HELMHOLTZ – WE DO RESEARCH FOR PEOPLE

ANNUAL REPORT 2011

THE HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

Research in Germany
Land of Ideas

HELMHOLTZ GEMEINSCHAFT

TABLE OF CONTENTS

PLEASE NOTE: The Helmholtz Annual Report 2011 shows the actual costs of research in 2010 and the financing of research programmes as recommended by the Helmholtz Senate for 2009 to 2013 in the research fields Earth and Environment, Health, and Aeronautics, Space and Transport. It also presents the financing recommendations for the programme period 2010 to 2014 for the research fields Energy, Key Technologies and Structure of Matter.
The general section of the report presents developments at the Helmholtz Association from 2010 to August 2011.

We contribute to solving the major and pressing problems facing society, science and industry today by conducting high-level research in the strategic programmes within our six research fields: Energy, Earth and Environment, Health, Key Technologies, the Structure of Matter, and Aeronautics, Space and Transport.

We research highly complex systems using our large-scale facilities and scientific infrastructure in cooperation with national and international partners.

We are committed to shaping our shared future by combining research and technological developments with innovative applications and prevention strategies.

This is our mission.

WE DO RESEARCH FOR PEOPLE

Professor Jürgen Mlynek

Dear Readers,

The Helmholtz Association focuses its research strategy on the most pressing problems and challenges of the day. We do research for people. This motto applies not only to our research in the area of health, where we investigate the causes and mechanisms of major common diseases, but also to our other five research fields, which range from energy to fundamental questions about the structure of matter. Research deepens our understanding of nature and enables us to conserve and wisely use resources such as water, the atmosphere, soil, energy and raw materials as a means of ensuring prosperity and quality of life over the long term. With its strategically based, solutions-oriented research, the Helmholtz Association is making an important contribution to achieving these goals.

This annual report is designed to inform you about developments, projects and achievements at the Helmholtz Association. We have made a conscious decision to keep it short in order to provide you with a quick overview. You can read our annual report as an online magazine and on all modern mobile devices.

I wish you a stimulating read,

Jürgen Mlynek, President

Helmholtz researchers are seeking to identify new active pharmaceutical ingredients and improve them for future patients. Thanks to this research, patients are benefiting more quickly from new findings. Photo: HZI/U. Bellhäuser

PRESIDENT'S REPORT

Over the past year, the Helmholtz Association has grown dynamically, strengthened its profile and continued to increase its visibility. These developments reflect the Helmholtz Association's importance and mission as an umbrella organisation of national research centres in Germany. Helmholtz research deals with pressing problems and complex challenges and seeks to develop effective solutions. A prime example of such a challenge is the pending transformation of the energy economy, for which Helmholtz energy research will provide an important underpinning. We are also facing major challenges in the field of health research. In ageing societies such as ours, the percentage of the population in need of medical assistance will continue to grow and, as a result, we need to conduct goal-oriented research in order to develop effective preventative measures, new diagnostic procedures and options for treatment. To this end, the Helmholtz centres have been involved in setting up "German Centres of Health Research", whose goal is to pool and increase the expertise of German researchers with regard to major common diseases. Our research agenda is focusing on these and other issues that will become increasingly vital as we move into the future. We are also working to ensure the strategic relevance and scientific excellence of Helmholtz research through the competitive process of programme-oriented funding. Our entire core budget of more than two billion euros will be awarded on the basis of this process, with the relevant research programmes coming under review at five-year intervals. Together with our funding bodies, we have examined and enhanced this process over the last year ("Programme-Oriented Funding III"). We have retained the basic features of a method that has proved highly successful as a whole, but adapted individual stages to the new conditions emerging in the world of scientific research.

> We are working to ensure the strategic relevance and scientific excellence of Helmholtz research through the competitive process of programme-oriented funding.

In order to enhance the actual impact of Helmholtz research, we have developed visions for the future in all six fields of research as part of a comprehensive portfolio

The first PET/MRT scanner to be approved for patients in Germany is based on an innovative technology that integrates two imaging procedures. It enables doctors to perform combined scans of the entire body for medical research. Photo: Helmholtz/ HZDR/F. Bierstedt

DEVELOPMENT OF THE HELMHOLTZ PORTFOLIO

During the year under review, the Helmholtz Association pressed ahead with the portfolio development and foresight processes initiated in individual fields of research in 2009. Drawing on all the key groups, the association sought to identify gaps in research and important future topics in order to strengthen its profile and focus research even more systematically on pressing issues in science, industry and society. The results of these processes will provide a foundation for defining the orientation of the Helmholtz Association's research agenda in the upcoming third period of programme-oriented funding. In the initial phase, a variety of research topics were selected: energy storage/battery research, water research, climate research, the bioeconomy, active product ingredients research and gas separation membranes.
The additional funds made available to the Helmholtz Association from the Joint Initiative for Research and Innovation II have played a special role in the portfolio development and foresight processes. The planned 5 percent increase in the total budget each year will be used, among other things, to implement the resulting decisions. The Helmholtz Association is aware of its special responsibility to use these funds efficiently to achieve the initiative's aims.

» www.helmholtz.de/en/portfolio

development process that has involved experts from all the Helmholtz centres. We have also identified a range of research topics that are closely aligned with our mission and will now be given higher levels of funding.
At the same time, the infrastructure required for future research fields must be planned and built in a timely fashion so that we can conduct research in Germany that is up to international standards. Helmholtz researchers have made strategic preparations for this planning process, drawing up a roadmap that identifies the most important research infrastructure. The results are currently being discussed with funding bodies in the federal government and the federal states.
Furthermore, after a thorough review, we have expanded and optimised the Initiative and Networking Fund together with other internal instruments. In the process, the Helmholtz Association has made an important contribution to modernising the German research landscape.

The Helmholtz Association is growing*

Thanks to the higher level of funding and the association's new members, we are now in a better position than ever to provide excellent conditions for research and to fulfil our mission. Total funding for fiscal year 2011 – amounting to 2,203 million euros – grew by 8 percent over fiscal year 2010. There are two reasons for this growth: the 5 percent increase in funding from the Joint Initiative for Research and Innovation (Pakt für Forschung und Innovation), and the increase in financing levels for special investments (*Sondertatbestände*). An additional factor was the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), which was transferred to the Helmholtz Association from the Leibniz Association in early 2011. The HZDR has a staff of around 800 and a total budget of more than 118 million euros.

*See also the chapter "The Helmholtz Association in Facts and Figures" on page 63.

In the coming year, IFM-Geomar will also be transferred from the Leibniz Association to the Helmholtz Association – and renamed the "Helmholtz Centre for Ocean Research Kiel (GEOMAR)". In terms of research focuses, the Helmholtz-Zentrum Dresden-Rossendorf and the future Helmholtz Centre for Ocean Research Kiel (GEOMAR) provide an excellent fit with the mission of the Helmholtz Association. They will enable the association to grow quantitatively and expand its strong profile. However, the Helmholtz Association is not only expanding but also becoming more visible: with the addition of the HZDR and the renaming of the former GKSS as "Helmholtz-Zentrum Geesthacht, Centre for Material and Coastal Research (HZG)", eight of the seventeen research centres now bear the Helmholtz name.

The association is growing quantitatively and expanding its strong profile.

The general public has also become more aware of the accomplishments of Helmholtz research. For example, immediately after the devastating natural disaster and nuclear catastrophe in Japan, the Helmholtz Association formed working groups to study the medium and long-term consequences of the disaster and apply the findings to ensure the safety of nuclear power plants in Germany. An additional working group is focusing on strategies for phasing out nuclear power and transforming the energy economy as a whole.

The German Centres of Health Research

The Helmholtz Association has been closely involved in establishing German Centres of Health Research, which are pooling the expertise of universities, university hospitals and research centres in the study of six major common diseases. The German Centre for Neurodegenerative Diseases (DZNE) was founded as a member of the Helmholtz Association in 2009. In 2010, the German Centre for Diabetes Research was established with the support and participation of the Helmholtz Zentrum München – German Research Center for Environmental Health. Four additional German Centres of Health Research will be set up to fight cancer, heart and circulatory disease, pulmonary disease and infectious illnesses. Through its member institutions – the German Cancer Research Center, the Helmholtz Zentrum München – German Research Center for Environmental Health, the Helmholtz Centre for Infection Research, the Helmholtz-Zentrum Dresden-Rossendorf, and the Max Delbrück Center for Molecular Medicine in Berlin Buch – the Helmholtz Association is providing these new health research centres with unparalleled expertise.

New Helmholtz institutes, alliances and virtual institutes

In mid-2011 the three institutes that were established in Jena, Mainz and Saarbrücken in 2009 were joined by two additional Helmholtz institutes. The Helmholtz Institute Ulm for Electrochemical Energy Storage was set up as a branch of the Karlsruhe Institute of Technology on the campus of Ulm University and began researching new battery systems. The Helmholtz Institute for Resource Technology was opened in Freiberg as a branch of the Helmholtz-Zentrum Dresden-Rossendorf. This latter institute aims not only to develop technologies for the efficient study, production and utilisation of mineral and metalliferous resources, but also to research the field of recycling and the use of resources in the home.
The seven Helmholtz alliances that were established in 2007/08 with the financial support of the Initiative and

Genetic changes occur in nearly all types of cancer. Research helps to classify tumours more precisely and treat them more effectively. Photo: Helmholtz/DKFZ/F. Bierstedt

Networking Fund have gained international visibility as independent consortia in their respective research fields. Committees of international experts have confirmed their progress in a number of intermediary evaluations. While the seven existing projects continue to run, additional alliances will be promoted. Three projects have already been selected: the DLR@Uni initiative, the Astroparticle Physics Alliance, and the Future Energy Supply Infrastructure Alliance. Up to now, funding has been provided to a total of 87 Helmholtz virtual institutes, involving 217 university partners from 55 different German universities. Twelve additional virtual institutes will be supported in the future, and the network will include companies and non-university research institutes in Germany and abroad, in addition to universities as the most important partners.

The Helmholtz Association has been closely involved in establishing German Centres of Health Research, which are pooling the expertise of universities, university hospitals and research centres in the study of six major common diseases.

Profile building and strategic planning: the portfolio development process and roadmap

In order to fulfil its mission, the Helmholtz Association must systematically evolve, constantly adapt to new demands, and anticipate new challenges. In a broadly based portfolio development process that has drawn on the advice of numerous experts, the association has been able to identify major challenges and prospects for the future. Part of the additional funding made available to the Helmholtz Association from the Joint Initiative for Innovation and Research is intended for its portfolio development process (see box on page 6). In an initial round of funding that began in 2011, seven portfolio topics and the energy storage initiative were awarded financial support until the next period of programme-oriented funding. University research partners will also benefit. Starting in the next funding period, research on these portfolio topics will continue as part of the individual research programmes. Nine additional portfolio topics will be approved in a second round of selections in fall 2011, with funding slated to begin in 2012.

Through this work, the Helmholtz Association will fulfil the obligations it has assumed in the Joint Initiative for Research and Innovation, under which it is required to dynamically develop scientific enquiry by means of new research topics and intensive cooperation with partner institutions.

In addition, the association has successfully completed the roadmap process to identify the infrastructure Germany requires for future research. Closely linked to the portfolio development process, the roadmap will serve as a foundation for strategic planning in the future and influence national and international debate.

Improving frameworks for scientific research

Greater financial resources create room for manoeuvre, but research policy initiatives are essential, too. One example is the Freedom of Science Initiative, which the Helmholtz Association has backed together with the other scientific

organisations in Germany. Last year we saw the first positive results of these efforts in the form of major construction projects and the establishment of new centres and institutes such as the DZNE. Improvements were also seen in the acquisition of top international personnel. This is why the association must continue down this path – and combine lump-sum budgeting with more flexible staff acquisition instruments as a means of strengthening the international competitiveness of German research as a whole.

Strengthening international ties

In order to continue improving conditions for research, the Helmholtz Association has taken an active role in shaping both the European research landscape and the 8th European Research Framework Programme. As part of the 7th European Research Framework Programme, it successfully participated in a total of 199 projects, 35 of which were coordinated by Helmholtz centres. The influx of EU research and development funds was slightly lower than in the previous year, but the number of approvals from the European Research Council, totaling 20, more than doubled.
In addition, an international agreement was signed in October 2010 for the FAIR accelerator facility, to be built at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. A total of nine countries, including India and, most notably, Russia, will be involved. FAIR (Facility for Antiproton and Ion Research) is one of the largest research projects and most complex particle accelerator facilities in the world. The international agreement has clarified all implementation details. Germany will assume 75 percent of the total costs of 1.153 billion euros (as estimated in 2009).
The Helmholtz Association has also concluded an exem-

THE HELMHOLTZ ROADMAP

In 2010, work began on a Helmholtz roadmap to ensure that the construction of new research infrastructure by the Helmholtz centres was based on concerted strategic planning. This roadmap is coordinated with a national roadmap and is embedded in the European context. In conjunction with the portfolio development and investment processes, the roadmap aims to establish an ongoing process for the strategic future planning of the association's research infrastructure. The Senate of the Helmholtz Association approved the first version of the Helmholtz roadmap in June 2011.

» www.helmholtz.de/en/roadmap

Understanding neurodegenerative diseases and developing therapeutic and preventive strategies are key goals of health research at the Helmholtz Association. Photo: Helmholtz/DZNE/F. Bierstedt

plary cooperation agreement with the University of Alberta in Edmonton, Canada, covering the fields of Earth, environmental and energy research. Central themes of this research collaboration include the capture and storage of CO_2 ("CCS"), the use of deep geothermal energy, water and soil remediation, the sustainable development of post-mining areas, as well as the energy-efficient upgrading of bitumen. There are also plans to extend this collaboration to include health research.

The Helmholtz Association has been promoting young scientists in Russia and China for years. Cooperation with the Russian Foundation for Basic Research will be continued beyond the stipulated time period so that support can be provided to additional groups of young Germans and Russians. And now the representatives of the Helmholtz Association's DESY research centre and the Kurchatov Institute have signed a letter of intent to establish a joint facility – the Ioffe-Röntgen Institute – which they intend to make one of the world's leading centres for the development and utilisation of large-scale infrastructure for materials research. With this project, Helmholtz has sent a clear signal during the German-Russian Year of Science 2011.

Offering career opportunities to staff

In order to achieve its complex aims in the present and future, the Helmholtz Association is developing effective promotion instruments for all levels of staff qualification. After all, it is people who drive research with their ideas and commitment (see also the chapter "Partner in the Joint Initiatve for Research and Innovation", page 11). The Helmholtz research and graduate schools – which are integrated into the Helmholtz centres – promote and support young people during their PhD work. In addition, outstanding young scientists can work independently as Helmholtz junior group leaders and optimally prepare for a career in research and teaching. The attractiveness of such opportunities is shown by, among other things, the large number and high quality of applications considered during the 2010 selection process. The Helmholtz Management Academy prepares selected research, infrastructural and administrative staff to take on leadership roles. Furthermore, through its international recruitment initiative, the association is aiming to attract the best personnel possible and offer them an optimal environment for developing their talents. Equal opportunity plays a central role at all stages of the careers we offer– starting with family-friendly working hours and the childcare in the Helmholtz centres and extending to appointment policy in research and research management fields.

Outstanding research provides the knowledge base we need to meet present and future challenges. The first priority of research is to serve people. Issues related to human health are a concrete example, but challenges such as ensuring adequate energy supplies, overcoming resource shortage, and combating climate change also require innovative solutions. In proactively identifying the most pressing challenges of the day and basing our future course on them, we are making an important contribution to safeguarding the future.

PARTNER IN THE JOINT INITIATIVE FOR RESEARCH AND INNOVATION

As a partner in the Joint Initiative for Research and Innovation, the Helmholtz Association is committed to doing its share for growth and prosperity – through scientific excellence, the establishment of national and international networks and collaborations, through the advancement of equal opportunity and young scientists, and through knowledge transfer and new approaches to promoting innovation.

Ever since it was launched in 2005, the Joint Initiative for Research and Innovation (Pakt für Forschung und Innovation) has given the Helmholtz Association the planning reliability it requires for its work and has enabled the association to establish and strengthen a range of strategic measures and instruments. For the second period of the initiative, which began in 2011 and will run until 2015, the Helmholtz Association has been guaranteed a 5 percent annual increase in its total budget.
In the years to come, the Helmholtz Association will continue to fulfil its obligations in achieving the initiative's aims. For this purpose, the association has developed innovative instruments and measures as part of its strategic approach and in consultation with its funding bodies. It has strengthened its profile and focused its research on the major social challenges of the present and future. As a result, the association is contributing to the creation of more effective approaches to science and innovation in Germany and, together with its partners, is shaping the European research landscape.

Achieving excellence through competition

The Helmholtz Association's mission is to conduct high-level research that contributes to solving the major challenges and pressing problems of our age. To ensure that this mission is optimally fulfilled, the association has embraced scientific competition. Internally, this competition informs programme-oriented funding, the financing of investments in strategic expansion, and the instruments of the Initiative and Networking Fund. Furthermore, the many honours that the Helmholtz Association has received – including the scientific awards presented to Helmholtz researchers – and the high level of funding it has acquired from the European Research Council highlight its outstanding competitive position in relation to external national and international research institutes. In addition, the Helmholtz centres, together with their university partners, have been especially successful participants in the Excellence Initiative. And the centres are looking to replicate this success in the initiative's final round of funding, to which they have submitted several applications.

Establishing promising partnerships

Closer ties with university partners and industry are an important pillar of the Helmholtz Association's strategy. Such ties are crucial to ensuring the effective exchange of knowledge, the applicability of research and the efficient use of resources. The Helmholtz centres initiate and participate in a large number of strategic partnerships. Working in networks and projects, they research pressing scientific, economic and social issues. One example is the Bioeconomy Science Center (BioSC), which the Forschungszentrum Jülich, RWTH Aachen University, and the universities of Bonn and Düsseldorf established in October 2010 as the first centre in Europe to research sustainable bioeconomics using an integrative global concept. The partners will study important topics associated with building an ecological economy based on renewable resources.
The successful concept embodied by the Helmholtz institutes has been continued and expanded (see also "President's Report", page 7). During the period under review, three new alliances were forged. The Helmholtz Astroparticle Physics Alliance, coordinated by the Karlsruhe Institute of Technology (KIT), brings together the entire German astroparticle research community under one roof, drawing on the Helmholtz centres KIT and DESY, fifteen university partners, three Max Planck institutes and two international institutes. The Helmholtz Alliance on Future Energy Supply Infrastructure, also coordinated by KIT, examines the role

PARTNER IN THE JOINT INITIATIVE FOR RESEARCH AND INNOVATION

that large and complex infrastructure plays in our lives. It works in cooperation with the Forschungszentrum Jülich, the German Aerospace Center (DLR), the Helmholtz Centre for Environmental Research – UFZ, and university partners. The Helmholtz DLR@Uni Alliance is an institutional framework for specialised cooperation that was created by the DLR's institutes in Munich, Stuttgart and Braunschweig. Its goal is to facilitate the joint appointment of institute and department directors and the education of junior scientists.
In addition, in early 2011, KIT and BASF SE entered into a long-term partnership for which 12 million euros will be made available over the course of five years to set up a joint laboratory for the development of efficient battery systems. The "BELLA" lab will optimally combine the two partners' electro-chemical expertise in the areas of basic research and industrial applications. The Helmholtz Association has also established important collaborations on an international level and works in international networks and consortia, often assuming a leading role. Two examples are its coordinative work in international infrastructure consortia and its involvement with the European Strategy Forum on Research Infrastructures (ESFRI). The association's future goals have been formulated in an Internationalisation Strategy, including its plan to expand its position in international research and to help shape international research policy. Cooperation with emerging and developing countries plays an especially significant role in this strategy.

Promoting knowledge and technology transfer

Additional focuses of the Helmholtz Association's work include the exchange and application of research findings. In order to study application-oriented technologies, the Helmholtz centres carry out numerous cooperative projects and have established a growing number of strategic partnerships with companies. License agreements and start-ups are an additional way of integrating research findings into new products and services. In 2010 the Helmholtz Association set up the Helmholtz Validation Fund to promote such transfer processes, capitalising it with up to 7.5 million euros annually. The goal of this new instrument is to close the funding gap between research and application and to provide an incentive to optimise ideas and inventions in order to

This new joining process, based on friction spot welding, is already in use in industry. Photo: HZG

TECHNOLOGY TRANSFER IN INDUSTRY AND SOCIETY

In 2010, the Helmholtz centres carried out more than 2,750 collaborative projects with companies, bringing in thirty-party revenues of 150 million euros. In the area of industrial property rights, 463 patent applications were filed, and revenues of more than 16 million euros were generated by some 1,150 licence agreements. Prime examples are the license agreement covering the heat-proof steel alloy patented by the Forschungszentrum Jülich and licensed to Thyssen-Krupp VDM, and the rights to a petrol vapour recovery method that the Helmholtz-Zentrum Geesthacht has licensed to industry for use at filling stations and fuel depots. Long-term strategic partnerships are especially important. Good examples are the tumour research partnership between the German Cancer Research Center and Bayer AG, and the partnership between KIT and BASF to establish the joint BELLA lab for the development of efficient battery systems. In addition, twelve Helmholtz start-ups were launched in 2010, including MRI Tools GmbH, which markets a process for enhancing MRT and is a spin-off from the Max Delbrück Center for Molecular Medicine, and TEMOS GmbH, which promotes the commercial use of telemedicine and is a spin-off from the German Aerospace Center (DLR).
For additional examples of the successful activities of the Helmholtz centres concerning collaborations, strategic partnerships, industrial property rights, license agreements and start-ups, please visit the following website:

» **www.helmholtz.de/en/technologytransfer**

Combining molecular biological research with clinical studies is of great importance for patients because it means that findings can be quickly incorporated into applications for the prevention, diagnosis and treatment of disease. Photo: MDC/D. Ausserhofer

attract the interest of potential business partners and facilitate start-ups. In mid-2011 the first four projects were selected by the fund's board of experts.
For years the Helmholtz Association has funded start-ups through the Helmholtz Enterprise funding programme. Between 2005 and 2010, 58 start-up projects were supported with sums of up to 200,000 euros each – shared by the Initiative and Networking Fund and the participating centres. About half of these companies have now been launched and are operating successfully in the market.
The shared services concept is an additional instrument that has been implemented as part of the Helmholtz Association's new technology transfer strategy. The basic idea behind this approach is for the well-staffed teams at KIT and the Forschungszentrum Jülich to provide support for smaller centres of technology transfer. The teams' consulting skills in the areas of start-ups, equity investments and the assessment of inventions are harnessed for other Helmholtz centres by funded key account managers.

Talent management and equal opportunity

The Helmholtz Association attaches particular importance to talent management and the promotion of equal opportunity. Both represent important means of acquiring and, most importantly, retaining outstanding staff. This is why the Helmholtz Association invests in the education and advanced training of its research and administrative/technical staff. Its diverse programmes and activities are carried out at both the level of the centres – e.g., specialised practical training for young women and men – and at the level of the association – e.g., management training at the Management Academy. Each year a large number of PhD candidates complete their dissertations at the Helmholtz research and graduate schools, which are integrated into the Helmholtz centres. In addition, grants from the Initiative and Networking Fund provide gifted postdoctoral candidates with the opportunity to establish their own research groups and conduct independent research on an exciting scientific topic. Finally, the Helmholtz Association uses targeted programmes to introduce children and young people to scientific research. These include the "Little Scientists' House" initiative, which is now being offered to 18,000 day-care centres in Germany, and the 25 Helmholtz School Labs, which are used by more than 60,000 school students each year.

HELMHOLTZ MANAGEMENT ACADEMY

Talent management and the promotion of young scientists are special goals of the Helmholtz Association. An important instrument is the highly successful Helmholtz Academy, which prepares executive staff for managerial tasks and expands and improves the managerial skills of experienced leaders. The Helmholtz Academy aims to develop a consistent understanding of leadership within the association and build strong ties between the centres. It also seeks to strengthen relations between the scientific and commercial/administrative departments of the Helmholtz centres at all levels of management – from junior executives to directors.

» **www.helmholtz.de/en/talentmanagement**

A lively exchange of scientific knowledge is key to the success of the joint research conducted by universities and Helmholtz centres – for example, at the five Helmholtz institutes. Photo: HZI/U. Bellhäuser

OPTIMISING THE WAY SCIENCE IS DONE

Integrated into the national and international research landscape, the Helmholtz Association is constantly optimising its structures in order to provide ideal conditions for its strategically oriented research. Through this process, it has made a significant contribution to the dynamic and sustainable development of German science. An important pillar of this process is the strategic collaborations with universities and other research facilities that have been established in conjunction with the Excellence Initiative: the founding of the Karlsruhe Institute of technology, the launch of the Jülich-Aachen Research Alliance, and the strategic alliance between the German Cancer Research Center and the Center of Molecular Biology at Heidelberg University. The Initiative and Networking Fund has generated effective instruments that are being used to strengthen additional collaborations with universities. The ten Helmholtz alliances and the five Helmholtz institutes – the most recent set up with the TU Bergakademie Freiberg – take up forward-looking themes that have a strategic relevance for the Helmholtz Association. In cooperation with universities and other partners, research around these themes is structured into internationally competitive consortia. The Helmholtz Association has also been closely involved in setting up the German Centres of Health Research, which will permanently transform the German research landscape. Finally, together with other major players in the scientific world, the association has lent its support to the Freedom of Science Initiative in order to improve general conditions for science.

» www.helmholtz.de/en/joint-initiative-for-innovation-and-research

In order to ensure that women and men receive equal opportunities for professional advancement, the Helmholtz Association sponsors diverse activities to create an optimal balance between careers and family life. The association is seeking to increase the proportion of women in leadership positions and to win outstanding female scientists for top positions. Measures such as the “Taking the Lead” mentoring programme are contributing to the achievement of these goals. Furthermore, the overarching concept of the Initiative and Networking Fund for the period from 2011 to 2015 calls for the expansion of the W2/W3 programme for outstanding female scientists, meaning that at least five new W2/W3 positions (based on the “W” remuneration system for German public servants) will be funded for female scientists each year. In all its activities to promote equal opportunity, the association bases it work on the equality standards of the German Research Foundation. The organisation is also a partner in the National Pact for Women in MINT Careers (MINT = mathematics, informatics, natural sciences and technology).

Shaping the national and international system

In the coming years Germany and Europe will face major changes, and groundbreaking developments were already seen in the period under review. In Germany these included the pooling of health research in the German Centres of Health Research, whose goal is to tackle common widespread diseases. In Europe developments were dominated by the re-conceptualisation of EU research funding in the “Innovation Union” flagship initiative and the related overhaul of the Research Framework Programmes as funding instruments. The Helmholtz Association has made an active contribution and provided expertise to all these crucial processes.

In the years to come, the Helmholtz Association will continue to fulfil its mission as a strategically active scientific organisation. It will address pressing scientific, economic and social problems and to this end will develop system solutions and create the necessary research frameworks. The funds provided by the Joint Initiative for Research and Innovation will enable the association to pursue its goals systematically, both now and in the future.

RESEARCH FIELD ENERGY

>> EARTH AND ENVIRONMENT
>> HEALTH
>> AERONAUTICS, SPACE AND TRANSPORT
>> KEY TECHNOLOGIES
>> STRUCTURE OF MATTER

Energy research at the Helmholtz Association supports the German government's strategy of restructuring and transforming the energy system in order to provide citizens and industry with safe, environmentally friendly and inexpensive energy and to reduce greenhouse gas emissions. To implement this strategy, our next energy research programme will focus on renewables, energy-efficiency and storage technologies, grid issues and the interaction between all forms of energy technology. Research for the safe disposal of radioactive waste remains essential. Furthermore, we are investigating nuclear fusion in order to ensure mankind has the potential to profit from this energy source in the more distant future. In all these areas, energy research at the Helmholtz Association has its own specific focuses, ranging from thin-layer photovoltaics and concentrated solar heating to biomass, deep geothermal energy and the optimisation of storage systems in cooperation with external partners. Finally, energy studies are supplemented by socioeconomic research.

Energy research is represented in the Senate of the Helmholtz Association by the senate members Professor Hermann Requardt and Professor Louis Schlapbach.

PROFESSOR LOUIS SCHLAPBACH
Member of the Helmholtz Association Senate,
former CEO of EMPA, an ETH domain, Switzerland

PROFESSOR HERMANN REQUARDT
Member of the Helmholtz Association Senate,
Member of the Siemens Managing Board and
CEO of Siemens Healthcare, former CTO of Siemens
and Director of Corporate Technology, Erlangen

RESEARCH FIELD ENERGY

PROFESSOR EBERHARD UMBACH
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Energy,
Karlsruhe Institute of Technology

GOALS AND CHALLENGES

In the field of energy research, Helmholtz scientists are aiming to secure a sustainable long-term supply of energy and to develop economically and ecologically viable energy solutions. These aims require a comprehensive study of relevant energy chains that takes into account constraints, associated phenomena and the consequences for the climate and environment. Key elements are the consideration of all primary energy forms and broad-based research into innovative technologies for the efficient and effective conversion, storage and use of energy.

Our long-term goal is to replace finite energy sources with sustainable climate-neutral ones. Short and medium-term goals include decreasing energy consumption through the efficient conversion and use of energy, reducing Germany's and Europe's dependence on imports, researching new storage technologies, mitigating the impact on the climate and the environment, and meeting special needs through mobile applications.

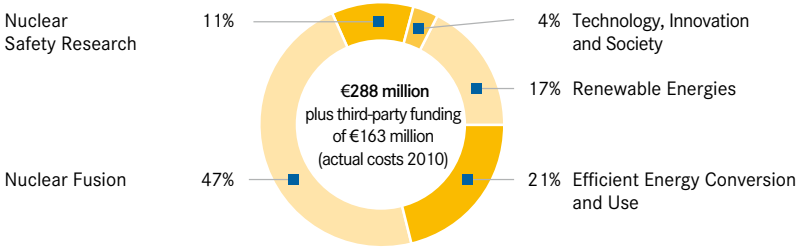
The energy strategy of the Helmholtz Association has been derived from this overall spectrum. It builds on the existing expertise and wealth of experience at the Helmholtz centres and takes in account the strengths and capabilities of other research and industrial partners. At the same time, the Helmholtz Association has identified research fields in which it must acquire and deepen its expertise.

To meet the energy needs of current and future generations, technologies must be developed that provide a foundation for competitive innovations. With this goal in mind, our researchers have been examining the potential offered by renewable sources such as solar, biomass and geothermal energy. They are putting greater efforts into increasing the efficiency of conventional power stations and energy use as a whole. Over the long term, research into power generation through nuclear fusion could lead to the development of an entirely new source of energy. This path is fraught with major scientific and technological challenges, which are being tackled in cooperation with international partners. Finally, with a level of nuclear safety expertise that is unique worldwide, the Helmholtz Association is contributing to the safe operation of nuclear reactors and the safe treatment and disposal of highly radioactive waste.

In addition to these diverse research activities, there have been structural changes at the Helmholtz Association that aim to strengthen energy research. As part of the Excellence Initiative of the German government and the federal states, the Karlsruhe Research Centre has successfully merged with the University of Karlsruhe to form the Karlsruhe Institute of Technology (KIT). Among other things, this merger has led to the establishment of the KIT Energy Centre, which is aspiring to become one of the leading energy research centres in Europe. KIT scored an initial success when the European Institute of Innovation and Technology approved its KIC InnoEnergy funding application in a Europe-wide competition to set up a "Knowledge and Innovation Community" (KIC) in the field of sustainable energy research.

In the JARA-ENERGY section of the Jülich-Aachen Research Alliance (JARA), the Forschungszentrum Jülich and RWTH Aachen University are pooling their complementary expertise in a pioneering international research alliance in order to develop new energy solutions. Finally, in cooperation with industry and the Technische Universität Berlin, the Helmholtz-Zentrum Berlin für Materialien und Energie has founded PVcomB (Competence Centre for Thin-Film Technology and Nanotechnology for Photovoltaics), which has expanded research into solar energy.

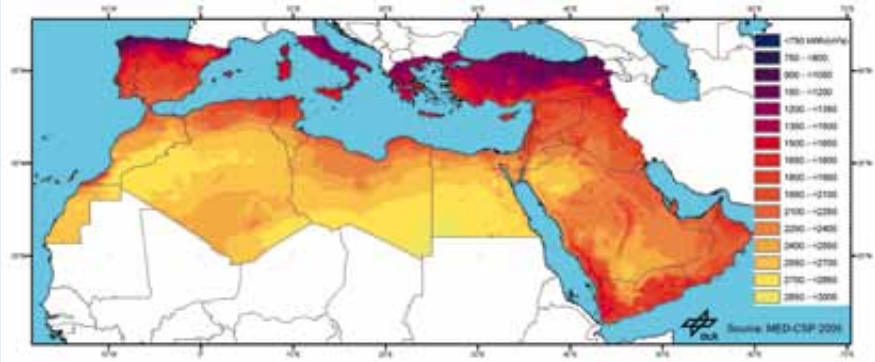
Structure of the research field Energy
Target costs of core financing 2010: 288 million euros
(incl. share of non-programme-linked research)



SOLAR ATLAS FOR THE MEDITERRANEAN REGION

From research conducted at the German Aerospace Center (DLR) Which countries can use solar energy reliably? A solar atlas that the DLR is creating together with international partners will provide answers to this question for the Mediterranean region. Its extensive maps, based on satellite and earth observation data, will offer dependable information on solar energy's potential at specific sites. To be released in 2012, the atlas will serve as a decision-making tool for investments in solar power stations. "The solar atlas can help policymakers to design successful support policies for solar energy. It can also assist investors in finding the best sites for solar power systems and significantly reduce investment risks," explains project manager Carsten Hoyer-Klick of the DLR Institute of Technical Thermodynamics.

You can find related media and content at **» www.helmholtz.de/en/gb11-solaratlas**



The graphic shows solar radiation levels in 2002 expressed in kilowatt hours per square metre. As part of the project, the database will be expanded to include at least 15 years of data in order to better represent fluctuations from year to year. Photo: DLR

PROGRAMME STRUCTURE
IN THE FUNDING PERIOD 2010–2014

The field of energy research at the Helmholtz Association currently consists of eight Helmholtz centres: the Karlsruhe Institute of Technology (KIT), the Forschungszentrum Jülich, the German Aerospace Center (DLR), the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), the 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. The Helmholtz Centre for Environmental Research – UFZ joined the field of energy research in 2010 and the new Helmholtz-Zentrum Dresden-Rossendorf (HZDR) became a member in 2011. The field is divided into five research programmes:

- Renewable Energies
- Efficient Energy Conversion and Use
- Nuclear Fusion
- Nuclear Safety Research
- Technology, Innovation and Society

The Technology, Innovation and Society Programme focuses on the social, ecological and economic aspects of energy research, thereby contributing to a holistic approach. All the programmes are implemented in interdisciplinary working groups and involve cooperation with international partners. They are all provided with research infrastructure, pilot facilities, resources for large-scale experiments, test systems for large components, high-performance analysis systems and high-capacity computers.

Dr. Alexander Schnegg mounting samples in the millimetre-wave probe-head of the 263 GHz EPR spectrometer at the Institute for Silicon Photovoltaics at the HZB. Photo: HZB

UNCOVERING THE CAUSE OF POWER LOSS IN ORGANIC SOLAR CELLS

From research at the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

Although organic solar cells can be manufactured with little energy, they produce only a fraction of the electrical power of crystalline silicon solar cells. Much of the current dissipates into the material. HZB researchers have now shed light on a mechanism involving a link between the electrical current in solar cells and the magnetic moment (spin) of the charge-carrying particles. Using strong magnetic fields and microwaves, researchers led by Dr. Alexander Schnegg and Dr. Klaus Lips managed to "turn" the spin of the charge-carriers. Measurements showed that the current is blocked when the spins are arranged parallel to each other, but flow freely when the tiny magnets are aligned opposite each other. Thanks to this important discovery, researchers can now improve organic solar cells – e.g., through the development of new plastics with special spin properties.

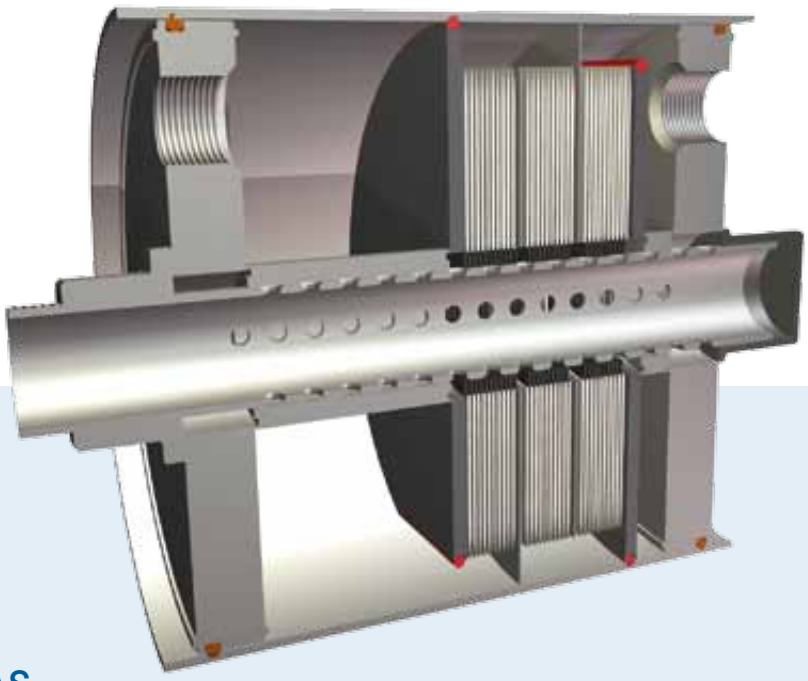
You can find related media and content at
» www.helmholtz.de/en/gb11-stromverlust

PROGRAMMES
IN THE FUNDING PERIOD 2010–2014

For the second period of funding, the Helmholtz centres involved in energy research adapted and expanded their strategy in order to address major challenges. In the future they will not only focus on power generation, but also consider all energy forms across the entire process chain in order to optimise the system as a whole.

Renewable Energies

This programme has broadened its range of research topics, adding work on biomass and solar fuel production to its ongoing focus on power generation through solar and geothermal energy. In the area of photovoltaics, researchers are continuing to develop thin-layer solar cells to increase efficiency up to its theoretical limits while using minimal amounts of materials and energy. Starting around 2030, solar thermal power stations erected in the Earth's sunbelt could potentially play a substantial role in the global generation of power. Commercial solar power plants have been around for years, but they are based on outdated technologies. Additional cost reductions are needed to successfully market new technologies. In the long term, concentrated solar power systems are expected to produce solar fuels in thermal processes.
Underground geological formations in Germany offer the potential to produce heat and power. Geothermal research is pooling the expertise of the participating centres in an effort to develop optimal technological solutions. The viability and economic efficiency of geothermal power generation is currently being studied in Groß Schönebeck.
Second-generation methods for biogas production and the thermochemical conversion of biomass into energy are becoming more sustainable. A large test plant is being built



Schematic representation of a membrane module designed to remove CO_2 from biogas. Graphic: HZG

CO_2 MEMBRANES FOR BIOGAS

From research conducted at the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research

Biogas is one of the most important forms of renewable energy in Germany, but biogas plants have a CO_2 problem: they produce a gas mixture that contains up to 40 percent CO_2. Before biogas is fed into the gas grid, this CO_2 must be removed. Researchers at the Helmholtz-Zentrum Geesthacht have developed polymer membranes and membrane processes that are well suited for this task. They consist of several layers of polymer, which allow the CO_2 to preferentially pass through while retaining most of the methane when biogas is fed to the membrane module under elevated pressure.

The membranes have undergone extensive tests and can be manufactured on an industrial scale. Even when used continuously under real conditions in a biogas plant run by our industrial partner BORSIG Membrane Technology, the membranes showed their worth as a simpler technical alternative to other CO_2 separation technologies such as gas scrubbing and active carbon filters.

You can find related media and content at **www.helmholtz.de/en/gb11-co2-membran**

for the Bioliq process developed by KIT, which offers new potential in this field.

Efficient Energy Conversion and Use

This programme pursues different avenues of research in order to increase the efficiency of renewable and fossil energy sources. Examples include intelligently bridging the gap between energy availability and use through power and heat storage systems, mobile energy storage systems, heat exchangers and synthetic fuels; interconnecting different requirement profiles with technologies such as combined heat and power generation and combined cooling and power generation; and studying thermochemical processes that can convert non-conventional energy sources such as biomass into higher-quality fuels. The power stations of the future will have to transform these different primary energy sources into useful energy in efficient, environmentally-friendly and reliable processes. Such developments require surges of innovation in the area of components – including turbomachines – as well as innovative materials that are capable of withstanding high temperatures.

CO_2 removal should not be “bought” at the expense of an increased consumption of resources. This means CO_2 capture from power plants requires research on gas separation methods and the development of new concepts. Over the medium term, solutions must also be developed to retrofit power plants.

In the area of fuel cell technology, the goal of research is to increase lifecycles and performance, cut costs and develop quality-assurance processes as well as new methods and processes for analysing ageing mechanisms.

Installing control coils in the plasma vessel of the ASDEX Upgrade fusion device. Photo: IPP/V. Rohde

PLASMA STABILITY MADE TO MEASURE

From research conducted at the Max Planck Institute for Plasma Physics As the buildings go up on the construction site in Cadarache in the south of France where the international ITER fusion test reactor will be housed, physicists around the world are fine-tuning the processes that will take place inside. As the precursor of a demonstration power plant, ITER will produce energy from the fusion of atomic nuclei – much like the sun. The open questions that are being heatedly debated in this field include the phenomenon of "edge localized modes" – energetic outbursts at the plasma edge. These can damage the wall of the plasma vessel but are also capable of expelling undesirable impurities from the plasma. Hence, what is needed are custom-made (i.e., sufficiently weak) instabilities. For this purpose special control coils were installed on the wall of the plasma vessel in the ASDEX Upgrade fusion device in Garching. Now, after a one-year installation period, the coils have enabled scientists to adjust the plasma instabilities to the required level. This has brought them much closer to answering the question of how the energy generated in the ITER plasma can be smoothly extracted.

You can find related media and content at » **www.helmholtz.de/en/gb11-plasma-stabilitaet**

The development of superconducting components for power grids can help reduce the amount of electrical power lost in transmission. Innovative energy storage concepts are required to make full use of fluctuating energy sources such as wind and the sun.

Nuclear Fusion

The Nuclear Fusion Programme at the Helmholtz Association is currently pursuing two main objectives. First, on Germany's behalf, it is contributing to the construction and operation of the international ITER project, a Tokamak experiment in Cadarache, France. Second, it is building and operating the Wendelstein 7-X stellarator in Greifswald. The goal of ITER is to demonstrate both the physical and – to a degree – technological feasibility of nuclear fusion under power plant-like conditions. But ITER alone will not be able to provide all the information needed to build the first demonstration fusion power plant (DEMO). Special consideration must also be given to developing suitable structural materials in parallel with ITER. Scientists have not yet exhausted the potential for improving the magnetic confinement of the fusion plasma. An excellent concept is provided by the stellarator, which in principle opens the way for the continuous operation of a fusion plant and is thus seen as an alternative to the Tokamak. The Wendelstein 7-X experiment is designed to develop the stellarator line to the point where, together with the results from ITER, a DEMO stellarator can be built (around 2040).

Nuclear Safety Research

Nuclear safety research is divided into two fields of inquiry: the safety of nuclear reactors and the safety of nuclear waste disposal. In the area of reactor safety, work

At the KALLA liquid metal lab at KIT, scientists are studying the behaviour of molten metals. Photo: KIT/M. Lober

A VISION OF THE FUTURE: PARTITIONING & TRANSMUTATION

From research conducted at the Karlsruhe Institute of Technology About 1 percent of the spent fuel from nuclear power plants consists of plutonium, americium and other transuranic elements that must be isolated from the biosphere for hundreds of thousands of years. Separating these highly problematic elements from the spent fuel (partitioning) and converting them into shorter-lived or stable isotopes (transmutation) has so far been achieved only in the lab. Scientists at the Karlsruhe Institute of Technology (KIT), led by Helmholtz expert Dr. Joachim Knebel, are working on a technical application based on these processes. At the KALLA liquid metal lab at KIT, they are examining the flow behaviour and corrosion characteristics of molten metals such as lead bismuth. These metals are used to cool surfaces such as the spallation beam window and fuel elements that are subject to high thermal loads. Furthermore, in cooperation with 36 international partners (including the GSI Helmholtz Centre for Heavy Ion Research, the Forschungszentrum Jülich and the Helmholtz-Zentrum Dresden-Rossendorf), the Helmholtz experts are helping to develop the safety-relevant components of the MYRRHA transmutation facility planned at the Belgian research centre in Mol. “If partitioning and transmutation can be achieved on a large scale, the high-level nuclear waste will only have to be stored for periods of around 2,000 years instead of for geologic periods spanning more than 200,000 years,” explains Joachim Knebel.

You can find related media and content at » **www.helmholtz.de/en/gb11-transmutation**

is focused on reactor and plant design as well as on the phenomena and processes accompanying design-based and non-design-based accidents. Researchers are studying and shaping international developments with respect to reactor safety, new safety concepts, new technologies and the minimisation of radioactive wastes. Furthermore, developments are being assessed through comparisons with existing reactors.

In the field of nuclear waste disposal, work is directed towards immobilising highly radioactive wastes through vitrification and reducing the radiotoxicity of minor actinides through partitioning and transmutation. In addition, various concepts for final disposal systems are being investigated. An important goal here is the application-linked, site-independent development and verification of geochemically sound concepts for the long-term safety assessment of these final disposal systems.

Technology, Innovation and Society

The goal of this interdisciplinary research programme is to study the ecological, economic, political, ethical and social aspects of new technologies in order to support decision-making processes in government, industry and society. The programme’s topics in the area of energy research have been chosen with the aim of establishing a comprehensive view of energy research and energy technologies and of helping to support current efforts to shift the global energy system onto a sustainable footing. The programme examines the entire chain of energy processes, from the extraction of primary energy sources to the conversion, storage, transmission and use of energy. A special focus is on innovation phases. Its goal is to assess technologies and technical systems that provide and use energy and to develop innovation and implementation strategies in accordance with the guiding principle of sustainable development.

GFZ researchers have built a multidisciplinary research platform in Groß Schönebeck in Brandenburg to study all the relevant processes of geothermal energy provision. Photo: GFZ

THE GROSS SCHÖNEBECK GEOTHERMAL RESEARCH PLATFORM: FROM RESERVOIR TO KILOWATT HOUR

From research conducted at the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Led by Dr. Ernst Huenges, GFZ researchers at the International Centre of Geothermal Research are creating a unique research platform to study the feasibility, sustainability, environmental compatibility and economic efficiency of geothermal energy. Utilisation of this energy form in Germany requires much deeper wells than in the Earth's volcanic regions. The two wells in Groß Schönebeck extend four kilometres into the Earth to water-bearing zones that are hot enough to operate the steam turbines of the power plant. Last year GFZ experts closed the thermal water cycle between the two wells at the surface. A corrosion bypass was integrated into this cycle to expose a test specimen to the extremely saline water and to improve the reliability of technical system components based on corrosion-resistant materials. A geothermal research power plant is currently under construction and will be put into operation in 2012 in order to investigate plant performance and identify optimisation potential for making geothermal power generation cost-effective and energy-efficient. In the long-term view, Huenges expects that geothermal energy will have the potential to meet about five percent of the demand for electricity and heating in Germany.

You can find related media and content at » **www.helmholtz.de/en/gb11-geothermie**

OUTLOOK

Now and in the future, the transformation of the energy system will be one of our greatest challenges. The German government's 6th Energy Research Programme concentrates on the strategies and technologies vital for restructuring energy supplies: renewables, energy efficiency, energy storage and grid technologies. The Helmholtz Association strongly supports the German government's strategy, and research by Helmholtz scientists is providing a strong foundation for the transition to a sustainable energy future.

However, there are no easy answers when it comes to successfully transforming the energy system. Optimising individual energy sources and specific technologies will not suffice to secure future supplies. This means that researchers need to study a broad spectrum of options and devote as much attention to basic research as to application-oriented studies. This type of approach is crucial to build a sustainable energy system that can be optimised in response to changing conditions. Furthermore, it is essential for future energy research that we take a look at the energy system as a whole. This is why the Helmholtz Association supplements technological research topics with socioeconomic research. Its goal is to optimise the energy system with respect to all social, economic and political factors.

RESEARCH FIELD EARTH AND ENVIRONMENT

The research field Earth and Environment examines the basic functions of the Earth system and studies interactions between society and nature in order to develop proposals for action and protect natural resources over the long term. It focuses on building and interlinking long-term observation systems, improving predictions and applying research findings within society. For example, REKLIM, a climate initiative launched by the Helmholtz Association, pools the expertise of eight Helmholtz centres in an effort to improve regional and global climate models. The Water Science Alliance, which brings together Helmholtz experts with universities and other partners, investigates how global change influences water resources. Furthermore, the planning carried out within the framework of the Helmholtz roadmap focuses on the topic of Earth monitoring, and discussions are already underway on a global Earth observation and verification system (GEMIS) that will provide the foundations for early warning systems and preventive measures in vulnerable regions.

The research field Earth and Environment is represented in the Senate of the Helmholtz Association by the senate members Professor Liqiu Meng and Professor Klaus Töpfer.

PROFESSOR KLAUS TÖPFER
Member of the Helmholtz Association Senate, former Undersecretary General, United Nations, and Founding Director of the Institute for Advanced Sustainability Studies, Potsdam

PROFESSOR LIQIU MENG
Member of the Helmholtz Association Senate, Vice-President of the Technische Universität München

RESEARCH FIELD EARTH AND ENVIRONMENT

PROFESSOR REINHARD F. J. HÜTTL
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Earth and Environment,
Helmholtz Centre Potsdam,
GFZ German Research Centre for Geosciences

GOALS AND CHALLENGES

The global challenge for Earth system and environmental research is to provide the basic and applied knowledge necessary for the long-term protection of the foundations of human life. Our impact on the planet is substantial and continues to grow. Climate change, disappearing biodiversity, and other critical developments have been observed for decades and are threatening to destroy the natural foundations of human life, including drinking water and fertile soil. The overriding challenge for the future is to develop strategies for preventing and coping with natural hazards and climate change in order to bring the sustainable, efficient use of resources into line with the long-term protection of geosystems and ecosystems. Finally, in order to develop options for political action, the socioeconomic consequences of the abovementioned factors must also be analysed.

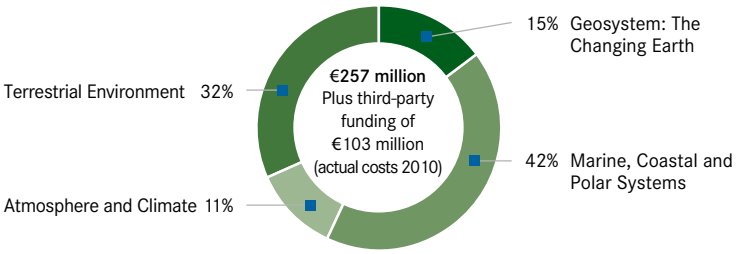
The research regarding Earth and Environment examines the basic functions of the Earth system and interactions between society and nature. Its goal is a comprehensive understanding of the complex changes affecting both the Earth and the environment and the formulation of accurate predictions of future trends. Due to the great variety of issues involved, it is essential that scientific infrastructure is used effectively and that new forms of strategic research networks are established within and beyond the Helmholtz Association. This concentration of forces is currently taking place in national and international collaborations with universities and non-university research institutes (e.g., in the form of “virtual institutes”) and through optimised cooperation at the European level.

One key research network is provided by the Regional Climate Change (REKLIM) initiative. In close cooperation with universities and non-university research groups, this initiative has combined the expertise of various Helmholtz centres in studies of the regional impact of global climate change. It cooperates not only with the regional Helmholtz climate offices responsible for southern, central and northern Germany, the polar regions and the rise in the sea level, but also with the Climate Service Center, which serves as a kind of platform for climate-relevant issues. The Helmholtz Association’s innovative Water Science Alliance, which strategically pools expertise in German water research, is an additional initiative in which university partners are closely involved.

Cross-centre and cross-institutional research projects, carried out on an international level, are playing an increasingly important role. The association has agreed to work closely with the Canadian University of Alberta on a variety of research topics in the coming years, including the sustainable use of oil sands, the separation and geological storage of CO_2 (CCS), geothermal energy, water and soil remediation, re-cultivation, and landscape development. In addition to the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, three other Helmholtz Centres are currently contributing expertise to the initiative, which spans the association’s six major research fields: the Karlsruhe Institute of Technology, the Helmholtz Centre for Environmental Research – UFZ, and the Forschungszentrum Jülich.

An additional goal of the research field Earth and Environment is to promote young scientists. Existing measures and structures are being optimised on an ongoing basis, in most cases in cooperation with external partners. In the area of education and advanced training, these structures include the Helmholtz graduate schools and the Helmholtz research schools, and, in the area of independent research, the “Young Investigators’ Groups”. Two graduate schools are currently receiving funding in the research field Earth and Environment: the Helmholtz Interdisciplinary Graduate School for Environmental Research at the Helmholtz Centre for Environmental Research – UFZ, which cooperates with six university partners, and the Helmholtz Graduate School for Polar and Marine Research at the Alfred Wegener Institute for Polar and Marine Research (AWI), which has three university partners. Funding is also going to the Helmholtz Research School on Earth System Science at the AWI (two university partners) and the Helmholtz graduate research school GeoSim (two university partners).

Structure of the research field Earth and Environment
Target costs of core financing 2010: 257 million euros
(incl. share of non-programme-linked research)



Damage in Castelnuovo after the L'Aquila earthquake in Italy in 2009. Photo: GFZ

EARTHQUAKE MAPS FOR EUROPE

From research conducted at the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Earthquakes in Europe can also strike areas north of the Alps. Even though most of these quakes are considerably weaker than those in the Mediterranean region or the Ring of Fire encircling the Pacific, they can still have devastating effects due to the high value of material assets in these regions. Damage to chemical and nuclear power plants is an additional risk.
Dr. Gottfried Grünthal and his colleagues at GFZ have created precise earthquake hazard maps by carefully analysing archival data on the earthquakes that have occurred in different parts of Europe in the last millennium. With the help of this data, civil engineers can construct buildings capable of withstanding the earthquakes expected in these regions, thus minimising the potential harm to people.

You can find related media and content at
» **www.helmholtz.de/en/gb11-erdbebenkarte**

PROGRAMME STRUCTURE
IN THE FUNDING PERIOD 2009–2013

Seven Helmholtz centres are currently active in in the research field Earth and Environment: the Alfred Wegener Institute for Polar and Marine Research (AWI), the Forschungszentrum Jülich, the Karlsruhe Institute of Technology (KIT), the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU), the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, and the Helmholtz Centre for Environmental Research – UFZ. In order to address overarching research topics and create methodological and organisational synergies, interdisciplinary cross-programme initiatives such as REKLIM (AWI, Forschungszentrum Jülich, KIT, GFZ, HZG, HMGU, UFZ), the Integrated Earth Observation System (EOS Network: AWI, GFZ, HZG, KIT, Forschungszentrum Jülich, German Aerospace Center) and Sustainable Bioeconomy (Forschungszentrum Jülich, GFZ, HMGU, KIT, UFZ) are being expanded. Another important task is the joint establishment and operation of cross-programme facilities and infrastructure, such as the HALO research aircraft and the Terrestrial Environmental Observatories (TERENO). This latter project involves the establishment of a network of terrestrial observatories in four representative German regions. A complementary approach is being taken in the COSYNA project, which will create a long-term observation system for the German North Sea and later extend it to Arctic coastal waters. The research programmes being pursued in this field are:

- Geosystem: The Changing Earth
- Marine, Coastal and Polar Systems
- Atmosphere and Climate
- Terrestrial Environment

Electromagnetic measurements of sea-ice thickness (EM) can be used to create profiles of sea ice over distances of several kilometres. The precision of the EM method was evaluated by comparing EM measurements with drillings carried out at the same time. Photo: S. Hendricks

THE GREAT MELTDOWN – A CHALLENGE FOR THE RESEARCH COMMUNITY, SOCIETY AND POLITICAL LEADERS

From research conducted at the Alfred Wegener Institute for Polar and Marine Research (AWI) The summer ice cap over the Arctic Ocean has been shrinking for over thirty years. AWI researchers led by Professor Rüdiger Gerdes regularly measure the extent and thickness of sea ice and use the data to create models to better predict the role ice plays in the global climate system and to assess the chances and risks associated with the changes in northern regions. One thing is clear: the affect are not confined to the polar region alone. Changing atmospheric and oceanic circulations affect the climate worldwide, new sea routes that are open a larger part of the year play a key role in shipping, and arctic oil and gas are of great importance for industry. Furthermore, people in northern Canada, Alaska and Siberia will be forced to change their lifestyles in a process that will be difficult and perhaps even painful. This makes reliable predictions all the more important.

You can find related media and content at » **www.helmholtz.de/en/gb11-arktisches-meereis**

PROGRAMMES
IN THE FUNDING PERIOD 2009–2013

Geosystem: The Changing Earth

This programme is focused on analyses of the physical and chemical processes in the Earth system, on the interaction between the geosphere, atmosphere, hydrosphere, pedosphere and biosphere, and on the effects of this interaction on the human habitat. The programme's mission is to observe, explore and model the relevant geoprocesses in order to understand the state of the geosystem and to recognise the trends transforming it. Its work is based on global geophysical and geodetic observation infrastructure, regional Earth system observatories, near-Earth satellites, airborne recording systems, mobile instrument arrays, drilling rigs and analytical and experimental infrastructure. All these instruments form an observation system that is integrated into national and international collaborations. In addition to researching the Earth's magnetic and gravitational fields, the programme examines natural resources and the cycle of materials, climate variability and the impact of the climate on the human habitat. Preventive strategies for natural disasters and the use of underground space (e.g., to store carbon dioxide) are additional priorities. With all these themes, the programme is contributing to the three fields of inquiry "Earth System Dynamics and Risks", "Climate Variability and Climate Change" and "Sustainable Use of Resources".

Marine, Coastal and Polar Systems

The goal of this research programme is to monitor current changes in the oceans, polar systems and coastal regions and, in particular, to evaluate them in light of changes in the past. In the research on coastal regions, special attention is being devoted to distinguishing between direct

Creatures washed into the mud flats by the tides are caught in pop nets and scooped from the water in dip nets. Photo: H. Asmus

SALTY SARDINES INSTEAD OF COD FILET

From research conducted at the Alfred Wegener Institute for Polar and Marine Research (AWI)

The North Sea is becoming warmer: over the past fifty years, seawater temperatures have risen by more than 1.5 degrees centigrade – too much for many organisms. Several species of fish have responded sensitively: coldwater fish have migrated northwards and warm water species have moved in from the south. Dr. Lars Gutow and his colleagues at AWI have closely followed these gradual changes. What significance do the invasive species have for the ecosystem? How do they compete with native species? The answers to these questions will improve predictions of how the North Sea food web will develop in the future and how the fishing industry and society must adapt. As Gutow puts it, "It is important that we not only realise that everything can change, but that we develop ways to deal with the upcoming changes so that we can continue to meet the great challenge of feeding the world."

You can find related media and content at **www.helmholtz.de/en/gb11-saure-sardine**

human influence and climate variability. One project launched in this area has involved the establishment of a comprehensive observation system in the German Bight (COSYNA). Research into the polar regions focuses in particular on the processes and interactions affecting and governing global climate. A deeper understanding of paleoenvironmental records – in combination with process studies – will allow us to draw more accurate conclusions about possible future developments. Researchers are developing a model system for medium-term developments that will encompass the cryosphere, the oceans, the marine biosphere and the Earth's chemosphere. This model will represent biodiversity and flows of energy and materials on different spatial and temporal scales. Research that seeks to distinguish between climatic fluctuations and human influences in a complex overarching system will provide a scientific foundation for decision-making processes and support the formation of political and social opinion. In order to achieve the targeted goals, it is crucial that mathematical system models be combined with modern research infrastructure such as measuring stations, ships, aircraft and polar stations.

Atmosphere and Climate

This programme deals with the role that the atmosphere plays in the climate system and the processes that have a key impact on climate change, natural disasters, air quality and hence the quality of life on earth. In this area scientists are examining the properties of the stratosphere, troposphere and biosphere and their complex interactions in the processes of global change. Research focuses include the study of the water cycle and the biochemical cycles of

Mosquito larvae compete with water fleas for food in small bodies of water. Photo: UFZ/A. Künzelmann

WATER FLEAS KEEP MOSQUITOES AWAY

From research conducted at the Helmholtz Centre for Environmental Research – UFZ We see mosquitoes mainly as a nuisance, but in Africa they can carry dangerous diseases and are thus a serious health risk. Researchers under Dr. Matthias Liess at the Helmholtz Centre for Environmental Research – UFZ in Leipzig have developed an effective method for fighting the insects. Female mosquitoes like to lay their eggs in small, recently formed bodies of waters such as puddles since these do not contain any amphipods or copepods that compete for the food of mosquito larva. "We introduced tiny crustaceans into these small bodies of water as natural competitors," explains Liess. During field tests in the Elbe floodplains around Leipzig – and also in Cameroon – the method proved effective in keeping the mosquitoes from multiplying. Now researchers intend to breed crustaceans whose eggs can survive for a long time in a dry state. Using these durable eggs, local residents can simply "inoculate" pools against mosquito plagues.

You can find related media and content at » **www.helmholtz.de/en/gb11-wasserfloh**

environmentally relevant trace gases and aerosols. Analyses are based on data collected from long-term aircraft and satellite measurements, ground-based stations, large simulation chambers (including AIDA and SAPHIR) and numerical modelling (transport and climate models, etc.). These numerical models are constantly being optimised in order to quantify the ecological and socioeconomic consequences of climate change and to acquire knowledge to protect against negative impacts. The regional level is a special focus. The new HALO research aircraft will also play an important role once it begins its missions with the support and participation of the programme's researchers.

The Terrestrial Environment

The goal of the Terrestrial Environment Programme is to preserve the foundations of human life and to develop options for the sustainable use of resources. In this respect, the programme is closely linked to climate change research: since climate change cannot be stopped by the mitigation of greenhouse gas emissions alone, we need to develop additional strategies to adapt our ecosystems and reduce their vulnerability. To this end, researchers are designing new technical solutions in the fields of agrotechnology, biotechnology, energy technology, and environmental technology. They are studying conflicts between food production, bioenergy generation and nature conservation and developing strategies to allow regions to adapt to global change. An additional priority is the analysis of the mechanisms governing the growth of microbes and plants with the goal of achieving sustainable biomass production. In the field of water resource systems, a new eco-technological approach is being conceptualised in order

Homeowners, local authorities and insurance companies need to know how to prepare for the heavier rainfall caused by climate change. Photo: iStockphoto

EXPLAINING CLIMATE CHANGE TO DECISION-MAKERS

From research conducted at the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research At the Climate Service Center (CSC) of the Helmholtz-Zentrum Geesthacht, interdisciplinary teams of scientists are working on preparing and communicating knowledge about climate change and adaptation strategies. Their aim is to help decision-makers in politics, public administrations and the business community to understand and consider the dimensions of climate change. One project at the CSC entails assessing the potential losses to the German economy caused by extreme weather events. For example, as a result of climate change, heavy rains may increasingly lead to local flooding and the overflow of drainage canals. The current CSC study entitled “Heavy Rain Risk 2050” is attempting to determine the connection between heavy rains and insured damage and to estimate how these risks will develop against the backdrop of climate change. The public will have access to the study’s maps showing changes in heavy rainfall for all districts in Germany. The CSC’s website provides current information and other services and can be visited at www.climate-service-center.de.

You can find related media and content at » **www.helmholtz.de/en/gb11-klimawissen**

to protect high-quality water and ensure it is available in sufficient quantities. A more thorough understanding of the processes of groundwater systems and the analysis of the vulnerability of groundwater reserves and their natural self-cleaning capacity will enable us to better assess the consequences of groundwater degradation for humans and the ecosystem. In the field of sustainable chemical use, in-depth knowledge of the fate of chemicals in the environment is offering new potential for the development of lower-risk substances and problem-specific remediation strategies for large contaminated sites. The Terrestrial Environment Programme has supplemented this research with a technological and methodological platform for the observation, integrated analysis and assessment of terrestrial systems. Finally, an important role is being played by innovative measuring and monitoring concepts, integrated modelling approaches, and the examination of methodological questions relating to upscaling at long-term observation sites such those in the TERENO network.

OUTLOOK

To effectively meet the abovementioned challenges in the future, the research field Earth and Environment research at the Helmholtz Association will continue to draw on the capacities of the participating centres in order to study integrated and integrative topics within a shared research portfolio. This process will create new alliances and expand technological competencies regarding Earth observation and knowledge systems and integrated approaches to modelling.

Microscopic image of the crushed spore of an arbuscular mycorrhiza of the genus *Gigaspora* (200 x magnification). Photo: UFZ/S. König

LONG-TERM EXPERIMENT IN JENA: DIVERSITY INCREASES PRODUCTIVITY

From research conducted at the Helmholtz Centre for Environmental Research – UFZ and the Forschungszentrums Jülich Helmholtz researchers at the Forschungszentrum Jülich and the UFZ have participated in one of the largest ecological field experiments in the world involving grassland biodiversity. For this long-term study, which was coordinated by the University of Jena, more than 90 experimental sites in the Saale Valley were sown with different combinations of grass, legumes and herb species in 2002 and their development was followed until 2009. The researchers found that plant diversity had an effect on the way the entire food web functioned – and particularly on the herbivores that eat the plants directly. As the number of plant species increased, so too did the number of plant-symbiotic fungi species, which increased the plant's nutrient suppy and enhanced plant productivity. According to microbiologist Dr. Stephan König of the UFZ, once more is known about such organisms, they could be used to increase harvests in an environmentally friendly manner. "Combinations of different plant species in nutrient-poor fields require fewer fertilizers or pesticides and could serve as a resource for biogas production," says Dr. Vicky Temperton of the Institute of Biosciences and Geosciences at the Forschungszentrums Jülich.

You can find related media and content at » **www.helmholtz.de/en/gb11-langzeitexperiment-jena**

The interdisciplinary portfolio project "Earth System Knowledge Platform – Observation, Information and Transfer" will pool and interconnect the knowledge acquired by all the centres and their partners in the area of Earth and environmental research. Its aim is to support members of society and important decision-makers in dealing with the complex challenges brought about by changes in the Earth system. The Climate Service Center will play an important role in these processes.

The planned integration of IFM-GEOMAR into the Helmholtz Association in 2012 will make an additional valuable contribution to the Helmholtz network of observatories and substantially expand the scope of this research field. The centres are working to ensure that their expertise will be safeguarded and developed over the long term. Now and in the future, researchers will be able to respond quickly and flexibly to new short and medium-term challenges.

RESEARCH FIELD HEALTH

In order to cope with the growing incidence of common diseases such as cancer, cardiovascular and metabolic disease, pulmonary illness, disorders of the nervous system and infections, we need to ensure a swifter translation of basic research findings into clinical applications, improve prevention and early detection and develop more targeted forms of treatment. The field of health research at the Helmholtz Association is well prepared to pursue the interdisciplinary approaches required to achieve these goals, by working in alliances with universities and other research institutions. Translational research has been strengthened through the Helmholtz health centres' strategic partnerships (particularly with medical schools), the establishment of translational centres, and exemplary alliances with industrial partners. Due to the establishment of the German Centres of Health Research, the quality of these interactions is systematically deepened leading to a new dimension of collaboration. The National Cohort, which was initiated by the Helmholtz Association, will bring together representatives of diverse disciplines in a long-term study designed to shed light on the interplay between environmental factors, genetics and lifestyle in the development of diseases.

Health research is represented in the Senate of the Helmholtz Association by the senate members Professor Babette Simon and Professor Andreas Barner.

PROFESSOR ANDREAS BARNER
Member of the Helmholtz Association Senate, Spokesman for Corporate Management and Head of Pharmaceutical Research, Development and Medicine, Boehringer Ingelheim

PROFESSOR BABETTE SIMON
Member of the Helmholtz Association Senate, President of the University of Oldenburg

RESEARCH FIELD HEALTH

PROFESSOR OTMAR D. WIESTLER
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Health,
German Cancer Research Center

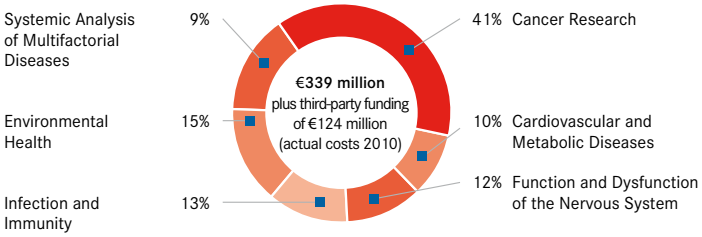
GOALS AND CHALLENGES

Due to increasing life expectancy and declining birth rates, the percentage of old people in the population is continuing to rise. This development has confronted society and the healthcare system with major challenges. Chronic common and ageing-associated diseases such as cardiovascular and metabolic disease, cancer, diabetes, pulmonary illness, disorders of the nervous system and chronic inflammations are becoming ever more significant, and the question of how they are impacted by environmental factors and lifestyles is attracting more scrutiny. In addition to infections, these diseases form the focus of health research at the Helmholtz Association. Scientists at the Helmholtz centres involved in health research are studying the causes and development of these often complex diseases and are using their findings to develop new strategies for early detection, prevention, diagnosis and treatment. These centres are increasingly drawing on new forms of collaboration with strong partners from medical schools, universities, other research organisations and industry.

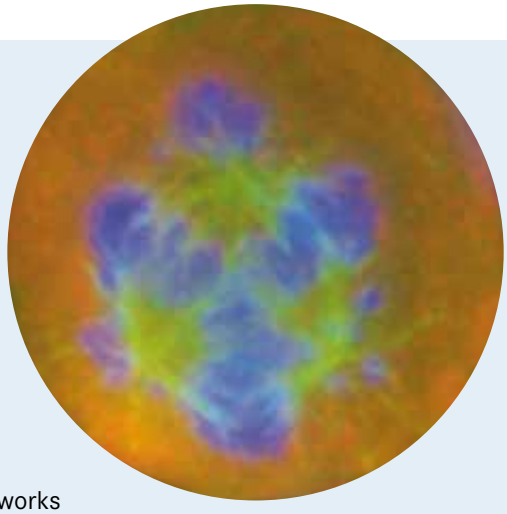
The Helmholtz health research centres are making a great effort to overcome the medical, social and financial consequences of the dramatic increase in complex chronic diseases in the population. The Helmholtz Association health centres are excellently positioned to provide impetus on the national level and to accelerate the translation of research findings into patient applications.

The Federal Research Ministry has established German Centres of Health Research in order to extensively expand the high level of scientific expertise at research institutes and clinics, better coordinate expertise and more effectively incorporate findings into applications. These centres are to play a key role in enhancing options for the prevention, diagnosis and treatment of major common diseases such as metabolic disorders, infections, cancer, disorders of the nervous system, and cardiovascular and pulmonary disease. Six Helmholtz centres are partnering with university and non-university institutes for this endeavour: the German Cancer Research Center (DKFZ), the German Centre for Neurodegenerative Diseases (DZNE), the Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU), the Helmholtz Centre for Infection Research (HZI), the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch. Through its member institutions, the Helmholtz Association is providing important expertise to the new German Centres of Health Research, which have also been assigned the task of effectively transforming research findings into clinical applications and strengthening translational medicine. Through the close cooperation of university and non-university partners, the effectiveness of translational medicine will be further improved in the future and the international standing of German health research will be placed on a qualitatively new footing.

Structure of the research field Health
Target costs of core financing 2010: 339 million euros*
(incl. share of non-programme-linked research)



*Plus the Neurodegenerative Diseases Programme currently being set up at the DZNE (52 million euros) as well as funding for the German Centres of Health Research and the Helmholtz Institute Saarbrucken (27 million euros).



Malformed multipolar spindle of a cancer cell. Photo: German Cancer Research Center

TAKING THE TENSION OUT OF CANCER

From research conducted at the German Cancer Research Center (DKFZ)

When a cell divides, it forms polar bodies from which spindle-shaped protein fibres emanate to distribute chromosomes to the newly generated cells. Cancer cells often have several polar bodies that must be clustered at two poles for proper division. According to the findings of Helmholtz researchers led by Professor Alwin Krämer at the DKFZ, this clustering only works if the protein fibres are tense. By knocking out individual genes, the researchers discovered that an entire range of proteins is responsible for this tension. “When we silence the genes, the fibres lose their tension and the cell forms a multipolar spindle and dies,” says Krämer. According to the scientist, this mechanism is a possible starting point in the search for new therapeutic agents for cancer. This type of agent would kill only the tumour cells, since they are the only cells that form several polar bodies.

You can find related media and content at » **www.helmholtz.de/en/gb11-krebszellen**

PROGRAMME STRUCTURE
IN THE FUNDING PERIOD 2009–2013

Within the second period of programme-oriented funding that began in 2009, research is based on three pillars: outstanding basic research, the analysis of complex biological systems (systems biology), and the translation of research findings into clinical applications. The structure and goals of health research at the Helmholtz Association have been reviewed in a joint process, given a sharper focus and tailored more closely to individual coordinating Helmholtz research centres. Nine Helmholtz centres work together in this field of research: the German Cancer Research Center (DKFZ), the German Centre for Neurodegenerative Diseases (DZNE), the Forschungszentrum Jülich, the GSI Helmholtz Centre for Heavy Ion Research, the Helmholtz Centre for Infection Research (HZI), the Helmholtz Centre for Environmental Research – UFZ, the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU), and the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch. Scientists conduct research in the following seven programmes:

- Cancer Research
- Cardiovascular and Metabolic Diseases
- Function and Dysfunction of the Nervous System
- Infection and Immunity
- Environmental Health
- Systemic Analysis of Multifactorial Diseases
- Neurodegenerative Diseases (currently under development)

Breast cancer patients can take part in customised sports programmes and integrate more exercise into their daily lives. Photo: Nationales Centrum für Tumorerkrankungen (NCT) Heidelberg

QUANTIFYING AVOIDABLE RISK FACTORS FOR BREAST CANCER

From research conducted at the German Cancer Research Center (DKFZ) Nearly one in three cases of post-menopausal breast cancer is caused by a lack of exercise and a hormone replacement therapy to ease the discomforts of menopause. This finding comes from a study involving 3,000 patients and more than 6,000 control persons conducted by the DKFZ and the Hamburg-Eppendorf University Medical Center. Non-modifiable factors such as early onset menstruation, late onset menopause and breast cancer in the family are responsible for 37 percent of malignant breast cancer cases – a figure that is only slightly higher. The study also showed that alcohol consumption and obesity increase the risk of cancer, but to a lesser extent. "If behavioural changes can be achieved, particularly with respect to hormone replacement therapy and physical activity, almost 30 percent of all breast cancer cases occurring after menopause can be prevented," says Professor Karen Steindorf.

You can find related media and content at » **www.helmholtz.de/en/gb11-brustkrebs**

THE PROGRAMMES
IN THE FUNDING PERIOD 2009–2013

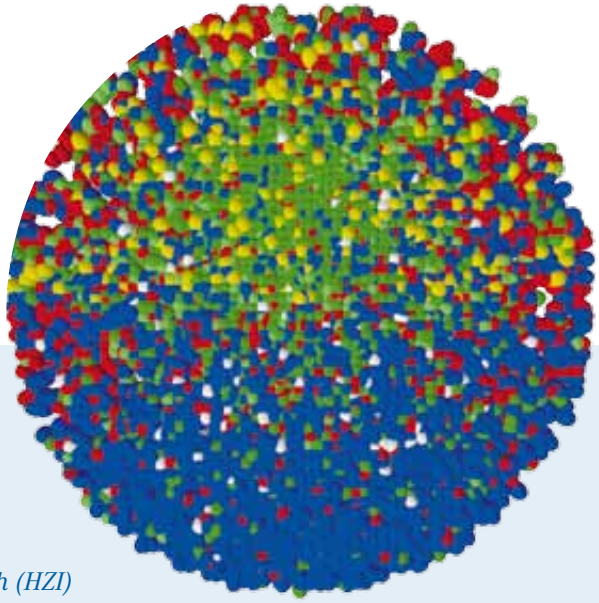
Cancer Research

Nearly 450,000 people in Germany contract cancer each year. Despite intensive research and many fundamental new developments in the field, more than half die as a result of the disease. The Cancer Research Programme aims to clarify the causes and pathogenesis of cancer. A main focus is on the development and application of innovative diagnostic and therapeutic procedures that are based on molecular, cell biological and immunological findings. By developing new imaging procedures and radiotherapy strategies to facilitate the more precise diagnosis, treatment, early detection and medical technology has also played an important role in the programme.

One of the great challenges for cancer research is to translate basic biomedical research findings into clinical applications. The Helmholtz Association is working to meet this challenge by intensively expanding the required infrastructure and strategic alliances. The National Centre for Tumour Diseases in Heidelberg will play a key role in this effort.

Cardiovascular and Metabolic Diseases

Cardiovascular diseases are the most common cause of death in Western industrialised countries. Major risk factors include high blood pressure, diabetes, increased blood cholesterol, smoking and obesity. In order to reduce the incidence of cardiovascular disease over the long term, scientists are studying the causes of vascular disorders, high blood pressure, heart and kidney disease and metabolic disorders such as diabetes and adiposity. They are also developing new methods for preventing, diagnosing and treating such diseases based on a variety of methodological approaches from the fields of genetics, genomics, systems biology, cell biology and epidemiology.



Model of the distribution of immune cells in the lymph nodes. The “dark zone” of the lymph node is predominantly blue, the “light zone” predominantly green. Graphic: HZI

CASTING SHOW IN THE LYMPH NODES

From research conducted at the Helmholtz Centre for Infection Research (HZI)

Lymph nodes are the marketplaces of the immune system: it is here that cells exchange information about pathogens that have entered the body and prepare their immune defence.

“What looks like a teeming mass of thousands of cells is in fact a highly structured organ,” says Professor Michael Meyer-Hermann of the HZI. Using a mathematical model that replicated the movement of immune cells in the lymph nodes, he and his team were able to explain findings provided by their American collaborators. The cells migrate back and forth between the light and dark zones of the lymph nodes, passing through different optimisation cycles. “The immune cells multiply, mutate and modify their antibodies. In the light zone the body checks whether these mutations offer a better immune defence. If the answer is yes, the cells in question are selected. Then the cycle begins anew. This process produces optimised antibodies that efficiently bind to the respective pathogens, marking them for phagocytes,” explains Meyer-Hermann.

In cycle after cycle, the defence cells that are better suited for fighting the pathogens are selected. The process provides the organism with optimised weapons (efficient antibodies). This new understanding of the selection of immune cells and the optimisation of immune responses could play an important role in the development of enhanced vaccinations based on the formation of highly effective antibodies in the body.

You can find related media and content at » **www.helmholtz.de/en/gb11-castingshow**

Function and Dysfunction of the Nervous System

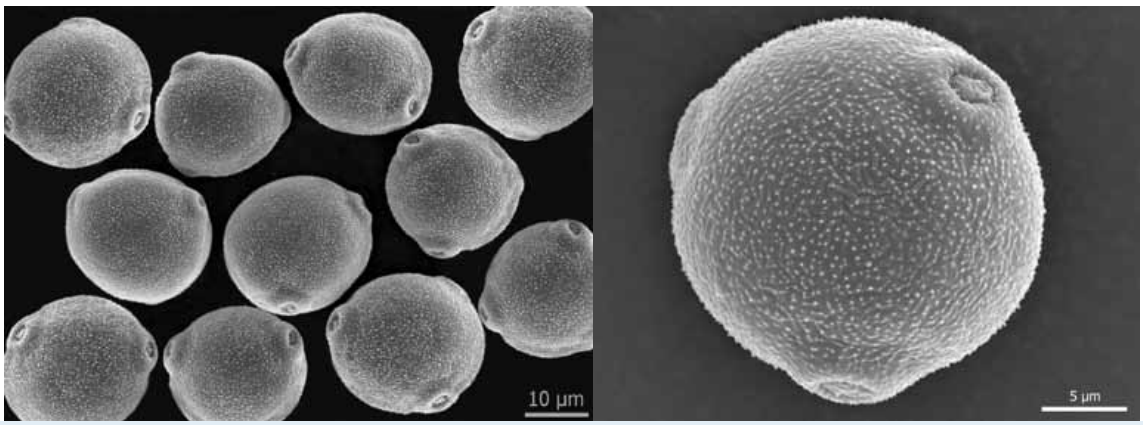
The risk of developing a neurological and psychiatric disorder increases with longer life expectancies. This is why the researchers in this programme are studying degenerative diseases of the central nervous system as well as epilepsy, brain tumours and post-stroke cognitive impairments. In order to analyse normal and pathologically altered mechanisms in living human brains, they draw on state-of-the-art non-invasive imaging procedures such as magnetic resonance imaging, positron emission tomography, magneto-encephalography, genomics and cell biology, and relevant animal models.

Infection and Immunity

More than 17 million people worldwide die of infectious diseases each year, accounting for one-third of all deaths. International mobility has caused pathogens to spread more quickly than in the past. Given the growing threat of infectious diseases, researchers are studying the molecular and cellular processes of infections in order to understand how and why specific pathogens trigger a disease’s symptoms. At the same time, they are analysing immunity mechanisms in order to formulate new strategies against infectious diseases and to develop immunotherapeutic approaches. Zoonoses research will be expanded in the future in order to gain greater insight into the viral and bacterial diseases transmittable from animals to humans (e.g., SARS).

Environmental Health

How do environmental factors affect human health? Which molecular and cellular mechanisms form the basis of such



Birch pollen under an electron microscope. Image: Helmholtz Zentrum München

WIDE VARIATIONS IN THE ALLERGEN CONTENT OF BIRCH POLLEN

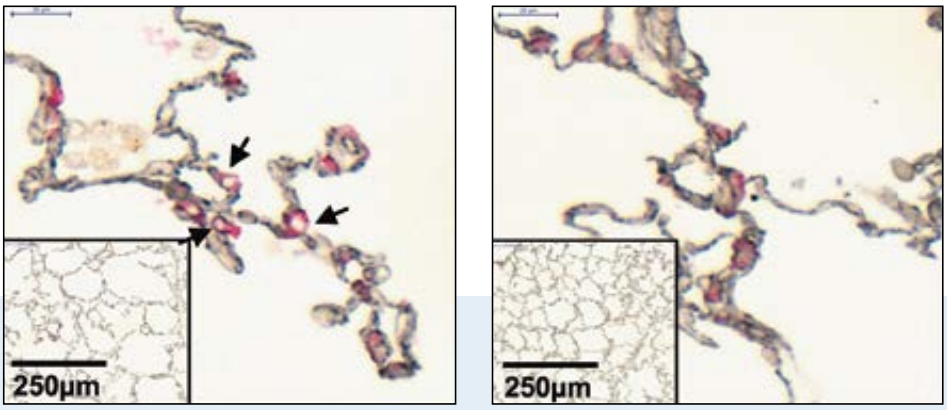
From research conducted at the Helmholtz Zentrum München – German Research Center for Environmental Health Up to now, allergy forecasts have been based solely on the levels of pollen in the air. Working at different sites in Europe, researchers from the Allergy and Environment Centre, run jointly by the Helmholtz Zentrum München and the Technische Universität München, have now discovered that the allergen content of the same amounts of birch pollen varies up to 10-fold from day to day. Their study shows that the intensity of the allergic reaction is due not only to the amount of pollen but also to its degree of maturation. "In our EU project HIALINE [Health Impacts of Airborne Allergen Information Network], we've expanded our focus beyond birches and grasses to include olive trees," says Professor Jeroen Buters. The researchers are now measuring the amounts of pollen and their allergen content and relating this data to the symptoms of allergy sufferers. They hope that the integrated approach to measurements will result in more precise allergy predictions. So far the study has also led to a better understanding and improved management of allergy symptoms.

You can find related media and content at **www.helmholtz.de/en/gb11-birkenpollen**

disorders and what role is being played by genetic disposition? What new preventative and therapeutic strategies can be derived from work in these fields? These are the key questions addressed by this programme. Research is focused on common diseases such as respiratory tract infections, allergies and cancer, whose pathogenesis is heavily influenced by environmental toxins such as particulate pollutants in the air (aerosols), chemicals and ionising radiation. On the one hand, scientists are researching toxic pollutants and the related disease-triggering mechanisms with the aim of developing strategies for risk evaluation and risk reduction. On the other hand, they are studying the pathogenetic mechanisms of the abovementioned diseases in order to evaluate the role of environmental factors. A further priority is basic research into chemical modifications of genetic material.

Systemic Analysis of Multifactorial Diseases

Integrated into joint interdisciplinary research platforms, the scientists in this programme are analysing the genetic and molecular biological mechanisms that lead to the development of multifactorial diseases in order to create new approaches to therapy. The German Mouse Clinic at the Helmholtz Center Munich, where technologies for genome, proteome and metabolome analyses are established, plays a central role within this context. These technologies as well as the expertise in analytics for small molecules and



Cross-section of a mouse lung before (left) and after (right) activation of the WNT signalling pathway. Activation resulted in improved lung structure (right). Image: HMGU/M. Königshoff

SELF-REPARING LUNG TISSUE

From research conducted at the Helmholtz Zentrum München – German Research Center for Environmental Health Chronic lung disease is often accompanied by the loss of lung tissue, which leaves patients with a diminished surface for gas exchange between the lungs and the environment. Scientists at the Helmholtz Zentrum München have now discovered how to induce the repair of destroyed lung tissue in mice. “This mechanism could enable researchers to develop a therapeutic approach to the previously incurable chronic obstructive pulmonary disease,” says Dr. Melanie Königshoff. Chronic obstructive pulmonary disease (COPD) is the fourth most frequent cause of death worldwide. It makes lungs lose their elasticity and prevents inhaled air from being completely exhaled. The team discovered that a specific signalling pathway is inhibited in COPD patients. In the disease model, the researchers succeeded in reactivating the WNT pathway and thus improving lung function.

You can find related media and content at » **www.helmholtz.de/en/gb11-lungengewebe**

specific mouse models provide an ideal research framework for identifying both individual risk factors and biomarkers that can be used to detect chronic illnesses at an early stage. Scientists are concentrating on major chronic ailments such as metabolic disease, diabetes, pulmonary illness, neurodegenerative diseases and disorders of the immune system.

Neurodegenerative Diseases (currently under development)
The goal of this research programme, which will be run primarily by the Helmholtz Association’s new DZNE centre, is to understand the causes and risk factors determining neurodegeneration and to develop new strategies for treatment and care. The spectrum extends from basic and clinical research to research into care and nursing within the healthcare system.

The DZNE is working closely with partner universities to pool the outstanding research being done on neurodegeneration in Germany. During the setup phase, the programme will focus on a range of provisional topics: the mechanisms of both neurodegeneration and neuroprotection; neuroregeneration; animal models of neurodegenerative diseases and chronic brain disorders; old age and comorbidity as risk factors; translational, diagnostic and functional imaging; epidemiology and population studies; the healthcare system and healthcare research as well as clinical research and intervention studies.

Excessive amounts of cake and wine are unhealthy, but genetic factors also influence the development of type 2 diabetes. Photo: Helmholtz/E. Fesseler

GENE VARIANTS INFLUENCE THE CONCENTRATION OF A DIABETES MARKER

From research conducted at the Helmholtz Zentrum München – German Research Center for Environmental Health Type 2 diabetes is characterised by a disruption of glucose metabolism: the hormone insulin is no longer produced in sufficient quantities or loses its effect. Both genetic and lifestyle factors are instrumental in the development of diabetes. The most important blood parameter for tracking the course of the disease is glycohemoglobin (HbA1C). Researchers at the Helmholtz Zentrum München have now identified new gene variants that influence the concentration of HbA1C. Seven of the affected gene loci are linked to rare hereditary illnesses such as anaemias and iron storage disorders. For their study the researchers examined the data of 46,000 people and discovered that common gene variants influence the biology of the red blood cells, making a small yet quantifiable contribution to the diagnosis of diabetes. A more precise understanding of the genetic foundations and causes of the disease can lead to more promising treatments.

You can find related media and content at » **www.helmholtz.de/en/gb11-gene-diabetes**

OUTLOOK

The long-term goal of health research at the Helmholtz Association is to improve medical care and quality of life for the population into old age. Its content is based on the German government's Health Research Programme and takes into account all the economic aspects of health care. Building on basic research findings, we are developing new strategies for the diagnosis, prevention, early detection and treatment of the major common diseases. Furthermore, utilising relevant models, we are investigating the first procedures for adapting therapies to patients' specific needs. A general focus is the more rapid translation of basic research findings into patient applications. All these goals are being pursued in collaborations between the Helmholtz health centres and partners from medical schools, universities and industry. The translational centres, the German Centers of Health Research as well as the National Cohort as a resource for epidemiology and prevention research will substantially contribute to the realization of these goals.

Scientists at the Max Delbrück Center identified a gene that regulates cholesterol levels in the body. Photo: MDC/D. Ausserhofer

NEW GENETIC FACTOR DISCOVERED FOR HIGH CHOLESTEROL LEVELS

From research conducted at the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch
Working with scientists from the University of Aarhus in Denmark, MDC researchers have uncovered a new genetic basis for high cholesterol levels. In their study, the MDC team led by Professor Thomas Willnow identified a specific cholesterol-regulating gene called *SORT1*. People with the active variant of *SORT1* have higher cholesterol levels than those with the less active gene variant. According to the MDC researchers, the liver protein sortilin, which is encoded by the gene, could be a good point of attack for more targeted drug treatments for patients with high cholesterol levels.

You can find related media and content at » **www.helmholtz.de/en/gb11-cholesterin**

Dr. Stefan Lechner (Max Delbrück Center) examining sensory nerve cells stained with fluorescent dye under a fluorescence microscope. Photo: MDC/D. Ausserhofer

BLOOD PRESSURE REGULATOR DISCOVERED IN THE LIVER

From research conducted at the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch People with orthostatic hypotension experience a sudden drop in their blood pressure that causes them to faint when standing up. They can be helped by a strategy that is both simple and effective and is used systematically in clinics: drinking a glass of water. The underlying mechanism was elucidated by Professor Gary Lewin and Dr. Stefan Lechner of the MDC, working with Professor Jens Jordan of the Hanover Medical School and Professor Friedrich C. Luft of the Experimental and Clinical Research Center (an institute run jointly by the MDC and the Charité Medical Faculty on the MDC's Berlin-Buch campus). In their study the scientists identified the sensory nerve cells in the liver that cause the increase in blood pressure by activating parts of the sympathetic nervous system via circuits in the spinal cord.

You can read the entire article in German at » **www.helmholtz.de/en/gb11-blutdruckregler**

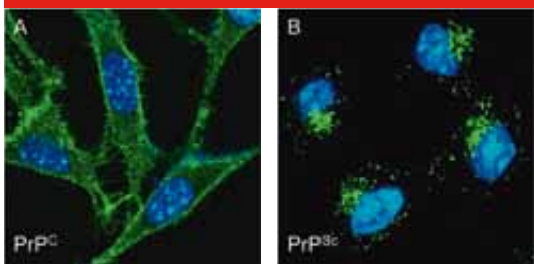
Dr. Sybille Krauß performing cell culture experiments in the lab. Photo: DZNE

A DIABETES DRUG FOR ALZHEIMER'S

From research conducted at the German Centre for Neurodegenerative Diseases (DZNE) The diabetes drug metformin may be suitable for treating Alzheimer's disease – this is one of the conclusions that researchers under Dr. Sybille Krauß at the DZNE laboratory in Bonn have drawn from the findings of their experiments. In patients with Alzheimer's disease, the tau protein changes its structure, forming deposits in the brain. This process is thought to contribute to the death of nerve cells. The researchers have shown that metformin counteracts the structural changes in tau. Hence, the drug could potentially prevent the formation of abnormal protein deposits and the death of brain cells. The team also shed light on the molecular mechanism by which metformin acts. If additional experiments on Alzheimer's mice proceed positively, clinical studies could begin shortly.

You can find related media and content at » **www.helmholtz.de/en/gb11-alzheimer**

The image on the left shows a normal prion protein (coloured green) in non-infected mouse cell cultures. The image on right shows a misfolded prion form (coloured green) in infected cells. These misfolded prions accumulate primarily in vesicles within the cell. Cell nuclei are depicted in blue. Photo: DZNE/I. Vorberg



TRACKING DOWN PRIONS

From research conducted at the German Centre for Neurodegenerative Diseases (DZNE) Neurodegenerative diseases such as Alzheimer's, Parkinson's and Creutzfeldt-Jakob disease are characterised by the misfolding of host-encoded proteins, which causes brain cells to die. At the DZNE laboratory in Bonn, Professor Ina Vorberg is investigating the mechanisms underlying these diseases. Her area of research is transmissible spongiform encephalopathies (TSEs), which include the fatal Creutzfeldt-Jakob disease. A special feature of TSEs is their transmissibility. They are triggered by prions – aggregates of misfolded proteins that can infect not only other cells, but also other organisms. "We are using two models to examine how prions recognise and penetrate their target cells and how they multiply within them," says Vorberg. According to the scientist, the elucidation of these mechanisms will provide a basis for medications as well as new knowledge for the treatment of Alzheimer's and Parkinson's.

You can read the entire article in German at » **www.helmholtz.de/en/gb11-prionen**

>> ENERGY
>> EARTH AND ENVIRONMENT
>> HEALTH

RESEARCH FIELD AERONAUTICS, SPACE AND TRANSPORT

>> KEY TECHNOLOGIES
>> STRUCTURE OF MATTER

Expertise in the field of aeronautics, space and transport research is contributing to the development of new concepts and technical solutions relating to a range of challenges and requirements from society at large. The necessary interdisciplinary collaboration both within and between the three programmes in this field will be maintained and expanded. With their increased focus on the theme of safety research, the individual programmes are pooling and expanding existing expertise on crisis and disaster management and on the infrastructure that is critical to safety.

Aeronautics, space and transport research is represented in the Senate of the Helmholtz Association by the senate members Dr. Detlef Müller-Wiesner and Professor Ulrich Seiffert

PROFESSOR ULRICH SEIFFERT
Member of the Helmholtz Association Senate,
Managing Director of WiTech Engineering GmbH,
Braunschweig

DR. DETLEF MÜLLER-WIESNER
Member of the Helmholtz Association Senate,
Senior Vice-President, Chief Operating Officer
Innovation and Deputy CTO, Corporate Technical
Office, EADS Deutschland GmbH, Munich

RESEARCH FIELD AERONAUTICS, SPACE AND TRANSPORT

PROFESSOR JOHANN-DIETRICH WÖRNER
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Aeronautics, Space and Transport,
German Aerospace Center

GOALS AND CHALLENGES

Mobility, information, communication, resource management, the environment and safety are all decisive factors for the economic, ecological and social development of modern economies and are thus extremely important for the elaboration of a long-term strategy. Addressing these challenges, scientists in the field of aeronautics, space and transport research are developing new concepts and solutions to technical problems and are providing advice for political decision-makers. With their enormous potential for technological development and innovation, these three research programmes have made a significant contribution to strengthening and providing greater visibility for Germany's international role as a locus of research and innovation.

The German Aerospace Center (DLR) is the only Helmholtz centre in the field of aeronautics, space and transport research. At the same time, it serves as the country's aeronautics and aerospace research centre and, as the national space agency, is responsible for research in the national aerospace programme and Germany's contribution to the work of the European Space Agency (ESA).

The DLR has a total of 13 locations spread across Germany, all of which are closely networked with universities and non-university research institutions. The Helmholtz DLR@Uni Alliance is responsible for both the diverse content of research and the conditions governing the respective collaborations. It establishes the framework for content-based partnerships, which can range from shared research arrangements and advanced training to joint start-up initiatives. The DLR also cooperates closely with other research centres in the Helmholtz Association, particularly in the research fields Energy and Earth and Environment.

Outstanding examples of collaboration between the DLR and the private sector include the national Earth observation satellite TanDEM-X, which was launched in 2010. This radar satellite is operated by a public-private partnership between the DLR and Astrium, which was funded by the Federal Ministry of Economics and Technology. TanDEM-X flies in formation with its twin satellite TerraSAR-X – sometimes as close as 200 metres – and generates three-dimensional images of the Earth's surface. Another example is the fuel-cell driven, electrical nose wheel installed in the DLR's A320 ATRA research aircraft, which was flown successfully with this new feature for the first time in June 2011. Installing the nose wheel in commercial aircraft can significantly reduce noise and exhaust emissions at airports.

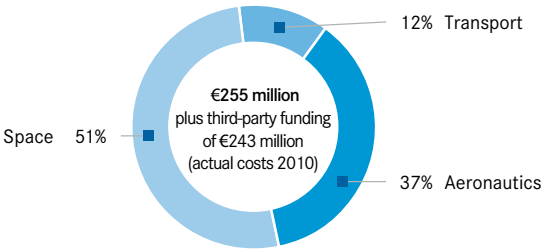
PROGRAMME STRUCTURE
IN THE FUNDING PERIOD 2009–2013

Scientists in the field of aeronautics, space and transport conduct research and collaborate in the following three programmes:

- Aeronautics
- Space
- Transport

Their work is shaped in both thematic and organizational terms by its integration under the umbrella of the DLR. This means that researchers working in all three programmes are able to draw on the core expertise they require in areas such as aerodynamics, structures and materials, communications, navigation and mechatronics. They are also able to take advantage of synergies generated at the interfaces between aeronautics, space and transport within fields such as air and space-based remote sensing.

Structure of the research field of Aeronautics, Space and Transport
Target costs of core financing 2010: 255 million euros
(incl. share of non-programme-linked research)



This design for a flying wing jet – produced by the EU's NACRE project – is based on models from nature, such as the flying seeds of a Southeast Asian creeper. Upper photo: DLR/NACRE; lower photo: Wiki Commons, Scott Zona.

A FLYING STINGRAY FOR 750 PASSENGERS

From research conducted at the German Aerospace Center (DLR) Low noise, manoeuvrability and one-third the fuel consumption of conventional aircraft – these goals will be achieved by the future "flying wing" passenger jets that are currently being developed at the DLR. Scientists envision an aircraft that is 65 metres long, almost 100 metres wide, will seat 750 and have the shape of a stingray.

The team led by Dirk Leißling at the DLR Institute of Flight Systems in Braunschweig has tested the flight characteristics of a flying wing configuration designed on a computer. For this purpose they fed all the data relating to the flying wing into the control system of their ATTAS research aircraft. As Leißling puts it, "ATTAS is a true chameleon and performs in real flight exactly like this not-yet-existent aircraft."

The test flight drew on all the pilot's skills, since the flight behaviour of the programmed ATTAS deviated significantly from that of conventional aircraft – a success for this experiment, which elegantly combines reality and simulation and represents a significant step forward in flying wing research.

You can find related media and content at
» **www.helmholtz.de/en/gb11-flugrochen**

PROGRAMMES
IN THE FUNDING PERIOD 2009–2013

Aeronautics

Scientists involved in DLR aeronautics research are working to increase the performance capability and economy of the air transport system, reduce aircraft noise and harmful emissions and guarantee safety. They are also pursuing these goals as part of a European collaboration within the EREA Network. Supporting this work, the DLR uses specially equipped research aircraft such as the FALCON, ATRA and HALO.

The Aeronautics Programme of the DLR is characterised by close ties with European partners, particularly with the French and Dutch partner organisations ONERA and NLR. Current focuses include the further development of transport aircraft in collaboration with ONERA, improving flight guidance technology in collaboration with NLR, and expanding the DLR-NLR wind tunnel network by integrating the wind tunnels operated by ONERA. The DLR/ONERA Aircraft Research Partnership is conducting joint research on fixed-wing aircraft, while in the field of helicopter research, DLR/ONERA Rotorcraft Research is focusing on ensuring flight safety, particularly under difficult weather conditions. It is also extending the operational scope of this air transport system and improving its environmental compatibility. Another goal is the development of efficient and environmentally friendly propulsion systems with a focus on the optimisation of all jet-engine components. In the process new concepts for jet engines are being investigated, such as turbofan engines with a very high bypass ratio and non-sheathed engines. Research revolving around ATM and flight operations is focusing on the field of air traffic management, above all in connection with the immediate environs of airports and especially with regard to environmental issues.

The radar image produced by the Earth observation satellite TerraSAR-X on 12 March 2011 illustrates the tsunami's impact on an airport on Japan's eastern coast. The blue patches show flooding and the magenta areas the extent of infrastructure damage. Photo: DLR

THE TERRASAR AND TANDEM-X MISSION: DISASTER AID AND 3D MAPS OF THE EARTH

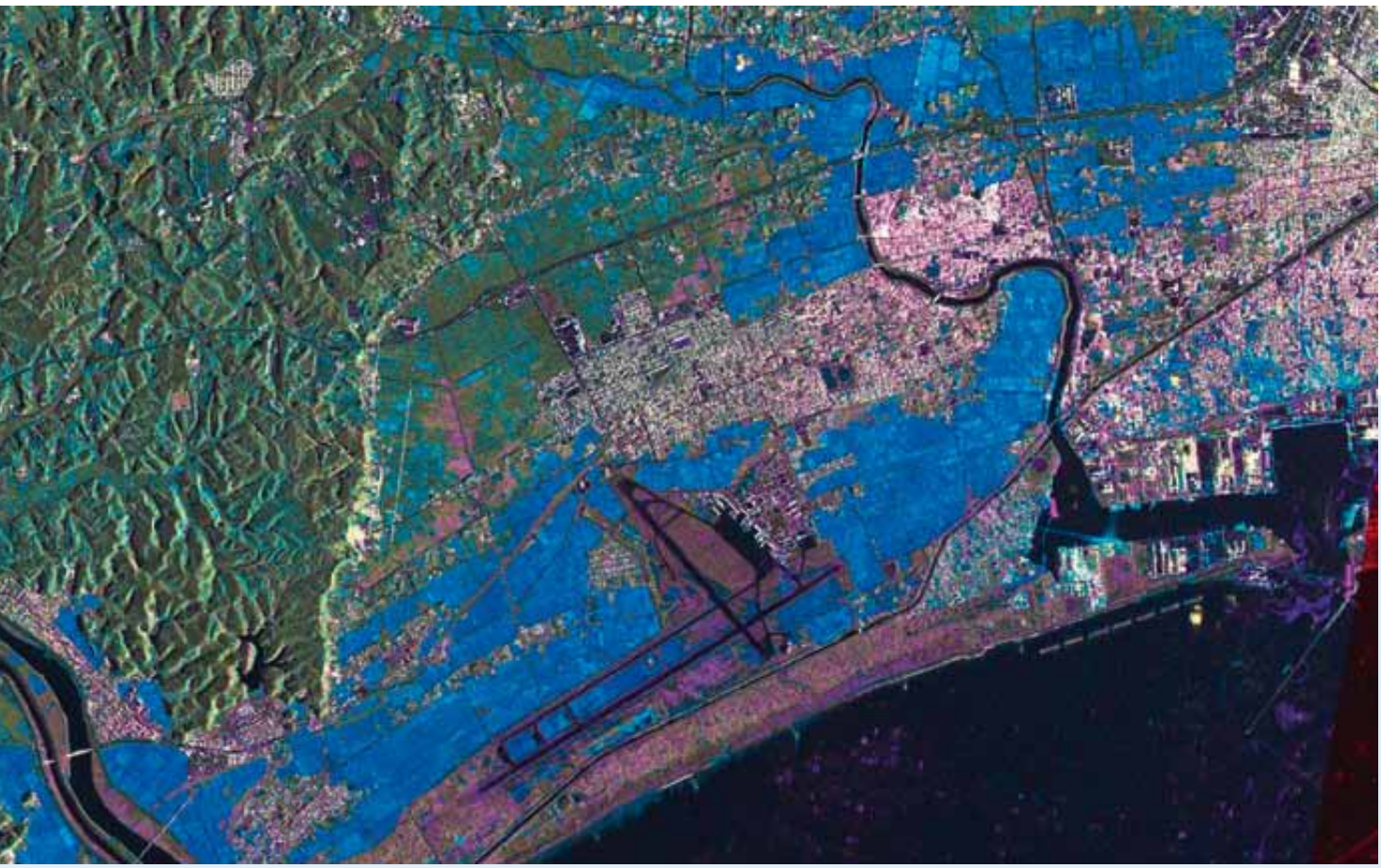
From research conducted at the German Aerospace Center (DLR) On 11 March 2011, the east coast of Japan was devastated by a tsunami. Just one day later the first satellite images were available to help emergency services plan their operations. In order to ensure the images could be produced this quickly, DLR experts reprogrammed the two radar satellites TerraSAR-X and TanDEM-X at short notice and worked around the clock to process the resulting data for damage analysts in Japan. In contrast to data provided by optical satellites, radar data is not affected by cloud cover or the time of day and therefore always delivers clear images of flooded or destroyed areas.
The actual goal of the TanDEM-X mission is to produce an elevation profile of the Earth's surface by 2013 and to provide data for an elevation model that will be unique in the world. The special features of this 3D model will be its homogeneity and an accuracy of better than two metres. But the twin satellites are also capable of providing rapid aid in the case of natural catastrophes by supplying data for detailed maps of the affected areas.

You can find related media and content at » **www.helmholtz.de/en/gb11-tandem-x**

Apart from the issue of noise, the climate compatibility of air traffic has now moved to the forefront of such research.

Space

Space research in Germany provides direct benefits to the public and inspiration for the future. Scientists working in the Helmholtz Space Programme are studying the Earth as a system of processes and changes, exploring the solar system, and researching the nature of life and materials when subject to the special conditions in outer space. They are also contributing to the development of space travel, working on advances in satellite communications and navigation, designing transporters and landing devices, and making preparations for actual missions. All these aspects involve collaboration with partners from industry, research institutions, universities, government authorities and public institutions. The Helmholtz Space Programme constitutes a central link between all parties contributing to space research.
In the coming years, work in the field of Earth observation will focus on the research and development of innovative radar, lidar and optical technologies, modern analytical processes and the development of high-quality products. In the field of satellite communications, emphasis will be placed on broadening the applications of optical connections and the research and development of a satellite-based terabit transport and distribution network. In the area of satellite navigation, work will be directed towards completing the Galileo system and developing new applications for it.



In the field of space exploration, the coming years will see the preparation and launching of missions to other bodies within the solar system, with a special emphasis on the search for life and the habitability of other planets. In research under space conditions, the entire range of available infrastructure – parabolic flights, sounding rockets and, in particular, the International Space Station – will be used to examine and extend fundamental knowledge in the life and material sciences. In order to ensure the economic viability of space transport, key technologies will be researched and technologies for orbital and planetary missions developed and tested. Work in the field of space robotics will target the development of technologies for "on-orbit servicing" and the design of robotic systems for exploratory missions.

Transport

Our current transport system is to a large extent already overloaded and is facing difficulties when it comes to absorbing the growing volume of traffic. This chronic overload represents a potential risk to the competitiveness of the German and European economies. High traffic volumes also affect the environment, reduce our quality of life and clearly increase the risk of accidents. The Transport Programme is therefore targeting three overarching goals: maintaining mobility, conserving resources and the environment, and improving safety levels. In order to achieve these goals, the DLR is developing solutions involving land-based vehicles, traffic management and the transport system as a whole. This work combines specific expertise in the transport field with competencies developed in aeronautics, the space field and our energy

Test subject during the sleep study at the Cologne sleep laboratory. Photo: DLR

NOISE IS NOT JUST NOISE

From research conducted at the German Aerospace Center (DLR) Many people are disturbed by traffic noise, especially at night. A research group from the DLR Institute of Aerospace Medicine led by Dr. Mathias Basner has conducted a study involving 72 people to determine the effects of various traffic noises on the quality of sleep. The subjects slept in the sleep laboratory for eleven consecutive nights, during which they were exposed to different acoustic scenarios ranging from street sounds to the noise of passing aircraft. The researchers monitored how often their subjects woke up and how quickly they were able to get back to sleep. They also measured heart rates and other parameters. The next day, participants were given concentration and memory tests in order to measure the effects of insufficient sleep. The study shows that the volume of a sound is not the only important factor in sleep disturbance but that changes in a sound over time as well as a sound's duration also play a key role. Overall, the results support the thesis that sustained exposure to noise increases the risk of cardiovascular disease. The insights provided by this research could also be of value for the optimisation of noise-protection techniques.

You can find related media and content at » **www.helmholtz.de/en/gb11-schlaf**

research. Some of the central themes being addressed in the development of next-generation road and rail vehicles include the optimisation of vehicle structures and energy systems, the minimisation of driving resistance and wear, increases in comfort, and the reduction of negative impacts on the environment. With regard to improving safety and providing support for drivers in specific situations, there is a strong focus on the development of individualised assistance schemes. Innovative road, rail and airport management solutions are contributing to improving the effectiveness and efficiency of infrastructure usage. Special traffic management information systems and tailored decision-making aids are being developed to help emergency services in the event of major incidents and disasters. Integrated observation of traffic development and its environmental effects is opening up new avenues in the investigation of transport systems.

OUTLOOK

Along with the evolution of current research themes, the coming years will see an increased focus on the multidisciplinary, numerical simulation of aircraft, the development of the next generation of rail-based vehicles and the development of reentry technologies for spacecraft. Research in these three areas will provide the DLR with access to groundbreaking technologies, for which, working with industry, it will develop new applications.

>> ENERGY
>> EARTH AND ENVIRONMENT
>> HEALTH
>> AERONAUTICS, SPACE AND TRANSPORT

RESEARCH FIELD KEY TECHNOLOGIES

>> STRUCTURE OF MATTER

Research focusing on the development of the next generation of key technologies requires multidisciplinary collaboration within a range of comprehensive programmes that address many areas of technology. Key technologies research builds a bridge from the life sciences, the natural sciences and engineering to nanoscience, microsystems technology and the macro world. Supercomputing, nanotechnology and, increasingly, the management of large data volumes play a central role. New research topics are emerging in particular at the interfaces with other fields of enquiry, such as energy storage, lightweight construction materials, biomaterials, the modelling of the human brain, and bioeconomics.

Key technologies research is represented in the Senate of the Helmholtz Association by the senate members Professor Katharina Kohse-Höinghaus and Professor Gerd Litfin.

PROFESSOR GERD LITFIN
Member of the Helmholtz Association Senate,
Managing Partner of Arkardien Verwaltungs KG,
Göttingen

PROFESSOR KATHARINA KOHSE-HÖINGHAUS
Member of the Helmholtz Association Senate,
Universität Bielefeld, Department of Chemistry

RESEARCH FIELD KEY TECHNOLOGIES

PROFESSOR ACHIM BACHEM
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Key Technologies,
Forschungszentrum Jülich

GOALS AND CHALLENGES

Research in the field of key technologies aims to develop generic technologies safeguarding the future sustainability of our society. New methods are being developed to identify ways of meeting the grand challenges involved in ensuring sustainable global development. The effectiveness of this field of research is based on multidisciplinary cooperation between holistic programmes involving a wide range of technological areas with an outstanding infrastructure tailored to the needs of large-scale research. This covers the entire spectrum from basic research up to actual applications. In the programmes "Supercomputing", "Fundamentals of Future Information Technology", "NANOMICRO: Science, Technology, Systems", "Advanced Engineering Materials", "BioSoft" and "BioInterfaces", Helmholtz scientists are building bridges between the life sciences, the natural and engineering sciences as well as between nanoscience, microsystems technology and the macroworld. Special significance is attached to "Supercomputing" and innovation and risk research within the framework of the "Technology, Innovation and Society" programme in their function as integrating elements.
Technological advances and pioneering innovations are set in motion by basic research and creative work. The discovery of the GMR effect by Nobel laureate Professor Peter Grünberg is an outstanding example of how research results can be transformed into future key technologies leading to innovative products of great economic and industrial relevance within ten to fifteen years. The Helmholtz centres in Geesthacht, Jülich and Karlsruhe are pooling their broad-based expertise and interdisciplinary potential to lay the foundation for the next generation of key technologies. A high potential for innovation has been identified at the interface between the disciplines of physics, chemistry, materials science, the life sciences and nanotechnology, which can be exploited on several levels and is strongly supported by modelling and simulation. Helmholtz-specific technology platforms cooperate closely with selected universities functioning as focal points for a broad user community made up of universities and industry. As a large-scale facility with high visibility, the petascale European Supercomputing Centre at Jülich will be firmly established as part of the German Gauss Centre for Supercomputing and as an architect of the Partnership for Advanced Computing in Europe (PRACE), and is available to all scientific research communities in Europe. The research field supports the high-tech strategy of the German federal government, particularly in the areas of bio- and nanotechnology, micro- and nanoelectronics, optical technologies, microsystems and materials technology, as well as information and communications technology. This research field sets the pace for innovation and develops these fields of the future which will secure Germany's leading position and consolidate its economic strength. Furthermore, the research field follows the recommendations of the Industry-Science Research Alliance with respect to the defined future fields, the resolution of the National Bioeconomy Council and the strategic considerations of the EU for key technologies.

PROGRAMME STRUCTURE

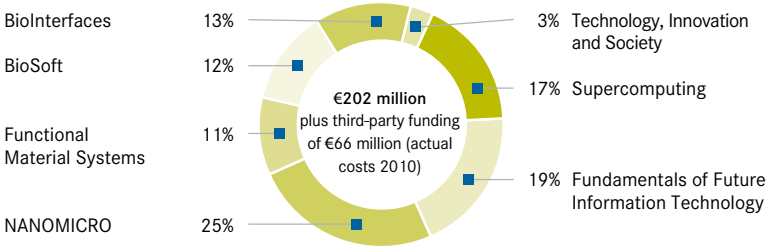
IN THE FUNDING PERIOD 2009–2013

The field of key technologies research consists of six core programmes. A seventh – Technology, Innovation and Society – is being implemented in cooperation with the field of energy research.

- Supercomputing
- Fundamentals of Future Information Technology
- NANOMICRO: Science, Technology and Systems
- Functional Material Systems
- BioSoft: Macromolecular Systems and Biological Information Processing
- BioInterfaces: Molecular and Cellular Interactions at Functional Interfaces
- Technology, Innovation and Society

The work is characterised by close cooperation with industry and by the coordination of networks linking research institutions and commercial enterprises. The research field brings together the common interests of science and industry in order to facilitate concerted action within the EU and on the international stage. The scientists involved also liaise with companies and associations, and provide

Structure of the research field Key Technologies
Target costs of core financing 2010: 202 million euros
(incl. share of non-programme-linked research)



Experts assembling the JUGENE supercomputer, which has a computational capacity of one thousand trillion operations per second (petaflop), making it one of Europe's fastest computers. Photo: Forschungszentrum Jülich

SUPERCOMPUTERS AS SCIENTIFIC TOOLS

From research conducted at the Forschungszentrums Jülich The dissemination of contaminants in the atmosphere, the development of new materials, the functionality of the brain, and improved safety measures at large events – all have been simulated by supercomputers. Alongside experimentation and theory, supercomputers have now become the third pillar of scientific research. The Forschungszentrum Jülich represents one of Europe's leading supercomputing centres and offers users from the scientific community world-class processing power. Its facilities include JUGENE, currently Germany's fastest computer, QPACE, one of the most energy-efficient computers worldwide, and JUROPA and HPC-FF, which rank among the most flexible computers in the world.
Jülich experts have the know-how to develop computers of this class, build them with partners from industry, and tap into their potential for a diverse range of questions pertaining to the great social challenges of the future. Some 300 research teams are granted access to one of the Jülich supercomputers each year. Scientists are also provided with support by the Jülich Supercomputing Centre (JSC) in the form of specifically configured simulation laboratories as well as cross-sectional groups that develop algorithms and methodologies, carry out code optimisations, and augment the performance of the users' programmes with the help of performance-analysis tools developed at the centre.

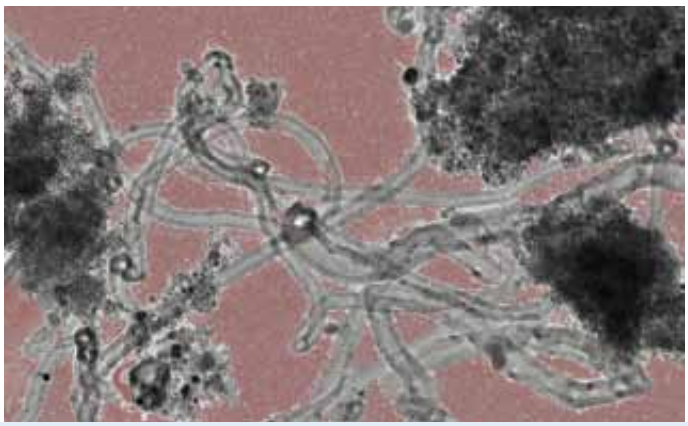
You can find related media and content at **www.helmholtz.de/en/gb11-supercomputer**

information for political decision-makers with regard to the opportunities and risks associated with new technologies. Wherever existing competencies complement each other, they are used for cross-programme collaboration. Work on key technologies also provides benefits for energy research, aeronautics, space and transport research, health research, and Earth and Environment.

PROGRAMMES
IN THE FUNDING PERIOD 2009–2013

Supercomputing

Computers that process large volumes of data and model complex systems are highly important research tools. With its focus on supercomputing and grid computing, this programme provides German science with invaluable infrastructure. At the John von Neumann Institute for Computing in Jülich and the Grid Computing Centre in Karlsruhe, experts are working to improve methods, tools and applications. Particularly in the simulation laboratories, they provide support for numerous internal and external users from various research fields and institutions. This research programme also aims to develop and operate the latest and most powerful generation of supercomputers – the JUGENE in Jülich is currently one of Europe's fastest computers. Processing the increasing amounts of data supplied by accelerators and



KIT researchers working on iron-carbon materials that are infused with carbon nanotubes (left). The goal of this research is to develop more efficient batteries. Photos: KIT.

MORE ENERGY WITH IRON AND CARBON

From research conducted at the Karlsruhe Institute of Technology (KIT) How can we pack more energy into batteries? Conventional lithium ion batteries can store around 0.2 kilowatt hours per kilogramme. By comparison, gasoline stores around nine kilowatt hours per kilogramme. Researchers at the KIT Institute of Nanotechnology have now developed a special synthetic process to produce highly efficient iron-carbon storage materials. Their aim is to increase storage density by as much as five times. In this process, which is currently the subject of a patent application, different starting materials are mixed with a lithium salt and heated to produce a completely new nanostructure that is infused with carbon wire. This new material achieves an energy density double that of conventional battery materials. Scientists are continuing to develop and investigate the process at the Ulm Helmholtz Institute for Electrochemical Energy Storage, a new research facility founded and sponsored by the KIT in collaboration with Ulm University.

You can find related media and content at **www.helmholtz.de/en/gb11-batterie**

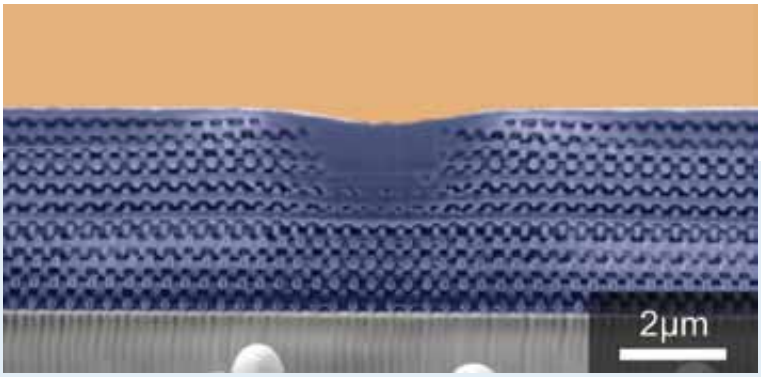
satellites poses a special challenge. The concept of grid computing, whereby computers are networked to form clusters, facilitates the analysis of increasing data volumes.

Fundamentals of Future Information Technology

According to Moore's Law, the size of the components on a chip will continue to shrink at a rapid pace. But how much smaller can these components become before losing their physical functionality? According to current knowledge, a characteristic size of 5 nanometres represents the physical limit of conventional electronics. In order to go beyond this limit, researchers will have to exploit new phenomena and develop new concepts for components. Research in this programme is therefore focused on quantum-electronic, magneto-electronic, ferroelectric, redox-switching and molecular nanostructures as well as on ultrahigh frequency electronics and bioelectrical signal processing. Within this framework, scientists are conducting basic research on materials and the processes occurring within them. They are exploring information processing in logic devices, the storage of information in both random access and mass memories, the transfer of information at the chip and system level, and the development of new sensors.

NANOMICRO: Science, Technology and Systems

While microsystem technologies are already in use in a broad range of applications, nanotechnology still requires extensive basic research. This programme focuses on the development of new functional microsystem structures made from plastics, metals and ceramics and the application potential of nanostructured materials. Researchers are developing components – often in collaboration with



Electron microscope photos of a tiny invisible cloak structure that resembles a pile of logs. In the region around the small depression, the refraction index for electromagnetic waves in the optical field changes continually. This influences light waves in such a way as to make the surface appear flat (in red light). The metamaterial made from a polymer-air mixture is coloured blue, and the areas coated with gold are yellow. Photo: CFN

REFINING THE KARLSRUHE INVISIBILITY CLOAK

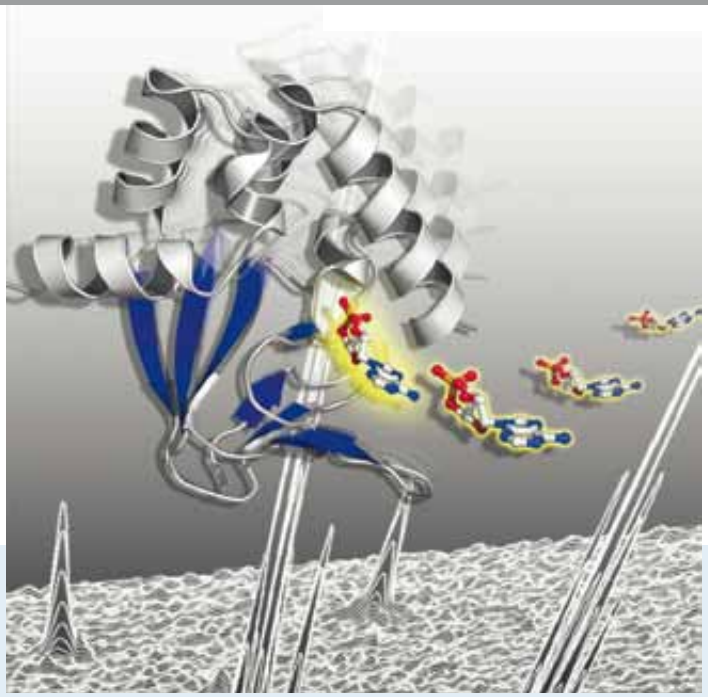
From research conducted at the Karlsruhe Institute of Technology (KIT) A material that allows us to purposefully direct light can be used to make objects invisible. This unusual property can be generated in so-called metamaterials by targeted microstructuring processes – but only for particular wavelengths of light and, until recently, only from a fixed direction of view (2D). The members of the group led by Professor Martin Wegener of the Center for Functional Nanostructures (CFN) at the KIT are international experts in this field. Last year they managed to create this invisibility cloak effect three-dimensionally at a wavelength range of 1500 to 2600 nanometres, which is no longer visible but plays a role in telecommunications. Now two members of Wegener's team, Joachim Fischer and Tolga Ergin, have refined the structure of the Karlsruhe invisibility cloak so that it can direct visible red light in the 700 nanometre wavelength range. In order to generate the required minute 3D structures in a polymer-air mixture, the KIT researchers used a process developed at the CFN known as direct laser writing, the resolution of which was improved using an "optical eraser". Metamaterials endowed with such optical characteristics have the potential to facilitate innovations in optics, solar cell development, chip production and data transmission.

You can find related media and content at » **www.helmholtz.de/en/gb11-tarnkappe**

industry – for microprocess engineering, gas analysis, microfluidics and the life sciences. Work is also being done on the development of nanomanufacturing facilities in which customised nanostructured systems can be produced on an industrial scale. Nanomaterials and nanoprocesses constitute the core of the programme, with optics and photonics representing key areas of application. An additional focus is on materials for energy storage, in particular for batteries in electrical vehicles. The broad scope of the programme, which ranges from knowledge-oriented research to application-oriented systems, allows for the direct translation of basic research into applications. The programme's central technical installations are being made available to the wider scientific community through the Karlsruhe Nano Micro Facility.

Functional Material Systems

This programme develops innovative metallic and functional polymer-based materials for use in lightweight construction for transport and energy technologies, chemical process engineering, future hydrogen technologies and medical technology. Helmholtz scientists are collaborating with national and international partners from science and industry on issues associated with alloy and polymer development and processing, as well as on the development and testing of components and processes. A recently introduced focus is the functionalisation of magnesium and titanium alloys for applications in biocompatible implants. Material characterisation and simulation processes extending from the micro level to complex components are providing the theoretical basis for the optimisation of manufacturing processes and the evaluation of the capacities of innovative



The figure shows an ion channel protein molecule that triggers the passage of ions through the membrane. The binding of the small second-messenger cAMP molecule promotes the opening of the ion channel. Graphic: Forschungszentrum Jülich/S. Schünke

INVESTIGATING HOW BIOLOGICAL PORES OPEN AND CLOSE

From research conducted at the Forschungszentrum Jülich Many diseases with a genetic basis can be traced to defective ion channels. Such disorders include cystic fibrosis, cardiac arrhythmia and certain diseases of the eye. Ion channels are protein molecules that form tiny pores in the cell membrane through which ions (e.g., K+, Ca2+, Na+ or Cl-) can flow. Ligand-gated ion channels play key roles in neuronal excitability and sensory signalling. The opening and closing behaviour of these channels is regulated by the binding of small "second-messenger" molecules to a particular part of the ion channel.
In cooperation with colleagues from Heinrich-Heine-Universität Düsseldorf and the Center of Advanced European Studies and Research in Bonn, Professor Dieter Willbold and Dr. Sven Schünke from the Forschungszentrum Jülich have now gained new insights into how the second-messenger molecule can open the ligand-gated ion channel. The scientists solved the structure of a certain part of the ion channel in atomic resolution using high-field nuclear magnetic resonance spectroscopy. Furthermore, they were able to show that the binding of the second-messenger cAMP molecule leads to major conformational changes in the protein structure and opens the channel.
The scientists used a bacterial ion channel as a model system that closely resembles channels in heart muscle cells. "What we have here is a wonderful example of the close interplay between structural biology as a key technology and the field of health research," says Willbold. A deeper understanding of the molecular processes occurring in ion channels could facilitate the rational development of drugs.

You can find related media and content at » **www.helmholtz.de/en/gb11-biopore**

lightweight structures. Building on the Helmholtz FuncHy Initiative, this programme is collaborating with the field of energy research on functional materials for the storage of hydrogen in tank systems. Areas of application include wind power stations, solar energy facilities and mobile tank systems in vehicles.

BioSoft: Macromolecular Systems and Biological Information Processing

Fascinating research areas and new technological approaches are currently emerging at the interface between physics, chemistry and biology. In the area of soft matter, the properties of macromolecules and their cooperative behaviour are being examined on length scales ranging from nano- to micrometres. The realisation that seemingly simple molecular machines can display a high degree of complexity – which applies even more to the networks of genes and proteins in living cells – has brought about fundamental change in the life sciences. The goal of this programme is thus to improve our understanding of the complex structures and mechanisms determining the behaviour of soft matter and biological systems and to facilitate the development of new materials and technologies. The programme is based on the interplay between experimental research and theory and the simulation sciences. Moreover, it offers broad interdisciplinary training for PhD students and young scientists within the framework of the International Helmholtz Research School of Biophysics and Soft Matter.

BioInterfaces: Molecular and Cellular Interactions at Functional Interfaces

The aim of the biologists, chemists, physicists, IT special-

Materials researchers at the HZG are developing titanium-based and degradable magnesium biomaterials for bone screws and other medical applications. Photo: HZG

BIOMETAL BONES

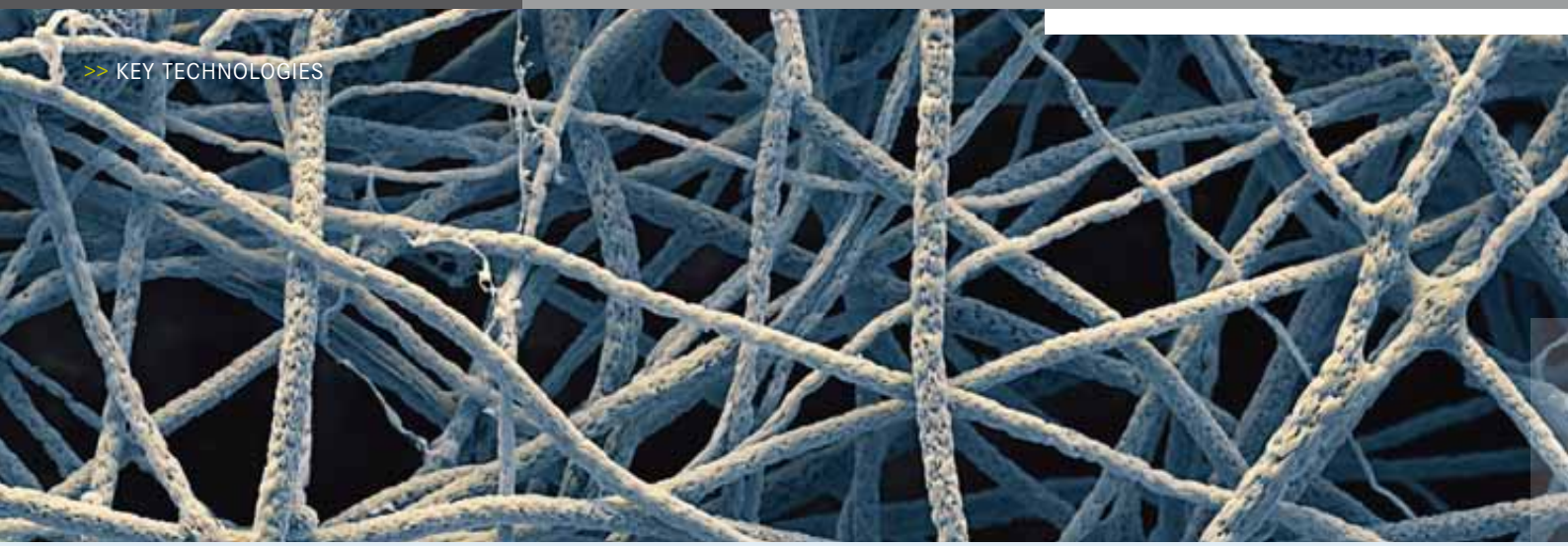
From research conducted at the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research Artificial hips, new knee joints, screws to fix broken bones – the demand for implants is growing. In order to improve the quality of life for patients by avoiding secondary operations, researchers led by Professor Karl Ulrich Kainer and Professor Regine Willumeit at the Helmholtz-Zentrum Geesthacht are developing new biomaterials that are more durable and resilient and that can be better integrated into the body. One example is a process by which the titanium used as a bone replacement is coated with lipids, improving contact with the body's cells and stimulating bone-cell growth.
Operations can be avoided through the use of biodegradable materials such as magnesium for bone screws. Magnesium dissolves quickly in salt water. In order to slow the degradation process to the required speed in the human body, chemical elements are added to the metal and the production process is adapted accordingly. Biological compatibility is always the prime concern, and new materials are therefore always tested in a specially constructed bioreactor in conditions resembling those in the human body.

You can find related media and content at » **www.helmholtz.de/en/gb11-bio-metalle**

ists, engineers and mathematicians working in the Bio-Interfaces Programme is to control living systems. Their primary focus is on the smallest living units of biological systems – not only on cells and their components but also on the interfaces between cells, the interfaces between cells and their environment, and the interfaces between molecules such as proteins in signal cascades. These interfaces constitute logical switching points that can be used to influence cell behaviour. Another focus of the programme is the control of the bacteria forming biofilms on surfaces. The scope of the programme extends from pure basic research to the development of application-oriented technologies and products for industry and medicine. The key technologies emerging here are facilitating the development of new therapies for degenerative diseases of the muscles, the retina and the central nervous system as well as the development of bioactive surfaces for implants and bioreactors.

Technology, Innovation and Society

The goal of this interdisciplinary programme is to investigate the ecological, economic, political, ethical and social aspects of new technologies in order to provide support for decision-making in politics, industry and society. In the field of key technologies, this research is focusing on the social expectations of the sciences, sustainable development, the knowledge community and its implications for decision-making processes in society as a whole. A second focus is on the opportunities and risks associated with key technologies and the factors promoting and inhibiting innovation, particularly in the areas of nanotechnology, the neurosciences, and information and communications technology.



Nanofibres like these are found in UV protective clothing. They are less than 300 nanometres in diameter, which is 1,000 times finer than a human hair. Photo: BASF press photo

ASSESSING THE CONSEQUENCES OF NANOTECHNOLOGY

From research conducted at the Karlsruhe Institute of Technology (KIT) Nanoparticles ensure that sunscreen protects the skin from UV rays and clothing repels dirt, but they have many other uses as well, ranging from microelectronics to medical applications. However, the full extent of their effects has still not been adequately investigated, and long-term damage to human health and the environment cannot be completely ruled out. Scientists at the KIT Institute for Technology Assessment and Systems Analysis (ITAS), led by Professor Michael Decker and Torsten Fleischer, are examining how researchers, policymakers, companies and members of society can best approach the opportunities and risks associated with nanotechnology and how they can enter into a constructive exchange of information and opinions. The goal of this project is to ensure that the utilisation of new technologies is based on the principle of prevention. ITAS also provides consultation on policy decisions and legislation.

You can find related media and content at **www.helmholtz.de/en/gb11-technikfolgen**

OUTLOOK

Work in the field of key technologies is oriented to both fundamental research and potential applications. Energy, health, mobility, safety and communications are all emerging as areas for which sustainable generic technologies need to be developed. For this reason research is focusing on strengthening existing programmes in the fields of materials science, the nanosciences, information and communications technology, and the life sciences. New interdisciplinary themes include technology and simulation in medicine and the sustainability of the bioeconomy, along with simulation and data management and analysis in the exascale field. Researchers are developing processes in the material sciences, physics and chemistry that will find application in the areas of energy generation, human mobility and medical therapies.

RESEARCH FIELD STRUCTURE OF MATTER

Helmholtz scientists investigate matter in all its manifestations, from its basic building blocks and fundamental forces to its more complex forms and place in the cosmological development of the universe. The scope of their activities ranges from pure knowledge-oriented research to projects geared towards concrete applications and the development of technologies. In the process researchers develop and operate research equipment and large-scale facilities that are often unique in the world, including accelerator-based super microscopes, telescopes and detectors. This infrastructure is made available to university and non-university research institutes both within Germany and abroad. Research into the structure of matter will increase the fundamental knowledge essential to develop the technologies of tomorrow in all areas of our society. It will cover new concepts for accelerators and detectors as well as the storage and analysis of large data volumes. This research field will have a significant impact on all the other areas of research at the Helmholtz Association. It will seek not only to develop strategic collaborations with universities but – as a hub of expertise – to remain open to national and international partners and industry.

Research into the structure of matter is represented in the Senate of the Helmholtz Association by the senate members Professor Vera Lüth and Professor Robert Rosner.

PROFESSOR ROBERT ROSNER
Member of the Helmholtz Association Senate,
University of Chicago, US

PROFESSOR VERA LÜTH
Member of the Helmholtz Association Senate,
SLAC National Accelerator Laboratory, Stanford, US

RESEARCH FILED STRUCTURE OF MATTER

PROFESSOR HORST STÖCKER
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Structure of Matter,
GSI Helmholtz Centre for Heavy Ion Research

GOALS AND CHALLENGES

Helmholtz research on the structure of matter explores the constituent parts of matter and the forces operating between them at very different orders of magnitude, from elementary particles to the largest structures in the universe. The work focuses not only on individual particles, but also on complex phenomena in solids and liquids resulting from interactions between myriad atoms. The insights gained from basic research facilitate the development of new materials with tailored electronic, mechanical and thermal properties.

This research field benefits from a particular strength of the Helmholtz research centres: the operation and utilisation of large-scale research facilities and complex infrastructure. The Helmholtz Association offers a range of large scientific facilities that in many cases are unique in the world, including particle accelerators and synchrotron-radiation, neutron and ion sources. These facilities are used by researchers both within Germany and abroad. With the planned European X-ray laser XFEL, which the Deutsches Elektronen-Synchrotron DESY is building in cooperation with European partners, an X-ray source will go into operation that has a maximum brilliance ten billion times greater than that of all previously built devices.

An additional large-scale research facility is being built with international partners at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. The Facility for Antiproton and Ion Research (FAIR) is a next-generation accelerator that will provide ion and antiproton beams of a previously unattained intensity and very high energies.

An important goal is the extension of the network we have established with universities and Max Planck institutes. Over the past few years, the Helmholtz alliances “Physics at the Terascale” and “Extreme Densities and Temperatures – Cosmic Matter in the Laboratory“ have made a decisive contribution to achieving this goal and have significantly improved the coordination of the German groups involved. Our own research has been significantly strengthened by the recently established Helmholtz institutes in Mainz and, in particular, in Jena, both of which have provided additional expertise in areas that include accelerator-relevant laser technologies and precision X-ray spectroscopy methods.

Our close ties with universities and research centres in Germany and abroad via the CFEL, KNMF, NanoLab, EMSC and CSSB research platforms will be further intensified. Research into the structure of matter is integrated into national and international roadmaps that delineate the focus of work within the individual programmes over a timeframe of ten to fifteen years. This basic research will provide an impetus for a multitude of technological developments.

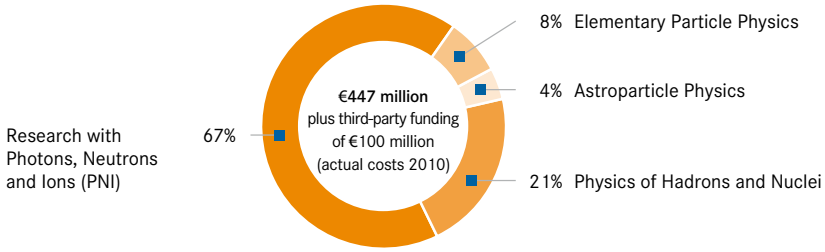
PROGRAMME STRUCTURE
IN THE FUNDING PERIOD 2009–2013

Seven Helmholtz centres work together on research into the structure of matter: the Deutsches Elektronen-Synchrotron DESY, the Forschungszentrum Jülich, the Karlsruhe Institute of Technology (KIT), the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, the GSI Helmholtz Centre for Heavy Ion Research, the Helmholtz-Zentrum Berlin für Materialien und Energie, and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). Since the second programme period began in 2010, scientists investigating the structure of matter have been working in four programmes, as the “Condensed Matter Programme” was transferred to the field of key technologies. These four programmes are:

- Elementary Particle Physics
- Astroparticle Physics
- Physics of Hadrons and Nuclei
- Research with Photons, Neutrons and Ions (PNI)

All programmes are based on the close interaction between theory and experimentation, and some have scientific and technological links. The programmes aim to continually develop research infrastructure, deploy it efficiently and provide optimal support for users in an effort to strengthen the leading role of Helmholtz scientists in this field through work with national and international partners.

Structure of research field Structure of Matter
Target costs of core financing 2010: 447 million euros*
(incl. share of non-programme-linked research)



*Plus 9 million euros for the Helmholtz Institute Mainz and the Helmholtz Institute Jena

GOLDEN RATIO IN THE NANOWORLD

Many natural forms are based on the principle of the golden ratio, a particular harmonic relationship between numbers, lines or surfaces. One example is the spiral form of the nautilus shell. Photo: iStock/P. Cardamone

From research conducted at the Helmholtz-Zentrum Berlin für Materialien und Energie Working with British colleagues in 2010, Helmholtz researchers led by Professor Alan Tennant discovered hidden symmetry properties that correspond to the golden ratio when studying a magnetic crystal. This proportional relationship of 1 to 1.618 has been regarded as an aesthetic ideal ever since antiquity. The material investigated by the research team was cobalt niobate, which has particular magnetic properties. The electron spins align to form chains, which function in concert like a thin bar magnet. However, this chain is only one atom thick. When a magnetic field is positioned perpendicular to the spin chain, the latter behaves like a guitar string, albeit on a nanolevel, explains Dr. Radu Coldea of Oxford University: "The vibration of the string is analogous to the interaction of neighbouring spin chains." As in the case of a guitar string, this process generates resonances, and the proportional relationship between the first two resonance frequencies corresponds to the golden ratio.

You can find related media and content at
» **www.helmholtz.de/en/gb11-nanowelt**

PROGRAMMES
IN THE FUNDING PERIOD 2009–2013

Elementary Particle Physics

This programme focuses on the smallest building blocks of matter and the forces operating between them. The insights this work provides have direct consequences for our understanding of the early evolution of the universe. The origin of mass, the unification of all the fundamental forces at extremely high energies, as well as the reconciliation of quantum physics with the general theory of relativity, rank among the basic questions of physics. Research in this field also aims to identify new particles and find the supersymmetry partners of all currently known particles.

In recent years the programme has increased its involvement in the two LHC experiments ATLAS and CMS in order to continue to ensure the international competitiveness of German particle physics. The experimental activities at the LHC have been supported by the further expansion of the Grid Computing Centre Karlsruhe (GridKa) at KIT and by the Tier-2 facilities and analysis centre at DESY. At the same time, work is underway to complete the precision analyses of the HERA experiments, the results of which are also highly significant for the LHC analyses. DESY is playing a leading international role in the ongoing development of superconducting accelerator technology, and developments in the detector field are also continuing. Theoretical investigations are closely tied to experimental activities and provide an interface to particle/astroparticle physics and string theory. In close collaboration with the John von Neumann Institute at the Forschungszentrum Jülich, the DESY centre in Zeuthen is continuing its work in the field of lattice gauge theory, including research and development of new kinds of processors. As a result of the programme review, resources will continue to be provided for the Helmholtz

Checking the sensors one last time before they are lowered into the ice. Photo: DESY

ICECUBE AT THE SOUTH POLE

From research conducted at the Deutsches Elektronen-Synchrotron DESY Deep beneath the US-run Amundsen-Scott South Pole Station, an international team has installed highly sensitive light sensors in almost one cubic kilometre of ice. The sensors are designed to measure the feeble blue light flashes caused by reactions of high-energy neutrinos. The search for these "ghost particles" is particularly difficult because neutrinos barely interact with the materials they pass through.
The installation of the "IceCube" neutrino telescope took six years and was completed in December 2010. IceCube is around 30 times more sensitive than its predecessor, AMANDA, and offers the first real prospects of detecting high-energy neutrinos from distant galaxies and gathering information about supernovas and other cosmic phenomena. A quarter of the more than 5,000 optical sensors were provided by German research groups and assembled and tested at the DESY centre in Zeuthen. The project is run by an international consortium led by the US National Science Foundation (NSF).

You can find related media and content at » **www.helmholtz.de/en/gb11-icecube**

Association's activities in the highly successful "Physics at the Terascale" alliance.

Astroparticle Physics

Astroparticle physics combines the study of the smallest building blocks of matter with the exploration of the largest structures of the universe. Astroparticle physicists study the sources of cosmic radiation and the mechanisms of cosmic accelerators. At the same time, the researchers working in this programme investigate so-called dark matter, the presence of which has so far only been inferred from its gravitational effects. Astroparticle physics has developed into an independent field in Germany and in many areas of research Germany is now a world leader.
Key aspects of this programme include the continued involvement with the Pierre Auger Observatory and the IceCube project. The Pierre Auger collaboration is planning to extend its coverage to include the entire sky, and accompanying research is underway in Karlsruhe on the radio detection of air showers. The IceCube neutrino telescope has now been completed and is certain to produce a wealth of results in the next programme period. In this connection, DESY is also planning to contribute to preparatory work on the Cerenkov Telescope Array. The search for dark matter is becoming increasingly important as a result of new astronomical studies and will be expanded within the framework of the European EURECA project, in which KIT is playing a leading role. Also connected with these endeavours is the ongoing work on so-called multi-messenger analysis, which seeks to combine information from several celestial sources. During the current programme period, the KATRIN experiment will conduct the world's most sensitive measurements of the mass of the neutrino.

The TPC (Time Projection Chamber) is the component in ALICE that delivers the most data, producing extremely precise measurements of the traces of the generated particles. Peter Glässel, the technical coordinator of ALICE, is pictured here in the centre of the TPC. Photo: CERN

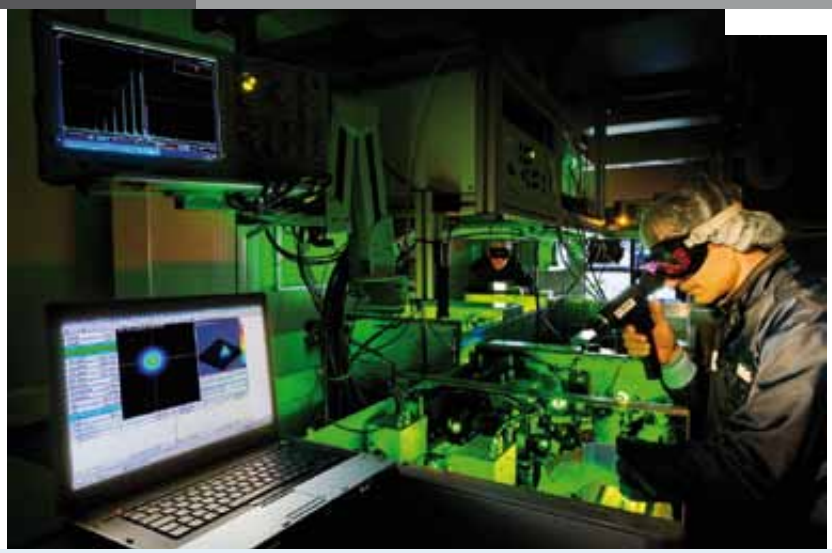
COSMIC PRIMEVAL SOUP IN GENEVA

From research conducted at the GSI Helmholtz Centre for Heavy Ion Research The Large Hadron Collider (LHC) has been in operation in Geneva since spring 2010. Although it is mostly used to accelerate protons, in late 2010 physicists filled it with lead ions to generate a quark-gluon plasma – an extremely hot state of matter that resembles conditions directly after the Big Bang. The LHC is able to "re-cook" this primeval soup. The lead collisions were monitored by the ALICE detector, for which the GSI Helmholtz Centre for Heavy Ion Research helped develop two core components.
ALICE was able to show that primeval soup is hotter and thicker than expected, with temperatures 100,000 times higher than those inside the sun and pressures greater than those inside a neutron star. In addition, the plasma behaves like an ideal liquid in the sense that it exhibits no interior friction. Two new measurements are planned for the end of 2011 and physicists are hoping they will provide clues about the evolution of the universe, since the behaviour of the primeval soup may well have played a decisive role in the universe's subsequent development.

You can find related media and content at **www.helmholtz.de/en/gb11-alice**

Physics of Hadrons and Nuclei

Hadrons – which include the atomic nuclear components protons and neutrons – are made up of quarks bound together by strong interaction. In this programme, researchers are addressing such questions as how the quark matter existing at the beginning of the universe was transformed into the matter making up our world, which consists of hadrons, atomic nuclei and atoms. They are also investigating how this matter provided the basis for the formation of the chemical elements inside stars and examining the limits of nuclear stability. An important part of their work is the synthesis of new "superheavy" elements, an area in which the GSI has achieved significant successes.
The focus for the new programme period is on the international project to construct the Facility for Antiproton and Ion Research (FAIR) at the GSI, with Helmholtz researchers playing a leading role. This accelerator complex will be the only one of its kind in the world and is being built by the GSI and the Forschungszentrum Jülich together with national and international partners. It will go into operation in 2017/2018. In addition to building FAIR, both centres are implementing a targeted experimentation programme at the existing facilities UNILAC/SIS 18 and COSY.
Together with German universities, the GSI is driving forward the development and utilisation of the ALICE detector as part of the LHC heavy ion programme at CERN.
The GSI also operates a powerful Tier-2 centre for ALICE.
Experimental activities are accompanied and supported by a strong theoretical programme with a special focus on ALICE and FAIR. Since 2008, the interdisciplinary alliance "Extreme Densities and Temperatures: Cosmic Matter in the Laboratory" has addressed questions revolving around



Physicists use the DRACO high-power laser at the HZDR to accelerate protons with laser light. Photo: HZDR

ION BEAMS TO COMBAT CANCER

From research conducted at the GSI Helmholtz Centre for Heavy Ion Research and the Helmholtz-Zentrum Dresden-Rossendorf The GSI has played a leading role in the development of carbon ion therapies for tumours. A team led by Professor Gerhard Kraft discovered that charged carbon atoms can be controlled so precisely that they can penetrate tissue with little damage to the surrounding area and release their energy within the targeted tumour. The GSI experts have helped construct a customised acceleration facility for tumour treatments at the Heidelberg Ion-Beam Therapy Center (HIT), where 1,300 patients can be treated annually.
However, this kind of therapy still relies on a ring accelerator with a diameter of 20 metres and a weight of several hundred tonnes in order to generate the required ion beam. Scientists at the Helmholtz-Zentrum Dresden-Rossendorf, led by Professor Ulrich Schramm, are now investigating the possibility of accelerating protons with the help of high-power lasers. Their aim is to develop a process in which ultra-short light impulses shoot particles out of a wafer-thin foil. Using the DRACO high-power laser, the team irradiated the first cancer cells with laser-accelerated protons and examined the biological impact of the protons. “We estimate that it will take around eight years to develop a prototype,” says Schramm.

You can find related media and content at » **www.helmholtz.de/en/gb11-ionenstrahlen**

the theme of matter under extreme conditions such as those prevailing at the beginning of the universe and inside stellar plasmas.

Research with Photons, Neutrons and Ions (PNI)

This programme is focused on ensuring the effective utilisation of existing photon, neutron and ion sources and continually adapting them to the needs of the user community. With the new emphasis on in-house research, the programme is undertaking the first cross-centre efforts to strengthen this form of research at large-scale PNI facilities. It is also improving the conditions for qualified user support and the further development of the scientific instrumentation at large-scale facilities. With regard to photon sources, particularly noteworthy aspects of the work in this programme include the leading role played by Helmholtz researchers in the European X-ray laser project XFEL based at DESY and the expansion of the Centre for Free Electron Laser Studies (CFEL) in collaboration with the Max Planck Society and the University of Hamburg as a basis for German use of the XFEL. The successful launch of PETRA III as the world’s most brilliant radiation source for hard X-rays and the further development of the FLASH laser also represent important successes. Following the shutdown of the Geesthacht neutron reactor, the HZG has now established the Centre for Structure and Dynamics of Condensed Matter on the Nanoscale and the Engineering Materials Science Center at DESY. In the case of BESSY II, efforts are focused on the “2007 Plus” expansion programme with a particular emphasis on microscopy in the terahertz range through to X-ray radiation and the generation and application of short X-ray pulses with selectable

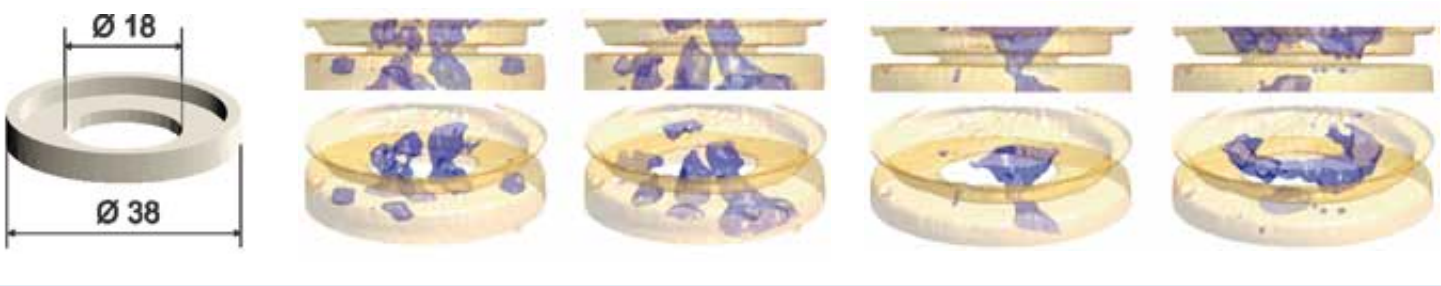
One of the fourteen measurement stations connected to the PETRA III X-ray source, used to decipher the molecular mechanisms of certain pathogens.Photo: DESY

X-RAY MAGNIFYING GLASS FOR TUBERCULOSIS PATHOGEN

From research conducted at the Deutsches Elektronen-Synchrotron (DESY) Today, methods derived from physics are standard tools in biology and medicine. One important procedure that falls into this category involves the use of X-rays to irradiate protein crystals and decipher the crystals' structure and functionality. The data collected in this way allows scientists to unravel the molecular mechanisms behind the development of diseases such as tuberculosis. One of the world's best X-ray sources is located at the Helmholtz Association's DESY research centre in Hamburg. The PETRA III facility has been supplying extremely short and powerful X-ray flashes since 2010, and three of its fourteen measuring stations are operated by the European Molecular Biology Laboratory (EMBL). Deciphering the protein structures of the tuberculosis bacterium will allow scientists to identify potential points of attack for future medication. Researchers will soon have the opportunity to intensify their efforts in a new interdisciplinary facility on the DESY campus: the Centre for Structural Systems Biology (CSSB).

You can find related media and content at **www.helmholtz.de/en/gb11-roentgenlupe**

polarisation. In combination with the infrastructure available at KIT, ANKA continues to be expanded as a user facility for special applications. In collaboration with Helmholtz health researchers, members of this programme are setting up a Centre for Structural Systems Biology at DESY in order to take advantage of the synchrotron sources there for the analysis of biological structures.
In the field of research with neutrons, the focus will be on the two national sources BER II and FRM II. In the current programme period, the three Helmholtz centres Forschungszentrum Jülich, HZG and HZB are building and operating further instruments at the FRM II. With regard to the BER II, which is operated at the HZB using the extreme sample environments available there, the first expansion stage (25T) of the high field magnet will soon go into operation. An upgrade of the cold source and upgrades of a selection of instruments and neutron guides are also imminent. On an international level, the Jülich Centre for Neutron Science (JCNS) is working with the Spallation Neutron Source (SNS) in Oak Ridge and the Laue-Langevin Institute (ILL). In addition, the three neutron centres are formulating concepts for the European Spallation Neutron Source (ESS) and its instrumentation.
Large-scale facilities for ion research in the PNI programme are available only at the GSI and offer unique possibilities for research in the fields of nuclear physics, plasma physics and materials research. The FAIR project is creating extremely promising prospects for research with ions.
In addition, the programme has helped launch an interdisciplinary initiative for data processing and analysis using the large-scale PNI facilities.



Ultrafast 3D X-ray computed tomography allows researchers to visualise the highly dynamic processes in multi-phase flows. The snapshots show a liquid with gas bubbles passing through an orifice. Some of the bubbles are accelerated and deformed in the process, while others are blocked by the obstacle. Graphic: HZDR/M. Bieberle

THREE-DIMENSIONAL FLOW IMAGES

From research conducted at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) In many technical facilities used in the chemical and energy industries, mixtures of liquids and gases flow through pipes. The behaviour of such multiphase flows is particularly complex, which makes it difficult to predict the heat and mass transfer and the mechanical loads on container walls. Dr. Martina Bieberle and her colleagues at the HZDR have developed a procedure to monitor these processes using three-dimensional imaging with a high temporal resolution. The ultrafast three-dimensional X-ray tomography is based on the rapid deflection of an electron beam, which generates an X-ray source that is flexible in three dimensions. Up to 500 volume images per second allow researchers to document complex bubble structures and their dynamics inside the metal pipes. The images provide unique insight into the behaviour of complex flows and are contributing to improvements in models and simulations. “This procedure could increase the efficiency of several processes because it allows us to predict the behaviour of multi-phase flows more accurately,” explains Martina Bieberle.

You can find related media and content at **» www.helmholtz.de/en/gb11-3d-stroemungsbilder**

OUTLOOK

Preparations are currently underway to reorganise research into the structure of matter into three programmes. This process is set to be implemented in the third period of programme-oriented funding. All disciplines related to basic research – particle and astroparticle physics, physics of hadrons and nuclei, and atomic and plasma physics – will be combined in the “Matter and the Universe” programme. Its researchers will form the backbone of German participation in large-scale international facilities used to investigate the origin and development of our universe and matter. In the second programme, “From Matter to Materials and Life”, the operators of modern radiation sources will work closely with an international user community from the natural sciences, engineering and medicine. Goals include the development of new materials and active substances and the decoding of new phenomena in condensed matter, electromagnetic plasmas and biological systems. The third programme, “Matter and Technologies”, will focus on new technological concepts for fields such as particle acceleration, detector systems and the optimisation of high-performance computing and data storage. The aim of the new programme structure is to more closely link scientific and technological research areas in order to generate additional synergies. Furthermore, on the basis of new research results, the new structure will increase the potential for developing enabling technologies for tomorrow’s world and beyond.

THE HELMHOLTZ ASSOCIATION IN FACTS AND FIGURES

The period under review saw an extremely positive development of performance indicators and resources. Due, in particular, to the 5 percent growth in funding from the Joint Initiative, the incorporation of the Helmholtz-Zentrum Dresden-Rossendorf into the Helmholtz Association, and the provision of additional funds to establish the German Centres of Health Research, total funding from the federal government and federal states increased by 8 percent to 2,203 million euros in the period from 2010 to 2011. In addition, the German Parliament approved a total of 36 W3 positions, which were urgently needed to carry out the additional activities. The positive development of all the performance indicators – discussed in detail in the *Pakt-Monitoring-Bericht 2011* (available in German at www.helmholtz.de/paktmonitoring) – demonstrates that the association has used its funding efficiently and successfully when implementing its research programmes.

DR. ROLF ZETTL
Managing Director,
Helmholtz Head Office

PERFORMANCE RECORD

During the 2010 reporting period, the Helmholtz Association implemented important measures to increase the quality, efficiency and capacities of its research activities. It not only launched and carried out numerous new projects, but, as in years past, experienced a period of solid growth that is reflected in the relevant performance indicators. The figures for the 2010 reporting period are based on data from the 16 centres that were members in 2010.

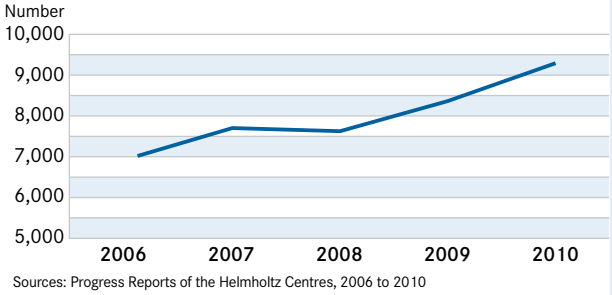
In 2010, the 16* Helmholtz centres received 2,038 million euros in funding from the federal government and federal states. In 2011, funding will amount to 2,203 million euros, representing an increase of 8 percent over fiscal 2010. In addition to institutional funding, in 2010 the research centres raised 1,031 million euros in third-party funds. As regards the third-party funding acquired through collaborations with industry, the association was particularly successful in the field of application-oriented research. This success can be taken as a clear sign of the attractiveness of Helmholtz research for industrial partners. In the area of basic research, a growing amount of funding has been acquired in competitions organised by the funding programmes of entities such as the EU, the German Research Foundation (DFG), and federal and regional ministries.
The Helmholtz Association's mission is to conduct high-level research that contributes to solving the major challenges and pressing problems of our day. To ensure that this mission is optimally fulfilled, the association has embraced scientific competition. Internally, this competition informs programme-oriented funding, the financing of investments in strategic expansion, and the instruments of the Initiative and Networking Fund. The scientific performance indicators compiled in the context of programme-oriented funding represent selected aspects of research that are characteristic of the association's work.

SCIENTIFIC PERFORMANCE

Publications

- In 2010, 9,285 publications appeared in ISI-indexed scientific journals and a further 2,285 refereed publications appeared in other outlets.
- The number of ISI-indexed publications increased by 11 percent over the previous year. The total increase over the past five years has been 32 percent.

ISI-indexed publications

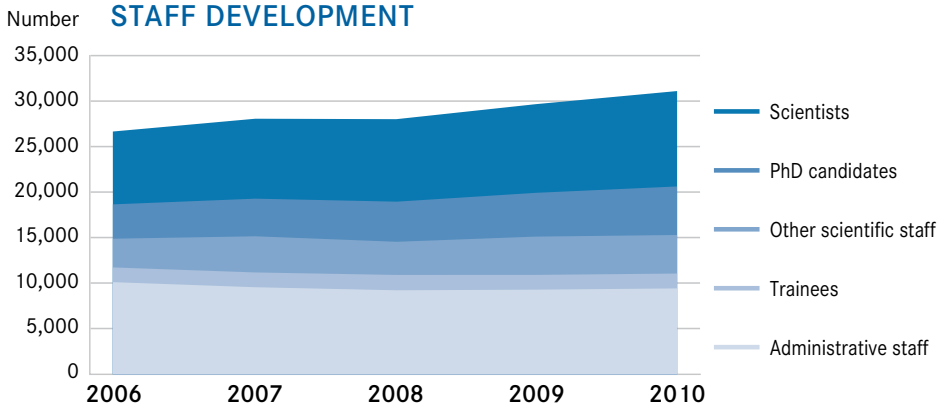


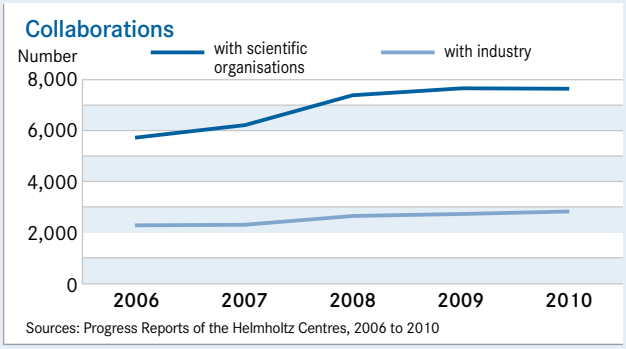
Sources: Progress Reports of the Helmholtz Centres, 2006 to 2010

Collaborations

- In 2010, the Helmholtz centres participated in 7,643 research collaborations.
- Between 2006 and 2010, the number of collaborations increased by a total of 30 percent, or at an annual rate of 7 percent. Collaborations with other scientific organisations rose by 33 percent (an average annual rate of 8 percent), and with industry by 21 percent (an average annual rate of 5 percent).

*The Helmholtz Association currently (2011) has 17 members, and an 18th is set to join in 2012. The new addition in 2011 was the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), and in 2012 the association will be joined by the Helmholtz Centre for Ocean Research Kiel (GEOMAR). The expenses incurred by the HZDR will be reported in the Annual Report 2012.

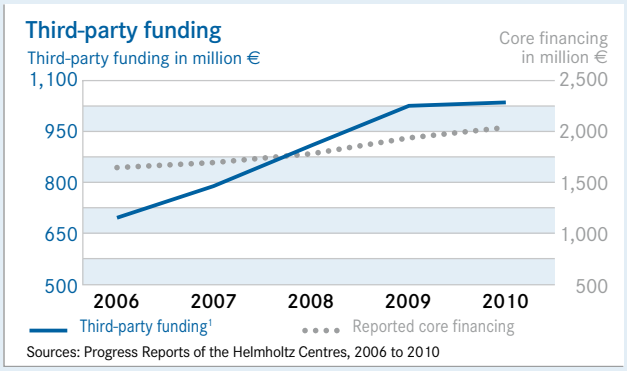




- In 2010, 248 research projects took part in the coordinated funding programmes of the German Research Foundation (DFG), compared to 226 for 2009.
- As of 31 December 2010, 319 Helmholtz scientists held W2 or W3 professorships at universities, an increase of 22 percent over the previous year.

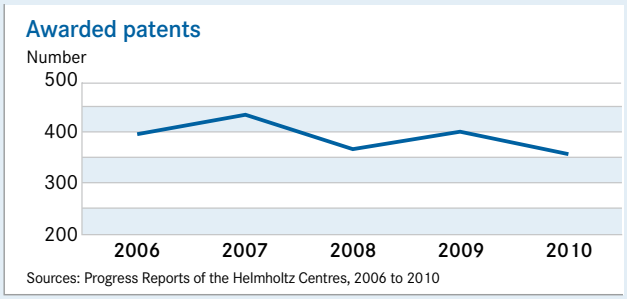
Third-party funding

- As in the previous year, the Helmholtz Association received over 113 million euros in EU funding in 2010, securing a leading position amongst German scientific organisations.
- In 2010, the association raised third-party funds of 1,031 million euros, representing an increase of 1 percent over 2009, when it acquired 1,025 million euros in funding.
- Over the past five years, third-party funding has grown by 48 percent, or at an average annual rate of 10 percent.



Technology transfer

- A total of 365 patents were awarded in the 2010 reporting period. In the preceding years, around 400 new patents were awarded on an annual basis.



- Over the last five years, the Helmholtz Association has launched 48 start-ups, including 12 in 2010, which have given it an edge in a competitive environment.

STAFF

Scientific staff

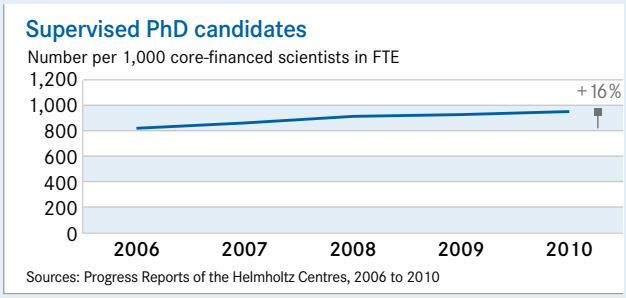
In 2010 the Helmholtz Association had a total of 30,995 employees (2009: 29,556), of whom 10,458 were scientists (2009: 9,718), 5,320 were supervised PhD candidates (2009: 4,797) and 1,627 were trainees (2009: 1,618). A total of 13,590 employees (2009: 13,423) worked in the technical and administrative fields.

Equal opportunity

The share of female scientists rose to 24 percent from 23 percent in 2009; the percentage of young female scientists stood at 38 percent (2009: 37 percent). The proportion of women working in research management has also continued to grow at both the institutional and departmental levels. All told, the share of women currently holding managerial positions in research, administrative and technical fields stands at 19 percent, representing an 11 percent increase over the previous year.

Young scientists

- In 2010, 5,320 PhD candidates completed dissertations at the Helmholtz centres, supervised by scientific staff. This marks an 11 percent increase over the 4,797 dissertations written in 2009. Over the past five years, the number of written dissertations has grown by 41 percent, or at an average annual rate of 9 percent.
- The ratio of core-financed scientists to PhD students is approximately 1 to 1. This ratio has increased by 16 percent over the past five years.



- A total of 1,638 post-doctoral candidates worked at the Helmholtz Association in 2010. Over the past five years, this number has increased by 14 percent, or at an average annual rate of 4 percent.
- In 2010, twelve Helmholtz scientists were awarded junior professorships.
- Helmholtz centres currently work together with 49 DFG graduate schools. The high level of involvement of the previous years was not only maintained but in fact increased by 2 percent.
- Helmholtz centres are currently participating in 65 “Marie Curie Actions” in the EU’s programme to promote young scientists. During the past five years there has been a 5 percent annual increase in the number of these funding measures.
- Over the past five years, the number of Helmholtz Young Investigators’ Groups has increased from 132 to 156.
- In 2010, the Helmholtz Association provided occupational training for 1,627 trainees. The trainee-staff ratio was 6.3 percent.
- With its 25 School Labs and the “Little Scientists’ House” initiative, which reaches a network of more than 18,000 day-care centres, the Helmholtz Association is ensuring long-term support for young researchers.

International exchange at the Helmholtz Association

The large number of guests who came to the research centres in 2009 to exchange scientific ideas and work in our research facilities demonstrates the appeal that the centres continue to hold for the international research community. Around 5,800 scientists from around the world made use of the research opportunities provided by the Helmholtz Centres – a 27 percent increase over the previous year.

PROGRAMME-ORIENTED FUNDING

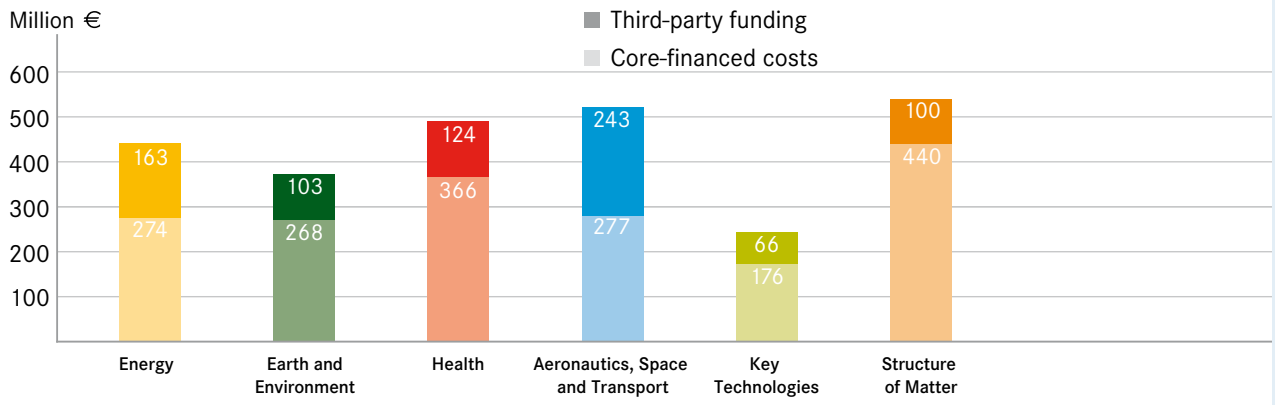
Programme-oriented funding

The Helmholtz Association is committed to the ongoing process of scientific competition. Its programme-oriented funding – the principle governing the way it finances its research – is consistent with this commitment. The core concept behind programme-oriented funding is the provision of financing on the basis of strategic reviews. The fact that funding is oriented to actual research programmes makes it possible for scientists to enter into collaborations that go beyond the boundaries of individual institutions and disciplines. At the same time, our programme-oriented funding promotes competition for funding among the 16 research centres (as of 2010) and our individual programmes. Programmes are financed over a period of five years, with the level of funding based on the results of strategic reviews. This approach helps to make costs and staff capacities within the Helmholtz Association more transparent.

Promoting new approaches to research

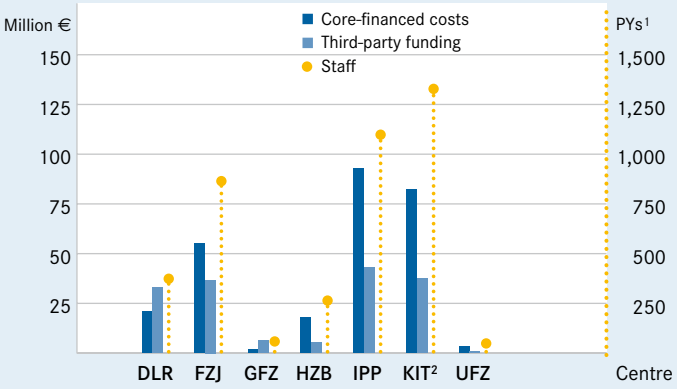
Additional funding for so-called non-programme-linked research is made available to Helmholtz centres so that they can address new scientific questions, pursue new research approaches, expand know-how and prepare for significant strategic projects. The level of this funding is tied to the success of the centres in the review process and amounts to 20 percent of the total programme funding acquired. If centres choose to use this funding to advance innovative approaches within existing research programmes, it is calculated as part of the cost of the respective programme. If centres use these resources to initiate new projects and develop new thematic fields, they are reported separately as costs of non-programme-linked research.

Costs financed by core and third-party funding in the individual research fields, 2010
(incl. funding for non-programme-linked research used to advance existing research programmes)

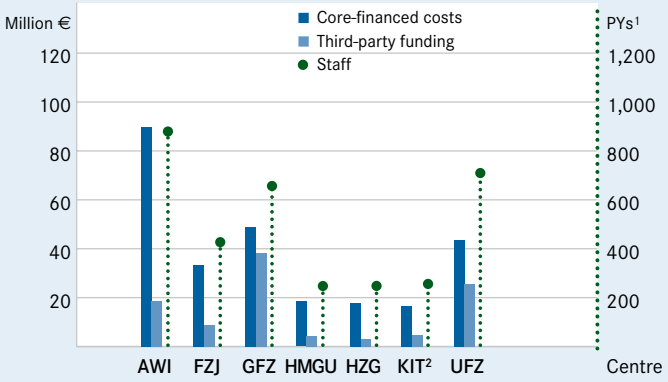


COSTS AND STAFF 2010

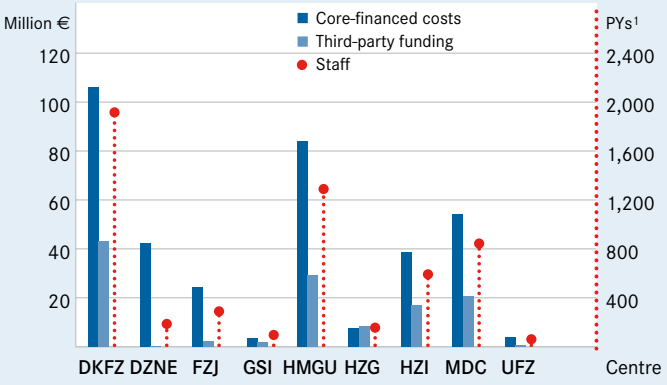
Research Field Energy



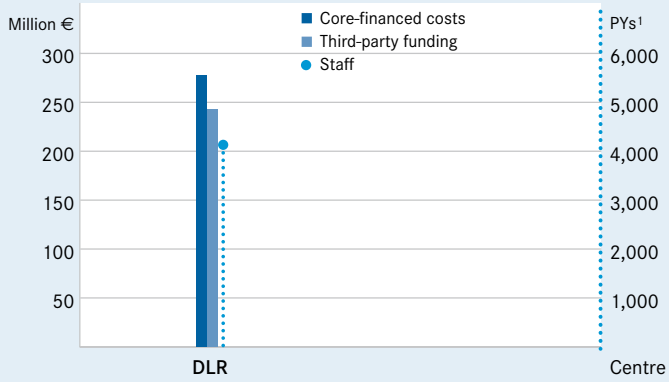
Research Field Earth and Environment



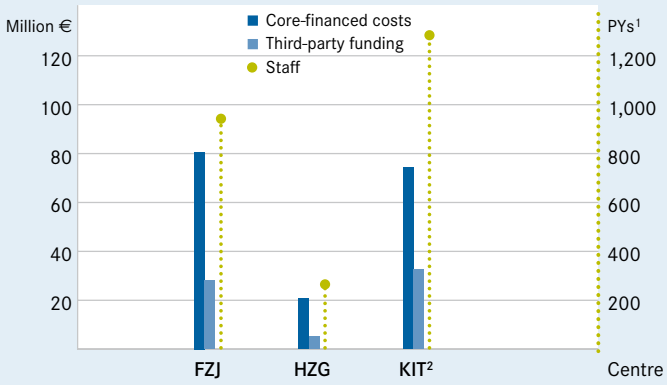
Research Field Health



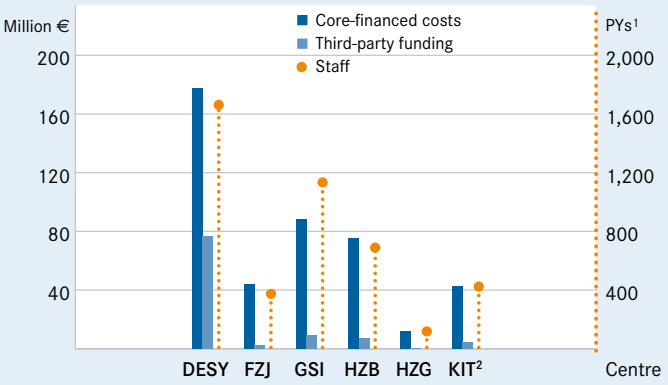
Research Field Aeronautics, Space and Transport



Research Field Key Technologies



Research Field Structure of Matter



[1]Person-years (full-time equivalents); [2] Share of the KIT Division of Large-Scale Research.

COSTS AND STAFF 2010
for the Helmholtz Association, overview

	Actual costs Core-financed costs T€ [1]	Actual costs Third-party funding T€	Actual costs Total costs T€	Staff Total staff PYs [1]
Research fields, total	1,801,339	797,987	2,599,326	23,689
Non-programme-linked research, total[2]	42,553	227,953	270,506	839
Special tasks, total[3]	17,571	4,848	22,419	1,924
Helmholtz Association, total	**1,861,463** [5]	**1,030,788**	**2,892,251**	**26,452** [4]

[1] Person-years (full-time equivalents). [2] The funds for non-programme-linked research amount to up to 20 percent of all acquired programme funding. If the centres use these funds to strengthen existing research programmes, they are allocated directly to the costs of the respective programme. [3] Mainly involving the dismantling of nuclear facilities. [4] Expressed as natural persons, the Helmholtz Association has 30,995 employees. [5] Total costs amount to 1,886 million euros including the Helmholtz institutes and the German Centres of Health Research.

Research Field Energy	Core-financed costs T€	Third-party funds T€	Total costs T€	Total staff PYs [1]
German Aerospace Center (DLR)	20,761	33,068	53,829	368
Forschungszentrum Jülich (FZJ)	55,090	36,828	91,918	860
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	17,845	5,256	23,101	258
Helmholtz Centre for Environmental Research (UFZ)	3,295	742	4,037	42
Helmholtz Centre Potsdam (GFZ)	1,639	6,421	8,060	52
Karlsruhe Institute of Technology (KIT)[6]	82,407	37,579	119,986	1,325
Max Planck Institute for Plasma Physics (IPP)	92,928	42,999	135,927	1,094
Research Field Energy, total	**273,965**	**162,893**	**436,858**	**3,999**
Research Field Earth and Environment				
Alfred Wegener Institute for Polar and Marine Research (AWI)	89,757	18,501	108,258	875
Forschungszentrum Jülich (FZJ)	33,189	8,910	42,099	422
Helmholtz Centre for Environmental Research (UFZ)	43,715	25,537	69,252	705
Helmholtz Zentrum Geesthacht (HZG)	17,958	2,954	20,912	243
Helmholtz Zentrum München (HMGU)	18,365	4,414	22,779	242
Helmholtz Centre Potsdam (GFZ)	48,993	38,345	87,338	652
Karlsruhe Institute of Technology (KIT)[6]	16,378	4,730	21,108	251
Research Field Earth and Environment, total	**268,355**	**103,391**	**371,746**	**3,390**
Research Field Health[7]				
German Cancer Research Center (DKFZ)	106,375	43,150	149,525	1,913
German Centre for Neurodegenerative Diseases (DZNE)	42,543	230	42,773	176
Forschungszentrum Jülich (FZJ)	24,453	2,265	26,718	278
GSI Helmholtz Centre for Heavy Ion Research (GSI)	3,604	1,757	5,361	85
Helmholtz Centre for Infection Research (HZI)	38,845	17,037	55,882	605
Helmholtz Centre for Environmental Research (UFZ)	4,012	760	4,772	50
Helmholtz Zentrum Geesthacht (HZG)	7,578	8,402	15,980	145
Helmholtz Zentrum München (HMGU)	84,232	29,209	113,441	1,279
Max Delbrück Center for Molecular Medicine (MDC)	54,222	20,821	75,043	836
Research Field Health, total	**365,864**	**123,631**	**489,495**	**5,367**
Research Field Aeronautics, Space and Transport				
German Aerospace Center (DLR)	277,279	242,531	519,810	4,108
Research Field Aeronautics, Space and Transport, total	**277,279**	**242,531**	**519,810**	**4,108**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	80,708	28,157	108,865	938
Helmholtz Zentrum Geesthacht (HZG)	20,821	5,057	25,878	260
Karlsruhe Institute of Technology (KIT)[6]	74,215	32,650	106,865	1,280
Research Field Key Technologies, total	**175,744**	**65,864**	**241,608**	**2,478**
Research Field Structure of Matter[8]				
Deutsches Elektronen-Synchrotron (DESY)	177,432	76,611	254,043	1,653
Forschungszentrum Jülich (FZJ)	44,300	2,088	46,388	365
GSI Helmholtz Centre for Heavy Ion Research (GSI)	88,343	9,302	97,645	1,125
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	75,411	6,937	82,348	680
Helmholtz Zentrum Geesthacht (HZG)	11,738	346	12,084	109
Karlsruhe Institute of Technology (KIT)[6]	42,908	4,393	47,301	415
Research Field Structure of Matter, total	**440,132**	**99,677**	**539,809**	**4,347**

[6] Share of the KIT Division of Large-Scale Research. [7] Plus costs of 19 million euros for the Helmholtz Institute Saarbrücken and the German Centres of Health Research.
[8] Plus costs of 6 million euros for the Helmholtz Institute Jena and the Helmholtz Institute Mainz.

COSTS AND STAFF

The Helmholtz Association's annual budget consists of core financing and third-party funding. Ninety percent of core financing is provided by the federal government and 10 percent comes from the federal states in which the member centres are located. The centres raise around 30 percent of the total budget themselves in the form of third-party funding. In the Annual Report, these core-financed and third-party funded costs are shown for the 2010 reporting period. Due to the Helmholtz Association's strategic focus on six research fields, total costs are broken down according to research field (see p. 67). In order to provide a clearer overview of the funding made available to the centres, this data is also presented in analogous form for the centres (see below). For both the research fields and the centres, the data on costs is supplemented by information on the number of staff members expressed as full-time equivalents. The overviews do not contain the costs of 25 million euros incurred by the German Centres of Health Research and the Helmholtz institutes – no third-party funding was reported.

Costs and staff by centre, 2010	**Actual costs** Core-financed costs T€	**Actual costs** Third-party funds T€	**Actual costs** Total costs T€	**Staff** Total staff [1] PYs
Alfred Wegener Institute for Polar and Marine Research (AWI)	89,757	18,501	108,258	875
Deutsches Elektronen-Synchrotron (DESY)	177,432	76,611	254,043	1,653
German Cancer Research Center (DKFZ)	106,375	43,150	149,525	1,913
German Aerospace Center (DLR)	298,040	275,599	573,639	4,476
German Centre for Neurodegenerative Diseases (DZNE)	42,543	230	42,773	176
Forschungszentrum Jülich (FZJ)	237,740	78,248	315,988	2,863
GSI Helmholtz Centre for Heavy Ion Research (GSI)	91,947	11,059	103,006	1,210
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	93,256	12,193	105,449	938
Helmholtz Centre for Infection Research (HZI)	38,845	17,037	55,882	605
Helmholtz Centre for Environmental Research (UFZ)	51,022	27,039	78,061	797
Helmholtz Zentrum Geesthacht (HZG)	58,095	16,759	74,854	757
Helmholtz Zentrum München (HMGU)	102,597	33,623	136,220	1,521
Helmholtz Centre Potsdam (GFZ)	50,632	44,766	95,398	704
Karlsruhe Institute of Technology (KIT)[2]	215,908	79,352	295,260	3,271
Max Delbrück Center for Molecular Medicine (MDC)	54,222	20,821	75,043	836
Max Planck Institute for Plasma Physics (IPP)	92,928	42,999	135,927	1,094
Non-programme-linked research	**42,553**	**227,953**	**270,506**	**839**
Special tasks	**17,571**	**4,848**	**22,419**	**1,924**
Helmholtz Association, total	**1,861,463**	**1,030,788**	**2,892,251**	**26,452** [3]

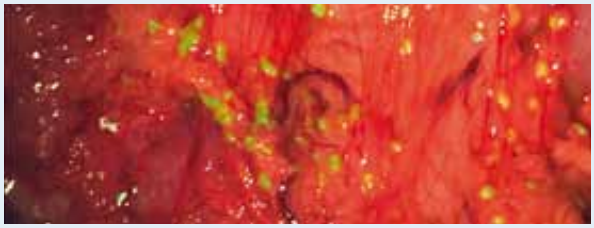
[1] Person-years (full-time equivalents). [2] Share of the KIT Division of Large-Scale Research.
[3] Expressed as natural persons, the Helmholtz Association has 30,995 employees.

SCIENCE AWARDS

The scientific excellence of the research conducted by the Helmholtz Association has been recognised over the past year by the many renowned science awards bestowed on researchers from our member centres. The following list represents a selection.

Hannes Alfvén Prize of the European Physical Society: Professor Jürgen Nührenberg, Max Planck Institute for Plasma Physics; Grand Prix 2010 de l'Académie de l'Air et de l'Espace: Professor Christoph Reigber, Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences; Becquerel Prize of the EU Commission: Professor Hans-Werner Schock, Helmholtz-Zentrum Berlin für Materialien und Energie; Berlin Science Award of the Governing Mayor: Professor Nikolaus Rajewsky, Max Delbrück Center for Molecular Medicine (MDC); Dechema Award of the Max Buchner Research Foundation: Professor Rolf Müller, Helmholtz Centre for Infection Research; Dingebauer Prize 2010: Professor Thomas Gasser, German Centre for Neurodegenerative Diseases; ERC Researcher Advanced Grant: Professor Hans Ströher, Forschungszentrum Jülich; Professor Hannah Monyer, German Cancer Research Center; Professor Holger Puchta, Karlsruhe Institute of Technology; ERC Advanced Researcher Grant: Professor Klaus Rajewsky, Harvard Medical School/Max Delbrück Center for Molecular Medicine (MDC); ERC Starting Grant: Dr. Matthew Poy and Dr. James Poulet, both from the Max Delbrück Center for Molecular Medicine (MDC)/ Charité – Universitätsmedizin Berlin; ERC Starting Independent Researcher Grant: Dr. Matthias Schneider, Karlsruhe Institute of Technology; Brigitte Gedek Science Award for Mycotoxin Research: Dr. Tobias Polte, Helmholtz Centre for Environmental Research – UFZ; Alexander von Humboldt Research Award: Professor Ralph Nuzzo, Karlsruhe Institute of Technology; Professor Jeffrey Trinkle, German Aerospace Center; Gay-Lussac Humboldt Prize: Professor Claus M. Schneider, Forschungszentrum Jülich; Professor Karsten Suhre, Helmholtz Zentrum München; Gerolamo Cardano International Award: Professor Pierluigi Nicotera, German Centre for Neurodegenerative Diseases; German Material Efficiency Award 2010: Professor Helmut Seifert and Dr. Peter Stemmermann, Karlsruhe Institute of Technology; Metlife Award 2010: Professor Eckhard and Eva-Maria Mandelkow, German Centre for Neurodegenerative Diseases; Richtzenhain Prize: Dr. Stephan Herzig, German Cancer Research Center; State Medal of the Bavarian Ministry of Economics: Professor Gerd Hirzinger, German Aerospace Center; Marcus Wallenberg Prize 2010: Professor Joachim Blaß, Karlsruhe Institute of Technology, Wolf Prize in Physics: Professor Knut Urban et al., Forschungszentrum Jülich, etc.

You can find the complete list at:
» www.helmholtz.de/en/science-awards



2011 ERWIN SCHRÖDINGER PRIZE

Researchers at the Helmholtz Zentrum München – German Research Center for Environmental Health and the Groningen University Medical Center have been awarded the 2011 Erwin Schrödinger Prize for developing a new surgical technique. Professor Vasilis Ntziachristos of the Institute for Biological and Medical Imaging at the Helmholtz Zentrum München and Professor Gooitzen Michell van Dam of the Groningen University Medical Center have developed a molecular imaging process that allows tumour cells to be detected in real time in the operating theatre using a fluorescence camera. Most operations and endoscopic interventions are still performed using only the human eye. However, surgeons have an extremely limited view of the inside of the body: even with modern techniques, they can see only the upper layers of tissue. Very small, concealed tumours remain practically invisible. The new technique uses a real-time camera that records fluorescence in tissue. It allows tiny tumours to be detected in the interior of the body without causing damage to surrounding tissue. Before this technique was developed, it was extremely difficult or even impossible to diagnose tiny tumour clusters during surgery. Now surgeons are able to evaluate results while they operate.

» www.helmholtz.de/en/schroedinger-prize-2011

CENTRAL BODIES

PRESIDENT

Professor Jürgen Mlynek

VICE-PRESIDENTS

Scientific Vice-President,
Coordinator of the Research Field Energy
Professor Eberhard Umbach, President of the Karlsruhe Institute of Technology

Scientific Vice-President, Coordinator of the Research Field Earth and Environment
Professor Reinhard F. J. Hüttl, Scientific Director of the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Scientific Vice-President,
Coordinator of the Research Field Health
Professor Otmar D. Wiestler, Chairman of the Management Board and Scientific Director of the German Cancer Research Center

Scientific Vice-President,
Coordinator of the Research Field
Aeronautics, Space and Transport
Professor Johann-Dietrich Wörner, Chairman of the Executive Board, German Aerospace Center (DLR)

Scientific Vice-President,
Coordinator of the Research Field
Key Technologies
Professor Achim Bachem, Chairman of the Board of Directors, Forschungszentrum Jülich

Scientific Vice-President,
Coordinator of the Research Field
Structure of Matter
Professor Horst Stöcker, Scientific Director of the GSI Helmholtz Centre for Heavy Ion Research

Administrative Vice-President
Dr. Nikolaus Blum, Administrative Director of the Helmholtz Zentrum München – German Research Center for Environmental Health

Administrative Vice-President
Dr. Heike Wolke, Administrative Director of the Alfred Wegener Institute for Polar and Marine Research

HEAD OFFICE

Managing Director
Dr. Rolf Zettl

SENATE

ELECTED MEMBERS

Professor Andreas Barner, Spokesman for Management and Head of Pharmaceutical Research, Development and Medicine, Boehringer Ingelheim GmbH, Ingelheim

Professor Katharina Kohse-Höinghaus, Chemistry Department, Bielefeld University

Professor Gerd Litfin, Managing Partner of Arkadien Verwaltungs-KG, Göttingen

Professor Vera Lüth, SLAC National Accelerator Laboratory, Stanford, US

Professor Liqiu Meng, Vice-President of the Technische Universität München

Dr. Detlef Müller-Wiesner, Senior Vice-President, Chief Operating Officer Innovation and Deputy CTO, Corporate Technical Office, EADS Deutschland GmbH, Munich

Professor Hermann Requardt, Member of the Siemens Managing Board and CEO of Siemens Healthcare, former CTO of Siemens and Head of Corporate Technology, Erlangen

Professor Robert Rosner, University of Chicago, US

Professor Louis Schlapbach, former CEO of EMPA, an ETH domain, Switzerland

Professor Ulrich Seiffert, Managing Partner of WiTech Engineering GmbH, Braunschweig

Professor Babette Simon, President of the University of Oldenburg

Professor Klaus Töpfer, former Undersecretary General, United Nations, and Founding Director of the Institute for Advanced Sustainability Studies, Potsdam

EX OFFICO SENATE MEMBERS

Werner Gatzer, State Secretary, Federal Ministry of Finance, Berlin

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

Renate Jürgens-Pieper, Senator for Education, Science and Health, Bremen

Professor Matthias Kleiner, President of the German Research Foundation, Bonn

Michael Kretschmer, Member of the German Bundestag, Berlin

Jens Lattmann, State Councillor, Department of Finances of the City of Hamburg

Professor Karl Ulrich Mayer, President of the Leibniz Association (= Gottfried Wilhelm Leibniz Scientific Community), Berlin

Professor Jürgen Mlynek, President of the Helmholtz Association, Berlin

René Röspel, Member of the German Bundestag, Berlin

Professor Annette Schavan, Federal Minister of Education and Research, Berlin

Professor Johanna Wanka, Minister of Science and Cultural Affairs for the State of Lower Saxony, Hanover

EX OFFICIO GUESTS

Professor Achim Bachem, Vice-President of the Helmholtz Association, Board Chairman of the Forschungszentrum Jülich

Dr. Nikolaus Blum, Vice-President of the Helmholtz Association, Administrative Director of the Helmholtz Zentrum München – German Research Center for Environmental Health

Professor Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft, Munich

Professor Peter Gruss, President of the Max Planck Society for the Advancement of Science, Munich

As of September 2011

Professor Reinhard F. J. Hüttl, Vice-President of the Helmholtz Association, Scientific Director of the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

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

Dr. Martin Lipp, Chairman of the Committee of Scientific-Technical Councils, Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch

Professor Wolfgang Marquardt, Chairman of the German Science Council, Cologne

N.N., Vice-Chairperson of the Committee of Scientific-Technical Councils of the Helmholtz Centres

Professor Horst Stöcker, Vice-President of the Helmholtz Association, Scientific Director of the GSI Helmholtz Centre for Heavy Ion Research, Darmstadt

Professor Eberhard Umbach, Vice-President of the Helmholtz Association, President of the Karlsruhe Institute of Technology, Karlsruhe

Professor Otmar D. Wiestler, Vice-President of the Helmholtz Association, Chairman of the Management Board of the German Cancer Research Center, Heidelberg

Professor Margret Wintermantel, President of the German Rectors' Conference, Bonn

Professor Johann-Dietrich Wörner, Vice-President of the Helmholtz Association, Chairman of the Executive Board of the German Aerospace Center (DLR), Cologne

Dr. Heike Wolke, Vice-President of the Helmholtz Association, Administrative Director of the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven

SENATE COMMISSIONS

PERMANENT MEMBERS*

Research Field Energy

Professor Thomas Hartkopf, Director of Regenerative Energies, Technische Universität Darmstadt

Research Field Earth and Environmental

Professor Volker Josef Mosbrugger, Director of the Senckenberg Research Institute and Nature Museum

Research Field Health

Professor Irmgard Sinning, Director of the Heidelberg University Biochemistry Centre

Research Field Aeronautics, Space and Transport

Jörg Feustel-Büechl, former Director of the European Space Agency

Research Field Key Technologies

Professor Dieter Jahn, Senior Vice-President of Science Relations and Innovation Management, BASF, Ludwigshafen

Research Field Structure of Matter

Professor Joël Mesot, Director of the Paul Scherrer Institute, Villigen, Switzerland

Federal Government Representative

Ulrich Schüller, Federal Ministry of Education and Research, Bonn

Representatives of the Federal States

Dr. Heribert Knorr, Head of Directorate, Ministry of Science, Research and Art, Baden-Württemberg, Stuttgart

Karl-Heinz Krems, Head of Division, Ministry of Innovation, Science and Research of the State of North Rhine-Westphalia, Düsseldorf

* The permanent members belong to all six Senate Commissions.

SENATE COMMISSION ON ENERGY

Senate Representatives

Professor Hermann Requardt, Member of the Siemens Managing Board and CEO of Siemens Healthcare, former CTO of Siemens and Head of Corporate Technology, Erlangen

Professor Louis Schlapbach, former CEO of EMPA, an ETH domain, Switzerland

Federal Government Representative

Dr. Knut Kübler, Head of Division, Federal Ministry of Economics and Technology, Bonn

SENATE COMMISSION ON EARTH AND ENVIRONMENT

Senate Representatives

Professor Liqiu Meng, Vice-President of the Technische Universität München

Professor Klaus Töpfer, former Undersecretary General, United Nations, and Founding Director of the Institute for Advanced Sustainability Studies, Potsdam

Federal Government Representative

Wilfried Kraus, Head of Division, Federal Ministry of Economics and Technoloogy, Bonn

SENATE COMMISSION ON HEALTH

Senate Representatives

Professor Andreas Barner, Spokesman for Management and Head of Pharmaceutical Research, Development and Medicine, Boehringer Ingelheim GmbH

Professor Babette Simon, President of the University of Oldenburg

Federal Government Representative

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*Abbreviations:
SdöR: Foundation under public law
SdpR: Foundation under private law
KdöR: Public body
e.V.: Registered association
GmbH: Limited liability company

HELMHOLTZ ASSOCIATION GOVERNANCE STRUCTURE

COMMITTEE OF FINANCING PARTNERS

The Committee of Financing Partners – made up of the federal government and the host states – sets research policy guidelines and the individual research fields for a period of several years. It also appoints members of the Senate.

SENATE

Together with the Members' Assembly, the Senate, which is made up of external experts, is the Helmholtz Association's central decision-making body. It consists of both ex officio members – representatives of the federal government, the federal states, the German parliament and scientific organisations – and individuals from science and industry. The latter are elected for three years. The Senate discusses important decisions and is responsible for electing the president and vice-presidents.

SENATE COMMISSIONS

The Senate has established Senate Commissions to lay the groundwork for its debates on programme funding recommendations (based on programme reviews) and on the setting of investment priorities. The Senate Commissions consist of both ex officio permanent members – representatives of the federal government and federal states – and external experts for the six research fields. It also includes alternating members who provide advice on the specific research field under discussion.

PRESIDENT

A full-time president heads the Helmholtz Association and represents it externally. He or she moderates the dialogue between science, industry and government, and is responsible for preparing and implementing the Senate's recommendations regarding programme-oriented funding. The president coordinates the development of programmes across research fields, the cross-centre controlling system, and the development of the association's overall strategy.

VICE-PRESIDENTS

The president is supported, advised and represented by eight vice-presidents. Six are scientific vice-presidents who coordinate the six research fields, while the other two represent the association's administrative arm.

HEAD OFFICE

The head office and the international offices in Brussels, Moscow and Beijing assist the president, the vice-presidents and the managing director in fulfilling their duties.

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

RESEARCH FIELDS

In the six research fields financed by programme-oriented funding, Helmholtz scientists carry out cross-centre research with external partners in interdisciplinary and international collaborations.

MEMBERS' ASSEMBLY

The Helmholtz Association is a registered association whose members comprise 16 legally independent research centres and one associated institute. A seventeenth* centre – the Helmholtz Centre for Ocean Research Kiel (GEOMAR) – will join the association on 1 January 2012. Together with the Senate, the Members' Assembly is the association's other central body. It is made up of one scientific and one administrative director from each of the member centres. The Members' Assembly is responsible for all the tasks performed by the registered association. It defines the framework for programme and cross-centre strategy development and is entitled to make recommendations regarding the election of the president and Senate members.

- Alfred Wegener Institute for Polar and Marine Research
- Deutsches Elektronen-Synchrotron DESY
- German Cancer Research Center
- German Aerospace Center (DLR)
- German Centre for Neurodegenerative Diseases (DZNE)
- Forschungszentrum Jülich
- GSI Helmholtz Centre for Heavy Ion Research
- Helmholtz-Zentrum Berlin für Materialien und Energie
- Helmholtz-Zentrum Dresden-Rossendorf
- Helmholtz Centre for Infection Research
- Helmholtz Centre for Environmental Research – UFZ
- Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research
- Helmholtz Zentrum München – German Research Center for Environmental Health
- Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences
- Karlsruhe Institute of Technology
- Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch
- Max Planck Institute for Plasma Physics (associate member)

*Currently the Leibniz Institute of Marine Sciences (IFM-GEOMAR)

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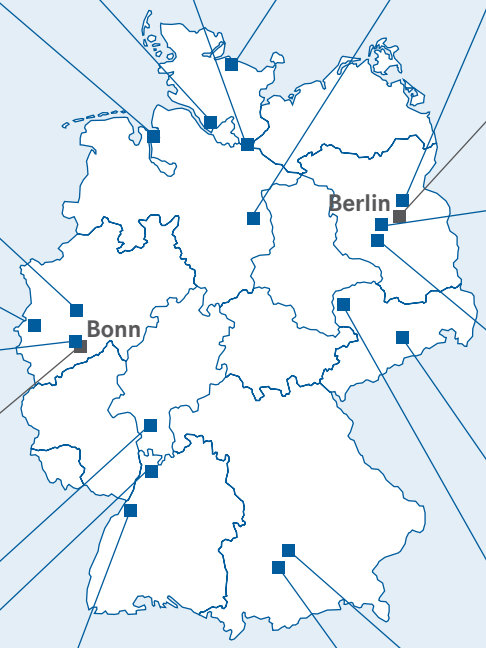

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