HELMHOLTZ INTERNATIONAL –
IDEAS FOR THE WORLD

ANNUAL REPORT 2008

HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

From the Research Fields

ENERGY I EARTH AND ENVIRONMENT I HEALTH
KEY TECHNOLOGIES I STRUCTURE OF MATTER
TRANSPORT AND SPACE

Research in Germany
Land of Ideas

HELMHOLTZ
ASSOCIATION

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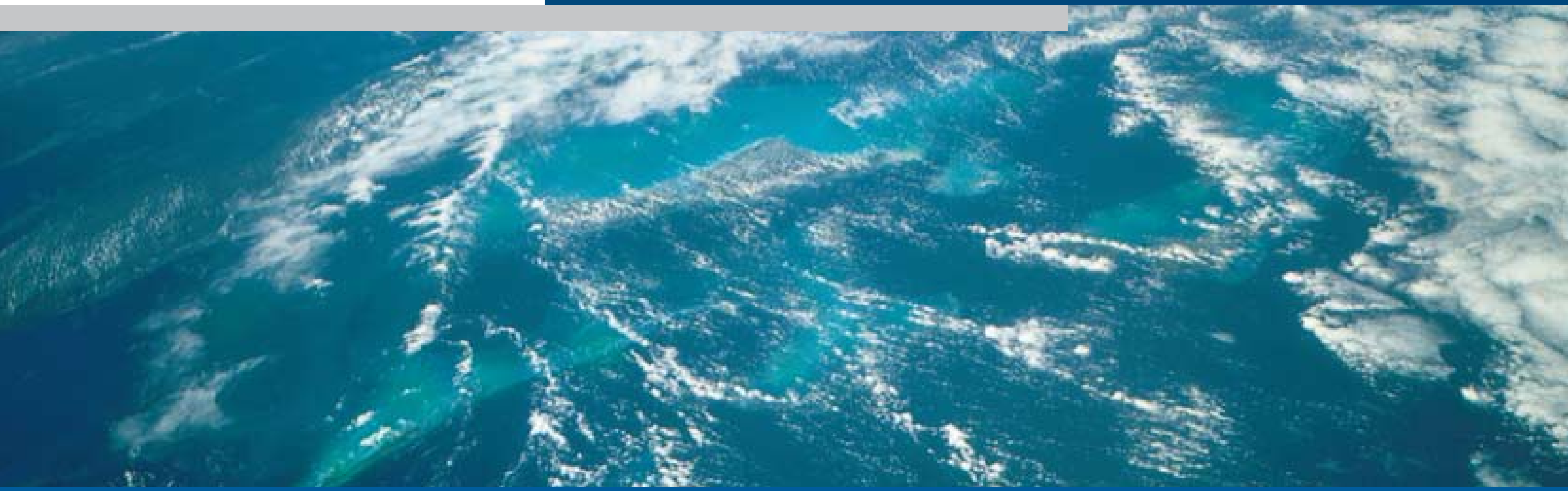


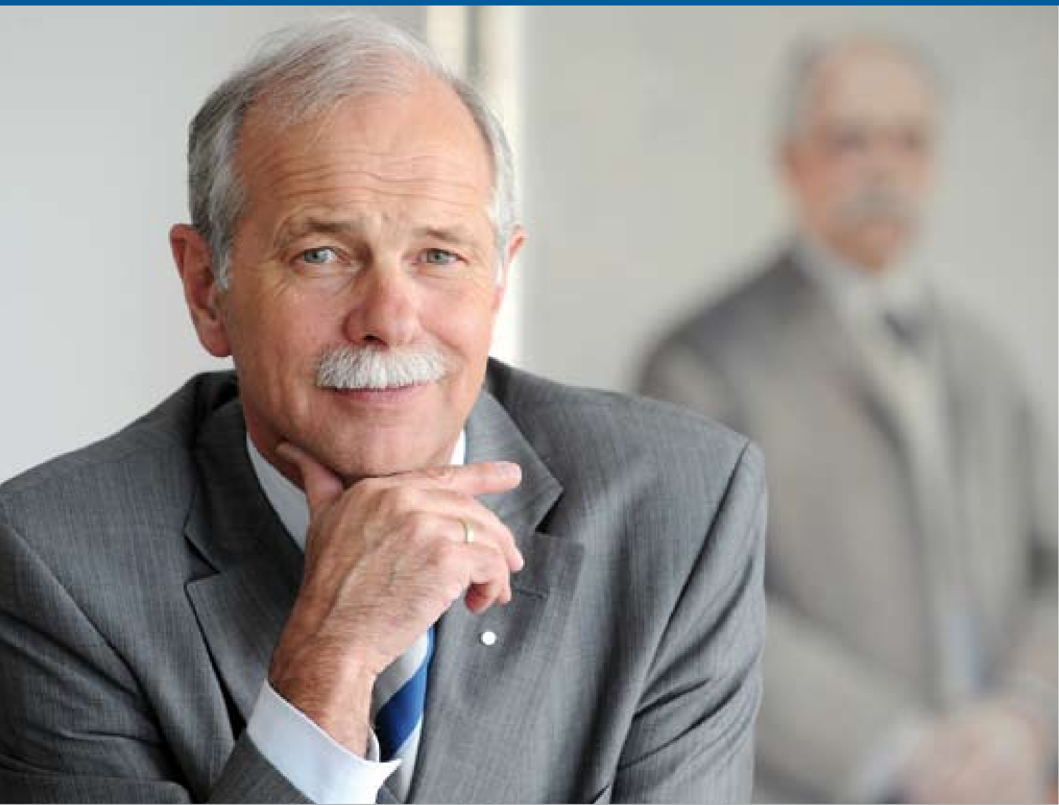
VIEW OF THE EARTH FROM SPACE. Photo: DLR/D2 mission

We contribute to solving grand challenges which face society, science and industry by performing top-rate research in strategic programmes in the fields of Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space.

We research systems of great complexity with our large-scale facilities and scientific infrastructure and in cooperation with national and international partners.

We contribute to shaping our future by combining research and technology development with perspectives for innovative applications and provisions for tomorrow's world.

That is our Mission.



PROFESSOR DR. JÜRGEN MLYNEK
President of the Helmholtz Association

HELMHOLTZ INTERNATIONAL – IDEAS FOR THE WORLD

Dear Readers,

We are thrilled – after Peter Grünberg received the Nobel Prize in Physics in 2007, Harald zur Hausen has now been awarded the Nobel Prize in Medicine for 2008. Our warmest congratulations go out to both of them for their monumental discoveries. These successes also serve to reinforce our commitment and determination to remain at the forefront of research, and we are ready to meet that challenge. One way to make that happen is to expand our networking activities with international partners around the world.

Scientists and researchers have always worked closely with others in their field throughout the world, critiquing one another's ideas and methods and forging ahead together. This kind of fruitful exchange serves to ensure and enhance the quality of research, and it is more important than ever today, in a time when business and political leaders are thinking and acting with an increasingly global focus. We are competing with the entire world for natural resources, market share and talent, yet we also face urgent problems like climate change, which we will not be able to solve by ourselves. Providing food, water and energy for a growing global population are issues that concern all of us. Similarly, health researchers around the world face new challenges as life expectancy continues to rise.

That is why our slogan for this year's annual report is "Helmholtz International: Research in Germany – Ideas for the World". It reflects the opposites of competition and collaboration – for while reconciling these conflicting demands is a challenge research has always faced, this tension is increasingly being felt in all areas of today's information society.

We invite you to read about the large-scale collaborative efforts that the Helmholtz Association is coordinating with its international partners and about the areas we intend to focus on more in the future. In addition, we introduce several projects from each of our Research Fields that are being advanced in international cooperation. Our annual report also puts you in the picture on the results of the independent evaluations conducted as part of our programme-oriented approach to funding. This instrument enables us, as the only research organisation in Germany, to award all funding in a transparent, competitive process that assesses applications according to scientific excellence and strategic relevance. Programme-oriented funding helps us fulfil our mission of conducting top-rate research to secure the future.

Excellent research is not only crucial to competing in the global market and maintaining our good standard of living, it is imperative if we want to help shape a better future for us all – in Germany, in Europe and all over the world.

Professor Dr. Jürgen Mlynek

2007 NOBEL PRIZE IN PHYSICS GOES TO PETER GRÜNBERG

Extremely small MP3 players and mini notebooks with 80-gigabyte hard drives are common on today's market – ever since the arrival of read heads that employ a special effect to read more highly compressed data, the capacity of magnetic storage media has expanded by leaps and bounds. This was made possible by a discovery made in the research work of Helmholtz researcher Professor Peter Grünberg from the Forschungszentrum Jülich, for which he was awarded the 2007 Nobel Prize in Physics. Grünberg shared the distinction with his French colleague Professor Albert Fert (Université Paris-Sud).
In 1988 the two independently discovered an effect called giant magnetoresistance in thin film structures composed of numerous alternating magnetic and non-magnetic material layers. Today this effect, also known as GMR, is used in almost all read heads for magnetic storage media. Over five billion have been produced so far – nearly one for every person on the planet.
In the late 1980s Peter Grünberg discovered that external magnetic fields caused drastic changes to the electrical resistance in thin "sandwiches" of iron and chrome layers. The quantum mechanical effect depends on the alignment of electron spins in the different layers of material. Grünberg quickly recognised that this phenomenon would be valuable both to physics researchers and to the computer industry, which is always trying to find new ways of packing more data onto smaller hard drives. Grünberg's discovery allows data to be stored using very little space on the storage medium by means of microscopically small areas magnetised in different directions. A highly responsive sensor makes use of the GMR effect and registers these minute differences as a change large enough to be measured, allowing it to read even very highly compressed hard drives and greatly expanding storage capacity without increasing the size of the storage medium.
Peter Grünberg worked hard to promote his discovery to the computer industry, and the first GMR read-out head for a computer hard drive was on the market by 1997. Thanks to the GMR effect, the research centre in Jülich, which holds a patent for the technology, earned tens of millions in revenue. The development was also milestone for science, since the new insights gained by Fert and Grünberg into the behaviour of magnetic layer structures gave birth to a new field of research called spintronics, which applies the quantum mechanical spin of electrons to microelectronics and nanoelectronics.

Professor Dr. h.c. mult. PETER GRÜNBERG was born in Plzen (now Czech Republic) in 1939. After completing his PhD in Darmstadt, Germany and spending three years as a researcher in Canada, in 1972 he joined the team at the Forschungszentrum Jülich, where he has continued to pursue his research since retiring. He has received numerous distinguished international awards in recognition of his achievements. In 1998 he was presented with the Zukunftspreis, the German president's award for scientific innovation, and in 2006 he was named European Inventor of the Year. In 2007 he received the Stern Gerlach medal from the German Physics Society, Israel's Wolf Foundation Prize and the Japan Prize in the category of "Innovations through Basic Research". In the same year he was awarded the first Helmholtz professorship by the Forschungszentrum Jülich. In 2008 he was honoured with the Cross of the Order of Merit of the Federal Republic of Germany.

2008 NOBEL PRIZE IN MEDICINE GOES TO HARALD ZUR HAUSEN

Each year, around 500,000 women worldwide are diagnosed with cervical cancer that is caused by certain types of papilloma viruses. For this discovery, the 2008 Nobel Prize in Medicine was awarded to Professor Harald zur Hausen from the German Cancer Research Center, a member of the Helmholtz Association. Zur Hausen's research led to the development of a vaccine against the third most common form of cancer in women. Half of this year's Nobel Prize goes to zur Hausen, the other half being shared by Françoise Barré-Sinoussi and Luc Montagnier, who were recognised for their discovery of HIV, the virus that causes AIDS.

Zur Hausen suspected a connection between cervical cancer and human papilloma viruses more than 30 years ago. "Old medical documents I read stated that in rare cases, benign genital warts can develop into cancer. This led me to think that the viruses that cause the warts – experts call them human papilloma viruses – may be connected to cervical cancer." These sexually-transmitted viruses are very common; nearly 80 per cent of women contract them at some point in their life. In most cases, these infections have no serious medical consequences. In some women, however, they lead to changes in the tissue which develop over several stages into cervical cancer. At first zur Hausen's hypothesis met with strong opposition from the scientific world. Undeterred, he continued to subject his idea to rigorous testing. In the early 1980s he and his team were the first to isolate the HPV 16 and HPV 18 viruses from a cervical cancer tissue sample, confirming zur Hausen's theory and ushering in a new era in cancer research. "We quickly realised that there had to be a way to develop a vaccine against these viruses. Several researchers in my department – especially Lutz Gissmann, Matthias Dürst and Jürgen Kleinschmidt – made crucial contributions to developing the vaccine that is available today," explains zur Hausen.

The vaccine that emerged from research done in zur Hausen's laboratory protects against the four main types of virus that cause cervical cancer. It has recently been approved for the German market, and many health insurance providers in Germany now cover the cost of vaccinating young girls. The vaccine is an outstanding example of successful technology transfer from basic research, of which zur Hausen has always been a strong supporter. "We still face plenty of challenges. The vaccine is still far too expensive, especially for the developing world, where it is most urgently needed. New techniques in molecular biology may enable us to make the vaccine more affordable. We also need to improve the vaccine to include all high-risk types of HPV."

Professor Dr. Dr. h.c. mult. **HARALD ZUR HAUSEN** was born in 1936. Following his studies in human medicine and various positions as Professor of Virology in Germany and the USA, from 1983 to 2003 Harald zur Hausen was chairman and scientific director of the German Cancer Research Center (DKFZ). Under zur Hausen's leadership the Cancer Research Center expanded its cooperation with university hospitals in the form of "clinical cooperation units", which strengthen the link between basic research and clinical medicine so that research findings can be applied as quickly as possible. Harald zur Hausen has already received numerous awards for his work, including the 2006 Prince Mahidol Award and the award of the German Cancer Aid in 2007. He has also been honoured with the German Cross of the Order of Merit for his outstanding contributions to society.

RESEARCH – MANAGING THE BALANCE BETWEEN COMPETITION AND COOPERATION

Top research is driven by competition. That is why the Helmholtz Association's work undergoes an evaluation by international experts every five years to ensure it is developing to meet the highest scientific standards. This year, a total of 169 experts were involved in mapping out our course in the Research Fields Earth and Environment, Health, Aeronautics, Space and Transport with their joint annual basic funding of 800 million euros.

The high points of the past few years have to be the two Nobel prizes that went to Helmholtz researchers in 2007 and 2008. Peter Grünberg from Forschungszentrum Jülich was awarded the Nobel Prize in Physics in 2007 and now, just one year later, virologist Harald zur Hausen from the German Cancer Research Center in Heidelberg has been honoured with the Nobel Prize in Medicine. The scientists have one thing in common – they were the first to see that the insights they gained in long years of fundamental research could also have practical applications. Grünberg discovered the giant magnetoresistance effect that is now used in producing nearly all read heads for hard drives, dramatically expanding their storage capacity. Zur Hausen discovered the link between infections with human papilloma viruses and cervical cancer, which allowed the development of a cervical cancer vaccine that was recently introduced to the market.

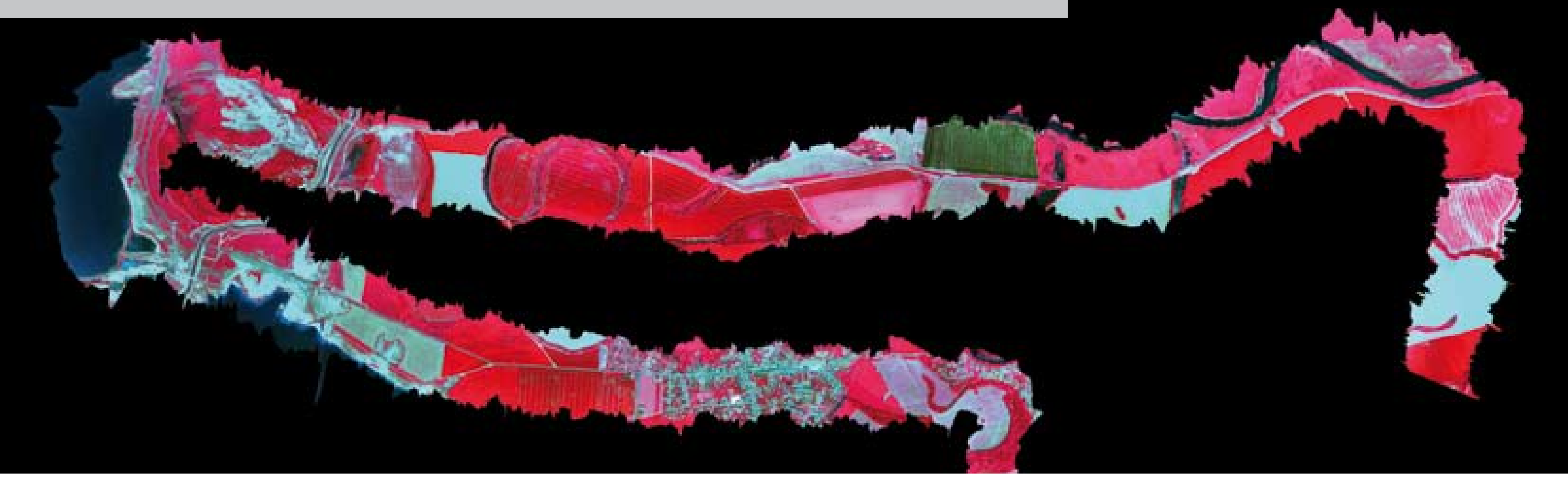
These successes are not a matter of pure chance. They can be attributed first and foremost to the creativity and dedication of our researchers – with the support of optimal research environments equipped with comprehensive infrastructure and technology platforms and research management that sets long-term objectives while giving scientists the freedom to explore new approaches and ideas. As the largest research organisation in Germany, we can draw on a wide range of resources and facilities, and it is our responsibility to ensure that we use them effectively. It is for this reason that we allocate funding on the competitive basis of our programme-oriented funding system. Our Research Fields are subjected to review every five years. Panels of internationally-appointed, independent experts assess the individual programmes according to the quality of their scientific content and their strategic relevance.

Programme-oriented funding

With the beginning of 2008, the programme-oriented funding process entered its second phase, during which the Research Fields Earth and Environment, Aeronautics, Transport and Space, and Health, with a joint total annual budget of 800 million euros, were appraised. All thirteen programmes received high marks from the 169 experts as judged against international standards, and many research topics were even rated excellent. Annual funding increases for our Research Fields are determined by the research policy requirements laid down by our Financing Partners; funding will increase yearly by 2.8 per cent in the Research Field Health (basic funding 2009: 327 million euros), 2.6 per cent in Aeronautics, Space and Transport (227* million euros) and 1.9 per cent in Earth and Environment (251 million euros). Certain individual research projects recommended by the reviewers and deemed of particular strategic relevance will receive a proportionately larger share of the increase.

Programme-oriented funding has enabled the Association to improve its performance significantly, while also clarifying its strengths and objectives. For instance, the strategic initiatives spanning different programmes are a clear success. Thus, in the Research Field Health, there are plans to intensify efforts in translation research, and a cohort study involving 200,000 people is being prepared that will enable scientists to carry

*The recently initiated activities "Space Institute Bremen" and the "Centre of Excellence for Robotics" are not included in this overview. A further 22 million euros will be available for these projects.



AERIAL PHOTOGRAPH OF A RIVER LANDSCAPE NEAR WÖRLITZ, TAKEN WITH A HYPERSPECTRAL SENSOR IN FALSE-COLOUR MODE. Photo: Angela Lausch/UFZ

out epidemiological studies of various diseases and conditions. In the Research Field Earth and Environment, the climate research initiative has been marked out for funding. The Research Fields Energy, Structure of Matter and Key Technologies will be evaluated in 2009.
Consistently revising and improving the programme-oriented funding system, as well as other Helmholtz objectives, through open discussion with the various parties concerned is a key target on the Helmholtz Association's Agenda as laid out in the strategic paper drawn up in 2007.

The Helmholtz Association's Agenda

In September 2008 the Helmholtz Association's Assembly of Members finished its present work on the agenda charting the course for the Association's future. The objectives set out in this document are to be implemented at Helmholtz-Centre level and include:

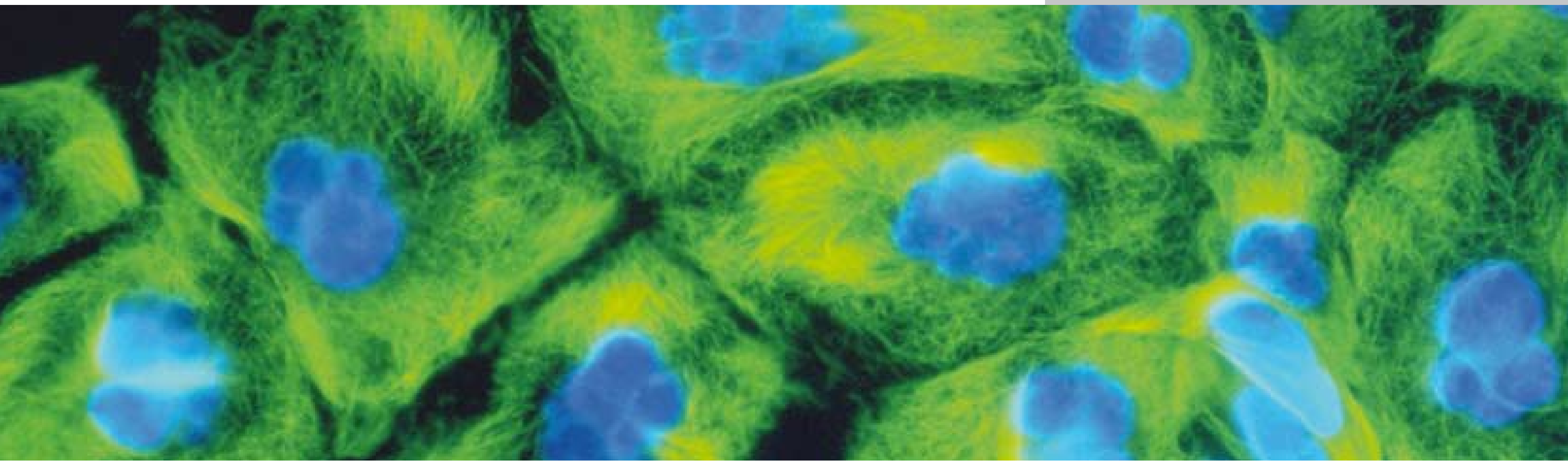
- **Promoting young scientists**
- **Offering all groups of employees prospects for further development and training and an attractive working environment**
- **Building strategic alliances and partnerships with universities and industry**
- **Helping to shape the European Research Area and fostering international cooperation**
- **Improving the transfer of knowledge and technology**
- **Providing expert advice to policymakers and society**

Continuing to increase the quality and relevance of our research is the ultimate aim underlying all objectives on our agenda. To achieve this we not only need excellent scientists; we also need management personnel capable of steering and organising large-scale research projects. Since autumn 2007 our Helmholtz Management Academy offers a specialised training programme for research management. We are also preparing the way for new research-policy initiatives to improve conditions for scientists – we need more autonomy and entrepreneurial freedom! The German Federal Ministry of Education and Research has taken a step in the right direction in launching the initiative on scientific freedom and its Five Point Plan, but is essential that we continue along this road if we are to compete for international talent and resources.

If we are to achieve our goals, the German federal government must honour the pledge it made in the Lisbon agreement to allocate at least three per cent of the national GDP to research and development. We therefore also need to ensure that the current Joint Initiative for Research and Innovation (Pakt für Forschung und Innovation) is extended beyond 2011. Recent increases in labour and energy costs have put a considerable strain on budgets, endangering our capacity to maintain performance at current levels. Only by drawing up a second initiative and securing an associated annual funding increase of at least three per cent can we hope to continue improving our performance and provide the necessary scope for new research projects exploring urgent problems facing society in our time.
Establishing the Helmholtz Association as a strong brand in the scientific community was a further aim defined in the agenda. The Helmholtz Association is not as not nearly as widely known as it should be in light of the fact that it is the largest research organisation in Germany. The good news is that our presence in the media has increased six-fold in the last three years, not least due to the changes in the names of several of our research centres. The GSF became the third Helmholtz Association centre to take this step, adopting the name Helmholtz Zentrum München – German Research Center for Environmental Health at the beginning of 2008. Two more centres announced their new names in June: the German Research Centre for Geosciences is now known as Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, and the former Hahn-Meitner-Institut is now the Helmholtz-Zentrum Berlin für Materialien und Energie. In addition, the Gesellschaft für Schwerionenforschung became the GSI Helmholtz Centre for Heavy Ion Research in October. These name changes reflect the centres' affiliation with the Helmholtz Association, emphasise the focuses of their scientific work and underline their roles as national research laboratories.

Research infrastructure

What sets the Helmholtz Association apart is the wealth of experience in planning, setting up and running large-scale research infrastructures on a large scale that all Helmholtz Centres can draw on. Increasingly these research infrastructures and technology platforms, many of which are unique, are being built up in partnership with other international organisations. One exam-



OPOSSUM CELLS THAT HAVE BEEN TREATED WITH NATURAL EPOTHILONES. Image: HZI

ple is the free-electron laser FLASH, which generates intense pulses of laser light, recently set up at Deutsches Elektronen-Synchrotron DESY. FLASH is paving the way for the building of the European XFEL, which will deliver high-intensity, ultra-short X-rays with the properties of laser light as from in 2013. Work on PETRA III, a new synchrotron source for high-brilliance, short-wave X-rays, is also currently underway at the DESY. Helmholtz scientists are also playing a key role in developing the Large Hadron Collider in Geneva; the Association's various activities are focused within two Helmholtz Alliances.
Work on the GSI Helmholtz Centre for Heavy Ion Research's new Facility for Antiproton and Ion Research, often known simply as FAIR, is also in full swing. Fifteen countries are involved in the project. Researchers at FAIR will use the existing particle accelerators at GSI as "injectors" in order to study materials in conditions similar to those prevailing immediately after the Big Bang and during extreme cosmic events. A new institution for the use of FAIR, the Helmholtz International Center for FAIR (HIC for FAIR), is being established with funding provided by the state of Hesse, university partners and the Helmholtz Association.

Expanding the Helmholtz Association

Germany's Federal Minister of Education and Research, Dr. Annette Schavan, commissioned the Helmholtz Association to set up a new Helmholtz centre for dementia research in December 2007. The Helmholtz Centre for Neurodegenerative Diseases is to be established in Bonn in cooperation with the University Hospital Bonn, the caesar (Center of Advanced European Studies and Research), the Max Planck Institute for the Biology of Aging, the University of Cologne and Forschungszentrum Jülich. In addition to the main location in Bonn, six partner sites are planned in Göttingen, Munich, Tübingen, Magdeburg, Witten and Rostock/Greifswald, which will be affiliated with the universities in the respective cities. In addition, it is planned to grant start-up funding for the establishment of a partner institute in Dresden at some point in the future. The federal government and the seven states involved will provide around 66 million euros in funding for the centre per year.
A national centre for diabetes research is also to be set up with the Helmholtz Zentrum München – German Research Center for Environmental Health as the core institution, with an additional 300 to 400 million euros to made available for the project over the next ten years.
The restructuring of the German research environment is a further factor contributing to the expansion of the Helmholtz Association. Thus in January 2009 the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB, formerly Hahn-Meitner-Institut) will merge with the Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung (Berlin Electron Storage Ring Association for Synchrotron Rays, or BESSY), which will thereby move from the Leibniz Association to the Helmholtz Association. The HZB will operate both the synchrotron radiation facility BESSY II and the neutron source BER II from January 2009, making it easier for external uses to access both systems. The German Council of Science and Humanities has also recommended that the Forschungszentrum Dresden-Rossendorf (FZD) transfer from the Leibniz Association to the Helmholtz Association. The FZD runs the ELBE radiation source, an ion-beam centre and high-field magnet laboratory, making it a perfect addition to the Helmholtz Association.
At the same time we will discontinue one area of work that no longer fits in with our objectives. We have been preparing the Schacht Asse mine for closure since 1995. The Asse has not been used in research on the permanent disposal of nuclear waste for several years now. The German Federal Office for Radiation Protection will now manage the closing of the disposal facility and keep on the current staff of 250 employees, as we will still need skilled staff in this area in the future.

Strategic partnerships

Besides the establishment and incorporation of new centres, new strategic partnerships are a key factor in improving our performance. In signing the Joint Initiative for Research and Innovation, we agreed to consolidate and extend our cooperation and partnerships with universities (see p. 86/87), with the help of our Initiative and Networking Fund. Thus we provide funding, for instance, for 87 Virtual Institutes and seven Helmholtz Alliances. Helmholtz Virtual Institutes are designed to support Helmholtz teams in working with universities on specific issues, fast and with minimal bureaucracy, while Helmholtz Alliances operate on a much larger scale. They have up

to 50 million euros at their disposal over a five-year period and bring together partners from universities, Helmholtz centres and, industry and other research institutions to advance research in new and emerging fields.
In participating in the Excellence Initiative, the Helmholtz Association has proved itself to be an attractive partner for universities and pioneered new forms of research partnerships. In February 2008, Forschungszentrum Karlsruhe and the University of Karlsruhe merged to form the Karlsruhe Institute of Technology (KIT), implementing the future concept which earned the university the designation "elite university" in the first round of the Excellence Initiative.
In addition, Heidelberg University forged an alliance with the German Cancer Research Center to create the ZMBH, a centre for basic and biomedical molecular biology in Heidelberg – a future concept that was successful in the second round of the Excellence Initiative.
Forschungszentrum Jülich entered into far-reaching partnership with RWTH Aachen to create the Jülich-Aachen Research Alliance (JARA), fulfilling one of the objectives of RWTH Aachen's future concept. The alliance involves three areas of research: JARA-BRAIN, for research in translational brain medicine, JARA FIT for research on the fundamentals of future information technology, and JARA-SIM, devoted to research in the simulation sciences. These will soon be joined by a fourth field, energy research.
The Federal Ministry of Education and Research has launched a new programme designed to promote top-level research and innovation in the eastern states. Three of the programme's six pilot projects involve Helmholtz centres. The Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences and the Brandenburg University of Technology in Cottbus have created a focus group for geothermal energy, in which Forschungszentrum Karlsruhe, the Helmholtz-Zentrum Berlin für Materialien und Energie and various energy suppliers will also be participating. The Technische Universität Dresden and the Helmholtz Centre for Environmental Research – UFZ in Leipzig will establish a centre of excellence devoted to water research. The Max Delbrueck Center for Molecular Medicine is in the process of founding an institute for medical systems biology with the Charité university hospital in Berlin and other partners.

Talent management

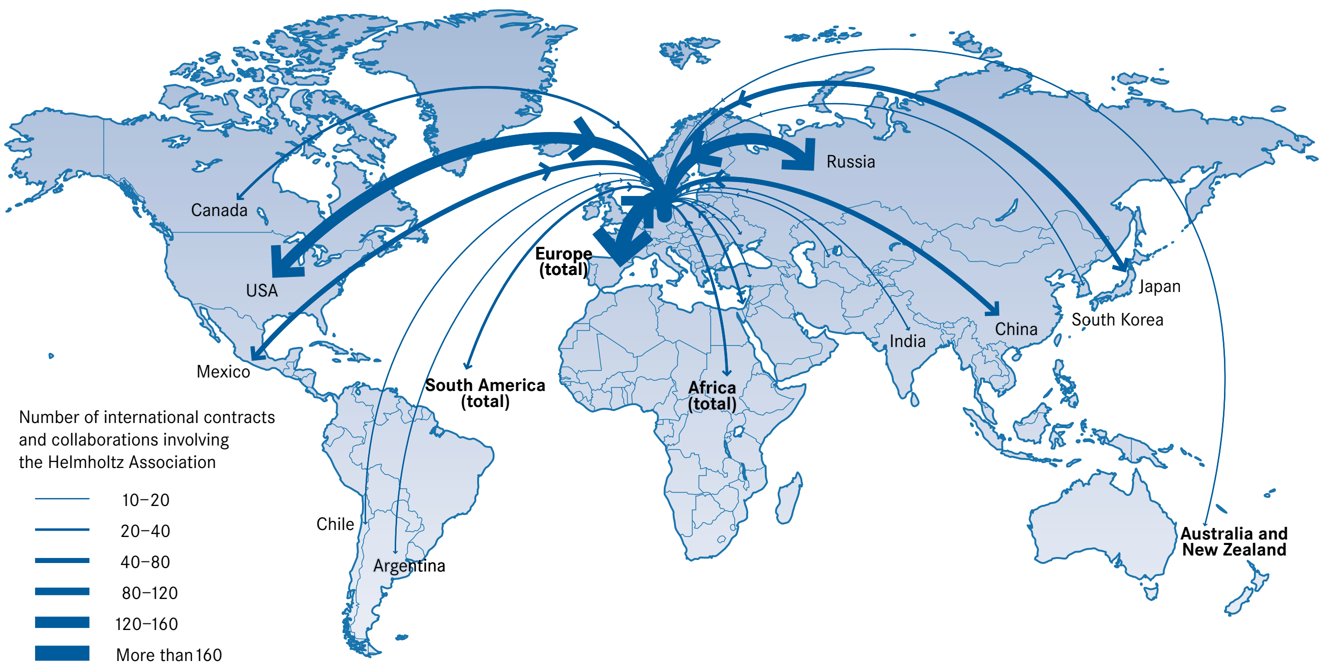
In cooperation with universities, we offer the next generation of scientists intriguing career perspectives, such as the opportunity to head a Helmholtz Young Investigators Group with an option for tenure. We are also collaborating with universities to expand our graduate schools and Helmholtz research schools in order to provide the PhD candidates at all of the Helmholtz Centres, who now number over 4,000, with structured academic training. Employees working in administration and academic research aiming for management-level positions can deepen their knowledge of research management by attending courses at the Helmholtz Management Academy as they continue to work.
We also aim to inspire children and teenagers with an enthusiasm for research and technology. The 23 School Labs at the various Helmholtz Centres are very popular with both pupils and teachers; they welcome a total of around 40,000 visitors every year. The Tiny Tots' Science Corner, a joint initiative of the Helmholtz Association, McKinsey, Siemens AG and the Dietmar Hopp Foundation, has also been very successful. Since May 2008 the Federal Ministry of Education and Research has been providing funding to support the expansion of the initiative under the patronage of Minister Schavan. Around 3,000 day-care centres currently participate in the project, a figure that is set to rise to 10,000 by 2010. Eventually the project is to be extended so that all pre-school children in Germany can benefit from this playful approach to learning about technology and the natural sciences.

We can look back at an eventful and successful year, and I would like to thank all our employees and also the representatives of our Financing Partners, the Federal Ministry of Education and Research, the Federal Ministry of Economics and Technology and the various Länder ministries – for their invaluable support and commitment. For we live in challenging times, and only if we invest more in research and innovation and improve Germany's performance will we be able to compete internationally and contribute to ensuring a secure future, both here in Germany and across the globe. These goals are reflected in our motto for this year "Helmholtz International: Research in Germany – Ideas for the World".

INTERNATIONALISING THE HELMHOLTZ ASSOCIATION

The Helmholtz Association contributes with its research to solving the great and urgent challenges facing governments and societies today. In order to fulfil this mission, the Association needs strong partners in international networks. Examining highly complex systems, developing system solutions and transferring findings into practical applications can only take place effectively today at international level. The Helmholtz Association believes that while partners in international networks must collaborate efficiently, they must also be in competition with one another – and it is the combination of these two principles that enables international research projects to succeed. The Helmholtz Association sees itself as both a partner in international research and as a shaper of international research policy. By collaborating with institutions around the world and especially by playing a leading role in coordinating large international research projects, the Association's Centres make an important contribution to sustaining and increasing Germany's attractiveness as a centre for research and innovation.

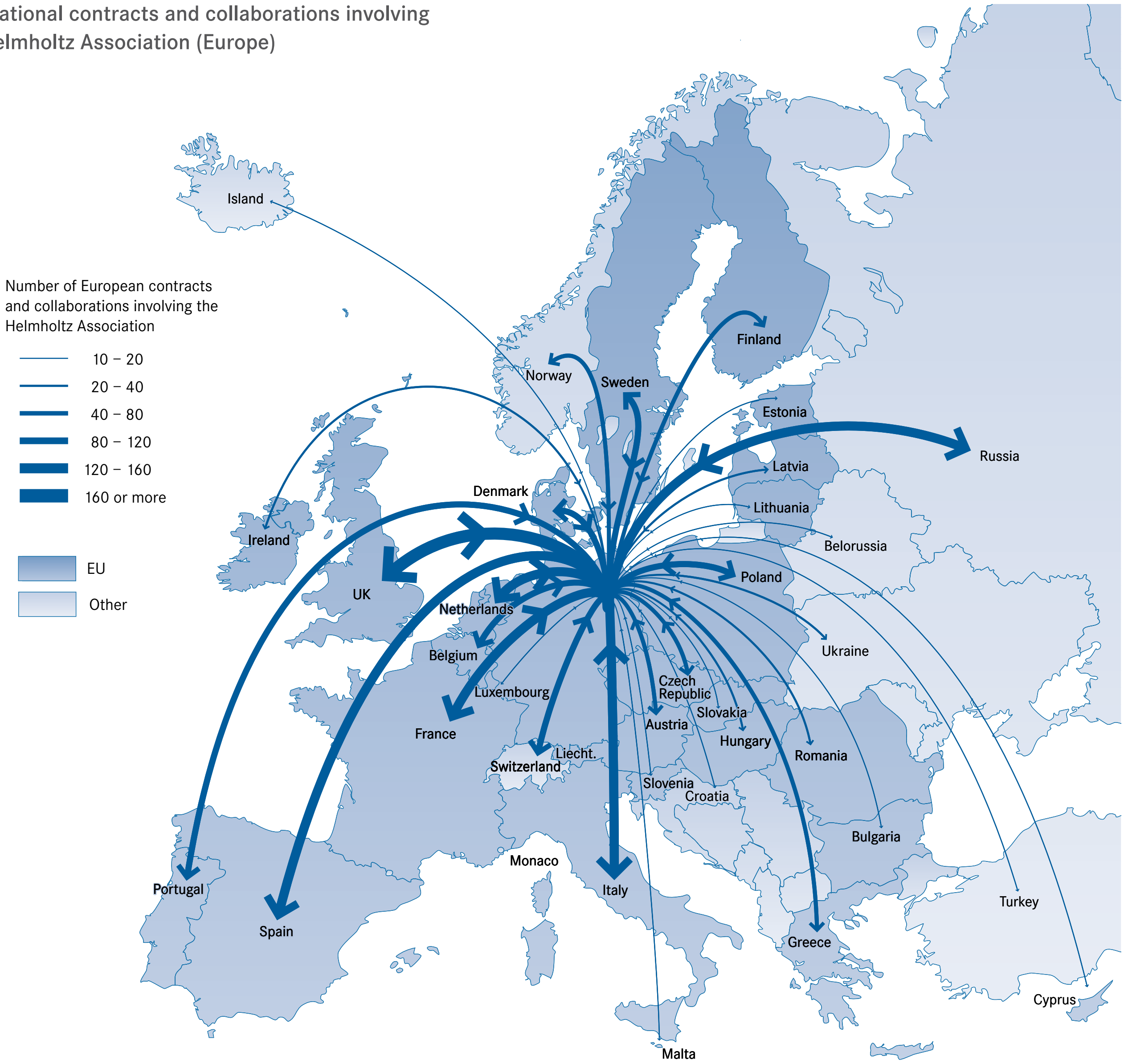
International contracts and collaborations involving the Helmholtz Association (worldwide)



The centres of the Helmholtz Association are involved in over 3,000 scientific contracts and collaborations in nearly every country of the world. Most of these take place in the European Union, the United States, Russia and China. The figures given in the overview compare the number of projects per country (see also p. 13).*

* As of 2007. Numbers are approximate and may contain errors, since not all Centres assign projects in the same way. Due to its complex organizational structure, no detailed information is included for the German Aerospace Center.

International contracts and collaborations involving the Helmholtz Association (Europe)



The Association has a long history of all types of scientific collaboration with countries in Western and Central Europe. Improving its scientific relations with Russia and the new EU Member States in Eastern Europe has been a more recent focus.*

International collaboration opens up more opportunities in basic research, promotes the exchange of ideas, and develops technologies that prosper in their respective markets. Just as importantly, it helps develop standards and enables the collaborative implementation of large-scale experiments and the shared use of high-performance infrastructure. The Helmholtz Association strives to provide international exposure for the excellent research and unique research infrastructures of the Association, to promote and recruit outstanding young researchers and well-established researchers alike and to raise the profile of the Association internationally.

Helping shape research communities in Germany, Europe and around the world

The Helmholtz Association has shown on many occasions that it is well equipped to supervise international research projects. It is well on its way to cementing its already strong reputation for scientific collaboration at the European and global level. As it approaches that goal, it should focus on topics which will benefit particularly from work-sharing and where the complementary know-how of the international partners can best be exploited. Another important point will be to define its focus regions. The Helmholtz Association concentrates on the United States, France and the UK as partner countries and India, Russia and China
as target regions. The Helmholtz-Russia Joint Research Groups and the joint doctoral programme with the China Scholarship Council are examples of international lines of funding which demonstrate the Association's focus on these regions. Jointly-funded programmes like these set standards for the future of international collaboration. Rallying international partners behind projects such as the Helmholtz Alliances and the Virtual Institutes provides a basis for major international collaboration projects. Discussions surrounding the European Research Area and preparations for the Eighth Framework Programme for Research are making the European Research Area a more tangible reality. This will be a chance for the Helmholtz Association to become a major influence, as will the Association's role in defining projects for ESFRI. Other activities influencing research in Europe include the European Technology Platforms, the Joint Technology Initiatives, and the European Technology Institute, which will further integrate education and innovation.

The Helmholtz Association's international programmes for young talent

Autum School about Application of Neutrons and Synchrotron Radiation in Engineering Materials Science I Berlin School on Neutron Scattering I DAAD CAPES Exchange Programme (Germany-Brazil) IDAAD RISE (Research Internships in Science and Engineering) I Dubna Summer School I EFDA Goal-Oriented Training Programme I ERCA (Educational Research Center of America) I European Fusion Education Network (FUSENET) I EU Training Networks: BIOCONTROL, COSY and EUROMEMBRANES I ESSRES: Helmholtz Earth System Science Research School I German-French Summer School: Analysis in Art with Radiation I German Research School for Simulation Sciences (GRS) I Helmholtz Fellowship, Moscow Institute of Physics and Technology (MIPT) I Helmholtz- DAAD Fellowships I Biosoft - International Helmholtz Research School on Biophysics and Soft Matter I Helmholtz International Research School for Infection Biology I Helmholtz Research School for Quark Matter Studies in Heavy Ion Collisions I Helmholtz Interdisciplinary Graduate School for Environmental Research I Helmholtz Graduate School for Molecular Cell Biology I Helmholtz International Graduate School of Cancer Research I Helmholtz Graduate School for Polar and Marine Research I Helmholtz Graduate School for Hadron and Ion Research I Helmholtz Graduate School for Infection Research I Helmholtz International Research School in Molecular Neurobiology I Helmholtz International Research School in Translational Cardiovascular and Metabolic Medicine I Helmholtz-Russia Joint Research Groups (HRJRG) I Helmholtz-China I Scholarship Council Exchange I Helmholtz Space Life Sciences Research School I International Doctoral Programme Cracow I International Doctoral Programme Shanghai I International Exchange Programme of the Research Centre Jülich and the American Nuclear Society I International Max Planck Research School "Bounded Plasmas" I International university course in Neutron Scattering I International Summer School I MARBEF – LargeNet Workshop on long term ecological observation I MARBEF – Summer School on Diversity and Functioning of Coastal Habitats I Marie Curie Research Training Network – HYTRAIN I Project of the German-Israeli Foundation (GIF) I Summer School on Diversity and Functioning of Coastal Habitats I Summer School on Persistent Pollution, GKSS Institute for Coastal Research

The best minds win

Whether or not the Helmholtz Association shines on the international stage will depend on whether we succeed in the following crucial areas – attracting talented young people to the world of research, involving them in research processes, developing their talents, offering them excellent career options, and creating a work environment that attracts the cream of the international research community.

The Association intends to achieve the following goals:

IMPROVE FRAMEWORK CONDITIONS FOR RESEARCH IN GERMANY

The Helmholtz Association is committed to improving framework conditions for scientists. One way to do this is to establish tenure track positions for outstanding young talent. Scientific organisations must be given the freedom to pay internationally competitive salaries and create the conditions required to attract the best scientists from at home and abroad. While many of the changes that must take place for this to happen must occur at the political level (by lowering visa restrictions and improving labour market access and social safety nets, for instance), the Centres themselves can also take action to improve the conditions they provide.

STRENGTHEN THE INTERNATIONAL FOCUS OF SCIENTIFIC TRAINING IN THE ASSOCIATION

With over 4,500 guest scientists from abroad working at its partly unique research facilities, the Association already has a strong international focus. It recruits doctoral students, established researchers and leaders for its Young Investigators Groups from all around the world. It will broaden its work in this area in the future. The Association has already taken a

"The Brussels Office sees itself as a guide at the European level. It helps support the development of the Helmholtz Association's research and business activities as the Association contributes to the creation of a European Research Area that will maintain and strengthen Europe's scientific, technological and economic competitiveness."

DR. SUSAN KENTNER Director of the Brussels Office

"The office in Beijing represents the interests of the Helmholtz Association in China. Its job is to facilitate contact with scientific partners, support scientific projects with China and improve scientific exchange. More specifically, we help Chinese scientists take advantage of fellowships and project funds to make it easier for them to do research in Germany, and we also help German researchers in China."

DR. HONG HE Director of the Beijing Office

"The Helmholtz Association chose Russia to be one of its strategic partners because it believes that our combined scientific collaboration will help us face the challenges of the future and create new strategic networks of scientific excellence. By functioning as a contact for both Helmholtz scientists and Russian researchers, the Moscow Office helps bring people together and identify new programmes and projects."

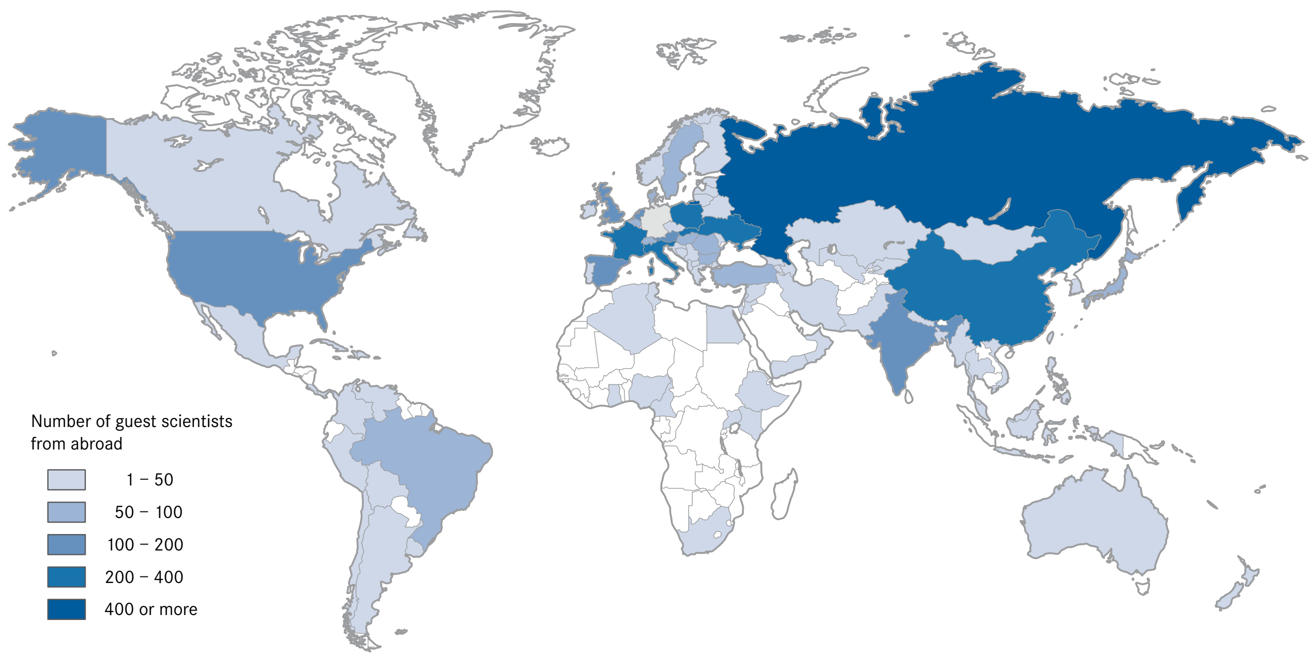
DR. BERTRAM HEINZE Director of the Moscow Office major step in this direction by introducing international standards for doctoral training. By setting up international research schools and graduate schools at its centres and making English the language of instruction they are able to attract graduates from all over the world.

Raise the international profile of the Association

The Helmholtz Association's Centres are known around the world for excellent working conditions, outstanding research and partly unique research infrastructure. They play a leading role in a large number of international collaborations and head the consortia for many EU research projects. Doing so helps further boost the profile of the Helmholtz Association and extend its influence at the EU level. For this to work well, we must create and develop the Helmholtz brand and increase the systematic presence of the Association in international bodies through the membership of our executive directors and finest scientists in such bodies. We must also define our strategic partner organisations[1] and establish international foresight conferences.

[1] Organisations with a similar range of activities and interests include CEA, ROSATOM and the Chinese Academy of Science: Future partnerships will also include individual institutions such as Imperial College, MIT and ETH.

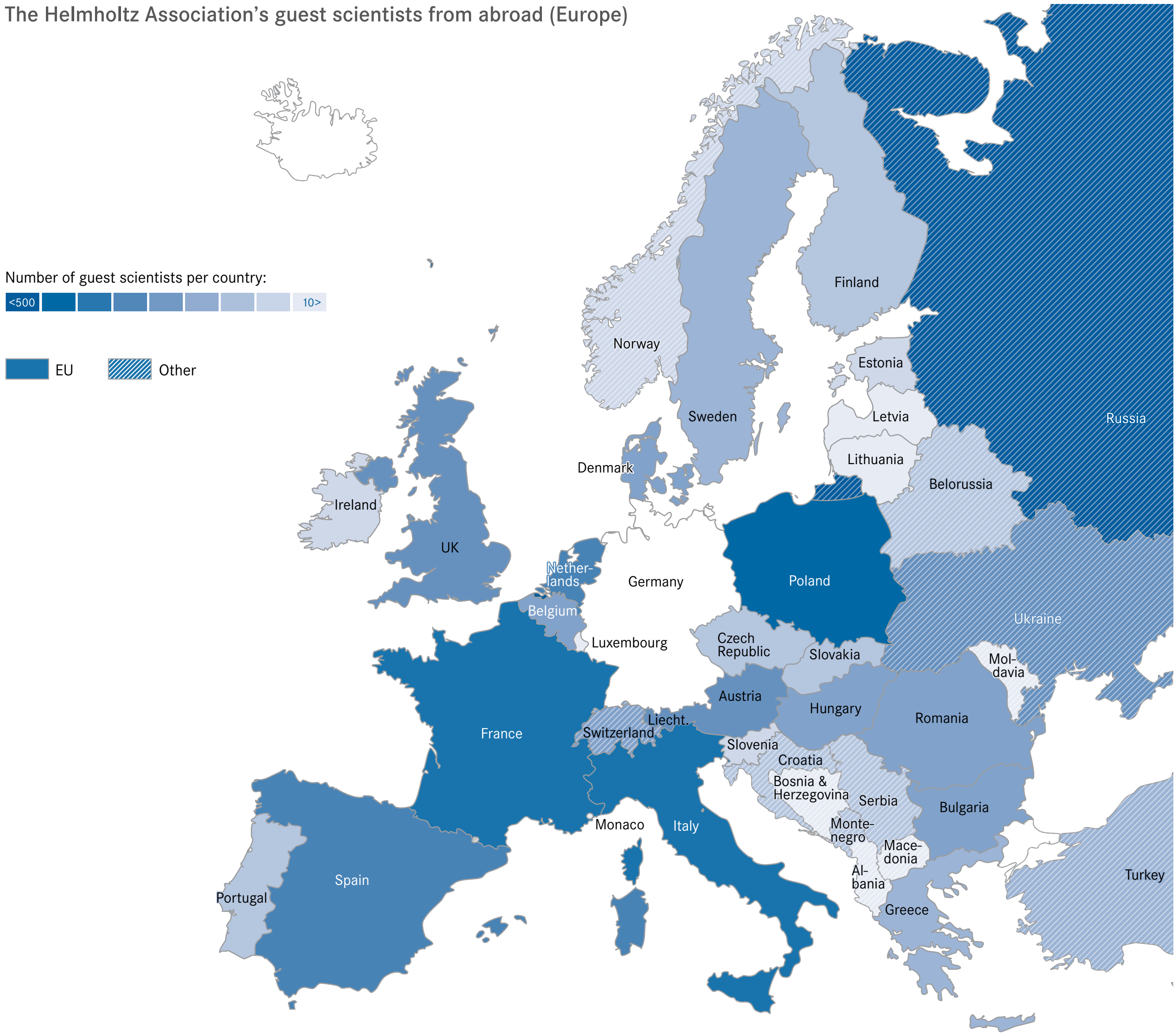
The Helmholtz Association's visiting scholars from abroad



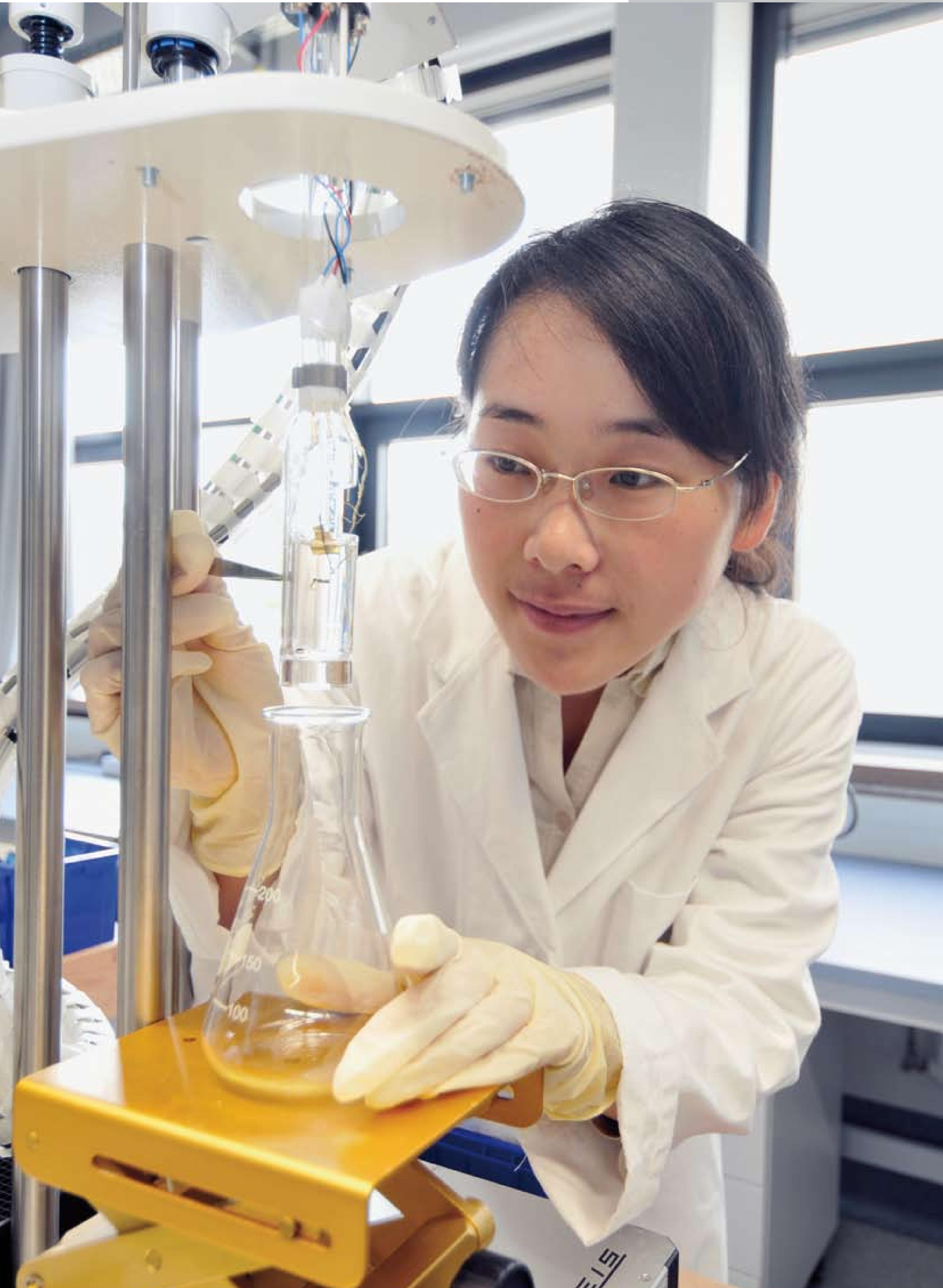
Helmholtz Centres host around 4,500 guest scientists each year. A majority of these scientists who make use of Helmholtz's unique research infrastructure come from Russia, Poland, China, India and EU countries such as France and Italy (see also p. 17).*

* See notes on page 12

The Helmholtz Association’s guest scientists from abroad (Europe)



Most European guest scientists at the Helmholtz Association’s 15 Research Centres come from Russia, Poland, France, Italy, Spain, the Netherlands and the UK.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RESEARCH IN INTERNATIONAL NETWORKS

International collaboration is essential, especially in top-rate research. Helmholtz-scientists collaborate with partners from around the world to help answer the most pressing questions of our time.

RESEARCH FIELD ENERGY

GOALS AND ROLES

The Helmholtz scientists and researchers working in the Research Field Energy see their core responsibility in reconciling the need to provide a sustainable, secure and economic supply of energy with the necessity to protect our climate, environment and natural resources. This objective also influences the scientific questions that are addressed in the projects and the strategic focus of the research. The aim is to satisfy the energy needs of present and future generations by developing new technologies, by drawing up national supply strategies, by paving the way for economically competitive innovations, and by making the disposal of wastes safer. The coming years will generally see energy research at the Helmholtz Association using its scientific competence to prevent foreseeable global energy bottlenecks and so secure the future development of the national economy. This requires effective concepts for peaceful and sustainable development in all the world's regions.

With this goal in mind, scientists and researchers are exploring the potential that lies in renewable energies, such as solar energy, biomass, and geothermics. They are increasingly making conventional power stations more efficient and are developing ways to use energy more efficiently. The Descartes Prize of the European Commission that was presented to the DLR and its partners for the HYDROSOL project 2007 demonstrated how society recognises the successes that have been made in this field. This project succeeded in using solar energy to split water into hydrogen and oxygen – without producing any carbon dioxide emissions.

The research done on generating power through nuclear fusion will open up a new source of energy in the long term. This approach presents a major challenge for big science and big industry, that key players are pursuing in a spirit of international collaboration. The Helmholtz Association is playing its part by contributing its unique know-how and expertise in nuclear safety research to ensure that the nuclear reactors continue to operate safely and to guarantee that the highly radioactive wastes are treated and disposed of safely. Besides the wide range of research activities that Helmholtz scientists engage in, structural developments are taking place within the Helmholtz Association itself that will also strengthen and consolidate the field of energy research. The creation of the Karlsruhe Institute of Technology, in short KIT, through a merger between the University of Karlsruhe and the Forschungszentrum Karlsruhe, under the Excellence Initiative, marked a great success. Now, it has set itself the goal, besides many others, of transforming the newly-founded KIT-Zentrum Energie into Europe's leading energy research centre. The Forschungszentrum Jülich and the RWTH Aachen have pooled their respective competencies and are introducing these into JARA-ENERGY, the Jülich-Aachen Research Alliance JARA. Its goal is to create a pioneering international research partnership so that new energy solutions can be developed in a cross-disciplinary and cross-departmental approach. And, finally, the field of solar energy research is being given an even stronger base with a new Centre of Excellence for Thin-Film and Nanotechnology for Photovoltaics in Berlin, established by the HZB in cooperation with industry and the TU Berlin.

Under the system of programme-oriented funding, scientists and researchers from the Research Field Energy subject their research findings to five-yearly quality check. The review process that takes place with a panel of international experts will set the strategic focus for the research field and its programmes in the first half of 2009. The research field will then enter the second period of programme-oriented funding on 1 January 2010.

"A sustainable energy supply is still far from secure. This is why we now have to develop new, reliable and climate-friendlier energy sources as cost-effectively as possible, why we have to use fossil and nuclear energy sources as safely and as cleanly as possible, and why we have to make the conversion and use of energy as efficient as possible."

PROF. DR. EBERHARD UMBACH Helmholtz Vice-President representing the Research Field Energy, Forschungszentrum Karlsruhe

PROGRAMME STRUCTURE

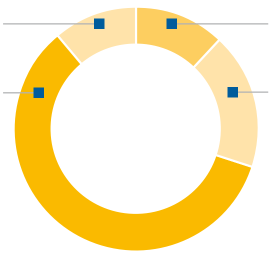
Six Helmholtz Centres are currently working together at the Research Field Energy of the Helmholtz Association: Deutsches Zentrum für Luft- und Raumfahrt (DLR), Forschungszentrum Karlsruhe (FZK), Forschungszentrum Jülich (FZJ), Helmholtz-Zentrum für Materialien und Energie (HZB), Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, and the Max Planck Institute for Plasma Physics (IPP) as an associate member of the Helmholtz Association. In the course of planning for the coming period of programme-oriented funding, the Helmholtz Centre for Environmental Research – UFZ will start doing research in the energy field as from 2010. The scientists and researchers have been working in four research programmes to date, with a fifth to follow in the future:

- Renewable Energies
- Efficient Energy Conversion
- Nuclear Fusion
- Nuclear Safety Research

The next period of programme-oriented funding will also see the new programme on Energy Systems Analysis introduced as part of the multidisciplinary cross-research-field programme on Technologies, Innovation and Society. The programmes will be driven forward by interdisciplinary research groups working in a spirit of international collaboration. Excellent research infrastructures, test plants and facilities for large components, high performance analysis systems and extensive computing capacities are available for this. Selecting research topics in the research groups also considers the distribution of tasks that has been agreed with partners from science and industry as well as between these groups. The dialogue between the umbrella organisations of industry and science has reached a consensus view, namely that no relevant energy option can be abandoned in the present situation. Only then can the power-generating industry master the three central problems: dwindling resources, potential risks of waste disposal and the climate problem.

Structure of the Research Field Energy
Core-financed Costs 2007: € 236 million

The Research Field Energy additionally receives € 122 million euros of external funds a total budget of € 358 million.



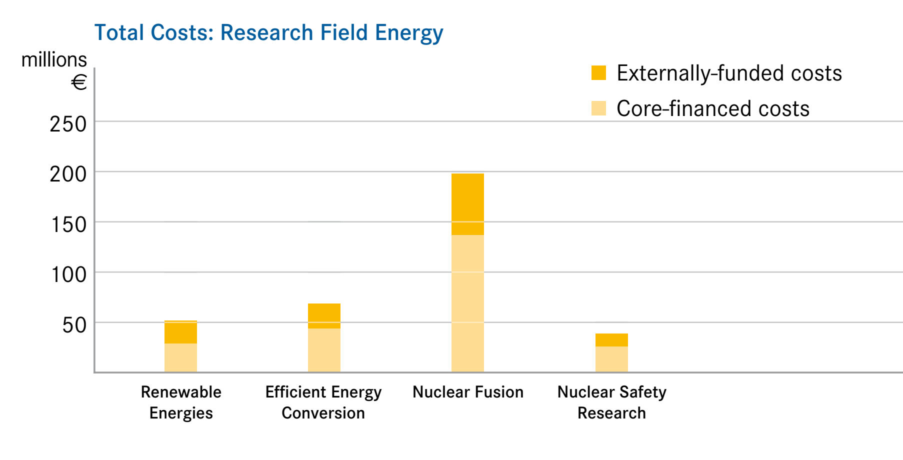
THE PROGRAMMES

Renewable Energies

Renewable energies using wind, the sunlight, geothermics or biomass are key options for a sustainable energy supply of the future, since they are inexhaustible and climate friendly. Further research not only has to develop new technologies, but to focus especially on reducing the costs of energy. Photovoltaic solar power generation is currently experiencing rapid growth. Several solar companies based on technology and know-how from the Helmholtz Centres are being established. The improvements to thin-film photovoltaics that result from Helmholtz research will use the full potential of this innovative technology and significantly reduce the cost of generating solar power.
The remarkable boom in the field of solar-thermal power stations has essentially profited from work done in the Helmholtz Association on advancing and testing novel and innovative components in the major test plant in Almería, Spain. Further developments aim to reach higher temperatures, to develop novel thermal energy accumulators and, in the long term, to chemically store the solar energy. In the field of deep geothermics, namely at depths of between 3,000 m and 6,000 m, the main objective is to intelligently combine power generation and thermal exploitation. Researchers are currently working on how to make efficient use of the existing hot water reservoirs and on how to exploit the hot rock layers with a stimulated water exchange system.
A systems analysis process uses technical, economic and ecological criteria, in particular to assess technologies suitable for using renewable energies. The knowledge and insights gained with this work are fed into scenarios for a future energy supply system and so contribute to an objective discussion on possible options for future energy sources and supplies.
Biomass stores solar energy and plays a special role in its capacity as the only renewable carbon resource. Biomass is not only suitable for generating heat and electricity, but also and above all for producing chemical raw materials and fuels. While other Helmholtz Association programmes are currently studying the sustainable use of biomass, this will become part of the „Renewable Energies“ research programme as from 2010.

Efficient Energy Conversion

Fossil energy sources like petroleum, natural gas or coal will continue to play a predominant role in the energy supply for decades to come. In addition, a substantial proportion of the future alternative energy sources, such as synthetic gas or synfuels made of biomass, will be converted into electricity in power station processes or will be used as fuels. Great potential savings can be made here by raising the efficiency of the conversion technologies. This provides the foundation for the work done by the Efficient Energy Conversion programme. The scientists investigate new technologies for power stations and fuel cells and examine the application of superconductors in the power industry. Further important topics include new materials, better solutions for high-performance gas turbines and carbon capture, also known as sequestration, for example. Particular investments are being made on developing fuel cells for stationary and mobile applications. In the field of stationary applications, work concentrates above all on Solid Oxide Fuel Cells (SOFC), while mobile applications include Polymer Electrolyte Fuel Cells (PEMFC and DMFC). Highly promising developments are also to be seen in developing superconducting current limiters and superconducting components for the power grid which make it possible to transmit electricity practically loss-free.



Nuclear Fusion

Nuclear fusion is a prime example of forward-looking strategic research. A demonstration power station could generate electricity in around 25 years, and the first fusion power stations could come on line as from the second half of the present century, thereby permanently solving some of humankind's energy problems. Research and development are working closely together with national and international partners. For example, fusion research done at the Helmholtz Association is part of an overarching European fusion programme. The German fusion programme is coordinated by the "Entwicklungsgemeinschaft Kernfusion", in which three Helmholtz Centres are represented. The research priorities for work in the Helmholtz Association that have been agreed with international partners are: participation in the creation and later operation of ITER, the large-scale Tokamak experiment, and the creation and operation of the European-supported, German Stellarator experiment WENDELSTEIN 7-X. Tokamak and Stellarator are two different concepts for confining hot fusion plasma in a magnetic field. ITER will demonstrate that generating power by means of fusion is technically feasible. The experiment will additionally deliver the data needed for building a demonstrator power station. The stellarator experiment WENDELSTEIN 7-X will aim to show that the stellarator concept is suitable for a fusion power station. To support this master plan, the Helmholtz Association is carrying out further experiments, is developing the associated theory, and is working on new technologies. For example, plasma-wall heating is being studied, high-performance plasma heating is being developed, and new materials are being explored in order to prepare components for a demonstrator power station. Recently, the ASDEX Upgrade was commissioned as the world's first divertor fusion plant with a wall made of tungsten tiles.

Nuclear Safety Research

In 2007, nuclear power stations generated 140.5 billion kWh of power in Germany, thereby covering 22.1 per cent of the power demand in total and 45 per cent of the base load demand. This demonstrates why research on the safety of nuclear reactors and on the safe disposal of nuclear wastes is indispensable. And that holds true for the future as well. In Germany, a strategically-planned, forward-looking research policy includes the necessity to maintain nuclear technology know-how for decades to come, even if the decision to abandon nuclear energy is upheld. The work done by the Nuclear Safety Research Programme at the Helmholtz Association serves to ensure that Germany has a broad base of expert technical and scientific knowledge of international standing available to it in all areas relating to the safety of nuclear reactors and nuclear waste disposal and that German researchers play a key part in all relevant international projects and decision-making bodies, and actively contribute to these. The Südwestdeutsche Forschungs- und Lehrverbund Kerntechnik was founded in October 2007. Partners in this network will work to expand the research and teaching done on nuclear engineering and will concentrate their capacities. Similar cooperation is being prepared in North Rhine-Westphalia.

PROJECTS

Helmholtz-Zentrum Berlin für Materialien und Energie

NEW SOLAR CELL TECHNOLOGIES MAKE SOLAR POWER MORE ECONOMICAL

The researchers at the Helmholtz-Zentrum für Materialien und Energie are modest optimists. They capture the sunlight as efficiently as possible and don‘t overdo it: literally. The thin-film solar cells that Professor Martha Lux-Steiner and her colleagues are studying form the basis for the next generation of photovoltaics. The new solar cells are much thinner than the conventional silicon solar cells, while providing almost the same efficiency. The light absorbing films measure only a few hundredths of a millimetre, meaning they are around a hundred times thinner that the conventional silicon cells. That is an advantage: less material and energy consumption, less complicated production processes, more versatile applications. And the solar power becomes cheaper as well.

> "The cost of peak output has to be noticeably reduced, in the long term we want to cut the price to less than half a euro."

A kilowatt hour of solar power currently costs 30 cents, even in sun-spoilt southern Europe. Despite record oil prices, that is still many times more than the cost of generating power from fossil fuels. If all the costs are included in the reckoning, then each watt of installed solar power capacity costs around five euros today. "This price for the so-called peak output still needs to fall markedly," says Lux-Steiner, "that is the key challenge! In the long term, we want to reduce the costs for modules to less than half a euro per watt." On average, the cells only convert one eighth of the sunlight into electricity. Reducing costs therefore primarily means substantially increasing the yield. However, optimising the production process and raising the output of units lowers the price for a solar kilowatt hour. To achieve this, development work has to be carried out across a broad front and then has to be transferred into industrial production as quickly as possible. A tough task. That is also reflected in the name given to the international research project that aims to achieve just this: ATHLET stands for "Advanced Thin Film Technologies for Cost Effective Photovoltaics". Led by the Helmholtz Team under the direction of Martha Lux-Steiner, scientists from 23 institutions in the field of research and industry across the whole of Europe have joined forces. The four-year project that has received some 11 million euros from the European Union since 2006 is very successful.

> "Our vision is a factory into which the substrates are fed and from which solar modules emerge and only have to be cut to size."

"Initially, however, all those involved had to take a leap of faith," recalls Lux-Steiner. For ATHLET unites two core technologies whose representatives previously saw themselves in healthy competition with each other. Thin-film solar cells made of chalcopyrites (CIS-films) and thin-film solar cells made of micromorphous silicon. On the one hand, the ATHLET researchers are optimising the CIS thin-film solar cells. These have films made of copper, indium and selenium or sulphur that are particularly efficient in converting light into power. The technology is already used in industrial production. Now, the "ATHLETs" are researching better materials for linking up the cells so as to once more raise the power output. Similarly, new and simpler production processes are to be developed for coating the cells. "Our vision is a factory into which substrates of several square metres in size are fed and from which solar modules emerge. These would only need to be cut to size in accordance with the required wattage," says Dr. Volker Hinrichs, who is coordinating the project at the Helmholtz Centre together with Martha Lux-Steiner. So-called micromorphous thin-film solar cells are also highly promising in which two thin silicon films are layered on top of each other. The trick is that the "tandem cell" then absorbs two different ranges of the solar spectrum and so generates more power. "We can achieve an energy yield of up to 40 per cent," explains Lux-Steiner.

SOLAR CELL RESEARCH AT THE HELMHOLTZ-ZENTRUM BERLIN IS WORKING ON TWO NEW TECHNOLOGIES IN THE EU-NETWORK ATHLET. PHOTO: HZB

So far, however, this has only been achieved in the lab. So, the scientists have to continue working on this flat out before they manage to achieve such output in practice as well. But they also achieve milestones on the way to their ultimate goal. For example, the researchers have already substantially improved the production process, with the result that hardly any toxic wastes are left. RANTY ISLAM

Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences

EARTH'S GEOTHERMAL RESOURCES

The whole of Iceland uses geothermal energy for heating, while five geothermal power stations generate around 20 per cent of the electricity. However, what is relatively easy on volcanic Iceland is a technical challenge in Central Europe. The boreholes have to be more than 4 kilometres deep before enough heat can be developed to drive a geothermal power station. "Geothermics could contribute more to the energy supply if we could manage to solve the technical problems and reduce the development costs," explains Dr. Ernst Huenges, Head of the Geothermics Section at the GFZ.

> "Geothermics could contribute more to the energy supply if we could manage to solve the technical problems and reduce the development costs."

This is why the GFZ has established a geothermics lab in Groß Schönebeck, the only one of its kind in the world. The geological conditions here are typical for large parts of Central Europe. Water-bearing rock layers with temperatures between 100 and 200 degrees Celsius are found here at a depth of between 4,000 and 5,000 metres. The two exploration boreholes extend 4,300 and 4,400 metres respectively into the earth's inner regions. The first borehole serves to transport hot water up to the surface in order to drive the turbines of the planned experimental power station, while cooled water is then pumped down into the subterranean surfaces again through the second borehole. Several sets of experiments previously created some artificial fissures in the rock through which the deep water can flow and absorb the heat. "This stimulation method enables us to raise the productivity of the geothermal deposits," explains Huenges. Geoscientists from several European partner countries are now developing new methods in the I-GET (Integrated Geophysical Exploration Technologies) project to precision locate suitable geothermics sites – without first having to drill any expensive test boreholes. They study the depth structure of the earth's crust with seismic and magnetotelluric measurements. This enables them, for example, to determine the distribution of electrical conductivity in the subterranean bedrock, which serves as an indicator for deep-lying, water-bearing layers. "This work is clearly moving the technology forward so we will also be able to make broader use of it in Europe in the future," says Huenges. ARÖ

PIPES ARE NEEDED FOR THE LONG-TERM STABILISATION OF DRILL HOLES THAT ARE SEVERAL KILOMETRES DEEP. Photo: GFZ

THE IPP PHYSICISTS COMMUNICATE WITH THE JAPANESE TEAM VIA A COMPUTER MONITOR. PHOTO: IPP, PETRA NIECKCHEN

Max Planck Institute for Plasma Physics (IPP)

MICROWAVES STABILISE THE FUSION PLASMA

In December 2007, the control commands for the Japanese fusion plant JT-60 Upgrade at the Naka Fusion Institute originated from the faraway Max Planck Institute for Plasma Physics (IPP) in Garching, Germany. Working together, the teams aimed to overcome plasma turbulence. This is necessary because before atomic nuclei can be fused in a fusion power station to generate power, the fuel – a hydrogen plasma – first has to be heated up to ignition temperatures of more than 100 million degrees. To be able to retain the high temperature, the plasma has to be confined in thermal-insulating magnetic fields. The complex interplay between plasma particles and magnetic cage can cause a whole series of instabilities. Particularly unwanted effects include the so-called “neoclassical tearing modes”: In large plants, like the international test reactor ITER or a later power station, such effects could severely reduce the power output.

> “We carried out the German-Japanese test series to determine how much microwave output is at least needed to stop the plasma instabilities.”

In fact, countermeasures had already been developed several years ago at the ASDEX Upgrade plant in Garching. Scientists there are combating the unwelcome plasma turbulence by means of microwaves that specifically heat up specially targeted critical areas in the plasma. The transcontinental Japanese-German test series now aims to directly compare the plasma‘s behaviour in the JT-60 Upgrade with that in the Garching plant. “In so doing, we wanted to determine how much microwave output is at least needed to break up the plasma instabilities,” explains Professor Hartmut Zohm from the IPP. In Garching, scientists, including doctoral student Laura Urso from Italy, had programmed some plasma discharges for the JT-60 Upgrade. On the day of the experiment, the physical parameters were sent to Japan via a secure data line and were fed into the plant‘s computer system in Naka. “We were immediately able to use the recorded gradients to judge the triggered discharges that were shown on the monitors in Garching, could then compare these with our expectations and make corrections for the next round of discharges,” describes Laura Urso.

> “The experiments worked as well as if we had been physically present on site. This kind of international collaboration will certainly become more important in the future, for example with ITER.”

Via video conference, the scientists were also personally in contact with the Japanese team. “The experiments worked as well as if we had been physically present on site. This kind of international collaboration will certainly become more important in the future, for example with ITER.” Parallel to these experiments, the scientists at the ASDEX Upgrade are working on improving the methods and on adapting these to the special conditions for ITER. To this end, the Russian company Gycom developed a microwave transmitter for the ASDEX Upgrade with two frequencies, and with three more multi-frequency tubes expected to be added soon. In contrast to the present transmitters with a fixed frequency, the frequency will now be variable. So, the frequency dependent resonance of the microwaves with the magnetic field will make it possible to reach any desired position in the plasma with the microwave beam. “Wherever a plasma disturbance occurs,” says Zohm, “it can be targeted and then broken up.” The results flow directly into the Advanced Microwave Heating for ITER (Advanced ECRH for ITER) at the Helmholtz Virtual Institute “Fortschrittliche Mikrowellenheizung für ITER” headed by the IPP. Partners are the Forschungszentrum Karlsruhe, the Universities of Stuttgart and Karlsruhe, the Russian Academy of Sciences in Nizhny Novgorod, and the Institute of Plasma Physics, Milan. “According to the current plan the microwaves for ITER will still come from single-frequency transmitters,” explains Hartmut Zohm, “while antennas that mechanically control the microwave beam will be used to transport these into the plasma.”

A development towards more flexibility – as in the case of the ASDEX Upgrade – would promise great benefits, however. This is why the Virtual Institute is working on a multi-frequency transmitter for ITER. A prototype ultra quick, non-mechanical switch for the powerful microwaves has already proven itself. “This then enables the German fusion programme to lead the way in advancing one of ITER‘s key auxiliary systems,” believes Zohm. Multi-frequency transmitters are already being developed for the ASDEX Upgrade; the experience with the microwave device for Wendelstein 7-X, which is comparable in size and frequency to the ITER system, will be valuable for ITER. And this, in turn, will strengthen the role of the German scientists at ITER – not only during the construction phase, but also once the plant is running. Because that is when the microwave experiments will be of decisive importance to the success of the whole project. ISABELLA MILCH

Deutsches Zentrum für Luft- und Raumfahrt

USING SOLAR HEAT IN A WIDE VARIETY OF WAYS

In human terms and dimensions, solar energy is inexhaustible, and yet its technical application is not yet fully matured. “We need intelligent solutions so that we can generate power around the clock and can also store the energy efficiently,” says Professor Robert Pitz-Paal, Head of Department Solar Research at the Institute of Technical Thermodynamics, German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt – DLR). DLR experts are working flat out on these solutions in several EU projects. They have helped to build the largest European test facility on a 100 or so hectare site on the Plataforma Solar in Almería in South-Eastern Spain which the Spanish partner organisation CIEMAT is meanwhile running. They are testing new components here to either convert sunlight into electricity or to store the solar energy, for example, in the form of hydrogen. To this end, DLR experts and their European partners have jointly developed the hydrogen reactor called Hydrosol that continuously and extremely efficiently uses the Sun’s heat to split water into hydrogen and oxygen. A solar-hybrid gas turbine has meanwhile become operational. DLR researchers developed the test facility in cooperation with

> “We need intelligent solutions so that we can generate electricity around the clock and also store the energy efficiently.”

eleven international partners working under the EU project Solhyco and have now installed it on the solar tower CESA-1. An array of mirrors directs the sunlight onto three solar receivers that gradually heat the compressor air of the 250 kilowatt gas turbine up to 800° Celsius. Only when needed does the turbine‘s biodiesel driven combustion chamber step in so that electrical energy can be generated regardless of time of weather. “These tasks were very demanding,” says Pitz-Paal, “but our scientists eventually solved them.” ARÖ

THE SOLAR POWER STATION TOWER ON THE PLATAFORMA SOLAR IN ALMERÍA IS SURROUNDED BY A MIRROR ARRAY THAT FOCUSES THE SUNLIGHT ONTO THREE RADIATION RECEIVERS. A SOLAR-HYBRID GAS TURBINE IS LOCATED WITHIN THE TOWER. Photo: DLR

RESEARCH FIELD EARTH AND ENVIRONMENT

The Research Field Earth and Environment was evaluated in early 2008 within the scope of the Helmholtz Association's programme-oriented funding. In the coming programme period from 2009 onwards, four freshly aligned scientific programmes will be carried out. Research will focus particularly on issues of climate change and its consequences. The current Annual Report 2007/2008 presents an overview of the current structure, conceptual formulations and scientific work of this Research Field, and then proceeds to specify the scientific programmes that will define the strategic direction of the Research Field in the next five years.

GOALS AND ROLES

Human activity now has global effects. In view of projected population growth to around nine billion by 2050, conflicts of interest for basic requirements such as energy, food, urban areas and natural resources will increase. As a consequence, the earth's climatic equilibrium is threatened and global ecological stability jeopardised. We at the Helmholtz Association are directing our research towards the problems the future may hold. The decisive challenge for earth science and environmental research is to provide the knowledge required to plan long-term sustainable security for the essentials of human life. To do this, it is necessary to understand the fundamental functions of System Earth and how human society and nature interact. The aim is to describe the complex changes to the earth and the environment as precisely as possible, supplying decision-makers in politics and society with recommendations for action based on sound scientific knowledge.

New forms of strategic research associations within and beyond the Helmholtz Association are called for in view of the multiplicity of questions to be answered and to ensure the effective use of scientific infrastructure. This concentration of research resources takes place at national and international level through collaborations with universities and other research institutions, via "Virtual Institutes" for example, or the further development of collaboration at European level. Currently, 17 Helmholtz Virtual Institutes demonstrate the successful research links between individual centres and partner universities. Three new Virtual Institutes were added to the group in 2007 in the fields "Terrestrial Modelling", "Water Management" and "Plankton Evolution". The Research Field's significant contributions to two Excellence Clusters, "The Ocean in the Earth System" (AWI) and "Integrated Climate System Analysis and Prediction" (GKSS), both of which were recently approved in the second round of the Federal Government's excellence competition, underline the high level of cooperation with partners outside the Helmholtz Association. In the same way, the German Climate Consortium, a communications and research platform founded in 2007, combines the resources and infrastructure of 19 national climate research institutes. The consortium is run by the Helmholtz Centres AWI, FZJ, FZK, GFZ, GKSS and UFZ with universities, Max Planck and Leibniz Institutions. In addition, the Helmholtz Association is currently setting up Helmholtz Climate Offices for southern, central and northern Germany and for the Polar Regions. These offices will draw together research findings on regional effects of climate change and make them public. The Helmholtz Association is also making a significant contribution to the establishment of the Climate Service Centre, which will provide a national service and communications platform for climate-related issues.

Research projects which span the centres and other institutions at international level are becoming ever more important to the Helmholtz Association. Five Helmholtz Centres, for example, have been cooperating with the UN organisation ECLAC/CEPAL and Latin American partners since 2007 in the initiative "Risk Habitat Megacity" to study strategies for sustainable development in megacities and conurbations.

Talent management is another core area for this Research Field. Current measures and structures are continually being expanded and supplemented, mostly in cooperation with external partners: graduate schools and Helmholtz research schools for further education and training, Young Investigators Groups for independent research. The UFZ's Helmholtz Interdisciplinary Graduate School for Environmental Research with its six university partners and the AWI's Helmholtz Research School on Earth System Science with two university partners have been brought on board in this context. Twelve Helmholtz Young Investigators Groups are currently being funded. Successful networking by the Research Field Earth and Environment in the area of teaching and talent management is also reflected in the institutions. In 2008, for example, the Forschungszentrum Jülich and the RWTH Aachen, with their Jülich Aachen Research Alliance – JARA will unite training and further education under one roof in the German Research School for Simulation Science, as will the Forschungszentrum Karlsruhe and the Universität Karlsruhe in their joint KIT Centre for Climate and Environment.

"Balanced and robust concepts for solving the environmental problems of our time demand a multidisciplinary approach that also takes social factors into account. The Research Field Earth and Environment unites the competences for system solutions of this kind in a unique way."

PROF. DR. GEORG TEUTSCH Vice-President representing the Research Field Earth and Environment, Helmholtz Centre for Environmental Research – UFZ

PROGRAMMES IN THE 2004-2008 FUNDING PERIOD

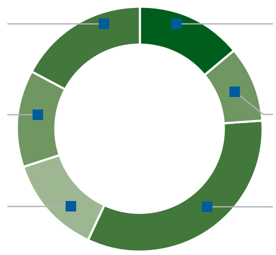
Eight Helmholtz Centres are actively involved in the Research Field Earth and Environment: the Alfred Wegener Institute for Polar and Marine Research, the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the Helmholtz Centre for Infection Research, the Helmholtz Centre for Environmental Research – UFZ, the GKSS Research Centre Geesthacht and the Helmholtz Zentrum München – German Research Center for Environmental Health. Environmental and System Earth research focuses on addressing the grand challenges that national and international bodies have identified: Natural disasters, climate fluctuation and climate change, water – availability and dynamics, sustainable use of resources, biodiversity and ecological stability plus the socio-political dimensions of global change. The Research Field addressed these central tasks of earth and environmental research in six programmes during the first programme period:

- Geosystem: The Changing Earth
- Atmosphere and Climate
- Marine, Coastal and Polar Systems
- Biogeosystems: Dynamics, Adaptation and Adjustment
- Sustainable Use of Landscapes
- Sustainable Development and Technology

None of these research tasks can be viewed in isolation from each other, since all elements and processes of the various spheres are closely connected with each other in System Earth. In consideration of these dynamics, scientists working within the Research Field Earth and Environment collaborate with each other beyond the boundaries of their programmes and also with colleagues from other Helmholtz Association research fields.

Programmes in the First Round of Funding, 2004-2008:
Structure of the Research Field Earth and Environment
Core-financed costs 2007: € 277 million

In addition, the Research Field Earth and Environment receives € 93 million in external funding, giving it total funds of € 370 million.



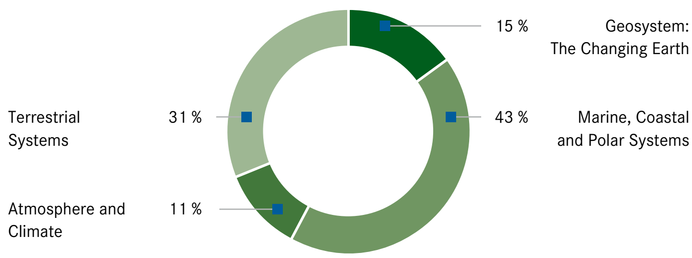
PROGRAMMES IN THE PROGRAMME-ORIENTED FUNDING 2009–2013

The strategic scientific development of the Research Field in the next few years comprises the reorganisation of the research programmes. The previous programme "Sustainable Development and Technology" will not be continued in the Research Field Earth and Environment. Large parts of the current programme will be relocated to the Research Fields Energy and Key Technologies. The programme "Terrestrial Systems" will unite the previous programmes "Biogeosystems: Dynamics, Adaptation and Adjustment" and "Sustainable Use of Landscapes". In this way the Research Field will concentrate its research activities in four programmes from 2009 onwards:

- **Geosystem: The Changing Earth**
- **Marine, Coastal and Polar Systems**
- **Atmosphere and Climate**
- **Terrestrial Environment – Strategies for a Sustainable Response to Climate and Global Change (Terrestrial Systems)**

Cross-programme and cross-research field topics such as "Climate" (DLR, GFZ, HMGU, GKSS, FZK, FZJ, UFZ, AWI) "Integrated Earth Observation" (AWI, DLR, GFZ, GKSS, FZJ, FZK) and methodical working groups such as "Modelling" (AWI, GFZ, FZK, FZJ, HMGU, GKSS, UFZ) have been set up to work on urgent social problems, to develop competences in the Research Field and to make the best use of research infrastructure. This structure will be maintained in the coming programme period. Here research topics relevant to more than one field can be tackled and methodological and organisational synergies developed. The joint development and operation of infrastructure whose use is relevant to more than one programme, such as the research aircraft HALO or the "Terrestrial Environmental Observatoria" (TERENO), are further important elements in the collaboration. For example, terrestrial observatories will be set up in a TERENO network in three or four selected representative regions in Germany by 2010 on the basis of existing research stations and long-term series data. Regional data on global and climate change will be collected there by in-situ measuring instruments and ground, aircraft and satellite-supported remote sensing processes. Based on the data of these observatories, the aim is to to analyse the measurable effects of global change on regional terrestrial systems over the next ten years, and simulate and forecast future changes using integrated modelling systems. Efficient measures for mitigating or adapting to global change can be derived from the results.

Programmes in the Second Round of Funding, 2009-2013:
Structure of the Research Field Earth and Environment
Core-financed cost plan 2009: € 251 million*



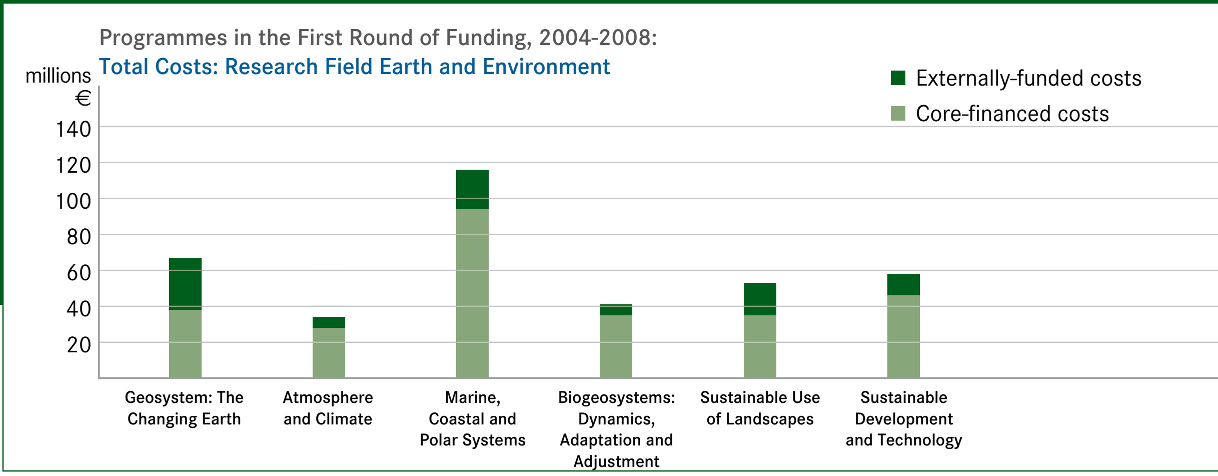
*Please note: On account of the Helmholtz Association's new Climate Initiative, it is currently only possible to give cost estimates for the Research Field Earth and Environment; definite figures will be available in early 2009.

Geosystem: The Changing Earth

This programme focuses on analysing the physical and chemical processes taking place within System Earth, how geosphere, atmosphere, hydrosphere, pedosphere and biosphere interact and the effects of these interactions on the human habitat. Its mission is to observe, investigate and model the relevant geo-processes, in order to assess the state of System Earth and to identify changing trends. The basis of this research is provided by a global geophysical and geodetic observation infrastructure, regional earth systems observatories, near earth satellites, airborne recording systems, mobile instrument arrays, drilling rigs and the analytic and experimental infrastructure. These merge to an observation system and are integrated into national and international collaborative structures. Besides studying the earth's magnetic and gravity fields, the key research topics are natural resources, materials cycles, climate variability and the impact of climate change on the human habitat. Prevention of and forward-planning strategies for natural disasters and the use of subterranean space, for carbon dioxide storage for example, are also the subject of research. The programme contributes to the topic areas “earth systems dynamics and risks”, “climate variability and climate change” and “sustainable use of resources”.

Marine, Coastal and Polar Systems

This research programme takes a multidisciplinary approach, focusing mainly on the observation and analysis of past, present and future changes in System Earth. The research concentrates on current changes in the Arctic, Antarctic and coastal regions, paying particular attention to direct human influence on the latter. In the Polar Regions, the research focus is on global processes and their interactions as they affect and control the climate. In addition, the further decoding of the paleoenvironmental archive together with the process studies will permit wide-ranging conclusions to be drawn from the earth's past. The goal is to develop a model system to help predict medium-term developments. This model aims to depict firstly the influence of the cryosphere, the oceans and the marine biological and geological chemospheres on the climate as well as biodiversity and how energy and materials flow in various space and time scales. The aim is to investigate changes to the earth's climate and human influences on this complex system to provide a scientific basis for medium-term predictions. This will help enable policy-makers and society to develop informed opinions. Modern research infrastructure for coastal, marine and polar research is being developed for this purpose.

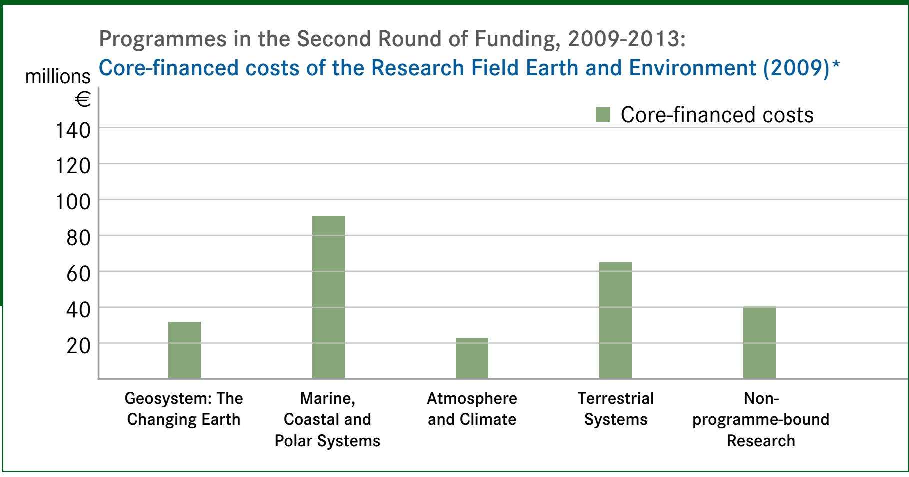


Atmosphere and Climate

This programme deals with the role played by the atmosphere in climate systems and the significant processes which decisively influence climate change, natural disasters, air quality and so the quality of life on earth. In this context, the behaviour of the stratosphere, the troposphere and the biosphere are examined, with their complex interaction in global change. The research focuses on studies of the water cycle and the bio-chemical and geo-chemical cycles of environmentally relevant trace gases and aerosols. Data from long-term aircraft and satellite measurements, ground stations, large simulation chambers (AIDA, SAPHIR, etc) and numerical models (e.g. transport and climate models) all form the basis of these analyses. The numerical models are constantly being developed to quantify the ecological and socio-economic consequences of climate change and to gain essential knowledge for protection from the effects, concentrating particularly on the regional level. The new research aircraft HALO will make a significant contribution once it has been put into service; scientists from the research programme play an important role in this process.

Terrestrial Systems

The Terrestrial Systems programme aims to preserve the basic elements essential for human life and to develop options for the sustainable use of resources. For this reason, the programme is closely related to climate change: rising global temperatures and the resulting effects cannot be stopped by mitigation alone, making it necessary to develop additional strategies to adapt to climate change and reduce the vulnerability of our ecosystem. To achieve this, new concepts for technological solutions (agricultural, biological, energy-related and environmental) are being developed with research focusing on the following areas: Land use conflicts where food production, biofuels and nature conservation clash are being examined and strategies for adapting to global change on a regional level developed. Mechanisms critical to the growth and vitality of microbes and plants are being analysed with the aim of developing sustainable biomass production. In the field of water resources management, an innovative eco-technological approach to protect and to provide sufficient quantities of high-quality water is being developed. More thorough understanding of the processes of ground water systems and



*Please note: On account of the Helmholtz Association's new Climate Initiative, it is currently only possible to give cost estimates for the Research Field Earth and Environment; definite figures will be available in early 2009.

analysis of the vulnerability of ground water bodies and their natural purifying potential aims to make it possible to predict the consequences of ground water degradation for people and eco-systems more reliably. Sustainable use of chemicals can only be achieved with better understanding of the fate of chemicals in the environment, opening up new possibilities of using safer substances and specific remediation strategies for sites of large-scale contamination. The research is supplemented by the establishment of a technological and methodological platform for observation, integrated analysis and evaluation of terrestrial systems. Innovative measuring and monitoring concepts, integrated modelling approaches and methodological issues of up-scaling at long-term observation sites such as TERENO all play an important part in this project.

PROJECTS

Alfred Wegener Institute for Polar and Marine Research

DEEP BLUE – OASES IN THE OCEAN

Eyeless spider crabs, worms with no digestive tracts or shellfish which live in close partnership with bacteria: some very strange creatures thrive around black smokers, mud volcanoes or cold water coral reefs. Dr. Michael Klages of the Alfred Wegener Institute (AWI) describes the deep-sea oases as explosions of life in a tiny area. But how do such "hot-spot" ecosystems function and what resources are hidden within them?

> "Hotspot communities are especially sensitive to local disturbances and to global climate change."

In the EU project HERMES (Hotspot Ecosystems Research on the Margins of European Seas), biologists, geologists, physicists, oceanographers and geochemists are investigating how highly specialised communities of living organisms develop without access to warmth, light or sometimes even oxygen, and succeed in defiance of the hostile environment. HERMES is one of the most extensive programmes of European marine research, funded with 15.5 million euros and with around 50 participating institutes in 15 countries.
Under this programme, Klages, a biologist and his colleagues are studying communities of living organisms on continental slopes and so-called cold seeps, where mineral-rich water seeps from underground sources along the continental slopes. Within the framework of the International Polar Year 2007/2008, the scientists travelled on the research icebreaker Polarstern to the cold water coral reefs in the icy seas of Norway. Four young school pupils were able to join them in their research for three weeks. They were present for the first launch of the mini-submarine JAGO and the underwater vehicle QUEST, two pieces of high-tech equipment which can reach depths of 400 metres or even 4,000 metres – one manned, the other remote controlled.

As well as research and educational work, the Helmholtz scientists have taken on the task of the data management of HERMES. All data and analyses come together here, including the data from the long-term deep-sea observatory Hausgarten, off Spitzbergen. Scientists in the observatory, located in the Fram Strait between the North Atlantic and the Arctic Ocean, have been observing developments along Europe's northern continental shelf since 1999. The network of sensors at depths between 1,000 and 5,500 metres continually measures salinity, temperature and currents and take regular sediment samples. A video camera photographs and films particular stretches of the sea bed at regular intervals. The researchers state that they are just beginning to understand the ecosystems there.
It has, however, already been established that hotspot communities are especially sensitive to local disturbances and to global climate change. The progressive warming of the northern ocean, for example, is changing life along Norway's continental shelf. Underwater photos show that where ten years ago, many large fauna species such as shellfish, prawns or sea anemones lived, the number of some of these species has been reduced by half. Life around the gas leaks or mineral springs is also being affected by the rise in global temperatures.

> "There is a gigantic gene pool down there. Some bacteria even survive in the high concentrations of heavy metals which flow from the earth's interior into the seawater."

No one knows how long this life in the deep can survive. Its end may be closer than we think – the loss of a valuable resource. "There is a gigantic gene pool down there. Some bacteria even survive in high concentrations of heavy metals which flow from the earth's interior into the seawater. Those genes could be extremely useful to mankind." For example, some of these micro-organisms might help provide environmentally-friendly purification of waste water contaminated by heavy metals.

THE UNDERWATER ROBOT ARM WITHDRAWS A SEDIMENT CORER WITH SEDIMENT SAMPLES FROM THE SEA BED. PHOTO: MARUM

"There may be many other habitats like this anywhere in the oceans, whose existence no-one yet suspects. HERMES helps us to understand in order to protect – so we don't destroy the underwater oases before they have been discovered and their secrets revealed". CORNELIA REICHERT

GKSS Research Centre Geesthacht

EFFECTS OF CLIMATE CHANGE ON THE BALTIC SEA REGION

Climate change is a global phenomenon but its regional effects are varied. Information about the current state of the region and projections are urgently needed in order to plan effective adaptation measures. Professor Hans von Storch, climate expert at the GKSS, is heading a group of 80 scientists from 13 states bordering the Baltic Sea in efforts to describe climatic changes in the Baltic Sea region, and to set up possible scenarios up to 2100. The initiative is coordinated by the BALTEX office at GKSS. The BACC report is a regional version of the IPCC report on global climate change," says von Storch.

> „Climate scenarios are plausible descriptions of possible futures."

The air temperature in the northern Baltic Sea basin rose by about one degree Celsius in the last century, while in the south, an increase of only 0.7 degrees was recorded. Without effective countermeasures, the air temperature could rise by four to six degrees in the north by 2100 and by three to five degrees in the southern area, leading to a reduction of 50 to 80 per cent in the winter ice cover of the Baltic Sea. The experts also anticipate more precipitation in the winter and drier summers. The possible increase in precipitation – which could also reduce in average salinity – could result in stronger inflow of nutrients into the Baltic Sea, which could enhance eutrophication and algae growth. The water temperature could also rise. These changes would affect the whole ecosystem, from bacteria and algae to commercial fish species such as cod. In the future, the Baltic ringed seal could have more difficulty in finding ice surfaces in winter that they require for reproduction. On the other hand, vegetation on land would probably grow more profusely and spring would come earlier. These findings should be interpreted with care, as von Storch emphasises: "Scenarios are plausible descriptions of possible futures." An updated version of the BACC report is planned in five years. "By then we will know a great deal more about the prospects and effects of climate change, and we can make more detailed comments on adaptation strategies," explains von Storch. ARÖ

Further information: www.baltex-research.eu/BACC/

SATELLITE PHOTO OF THE BALTIC REGION IN SPRING 2004. THE ICE COVER OF THE NORTHERN BALTIC SEA COULD ALSO BE CONSIDERABLY REDUCED IN FUTURE. Photo: NASA/goddard space flight center/GeoEye

TAKING GPS MEASUREMENTS DURING FIELD WORK ON THE INYLCHEK GLACIER. PHOTO: GFZ

Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences

CHANGING MOUNTAIN LANDSCAPES

Kyrgyzstan is home to barren steppes 2,500 metres above sea level, walnut forests and towering mountain ranges with peaks over 7,000 metres. The majority of the population of five million is still dependent on agriculture and mining; outdated infrastructure and the lack of industry means that modernisation is proceeding more slowly than hoped. Yet the land is not only undergoing social upheaval; constant geological change is altering the landscape as well.

> "Geoscientific data is essential in predicting risks for settlements, roads and pipelines, because this is one of the most geologically active regions in the world."

Kyrgyzstan's landscape both above and below ground have been formed by the upthrust of the Pamir, Tien Shen and Himalaya ranges. This Central Asian region is one of the most tectonically active areas in the world. Scientists of the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences set up a modern georesearch institute four years ago in the capital Bishkek, under the leadership of Professor Christoph Reigber and Dr. Bolot Moldobekov, to study the geological, hydrological and climatological processes involved. The Central Asian Institute for Applied Geosciences (CAIAG) was set up as a collaborative project between the Kyrgyz Republic and the GFZ and other partners, including the International Center for Development and Environmental Research at the Justus Liebig University, Gießen. The Institute is funded by the German Federal Ministry of Education and Research (BMBF) and the Kyrgyz government. Scientists from Central Asian countries can perform research at the institute and the next generation of earth scientists can also be educated here. Dr. Oliver Bens, head of staff of the scientific executive board at the GFZ, explains, "We want to enable our Kyrgyz colleagues to link up with international research." One of their tasks is to set up a Global Change Observatory Central Asia at CAIAG, because Kyrgyzstan is the ideal location from which to observe the forces which form and alter landscape and climate. "The Indian subcontinent is in collision with the Eurasian plate and the geological forces are enormous, as shown by the upthrust of the Himalayas. These forces are felt as far away as China and Central Asia," Bens explains. This research is fascinating to scientists but also of practical relevance. In Kyrgyzstan, the activity of System Earth can be experienced on a day-to-day basis. In Bens' words, "Geoscientific data is essential in predicting risks for settlements, roads and pipelines, because this is one of the most geologically active regions in the world." Landslips, rock slides, mudflows and even earthquakes are everyday occurrences. At CAIAG, satellite data are evaluated along with findings from ground stations and glacier measurements to record current developments.

> "Founding an institute like this helps the country to help itself and to activate its own geoscientific potential."

Geoscientists do not just see the landscape as it is: they are also interested in how it was formed and shaped and how it will develop in the next millennia. The same applies to the climate: sediment drilling in lake beds helps the researchers to reconstruct the development and climatic history of the region, for the deposits of flora and fauna enable conclusions to be drawn about more than 100,000 years of varied climatic history – enough dissertation topics for all the doctoral students from all over the world who work at CAIAG. Water as a geo-resource is a further subject of research. In early summer, when snowfields and glaciers melt, large quantities of water are dammed; when the dam breaks, fields and settlements are flooded. At the same time there is a lack of water in the plains of Central Asia, so the steppes are expanding, the ground is

becoming saline and eroding. Contamination is also a problem, for example caused by uranium mining; landslips can cause spoil from former mines to contaminate drinking water reservoirs. As Bens says, “Kyrgyzstan is an enormous landscape laboratory”, and the Kyrgyz-German research institute CAIAG can provide the scientific basis for wise decisions, enabling the country to develop and improve its infrastructure. An institute like this which deals with the use and management of natural resources helps the country to help itself and to activate its own geoscientifical potential, as Bens explains. His Kyrgyz colleagues can develop problem-solving strategies and implement them with partners from other central Asian states and Germany. ARÖ

Helmholtz Centre for Environmental Research – UFZ

SMART WATER USAGE

Clean drinking water is an increasingly scarce and precious resource in view of climate change and population growth. In the border area between Jordan, Israel and the Palestinian territories, ground water reserves are overused, the water level of the Dead Sea is sinking and the Sea of Galilee is in danger of salinity. Some settlements have to be supplied with drinking water by tanker delivery. Specialists from the Helmholtz Centre for Environmental Research – UFZ are joining the search for sustainable water management for the future, the solution to the crisis in this area. In collaboration with research partners in Germany and the Middle East and regional policy makers, they have set up the SMART project: “Sustainable Management of Available Water Resources with Innovative Technologies”. Dr. Stefan Geyer, Dr. Christian Siebert and Dr. Tino Rödiger of the UFZ are using hydro-geological methods to establish how the groundwater resources are formed and how they develop over time. One problem is that a large proportion of rainwater does not seep into the ground but runs off over the barren surface straight into the heavily polluted river Jordan or the Dead Sea. Siebert states that, among other methods, they are investigating the possibility of saving some of the surface run-off by planting vegetation in trial areas to make the soil more permeable to water.

> “If we can find good solutions for this region in crisis, some of the ideas can be transferred to other regions.”

At present, agriculture is the biggest user of valuable groundwater – but the fields could be irrigated using purified waste water. The SMART project is also tackling this issue: Dr. Roland Müller of UFZ is working with three German partners in industry to test methods of purifying waste water economically. Meanwhile, Siebert and his colleagues aim to examine how this purified waste water can be drained into the underground and is further purified naturally as it percolates through the rock, to the extent that it can be used later for irrigation or even as drinking water. “If we can find good solutions for this region in crisis, some of the ideas can be transferred to other regions,” as Siebert says. ARÖ

Further information: www.iwrm-smart.org

IN THE BORDER AREA BETWEEN JORDAN, ISRAEL AND THE PALESTINIAN TERRITORIES DRINKING WATER OFTEN HAS TO BE DELIVERED. Photo: A. Künzelmann/UFZ

Helmholtz Centre for Environmental Research – UFZ

MEGACITIES: LABORATORIES FOR THE FUTURE

Around two per cent of the earth's land surface is currently covered by cities, yet about 50 per cent of the human population live in them, and this percentage is increasing daily. It's not all bad news: in crowded cities, people can work more economically and use fewer resources to maintain the same living standards as in less densely populated areas. Problems arise when a city's growth is unplanned and unchecked, leading to development of land at risk from natural disasters, traffic jams and air and water pollution, all of which greatly reduces quality of life and opportunities for the inhabitants.

> "What is driving the rapid changes and how can these processes be controlled to raise living standards and reduce environmental pollution?"

The Helmholtz Initiative Risk Habitat Megacity was set up to tackle this problem. 40 scientists from five Helmholtz Centres (DLR, FZK, HZI, and GFZ, headed by the UFZ) are collaborating with Chilean research institutes to examine the dynamics and complexity of growth in the capital Santiago. The aim is to discover levers with which political leaders can control the development processes. Dr. Dirk Heinrichs, scientific coordinator of the UFZ, formulates the issue: "What is driving the rapid changes and how can these processes be controlled to increase living standards and reduce environmental pollution?" Or to put it another way, how can the opportunities provided by urbanisation be exploited and the disadvantages be avoided? Urbanisation is as far advanced in Latin America as in Europe – more than three quarters of the population live in cities. On the other hand, the transition to a service and knowledge-based society is not complete. For example, copper mining and fish farming are key factors in Chile's economic strength. This also makes Santiago de Chile an ideal laboratory for the interdisciplinary approach of the Helmholtz initiative. Santiago is decades ahead of many megacities in developing countries, as Heinrichs explains, giving scientists the chance to see into the future. Santiago is considered a mature megacity; migration from rural areas has slowed, the birth rate is sinking and life expectancy has increased. Nevertheless, the city's expansion has speeded up in recent years and the structure is splintering. Inner city areas are decaying while luxurious gated communities are being built on the periphery. Because the city is confined in its valley setting, these 'barrios cerrados' are often built in problematic locations, such as on previously forested mountain slopes, in water protection areas or earthquake zones. The Chilean and German researchers create models of the dangers of torrential rain run-off or landslides, supported by hydrological and seismic measurements. The settlements of poor migrants also lie on the periphery, so the social contrasts are starker than ever before. "The new proximity of the communities may bring opportunities for improving infrastructure and creating jobs, but also the risk of displacement," as Heinrichs states. The social scientists use questionnaires and structured interviews to help estimate the social risks and opportunities.

> "Regional policy makers want to know what levers exist to enable them to control the metropolitan region's growth."

Water and power supplies, waste water and waste disposal, air quality and mobility requirements of different population groups are also issues the Helmholtz Initiative is investigating. For example, the public transport system is insufficient and the increasing numbers of private vehicles is causing air pollution and affecting people's health. One of the Helmholtz Initiative's aims is to generate realistic scenarios to play out the various courses future development may take, giving a clear picture of how living space, energy or water resources will be used. Each topic of the initiative is tackled by a mixed team of German and Chilean researchers with at least one doctoral student in each group. Chilean partner universities offer workshops and seminars which are open not only to students but also to members

SANTIAGO LIES IN A LARGE BOWL-SHAPED VALLEY AND IS GRADUALLY EXPANDING UP INTO THE MOUNTAINS. PHOTO: KÜNZELMANN/UFZ

of municipal government and political bodies. “Regional policy makers are some of the project’s most important partners. They want to know what levers exist to enable them to control the metropolitan area’s growth,” says Heinrichs. The right incentives could help ensure that development is made more sustainable and settlement in water protection areas and risk areas is avoided. Heinrichs explains that their studies increase awareness of the problems caused by poor development decisions for the quality of life and opportunities of future generations. By the end of 2010, some elements of a sustainable development strategy for Santiago should already be available. In subsequent stages of the megacity project from 2010 to 2013, the project partners aim to involve other Latin American cities in their research and to test whether the solutions and approaches they have found can be transferred to other cities. ANTONIA RÖTGER

Alfred Wegener Institute for Polar and Marine Research

THE GREAT POLAR MELT

The Arctic sea ice is dwindling at dizzying speed. Researchers of the Alfred Wegener Institute, Bremerhaven, assume that the cause lies in the interplay of ice, ocean and atmosphere. Using models, process studies and long-term observations, they hope to identify the precise mechanisms of this process. They are joining forces with colleagues from 13 countries and 48 partner institutes within the framework of the EU project DAMOCLES (Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies). To carry out observations independently of expeditions, for example, autonomous buoys deployed on ice flows regularly transmit information about currents, temperature and salinity via satellite. An important quantity of the sea ice budget, the thickness, is studied by the AWI sea ice experts. Besides melting, also wind piling up ice floes decreases the area of sea ice, but does not change the quantity. In the regions studied by DAMOCLES, the ice has become thinner. Since natural climate variation is overlaying the greenhouse effect, the very abrupt sea ice decline in recent years suggests that the northern polar region is particularly sensitive due to a positive feedback: When the white ice cover decreases more dark sea surface can absorb sunlight, which speeds up the melting. “Also the temperature of the Arctic Ocean has increased markedly to a depth of several kilometres due to warmer inflow from low latitudes.

> „The temperature of the Arctic Ocean has increased markedly to a depth of several kilometres due to warmer inflow from low latitudes.“

Yet we don’t know exactly if this is an independent development or if there are links to the sea ice decrease,” explains Professor Ursula Schauer. The goal of DAMOCLES is the exact quantification of the interplay of various influences. This is a prerequisite to improve climate models, which finally will enable more reliable predictions of future climate. AWI

AUTONOMOUS MEASURING BUOYS THAT TRANSMIT DATA VIA SATELLITE WERE DEPLOYED IN THE CENTRAL ARCTIC DURING AN EXPEDITION OF THE POLARSTERN RESEARCH VESSEL IN 2007. Photo: Karel Bakker/NIOZ

RESEARCH FIELD HEALTH

The Research Field Health was evaluated in early 2008 within the scope of the Helmholtz Association's programme-oriented funding. In the coming programme period from 2009 onwards, six freshly aligned research programmes will be carried out. They will focus on the great challenges facing health research and in particular, the transfer of research findings from the laboratory to the hospital. The Annual Report 2007/2008 first gives an overview of the current structure, conceptual formulations and the scientific work of the Research Field. It then presents the research programmes that will define the strategic orientation of the Research Field in the next five years.

GOALS AND ROLES

Helmholtz Association's Research Field Health is dedicated to investigating the causes of complex diseases and developing new strategies for their prevention, diagnosis and treatment, enabling more diseases to be tackled at their root and thus making them curable. The range of disease is being extended as an ageing population changes its habits and lifestyle, requiring new priorities to be set in research. The Federal Ministry of Education and Research (BMBF) took the decision to strengthen research into degenerative diseases of the brain by establishing the Helmholtz Centre for Neurodegenerative Diseases, in early 2008. The core location in Bonn is allied with the universities of Bonn and Cologne, the Forschungszentrum Jülich and the caesar Research Centre in Bonn and six partner institutes for dementia research in Göttingen, Magdeburg, Munich, Tübingen, Witten and Mecklenburg-West Pomerania.
A new structure has also been created by the strategic alliance of the DKFZ with the Centre for Molecular Biology at the University of Heidelberg. The alliance, with a staff of over 500, was officially founded in December 2007 when the contract was signed. This centre for cellular and molecular life sciences with its greater emphasis on basic biomedical research will contribute significantly to the development of new approaches to prevention, diagnosis and treatment of cancer. The contract for the new strategic alliance JARA-BRAIN, a joint institution of the University Hospital Aachen (UKA) and the health division of the Forschungszentrum Jülich, has concentrated expertise in basic and translational research into complex neuropsychiatric diseases. JARA-BRAIN will also facilitate the provision of the Clinician Neuroscientist training course, comprising the structured training of young scientists and doctors in basic research and clinical medicine.
In taking its new name, the Helmholtz Zentrum München – German Research Center for Environmental Health, formerly GSF – National Research Center for Environment and Health, affirms its affiliation with the Helmholtz Association and its position in the Munich research landscape. The new name also makes a clear statement on the Research Centre's strategic development which will concentrate increasingly on the links between health and global change.

"We must use our excellent basic research to develop new approaches to the prevention and treatment of the most common diseases and introduce these innovations into clinical practice to improve the quality of life in an ageing society."

PROF. DR. OTMAR D. WIESTLER Helmholtz Vice-President representing the Research Field Health, German Cancer Research Center

PROGRAMME STRUCTURE IN THE FUNDING PERIOD 2003*-2008

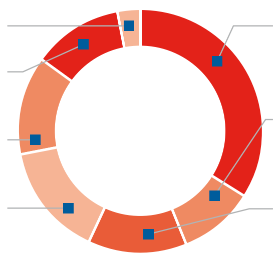
Ten Helmholtz Centres cooperated in the Research Field Health during the first programme period. They include the Helmholtz Centre for Infection Research, the German Cancer Research Center, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the GKSS Research Centre Geesthacht, the Helmholtz Zentrum München – German Research Center for Environmental Health, the GSI Helmholtz Centre for Heavy Ion Research, the Helmholtz-Zentrum Berlin für Materialien und Energie, the Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch and the Helmholtz Centre for Environmental Research – UFZ. The researchers are working on seven programmes:

- Cancer Research
- Cardiovascular and Metabolic Diseases
- Function and Dysfunction of the Nervous System
- Infection and Immunity
- Environmental Health
- Comparative Genome Research
- Regenerative Medicine

*The first period of funding for the Research Field Health began in 2003 and was extended by one year until 2008.

Structure of the Research Field Health
Core-financed Costs 2007: € 277 million

In addition, the Research Field Health receives € 108 million in third party funds, giving it total funds of € 385 million.



THE PROGRAMMES IN THE FUNDING PERIOD 2003*-2008

Cancer Research

The word cancer refers to a whole group of serious, complex illnesses whose common characteristic is uncontrolled somatic cell reproduction. About 450,000 people annually are diagnosed with cancer in Germany, of whom over half die from the disease. The course of the disease is often drawn out and the poor prognosis adds to the serious psycho-social and socio-economic effects for patients and their families.
Our research aims to significantly improve cancer prevention, early recognition, diagnosis and treatment. To this end, researchers analyse signalling pathways between tumour cells, explore the genetic roots of the disease and identify risk factors that lead to cancer. A key focus of the programme is on the development and application of innovative diagnostic and therapeutic methods based on molecular, cell biological, immunological and radiophysical findings and technology. The programme also addresses the role of the immune system in cancer and examines the links between infections and cancer. Medical engineering also plays an important part in cancer research – new imaging processes and innovative radiation treatment strategies make diagnosis and therapy more precise. An excellent example of successful research transfer was the market introduction of a preventive vaccine against human papillomavirus, which plays a part in causing cervical cancer. The basic research which led to the development of this vaccine, which is now used worldwide, was conducted at the German Cancer Research Center.

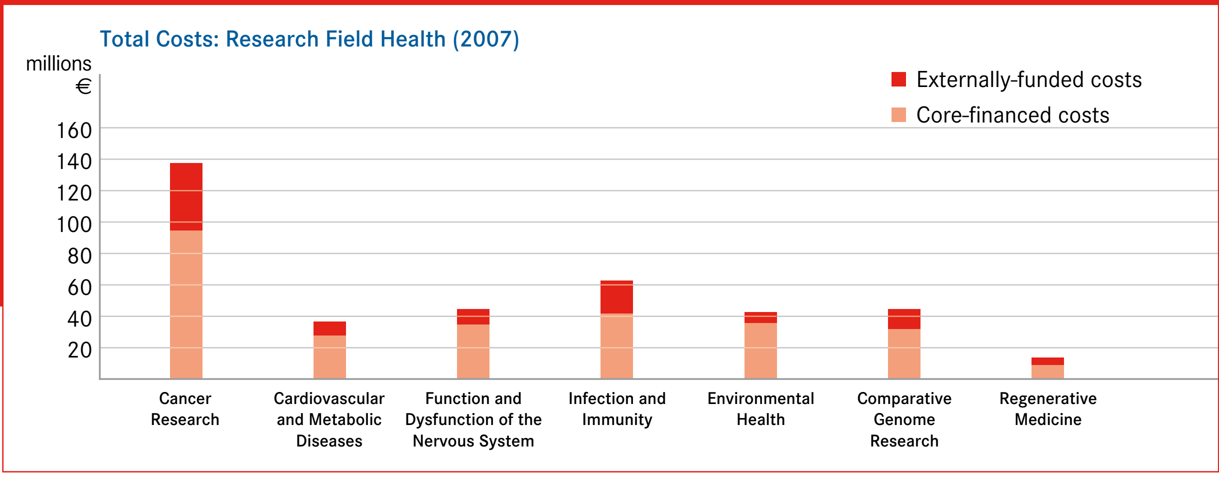
Cardiovascular and Metabolic Diseases

Cardiovascular diseases are the most common cause of death in western industrial nations. Major risk factors are high blood pressure, diabetes, raised blood lipid levels, smoking and obesity, which are a tremendous burden on the public health system. To achieve a sustainable long-term drop in numbers of cases, scientists study the causes of vascular disease, high blood pressure, heart and kidney disease and metabolic diseases such as diabetes and adiposity. In addition, they develop new ways of preventing, diagnosing and treating such illnesses, drawing on various methodological approaches based on genetics, genomics, bioinformatics, cell biology and epidemiology.

Function and Dysfunction of the Nervous System

As human life expectancy increases, so does the risk of neurological and psychiatric disease. The Helmholtz Association's basic neuroscience research extends our knowledge of the causes of these disorders. In the first round of programme-oriented funding, research focused on degenerative diseases of the central nervous system such as Parkinson's or Alzheimer's as well as epilepsy, brain tumours or cognitive function disorders resulting from strokes. In order to analyse the relevant mechanisms, individual signal-transmitting molecules and cells must be examined as well as the neural system as a whole. Scientists use large-scale facilities to analyse normal and pathologically transformed mechanisms in the living human brain and employ the state-of-the-art non-invasive imaging procedures such as magnetic resonance tomography, positron emission tomography and magneto-encephalography as well as genome research, cell biology and significant animal models.

*The first period of funding for the Research Field Health began in 2003 and was extended by one year until 2008.



Infection and Immunity

More than 17 million people die of infectious diseases every year – that is one third of all deaths worldwide. In view of the growing threat posed by infectious diseases, the goal of the last five years' research has been to understand the fundamental mechanisms of infection and immunity. Researchers examine the causes of pathogens to gain new insights into molecular and cellular infection processes. They also analyse how immunity functions – the host organism's ability to prevent or control infection. Based on these findings, they are able to produce new strategies to combat infectious diseases and develop immune-therapy based strategies for the treatment of other chronic diseases such as auto-immune disorders and cancer.

Environmental Health

Human health depends on complex states of equilibrium which on the one hand can be genetically determined and on the other, can be influenced by the environment. How strongly do environmental factors affect human health? What molecular and cellular mechanisms underlie these disorders? What new preventative and therapeutic strategies can we derive from this? Answering questions like these is the key goal of the research done in this programme. The work focuses on common diseases such as inflammations of the respiratory tract, allergies and cancer, whose formation is significantly influenced by environmental toxic agents such as particulate airborne pollutants (aerosols), chemicals and ionising radiation. The scientists take two approaches. Firstly they look at the toxic agent to identify it and to understand its disease-triggering mechanism so that they can develop risk assessment and risk reduction strategies. Secondly, they consider the diseases themselves and study their developmental mechanisms to find out what kind of role environmental factors play in all this.

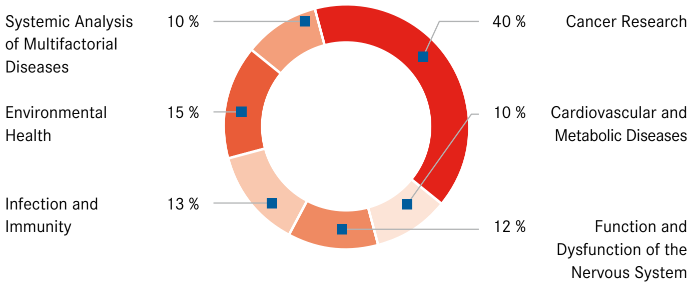
Comparative Genome Research

Understanding health and illness at genetic and cellular level is the key task performed by comparative genome research. To comprehend the molecular causes of illness, researchers first sequence the genomes of model organisms such as the mouse and apply this knowledge to analogous mechanisms in the human genome. The findings are collected and analysed in databases. Proteome research complements the knowledge acquired on the genetic components of diseases by contributing information about genetic products, the proteins, and their intercellular disease-relevant interactions. The researchers involved in this programme contribute significantly to the German National Genome Research Network.

Regenerative Medicine

Growing life expectancy in industrialised countries results in the incidence of age-typical diseases associated with functional disorders or failure of cells, tissue and organs increasing. This is why therapeutic methods developed by the field of regenerative medicine are therefore becoming ever more important. Helmholtz scientists are developing materials, methods and systems for the field of regenerative medicine which can be used for tissue engineering and organ replacement systems. The goal is to get the closest possible insight into the role played by the natural models and to support or even replace the diseased organ. Researchers are also attempting to improve the interface between technology and organism, for instance through neural coupling.

Structure of the Research Field Health
Core financed cost plan 2009: € 327 million



THE PROGRAMMES IN THE PROGRAMME-ORIENTED FUNDING 2009–2013

Life expectancy is increasing, the birth rate is sinking and lifestyles are changing: these are some of the far-reaching demographic and socio-economic changes our society is facing. The consequences include an increase in chronic illness and the rapid spread of infectious diseases due to increasing mobility. It is well known that the interaction of individual genetic predisposition with environmental influence is a significant factor in the genesis of complex chronic diseases. New approaches to diagnosis, treatment, early recognition and prevention of the most common diseases are required to meet this challenge. On the basis of its excellent basic research, the Helmholtz Centres in the Research Field Health have made it their goal to understand the causes and pathogenic mechanisms of common, economically relevant diseases, to develop new strategies for clinics. The three pillars of this scientific work are:

- Excellent basic research
- Analysis of complex biological systems (systems biology)
- Translation of research findings into clinical practice

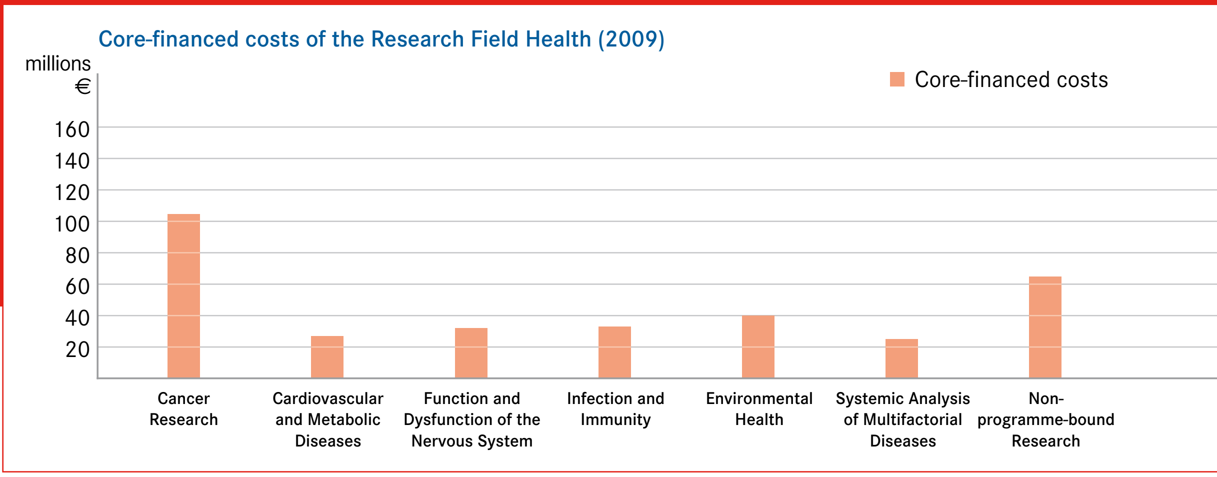
Eight Helmholtz Centres will collaborate in the Health Research Programmes in the coming funding period 2009–2013:
the Helmholtz Centre for Infection Research, the German Cancer Research Center, the Forschungszentrum Jülich, the GKSS Research Centre Geesthacht, the Helmholtz Zentrum München – German Research Center for Environmental Health, the GSI Helmholtz Centre for Heavy Ion Research, the Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch and the Helmholtz Centre for Environmental Research – UFZ.
The structure and goals in the Helmholtz Association's field of health have been jointly reassessed, brought into focus and even more closely tailored to a leading centre during the period leading up to the second programme-oriented funding phase. In the field of translational research, a special role will be played by the interaction with partners at university medical schools. In future, researchers will focus on the following six programmes:

- **Cancer Research**
- **Cardiovascular and Metabolic Diseases**
- **Function and Dysfunction of the Nervous System**
- **Infection and Immunity**
- **Environmental Health**
- **Systemic Analysis of Multifactorial Diseases**

In order to be able to respond rapidly to new developments a new, flexible system of interdisciplinary activities has been set up, which interconnects the programmes and contributes to the joint further development of important resources and technologies. This includes:

- Epidemiology and preventive medicine
- Systems biology
- Imaging processes
- Regenerative medicine and active biomaterials
- Structural biology
- Disease models

The programmes and participating centres specified above underwent a strategic scientific evaluation in early 2008. Groups of highly-qualified international experts were invited to give a critical assessment of the projected research goals and the strategies planned to achieve these in the individual programmes. This complex process gives a reliable and long-term guarantee of the Helmholtz Association's primary aim: to apply excellent research and scientific work of the highest quality to solving healthcare policy issues.
The experts assessed the past scientific work and successes as excellent and judged the projected research programmes for the next five years to be well planned and very promising. Encouraged by this, all the health programmes and participating centres are now confidently approaching the next programme-oriented funding period.



New progamme-specific focuses:

Some of the most important aspects to be tackled particularly thoroughly in the individual programmes are:

- In cancer research: the development of testing procedures which give information about how a patient will react to a particular type of treatment and its chances of success (predictive procedure for individualised treatment); further development of highly innovative radiation tumour treatment methods, such as heavy ion treatment.
- In cardiovascular research: the analysis of common metabolic malfunctions and their contribution to the development of cardiovascular disease.
- In research on diseases of the nervous system: the analysis of the molecular, cellular and systemic processes behind the diseases; in addition, the development of innovative imaging techniques such as MRI/PET technology for the simultaneous analysis of anatomical and functional details of organs and clinical studies to test these techniques.
- In research into infections: increased research into zoonoses, i.e. viral and bacterial diseases which can be transmitted from animals to people (e.g. SARS).
- In research into environmental influence on diseases: the field of inflammatory diseases caused by environmental factors (e.g. by nanoparticles) and using the findings to develop treatment procedures; also strengthening basic research on chemical modifications to genetic material and the resulting changes to genetic control.
- In research into multifactorial diseases: development and characterisation of suitable animal models, in order to gain more insight into the underlying complex molecular changes during pathogenesis.

Cross-programme strategic initiatives

The Research Field Health has launched initiatives in two strategically significant subject areas, first, epidemiology or preventive medicine and second, translational research.
Most human chronic illness is only diagnosed at a late stage. This means that ascertaining risks and prevention will be extremely important in future. Epidemiological research promises the most success in bringing findings to help prevent the most common diseases. The aim is to identify both genetic and environmental risk factors, the knowledge of which will permit early recognition and treatment of diseases. The planned extension of the field of epidemiology in all Helmholtz health research centres is a significant step. A particularly important strategic factor in strengthening epidemiological research will be the coordination of a projected large-scale cohort study involving 200,000 test subjects (Helmholtz Cohort). This is planned as a long-term project to be carried out by the Helmholtz Association with university partners, in which healthy test subjects will be examined for clinical parameters and habits and then followed over a period of 15 to 20 years. The German Cancer Research Center, the Helmholtz Zentrum München, the Max Delbrueck Center, the Helmholtz Centre for Infection Research, the Helmholtz Centre for Neurodegenerative Diseases and the Forschungszentrum Jülich are collaborating in this initiative.
The second focus point for cross-programme research is the funding of translational health research. This term covers all projects which are tackled jointly by basic research and clinical science, to ensure that promising research approaches can reach clinical application as rapidly as possible. Local clinical translation centres are currently being set up in collaboration with university hospitals, creating infrastructure platforms to speed up this process considerably. Strategic alliances with the pharmaceutical, biotechnology and medical engineering industries have strengthened the expertise in this area. The Helmholtz health centres have declared their intention of playing a leading part in this field at national and international level.
The participating institutions in health research also intend to create a joint standard for training the next generation of researchers and to improve career structures in order to provide optimum conditions for the best scientists in national and international health research.

THE CT IMAGE SHOWS THE DESTRUCTION OF LUNG TISSUE (BLACK HOLES) IN AN EMPHYSEMA PATIENT WHO IS A SMOKER. PHOTO: HMGU, ZIEGLER-HEITBROCK

PROJECTS

Helmholtz Zentrum München –
German Research Center for Environmental Health

SPOT THE DIFFERENCE

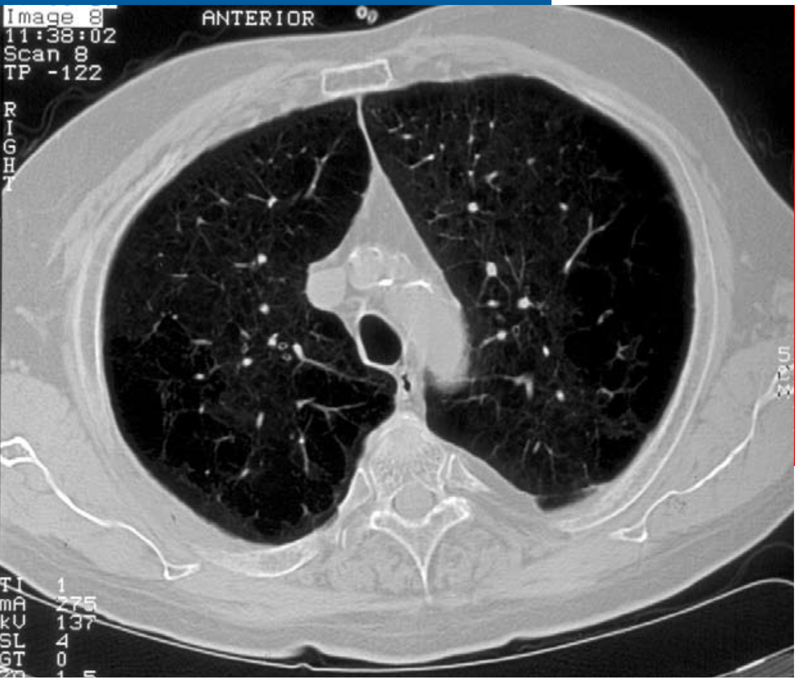
EvA files already take up one metre of table space in the office of Professor Loems Ziegler-Heitbrock of the clinical collaboration group for inflammatory lung disease at the Helmholtz Zentrum München. Yet the EvA project – an EU funded project on Emphysema versus Airway Disease - has only just got under way. An initial meeting of the fourteen research partners from

> "Specific markers would make the diagnosis of COPD subtypes far easier and of course we hope to find new starting points for treatment too."

nine European countries is planned for some time this summer. Researchers aim to discover molecular characteristics, so-called markers, for two forms of Chronic Obstructive Pulmonary Disease (COPD), emphysema and chronic bronchitis, within the next three years. Ziegler-Heitbrock explains that COPD is a kind of collective term for patients who suffer from various subtypes of the disease. "Specific markers would make the diagnosis of COPD subtypes far easier and of course we hope to find new starting points for treatment too." COPD, often known under the harmless-sounding name smoker's cough, is currently the fifth most common cause of death globally and is predicted by current WHO estimates to take fourth place in the statistics by 2030. There are around five million COPD sufferers in Germany and presumably 600 million worldwide. Most victims are smokers, but the smoke from open fires, often used in developing and emerging countries, is also considered to be one of the main causes of irreversible constriction of the airways, resulting in the coughing, shortness of breath and feelings of suffocation symptomatic of COPD. The disease restricts lung function and the organs can no longer be supplied with sufficient oxygen. Current methods of treatment aim to slow the progress of the disease. Ziegler-Heitbrock explains that there is no specific treatment for COPD, making it all the more important to comprehend the mechanisms behind its different forms. Emphysema destroys the alveoli, whereas chronic bronchitis causes inflammation and swelling of the bronchial walls. "A special computer tomography and complex software to interpret the lung scan should help differentiate between the two types," Ziegler-Heitbrock explains. The EvA partners aim to recruit 150 patients with emphysema and 150 with chronic bronchitis to apply this new method. Blood and bronchoscope samples from these patients and from 300 healthy control subjects will be taken and examined, enabling researchers to decode in detail mutations and differences with reference to the activated genes and the proteins present in order to detect the differences in the course of the diseases. Researchers also hope to develop a diagnostic test which is as simple, quick and cheap as possible.

> "A special computer tomography and complex software to interpret the lung scan should help differentiate between emphysema and chronic bronchitis."

Ziegler-Heitbrock and his colleagues have been preparing the study for about two years. Not only must the application be made to the EU, but applications for ethical approval must be made in all participating countries as well, and precise instructions for all experiments and sample taking written. Project co-ordinator Ziegler-Heitbrock says that they are currently making a video film to show how the bronchoscopy will take place. All data and samples will be collected at the Helmholtz Zentrum München; the detailed schedule including each project member's tasks is already complete.
But will everyone keep to the plan? Ziegler-Heitbrock emphasises the importance of motivation. An international project of this kind can only work if participants are in close contact by telephone, email and most important, personally. The researchers will meet at least every six months, for example at congresses and conferences. However, the prospect of publications is still the best motivation for researchers – and with EvA, the chances of this are high. JULIA GROSS



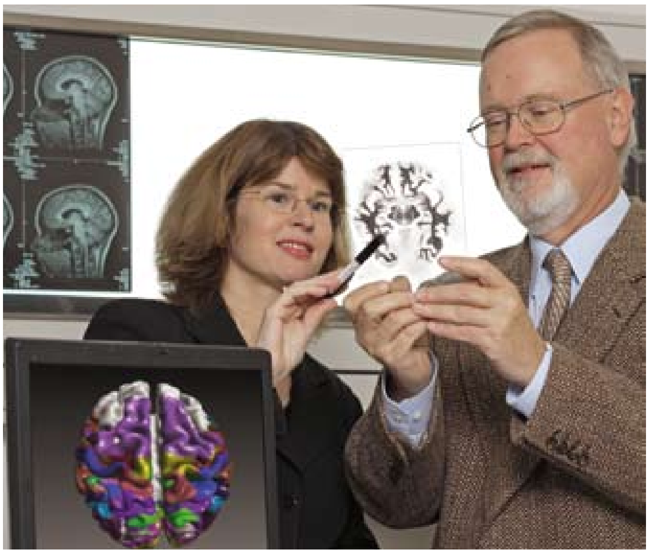
Forschungszentrum Jülich

A NEW BRAIN MAP

Cognitive and other simpler sensory and motor tasks activate different brain regions, as demonstrated by functional imaging studies, such as functional magnetic resonance imaging (fMRI) or positron emission tomography (PET). The cerebral cortex plays an important role here. It has long been known that the cerebral cortex is not homogeneous, but is organised in the form of specialised cortical areas. These cortical areas are characterised by a distinct cellular and molecular architecture as well as connectivity. However, so far no one has succeeded in shedding light on the relationship between brain structure and function on the complex systems level, because data from microstructural examinations could not be directly compared with the findings of functional imaging studies in the same spatial coordinate system. Moreover, the extent, localisation and microstructure of cortical areas vary from brain to brain. Such variability was not accounted for in previous brain atlases, and the sources and relevance of structural intersubject variability for brain function and human behaviour are not well understood. Intersubject variability is influenced by genes and other factors such as environment, education and training, as shown by violinists' and pianists' enlarged motor and sensory areas.

> "Our data will be the basis for a virtual human brain, a tool for the interpretation of functional imaging data and also a significant contribution to basic research."

A unique electronic atlas system for the brain is currently being created encompassing the cell architecture, the regional organisation of the cortex and the distribution of signal-carrying receptor molecules, and allocates functions to individual cortical areas with levels of defined probability. Professor Katrin Amunts and Professor Karl Zilles from Forschungszentrum Jülich are working on this international research project with colleagues from three big American and Canadian research institutions. The neuroscientists combine information from living test subjects, obtained by imaging procedures such as MRT and PET, with information from tissue sections to make "probability maps". Amunts explains that they give the probability of locating a particular function and structure in an element with a volume of one cubic millimetre. And Zilles adds that this data will create a virtual human brain, a tool for the interpretation of functional imaging data and also a significant contribution to basic research. Parts of the new atlas are already available to the scientific community on the internet and new findings are being added on an ongoing basis. ARÖ



PROF. KATRIN AMUNTS AND PROF. KARL ZILLES INTEGRATE STRUCTURAL AND FUNCTIONAL DATA IN THE BRAIN ATLAS. Photo: Forschungszentrum Jülich

Helmholtz Centre for Infection Research

HUMANISED MICE: A TEST SYSTEM FOR VACCINE DEVELOPMENT

Around 170 million people worldwide are infected with the hepatitis C virus (HCV), most of them in developing countries. Anti-viral treatments are very expensive, have serious side effects and are only effective for some patients. Most of the victims carry the infection for the rest of their lives, with the threat of later developing liver cirrhosis and cancer. The most effective way to combat Hepatitis C would be with a vaccine against the virus – but so far, no vaccine exists.

> "Up to now, there has been no substitute for primate models when developing vaccines against certain human pathogens."

One of the main reasons for this is the lack of appropriate animal models for the development of the vaccine. HCV can only infect the liver cells (hepatocytes), of humans and certain primates, but using great apes for testing purposes is ethically controversial and expensive as well. Mice, on the other hand, cannot be infected with HCV. This is the starting point for the researchers of the Helmholtz Centre for Infection Research around Professor Carlos A. Guzmán and their colleagues in the Human Vaccine Consortium, which, along with the Brunswick scientists, includes researchers from the Hanover Medical School, the Institut Pasteur and the Institute National de la Santé et de la Recherche Médical (both in France), the Academic Medical Center at the University of Amsterdam (Netherlands) and the Rockefeller University (USA). Their joint aim is to develop humanised mouse models: mice engrafted with human hepatocytes and immune system cells, to evaluate the efficacy of vaccine candidates against HCV. For the successful transplantation of human tissues and cells into mice their immune system should be deactivated. In order to transplant the human immune system as completely as possible to the mice, human genes, essential for various immune system functions, must be provided as well as human blood stem cells. So researchers are developing strains of mice with a defective immune systems carrying different human genes. The second step is to transplant either human blood stem cells or hepatocytes into these mice. The aim is to optimise the conditions for organ transfer: In which recipient mice do the human immune system components function most effectively? What conditions are most suitable for an effective engraftment of human hepatocytes in mouse livers? Guzmán explains that all procedures must be standardised and validated to ensure that they can be reproduced in any laboratory, which is essential if the animal models are to be used to test vaccines.

> "The effects of possible vaccines against the hepatitis virus can be tested on humanised mice."

After three years' work, the consortium researchers reached an important milestone in 2008. They now have a validated process of generating mice which are either engrafted with the cells of the human immune system (HIS mice) or whose livers contain human hepatocytes (HuHEP mice). Mice like these are researchers' preferred tools to predict human immune responses to vaccine candidates. The humanised mice are also much cheaper than primates, despite the high breeding costs, and permit a variety of other applications. HIS mice can be used to test vaccines and thereby predicting human immune responses whereas HuHEP mice can provide answers on toxicological and infection biology. Furthermore, both models can be used to test toxicity and efficacy of drugs against various infectious agents.
Work is continuing on optimising the two models and at the same time, the consortium aims to combine the HIS and the

THE PARTNERS IN THE HUMAN VACCINE CONSORTIUM HAVE DEVELOPED MOUSE MODELS TO TEST VACCINES AGAINST HEPATITIS. PHOTO: HZI

HuHEP mice. Guzmán explains the importance of transplanting human immune and liver cells into the same mice. The human hepatocytes are necessary in order to infect the mice with HCV and other hepatotrophic agents, whereas the human immune cells give information about the immune responses to the infection. Both of these processes are necessary in order to test a vaccine against HCV. If researchers succeed in producing such mice, that would be a huge milestone. The mouse model would be a suitable test system to help achieve the goal of developing vaccines against a number of human pathogens for which up to now, there were no alternatives to primate models. It would also enable much more accurate testing of the efficacy and toxicity for humans of possible vaccines than in conventional mice or other animal models. HELMUTH PROKOPH

Helmholtz Centre for Infection Research

EATRIS – FROM BENCH TO BEDSIDE

The EATRIS project is dedicated to improving translation of research into the clinical setting and streamlining research efforts, so that the enormously increased potential of basic biomedical research can be utilised effectively for the development of new treatments and diagnostic procedures. Research institutions and governmental institutions from nine European countries have come together under the EATRIS umbrella. Professor Rudi Balling, who coordinates EATRIS, says that the intention is to build a bridge between bench and bedside, across which information can pass in both directions. Under EATRIS, infrastructure across Europe is to be built up to support the development of clinical applications, covering everything from the screening of possible active ingredients through production according to good manufacturing practice (GMP) standards to conducting clinical studies. Project manager Dr Rebecca Ludwig explains, “We aim to equip existing institutions so that external users can use them to work on their research and development tasks, similar to the sharing of large-scale facilities in physics research.”

> “Under EATRIS, infrastructure across Europe is to be built up to support the development of clinical applications.”

During the preparatory phase up to 2010, the focus is on developing a joint strategy for building up the infrastructure. This also involves the organisation of an infrastructure which will be distributed over the entire European continent as well as the necessary European harmonisation for such an undertaking and the development of new training programmes. HELMUTH PROKOPH

FACILITIES CAPABLE OF DELIVERING CONSISTENTLY HIGH QUALITY ARE REQUIRED FOR THE MANUFACTURE OF ACTIVE INGREDIENTS: Photo: HZI

PIPETTE ROBOTS ARE USED IN PREPARING FOR LARGE-SCALE SCREENING. PHOTO: T. SCHWERDT/DKFZ

German Cancer Research Center

DRAGNET INVESTIGATION IN THE GENOME

The robot arm whirs quietly as it aims precisely for the 384 dimples in a plastic plate and inserts minute quantities of various reagents. More than 200 of these plates pass through the fully automated stations from preparation to partially automated microscopic evaluation. “We are carrying out a kind of dragnet investigation of the human genome,” smiles Professor Michael Boutros, head of the department of Signalling and Functional Genomics at the German Cancer Research Center. “We are looking for genes which play an important part in cancer.”

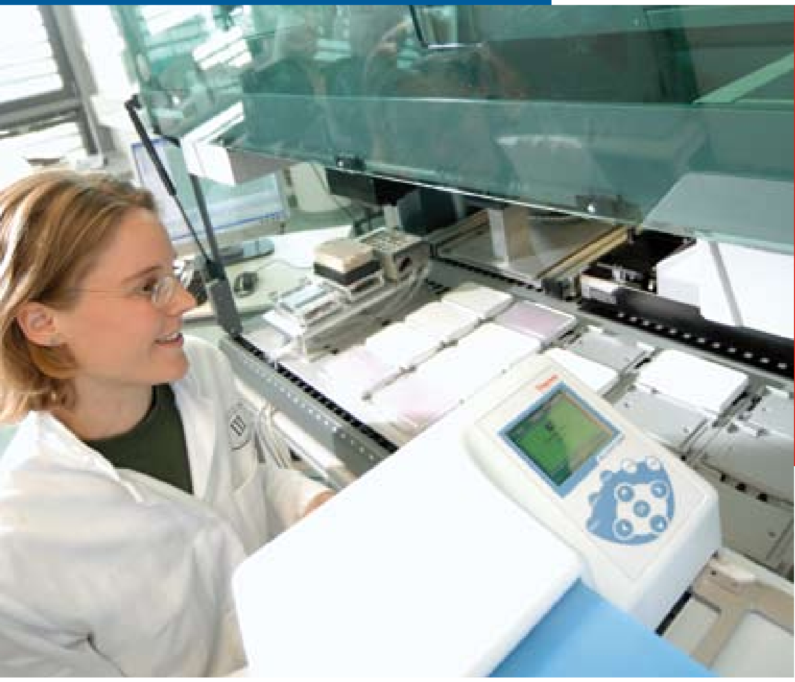
> “We are conducting a genome-wide search for suspicious genes.”

In the current project, Heidelberg researchers around Michael Boutros are collaborating with Professor Georg Halder and colleagues from the M.D Anderson Cancer Center in Houston, Texas, to detect genes whose activity is responsible for the survival of cancer cells. The two groups’ experience complement each other perfectly: the Boutros laboratory has established the large-scale screening process while the colleagues at M.D. Anderson Cancer Center have wide experience in developing and testing active ingredients. In the “hunt” for the genes, Boutros uses the RNA interference (RNAi) as a screening method. This method uses short double-stranded RNA molecules which suppress certain gene sequences and thus inhibit the production of proteins within the cell. In their experiment, the researchers expose cancer cells and normal cells under identical conditions to the effects of gene-specific RNAi samples. If the cancer cells die while normal cells survive, this could indicate the presence of one of the genes they are looking for. “We are conducting a genome-wide search for suspicious genes,” says Michael Boutros, “in other words, hunting for a needle in a haystack.” Without large-scale screening, it would not be possible to cope with the task of examining 25,000 genes and many times that number of RNAi samples, hence the large amount of time and effort spent by Boutros and his working group developing and establishing the large-scale RNAi screening.

> “We may discover genes which permit an entirely new approach to cancer treatment.”

To test automatically how cells behave after the genes have been suppressed, they have also developed special microscopy processes which enable thousands of images to be taken and analysed. All data are collected and entered into a database which is widely used internationally. They also make their experience and infrastructure available to other researchers. Michael Boutros explains that they almost always have several visiting researchers who study their methods and then apply them to their own projects. The Heidelberg scientist ran an international EMBO course on large-scale RNAi screening in June 2008. In the first screening phase, the Boutros laboratory often uses Drosophila fruit fly cells. “Drosophila mostly lack functional redundancy, so that the suppression of a gene has immediately visible effects,” Michael Boutros explains. “This is an advantage if you want to prove loss of function.” This makes the system so well suited to finding prospective candidates among the genes whose relevance must of course then be tested in further experiments. Using this strategy, the Heidelberg-based researchers have already found several interesting genes, including Evi, identified in Drosophila; a gene which intervenes in the signalling pathways of cell differentiation and tumour formation. Experiments show that Evi has an important signalling function in human cells too.

Human cancer cell strains are used in the second screening phase. Established active ingredients and new ones still in the experimental stage are tested to find genes whose suppres-



sion increases the effectiveness of cancer medication. Michael Boutros and his scientific team anticipate findings which lead to a more focused cancer therapy, for example, which chemotherapeutic medicine could be best used for patients with a particular genetic disposition. Looking to the future, Michael Boutros envisages perhaps discovering genes which permit an entirely new approach to cancer treatment.
HELMUTH PROKOPH

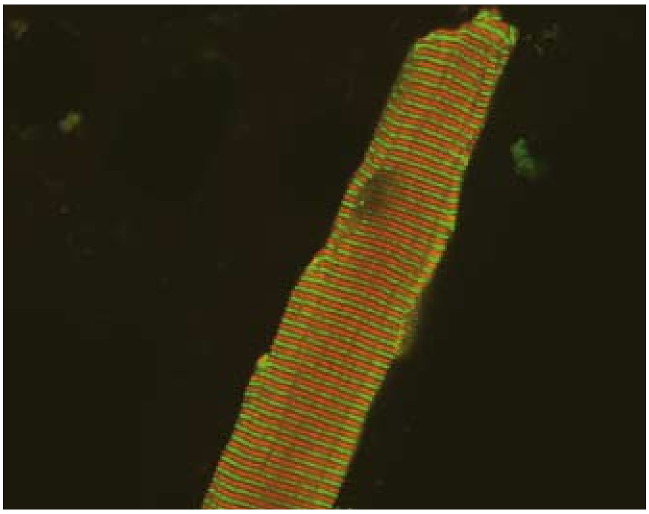
Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

TITIN – TRACKING AN ALL-ROUNDER AND ITS FUNCTIONS

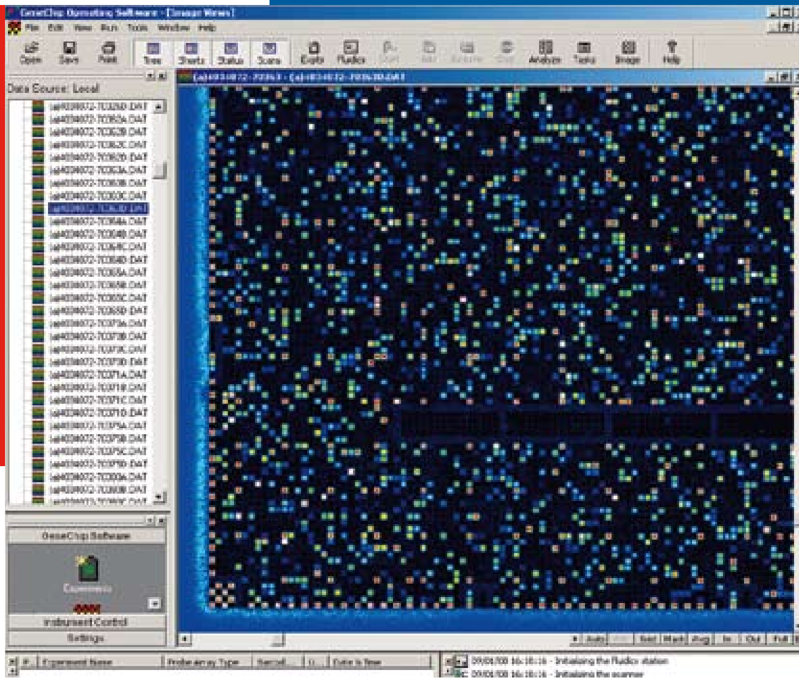
Titin is the largest protein in the human body and is located in the sarcomere, the molecular unit of the muscle fibres in the musculoskeletal system and the heart. It creates an elastic link between parts of the sarcomere, which move towards each other as the muscle contracts and return to their original position when the muscle is at rest. Professor Michael Gotthardt and his working group at the Max Delbrueck Center in Berlin are collaborating with colleagues from the University of Arizona and Washington State University to examine the functions of titin in the context of biomechanics, metabolism and signalling pathways. They hope that their research will reveal more about the causes of heart disease and amyotrophy. The titin molecule is made up of 26,000 parts grouped in functional modules. In order to gain an idea of the functions of the

> Michael Gotthardt's working group has produced the first titin-based animal model for diastolic cardiac insufficiency, which is especially prevalent in women.

various modules, the Gotthardt laboratory has produced mice whose heart muscles produce titin with altered modules. Either a particular module does not function from the start or its production can be switched off. Through these experiments, the researchers have established that titin has many regulatory functions. For example, if the N2B module is switched off, the mouse develops a smaller heart with less elasticity.
Michael Gotthardt and his group of researchers have produced a strain of N2B-KO mice, the first titin-based animal model for diastolic cardiac insufficiency, which is especially prevalent in women. Molecular mechanisms which lead to cardiac insufficiency can be examined using this model; researchers hope that this will enable them to develop new treatment strategies.
HELMUTH PROKOPH



ISOLATED MOUSE CARDIAC CELL. THE STRIPES ARE CAUSED BY THE REGULAR ARRANGEMENT OF THE PROTEINS ACTININ (RED) AND TITIN (GREEN). Photo: Michael Radtke, MDC



Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

STAR MAKES RATS APPEALING FOR GENETIC RESEARCH

Rats have been used as laboratory animals for over a century. Over 500 strains of rats have been bred which are particularly susceptible to common diseases such as high blood pressure, arthritis or diabetes. They are used in the examination of the physiology of diseases and the efficacy and tolerability of new medicines. These homogenous strains make it easier to identify genes related to the disease and if the gene has been discovered in rats, it is easier to find in humans.

> "We chose the rat model because there is a rat strain which reflects the clinical picture of human cardiac insufficiency extremely well."

For this purpose, the variations in the rat strains genomes have to be analysed in as much detail as the physiological variations have already been. Researchers of the international STAR consortium have set themselves this task [STAR is RATS, backwards]. Professor Norbert Hübner, head of a research group at the Max Delbrueck Center in Berlin-Buch and coordinator of the STAR project, explains that their aim was to establish subtle variations in the genome showing differences between the rat strains. Above all, they wanted to map variations in individual sequences of the genome, so-called SNPs. If the SNPs' relative positions can be established, the genome can be mapped. The SNPs act as milestones. The closer together they are, the more precisely one can orient oneself in the genome. Dr Kathrin Saar of the Buch-based working group and project manager in the STAR consortium says that they have already found about three million new SNPs and have mapped over 20,000 SNPs which are evenly distributed throughout the genome in more than 200 frequently used rat strains. Now they can make statements about the genetic relationships of the strains. This means that detailed genetic maps are now available for the functional analysis of variations in the genome. This gives researchers the chance to start with rat models when they are hunting for genes which are relevant for common human diseases. Hübner's working group has used this new tool of rat genetics to find variations in the genome which are connected to cardiac insufficiency. "We chose the rat model because there is a rat strain which reflects the clinical picture of human cardiac insufficiency extremely well. These rats spontaneously develop high blood pressure and later in life they tend to develop cardiac insufficiency. They are known as SHHF rats," Huber explains. "Animals of a different strain, so-called SHRSP rats, have similar blood pressure levels but tend not to suffer from cardiac insufficiency." To find the variations in rat genome associated with cardiac insufficiency, the Buch-based research group aim to compare the genomes of rats with high blood pressure and cardiac insufficiency, those with high blood pressure but healthy hearts and those with normal blood pressure.

> "Our findings provide the scientific basis for testing particular active ingredients in the treatment of cardiac insufficiency."

Rats from the strain with a tendency to cardiac insufficiency have been crossed with rats from other strains. Both cardiovascular and genetic data were analysed in the offspring. From the genetic variations associated with cardiac insufficiency, the Buch researchers were able to identify a gene which favours the development of cardiac insufficiency in rats. It is the gene for the enzyme soluble epoxy-hydrolase. In rats with a tendency to cardiac insufficiency, a variation in the gene caused an increase in amounts of the enzyme and thus to excessive hydrolase activity. Because the enzyme metabolises substances which protect the heart muscle, excessive activity can lead to cardiac damage. In order to find out if the increased amounts found in the rats also apply to other animals, further experiments were carried out. Tests on mice and on tissue samples from cardiac insufficiency patients confirmed the Buch researchers' interpretation that the

THE DATA ON MANY GENE CHIPS WAS EVALUATED IN THE PROCESS OF MAPPING THE RAT GENOME. PHOTO: K. SAAR/MDC

faulty regulation of epoxy-hydrolase increases the likelihood of cardiac insufficiency not only in rats, but also in humans. Hubner believes that this could enable new approaches to treatments for cardiac insufficiency: the findings provide the scientific basis for trials of active ingredients which restrict the epoxy-hydrolase. HELMUTH PROKOPH

Helmholtz Zentrum München –
German Research Center for Environmental Health

THE DATA TREASURE-TROVE IN THE SOUTHERN URALS

Sometimes Dr Peter Jacob's job is like a detective's. How much radiation was a worker exposed to fifty years ago in the Russian plutonium factory Mayak? How did the system of dams on the Techa river work, into which the radioactive waste used to be released? Jacob coordinates the project on radiation risk research in the Southern Urals (SOUL) which involves fourteen Russian and European research institutions. The researchers aim to analyse the unique data from the medical records of the Mayak workers and the people living on the river. Both groups were exposed to radiation in the late 1940s and early 1950s, the period when plutonium production for nuclear weapons was being expanded in the so-called secret cities. Peter Jacob says that many of the estimates about the amount of radiation exposure the people suffered have large uncertainties. His laboratory in the Helmholtz Zentrum München is therefore examining items such as bricks from buildings on the banks of the Techa and affected people's teeth. The results indicate a relatively low exposure for the local inhabitants – comparable with that of more exposed workers in Germany or patients who have had several whole body CT scans. For exposure of this type, it was previously thought that the cancer risk per dose was less than for nuclear bomb survivors. However, initial analyses of the Techa residents do not confirm this. The cancer risk per radiation dose appears to be just as high for them.

The Mayak workers, on the other hand, were exposed to relatively high levels of radiation. Jacob explains that through the study of Mayak workers, the lung cancer risk resulting from plutonium exposures could be established for the first time. Plutonium causes about ten times as many cases of

> "This study of the Mayak workers allowed for the first time a direct assessment of the lung cancer risk resulting from plutonium exposures."

lung cancer as the same dose of gamma radiation. The researchers are now eagerly anticipating the analysis of cardiovascular disease among the Mayak workers. The indications are that radiation protection must take not only the risk of cancer but also of cardiovascular disease into account. JULIA GROSS

LUMINESCENCE MEASURING OF BRICK SAMPLES ENABLE THE RECONSTRUCTION OF EARLIER RADIATION EXPOSURE. Photo: Helmholtz Zentrum München/Y. Gösku

RESEARCH FIELD
KEY TECHNOLOGIES

GOALS AND ROLES

Whether in mobile phones, digital cameras or PCs, in cars or aircraft – novel materials which are used to make ever tinier transistors and chips on semiconductor crystals, lighter vehicle bodywork or more powerful aero engines form the basis for modern communications and mobility while at the same time conserving the environment and natural resources. The Helmholtz research field key technologies paves the way for new fields of technology that have an enormous innovation potential for science, industry and society. In the Helmholtz Association, scientists focus their work on technologies that require high competence in system solutions, that promise new methods and solutions for other research areas, or that are particularly interesting for industrial applications. This includes the fields of nanoelectronics, nanotechnology, microsystems technology, functional material systems and scientific computing. Research is intensified in those areas where considerable application potential is identified until the innovations have proved their suitability for specific fields of application. The exploration of key technologies deliberately builds on a broad scientific basis. On the one hand, this ensures that all options and opportunities for use are covered and, on the other hand, this enables the chances and risks for society to be evaluated. Partnership with the universities, which is so eminently important in this field, is continuously developed. Special mention must be made here of the newly founded Karlsruhe Institute of Technology – KIT – and the Jülich Aachen Research Alliance – JARA.
The 2007 Nobel prize for physics awarded to Professor Peter Grünberg was of particular significance for this area of research. Together with his colleague Albert Fert from the University of Paris, he was honoured for his discovery of giant magnetoresistance (GMR), which brought about the breakthrough to gigabyte hard disk drives and laid the foundation for the pioneering technology of spintronics.

As part of programme-oriented funding in the Helmholtz Association, after five years of successful work scientists in the research field of key technologies undergo a quality control process. In the evaluation process with international reviewers, the strategic orientation of the research field and the programmes will be laid down in the second half of 2009. On 1 January 2010, the research field will then embark upon the second round of programme-oriented funding.

"The GMR effect and the Nobel Prize in Physics awarded to Peter Grünberg illustrate the relevance and the potential of the future key technologies that we are investigating on a broad scientific basis in order to enhance Germany's economic strength by inventions and innovations."

PROF. DR. ACHIM BACHEM Helmholtz Vice-President representing the Research Field Key Technologies, Forschungszentrum Jülich

PROGRAMME STRUCTURE

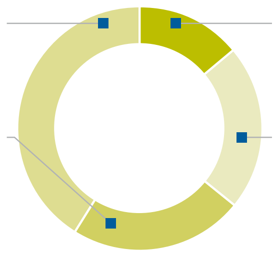
Three Helmholtz Centres cooperate in the research field of key technologies: Forschungszentrum Jülich, Forschungszentrum Karlsruhe and GKSS Research Centre Geesthacht. In its cross-cutting function, the research field provides supercomputing capacities and supplies important and indispensable user support. This research field has overall responsibility for materials research in the Helmholtz Association, which is pursued in various research fields on a problem-related basis. The scientists work in the following four programmes:

- Scientific Computing
- Information Technology with Nanoelectronic Systems
- Nanosystems and Microsystems
- Advanced Engineering Materials

This work is characterised by close cooperation with industry and by the coordination of networks linking the research institutions and commercial enterprises. The research field focuses the common interests of science and industry in order to act in a concerted manner within the European Union and on the international stage. The scientists involved also function as contacts for commercial enterprises and associations and provide information for political decision makers on the opportunities and risks of new technologies. Wherever existing competences complement each other this synergy is exploited for cross-programme cooperations. One example is molecular electronics, which at Jülich and Karlsruhe is sited at the interface between information technology and nanotechnology. Moreover, other Helmholtz research fields also profit from work on key technologies such as the research fields of energy, transport and space, health, and the research field of earth and the environment.

Structure of the Research Field Key Technologies
Core-financed Costs 2007: € 105 million

The Key Technologies research field receives a further € 38 million in third-party finance.
It thus has at its disposal a total of € 143 million.



THE PROGRAMMES

Scientific Computing

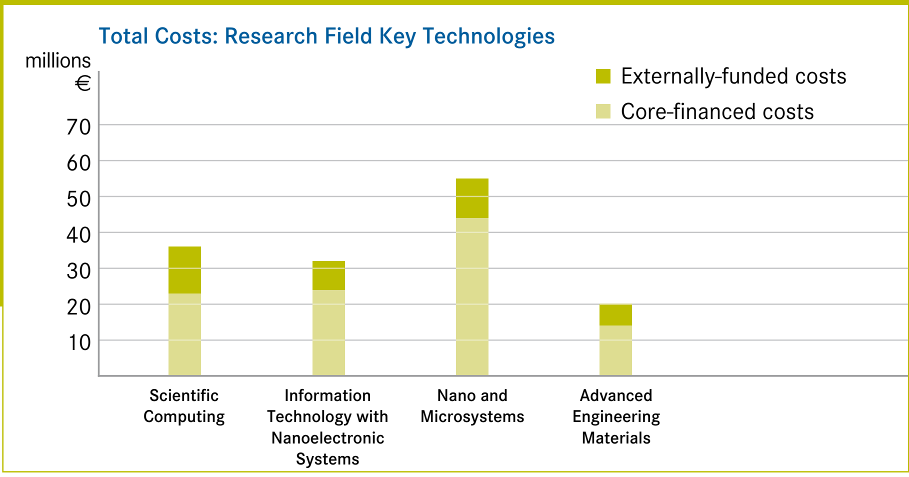
The processing of large volumes of data or the modelling of complex systems are important tools for research and are subsumed under the heading of scientific computing. With its priorities of supercomputing and grid computing, the programme provides indispensable infrastructures for German science. At the John von Neumann Institute for Computing (NIC) in Jülich and the Grid Computing Centre Karlsruhe, experts work on improving methods, tools and application developments, and provide support for numerous internal and external users from other research fields and institutions. This research programme has the mission of establishing and operating the latest and most powerful generation of supercomputers.
In October 2007, the most powerful computer for civil research in existence at that time – JUGENE – was put into operation at Forschungszentrum Jülich and officially unveiled in February 2008. As a further step towards the creation of a European infrastructure for high-performance computing (HCP), the consortium “Partnership for Advanced Computing in Europe – PRACE” was established in 2007. This partnership means that the area of the simulation sciences will continue to be extended – especially at Forschungszentrum Jülich. Meaningful processing of the ever greater flood of data supplied by accelerators and satellites represents a special challenge. The concept of grid computing, in which computers are networked to form functional clusters, enables ever greater volumes of data to be analysed. The GridKa computer network has been established at Forschungszentrum Karlsruhe, since 2007 it has been processing part of the data from the Large Hadron Collider (LHC) at CERN – the European Organization for Nuclear Research – and is linked to computer centres in other countries. Researchers find large-scale computing resources here to help them, for example, in their search for new active substances to combat malaria.

Information Technology with Nanoelectronic Systems

Semiconductor components are becoming ever smaller and still have not reached the boundaries of miniaturisation. Research in this programme precedes industrial developments and explores quantum electronic, magnetoelectronic, ferroelectric and molecular nanostructures. Ultrahigh-frequency electronic and bioelectronic signal processing is also part of this programme. The scientists perform basic research on materials and the processes taking place within them. They explore information processing in logic devices, the storage of information in random access memories (RAMs) and mass memories, the transfer of information on the chip and systems level, and they also develop new sensors.

Nanosystems and Microsystems

Whereas microsystems technology is almost ready for application, nanotechnology still requires extensive basic research. The two are combined in this programme. New microsystem structures of plastics, metals or ceramics are developed here, capable of fulfilling functions unattainable by sillicon-based microsystems. The scientists design microtechnological components and systems for selected fields of application – usually in cooperation with industry: for example for microoptics, micro process engineering, gas analysis, microfluidics and life sciences.
The application potential of inorganic, organic and bioorganic nanostructured systems is very promising and as yet has hardly been explored. On the one hand, this involves the understanding of the essential processes. On the other hand, it also concerns the development of materials with completely new properties, some of which are of great interest for industry. The researchers furthermore also work on the controlled gerneration of biological functional units technological materials. Nanofabrication plants will emerge at the



interface between micro- and nanotechnologies, where it will be possible to produce nanostructured systems with tailor-made properties on an industrial scale. For the first time anywhere in the world, researchers at Forschungszentrum Karlsruhe, together with their scientific partners, have succeeded in directly observing the decisive steps in molecular self-assembly processes on the single-molecule level.

Advanced Engineering Materials

New materials and material systems such as composites for the sustainable and efficient use of raw materials and energy, also for applications in medical engineering - this is the aim of research work in this programme. Developments are focused on materials with great application potential: novel metallic and functional polymer-based materials. They will be applied for lightweight construction in transport and energy technology, in chemical process engineering, in future hydrogen technology and also in medical engineering. Helmholtz scientists are working on basic issues of alloy and polymer development, processing, and development and testing of components and processes, in close cooperation with national and international partners from universities, research institutions and industry. Recently developed material and computer models provide valuable support in the design and evaluation of new materials systems. Breakthroughs in materials development have been achieved both in the synthesis of high-temperature titanium aluminides for high-performance turbines in aviation and energy generation and also in the development of novel magnesium recycling alloys for vehicle technology, and they are expected to be used in industrial applications very shortly. The simulation of magnesium extrusion pressing processes and the failure evaluation of lightweight components made of aluminium represents one of the most important and particularly successful research topics.
The MemBrain Helmholtz Alliance was especially successful since in this programme composite membranes were developed with as yet unparalleled performance for CO_2 separation. They are now being subjected to long-term testing. At GKSS, the storage capacity of metal hydrides and the system properties of fuel cells were modified in such a way that the overall properties of a potential hydrogen drive have been significantly improved. These projects were implemented as part of the Helmholtz Initiative and Networking Fund in the European Helmholtz Initiative FuncHy (Functional Materials for Mobile Hydrogen Storage) at GKSS together with Forschungszentrum Karlsruhe (2005–2009), the Virtual Institute "Asymmetric Structures for Fuel Cells" with DESY (2005–2008) and the project involving the Helmholtz Association and the National Research Council Canada "Development of membrane-electrode assemblies for fuel cell operation at high temperature and low humidity conditions" (2008–2010) with other leading European and Canadian research institutes.

CRICKET NERVE CELLS INTERCONNECT IN THE LABORATORY ALONG PREDEFINED PROTEIN STRUCTURES. PHOTO: FORSCHUNGSZENTRUM JÜLICH

PROJECTS

Forschungszentrum Jülich

LEARNING FROM CRICKETS

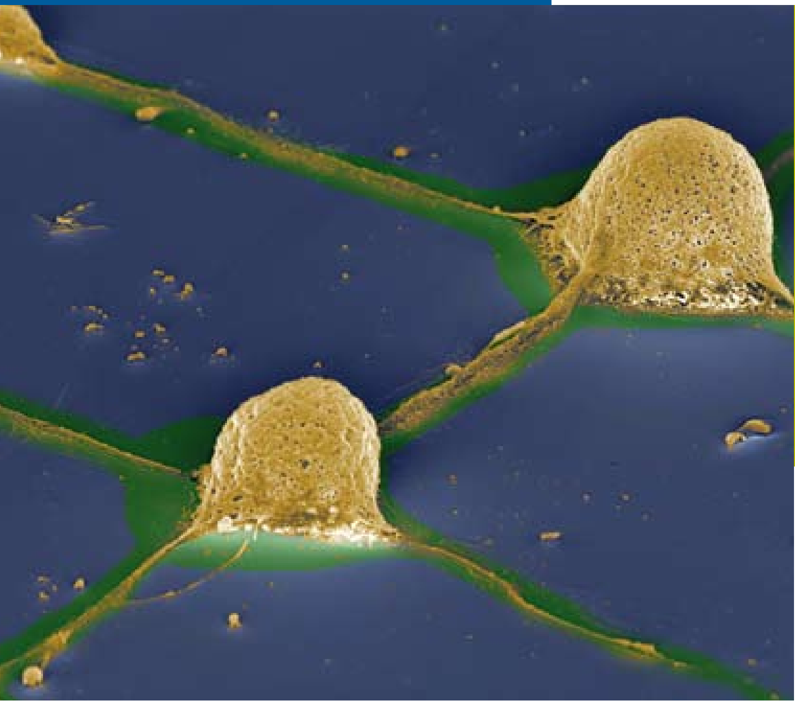
The wind whistles through the grass and the cricket sits calmly on the ground. All at once a wolf spider appears, ready to attack. Its approach is almost soundless amongst the general rustling of leaves and stalks. But the cricket senses the characteristic vibrations made by the predator, and as fast as lightning it gets out of harm's way. "How the cricket manages to filter out such quiet signals in a noisy environment is what we would like to be able to understand better, partly so that we can use it for technical applications," says Professor Andreas Offenhäusser of the Institute of Biosystems and Nanosystems at Forschungszentrum Jülich. The physicist coordinates the European project CILIA (Customised Intelligent Life-inspired Arrays), in which experts in biology, physics and engineering sciences from the universities in Bonn and Munich (in Germany), Antwerp (in Belgium), and Twente in the Netherlands, from Odense in Denmark, Reading in the UK, Tours in France and Shandong in China are participating.

> "We are above all interested in the principles which the sensor systems of different species have in common, as we can learn most from these."

Crickets, fish, bats and many other living creatures often use several hundred sensitive sensors in order to gain their bearings or to recognise dangers quickly. Here both the geometrical arrangement of these sensors and also the subsequent processing of the incoming signals in the nerve cells play a crucial role in determining how efficiently the sensory network filters out the important signal from the rustling sound. Compared with what nature can do, technology is still very primitive and achieves a much poorer result even with more components and using more energy. Anyone who has a hearing aid experiences this when trying to concentrate on a conversation at a noisy party. The "danger detectors" in the case of the cricket are apendages on the rear body (cerci) which are covered with several hundred very thin hairs. At the hair roots there are nerve cells, which measure the air stream via the deflection of the hairs. These signals are processed in a nerve node in the rear body of the cricket, which consists of only a few hundred nerve cells. Scientists suspect that unimportant information is already filtered out at this stage, so that the succeeding nerve centres are not overburdened with data and can quickly trigger the life-saving reflexes. "We are above all interested in the principles which the sensor systems of different species have in common, as we can learn most from these," says Offenhäusser.

> "The intelligent networking which crickets, fish or bats have optimised in their sensor fields in the course of evolution could be transferred to the design of circuitry for technology."

Researchers at Tours in France simulate the air streams of various ecological situations in the laboratory and test how the cricket reacts to them. "These experiments are very important for us, since now we know what the incoming signals which are processed in the nerve node look like," explains Offenhäusser. The engineering scientists at the University of Twente have in fact already constructed artificial sensors modelled on the cricket hairs, which they also arranged as they appear on the cricket itself. In this way they can examine how the sensors work together. Offenhäusser and his team are working on how to decipher the way in which the signals are processed in the nerve node of the cricket's rear body. They are looking at both living crickets and single nerve cells in order to understand how signals are passed on and how the nerve cells link up to become a neural network, which can calculate the correct reaction from the incoming "noise". For this purpose they place the nerve cells on a substrate, where they can link up with one another. Using a procedure which is reminiscent of potato printing, they first impress thin nanometre patterns consisting of specific proteins on the substrate.
The nerve cells, which they have previously extracted from the nerve node on the rear body of the cricket, adhere to the proteins and interconnect along the predefined structures.



In this way Offenhäusser tests how certain patterns affect the performance of the neural network. Placed in a line, each nerve cell has only two neighbours, so that the complexity is small, whereas in right-angled networks each cell can communicate with four neighbours, and in honeycomb-like structures with six neighbours. “However, it is extremely difficult to place large functioning networks consisting of live nerve cells on this substrate; we are working here at the limits of what is possible,” Offenhäusser explains. The Jülich group is also working on the development of interfaces between biological and electronic systems by linking nerve cells with components such as transistors. The intelligent networking which crickets, fish or bats have optimised in their sensor fields in the course of evolution could be transferred to the design of circuitry for technology, the CILIA partners hope. And thus in the long term hearing aids could be improved, so that even conversations in the middle of a lively party will once again become a pleasure. ANTONIA RÖTGER

Forschungszentrum Karlsruhe

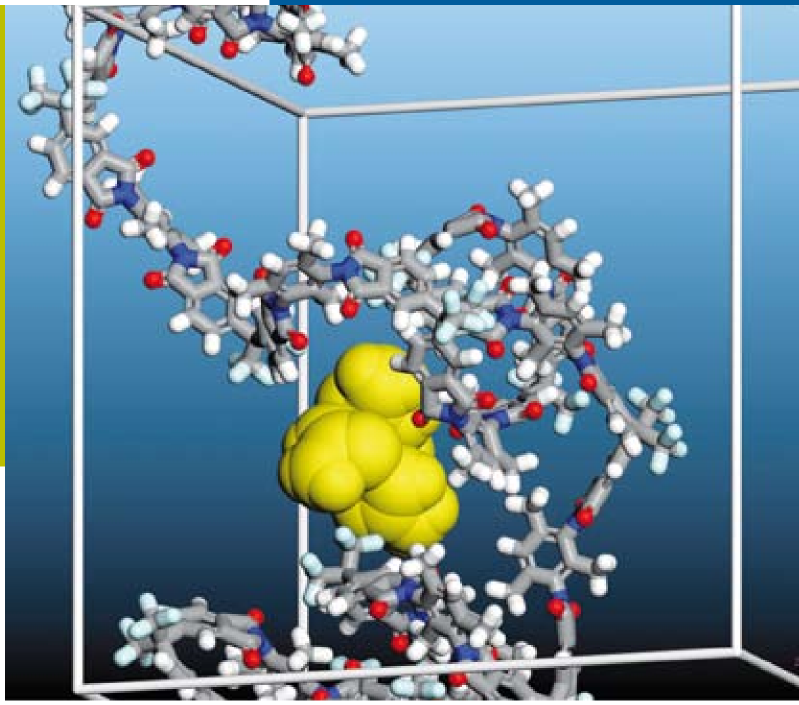
A NET CAPTURES THE DATA FLOOD FROM PARTICLE PHYSICS

The four most important experiments ALICE, ATLAS, CMS and LHCb at the Large Hadron Collider at CERN in Geneva alone will generate about 15 million gigabytes of data and simulation data annually. No computing centre in the world could cope with this flood of information on its own. For this reason regional computing centres are now being set up in several countries and linked up via high-speed cables. Grid software provides for the automatic distribution of data and burden-sharing. In Germany, Forschungszentrum Karlsruhe has assumed this task. As a result of the establishment of the Grid Computing Centre Karlsruhe (or GridKa), the German elementary particle groups now have at their disposal enough computing power and storage capacity to make their contribution to the data analysis of the LHC experiments. GridKa participates in the global LHC Computing Grid Project as a regional data and computing centre of the “Tier 1” category for the experiments ALICE, ATLAS, CMS and LHCb.

> “Apart from this, we are developing and testing new technologies with GridKa, and these will simplify the evaluation of experiments in high-energy physics.”

However, research groups from Germany can also use GridKa in order to evaluate their experiments at other large particle accelerators at Fermilab or CERN. “Apart from this, we are developing and testing new technologies with GridKa, and these will simplify the evaluation of experiments in high-energy physics,” explains Klaus-Peter Mickel, director of the Steinbuch Centre for Computing at Forschungszentrum Karlsruhe, which coordinates GridKa. “In the process we are gaining insights and experience which will also be useful for other branches of science with similar computing time requirements and amounts of data.” ARÖ

AT FORSCHUNGSZENTRUM KARLSRUHE A GRID COMPUTING CENTRE HAS BEEN SET UP. IT IS LINKED GLOBALLY VIA HIGH-SPEED CABLES WITH OTHER COMPUTING CENTRES. Photo: Forschungszentrum Karlsruhe



GKSS Research Centre Geesthacht

BIOMATERIALS AND MEMBRANES DESIGNED AT THE COMPUTER

On Professor Dieter Hofmann's screen we see a confused mass of balls and lines. "When a hydrogen atom makes its way through a layer of synthetic material, it is as if a tiny marble were moving aimlessly through a bundle of pearl necklaces," Hofmann explains. He can predict approximately which path the marble will take. For many practical applications a transport process of this kind is of great significance. For example, when water molecules are supposed to dissolve the thread with which surgeons have sewn up a wound. Or furthermore for membranes, which in a fuel cell permit hydrogen atoms to pass through to the oxygen in carefully measured doses, which separate alcohol from beer, or release medicines from capsules in very small amounts. Designing biomaterials and membranes for special purposes at the computer is a speciality of Dieter Hofmann at the GKSS Research Centre in Teltow near Berlin. The physicist coordinates the European research project Multimatdesign. With reference to concrete examples such as refining natural gas or biologically degradable suture threads, eleven European partners are working on new strategies for computer-aided material development.

> "In the last twenty years there has been tremendous progress in the programming of molecular processes. The Multimatdesign project is building on these developments."

The demands made on these materials are enormous. Their task is to separate mingled substances precisely, or they must be easily degradable in wet surroundings. To achieve this they must block certain molecules, and let others through. And depending on the application, they are supposed to be mechanically stable, compatible with other substances and if possible simple to produce. Hitherto such highly specialised synthetic materials were developed with the help of systematic experimentation. Starting out with an idea of what might be suitable chemical components, researchers synthesised polymers in the laboratory – long chains of complex molecules – and then used them to make a membrane, for example, whose properties could then be tested. "This is a lengthy and expensive process," says Hofmann. So why not let a computer do all the hard work? "In the last twenty years there has been tremendous progress in the programming of molecular processes," Hofmann explains. And the Multimatdesign project is building on these developments.

> "The French company Air Liquide wants to use the results in the very near future for quite specific tasks in the field of gas separation."

For the virtual test tube, too, the computer chemists select molecules with favourable properties. They add information about their type and size, and about the strength and geometry of their bonding. Then the computer sets to work, and calculates how the chains of molecules would finally end up arranging themselves. "This modelling procedure takes a lot of know-how," Hofmann emphasises. The mutual interaction of the many atoms in such a process is very complex. At various size levels different mechanisms come into play. These range from quantum chemistry, which influences the atoms and their bonding, to thermodynamics, which describes larger collections of particles in statistical terms. "In the Multimatdesign project we have brought together leading international experts from all these fields," Hofmann is pleased to tell. "It enables us to work at a problem in its entirety." For example, the physicist and his team at the GKSS Zentrum für Biomaterialentwicklung designed various models for a material that can be used to separate gases. In refining natural gas it could filter the unwanted components, butane and propane, out of the methane. The properties of the virtual membrane are also tested on the computer. Above all, the researchers calculate the path and the speed with which a propane molecule passes through the polymer. This depends, for example, on the size and distribution of the available volume between the swirling chains of pearls, and on how propane interacts with the membrane polymer – whether it is bound, permitted to pass, or is actively

COMPUTER SIMULATIONS CAN SHOW MOLECULAR CHAIN ORDER AND THE PROPERTIES OF NEW MATERIALS. PHOTO: GKSS

transported elsewhere. An Italian team from the research institute ITM-CNR participated in the project segment on gas refining. The French company Air Liquide wants to use the results in the very near future for quite specific tasks in the field of gas separation, for example, refining natural gas. For Multimatdesign is certainly not restricted to virtual chemistry. At each stage of the development chain there are experiments designed to test whether the models and simulations actually coincide with reality. However, the use of computers does not only make it possible to develop new materials more efficiently. “The simulations also make it possible for us to improve our understanding of fundamental processes,” emphasises Hofmann. “And that is the precondition for the ongoing development of wholly new ideas and rules pertaining to effective material screening.” UTA DEFFKE

Forschungszentrum Jülich

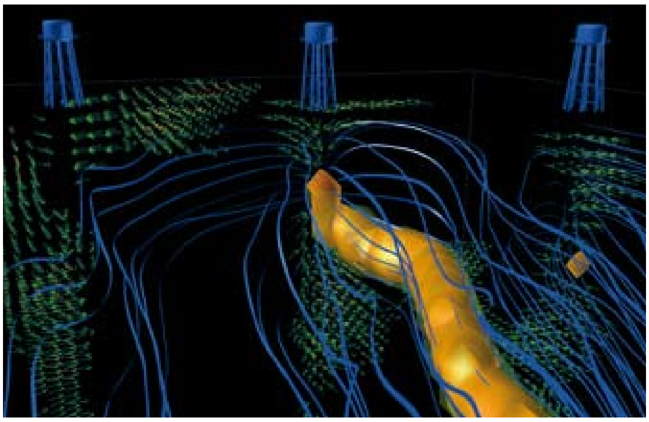
A SUPERCOMPUTER INFRASTRUCTURE FOR THE WHOLE OF EUROPE

When it comes to climate modelling, molecular biology or materials research, scientists need to have increasingly powerful computers at their disposal in order to be able to simulate complex systems in a realistic manner. “The great leaps of understanding in the future will come about with the help of the simulation sciences,” explains Professor Thomas Lippert, director of the Jülich Supercomputing Centre (JSC) at Forschungszentrum Jülich. The Helmholtz Centre not only has one of the most powerful supercomputers in the world, the IBM Blue Gene computer JUGENE, but is also promoting a Europe-wide network. In the “Partnership for Advanced Computing in Europe” project a total of 16 partner countries are constructing a joint supercomputer infrastructure for research purposes. Austria, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and the UK are cooperating in the PRACE consortium. They have recently been joined by Turkey and Ireland. The German representative in PRACE is the Gauss Centre for Supercomputing, which coordinates the activities of the three high-performance computing centres in Jülich, Stuttgart and Garching. In this way researchers from the whole of Europe will have access to supercomputer performance at the top international level, which national computing centres simply cannot provide. Yet until then much remains to be done. Hardware and software will have to be coordinated throughout Europe, prototypes for future supercomputers will have to be developed and tested.

“The great leaps of understanding in the future will come about with the help of the simulation sciences.”

At the same time the installation of the first petaflop systems at Forschungszentrum Jülich is in the pipeline. Besides customising hardware and software, the user support is also changing to high-level community-oriented support through simulation laboratories and targeted workshops. “This will enable our scientists and many European colleagues to further strengthen their leading position in the field of simulation sciences”, Lippert explains. ARÖ

Further information: www.prace-project.eu



SUPERCOMPUTERS SIMULATE GROUNDWATER CURRENTS, ALLOWING US TO ESTIMATE THE CONCENTRATION OF NOXIOUS SUBSTANCES (YELLOW) IN THE CATCHMENT AREAS AROUND WELLS (GREEN). Picture: Forschungszentrum Jülich

RESEARCH FIELD
STRUCTURE OF MATTER

GOALS AND ROLES

From inconceivably small elementary particles to the structure of the universe: this Helmholtz Research Field studies and explores the constituents of matter and the forces acting between them in completely different orders of magnitude. The focus is not only on single particles, but also on the complex phenomena caused by the interaction of myriads of atoms in liquids and solids. Basic research also provides us with insights which make it possible to develop novel materials with tailor-made electronic, mechanical or thermal properties. This research field particularly benefits from one of the special strengths of Helmholtz research: the operation and utilisation of large-scale facilities and complex infrastructure for research purposes. Whether we are talking about particle accelerators, synchrotron radiation or neutron sources – the Helmholtz Association makes available large and in some cases unique kinds of scientific infrastructures which are used by many researchers from home and abroad. The planned X-ray laser European XFEL now being built at Deutsches Elektronen-Synchrotron DESY in cooperation with European partners will create an X-ray source whose maximum performance will be 10 billion times greater than that of any previously built facility. Another large-scale instrument is being built at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. The "Facility for Antiproton and Ion Research FAIR" is a next generation accelerator which will generate ion beams of a hitherto unknown intensity and with very high energies. With its alliances, the Helmholtz Association has created new structures in order to be able to offer the very best conditions for research by means of improved networking. For example, two new Helmholtz Alliances were formed in 2007 in the Research Field Structure of Matter: "Physics at the Terascale" and "Cosmic Matter in the Laboratory." The network "Physics at the Terascale" brings together top German scientists who are working at the limit of achievable accelerator energy. In an increasingly global research environment, this is a way of giving particle physics in Germany greater clout and stature. Thus particle physicists from two Helmholtz Centres, the Deutsches Elektronen-Synchrotron DESY and the Forschungszentrum Karlsruhe, have joined forces with colleagues from a total of 17 universities and the Munich Max Planck Institute for Physics. The second alliance, "Cosmic Matter in the Laboratory", will lead to the foundation of a new institute, "ExtreMe Matter Institute (EMMI)", on the grounds of the GSI and to greater networking among the leading research institutions in this field. Unique insights can be expected from research into matter under extreme conditions, such as those prevailing shortly after the Big Bang. They will make a major contribution to the planning of experiments to be carried out on the new large-scale facilities under construction at GSI, at DESY and at CERN. An important decision was taken in January 2008: the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), formerly Hahn-Meitner-Institut will merge with the research centre BESSY at the beginning of 2009 to become the largest research institution in Berlin. It will then be known as the Helmholtz-Zentrum Berlin für Materialien und Energie. The HMI already officially changed its name in June 2008.

Within the framework of programme-oriented funding, scientists working in the Research Field Structure of Matter subject their research to a quality check after a period of five years. In the first half of 2009 an international review panel will evaluate the strategic alignment of the Research Field and its programmes. The second round of programme-oriented funding for the research field begins on 1 January 2010.

"We develop, build and utilise unique modern research facilities in order to understand the structure and function of matter and materials. Our facilities are used each year by several thousand scientists from home and abroad, whose research is made possible by the Helmholtz large-scale facilities and whom we support in their work. In this way we are making an important contribution to the attractiveness of Germany as a research location."

PROF. DR. ALBRECHT WAGNER Vice-President representing the Research Field Structure of Matter, Deutsches Elektronen-Synchrotron DESY

PROGRAMME STRUCTURE

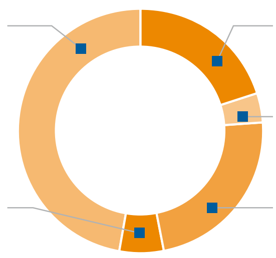
Six Helmholtz Centres work together in the Research Field Structure of Matter: the Deutsche Elektronen-Synchrotron DESY, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the GKSS Research Centre Geesthacht, the GSI Helmholtz Centre for Heavy Ion Research and the Helmholtz-Zentrum Berlin für Materialien und Energie. The scientists currently work in five programmes:

- Elementary Particle Physics
- Astroparticle Physics
- Physics of Hadrons and Nuclei
- Condensed Matter Physics
- Large-Scale Facilities for Research with Photons, Neutrons and Ions

All of the programmes are based on the close interaction of theory and experiment, and some of them are interlinked in scientific and technological ways. The goal is to continually advance the development of the research infrastructures, to use them efficiently and to give the users the best possible support in order to maintain the leading role of Helmholtz scientists in this field together with their national and international partners.

Structure of the Research Field Structure of Matter
Core-financed Costs 2007: € 449 million

The Research Field Structure of Matter additionally receives third-party finance amounting to € 61 million. It thus has a total budget of € 510 million.



THE PROGRAMMES

Elementary Particle Physics

This programme investigates the smallest building blocks of matter and the forces acting between them. The results directly affect our picture of the evolution of the early universe. The origin of mass, the unification of all fundamental forces at extremely high energies and the reconciliation of quantum physics with the general theory of relativity are among the grand challenges of physics today. Scientists are also searching for traces of new particles and for the supersymmetrical partners of all the known particles. Apart from the accelerator capacities throughout the world, scientists in this research field also have access to high-performance computers for data analysis and for questions relating to theoretical physics. The Grid Computing Centre at the Forschungszentrum Karlsruhe (GridKa), which went into operation in 2007, is a powerful computing centre which is part of an international network. This means that powerful computer links to CERN are now available, as well as to all the other participating centres in Europe, the US and Asia. This will play a crucial role in the evaluation of the large amounts of data which will be produced by the Large Hadron Collider (LHC) at the European research centre CERN. The successful operation of the HERA accelerator at DESY was concluded as planned. After 15 years of productive physics research it proved possible to obtain a uniquely detailed picture of the proton and of the forces active within the proton, which for the foreseeable future are unlikely to be surpassed by any other accelerator in the world. The measurements have considerably enlarged our understanding of subatomic physics and have already been incorporated into physics textbooks. They constitute an essential point of departure for the new experiments in the field of terascale research.

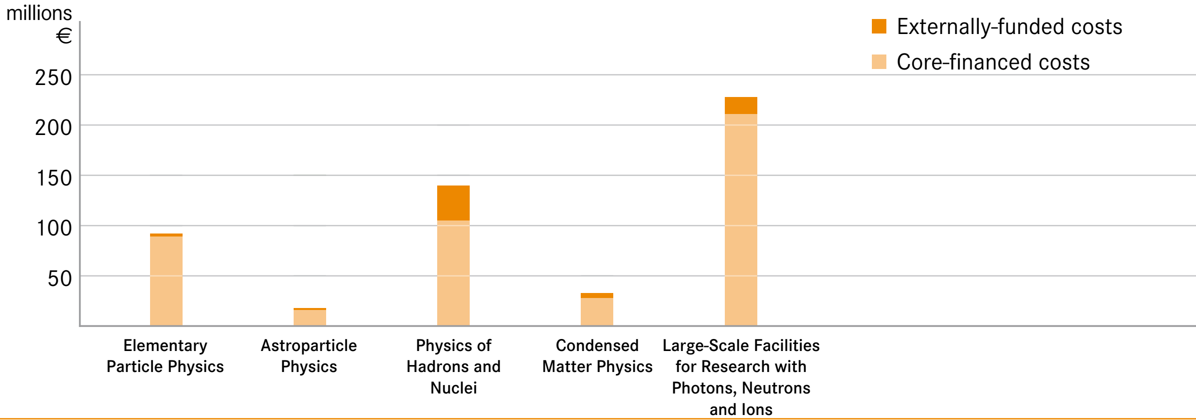
Astroparticle Physics

Astroparticle physics is a relatively young interdisciplinary research field that combines research into the smallest building blocks with investigations into the largest structures of the universe. Astroparticle physicists study the sources of cosmic radiation and the mechanisms of cosmic accelerators. They investigate astrophysical objects using not only visible light but also nuclei, neutrinos and high-energy gamma radiation as messengers from space. At the same time, the scientists in this programme are investigating what is known as dark matter, whose presence could previously only be inferred from its gravitational effect. The programme currently has three core focuses: research into electrically charged cosmic radiation at high energies (Pierre Auger Observatory, Argentina), the search for high-energy cosmic neutrinos (IceCube neutrino telescope, Antarctica), and the measurement of the neutrino mass with hitherto unattained precision (KATRIN, Karlsruhe). In order to accomplish these tasks the research field has to develop, build and operate large detector facilities with an efficient infrastructure, mostly at locations far away from existing research centres. Last year scientists celebrated two great successes: The collaborative IceCube project has already been able to start deploy half of the detector, which is a total of one cubic kilometre in size. In 2007 the Pierre Auger project produced a trailblazing scientific result; by ascertaining the direction from which they arrived, it was possible to establish a link between the origins of the highest-energy particles provable on earth and the position of nearby galaxies.

Physics of Hadrons and Nuclei

Neutrons and protons (hadrons) are made up of quarks, which are bound together through strong interaction. Scientists in the Physics of Hadrons and Nuclei programme primarily work on the following topics: quark confinement in hadrons, the spontaneous breaking of chiral symmetry, the origin of hadron mass, properties of nuclear multi-particle systems, exotic nuclei at the limits of stability, the generation of superheavy elements, and the behaviour of extended nuclear matter in astrophysical objects such as neutron stars and supernovae. The search for hitherto unknown types of matter such as quark-gluon plasma is a further research topic. In the field Structure of Nuclei, the SHIP collaboration was able to produce element 112 by means of so-called warm fusion reactions. As a result, it is hoped that it will soon be possible to move forward into the long aspired to field of spherical superheavy nuclei.

Total Costs: Research Field Structure of Matter



The Facility for Antiproton and Ion Research (FAIR), which is being constructed at GSI as an international project, is an accelerator of the next generation. Work on the construction of FAIR at the GSI Helmholtz Centre for Heavy Ion Research began in Darmstadt on 7 November 2007. The first experiments are scheduled for 2013. FAIR will supply ion beams with which it will be possible to create exotic atom nuclei and antiprotons in order to study quark-gluon plasma and forms of matter which shaped the beginnings of the universe. Further research into quark-gluon plasma will be carried out at CERN with the LHC.

Condensed Matter Physics

The most momentous occasion in 2007 was the award of the Nobel Prize in Physics to Peter Grünberg. The Condensed Matter programme studies the properties of solids, of so-called soft matter, and of liquids. Scientists examine the interactions between electrons and atoms which determine the mechanical, thermal, electronic, magnetic and optical qualities of matter. The focus is on systems which consist of many particles and possess new and complex qualities. These include nanosystems, which form the transition from atoms to solid bodies. The principal goal of the programme is to examine new and unusual states in these materials. The programme profits from the large-scale facilities in the Research Field, which provide probes in the form of neutron, ion and synchrotron beams. The scientists also use spectroscopic procedures, high-resolution electron microscopes and large computers, which allow them to carry out theoretical modelling and simulation. From 2009 the programme will form part of the Research Field Key Technologies.

Large-Scale Facilities for Research with Photons, Neutrons and Ions

This programme comprises the large-scale facilities which are especially important for many fields such as nuclear and molecular physics, plasma and condensed matter physics, structural molecular biology, chemistry and material sciences, earth and environmental research, as well as engineering. Research in the programme focuses on the effective use of existing photon, neutron and ion sources and their ongoing adaptation to the needs of the user communities. It is particularly noteworthy that a new world record was set up in 2007 at the free-electron laser facility FLASH at DESY. With the maximum energy of the electron beam of 1 gigaelectron volt and 6 nanometres, the laser beam attained the shortest wavelength which has ever been created with a free-electron laser. Another highlight was the official launch of the European XFEL project on 1 January 2008. The European XFEL is being built in close co-operation between the European XFEL GmbH, the Helmholtz Centre DESY and other international partners. From 2013 onwards it will deliver flash X-rays with extremely high intensities. This will enable scientists to film reactions in chemical or biological systems, for example, and to decipher atomic details of molecules. Furthermore, at the Helmholtz-Zentrum Berlin für Materialien und Energie the world's most powerful magnet for neutron experiments is currently being constructed. In combination with unique sample surroundings scientists believe that it will help them to make significant progress in materials research and a fundamental understanding of high-temperature superconductivity. The conversion of the X-ray radiation source PETRA III has been in progress since the middle of 2007. The foundation laying and topping-out ceremonies have already taken place. From 2009 onwards scientists will have access to the world's best storage ring source for hard X-ray radiation.

FLASH DELIVERS HIGH-INTENSITY FLASH X-RAYS FOR RESEARCH FROM BIOLOGY TO PHYSICS. PHOTO: DESY

PROJECTS

Deutsches Elektronen-Synchrotron DESY

WORLD RECORD LASER FROM HAMBURG

FLASH is the jewel in a new generation of lasers. It is located at the research centre DESY in Hamburg and fires high-intensity X-ray pulses at minute samples of material. The machine holds various records and fascinates not only German researchers, but scientists from all over the world. FLASH is a large-scale facility, 260 metres in length, and belongs to the genre of "Free-Electron Lasers" (FEL). It functions as follows: A superconducting accelerator speeds up minute electron packets almost to the speed of light. Then the electrons shoot through so-called undulators – magnet structures made up of many hundred pairs of magnets. They force the electrons to adopt a slalom path. "During the slalom the electrons lose energy, which they emit as laser flashes," explains DESY physicist Dr. Rolf Treusch.

> "FLASH is a machine that is unique worldwide and takes us a giant step forward."

"They are short, very powerful flashes of light with very short wavelengths ranging from extreme ultraviolet to X-ray radiation." Let's crunch the numbers: With a wavelength of 6.5 nanometres ("soft X-ray radiation") each FLASH burst of light has the power of about one gigawatt – 10,000 times more than all previous X-ray lasers. In order to achieve these results, the researchers have to exercise minute control over their facility. The electron packets on their zigzag route through the undulator are not allowed to deviate more than a hundredth of a millimetre from their prescribed path. The slightest disturbance can affect the laser. "At eight o'clock in the morning, when the people of Hamburg switch on their coffee machines, we sometimes get a power fluctuation and have to adjust our facility accordingly," explains Treusch with a smile. The key components of FLASH are superconducting accelerator elements known as cavities. They were developed at DESY from the 90s onwards under the label "TESLA Technology" both for particle physics and for this new laser generation. The new technology met with great interest internationally, and 52 institutes from 13 countries became involved in the development process. A test facility was set up, and in February 2000 it produced the first short-wave FEL flashes in the world. This finally led to FLASH. "A machine that is unique worldwide and takes us a giant step forward," says Professor Janos Hajdu of the University of Uppsala in Sweden. He is very enthusiastic about the pioneering spirit at FLASH: "It is great to work at the spearhead of research together with an international team."

> "They are short, very powerful flashes of light with very short wavelengths ranging from extreme ultraviolet to X-ray radiation."

Since 2005 the laser has been operating on a routine basis and is available to researchers from all over the world. It has elicited enormous interest. FLASH is completely overbooked, and by no means every scientist who would like to work with the intense X-ray flashes can be given the opportunity to do so. So far, almost 300 experts from 18 countries have examined their samples under the high-intensity X-ray light. The short wavelengths of the FLASH bursts of light are of such interest as they make it possible, among other things, to scan the most intricate details of a sample. Another positive feature is the fact that the pulses are so powerful that a measurement can often be successfully completed after only a single flash – an important precondition, for example, when studying microscopically small biological samples such as the minute plankton organisms. These "picoplankton" play an enormously important role in the earth's carbon cycle, since they bind considerable amounts of CO_2. Other scientists are using FLASH to examine single nano particles of a precisely defined size in the hope that this will enable them to create important preconditions for nanotechnology. With the help of bright X-ray flashes astrophysicists can analyse matter which can actually only be found in outer space – highly charged iron ions, for example, such as those which occur in the atmosphere of the sun.

And still other scientists are planning to "film" chemical reactions – the experts speak of pump-and-probe experiments. For this purpose an optical laser is set up in the measuring hall, and this triggers the chemical reaction. While the reaction is in progress, FLASH observes the microscopic spectacle with the help of its short bursts of light. Yet FLASH not only performs the function of a measuring instrument. It is also a pilot facility for a laser ten times its size. In 2014 the European X-ray laser is due to light up in Hamburg (European XFEL) – 3.5 kilometres long and at a cost of one billion euros. It will produce short-wave radiation of no more than about 0.1 nanometres and is designed to shed more light on the atomic structure of molecules and crystals. The researchers want to go further than just taking snapshots as they have until now, and actually observe minute bio-machines such as proteins at work. FRANK GROTELÜSCHEN

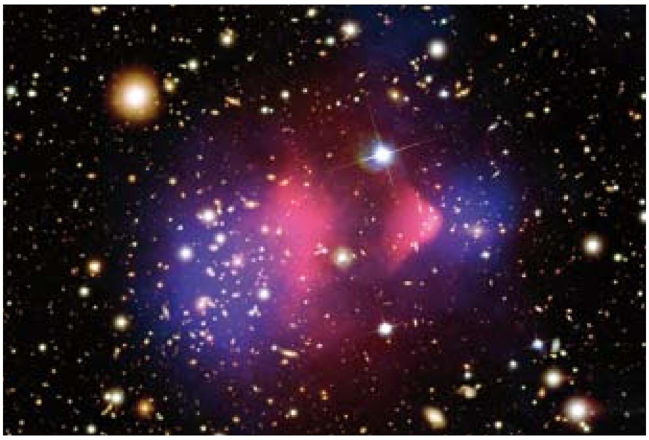
Deutsches Elektronen-Synchrotron DESY

IN SEARCH OF DARK MATTER

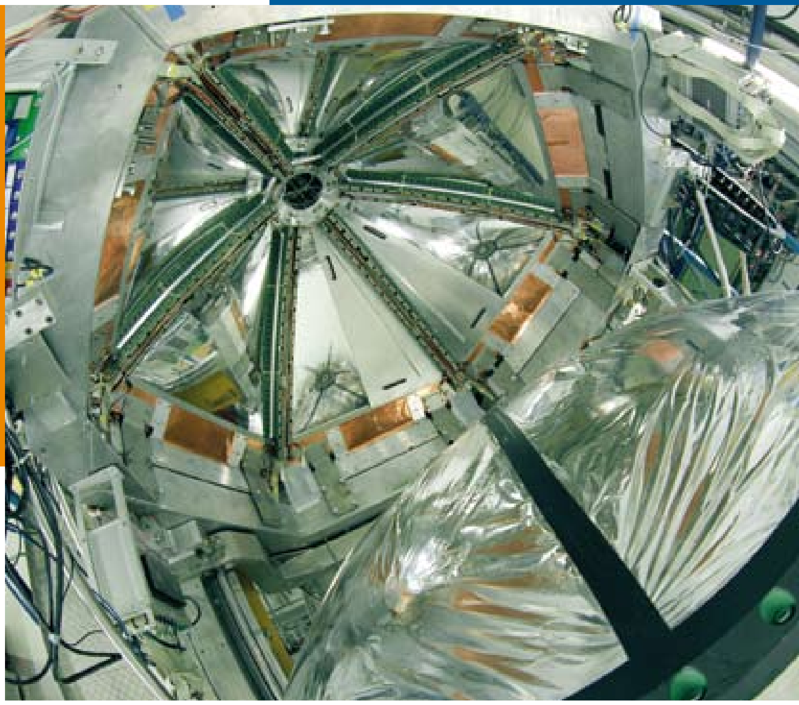
We can only "see" or use instruments to register a small part of matter in outer space; the greater part, known as dark matter, can only be inferred through its gravitational force. Yet no one knows what the elementary particles which make up dark matter actually are, and until now this has been no more than a matter of conjecture. Scientists working with Professor Wilfried Buchmüller at the Deutsches Elektronen-Synchrotron DESY and their colleagues working with Professor T. Yanagida of the University of Tokyo are interested in the hypothesis that dark matter in outer space consists of gravitinos. These are the supersymmetrical partner particles of gravitons, which carry the gravitational force, just as photons are the carriers of electromagnetic power. The theoretical physicists are constructing their hypothesis on new insights into the early stages of the universe, in which matter must have gained the upper hand against antimatter. This process occurred at very high temperatures, at which gravitinos are thermally created. If their conjectures are correct, there would now be new ways of registering dark matter through measurements. For it would mean that gravitinos are everywhere and – despite their extremely long lifespan – could occasionally, just like other particles, decay into photons and neutrinos, the lightest elementary particles. Both from within the Milky Way and from other galaxies they would, in decaying, emit photons with their characteristic kind of energy. It should be possible to observe such photons, even in 2008, with the help of the new space telescope Gamma Ray Large Area Space Telescope GLAST.

"The secret of dark matter may have been solved in five years' time."

In experiments at the Large Hadron Collider LHC at CERN the existence of gravitinos could perhaps be demonstrated by means of characteristic decay. "There are exciting years ahead of us. The secret of dark matter may have been solved in five years' time," according to Buchmüller. ARÖ



THE OVERLAPPING IMAGES TAKEN WITH GRAVITATION LENSES (BLUE) AND AN X-RAY TELESCOPE (RED) POINT TO THE EXISTENCE OF DARK MATTER IN THE BULLET CLUSTER. Photo: NASA



GSI Helmholtz Centre for Heavy Ion Research

NEUTRON STAR IN THE LABORATORY

What does it look like deep down in a neutron star? The question sounds presumptuous. After all, we are talking about highly unusual objects far out in the depths of space. Neutron stars are the remnants of massive stars after they have exploded as supernovae.

Neutron stars are only 10 to 20 kilometres in size, but have twice or three times the mass of the sun. Their gravitational field is enormous. On their surface an ordinary cent coin would weigh about four million tons. And on account of the enormous gravitational force, the matter at the centre of a neutron star does not consist of atoms, as would normally be the case, but of tightly packed nuclear particles, or neutrons.

> "With HADES we can look almost directly into the dense nuclear matter."

Even if this sounds surprising, this highly unusual kind of matter, known in technical terms as "nuclear matter," can to a certain extent be recreated in the laboratory. In Germany this occurs at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. Using powerful accelerators, the physicists fire gold nuclei, for example, at a target such as a piece of foil also made of gold. The impact of the gold nuclei is so violent that for a very brief moment a kind of fireball occurs – hot, highly compressed nuclear matter which is thought to occur in a similar though decidedly colder form in neutron stars. The problem is that the fireball cannot be directly observed in the experiments, since its existence is much too short. However, the extremely hot nuclear matter decays into countless subatomic particles, and with the help of detectors as high as a house, the physicists can track and measure these precisely. Subsequently they attempt to reconstruct in painstaking detail what the nuclear matter actually looked like. One of these detectors is called HADES (High Acceptance Di-Electron Spectrometer). It is an international project in which about 150 physicists from nine European countries are involved. What is unusual about HADES is the fact that it targets a special genre of particle that is created in the complex decay processes within the fireball: electrons and their antiparticles, positrons. "In contrast to most of the other particles, the electrons in the fireball are hardly deflected and can leave it in a relatively unhindered way," says GSI scientist Joachim Stroth, Professor at the University of Frankfurt and deputy speaker of HADES. "In this way we can look almost directly into the dense nuclear matter." However, it is rather rare for such electrons to be generated in the fireball decay processes. "For this reason we have built HADES in such a way that it can process up to 20,000 reactions per second," adds Stroth. Furthermore, certain components of the detector only react if electrons shoot through them. This ensures that only relevant reactions are recorded and analysed. HADES has been supplying data since 2002. So far, the physicists have discovered, among other things, how the energy distributes itself among the exotic particles which are briefly created in the fireball. "That is an important insight," says Stroth. "If we know how these particles behave, we can also make inferences about what is happening in a neutron star with its enormous gravity."

> "If we know how these particles behave, we can also make inferences about what is happening in a neutron star with its enormous gravity."

Already when HADES was being built foreign partners supplied and financed some of the components. "In addition, every group pays a certain amount per year in order to defray the running costs," explains Stroth. The experiment does not run all the time, but is usually conducted once a year over a four-week period. In order to make best possible use of the restricted amount of time available, the physicists work round the clock in shifts. "During this time, many foreign physicists come to Darmstadt to take over some of the shifts," says Joachim Stroth. "Since the start of the project in 1996, international teamwork has been very harmonious," enthuses Professor

THE DETECTOR HADES PROCESSES UP TO 20,000 REACTIONS PER SECOND. PHOTO: A.ZSCHAU/GSI

Piotr Salabura of the University of Cracow and spokesperson of HADES. "I especially value working together with the many research students from the partner countries. They do a large part of the work." The evaluation of the data in particular is very time-consuming. The physicists regularly discuss the interim results – in telephone calls, during video conferences or at one of the regular meetings. These do not always take place at GSI in Darmstadt. In 2007 the HADES meeting was held in far-away Cyprus, the local university being one of the project partners. The decision was taken to remodel HADES after 2009 and make it fit for the future. For in the forthcoming decade it is destined to conduct experiments at a new, even more powerful accelerator facility - the GSI future project FAIR.
FRANK GROTELÜSCHEN

Helmholtz-Zentrum Berlin für Materialien und Energie

HIGH-TEMPERATURE SUPERCONDUCTOR

In 1987, when the Nobel Prize was awarded for the discovery of high-temperature superconductivity, hopes were high that materials would be available in only a few years' time that would be capable of loss-free power transmission even at room temperature. Yet this magic conductor still doesn't exist and to make matters worse, no one as yet really understands why certain ceramic crystals with complex structures suddenly become superconductors at minus 150 degrees Celsius even though at room temperature they are insulators. New insights into the principles underlying high-temperature superconductors have now been gained by Prof. Pengcheng Dai and Dr. Stephen D. Wilson of the University of Tennessee working in conjunction with Dr. Klaus Habicht of the Helmholtz-Zentrum Berlin für Materialien und Energie. They investigated superconductors in which electric conductivity is carried by "surplus" electrons. However, samples with surplus electrons are more difficult to produce than normal high-temperature superconductors in which "holes" – that is, places at which an electron is missing – conduct the electric current. At the Helmholtz-Zentrum Berlin scientists have examined the samples with the help of neutrons and observed the inner magnetic order at various temperatures and in conjunction with different external magnetic fields. As long as the sample was fully superconductive, there was no inner magnetic structure. However, if a powerful external magnetic field destroyed the superconducting property, the elementary magnets arranged themselves in regular patterns. Such competition between two phenomena – magnetic order on the one hand and superconductivity on the other – is a familiar feature in samples in which holes conduct the electric current. The experiments also show that the transition between the two states is instantaneous. "That is not the case with conventional superconductors," says Habicht, "so it must be a fundamental feature of high-temperature superconductors, since it appears independently of the nature of the charge carrier, even if electron-doped superconductors are clearly different to hole-doped ones." ARÖ

"So it must be a fundamental feature of high-temperature superconductors!"

WITH THE HELP OF NEUTRONS PHYSICISTS EXAMINE HOW HIGHTEMPERATURE SUPERCONDCUTIVITY COLLAPSES IN A MAGNETIC FIELD. Photo: HZB

1,600 SUCH WATER TANKS AND FOUR TELESCOPES ARE DISTRIBUTED OVER THE PAMPAS IN ORDER TO REGISTER PARTICLE SHOWERS AND TRACES. PHOTO: FZK

Forschungszentrum Karlsruhe

PARTICLE SHOWERS OVER THE PAMPAS

The earth's atmosphere is subjected to an unceasing bombardment of particles from space. Although the phenomenon of cosmic radiation has been known for over 90 years, the origin of the highest-energy particles has remained a mystery. A collaborative research project with participants from 17 nations has set up a globally unique facility in the Argentinian Pampas called the Pierre Auger Observatory in order to answer this question. The cosmic invaders arrive here with quite different kinds of energy. The vast majority are probably hydrogen nuclei (protons), some of which have the energy of a tennis ball which has been hit fairly hard – a hundred million times more than in the new storage ring LHC at CERN in Geneva.

> "It's rather like trying to take a picture at a distance of 30 kilometres of a 40-watt bulb which is hurtling through the atmosphere almost at the speed of light."

When a proton collides with the atomic nucleus of an air molecule in the atmosphere, both particles burst apart into many new particles which continue to hurtle to the ground. These in turn collide with other atomic nuclei and give rise to even more particles. What finally arrives on the ground are billions of particles in an avalanche, which can be tens of kilometres in diameter. The new observatory has been named after the French physicist Pierre Auger, who discovered these so-called air showers in 1938.

Scientists know little about these highest-energy particles because they are extremely rare. On average only one per century enters the atmosphere over an area one square kilometre in size. Thus in order to prove their existence a facility covering a very large area is required. The Pierre Auger Observatory extends over 3,000 square kilometres, more than three times the area of Berlin. The facility consists of 1,600 tanks, which stand at a distance of 1.5 kilometres from each other. Each tank is filled with 12,000 litres of pure water. Whenever particles from an air shower plunge into the liquid, they trigger a short flash of light which is registered by sensitive internal detectors. Normally several tanks are hit simultaneously. This makes it possible to calculate the direction of the shower and thus of the original primary particle. Furthermore, the Auger Observatory is also using telescopes for the optical detection of showers. They were built under the supervision of the Forschungszentrum Karlsruhe. An air shower also creates a weak UV trace high up in the atmosphere which can be seen by telescopes with ten million exposures per second. "It's rather like trying to take a picture at a distance of 30 kilometres of a 40-watt bulb which is hurtling through the atmosphere almost at speed of light," explains Professor Johannes Blümer of Forschungszentrum and the University of Karlsruhe. The electronic telescopes were co-produced by Germany, Italy and the Czech Republic, whereas Australia, Germany, Slovenia and the US participate in monitoring the atmosphere. The water tanks were developed in the US, built in Argentina, Brazil and Mexico, and fitted out with French electronics. The radio data transmission comes from the United Kingdom. The idea for this largest observatory on earth was conceived by Nobel Prize winner James Cronin of the University of Chicago and Alan Watson of the University of Leeds at the beginning of the 1990s. A few years later Blümer strongly advocated German participation in the project. So far, Germany, together with the US and the host country, Argentina, have made the greatest contribution to the Auger Observatory. How do they manage to organise cooperation in such a large and global project? "Certainly not through a centralised leadership structure," says Blümer. "The division of tasks is worked out at conferences, at meetings and over cups of coffee." It is the pursuit of a common goal that unites the scientists. Last September the Auger project published its first results, according to which the particles seem to come from distant active galaxies, the centres of which, astrophysi-

cists believe, are supermassive black holes. These are possibly surrounded by powerful magnetic fields in which the particles are accelerated. Although the prospect of identifying individual objects is extremely exciting, it is as yet uncertain.

> "We are now sure that the cosmic radiation particles with the highest energy come from distant galaxies."

The Auger Observatory is to scan the southern skies for another 20 years. Currently scientists are canvassing for a second and even bigger observatory of this kind in the northern hemisphere. A suitable location has already been found in the US state of Colorado, though arranging for funding from 17 countries is a special challenge. "Only the Helmholtz Association as the largest research organisation in Germany and the Forschungszentrum Karlsruhe here at the Karlsruhe Institute for Technology KIT can come up with the leading German contribution," says Blümer. His team is already working at the problem full tilt, as are the working groups at the universities of Aachen, Wuppertal and Siegen. They would be ready to start building in two years' time. THOMAS BÜHRKE

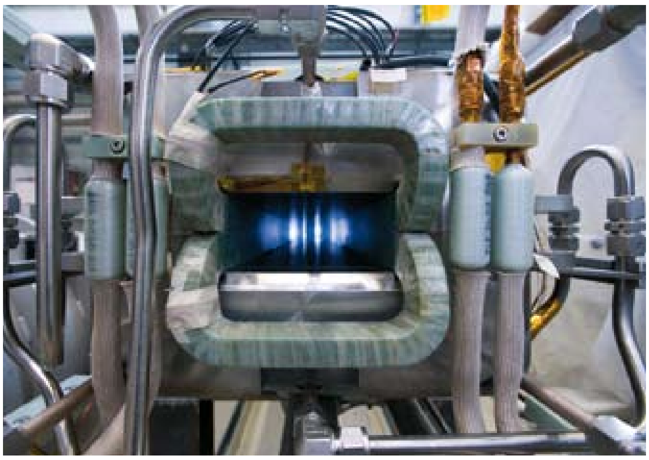
GSI Helmholtz Centre for Heavy Ion Research

UNIQUE ION ACCELERATOR

At the GSI Helmholtz Centre for Heavy Ion Research a unique large-scale facility, the Facility for Antiproton and Ion Research, FAIR for short, is currently being built in international cooperation. Several hundreds of scientists from all over the world have worked on the idea of FAIR and its practical realisation for many years. The total building costs for FAIR, amounting to about 1.2 billion euros, have been co-financed by 14 partner countries. Construction work will begin in 2009 and completion is scheduled for 2016. "With FAIR we are bringing the physics of the early universe into the laboratory," explains the scientific director of GSI, Professor Horst Stöcker. In this field, research is still confronted by weighty questions. Why does antimatter hardly appear in the universe, except for a few minute remnants, and why has the matter which surrounds us gained the upper hand in such an obvious way? FAIR could also be used to investigate dark matter, of which a large part of the mass of the universe must consist.

> "All matter ultimately consists of stardust."

Scientists also want to use the planned facility to conduct experiments on how stars explode and which processes play a major role in these explosions. Going by what we know today, the chemical elements were created in gigantic stellar explosions. "This means that all matter – and that includes us, of course – ultimately consists of stardust, the remnants of exploded stars," says Stöcker. The centrepiece of the FAIR facility is a large superconducting double ring accelerator 1,100 metres in circumference. Attached to it is a complex system of cooler-storage rings and experiment stations. The existing GSI accelerators will be used as injectorsfor the FAIR accelerator. GSI



108 SUCH DIPOLE MAGNETS ARE NEEDED FOR THE LARGE CIRCULAR ACCELERATOR OF THE FAIR FACILITY. PHOTO: C. GRAU/GSI

RESEARCH FIELD TRANSPORT AND SPACE

The Research Field Transport and Space was evaluated in spring 2008 within the scope of the Helmholtz Association's programme-oriented funding. This Annual Report 2007/2008 gives an overview of the defined research goals and the scientific work of this Research Field, based on the first round of the programme-oriented funding. The Research Field will change its name to "Aeronautics, Space and Transport" on 1 January 2009. The three research programmes which represent the strategic direction of this Research Field in the next five years are introduced in this report.

GOALS AND ROLES

Mobility, communication and information are essential elements of a modern economy. They are examples of the social challenges tackled by scientists working in the Research Field Transport and Space. In times of increasing environmental pollution, capacity squeezes and tighter safety and security standards, our researchers are working to produce new concepts and technical solutions, and to give advice to policy makers. The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt – DLR) is the only Helmholtz centre in the Research Field Transport and Space. Parallel to this it is the German national aerospace research agency. As the German aerospace agency, the DLR is responsible for conception and implementation of research within the national space programme and for contributions to the European Space Agency ESA on behalf of the Federal Government. The DLR's 13 sites are located in various federal states and work closely with a network of universities and other research institutions. The DLR also cooperates with other Helmholtz research centres, especially in the Research Fields Energy and Earth and Environment. In the Research Field Transport and Space, cooperations with various partners have been extended and new research infrastructures put in place during the past year: e.g. a high-performance computer, the heart of the Center for Computer Applications in AeroSpace Science and Engineering ($C^2A^2S^2E$), was able to begin operating in May 2008 after only seven months' preparation. $C^2A^2S^2E$, at the DLR's Brunswick location, has been set up as a research environment with a campus-like character, where research, development and industrial application can be directly integrated. In the Helmholtz Alliance "Planetary Evolution and Life", six DLR institutes work with twelve partners, mostly universities. In addition, the Institute of Air Transport Concepts and Technology Valuation was founded with the Hamburg University of Technology (TUHH). The fundamental task of the institute is to assess new concepts in aviation and flight control. The founding of the Institute of Aerospace Systems in Bremen last year completed the range of issues covered in the DLR's space department. This institute has the task of assessing and analysing complex space systems from technical, economic, social and political standpoints.

"Guaranteeing mobility, communications and security for coming generations is a challenge our society must find a solution for. In future, this Research Field will make even more important contributions to progress in these areas. As a national research institution, we represent the interests of the Federal Republic of Germany in European and international contexts, especially in the fields of aeronautics and space."

PROF. DR. JOHANN-DIETRICH WÖRNER Vice-President representing the Research Field Transport and Space, Deutsches Zentrum für Luft- und Raumfahrt

PROGRAMME STRUCTURE IN THE FUNDING PERIOD 2003*-2008

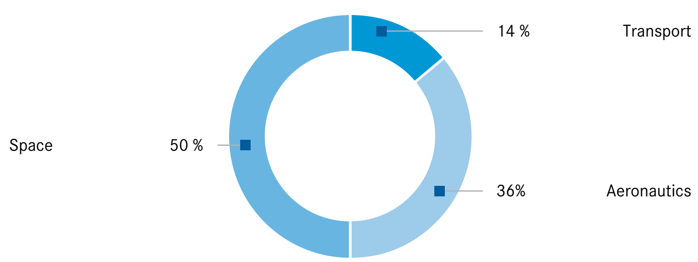
DLR scientists collaborate in three programmes:

- Transport
- Aeronautics
- Space

The work done in these programmes is characterised by their thematic and organisational integration under the DLR umbrella. Researchers in all three programmes have direct access to the shared core competencies they need in aerodynamics, structures and materials, communications, navigation, mechatronics and other fields. Synergies arise at the interface of aeronautics, space and transport, for example in the area of air and space-supported remote sensing.

*The first funding period of the Research Field Transport and Space began in 2003 and was extended by one year until 2008.

Structure of the Research Field Transport and Space
Core-financed costs 2007: € 193 million
In addition, the Research Field receives € 197 million in external funding, giving it total funds of € 390 million.



THE PROGRAMMES IN THE FUNDING PERIOD 2003*-2008

Aeronautics

European integration is a key factor in the aviation industry today. This is why the Aeronautics programme attaches particular importance to intensifying cooperation with European partners, especially the French and Dutch partner organisations ONERA and NLR. Current research priorities are advancing and optimising transport aircraft in cooperation with ONERA, developing flight guidance technology in cooperation with the NLR, and expanding the DLR-NLR wind tunnel network by integrating the wind tunnels operated by ONERA. In terms of content, the research programme focuses on the following strategic goals: raising safety standards, reducing aircraft noise and emissions, improving the cost-effectiveness and efficiency of the air transport system. The work on fixed-wing aircraft has been concentrated in the joint DLR/ONERA Aircraft Research programme. Helicopter research conducted under the heading of DLR/ONERA Rotorcraft Research focuses particularly on expanding the flight envelope by ensuring flight safety, even in difficult weather conditions, while also aiming to improve the environmental compatibility of this air transport system. Efficient and environmentally-friendly propulsion systems are another research topic. The research topic air traffic management involves research into safe and efficient air traffic control, especially in the vicinity of airports.
Interdisciplinary research on aviation and the environment concentrates on reducing pollutant and noise emissions and wake vortex research. The use of fuel cells in aircraft is also under investigation; a fuel cell has been integrated in the DLR research aircraft Airbus A320 ATRA under the auspices of the ELBASY project funded by the Federal Ministry of Economics and Technology (BMWi). The research project LAnAb on reducing noise emissions on take-off and landing has now been completed. DLR aviation research, as a partner in the EU project VITAL, contributed to the seven percent reduction in CO_2 emissions from aircraft engines and the six decibel reduction in aircraft noise. The aircraft and rocket engines manufacturer Snecma developed the concept of the counter-rotating slow-turning blade wheel fan, for engines with a high bypass ratio. The DLR is involved in this project, and is responsible for the development of an aerodynamic, aeroelastic, acoustic and mechanical design for a cheaper version of this engine type.

Space

Space research and development in Germany is driven by two considerations: providing direct benefits to humanity and inspiration for the future. The challenge of sustainably securing the foundations of life on earth which faces humanity in a changing world can only be approached scientifically if we have access to vital data and information about the earth and the events on it. Space flight is a key to this understanding, and also enables science to break through into entirely new dimensions of research. Space flight radically changes our image of the earth and the world beyond our planet. How did the universe come into existence? Is there life on other planets? How do the conditions in space influence scientific processes in materials science and life sciences? Germany's strategic and political space goals are implemented in an integrated space programme, of which the Helmholtz space programme is a part, along with the national space programme and the German contribution to ESA. The development of the TerraSAR-X satellite and the decision to produce another almost identical satellite, TanDEM-X, as part of a public-private partnership, were highlights of the earth observation programme. TerraSAR-X was launched in the summer of 2007 and was transmitting excellent images suitable for a wide variety of applications within a few weeks. When completed, TanDEM-X will orbit the earth in close formation with TerraSAR-X. The DLR heads the European "Network of Excellence in Satellite Communication". The focus of the satellite navigation programme was on preparations for Galileo and its applications. In recent years, space exploration has centred on participation in international missions including Cassini (to the Saturn system), Venus Express, COROT (the search for extrasolar planets), preparations for DAWN (a mission to two

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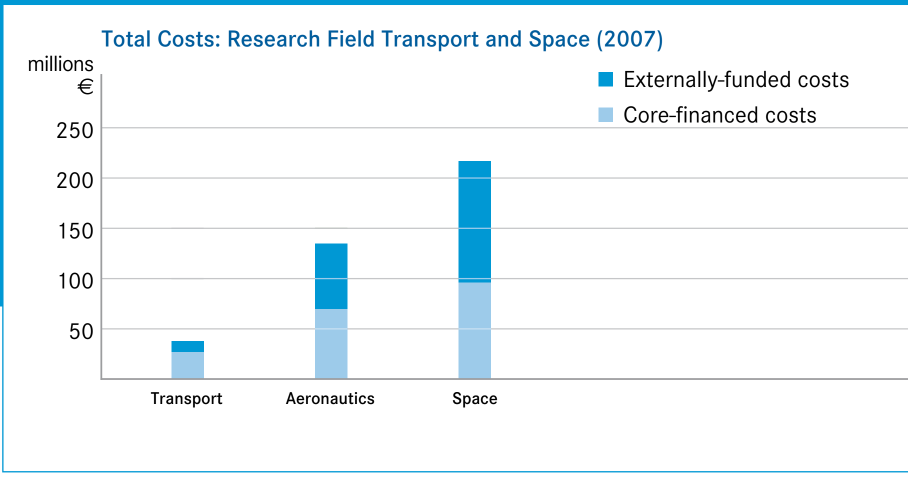
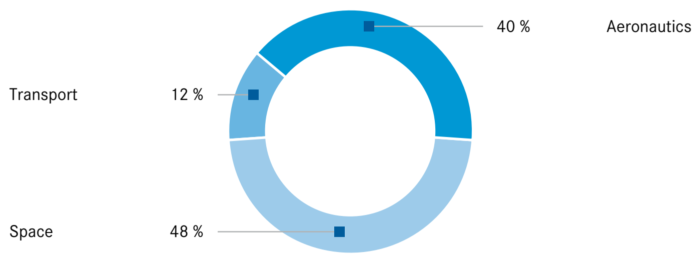


asteroids) and for Bepicolombo to Mercury, Mars Express and Rosetta. Within the framework of the programme "Research under Space Conditions", issues from the fields of life sciences and materials science were investigated under the particular conditions of weightlessness in parabolic flight, sounding rockets and on the International Space Station. If the European carrier is to maintain international competitiveness and keep pace with the increasing demands on reliability and flexibility, it is essential to gain thorough, validated scientific and technological insight into key technologies for carrier systems. Research has been done in many areas in recent years, including space propulsion systems, robust structures, innovative cooling concepts, and also for propulsion systems, numerical simulation and modelling and flight guidance. "Technology for Space Flight Systems" is a part of the programme which creates the foundations for future space flight systems and missions through the development and provision of innovative technologies. The DLR contributes a number of technological components to these projects, including robotics research for servicing robots in space, innovative operating technologies, development and qualification of up-to-the-minute satellite components, and the contribution to the on-orbit verifications of the national programme.

Transport

The transport system is struggling to cope with the present volume of traffic and can no longer really accommodate the ever-increasing demand. It is this situation of chronic overload that could jeopardise the competitiveness of the German and European economy. High traffic volumes also affect the environment, reduce people's quality of life, and clearly bring substantial risks of hazards and accidents. Hence, the Transport programme targets three overriding goals: securing mobility, protecting the environment and preserving resources, and improving safety and security. To achieve these goals, the DLR develops problem-solving approaches on terrestrial vehicles, traffic management and the transport system, interlinking specific transport expertise with existing competencies from the fields of aeronautics, space and energy research. Research and development in the next generation of road and rail vehicles focuses on optimising vehicle structures and energy systems, reducing driving resistance and wear, increasing comfort and reducing environmental impact. Individualised assistance systems aim to further increase safety levels and to provide traffic participants with assistance tailored to suit every situation. Innovative road, rail and airport management solutions contribute to improving the effectiveness and efficiency of the infrastructure's use. Special traffic management information systems and tailor-made decision-making aids fulfil the requirements of police and rescue services during mass public events and in disasters. New methods of examining the transport system centre on integrated research of the complete chain from traffic demand and development to their effects on the environment.

Structure of the Research Field Aeronautics, Space and Transport
Core financed cost plan 2009: € 227 million*



*The recently initiated activities “Space Institute Bremen” and the “Centre of Excellence for Robotics” are not included in this overview. A further 22 million euros will be available for these projects.

THE PROGRAMMES IN THE PROGRAMME-ORIENTED FUNDING 2009 – 2013

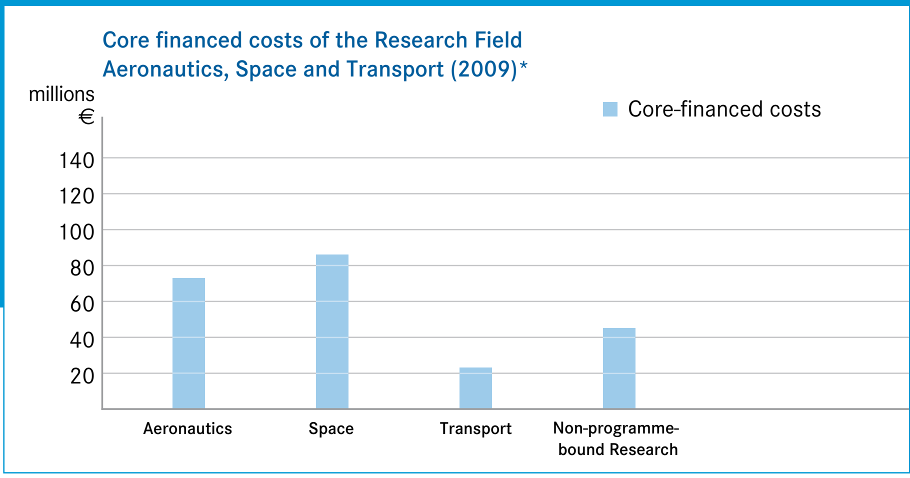
In uniting the programmes Aeronautics, Space und Transport in a single Research Centre, Germany has gained a unique position in the European scientific community which it will be able to build on in the years to come. The Deutsches Zentrum für Luft- und Raumfahrt does not work in isolation but is an active part of the national, European and international scientific community. The DLR collaborates with other Helmholtz centres in the Research Fields Energy, Earth and Environment, Health and Key Technologies. The goal for the next programme-oriented funding period is to make significant research contributions which bring the ambitious aims of Aeronautics, Space und Transport in closer reach.

Aeronautics

The primary aim of the DLR aeronautics research is to strengthen the competitiveness of the national and European aeronautics industry and to fulfil the demands of policy makers and society as a whole. Building on the research of the first round of programme-oriented funding, the most important goals in the next five years will be to pursue the main lines of inquiry: to increase the capacity and efficiency of the air transport system, to reduce emissions of noise and pollutants and to guarantee safety and security in the face of increasing risks. These goals are the subject of joint efforts by the European cooperative network EREA. Specially equipped research aircraft, in particular HALO and ATRA, assist the work in these five areas of research.

Space

Researchers in the Helmholtz Programme Space develop future applications of space technology, work out technological solutions and prepare concrete scientific and application-based missions. All this takes place in collaboration with industrial partners, research institutions, universities, the authorities and state institutions, establishing the programme as a key link between all participants in space projects, from the concept stage through implementation to application. The goals for the next five years build on the findings and challenges which emerged from the first programme period. The national TerraSAR-X, TanDEM-X and EnMAP missions, the European ESA and EUMETSAT missions and the European GMES Initiative form the focus of the earth observation work. In the field of satellite communication, the widespread use of optical connections, up to the creation of a satellite-based Terrabits/s transport and distribution network is to be researched and developed. Setting up Galileo and developing applications form the core focus of satellite navigation research. The search for life in material samples brought back to earth and research into the life-sustaining possibilities of other planets will be a central point of interest in future space exploration. Research in conditions of weightlessness, especially on the ISS, which is on the threshold of its full-use phase, brings new knowledge in materials science and life sciences. The DLR has the task of researching key technologies to guarantee cost-effective space transport, applicable in the future



*The recently initiated activities “Space Institute Bremen” and the “Centre of Excellence for Robotics” are not included in this overview. A further 22 million euros will be available for these projects.

predicted uses of space travel: missions in the name of science, exploration, application, tourism and technology. Technologies for orbital and planetary missions are developed and validated in the technology for space travel systems.

Transport

The mobility of people and goods is a cornerstone of modern industrial society. To enable mobility in a quick, reliable, safe, secure and at the same time environmentally-friendly way is the major challenge. As demand is constantly increasing, isolated ad-hoc solutions are clearly not sufficient. Instead, a long-term approach is needed both for individual modes of transport and for the multi-modal transport system, taking due account of economic, societal and ecological needs. This is the starting point for DLR research into road and rail vehicles, traffic management and the transport system. It is based on the systematic combination of innovative ideas and specific competencies of researchers in more than 20 DLR institutes.

ALUMINIUM (GREEN) AND MAGNESIUM (YELLOW) PARTS REDUCE THE WEIGHT OF THE CAR BY 24 KG. IMAGE: DLR

PROJECTS

Deutsches Zentrum für Luft- und Raumfahrt

SUPER-LIGHT YET STRONG

Weight loss is the key to the future of automobiles. Lighter vehicles use less fuel, which in turn reduce CO_2 emissions. The days when innovations improving comfort and safety made each new series heavier than its predecessor are over, as Gundolf Kopp of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt – DLR) in Stuttgart explains. In fact, the trend has been reversed. Models launched in the last two years have not got heavier and in future, steep decreases are planned in this department, taking as much as thirty per cent off the weight of the bodywork, compared with a medium-class steel car. That is a difference of 85 kilogrammes – or 6.8g CO_2/km.

> "We aim to reduce the weight of the bodywork by thirty per cent, compared with a medium-class steel car."

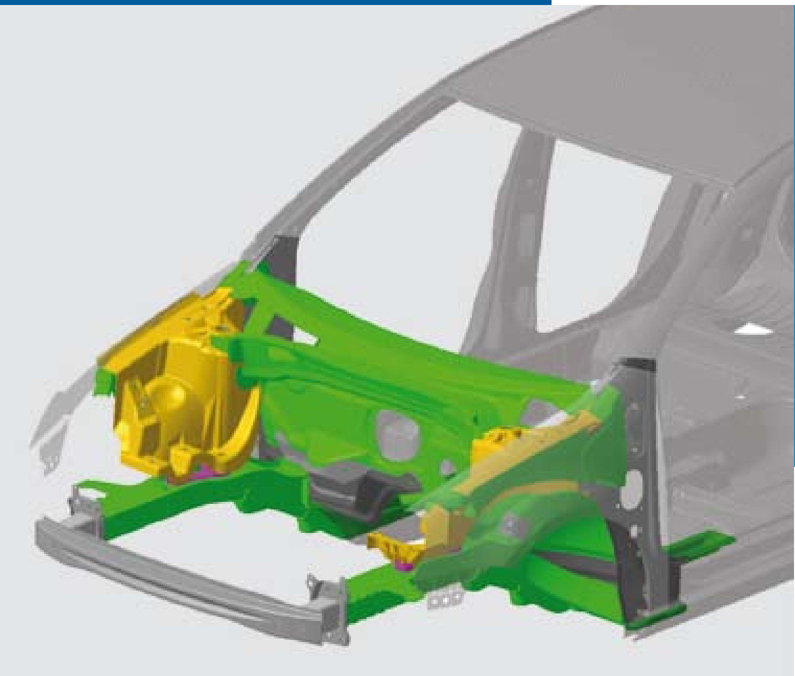
Stricter EU directives on CO_2 emissions and continually rising fuel prices motivate the search for ways of reducing fuel consumption, such as by using lighter materials. Developing new concepts for light construction has become a European challenge; Volkswagen AG is heading the project Super Light Car (SLC) with 37 partners from nine countries. Seven big car-producing companies have brought their component suppliers and renowned research institutions on board, including the DLR with its Institute of Vehicle Concepts in Stuttgart. The partners in development of light vehicles started work in 2005 under the sixth EU Framework Programme and have a total budget of 19.2 million euros. The research motto is Multi Material Design. As the DLR project director for SLC Gundolf Kopp explains, it would be possible to build a car of super-light carbon-fibre reinforced plastic (CFP), but no one would be able to afford it. Instead, efforts are concentrated on using the right material in the right places. The scientists test each component to see if weight can be saved and which of the light materials – magnesium, aluminium, steel types, CFP – is most suitable. It is not enough simply to consider the technical strengths of each material. Kopp emphasises that the project partners must consider the vehicle's whole life-cycle, including recycling. The materials cannot be too expensive and the manufacturers must be able to work with them. The vehicle must also meet all the car industry's demands regarding crash safety, corrosion protection and material fatigue, without the price spiralling out of reach. The DLR team in Stuttgart has contributed a 24 kg reduction to the front module of the car where the motor is located, for example, by designing a magnesium strut tower and a longitudinal rail and other parts of aluminium. Gundolf Kopp claims that the use of magnesium brings a double bonus: magnesium is lighter than steel or aluminium, and it can also be cast, so different elements can be united in one component. This reduces weight and makes assembly easier.

The disadvantage of magnesium is that it is less ductile than other light metals. This means that the engineers must test – initially using virtual crash testing methods - whether the components fail too soon, possibly penetrating the car interior in a serious accident. "It is an enormous challenge to unite

> "The project partners consider the vehicle's whole life-cycle, including recycling."

all these sometimes contradictory qualities – light and safe, innovative, reliable and inexpensive," says Kopp. This makes it all the more important to share the international partners' expertise in various areas and to support each other in parts of the project, such as complex calculations or materials testing.

The Stuttgart car engineers contribute their expertise in design, construction and simulation and their experience with various materials, including magnesium as a light material. "The Italian car manufacturer Fiat is an important partner, especially on issues of combining different materials and components, such as strut towers and longitudinal rails,"



says Kopp. They also collaborate closely with the Swedish engineers at Volvo, who specialise in optimising the wall thickness of structural elements. Finally, the British company ARUP provides a computer simulation of the whole vehicle. Various car manufacturers and suppliers aim to put the lightweight construction concept into practice by early 2009. They will produce several prototypes of the newly developed structures – from individual elements through the front end to the complete chassis. The prototypes will then be thoroughly tested to ensure that they fulfil all expectations, not just the anticipated weight reduction. UTA DEFFKE

Deutsches Zentrum für Luft- und Raumfahrt

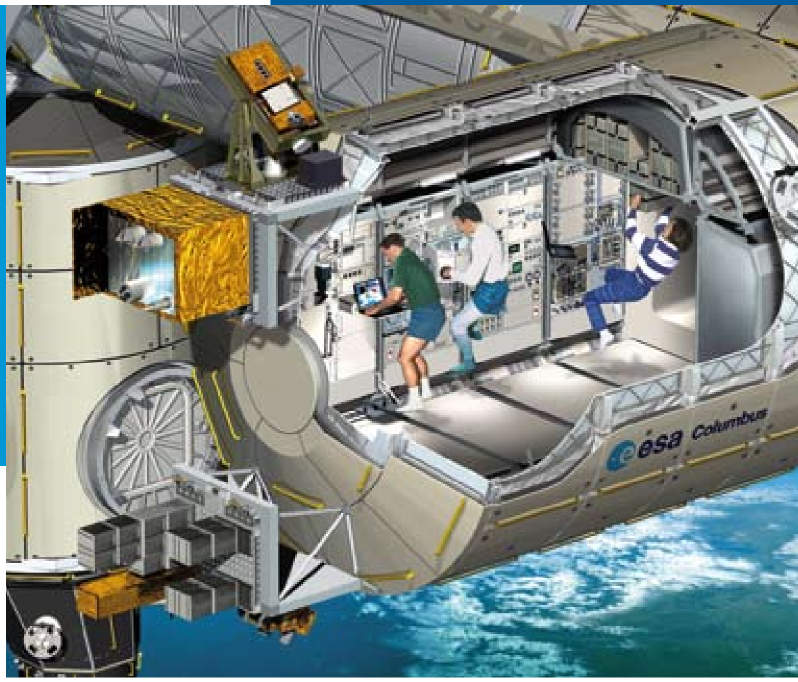
FLYING INTERNET

It can be a risky business for a passenger to make a phone call or surf the internet during a flight without the necessary technical equipment, because the radio signals from mobile devices can, under certain conditions, disturb the pilot's radio communications or the avionics. Even the pilots do not have access to modern means of communication at present; they usually communicate with air traffic controllers using analogue radio or short text messages no larger than an SMS. This situation may soon change. The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt –DLR) is heading a European research project called Networking the Sky, NEWSKY for short, whose aim is to connect aircraft, satellites and earth stations in a network based on internet technologies. Engineers from Thales Alenia Space, QinetiQ, Frequentis, Triagnosys, the German air traffic control company DFS and University of Salzburg are collaborating to make this vision of a networked sky a reality. "We need new means of communication to reach the high safety standards required as the volume of air traffic increases and to reduce pollution by optimising flight routes," says project director Dr. Frank Schreckenbach. Pilots must be able to rely on their communication with air traffic controllers and the reception of information such as weather or traffic data even in the most distant areas over oceans or the poles as well as in densely populated areas.

> "In about ten years' time, both passengers and pilots will have access to all the internet offers during the flight."

NEWSKY is a modular concept which builds on available technologies from the internet, mobile radio and cockpit communication and can simply integrate new technologies. It is essential that pilots automatically have data priority, so that an internet video does not block the reception of vital cockpit data. "In about ten years' time, both passengers and pilots will have access to all the internet offers during the flight," says Schreckenbach. ARÖ

THE EU PROJECT NEWSKY AIMS TO LINK UP AIRCRAFT, SATELLITES AND EARTH STATIONS IN A UNIFIED COMMUNICATIONS NETWORK. Image: DLR



Deutsches Zentrum für Luft- und Raumfahrt

COLUMBUS SPACE LABORATORY

It is supposed to be perfectly round: heated by electromagnetic fields and held in suspension, free of the effects of gravity, the metal drop at 1,500° Celsius will form a perfect sphere. If the same electromagnetic fields force it to take another shape, the deviance from the ideal will reveal something about the internal forces of the melt. Professor Andreas Meyer, materials scientist at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt – DLR) in Cologne, wants to find out exactly how, for instance, aluminium-titanium alloys react when heated in terms of expansion, surface tension and viscosity. He also hopes to discover the influence of the fluid flow and concentrations of the individual elements as melts solidify. This information will help generate more precise models for the simulation of metal casting processes on the computer, which in turn will accelerate the development of new materials and casting processes, for example for turbine blades or engine blocks. Meyer, who heads the DLR Institute for Materials Physics in Space, explains that the intention is not to examine how weightlessness influences these physical processes, but to reduce gravity's interference on the flow of material in the melt. Because there are no machines which can switch off gravity, researchers need the weightlessness of space.

> "In order to make best use of Columbus during its projected ten-year lifespan, only the most important experiments are selected for the space lab."

Launched on 7 February 2008 with the Atlantis space shuttle to the International Space Station ISS, the European space laboratory Columbus is now available for their experiments. It was mounted permanently on the ISS within four days and connected to the electricity supply, the air conditioning and the computer system. The module is almost seven metres long and 4.5 metres in diameter, providing space for up to 16 racks, as the cupboards for the experimental equipment are called. Platforms on the outer wall make it possible to examine the influence of free space directly. The Europeans have invested 880 million euros and can claim 51 per cent of the laboratory capacity. "In order to make best use of Columbus during its projected ten-year lifespan, only the most important experiments are selected for the space lab," Andreas Meyer explains, adding that projects are selected in a tough European competition. Projects only have a chance of succeeding on this level if they are the product of a lively international exchange of views and intensive collaboration.

> "We intend to make use of the resource space...to learn as much as we can for future experiments back on earth."

130 experiments are already planned and the first began within a few days of the space lab docking on to the ISS. In the Biolab, for example, molecular biological methods are used to examine how micro-organisms, plants and invertebrates perceive and deal with gravity. DLR scientist Professor Rupert Gerzer, head of the Institute for Aerospace Medicine in Cologne, is in charge of the analysis of space radiation and its effects on the human organism. Physicists and engineers are more interested in inanimate materials. In the Geoflow project, for example, they are attempting to increase their understanding of the currents in the earth's molten outer core, using a small model. The Levitator, which is intended to generate the electromagnetic fields for the perfectly spherical melt, is not yet on board. DLR materials scientist Meyer, whose institute is involved in ten projects and in charge of five of them, will have to wait until 2009 and 2011 to start his space experiments. They are, however, already working hard preparing the Columbus experiments. The ESA has also approved his institute responsibility for preparing and conducting all the experiments which take place in the Materials Science Lab of the Space Laboratory. All the experimental equipment will be thoroughly tested and automated using parabolic flights and full-scale models to make

ASTRONAUTS CARRY OUT EXPERIMENTS IN 16 RACKS IN THE EUROPEAN SPACE LAB COLUMBUS ON THE INTERNATIONAL SPACE STATION ISS. IMAGE: ESA

work for the astronauts as easy as possible. After all, they do not have much time. Most of the work is monitored and carried out from the Microgravity User Support Center in Cologne. The DLR also directs the overall activity in the space lab from the European Columbus Control Centre in Oberpfaffenhofen. Although it has only just begun, the researchers have to think ahead. “Science in space itself is not our goal,” Meyer emphasises. “We intend to make use of the resource space in the limited time and restricted area available to us to make significant scientific advances and to learn as much as we can for future experiments back on earth.” – for the time after Columbus. UTA DEFFKE

Deutsches Zentrum für Luft- und Raumfahrt

ALPINE TRAFFIC OVERLOAD

The Alpine countries are severely impacted by the increasing load of transit traffic. The problem is exacerbated by the fact that, compared to flatter areas, meteorological conditions can significantly amplify pollution and noise along the main Alpine roads. Experts from universities and research centres in Germany, Austria, Italy and France have set up ALPNAP, an Alpine network which uses scientific methods to support measures to reduce noise and pollution levels in the Alps. The European project is coordinated by the DLR Institute of Atmospheric Physics. “Our aim was not simply to shift the traffic load to other major arteries but to reduce its impact on residents,” Dr. Dietrich Heimann, project director at the DLR,

> “Our aim was not simply to shift the traffic load to other major arteries but to reduce its impact on residents.”

emphasises. The scenario calculations yielded some surprising results: for example, transferring goods traffic from road to rail would indeed reduce the impact of pollution and noise for a large proportion of the population, but at a price for those living in the vicinity of railway lines, who would suffer more noise. Other experiments revealed that noise barrier walls along motorways in valleys provide only limited protection for residents on the mountain slopes and that certain meteorological conditions actually amplify the noise and pollution. Based on these findings, new traffic guidance systems can now be adjusted for weather conditions to prevent peak impact.

The ALPNAP partners have compiled their findings in a handbook. Practical recommendations support the authorities in planning measures such as tolls, speed limits or limited driving bans for heavy goods vehicles. Implementing such measures, however, also requires the corresponding political will and acceptance by players in the transport industry, as Heimann emphasises. ARÖ

HEAVY TRAFFIC ON THE TRANSALPINE BRENNER MOTORWAY FROM AUSTRIA TO ITALY SUBJECTS RESIDENTS TO NOISE AND AIR POLLUTION.
Photo: Heimann/DLR

HUMAN PROTEIN INTERACTIONS CHARTED

A team of scientists led by Professor Erich E. Wanker from the Max Delbrück Center (MDC) in Berlin-Buch was the first to investigate the human body's large network of protein-protein interactions. At its annual meeting on 11 September 2008, the Helmholtz Association awarded the team with the 50,000 euros Erwin Schrödinger Prize.

The jury stated that the project represented a significant step forward for biomedical research, citing the interdisciplinary nature of the project, which included contributions from scientists from research institutions focusing on molecular biology, bioinformatics and engineering.

The human genome contains about 22,500 genes. Yet genes cannot control cellular processes on their own; they first need to be activated and selected so that certain proteins can be produced. These proteins affect one another and together they are responsible for keeping an organism in good working order. Understanding how they interact is crucial to understanding how and why they sometimes fail to work correctly, as in the case of genetic disorders. The problem is that this task is extremely complex. As Prof. Wanker explains, "Each gene codes for at least one protein, so there are about 22,500 proteins. This means that a comprehensive interactome study would have to systematically examine about 250 million protein pairs."

Molecular biologists Erich Wanker and Ulrich Stelzl began examining these interactions as early as 2002. Very little was known about the interactions at the time. They soon realized that they would have to automate the process, so they brought engineer Christian Hänig on board. "We were able to analyse about 750 protein interactions per day when we were working by hand. After we automated the process, the number increased to about 125,000 interactions per day," says Prof.

The Erwin Schrödinger Prize is endowed with 50,000 euros and presented on an alternating basis by the Helmholtz Association and the Stifterverband in recognition of outstanding interdisciplinary work. This year's winners were Prof. Erich E. Wanker (MDC), Dr. Ulrich Stelzl (Max Planck Institute for Molecular Genetics), Dipl.-Ing. Christian Hänig (MDC), and Dr. Matthias Futschik and Gautam Chaurasia, M.Sc., (Humboldt-Universität).

ERICH E. WANKER, ULRICH STELZL, JÜRGEN MLYNEK, CHRISTIAN HÄNIG, GAUTAM CHAURASIA AND MATTHIAS FUTSCHIK (FROM LEFT TO RIGHT). Photo: E. Fesseler/Helmholtz-Gemeinschaft

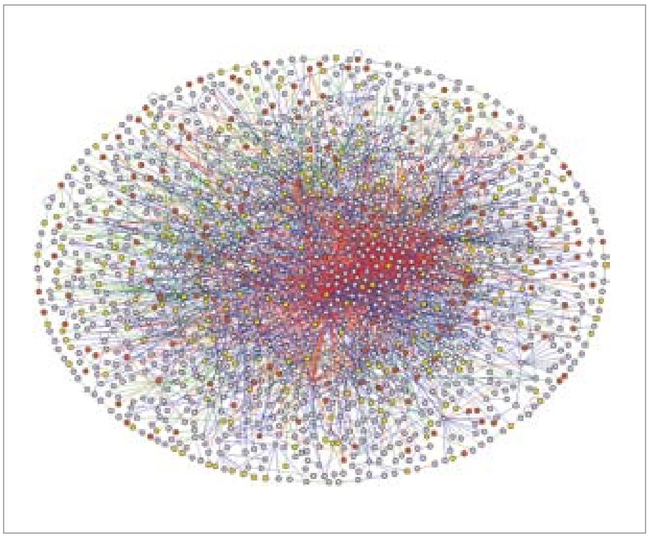
Wanker. He and Hänig automated what is known as "yeast two-hybrid" technology so they could systematically index protein-protein interactions. This enabled them to increase efficiency by a factor of 150 while also improving the quality and reproducibility of individual experiments.

They focused first on interactions that related to the emergence of Huntington's disease, a genetic neurodegenerative disorder. No cure is known for this disorder, which is caused by a single faulty gene on the short arm of the fourth chromosome, first manifests itself in middle age in the form of irregular body movement. "In this small network alone, we found 165 new potential Huntington protein interactors. We were able to connect 16 of those proteins with a specific function," explains Hänig. This network of protein interactions will be a valuable tool for future Huntington's disease research.

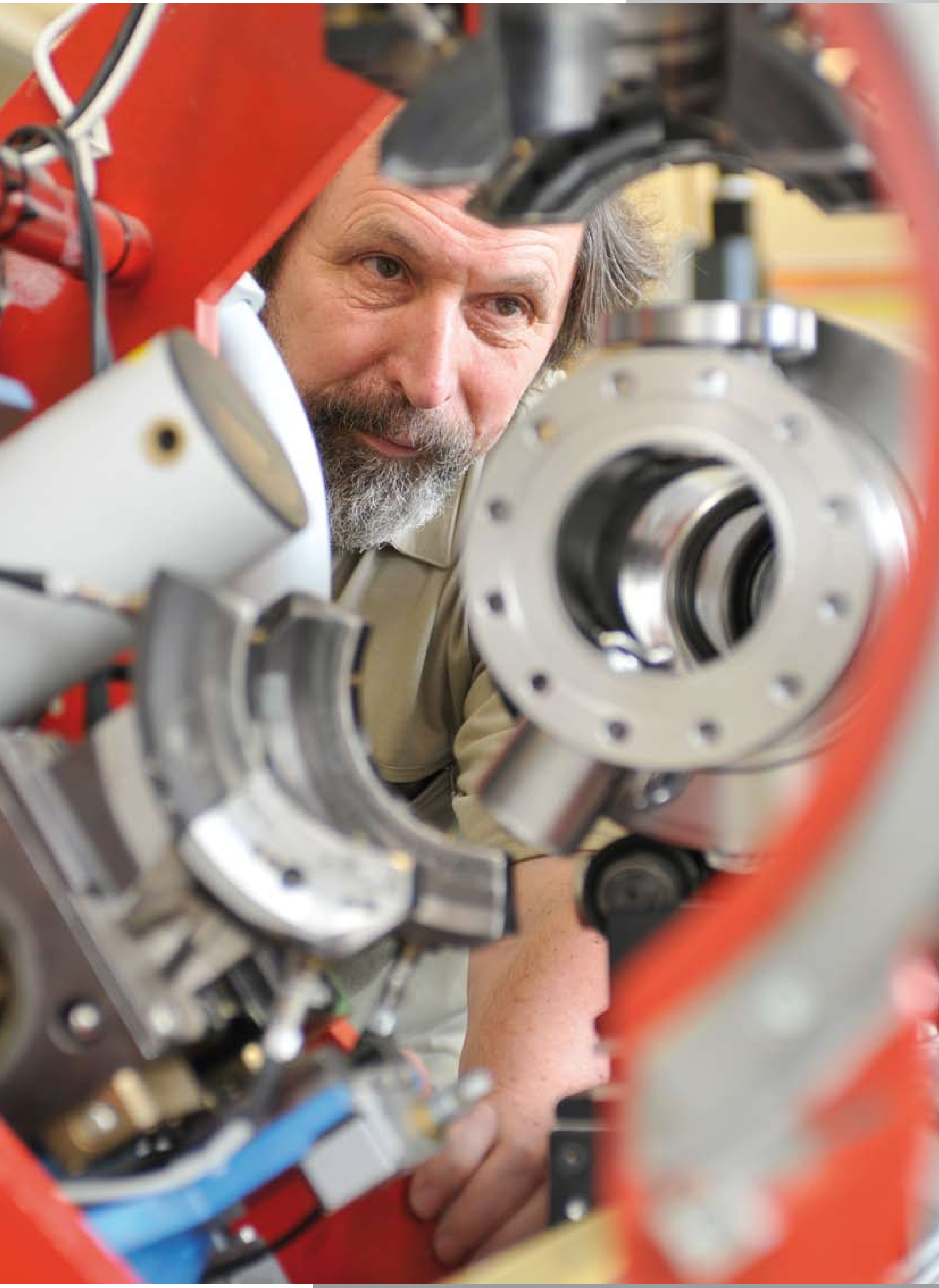
After this initial success, they used the technique to create a network comprising all the proteins in the human body. Using a robotic unit of their own design, they tested over 25 million protein pairs and discovered 3,200 interactions between 1,700 proteins. They documented these interactions on an "interactome map," a kind of circuit diagram for biological processes.

The interactome map reveals previously unknown pairings with 195 disease-related proteins and assigns 342 formerly uncharacterised proteins to known signal pathways. The researchers supplemented the robot study with a large-scale database project developed in cooperation with bioinformatics experts Dr. Matthias Futschik and Gautam Chaurasia of the Humboldt-Universität in Berlin. The database has two purposes: to present the results of this study to researchers in the field and to bring together the most important interaction datasets from around the world in a unique mega-database. The mega-database will be continuously updated and extended and every researcher on the planet will be able to access it free of charge.

"We have still only recorded a fraction of these interactions," says Prof. Wanker. "Our work could provide a starting point for an international human interactome project that, in a similar way to the Human Genome Project, would trace all the protein complexes in the human body." This will enable researchers to pinpoint signal paths and disease mechanisms much more quickly than before.



THE INTERACTOME MAP SHOWS HUMAN PROTEIN-INTERACTION. Graphic: C. Hänig/MDC



PEOPLE AND FINANCES

The following pages document how we invest our resources. Our staff are our most important resource. It is their ideas, creativity, dedication and commitment that drive science and research forward.

PARTNER IN THE JOINT INITIATIVE FOR RESEARCH AND INNOVATION

The Helmholtz Association makes an important contribution to the continued growth and prosperity of our society. In joining the German government's Joint Initiative for Research and Innovation, the Association has pledged to further consolidate its activities in a variety of fields in order to become even more efficient. This includes expanding our networking with universities and national and international research institutions, intensifying technology transfer activities, promoting talented young scientists and fostering equal opportunities to an even greater extent than before.

In the past year the Helmholtz Association has once again made great strides in implementing the goals formulated in the Joint Initiative. The projects have been financed on the one hand through the system of programme-oriented funding, and on the other through the President's Initiative and Networking Fund. The Joint Initiative for Research and Innovation strengthened both of these sources of funding, particularly benefiting the Initiative and Networking Fund, which grew from 47 million euros in 2007 to 57 million euros in 2008.

Driving research forward

One of the most important goals of the Joint Initiative for Research and Innovation is to further improve the quality of research. We are achieving this goal by adopting a programme-oriented funding approach in which scientific quality is objectively assessed by independent reviewers. This approach is unique in the German research community as it allocates all resources on a competitive basis and concentrates research into strategically oriented programmes. In a nutshell, it uses competition and cooperation to achieve outstanding performance. The programmes spell out the key challenges that a particular area of research involves, define goals as well as the measures required to meet these goals. Funding totalling 1.7 billion euros is available to achieve the Joint Initiative's goals. But these funds are not earmarked for particular institutions; they are targeted at cross-centre research programmes that are in competition with one another. An important milestone in the performance-based funding process is the strategic evaluation of the Research Fields. The second round of programme-oriented funding began in early 2008 with the evaluation of the three Research Fields Transport and Space, Health, and Earth and Environment. The evaluation of the Research Fields Energy, Structure of Matter and Key Technologies will follow in 2009. The second programme period begins in 2009/2010 and lasts five years. During this period, the Helmholtz Association intends to reinforce its medium-term strategic research goals with additional projects that build on and go beyond previous efforts and that are in line with the overall strategy, while not exceeding its predefined budget.
The Initiative and Networking Fund has become one of the Helmholtz Association's main instruments for achieving its

strategic goals. The Fund opens up new, forward-looking research topics in the Helmholtz Association, helps extend networking with universities, initiates new methods of promoting young researchers and improves framework conditions for top-flight research. The Initiative and Networking Fund will continue to be an essential instrument for further developing the Helmholtz Association in the future. An evaluation of the Initiative and Networking Fund took place in December 2007. The results showed that the additional resources provided to the Fund by the Joint Initiative for Research and Innovation have been well invested. In its report, the external review panel emphasises that the Initiative and Networking Fund and the areas on which it focuses are “of incalculable value to the Helmholtz Association’s capacity for renewal.” In 2008, the Fund has a budget of 57 million euros, which is overseen by the president of the Helmholtz Association.

Building strong partnerships

Great progress has been made in networking with research partners during the reporting period, thanks to the Centres’ extensive participation in external competitions such as the German federal and state governments’ Initiative for Excellence. During the second round of the programme, which is now over, approval was granted for five Graduate Schools, three Excellence Clusters and two Future Concepts, one in cooperation with the University of Heidelberg and the other with RWTH Aachen. Helmholtz Centres are involved in a total of 100 Priority Programmes of the German Research Foundation (DFG) and 67 of its Collaborative Research Centres. The Helmholtz Centres DLR, MDC, GKSS and FZJ are taking part in a competition organised by Germany’s Federal Ministry of Education and Research (BMBF) to promote Germany’s top clusters.

We have successfully consolidated existing instruments for promoting research and fostering young talent. There are now 87 Helmholtz Virtual Institutes working with over 52 different universities and a long list of international partners. They all receive funding from the Initiative and Networking Fund. Helmholtz Centres are expected to be among the most highly awarded German contestants to emerge from the EU’s Seventh Framework Programme.

The Helmholtz Alliances are a fine example of extremely comprehensive networking projects. Within these clusters, the Helmholtz Centres and their partners from universities, other domestic and international research institutions or from industry, concentrate their combined efforts on a common strategic goal. The alliances work across borders and disciplines and create new research focuses which give rise to new structures and topics, such as translational approaches in health research in the two alliances Immunotherapy of Cancer and Mental Health in an Ageing Society.

Funds from the Joint Initiative for Research and Innovation help the Helmholtz Association create an optimal environment for competitive, top-rate research in Germany. This is particularly due to the research infrastructures it develops and operates, many of which are unique worldwide. The GSI in Darmstadt, for instance, is working on a Facility for Antiproton and Ion Research (FAIR), which will enable scientists to discover more about the strong force that holds atomic nuclei together. Fifteen countries are involved in this large-scale project.

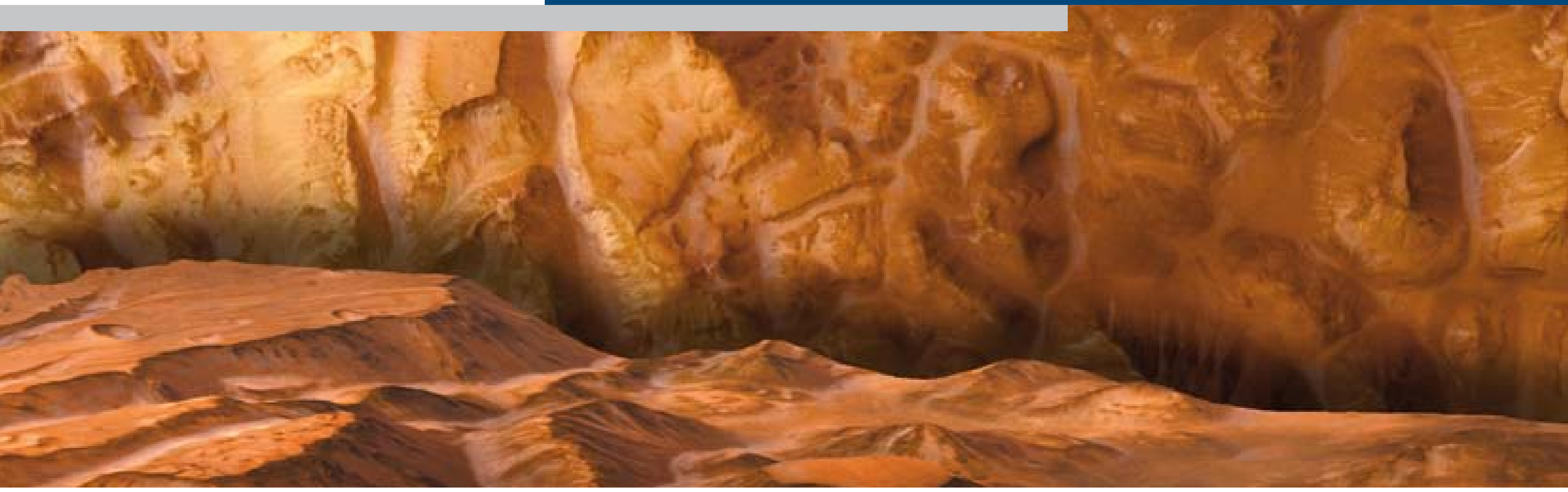
On 22 February 2008, one of the world’s most powerful civilian supercomputers, called JUGENE (Jülich Blue Gene), was put into commission at the Forschungszentrum Jülich, one of the three locations making up Germany’s Gauss Centre for Supercomputing. The Gauss Centre plays a leading role in creating a European centre for supercomputing. The technology enables scientists to simulate complex processes and has become an indispensable tool for climate research, medical research, high-energy physics, plasma physics and vehicle engineering. About 200 different European research groups work with the Jülich supercomputers each year.

Advancing knowledge

The Helmholtz Association strives to transfer its research findings to benefit science, society and industry. It must also endeavour to find comprehensive answers to society's most pressing challenges and questions from a scientific perspective. There is, however, no one sure way of transferring scientific knowledge; the most effective method must be decided upon according to the specific research topic or social issue. The Association's health research has already shown that it is capable of laying the foundation for innovative products, such as Gardasil, a vaccine against cervical cancer developed at DKFZ; Epothilon, an anticancer drug developed at HZI; and ion beam therapy, developed at GSI. The Heidelberg Ion Beam Therapy Centre (HIT), which is run by the Heidelberg University Clinic, is an example of successful technology transfer. The technology in use at HIT was developed in large part by GSI and has led to 40 new patents. This has made HIT the first marketable location for ion beam therapy. More than 1,000 patients will be able to receive treatment there each year at a cost of about 20,000 euros each. A licence agreement with Siemens Medical Solutions provides for the construction of more facilities of this kind. This strategic alliance will also lead to the construction of two high-frequency magnetic resonance tomography scanners at DKFZ and MDC, which will provide valuable insights for research and development. There will be a continual exchange of expertise between Siemens Medical Solutions and the users, which will enable health researchers of the Helmholtz Association to significantly improve diagnoses of common conditions such as cancer and cardiovascular disease as well as less common neurodegenerative diseases. An innovative 9.4 Tesla high-frequency hybrid scanner is in development at the Forschungszentrum Jülich since 2007 as a public-private partnership with Siemens AG. Support for this project comes from the Federal Ministry of Education and Research (BMBF).

The DLR, an important partner and catalyst for industry, has developed a process that uses microwaves for carbon fibre composite technology. This development helps secure Germany's position as an industry leader for lightweight composite structures. The innovative technology will enable industries to manufacture large, high-performance composite structures from carbon fibre materials while also saving energy and reducing production times. The microwave process is a joint development by the DLR and partners from industry; both the process and the large autoclave built especially for it are unique worldwide.

One of the Helmholtz Association's main objectives is to help solve pressing problems facing society today and tomorrow in collaboration with partners from science and industry. Since June 2007 the German Earth observation satellite TerraSAR-X has been circling the globe and sending detailed images of the Earth's surface back to the DLR's labs in Oberpfaffenhofen for processing. TerraSAR-X was built and put into operation as a public-private partnership between the DLR and Astrium, a wholly owned subsidiary of EADS. The information transmitted by the new satellite can be used to protect and preserve coasts and inland water and to analyse vegetation and meteorological data. TerraSAR-X can also play a major role in Europe's Global Monitoring for Environment and Security (GMES) programme. The Helmholtz Association has responded to the growing demand for information and advice on climate change in specific regions by creating a nationwide network of regional climate offices. Each office collects and provides the results of research that is particularly relevant for its specific region. The offices will supply farmers, coastal construction engineers, civil engineers and decision makers in politics and industry with first-hand information that will help them to respond to climatic changes in their region.



SECTION OF THE VALLES MARINERIS ON MARS. Image: ESA/DLR/FU Berlin (G. Neukum)

The best minds win

The Helmholtz Association has introduced measures specifically aimed at supporting its most talented young scientists and so helps to secure the future of science. In addition to the Young Investigators Groups which the Centres have established with their own or third-party funds, the Initiative and Networking Fund is currently funding 80 Helmholtz-Young Investigators Groups with a tenure option. This makes the path to a career in science much easier to plan and realise for many leaders of these Young Investigators Groups. In the last five calls for applications, up to 20 Young Investigators Groups in each round were able to meet the exacting demands of the review panel and received funding. Special mention should be made of the increase in the number of leaders for Young Investigators Groups that have been recruited from abroad – the portion of international applicants rose from 22 per cent during the second call for applications to 74 per cent in the fourth. There has also been significant 'brain gain' since the first call for applications, thanks to foreign scientists and returning expatriates. With funding from the Joint Initiative for Research and Innovation, the Initiative and Networking Fund was able to provide an additional 7 million euros last year, over and above the generous amount coming from the Centres' core funding. The money was used to pay for equipment and facilities not covered by the basic funding, further improving research conditions for Young Investigators Group leaders.

The Association's structured training programmes for doctoral students are moving ahead as well: in 2007, two more Helmholtz Research Schools were selected to receive funding.

Since 2007 the Initiative and Networking Fund has also helped the Association expand its existing range of training programmes by providing funds to establish new Graduate Schools. Three new Graduate Schools opened in 2007.

The Helmholtz Management Academy, which the Helmholtz Association founded in late 2007, offers young researchers and managers a customised advanced training programme to prepare them for the challenges of the future. The Excellence Programme draws on the Initiative and Networking Fund to support the creation of W2/W3 positions for outstanding female professors, helping promote equal opportunities for women while also attracting exceptional minds to the Association. Similarly, a new Helmholtz professorship for older researchers helps preserve the potential of researchers who are nearing retirement. Nobel laureate Peter Grünberg at the Forschungszentrum Jülich was the first to receive such a professorship.

Remaining flexible for the future

A measure of flexibility in allocating funding, uniting scientific competencies across institutional boundaries and providing research infrastructures – this is how the Helmholtz Association opens up new areas of research. Since innovative projects are often difficult to plan in advance, the Helmholtz Centres leave 20 per cent of their resources available for flexible use. The Initiative and Networking Fund also provides a way to fund unexpected activities quickly so scientists can pursue new strategic developments. This freedom to pursue unforeseen developments enables the Helmholtz Association to identify new topics outside of the five-year programmes of its Research Fields, ensuring that the Association can continue to thrive in the future. The independent review panel cited this ability to react quickly to new developments as a particularly valuable strategic element in the Initiative and Networking Fund.

OVERVIEW OF THE HELMHOLTZ ASSOCIATION

PERFORMANCE RECORD

As in the previous years, the Helmholtz Association can point to a solid increase in the relevant performance indicators for the 2007 reporting period. The figures for the 2007 reporting period are based on data from the 15 research centres that are members of the Association.

In 2007 the Helmholtz Centres raised 789 million euros in external funds in addition to the institutional funding of 1.644 billion euros in total provided by the federal and state governments. The external funds raised in the applications-oriented fields of research largely originate from cooperation with business and industry, while those generated by the more basic-research oriented fields comes mostly from research grants won in competition with other organisations, for example in funding programmes run by the European Union, the German Research Foundation (DFG), or the federal and state ministries. The impressive amount of external funding confirms the great appeal that Helmholtz research has for science and industry.

Research programmes lead to better performance

The Helmholtz Association invests a major part of its resources in cross-centre research programmes that compete with one another for funds. With the introduction of programme-oriented funding, the Helmholtz Centres began to systematically catalogue programme progress not only on the basis of activity reports but also on that of quantitative performance indicators. Though the success of a scientific endeavour may be measured in different ways depending on the particular project, certain general criteria have become established as a means for evaluating successful work. Some of our achievements, for example, in developing and delivering concrete solutions to problems faced by society, cannot, however, be adequately represented by rigid quantitative formulas alone. The selected examples of international research projects presented in the scientific section of this annual report serve to give readers an idea of some of the social issues addressed in the Helmholtz Association's six Research Fields.

Scientific excellence

Scientific excellence and leadership in certain areas of specialisation can be manifested in very different ways. Thus a high number of ISI citations attests to recognition by scientific peers, while the high number of Young Investigators Groups is evidence of the Helmholtz Association's appeal to promising young scientists at the beginning of their careers. We will therefore present a number of different indicators here to provide a comprehensive picture of the outstanding quality and performance of research conducted within the Helmholtz Association:

- The number of scientific partnerships maintained by the Helmholtz Association has risen 78 per cent in the past five years to reach 6,200 in 2007 – an increase of 9 per cent over the previous year.

- Helmholtz Centres were involved in 100 of the DFG's Priority Programmes and 67 DFG Collaborative Research Centres in 2007; in 2006, the equivalent figures were 95 and 86, respectively.

- In 2007, 107 Helmholtz scientists were appointed to professorships (W2/W3 grades), an increase of 54 per cent compared to the 70 appointments in 2006.

Talent management

- The number of PhD candidates whose dissertations were supervised at one of the Helmholtz Centres rose by 8.5 per cent, from 3,800 in 2006 to 4,124 in 2007. In the past five years, this number has risen by 76 per cent, or 15 per cent per year on average.

- All in all, 1,492 post-doctoral fellows conducted research within the Helmholtz Association in 2007; this number did not change significantly compared to the previous year.

- In the years 2006 and 2007, 42 academics gained their postdoctoral teaching qualification (habilitation) and twelve junior professors were appointed at Helmholtz Centres. Overall, 242 habilitation treatises were supervised at the Helmholtz Association from 2003 to 2007.

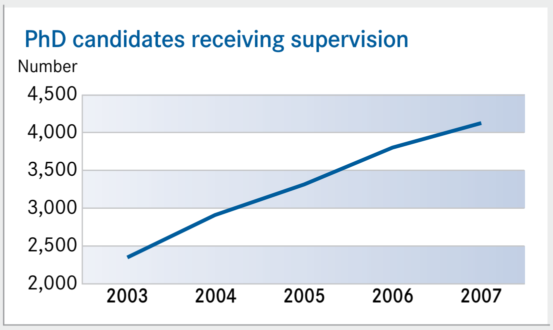
- Helmholtz Centres are involved in 52 DFG graduate schools, 12 more than in the last reporting period.

- Helmholtz Centres are involved in 42 Marie Curie Actions within the EU's funding programme for early stage reseachers. In 2006, there were 65 participations.

- The number of Young Investigators Groups in the Helmholtz Association climbed from 132 to 142.

- The Helmholtz Association continues to foster the talent of tomorrow's scientists with 23 School Labs and its "Tiny Tots Science Corner" initiative, involving approximately 3,000 day-care centres all over Germany.

- The Helmholtz Association provided vocational training for a total of 1,620 young people in 2007; this corresponds to a "training quota" of 6.8 per cent in terms of overall staff, excluding PhD students.

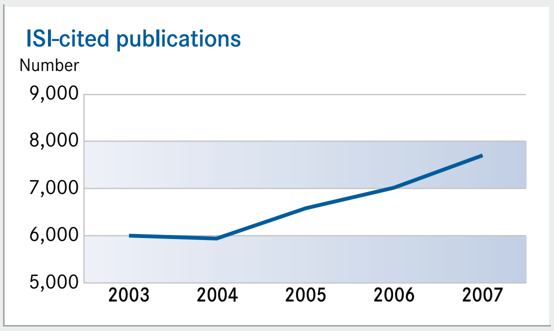


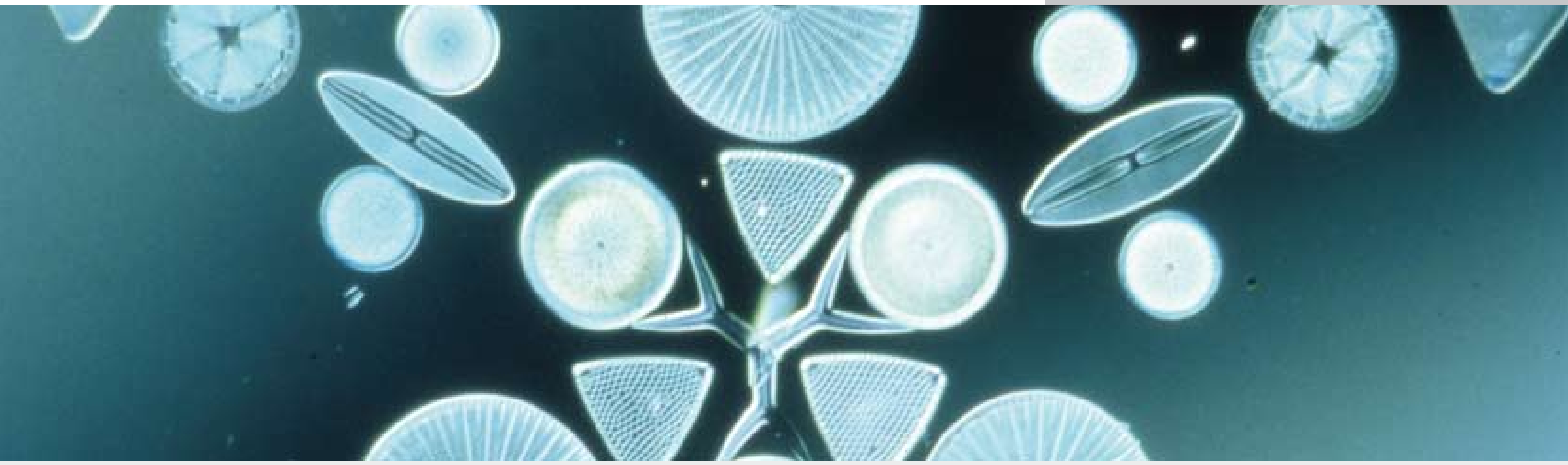
Publications

- A total of 12,617 academic publications appeared in 2007, of which 7,631 in professional journals cited by the ISI.

- The number of publications rose by 5.5 per cent compared to the previous year and by 25 per cent in total over the last five years.

- From 2005 to 2007, an average of approximately 1,500 textbooks and reference volumes were produced by Helmholtz Association academics per year.





DIATOMS ARE THE MAIN COMPONENT OF MARINE PHYTOPLANKTON AND ARE RESPONSIBLE FOR FIXING A LARGE AMOUNT OF GLOBAL CO_2. Photo: Richard Crawford/AWI

Staff

Scientific staff

The total staff of the Helmholtz Association in 2007 comprised 27,962 employees (previous year: 26,558), of which 8,763 were researchers and scientists (previous year: 7,986), 4,124 PhD candidates working on their dissertations under supervision by Helmholtz staff (previous year: 3,762), and 1,620 trainees and apprentices (previous year: 1,613). The total number of employees working as technicians or in administrative positions was 13,455 (previous year: 13,197).

Women in academic research

Women made up 21 per cent of the total academic staff and 37 per cent of junior scientists and researchers. In regard to science management, a marked upward trend is evident in the number of women heading institutes and departments. Currently women hold 16 per cent of all leading scientific, technical and administrative positions, compared to 14 per cent in 2006.

Guest researchers

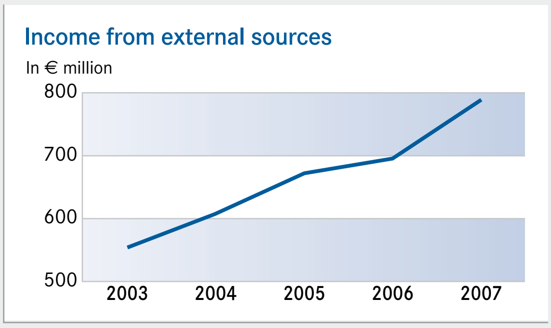
The Helmholtz Association continues to attract scientists from all over the world, as can be seen from the increasing numbers of guest researchers who spent time at Helmholtz Centres in 2007 to take advantage of our research infrastructures and exchange insights and ideas with other scientists: nearly 4,500 compared to 3,700 in 2006.

Partner of industry

Income from external sources

- External funds totalling 789 million euros were raised in 2007, which represents an increase of 13 per cent compared to the 696 million euros raised in 2006.

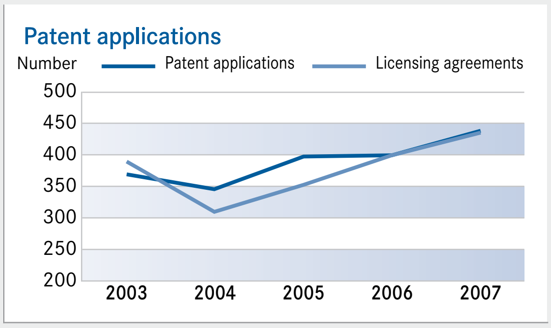
- Thus external funding has risen by 42 per cent overall in the past five years, corresponding to an average growth of 9 per cent per year.



Patent applications and licensing agreements

- A total of 440 patent applications were submitted in the year under review, corresponding to an increase of 10 per cent over the approximately 400 applications registered in each of the two preceding years, 2005 and 2006.

- The 436 licensing agreements concluded in 2007 represent an increase of 9 per cent compared to the previous year. Income from licensing agreements amounted to approximately 11 million euros per year, even reaching 15 million euros in 2007.



PROGRAMME-ORIENTED FUNDING

The Helmholtz Association funds research according to the principle of programme-oriented funding based on strategic evaluation. This approach means that researchers from different fields and institutions work together in research programmes toward a common goal, while at the same time fostering healthy competition between the 15 Centres and the various programmes for research funds. Funding is granted for the duration of a research programme, i.e., five years, with the precise amount depending on the results of the strategic evaluation of the particular programme. Introduced in 2003, the principle of programme-oriented funding has enabled the Helmholtz Association to make costs and staff capacities in the six Research Fields more transparent.

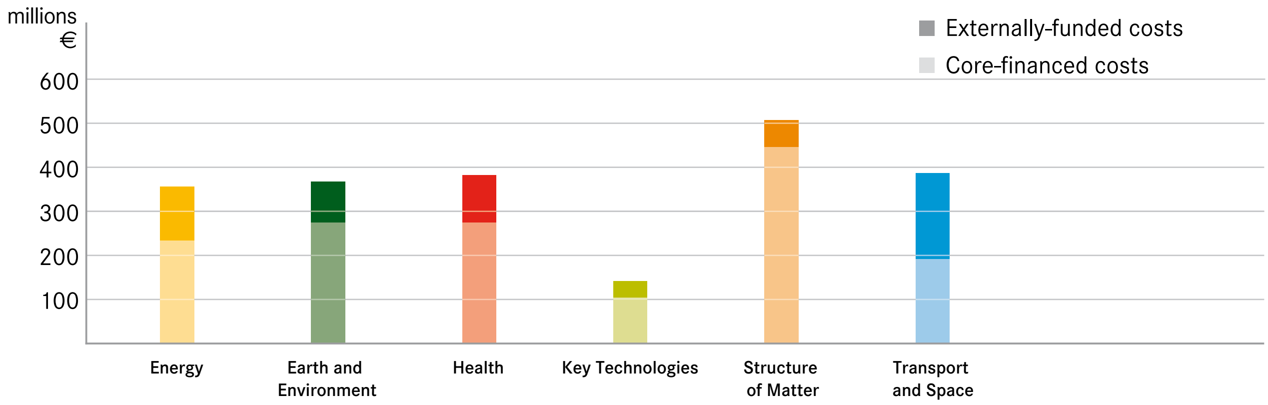
Research within programmes

In addition, the Centres can draw on so-called non-programme-bound funds to address new scientific issues and take up innovative approaches, expand specialised knowledge and lay the groundwork for strategically important projects. This funding amounts to 20 per cent of total programme funding raised by the individual Centres and thus depends on how well it fares in the evaluations. If Centres apply these resources to already existing research programmes, they are assigned directly to the costs of the respective programme. If the resources are used to launch new projects, they are reported separately under the item non-programme-bound research.

Special tasks

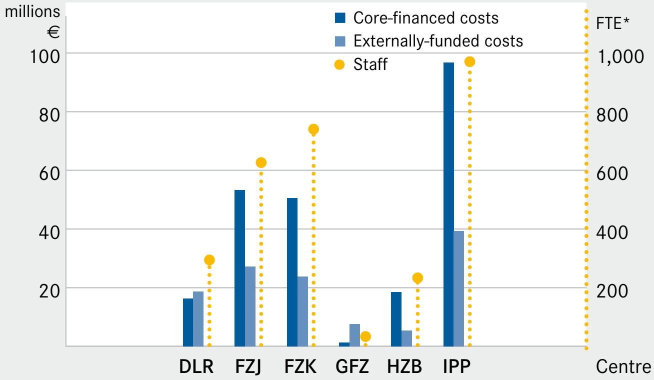
The tasks which the Centres perform that are independent of their scientific goals and aims are subsumed under the heading “special tasks”. Examples of such functions are providing vocational training in technical and administrative professions or performing special scientific-technical or administrative management tasks for federal or state ministries.

Core-financed and externally-funded costs of the Research Fields in 2007

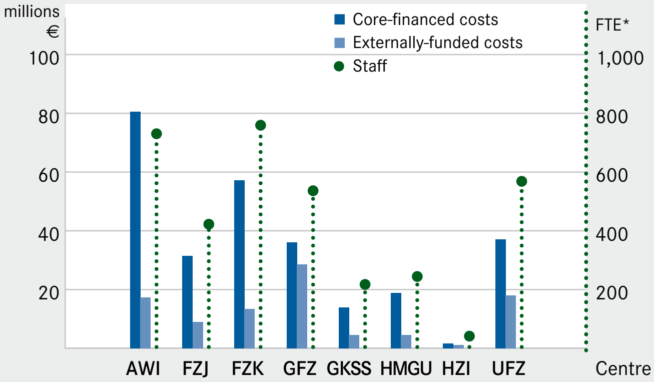


COSTS AND STAFF 2007

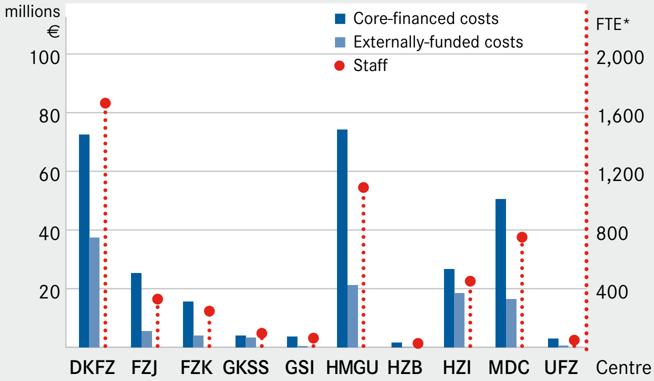
Research Field Energy



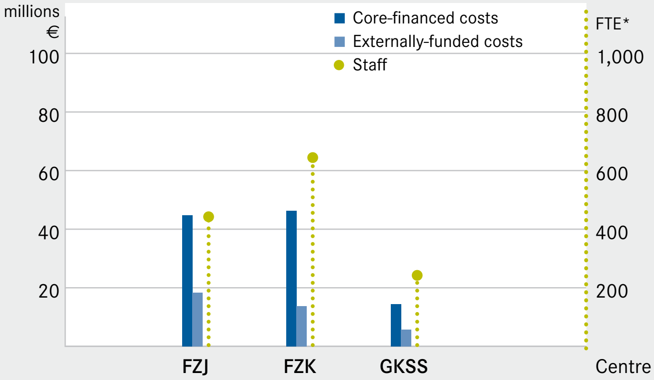
Research Field Earth and Environment



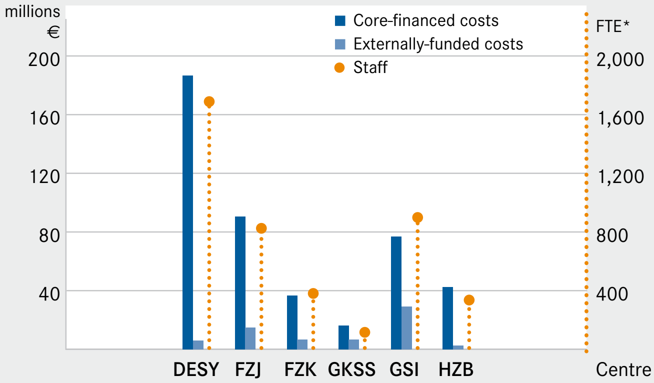
Research Field Health



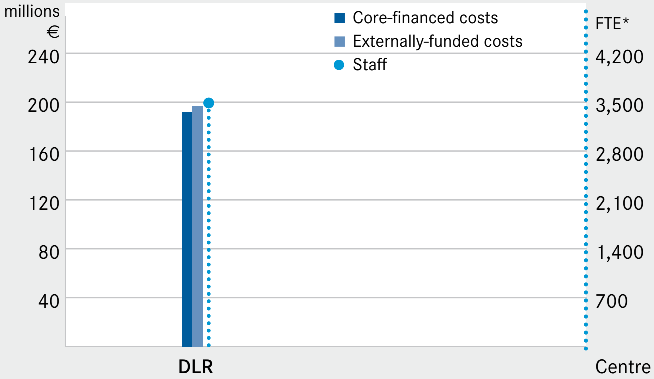
Research Field Key Technologies



Research Field Structure of Matter



Research Field Transport and Space



Overview of Helmholtz Association costs and staff	Costs Core-financed costs, in EUR'000s	Costs Externally-funded costs, in EUR'000s	Costs Total costs, in EUR'000s	Staff Total staff, FTE*
Total, Research Fields	1,537,534	619,304	2,156,838	20,012
Non-programme-bound research***	32,443	14,808	47,251	638
Special tasks	74,176	155,097	229,273	2,789
Total, Helmholtz Association	**1.644,153**	**789,208**	**2,433.362**	**23,439****

** In terms of natural persons, the Helmholtz Association employs 27,962 staff.

	Core-financed costs, in EUR'000s	Externally-funded costs, in EUR'000s	Total costs, in EUR'000s	Total staff, FTE*
Research Field Energy				
Deutsches Zentrum für Luft- und Raumfahrt (DLR)	16,244	18,637	34,881	290
Forschungszentrum Jülich (FZJ)	53,201	27,222	80,423	622
Forschungszentrum Karlsruhe (FZK)	50,554	23,856	74,410	736
Helmholtz Centre Potsdam (GFZ)	1,241	7,560	8,801	29
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	18,510	5,292	23,802	229
Max Planck Institute for Plasma Physics (IPP)	96,701	39,331	136,032	966
Total, Research Field Energy	**236,450**	**121,900**	**358,350**	**2,872**
Research Field Earth and Environment				
Alfred Wegener Institute for Polar and Marine Research (AWI)	80,535	17,239	97,774	726
Forschungszentrum Jülich (FZJ)	31,388	8,883	40,271	418
Forschungszentrum Karlsruhe (FZK)	57,149	13,348	70,497	755
GKSS Research Centre Geesthacht (GKSS)	13,922	4,474	18,396	213
Helmholtz Centre for Environmental Research – UFZ	37,137	17,945	55,082	564
Helmholtz Centre for Infection Research (HZI)	1,682	1,172	2,854	37
Helmholtz Centre Potsdam (GFZ)	36,117	28,519	64,635	532
Helmholtz Zentrum München (HMGU)	18,754	1,801	20,555	240
Total, Research Field Earth and Environment	**276,684**	**93,380**	**370,064**	**3,485**
Research Field Health				
Forschungszentrum Jülich (FZJ)	25,293	5,539	30,833	320
Forschungszentrum Karlsruhe (FZK)	15,662	3,952	19,614	238
German Cancer Research Center (DKFZ)	72,605	37,347	109,952	1,656
GKSS Research Centre Geesthacht (GKSS)	4,039	3,248	7,287	87
GSI Helmholtz Centre for Heavy Ion Research (GSI)	3,751	510	4,261	54
Helmholtz Centre for Environmental Research – UFZ	2,976	643	3,619	40
Helmholtz Centre for Infection Research (HZI)	26,719	18,498	45,217	442
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	1,657	127	1,784	18
Helmholtz Zentrum München (HMGU)	74,146	21,302	95,448	1,081
Max Delbrueck Center for Molecular Medicine (MDC)	50,514	16,527	67,041	742
Total, Research Field Health	**277,362**	**107,693**	**385,056**	**4,678**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	44,817	18,304	63,121	438
Forschungszentrum Karlsruhe (FZK)	46,324	13,663	59,988	640
GKSS Research Centre Geesthacht (GKSS)	14,330	5,707	20,037	238
Total, Research Field Key Technologies	**105,472**	**37,675**	**143,146**	**1,316**
Research Field Structure of Matter				
Deutsches Elektronen-Synchrotron DESY	186,585	5,914	192,499	1,680
Forschungszentrum Jülich (FZJ)	90,355	14,693	105,048	816
Forschungszentrum Karlsruhe (FZK)	36,687	6,713	43,400	372
GKSS Research Centre Geesthacht (GKSS)	16,073	2,306	18,379	107
GSI Helmholtz Centre for Heavy Ion Research (GSI)	76,856	29,314	106,170	890
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	42,493	2,466	44,958	327
Total, Research Field Structure of Matter	**449,048**	**61,406**	**510,454**	**4,192**
Research Field Transport and Space				
Deutsches Zentrum für Luft- und Raumfahrt (DLR)	192,518	197,250	389,768	3,469
Total, Research Field Transport and Space	**192,518**	**197,250**	**389,768**	**3,469**

*Full-time equivalents **In terms of natural persons, the Helmholtz Association employs 27,962 staff.

***Funding for non-programme-bound research is calculated as 20 per cent of the total programme fund raised by the individual Centres. Centres that use these funds for existing research programmes assign them directly to their programme costs.

The Helmholtz Association's annual budget is composed of core financing and external funding. Ninety per cent of core financing comes from the German federal government while ten per cent comes from the federal states in which the Centres' headquarters are located. Thirty per cent of the total budget is raised by the Centres from external sources. Both core-financing costs and externally-funded costs are described in the Annual Report for 2007. Total costs are shown according to how they are distributed among the Helmholtz Association's six strategic Research Fields (see p. 95). An overview of funding according to how it is distributed among the Centres is also provided (see below). Both overviews also provide number of staff, indicated in full-time equivalents.

Costs and staff by Centre in 2007	Core-financed costs, in EUR'000s	Externally-funded costs, in EUR'000s	Total costs, in EUR'000s	Total staff, FTE*
Alfred Wegener Institute for Polar and Marine Research (AWI)	80,535	17,239	97,774	726
Deutsches Elektronen-Synchrotron DESY	186,585	5,914	192,499	1,680
Deutsches Zentrum für Luft- und Raumfahrt (DLR)	208,762	215,887	424,649	3,759
Forschungszentrum Jülich (FZJ)	245,054	74,642	319,696	2,613
Forschungszentrum Karlsruhe (FZK)	206,376	61,533	267,908	2,741
German Cancer Research Center (DKFZ)	72,605	37,347	109,952	1,656
GKSS Research Centre Geesthacht (GKSS)	48,364	15,735	64,099	646
GSI Helmholtz Centre for Heavy Ion Research (GSI)	80,607	29,825	110,431	944
Helmholtz Centre for Environmental Research – UFZ	40,113	18,588	58,701	604
Helmholtz Centre for Infection Research (HZI)	28,401	19,670	48,071	479
Helmholtz Centre Potsdam (GFZ)	37,357	36,079	73,437	561
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	62,660	7,885	70,545	574
Helmholtz Zentrum München (HMGU)	92,900	23,103	116,003	1,321
Max Delbrueck Center for Molecular Medicine (MDC)	50,514	16,527	67,041	742
Max Planck Institute for Plasma Physics (IPP)	96,701	39,331	136,032	966
Non-programme-bound research	**32,443**	**14,808**	**47,251**	**638**
Special tasks	**74,176**	**155,097**	**229,273**	**2,789**
Total, Helmholtz Association	**1,644,153**	**789,208**	**2,433,362**	**23,439**

*Full-time equivalents

SECOND ROUND OF PROGRAMME-ORIENTED FUNDING, 2009 TO 2013

Research Fields Earth and Environment | Health | Aeronautics, Space and Transport

2009 will see the start of the second round of programme-oriented funding, beginning with the Research Fields Earth and Environment, Health and Aeronautics, Space and Transport. The Centres involved in these Research Fields have reorganised their R&D capacities in those fields to form 13 new programmes. This page shows 2009 funding as recommended for the 13 programmes by the Senate following the evaluations. The calculations are based on full costs from core funding. In contrast to data provided in the first round, these full costs also include infrastructure costs. In order to better enable readers to see the changes between the first and second rounds of funding, the infrastructure costs for the reporting year 2007 have also been added to the individual programmes by means of an internal key.

	Core-financed costs, in EUR'000s
Research Field Earth and Environment*	
Alfred Wegener Institute for Polar and Marine Research (AWI)	85,694
Forschungszentrum Jülich (FZJ)	28,567
Forschungszentrum Karlsruhe (FZK)	17,575
GKSS Research Centre Geesthacht (GKSS)	18,954
Helmholtz Centre for Environmental Research – UFZ	44,091
Helmholtz Centre Potsdam (GFZ)	38,190
Helmholtz Zentrum München (HMGU)	18,090
Total, Research Field Earth and Environment	**251,161**
Research Field Health	
Forschungszentrum Jülich (FZJ)	29,139
German Cancer Research Center (DKFZ)	111,002
GKSS Research Centre Geesthacht (GKSS)	4,892
GSI Helmholtz Centre for Heavy Ion Research (GSI)	3,680
Helmholtz Centre for Environmental Research – UFZ	5,234
Helmholtz Centre for Infection Research (HZI)	41,540
Helmholtz Zentrum München (HMGU)	76,363
Max Delbrueck Center for Molecular Medicine (MDC)	55,543
Total, Research Field Health	**327,329**
Research Field Aeronautics, Transport and Space	
Deutsches Zentrum für Luft- und Raumfahrt (DLR)	248.981
Total, Research Field Aeronautics, Transport and Space	**248.981**

The three Research Fields evaluated in 2008 will implement restructured research programmes beginning on 1 January 2009. Charts showing the new distribution of funding at the programme level can be found next to the descriptions of the new programmes – for Earth and Environment, see p. 30; for Health, see p. 44; for Aeronautics, Space and Transport, see p. 76.

*Please note: Due to the Helmholtz Association's new Climate Initiative, the costs shown for the Research Field are only provisional. Exact figures are expected in early 2009.

CENTRAL BODIES

Last updated October 2008

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Prof. Dr. Jürgen Mlynek

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Prof. Dr. Eberhard Umbach, Chairman of the Executive Board, Forschungszentrum Karlsruhe

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Vice-President for the Research Field Health
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Vice-President for the Research Field Key Technologies
Prof. Dr. Achim Bachem, Chairman of the Board of Directors, Forschungszentrum Jülich

Vice-President for the Research Field Structure of Matter
Prof. Dr. Albrecht Wagner, Chairman of the Board of Directors, Deutsches Elektronen-Synchrotron DESY

Vice-President for the Research Field Transport and Space
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Administrative Vice-President
Klaus Hamacher, Vice-Chairman of the Executive Board, Deutsches Zentrum für Luft- und Raumfahrt

Administrative Vice-President
Dr. Bernhard Raiser, Administrative Executive Board, Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Managing Director

Dr. Tania Lieckweg (Acting Head, until 15/9/2008)
Dr. Rolf Zettl (from 1/10/2008)

Members of the Senate

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Prof. Dr. Ralph Eichler, President of the ETH, Zurich, Switzerland

Prof. Dr. Katharina Kohse-Höinghaus, Bielefeld University, Faculty of Chemistry

Prof. Dr. Gerd Litfin, Chairman of the Supervisory Board, Linos AG, Göttingen

Dr. Detlef Müller-Wiesner, Senior Vice-President, Chief Operating Officer Innovation und CTO Deputy Corporate Technical Office, EADS Suresnes, France

Prof. Dr. Mary Osborn, Max Planck Institute for Biophysical Chemistry, Göttingen

Prof. Dr. Hermann Requardt, Member of the Managing Board, Siemens AG, Munich

Prof. Dr. Robert Rosner, Director, Argonne National Laboratory, USA

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Prof. Dr. Klaus Töpfer, Former Under Secretary General, United Nations, Höxter

Prof. Dr. Ulrich Wagner, Technical University Munich, Chair of Institute for Energy Economy and Application Technology

Prof. Dr. Alexander J. B. Zehnder triple Z, Zurich, Switzerland

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Jochen Homann, Secretary of State, Federal Ministry of Economics and Technology, Berlin

Michael Kretschmer, Member of the German Bundestag, Berlin

Prof. Dr. Jürgen Mlynek, President of the Helmholtz Association

Renate Jürgens-Pieper, Senator for Education and Science of the State of Bremen

Dr. Annette Schavan, Federal Minister of Education and Research

Jörg Tauss, Member of the German Bundestag, Berlin

Prof. Dr. Margret Wintermantel, President of the German Rectors' Conference, Bonn

GUESTS

Prof. Dr. Achim Bachem, Vice-President of the Helmholtz Association, Chairman of the Board of Directors, Forschungszentrum Jülich

Prof. Dr. Peter Gruss, President of the Max Planck Society for the Advancement of Science, Munich

Klaus Hamacher, Vice-President of the Helmholtz Association, Vice-Chairman of the Executive Board, Deutsches Zentrum für Luft- und Raumfahrt, Cologne

Cornelia Jebsen, Representative of the Staff and Works Councils of the Helmholtz Centres, Forschungszentrum Jülich

Prof. Dr. Matthias Kleiner, President of the German Research Foundation, Bonn

Dr. Martin Lipp, Chairperson of the Committee of Scientific-technical Councils of the Helmholtz Centres, Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

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Prof. Dr. Georg Teutsch, Vice-President of the Helmholtz Association, Scientific Director, Helmholtz Centre for Environmental Research – UFZ, Leipzig

Prof. Dr. Eberhard Umbach, Vice-President of the Helmholtz Association, Chairman of the Executive Board, Forschungszentrum Karlsruhe

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Prof. Dr. Otmar D. Wiestler, Vice-President of the Helmholtz Association, Chairman of the German Cancer Research Center, Heidelberg

Prof. Dr. Johann-Dietrich Wörner
Vice-President of the Helmholtz Association, Chairman of the Executive Board, Deutsches Zentrum für Luft- und Raumfahrt, Cologne

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Chairman of the Board of Directors,
Christian Scherf, Administrative Director

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Chairman of the Executive Board,
Klaus Hamacher,
Vice-Chairman of the Executive Board

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Chairman of the Management Board,
Dr. Josef Puchta, Administrative-Commercial Member of the Management Board

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Michael Ganß,
Administrative Director

GSI Helmholtz Centre for Heavy Ion Research
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Scientific Director,
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Administrative Director

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Scientific Director,
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Helmholtz Centre for Infection Research
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Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences
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Dr. Ulrich Breuer, Administrative Director

Helmholtz Zentrum München – German Research Center for Environmental Health
Prof. Dr. Günther Wess,
Scientific and Technical Director,
Dr. Nikolaus Blum,
Administrative Director

Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch,
Prof. Dr. Walter Birchmeier,
Chairman of the Foundation Board,
Cornelia Lanz, Administrative Director

Max Planck Institute for Plasma Physics (Associate Member)
Prof. Dr. Alexander M. Bradshaw,
Scientific Director,
Dr.-Ing. Karl Tichmann,
Managing Director

SENATE COMMISSIONS

Last updated October 2008

The Senate Commissions convene under the chairmanship of the Helmholtz Association President, Prof. Dr. Jürgen Mlynek.

PERMANENT MEMBERS

Research Field Energy
Prof. Dr. Thomas Hartkopf
Department Head Renewable Energies, Technical University Darmstadt

Research Field Earth and Environment
Prof. Dr. Dr. h.c. Volker Josef Mosbrugger Director of the Senckenberg Research Institute and Natural History Museum, Frankfurt

Research Field Health
Prof. em. Dr. Heidi Diggelmann
University of Lausanne, Switzerland, and former President of the Research Council of the Swiss National Science Foundation

Research Field Key Technologies
Dr. Thomas Grandke
Vice-President, Technology Materials & Microsystems, Siemens AG, Berlin

Research Field Structure of Matter
Prof. Dr. Vera Lüth
Stanford Linear Accelerator Center, Stanford, USA

Research Field Aeronautics, Space and Transport
Prof. Dr. Hans Michael Kappler
former Director European Space Agency

Representative of the Federal Ministry of Education and Research
Dr. Christian D. Uhlhorn
Federal Ministry of Education and Research, Bonn

Representatives appointed by the Länder
Dr. Beate Wieland
Federal Ministry of Innovation, Science, Research and Technology of the State of North Rhine-Westphalia, Düsseldorf

Dr. Heribert Knorr
Ministry of Science, Research and the Arts of the State of Baden-Württemberg, Stuttgart

The permanent members belong to all six Senate Commissions.

SENATE COMMISSION
Research Field Energy

Member of the Senate **Prof. Dr. Hermann Requardt,**
Member of the Managing Board of Siemens AG, Munich
Member of the Senate **Prof. Dr. Ulrich Wagner,**
Chair of Institute for Energy Economy and Application Technology, Technical University Munich
Representative of the Federal Ministry **Dr. Knut Kübler,**
Federal Ministry of Economics and Technology, Bonn

Chairpersons of the review panels*

Renewable Energies **Prof. Dr. Louis Schlapbach,** ETH Zurich, Switzerland
Nuclear fusion **Prof. Dr. Walter F. Henning,**
Argonne National Laboratory, Illinois, USA
Nuclear Safety Research **Dr. Phillip Finck,**
Idaho National Laboratory, Idaho Falls, USA
Efficient Energy Conversion and Use **Prof. Dr. Alexander Wokaun,**
Paul-Scherrer-Institut, Villigen, Switzerland
Technology, Innovation and Society **Prof. Dr. Ortwin Renn,**
University of Stuttgart

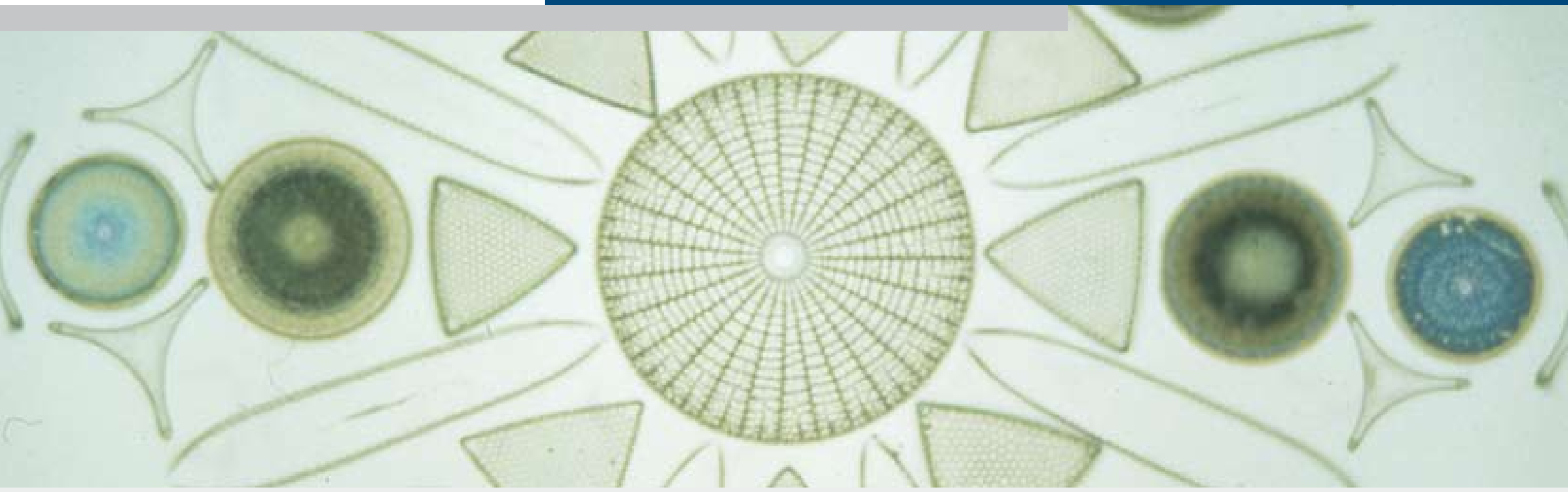
SENATE COMMISSION
Research Field Earth and Environment

Member of the Senate **Prof. Dr. Klaus Töpfer,**
Former Under Secretary General, United Nations
Member of the Senate **Prof. Dr. Alexander J.B. Zehnder,**
triple Z, Zurich, Switzerland
Representative of the Federal Ministry of Education and Research
Hartmut Grübel, Federal Ministry of Education and Research, Bonn

Chairpersons of the review panels*

Geosystem: The Changing Earth **Prof. Dr. Roy H. Gabrielsen,**
Dept. of Geosciences, University of Oslo, Norway
Marine, Coastal and Polar Systems **Prof. Dr. Guy Brasseur,**
National Center for Atmospheric Research, Earth and Sun Systems Laboratory, Boulder, USA
Atmosphere and Climate **Prof. Dr. Thomas Stocker,** Institute for Climate and Environmental Physics, University of Berne, Switzerland
Terrestrial Environment **Prof. Dr. Johan Bouma,**
formerly of Wageningen Agricultural University, Netherlands

*The review panels relate to the programme structure of the second round of programme-oriented funding.



IT IS ESTIMATED THAT THERE ARE OVER 100,000 EXTANT DIATOM SPECIES. THEIR GEOMETRIC CELL WALLS ARE MADE OF SILICA DIOXIDE. Photo: Richard Crawford/AWI

SENATE COMMISSION
Research Field Health

Member of the Senate **Prof. Dr. Dr. Max M. Burger,** Chairman Novartis Science Board, Novartis International AG, Basel, Switzerland
Member of the Senate **Prof. Dr. Mary Osborn,** Max Planck Institute for Biophysical Chemistry, Göttingen
Representative of the Federal Ministry of Education and Research **Dr. Peter Lange,** Federal Ministry of Education and Research, Berlin

Chairpersons of the review panels*

Cancer Research **Prof. emer. Dr. Paul Neiman,** Member and Director emer. Division of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, USA
Cardiovascular and Metabolic Diseases **Prof. Dr. Thomas F. Lüscher,** Chairman, Cardiology Clinic, University Hospital Zurich, Switzerland
Function and Dysfunction of the Nervous System **Prof. Dr. Mark Hallett,** Chief of Human Motor Control Section, National Institute of Neurological Disorders and Stroke, NINDS, Bethesda, USA
Infection and Immunity **Prof. Dr. Dennis L. Kasper,** Channing Laboratory, Department of Medicine, Harvard Medical School, Boston, USA
Environmental Health **Prof. David A. Schwartz,** Director, National Institute of Environmental Health Sciences, Research Triangle Park, USA
Systemic Analysis of Multifactorial Diseases **Prof. Dr. Nouria Hernandez,** Director, Center for Integrative Genomics, University of Lausanne, Switzerland

SENATE COMMISSION
Research Field Key Technologies

Member of the Senate **Prof. Dr. Gerd Litfin,** Chairman of the Supervisory Board, Linos AG, Göttingen
Member of the Senate **Prof. Dr. Katharina Kohse-Höinghaus,** Faculty of Chemistry, University of Bielefeld
Representative of the Federal Ministry of Education and Research **Dr. Wolf-Dieter Lukas,** Federal Ministry for Education and Research, Bonn

Chairpersons of the review panels*

Supercomputing **Prof. Dr. Horst Simon,** Associate Laboratory Director, Computing Sciences, Lawrence Berkeley National Laboratory, Berkeley, USA
Fundamentals of Future Information Technology **Prof. Dr. Michael M. T. Loy,** Chair Professor, Department of Physics, The Hong Kong University of Science and Technology, Hong Kong
BioSoft: Molecular Systems and Biological Information Processing **Prof. Dr. Georg Maret,** Soft Matter Physics, University of Konstanz
Nano and micro system technologies **Prof. Dr. Erich Gornik,** Institute of Semiconductor Electronics, and Center for Micro and Nanostructures, Vienna University of Technology, Austria
Nanobiology **Prof. Dr. Ernst Hafen,** Department of Biology, ETH Zurich, Switzerland
Advanced Engineering Materials **Prof. Dr. Berthold Scholtes,** Institut für Werkstofftechnik, Metallische Werkstoffe, University of Kassel

SENATE COMMISSION
Research Field Structure of Matter

Member of the Senate **Prof. Dr. Robert Rosner,** Director, Argonne National Laboratory, USA
Member of the Senate **Prof. Dr. Ralph Eichler,** President, ETH Zurich
Representative of the Federal Ministry of Education and Research **Dr. Beatrix Vierkorn-Rudolph,** Federal Ministry of Education and Research, Bonn

Chairpersons of the review panels*

Astroparticle Physics **Prof. Dr. Roger Blandford,** Director, Kavli Institute for Particle Astrophysics and Cosmology, Stanford, USA
Elementary Particle Physics **Prof. Dr. Michael Davier,** Laboratoire de l'Accélérateur Linéaire, Université Paris-Sud 11, France
Physics of Hadrons and Nuclei **Prof. Dr. Barbara Jacak,** State University of New York, USA
Research with Photons, Neutrons and Ions **Prof. Dr. Joël F. Mesot,** Paul-Scherrer-Institut, Villigen, Switzerland

SENATE COMMISSION
Research Field Aeronautics, Space and Transport

Member of the Senate **Prof. Dr. Ulrich Seiffert,** Managing Director, WiTech Engineering GmbH, Braunschweig
Member of the Senate **Dr. Detlef Müller-Wiesner,** Senior Vice-President, Chief Operating Officer, Innovation and CTO Deputy Corporate Technical Office, EADS, Suresnes, France
Representative of the Federal Ministry of Economics and Technology **Helge Engelhard,** Federal Ministry of Economics and Technology, Bonn

Chairpersons of the review panels*

Aeronautics **Prof. Dr. Jürgen Klenner,** Senior Vice-President Flight Physics, Airbus Engineering, Blagnac, France
Space **Dipl.-Ing. Jürgen Breitkopf,** Director, Kayser-Threde GmbH, Munich
Transport **Prof. Dr. George A. Giannopoulos,** Head of Hellenic Institute of Transport, Thessaloniki, Greece

*The review panels relate to the programme structure of the second round of programme-oriented funding.

SCIENCE PRIZES FOR SCIENTISTS AND RESEARCHERS FROM THE HELMHOLTZ ASSOCIATION

Prizes worth more than 10,000 euros awarded during the period 2007/2008; last updated July 1, 2008

A | Hannes Alfvén-Preis 2007 der Europäischen Physikalischen Gesellschaft (EPS)
Professor Dr. Friedrich Wagner, Max-Planck-Institut für Plasmaphysik, Ass. Member, Helmholtz Association

B | Behnken-Berger Prize for Dose Reduction in Medical Imaging Technology
Dr. Christoph Hoeschen, Helmholtz Zentrum München – German Research Center for Environmental Health (2007)

Dr. Hella Bühler Prize
Dr. Stefan Pfister, German Cancer Research Center (2007)

C | German Cancer Aid Award 2006 (awarded 2007)
Prof. Dr. Harald zur Hausen, former Chairman German Cancer Research Center Heidelberg

Communicator Award 2007 from the German Stifterverband für die Deutsche Wissenschaft
Epica Working Group, Prof. Heinz Miller, Alfred Wegener Institute for Polar and Marine Research

Coolidge Award 2007
Dr. Marc-André Weber, German Cancer Research Center

D | René Descartes Research Prize from the European Union
Epica Project of the Alfred Wegener Institute for Polar and Marine Research

Dupont Science and Engineering Grant 2007
Dr. Kai Uwe Goss, Helmholtz Centre for Environmental Research – UFZ

René Descartes Research Prize from the European Union
Virlis Project, Helmholtz Center for Infection Research

Do it.Software Award, 2nd place
Thomas Horn, Zeynep Arziman, Dr. Michael Boutros, German Cancer Research Center (2007)

E | The Economist Innovation Award 2007
Prof. Dr. Peter Grünberg, Forschungszentrum Jülich

Energy Globe Award
Sowarla Cooperation Project, Deutsches Zentrum für Luft- und Raumfahrt and participating companies

European Research Council (ERC) Investigator Grant
Dr. Björn Rost, Alfred Wegener Institute for Polar and Marine Research (2008)

F | Felix Wankel Animal Welfare Research Award 2007
Dr. Jürgen Biederer, German Cancer Research Center

G | Gairdner International Award
Prof. Dr. Harald zur Hausen, former Chairman of the German Cancer Research Center (2007)

German Science Foundation Award 2008
Dr. Ralf Bischoff, Dr. Frank Breitling, Dr. Thomas Felgenhauer, Dr. Simon Fernandez, Klaus Leibe, Dr. Volker Stadler, German Cancer Research Center

H | Heinrich Hertz Prize 2007
Prof. Dr. Peter Komarek, Forschungszentrum Karlsruhe

L | Gottfried Wilhelm Leibniz Prize 2008
Prof. Stefan Hell, Cooperation Division at the German Cancer Research Center

M | Curt Meyer Memorial Award
Dr. Martin Janz, Max Delbrueck Center for Molecular Medicine (MDC), Berlin-Buch, and **Dr. Stephan Mathas,** Charité – Universitätsmedizin, Berlin

N | Georg von Neumayer Medal
Prof. Dr. Jörn Thiede, Alfred Wegener Institute for Polar and Marine Research(2007)

Novartis Young Endocrinology Prize
Dr. Alexandros Vegiopoulos, German Cancer Research Center

Novartis Prize for therapy-relevant pharmacological research 2006
Prof. Frank Lyko, German Cancer Research Center (awarded 2007)

CONNECTIVE TISSUE CELLS ON A THREE-DIMENSIONAL POLYMER MOLECULAR STRUCTURE. Photo: GKSS 2007

Jean-Pierre Noblanc Award of the MEDEA+ European Programme in Microelectronics
Silonis project by the working group led by Prof. Siegfried Mantl, Forschungszentrum Jülich (2007)

Nobel Prize in Medicine 2008
Prof. Dr. Harald zur Hausen, former Chairman of the Management Board and Scientific Director, German Cancer Research Center and Prof. Dr. Françoise Barré-Sinoussi, Institut Pasteur Paris, France; Prof. Dr. Luc Montagnier, World Foundation for AIDS Research and Prevention, Paris, France

Nobel Peace Prize 2007
Intergovernmental Panel on Climate Change (IPCC) and Albert A. Gore, with participation by Prof. Peter Lemke, Dr. Annette Rinke, Alfred Wegener Institute for Polar and Marine Research and other researchers from the Helmholtz Association

Nobel Prize in Physics 2007
Prof. Dr. Peter Grünberg, Forschungszentrum Jülich and Prof. Albert Fert of the University of Paris

Novartis Award for Hypertension Research from Novartis and the American Heart Association
Prof. Dr. Friedrich C. Luft, Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch (2007)

O | **L'ORÉAL-UNESCO Awards for Women in Science Programme in partnership with the Christiane Nüsslein-Volhard Foundation**
Dr. Maïwen Caudron-Herger, German Cancer Research Center (2007)

Outstanding Volunteer Award for excellence in cancer control
Prof. Dr. Harald zur Hausen, former Chairman of the German Cancer Research Center

P | **Pecora Award**
German-American GRACE Team, Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences (2008)

R | **Ernst von Rebeur-Paschwitz Medal**
Dr. Winfried Hanka, Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences (2008)

S | **Salvatore Medal of the Anton Dohrn Marine Biology Station**
Prof. Victor Sematcek, Alfred Wegener Institute for Polar and Marine Research

Hans Stille Medal of the German Geological Society
Prof. Dieter Fütterer, Alfred Wegener Institute for Polar and Marine Research

T | **Technology Transfer Award 2008**
Dr. Rüdiger Giese, Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Tycho Brahe Award 2007 of the American Institute of Navigation ION
Dr. Oliver Montenbruck, Deutsches Zentrum für Luft- und Raumfahrt

W | **Anita and Cuno Wieland Award 2007**
Prof. Dr. Lutz Gissmann, German Cancer Research Center

Sir Geoffrey Wilkinson Award 2007 for Numerical Software
Dr. Ralf Hartmann, Deutsches Zentrum für Luft- und Raumfahrt

Wilhelm P. Winterstein Award
Dr. Martin Bergmann, Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

Georg Wüst Prize 2007
Dr. Eberhard Fahrbach, Alfred Wegener Institute for Polar and Marine Research

Y | **Young Scientist Prize awarded by the state of Brandenburg**
Prof. Dr. Ulrike Herzschuh, Alfred Wegener Institute for Polar and Marine Research

RECIPIENTS OF THE HELMHOLTZ-HUMBOLDT RESEARCH AWARD

Prof. Dr. Roberto Bassi, Universita degli Studi di Verona, Italy
Prof. Dr. Shigemasa Suga, Osaka University, Japan
Prof. Dr. Pulickel M. Ajayan, Rensselaer Polytechnic Institute, USA

THE GOVERNANCE STRUCTURE OF THE HELMHOLTZ ASSOCIATION

COMMITTEE OF FINANCING PARTNERS

The Committee of Financing Partners – federal government and host states – defines the research policy requirements, including the research fields, for a term of several years and appoints the members of the Senate.

SENATE

Besides the Assembly of Members, the externally appointed Senate is the central decision-making body of the Helmholtz Association. The members are "ex officio" representatives of federal and state authorities, parliament and science organisations, as well as public figures from science and industry who are elected for three years. The Senate consults on all major decisions, and elects the president and vice-presidents.

SENATE COMMISSIONS

The Senate established Senate Commissions which prepare their deliberations on the funding of the programmes, basing their decisions on the results of the programme evaluations, and their decision on investment prioritization. The Senate Commissions are made up of permanent members – "ex officio" representatives of federal and state authorities – as well as experts covering the spectrum of the six research fields, and also alternating members depending on the research field under discussion.

PRESIDENT

A full-time president heads the Helmholtz Association and represents it externally. He takes on a leading role in the dialogue between science, industry and politics. He is responsible for preparing and implementing the senate's recommendations on programme-oriented funding. He coordinates the development of programmes for the research fields, the cross-centre controlling system, and the development of the association's general strategy.

VICE-PRESIDENTS

Eight vice-presidents support, advise and represent the president in the fulfilment of his duties. The six scientific vice-presidents are also the coordinators of the six research fields. A further two vice-presidents come from the centres' administrative bodies.

HEAD OFFICE

The head office and the offices in Brussels, Moscow and Beijing support the president and vice-presidents in the fulfilment of their duties.

Energy | Earth and Environment | Health | Key Technologies | Structure of Matter | Transport and Space

RESEARCH FIELDS

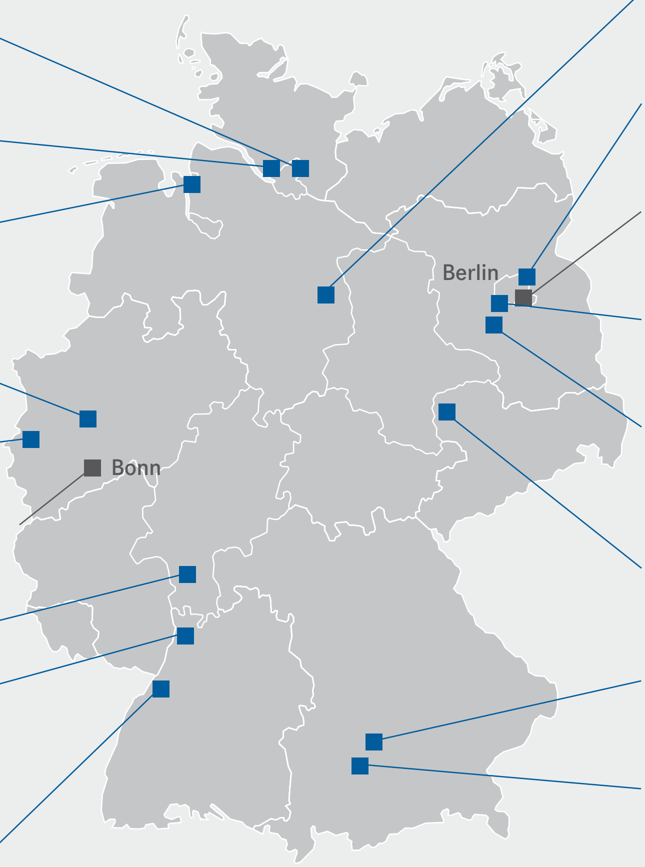
Helmholtz scientists work in six centre-overlapping research fields financed within the framework of programme-oriented funding. Their cross-centre research is performed with external partners in interdisciplinary and international collaborations.

ASSEMBLY OF MEMBERS

The Helmholtz Association is a registered association. Its members are 14 legally independent research centres and one associate member. Besides the Senate, the Assembly of Members is the central decision-making body of the association. The members are the scientific-technical and administrative directors of the member centres. The Assembly of Members is responsible for all of the association's tasks. It defines the framework for the cross-centre development of strategies and programmes, and has the right of proposal for the election of the president and members of the senate.

- Alfred Wegener Institut Institute for Polar and Marine Research
- Deutsches Elektronen-Synchrotron DESY
- Deutsches Zentrum für Luft- und Raumfahrt
- Forschungszentrum Jülich
- Forschungszentrum Karlsruhe
- German Cancer Research Center
- GKSS Research Centre Geesthacht
- GSI Helmholtz Centre for Heavy Ion Research
- Helmholtz Centre for Environmental Research – UFZ
- Helmholtz Centre for Infection Research
- Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences
- Helmholtz-Zentrum Berlin für Materialien und Energie
- Helmholtz Zentrum München – German Research Center for Environmental Health
- Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch
- Max Planck Institute for Plasma Physics (Associate Member)

SITES OF THE HELMHOLTZ RESEARCH CENTRES



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GSI Helmholtz Centre for Heavy Ion Research
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Last update: October 2008

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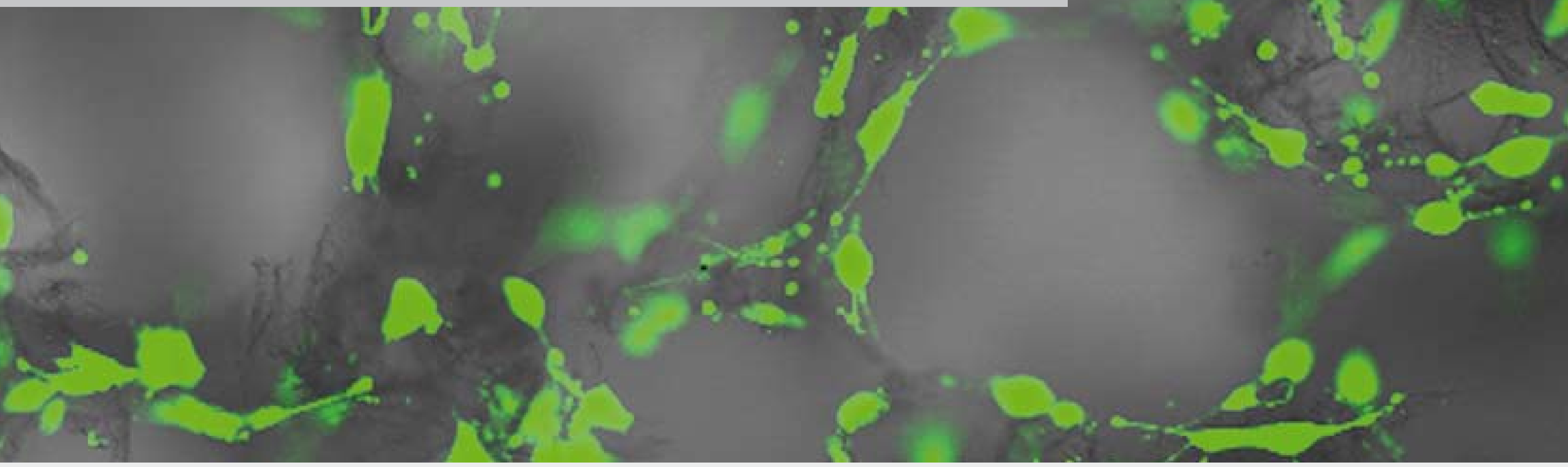

AN IMAGE OF STREPTOCOCCUS BACTERIA ATTACHING THEMSELVES TO COLLAGEN STRANDS, TAKEN WITH AN ELECTRON MICROSCOPE. Photo: HZI

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