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: irradiation device in the reactor core
DBVR: turnable 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.

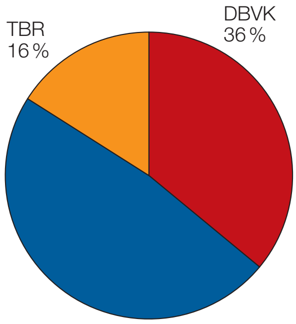
Device	$\Phi_{thermal}$ [1/cm²s]	Φ_{fast} [1/cm²s]	Container
DBVK	1,5E+14	4,3E+13	6
DBVR	7,5E+12	1,9E+10	9
TBR	3,4E+12	2,2E+10	1
SRT	4,4E+11	3,9E+10	1

Status 2004

- Due to shortage in manpower, the project of the renewal of the SRT, the device for short time irradiation, has to be postponed.
- The upgrading of the DBVK, the in-core device, has been completed. Now irradiation of destructible materials is possible.
- New control units for DBVK and DBVR have been installed. The rotation of the carrier of the DBVR is now freely programmable, starting from one turn per second.

Irradiation experiments 2004
Since June 2004, irradiation of destructible material, particularly biological material in the DBVK has been possible. Consequently, the contribution of this device rose from 9 % in 2003 up to 35 %. During the shutdown of the BER II in the fourth quarter, we had the opportunity to irradiate some samples at the reactor of the GKSS in Geesthacht. Thanks to Mr. Pfaffenbach and Mr. Heuer.

Utilisation of the Irradiation Devices

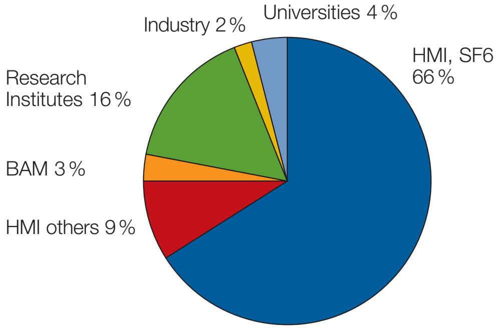


A total of 3314 samples were irradiated in 2004. 81 % of the 265 irradiation experiments, were performed with the DBVK or DBVR. With these devices it is possible to irradiate up to 24 samples simultaneously in one aluminum container. About 40 % of the irradiation experiments and the analysis of samples 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 other departments (SF2, SF3, SE2, SE5, RE).

External users
Irradiation experiments and NAA was performed for users from the German universities (Berlin, Gießen, Mainz, Heidelberg, Leipzig, Munich, Kiel) and from research institutes like BAM (Berlin), GSF (Neuherberg), IZW (Berlin), and the Rathgen Research Laboratory (Berlin).

Irradiated Samples



ISL Operations and Developments

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

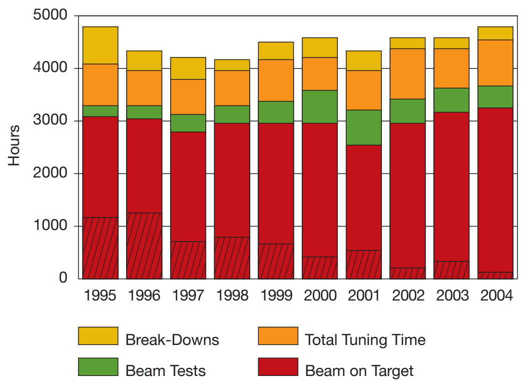


Fig. 1: ISL Operations since 1995: ISL has managed to operate the facility with an average of 3000 hours of beamtime on target.The hatched parts are low energy (Van-de-Graaff) beams. 2004 marks a new record: The highest amount of beam time on target, in particular high energy beams. This is due to the fact that the reliability for Au ion beams increased.

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 2004 (see Fig. 1). At the beginning of the year, the only major breakdown was caused by insulation problems of the electrostatic injection element. For the repair, we had to open the extraction system. This gave us the rare occasion to have a look at the inner parts of the cyclotron as shown in Fig. 2.

The production of high energy beams within the scheduled operation time of nearly 4500 hours climbed to a new all-time high of 3200 hours. Two reasons contributed to this excellent outcome: I) improved operations of the ion source for Au-ion beams which was again the most attractive beam used in 2004, II) a larger demand for high energy proton beams, providing an effective use of the time between therapy sessions either for high-energy PIXE, radiation hardness testing or device testing for a large proton-therapy machine.

Fig. 2: A rare picture of the inner part of the cyclotron: The electrostatic inflector during the repair

49 different projects (41 in 2003) involving more than 100 scientists received beamtime in 2004. In total, more than 80 projects are active at ISL. At its annual meeting, the programme advisory committee accepted, on the basis of the proposals' scientific merit, 44 proposals: 20 new ones and 24 addenda to running experiments.

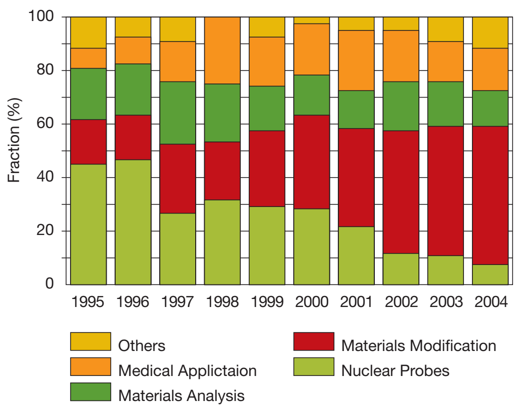


Fig. 3: Use of ISL ion beams. Materials modifications have become the largest part of research and development at ISL. The corresponding user groups come essentially from universities.

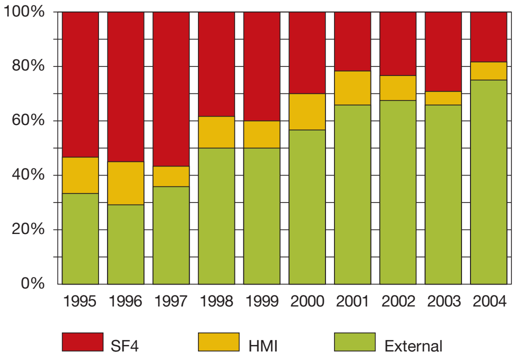


Fig. 4: ISL's development into a user facility. External users including proton therapy used 75 % of the beam-time in 2004.

Materials analyses with an average of 15 % of the beam time have been performed exclusively with fast ions, either heavy ions for ERDA – predominantly to determine the stoichiometry of thin layers for the solar energy programme of the Hahn-Meitner-Institut – or protons for high-energy PIXE. Eye tumour therapy was performed at 10 therapy blocks for 100 patients. The total share of 17 % includes beam time for research work.

Beamtime used for materials modifications and ion-solid interactions is still rising. We expect this trend to continue as their share of applications for beam time at the programme advisory committee increased from 60 % to almost 80 %. The term *others* in Fig. 3 comprises radiation hardness tests as well as testing of a scanning system for a large proton therapy machine (see p. 20). The amount of beam time used by external users increased again to up to now 75 % of the total time as shown in Fig. 4.

The universities further increased their share, due to the on-going trend in the scientific programme towards ion beam modification of materials.

Though a lot of different ion species have been produced (see Fig. 6), for two thirds of the beam-time either lightest (protons) or the heaviest (Au) ions have been used. It is very clear that the intense Au-ion beam has pushed forward the materials-modification programme. Very important for this programme is an intermediate mass beam which could be supplied with a newly developed Cu-ion beam (120 MeV). Two more so-called cocktail beams, ions with the same charge/mass ratio and the same velocity, have been produced: 10 MeV/u Ne/Ar using the Van-de-Graaff as injector and 6 MeV/u O/Ar/Kr with the RFQ-injector. We assume an increasing demand for these cocktail beams as they will allow rapid changes of the ion species and therefore the energy deposition.

Most of the development was dedicated to increasing the reliability of the facility in general. Quadrupole power supplies in the injection system were replaced. The target place TM was modified to host an industrial company for tests of parts of a proton therapy unit. The set-up of the new platform for the injection into the RFQ could be finished. When this platform is in operation, we expect a reduction of tuning times as the ECR ion-source can be tuned parallel to a running experiment. We expect the first beam from the second platform by the beginning of 2005.

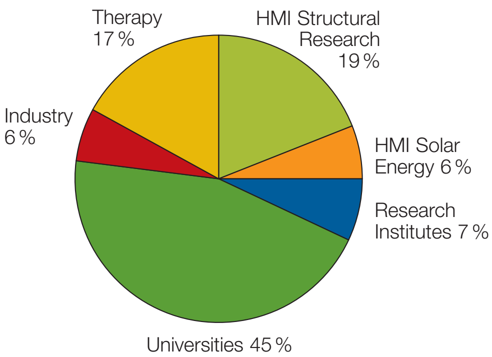


Fig. 5: Origin of ISL Users: The university share has again increased. This is due to their active involvement in the materials modification programme. The solar energy departments mainly use ERDA for the analysis of thin film solar cells.

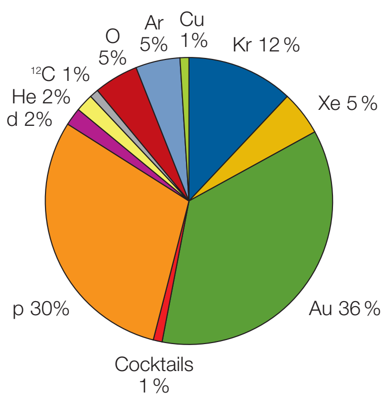


Fig. 6: Fast ion beams used at ISL: in 2004, most of the beam time used either the lightest or the heaviest ions available. In addition, so-called cocktail beams have been produced.