News and Activities 2007/2008

Prof. Dr. Anke Rita Kaysser-Pyzalla

Prof. Dr. Anke Rita Kaysser-Pyzalla took office as Scientific Director and Chief Executive of the new centre HZB on October 1st 2008.

After studying Mechanical Engineering and Mechanics Anke Kaysser-Pyzalla graduated at the TU Darmstadt and received a Dr.-Ing. degree in 1995 with a thesis in materials science at the Ruhr-Universität Bochum. As a Post-Doc she assumed responsibility for an instrument at the BER II reactor of the Hahn-Meitner-Institut. She then joined the TU Berlin as a group leader at the "Institute for Materials Science and Technology". In 2001, Anke Kaysser-Pyzalla submitted her "Habilitation", which focused on material characterisation with synchrotron radiation and neutrons, and received her "venia legendi" in materials science at the Ruhr-Universität Bochum. She then moved to Austria to the TU Wien to become a full professor for "Materials Selection, Materials Testing and Joining" at the "Institute of Materials Science and Technology" in 2003. Already two years later she became director and executive head of the department "Materials Diagnostics and Steel Technology" at the Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf. Anke Kaysser-Pyzalla has been elected as a member of the academies "acatech" and the "Österreichische Akademie der Wissenschaften".

Anke Kaysser-Pyzalla's research interests are in materials science, in particular method developments for materials characterisation with synchrotron radiation and neutrons, function/property relations of materials, materials development and optimisation. She has served in various scientific committees, e.g. as vice-chair of the Photon Science Committee at DESY, in the ESRF User Organisation, in proposal selection committees at BESSY, ESRF, and FRM II. She is editor of the Journal of Applied Crystallography and member of the senate of the Deutsche Forschungsgemeinschaft DFG, the "Wissenschaftliche Kommission Niedersachsen", and a panel of the European Research Council.

In her function as the new Scientific Director for Research with Photons and Neutrons and as Chief Executive of the Helmholtz-Zentrum Berlin (HZB), Anke Kaysser-Pyzalla is determined to give a new impetus on the complementary use of neutrons and synchrotron radiation in research, as well as in further developing the HZB with its now two large scale facilities as a leading science centre for an international user community. She highlights the potential of a strong in-house scientific programme in magnetism, functional materials and energy research, and therefore strongly welcomes increasing co-operations between scientists who are focusing on energy research and those with neutron and photon research expertise. She sets a special accent to further strengthen the strong ties to universities, e.g. through joint appointments of institute heads, by establishing joint working groups, and through groups headed by junior scientists, such as Helmholtz Young Investigator Groups.

Anke Kaysser-Pyzalla, new Scientific Director and Chief Executive of the HZB

Dr. Ina Helms, Head of the public relations department and HZB press relations officer

Ina Helms

Since 1st January 2007, the public relations department is headed by Ina Helms, a chemist and science journalist. She replaces Thomas Robertson, who went into partial retirement one year ago. Ina Helms worked freelance for various editorial and press departments, like the Technische Universität Berlin, Die Welt or the Max-Planck-Gesellschaft. She was formerly employed as editor at the Brockhaus-Lexikon Verlag.

Dr. Mirko Vogel was awarded the HMI Communication Award for his dissertation about organic solar cells.

Mirko Vogel

Mirko Vogel has won the HMI Communication Award 2007.
The 30-year old physicist illustrated in his dissertation “solar cells, malicious interfaces and how scientists fool them” the importance of interfaces in organic solar cells between electrodes and active matters(materials).

Prof. Dr. Susan Schorr, scientist at HZB and professor for Geo-Material Sciences

Susan Schorr

Susan Schorr, scientist at the department SE3, has been appointed professor for Geo-Material Sciences at the Freie Universität Berlin. She assumed office in February 2008.
In her function at the university, she is in charge of an Ph.D student who will do his research in the field of technology relevant structure analyse at the HZB.

Prof. Dr. Marcus Bär, Leader of the ‘Young Investigator Group Interface design’ at the Solar Energy department

Markus Bär

Since November 2007 Marcus Bär has been leading the new founded ‘Young Investigator Group Interface design’ at the Solar Energy department. The 32-year old engineer, formerly employed at the University of Nevada, USA, analyses advancements of thin-film solar cells at the HZB. In cooperation with the BTU Cottbus, he will give lectures about his research results and experiences.

Dr. Rutger Schlatmann, new coordinator of the PVcomB – Competence Centre Thin-Film- and Nanotechnology for Photovoltaics Berlin

Rutger Schlatmann

On 1st May 2008 Rutger Schlatmann took office as coordinator of the newly founded PVcomB – Competence Centre Thin-Film- and Nanotechnology for Photovoltaics Berlin .
Rutger Schlatmann was formerly employed at Helianthos, where he was in charge of various F& E-aspects, as patents or strategic business-planning.

HMI and BESSY team up to showcase their work

The merger of Hahn-Meitner-Institut and BESSY had hardly been made public when both institutes decided to get together to present their work at the 2007 "Long Night of Science", the joint open day of the scientific institutes in Berlin. The HMI site at Wannsee remained closed and anything of interest – models, lab equipment, and other examples of the work undertaken there – were brought to Adlershof where they filled all the empty space in the experimental hall and the lobby of BESSY. Thus, in some areas, the blue HMI T-shirts outnumbered the green ones worn by the BESSY team.

For HMI, the joint presentation was not only a sign of the closer ties between the two institutes, it was also an opportunity to present its work to the huge audience visiting Adlershof during the Long Night each year. More than 4,000 visitors – vastly more than could usually be expected to visit the Wannsee site – had the opportunity to discover how neutrons reveal the structure of matter and how new solar cells are developed. Of course, those who only visited the HMI exhibition at BESSY missed some of the main attractions: the experimental halls around the research reactor and the proton therapy accelerator. So, in 2008, the institute – now renamed Helmholtz-Zentrum Berlin für Materialien und Energie – opened its doors at Wannsee once again, presenting the instruments at the reactor, the proton therapy accelerator and many, many more labs in the Structure Research and Solar Energy Divisions. But since it was clear at that point that BESSY and the former HMI would become one institute in 2009, there was also an exhibition about the activities at Wannsee in the BESSY lobby. Preparing this extensive programme was hard work for the whole HZB team. But it was worth it: 2,200 people visited the institute at Wannsee and many more had the chance to learn about neutrons, proton therapy and solar energy during their visit to BESSY.

2007: HMI and BESSY – "a new option for Berlin" was the motto of the first joint presentation at the Long Night of Science.

2007: The blue team and the green team: in some parts of BESSY's experimental hall there were more blue HMI T-shirts than green BESSY ones.

2008: Leading the way between partners to be

2008: Science enthusiasts surge onto the Helmholtz-Zentrum campus at Wannsee.

2008: Watching a 3D tomography presentation

"Sun & Science" – The Late summer Party

For the first time, on September 26th, the staff of BESSY and HZB celebrated their annual summer party together. The diverse open-air program combined on stage a mix of science shows, interactive games and live music as well as dance performances. At the same time, the visitors enjoyed the catering and participated in various activities, with bull-riding as a highlight.

Members of both institutes with their family and friends as well as neighbours enjoyed an entertaining late summer afternoon at the HZB Campus Wannsee.

Music from the Mia Carla Trio

Soap bubbles experiment

Get together

Summer Student Programme

Summer students in a photovoltaics laboratory

"What is the everyday life of a scientist like?" This and many more questions can be answered during the eight-week Summer Student Programme at Helmholtz-Zentrum Berlin für Materialien und Energie (HZB). Advanced students from physics, chemistry or engineering are invited to participate in the programme that will provide access to the daily work of the scientists. Further insights will be given by guided tours and lectures which will be held on the diverse research topics covered by the institute, in the two main areas of solar energy and structural research. This international programme will be held in English.
In the summers of 2007 and 2008, participants from 11 different countries came together and worked with the scientists here in Berlin-Wannsee and Berlin-Adlershof. The 20th anniversary of the Summer Student Programme was celebrated in 2008, and in the last two years the programme has been more successful than ever with more than 30 students attending each year. 2008 was the first time that scientists from BESSY participated and offered projects at the synchrotron source. All supervisors prepared projects and during July and August students took responsibility for their own research, working in small groups or individually, but with the support of the supervisors. All the students benefited from the programme and some exciting projects led to many interesting results. In the last two years, students of physics, chemistry, electronic engineering, chemical engineering, industrial engineering, computer science and materials science have joined the programme and it is notable that there have been a significant number of female students.

Kids & Youth

Science can be exciting, even before going to university. The HMI offered a variety of possibilities in 2007 for youthful visitors to become "young scientists".

Cool girls: what happens to a balloon in liquid nitrogen (minus 196° C)

Girls'Day
Mädchen-Zukunftstag

26th April 2007: Girl's day
Girls'Day provides female pupils with an opportunity to gain practical insights into the world of work, particularly in technical and technology-related fields. The focus is on hands-on practical experience. The HMI supports this activity with scientific practice guided by female researchers.

20th September 2007 "Jugend Forscht"
"Jugend forscht" (young researcher) is a national initiative to promote science in the age group of pupils. The winners of the 2007 competition visited the HMI, after they met with the German chancellor Angela Merkel.

21st September 2007 BundesUmweltWettbewerb
The BundesUmweltWettbewerb (a nationwide environmental competition) aims to promote knowledge about the environment and to further budding creativity and initiative in the tackling of environmental issues. It is conducted by the Federal Ministry for Education and Research (BMBF). The award ceremony 2007 was hosted by the HMI.

Tough theory: studying and discussing the periodic table of elements

School Lab

Girls in the School Lab

Since 2007 the HZB-School Lab has largely extended its spectrum of activities and has attracted more and more students of primary and secondary schools from the Berlin-Brandenburg region, other German states, and neighbouring European countries like Denmark. On two days per week the School Lab now hosts and organises so-called project days, when school classes carry out experiments on topics such as magnetism, superconductivity, interference, solar energy, and materials research. In 2008 more than one thousand students have used the opportunity to visit the School Lab. To meet the increasing demands of primary schools, our program was complemented by special activities for the very young students.

In 2007 a weekly student workshop ("Schüler AG") was founded. Later on the workshop was split into one group for primary school and one for secondary school students to account for the different age and skills of the students. For their studies on ferrofluids the workshop members Timo Stein and Fabian Nickel were awarded the first prize of the regional Berlin Jugend forscht competition 2007. In the subsequent national Jugend forscht competition they were awarded the special prize of the Deutsche Physikalische Gesellschaft. In 2008 Timo Stein and Christopher Förster contributed a study on cosmological radiation to the Jugend forscht competition and were awarded the first prize for physics of the regional Berlin competition and the first prize for geosciences and astrophysics of the national competition, where in addition they were awarded the special prize of the Astronomische Gesellschaft Deutschland.

The School Lab also participated in events apart from the regular activities. In 2007 the lab team together with other Helmholtz School Labs organized a joined hands-on exhibition in the European Parliament in Brussels. In 2007 and 2008 the lab contributed to the Wissenschaftssommer in Leipzig and to the Lange Nacht der Wissenschaften with various programs. Recently it created and performed a play at Science on Stage in Berlin, an event meant to make science meet education. In the framework of JugendKulturService activities were organised during school vacations. By hands-on-experiments trainees and volunteers of the HZB were introduced to the scientific scope of the HZB.

School Lab (Michael Tovar) at Science on Stage

Die Lange Nacht der Wissenschaften 2008 provided an opportunity to exchange hands-on-experiments for visitor groups and to cooperate in other areas with BESSY. In 2009 a considerable part of the School Lab activities will be the coordination and development of further joint activities with BESSY with the medium-term aim to establish a School Lab on the BESSY campus.

Technology transfer for photovoltaics: the new PVcomB

In April 2007, the HMI and the TU Berlin signed a 'Memorandum of Understanding' (MoU) to start the new PVcomB – Competence Centre Thin-Film- and Nanotechnology for Photovoltaics Berlin. The driving force behind the new competence centre is the rapid boom of the solar industry, with the key area lying in the new East German federal states. Several companies have currently begun constructing production facilities for innovative thin-film solar cells. "These future technologies must be successfully established and developed over the long-term in Germany", emphasizes Prof. Michael Steiner. Together with the research institutes in Berlin, eight renowned industrial companies signed the MoU and will support the center's construction. Additional companies have already announced major interest in participating in a collaboration.
Thus being brought on its way, the PVcomB commenced work in May 2008, when its new director, Dr. Rutger Schlatmann (see people p. 9), took up office. The first challenge was to find a building and infrastructure for the new centre as well as get financing and the organizational structure on its way. At the end of 2008, the location was finally found. A building of the Center of Photonics and Optical Technologies, located at the science and technology park Adlershof (WISTA), will be refurbished. Once finished in early summer 2009, the PVcomB will have around $500 m^2$ laboratories plus office space at its convenience.

Intermediate sized 30 × 30cm^2 Modules will be produced by the PVcomB

Bridging the gap between science and industry
Germany has gained a leading position in the photovoltaics (PV) market. To stay ahead, it is crucial to increase the technological effort in the rapidly expanding field of thin-film PV as well. Here, swift transfer from lab developments into cost effective production is a key factor. PVcomB's main goal is to support world wide growth of thin-film photovoltaic technologies and -products by providing the much needed technology transfer.

There exists a large gap between production of lab-sized photovoltaic cells and industrial-size modules. PVcomB bridges this gap by operating two dedicated pilot-lines for intermediate size PV modules with an area of 30 × 30 cm^2. This intermediate module size is well suited to address questions arising in industrial production. At the same time, alternatives will be developed and tested for each process and analytical step. The great variety of analytical tools available ensures that changes in the product-performance can be linked to fundamental material or process properties. A truly unique feature of PVcomB´s pilot-lines is that both thin-film silicon as well as CIS based modules will be studied within a single laboratory. This convenient arrangement offers the potential to unlock significant synergies in many topics common to all thin-film based technologies. Additionally, education and training will provide the industry with highly skilled thin-film PV professionals. The close involvement with universities and private education centers will allow highly-qualified engineers and scientists to be trained at the same time. These engineers and scientists are desperately needed in the booming solar industry.

pvcomB

The new logo of the PVcomB

New laboratory for new cluster-tool

The old clustertool: dismantling in the old laboratory…

… and with new components: the clustertool II shining in its new location.

To produce larger (test-)modules, larger machinery is needed. In March 2008, the department SE3 Technology opened up its new laboratory. Here, the new Cluster-Tool II was installed so that the scientists can now cover areas of 10x10 cm^2. The new clustertool gives more possibilities regarding deposition speed and area as well as more possible combinations of materials. In the two additional chambers, spuutering and physical vapour deposition (PVD)for new materials is now possible. One Example of these new materials is kesterite, in which the indium is replaced by zinc and tin.

Through the move in the new and larger laboratory, a larger and better equipped infrastructure is now available for developing thin-film solar cells.

The golden anniversary of neutron research in Berlin

When change is in the air it is a good opportunity to take stock, looking back on what has been achieved in the past. As luck would have it, the 50th anniversary of the beginnings of neutron research in Berlin coincided with preparations for the merger of the Hahn-Meitner-Institute and the Berlin Synchrotron Radiation Source BESSY.

Neutron scientists from other centres, users and retired employees joined in the celebrations with the staff of what in June became known as the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB). They spent two days enjoying a varied programme of talks on neutron science in Berlin and elsewhere – past, present and future.

But before turning to hard science, it was time for pure celebration: seven representatives of other neutron sources and scientific organisations delivered birthday greetings on behalf of their institutions, and Hans-Gerhard Husung, Berlin's Permanent Secretary for Education, Science and Research, was the bearer of both the compliments of the local government and a promise of continued support in the future.

Alexander Belushkin (left) congratulates Michael Steiner on behalf of the Frank Laboratory of Neutron Physics (Dubna)

It fell to Jost Lemmerich to describe the early days of neutron science in Berlin. The idea of building a research reactor in Berlin was first put forward in 1955 in a declaration by professors at the local universities who wanted Germany to catch up on nuclear research – the field of science considered most important and promising at that time. Despite the difficulties connected with the special legal status of Berlin and the fact that West Berlin was an enclave within East Germany, Berlin's first research reactor – a 50 Kilowatt homogeneous reactor – went into operation in July 1958 and was used almost exclusively for irradiation experiments in nuclear chemistry.

BER I under construction

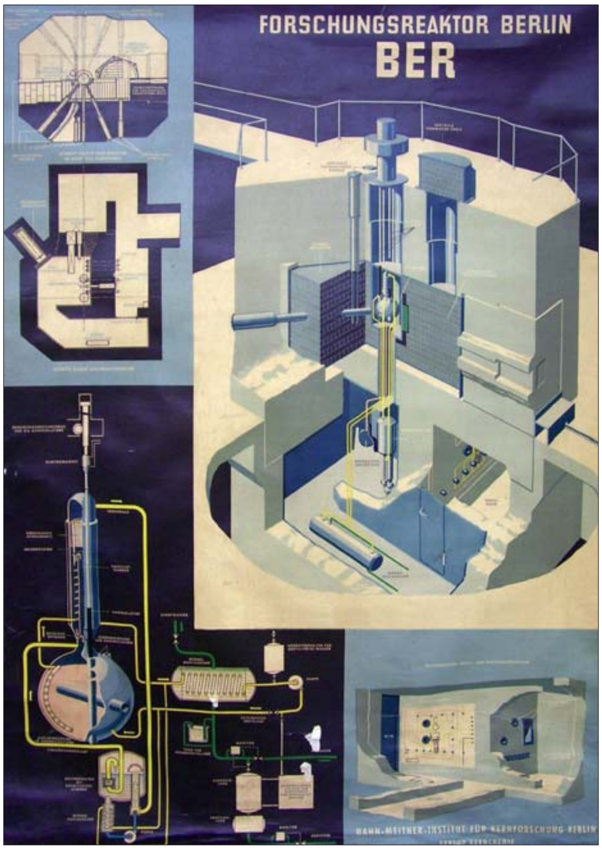
Shortly after the institute's second reactor BER II became operational in 1973, Hans Dachs introduced neutron scattering as a further method of investigation that was soon to become the primary way of using neutrons at HMI. The general development of neutron scattering was the topic of Andrew Taylor's introductory talk on *Expanding the Frontiers of Neutron Scattering*, while Michael Steiner and Ferenc Mezei told the story of neutron scattering in Berlin. Steiner outlined HMI's contribution to the development of neutron science over the last few decades and emphasized that HMI is a good example of how an institute with only a medium-flux reactor can rank among the best by investing in excellent instrumentation, e.g. the institute's

Lively discussions during the programme celebrating the golden anniversary of neutron research in Berlin

extreme sample environment equipment that attracts a considerable number of neutron users to Berlin.

A series of presentations called “Current trends in neutron science” followed. They offered a broad overview of developments in technology for neutron research – new sources and sample environments – and the use of neutrons in different fields of science: magnetism, soft matter, engineering materials and art history. Having taken a look at the past and the present, Alan Tennant’s talk concentrated on the future of neutron science at HZB with the new high field magnet providing magnetic fields of 25 or even 30 Tesla for neutron experiments being the most important current project. Developing instruments that will meet the demands of users working in the fields of soft matter and quantum magnetism are further priorities.

In his final statement, Michael Steiner stressed that only the use of different complementary methods will allow us to solve the questions posed by modern science. He recalled that Hans Dachs had had the vision of applying various complementary methods at HMI and that he had already entrusted a young scientist with exploring X-ray scattering as a complementary method to neutron research. With the merger of the former Hahn-Meitner-Institute and BESSY, Dachs’ vision of operating sources of neutrons and synchrotron radiation within one institute will now become reality.



Poster showing the layout of HMI’s first research reactor BER I

Photovoltaics abroad

To promote the excellent science in photovoltaics, the scientists offered or supported many international workshops in 2007/2008. One of them took part in Africa, Nairobi: The summer school Cost-effective Photovoltaics Research was held from 19th August to 1st September 2007 at Jomo Kenyatta University of Agriculture and Technology in Nairobi, Kenya. It trained thirty young scientists from eight East African countries in both theoretical and experimental aspects of cost-effective photovoltaics. The summer school was prepared during the preceding two years by Dr. Dittrich, together with Prof. Lux-Steiner, from Hahn-Meitner Institute in Berlin and partners, it is funded amongst others by the Volkswagen Foundation.

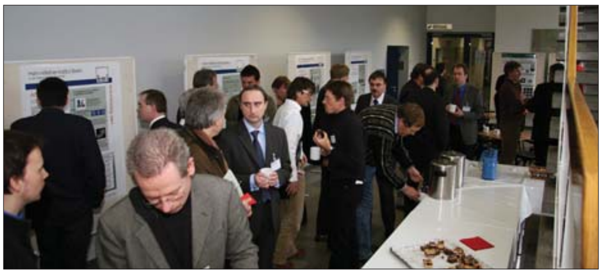
At another far-away location in Thailand, the Photovoltaic workshop at Kasetsart University (Bangkok, Thailand) took place from 1st to 12th of August 2008. Here, students attended lectures and practical sessions to familiarize themselves with the basics in photovoltaics. The Workshop was organized by Dr. Dittrich (SE2). The workshop is planned to be repeated in 2009 as part of a new masters course.

Particpiants of the summer school Cost-effective Photovoltaics Research at the reception

Participants of the Photovoltaic workshop

Imaging in three Dimensions – Information day at the HMI

A detailed three-dimensional view of the inside of a material or of a device offers incalculable value for the industrial development. The HMI offers a wide range of imaging procedures, which can be used by industrial partners in different cooperation models. Some of these methods are only available at few places worldwide, one of them the HMI. To show the whole range of technical and cooperation possibilities, the HMI invited for a free information-day, or 'Industrietag' (industry day), on November 11th, 2007. The wide range of visitors showed a lively interest in the talks and the guided tours to the laboratories. Representatives from companies as well as research institutions presented examples from their work at the HMI. At the poster session, the visitors could talk directly to a scientist representing one imaging method.



Meeting the scientists during the postersession

Explanations at the model of the new high-field magnet to be built at the HZB

Solar exhibition and conference PVSEC

In both years, 2007 and 2008, the HMI took part in the exhibition of the PVSEC – European Photovoltaic Solar Energy Conference and Exhibition.
In Milano 2007 (Italy), three former graduate students of the HMI were awarded the "SolarWorld Einstein New Talent Award". The junior scientists focused their theses on the specific influence of grain boundaries on the electrical properties of chalcopyrite layers. In both years, the HMI shared a stand with sulfurcell, a spin-off of the HMI. The visitors could thus ask questions regarding the production as well as the research of thin-film photovoltaics.

Visitors admiring the flexible solar cell at the HMI-stand (Valencia, 2008)

Frank H. Asbeck (CEO Solar World), Tobias Eisenbarth, Caspar Leendertz and Mark Wimmer (left to right) at the award ceremony of the the "SolarWorld Einstein New Talent Award" (Milano, 2007)

School on Neutron Scattering

The HMI School on Neutron Scattering (NSSc) is part of the curriculum of the Faculty of Mathematics and Sciences of the Technical University Berlin and is sponsored by the European Union under its NMI3 Program. Professors Alan Tennant and Prof. Bella Lake were responsible for the schools in 2007 and 2008, several scientists of HMI contributed by tutoring the hands-on experimental work at the neutron scattering instruments at BENSC and by lectures.

The schools in 2007 and 2008 were held at the Berlin Neutron Scattering Center (BENSC) of the Hahn-Meitner-Institute (HMI) Berlin. About 30 students took part from 26th February to 2nd March 2007 and from 3rd to 7th March 2008 in the 28th and 29th school respectively.

The NSSc follows a given curriculum, starting with a theoretical introduction to methods of neutron scattering which comprises the basic principles of neutron scattering, an introduction to neutron sources, the different types of neutron instrument and sample environment.

However, the main emphasis lies on hands-on experience of the neutron scattering techniques at BENSC, including triple-axis spectroscopy, powder diffraction, small angle neutron scattering, reflectometry, time of flight spectroscopy, and tomography. The students are divided into streamed groups of 4 or 5 people and spend three hours on each instrument over a period of three days doing experiments.

Nikolay Kardjilov (HZB) shows the students a 250 million years old reptile skull at the CONRAD tomography station

Technology Transfer Prize goes to fuel cell researcher

In 2007, HZB's Technology Transfer Prize was awarded to Dr. Peter Bogdanoff of the institute's Solar Energy Division for his work on innovative catalysts for fuel cells.
The winner and his team were successful in making efficient catalysts for oxygen reduction in fuel cells without using the expensive element platinum. These results convinced the Toyota Motor Cooperation to invest in several collaborations with HZB.
The winners were selected by a jury composed of representatives of industrial companies, the Chamber of Commerce and Industry and the Technology Foundation Berlin. The main criteria for selection were the project's innovative potential and the prospects for using the new process on an industrial scale.
The prize was conferred on Peter Bogdanoff at an award ceremony in HZB's lecture hall by Dr. Florian Holzapfel, CTO of Q-Cells AG, which also donated the prize money of 5,000 EUR. In his welcome address, Prof. Michael Steiner emphasized the increasing importance of the transfer of knowledge between scientific institutions and industrial companies and the institute's commitment to supporting the industrial exploitation of results achieved by HZB's scientists. At the end of the ceremony, Peter Bogdanoff showcased prize winning technology and its potential for commercial applications.

Dr. Bogdanoff receives the Technology Transfer Price

AARD 2007: Franco-German Summer School on "Analysis in Art with Radiation"

Following the summer schools on ion tracks in Mühlhausen, 2003, and on "Physics with Ions - from Analysis to Nanotechnology" in Blainville-sur-Mer, Normandy, 2005, a German-French summer school was held on "Analysis in Art with Radiation" (AARD) in Mühlhausen, Thüringen, September 2007. This transdisciplinary subject intended to bring together natural science, its analytical methods, and questions related with cultural heritage. The school was chaired by Heinz-Eberhard Mahnke (HMI and FU Berlin) and Michel Menu (C2RMF), with the support of Oliver Hahn (BAM). It received financial support from the DFH-UFA (Saarbrücken), with additional support from the organizing institutes.

In both France and Germany, but elsewhere too, some user-time at large-scale facilities (e.g. neutron and photon sources, ion beam accelerators) is devoted to cultural heritage objects to complement investigations using "table top" methods. Participants learned how to use tomographic methods to look into papyrus rolls without unrolling them, why certain precious scripts, like the Qumran Scrolls, deteriorate, or, where the 'cracks' arise from in Leonardo da Vinci's Mona Lisa. A specialty of the school was practical courses on analytical computer programme packages (quantitative analysis of particle induced X-ray emission, X-ray fluorescence analysis (XFA) and ion beam analysis), and, as highlight, the course on a portable XFA system used for on-site investigations (e.g. paintings in churches).

Out of the regional richness in culture, the participants took home impressions from the Wartburg (a special exhibit connected to Saint Elisabeth), music by J. S. Bach (Eisenach, Mühlhausen Divi Blasii), and the intriguing story of the "Sky Disk of Nebra", recently discovered nearby.

The next German-French summer school is scheduled for September 2009 on "Nanophotonics in Nature and Art", from fundamentals of structural colouration to applications in biomimetics.

Heinz-Eberhard Mahnke, mahnke@helmholtz-berlin.de

Meetings, Conferences organized by HMI

Event	Organized together with	Location	Dates
Analysis in Art with Radiation AARD 07	UFA-DFH Université Franco-Allemande BAM Berlin	Hahn-Meitner-Institut Berlin	3rd to 9th September, 2007
PNAM Autumn School about Application of Neutrons and Synchrotron Radiation in Engineering Materials Science	TU Berlin	Haus am Schüberg, near Hamburg	17th to 21st September, 2007
NIAC Meeting 2007		Hahn-Meitner-Institut Berlin	24th to 26th September, 2007
Orbital 2007	University of Hamburg, Max-Planck-Institute for Solid State Research in Stuttgart	Max-Planck-Institut in Stuttgart, Germany	10th to 11th October, 2007
Workshop on Tomography in Materials Science using TEM and FIB		Hahn-Meitner-Institut	11th to 12th October, 2007
Dreidimensionale Einblicke in Werkstoffe und Geräte		Hahn-Meitner-Institut Berlin	16th November, 2007
29th Berlin School on Neutron Scattering	Technische Universität Berlin	Hahn-Meitner-Institut Berlin	3rd to 7th March, 2008
European Summer School on Photovoltaics and New Concepts of Quantum Solar Energy Conversion	European Society for Quantum Solar Energy Conversion (QUANTSOL)	Hirschegg, Austria	14th to 21st September, 2008
ICTMC-16 16th International Conference on Ternary and Multinary Compounds	Freie Universität Berlin	TU Berlin	15th to 19th September, 2008
European Cyclotron Progress Meeting – ECPM XXXVI	Charité Berlin	Hahn-Meitner-Institut Berlin	15th to 18th October, 2008
European Conference on Metallobiolomics	Helmholtz-Zentrum München, Deutsches Forschungszentrum für Gesundheit und Umwelt	Hahn-Meitner-Institut Berlin	3rd to 4th December 2008

High Field Magnet Project – Progress in Design and Construction

Hartmut Ehmler, Peter Smeibidl and Alan Tennant

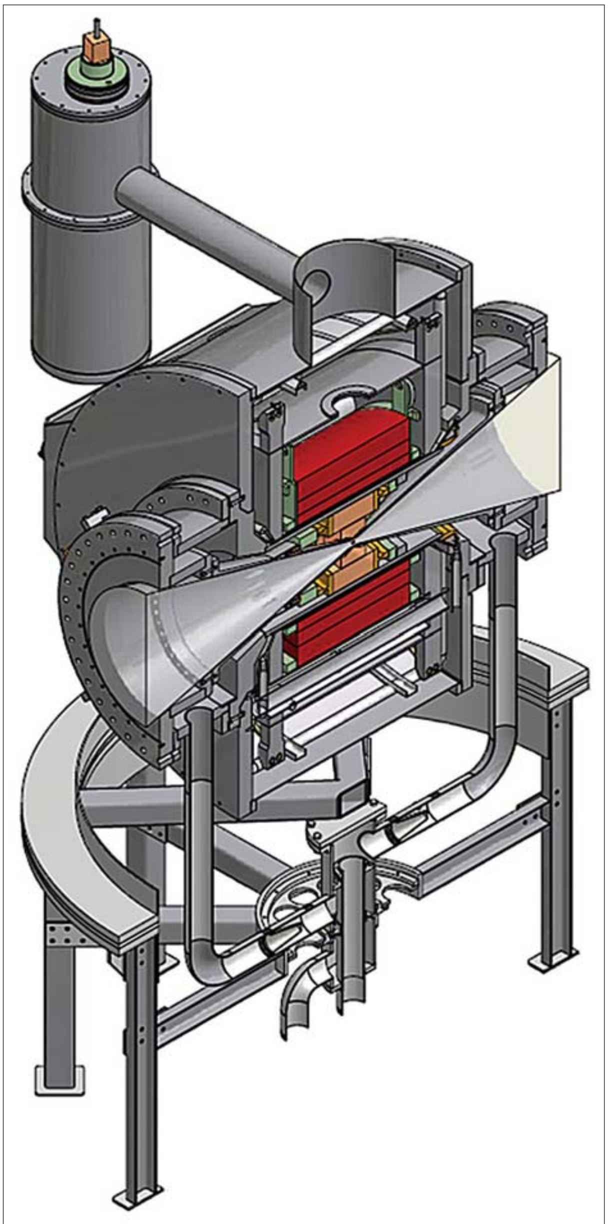


Fig. 1: Cross sectional view of the hybrid magnet system: The superconducting coil is shown in red. At its centre is the water cooled copper magnet. Cooling water is channelled to the resistive magnet through the pipes below the centre of the magnet. The small satellite cryostat (top left) contains the 20 Kiloampere current leads made from high temperature superconducting material.

A new research magnet for neutron scattering experiments under extreme fields is presently under construction at the Lise-Meitner Campus of the Helmholtz-Zentrum Berlin. The system will produce magnetic fields stronger than 30 Tesla in its final stage. Scientists expect that neutron scattering experiments in the new magnet will contribute to important insights in many fields of condensed matter research. Condensed matter systems with magnetic degrees of freedom cover the whole range from fundamental to applied science. The basic elementary excitations in certain types of chain materials ("spinons") allow us to observe the equivalent of quarks, i.e. one of the basic constituents of matter. Correlated electrons in certain layered compounds offer the chance to tailor high temperature superconductors, i.e. materials with an enormous potential for industrial applications. What these topics have in common is that their behaviour is dominated by the laws of quantum mechanics, and both neutrons and high magnetic fields are required in order to understand their microscopic behaviour, for fundamental physics as well as for material science.

A research contract with the National High Magnetic Field Laboratory (NHMFL) in Tallahassee, Florida was signed in March 2007. This world-leading laboratory in magnet science and technology has developed the concept of a “series-connected hybrid magnet” (SCH). The magnetic field will be produced by two coaxial coils connected in series: the large outer coil is a superconducting "cable-in-conduit" system and the smaller inner coil is made from copper. The reason for using a resistive inner coil is that, at present, no superconducting material is available that could carry high currents in these strong magnetic fields without degrading under the enormous acting forces. The design activities by NHMFL are focused on the detailed layout of the superconducting winding and the integration of all helium cooled components inside a cryostat. The superconducting cable underwent an extensive test programme which was successfully completed in autumn 2008. The cable is a novelty in itself and will carry more than twice as much current density as state-of-the-art superconducting cables. The detailed design of the coil winding includes calculations of the high mechanical stresses due to the magnetic forces. These forces cause strains within the conductor which have a negative impact on the superconducting properties. Therefore, tensile tests of full-size conductors under full current in a dedicated test facility at NHMFL were also necessary another world novelty in this field.

Fig. 2: Beside the neutron guide hall 2 (light blue) the new building for the magnet infrastructure has been under construction since summer 2008.

The magnet will need several supply media for operation: large quantities of high pressure water at 30 bar to cool the resistive copper coil, supercritical helium of 4 Kelvin to cool the superconducting circuit and, last but not least, an electrical current of 20,000 Ampere to provide the magnetic field. All the supply facilities are to be hosted in a separate infrastructure building which is currently being erected on site at the Lise-Meitner Campus, near the neutron guide hall 2 (NLH-2), where the neutron instrument ExED and the magnet will be installed. On three floors inside of the building all necessary technical components will be constructed. The cooling towers of the water cooling system will be located behind a sound insulating wall on top of the building.

The challenge for the small project control team is to organise and monitor the various activities in magnet design and construction of the infrastructure components. Project control has to manage the various subprojects and work packages with all important interfaces as efficiently as possible. For example: all project documents are stored in a central database with a work flow of check and release. Several external companies and collaboration partners are working together to maintain a tight schedule to achieve the aim of final commissioning of the magnet within the next three to four years.

Fig. 3: Location of the new High Field Magnet

Sample environment service beyond neutron and X-ray scattering

Klaus Kiefer, Dirk Wallacher, Michael Meißner - Helmholtz-Zentrum Berlin für Materialien und Energie

Fig. 1: The recently installed 17T System for LaMMB CM-17T.

BENSC is part of HZB's user facility for structural research with neutrons and synchrotron radiation and focuses on experiments under extreme sample conditions, i.e. involving the highest magnetic fields, the lowest temperatures and a wide range of pressures. Therefore, a broad range of mobile equipment, such as superconducting magnets, cryostats, furnaces, vacuum pumps and pressures cells, is available and is constantly being developed to adapt to the requirements of the sample environment for scattering experiments. Furthermore, in the last decade, there has been growing demand in the neutron and x-ray user community for new experimental set-ups and methods, both at the beamline and in the laboratory, to complement the scattering investigations by additional measurements. The BENSC sample environment group has reacted to this situation by initiating two major new projects that are being presented in this article. The first is the **La**boratory for **M**agnetic **M**easurements at **B**ENSC (**LaMMB**) which provides users with access to complementary bulk measurements using high level laboratory techniques. The second is a **D**edicated sample **E**nvironment which responds to the users' request for in-situ **G**as **A**dsorption experiments with neutron and X-ray **S**cattering (**DEGAS**). Both projects are presently under development. First results are very promising and the BENSC user community is already profiting from these facilities.

Laboratory for Magnetic Measurements at BENSC (LaMMB)

With its special emphasis on experiments involving high magnetic fields and low temperatures, BENSC is offering extreme physical conditions for structural research. Beamline based investigations, however, usually require complementary measurements. In recent years, the departments for structural research, SF-1 and SF-2, have operated a variety of research laboratories for sample characterisation and preparation. In order to install a service for BENSC users providing access to complementary measurements

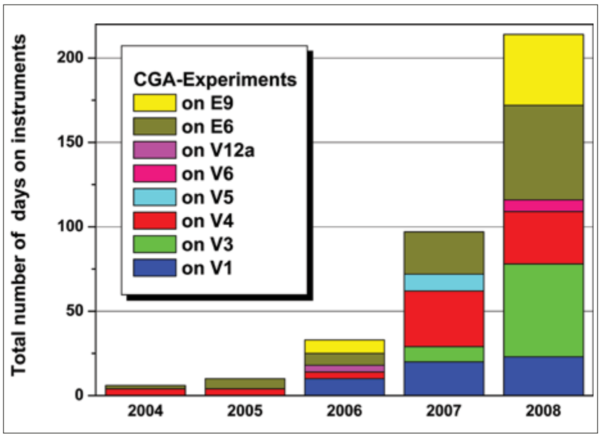


Fig. 2: Statistics showing the development of gas adsorption experiments at BENSC.

at extreme conditions, these laboratories have been combined to form LaMMB. At present, LaMMB offers four different measurement systems with magnetic fields up to 14.5 Tesla (T) and temperatures down to 260 mK. The measurement options are heat capacity, heat conduction, magneto-caloric effect, magnetization, magnetic susceptibility, AC/DC resistivity, and dielectric properties. With more than 100 measurement projects per year in 2007 and 2008, LaMMB has become a regular and important user service (Rüegg et al.).

In 2009, LaMMB will extend its range of experiments, aiming for lower temperatures and higher magnetic fields. Figure 1 shows the new cryogenic system CM-17T with magnetic fields up to 17 T and temperatures down to 8 mK which was installed at the end of 2008. First test measurements with this system have already been performed. The CM-17T's first magnetic measurement when it goes into operation will be low temperature magnetisation based on a cantilever magnetometer. For this purpose the CM-17T is equipped with a 17T primary superconducting magnet and a gradient coil. In addition to the primary 17T magnet, an 8T secondary magnet is located below the primary magnet. This is preparing the next stage of LaMMB's development towards sub-millikelvin temperatures with the help of a demagnetisation stage.

Controlled Gas Adsorption (DEGAS)

In the past, most of the neutron and x-ray scattering experiments have been carried out on samples which change their properties due to externally applied fields of an electro-magnetic nature, temperature or mechanical pressure, but which do not change with respect to their chemical composition. Only a small but fast-growing number of hard and soft matter investigations (Figure 2) deals with samples that are modified in-situ in the beam by simply adding or removing particles using gas ad- or desorption. Reasons for the growing interest in this type of experiment are manifold. In-situ gas adsorption studies in the context of structural research on materials for energy storage are certainly one of the main reasons (A. Remhof et al., p. 42), but also the detection of property changes in a soft or bio-material due, for example, to variations in the moisture of the sample opens up a wide field of applications. The controlled filling and emptying of voids in new nanostructured materials offers the option to change the contrast in a scattering experiment so that complex structures can be visualised (B. Smarsly et al., p. 38). In-situ synthesis and catalysis under extreme pressure and temperature conditions can also be easily investigated with neutrons, for instance to understand chemical processes while forming new materials (M. Russina et al., p. 54).

It is still proving a great challenge to create all the unique experimental conditions with regard to gas pressure and temperature in combination with the powerful neutron and synchrotron scattering methods. At BENSC we have started to develop several new sample environments for controlled gas adsorption (CGA) in which pressure, volume and temperature of a gas in neutron suited sample cells can be handled remotely (and with high precision) by the user via automated gas handling systems. Pressures from 10^{-5} bar to 300 bar and temperatures ranging from 1.5 K to 1300 K can be achieved by modular designed gas dosing systems and temperature controlling devices. For ultra high pressure experiments with hydrogen up to 10.000 bar, a unique gas supply system has been developed at BENSC

Fig. 3: Unique fully automated 10 kbar hydrogen gas-handling system for highest controlled gas pressures in combination with neutron investigations.

(Figure 3), while for controlled humidity and continuous gas flow experiments a sophisticated gravimetric system (based on a magnetic suspension balance) has been purchased for in-situ sample weighing during gas exposure up to 500 bars in a wide temperature range.

Since most of the "beamline" equipment provides unique opportunities to combine pressure and temperature it can also be utilised by internal and external users in the laboratory for approving new methods, characterising samples or preparing scattering experiments. For BESSY the first in-situ experiments in an x-ray setup is planned for 2009 to respond to the frequent user request in the last year.

New instruments for ANTOME

In April 2006, the Application Centre for Tomographic Methods in Materials Science (ANTOME) became the proud possessor of a ZEISS Cross-Beam 1540 EsB focussed ion beam system (FIB). This electron microscope, which was financed jointly by the European Union and the City State of Berlin, has been installed in the Microstructure Group in Department SF3.

The FIB combines an imaging column using field emission (SEM) technology and a high performance focussed ion beam column. It is mainly used in a wide area of materials for tomography by serial sectioning. It also comprises various detectors and analytical devices, such as an inlens detector, a high resolution electron backscattering detector, a secondary electron detector and detectors for energy dispersive X-ray analysis and for scanning transmission electron microscopy. The variety of detectors means the microscope can be utilised in a large number of research fields. And it is not just intended for internal use either: the many users of the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) and Technische Universität Berlin (TU Berlin) are also able to profit from the FIB.

Prof. Schubert's group at TU Berlin investigates biocompatible ceramic foam materials; Prof. Boit's group, also at TU Berlin, is interested in the failure diagnostics of integrated circuits. Materials for solar cells (layers preparation, microstructure analysis) are the focus of study in Prof. Schock's group (SE3, HZB). High precision transmission electron microscopy sample preparation and sharp tip preparation for atom probe tomography of metallic materials are performed by Prof. Banhart's group (SF3) while Prof. S. Eisebitt's group from BESSY is concerned with the preparation of specimens for lithography.

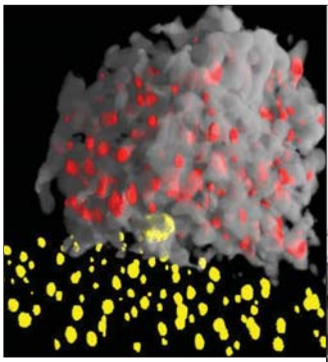


Fig. 2: Visualization of a 3D data set reconstructed from a tilt series of TEM images showing catalyst particles (red) on carbon black (gray). The carbon black particles are supported on a carbon foil with small gold particles (yellow) which have a typical diameter of about 5 nm.

Fig. 1 Construction of the Zeiss LIBRA transmission electron microscope

Fig. 3: Participants in HZB's tomography workshop in October 2007

Spring 2007 saw the arrival at HZB of the Zeiss Libra 200 transmission electron microscope (TEM) which passed the final acceptance tests later in the summer (Fig. 1). The installation of the new TEM completed the array of instruments at ANTOME which now offers the complete range of 3D-characterization methods from the nanometre scale up to specimen sizes of several decimetres. Moreover, it complements other methods employed at HZB, such as small angle scattering. Due to its modular design the microscope is one of the most versatile machines at HZB, making it possible to employ several imaging techniques, electron diffraction, electron energy loss and X-ray spectroscopy at a given specimen site with a lateral resolution in the nanometre range.
Current fields of investigation include technical and amorphous Al-alloys, thin film solar cells and magnetosoms in bacteria (in cooperation with MPI in Golm). One of the main methods employed is electron tomography (ET). For example, the size distribution and deposition characteristics of Se-modified Ru-catalysts on carbon black are investigated in three dimensions in cooperation with scientists in Department SE 5 at HZB. Fig. 2 shows an example of a three dimensional data set reconstructed from a tilt series of TEM images showing the catalyst particles (red) on carbon black (gray). The carbon black particles are supported on a carbon foil with small gold particles (yellow). Such images already allow qualitative discrimination of the catalyst locations with respect to the carbon black support, which is important for understanding the differences in the catalytic activity of the material.
To mark the completion of ANTOME the project partners organised a very successful two-day Workshop on Tomography in Materials Science using TEM and FIB in October 2007 (Fig. 3). Plans are currently being discussed for a similar workshop in the near future. The number of joint research projects with other groups at HZB and different research institutions, e.g. TU Berlin and Freie Universität Berlin, is steadily increasing.

The ANTOME project time line officially ended in July 2008. However, ANTOME's scientific work is continuing and branching out into other fields of activity, especially electron tomography.

N. Wanderka, M. Wollgarten

X-ray micro-imaging using different contrast modes and partially coherent synchrotron light

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■ 1 Helmholtz-Zentrum Berlin ■ 2 European Synchrotron Radiation Facility,
■ 3 Technische Universität Berlin ■ 4 Bundesanstalt für Materialforschung und -prüfung

Synchrotron-based micro-imaging is a valuable tool in materials research, life science, non-destructive evaluation, and palaeontology. The high brilliance at synchrotron light sources can be used to record images with an extremely low noise level and high spatial resolution within short acquisition times. Additionally, monochromatic radiation can be used to reduce artefacts while increasing the material contrast. The spatial coherence of the light source gives access to improved interfaces- and/or material-contrast by adding interferometric techniques to the available imaging modes. Novel contrast mechanisms which were applied to micro-tomography (μCT) are: X-ray fluorescence tomography (sensitive to the local chemical species distribution), refraction enhanced tomography (sensitive to inner surfaces and interfaces), diffraction tomography (contrasting the local texture of polycrystalline material grains) and holotomography (imaging the real decrement of the materials' refractive index) [1-3].

Over the past few years, the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), together with the Bundesanstalt für Materialforschung und –prüfung (BAM), has developed a micro-imaging station at Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung (BESSY). Absorption contrast, refraction enhanced imaging as well as inline phase contrast μCT are the standard imaging modes [2]. The available contrast mechanisms were recently extended to holotomography [3].

The principle of holotomography is illustrated in Figure 1. Tomographic datasets are recorded at different sample-detector distances. Here, the phase contrast imaging mode yields to the formation of high-contrast interference fringes at materials interfaces and micrometre-sized inhomogeneities. This effect gains in strength the more the images are defocused, i.e. for larger sample-detector distances. Whilst the inline phase contrast mode is often used directly for imaging, numerical phase retrieval can be applied to one or several such images, yielding a projection map of the real decrement of the materials' refractive index (absorption images represent the imaginary part, usually 2-3 orders of magnitude smaller than the real decrement which is approximately the local electron density). These so-called phase-maps are used for reconstructing volume images. Figure 2 illustrates the differences between (a) absorption, (b) inline phase contrast and (c) holotomography for a tomographical slice showing the microstructure of a metallic specimen made from AZ91 alloy (Mg-particles in Mg-Al matrix). Holotomography features a highly improved density contrast which is important for imaging specimens of weak absorption (biological samples) and specimens with two or more material phases of similar density.

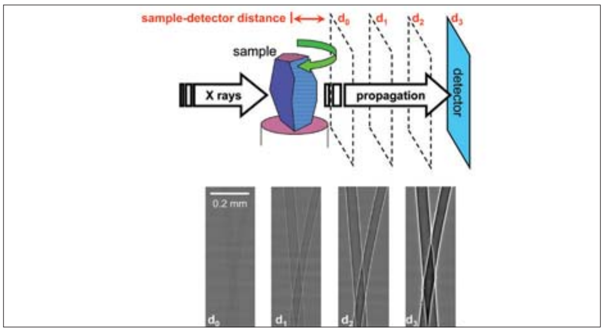

Fig. 1 Fresnel-propagated X-ray imaging illustrated for radiographs of two hairs recorded with increasing sample-detector distance [2,4].

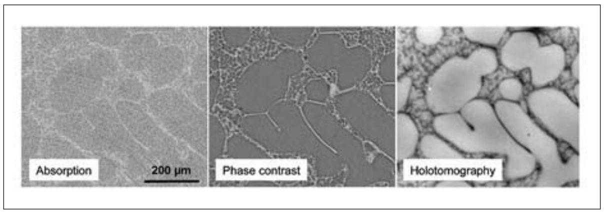

Fig. 2: Slices taken from three different tomograms of an AZ91 alloy: a) absorption contrast tomography, b) phase contrast tomography and c) holotomography [2].

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A decade of precision: proton therapy at HMI and Charité

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The use of protons in radiotherapy has obvious advantages compared to other clinically available irradiation techniques. Protons exhibit "inverse" depth dose distribution, i.e. the dose applied to the irradiated tissue increases with depth and vanishes after a steep maximum, the so-called Bragg peak (Fig. 1). The position of the Bragg peak can be adjusted precisely by varying the proton energy. In addition, the lateral scattering area of proton beams is much smaller than the penumbra of conventional X-ray or electron beams. Thus the irradiation dose applied with protons can be concentrated on the tumour, causing less collateral damage to healthy tissue and sensitive organs such as – in the case of the eye – the macula or the optic disc.

From 1998 onwards, eye tumours were treated with 68 MeV protons in the ion beam laboratory ISL at Hahn-Meitner-Institut in collaboration with the University Hospital Benjamin Franklin, now known as Charité - Campus Benjamin Franklin. ISL, providing light and heavy ion beams for research and applications in solid state physics and medicine, was closed down at the end of 2006. In order to ensure the continuation of the eye tumour therapy in Berlin - the only proton therapy facility in Germany to this day - a cooperation agreement was signed between Charité and HMI in December 2006. Accelerator operation continued with reduced manpower, which required changes in the set-up of the accelerators. Thus in spring 2007, a 2 MV tandetron was acquired from the Bundesanstalt für Materialforschung und -prüfung to replace the Van-de-Graaff-injector. The tandetron was dismantled, packed up, moved, and installed at its new location in the cyclotron vault. The first beam from the ion sources of the tandetron was obtained in September 2008.

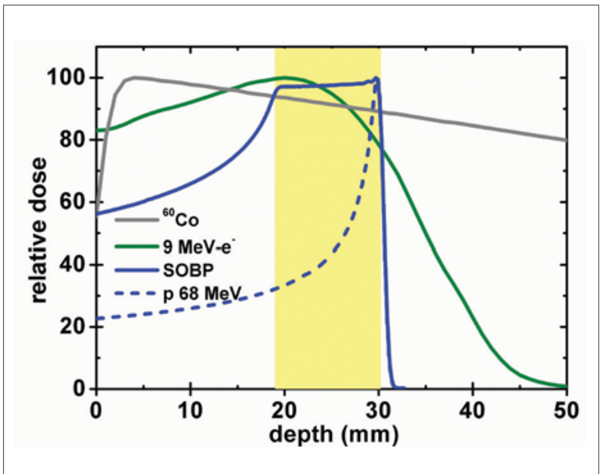

Fig. 1: Depth dose distribution of electron beams (dark green line) and X-rays (grey line), both used for conventional radiotherapy, in comparison with the depth dose distribution of a mono-energetic proton beam (dashed blue line). No dose is applied after the steep maximum, the so-called Bragg peak. By overlapping various proton energies it is possible to cover the target depth (yellow) with a homogenous dose (blue line).

A crucial point for proton therapy is reliability. In 2007, the accelerators were available for 92% of therapy time: Due to a fault in the cyclotron, one of the eleven therapy weeks in 2007 started one day late. During the twelve weeks scheduled for therapy in 2008, an up-time of more than 95% was achieved.

Tumour irradiation is performed during the radiotherapy week on four consecutive days, the first day of the week being used for quality control. Typical irradiation times for dose application are about 30 seconds to 1 minute for each fraction, while patient preparation and positioning take about 15 minutes to half an hour. Tumour control rates are above 96% [1]. In most cases, the patient's visual acuity can be maintained to a satisfactory degree.

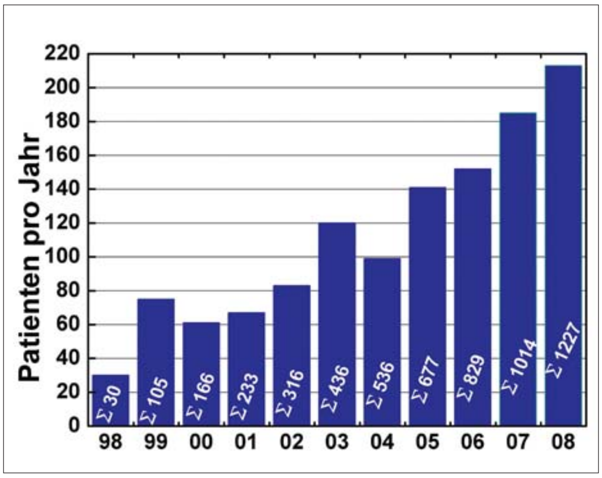

Fig. 2: Number of patients per year (blue bars) and the integral number of patients treated (white numbers).

**"If you can't see it, you can't hit it,
and if you can't hit it, you can't cure it."**
Harold Johns

Proton therapy of eye tumours requires positioning in the sub-millimetre range. For this purpose, small tantalum clips sutured to the eye globe serve as landmarks. While the patient is immobilised in the treatment chair, looking at a fixation light, clip and eye positions are determined with a digital X-ray system providing orthogonal images. The clip projections from the treatment plan are superimposed on the immediate X-ray images for position control. By correcting the coordinates of the chair and fixation light the patient is repositioned until both actual and target clip projections fit together perfectly.
In order to avoid a time-consuming trial-and-error approach to correction, the image processing software was further developed to compare both projections with each other by automatically detecting the clip positions from the X-ray pictures and calculating the necessary corrections of chair and light coordinates. This novel use of the positioning software facilitates the adjustment to the final treatment position. Perpendicular X-ray views allow precise patient positioning at a degree of accuracy below 0.3 mm. The installation of an on-site digital X-ray system for patient positioning is unique in proton therapy. The automated procedure reduces mean positioning time which makes therapy more tolerable for the patient and results in higher patient throughput.
The number of patients has continuously increased (Fig. 2). In 2007, 185 patients were treated in 11 therapy weeks and, in December, we were able to welcome the 1000th patient with a bunch of flowers (Fig. 3). The average number of patients treated per week continued to rise in 2008, with 18 patients being treated every weekday.

A particular challenge in 2007 was the treatment of a patient with Ankylosing spondylitis who had a spinal curvature of about 60°. A custom made tiltable seat with extra footrests and remote adaptation of the mask holder to position the patient in the isocentre had to be built, requiring four simulation sessions at intervals of more than a week.

Fig. 3: December 2007: The 1000th patient is welcomed with a bunch of flowers

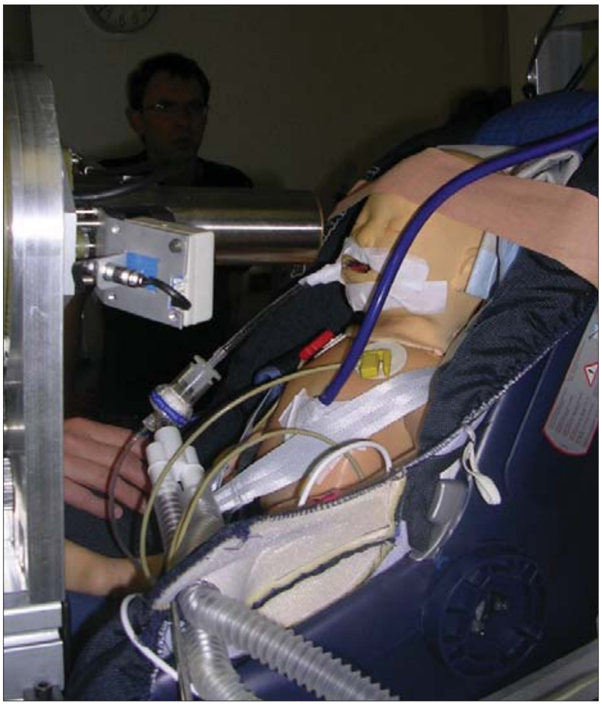

Fig. 4: Summer 2007: The sequence of treatment under anaesthesia being tested using a dummy baby

In 2008, the case of an infant posed even greater challenges, as the treatment of babies has to be performed under general anaesthesia. Prior to the treatment itself, preparation sessions using a dummy (Fig. 4) were held to test all the equipment and the sequence of eventsprecisely.

Since the beginning of the therapy in 1998, more than 1,200 patients have been treated. The accelerator has operated smoothly and reliably. Greater precision has been achieved by improved beam delivery, better planning procedures, and enhanced treatment methods in close, multi-disciplinary cooperation between physicists, radiation therapists, and oncologists. And we will continue to provide unique therapeutic possibilities for patients in Germany.

[1] C. Mans, S. Hanning, C. Simons, A. Wegner, A. Janssen, M. Kreyenschmidt, *Development of suitable plastic standards for XRF*, Spec trochimica Acta, Part B: Atomic Spectroscopy 62B (2007) 116-122.

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BENSC User Operation

BENSC in Short
Berlin Neutron Scattering Centre (BENSC) is the administrative unit within Helmholtz-Zentrum Berlin (HZB) responsible for the instrumentation and user operation at the medium-flux research reactor BER-II. BENSC operates more than 20 instruments and has established itself as a major research facility for neutron science on an international scale with exceptionally high demand from European users. BENSC offers access to a great variety of neutron scattering and radiography instruments with some unique features suitable for research in many fields of science. At present, 14 instruments are in routine operation for external users. These instruments cover practically all neutron scattering and radiographic techniques, with the exception of backscattering. Several of them provide neutron intensities and resolutions which can compete with the best instruments available worldwide.

The major scientific fields actively pursued at BENSC are research on magnetism, soft-matter and biological materials, as well as on nano-sized and engineering materials. A unique and internationally recognised strength of BENSC is the large range of sample environment equipment available to carry out experiments under extreme conditions. Highest magnetic fields (up to 17.5 T) and lowest temperatures (down to 30 mK) are routinely offered to users together with extensive expert support by in-house scientists and technical staff. A further focus in sample environment is now available (specialised equipment for neutron scattering experiments under controlled gas atmosphere), to serve a rapidly growing user community in the fields of soft matter, biology and materials science

Personnel
An important change occurred in 2007. Professor Ference Mezei, director of BENSC for many years, retired from HZB and Professor Alan Tennant, head of the department of magnetism, was appointed BENSC director.

User Operation
At the 14 user instruments, 70% of the beam time is reserved for external users (who are selected on the basis of peer reviewed research proposals), and 30% for in-house research. A minor part of the beam time for external users (up to 20% of the total beam time of an instrument) is available for long-term collaborative groups, such as university groups (predominantly German), allowing them to plan research work for theses.

User and instrument statistics
Table 1 gives a short overview on the number of projects performed at BENSC by external users in the years 2007 and 2008. The overall development of the number of external proposals submitted to BENSC as well as the number of accepted proposals through the years 2002 to 2008 is displayed in Fig. 1. There are two calls for proposals per year, in spring and in autumn. The submitted proposals are peer-reviewed by an international Scientific Panel meeting at the HZB. The panel decides on the beam time allocation based on the scientific merits of the proposals.

	Projects		Visitors	
	2007	2008	2007	2008
Germany	66	72	141	151
Europe	95	92	180	175
Others	37	63	61	87
Sum	198	227	382	413

Table 1: Projects performed by external users (visitors) at BENSC in 2007 und 2008

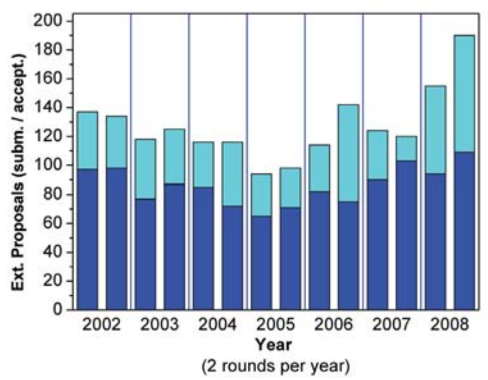

Fig. 1: Number of proposals submitted per round, from 2002 to 2008 (2 proposal rounds per year). The dark-blue part of a bar corresponds to the number of accepted proposals.

The number of proposals submitted has been consistent over the years except for a decline in 2005 which was due to an extended shut-down of several instruments. This shut-down had become necessary for the installation of the new neutron guide system for the second neutron guide hall of BENSC (built in 2004 - 2005). After this shut-down the number of proposals submitted has steadily increased again, most significantly in 2008. The overload factors for the major user instruments of BENSC in 2008-II are given in Figure 2. Here, the average overload factor is 1.7.

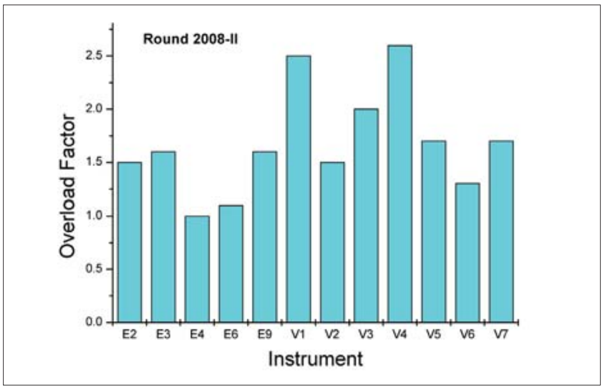

Fig. 2: Overload factors for the major user instruments in 2008-II. Average over all instruments: 1.7.

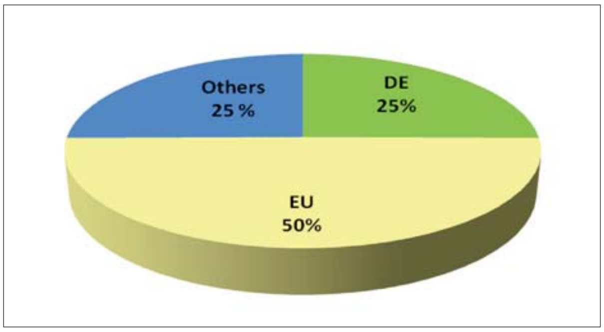

Fig. 4: Proposals from Fig. 3 (round 2008-II) summed up in three categories DE (Germany), EU (EU countries except Germany) and Others (other countries).

User Profile

The degree of international recognition for BENSC is illustrated by Figure 3 which shows the origin of the user groups in 2008-II. The figure demonstrates that BENSC has truly established itself as a major research facility for neutron science, with users from throughout the world.

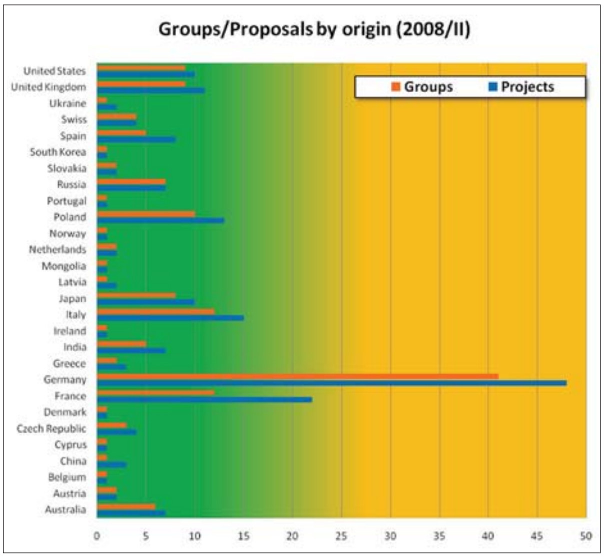

Fig. 3: Origin of users in round 2008-II.

European funding for BENSC

The user programme of BENSC, with its exceptionally large percentage of European users (see Fig. 4), has been highly rated and strongly supported by the European Commission since 1993. Over the last 4 years, a European Access programme has been organised under the 6th EU Framework Programme (FP6), where BENSC is a major partner in the "Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy (NMI3)".

Science at BENSC

Figure 5 shows that the scientific topics covered by the external proposals can basically be grouped in three categories of similar size: biology and soft condensed matter (37%), magnetism (36%) and material science plus hard condensed matter (structure) together making 24%. It is interesting and informative to follow the development of these fields of study over the years of BENSC's existence. This is shown in Figure 6 which gives a year-by-year overview of the scientific topics of external as well as in-house projects performed at BENSC since its start in 1993. ▸▸

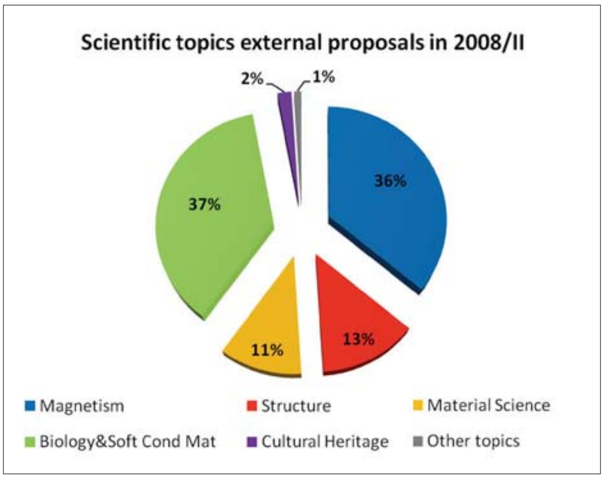

Fig. 5: Scientific fields covered by the external proposals in round 2008-II.

[continued]

BENSC User Operation

Figure 6 clearly demonstrates the increasing importance of neutrons for research on soft condensed matter and bio-related materials. Whilst the field of study of magnetism has stayed rather constant and at a high level (about 30%) over the years, the number of neutron scattering experiments on soft condensed matter and bio-related materials has increased almost linearly from below 10% in 1993 to about 30% in 2007, equal to that of magnetism.

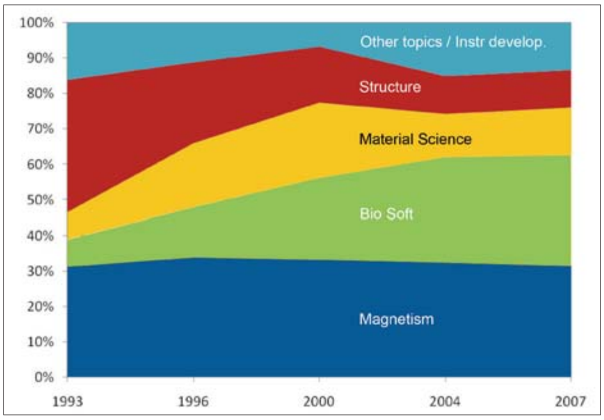

Fig. 6: Development of the scientific fields covered by experiments at BENSC between 1993 and 2007.

It is clear that there is also interdependence between the development of instrumentation for soft-matter experiments and the demand by users of such experimental facilities. When the trend displayed by Figure 6 was recognised, BENSC reacted pro-actively by increasing the experimental capacity, and the number of existing 'work-horse' instrument types for soft-matter experiments is being doubled from 2 to 4. Currently, a second very small-angle scattering machine (VSANS, in the new neutron guide hall) and a second reflectometer (BioRef, a collaborative research project of the University of Heidelberg) are being constructed. These new instruments will be commissioned in 2009.
In addition, a further focus in sample environment is the development of equipment for neutron scattering experiments under controlled gas atmosphere, to serve a growing user community. This new "Dedicated Environment for Combined Gas Adsorption and Scattering Experiments" (DEGAS) includes humidity chambers for investigating biological samples as well as equipment for in-situ adsorption experiments on, for example, metal-organic framework systems. Such mesoporous systems also represent a new scientific focus for material scientists and are being widely explored in terms of their catalytic or hydrogen storage potential. The increasing demand for this new equipment is demonstrated in the article on "News from the Sample Environment" of the present report.

Training the next generation of users

For almost 30 years, the annual Berlin School on Neutron Scattering has been held at HZB. Again in 2007 and 2008, 30 external students and young postdoctoral scientists from different countries were selected to attend this highly regarded training school. Following an introduction to the theory and methods of neutron scattering, the main emphasis was hands-on experience of the neutron scattering techniques at BENSC, including triple-axis spectroscopy, powder diffraction, small angle neutron scattering, reflectometry, time of flight spectroscopy and tomography.

Important events

Outstanding events at BENSC have been the 14th BENSC User Meeting in May 2007, the European Conference on Neutron Scattering (ECNS) in June 2007 (Lund, Sweden) and the celebration of 50 years of research with neutrons at HZB in 2008.
The BENSC User Meeting attracted 117 participants, 52 of them coming from HZB, 34 from other German institutes and 31 from foreign research institutions. The 15 invited lectures and 53 poster contributions gave ample opportunity for lively discussions and scientific exchange on the latest results from experiments performed at BENSC.
At the ECNS in Lund, there were an extraordinarily high number of scientific contributions from work undertaken at BENSC, as has been the case at previous conferences. Of the 612 posters presented at Lund, 17% were based on BENSC experiments performed by inhouse scientists and external users. This was the largest number of contributions from a single centre after the Laue-Langevin Institute (ILL, 24%) and much greater than that of other centres.
In July 2008, HZB celebrated the 50th anniversary of the first research reactor BER-I becoming critical. Numerous neutron scientists from other centres, current users and retired employees joined the staff of HZB in their celebration. During the two days, the participants enjoyed a varied scientific programme on past, present and future neutron science in Berlin and elsewhere.

Important forthcoming changes

By January 2009, two of Berlin's largest research centres, the Hahn-Meitner-Institut and the Berlin synchrotron radiation source BESSY, will merge to form the HZB - Helmholtz-Zentrum Berlin für Materialien und Energie GmbH. With this merger, a new era dawns in the user facilities of the joint institute. HZB will be one of the few centres worldwide that is able to offer the whole range of instruments for neutron and synchrotron radiation experiments in one laboratory structure. A common user entry point, a unified proposal procedure and one common scientific panel for both facilities will help to facilitate the synergistic use of neutron and synchrotron radiation.

NAA Laboratory and Irradiation Service

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The laboratory for neutron activation analysis (NAA) in the BER II research reactor at Helmholtz-Zentrum Berlin provides irradiation services for universities, scientific institutions and industry.

Typical fields of application are:

- Trace elements analysis by means of NAA, for example in biology, medicine, geology and archaeology. Certification of reference materials.
- Irradiation experiments, such as isotope production for medical applications, sources for Mößbauer spectros copy and production of tracers for scientific and industrial applications.

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

Fig.1: Wheat plants enclosed in ampoules made of high purity silica

Irradiation devices

Three irradiation devices are available for different applications.

DBVK: 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

DBVK and DBVR are used for long term irradiation experiments. Up to nine aluminum containers can be irradiated simultaneously. Usually the samples have to be enclosed in ampoules made of high purity silica. Short time irradiation experiments are carried out by means of TBR. The samples have to be enclosed in containers made of polyethylene.

Device	Φthermal	Φfast	Container
	[1/cm²s]	[1/cm²s]	
DBVK	1,5E+14	4,3E+13	6
DBVR	7,5E+12	1,9E+10	9
TBR	3,4E+12	2,2E+10	1

Table 1: Fast and thermal neutron flux at different irradiation positions

Irradiation Experiments 2007 and 2008

Most of the irradiation experiments (243 in 2007; 334 in 2008), were performed using the DBVK or DBVR. With these devices it is possible to irradiate up to 24 samples simultaneously in one aluminum container.

Internal users

Most of the internal users are from Department SF6, but irradiation and analyses were also performed for users from other departments (SF2, SF4, SE5, RE).

External users

Irradiation experiments and NAA were performed for users from German universities (Berlin, Mainz, Münster, Leipzig, Nürnberg) and from research institutes, such as Bundesanstalt für Materialforschung und -prüfung (BAM, Berlin), GSF Forschungszentrum für Umwelt und Gesundheit (Neuherberg), and Fraunhofer Institute (Dresden). For industrial companies neutron activation analysis was performed and radioactive materials were produced for tracer experiments.

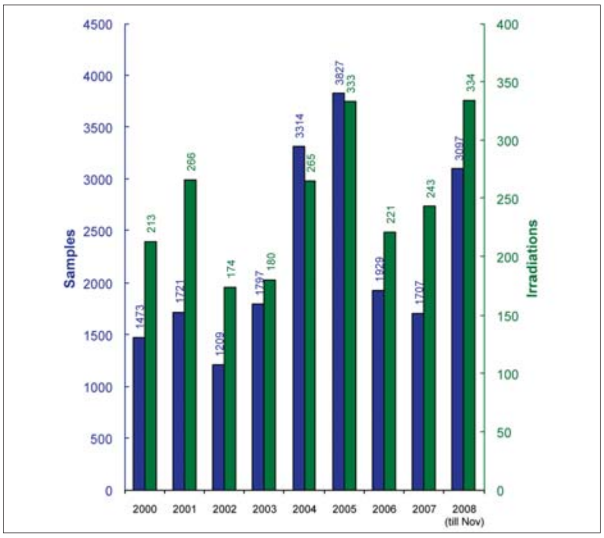

Fig.2: Statistics for irradiated samples and irradiation experiments