HELMHOLTZ – RESEARCH FOR CHANGE

ANNUAL REPORT 2013

THE HELMHOLTZ ASSOCIATION
OF GERMAN RESEARCH CENTRES

Research in Germany
Land of Ideas

HELMHOLTZ
ASSOCIATION

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NOTE ON REPORTING PERIOD: The general section describes developments at the Helmholtz Association from 2012 to August 2013.

More in-depth information on the research examples can be found at www.helmholtz.de/gb13, where the Helmholtz Annual Report 2013 is available as an online document. The Annual Report 2013 shows the actual costs of research in 2012 and the Helmholtz Senate's financing recommendations for 2014–2018 for the research programmes in Earth and environmental research, health research, and aeronautics, space and transport research. The report also presents the financing recommendations for the programme period 2010–2014 for energy research, key technologies research and research into the structure of matter.

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

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.

The Human Brain Project

EXPEDITION INTO THE HUMAN BRAIN

Scientists from more than 20 countries have embarked on a research expedition into the unknown. Their goal: to create a realistic simulation of the human brain on a future supercomputer. From the molecular and genetic levels to the interaction between entire groups of cells, the model will capture every last detail. The Human Brain Project (HBP)

In centuries past great explorers such as Christopher Columbus, Marco Polo and Vasco da Gama travelled thousands of miles through uncharted territory. By contrast, the destination of the Human Brain Project (HBP) is spatially circumscribed: the human brain has a volume of just 1,500 cubic centimetres. However, it still poses many challenges. “Although our thinking organ has been studied intensively for more than 150 years, it continues to hold many secrets,” says Katrin Amunts, head of the Multi-Level Organisation of the Human Brain unit at the HBP. The neuroscientist directs the Institute of Neurosciences and Medicine (INM-1) at the Forschungszentrum Jülich and is participating in the HBP together with other scientific teams from Jülich. The ten-year EU flagship project is being coordinated by Henry Markram from the École Polytechnique Fédérale de Lausanne (EPFL). Its estimated cost: roughly one billion euros. What gives us the ability to do basic mathematics? How do we make decisions? Why do we instinctively know that fire is dangerous? Whether it is talking, laughing, remembering or walking, our brain coordinates sensory perceptions, cognitive and emotional processes, movement and communication with our environment. The work is done by around 86 billion neurons, each of which possesses around 10,000 synapses, the connecting points in the neural network. These numbers illustrate just how many parts of the human brain communicate with one another on the neural level alone. But the brain operates on many different levels, from molecules and neurons to entire brain networks – an inexhaustible field of inquiry for scientists from different disciplines.

Collecting all the data about the brain in a virtual brain atlas

Katrin Amunts and her team have been working for several years on a three-dimensional brain atlas to store all the information available from and about the brain. Like the explorers of earlier times, her job entails recording reams of new data – though not with a pen, compass and map, but in digital form in vast data storage systems. Thousands of extremely thin brain slices have provided a foundation for the project. These are scanned with the help of modern microscopes and image-analysis methods and then integrated into the virtual three-dimensional model of the brain. Approximately 70 per cent of the human brain has already been charted. The brain atlas is intended to serve as a navigational system within the HBP. In addition, the researchers have developed a high-resolution model that allows them to zoom in on the neuronal level.
Every year neuroscientists publish around 60,000 scientific documents describing phenomena such as the role of particular genes or molecules, different aspects of the electrical behaviour of neurons, neural networks and the mechanisms of individual neurological diseases. The HBP plans to organise all this data and integrate it into standardised models that will then be simulated on supercomputers.

is one of two flagship projects of the European Union. Its participants include neuroscientists, computer scientists, physicists, mathematicians and other specialists from over 80 scientific organisations – including experts from the Forschungszentrum Jülich and the Karlsruhe Institute of Technology (KIT).

The brain as a model for energy-efficient computers of the future

These vast quantities of data are being analysed with the help of models, innovative simulation programmes and supercomputers, all of which will be further developed within the framework of the HBP and integrated into joint work platforms. Existing software tools and computers are not powerful enough to represent the entire human brain. Thomas Lippert directs the Jülich Supercomputing Centre (JSC) and is responsible for high-performance computing and the design of the new supercomputer at the HBP. He is certain of one thing: “The simulation of the human brain is one of the greatest scientific challenges ever. To represent the entire brain, we need high-performance computers with huge computing and storage capacities. And these must first be developed.”

The Forschungszentrum Jülich is home to JUQUEEN, one of the ten fastest computers in the world. But its more than 458,000 processing cores, capable of six quadrillion operations per second, are not nearly enough to simulate the entire brain. This is why the IT experts at the Helmholtz centre are working at full speed with industrial partners to develop next-generation computers, which will lay the foundation for the HBP’s extremely memory-intensive applications. In addition, the HBP is receiving data management support from the experts at the Steinbuch Centre for Computing at the Karlsruhe Institute of Technology. The scientists at this Helmholtz facility in Baden-Württemberg are developing cloud interfaces to ensure smooth access to the data that is used and generated by the project.

Conversely, the computer specialists are hoping that the project will provide them with additional insight into new high-capacity, energy-efficient computers. In contrast to computers, the human brain can partially compensate for damage and is able to access a gigantic “memory” at all times. In addition, it is creative and can even make decisions based on incomplete data. Finally, it requires less energy than a 60 watt light bulb to process and transfer information in highly complex operations.

Socio-political challenges: new therapies for neurodegenerative diseases such as Alzheimer’s and Parkinson’s

The EU funding programme has made it possible to pool scientific expertise and manpower in order to research and represent the structure and processes of both the healthy and diseased brain at different levels in all its complexity. In view of the demographic changes occurring in many Western industrial nations today, this research topic has top priority. After all, the number of people with neurodegenerative disease will increase dramatically in ageing societies. Around 1.3 million people have already been diagnosed with dementia in Germany alone and this trend is expected to accelerate in the future: experts estimate that the number will double by 2050. These developments will have a tremendous impact not only on individuals’ quality of life, but also on the healthcare system as a whole.

The HBP will make it possible for future doctors to understand the structure and workings of both the healthy and diseased brain and to develop effective therapies. Whether in connection with Parkinson’s or Alzheimer’s, the HBP is expanding current methods in medicine and neuroscience in decisive ways. *it*

Prof. Dr. Jürgen Mlynek, President

HELMHOLTZ – RESEARCH FOR CHANGE

Dear Reader,

Despite global migration movements, 40 years from now Europe will have 40 million fewer inhabitants than it does today. At the same time, society will be more diverse and older. Such demographic and structural changes, together with technological progress, are already making themselves felt in our everyday lives. Political and business leaders face increasing pressure to prepare for these changes and to frame intelligent, farsighted policies. In our view, one of the key long-term goals of research is to provide the knowledge they need for doing so.

In full awareness of this responsibility, we have devoted the 2013 Annual Report of the Helmholtz Association to the important topic of demographic change and the great diversity of research it has called for. We aim to show how Helmholtz researchers are leading the way into the future.

On the next few pages I would also like to describe the most important developments at the Helmholtz Association during the past year. You will learn how the association is fulfilling the objectives of the Joint Initiative for Research and Innovation and gain insight into the strategic decisions we have made during the newly launched third round of programme-oriented funding.

I hope you enjoy the read,

Jürgen Mlynek

PRESIDENT'S REPORT

"MORE THAN EVER BEFORE, THE SCIENTIFIC COMMUNITY IS CALLED UPON TO HELP SOLVE THE MAJOR AND PRESSING PROBLEMS OF HUMANITY."

Jürgen Mlynek

The mission of the Helmholtz Association is more relevant today than ever before: to help solve the major and pressing problems of humanity. Our goal as a research organisation is to identify important long-term challenges early on and to develop the knowledge and technologies necessary to meet them. We regard ourselves as a dynamic element of Germany's highly effective research system, which is constantly optimising its structures and focuses to meet tomorrow's challenges.

An evolving research system

During the period under review, the Helmholtz Association was actively involved in discussions on the prospects of Germany's research system. In September 2012 its members adopted the position paper "Helmholtz 2020 – Shaping the Future through Partnership", which focuses on improving the research system through additional strategic partnerships and implementing suitable collaboration models. One of the proposals made in the paper is to combine institutional and project funding. From the Helmholtz Association's perspective, close cooperation between research partners is the only effective way to preserve and safeguard the international competitiveness of Germany's research system over the long term. In the recommendations published on 15 July 2013 under the title "Perspectives of the German Research System", the German Council of Science and Humanities welcomed the Helmholtz Association's strategy. The council remarked above all on the new collaboration models, especially with universities, and encouraged the association to intensify its activities in this area. Furthermore, the council underscored the increasing importance of providing large-scale research infrastructure, which is a unique characteristic of the Helmholtz Association within the German research system, and it recommended further expanding its large-scale research facilities.

Research organisations require financial leeway in order to optimally align their resources with their scientific goals. In this respect the Law to Increase the Flexibility of Budgetary Provisions for Non-University Research Institutions – Academic Freedom Act for short – was a crucial development for the Helmholtz Association. The Academic Freedom Act, which went into effect in December 2012, eliminates red tape and increases the international competitiveness of the Helmholtz Association and the other research organisations that are given favourable treatment. It grants research organisations more latitude when making budgetary and personnel decisions, taking stakes in firms and implementing construction projects. As a result, the Helmholtz Association will have greater autonomy and responsibility in future budgetary matters. However, the association must still formally approve the financial statutes that were adapted to reflect the act.

Strategically oriented research

Core-funded research at the Helmholtz Association is organised into programmes that are financed for five

Selected highlights from the reporting period

2012

1 Jan 2012	14 Feb 2012	27 Feb 2012	30 May 2012	14 June 2012	15 June 2012	28 June 2012
GEOMAR Helmholtz Centre for Ocean Research Kiel becomes a new member	Funding for three new energy alliances approved	Leibniz Prizes for the Helmholtz scientists Prof. Rajewksy (MDC), Prof. Sanders (KIT) and Prof. Riebesell (GEOMAR)	Helmholtz energy research strengthened with an additional 135 million euros	Funding for four new Helmholtz alliances with universities and non-university partners	Excellence Initiative II: Helmholtz to participate in ten future projects	Helmholtz supports collaboration with universities in eleven new virtual institutes

years on the basis of strategic reviews. The reviews for the third round of programme-oriented funding (POF) began in 2013. This competitive process of allocating research funds combines quality assurance with strategic research planning. The Helmholtz Association bases its work on the strategic guidelines formulated jointly with its funding bodies. The preliminary stage of the third round of reviews took place in 2011, when the Helmholtz Senate and the Board of Funding Bodies agreed on the conditions and the procedure for the third round of programme-oriented funding. In 2012 intensive preparations began at the research centres for the review of 13 of the 30 research programmes; the remaining 17 will be evaluated in 2014. Parallel to these preparations, the actual review process – involving more than 200 internationally renowned scientists – was put into place. In 2013 it encompassed the first three Helmholtz research fields: Earth and environmental research, health research and aeronautics, space and transport research. The fields of energy research, key technologies research and research into the structure of matter will be assessed in 2014 (for further information on the current review process, please see “Third Round of Programme-Oriented Funding”, pp. 14–15).
The principles underlying the competitive programme-oriented allocation of funds have proven highly successful – a fact emphasised by the German Council of Science and Humanities in its current recommendations, “Perspectives of the German Research System”. At the same time, programme-oriented funding is a dynamic process that must continue to evolve to reflect developments within the research system. It is for this reason that, upon completion of the third round of reviews, the Council of Science and Humanities will evaluate the process itself. This will go beyond the regular internal evaluation and focus on the review procedure, the effectiveness of competition, the use of the multidisciplinary potential at the association and collaboration with national and international partners.

Shaping the association

The Leibniz Institute of Marine Sciences (IFM-GEOMAR) joined the Helmholtz Association in January 2012 and has since gone by the name of GEOMAR Helmholtz Centre for Ocean Research Kiel. One of Europe’s leading marine research facilities, GEOMAR has contributed to the field of Earth and environmental research at the Helmholtz Association through its expertise in ocean and deep sea research, its unique deepwater technologies and the basic research it has pursued in major projects such as the “The Future Ocean” excellence cluster. With the addition of GEOMAR, the Helmholtz Association has grown to include 18 research centres.
As part of the ongoing conceptual development of the Helmholtz Management Academy, a call for tenders was issued throughout Europe to design and implement the academy’s future programme. In August 2013 the consortium of osb Berlin GmbH and the Institute for Systemic Management and Public Governance at St. Gallen University was selected as a partner. A science-based understanding of leadership, a coherent systemic approach to general management and a closer “fit” with the Helmholtz Association in particular and with science as a whole will now provide a foundation to reposition the academy. The joint development work will also focus on defining the academy’s strategic underpinnings.

New collaboration models

The Helmholtz Association co-founded a new institution in 2013, the Berlin Institute of Health (Berliner Institut für Gesundheitsforschung, BIG). Inaugurated by Federal Minister Johanna Wanka on 18 June 2013, BIG is an innovative, long-term collaborative model in which both the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch and the Charité University Hospital of Berlin – one of Europe’s largest university clinics – will pool their research. For the first time ever, scientists will be

4 July 2012	6 Aug 2012	19 Sept 2012	5 Oct 2012	9 Nov 2012	22 Nov 2012	14 Dec 2012
Helmholtz researchers involved in the discovery of the Higgs boson at CERN	Helmholtz researchers contribute to the landing of NASA’s Curiosity rover on Mars	Adoption of the strategy paper “Helmholtz 2020 – Shaping the Future through Partnership” by the members’ assembly	Radar in space: DLR researchers nominated for the German Future Award	DESY researchers decode first biological structure with an X-ray laser	First “Innovation Days” bring together German research organisations and industry	Helmholtz researcher Prof. Ntziachristos (HMGU) wins 2013 Leibniz Prize

“RESEARCH ORGANISATIONS REQUIRE FINANCIAL LEEWAY IN ORDER TO OPTIMALLY ALIGN THEIR RESOURCES WITH THEIR SCIENTIFIC GOALS.”

Jürgen Mlynek

examining symptoms from a cross-organ perspective and implementing an approach from the field of systems medicine. An additional objective is to improve the translation of research findings into clinical applications. Following the foundation of the Karlsruhe Institute of Technology and the Jülich Aachen Research Alliance, BIG is continuing the Helmholz Association’s strategy of developing new models of collaboration between Helmholtz centres and other research institutions. In June 2013 the decision was also made to set up a new Helmholtz institute for renewable energy in northern Bavaria, based on recommendations from an international experts’ commission. The Forschungszentrum Jülich, the Helmholtz-Zentrum Berlin and the Friedrich Alexander University of Erlangen-Nuremberg (FAU) will work together at this new facility, called the “Helmholtz Institute Erlangen-Nuremberg for Renewable Energy”, or “HI ERN” for short. HI ERN will devote itself to two topics: 1) solar materials research for printable photovoltaics and 2) solar fuels and innovative methods for chemical energy storage using hydrogen technologies. Both of these topics are crucial for the broad-based, cost-effective use of renewable energy and the success of the clean energy revolution in Germany. The Helmholtz Association will provide the new institute with annual funding of 5.5 million euros for personnel, operations and investments. The state of Bavaria will make available an investment grant of around 32 million euros, which is expected to be supplemented by start-up funding of one million euros per year for the launch phase through 2018.

Establishing and utilising research infrastructure

Powerful modern research infrastructure is not only an essential instrument for the acquisition of scientific knowledge but also a highly effective driver of technology and innovation. One of the Helmholtz Association’s core competencies and a central element of its mission is to develop, construct and operate large-scale devices and complex research facilities, some of which are unique in the world. The association makes these facilities available to the scientific community as user platforms. Large-scale research infrastructure creates a high level of international visibility, which in turn increases the appeal of the Helmholtz Association as an employer and all of Germany as a centre of research and innovation.
As part of the pilot phase of the national roadmap, the Federal Ministry of Education and Research (BMBF) commissioned the German Council of Science and Humanities in 2011 to develop and implement a process for the science-driven evaluation of large-scale research infrastructure. In April 2013 the council submitted its report examining a total of nine concepts for large-scale research infrastructure projects. Helmholtz centres are involved in all of them. The BMBF incorporated three of these research infrastructure projects into its roadmap: the Cherenkov Telescope Array, to which DESY is contributing; the project “In-Service Aircraft for a Global Observing System”, whose German coordinator is the Forschungszentrum Jülich and in which the DLR, GVW and KIT are participating; and EU-OPENSCREEN, a platform for the provision of new biologically active substances that is supported by the Helmholtz centres HZI and the MDC. Germany must now tackle the important task of developing a national roadmap with input from the leading German science organisations.

The user and service-oriented operation of research infrastructure is an additional important aspect of strategically focused research, and the ability to plan over the long term is crucial. For this reason the Helmholtz members’ assembly approved a transparent facility-specific framework for full cost budgeting. This will ensure that operation by users is not jeopardised by cost drivers such as increases in the price of electricity.

2013

14 Jan 2013	15 Jan 2013	28 Jan 2013	7 Feb 2013	11 March 2013	6 June 2013	18 June 2013
Helmholtz establishes 100th virtual institute	Helmholtz International Research Groups: Helmholtz Association launches new funding programme	EU supports Human Brain Project as flagship venture at the Helmholtz Association	Beginning of the 3rd round of programme reviews by 200 international experts	Berlin opening of the travelling exhibition “Ideas 2020 – A Tour of Tomorrow’s World”	Preparations for the establishment of the Helmholtz Institute Erlangen-Nuremberg for Renewable Energy	Opening of the Berlin Institute of Health by MDC and the Charité Hospital

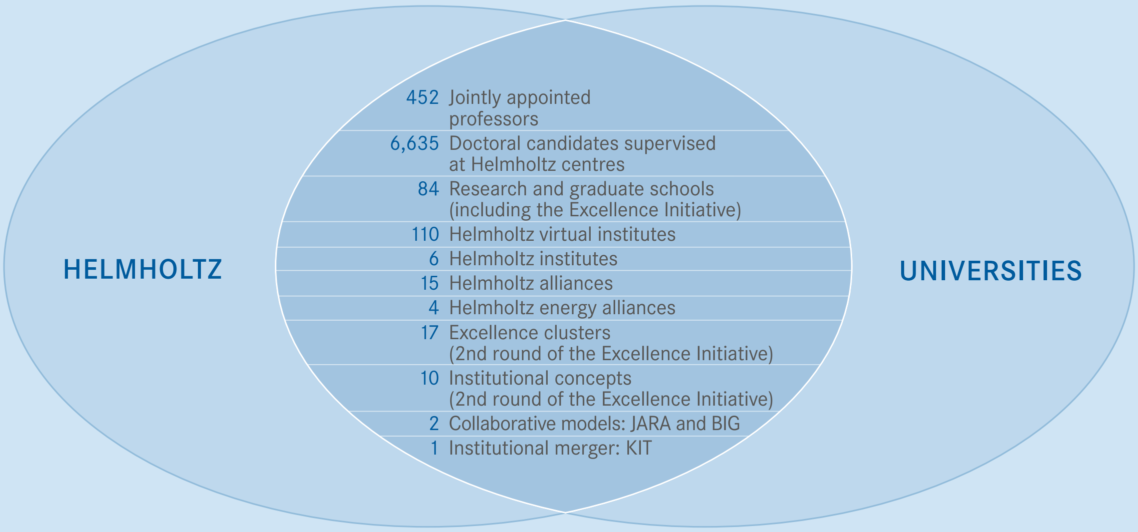
JOINT INITIATIVE FOR RESEARCH AND INNOVATION

The Joint Initiative for Research and Innovation guarantees the Helmholtz Association and other non-university research organisations a budget with annual increases of 5 per cent until 2015. With this joint programme, Germany's federal and state governments have created optimal conditions for the development of the research organisations participating in the initiative. The report on the following pages describes how the Helmholtz Association and its member centres are fulfilling the initiative's objectives.

The Helmholtz Association is using this additional financial leeway to systematically expand its research portfolio as it seeks to fulfil its mission, extend national and international scientific networks, recruit and promote talented scientists and accelerate technology transfer.

New research fields with a strategic importance

The Helmholtz Association is committed to conducting socially relevant research and addressing the major challenges facing society, science and industry today. Core-funded research is organised into programmes that are aligned with this mission. The future structure of the programmes is the result of a broad-based thematic planning process that began in 2010 in all of the association's research fields. Within the scope of this portfolio process, which is aimed at further developing the association's research agenda, 16 topics were identified as being especially important for the Helmholtz mission. They were allocated funding from the Joint Initiative for Research and Innovation so that they could be taken up before the start of the new 2014/15 programme period. In addition to the Helmholtz Association, several universities and partners from other research facilities are participating in each of these portfolio topics, which will be continued within the framework of the programmes (i.e., as part of core-financed Helmholtz research). The additional resources provided by the Joint Initiative have made it possible to meet the major challenges of society with the help of substantial advances in science. An important focus is the research associated with the *Energiewende*, or clean energy revolution. Approximately 63 million euros is being directed toward the study of new topics in this area, including energy storage systems, the bioeconomy, CO_2-free fossil fuel power plants, materials research and geothermal energy. However, the new portfolio topics are also benefiting the REKLIM climate initiative, which is conducting new research on regional climate change, and health research, particularly studies of the metabolic syndrome. In the field of basic physics research, the capacities of the Helmholtz Association have been expanded through measures such as the construction of a platform for detector technology. Additional new portfolio topics include security and safety research and the analysis and



The Helmholtz Association and its university partners: linked through people, projects and institutions

management of the large quantities of data typical of high-capacity scientific computing. All told, funding from the Joint Initiative has played a crucial role in strengthening the Helmholtz Association's research profile.

Pooling expertise by building networks within the research system

Science thrives on collaboration and the exchange of ideas. The Helmholtz Association has used the funding from the Joint Initiative to introduce a wide range of collaborative models, from temporary networks in which project partners in different locations pursue a common goal to permanent structures such as the Helmholtz institutes. The latter are branches of the Helmholtz centres set up on the campus of a university partner. With the Joint Initiative, it has become possible to provide targeted support for these new structures. The association's most important collaborating partners are the German universities that – thanks to the funding of joint projects by the association – are also able to benefit from the resources of the Joint Initiative.
In many cases the Helmholtz Association's Initiative and Networking Fund provides start-up assistance for networking activities through its own funding instruments. In 2012 the fund began supporting four new Helmholtz alliances in which Helmholtz centres pool their expertise with universities and non-university partners in order to achieve rapid progress and international visibility in strategically important research areas. The topics range from diabetes research to remote sensing and robotics to liquid metal technologies. These four new Helmholtz alliances will receive a total of 50 million euros over five years. The participating partners will contribute at least the same level of funding from their core budgets in order to ensure these initiatives have the necessary capacities. In 2012 eleven new Helmholtz virtual institutes were launched and will receive 30 million euros for the funding period up to 2018. Here scientists from the Helmholtz centres conduct research on a common topic with partners from universities and other prestigious research institutes in Germany and abroad. The Initiative and Networking Fund will grant the virtual institutes annual funding of up to 600,000 euros for three to five years. This sum is supplemented by funds from the centres and their partners, meaning that the research projects can be supported with up to 900,000 euros per year.
Creating networks within the research system continues to be a core goal of the association's strategy. The strategy paper "Helmholtz 2020 – Shaping the Future through Partnership", which the association adopted in 2012, identifies a wide range of collaborative models that represent the contribution made by the association to optimising the research system through partnerships.

New impetus from international networks

A large number of Helmholtz networks have an international reach. This is true of eight of the fifteen alliances supported by the Initiative and Networking Fund and 21 of the 110 Helmholtz virtual institutes. The Joint Initiative for Research and Innovation has also made it possible to launch special association-wide funding programmes for collaborations with important regions. These programmes include the Helmholtz-Russia Joint Research Groups, which have been supported since 2007 and focus on young scientists. In 2012 six new research groups were selected for the bilateral programme, which now has financed a total of 32 joint projects.

The Joint Initiative has also brought a new dynamic to the exchange of ideas with China. As part of a new programme, the Helmholtz Association has teamed up with the Chinese Academy of Sciences (CAS) in order to support five German-Chinese research projects from all research fields with up to 155,000 euros per year – initially for a three-year period. Collaborative projects with partners from different countries are also supported by the Helmholtz International Research Groups, a funding programme established in 2012. It provides the selected teams with up to 50,000 euros annually for an initial period of three years. The foreign partners contribute the same level of funding to strengthen collaboration. So far this programme has provided support for 15 teams.

The new Helmholtz International Fellow Award promotes collaboration with particular individuals. It is presented not only to outstanding researchers from abroad, but also to international science managers who have distinguished themselves in fields relevant to the association. In 2012 and 2013, Helmholtz International Fellow Awards were presented to 28 individuals. Thanks to this additional networking opportunity, the funds from the Joint Initiative are helping to create close bonds between the world's best scientists and the Helmholtz Association and to strengthen Germany as a centre of science.

Talent management: attracting and promoting the best people

With its "Attracting the Best" concept, which was adopted in 2012, the Helmholtz Association has established an overarching strategy for talent management. The Joint Initiative is creating additional capacities for a rapid implementation of the measures making up this strategy. One focus is on the recruitment of senior scientists. In this area the Helmholtz Association has begun an organisation-wide recruitment initiative that the Joint Initiative is supporting with 102 million euros for the period 2013–2017.

Faced with the challenges of the clean energy revolution, the recruitment initiative is aiming to bring not only international scientists and researchers to the association, but also specialists in energy research. The newly acquired top scientists are allocated funds from the association's core budget. As part of the initiative, the association has begun negotiations with 38 researchers, eight of whom were already appointed by August 2013.

To further the recruitment initiative's objective of hiring more women for leadership positions, the Helmholtz Association has established a fixed quota system for research based on a "cascading" model. As part of this approach, the targeted participation rate for women at a specific stage in their careers is based on the proportion of women in the previous career stage (see chart). Through this combination of clearly formulated goals and expanded capacities, the Helmholtz Association has been making a determined effort to recruit more women scientists.

In addition, women are trained specifically for leadership positions in the "Taking the Lead" mentoring programme at the Helmholtz Management Academy, which targets young women managers.

To supplement its recruitment drive for top scientists, the association has also expanded its efforts to promote young researchers. This goal is being realized with the help of the Helmholtz Young Investigators Groups, a well-established means of promoting young talent, and the comprehensive establishment of structured graduate education at the Helmholtz centres through the funding

More women in leadership positions as a result of support along the talent chain

Programme reviews: the quota for experts has been set at 30 per cent for all competitions for funds

In its “cascading” model the Initiative and Networking Fund provides a number of funding instruments for postdoctoral women scientists. The Helmholtz Association is using this model to counter the declining proportion of women in senior positions and to achieve the targeted quotas.

of graduate and research schools. Furthermore, in 2012 the association launched the Helmholtz Postdoc Programme with a first call for applications. The 37 candidates selected for grants will receive up to 300,000 euros for two to three years in order to establish themselves in their respective research fields. Thanks to the Joint Initiative, a well-rounded funding portfolio has thus emerged that covers all the important links in the talent chain, from doctoral candidates to professors. The association pursues a two-pronged strategy at every career stage, opening up prospects for the best scientists through additional capacities and providing these scientists with ongoing training. A key role is played not only by the graduate and research schools, but especially by the Helmholtz Management Academy and Helmholtz mentoring programmes. As a result of the Joint Initiative, the Helmholtz Association has seen a marked expansion of its staff. Targeted staff development has transformed its investment in the best minds into a permanent advantage for Germany as a centre of science and research. This advantage is being further secured by programmes that generate an interest in science at an early age. Two important initiatives in this regard are the Little Scientists’ House, whose successful work with young children across Germany is being comprehensively expanded, and the 28 School Labs at Helmholtz centres, which – attracting 60,000 school students each year and offering numerous continuing education courses for teachers – are playing an important role in promoting tomorrow’s scientists.

Technology transfer: added value through knowledge

With the help of the Joint Initiative, the Helmholtz Association has continued to strengthen its technology transfer initiatives in the period under review. Here too, the association can look back on a number of successes. In addition to optimising technology transfer strategies at the individual Helmholtz centres, the Helmholtz Association has supported the transfer process through three key instruments: the Helmholtz Validation Fund, the Helmholtz Enterprise funding programme and the model project “Shared Services”, in which the technology transfer offices at the Karlsruhe Institute of Technology and the Forschungszentrum Jülich make their services available to other Helmholtz centres.

The Validation Fund, established in 2011, is making it possible to close the innovation and financing gap between promising technologies and marketable products and services. Since the fund was launched, twelve projects have been implemented. The Helmholtz Enterprise programme, by contrast, offers support for research spin-offs. In 2012 and 2013, it provided up to 100,000 euros a year for a total of 13 start-up projects, which were allocated at least the same level of funding from the respective Helmholtz centres. These projects bring to 79 the total number of Helmholtz Enterprise spin-offs that have received funding since 2005.

The organisation of Innovation Days is providing a new opportunity for the scientific and business communities to exchange ideas. This partnering event was held for the first time in 2012 by the Helmholtz Association in collaboration with the Max Planck Society, the Leibniz Association and the Fraunhofer Society. The forum was a great success, attracting more than 250 experts from industry and science, and will be continued as a series in the future.

THIRD ROUND OF PROGRAMME-ORIENTED FUNDING

Every five years, the strategic scientific focus of research and the related core funding of the Helmholtz Association are reviewed within the framework of programme-oriented funding. The drafting of programme applications by the Helmholtz centres – in most cases by several centres working together – and the assessment of these applications by international experts are core elements of this process. In 2013 experts evaluated the programmes in three of the association's six research fields – Health, Earth and Environment, and Aeronautics, Space and Transport.

As a result of a thorough evaluation, several important aspects of the review process for the third programme period were adapted to current requirements. The changes include a separate assessment of the large-scale research infrastructure which are used mainly by external scientists. Life-cycle analysis and user management play a particularly important role in evaluations of these large-scale research facilities, in addition to their overall scientific concept, the scientific achievements associated with them and the technical equipment they provide. The reviews proceeded in an extremely positive manner and provided a number of highly valuable insights regarding future use. Based on the results, the centres will receive adequate funding to operate the positively evaluated research infrastructure. The funding levels take expected price increases into account.

The most important question: Are we doing the right things – and are we doing them right?

As regards the review of in-house research carried out within the programmes themselves (Performance Category I, or PC 1), the tasks performed by the reviewers were further developed and more precisely defined. The evaluation of scientific quality takes into account scientific expertise and originality as well as the innovative potential of new technologies and developments. The assessment of strategic relevance concentrates above all on the selection of topics, on the coherent makeup and coordination of processes, content and expertise, as well as on programme management as a whole. In addition, contributions to the objectives of the Joint Initiative for Research and Innovation are considered, including not only new collaborative structures – particularly those with university partners – but also the overall collaborative culture (degree of development, international scope and importance for the visibility of the entire programme). Other important points are the contribution made by the programmes to training and supporting young scientists and to transferring findings to industry and society. Finally, the programme applications were supplemented by descriptions of multidisciplinary activities – i.e., cross-programme research topics that in many cases also span different research fields at the Helmholtz Association. These are of special importance to the association because major future challenges such as demographic change, climate change and the clean energy revolution cannot be tackled without inter- and transdisciplinary approaches. A programme spokesperson is responsible for coordinating such activities. A separate review was carried out for the cross-programme initiative "Personalised Medicine" for which an annual funding of five million euros has been reserved from the research field Health.

The most important objective: Today we are good – tomorrow we are better!

A total of 13 programme applications were submitted, as were seven applications for large-scale research infrastructure and the application for the above-mentioned

The review process at GEOMAR at the start of the third round of programme-oriented funding in spring 2013. *Photo: Jan Steffen/GEOMAR*

Personalised Medicine initiative. The evaluations took place between January and April 2013 as part of an international peer-review process involving 46 female and 134 male experts. Based on the results, financing recommendations were made for the programmes and/or the centres participating in them. In addition, particularly relevant "strategic recommendations" were formulated that will be especially important for the improvement of individual programmes in the future and whose implementation will be monitored on an annual basis by the Helmholtz Senate.

The results of this first round of reviews confirmed all the programmes' outstanding scientific quality and performance, which in some cases is unique in the world. In the research field Earth and Environment, activities deserving special attention include the long-term studies by terrestrial and marine observatories and by satellite-based systems. Polar research also continues to be world-class, benefiting from unique research infrastructure such as the Neumayer Research Station in Antarctica and the *Polarstern* vessel. Finally, with the addition of the GEOMAR centre in Kiel, the association has acquired an ocean research programme that received consistently high marks from the experts. Research networks are playing an increasingly important strategic role, whether at the national level (e.g., the REKLIM climate initiative) or at the international level (e.g., the Water Initiative). The growing trend toward effective collaboration and integration is also evident in the pursuit of five multidisciplinary topics, ranging from the bioeconomy and disaster forecasting to climate, water and mineral resources.

Significant advances and internationally unique activities are also hallmarks of the research field Health. The entire range of basic research was judged to be outstanding by international standards. The strategy of swiftly developing potentially relevant findings for clinical applications and creating suitable structures and strategic research alliances to achieve this goal has invested this research field with an extraordinary dynamism. The contributions made by the Helmholtz centres to the German Centres for Health Research, formed with numerous university partners, have also been positively evaluated by the reviewers. Medical imaging techniques and immunological research are additional highlights. Moreover, in order to develop less invasive and more targeted options for treatment, the field of health research is devoting itself to cross-programme activities, particularly to the field of personalised medicine. The National Cohort was seen as being extremely important for all of these research topics in both strategic and scientific terms.

As concerns the research field Aeronautic, Space and Transport, the scientific quality of the three programmes was judged to be extremely high by national and international standards. Among other things, the reviewers underscored the increasingly important field of safety and security research, which pools the expertise of all three programmes and is continuing to expand its activities. The researchers' holistic view of the air transport system continues to be regarded as one of the field's key differentiators. Finally, the reviewers identified three areas in which the research field is a world leader: Earth observation, space exploration and robotics. The transport programme is undergoing a highly dynamic phase of development, particularly with regard to its overall systems approach and tasks ranging from the prediction of mobility trends to the development of innovative mobility solutions.

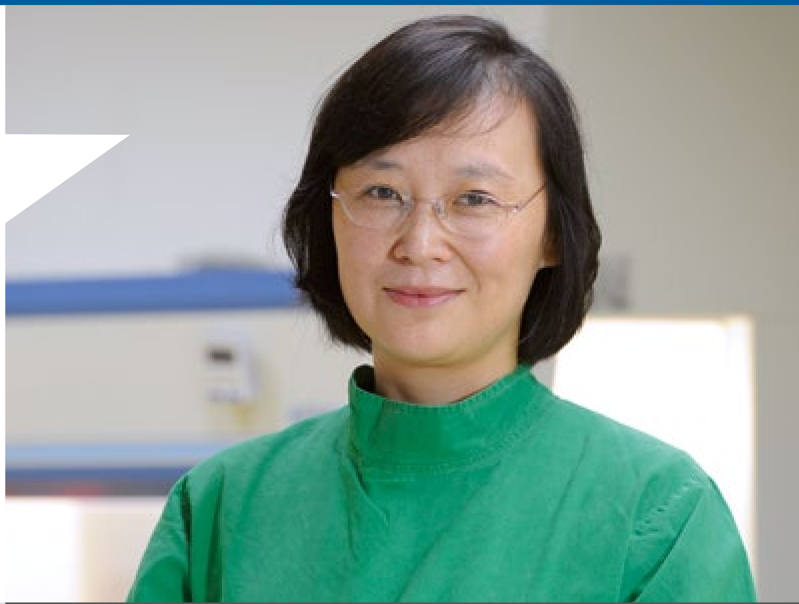
All told, the first phase of programme reviews in 2013 was highly successful and produced a large number of results that are important for the further strategic planning and improvement of the programmes. Seventeen programmes in the fields of energy research, key technologies research and research into the structure of matter will be reviewed in 2014. Preparations are already in full swing.

DIVERSITY

“The research conducted at the Institute of Biomaterial Science focuses on the polymer-based biomaterials used to develop new therapeutic approaches in regenerative medicine. Biomaterials offer tremendous application potential – e.g., as both scaffold and carrier materials for cell cultivation and organ support. At the Biocompatibility Department we are exploring the interaction between stem cells and biomaterials and investigating the effects of chemical and physical stimuli on cell survival capability. Our goal is to guarantee the materials’ compatibility with cells.”

ADJUNCT PROFESSOR NAN MA

Head of the Biocompatibility Department, Institute of Biomaterial Science, Helmholtz-Zentrum Geesthacht



“We are doing research to detect dementia at an early stage. With this goal in mind, we are investigating specific brain structures and endogenous substances that are the first signs of the disease often many years in advance. We are looking for reliable biomarkers of dementia and employing high-resolution MRI devices in order to make early diagnoses, which are important for both new preventive strategies and treatments. Our goal is to help people – ideally before the onset of the disease.”

PROFESSOR EMRAH DÜZEL

Speaker of the DZNE site Magdeburg, Head of the Institute of Cognitive Neurology and Dementia Research, University Hospital Magdeburg

“In order to recognise changes in the brain that result from disease, we must understand the healthy brain. However, it is important to keep in mind that every brain is slightly different. Our three-dimensional brain atlas will help us to meet this challenge. We have already mapped out 70 per cent of the human brain and are making the atlas available to the public.”

PROFESSOR KATRIN AMUNTS

Director of the Institute of Neuroscience and Medicine, Forschungszentrum Jülich

CURRENT HELMHOLTZ RESEARCH PROJECTS

"As infection epidemiologists, we study the effect of pathogens on the population. Our findings can help to prevent infections or at least to detect and control them early on. The work we are doing at our Hanover centre as part of the National Cohort is particularly promising for studying the long-term links between infectious and non-infectious diseases."

PROFESSOR GÉRARD KRAUSE
Director of the Epidemiology Department, Helmholtz Centre for Infection Research

"Our population is ageing and facing major health challenges. The lives of older people are often severely impacted by multiple illnesses, the loss of functional ability and mental health impairments. In our 'KORA Age' study we are examining the relationship between the health of people older than 65, on the one hand, and their behaviour and environment, on the other. Our goal is to determine the factors that make it possible to grow older in a healthy way and be content with life."

PROFESSOR ANNETTE PETERS
Director of the Institute of Epidemiology II, Helmholtz Zentrum München

"We studied how much exercise women need in different stages of their lives in order to lower the risk of breast cancer. For this purpose we examined the physical activity of women aged 30–49 and those older than 50. We found that exercise pays off, especially in old age. Women who engage in regular physical activity after menopause reduce their risk of postmenopausal breast cancer by about one-third compared to women who get no exercise at all."

PROFESSOR KAREN STEINDORF
Exercise and Cancer Working Group, Department of Preventive Oncology, German Cancer Research Center

RESEARCH FIELD ENERGY

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

GOALS

The Helmholtz scientists involved in the field of energy research are working to secure an economically, ecologically and socially sustainable supply of energy. They are examining the relevant conversion, distribution, utilisation and storage technologies, studying system relationships and social factors and taking climatic and environmental impacts into account. One important goal is to replace fossil and nuclear fuels with sustainable climate-neutral energy sources. For this purpose researchers are seeking to determine the potential of renewables such as solar, biomass and geothermal energy. They are also working to increase the efficiency of conventional power plants and energy use as a whole. Finally, the Helmholtz Association is researching nuclear fusion in order to develop a new source of energy over the long term, and its scientists are experts in the area of nuclear safety and final repository research.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

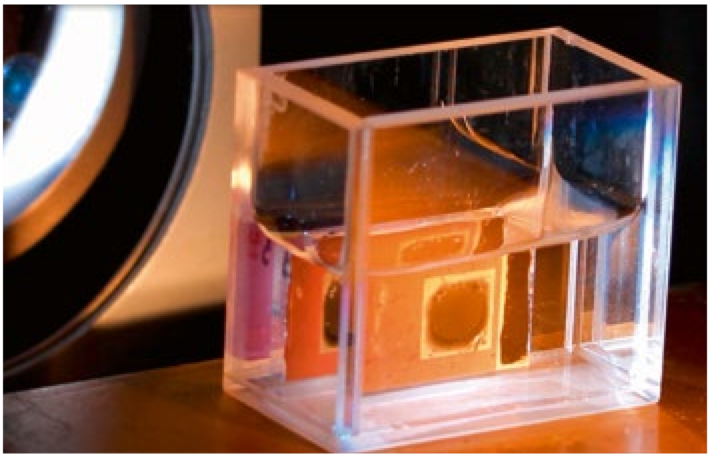
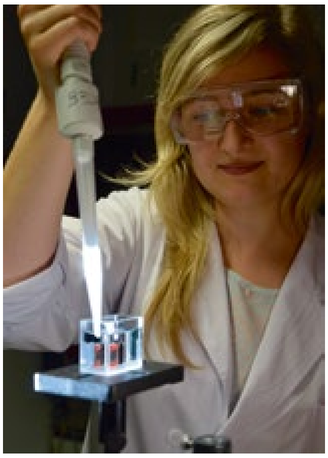
Eight Helmholtz centres are currently working in the field of energy research, which is divided into five research programmes:

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

These programmes are implemented in interdisciplinary working groups and international collaborations. The association provides research infrastructure, resources for large-scale experiments, pilot facilities, test systems for large components, high-performance analysis systems and high-capacity computers.

OUTLOOK

The *Energiewende*, or energy turnaround, is one of the greatest challenges facing present and future generations. In its 6th Energy Research Programme, the German government is focusing on 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, by providing expertise and experience in the identified key fields, it is making a major contribution to its implementation. In addition, the association is closing research gaps and carrying out both basic and application-oriented research. Technological research is supplemented by socioeconomic studies in order to optimise energy systems with respect to all social, economic and political factors.

Diana Stellmach has developed a stable monolithic structure that splits water molecules using light and does not corrode in the process. *Photos: HZB (left)/Andreas Kubatzki (right)*

POLYMER-COATED CATALYST PROTECTS "ARTIFICIAL LEAF"

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB): Solar energy is readily available on Earth, but only as long as the sun shines. Scientists at the HZB Institute for Solar Fuels are developing solutions to store solar energy in hydrogen fuel.

After all, hydrogen stores energy in chemical form and has a wide variety of applications. It can be used directly as a fuel or can be efficiently converted into electricity in fuel cells. Hydrogen can be derived from the electrolytic decomposition of water molecules into hydrogen and oxygen, a process that requires two electrodes coated with suitable catalysts and a minimum voltage of 1.23V flowing between them. Hydrogen is of particular interest when solar energy can be used to produce it.

To achieve this goal, a working group led by Sebastian Fiechter is using photovoltaic structures consisting of several ultrathin silicon layers that are custom-made at the Photovoltaics Competence Centre of Berlin – another HZB institute. The advantage of these photovoltaic cells is their so-called superstrate architecture: "Light enters the transparent front contact that is deposited on the substrate glass. There is no opacity from mounted catalysts," explains Diana Stellmach, a doctoral student on the team. In fact, the catalysts are located on the rear of the solar cell, where they are in contact with the corrosive water/acid solution. Because the cell with the catalysts and contacts consists of a single piece of material, it is known as a monolithic system. The cell functions like an artificial leaf. When sunlight falls on it, gas bubbles rise on the two contacts coated with catalysts as the water is broken down into its components. But there is one major problem: the solar cell is located in acidic water, which corrodes it over time.

Diana Stellmach has come up with a new solution to prevent this corrosion. She mixed nanoparticles of ruthenium dioxide, which accelerate the production of oxygen, with a conductive polymer and applied this mixture to the cell's rear contact as a catalyst. Similarly, she coated the site of hydrogen production with platinum nanoparticles. This sealed the cell's sensitive contacts against corrosion.

All told, this "artificial leaf" achieved an efficiency level of 3.7 per cent and remained stable for at least 18 hours. "This made Diana Stellmach the first scientist in Europe to create a solar cell structure capable of splitting water molecules," says Sebastian Fiechter. And perhaps she was even the first in the world – comparable solutions by rivals have proved far less stable than hers. *HZB*

The InnovaRig deep drilling rig (left) and the rotary bits on the head of the drill pipe. *Photos: GFZ*

GEOTHERMAL ENERGY – TAPPING A SOURCE BELOW THE EARTH'S SURFACE

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences: Wind power, solar and biogas are playing an increasingly important role in the energy supply. Geothermal energy is less popular, but still remains one of the world's most widely used sources of renewable energy today. Unlike solar or wind, it is available around the clock almost anywhere in the world – regardless of climate, time of day or season. "This is why geothermal energy is particularly interesting for base-load power supply in addition to its use for heat recovery," says Ernst Huenges, head of the International Centre for Geothermal Research at GFZ.
At the Groß Schönebeck geothermal research station in Brandenburg, Huenges and his team are studying efficient and secure ways to produce electricity and heat from deep geothermal energy. In the laboratory in Groß Schönebeck, which is unique in the world, GFZ researchers can examine the properties of large ground structures under natural conditions. "Groß Schönebeck is an excellent reference site because the geological conditions are representative of those in large parts of Central Europe," Huenges says. "The methods used here can be applied to regions with a similar geology. Groß Schönebeck is thus an important pilot project for the development of geothermal technology."
Groß Schönebeck features two wells more than four thousand metres deep. The rock deep in the Earth is very hot and heats the water in the ground to a temperature of around 150 degrees Celsius. In order to use geothermal energy, the hot water is pumped through a well to the surface, where the heat is extracted via a heat exchanger and can be used to supply heat or generate electricity. The cooled water is returned to the ground through the second well. It once again flows through the hot rock below the surface, absorbs the heat and is pumped back up. As Huenges explains, "Geothermal energy is virtually inexhaustible and is therefore a highly sustainable method of energy production. Basically, we're just borrowing the water, cooling it and returning it to the same site." In terms of the basic concept, this is very environmentally friendly, he says, but the pumping process alone represents an intervention in the system and has to be done very carefully. Because the underground rock is usually not very permeable and ill suited for geothermal energy production, the areas below the surface must first be "stimulated": large quantities of water are injected into the rock under high pressure in order to fracture the stone. The water can then circulate through and be removed from the extensive system of cracks – also known as an "enhanced geothermal system" (EGS). Huenges explains: "We are studying the technologies and processes of deep geothermal energy to achieve the greatest possible efficiency and, of course, to ensure the safe and environmentally friendly use of this resource." The GFZ takes a holistic approach to research, considering all steps of deep geothermal energy production. Furthermore, it has close ties with international partners, as joint projects with Indonesia, Japan and Iceland show. "We are laying the foundation for robust risk management," says Huenges. "Geothermal energy technology is currently in an early stage of development, but it has great innovative and developmental potential to supply energy in the future." If scientists succeed in tapping into this potential, geothermal energy could make an important contribution to a sustainable energy mix. *si*

"One of the great challenges of the present day is to provide safe, affordable and environmentally friendly energy and to use it efficiently worldwide. As a future member of the Helmholtz Senate, I look forward to supporting Helmholtz scientists in meeting this challenge and developing the scientific foundations, technical solutions and innovative concepts for tomorrow and beyond."

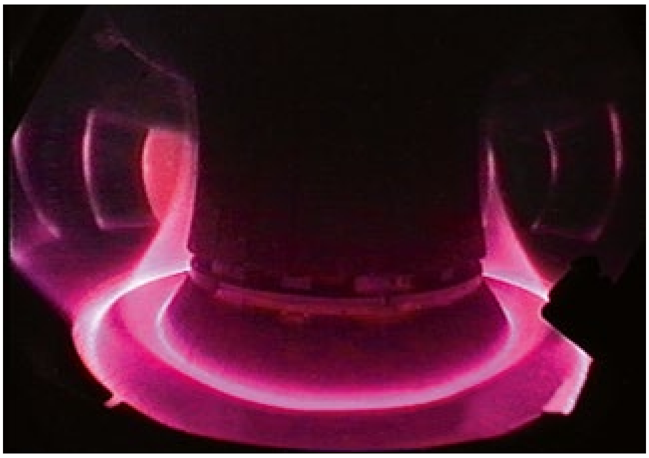
DR. SIEGFRIED DAIS
Member of the Helmholtz Senate

Partner at Robert Bosch Industrietreuhand AG

DLR scientists checking the temperature profile of an experimental thermochemical storage unit.
Photo: DLR (CC-BY 3.0)

ENERGY – FUTURE SCENARIOS

German Aerospace Center (DLR): What do scenarios and oracles have in common? Both provide us with a glimpse of the future. But unlike oracles, scenarios are developed according to scientific criteria. They predict possible future developments and describe alternative situations and the paths that could lead to them. Under the direction of the DLR Institute for Technical Thermodynamics, scientists have examined a variety of realistic ways Germany could establish a climate-friendly energy system as part of the study "Long-Term Scenarios and Strategies for the Expansion of Renewable Energies in Germany".
They have based their calculations on the federal government's current energy concept and the set of laws associated with the Energiewende, or clean energy revolution. Their scenarios illustrate possible ways of achieving the goal of using renewable resources to meet more than 80 per cent of heating and transportation energy needs by 2050.
The scientists have concluded that a fundamental restructuring of energy supplies is possible, but Germany needs to achieve its energy-saving policy targets and quickly and reliably expand the use of renewable energy sources. According to the scientists, by 2025 this transition could be far enough along to have considerable positive effects on the economy. They have assumed that the price of fossil fuels will continue to rise. "Electricity will play a larger role in the future, particularly in the transport sector but also in industry. In the long run it will be necessary to convert electricity into hydrogen or other synthetic fuels like methane in order to replace fossil fuels. In addition, electricity and heat must be used far more efficiently – for example, through the systematic insulation of buildings," says Thomas Pregger, coordinator of the pilot study at the DLR. *ckw*



A view of the plasma inside the ASDEX Upgrade fusion facility, which reaches temperatures of many million degrees. *Photo: IPP*

Superconducting cables transmit large amounts of electricity with low power loss. Nexans and KIT are optimising cable structures to meet the requirements of various applications. *Photo: Nexans*

RECORD-BREAKING EXPERIMENTS AT THE ASDEX UPGRADE FUSION FACILITY

Max Planck Institute for Plasma Physics (IPP): Research on fusion power plants is going full pelt. After all, such plants could play an important role in the generation of heat and power in the future. The ASDEX Upgrade (Axially Symmetric Divertor Experiment) fusion facility at the IPP, the largest of its kind in Germany, currently holds a world record: "In relation to the device's radius, we were able to achieve a world record of 14 megawatts of heating power per metre without thermally overloading the wall," says Arne Kallenbach, the project's director.

The meaning of thermal overload in fusion research can be illustrated by one number: the plasma reaches temperatures of 100 million degrees. In order to keep it from destroying the wall during fusion, Kallenbach and his team have developed a special cooling technique that involves injecting argon and nitrogen between the wall and the plasma. As a result of the high temperatures, the gases begin to glow; heat energy is converted into light energy and the plasma edge is cooled. "By controlling the gas supply on a real-time basis, we can precisely adjust the heat flow," says Arne Kallenbach. "As a result, the heat load remains low despite the high heating power." In addition, the plasma in the centre exhibits the desired purity, temperature and heat insulation.

ASDEX Upgrade closely approximates the conditions in the international ITER research reactor that is currently under construction. ITER's heating power will be about 150 megawatts. The radius of the fusion plant will be about four times as large as that of ASDEX Upgrade. "To make successful predictions about the conditions in the ITER reactor, we will need to work with a quarter of ITER's capacity at the ASDEX Upgrade ," says Kallenbach. "We've already achieved about one-eighth and are hopeful that we will reach the desired one-quarter in the coming years." *si*

SUPERCONDUCTING CABLES FOR THE FUTURE POWER SUPPLY

Karlsruhe Institute of Technology (KIT): "AmpaCity could pave the way for restructuring urban power grids," says Mathias Noe, director of KIT's Institute for Technical Physics. In late 2013, the world's longest superconducting cable will be put into operation within the framework of the joint AmpaCity project, carried out by the RWE Group, Nexans and KIT. This superconducting cable, which is approximately one kilometre long, has a transmission capacity of 40 megawatts and will be installed in the city of Essen. KIT will provide scientific support for the project, which will run over four and a half years.

A superconducting cable carries roughly five times as much electrical current as a similarly sized copper cable, but with less power loss. To achieve high conductivity, the superconducting cables need to be cooled. This is done by pumping liquid nitrogen through the cable. "At KIT we have both the expertise and laboratory equipment to carry out theoretical and experimental studies of the complex alternating current behaviour of superconducting cables," says Noe. "In order to optimise new configurations, we have developed a model and set up a new test station as part of the project. These can be used to analyse the loss of alternating current in the superconductor with great precision."

Superconducting cables have the potential to simplify urban power infrastructure and, by eliminating the need for large transformer stations, to reduce land use. "As far as investment and operating costs are concerned, we have conducted a study that shows that superconducting cable systems can be less expensive than conventional systems using high-voltage copper cables," says Noe. "Through our research we hope to provide an important foundation for the power supply of the future." *si*

The Tayler instability slows down neutron stars in space; in large liquid metal batteries it can cause short circuits. Scientists first demonstrated this magnetic phenomenon in the laboratory using this experiment array at the HZDR – pictured here with doctoral candidate Marco Starace. *Photo: Frank Bierstedt/HZDR*

USING KNOWLEDGE ABOUT SPACE FOR BATTERY DESIGN

Helmholtz-Zentrum Dresden-Rossendorf (HZDR): Batteries are in great demand, not least to ensure that solar and wind power is available when there is little sun or wind. Suitable battery concepts are under study, particularly for portable applications. However, researchers at the HZDR led by Tom Weier and Frank Stefani are convinced that batteries are also well suited for stationary applications and will become increasingly important within the framework of the clean energy revolution. They have a special type of battery in mind as well, one made of liquid metal. “Due to the high current densities in liquid metals, they can quickly store and discharge electricity,” says Weier. “This is why these batteries are especially well suited for storing electricity during the power peaks generated by renewable sources under favourable conditions.”

The batteries have a simple design: two liquid metals such as magnesium and a magnesium-antimony alloy serve as the negative and positive electrodes. They are separated by a molten salt electrolyte that contains magnesium as well. Due to their different densities, the liquids automatically arrange themselves into three layers.

During the discharging process, magnesium ions move from the electrolyte to the antimony alloy, where they attach to antimony atoms. Ions from the magnesium anode migrate to the electrolyte. The electrons that are released in this process flow outside the battery as electricity. When the battery is charged, electrons are added to the magnesium and magnesium ions migrate from the electrolyte to the magnesium electrode. In the magnesium alloy, magnesium-antimony compounds break up and magnesium ions return to the electrolyte. The temperatures of several hundred degrees Celsius that are needed to keep the metals liquid are generated in the salt layer when the battery is charged and discharged. This is why the battery is well suited for the rapid alternation between these two processes.

The underlying principle of the liquid metal battery was developed in the United States in the 1960s. “The concept is especially advantageous when building large batteries covering an area of several square metres,” says Tom Weier. The reason: production costs are reduced. However, problems can arise due to the stronger current. All electrical currents produce a magnetic field around themselves. If this field exceeds a certain size, currents form within the liquid metal that in the worst-case scenario can agitate the three liquid layers, resulting in a short circuit. Frank Stefani is familiar with this phenomenon from a completely different context. Known as the Tayler instability and first theorised in 1973, it plays an important role in processes in space such as cosmic jets and collapsing stars. It is only recently that the Dresden researchers – collaborating with colleagues from the Leibniz Institute for Astrophysics in Potsdam – have been able to demonstrate it for the first time in the laboratory.

Tom Weier and Frank Stefani have come up with an idea to solve the scaling problem for the novel battery type. An insulating pipe is installed in the middle of the cylindrical battery. The pipe contains a copper cable that conducts the current generated during the charging and discharging phases in the reverse direction. The magnetic field thus created can compensate for the field in the liquid metal to such a degree that the Tayler instability does not occur. The Dresden researchers have patented this solution and are currently testing it on a small scale using a gallium-indium-tin alloy that is liquid at room temperature. “Battery experiments are planned, but they will be considerably more demanding due to the high temperatures involved,” says Weier. *ud*

RESEARCH FIELD EARTH AND ENVIRONMENT

PROFESSOR GEORG TEUTSCH
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Earth and Environment,
Helmholtz Centre for Environmental Research – UFZ

GOALS

The Helmholtz scientists involved in the research field Earth and Environment examine the basic functions of the Earth system and interactions between society and nature. They focus on expanding and interconnecting long-term observation systems, improving predictions and transferring outcomes efficiently to stakeholders and society. They formulate knowledge-based policy recommendations on how the Earth's resources can be used in a sustainable fashion without destroying the foundations of life. REKLIM, an example of a Helmholtz climate initiative, is bringing together the expertise of eight Helmholtz centres in an effort to improve regional and global climate models. Establishing and operating infrastructure and facilities such as the HALO research aircraft and the TERENO network with its four terrestrial observatories in Germany are further important aims of the Helmholtz research field Earth and Environment. Within the scope of the COSYNA project, a long-term observation system will be created for the German North Sea and later extended to Arctic coastal waters.

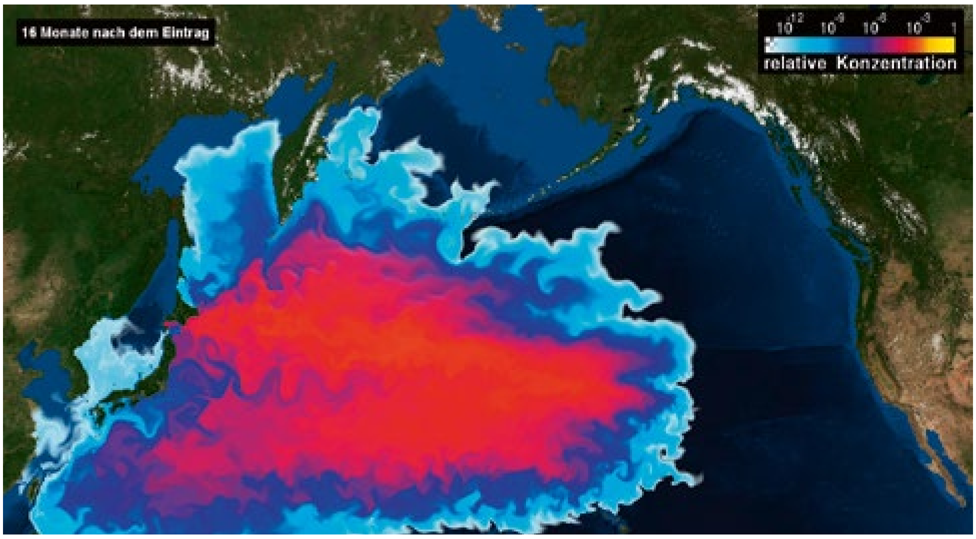
PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Eight Helmholtz centres are currently participating in the research field Earth and Environment. Research is carried out in four programmes:

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

OUTLOOK

To meet the current challenges, the research field Earth and Environment will continue to pool the capacities of the participating centres within shared research portfolios. This strategy will lead to new alliances and facilitate the expansion of Earth observation and knowledge systems as well as integrated modelling approaches. The interdisciplinary portfolio project “Earth System Knowledge Platform – Observation, Information and Transfer” is integrating the knowledge acquired by all the centres in this research field and by their partners. It aims at helping society to cope with the complex challenges brought about by changes in the Earth system. In the next programme period (2014–2018), the research field will be supported by the new programme “Oceans: From the Deep Sea to the Atmosphere”.



Simulated distribution of radioactivity in the Pacific Ocean 16 months after the Fukushima reactor disaster. *Graphic: GEOMAR*

FUKUSHIMA – WHERE IS THE RADIOACTIVE WATER?

GEOMAR Helmholtz Centre for Ocean Research Kiel:
The nuclear reactor disaster that took place on Japan's west coast in March 2011 was the worst in recent decades. In the weeks afterwards, large amounts of radioactivity, including long-lived isotopes such as the highly water-soluble caesium 137, entered the atmosphere and ocean. In a complex model simulation, GEOMAR scientists have calculated the long-term distribution of radioactively contaminated water across the entire Pacific over a period of ten years.
The researchers assumed that in fall 2013 – about two and a half years after the disaster – the first wave of radioactive seawater would lap the shores of the Hawaiian Islands approximately 6,500 kilometres away. Two years later the contaminated water could then reach the city of San Francisco on the coast of North America, covering a distance of over 10,000 kilometres in five years.
The computer simulations created by the research team led by Claus Böning provide detailed information on the strength of the currents and the influence of the wind and waves. Immediately after the disaster, the Kuroshio Current off the Japanese coast quickly transported and distributed the contaminated water far out into the North Pacific. In addition to the main current, strong and highly variable eddies are also influencing the distribution of the radioactive water. Moreover, each year winter storms churn up the ocean water to a depth of 500 metres. In the model's calculations, all these factors lead to a rapid decrease in caesium concentrations in the water.
However, further dilution will be significantly slowed in the future by oceanic eddies that are much weaker in the eastern Pacific than they are in the Kuroshio region. This means that for years to come radiation levels in the northern Pacific will remain significantly higher than levels measured before the disaster. The differences in ocean mixing become particularly clear when radiation values from the Pacific model are compared to Baltic Sea conditions. "The amount of radioactivity that flowed into the Pacific in March and April 2011 was at least three times as high as the amount entering the Baltic in 1986 as a result of the Chernobyl disaster," says Böning. "Nevertheless, the radiation values simulated for the Pacific are now of the same magnitude as those that are still measured today in the Baltic Sea, 27 years after Chernobyl." *ckw*

PROGRAMMES IN THE COMING FUNDING PERIOD 2014–2018

The Geosystem Programme

This programme analyses processes in the geosphere and their interaction with the hydrosphere, atmosphere and biosphere. Long-term goals include monitoring, modelling, understanding and evaluating key processes, creating solutions and strategies to prevent disasters, and developing geotechnologies for the utilisation of underground space. To attain these goals the programme utilises satellite missions, airborne systems, permanent global geophysical and geodetic networks, regional observatories, deep drilling rigs, mobile instrument pools and analytical and experimental facilities.

How can today's cities be redesigned so that they can better meet future needs? The demolition of large housing developments provides opportunities to create new buildings and more green areas. *Photo: André Künzelmann/UFZ*

These children are looking to the future with confidence. Currently, the population in their countries in the Middle East is still growing. However, UN forecasts suggest that as these countries become more developed, this trend will change. *Photo: André Künzelmann/UFZ*

WHAT ARE THE CONSEQUENCES OF DEMOGRAPHIC CHANGE?

Helmholtz Centre for Environmental Research – UFZ: Demographic change is transforming Germany. People are having fewer children and living longer. They are moving from the countryside to the city, settling in economically better off regions and changing their lifestyles. Entire areas are becoming depopulated. What new challenges will these changes bring and how can they best be dealt with? Scientists at the Helmholtz Centre for Environmental Research – UFZ are searching for answers to these questions.
Urban sociologist Sigrun Kabisch and her colleagues are interested in, for example, the future of cities. This will vary widely by region in Germany. Whereas Munich, Hamburg and Berlin are continuing to attract new residents, the populations of medium-sized cities in northern Bavaria, the Ruhr region and eastern Germany are shrinking. The researchers are attempting to determine the consequences of these trends using the Leipzig district of Grünau as an example. Its original population of 85,000 has declined by 40,000, which has led to significant changes in its appearance: many buildings have been demolished and small forests have been planted in the open areas left behind.

However, demographic change will affect not only cityscapes but also infrastructure. There will be a greater demand, for example, for more flexible wastewater treatment plants that can adapt to shrinking population numbers. A team led by the economist Erik Gawel is currently investigating the political and economic policies required to ensure infrastructural adaptability, while a group of environmental technologists headed by Roland Müller are working on solutions to wastewater disposal problems in specific regions.
Nevertheless, even the most sophisticated waste management concepts will not be able to remove all the unwanted substances from wastewater. Pharmaceutical residues often pass through treatment plants unimpeded and flow into the nearest river. Ecotoxicologist Rolf Altenburger expects that the composition of this chemical cocktail will also change in the future. After all, the demand for certain types of drugs is likely to increase in our ageing society: we will be using more blood thinners, cancer drugs and potency pills. No one can say exactly what consequences this will have for the environment. This means that demographic change will provide many interesting research topics for aquatic ecologists as well. *UFZ*

PROGRAMMES IN THE COMING FUNDING PERIOD 2014–2018

The Marine, Coastal and Polar Systems Programme

This programme concentrates on changes in the Arctic and Antarctic, their interaction with the global climate and polar ecosystems, vulnerable coasts and shelf seas, the polar perspective of Earth system analysis, as well as the relationship between science and society. It provides insights into climate variability and regional climate change, sea-level change as an element of risk analysis within the Earth system, and the transformation of coastal and polar ecosystems. It also lays the scientific foundation for answering pressing questions in society about the social and economic impact of climate change on our environment. The new programme topic – the interaction between science and society – focuses on how research findings can be effectively integrated into information and decision-making processes in society as a whole.

"Another aspect of Earth and environmental research is the interaction between nature and society. Here we find many of the main focuses of the observation systems designed to facilitate improved forecasts of the long-term impact of human beings on the environment, water and land. These systems must be expanded and more effectively interconnected. What we need most of all are knowledge-based policy recommendations on how the Earth's resources can be used in a sustainable fashion without destroying the foundations of life. This is the starting point for basic research at the Helmholtz Association."

PROFESSOR KLAUS TÖPFER
Member of the Helmholtz Senate

Executive Director of the Institute for Advanced Sustainability Studies, Potsdam

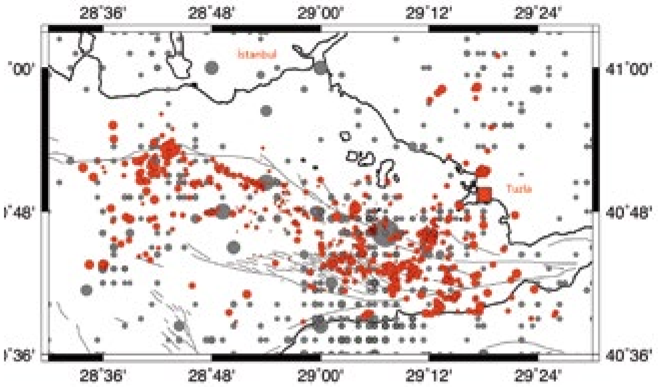
The Research Vessel *Polarstern* moored to an ice floe so that expedition members could study Arctic ice close up. *Photo: Meereisgruppe/AWI*

THE ARCTIC – AN OCEAN IN TRANSITION

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI): With its deep waters the Arctic Ocean is one of the last unexplored regions on Earth. Nevertheless, satellite images of sea ice have revealed just how quickly the ice extent is shrinking due to the warming of the atmosphere. An international research team led by Antje Boetius, who heads a joint Helmholtz/Max Planck research group at the AWI, has examined the impact of melting ice on the ecosystem. On an expedition aboard the *Polarstern* research ship, the researchers observed for the first time that the entire ecosystem, including deep sea zones, is responding with astonishing speed to the changes. *Melosira arctica*, a species of ice algae that forms long chains on the bottom of the ice floes, is playing a central role. In 2012 ice algae made up almost half the biomass formed on the sea ice in the central Arctic. When this icy habitat melts, the algae quickly sink to the sea floor thousands of meters below. Patches of algae now cover up to ten per cent of the ocean floor. Deep sea animals such as sea cucumbers and brittle stars feed on the algae, with bacteria metabolising the rest. In this area of the ocean floor, the oxygen content in the sediment is decreasing dramatically.
"These low-oxygen zones are alarming," says Boetius. "But we know too little about the Arctic ecosystem to predict the consequences." *ckw*

The Oceans Programme

Oceans cover 70 per cent of the Earth's surface. Deep oceans, in particular, are difficult to access and are still largely unexplored. This interdisciplinary programme examines the physical, chemical, biological and geological processes in oceans as well as the interactions between these processes and both the ocean floor and the atmosphere. It focuses on the role of the ocean in climate change, human impact on marine ecosystems, the possible use of the oceans' biological, mineral and energy resources, and the potential risks of geodynamic processes in oceans and deep seas. It is divided into the topics "Ocean Circulation and Climate", "Ocean Warming, Acidification and Deoxygenation", "Marine Biodiversity and Ecosystem Evolution", "The Dynamics of Ocean Floor", "Natural Hazards" and "Natural Resources".



The eastern Marmara Sea with the sites of the earthquakes that have taken place over the last hundred years (gray) and the micro-quakes (red) recorded between 2006 and 2010 by the monitoring system on the Princes' Islands. Using the measurement data from the GONAF borehole, scientists are now able to detect much smaller quakes. *Graphic: GFZ*

Fluorescent microplastic particles, visible as small light-blue dots in the intestine of a marine isopod. *Photo: Julia Hämer/AWI*

THE MEGACITY OF ISTANBUL – A CRITICAL EARTHQUAKE ZONE

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences: Only 15 to 20 kilometres from the historic centre of Istanbul, earthquake researchers including Marco Bohnhoff from the GFZ, his team, as well as Turkish colleagues from the Kandilli Earthquake Observatory, have identified a hooked-shaped zone below the Earth's surface that could become the starting point of a powerful earthquake. Here the Anatolian tectonic plate is shifting westward along the Eurasian plate. "The area is under extreme pressure. Any earthquake that occurs is likely to have a magnitude of at least seven," says Bohnhoff. "But no one can say when this will happen."

In 2006 the GFZ researchers built a seismic monitoring network on the Princes' Islands – a small archipelago near the Bosporus – in order to learn more about the events leading up to earthquakes and to gain a better understanding of the possible effects of a quake on Europe's only megacity with more than 13 million residents. Istanbul lies on the northern shore of the Marmara Sea, and together with the Turkish Disaster and Emergency Management Presidency, the researchers are currently drilling several boreholes at sites around the sea's eastern boundaries and equipping them with highly sensitive seismometers. Bohnhoff explains, "They are bringing us closer to the earthquake zone than ever before and will provide us with a very accurate picture of the possible starting point of potential earthquakes." *ckw*

MICROPLASTICS – AN UNDERESTIMATED RISK

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI): Plastics became popular across the world decades ago, but the price we are paying for its use is only now becoming clear. Increasing amounts of plastic waste end up in the world's oceans. As a result of chemical and physical ageing processes, this plastic breaks down into smaller and smaller fragments, resulting in the accumulation of microplastic in the oceans. Researchers cannot adequately predict the effects of this microplastic on human health and the marine environment because fundamental knowledge is lacking in this area. This is why AWI researchers are developing standardised methods to learn more about its quantity, origins, distribution and potential risks. As part of the MICROPLAST project, which is supported by the Federal Ministry of Education and Research, biologists from the AWI are using infrared spectroscopic methods on the island of Helgoland to determine the properties and occurrence of microplastics. They are studying its molecular composition and showing which toxic substances are present in the microplastics or build up on its particles. Experts at the AWI in Bremerhaven are studying whether bound contaminants end up on our plates via the food chain. Using a marine isopod as an example, they have shown that crabs excrete ingested microplastics. However, other species such as mussels store the microplastic taken in through their digestive systems, where it can trigger inflammations. *ckw*

PROGRAMMES IN THE COMING FUNDING PERIOD 2014–2018

Atmosphere and Climate Programme

The goal of this programme is to better understand the function of the atmosphere within the climate system. For this purpose scientists will carry out extensive measurements of atmospheric parameters, perform laboratory tests and create numerical models of processes that play an important role in the atmosphere. Research focuses include high-resolution satellite measurements of tropospheric trace gases and studies of the role of the middle atmosphere within the climate system, the variability of biogenic emissions, and the use of atmospheric water isotopes for a better understanding of the water cycle. The programme is divided into four topics: "Clouds and Weather Research to Improve Forecasts and Regional Climate Models", "Land Surface Processes in the Climate System", "Tropospheric Trace Gases and Regulatory Chemical

The GLORIA infrared spectrometer can measure greenhouse gases in the atmosphere with unprecedented precision.
Photo: Forschungszentrum Jülich

GLORIA – AN EXPERIMENT UNIQUE IN THE WORLD

Karlsruhe Institute of Technology (KIT): "For a better understanding of climate change, we need to examine the atmosphere – after all, it is here that the key changes are taking place," says Johannes Orphal from the Institute of Meteorology and Climate Research at KIT. A new infrared spectrometer called GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere) will provide assistance – it is capable of measuring the distribution of atmospheric gases with unprecedented precision.

GLORIA was jointly developed by KIT and the Forschungszentrum Jülich within the framework of a Helmholtz investment programme. In the summer of 2012 it was deployed during TACTS (Transport and Composition in the Upper Troposphere/Lowermost Stratosphere), the first atmospheric mission of Germany's new HALO research aircraft. As Martin Riese of the Jülich Institute of Energy and Climate Research says, "An important task was to stabilise GLORIA so that its high-precision optical measurements were not affected by the motion of the aircraft." To this end the researchers equipped the three-axis suspension system with sensors and motors that held GLORIA in the desired position using active counter-adjustments.

Flying at an altitude of five to sixteen kilometres en route from the Arctic to the Antarctic, GLORIA collects data on atmospheric trace gases such as carbon dioxide, methane, ozone, water vapour and various nitrogen and halogen compounds. This involves measuring the thermal radiation emitted by the gas molecules in high resolution. With the help of a 2D infrared detector array, it also records the spatial distribution of the atmospheric gases. Orphal says: "We can now literally generate 3D images of the atmosphere in flight."

The initial results show that the vertical air layers of the atmosphere mix together on a much finer scale than was originally assumed. "This is very important for the design of climate models that can provide reliable predictions," says Martin Riese. "The HALO research aircraft is ideal for our measurements because it can fly at a very high altitude and also cover long distances." In parallel, the scientists are working on ways of using GLORIA on stratospheric balloons so that they can observe the atmosphere from a stationary point over the course of several days. Orphal explains: "If we can measure the vertical structure of the atmosphere more precisely, we can predict the weather more accurately – up to two weeks in advance." One day an improved version of GLORIA will also be deployed on satellites for this purpose." *si*

Processes" and "The Composition and Dynamics of the Upper Troposphere and Middle Atmosphere".

Terrestrial Environmental Research Programme

The goal of this programme is to preserve the natural foundations of human life and health. It addresses the effects of global change and climate change on terrestrial environmental systems and formulates management strategies and options for sustainable social and economic development. The research ranges from the micro to the global level, often emphasizing selected regions and landscapes. It is here that environmental problems become directly visible and management options can be identified. Programme topics include land use, biodiversity and ecosystem services, plant growth, water resource management, risk assessment and risk reduction of chemicals in the environment, as well as observation platforms and integrated modelling.

RESEARCH FIELD HEALTH

PROFESSOR GÜNTHER WESS
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Health,
Helmholtz Zentrum München – German Research
Center for Environmental Health

GOALS

The scientists involved in health research at the Helmholtz Association are studying causes and the development of major common diseases such as cancer, cardiovascular and metabolic diseases, pulmonary illnesses, disorders of the nervous system and infectious diseases. Building on a strong foundation of basic research, they aim to develop evidence-based methods for the prevention, diagnosis, early detection, and individualised treatment of common diseases. Research into complex and often chronic illnesses requires interdisciplinary approaches, which the Helmholtz centres implement in cooperation with partners from medical schools, universities, other research organisations and industry. Furthermore, the Helmholtz centres active in the field of health research are contributing their excellent basic research to the German Centres of Health Research – founded by the Federal Ministry of Education and Research – in order to translate research findings more rapidly into clinical applications.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

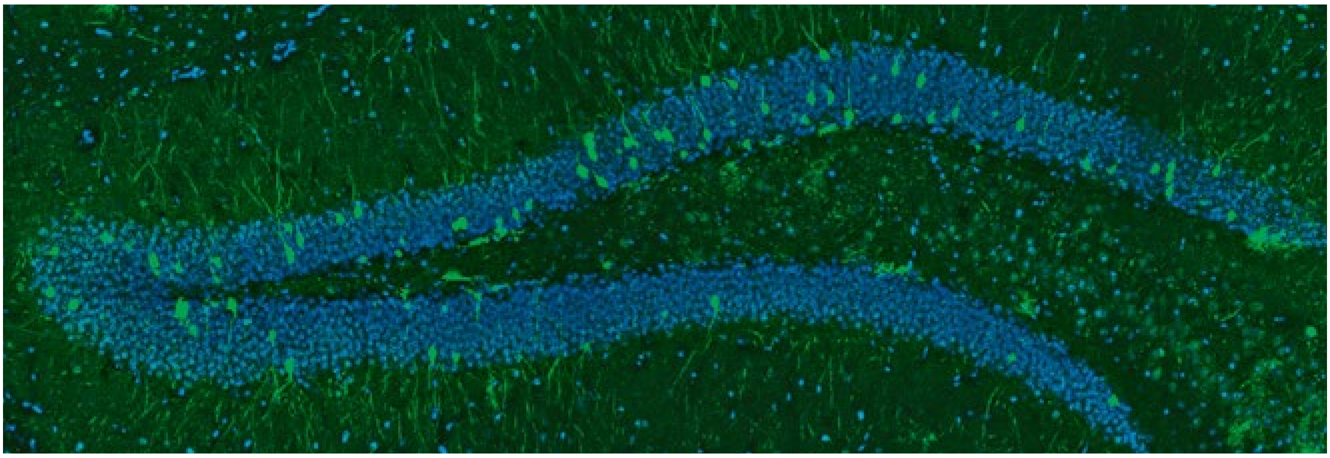
Ten Helmholtz centres are collaborating in the field of health research. In the current funding period they are working in the following six programmes:

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

A seventh programme, “Diseases of the Nervous System”, is currently under development.

OUTLOOK

The long-term goal of Helmholtz health research is to improve medical care and quality of life for the population into old age. For this reason the Helmholtz health centres are expanding their research programmes to include approaches from the field of health services research. The Helmholtz Association has initiated the “National Cohort” health study to assess individual risk factors and to develop personalised prevention strategies. The ongoing discourse between scientists and physicians will also play an important role in the future.



"Newborn" neurons (green) in the brain of a three-month-old mouse. *Photo: A. Martin-Villalba/DKFZ*

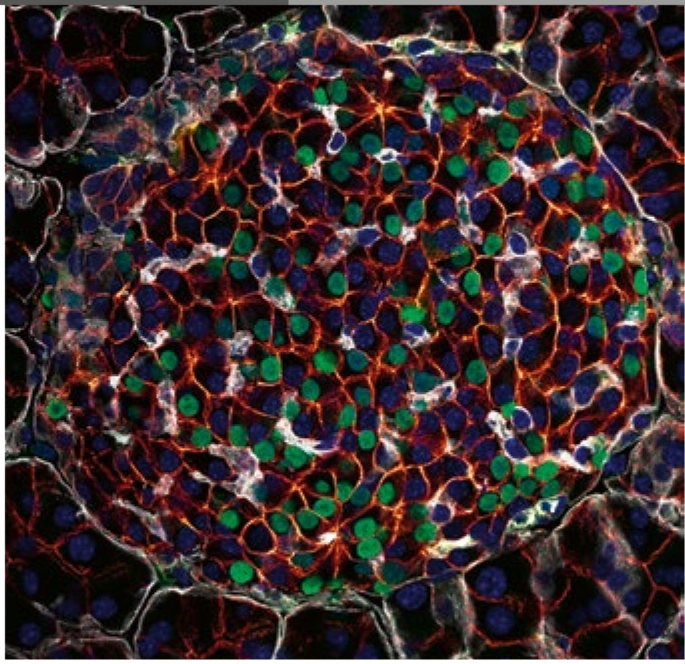
STAYING MENTALLY FIT IN OLD AGE – TOO GOOD TO BE TRUE?

German Cancer Research Center (DKFZ): "People can do a lot to keep themselves mentally fit as long as possible. However, it is a simple fact of life that at some point our brains become less powerful," says Ana Martin-Villalba, head of the Department of Molecular Neurobiology at the DKFZ. The production of new neurons decreases dramatically in old age. In a recently published study, Martin-Villalba and her team were able to demonstrate why.
A key role is played by the signalling molecule Dickkopf-1, which was discovered at the DKFZ in 1998. Its name comes from its function in regulating head development in the embryo. It is also known as the counterpart of the Wnt signalling molecule, which promotes the production of new neurons. As Martin-Villalba explains, "We found that there is a much higher concentration of Dickkopf-1 proteins in the brains of older mice than in those of younger ones. This higher concentration of Dickkopf-1 could be responsible for the fact that an ever smaller number of neurons are produced in old age." The DKFZ researchers pursued this question. In studies involving genetically modified older mice in which the Dickkopf-1 gene was silenced, they found that these mice generated 80 per cent more neurons than the same-age mice in the control group. In spatial orientation and memory capacity tests, the older mice exhibited the same mental ability as the younger mice. "Our findings show that Dickkopf-1 is indeed an important cause of the decline in mental capacity in old age," says Martin-Villalba. "But the fact that the older mice without Dickkopf-1 reached the same performance levels as the younger mice really surprised us." By deactivating the Dickkopf-1 gene, the scientists were able to turn on the fountain of youth, as it were, with the touch of a button. While slowing down or even reversing the ageing process in the brain is a tempting proposition, there will be no drug for this in the near future. A Dickkopf-1 inhibitor would have to pass the blood-brain barrier, which is currently impossible. "But that's not all," says Martin-Villalba. "Before a drug can be developed, we need to learn a lot more about Dickkopf-1. After all, it may affect other important brain processes. We have already been able to learn a great deal and further research will be exciting." *si*

PROGRAMMES IN THE COMING FUNDING PERIOD 2014–1018

Cancer Research Programme

The goal of the Cancer Research Programme is to make significant improvements in the prevention, early detection, diagnosis and treatment of cancer. It focuses on developing new diagnostic, and individualised therapeutic procedures on the basis of molecular, cell-biological, immunological, and radio-physical findings and technologies. It will continue to translate basic research findings into clinical applications together with strategic partners, with the National Centre for Tumour Diseases (NCT) and the nationally active German Consortium for Translational Cancer Research (DKTK) playing key roles. The programme is also developing new approaches in the fields of cancer genome and epigenome research, metabolic dysfunction, personalised radiation oncology and ion



Scientists at the Institute of Diabetes and Regeneration Research are studying the insulin-producing beta cells in the pancreatic islet. *Photo: Heiko Lickert/Helmholtz Zentrum München*

NEW FINDINGS IN DIABETES RESEARCH

Helmholtz Zentrum München – German Research Center for Environmental Health: If detected too late, diabetes can cause organ damage. The results of a study by scientists at the Helmholtz Zentrum München have revealed one possible approach to this problem. The team led by Rui Wang-Sattler in the Molecular Epidemiology Research Unit has identified three metabolites in the blood that serve as biomarkers for diabetes. Furthermore, two of these metabolites make it possible to predict the individual course of the disease. “Abnormal concentrations of these biomarkers occur at a very early stage of the disease,” says Wang-Sattler. Early detection is crucial because if the disease is diagnosed in the pre-diabetes stage, targeted measures can be taken to delay or even prevent its development. Such measures include changing one’s diet and getting more exercise. Scientists from several institutes at the Helmholtz Zentrum München participated in the study together with partners at the German Center for Diabetes Research, the German Diabetes Center in Düsseldorf and the German Institute of Human Nutrition in Potsdam-Rehbrücke.
An additional study by scientists at the Helmholtz Zentrum München was devoted to the tissue-specific use of drugs for treating type 2 diabetes and metabolic syndrome. One of the most promising treatments for type 2 diabetes is based on activating the receptor for the hormone GLP-1. Researchers from the Institute for Diabetes and Obesity, directed by Matthias Tschöp, investigated a drug in which the hormone GLP-1 was chemically linked to estrogen. In an animal model they were able to demonstrate that, compared to a pure GLP-1 agent, estrogen greatly enhanced the effect of GLP-1 on energy metabolism, reducing blood sugar and decrease body fat. Because the conjugate, due to its GLP-1 content, is directed only to the target cells of GLP-1, it does not have any tumour-inducing side effects on estrogen-sensitive organs such as the uterus. “With this study we may have developed a completely new therapeutic concept that can be applied to other diseases. We will investigate this follow-up studies,” says study leader Matthias Tschöp.
There is an urgent need for these new diagnostic and therapeutic concepts, as well as for new preventive approaches to diabetes and other common diseases. Meeting these needs is one of the goals of the research being done at the Helmholtz Zentrum München. *Red.*

therapy, molecular imaging, neuro-oncology, individualised cancer medicine and health economics.

Cardiovascular and Metabolic Diseases

The aim of this programme is to shed light on the causes and pathophysiological aspects of cardiovascular disease at the cellular, genetic and epigenetic levels and to investigate their interaction with environmental causes. The findings of this research serve as a foundation for developing new diagnostic, preventive and therapeutic strategies. The programme takes a translational approach, transforming new basic research findings into clinical applications as quickly as possible. It focuses on the interplay between the immune system and cardiovascular disease, non-coding RNA, the role of metabolism in the prognosis, prevention and development of cardiovascular disease, new ani-

Meeting in a general practitioner's office.
Photo: www.schmelz-fotodesign.de/DZNE

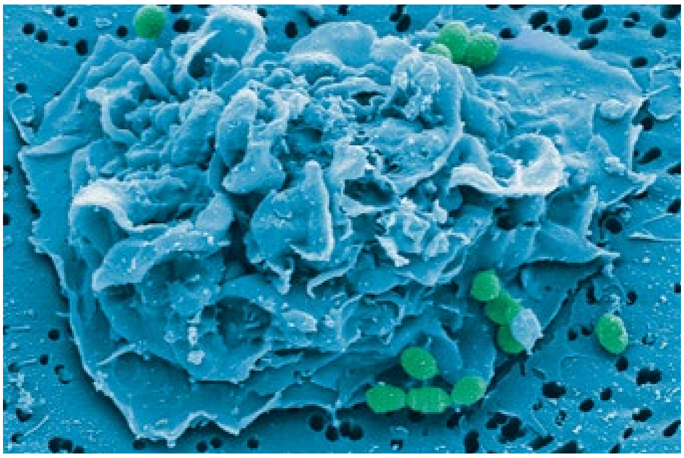
BETTER QUALITY OF LIFE FOR PEOPLE WITH DEMENTIA AND CARE-GIVING RELATIVES

German Center for Neurodegenerative Diseases (DZNE): "Two major challenges for society posed by demographic change are medical and nursing care," says Wolfgang Hoffmann, speaker of the DZNE site Rostock/Greifswald. The incidence of dementia is expected to increase twofold in the coming years. Now and in the future, the greater share of the care will be provided by family members. "The burden is often enormous – many family members neglect their private and working lives. They often place a tremendous strain on their own health," says Hoffmann.
In collaboration with the universities and university hospitals in Greifswald and Rostock, Hoffmann is directing the DZNE study "Dementia: Life- and Person-Centred Help in Mecklenburg-Western Pomerania [MV]" (DelpHi-MV). As he explains, "The aim of the DelpHi-MV study is to improve medical and nursing care and thus the quality of life for people with dementia and their families. We also want to support efforts to keep patients in their home environment." The DZNE cooperates with more than 60 general practitioners from the region of Mecklenburg-Western Pomerania. If early symptoms of dementia are detected, the doctor encourages the patient to participate in the study. Hoffmann says, "Dementia patients and their families should be advised in the early phase of the disease and offered all the support available in the health care system. In the DelpHi-MV study we are examining whether and how this can be done using specially trained nursing professionals." These professionals, called "dementia care managers" (DCMs), visit families in their homes and work with them to develop tailored care solutions.
In addition, the DCMs regularly record data on the progress of treatment, the caregiving situation, the quality of life and the level of satisfaction among patients and their relatives. In doing so, they document and assess the effects of optimised care on the quality of life for all those involved. "We need to fundamentally review existing caregiving routines and develop new, more sustainable approaches. Only then can we ensure that dementia patients receive optimal care in the future," says Hoffmann. "We hope that with the DelpHi-MV study we will be able to make a contribution to new solutions that meet future demographic challenges." *si*

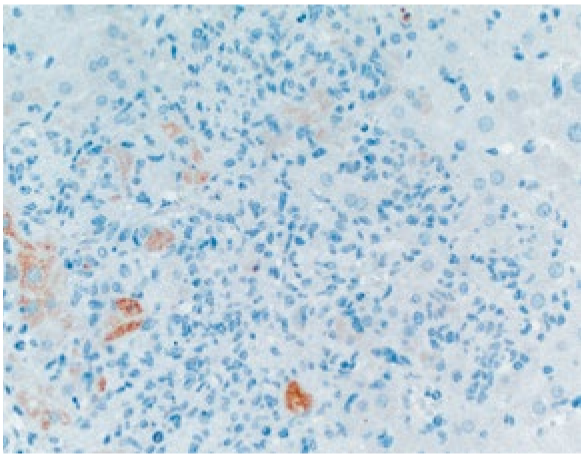
mal models for disease, and the development of effective phenotyping. Its researchers study heart development and congenital heart disease, active biomaterials as the source of new drugs, and regenerative medicine. In the third funding period, research into these last two topics will be continued in the programme "Biomaterial-Based Technologies for Regenerative Medicine" in the field of key technologies research.

Infection Research

This programme concentrates on the molecular mechanisms responsible for the development and course of infectious diseases. Knowledge of the interactions between hosts and pathogens provides a foundation for developing new prevention and treatment strategies. Programme focuses include the study of newly emerging infectious diseases, the identification of new drugs to overcome pathogen resistance, the re-



Scanning electron micrograph of a scavenger cell with streptococci (green). *Photo: M. Rohde/HZI*



Optical micrograph of liver cells in which the brown cells are undergoing programmed cell death. *Photo: I. Schmitz/HZI*

SPECIAL CHALLENGES FOR THE IMMUNE SYSTEM

Helmholtz Centre for Infection Research (HZI): Flu, which is caused by viruses, is not only a seasonal problem, but has also been responsible for deadly pandemics. Spanish flu, which raged around the world from 1918 to 1920, is thought to have claimed around 25 million lives, making it a significant demographic event. A less-known fact is that flu patients often contract bacterial superinfections that cause many of their health problems. The patients' immune systems apparently have difficulty fighting off bacteria such as pneumonia pathogens. Researchers at the HZI are studying the underlying interactions within the immune system and examining how it responds to infections and combats harmful bacteria and viruses.

"Our body has an alarm system for viruses – an immune system molecule called TLR7 that recognises a virus's genetic information and alerts our immune system. However, the molecule simultaneously weakens the body's defence against bacteria, which can then attack the body more easily," says Dunja Bruder, head of the Immune Regulation Group at the HZI. Her team has helped researchers better understand how flu-related illnesses and bacterial infections are linked at the molecular level.

In a healthy body, invading bacteria are usually engulfed by scavenger cells called macrophages before they can do damage. The situation is different when the immune system is already under stress from flu: in this case the macrophages seem to lose their appetite and eliminate far fewer bacteria. As a result, the bacteria disperse more quickly through the bloodstream and can trigger a superinfection. In mouse studies the researchers observed that TLR7 acts like an appetite suppressant on the scavenger cells: if mice lack this molecule due to genetic modification, they are initially able to fend off a bacterial superinfection. However, in the immune system of mice with TLR7, the macrophages are indirectly inhibited – probably an unintended side effect of the viral infection. A therapeutic intervention is not easy here because the participating immune system molecules are part of a tightly regulated network. It is though conceivable that by inhibiting TLR7 doctors can gain valuable time to determine which antibiotics they should use to fight the superinfection. *HZI*

lationship between infection and age, as well as diagnostics for personalised therapies. An important role is played by post-infection diseases such as cancer, metabolic dysfunction, neurodegeneration and chronic infections. The programme also emphasises functional and integrative genomics, which in combination with systems biology research is expected to contribute to a better understanding of infection processes and drug function.

Disorders of the Nervous System

This programme has been under development since the founding of the German Center for Neurodegenerative Diseases in 2009 and will be implemented for the first time in the third phase of programme-oriented funding beginning in 2014. Its aim is to examine the causes of nervous system disorders and create more efficient methods for their prevention, diagnosis, treatment and care. The research will

"In their assessments of the field of health research, our international colleagues have once again confirmed that the Helmholtz Association is conducting high-quality research. Outstanding basic research provides an ideal foundation for tomorrow's groundbreaking translational projects. This is why I am pleased that the Helmholtz Senate has approved special funding to integrate personalised medicine – as a topic of great importance for the future – into all health research programmes and strategically strengthen bi-directional translational research."

PROFESSOR BABETTE SIMON
Member of the Helmholtz Senate

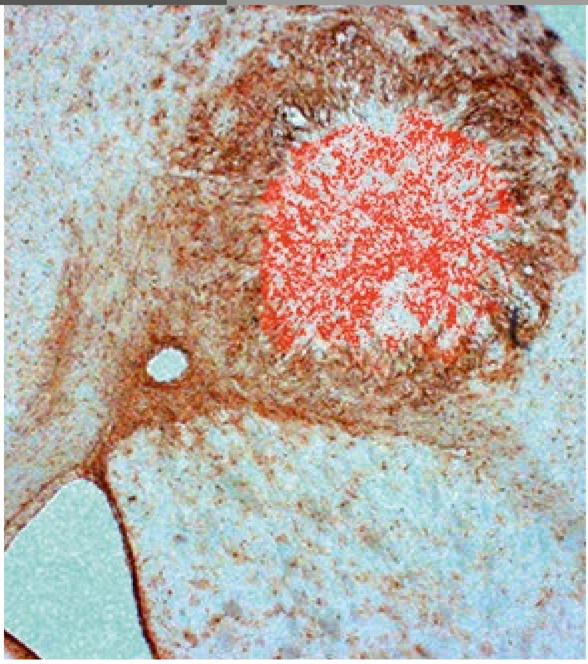
President of the Carl von Ossietzky University of Oldenburg

Amyloid plaques (yellow) are deposited in the brain of patients with Alzheimer's disease.
Graphic: Juan Gärtner/Fotolia

ALZHEIMER'S – EARLY DETECTION IS VITAL

Forschungszentrum Jülich: There is still no cure for Alzheimer's and it has so far been impossible to diagnose the disease at a sufficiently early stage. However, Dieter Willbold and his colleagues at the Forschungszentrum Jülich have now made a breakthrough, developing a highly sensitive method for the early detection of Alzheimer's. Alzheimer's is the most common cause of dementia. Clumps of protein form in the brain that impair or even kill neurons. These clumps consist of amyloid-ß (Aß), which occurs individually in healthy people but not clumped together. To demonstrate the existence of these clumps and diagnose Alzheimer's disease, the researchers resorted to a trick, selecting different antibodies that fit on a specific site on the Aß molecules. They then mixed proteins from the patient's blood or spinal fluid with a capture antibody that blocks the binding sites of all non-clumped Aß molecules. However, a binding site for a marker antibody remained open on the clumps. The antibody attached to the site, thus revealing incipient Alzheimer's disease. "It's important to detect Alzheimer's as early as possible," says Dieter Willbold. "It will increase the chances of finding a drug for Alzheimer's in clinical studies involving patients in the early stages of the disease." *Red.*

focus above all on major neurodegenerative diseases such as Alzheimer's and Parkinson's, but will also address less common afflictions such as Huntington's chorea, amyotrophic lateral sclerosis and prion diseases. Furthermore, researchers will study disorders that may in part be based on similar pathological processes or that are often associated with classical neurodegenerative diseases. In order to develop better strategies for diagnosis, treatment and care, it will be necessary, with the help of basic research, to learn more about disease mechanisms and the brain's response to disease. For this purpose the programme will take a translational approach. Research topics include molecular signal pathways in the nervous system, disease mechanisms and model systems, clinical research, health services research, population studies and genetics. Scientists will investigate, among other things, physiological ageing pro-



Many layers of neural progenitor cells (brown) from the brain of a transgenic mouse surround a brain tumour (red) and release tumour suppressants that activate a receptor on the tumour, thus inducing tumour cell death. *Photo: Rainer Glaß*

NEURAL STEM CELLS DESTROY BRAIN TUMOURS

Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch: Researchers from the MDC and the Charité – Universitätsmedizin Berlin have decoded a mechanism used by stem cells to protect the brain from tumours. The stem cells release fatty acids that activate an ion channel on the tumour cells that has previously been identified as the taste receptor for chilli pepper. This “stresses” the cancer cells, which then die. With this work the Berlin-based researchers have become the first to identify neural stem cells as a source of cancer-destroying fatty acids and to demonstrate the ion channel’s role in combating brain tumours.

Several years ago the laboratory led by Helmut Kettenmann at the MDC showed that at a young age, the body is able to protect itself against brain cancer. Neural stem cells migrate to the tumour and release a protein there that directly attacks the tumour stem cells. Tumour stem cells are believed to be an underlying cause of tumor recurrence. Now the Berlin researchers have discovered a new mechanism used by neural stem cells to fight a type of brain tumour called glioma. As part of this mechanism, these stem cells also migrate to the tumour, where they release fatty acids that are harmful to the cancer cells. However, the fatty acids require the assistance of an ion channel to unleash their lethal effect. Known to researchers as the TRPV1 channel or as vanilloid receptor 1, this channel helps to transmit pain stimuli and contains a binding site for capsaicin, the irritant in chilli pepper. In clinical studies on pain treatments, it is desensitised or blocked. However, in the fight against cancer the ion channel, which sits on the surface of glioma cells, needs to be activated. If it is inactive or blocked, the tumour will continue to grow unchecked.

The activity of stem cells in the brain decreases with age, weakening the body’s defence mechanism against gliomas. This could explain why these tumours usually occur in elderly patients but not in children or young people. The researchers have succeeded in activating TRPV1 channels in older mice using the synthetic substance arvanil, which resembles capsaicin, thereby slowing tumour growth. Arvanil has not yet been approved as a drug since it has severe side effects for humans. It is used only in research on mice, which tolerate the substance. “In principle,” says Helmut Kettenmann, “this approach provides us with options for developing new drugs for previously incurable brain tumours.” *MDC*

cesses, the influences of inflammations and metabolic disorders, imaging methods for the early detection of disease and options for clinical intervention.

Genetic and Environmental Influences on Common Diseases

The major common diseases – diabetes, pulmonary illnesses, disorders of the nervous system, cardiovascular diseases and cancer – have complex causes and result from the complex interplay between genetics, environmental factors and personal lifestyles. Due to changing living conditions and longer life expectancies, these diseases are becoming increasingly common. This research programme focuses on the influence of both genes and environmental factors on human health. It is crucial to clarify the interactions between the organism and environmental factors in order to understand the importance of this interplay for human

A patient is examined in a combined PET/MRT system.
Photo: F. Bierstedt/HZDR

TAKING AIM AT TUMOURS

Helmholtz-Zentrum Dresden-Rossendorf (HZDR): It is vital to detect tumours as early as possible in order to fight cancer successfully. The cross-sectional imaging techniques PET (positron emission tomography), CT (computed tomography) and MRT (magnetic resonance tomography) all play an important role in this effort. One strategy pursued by the developers of these technologies is to combine several of the techniques, such as MRT and PET, in a single system. Whereas PET detects tumour tissue on the basis of altered biochemical parameters, MRT at first produces anatomical images of the brain and internal organs with high spatial resolution and high contrast.
The PET-MRT system at the HZDR is already providing highly detailed images of the inside of the human body. Scientists led by Jörg van den Hoff at the PET Center Dresden-Rossendorf, which is jointly operated by the HZDR and the TU Dresden, are working to improve the characterisation of tumours. They are developing a new MRT-based measuring technique to provide more information about the potential success of cancer treatment, thus supporting individual therapeutic planning. In the future the researchers hope to measure how tumour tissue is supplied with blood. For this purpose they are taking advantage of the MRT system's ability to magnetise and thus mark circulating blood. As the blood flows through the arteries to the tissue, this magnetisation subsides. The tapering-off effect can be measured both temporally and spatially. On the basis of these measurements, researchers can, for example, determine which areas of a tumour are characterised by limited blood flow. The simultaneous documentation of local blood flow and metabolism has the potential to improve the quality of imaging diagnostics and make it possible to plan and adjust treatment more precisely.
Daily routines in nuclear medicine are determined by the use of technetium-99m labelled radiopharmaceuticals. However, currently there are only a few nuclear research reactors in the world available to produce this radionuclide. Many have been shut down due to ageing or maintenance, which has led to repeated shortages in recent years. Experts do not see this situation ending until 2016 or even later. In order to minimise the shortages, HZDR researchers have made an alternative available for a broader clinical application: sodium [fluoro-18] fluoride. This radiopharmaceutical is approved for use under the name NAFRos®. Its production is based on a small accelerator (cyclotron) and does not require a nuclear research reactor. The HZDR supplies this drug to hospitals within a radius of 250 kilometres. *ud*

health and the development of diseases. The programme aims to develop strategies and procedures for the personalised prevention, early detection, diagnosis and treatment of complex chronic diseases. The focus is on diabetes and chronic pulmonary illness, but the research is also making important contributions to understanding other common diseases such as neuropsychiatric disorders, cardiovascular diseases and cancer. The scientific focus of the programme is the systematic analysis of the interactions between the genome, environmental factors and ageing. Scientists are carrying out genetic, epigenetic, proteomic, metabolic and microbial studies to understand the causes of disease at a molecular level. As part of the programme's translational approach, their findings are contributing to the development of personalised drugs for the prevention and treatment of common diseases.

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

The scientists involved in aeronautics, space and transport research address the major challenges facing our society in the fields of mobility, information systems, communication, resource management, the environment and safety. They develop concepts and solutions and provide advice for policy-makers. The German Aerospace Center (DLR) is Germany's national centre for aeronautics and aerospace research. On behalf of the German government and in its capacity as the German space agency, the DLR is responsible for research within the framework of the national aerospace programme and for Germany's contribution to the European Space Agency (ESA). The Helmholtz DLR@UNI Alliance provides a framework for content-based partnerships between universities and selected DLR facilities throughout Germany. At the same time, the DLR works closely with other Helmholtz research centres, particularly in the two areas of energy research and Earth and environmental research. Furthermore, it collaborates with the private sector, one example being the TAMS project, funded by the Federal Ministry of Economics and Technology. Together with Siemens and the various medium-sized companies involved in this project, the DLR has demonstrated how costs, emissions, noise and flight delays can be reduced by integrating ground and air-based systems at airports. Close cooperation with industry was also a cornerstone of the E-City Logistics project in the "model regions" of Berlin and Brandenburg. Supported by DHL and the Meyer & Meyer logistics company, this project focused on the pilot use of electric vehicles for urban delivery services.

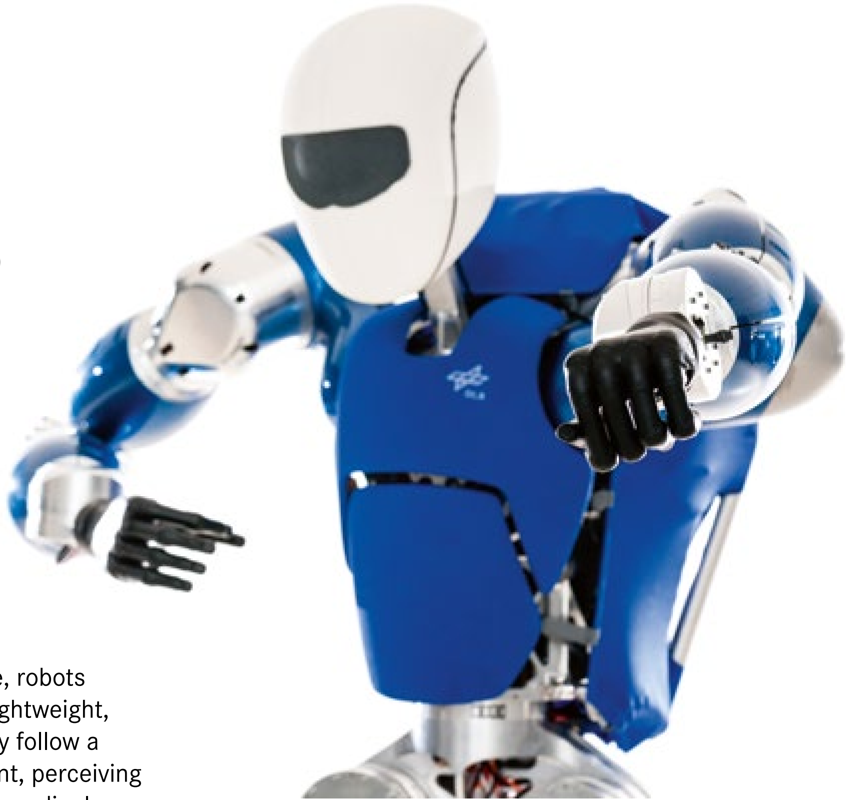
PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

The German Aerospace Center (DLR) is the only Helmholtz centre in the field of aeronautics, space and transport research. Its scientists conduct research and collaborate in the following three programmes:

- Aeronautics
- Space
- Transport

OUTLOOK

In addition to the ever-evolving implementation of the previous research topics, the scientists in this research field will collaborate with industry on research projects devoted to aircraft simulation, next-generation rail-based vehicles and the development of robots. In mid-2011, the DLR established an internal maritime safety research group in order to pool and expand research at the various DLR institutes. The activities in this area are supported by a positively evaluated portfolio proposal "R&D and Real-Time Services for Maritime Safety" and are coordinated with the Forschungszentrum Jülich and the Karlsruhe Institute of Technology.



TORO stands for "TOrque-controlled humanoid RObot". *Photo: DLR (CC-BY 3.0)*

FLEXIBLE AND SENSITIVE – ROBOTS OF THE FUTURE

German Aerospace Center (DLR): In the future, robots designed to work closely with people will be lightweight, flexible and sensitive. "They will not stubbornly follow a predefined path but will be physically compliant, perceiving their surroundings via sensors and reacting accordingly. Ultimately we will have to ensure that robots do not endanger people through inadvertent movements," says Alin Albu-Schäffer, director of the Institute of Robotics and Mechatronics.

Robot Justin is an arm and hand specialist with an acute sense of his surroundings. This new generation of robots registers every physical contact with humans. The scientists can direct Justin's lithe movements without difficulty. If the robot unexpectedly encounters an obstacle, he immediately stops. His arms go slack – and thus become harmless to the robot's environment. This means that such robots can safely work alongside people.

The focus of this research is the deployment of flexible robots in automobile production. When it comes to complex assembly tasks, robots need to be able to adjust to unfamiliar surroundings and respond to human commands immediately and safely. The potential applications are many. For example, in the future the gripping arm of a lightweight robot could be used for unhealthy and strenuous tasks such as overhead work and fastening processes. Older automotive industry employees, in particular, would have their work made easier by a "robot colleague".

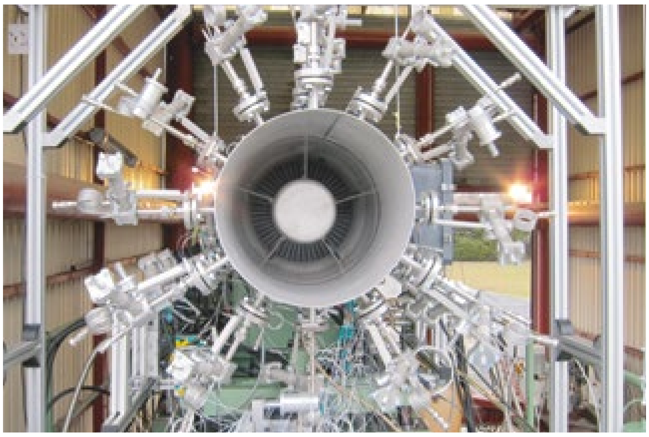
Robots can be taught not only to assemble parts but also to walk. Thanks to modified lightweight robot joints and sophisticated control programmes, the two-legged TORO robot is a "leg man". TORO's legs are designed to imitate the elastic nature of the human stride step for step. The robot reacts flexibly to external influences such as blows without immediately tipping over. The goal of the researchers led by Christian Ott is to teach TORO to move securely in various unfamiliar environments. The robot has now been equipped with an upper body with arms, which is extending its possibilities and fields of application. The successors of Justin and TORO could one day be deployed as anthropomorphic robots in fields such as service provision.

A variety of interdisciplinary topics can be tackled together with other fields, including electromobility, robots in flight and the use of robots on other planets. In April 2013 three DLR institutes laid the foundation stone for a new building for the Robotics and Mechatronics Centre (RMC) in Oberpfaffenhofen that will provide more scope for such research. The RMC is one of the world's biggest and most important research centres for applied automation and robotics. *ckw*

PROGRAMMES IN THE COMING FUNDING PERIOD 2014–2018

The Aeronautics Programme

The significant increase in air transport in recent decades is likely to continue. In Europe, policymakers, representatives of industry and scientists have already agreed on a common research agenda that establishes basic conditions for Helmholtz research. Its goals are an increased capacity of the air transport system, greater cost-effectiveness on both the developmental and operational levels, the reduction of aircraft noise and harmful emissions, the enhanced attractiveness of air travel for passengers and higher safety standards. A key aspect of the research agenda is its holistic view of the air transport system. At the same time, the Helmholtz programme places a strong emphasis on application-oriented research.



For the DLR's engine-acoustics measurement campaign, a range of microphones were mounted at different positions inside the engine and around its exhaust outlet. Each recorded signals simultaneously. *Photo DLR (CC-BY 3.0)*

HOT GAS MICROPHONES – ACOUSTIC SPIES INSIDE ENGINES

German Aerospace Center (DLR): Whether responding to traffic accidents or transporting the sick, helicopters save lives. However, especially during takeoff and landing, their rotors and motors produce a great deal of noise and sound pressure waves, which are particularly disturbing for people living near helicopter landing areas.

In recent years, the further development of the composition, configuration and number of rotor blades has already significantly reduced the level of noise they generate. Now Berlin scientists at the Division of Engine Acoustics at the DLR Institute of Propulsion Technology have for the first time gained an "acoustic view" of the interior of helicopter engines. The challenges were considerable. After all, the microphones needed to function reliably in an environment subject to extreme pressure and temperature variations of up to twelve bars and 1,200 degrees Celsius, respectively.

At the beginning of 2013, the engine-acoustics researchers employed their hot gas microphones in a measurement campaign conducted in cooperation with French engine manufacturer Turbomecca. The comprehensive sound-field analysis provided valuable acoustic data from the interior of the engine. "These measurement results are enabling us for the first time to conceptualise ways of reducing noise inside the motor and undertake appropriate structural changes," says project leader Karsten Knobloch. *ckw*

"As the recently completed, comprehensive review of the research field and its programmes has shown, the research field is leading the way internationally in many areas. Noteworthy examples include not only atmospheric research and the research into technologies for the reduction of aircraft fuel consumption, but also Earth observation studies, whose success is based in part on the field's particularly high level of radar expertise."

DR. DETLEF MÜLLER-WIESNER
Member of the Helmholtz Senate

Senior Vice-President and Head of External Affairs, Business and Transverse Initiatives, Corporate Technical Office, EADS Deutschland GmbH, Munich

PROGRAMMES IN THE COMING RESEARCH PERIOD 2014–2018

The research is structured around four topics relating directly to fundamental segments of the aeronautics industry and air transport business: aeroplanes, helicopters, propulsion systems, air transport management and air traffic.

The Space Programm

The goal of this programme is to develop new technologies for use in basic research, operational services and commercial applications. The programme is oriented to the federal government's space strategy and has been tasked with developing the required technological foundations for new space missions while creating maximum value added. The programme's research topics include Earth observation, communications and navigation, space exploration, research under space conditions, space transport, space systems technology and robotics.

In rural areas elderly people often have to rely on family or neighbourhood carpools. *Photo: iStockphoto*

AGEING IN THE COUNTRYSIDE – MOBILITY AND DEMOGRAPHIC CHANGE

German Aerospace Center (DLR): How can elderly people living in rural areas remain mobile when transport services are being reduced due to population decreases? This is one of the questions that researchers at the DLR Institute of Transport Research examined in a recent analysis of the mobility patterns of people over 65 in rural areas.

Only people who are mobile can shop for themselves, manage their own recreational activities and visit a doctor. Such tasks represent a particular challenge above all for elderly people in thinly populated rural areas. An additional problem is that the decline in the population caused by demographic change will severely affect these regions. As a result of population decline, regional infrastructure will become less comprehensive and there are likely to be fewer general medical practitioners, treatment facilities and hospitals. This means that elderly people with limited mobility must travel long distances for medical treatment, which will result in a lower quality of medical care and demonstrably higher costs. In addition, the analysis confirmed that cars are enormously important for elderly people in rural areas, who seldom use public transport services. However, due to medical conditions or the lack of a driver's licence, the elderly may not be able to drive a car themselves. This applies above all to women over 75 with limited mobility. The study shows that only 37 per cent of this group has a car, whereas the corresponding figure for men is 80 per cent. It is therefore important in the coming years to guarantee an adequate level of mobility and basic medical care for the increasing percentage of elderly people in rural areas. In addition to effective local transit systems, innovative transport concepts, such as car-sharing and electromobility, need to be implemented in these regions. Other solutions could include neighbourhood networks and voluntary services that provide carpools and community bus services. Medical care can be improved through the use of collection-and-delivery systems and buses for patients. Further possibilities involve the increased use of telemedicine and the performance of certain medical procedures by non-medical specialists. *ckw*

The Transport Programme

Ensuring mobility in the future is a central challenge. For many years now, the capacity of passenger and goods transport systems has been expanding. However, there is a constant tension between the individual desire for unlimited mobility, on the one hand, and the overburdened transport system, the effects of traffic on people and the environment, and the high number of accident victims, on the other. What is needed is a modern transport system for people and goods that is sustainable over the long term from an economic, ecological and social perspective. The strategic goals of this programme include the reduction of traffic-induced stresses on people and the environment, increases in safety and reliability, an efficient utilisation of the existing transport infrastructure, the improvement of multimodal transport use and the extension of the trans-European transport network.

RESEARCH FIELD KEY TECHNOLOGIES

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

GOALS

In the field of key technologies research Helmholtz scientists develop generic technologies that contribute to the future viability of our society. The individual research programmes extend from fundamental research to concrete applications, are based on multidisciplinary collaboration, and are able to draw on an excellent research infrastructure. The Helmholtz Association supports the high-tech strategy of the German government. It is setting the pace for innovation and the development of future technologies in order to secure Germany's leading position in these fields and to ensure its continuing viability as a location for business. Our research into key technologies takes into account the recommendations of the Science and Industry Research Union on the specified fields, the vote of the Bioeconomy Research and Technology Council, and strategic considerations in the EU regarding the direction of key technologies development.

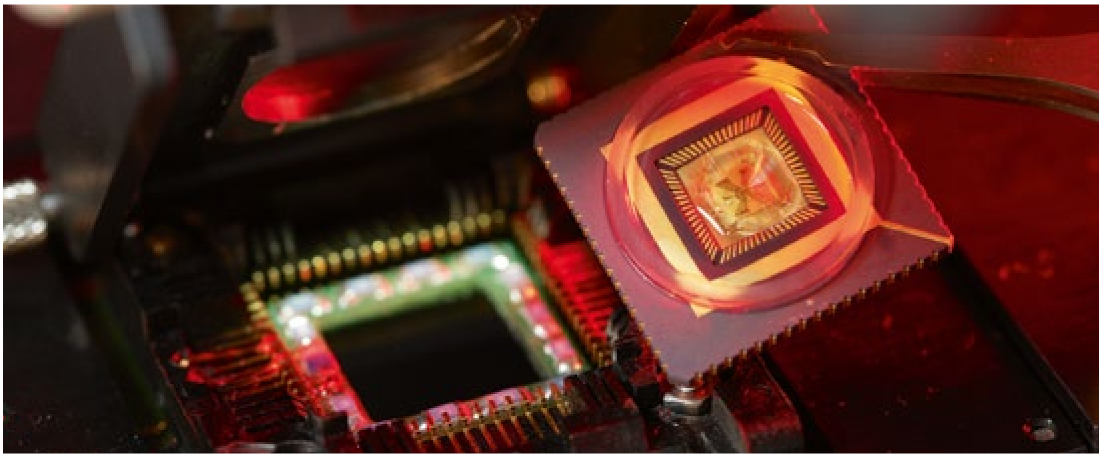
PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Three Helmholtz centres are involved in key technologies research. The field comprises six programmes as well as a programme conducted in collaboration with scientists from 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 (collaborative research programme)

OUTLOOK

Energy, health, mobility, safety and communications are the areas for which sustainable technologies are being developed. To this end, we are strengthening existing programmes in the fields of materials science, the nanosciences, information and communications technology, and the life sciences. Helmholtz research is also using new interdisciplinary structures to create the foundation for future technologies in medicine and the life sciences. New topics spanning the association's research fields include technology and simulation in medicine, the sustainability of the bioeconomy, structural and synthetic biology, and simulation, data management and data analysis in the exascale field. Key technologies researchers are working to develop processes in the materials sciences, physics and chemistry that will have applications in the areas of energy generation, human mobility and medical therapies.



Electronic chips made of graphene
are used in innovative neural implants.
Photo: Forschungszentrum Jülich

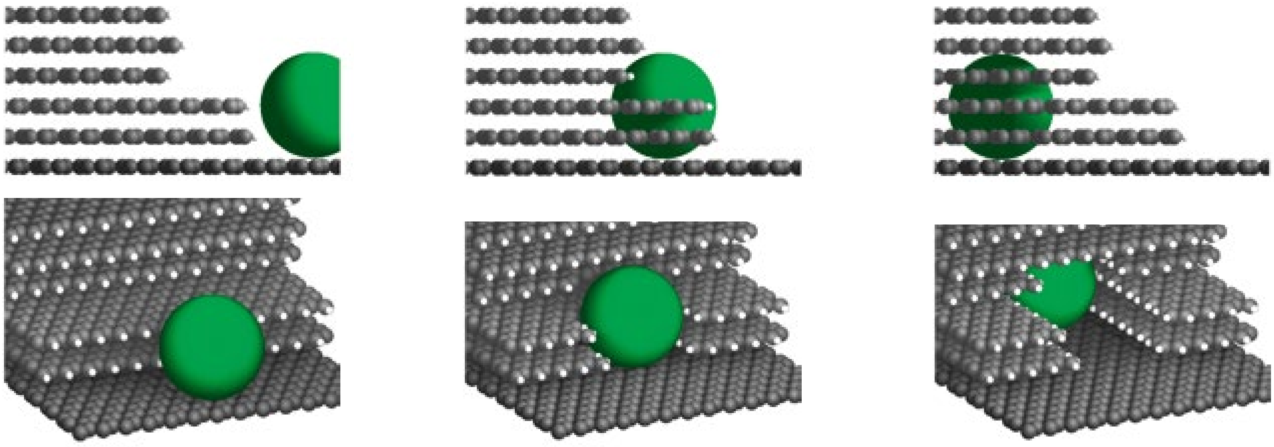
RESEARCH TO DEVELOP INNOVATIVE NEURAL IMPLANTS

Forschungszentrum Jülich: The blind will see again and the deaf will hear – in the future tiny neuronal implants could control prostheses and replace destroyed sensory cells in the eyes, ears and brain, thus fulfilling an age-old dream of humanity. However, developing compatible and highly sensitive interfaces that can connect human tissue with microelectronic devices is an enormous challenge. In the Neurocare project, scientists at the Forschungszentrum Jülich have been working with European colleagues since 2012 to develop new concepts for retinal, cochlear and cortical implants made of graphene.

For several years now, scientists have been developing neural implants to enable deaf patients to hear and to compensate for traumatic damage to the nervous system. Until now such implants have been made of silicon. However, the interface produced by this metal between living cells and electronic implants is problematic, and researchers are looking for a more effective material. One problem is that silicone implants are many times bigger than the nerve cells with which they are supposed to communicate. Moreover, it is difficult to connect flexible cells containing water with solid, rigid electrodes. Implants made of graphene could provide a more effective alternative. "We are focusing on the development of new carbon-based biointerfaces, which are more readily accepted by living tissue and cause fewer problems with biofouling," says Andreas Offenhäusser, head of bioelectronics at the Forschungszentrum Jülich. Biofouling refers to the accumulation of layers of microorganisms on wet surfaces. When this occurs on implants or medical instruments such as catheters, these organisms can cause infections. Apart from its antibacterial effect, graphene has excellent electrical properties, is chemically stabile and can be produced cost-effectively in large quantities. Moreover, it can be manufactured in the form of flexible, extremely thin but highly robust films or mats, which can, for example, be laid on the brain and form close contacts with cells over a large area.

In late 2011 scientists from the Forschungszentrum Jülich and the Munich University of Technology managed to show that living cells effectively bond with graphene-based microelectronic devices. They grew cardiac muscle cells across a microchip made of graphene and found that the chip was able to absorb and transmit the signals generated by the living cells. "We observed that the cardiac cells grew very well on the chip and developed a healthy pulsation," says Jülich biologist Vanessa Maybeck. The researchers were able to track and record the dissemination of the electrical action potentials typical of cardiac muscle cells. When they added the stress hormone noradrenalin to the culture medium, the cells reacted with an increased pulse frequency.

It has also been demonstrated that nerve cells can grow on graphene. In the Neurocare project, scientists are investigating the effects of this material on the biology of optical nerve cells. Institutions from six countries are working on new concepts for retinal, cortical and cochlear implants, which could come onto the market in the next five to ten years. *Red.*



Development of open channels and tunnels. Above: a nanoparticle (green) bores into the edge of a graphite step, initially creating a channel in a lower layer and then a tunnel in a higher one. *Diagram: KIT*

A NANO-SIZED TUNNEL DRILL

Karlsruhe Institute of Technology (KIT): Not everyone needs heavy machinery to build a tunnel, especially when the tunnel in question is only a few nanometres in diameter. When Maya Lukas from KIT and her colleagues from Rice University in the US drill into layers of carbon, they use a single nanoparticle made of nickel. When the carbon is heated and hydrogen is added, the particle digs forward and in the process removes carbon atoms in the form of methane. This gas is produced as a result of the nickel acting as a catalyst that causes the hydrogen to react with the carbon. The methane molecules diffuse out of the hollow space, while the nickel particle is drawn further into the tunnel by capillary forces. "In this way spaces can be hollowed out of the graphite in a controlled procedure," says Lukas. "This is a process that in principle also lends itself to mass production, which in turn opens up interesting areas of application." Porous graphite is already used, for example, in lithium-ion batteries. It is conceivable that the hollow spaces could also be used as repositories for slow-release drugs in medical treatments. "Such tunnel structures are probably not really new," says Lukas. But until now they have not been detected because they are concealed beneath the surface of the graphite and often leave only a very weak trace in scans. Indeed, the Helmholtz researchers themselves were not actually looking for tunnels when they began their measurements. Their aim was to examine the edges of graphite samples and to use nickel particles to cut strips a few atoms wide out of the material. For this purpose, it suffices to generate open channels which structure the material.

While US researchers were responsible for preparing the samples, it was the Karlsruhe scientists who examined them using scanning electron and scanning tunnelling microscopy. The latter technique enabled the scientists to generate atomically precise images of the surface of the graphite. In addition to the expected channels, Maya Lukas discovered further elongated structures on the images. She was able to demonstrate that these were in fact the sagging ceilings of tunnels bored underneath the surface of the samples. Using theoretical calculations, KIT scientist Velimir Meded was able to establish that these structures were in fact the result of changes to the surface topography and not effects of the electron structure of the atoms.

The reason that tunnels as well as channels are formed has to do with the nature of the material used. The sample features corners and edges which can be several atoms thick and which occur naturally or are etched into the graphite by the researchers. The nickel particles preferentially migrate to these edges, where they begin the exchange process. As soon as the nickel encounters a layer higher than the particle diameter, a tunnel develops, as in the case of a mountain escarpment.

For the most part the tunnels maintain an even course, running parallel to the crystal structure of the graphite layers, which are also known as graphene. This structure also determines the course of the tunnels in the horizontal plane. The width of the tunnel depends on the size of the particle boring into the graphite. Because the graphite layers are very stable in themselves, it is all but impossible for the same process to take place vertically. "We have never observed the sample being tunnelled from top to bottom," confirms Lukas. The physicist sees potential applications for the tunnels above all in the field of nanoelectronics. "We have opened up a whole new possibility for graphene structuring," she says. For example, it has been demonstrated that etching out the floor of a tunnel allows for the creation of a free-standing, easily connectable graphene bridge. *ud*

"As a new member of the Helmholtz Senate, I look forward to gaining broad and more detailed knowledge of key technologies and the research in this field – in connection with insight into socially relevant areas of demand such as the life sciences and energy research. The interconnectedness of society, science and business has an elemental significance for our country. In my new role I also look forward to providing impetus and ideas from the world's biggest IT think tank."

MARTINA KOEDERITZ
Member of the Helmholtz Senate

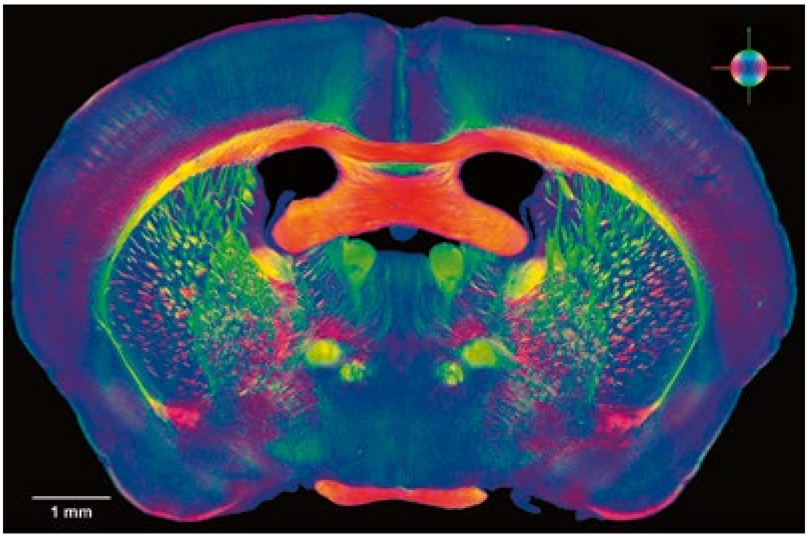
General Manager, IBM Germany, General Manager, DACH IMT

A Geesthacht scientist manufactures the individual components of the membrane in the laboratory. *Photo: Christian Schmid, Hamburg*

BETTER AIR THROUGH NITROGEN OXIDE REDUCTION

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG): Nitrogen oxides are poisonous for humans and the environment. They damage our lungs and contribute to global warming. Scientists from the HZG are currently collaborating with the Scientific Technical Centre (WTZ) in Roßlau on the development of special membranes for use in diesel ship engines that can reduce their dangerous exhaust emissions by 80 per cent. Along with sulphur dioxide, ships emit large quantities of nitrogen oxides. These are produced when nitrogen reacts with oxygen in the combustion process. The gases not only contribute to air pollution along coasts but also increase the concentrations of particulate matter hundreds of kilometres inland. The International Maritime Organization has called for an 80 per cent reduction of nitrogen oxide emissions in sensitive ocean areas such as coastal regions beginning in 2016. The new membrane technology developed at the HZG Institute of Polymer Research seems capable of realising this goal. The membrane is composed of a porous support material and a nanometre-thin separation layer. The latter is made of a special polymer that is more permeable for oxygen than nitrogen. As a result, the membrane is able to separate a portion of the oxygen from the combustion air before it enters the ship's engine. The increased proportion of nitrogen reduces the temperature in the engine cylinders, which results in less nitrogen oxide forming.

The technology is reliable and requires little maintenance since it intervenes prior to combustion. It thus prevents the formation of polluted exhaust fumes that would require a complex cleaning process. Geesthacht scientists are constantly improving the membrane technology and are currently looking for partners in industry to help create applications based on it. *Red.*



Neuronal fibre tracts in mouse brains made visible using the polarised light imaging method. In this image the fibre tracts in a single thin section (70 µm thick) are colour-highlighted, with each measured tract assigned a different colour. Image: *Amunts, Zilles, Axer et. al./FZJ*

THE SUPER BRAIN AND SUPERCOMPUTING

Forschungszentrum Jülich: Why do we snatch out finger away from a hot stove? What happens in our brains when we remember things or solve arithmetic problems? At the Forschungszentrum Jülich the human brain is the focus of an interdisciplinary team made up of neuroscientists, IT specialists, biologists, physicists and experts from other fields. Using supercomputers and models, their aim is conduct intensive research into the structure and workings of the human thinking organ. This research is taking place against the backdrop of demographic change. People are living longer, which means that in the future many more will suffer from neurodegenerative diseases. New diagnostic and therapeutic methods are therefore urgently required for the improved treatment of conditions such as Alzheimer's and Parkinson's disease. The insights gained from research connected with the Helmholtz portfolio topic “Supercomputing and Modelling for the Human Brain” are being used in the Human Brain Project, which is funded by the European Union (see page 4). Jülich scientists are pooling their decades of experience in interdisciplinary teams, which collaborate, for example, in the Neuroscience Simulation Lab. While neuroscientists are contributing their knowledge of brain structure and function across a scale ranging from the individual nerve cell to entire brain areas and their networks, IT specialists are providing storage capacity and computing power as well as expertise in a diverse range of analytical methods. Both groups of researchers are profiting from this interdisciplinary exchange. Computer simulation enables the neuroscientists to more effectively analyse the structure and workings of the brain. The IT experts will in turn use the knowledge they acquire of neuroscientific requirements and the actual processes in the human “control centre” to develop new supercomputers. Here the brain will serve as a model. It is fault-tolerant, incredibly quick and extremely energy-efficient. In order to replicate structures or processes observed on the brain's different levels, supercomputers need enormous computational capacities and must be equipped with a large working memory. This is illustrated by Katrin Amunts' digital, three-dimensional brain atlas. The director of the Institute of Neuroscience and Medicine and her team are successively producing a unique computer model of the brain based on thousands of brain slices.

However, today's supercomputers do not yet have the capacity to depict complex brain simulations live in 3D. “In the future, using interactive supercomputing, scientists will be able to intervene directly in simulations and alter certain parameters,” says Thomas Lippert, director of the Jülich Supercomputing Centre. Such future tasks will require new exascale-generation computers, which are the subject of intensive research in Jülich. *it*

Metal powder injection moulding: top, the metal powders, to the left, the polymer components, and in the centre, the mixed granulate. Below: component precursors and, to the right, the completed Mg-Ca-bone screw. *Photo: M. Wolff/HZG*

Implants currently used in bone surgery are predominantly made of titanium or stainless steel. *Photo: iStockphoto*

A NEW GENERATION OF IMPLANTS

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG): Our society is becoming older, and as a result there is a growing need for implants and prostheses that enable elderly people to maintain their mobility and quality of life. For science, the production of small, highly stable and complexly formed implants that naturally degrade after completing their task in the body represents a particular challenge. Apart from conventional techniques such as casting and milling, researchers from the HZG are making use of a special technology for this purpose: metal powder injection moulding (MIM).

As the name already indicates, the MIM technique uses metal powder as its raw material, which is combined with a so-called binder. This putty-like mixture is melted at a temperature of around 100 degrees Celsius and can then be sprayed into a mould of almost any shape. The binder is then removed chemically or thermally and the remaining powder is transformed into a solid and compact metal by means of a sintering process. Researchers are currently developing new theories and simulation models in order to perfect this technique. The resulting components can be polished, coated or processed in other ways, or used directly.

“With this technique we can manufacture extremely small, geometrically complex, metallic components that can be reproduced in large numbers,” says Thomas Ebel, director of the HZG Powder Technology Department. “The fact that the manufacturing process is very cheap means that we are making a contribution not only to German healthcare but also to healthcare in developing and newly industrialised countries.” The researchers can also produce these components with a porous structure, which is designed to allow the bone tissue to grow into the material and thus strengthen its connection with the implant. In addition, the structure can be immersed in an agent that prevents post-operative infections.

In 2005 Ebel and his colleagues in Geesthacht used the MIM technique to produce the prototype of a complex vertebrae screw made of titanium alloy powder. This type of bone screw is used to stabilise breaks in cervical vertebrae, such as those resulting from rear-end collisions. Titanium is particularly well suited to such implants because it is very stable and biocompatible. However, titanium implants need to be removed after the bone has healed to avoid infections and bone loss. “It is for this reason that in recent years we have been researching how implants can be produced with magnesium using the MIM process,” says Ebel. “We have been producing the first such implants in the world for a year now.” The advantage of this metal is that it occurs naturally in the body and can biodegrade in a predetermined manner. This means that it initially supports the bone and then disappears on its own after the healing process has been completed. However, magnesium also has a high affinity for oxygen, and a reaction between the two elements has the potential to alter the mechanical features of the implanted component. For this reason the researchers looked for an effective alloying element and ultimately selected calcium, which absorbs oxygen during the manufacturing process and gives the material greater solidity. Furthermore, like magnesium, calcium degrades into non-toxic elements in the body. In fact, the products of such degradation may even stimulate bone growth. However, as yet such magnesium-calcium alloys remain in the developmental phase. *Red.*

RESEARCH FIELD STRUCTURE OF MATTER

PROFESSOR HELMUT DOSCH
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Structure of Matter,
Deutsches Elektronen-Synchrotron DESY

GOALS

Helmholtz research into the structure of matter explores the constituent parts of matter and the forces operating between them at a wide range of levels, from elementary particles to complex functional materials to gigantic objects and structures in the universe. An important part of this work entails the development, construction and operation of large-scale devices and complex infrastructure. The Helmholtz Association provides researchers from Germany and abroad with access to a variety of large-scale scientific facilities that in many cases are unique in the world, including detectors, data acquisition systems and particle accelerators. When completed, the European XFEL and the Facility for Antiproton and Ion Research (FAIR), currently being constructed in Germany with the help of international partners, will provide internationally unrivalled research facilities for the generation of X-ray laser radiation on the one hand and antiprotons and ions on the other. The Helmholtz alliances “Physics at the Terascale”, “Extreme Densities and Temperatures – Cosmic Matter in the Laboratory” and “Astroparticle Physics” bring together expertise from the Helmholtz centres, universities and Max Planck institutes.

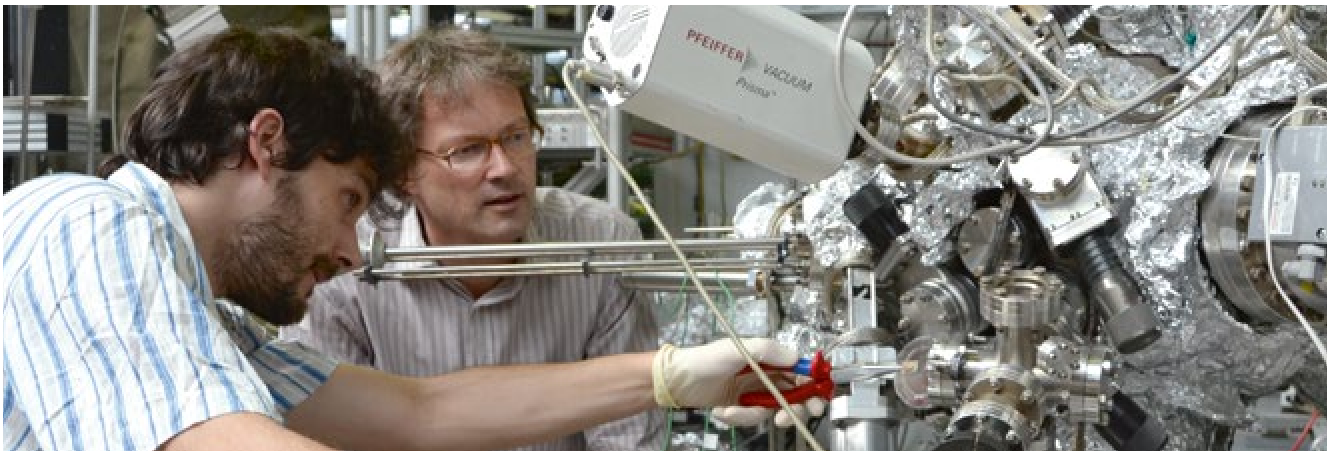
PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Seven Helmholtz centres work together on research into the structure of matter. Their research is divided into four programmes:

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

OUTLOOK

From 2015 onwards, this research field will comprise three programmes. “Matter and the Universe” will bring together the disciplines oriented to basic research – particle and astroparticle physics, physics of hadrons and nuclei, and atomic and plasma physics. In the programme “From Matter to Materials and Life” the operators of modern radiation sources will work together with researchers from the natural sciences, engineering and medicine to develop new materials and active substances and to investigate phenomena in condensed matter, electromagnetic plasmas and biological systems. The “Matter and Technologies” programme will focus on new technological concepts in areas such as particle acceleration, detector systems and the optimisation of high-performance computing and data storage. The goal of this restructuring process is to create synergies and to generate innovations that can further the development of future technologies.



Oliver Rader (centre) and Jaime Sánchez-Barriga (left) are investigating the characteristics of topological insulators at BESSY II. *Photo: Andreas Kubatzki/HZB*

DEVICES FOR THE FUTURE

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB): In the future we will have to achieve more using less energy and fewer raw materials. An important role will be played by new classes of materials such as topological insulators, which consist of an insulating core surrounded by a surface that can conduct electricity extremely effectively. Oliver Rader and his team at the HZB have now shown that these exotic conductivity characteristics remain stable even when the surface is coated with a magnetic material. This property makes this new class of materials interesting with regard to applications in information technology.

Theoreticians predicted the existence of topological insulators as early as 2006. Soon afterwards the first such materials were discovered. The peculiar properties of topological insulators are linked to the electron energy bands "permitted" by quantum physics. On the surface of such materials, the gap between the so-called conduction band, in which electrons can move freely, and the valence band, in which electrons are trapped in particular energy states, disappears. The overlap of the bands results in the charge carriers being mobile and, additionally, without dissipating energy leading to high conductivity. In the interior of the material, on the other hand, there is a large band gap, which the bound electrons are unable to overcome.

Topological insulators have since been found in many common materials, even at room temperature. Currently, the most well-known of these materials is bismuth selenide, which is also being studied by the group led by Oliver Rader in HZB's Department of Magnetisation Dynamics. As part of his doctoral thesis Markus Scholz coated bismuth selenide with iron and examined how the conductivity of the surfaces changes. Finding out what happens at the boundary surfaces of a topological insolator and a ferromagnetic material such as iron is crucial to potential applications such as the development of new storage media for the computer industry. "When topological insulators were first discovered, everyone was ecstatic," says Markus Scholz. "Scientists had found a class of materials believed to hold the key to the future of computer technology." However, this euphoria faded when theoretical work in the field suggested that the surface state of bismuth selenide was extremely sensitive to magnetic materials, which posed significant problems for practical applications.

In order to find out what was really going on, Markus Scholz produced clean-cut surfaces of crystalline bismuth selenide with the help of adhesive tape. As he explains, "From a structural point of view, bismuth selenide can be conceived of as two-dimensional in the sense that five very tightly bonded layers are followed by a weak layer. When the tape is pulled off, the crystal fractures along this weak layer." The team coated this broken edge with an ultra-thin iron film and then examined the coated crystal surface using angle-resolved photoemission spectroscopy (ARPES), a highly surface-sensitive measuring technique.

The result was extremely surprising and called into question previous inferences about the properties of the material. In fact, bismuth selenide continues to exhibit its topological surface states even after being coated with iron. "This finding certainly justifies new research efforts geared to the development of applications for computer technology such as magnetic transistors," says Rader. The German Research Foundation (DFG) has now established a Priority Programme for topological insulator research, which is being coordinated by Oliver Rader. *HZB*

Hans Geissel assembling a new target chamber. *Photo G. Otto/GSI*

THE ATOMIC NUCLEUS FACTORY

GSI Helmholtz Centre for Heavy Ion Research: Hans Geissel holds an unusual record: he has now produced and discovered more new atomic nuclei than any other scientist in the world. Not long ago Giessel and his colleagues reported that they had discovered 60 new, neutron-rich nuclei, which, according to a recently compiled world ranking list, brings his total to 272.

However, the record is not really that important to the 62-year-old scientist from the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, who also holds a professorship at the Justus Liebig University in Giessen. More significant for Giessel is what lies behind these discoveries and everything than can be learned from the new atomic nuclei. For example, they can provide information on the interaction that holds positively charged protons and uncharged neutrons together inside atoms, a mechanism that is still not completely understood. Every chemical element has a particular number of protons but a variable number of neutrons, which is why elements have different isotopes. In particular, the heavy, neutron-rich nuclei help scientists to better understand the processes that take place in stars, which is where the universe's different chemical elements are formed. "In this way we also learn something about how the elements occurring on our own planet came into being," says Geissel.

Producing new atomic nuclei is a complex undertaking and there are only a few experimental facilities in the world where it is possible. One of them is located at the GSI, where Hans Geissel leads the FRS-ESR working group. The abbreviation stands for "Fragment Separator and Experimental Storage Ring," a facility the group uses to accelerate atomic nuclei such as uranium to almost 90 per cent of the speed of the light. When these nuclei smash into a so-called target – a material such as lead or beryllium – they burst into a range of diverse fragments. In order to identify the new nuclei among these reaction products, the researchers first need to filter them out. This separation process must be carried in just a few hundred nanoseconds as the fragments are flying through the FRS, since the artificially generated nuclei often have an extremely short lifespan lasting only a few microseconds. As the fragments fly along a curved route measuring over 100 metres, a combination of multiple magnetic deflections and element-specific deceleration – achieved by passing them through a layer of material – produces an isotopically pure fragment beam, which can then be used for further research.

"The mass of the particles can be determined most precisely by means of frequency measurements," explains Geissel. For this purpose the particles are directed into the ESR storage ring, around which they circulate approximately two million times a second. The precise determination of their mass reveals the bond energy stored between the protons and neutrons and thus provides information about the nuclear forces involved. Using a systematic series of experiments, the researchers are also able to learn something about the external form of the nuclei and the limits of their capacity to absorb protons and neutrons.

Hans Geissel does not, of course, work alone, but as part of an international team. It is important to him that students are involved in this work and thereby introduced to this type of science. He is currently engaged in a large-scale project to develop the super fragment separator for FAIR, the new particle accelerator centre being built in Darmstadt as part of a large international project. A few years from now, this facility will make it possible to generate nuclei that have not been previously obtainable and to measure them even more precisely. *ud*

"Through the development, construction and operation of unique, large scale research facilities and infrastructure, the research field 'Structure of Matter' is making an important contribution to fundamental research at both the national and international level. By examining properties of elementary particles and interactions of heavy ions as well as structures and functions of complex materials, ranging from biological cells to gigantic objects in the universe, answers to pressing questions might be found that are likely to lead technological developments and ultimately benefit society at large."

PROFESSOR VERA LÜTH
Member of the Helmholtz Senate

SLAC National Accelerator Laboratory, Stanford, USA

Enlarged image of a tsetse fly, the carrier of sleeping sickness. The parasite is spread from infected to uninfected hosts by the fly's bite. *Image: M. Duszenko, Universität Tübingen*

THE ACHILLES' HEEL OF SLEEPING SICKNESS

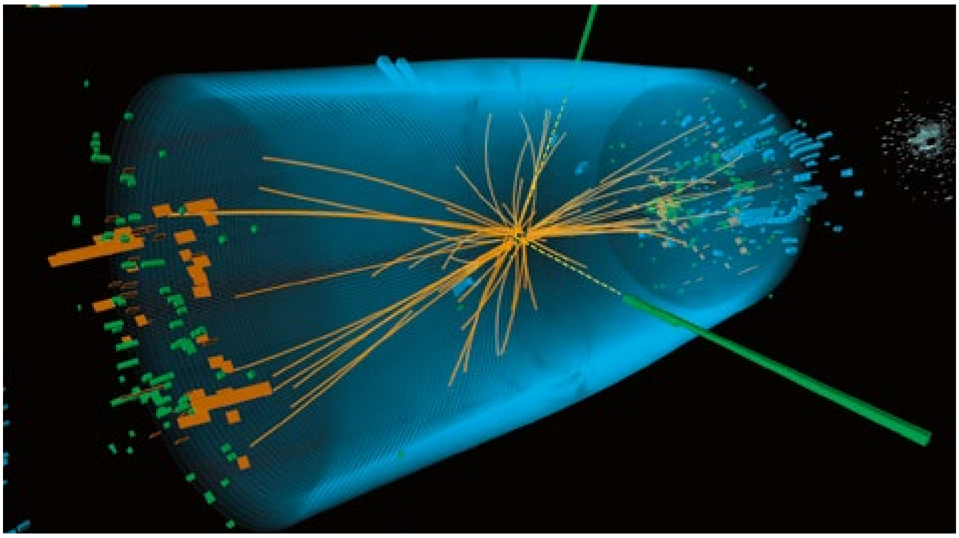
Deutsches Elektronen-Synchrotron DESY: For years biological research has had its sights trained on cathepsin B, an enzyme found in the sleeping sickness pathogen. If researchers are able to find a drug that can specifically target this enzyme, they will be able to weaken the parasite and possibly defeat the disease. To achieve this, scientists first need to know as much as possible about the structure of the enzyme. The problem is that the usual approach, which entails growing biomolecules into crystals and then illuminating them with X-rays, does not work in the case of cathepsin B. Crystals that can be grown from the enzyme are smaller than one micrometre in size, which is too tiny to allow researchers to unravel its molecular structure.

Now a team led by DESY researcher Henry Chapman from the Hamburg Center for Free-Electron Laser Science (CFEL) has developed a new method using the LCLS X-ray laser in California – an accelerator several kilometres long that sends electrons travelling at almost the speed of light through a sequence of magnets, producing X-ray pulses of unprecedented brilliance. A decisive feature is the fact that the pulses are so rich in energy that even the micrometre-small cathepsin B crystals can be used to determine the precise structure of the enzyme – a breakthrough that the US magazine Science numbers among the most important of 2012. "We have proved just how useful X-ray lasers are for structural biology," says Chapman. "Our method can also be used to examine many other biomolecules whose structure is as yet unknown." A machine suited to this purpose, the "European XFEL", is currently being constructed in Hamburg and is scheduled to produce its first X-ray flashes in 2015. "It will produce around 200 times the number of pulses per second currently generated by the facility in California," says Chapman. "This will make the European X-ray laser the world's best source for structural biology." *fg*

A patient receiving radiation treatment at the GSI. *Photo: A. Zschau/GSI*

USING PARTICLES TO COMBAT TUMOURS

GSI Helmholtz Centre for Heavy Ion Research: When a tumour is irradiated, it is destroyed. The radiation disintegrates the DNA of the cancer cells, causing them to die or at least preventing them from continuing to proliferate. One of the problems with conventional therapies using photon or X-ray radiation is that their dosage reaches its maximum strength a few millimetres under the skin, after which it gradually decreases. As result the effect is usually weaker inside the tumour itself than in the healthy tissue above it. Ion radiation offers an alternative approach. Ion beams consist of charged atomic particles such as protons or carbon ions that are twelve times as heavy. The ions are accelerated by particle accelerators to around 75 per cent of the speed of light and then focused on the tumour. A new technology for this treatment was developed and tested at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt before being used in a pilot phase from 1997 to 2008, during which 440 patients were treated. Although the technology is far more costly than X-ray radiation devices, it is more effective, says Michael Scholz, head of the Biological Modelling research group. “Ion rays produce a far more targeted effect. They release their destructive energy primarily where they come to a stop, namely in the tumour itself rather than on their way to the tumour,” he explains. For this reason, ions do far less damage to healthy tissue than X-rays – and are particularly suitable for the treatment of tumours lying deep in the body or in areas surrounded by sensitive organs such as the lungs, spine or head. Ion rays are also more effective inside the tumour because they release their energy over only a few nanometres around their trajectory. Michael Scholz and his colleagues have developed a model with which they can precisely calculate the radiation dose required by each patient. It is particularly important to determine the energy and number of ions that need to be shot into the body, since these measurements have a decisive influence on the depth of penetration and the biological effect of the ion beams. The local effect model (LEM) used to calculate the biological effect was already successfully deployed in the pilot project and is now being used in the clinical context – for example, at the Heidelberg Ion-Beam Therapy Center, where the GSI, working with partners from industry, has built the world’s first purely clinical system. Since 2009 more than 1,200 patients have been treated here. In spring 2013, the LEM was licensed to the Swedish firm RaySearch Laboratories, which is developing a planning module for radiation therapy centres. In order to calculate the parameters required to achieve the maximum effect of the ion beams, Scholz and his colleagues are drawing on two types of information. On the one hand, they are making use of the detailed information available about the destructive effect of conventional X-ray radiation, which helps them to determine the dosage of ion radiation required at the tumour site. On the other hand, they are taking into account the type of ions used, the type of tissue they have to penetrate to reach the tumour, and the biological characteristics of the tumour itself. “Although we cannot create mathematical models of all the details of the cellular reaction to radiation,” says Scholz, “we have been able to use a more precise description of the damage pattern caused by the radiation to significantly improve the accuracy of the model’s calculations.” *ud*



A Higgs boson in the CMS detector. Each of the broken yellow lines and green cones represents a photon. The image illustrates the decay of a Higgs boson into two photons. *Photo: CERN*

THE DISCOVERY OF THE YEAR

Deutsches Elektronen-Synchrotron DESY: Applause rang out for several minutes in the large auditorium at CERN, the European Organisation for Nuclear Research, after the announcement of the discovery of a new elementary particle – probably the long-sought Higgs boson. For decades, scientists have been looking for this tiny particle, which can help to explain why other elementary particles have mass. Now, for the first time, its existence had been proved by the Large Hadron Collider (LHC), the world's largest particle accelerator. Contributors to this breakthrough in particle physics include two member centres of the Helmholtz Association: DESY and the Karlsruhe Institute of Technology (KIT).

The experiments conducted in Geneva are elaborate undertakings. The LHC, an underground ring accelerator with a circumference of 27 kilometres, brings protons close to the speed of light and then smashes them into one another. Some of these collisions produce new elementary particles, including the Higgs boson. However, the Higgs is not very stabile and promptly bursts into other particles. Two detectors observe this "debris", ATLAS and CMS, which are house-sized structures studded with sensors. Each of these behemoths represents an enormous concentration of engineering power and is monitored by an international team of well over 2,000 physicists. One of the greatest challenges presented by the experiments is the complexity of the computer analyses used by the experts to determine in retrospect whether Higgs particles were in fact generated by the proton collisions. "There are innumerable processes that very closely resemble the generation and decay of a Higgs boson but which are caused by something else that we have already known about for a long time," says Kerstin Tackmann, one of around 60 DESY specialists working on the ATLAS experiment. She adds: "In order to find the needle in the haystack, the research teams need to evaluate enormous amounts of data." Tackmann and her five-member research group have focused in particular on detecting events in which the Higgs boson decays into two "gamma quanta" – one of the most important indicators of the presence of the particle.

DESY researchers are also contributing to the CMS, the other giant detector at the LHC. Among other things, they are investigating how often the Higgs boson decays into two "tau leptons", heavy relatives of the electron. In addition, the Hamburg-based researchers have contributed two subsystems to the detector: a calorimeter that registers the energy of particles generated by collisions and a measurement system that monitors the LHC's high-energy proton beams. "The system uses diamond sensors to monitor the quality of the beam," explains DESY physicist Kerstin Borras. "For instance, it checks whether too many protons are being lost from the beam and whether the background is too strong for our sensitive detectors."

The DESY is integrated into the Helmholtz alliance "Physics at the Terascale", a Germany-wide network that includes the Max Planck Institute for Physics and 18 universities. The alliance supports the development of new technologies, participates in the analysis of LHC data and promotes talented young scientists. The LHC is currently being upgraded to handle higher collision energies and should be back online by the end of 2014. The ATLAS and CMS teams are using this shutdown period to refine their detectors. Among other things, DESY researchers are helping to improve the operation of the hadronic calorimeter, a key component of the CMS, and they are also involved in the upgrade of the ATLAS silicon pixel detector. The LHC is scheduled to go into operation again at the beginning of 2015, when it will smash protons together at almost twice the previous level of energy and deliver more collisions and thus more Higgs bosons, which will make it possible to subject this exotic particles to even more detailed examinations. "We may encounter something quite unexpected," says Kerstin Tackmann, "such as values that deviate from the predictions of conventional theories as expressed in the standard model." That could mean yet another breakthrough for particle physics. *fg*

DIVERSITY

"Almost 300 million Africans live in cities. The proportion of the urban population is growing faster in Africa than on any other continent. At the same time, many sub-Saharan African cities must cope with population growth, development problems, urbanisation, the effects of climate change and their vulnerability to extreme weather phenomena such as droughts and floods. Through our research project CLUVA ("Climate Change and Urban Vulnerability in Africa"), we aim to provide urban planners and local decision-makers with reliable application-oriented knowledge."

NATHALIE JEAN-BAPTISTE

PhD in Urban Studies, Department of Urban and Environmental Sociology, Helmholtz Centre for Environmental Research

"We are studying the equilibrium of the immune system in extreme situations. With this work we can better understand what happens when different pathogens infect the body simultaneously. An example is the common flu, during which the viral infection is often followed by a bacterial superinfection. In a changing population, we are thus contributing to research on diseases that hit the elderly particularly hard."

PROFESSOR DUNJA BRUDER

Head of the Immune Regulation Group, Helmholtz Centre for Infection Research

"A growing number of people are living to old age and as a result age-related diseases such as Alzheimer's are becoming more common. The increase in these diseases in an ageing population is a major challenge for research. We are working to ensure that neurodegenerative diseases can be detected and treated with innovative methods at an early stage."

PROFESSOR DIETER WILLBOLD

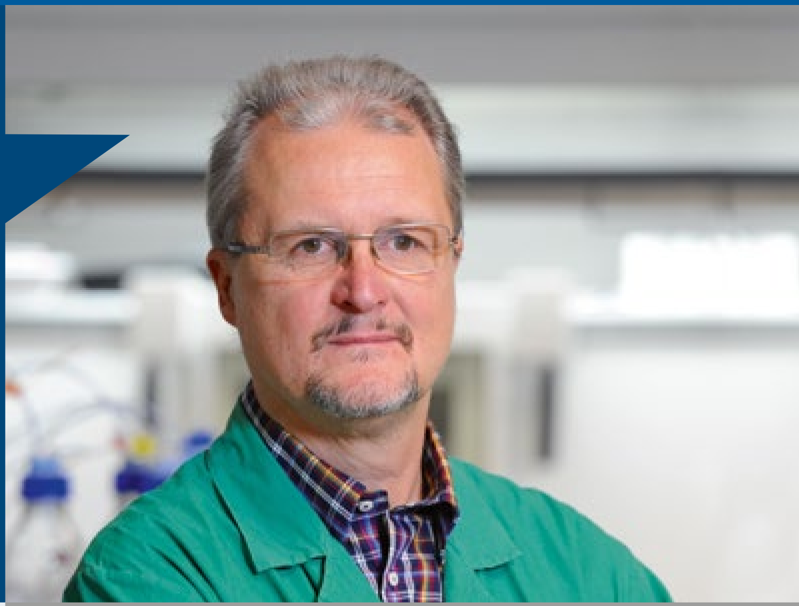
Director of the Institute of Complex Systems (ICS), Department of Structural Biology, Forschungszentrum Jülich

PEOPLE AND RESOURCES AT THE HELMHOLTZ ASSOCIATION

"Cancer is the second most common cause of death in industrialised countries and the result, among other things, of an ageing population. Early detection significantly increases the chance of successful treatment. We are working to develop tailored nanomaterials to visualise, characterise and successfully treat cancer."

DR. HOLGER STEPHAN

Group Leader of Nanoscale Systems at the Institute of Radiopharmaceutical Cancer Research, HZDR,
Spokesperson for the Helmholtz Virtual Institute "NanoTracking"



"The number of people with dementia is increasing, as is the demand for treatments and health care. The first nationwide 'Dementia Monitor' allows us to collect and analyse robust data on the incidence and progression of dementia, which we can then use to derive possible trends. With this approach we can better evaluate the challenges of demographic change for society – including the increasing demands on families and the health care system – and also develop viable solutions for a disease affecting the elderly that requires high levels of care and is one of the most expensive."

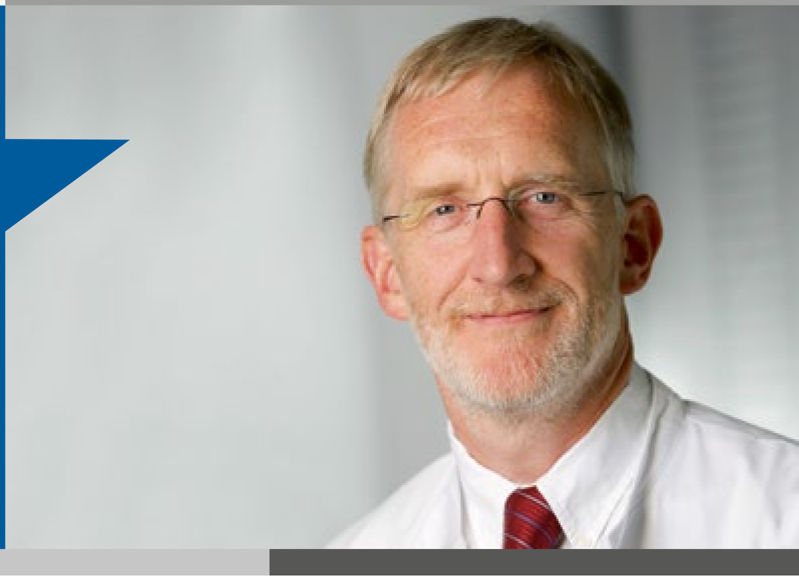
PROFESSOR GABRIELE DOBLHAMMER

Senior Group Leader of Demographic Studies,
DZNE and Rostock University

"We are currently examining how new cancer treatments work in everyday conditions. This is important because the participants in drug registration trials tend to be younger and healthier than the cancer patients we see on an everyday basis in the real world. The latter often have accompanying illnesses and need to take many medications. The Clinical Cancer Registry, which will be set up throughout the country under a law passed by the Bundestag this spring, is what makes our research possible."

PROFESSOR CHRISTOF VON KALLE

Director of the National Center for Tumor Diseases (NCT) in Heidelberg
and Department Head at the German Cancer Research Center



PERFORMANCE RECORD

The Helmholtz Association's mission is to conduct research that makes an important contribution to addressing the major and pressing challenges of science, society and industry. The Helmholtz Association is the largest scientific organisation in Germany with around 36,000 staff members working at 18 research centres and a total annual budget of more than 3.8 billion euros. Approximately 70 per cent of its funds are provided by Germany's federal and state governments at a ratio of 90 to 10. The centres raise around 30 per cent of the total budget themselves in the form of third-party funding. The association uses these funds to carry out cutting-edge research. The following pages present a range of informative indicators concerning people and resources at the Helmholtz Association in order to demonstrate the scope and effects of its performance.

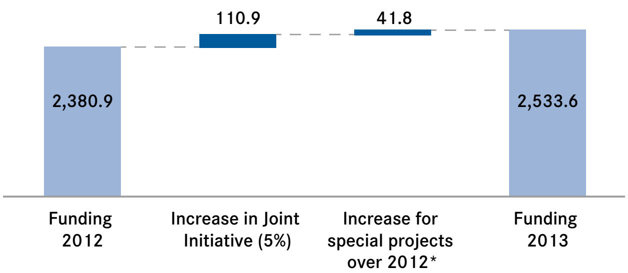
RESOURCES

Core funding for the Helmholtz Association for fiscal 2013 increased to around 2,534 million euros from approx. 2,381 million euros during the previous year.

Development of resources

Growth 2012–2013

in million € (federal and state governments)

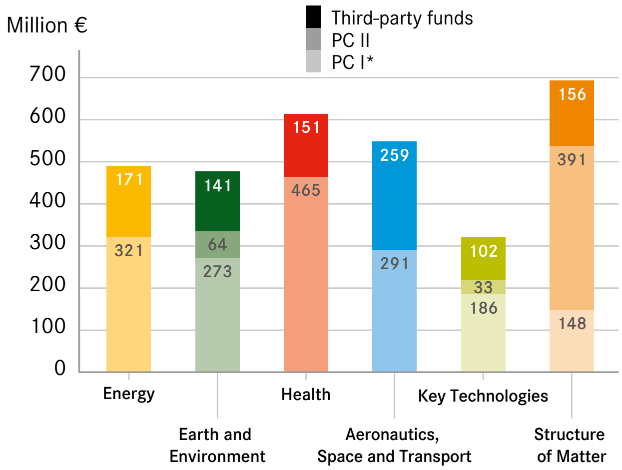


* Special projects funded by the BMBF: German Centres for Health Research, BIMSB, CSSB, DZNE

This growth is due to two factors: the 5 per cent increase in funds from the Joint Initiative for Research and Innovation and the increase in funding for a number of special projects. These special projects, which are given additional support by the funding bodies, include in particular the establishment of the German Centres for Health Research (total volume for 2012: 54 million euros), the expansion of the German Center for Neurodegenerative Diseases (DZNE) with the help of more than 12 million euros in 2012 and the funding of both the Centre for Structural Systems Biology (CSSB) and the Berlin Institute for Medical Systems Biology (BIMSB). Furthermore, the Helmholtz Association's resources were increased through the addition of a new centre – the GEOMAR Helmholtz Centre for Ocean Research Kiel. GEOMAR became a member of the association on 1 January 2012 and will boost the association's funding by around 46 million euros per year.

2012 budget showing core and third-party funding for the research fields

(including funds for the non-programme-linked research used to strengthen existing research fields)



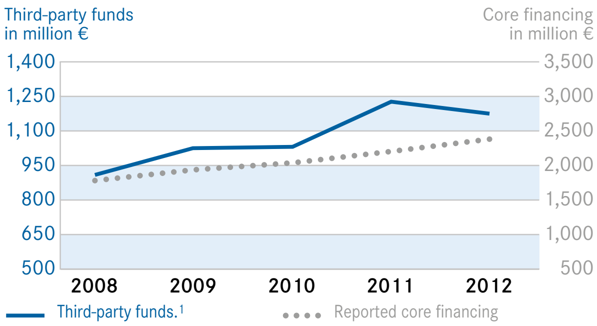
*including funds for portfolio topics, the Helmholtz institutes and the Helmholtz share of the German Centres for Health Research.

The above chart shows core and third-party funds as actual costs for 2012. Actual costs represent the funds that were in fact used by the research centres during the year under review.

Third-party funding

The association raised third-party funds of 1,182 million euros in 2012, representing a decrease of 4 per cent over 2011, when third-party funds totalled 1,227 million euros. This decline is due among other things to the expiration of special financing from an economic stimulus programme.

"Concomitant with the solid expansion of financial and human resources, research performance at the Helmholtz Association has also improved. The addition of new Helmholtz centres and institutes and the investments in people, new research topics and additional research infrastructure are having a clear impact."
DR. ROLF ZETTL, Managing Director of the Helmholtz Association

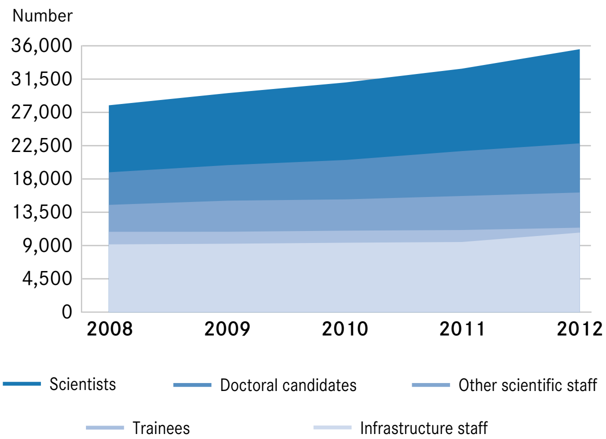


Sources: Progress Reports of the Helmholtz Centres, 2008 to 2012

[1] Project sponsorships have been taken into account since 2011 (approx. 138 million euros in 2012). The Helmholtz institutes and the German Centres for Health Research contributed around 0.3 million euros in third-party funds.

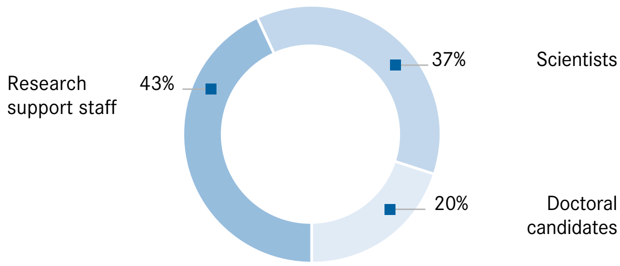
Staff developments

In 2012 the number of employees at the Helmholtz Association grew once again and totalled 35,672 (2011: 32,855)



In 2012 the association had a total of 12,709 scientists (2011: 11,121), 6,635 supervised doctoral candidates (2011: 6,062) and 1,652 trainees (2011: 1,617). In addition to scientists and doctoral candidates, the Helmholtz Association employs research support staff, a category that includes all other personnel. A total of 14,676 employees (2011: 14,055) work in technical and administrative fields.

Staff according to staff categories (without trainees)

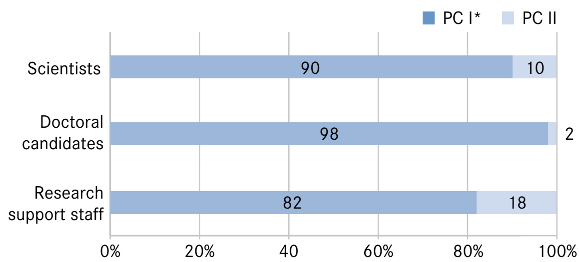


A special feature of the Helmholtz Association's staff structure is the high proportion of research support staff (43 per cent) in relation to scientists (37 per cent). This is due to the large-scale research infrastructure unique to the Helmholtz Association. Furthermore, with doctoral students making up 20 per cent of staff, the association is committed to promoting young scientists. Research support staff (e.g., technical assistants and graduates of applied science universities) include all employees besides scientists and doctoral candidates who can be directly assigned to Performance Category I or II (PC I or II) or to a specific research programme.

PC I includes the staff members of the Helmholtz centres who are engaged in research and development (in-house research).

PC II pertains to the operation of large-scale research infrastructure and facilities for external users, including the provision of large-scale research devices.

Staff involved in in-house research and the operation of large-scale research infrastructure (expressed in per cent)



* including the Helmholtz staff linked to portfolio topics, the Helmholtz institutes and the Helmholtz Association's share of the German Centres for Health Research

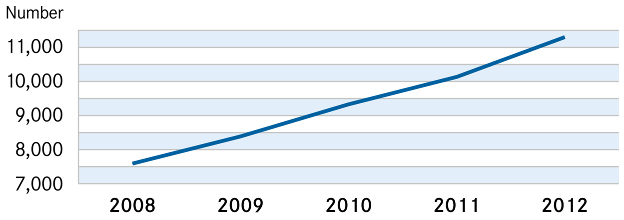
Detailed information on the Helmholtz Association's resources can be found in the tables on pages 60–61, broken down by research field and research centre.

SCIENTIFIC PERFORMANCE

Research performance

Scientific publications are an indicator of the success of top-notch research. In this area the association has seen a significant increase in activity during the last few years. In 2012, 11,308 publications appeared in ISI-indexed scientific journals and an additional 3,209 in peer-reviewed journals. The number of ISI-indexed publications has increased by 12 per cent over the previous year and by a total of 49 per cent over the past five years.

ISI-indexed publications



Sources: Progress Reports of the Helmholtz Centres, 2008 to 2012

User platforms

The development, construction and operation of research infrastructure is one of the special strengths of the Helmholtz Association. Its facilities are in great demand nationally and internationally. The use of large-scale devices by external users increased substantially in 2012 compared to 2011.

Large-scale devices at the Helmholtz Association

	Type of use	Actual value 2011	Actual value 2012
Availability		78.4%	77.7%
Use	Use by internal Helmholtz scientists	35.8%	33.5%
	Use by external scientists	62.3%	66.0%

The table shows average values for all large-scale devices at the Helmholtz Association. Average use represents the share of the total available capacity that was actually used by scientists. The unit of capacity measurement is device-specific. Internal and external use added together total a maximum of 100 per cent. Average availability: number of days per year when the device was available (without maintenance or downtime), given in per cent.

European collaboration

The Helmholtz centres have entered into numerous strategic collaborations. These provide a foundation for the associations's effort to develop solutions to major challenges affecting Germany. This work has a global reach, is long-term in nature and makes coordinated and systematic use of the association's resources. In 2012 the Helmholtz centres were involved in 227 projects that were newly funded by the EU research programme. The association acquired a high level of EU research funds during the year:

Acquired EU research funds

	2009 in T€	2010 in T€	2011 in T€	2012 in T€
Funds from the EU for research and development	131,769	118,477	146,188	126,936
Joint funds from federal and state governments*	1,990,000	2,038,000	2,203,147	2,381,000
Total	2,121,769	2,156,477	2,349,335	2,507,936
Proportion of EU funds	6.2%	5.5%	6.2%	5.1%

*Funding on the basis of the GWK Agreement (target amounts without funds for decommissioning and dismantling nuclear facilities or resources used for defence-related aerospace research)

International exchange

Helmholtz research centres continue to hold great international appeal for foreign scientists. Around 7,765 scientists came to the centres from all over the world in order to exchange scientific ideas and take advantage of the research opportunities they offer – an increase of 5 per cent over the previous year.

Foreign scientists at the Helmholtz centres

	2008	2009	2010	2011	2012
Postgraduate	863	1,085	1,192	1,425	1,705
Postdoctoral	623	695	825	940	1,103
Experienced scientists/ university teachers	963	1,531	1,677	1,680	2,175
Guest scientists	1,910	2,308	2,406	3,153	2,577
No categorisation possible/ no information	203	172	167	165	205
Total	4,562	5,791	6,267	7,363	7,765

National collaboration

The table illustrates the success of the Helmholtz centres in the competitions held by the German Research Foundation (DFG). It includes projects in which the participating researchers noted their Helmholtz affiliation in their applications. Taking into account the projects for which Helmholtz researchers submitted applications within the scope of their university activities, the numbers for 2012 increase to 93 collaborative research centres, 61 priority programmes and 71 research units.

German Research Foundation (DFG)

	2008	2009	2010	2011	2012
Research centres	1	1	1	1	2
Collaborative research centres	66	59	61	64	68
Priority programmes	41	50	50	52	52
Research units	41	53	56	62	58

In the first phase of the Excellence Initiative, the Helmholtz centres proved to be important partners for universities. Funding decisions for the initiative's second phase were made in 2012 and the Helmholtz centres are currently involved in 17 clusters of excellence and 12 graduate schools. The centres' involvement in ten institutional concepts reflects their close strategic link to their university partners.

Participation in the Excellence Initiative

	Excellence cluster	Graduate schools	Institutional concepts
1st phase	13	15	3
2nd phase	17	12	10

Compared to 2011, the year 2012 saw a 21 per cent increase in the number of Helmholtz scientists who received a joint appointment to a W2 or W3 professorship at universities.

Joint appointments

	2008	2009	2010	2011	2012
Joint appointments with universities, W2 and W3 staff	255	262	319	374	452

Talent management

In 2012 the number of Helmholtz scientists appointed to junior professorships jumped by more than 50 per cent.

Junior professors

	31.12.08	31.12.09	31.12.10	31.12.11	31.12.12
Number of junior professors appointed jointly with universities	7	13	15	18	28
Number of junior professors appointed jointly with universities who took up their posts in the year under review	3	6	2	3	10

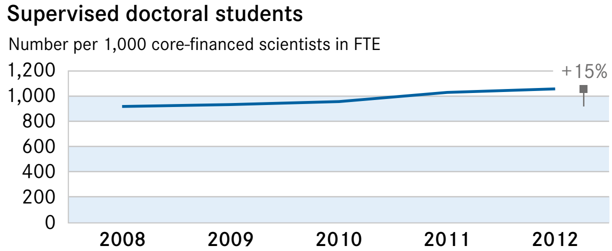
More than 37 per cent of the leaders of the Helmholtz Young Investigators Groups are women and the proportion of women supervising other junior research groups is around 26 per cent:

Junior research groups

		Total	Women
Leaders of junior research groups	**Leaders of Helmholtz Young Investigators Groups** (funded by the Initiative and Networking Fund within the framework of the Helmholtz Young Investigators Group programme)	104	39
	Leaders of other junior research groups (junior research groups at the centres, Emmy Noether groups, etc.)	132	34

In the past five years the number of supervised doctoral students has increased by 51 per cent. This represents an average growth rate of 11 per cent per year. In addition, there were a total of 2,359 postdoctoral candidates working at the Helmholtz Association in 2012. The ratio of core-financed scientists to doctoral students is approximately one to one. This share has increased by 15 per cent over the last five years:

Supervised doctoral students



Sources: Progress Reports of the Helmholtz Centres, 2008 to 2012

More than 6,635 young scientists undertook doctoral work at the Helmholtz centres in 2012. More than 803 dissertations were filed, with 318 of them, or 40 per cent, completed by women.

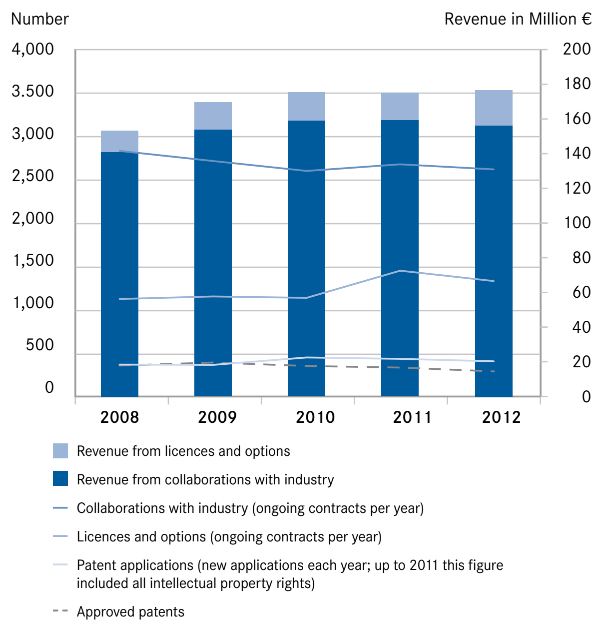
Doctoral work

	31.12.08	31.12.09	31.12.10	31.12.11	31.12.12
Number of funded graduate and research schools*	33	48	49	75	84
Number of supervised doctoral candidates**	4,521	4,797	5,320	6,062	6,635
Number of completed dissertations	756	848	783	822	803

* including 12 of the graduates schools supported by the DFG
** including the individuals who use the research infrastructure of the Helmholtz Association

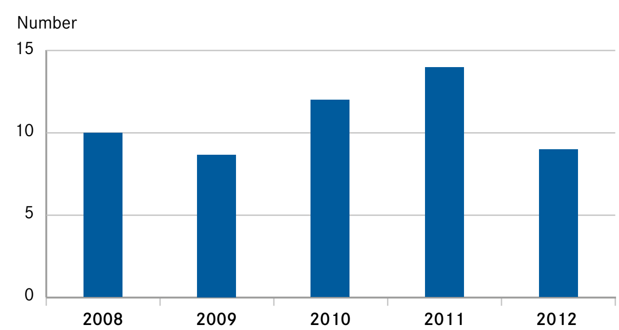
Technology transfer

Technology transfer



The key figures for technology transfer in 2012 show an upward trend, particularly as regards the licence revenue earned by Helmholtz centres. Due in part to one-off effects, this revenue rose from 16 million euros to more than 20 million euros during the previous year. However, income from collaborations with industry declined slightly to 156 million euros in the year under review, down from 159 million euros in each of the previous years. There was a slight decrease in the number of contracts with industry and the number of licence and option agreements, mainly due to the stricter definitions of key parameters. The number of applications to register intellectual property rights also declined slightly since in order to meet international standards the figures for 2012 include only patent applications.

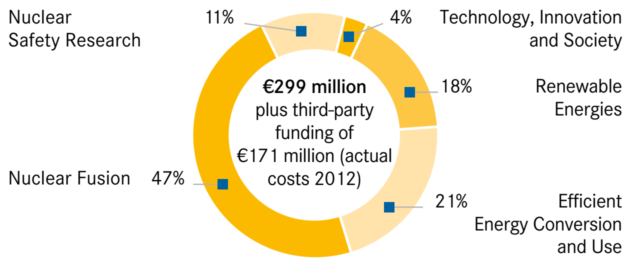
Research spin-offs



The definition of “research spin-off” was modified to comply with international standards. However, this new definition is not the reason that the number of spin-offs decreased to nine. After a record year in 2011, the association merely returned to a normal rate, with roughly the same number of start-ups as in the previous eight years (an average of ten per year).

COSTS AND STAFF

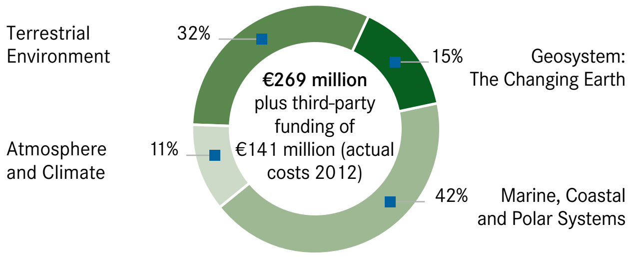
Structure of the research field Energy
Target costs of core financing 2012: 299 million euros*
(incl. share of non-programme-linked research)



*No target costs are available for the HZDR in this research field.
Plus portfolio funds of €9 million.

Source: Progress Report of the Centres 2012

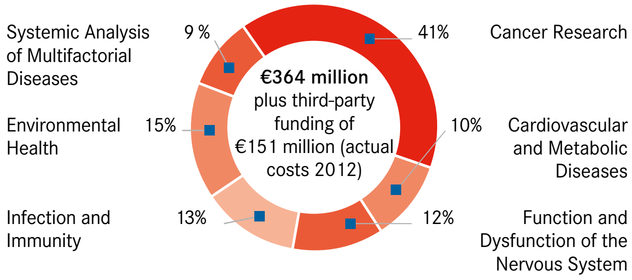
Structure of the research field Earth and Environment
Target costs of core financing 2012: 269 million euros*
(incl. share of non-programme-linked research)



*Plus the programme "Oceans: From the Deep Sea to the Atmosphere" currently under development at GEOMAR: €39 million.
Plus portfolio funds of €10 million.

Source: Progress Report of the Centres 2012

Structure of the research field Health
Target costs of core financing 2012: 364 million euros*
(incl. share of non-programme-linked research)



*Plus the "Neurodegenerative Diseases" programme currently under development at the DZNE: €75 million.
Plus funds of €31 million for the German Centres for Health Research and the Helmholtz Institute Saarbrücken.
No target costs are available for the HZDR in this research field.
Plus portfolio funds of €8 million.

Source: Progress Report of the Centres 2012

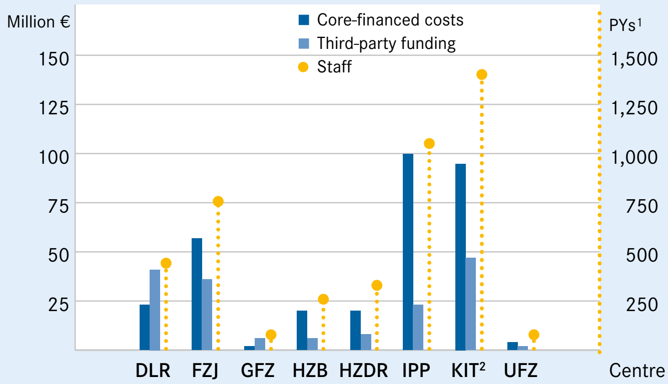
COSTS AND STAFF

COSTS AND STAFF 2012 for the Helmholtz Association, overview	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total staff PYs [1]
Research fields, total[2]	2,173,155	980,980	3,154,135	27,798
Non-programme-linked research, total [3]	33,136	51,105	84,241	455
Special tasks[4] and project sponsorships, total	21,225	149,732	170,957	1,683
Helmholtz Association, total	**2,227,516**	**1,181,817**	**3,409,333**	**29,936** [5]

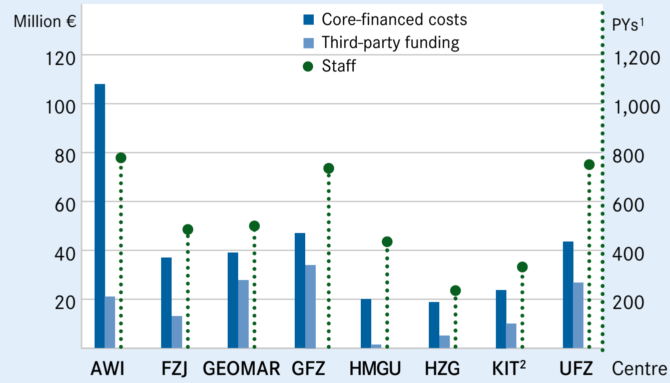
All amounts in thousands of euros. [1]Person-years. [2]In addition to the six research fields, this category includes the funds for portfolio topics, the Helmholtz institutes and the Helmholtz share of the German Centres for Health Research. [3]The funds for non-programme-linked research can amount to a maximum of 20 per cent of all acquired programme funding. If the centres use these funds to strengthen existing research programmes, the funds are allocated directly to the costs of the respective programmes. [4]Mainly involving the dismantling of nuclear facilities. [5]Expressed as natural persons, the Helmholtz Association has 35,672 employees. [6]Share of the KIT's Division of Large-Scale Research.

Research Field Energy	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total staff PYs [1]
German Aerospace Center (DLR)	22,698	41,346	64,044	437
Forschungszentrum Jülich (FZJ)	56,755	35,991	92,746	867
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	20,432	5,870	26,302	253
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	19,554	8,478	28,032	324
Helmholtz Centre for Environmental Research (UFZ)	4,138	1,603	5,741	72
Helmholtz Centre Potsdam (GFZ)	1,893	6,489	8,382	72
Karlsruhe Institute of Technology (KIT) [6]	94,945	47,415	142,360	1,399
Max Planck Institute for Plasma Physics (IPP)	100,452	23,427	123,879	1,047
Research Field Energy, total	**320,867**	**170,619**	**491,486**	**4,471**
Research Field Earth and Environment				
Alfred Wegener Institute (AWI)	107,879	21,251	129,130	774
Forschungszentrum Jülich (FZJ)	37,020	13,263	50,283	485
GEOMAR Helmholtz Centre for Ocean Research Kiel	38,990	27,789	66,779	495
Helmholtz Centre for Environmental Research (UFZ)	43,788	27,002	70,790	753
Helmholtz-Zentrum Geesthacht (HZG)	18,562	5,402	23,964	232
Helmholtz Zentrum München (HMGU)	20,345	3,147	23,492	430
Helmholtz Centre Potsdam (GFZ)	46,880	33,664	80,544	731
Karlsruhe Institute of Technology (KIT) [6]	24,396	9,647	34,043	330
Research Field Earth and Environment, total	**337,860**	**141,165**	**479,025**	**4,230**
Research Field Health				
German Cancer Research Center (DKFZ)	127,356	54,580	181,936	1,987
German Center for Neurodegenerative Diseases (DZNE)	72,014	1,865	73,879	455
Forschungszentrum Jülich (FZJ)	28,441	6,025	34,466	358
GSI Helmholtz Centre for Heavy Ion Research (GSI)	3,948	2,060	6,008	72
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	12,279	1,528	13,807	164
Helmholtz Centre for Infection Research (HZI)	42,914	27,776	70,690	661
Helmholtz Centre for Environmental Research (UFZ)	4,144	995	5,139	55
Helmholtz-Zentrum Geesthacht (HZG)	10,556	4,228	14,784	139
Helmholtz Zentrum München (HMGU)	106,941	33,763	140,704	1,509
Max Delbrück Center for Molecular Medicine (MDC)	56,428	18,502	74,930	912
Research Field Health, total	**465,021**	**151,322**	**616,343**	**6,312**
Research Field Aeronautics, Space and Transport				
German Aerospace Center (DLR)	291,219	258,981	550,200	4,595
Research Field Aeronautics, Space and Transport, total	**291,219**	**258,981**	**550,200**	**4,595**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	100,428	50,420	150,848	1,216
Helmholtz-Zentrum Geesthacht (HZG)	24,601	5,789	30,390	295
Karlsruhe Institute of Technology (KIT) [6]	94,112	45,624	139,736	1,461
Research Field Key Technologies, total	**219,141**	**101,833**	**320,974**	**2,972**
Research Field Structure of Matter				
Deutsches Elektronen-Synchrotron (DESY)	219,637	90,773	310,410	1,987
Forschungszentrum Jülich (FZJ)	48,223	9,348	57,571	451
GSI Helmholtz Centre for Heavy Ion Research (GSI)	102,845	28,391	131,236	1,160
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	80,467	8,926	89,393	660
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	33,280	6,966	40,246	422
Helmholtz-Zentrum Geesthacht (HZG)	8,528	2,654	11,182	80
Karlsruhe Institute of Technology (KIT) [6]	46,067	10,002	56,069	458
Research Field Structure of Matter, total	**539,047**	**157,060**	**696,107**	**5,218**

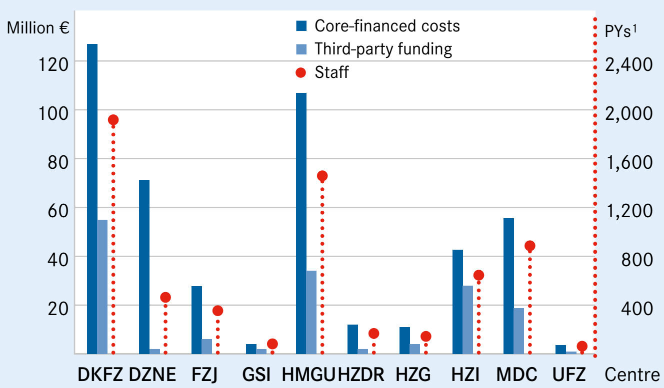
Research Field Energy



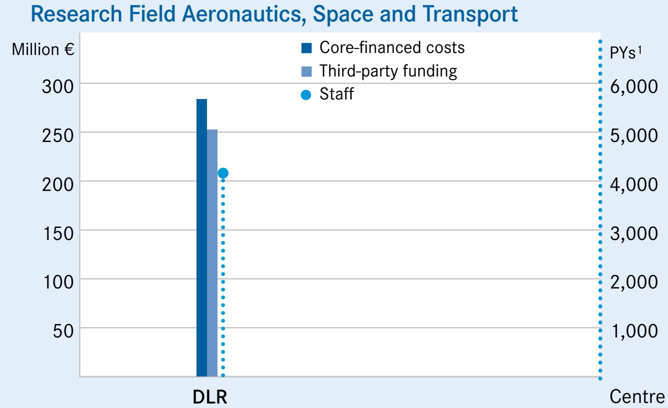
Research Field Earth and Environment



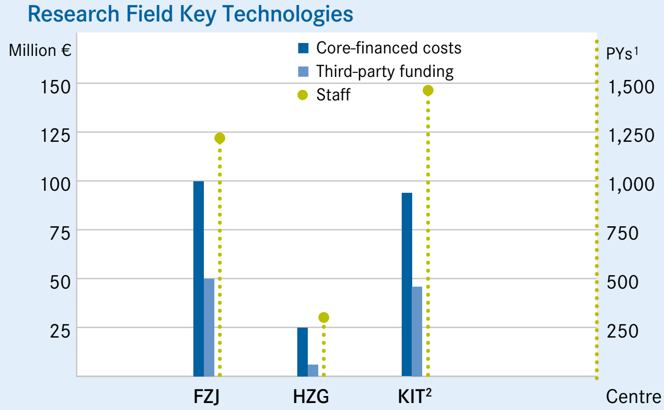
Research Field Health



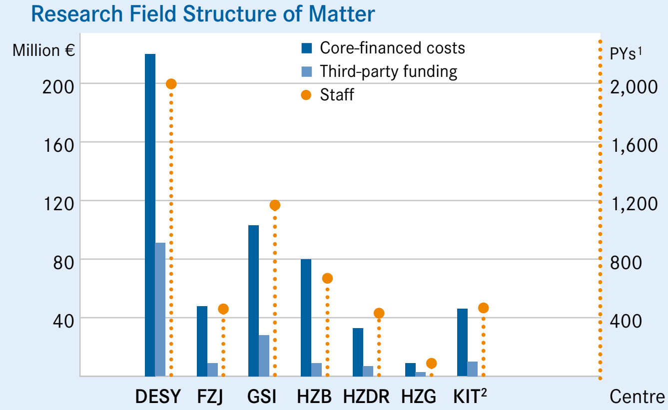
Research Field Aeronautics, Space and Transport



Research Field Key Technologies

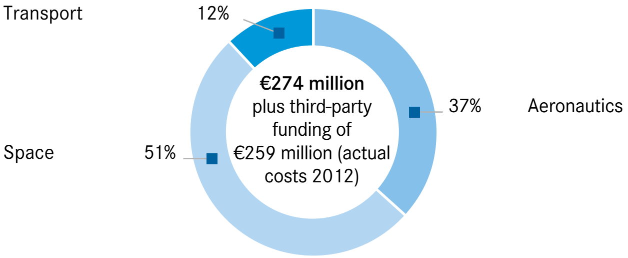


Research Field Structure of Matter



[1] Person-years; [2] Share of KIT's Division of Large-Scale Research

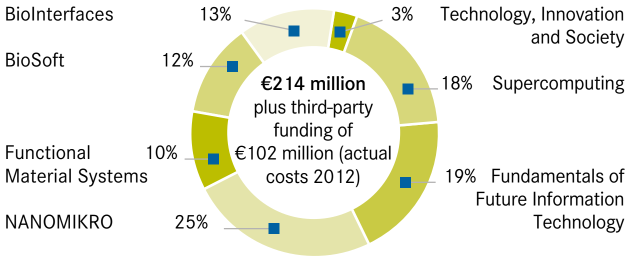
Structure of the research field Aeronautics, Space and Transport
Target costs of core financing 2012: 274 million euros*
(incl. share of non-programme-linked research)



*Plus portfolio funds of €6 million.

Source: Progress Report of the Centres 2012

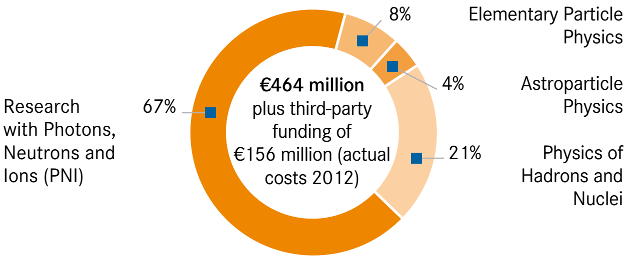
Structure of the research field Key Technologies
Target costs of core financing 2012: 214 million euros*
(incl. share of non-programme-linked research)



*Plus funds of €6 million for the Helmholtz Institute Ulm.
Plus portfolio funds of €6 million.

Source: Progress Report of the Centres 2012

Structure of the research field Structure of Matter
Target costs of core financing 2012: 464 million euros*
(incl. share of non-programme-linked research)



*No target costs are available for the HZDR in this research field.
Plus funds of €11 million for the Helmholtz Institutes of Mainz and Jena.
Plus portfolio funds of €4 million.

Source: Progress Report of the Centres 2012

2012

COSTS AND STAFF BY CENTRE

The Helmholtz Association's annual budget consists of core financing and third-party funding. Ninety per cent of core financing is provided by the federal government and 10 per cent comes from the federal states in which the member centres are located. The centres raise around 30 per cent of the total budget themselves in the form of third-party funding. The Annual Report shows these core-financed and third-party-financed costs for the 2012 reporting period. Due to the Helmholtz Association's strategic focus on six research fields, total costs are broken down according to the research fields and the centres. This overview is supplemented by information on the number of staff members expressed as full-time equivalents (for both the centres and the research fields). The overview contains the 28 million euros in actual costs attributable to the Helmholtz institutes and the Helmholtz Association's share of the German Centres for Health Research. The contribution made by these latter collaborations to third-party funding amounts to 0.3 million euros.

Costs and staff by centre, 2012	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total staff PYs[1]
Alfred Wegener Institute (AWI)	107,879	21,251	129,130	774
Deutsches Elektronen-Synchrotron (DESY)	219,637	90,773	310,410	1,987
German Cancer Research Center (DKFZ)	127,356	54,580	181,936	1,987
German Aerospace Center (DLR)	313,917	300,327	614,244	5,032
German Center for Neurodegenerative Diseases (DZNE)	72,014	1,865	73,879	455
Forschungszentrum Jülich (FZJ)	270,867	115,047	385,914	3,377
GEOMAR Helmholtz Centre for Ocean Research Kiel	38,990	27,789	66,779	495
GSI Helmholtz Centre for Heavy Ion Research (GSI)	106,793	30,451	137,244	1,232
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	100,899	14,796	115,695	913
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	65,113	16,972	82,085	910
Helmholtz Centre for Infection Research (HZI)	42,914	27,776	70,690	661
Helmholtz Centre for Environmental Research (UFZ)	52,070	29,600	81,670	880
Helmholtz-Zentrum Geesthacht (HZG)	62,247	18,073	80,320	746
Helmholtz Zentrum München (HMGU)	127,286	36,910	164,196	1,939
Helmholtz Centre Potsdam (GFZ)	48,773	40,153	88,926	803
Karlsruhe Institute of Technology (KIT)	259,520	112,688	372,208	3,648
Max Delbrück Center for Molecular Medicine (MDC)	56,428	18,502	74,930	912
Max Planck Institute for Plasma Physics (IPP)	100,452	23,427	123,879	1,047
Non-programme-linked research	**33,136**	**51,105**	**84,241**	**455**
Special tasks[2] and project sponsorships	**21,225**	**149,732**	**170,957**	**1,683**
Helmholtz Association, total	**2,227,516**	**1,181,817**	**3,409,333**	**29,936**

All amounts in thousands of euros. [1] Person-years (full-time equivalents). [2] Mainly involving the dismantling of nuclear facilities.

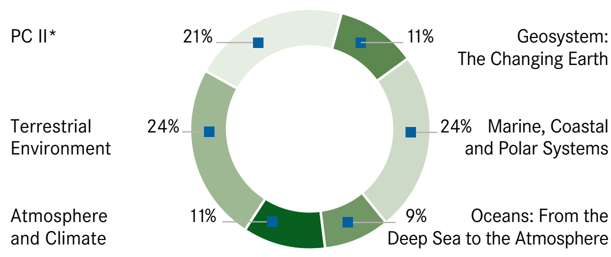
THIRD ROUND OF PROGRAMME-ORIENTED FUNDING, 2014–2018

The third period of programme-oriented funding will begin in 2014, initially for the research fields Earth and Environment, Health and Aeronautics, Space and Transport. The centres involved in these research fields have repositioned themselves for the new programme period, combining their R&D capacities in a total of 13 programmes. The following section presents the funding for these programmes for 2014, as recommended by the Helmholtz Senate based on the results of its strategic reviews.

Earth and Environment

The evaluation of the five programmes in the research field Earth and Environment took place between January and March 2013. The reviewers confirmed the high scientific and strategic relevance of the programmes "Geosystem: The Changing Earth", "Marine, Coastal and Polar Systems", "Atmosphere and Climate" and "Terrestrial Environment". A new addition is the research programme "Oceans: From the Deep Sea to the Atmosphere". Financing recommendations for the entire funding period, formulated on a cost basis, total 1,925 million euros, including 1,529 million euros for Performance Category I financing (PC I) and 396 million euros for Peformance Category II (PC II).

Structure of the resarch field Earth and Environment
Core-financed costs
Recommendations for 2014 to 2018: 1,925 million euros

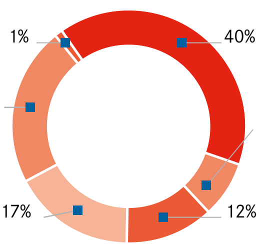


* The PC II facilities are as follows (all figures in thousands of euros): MESI (GFZ) €39,976; the *Polarstern* research vessel (AWI) €191,514; the *Heincke* research vessel (AWI) €26,687; Neumayer Station III (AWI) €68,722; the *Poseidon* research vessel (GEOMAR) €44,267 and the *Alkor* research vessel (GEOMAR) €25,161.

HEALTH

In the research field Health the review of the five programmes and the Helmholtz Association's contribution to the National Cohort took place between February and April 2013. The programmes "Cancer Research", "Cardiovascular and Metabolic Diseases", "Infection Research", "Diseases of the Nervous System" and "Genes and Environment in Common Diseases" were deemed to be outstanding by international standards. Top ratings were also given to the Personalised Medicine initiative, jointly supported by all the programmes with annual funding of five million euros. The financing recommendations for the entire programme period, formulated on a cost basis, amount to 2,476 million euros, including 2,438 million euros for PC I financing and 38 million euros for PC II financing. On 18 October 2013, in conjunction with the third period of programme-oriented funding, the Helmholtz Senate approved special strategic funding of 1.75 million euros per year for the ESFRI measure INFRAFRONTIER and an annual grant of 2.582 million euros for the Berlin Institute for Medical Systems Biology (BIMSB), effective from 2015. These monies will come from the budget of the research field Health.

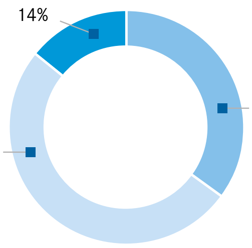
Structure of the research field Health
Core-financed costs
Recommendations for 2014 to 2018: 2,476 million euros



Aeronautics, Space and Transport

The review of this field's three programmes – "Aeronautics", "Space" and "Transport" – took place between January and April 2013. Their high scientific quality and strategic relevance was confirmed by the external experts, and as a result the research field will receive increasing levels of funding during the upcoming funding period of 2014–2018. The financing recommendations for the entire period, formulated on a cost basis, total 1,744 million euros.

Structure of the research field Aeronautics, Space and Transport Core-financed costs
Recommendations for 2014 to 2018: 1,744 million euros



Third round of programme-oriented funding, 2014 to 2018, for the reviewed research fields

	Core-financed costs T€
Earth and Environmental	
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	587,884
Forschungszentrum Jülich (FZJ)	143,104
GEOMAR Helmholtz Centre for Ocean Research Kiel	253,580
Helmholtz Centre for Environmental Research (UFZ)	292,919
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	158,979
Helmholtz Zentrum München (HMGU)	106,323
Helmholtz Centre Potsdam (GFZ)	254,043
Karlsruher Institute of Technology (KIT)	127,928
Earth and Environmental Research, total	**1,924,760**
Health	
German Cancer Research Center (DKFZ)	754,210
German Center for Neurodegenerative Diseases (DZNE	336,013
GSI Helmholtz Centre for Heavy Ion Research (GSI)	23,299
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	113,866
Helmholtz Centre for Infection Research (HZI)	295,385
Helmholtz Centre for Environmental Research (UFZ)	26,757
Helmholtz Zentrum München (HMGU)	532,389
Max Delbrück Center for Molecular Medicine (MDC)	394,029
Health Research, total	**2,475,948**
Aeronautics, Space and Transport	
German Aerospace Center (DLR)	1,743,945
Aeronautics, Space and Transport Research, total	**1,743,945**

CENTRAL BODIES

As of October 2013

PRESIDENT

Prof. Dr. Jürgen Mlynek

VICE-PRESIDENTS

Scientific Vice-President, Coordinator of the Field of Energy Research

Professor Eberhard Umbach (to 30 Sept 2013); Professor Holger Hanselka (from 18 Oct 2013) President of the Karlsruhe Institute of Technology

Scientific Vice-President, Coordinator of the Field of Earth and Environmental Research

Professor Georg Teutsch, Scientific Managing Director of the Helmholtz Centre for Environmental Research – UFZ

Scientific Vice-President, Coordinator of the Field of Health Research

Professor Günther Wess, Scientific Director of the Helmholtz Zentrum München – German Research Center for Environmental Health

Scientific Vice-President, Coordinator of the Field of Aeronautics, Space and Transport Research

Professor Johann-Dietrich Wörner, Chairman of the Executive Board, German Aerospace Center (DLR)

Scientific Vice-President, Coordinator of the Field of Key Technologies Research

Professor Achim Bachem, Chairman of the Board of Directors, Forschungszentrum Jülich

Scientific Vice-President, Coordinator of Research into the Structure of Matter

Professor Helmut Dosch, Chairman of the Board of Directors, Deutsches Elektronen-Synchrotron DESY

Administrative Vice-President

Karsten Beneke, Vice-Chairman of the Board of Directors, Forschungszentrum Jülich

MANAGING DIRECTOR

Dr. Rolf Zettl

SENATE

ELECTED MEMBERS

Professor Andreas Barner, Chairman of the Board of Managing Directors, Boehringer Ingelheim GmbH

Professor Katharina Kohse-Höinghaus, Chemistry Department, Bielefeld University

Professor Gerd Litfin, Executive Associate of Arkadien Verwaltungs KG, Göttingen

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

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

Dr. Detlef Müller-Wiesner, Senior Vice-President, Head of External Affairs, Business and Transverse Initiatives, 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, ETH Domain, Switzerland

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

Professor Babette Simon, President of the University of Oldenburg

Professor Klaus Töpfer, Executive Director of the Institute for Advanced Sustainability Studies, Potsdam

EX OFFICO SENATE MEMBERS

Theresia Bauer, Minister of Science, Research and the Arts for the State of Baden-Württemberg, Stuttgart

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

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

Anne Ruth Herkes, State Secretary, Federal Ministry of Economics and Technology, Berlin

Michael Kretschmer, Member of the German Bundestag, Berlin

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

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

Professor Jürgen Mlynek, President of the Helmholtz Association, Berlin

René Röspel, Member of the German Bundestag, Berlin

Professor Sabine von Schorlemer, Minister of Science and the Arts for the State of Saxony, Dresden

Professor Johanna Wanka, Federal Minister of Education and Research

GUESTS

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

Karsten Beneke, Vice-President of the Helmholtz Association, Vice-Chairman of the Board of Directors of the Forschungszentrum Jülich

Professor Thomas Brey, Chairman of the Committee of Scientific-Technical Councils, Alfred Wegener Institute, Helmholtz Centre for Polar and Ocean Research, Bremerhaven

Professor Helmut Dosch, Vice-President of the Helmholtz Association, Chairman of the Board of Directors of the Deutsches Elektronen-Synchrotron DESY, Hamburg

Professor Horst Hippler, President of the German Rectors' Conference, Bonn

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

Professor Karl Ulrich Mayer, President of the Leibniz Association, Berlin.

Professor Reimund Neugebauer, President of the Fraunhofer-Gesellschaft, Munich

Professor Peter Strohschneider, President of the German Research Foundation, Bonn

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

Professor Holger Hanselka, Vice-President of the Helmholtz Association, President of the Karlsruhe Institute of Technology, Karlsruhe

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Professor Günther Wess, Vice-President of the Helmholtz Association, Scientific Director of the Helmholtz Zentrum München – German Research Center for Environmental Health

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

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

Dr. Rolf Zettl, Managing Director of the Helmholtz Association

SENATE COMMISSIONS

PERMANENT MEMBERS*

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Professor Wolfram Münch, Head of Research and Innovation, EnBW Energie Baden-Württemberg AG, Karlsruhe

Earth and Environmental Research

Professor Susanne Crewell, Institute of Geophysics and Meteorology, University of Cologne

Health Research

Professor Irmgard Sinning, Director of the Heidelberg University Biochemistry Centre

Aeronautics, Space and Transport Research

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

Key Technologies Research

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

Research into the 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

Michael Kleiner, Head of Directorate, Ministry of Science, Research and Art, Baden-Württemberg, Stuttgart

Dr. Thomas Grünewald, Head of Division, Ministry of Innovation, Science and Research of the State of North Rhine-Westphalia, Düsseldorf

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Professor Louis Schlapbach, former CEO of EMPA, ETH Domain, Switzerland

Federal Government Representative

Professor Diethard Mager, Head of Directorate, Federal Ministry of Economics and Technology, Berlin

* The permanent members belong to all six Senate Commissions.

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Renewable Energy: **Professor Ferdi Schüth,** Max Planck Institute for Carbon Research, Mülheim

Storage and Integrated Infrastructure: **Professor Jack Fletcher,** University of Cape Town, South Africa

Nuclear Disposal and Safety, Radiation Research: **Professor Sue B. Clark,** Washington State University, US

Nuclear Fusion: **Professor Albrecht Wagner,** formerly Deutsches Elektronen-Synchrotron DESY, Hamburg

Chairs of the Experts' Groups for the Joint Programmes of the Fields of Energy and Key Technologies Research

Technology, Innovation and Society: **Professor Paul Alivisatos,** Lawrence Berkeley National Laboratory, US

Future Information Technology: **Professor Harald Rohracher,** Linköping University, Sweden

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Senate Representatives

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Professor Klaus Töpfer, Executive Director of the Institute for Advanced Sustainability Studies, Potsdam

Federal Government Representative

Wilfried Kraus, Head of Division, Federal Ministry of Education and Research, Bonn

Chairs of the Experts' Groups:

Geosystem: The Changing Earth: **Professor Ekhard Salje,** University of Cambridge, UK

Marine, Coastal and Polar Systems: **Professor Nicholas Owens,** Sir Alister Hardy Foundation for Ocean Science (SAHFOS), Plymouth, UK

Oceans: From the Deep Sea to the Atmosphere: **Professor Susan K. Avery,** Woods Hole Oceanographic Institution, US

Atmosphere and Climate: **Professor A. R. Ravishankara,** National Oceanic and Atmospheric Administration, Boulder, US

Terrestrial Environment: **Professor P. Suresh Rao,** Purdue University, West Lafayette, US

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Senate Representatives

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Professor Babette Simon, President of the University Oldenburg

Federal Government Representative

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Cardiovascular and Metabolic Diseases: **Professor Joseph Loscalzo,** Harvard Medical School, US

Infection Research: **Professor Philippe Sansonetti,** INSERM, France

Diseases of the Nervous System: **Professor Yves Agid,** Brain and Spine Institute, France

Genes and Environment in Common Diseases: **Professor Maja Bucan,** University of Pennsylvania, Philadelphia, US

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Federal Government Representative

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Space: **Professor Günther Hasinger,** University of Hawaii at Manoa, US

Transport: **Professor Bharat Balasubramanian,** University of Alabama, US

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Professor Gerd Litfin, Executive Associate of Arkadien Verwaltungs KG, Göttingen

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Science and Technology of Nanosystems: **Professor Jean-Philippe Bourgoin,** Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France

Advanced Engineering Materials: **Professor Matthias Kleiner,** TU Dortmund

BioSoft – Fundamentals for Future Technologies in the Fields of Soft Matter and Life Sciences: **Professor Brigitte Voit,** Leibniz Institute of Polymer Research, Dresden

BioInterfaces in Technology and Medicine: **Professor Ann-Christine Albertsson,** KTH Royal Institute of Technology, Sweden

Decoding the Human Brain: **Professor Marcus E. Raichle,** Washington University School of Medicine, US

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Chairs of the Experts' Groups for the Joint Programmes of the Fields of Energy and Key Technologies Research
Technology, Innovation and Society: **Professor Paul Alivisatos,** Lawrence Berkeley National Laboratory, US

Future Information Technology: **Professor Harald Rohracher,** Linköping University, Sweden

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Professor Robert Rosner, University of Chicago, US

Federal Government Representative
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Matter and the Universe: **Professor Felicitas Pauss,** CERN, Switzerland

From Matter to Materials to Life: **Professor William Stirling,** CEA, France

Matter and Technology: **Professor Francesco Sette,** ESRF, France

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Dr. Heike Wolke, Administrative Director

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Professor Helmut Dosch, Chairman of the Board of Directors,
Christian Scherf, Director of Administration

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Klaus Hamacher, Vice-Chairman of the Executive Board

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Professor Josef Puchta, Administrative-Commercial Director

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Helmholtz Centre for Environmental Research GmbH – UFZ
Professor Georg Teutsch, Scientific Director,
Dr. Heike Graßmann, Administrative Director

Helmholtz Centre for Infection Research GmbH*
Professor Dirk Heinz, Scientific Director,
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Michael Ganß, Administrative Director

Helmholtz Zentrum München German Research Center for Environmental Health GmbH*
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Dr. Nikolaus Blum, Administrative Director,

Karlsruhe Institute of Technology, KdöR*
Professor Holger Hanselka, President,
Dr. Elke Luise Barnstedt/Dr. Ulrich Breuer, Administrative Vice-Presidents

Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch, SdöR*
Professor Walter Rosenthal, Board Chairman and Scientific Director,
N.N., Administrative Director

Max Planck Institute for Plasma Physics (associate member)
Professor Sibylle Günter, Scientific Director,
Christina Wenninger-Mrozek, Managing Director

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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

SCIENCE AWARDS

Livestock farming in steppe and prairie regions can reduce nitrous oxide emissions into the atmosphere. *Photo: K. Butterbach-Bahl/KIT*

SCIENCE AWARD OF THE STIFTERVERBAND

Climate researchers receive 2013 Erwin Schrödinger Prize

Scientists previously assumed that livestock farming on large tracts of land contributed to the constantly increasing concentrations of nitrous oxide in the atmosphere and thus to global warming. But in fact the opposite is true: a five-member research team led by Klaus Butterbach-Bahl from the Karlsruhe Institute of Technology (KIT) has shown that livestock farming in steppe and prairie regions reduces greenhouse gas emissions. Butterbach-Bahl's team included ecosystem and climate scientists Xunhua Zheng (Chinese Academy of Sciences), Nicolas Brüggemann (now Forschungszentrum Jülich), Michael Dannenmann (KIT) and Benjamin Wolf (now EMPA). For their long-term study, they have been awarded the 2013 Erwin Schrödinger Prize, worth 50,000 euros, by the Helmholtz Association and the Stifterverband für die Deutsche Wissenschaft. Because measuring nitrous oxide emissions is a complex technical process, data are usually collected over a short period of time during the growing season. The research team, however, collected data on nitrous oxide production in the soil over the entire year. Previous short-term studies overlooked the fact that the release of nitrous oxide from steppe soils is a natural process and that most of these natural emissions are attributable to spring thawing. In livestock farming these emissions are reduced due to shorter grass heights and the resulting colder, drier soil. Cold, dry conditions inhibit microbial activity, leading to less nitrous oxide. The scientists believe that previous calculations overestimated the nitrous oxide emissions in these areas by as much as 72 per cent. "Even so, a great deal of research is still needed to understand the source of the growing concentrations of nitrous oxide in the atmosphere," says Butterbach-Bahl. *Red.*

www.helmholtz.de/en/schroedinger-prize

PRIZES AND SCIENCE DISTINCTIONS

Awards and prizes draw attention to the outstanding researchers at the Helmholtz Association. The following list reflects the achievements of scientists at different stages of their careers. Particularly noteworthy are the four Leibniz Prizes presented to Helmholtz researchers in 2012 and 2013.

Alexander von Humboldt Professorship: Professor Matthias Tschöp, HMGU, Professor Emmanuelle Charpentier, HZI; Alzheimer Research Award of the Hans und Ilse Breuer Foundation: Professor Thomas Misgeld, DZNE; 2012 Bengt Winblad Lifetime Achievement Award of the Alzheimer's Association (US): Professor Monique Breteler, DZNE; Klaus Tschira Award for Achievements in Public Understanding of Science: Dr. Thomas König, DKFZ; Condensed Matter Division Europhysics Prize: Professor Alan Tennant, HZB; German Innovation Award for Climate and Environment (IKU), presented by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Association of German Industry: Dr. Hanns-Günther Mayer and Dr. Peter Stemmermann, KIT; German Cancer Aid Award: Professor Peter Krammer, DKFZ; eCarTec Award 2012 – Bavarian State Award for Electromobility: Professor Gerd Hirzinger and Jonathan Brembeck, DLR; Ernst Friedrich Pfeiffer Award: Dr. Christiane Winkler, HMGU; ESHG Award of the European Society of Human Genetics: Professor Peter Lichter, DKFZ; European Research Council Advanced Grant: Professor Thomas Willnow, MDC; European Research Council Starting Grant: Professor Gil Gregor Westmeyer, HMGU, and Dr. Markus Schubert, HZDR; European Research Council Advanced Grant: Professor Rafal Dunin-Borkowski, FZJ; EUSAR Award of the European Conference on Synthetic Aperture Radar, TanDEM-X Mission: Dr. Rolf König, GFZ; Research Award "Next Generation of Biotechnological Processes – Biotechnology 2020+": Dr. Falk Harnisch, UFZ; Research Award for Technical Communication of the Alcatel-Lucent Foundation: Professor Tanja Schultz, KIT; Gottfried Wilhelm Leibniz Prize 2012: Professor Ulf Riebesell, GEOMAR, Professor Peter Sanders, KIT; Gottfried Wilhelm Leibniz Prize 2013: Professor Vasilis Ntziachristos, HMGU; Hector Fellow of the H.W. & J. Hector Foundation: Professor Hilbert von Löhneysen, KIT; Hella Bühler Award: Dr. Christiane Opitz, DKFZ; Inserm Prix International: Professor Ingrid Grummt, DKFZ; José Carreras Award 2013: Professor Klaus Rajewsky, MDC; Research Award "Next Generation of Biotechnological Processes – Biotechnology 2020+": Dr. Falk Harnisch, UFZ; Khalid Iqbal Lifetime Achievement Award 2013: Dr. Eva-Maria Mandelkow and Professor Eckhard Mandelkow, DZNE/Center of Advanced European Studies and Research; State Research Award of Baden-Württemberg: Professor Peter Sanders, KIT; Lise Meitner Prize of the European Physical Society: Professor Karlheinz Langanke, GSI; 2012 Max Auwärter Award Prize: Dr. Giuseppe Mercurio, FZJ; Paul Ehrlich and Ludwig Darmstaedter Award for Young Scientists: Dr. James Poulet, MDC/NeuroCure Excellence Cluster at the Charité; Sofja Kovalevskaja Award: Dr. Dmitry A. Fedosov, FZJ; Environmental Award of the Viktor and Sigrid Dulger Foundation: Dr. Sebastian Westermann, AWI; Walther and Christine Richtzenhain Prize: Dr. Mathias Heikenwälder, HMGU; William Nordberg Medal of the Committee on Space Research (COSPAR): Professor Herbert Fischer, KIT ... The complete list of awards can be found at:

www.helmholtz.de/preise2013

HELMHOLTZ ASSOCIATION GOVERNANCE STRUCTURE

COMMITTEE OF FUNDING BODIES

The Committee of Funding Bodies – made up of the federal government and the host states – defines the research policy guidelines for the individual research fields for a period of several years. It also appoints members to the Helmholtz 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 and state governments, the German Bundestag and scientific organisations – and figures from science and industry. The latter are elected for three years. The Senate deliberates on all important matters and is responsible for electing the president and the 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 setting investment priorities. The Senate Commissions consist not only of permanent members – ex officio representatives of the federal and state authorities and external experts for the six research fields – but also of temporary members for the specific research field under discussion.

PRESIDENT AND PRESIDENTIAL COMMITTEE

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 programme development across the research fields, the cross-centre controlling system and the development of the association's overarching 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.

MANAGING DIRECTOR

The managing director of the Helmholtz Association represents, advises and supports the president in fulfilling his or her duties and runs the association's head office. As a special officer for administrative matters, the managing director represents the Helmholtz Association both internally and externally.

The Helmholtz Association's Executive Committee is made up of the president, the eight vice-presidents and the managing director.

HEAD OFFICE

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

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

RESEARCH FIELDS

In the six research fields supported 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 comprising 17 legally independent research centres and one associate institute. Together with the Senate, the association's central body is the Members' Assembly, to which the scientific and administrative directors of each member centre belong. The Members' Assembly is responsible for all the tasks performed by the association. It defines the framework for the cross-centre development of both strategies and programmes and makes recommendations regarding the election of the president and Senate members.

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

LOCATION OF THE RESEARCH CENTRES

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
www.hzg.de

Deutsches
Elektronen-Synchrotron DESY
www.desy.de

Alfred Wegener Institute,
Helmholtz Centre for
Polar and Marine Research
www.awi.de

German Aerospace
Center (DLR)
Cologne (headquarters)
www.dlr.de

Forschungszentrum Jülich
www.fz-juelich.de

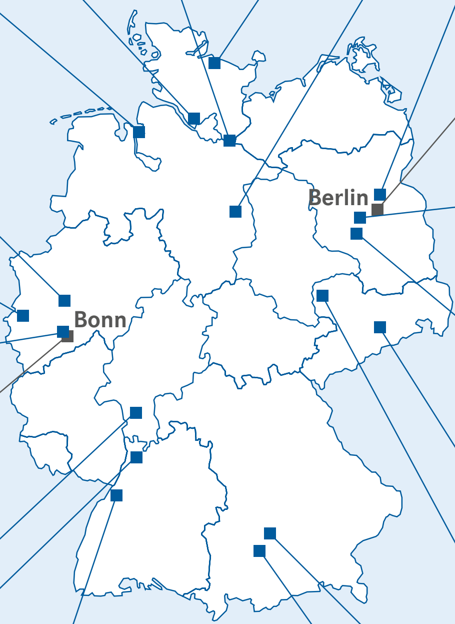
German Centre for Neuro-
degenerative Diseases (DZNE)
www.dzne.de

Helmholtz Association
Headquarters, Bonn
www.helmholtz.de

GSI Helmholtz Centre for
Heavy Ion Research
www.gsi.de

German Cancer
Research Center
www.dkfz.de

Karlsruher Institute of Technology
www.kit.edu



GEOMAR Helmholtz Centre for
Ocean Research Kiel
www.geomar.de

Helmholtz Centre
for Infection Research
www.helmholtz-hzi.de

Max Delbrück Center for
Molecular Medicine (MDC) Berlin-Buch
www.mdc-berlin.de

Helmholtz Berlin Office
www.helmholtz.de

Helmholtz-Zentrum Berlin für
Materialien und Energie
www.helmholtz-berlin.de

Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences
www.gfz-potsdam.de

Helmholtz-Zentrum Dresden-Rossendorf
www.hzdr.de

Helmholtz Centre for
Environmental Research – UFZ
Leipzig (Zentrale)
www.ufz.de

Max Planck Institute for Plasma Physics
(associate member)
www.ipp.mpg.de

Helmholtz Zentrum München
German Research Center for
Environmental Health
www.helmholtz-muenchen.de

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OF THE HELMHOLTZ ASSOCIATION

As of October 2013

ALFRED WEGENER INSTITUTE HELMHOLTZ CENTRE FOR POLAR AND MARINE RESEARCH

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Dr. Heike Wolke, Administrative Director
Members of the Directorate:
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GEOMAR HELMHOLTZ CENTRE FOR OCEAN RESEARCH KIEL

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