HELMHOLTZ – LONG-TERM RESEARCH WITH A LASTING IMPACT

ANNUAL REPORT 2012

THE HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

Research in Germany
Land of Ideas

HELMHOLTZ
ASSOCIATION

PLEASE NOTE: The Helmholtz Annual Report 2012 shows the actual costs of research in 2011 and the financing of research programmes as recommended by the Helmholtz Senate for 2010 to 2014 in the research fields Earth and Environment, Health, and Aeronautics, Space and Transport. The report also presents the financing recommendations for the programme period 2011 to 2015 for Energy research, Key Technologies research, and research into the Structure of Matter. The general section describes developments at the Helmholtz Association from 2011 to August 2012.

More in-depth information on the research examples can be found at www.helmholtz.de/en/gb12. On this page you can also download the annual report as a PDF document.

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Helmholtz Association Headquarters
Ahrstraße 45, 53175 Bonn
Telephone +49 228 30818-0
Telefax +49 228 30818-30
E-mail info@helmholtz.de, www.helmholtz.de/en

Communications and Media Department
Berlin Office
Anna-Louisa-Karsch-Straße 2, 10178 Berlin
Telephone +49 30 206329-57
Telefax +49 30 206329-60

Responsible under the German Press Act
Professor Angela Bittner

Editorial staff
Dr. Andreas Fischer
(project management English version)
Dr. Antonia Rötger (scientific editor)

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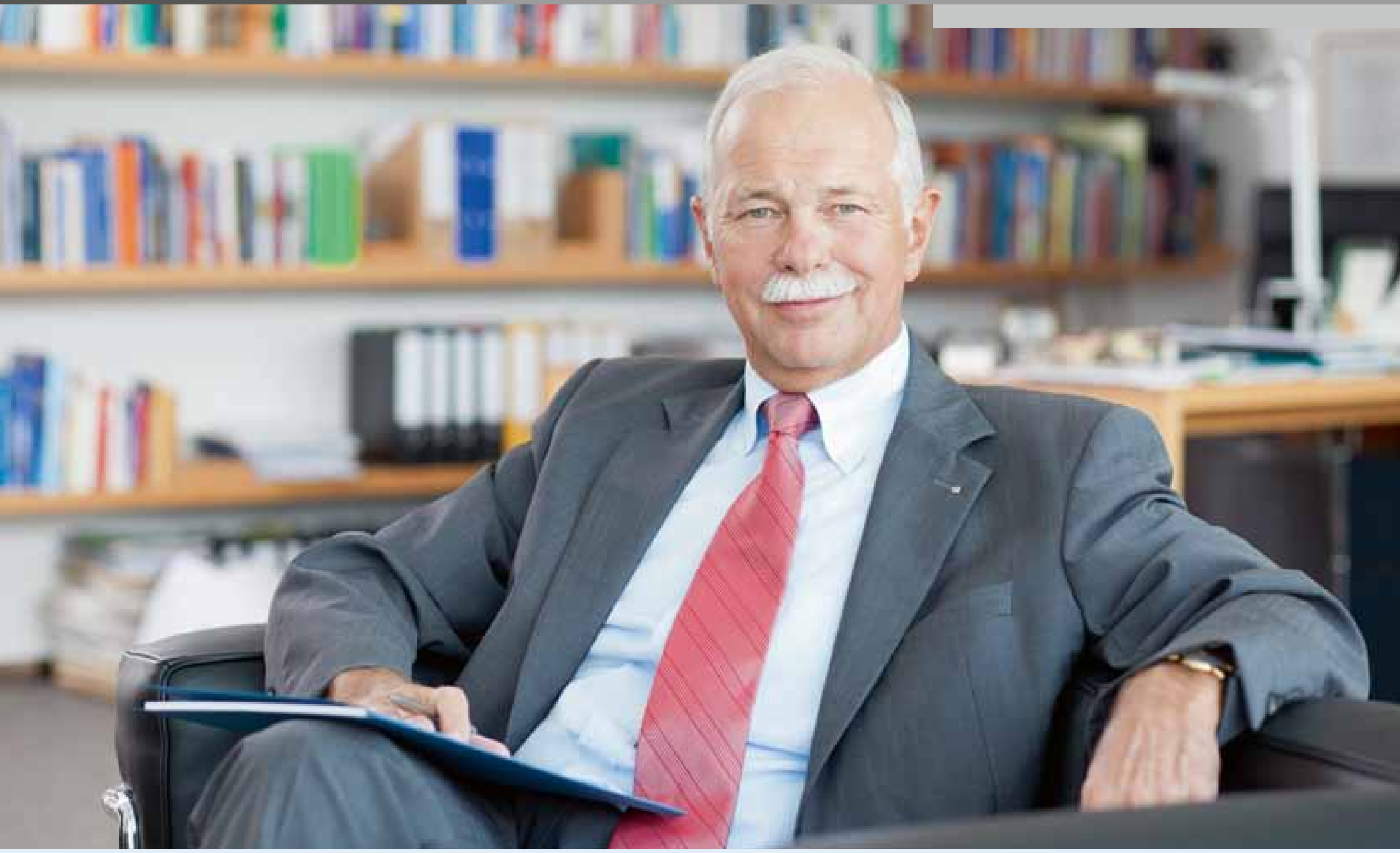
We contribute to solving the major and pressing problems of society, science and industry by conducting high-level research in the strategic programmes within our six research fields: Energy, Earth and Environment, Health, Aeronautics, Space and Transport, Key Technologies, and the Structure of Matter.

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.



Professor Jürgen Mlynek

HELMHOLTZ – LONG-TERM RESEARCH WITH A LASTING IMPACT

Dear Readers,

In order to shape the future we conduct research on the major challenges of today: How can we secure energy supplies, how can we use the planet's resources in a sustainable fashion, and how can we ensure human health and quality of life in an ageing society? These are just a few of the important questions driving us. To answer them, we have formulated a forward-looking research strategy that is essentially long term in nature but flexible enough to allow us to quickly integrate new research topics into our work. Our goal is to achieve a sustainable improvement in future prospects through research. This is one reason we are working to ensure that the knowledge we gain from basic research is more quickly translated into innovative applications and new technologies, products and services. This annual report introduces you to our activities.

I wish you pleasant reading,

Jürgen Mlynek, President

PRESIDENT'S REPORT

Throughout society and among policymakers there is broad agreement that education and research constitute crucial investments in the future. Despite the economic and financial crisis that has severely impacted many countries in Europe, Germany has continued to expand investments in these two areas. The Helmholtz Association is using this support to create a broader foundation for new technologies, products and services through its research and to secure prosperity and quality of life over the medium and long term.

RESEARCH AS AN INVESTMENT IN THE FUTURE, AND THE GROWTH OF THE HELMHOLTZ ASSOCIATION

In recent years, research policy initiatives such as the Higher Education Pact, the Excellence Initiative and the Joint Initiative for Research and Innovation have added a new dynamism to the scientific community, especially through greater competition and new forms of collaboration. In the second phase of the Excellence Initiative, the Helmholtz centres – as partners of the universities – will be taking part in a total of nine institutional strategies as well as numerous excellence clusters and graduate schools. The Joint Initiative for Research and Innovation ensures that non-university research organisations receive annual increases in funding, which is creating urgently needed room for manoeuvre. The Helmholtz Association is using this additional funding to increase the capacity of the research system, expand ties with partners from science and industry, improve the transfer of knowledge to the economy, and win and promote the best scientists for both scientific and administrative-technical fields.
The political framework for education and research is also improving: The planned elimination of the ban on collaboration between the federal government and state governments will ultimately lead to more options for strengthening chronically underfunded universities over the long term. The new Academic Freedom Act is designed to give research institutions more leeway in central fields such as budget-making, construction projects, equity stakes and, in particular, staffing issues. It will enhance the attractiveness of German research institutions in the competition for internationally renowned experts.
These developments are providing the Helmholtz Association with the necessary support to fulfil its mission and – through its cutting-edge research – to contribute to solving the major and pressing challenges of our time. Furthermore, the Helmholtz Association has continued to grow over the past year. The GEOMAR Helmholtz Centre for Ocean Research Kiel has been admitted as a new member, bringing the number of large, internationally acclaimed research centres united under the association's umbrella to 18. Around 34,000 highly skilled employees are currently working to develop solutions to major challenges in the areas of climate change, human health and energy – or are engaged in the urgently needed basic research on these topics.

THE MAJOR CHALLENGES: THE ENERGY TRANSITION, CLIMATE CHANGE, WATER AND HEALTH

One of the greatest challenges currently confronting our society is the transition to renewable energy sources. The 2011 Energy Transition Resolution of the German government stipulates that by 2050 at least 80 percent of electricity demand must be met by renewable energy sources.[1] In order to achieve this target, Germany requires new grid and intermediary storage solutions as well as improvements in the efficiency of all technologies. The Helmholtz Association is committed to addressing these issues and will make 135 million euros available in the coming years in order to advance the energy transition. This targeted expansion of energy research has been made possible in part by the annual increase in funds from the Joint Initiative for Research and Innovation.
We will be investing around 63 million euros in six portfolio topics[2] that cover gaps in research identified by experts. A total of 24 million euros will go to the Helmholtz energy initiative "Rapid Expansion of Energy Research", which is helping to develop sustainable energy technologies in four Helmholtz Energy Alliances. The restructuring of energy provision requires not only technological solutions but also changes that will affect all members of society. New infrastructure such as power lines, pumped-storage plants and wind farms – as well as price increases and energy savings targets – must take into account the perspectives of the

[1] Source BMU:
http://www.bmu.de/english/energy_efficiency/doc/46738.php

[2] For more information on the portfolio topics:
http://www.helmholtz.de/en/research/portfolio_process

different stakeholders in society and must be negotiated with them to ensure that plans can be reliably implemented. In the Helmholtz Alliance ENERGY-TRANS, which will receive 8.25 million euros in funding, experts from three Helmholtz centres and four partner institutions are working to resolve the socioeconomic issues associated with the design and implementation of the energy transition.
Furthermore, we have established two new Helmholtz institutes in Ulm and Freiberg, each of which will be funded with 20 million euros in the coming years. At the Helmholtz Institute for Electrochemical Energy Storage in Ulm, scientists are studying the electrochemical foundations of innovative battery systems and developing new materials for these systems. The institute is sponsored by the Karlsruhe Institute of Technology (KIT) and the University of Ulm and has two associate partners, the German Aerospace Center (DLR) and the Center for Solar Energy and Hydrogen Research. At the Helmholtz Institute Freiberg for Resource Technology, which was founded by the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and the TU Bergakademie Freiberg, research focuses on the mining of mineral and metal resources. Scientists are currently examining how valuable raw materials can be used more efficiently, recovered from waste products and replaced by other materials.
The topic of energy is closely related to climate change and other global challenges associated with the finite nature of natural resources and their sustainable use. These themes are at the heart of the "Science Year 2012", which, under the heading of "Project Earth: Our Future", is addressing the topic of sustainability from various perspectives and presenting it to the public. They are also at the heart of Helmholtz environmental research, which focuses on the climate, soil, water and biodiversity as well as on global and regional environmental changes. In addition to researching the complex and manifold interconnections in the Earth system, Helmholtz research groups are working to develop innovative policies and technologies for climate protection, adaptation strategies for inevitable changes in the global climate, and more sustainable ways of using resources. Within this context, water deserves special attention as one of our most valuable resources. In many regions of the globe, climate change, industrialisation and population growth have already resulted in a scarcity of clean water. In the new portfolio topic "Helmholtz Water Network", five Helmholtz centres are collaborating with numerous university partners to catalogue and improve water quality and availability and to develop sustainable water management systems for the future – at both the regional and global levels. The Helmholtz Association will fund this project through 2015 with more than 21 million euros.
As demographic change progresses, we will have to devise more sustainable strategies for coping with a scarcity of resources in areas such as health care and the labour market. Helmholtz health research will make an important contribution to solving these problems. If we can prevent disease through preventive medicine and treat sick people more effectively through early diagnosis and personalised therapies, people will stay healthy and active longer, enabling us to manage demographic change. Helmholtz health research is helping to elucidate the causes of major common diseases and to develop new methods for their prevention, early diagnosis and treatment. Working with university medical centres, we have considerably expanded translational research in order to apply knowledge more effectively; in this area we are also relying on strategic relationships with business partners. Most importantly, the Helmholtz health centres are important partners of the German Centres for Health Research, which have been established and funded by the Federal Research Ministry in order to optimise the translational process and improve the prevention and treatment of common diseases. Over the past year, four new German Centres for Health Research were established in the fields of infectious disease, cardiovascular disease, pulmonary illness and cancer. Along with the Helmholtz centres, more than one hundred universities, university hospitals and industrial partners are participating in these centres to ensure that knowledge is effectively transferred from research to applications and to pave the way for innovative and affordable health care over the long term.
Individual Helmholtz centres are also expanding ties with university partners. For example, the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch and the Charité Hospital's research division have considerably expanded their joint research activities in the fields of cancer, cardiovascular diseases and nervous system disorders and are entertaining the option of combining parts of both facilities under a single roof.
These and other strategic collaborations are pointing the way to the future. With its commitment to expanding such partnerships, the Helmholtz Association is helping to shape the research community and creating synergies and optimal conditions for successful research.

OUR MOST IMPORTANT RESOURCE: INFRASTRUCTURE AND TALENT

Our most important resource is the people who work at the Helmholtz Association and drive research through their ideas, commitment and talent. This is why we are focusing particularly on supporting gifted staff members through a **comprehensive talent management programme** encompassing all levels of our organisation. With the **Helmholtz Academy**, we have developed a unique supplementary educational programme in the field of research management for young leaders. All our staff in research, administration and infrastructure can gain further qualifications and are given support for their career planning. Women, in particular, are benefiting from the **"Taking the Lead" mentoring programme**, designed to prepare them for leadership positions in science. Equal opportunity is a central goal of talent management and is of course a given when we recruit both seasoned executives and junior staff. The Helmholtz centres are training young people for demanding professions and are currently providing **more than 6,000 doctoral candidates**[3] with an excellent research environment for their doctoral dissertations. Each year a growing number of young scientists from around the world apply to lead a **Helmholtz Young Investigators' Group**. These positions offer an excellent start to a career in science. We are pleased that with these programmes we have been able to attract excellent researchers from around the world and to contribute to the "brain circulation" in international science. From 2013 onwards, we will be providing additional resources for the Helmholtz Association's recruitment initiative in order to motivate experts to take part in Helmholtz energy research.
In the research community, the Helmholtz Association is increasingly being recognised as **an employer of choice** that allows dedicated people to develop their talents, pursue research with highly qualified colleagues and profit from a variety of networking and collaboration opportunities.
Our scientists have the opportunity to help develop and operate a unique research infrastructure – a special feature of the Helmholtz Association. The association designs and builds **powerful modern research facilities** in order to expand the frontiers of knowledge. At the same time, this work on new detectors, satellites and large-scale measurement networks produces many technological innovations that have applications in very different fields.

The Helmholtz Association has in part assumed the role of architect at both the national and international levels. In a broad-based strategy development process ("The Helmholtz Roadmap for Research Infrastructure"), it has identified the major research infrastructure that is necessary and strategically relevant to implement its scientific portfolio in the coming years. After these complex, large-scale devices are built, they are made available free of charge to a multidisciplinary international user community – particularly to universities. The Helmholtz Association is also playing an important role in international projects. For example, the European XFEL X-ray laser is currently being assembled at the Deutsches Elektronen-Synchrotron DESY; a unique ion accelerator, the Facility for Antiproton and Ion Research (FAIR), will be constructed by international partners at the GSI Helmholtz Centre for Heavy Ion Research; and ITER, an experimental reactor for nuclear fusion, is being built in Cadarache, France, with the help of several Helmholtz centres.

LOOKING TOWARDS THE FUTURE

With its cutting-edge research, the Helmholtz Association is contributing to meeting the major and pressing challenges of today and to ensuring a sustainable quality of life and prosperity. For this purpose, we are pursuing strategic partnerships and collaborations in a goal-oriented manner in an effort to pool expertise and accelerate progress in key fields. The Helmholtz Association's success rests on the dedicated staff members that we are able to attract, retain and support. At the Helmholtz Association, these employees find optimal working conditions and a unique research environment for their work.
On behalf of society, we are providing a knowledge base with which to address the major issues of the future. This mandate is central to our mission. The Helmholtz Association sees its role as a **reliable partner of policymakers and society as entailing an obligation to help shape the future**. In the position paper **"Helmholtz 2020 – Shaping the Future through Partnership"**, the members of the Helmholtz Association present proposals on how the association can take on more responsibility in the research community in the future as part of the effort to further develop German science.

» **www.helmholtz.de/en/helmholtz2020**

[3] Figures for 2011, including GEOMAR

PARTNER IN THE JOINT INITIATIVE FOR RESEARCH AND INNOVATION

With the launch of the Joint Initiative for Research and Innovation in 2005, the federal and state governments made an important decision on the direction of research policy, agreeing to devote themselves to topics of future relevance, foster young scientists and make the system of scientific research more effective in Germany.

During the second funding period set to end in 2015, the Joint Initiative for Research and Innovation grants a 5 percent increase in funding each year. This growth will provide the Helmholtz Association with the scope for action it requires both to expand strategic activities and instruments and to establish new ones. As a partner in the campaign for greater innovation, the association has agreed to contribute to growth and prosperity by dynamically optimising the **system of scientific research** in Germany, expanding ties, establishing new forms of strategic partnerships, strengthening **international collaborations**, facilitating added value through the **transfer of knowledge to society and the economy** and – finally and most importantly – by attracting and fostering excellent scientists at all stages of their careers so that they can optimally develop their talents.

1. DYNAMIC DEVELOPMENT OF SCIENCE

Integrated into the national and international research landscape, the Helmholtz Association is constantly refining its structures in order to provide ideal conditions for its strategically oriented research. Through this process, it is making a significant contribution to the dynamic and sustainable development of German science.

Global transformation processes present society with major challenges and require solutions from research. Growing energy needs, climate change and demographic developments are just a few examples. The mission of the Helmholtz centres is to help solve these important future challenges through excellent research, to work with a long-term focus, and to implement findings for the benefit of society and the economy.

The strategic development of new research fields

The Helmholtz Association will use part of the annual increase in funding to support a variety of portfolio topics that experts from the 18 Helmholtz centres – as part of a major review – have identified as particularly promising. With important research focuses such as the bioeconomy and the Helmholtz Water Network, the association is continuing the portfolio process it launched in 2010. This strategy development process encompasses the major research infrastructure and facilities for which the Helmholtz Association has assumed a prominent role as architect. In the "Helmholtz Roadmap for Research Infrastructure", the association has identified the structures and large-scale devices that are necessary and strategically relevant to the implementation of its scientific portfolio in the coming years. They include large accelerator facilities, large-capacity computers and planned health care infrastructure.

Competition for Resources

To pursue research on these topics, the Helmholtz Association must create comprehensive programmes and make funding available. The funds are in part allocated on the basis of **internal competition** amongst the Helmholtz centres within the framework of programme-oriented funding. In this process, which creates transparency and planning security, the Helmholtz Association is taking its cue from the research policy requirements of its funding bodies. For the five-year duration of the programmes, funding is linked to the results of strategic programme reviews. The third round of evaluations to be performed since the founding of the Helmholtz Association in 2001 will begin in 2013/2014. In 2011 the Helmholtz Senate and the funding bodies agreed on guidelines for the further development of this process. These guidelines – which will be incorporated into the third round of evaluations – call for the streamlining of procedures and for consideration to be given to the links between centres and programmes, on the one hand, and external partners, on the other. A further aim is to strengthen the association's contribution to modernising the German research community.

Within the scope of the president's **Initiative and Networking Fund** (IVF), which has proven its worth over a period of many years, the Helmholtz Association has developed a variety of measures to achieve the Joint Initiative's objectives. IVF funds are being used to initiate strategically important

Research creates a foundation for innovations by developing materials such as new sealants for fuel cells.
Photo: Forschungszentrum Jülich

activities and to strengthen collaborations with universities. With projects such as the Helmholtz Alliances and the W2/W3 positions for outstanding scientists, the IVF has contributed to building stronger ties with universities and establishing cross-Helmholtz quality standards for the advancement of young scientists and the promotion of equal opportunity. The basic principle is to allocate funds competitively. The increase in IVF funding from 65 million euros in 2011 to around 68 million euros in 2012 will allow the initiated activities to be continued and new instruments to be introduced.

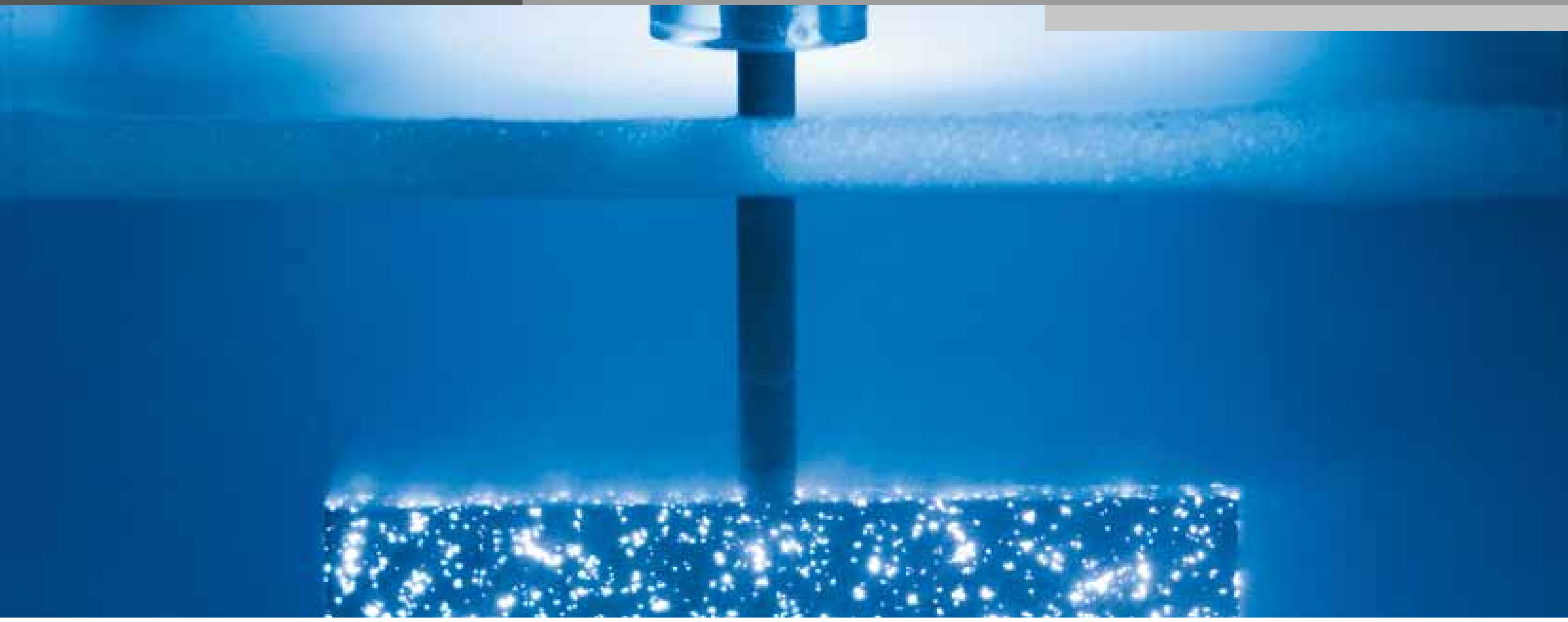
The Leading-Edge Cluster Competition

Germany's strong competitive position in the global arena is based not least on the excellent research done by German companies and their capacity for innovation. However, the major social and economic challenges of the present day can only be tackled if science and industry work together. This collaboration can take the form of theme-based regional alliances that pool and expand strengths. The potential of such "clusters" is being supported by the Federal Ministry of Education and Research (BMBF) through its "Leading-Edge Cluster Competition". The competition is not confined to any one theme and is thus directed at all industries and research fields of future relevance. Three Helmholtz centres have emerged as winners in the third round of the BMBF's Leading-Edge Cluster Competition. The three new clusters, which will address the topics "bioeconomy", "electric mobility" and "immunotherapy", will receive up to 40 million euros in funding from the BMBF in order to implement their strategies. Taking the winners of the third round into account, a total of 15 leading-edge clusters are currently receiving a total of 600 million euros in funding and Helmholtz centres are involved in nine. This funding is matched by the participating companies, with the result that an additional 1.2 billion euros will be invested in Germany as a centre of innovation.
The Helmholtz centres have been especially successful in **international competitions**. For example, during the year under review, the number of proposals selected by the European Research Council (ERC) has increased significantly. The centres involved in health research have performed particularly well. In order to further motivate young scientists to apply for ERC Starting Independent Researcher Grants, the Helmholtz Association is offering bonuses of up to 250,000 euros. This additional funding is meant to be used by successful Helmholtz scientists to fund additional PhD candidates and other projects. Furthermore, Helmholtz scientists have won many prestigious international awards, including the Potamkin Prize of the American Academy of Neurology and two mega-grants from the Russian government.

2. TIES IN THE SCIENTIFIC COMMUNITY

Strategic Partners

Closer ties with university partners and industry are a central pillar of the Helmholtz Association's strategy. These ties are crucial to ensuring the exchange of knowledge, the applicability of research and the efficient use of resources. As shown by the results of the Excellence Initiative II, universities have a special strategic importance for the association: Helmholtz centres are currently involved in nine institutional strategies, 16 excellence clusters and numerous graduate schools. Thus, even in the last phase of the Excellence Initiative, the centres have proven themselves to be important partners of the universities. However, the Helmholtz Association also maintains close ties with other **research institutions, companies** and **international partners**. Its collaborative philosophy ensures that scientific exchange takes place amongst equals while mobilising existing synergies between partners and helping to achieve the pact's objectives and the strengthening of science. In alliances and projects with strategic partners, the Helmholtz centres are conducting research on the most pressing problems in science, industry and society. **Helmholtz Virtual Institutes** and **Helmholtz Alliances** are providing support for the collaborations that the Helmholtz Association has established with national and international universities and research institutes in order to take up and work on innovative topics.
The **Helmholtz Virtual Institutes** initiate and expand



Researchers are developing new ultra-light magnesium alloys for various applications. *Photo: HZG*

collaborations between universities and Helmholtz centres in a variety of fields. Many of these virtual institutes form the core of larger collaborative networks. One example is the “Helmholtz Virtual Institute Molecular Basis of Glucose Regulation and Type 2 Diabetes”. A few institutes, such as the “Helmholtz Virtual Institute of Neurodegeneration and Ageing”, have contributed to programme innovations. Others, such as the “Helmholtz Virtual Institute Translating Hadron Therapy from Basic Research to Clinical Application”, are reaping direct benefits for applications (in this case for the radiotherapy of cancer). In the five calls for proposals to date, almost 100 million euros have been awarded to 99 virtual institutes involving 326 university partners from 61 different German universities. Of this total funding, around 56 million euros has gone or will go to the universities. The added value results from the opportunity to combine basic and applied research and increase the partners’ international visibility. In addition, young scientists can be systematically fostered and infrastructure can be used complementarily.

The successful concept of the **Helmholtz Alliances** is based on taking up and innovatively developing new, future-oriented, strategically important themes. Together with universities and other external partners, alliances with a clearly recognisable critical mass are formed in an attempt to establish and expand internationally visible “beacons” in line with the programme portfolio of the Helmholtz Association's research fields. The association aims to continue proven alliances at an institutional level in order to ensure the sustainability of the research projects. Furthermore, Helmholtz Alliances are contributing to structural innovations by bringing together national and international partners from universities, other research institutions and companies. In the summer of 2012, four new alliances were selected and will be granted a total of 50 million euros in funding from the Initiative and Networking Fund. The topics range from diabetes research and remote sensing to robotics and liquid metal technologies.

3. INTERNATIONAL COLLABORATION

Major challenges such as the future supply of energy, climate change and the fight against common diseases can only be met globally, over a long timeframe and through the coordinated and systematic use of resources. This is why the Helmholtz centres are working with leading research facilities worldwide, including institutes in Russia, China, the United States and Canada. In addition, the association’s globally unique research facilities and infrastructure – one of its distinguishing features – are providing a platform for international cooperation and research of the highest calibre. The association makes its research infrastructure available to the European scientific community, attracting more than 6,200 visiting scientists each year.

With the **International Strategy** it adopted in 2010, the Helmholtz Association has strengthened its competitive position in the recruitment of highly qualified foreign staff. It has also ensured access to research resources at partner institutions and expanded opportunities for future collaboration through the strategic development of partner networks. This strategy is helping the association to meet the obligations arising from the Joint Initiative for Research and Innovation and to continue to expand its role in the international scientific community.

The association’s research centres are pursuing successful, long-term **collaborations with European research institutions** as strategic partners and are strongly benefiting from the instruments of the EU’s Research Framework Programmes. They are actively involved in European collaborative projects and have been particularly successful in calls for proposals from the ERC. Within the scope of the 7th EU Research Framework Programme, the Helmholtz centres are successfully participating in 285 projects and are performing a coordinating role in 41. Finally, as one of Europe's largest research organisations, the Helmholtz Association is contributing to the dialogue on further developing EU research funding beyond 2014 and implementing the European Research Area (ERA).

4. SCIENCE AND INDUSTRY

The Helmholtz Association is dedicated to high-level basic research with a strong focus on application. Research collaborations – particularly strategic partnerships with industry – are important channels for technology transfer. The association pursues numerous activities within the scope of business collaborations that focus on the transfer of knowledge to society and the transfer and commercialisation of research findings. The Helmholtz Association's technology transfer efforts are bearing fruit and have led, among other things, to several award-winning research spin-offs from Helmholtz centres. The course has been set for more dynamic developments in this field by the successful establishment of the Validation Fund and the introduction of "shared services" for the more efficient use of technology transfer capacities across the association. The **Helmholtz Validation Fund** is capitalised with up to 7.5 million euros per year and is intended to close the funding gap between research and application. At the same time, this instrument aims to provide an incentive for developing ideas and inventions in order to attract the interest of potential business partners and facilitate research spin-offs. For years, the Helmholtz Association has promoted spin-offs through the Helmholtz Enterprise funding instrument. Between 2006 and 2011, 73 spin-off projects were supported with sums of up to 200,000 euros – shared by the Initiative and Networking Fund and the respective centres. More than half of these companies have now been launched and are operating successfully on the market. Through research collaborations with industry – either joint research projects or contract research – Helmholtz centres generated revenue of nearly 160 million euros in 2011. Here the German Aerospace Center (DLR) and its application-based research fields have again proven highly successful. The contributions made by the centres to the creation of economic value have been greatly enhanced by the successful transfer of knowledge and technology, the regional labour market effects of research spin-offs, and the licensing of intellectual property rights, which are largely awarded to small and medium-sized companies in Germany.

5. ATTRACTING THE BEST PEOPLE

The Helmholtz Association places special emphasis on **talent management** at all levels and in every field of the organisation. Outstanding staff members are our most valuable asset and can be attracted and retained only if we ensure career development opportunities and equal opportunity. This is why the association is investing in the education and training of scientific and administrative/technical staff. Its efforts are already paying off: the association is becoming younger, more female and more international at the highest level, which is leading to additional outstanding award-winning research.
The association relies on established and new instruments for the targeted recruitment, advancement and training of both top executives and personnel in research, administration and infrastructure fields. In addition to the constantly growing number of trainees, during the year under review the association provided support for more than 6,000 **doctoral candidate**s and 150 **Helmholtz Young Investigators' Groups**. It also launched a new instrument to promote independent work among young researchers within the scope of the Initiative and Networking Fund. The **Helmholtz Postdoc Programme** is designed to provide outstanding young researchers who have just completed their doctorates with the opportunity to continue the independent study of a research topic that they themselves have defined and to establish themselves in this field. In this way, the Helmholtz Association is contributing to **establishing a "cascade model"** in line with the equality standards at the German Research Foundation (DFG). The association is serious about introducing flexible target quotas to ensure equal opportunity at all levels; its central bodies will devote themselves to this topic in the future.
Efficient and effective management structures are essential for a modern research organisation. With the establishment of the Helmholtz Management Academy in 2007 and the development of customised educational portfolios for selected target groups, the association has set new standards for training programmes in research management in Germany. Particular attention is paid to training young female managers.
Finally, the Helmholtz Association is investing heavily in efforts to introduce children and young people to research and is thus fulfilling its stated objective of improving the transfer of knowledge to society and promoting equal opportunity. To generate enthusiasm for science and technology among children and young people, the Helmholtz centres are participating in numerous activities throughout Germany as part of the "Year of Science" organised by the Federal Ministry of Education and Research. Programmes such as the **School Labs** and the project "Six to Ten Year Olds" (carried out by the **"Little Scientists' House"** initiative) are aimed at the next-generation of researchers in an early and critical phase of their development.
The Helmholtz Association is using a coherent and focused set of measures to fulfil the aims of the Joint Initiative. With its diverse expertise and research infrastructure, the association will continue to systematically pursue its objective of formulating answers to the pressing challenges of science, business and society today. This work will enable it to make an important contribution to strengthening Germany as a location for research and innovation.

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

HELMHOLTZ: RESEARCH FOR SOCIETY

In keeping with its mission, the Helmholtz Association is helping to solve major social, scientific and economic questions through strategically oriented, programme-based research. The topics it focuses on – such as energy, climate, mobility and health – have a high degree of social relevance and offer immense potential for commercialisation and application.

The Helmholtz centres conduct use-inspired basic research within the framework of programme-oriented funding. Their goal is to implement research findings for the benefit of society and to commercialise them through innovations in the marketplace.
For both the application of newly generated knowledge within society and the commercialisation of technology through products and services, research organisations require appropriate processes and tools to ensure that the transfer of findings to both society and the economy takes place on a professional basis. The Helmholtz centres offer different types of infrastructure to support this transfer – e.g., service units and model projects that, among other things, offer policy advice on the implementation of the transition to alternative energy, analyse earthquakes across the world and provide important climate data. Furthermore, in the technology transfer offices at the Helmholtz centres, a staff of more than 100 is helping to transform application-based research ideas into commercially viable products and services.

The following figures demonstrate the association's success in recent years:

- Each year around 3,000 collaborations are implemented with industry, including collaborative projects with small and medium-sized enterprises, long-term strategic partnerships with industrial concerns, traditional contract research, and arrangements under which innovative companies are permitted to use the association's unique large-scale research infrastructure. These partnerships with the business community generate revenue of about 160 million euros a year.
- The Helmholtz centres apply for around 400 patents and other intellectual property rights each year. They are actively marketing a broad portfolio of patents and have entered into around 1,500 licence and option agreements, which in 2011 generated revenue of around 16 million euros.
- The Helmholtz Association is continuing to support and take stakes in research spin-offs. In 2011, for example, around 14 high-tech companies were spun off from Helmholtz centres. A comparison with the Fraunhofer Society, which has launched an average of 13 spin-offs per year since 2005, underscores the enormous application potential of Helmholtz research.

Activities at the technology transfer offices are provided with intensive support at the association level:

- Using the "Helmholtz Enterprise" funding instrument, the association has fund over 70 research spin-offs since 2005.
- Since 2011, the new Helmholtz Validation Fund has been used to support projects that require additional developmental steps in order to commercialise research findings through spin-offs, licence agreements and business partnerships. This instrument is designed in such a way that revenue from successfully implemented projects flows back into the fund and is invested in new validation projects.
- Both these programmes are financed by the Initiative and Networking Fund, as is the model project "Shared Services". The goal of the Shared Services project is to ensure that the special expertise acquired in the large technology transfer departments of the Forschungszentrum Jülich and the Karlsruhe Institute of Technology (KIT) is made accessible to the technology transfer offices at all the Helmholtz centres. This includes the special expertise in invention evaluation and IP strategy at the Forschungszentrum Jülich and in research spin-off support and equity management at the KIT.
- The Shared Services project is adding a new dimension to the longstanding collaboration in the working group "Technology Transfer and Intellectual Property Rights". It is also complementing the successful cooperation in the life sciences via Ascenion GmbH, the Helmholtz centres' joint commercialisation partner. In the field of the life sciences, the Helmholtz Association continues to be a partner of the Life Science Incubator.
- Moreover, the Helmholtz head office regularly organises workshops in collaboration with companies such as BASF, Eon, Zeiss, Siemens and Roche. Its "Innovation Days" serve as a central commercialisation platform and are intended to permanently improve contact with the business community and to bring Helmholtz technologies to market. The Helmholtz centres are also expanding marketing and business development activities. They are holding events, participating in clusters and creating institutionalised networks such as the KIT Business Club at the regional level. Trade shows and other marketing channels are being used to profitably translate research findings into commercially viable products and services.

Helmholtz Association
Innovation Days

DKFZ – mtm laboratories and Gardasil

mtm laboratories AG, a research spin-off founded by the German Cancer Research Center (DKFZ) in 1999, was sold to Roche in 2011, bringing stakeholders hundreds of millions of euros in revenues. mtm was one of the first spin-offs in which the DKFZ took a direct stake. In the event of a sale of the company or an IPO, the DKFZ was ensured a share in the proceeds through a combined licence and participation agreement and through product-related licence revenues. The company has developed a test for the early detection of cervical cancer based on a cancer protein. After the test successfully passed clinical trials, mtm became an attractive acquisition candidate for a major partner in the diagnostics and pharmaceutical industry. The DKFZ has already earned several million euros by licensing the Gardasil vaccine against cervical cancer, the basis of which was developed at the DKFZ by Nobel laureate Professor Harald zur Hausen.

DLR – Licence Agreement and Award for Early Warning System for Forest Fires

Researchers at the DLR's Institute of Planetary Research have developed an early warning system for forest fires that uses cameras originally intended for space exploration. The product was brought to market by IQ wireless GmbH in 2000 and has since earned the DLR substantial income under a licence agreement. The early warning system for forest fires is currently being used internationally in countries such as Spain and Australia. All told, around five million hectares of forest worldwide are being monitored by the more than 280 installed systems. In 2011, the system was honoured by the US Space Foundation as an outstanding example of how technologies from space research can spawn market innovations that benefit society.

DESY – MTCA.4 for Industries

The large-scale research infrastructure and facilities that are a distinguishing feature of the Helmholtz Association are being used to generate scientifically and commercially applicable research findings. For example, as part of a current project supported by the Helmholtz Validation Fund, scientists at the Deutsches Elektronen-Synchrotron DESY are developing new electronic standards for German and European accelerator systems and commercial use.

The examples illustrate the association's successful strategy:

- The Helmholtz Association is providing research services for socially relevant topics with a clear link to applications.
- Professional service units have been set up to systematically transfer research results to applications and commercialisation activities.
- Key data show that the efforts have been successful.
- The association will continue its substantial and systematic efforts to strengthen activities in fields such as validation, business development and marketing.

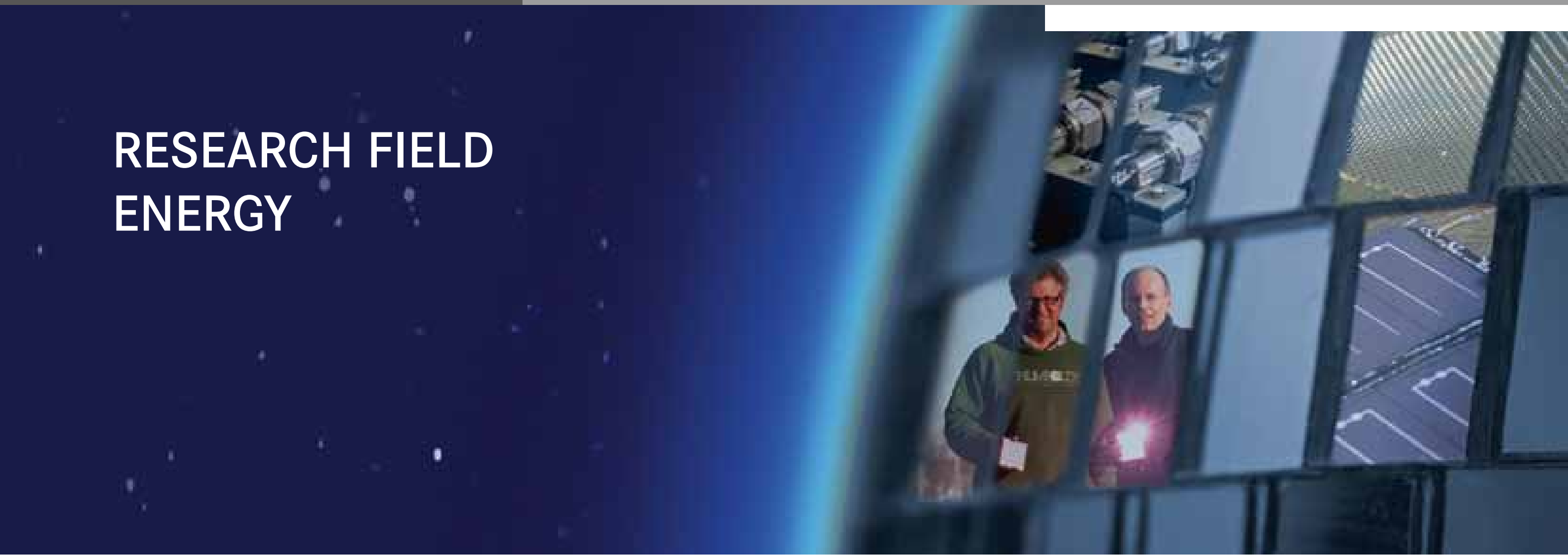
These results show that the Helmholtz Association is transforming its special product knowledge into applications for the benefit of society. Its goal is to generate revenues through professional technology transfer and successful commercialisation efforts.

www.helmholtz.de/en/erfolgsbilanz

CURRENT HELMHOLTZ RESEARCH PROJECTS


IBM

RESEARCH FIELD ENERGY



Goals

The Helmholtz scientists involved in the field of energy research are working to develop solutions to secure an economically, ecologically and socially sustainable supply of energy. They are examining all the relevant energy chains, including technological and socioeconomic conditions and impacts on the climate and environment. One important goal is to replace fossil and nuclear fuels with sustainable climate-neutral energy sources. Scientists are also seeking to determine the potential of renewables such as solar, biomass and geothermal energy. They are 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 research.

Programme structure in the funding period 2010–2014

The field of energy research at the Helmholtz Association consists of eight Helmholtz centres: the Karlsruhe Institute of Technology (KIT), the Forschungszentrum Jülich, the German Aerospace Center (DLR), the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), the Helmholtz Centre for Environmental Research – UFZ, the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, and, finally, the Max Planck Institute for Plasma Physics (IPP) as an associate member of the Helmholtz Association. The field is divided into five research programmes:

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

All the 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 energy transition is one of the greatest challenges for the present and the future. In its 6th Energy Research Programme, the German government focuses on strategies and technologies that are 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, is making a major contribution to its implementation. In addition, it is closing research gaps and seeking to achieve more rapid progress in all relevant fields. Helmholtz research engages with a broad spectrum of options and devotes as much attention to basic research as to application-oriented studies. Furthermore, the Helmholtz Association is supplementing technological topics with socioeconomic research in order to optimise energy systems with respect to all social, economic and political factors.

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

Glove boxes allow scientists to handle radioactive substances safely while protecting samples from environmental influences. *Photo: Oliver Killig/HZDR*

WHEN CONTAINERS RUST

Helmholtz-Zentrum Dresden-Rossendorf Highly radioactive waste from nuclear reactors has to be isolated from the biosphere for thousands of years, but the steel and other materials used for this purpose cannot guarantee safe containment for such long periods of time. In 2011 an important discovery was made by the HZDR scientists Dr. Regina Kirsch and Dr. Andreas Scheinost. They were able to demonstrate that the ferrous minerals that form as corrosion products on rusting containers bind plutonium, which is a particularly problematic element due to its longevity and radiotoxicity.

In order to simulate the conditions pertaining in radioactive waste repositories, the researchers put a great deal of time and effort into producing samples in the laboratory and measuring them on the Rossendorf Beamline at the European Synchrotron (ESRF) in Grenoble. A particularly significant feature of such repositories is the absence of oxygen, with the result that all chemical processes take place in an "anoxic" environment. In the past, other research groups had studied the reactions of these highly radioactive wastes at atmospheric oxygen concentrations because it was technically easier to do so. Scheinost and Kirsch showed that under anoxic conditions plutonium is more strongly reduced than was previously thought. Although trivalent plutonium is easily soluble in water and should therefore be extremely mobile, it is firmly bound and immobilised on the surface of the rusting minerals.

"Our results suggest that even rusting steel storage units can contain the plutonium. But they also make clear that further studies are needed under realistic final storage conditions in order to assess the safety of future radioactive waste repositories," says Scheinost.

» **www.helmholtz.de/en/gb12-rostige-faesser**

"Helmholtz scientists are working to secure a sustainable and economical supply of energy. This requires comprehensive research approaches that include all the energy chains and consider factors relevant to both the climate and the environment. We are researching innovative technologies for the effective conversion, storage, distribution and use of energy. Our long-term goal is to replace finite energy sources with permanent, sustainable and climate-neutral forms."

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

The solar tower in Jülich is allowing DLR experts to develop and test innovations in solar thermal power generation more quickly and on a real-life scale. *Photo: DLR*

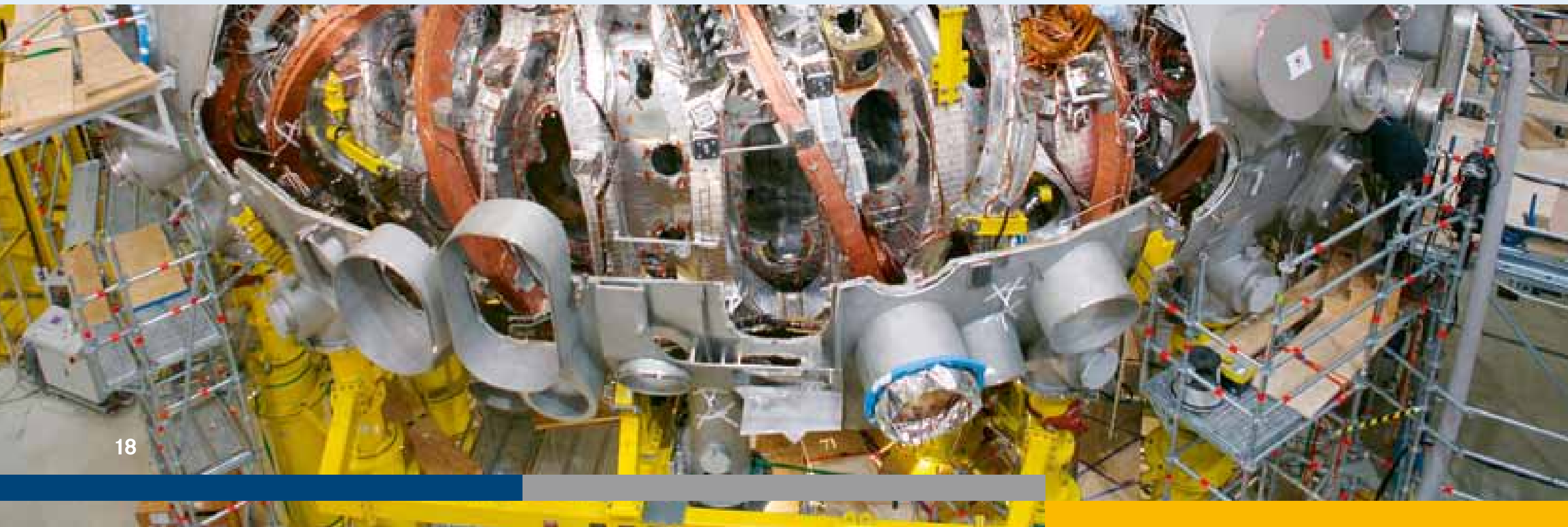
FURTHER IMPROVEMENTS IN SOLAR THERMAL POWER

German Aerospace Center For around 30 years, the DLR has been advancing the development of solar thermal power plants and testing their feasibility in demonstration plants in Spain. In 2011 the DLR established the Institute for Solar Research in Germany and took over operation of the solar tower power plant in Jülich. This facility was developed and built by a research and industrial consortium that included the Jülich municipal utilities company. The DLR has supported the Jülich solar-thermal experimental and demonstration plant from the outset and will continue to use it as a research facility.
A total of 2,153 movable mirrors (heliostats) direct the rays of the sun to the top of the 60-meter solar tower, where they are absorbed by the solar receiver and converted into heat. The receiver consists of porous ceramic elements through which incoming air flows. Heated to a temperature of up to 700 degrees Celsius, the air produces steam that drives the electricity-generating turbine. Using the experimental solar power plant, researchers can test new components and processes intended to make solar power plants more efficient and less expensive. The solar tower in Jülich is serving as a pilot facility for future commercial power stations in southern Europe and North Africa.
www.helmholtz.de/en/gb12-solarthermie

PUTTING THE LAST PIECE IN PLACE

Max Planck Institute for Plasma Physics Installation work on the Wendelstein 7-X in Greifswald is in full swing and the apparatus can now be seen in its final form. The Wendelstein 7-X will be the largest stellarator-type fusion device in the world and will be used to test the suitability of this type of design for a power plant. In order to harness energy from the fusion of atomic nuclei, hydrogen plasma will have to be enclosed in magnetic fields in future power plants and heated to temperatures of over one hundred million degrees.
The Wendelstein 7-X has been constructed from five almost identical modules, each weighing around 120 tons and consisting of part of the plasma vessel, its thermal insulation, 14 superconducting magnetic coils and a section of the support ring. Enclosed in an outer shell of steel, all five modules are now mounted on the base of the device. Recently, the top section, weighing approximately 14 tons, was put in place. “It’s just a pity that we can no longer see the inner workings of the device, particularly the coils, which are the hallmark of the Wendelstein 7-X,” says Dr. Hans-Stephan Bosch, the project’s associate director. The Wendelstein 7-X will commence operations in two years.
www.helmholtz.de/en/gb12-wendelstein

Putting the last piece in place: the Wendelstein 7-X before installation of the final cryostat component. *Photo: Anja Richter-Ullmann/IPP*

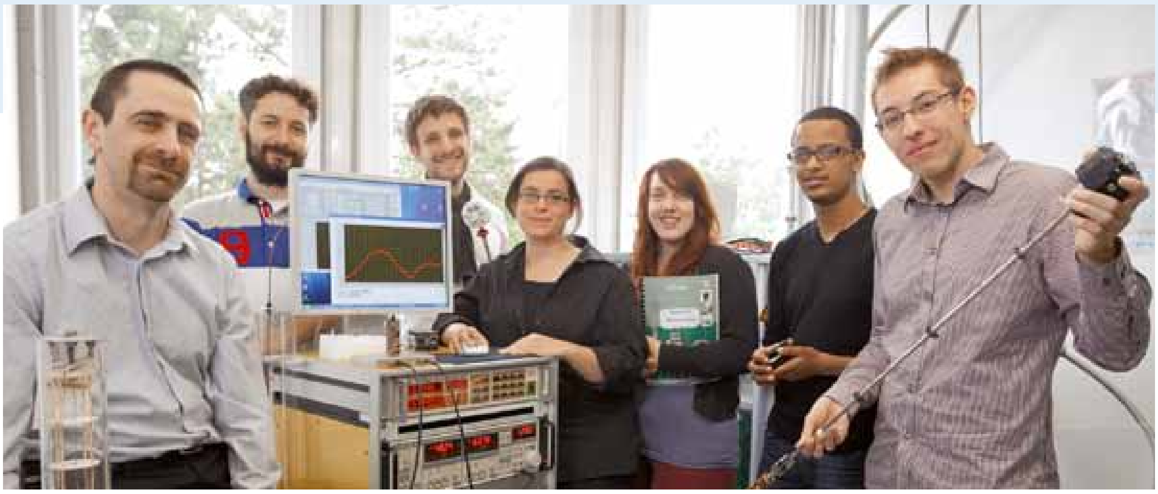


"Thermal conductivity is not determined by electrical charge carriers alone; it can also be influenced by lattice vibrations. By reducing these vibrations, we can create more efficient thermoelectric materials."
DR. RAPHAËL HERMANN Group leader at the Jülich Centre for Neutron Science.

ELECTRICITY FROM WASTE HEAT

Forschungszentrum Jülich Around 60 percent of the energy that a car engine generates from fuel is lost in the form of heat. Heat is also released in many industrial processes and in combined heat and power plants. However, thanks to the so-called Seebeck effect, this heat can potentially be utilised. If the contact points between two different electrical conductors or semiconductors are kept at different temperatures, an electric voltage is produced that increases with the temperature differential. The problem is that thermoelectric generators (TEGs) are currently only able to convert a small amount of the waste heat into electricity – usually less than 10 percent.
In order to improve this level of efficiency, we need materials that conduct electric current well and heat poorly. The difficulty is that good electrical conductors tend to be good heat conductors as both properties are influenced by the mobility of electrons. "However, thermal conductivity is not determined by electrical charge carriers alone; it can also be influenced by lattice vibrations. By reducing these vibrations, we can create more efficient thermoelectric materials," says Dr. Raphaël Hermann. Together with his team at the Jülich Centre for Neutron Science, he uses neutron scattering and synchrotron radiation to investigate the mechanisms of thermal conductivity.
The energy quanta of lattice vibrations are called phonons. Their speed, free path lengths and heat-storing capacity determine thermal conductivity. "It's like the transport of goods by road: if a truck is faster, spends less time in traffic jams and has a larger cargo space, more goods will be transported," says Hermann. Examining thermoelectric materials such as Zintl phases, skutterudites and clathrates, the researchers identified the factors that play a key role in limiting the thermal conductivity of the phonons. In this way, the scientists have gained insight into the parameters that can be tweaked in order to further increase the efficiency of these components.
» **www.helmholtz.de/en/gb12-abwaerme**

The research group headed by Raphaël Hermann is conducting research into materials that can convert waste heat from engines into electricity. *Photo: Forschungszentrum Jülich*



A scientist assembling a test cell in a glove box with an inert gas atmosphere that prevents unwanted reactions. *Photo: KIT*

FLUORIDE BATTERIES: A PROMISING CONCEPT FOR THE FUTURE

Karlsruhe Institute of Technology Lithium-ion batteries are currently the most powerful battery systems on the market, but their storage capacity cannot be increased much further. Nevertheless, many applications – especially in vehicles and fixed and mobile devices – require batteries that can store more energy and are considerably more compact. An entirely new battery concept has been developed by KIT scientists working under Dr. Maximilian Fichtner at the Institute of Nanotechnology. The group is using new composite electrodes in which the cathode consists primarily of a metal fluoride compound and the main component of the anode is a metal.

Today's lithium-ion batteries can only store up to one electron per heavy transition metal atom of the electrode, but with the help of fluoride ions, storage capacity can be increased to up to three charge carriers. At that point metal fluoride forms on the electrode or, conversely, fluoride ions are released and the metal is reconstituted. "Using this process we can theoretically achieve energy densities up to 50 percent higher than those of the lithium-ion battery that is currently regarded as the upper limit," says Fichtner. Although the principle works, researchers still have a great deal of work to do on the details: they need to improve the battery system's initial capacity, operating life and cycle stability. In addition, the solid electrolyte, which enables the charge to be transferred between electrodes, works only at elevated operating temperatures. "We're now developing new solid and liquid electrolytes that will make it possible to use the battery at room temperature," says Fichtner.

www.helmholtz.de/en/gb12-fluorid-batterien

Battery cells being tested under controlled temperature conditions. *Photo: KIT*

Timothy Schmidt from the University of Sydney and HZB researcher Klaus Lips have improved the efficiency of amorphous silicon solar cells using upconversion. *Photo: Philipp Dera/HZB*

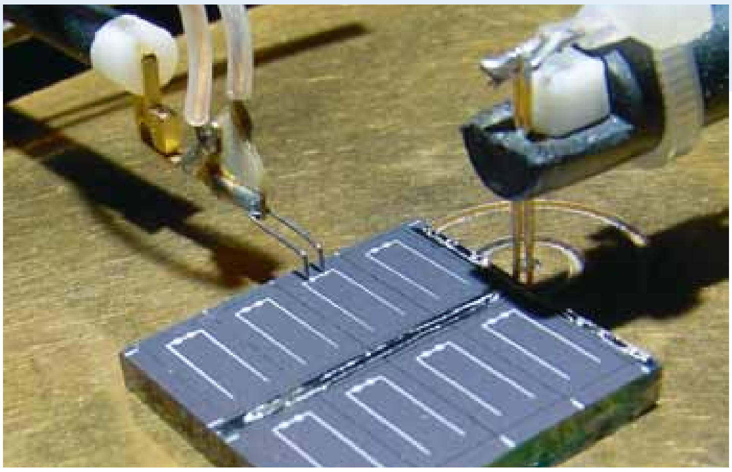
A TURBO BOOSTER FOR THIN-FILM SOLAR CELLS

Helmholtz-Zentrum Berlin für Materialien und Energie
Modern silicon solar cells have a maximum efficiency of about 25 percent and scientists worldwide are competing to find ways of further increasing this efficiency. A natural limit exists at around 30 percent, partly because solar cells do not absorb light containing energy below a material-specific threshold. In laboratory experiments scientists at the University of Sydney and the Helmholtz-Zentrum Berlin (HZB) have now developed a solar cell "turbo booster" known as photochemical upconversion. In the process two low-energy photons that are normally not absorbed in the cell are combined to form a high-energy photon that can generate charge carriers that contribute to current flow within the cell.
The photochemical turbo booster utilises organic molecules to merge low-energy red photons to form high-energy yellow photons. "We were able to demonstrate that the efficiency of a solar cell can be increased using photochemical upconversion," says project leader Dr. Klaus Lips from the HZB's Institute for Silicon Photovoltaics. The improvement in efficiency is still small, but further research could potentially boost it far beyond the 30-percent mark.
» **www.helmholtz.de/en/gb12-turbo-solarzellen**

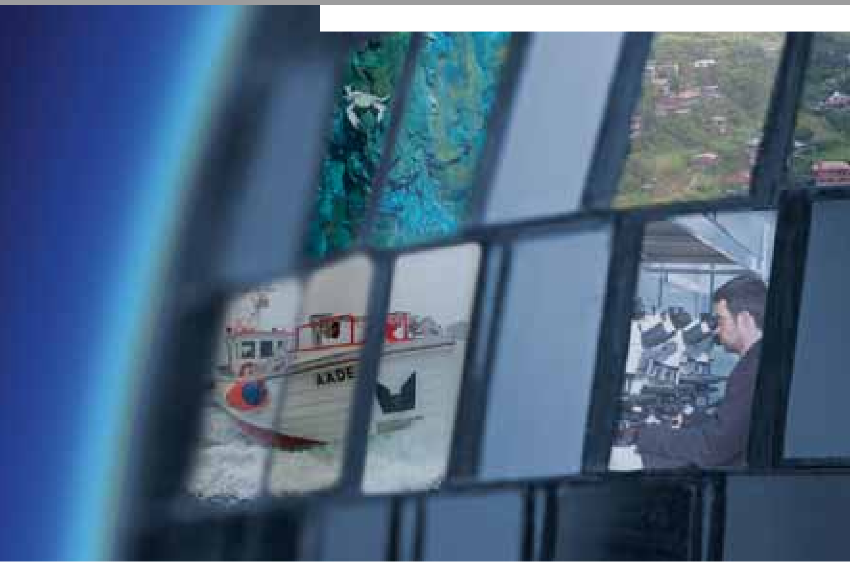
IMPROVING CIS MODULES WITH ILGAR

Helmholtz-Zentrum Berlin für Materialien und Energie
Thin-film solar modules made from copper compounds require less material and energy in production, but they convert sunlight into electricity less efficiently than crystalline silicon cells. Furthermore, their buffer layer is usually made from cadmium sulphide, which means that highly toxic cadmium must be used in the manufacturing process. HZB researchers led by Professor Christian Herbert Fischer from the Institute for Heterogeneous Materials Systems have achieved significant improvements in this area, producing the various semiconductor layers using the ILGAR (ion layer gas reaction) method developed at the HZB. The buffer layers made in this way consist of indium sulphide or zinc sulphide/indium sulphide, which takes the place of the heavy metal cadmium in the thin-film solar cells. In addition, this method eliminates the need for an environmentally harmful deposition process. For their certified record-breaking cells, the HZB researchers used light-absorbing layers made in standard industrial production processes. As a result, they have been able to produce solar cells that achieve certified efficiencies of more than 16.1 percent, clearly exceeding those with indium sulphide buffer layers produced by several other methods.
» **www.helmholtz.de/en/gb12-cis-module**

A thin-film chalcopyrite solar cell on a solar simulator test device. *Photo: HZB*



RESEARCH FIELD
EARTH AND ENVIRONMENT



Goals

The research field Earth and Environment examines the basic functions of the Earth system and interactions between nature and society. It focuses on expanding and interconnecting long-term observation systems, improving predictions and applying results within society. One special goal is to formulate scientifically based policy recommendations on how the Earth's resources can be used in a sustainable fashion without destroying the foundations of life.

For example, REKLIM, a Helmholtz climate initiative, brings together the expertise of eight Helmholtz centres in an effort to improve regional and global climate models. In the Water Science Alliance, Helmholtz experts work together with universities and other partners to investigate the impact of global change on water resources. An important aim is to establish and operate infrastructure and facilities such as the HALO research aircraft and the TERENO network. This latter project involves the construction of terrestrial observatories in four selected regions in Germany. 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 for the funding period 2009–2013

Eight Helmholtz centres currently participate in the research field Earth and Environment: the Alfred Wegener Institute for Polar and Marine Research (AWI), the Forschungszentrum Jülich, the GEOMAR Helmholtz Centre for Ocean Research Kiel (since 2012), the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the Helmholtz Zentrum München – German Research Center for Environmental Health, the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, the Helmholtz Centre for Environmental Research – UFZ, and the Karlsruhe Institute of Technology (KIT).

Research is currently being conducted in four programmes:

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

Outlook

To meet the 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" will integrate the knowledge acquired by all the centres in this research field and by their partners. It aims to help society to cope with the complex challenges brought about by changes in the Earth system. The incorporation of the GEOMAR Helmholtz Centre for Ocean Research Kiel into the Helmholtz Association has significantly expanded its research spectrum.

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

Long-term measurements of energy and water flows across a lake in the Siberian Lena Delta provide information on climate change. *Photo: Julia Boike/AWI*

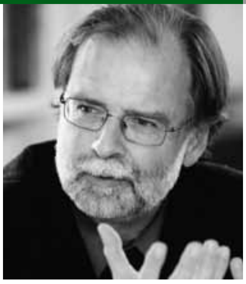
THE EFFECTS OF THAWING PERMAFROST ON CLIMATE CHANGE

Alfred Wegener Institute for Polar and Marine Research

About a quarter of the Earth's surface in the northern hemisphere is underlain by soil that is frozen throughout the year. In central Siberia the ground can even freeze to a depth of more than 1,500 metres. The interaction between climate change and permafrost is the focus of research by Professor Hans Wolfgang Hubberten, director of the Potsdam research unit of the Alfred Wegener Institute (AWI). When permafrost thaws, previously frozen microorganisms suddenly become active and begin to transform carbon compounds stored in the soil into methane, water vapour and carbon dioxide, all of which intensify the greenhouse effect. So far these processes have only partially been incorporated into climate models. Now teams from 18 partner institutions are performing ground measurements and remote sensing campaigns in various regions of the Arctic in order to determine the amount of greenhouse gases released as the permafrost thaws. This EU project, called PAGE21, is being coordinated by Professor Hubberten. For more than 15 years, the AWI team has been studying permafrost processes at the German-Russian Samoylov research station in the Lena Delta. "Here, too, climate change is clearly making itself felt. Between 2006 and 2011, researchers measured a temperature rise of up to 0.5 degrees Celsius, even at depths of 18 to 26 metres in the frozen soil," says Hubberten. The research findings of PAGE21 will flow into the 5th Assessment Report of the United Nation's Intergovernmental Panel on Climate Change (IPCC).

» **www.helmholtz.de/en/gb12-permafrost**

This measuring device records the exchange of energy and mass flows between higher and lower-lying layers of air. *Photo: Günther Stoof/AWI*



"Our impact on the planet is substantial and continues to grow. Climate change, disappearing biodiversity and the overexploitation of natural resources are just a few of the problematic developments. The global challenge for Earth and environmental research at the Helmholtz Association is to provide the knowledge of systems and applications needed to secure the foundations of life for the growing world population in a sustainable fashion over the long term."

PROFESSOR VOLKER MOSBRUGGER
Member of the Helmholtz Association Senate,
General Director of the Senckenberg Gesellschaft für Naturforschung

Rice terraces in Banaue in the Philippines. The terraces in the north of Luzon Island rise to a height of 1,500 metres and are listed as UNESCO World Heritage Sites. *Photo: Josef Settele/UFZ*

USING LAND, PRESERVING ECOSYSTEMS

Helmholtz Centre for Environmental Research – UFZ More than 40 percent of the terrestrial surface of the Earth is used by humans for agriculture, animal grazing, infrastructure and settlements. Between 1960 and 2000, agricultural production doubled, mainly because of the increasing industrialisation of agriculture. This growth has promoted soil degradation, the spread of impervious surfaces and the loss of biodiversity and ecosystem services. It has also increased greenhouse gas emissions, 20 to 30 percent of which come from land use.

How can land use be managed so as to maintain the productivity of the ecosystem over the long term? This question is at the heart of the Sustainable Land Management Programme, which is being funded by the Federal Ministry of Education and Research (BMBF) and provided with scientific support by UFZ researchers. In the affiliated coordination and synthesis project GLUES,[1] UFZ researchers led by Professor Ralf Seppelt are integrating the findings from twelve different regional projects into a global context and making the results available to potential user groups. “Through this work we are expanding the knowledge base on the effects of various land use concepts and ensuring that decision-makers and planners give greater consideration to the aspect of sustainability,” says Seppelt.

For example, yields from rice production in Southeast Asia must be increased in order to feed the growing population. In the regional BMBF project LEGATO,[2] UFZ researchers under Associate Professor Josef Settele are examining which ecosystem functions and services are provided by irrigated rice production in the Philippines, Vietnam and Malaysia. As part of this process, they are also using data provided by rice farmers and the general population. “For instance, it is well known that dragonflies are good indicators of ecosystem health. We hope to offer a solution that enables the population to easily identify species using cell phones and to support our scientific work,” says Settele. Together with local partners, the UFZ experts are developing and testing new approaches to highly productive ecological rice cultivation. “We have solid evidence that agricultural intensification is not necessarily harmful, that we can achieve high productivity in a sustainable fashion,” says Settele.

www.helmholtz.de/en/gb12-land-nutzen

1) GLUES stands for “Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services”. It is the scientific coordination and synthesis project of the Sustainable Land Management Research Programme.

2) LEGATO is the acronym for “Land-Use Intensity and Ecological EnGineering – Assessment Tools for Risk and Opportunities in Irrigated Rice-Based Production Systems”.

A sophisticated irrigation system has enabled the local population to cultivate rice and vegetables on the terraces until the present day. *Photo: Josef Settele/UFZ*

"Hydrothermal vents on the ocean floor emit metals from the Earth's interior, but most of these metals are deposited in highly diluted form in the surrounding area and are unavailable for mining. This factor has been underestimated." **DR. SVEN PETERSEN,** GEOMAR

ORES FROM THE OCEAN

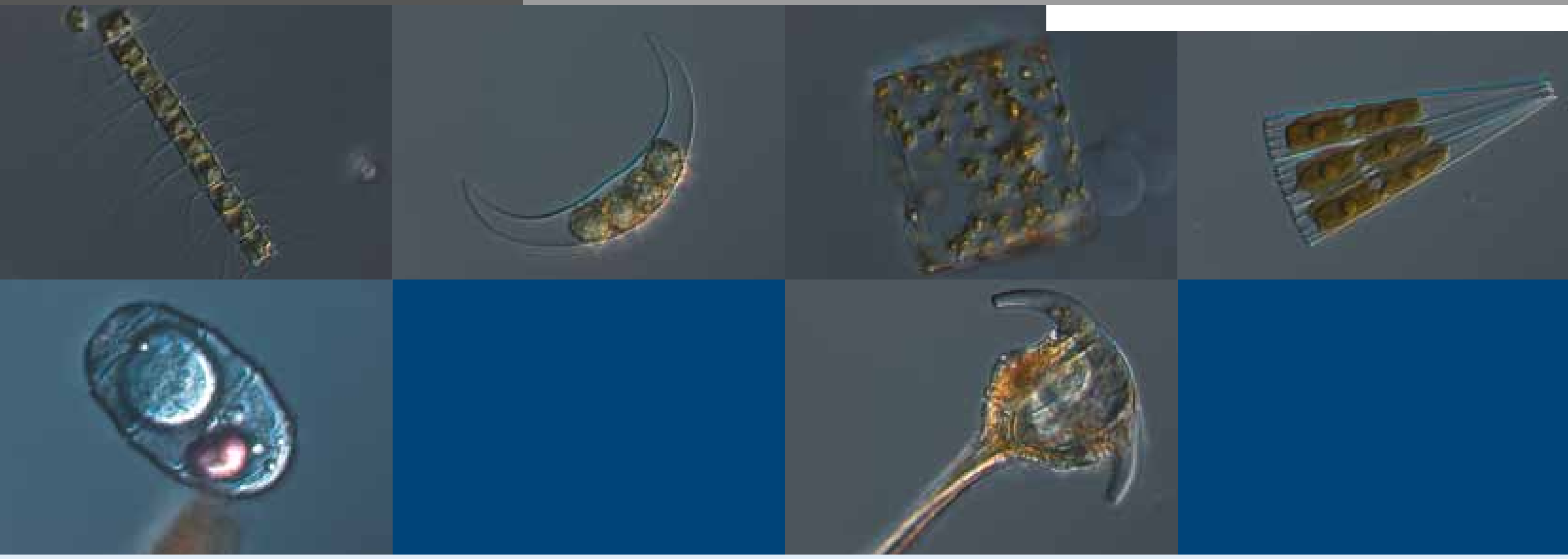
GEOMAR Helmholtz Centre for Ocean Research Kiel
Minerals such as copper, zinc, silver and gold occur along the boundaries of tectonic plates at the bottom of the sea, where smoking vents spew out large amounts of metal sulphur compounds that are then deposited on the seafloor in the form of massive sulphides. Geologists from Canada, the United States and Germany have now attempted to determine whether such deposits are large enough to contribute to covering the worldwide demand for raw materials.

For this purpose they selected 106 deposits regarded as representative of all occurrences on the seafloor. They estimated their metal content using several well-studied deposits as a basis and by performing theoretical calculations. Their results revealed a significant discrepancy between the sulphide deposits and the amount of material emitted from the black smokers. The hydrothermal vents release considerably more metals from the bowels of the Earth than is actually found in the deposits on the ocean floor. Most of the metals are deposited in the surrounding area in highly diluted form and are therefore unavailable for mining. "This factor has been underestimated," explains Dr. Sven Petersen, a geologist at GEOMAR and co-author of the study. "As a result, the potential of deep-sea mining has often been exaggerated."

"We estimate that around 600 million tons of massive sulphides have been deposited in the immediate vicinity of the world-famous volcanic ridges," says Petersen. Of this, only around 30 million tons consist of zinc and copper, the two most important metals that can be recovered from the deposits. This means that the area of the seafloor that is accessible to mining contains the same amount of zinc and copper that is mined worldwide in a single year. Given these findings, the authors suggest that costs and potential profits should be carefully analysed. At any rate, says Petersen, "Mines on land cannot be replaced by deep-sea massive sulphide mining."

» **www.helmholtz.de/en/gb12-erze-meer**

A black smoker at the Mid-Atlantic Ridge. Precious metal ores are found in the areas around these hydrothermal vents. *Photo: ROV KIEL 6000/GEOMAR*



The North Sea is home to a large number of plankton species, including diatoms and dinoflagellates. *Photos: Leonie Vogt/AWI, Alexandra Kraberg/AWI*

THE “HELGOLAND ROADS” TIME SERIES

Alfred Wegener Institute for Polar and Marine Research
A single hot summer is not necessarily a sign of a long-term trend, nor is a single large algal bloom. Many natural phenomena occur by chance or are related to cyclical events such as solar activity. This is why long-term measurements are crucial for distinguishing long-term changes from short-term fluctuations. One of the most important long-term data sets is being collected by the Alfred Wegener Institute (AWI) on the North Sea island of Helgoland. Since 1962, a team of AWI researchers has sampled the Helgoland Roads time series station off the island’s coast on a work-daily basis to measure water temperature, salinity, water transparency and nutrient levels. The plankton that serve as food for marine fauna is also sampled. “With these long-term measurements, we have solid proof that the average temperature of the waters at Helgoland Roads have warmed by 1.7 degrees Celsius compared to the 1960s,” says Dr. Alexandra Kraberg, who is responsible for the time series jointly with Professor Karen Wiltshire. At the same time, the water has become clearer and more saline. Furthermore, over time, the biologists have observed many new species of plankton. Since some of these species are considered warmth-loving, it is tempting to regard them as indicators of ongoing global warming. By combining the Helgoland Roads time series data with laboratory tests and mesocosm experiments, the scientists are investigating whether these new species can become a permanent component of the local plankton community and, if so, whether these changes might have implications for future food web interactions.
However, the Helgoland data are not only used by AWI scientists but also by scientists around the world. In addition, they provide a reliable basis for the development of science-based adaptation strategies by public authorities.
» **www.helmholtz.de/en/gb12-helgoland-langzeitreihe**

The Aade research vessel allows AWI scientists to take samples on the open sea. *Photo: Solvin Zankl*

The Earth's gravitational field is not uniform but depends on the density distribution of masses lying below and on the Earth's surface. Using gravitational field measurements from the LAGEOS, GRACE and GOCE satellites, scientists were able to quantify more accurately and on global scales to what extent water storage and ice masses undergo seasonal variations and permanent changes. *Photo: GFZ*

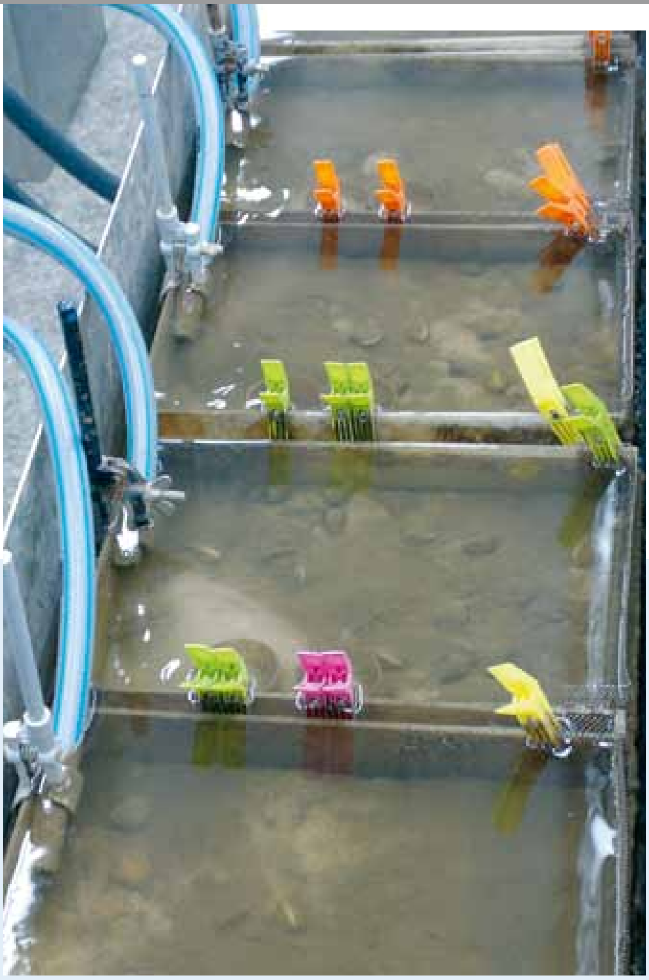
THE GRAVITATIONAL FIELD THROUGH THE SEASONS

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences The Earth's gravity not only differs from place to place, but fluctuates with the seasons and changes permanently. These variations have been factored into the latest "Potsdam gravity potato," which GFZ experts have computed using data from the GOCE, GRACE and LAGEOS satellites. For this purpose, the Potsdam-based researchers created a new gravitational field model that takes into account the hydrologic balance of the continents as well as the melting and expanding ice masses in the polar regions. Called EIGEN-6C, this model is even more accurate than previous gravitational field models and was developed in close collaboration with researchers from Toulouse. Dr. Christoph Förste and Dr. Frank Flechtner, who chair the gravitational field working group at the GFZ, emphasise particularly the importance of ESA's GOCE satellite for supplying measurements of the mean static gravitational field of the oceans. These measurements are essential to estimating the mean dynamic topography of the oceans, which facilitates a more accurate determination of the ocean currents. In addition to GOCE, long-term gravity measurement data have been supplied by the NASA-DLR twin satellite mission GRACE. GRACE has made it possible for the first time to record the large-scale temporal variations in the gravitational field that are caused by mass redistributions on the Earth's surface. These redistributions include glacier melting in the polar regions as well as seasonal water storage fluctuations in large river basins.

Due to these improvements, the new Potsdam potato is no longer a static body, but, for the first time, a surface that changes with time and provides information on climate-relevant processes in the Earth system. The GRACE mission will end in 2015 but a follow-up mission is planned for August 2017. "By then more than two decades of data will enable us to learn a great deal about the long-term, large-scale changes of the Earth that we might otherwise not have detected by other methods," says Förste.

» **www.helmholtz.de/en/gb12-schwerekartoffel**

ESA's 5.3-metre GOCE satellite flies in a sun-synchronous polar orbit at an altitude of about 260 kilometres taking measurements of the Earth's gravitational field. *Photo: ESA/AOES Medialab*



The MOBICOS system allows experiments to be performed under natural conditions in the ecosystems of lakes and rivers. The container is set up close to the lake or river and filled with water taken directly from this source. Researchers can then study how organisms respond to various environmental stresses. *Photo: Helge Norf/UFZ*

WATER RESEARCH IN CONTAINERS

Helmholtz Centre for Environmental Research – UFZ

Although targeted efforts to improve water quality have been underway for decades, only about 10 percent of water bodies are in good ecological condition as defined by the European Water Framework Directive. Surface and ground water bodies must be "healthy" in order to provide clean drinking water and other ecosystem services over the long term. In order to understand how freshwater ecosystems respond to various stresses, UFZ researchers led by Professor Dietrich Borchardt, Professor Markus Weitere and Dr. Helge Norf have developed a large mobile mesocosm system called MOBICOS. The system consists of containers that are set up close to water bodies and fed with water, thereby creating a "natural" testing environment. "The surface water is directed into various test basins in the containers. Researchers can then examine and experimentally manipulate the water – e.g. by adding nutrients or changing the temperature," says water ecologist Mark Weitere.

In one MOBICOS container scientists are currently carrying out a comparative study of the ecology of the Asian clam (*Corbicula fluminea*) in the Rhine and Elbe rivers. The clam filters algae from the water column and thus prevents their excessive growth (eutrophication). The Asian clam is found in large numbers in the Rhine, yet it is relatively rare in the Elbe, although the food supply and sediments in the latter provide an optimal environment. An identical experiment is underway at the Ecological Rhine Station of Cologne University to determine the causes of the different contributions made by the Asian clam to ecosystem functions in the Rhine and Elbe.

The containers are also being used in the Helmholtz Association's Terrestrial Environmental Observatories (TERENO), a long-term project in four German regions that aims to catalogue the development of the climate, water and soil and to provide a foundation for reliable model-based predictions.

» **www.helmholtz.de/en/gb12-container**

The well-equipped laboratory in the MOBICOS container allows researchers to perform on-site analyses and field experiments. *Photo: Jürgen Lösel*

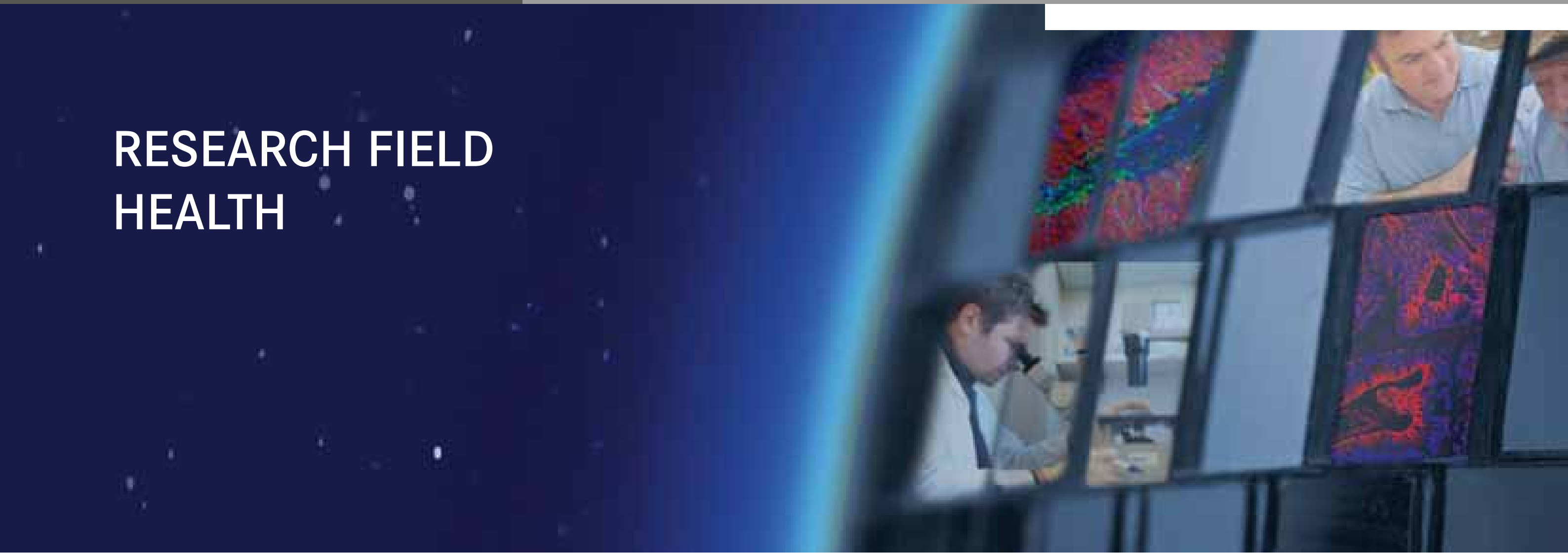
In the last century, the sea level in the German Bight has risen by 20 centimetres.
Photo: Marcus Reckermann

NORTH SEA STORM SURGES AND CLIMATE CHANGE

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research Future changes in the height of storm surges on Germany's North Sea coast will be determined by rises in the mean sea level and wind climate changes in the German Bight. Scientists led by Professor Hans von Storch and Dr. Ralf Weiße from the Institute for Coastal Research at the Helmholtz-Zentrum Geesthacht (HZG) have investigated how these two factors have changed over the course of the past century. Working with engineers from the University of Siegen, the scientists have analysed the sea level rise in the German Bight and evaluated all reliable water level measurements. “We wanted to know how and why the intensity and frequency of storm surges has changed in the past,” says Storch. According to the team's analyses, the mean sea level in the German Bight has risen by about 20 centimetres over the past century. Due to rising mean sea levels over the last 50 years, a storm surge similar to the one in 1962, which flooded large parts of Hamburg, would be about ten centimetres higher today. By contrast, the wind climate has not undergone any fundamental change. Although it varies from year to year, the fluctuations fall within the normal range. Compared with the start of the last century, storm seasons today are not marked by a larger number of storms or storms that are more violent than in the past, but this could change in the future, say the coastal researchers at Geesthacht. Furthermore, the sea level will continue to rise as the climate changes. As a result, by the end of the century, storm surges could be 30 to 110 centimetres higher than they are today. Based on current knowledge, flood protection measures will retain their effectiveness through 2030, but will then have to be reassessed. An interactive website run by the HZG’s North German Climate Office provides decision-makers and residents with information on whether new coastal protection measures are required for their regions.

» **www.helmholtz.de/en/gb12-nordseesturmflut**

Due to rising sea levels, future storm surges may cause higher flooding. This photo shows floodwaters at the piers in Bremerhaven.
Photo: RKB/Pixelio



RESEARCH FIELD HEALTH

Goals

The scientists involved in health research at the Helmholtz Association are studying the causes and development of cancer, cardiovascular and metabolic diseases, pulmonary illnesses, nervous system disorders and infectious diseases. Their aim is to help develop efficient methods for the early detection, prevention, diagnosis and treatment of these major common diseases.

The research on 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. The Helmholtz centres active in the field of health research perform outstanding basic research and apply their expertise to the development of new methods for the prevention, diagnosis and treatment of illnesses. They are making this expertise available to the German Centres of Health Research, which were founded by the Federal Ministry of Education and Research in order to improve the translation of basic research findings into clinical applications.

Programme structure for the funding period 2009–2013

Ten Helmholtz centres work together in the field of health research: the German Cancer Research Center (DKFZ), the Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch, the German Center for Neurodegenerative Diseases (DZNE), the Helmholtz Centre for Infection Research (HZI), the Helmholtz Zentrum München – German Research Center for Environmental Health, the Forschungszentrum Jülich, the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the GSI Helmholtz Centre for Heavy Ion Research, and the Helmholtz Centre for Environmental Research – UFZ.

These centres gained a new partner on 1 January 2011, when the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) joined the Helmholtz Association. In the current period of programme-oriented funding, the centres involved in health research will serve as partners for both the German Health Centres and various research consortia and will work 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

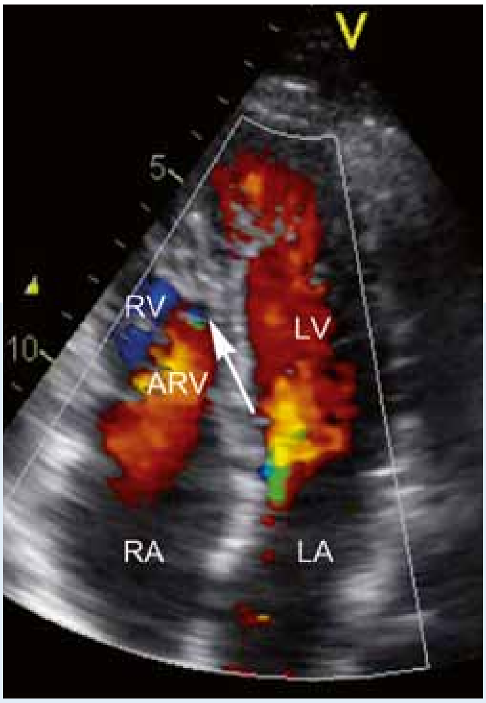
A seventh programme, “Diseases of the Nervous System”, is currently under development.

Outlook

The long-term goal of health research at the Helmholtz Association is to improve medical care and quality of life for the population into old age. Individually tailored options for prevention and treatment will play a vital role in the future, but it will also be important to better understand the role of the metabolic syndrome as a risk factor for several of the major common diseases. A key contribution will be made by the Helmholtz translational centres and the German Centres of Health Research – together with the National Cohort as a resource for epidemiology and prevention research.

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

This mirror-inverted ultrasound image shows a partial reversal of blood flow (blue) in the right ventricle (RV), caused by a malformed heart valve (arrow). In the healthy left side of the heart, blood flows in a straight line (red). The different directions of blood flow are highlighted in colour. RV = right ventricle, RA = right atrium, LV = left ventricle, LA = left atrium; ARV = atrialised right atrium. *Photo: Sabine Klaassen/MDC*



PREVENTION OF CARDIOVASCULAR DISEASE

Max Delbrück Center for Molecular Medicine (MDC) Berlin-Buch Cardiovascular disease is the number one killer in industrial and emerging countries. Each year in Germany alone, around 300,000 people suffer a heart attack, 80,000 have a stroke and 20,000 need to be treated for kidney failure. High blood pressure, excess weight and obesity play a major role in the development of these diseases. According to the WHO, around 250,000 people die of cardiovascular disease in Europe each year as the direct result of obesity; worldwide, the number is between two and five million. Scientists at the MDC have been studying the genetic causes of cardiovascular and metabolic diseases in order to develop new approaches to their prevention, diagnosis and treatment. They have been examining the role played by individual genes in the pathogenesis of the diseases and comparing the genomes of model organisms and humans in order to chart out pathogenic mechanisms. Their work has resulted in a preventive treatment for young men at risk of sudden cardiac death. Together with researchers from the Netherlands and Great Britain, Associate Professor Sabine Klaassen and Professor Ludwig Thierfelder of the MDC have demonstrated that the Ebstein's anomaly, a rare congenital valvular heart disease, has a genetic cause. In its advanced stage, the disease causes an enlargement of the right side of the heart and restricted cardiac function. The researchers hope that their findings will lead to quicker diagnosis procedures and new and more targeted treatments. In addition, MDC researchers are using systems biology to elucidate the regulation of genes and proteins and their interactions. Their methods also include innovative imaging techniques such as magnetic resonance imaging as well as epidemiology. The MDC is taking part in a study of 200,000 people to examine the causes of cardiovascular disease, diabetes and other illnesses, to identify risk factors for these diseases and to develop new methods of prevention.

www.helmholtz.de/en/gb12-herz-kreislauf

"Helmholtz health research uses interdisciplinary approaches to gain a better understanding of the complex mechanisms of pathogenesis and the interactions between genetic predisposition and environmental factors. Such insights will provide a foundation for developing new approaches to personalised medicine and new early detection and prevention strategies."

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

HZI scientists have developed a method to immortalise endothelial cells while preserving their typical cell properties. *Photo: Frank Bierstedt/HZI*

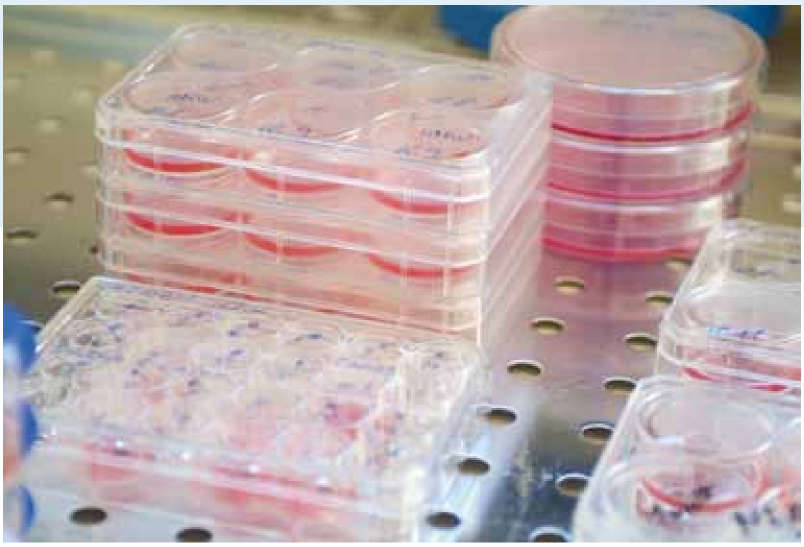
NEW CELL CULTURE MODELS TO REPLACE ANIMAL EXPERIMENTS

Helmholtz Centre for Infection Research Animal studies are often prescribed for the development of drugs and methods of diagnosis and treatment. Scientists from the Helmholtz Centre for Infection Research (HZI) and its branch facility, the Helmholtz Institute for Pharmaceutical Research Saarland (HIPS), have now designed new cell culture models that may be able to replace some animal experiments in the future.

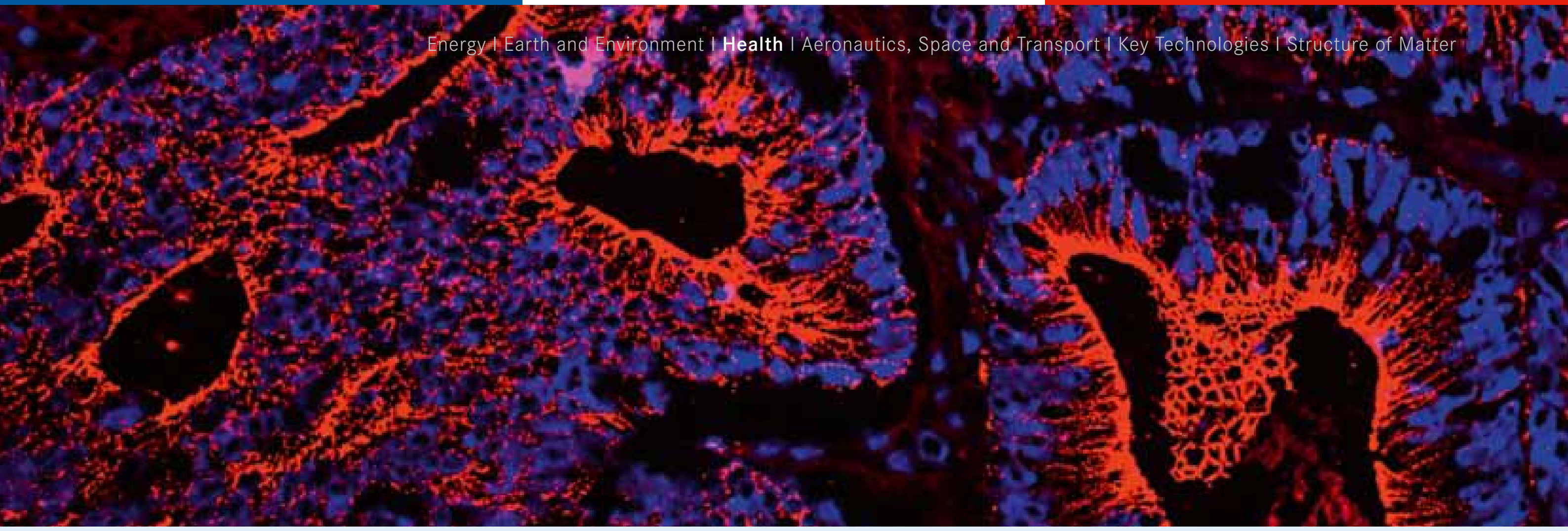
Working with Saarland University, the Drug Delivery Department of HIPS, directed by Professor Claus-Michael Lehr, has developed a cell culture model that can be used to simulate chronic enteritis. The special feature of this model is that it combines mucosal cells, which simulate a healthy colon, with immune cells and various inflammatory substances. The inflammation replicated in this way will help researchers to better understand the processes underlying intestinal disorders such as Crohn's disease and ulcerative colitis. "This is especially important for testing the absorption of drugs and delivery systems in a diseased intestine," says Lehr.

In Lehr's department, researchers led by Dr. Nicole Daum are working on advanced models of the lung. Together with colleagues from the HZI, they aim to immortalise human and murine lung cells in order to investigate the entry of pathogens into the body and to test new drugs. In the past, immortalising lung cells has always led to the loss of typical cell properties, making studies on living animals inevitable. Now a working group under Dr. Dagmar Wirth at the HZI has developed a technique for preserving cell properties. "We only prompt the cell to divide as required," explains Wirth. "This has allowed us, for example, to preserve the properties of endothelial cells. We now plan to transfer the procedure to epithelial lung cells."

www.helmholtz.de/en/gb12-tierversuchersatz



Cell culture models have the potential to replace some of the animal experiments needed to develop new drugs and diagnostic procedures. *Photo: Frank Bierstedt/HZI*



Fluorescent stain of colon cancer tissue. *Photo: Lutz Langbein/DKFZ*

EARLY SCREENING FOR COLORECTAL CANCER

German Cancer Research Center Colorectal (colon) cancer develops slowly. Precancerous stages often take several years to develop into a dangerous cancer. These stages are easy to detect with a colonoscopy and can be removed during the examination. As a result, colorectal cancer can be prevented far more effectively through targeted screening than other types of cancer. Since 2002, insured people in Germany have been eligible for a free screening colonoscopy starting at age 55.

“If more people had themselves screened, a significant number of colorectal cancer cases could be prevented in Germany,” says Professor Hermann Brenner of the German Cancer Research Center (DKFZ). According to an analysis by DKFZ scientists under Brenner, in the period 2003–2010 almost 100,000 cases of colorectal cancer were prevented by early screening nationwide and almost 50,000 additional cases were detected in a treatable early stage. But so far only a small number of people eligible for such early screening have taken advantage of this service. This is why the DKFZ epidemiologist is working together with the Saarland cancer registry to launch a model project in which an organised screening approach will be tested. As part of the project, personal invitations will be sent out to 30,000 randomly selected people from the relevant age group to take part in a colonoscopy.

“Of course, we will determine the costs of the invitation-based screening and compare them to the expected long-term decline in cancer cases,” says Hermann Brenner. “If the project is successful – as we anticipate – it could make sense to send out invitations throughout Germany for early screenings.”

» **www.helmholtz.de/en/gb12-frueherkennung-darmkrebs**

“If more people took part in the early screening colonoscopies that are covered by health insurance from age 55, a significant number of colorectal cancer cases could be prevented in Germany.” **PROFESSOR HERMANN BRENNER** Head of the Division of Clinical Epidemiology and Aging Research

Relatives of dementia patients are often overwhelmed by the demands of caregiving. *Photo: shutterstock*

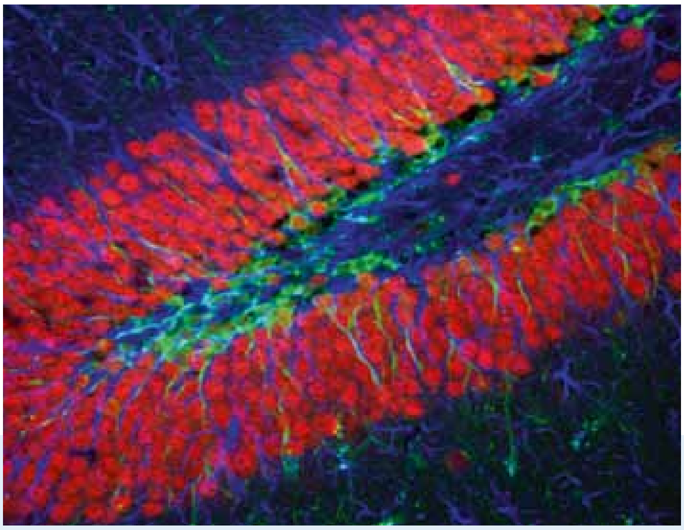
IMPROVING CARE FOR DEMENTIA PATIENTS

Helmholtz Zentrum München – German Research Center for Environmental Health A large number of people with dementia are currently cared for at home, mostly by relatives who are supported by community services and their general practitioners. This approach demonstrably reduces the high cost of care for society as a whole. However, in the coming decades the proportion of very old people who have a particularly high risk of developing dementia will increase. At the same time relatives will no longer be able to provide the same amount of care. So what can be done to postpone the admission of seniors with dementia to expensive nursing homes? This question was addressed in an IDA study conducted by Professor Rolf Holle of the Institute of Health Economics and Health Care Management at the Helmholtz Zentrum München in collaboration with colleagues from the Erlangen University Medical Center. The researchers observed 390 dementia patients still living in their home environments and tested various support services for family caregivers in comparison to routine care. An important factor was the provision of easily accessible caregiver counselling by specially trained personnel.

At the end of the four-year study, no significant differences were detected in terms of caregiver burden or the length of time before seniors had to be admitted to a nursing home. "These unexpected results in a major study with high methodological standards show that several obstacles may exist that prevent potentially helpful interventions from yielding expected impacts under routine care conditions. These obstacles include acceptance thresholds among relatives," explains Holle. Care strategies must therefore be individualised to find the best solution for each family. This and the careful choice of the time point for intervention seem to be important factors in further developing dementia care.

www.helmholtz.de/en/gb12-demenzversorgung

Counselling services must be further improved so that dementia patients can live at home as long as possible. *Photo: shutterstock*



Tissue from the hippocampal gyrus dentatus of an adult mouse. The neural precursor cells are shown in green, the differentiated granule cells in red, and the astrocytes in blue. *Photo: DZNE*

NEW NEURONS FOR OLD BRAINS

German Center for Neurodegenerative Diseases It is a long-established fact that physical and mental activity can reduce the risk of developing Alzheimer's disease and other forms of dementia. But it is far from clear why this is so and how this knowledge can be used to develop more targeted methods of prevention and treatment. Researchers now know that even in the adult organism physical and mental activity can stimulate the formation of new nerve cells in the brain. This takes place in the hippocampus, the region of the brain that plays a central role in memory formation and is severely affected by dementia.

One of the pioneers in the field of “adult neurogenesis” is the neuroscientist Professor Gerd Kempermann, who is affiliated with both the Center for Regenerative Therapies Dresden (CRTD) and the Dresden partner centre of the DZNE. Kempermann has examined in mice how the formation of new neurons in the brain is controlled not only by genes but also by behaviour. After all, neurogenesis is based on a complex biology, and research into the function of new neurons and their integration into the existing neural network of the brain is still in its infancy. “We are investigating how new neurons are integrated into brain function and how a disruption of adult neurogenesis contributes to neurodegenerative diseases and cognitive problems in old age,” explains Kempermann. Only recently has it become clear what purpose new neurons serve in the brain: Kempermann and his colleagues are convinced that they help people to deal flexibly with new information and to integrate it into familiar contexts. In the case of dementia and depression, this function is often disrupted at an early stage. Kempermann’s group is using tests based on virtual realities in order to examine this special flexibility in humans. “Our goal is to learn how we can stimulate neurogenesis in a targeted fashion in order to prevent the disturbances in brain function that are caused by neurodegenerative diseases. We also hope to compensate for these malfunctions and, in the best-case scenario, cure them over the long term.”

» **www.helmholtz.de/en/gb12-neue-neurone**

Physically active mice remain mentally fit for a longer time. The group led by Professor Gerd Kempermann is studying how physical activity is related to the formation of new nerve cells. *Photo: DZNE*

RESEARCH FIELD AERONAUTICS, SPACE AND TRANSPORT

Goals

The scientists involved in aeronautics, space and transport research address the major challenges of society in the fields of mobility, information systems, communication, resource management, the environment and safety. They develop concepts and solutions and provide advice for policymakers. The German Aerospace Center (DLR) is Germany's national centre for aeronautics and space research. On behalf of the German government and in its role as the German space agency, the DLR is responsible for research in 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 the DLR's facilities at 16 locations throughout Germany. At the same time, the DLR works closely with other Helmholtz research centres, particularly in the areas of energy research and research on Earth and the environment. It also 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 integrating ground and air-based systems at airports can reduce costs, emissions, delays and noise. Close cooperation with industry has also been required for 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 and, with its research findings, has made a major contribution to the use of such vehicles in the logistics sector. Finally, within the scope of the EU's COFRET project, the DLR has worked with Deutsche Bahn, Maersk and other industrial partners to develop a practical methodology for calculating CO2 emissions along supply chains and has thus laid the foundation for international standardisation in this field.

Programme structure in the funding period 2009–2013

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

- Aeronautics
- Space
- Transport

Outlook

In addition to the ever-evolving implementation of current research themes, 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 spacecraft re-entry technologies. In 2011, the DLR established an internal maritime safety research group in order to pool and expand research in the various DLR institutes. The activities in this area are supported by a positively evaluated portfolio proposal entitled "R&D and Real-Time Services for Maritime Safety."

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

"Ship tracks" (contrails) are visible on satellite images as elongated low-lying cloud formations over the sea that are clearly not of natural origin. They are caused by waste gases, particularly the high sulphur dioxide emissions from large ships. *Photo: DLR/NASA*

THE ENVRIONMENTAL IMPACT OF SHIP TRAFFIC – FEWER EMISSIONS WITH LOW-SULPHUR FUELS

German Aerospace Center The approximately 90,000 container ships on the world's seas consume up to one billion litres of fuel each day. In most cases, their large marine diesel engines are driven by heavy fuel oil, which contains up to 4.5 percent sulphur. The resulting harmful emissions cause an unwanted burden on both the environment and human beings, especially in densely populated coastal regions and ports. In 2011, DLR researchers from the Institute of Atmospheric Physics in Oberpfaffenhofen analysed how alternative fuels could help solve this problem. Building on experience from the long-standing project "SeaKLIM, Impact of Shipping on the Atmosphere and Climate", Dr. Veronika Eyring and her colleagues examined how the environmental impact could be lessened by switching to biofuels or so-called marine diesel oil with a lower sulphur content. Using cargo shipping data and sophisticated computer models, the researchers simulated the exhaust pollution in the atmosphere. One important finding was that sulphate aerosol concentrations could be cut by up to 60 percent along busy sea routes if heavy fuel oil was no longer used. The pollution caused by soot and sulphur dioxide could also be reduced but the level of emitted carbon monoxide and nitrogen oxides would largely remain the same.

Studies like this provide an important basis for the more stringent emission regulations that are currently being discussed for global shipping. For the period 2020–2025, the International Maritime Organization (IMO) aims to gradually introduce lower limits, particularly for the sulphur in fuels. Europe is a pioneer in this field. Beginning on 1 July 2010, ships travelling in the special emissions area in the North and Baltic Seas have been subject to a 1 percent limit on sulphur in fuel and ship emissions.

» **www.helmholtz.de/en/gb12-schiffsverkehr**

"Factors such as mobility, information, communication, resource management, the environment and safety are crucial for the sustainable economic and social development of a modern economy and are thus of tremendous strategic importance. Scientists working on aeronautics, space and transport research are tackling these challenges and offering solutions."

DR. DETLEF MÜLLER-WIESNER
Member of the Helmholtz Association Senate, Senior Vice President and Head of External Affairs, Business and Transverse Initiatives, EADS Deutschland GmbH, Munich

The DLR's fuel cell system was installed in the ATRA research aircraft to drive the electric nose wheel. *Photo: DLR*

ELECTRICALLY POWERED NOSE WHEEL SAVES KEROSENE

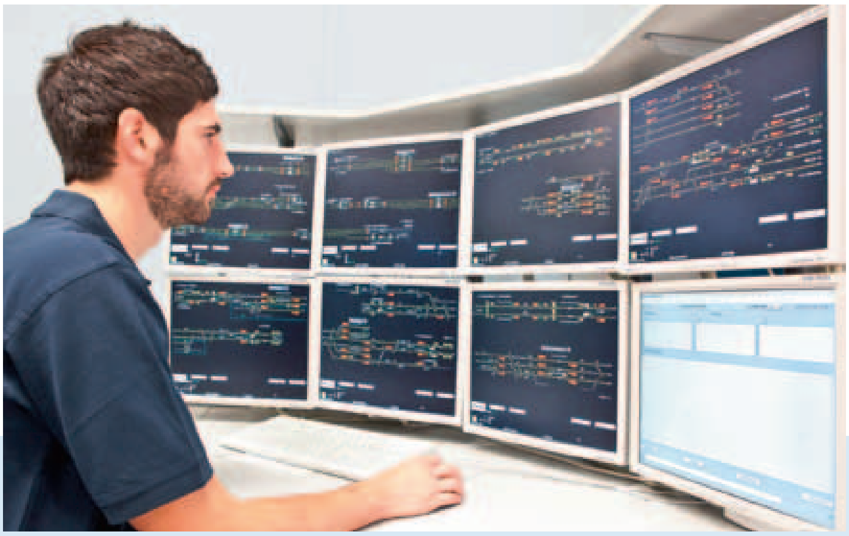
German Aerospace Center Passenger planes at airports across the world keep their engines on in order to taxi between the runway and the passenger-loading gates. At Frankfurt Airport alone, this practice leads to the consumption of around 44 tons of kerosene a day. In collaboration with Airbus and Lufthansa Technik AG, the DLR's Institute of Technical Thermodynamics in Stuttgart, Germany, has developed an electrically powered nose wheel that could help save this fuel. In an initial taxiing test at Hamburg Airport in June 2011, an Airbus A320 equipped with a fuel-cell powered electric nose wheel successfully demonstrated the feasibility of the drive system.

Lower levels of fuel consumption, noise and air pollution from exhaust gases are the main advantages of the powerful electric motor combined with the fuel cell system. “There is tremendous interest in our technology and we're surprised at how quickly the idea has caught on,” says DLR project manager Dr. Josef Kallo, who expects an electrically powered nose wheel to be introduced within five to seven years. Initially the nose wheel is likely to be powered by an on-board kerosene-fueled generator, the auxiliary power unit (APU), but later it could also be driven by a fuel cell, which generates electricity from hydrogen.

In addition to saving expensive fuel, airlines could reap other advantages from this technology. Since it would enable pilots to turn off their engines more quickly after landing, engine operation time could be reduced by 900 hours per year, which would allow maintenance intervals to be extended. If on-board power could be obtained from fuel cells, the water resulting from hydrogen conversion could be fed into the on-board tank. Less water would have to be pumped into the tank on the ground and the takeoff weight of the jet could be reduced, bringing additional fuel savings.

» www.helmholtz.de/en/gb12-elektrisches-bugrad

The DLR's ATRA research aircraft was equipped with a fuel-cell powered nose wheel for testing purposes. *Photo: C. Brinkmann/Airbus*



The RailSiTe railway laboratory at the DLR's Institute of Transportation Systems in Braunschweig simulates the complex interactions between train control and train safety systems. *Photo: DLR*

IMPROVED SAFETY ON EUROPE'S TRAIN TRACKS

German Aerospace Center Rail traffic throughout Europe has enormous untapped potential when it comes to transporting passengers to their destinations quickly, safely and at low cost. New high-speed trains and railway lines are being developed and built to unlock this potential. But control systems and safety installations in the network must keep pace with the expansion of rail traffic. Smooth operability by personnel, ranging from drivers to dispatchers, must also be ensured.

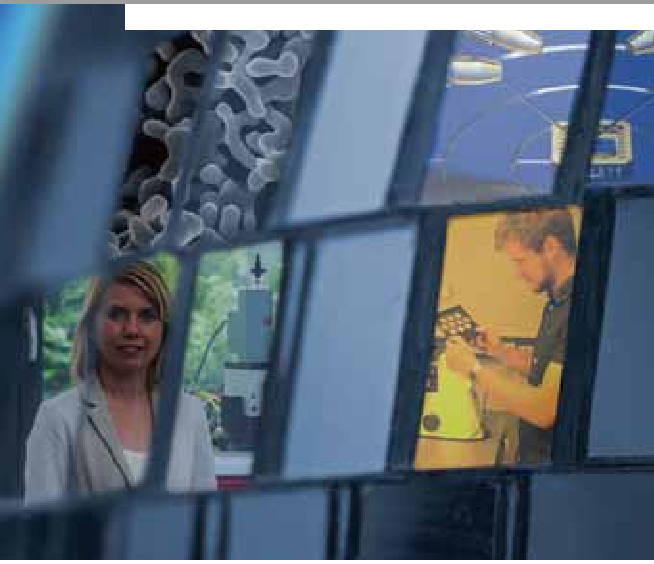
To meet these goals, the DLR's Institute of Transportation Systems in Braunschweig, Germany, examines new technologies and test methods in detail years before they are adopted nationwide. In 2011 the team led by Professor Karsten Lemmer, the institute's director, optimised the RailSiTe® railway simulation laboratory, which allows researchers to create realistic and detailed simulations of the complex interactions between control and safety technologies, from virtual control centres to simulated drivers' cabs in locomotives. Since early 2012, the optimised laboratory has been one of Europe's three independent reference labs accredited for the new European control and safety technologies of the European Train Control System (ETCS).

RailSiTe is supplemented by the RailSET® simulation laboratory, in which test persons evaluate the functionality of new systems, thereby helping to design the railway workspaces of tomorrow. In addition to these simulations at the Braunschweig institute, the RailDriVe® test and measuring vehicle provides researchers with a mobile laboratory for the time-synchronous recording of multiple sensor data, which are used to develop algorithms for train positioning and condition monitoring. It consists of a truck with various measuring systems and an integrated chassis that allows it to be placed on rails.

» **www.helmholtz.de/en/gb12-sicherheit-schienen**

The DLR's RailSET railway laboratory allows researchers to carry out technical and operational tests for train trips. *Photo: DLR*

RESEARCH FIELD KEY TECHNOLOGIES



Goals

The goal of research in the field of key technologies is to develop generic technologies that contribute to the future viability of our society. The research programmes pursued in this field cover the spectrum from fundamental research to concrete applications, are based on multidisciplinary collaboration, and make use of an excellent infrastructure specifically catering to large-scale research. Key technologies research at the Helmholtz Association supports the high-tech strategy of the German government, particularly in the areas of bio- and nanotechnology, micro- and nanoelectronics, optical technologies, microsystems and materials technology, and information and communications technology. It is setting the pace for innovation and developing these future technologies in order to secure Germany's leading position in these fields and to ensure its competitiveness as a location for industry. Our research into key technologies takes into account the recommendations of the Industry-Science Research Alliance concerning the specified fields, the resolutions of the Bio-economy Research and Technology Council, and strategic considerations in the EU regarding key technologies.

Programme structure in the funding period 2010–2014

Three Helmholtz centres are involved in key technologies research: the Forschungszentrum Jülich, the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), and the Karlsruhe Institute of Technology (KIT). The six core programmes in this research field are supplemented by a seventh, "Technology, Innovation and Society", which is being pursued in cooperation with the field of energy research at the Helmholtz Association.

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

Outlook

The research field of key technologies pursues basic and application-oriented research. Energy, health, mobility, safety and communications are all emerging as areas for which sustainable technologies need to be developed. For this reason, the research field is consolidating existing programmes in the areas of materials science, the nanosciences, information and communications technology, and the life sciences. New interdisciplinary topics include technology and simulation in medicine, a sustainable bioeconomy, structural and synthetic biology, along with simulation, data management and data analysis on the exascale. Key technologies researchers are working to develop processes in the materials sciences, physics and chemistry; these will find application in the areas of energy provision, mobility and medical treatments.

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

Andreas Wischnewski (left) and Wim Pyckhout-Hintzen investigate materials that are particularly durable and have "self-healing" capabilities. *Photo: Forschungszentrum Jülich*

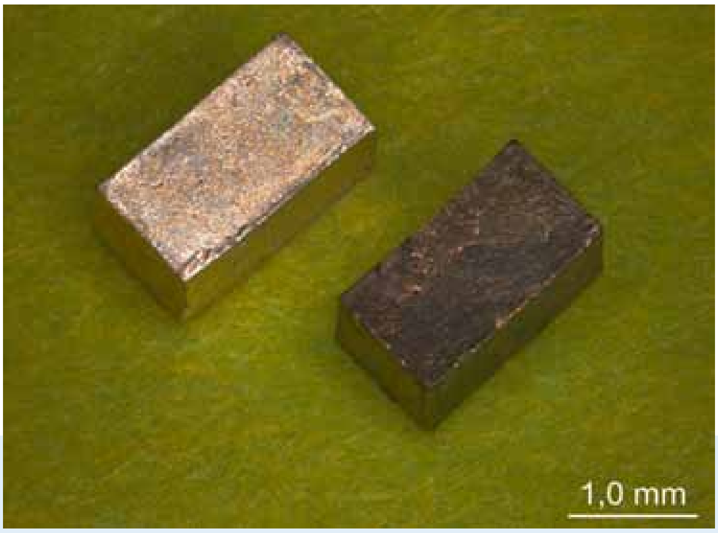
IN KEEPING WITH NATURE – SELF-HEALING MATERIALS

Forschungszentrum Jülich Many of the wounds suffered by plants, animals and people heal by themselves. Even broken bones grow back together. But in the case of steel, concrete and plastics, damage worsens over time and then requires laborious repair work. Currently only a few materials exist that can repair small defects by themselves, but this could change. Since 2011, a team headed by Dr. Andreas Wischnewski and Dr. Wim Pyckhout-Hintzen at the Jülich Centre for Neutron Science (JCNS) has been working with researchers from Germany and the Netherlands in the DFG's priority programme "Design and Generic Principles of Self-healing Materials" in order to understand self-healing processes in materials and to develop them for practical applications. Their colleague Dr. Ana Bras is working at Jülich mainly on self-healing plastics. These consist of long molecular chains, or polymers, which are composed of smaller structural units. When the bonds between these molecules are optimally configured, small defects close as if by themselves. Using neutron scattering experiments, the Jülich researchers have ascertained the role that hydrogen bonds play in this process. They have shown that the chain-like molecules are loosely connected to each other via multiple hydrogen bonds. "These bonds can be broken and re-established," explains Bras. "They form a mesh. When it breaks, it can remesh itself anew." This capability represents a decisive advantage over self-healing products that already exist, such as bicycle tyres that release a viscous substance when punctured and seal a hole. This feature of the tyre only works once in a particular spot. Jülich researchers are aiming to design materials that can grow back together repeatedly so that one day we'll be able to say: A scratch in the paintwork? A crack in the seal? No need to worry – it'll heal in no time!

» **www.helmholtz.de/en/gb12-selbstheilende-materialien**

"As the name suggests, key technologies open doors to the future. In this field, the Helmholtz Association provides the interdisciplinary know-how, instruments and methods required to successfully solve the grand challenges of our future. Important elements in this concept include collaborating with scientists in other research fields and training young people to work on transdisciplinary issues."

PROFESSOR KATHARINA KOHSE-HÖINGHAUS
Member of the Helmholtz Association Senate,
Faculty of Chemistry, University of Bielefeld



An electrical signal switches the mechanical properties of these samples between strong and ductile. *Photo: HZG/TU HH*

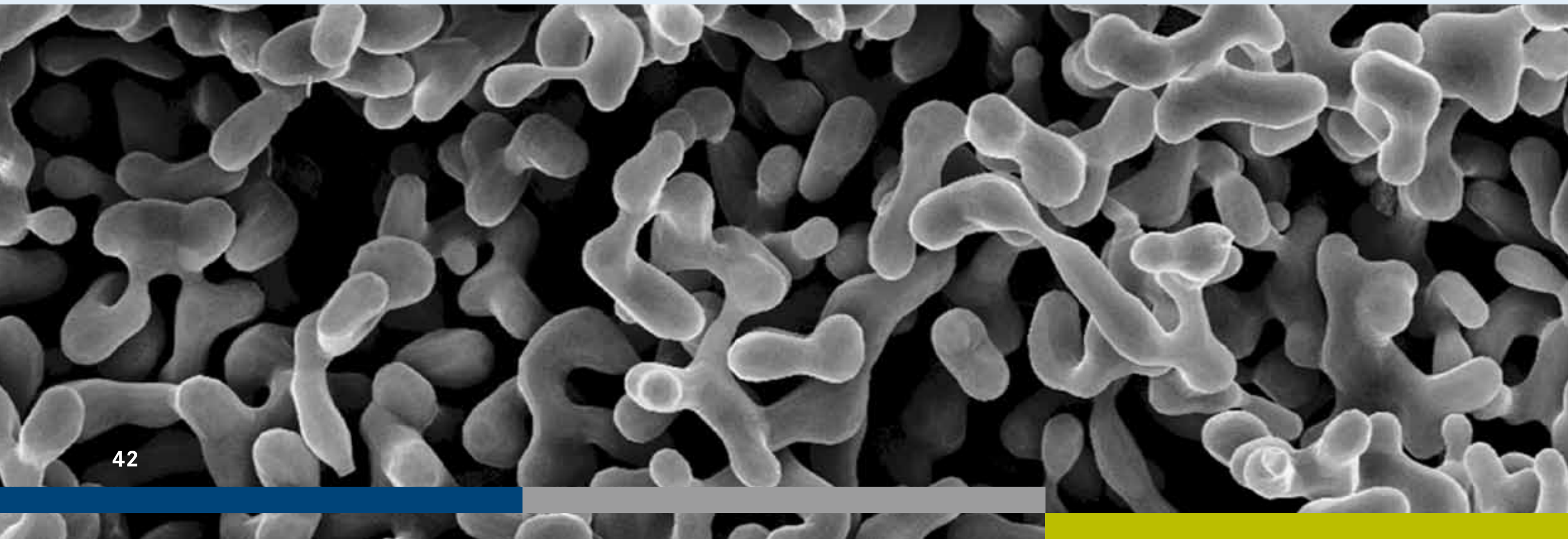
NEW NANOMATERIAL CHANGES FROM HARD TO SOFT

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research As a rule, high-strength materials are brittle and therefore prone to failure. Conversely, fracture-resistant materials that absorb energy when they are deformed lack strength. Materials researchers have now developed a material that can switch back and forth between the mechanical properties of strong and ductile. Dr. Jörg Weißmüller, affiliated with both the Helmholtz-Zentrum Geesthacht (HZG) and the Hamburg University of Technology, worked together with Dr. Haijun Jin from the Institute of Metal Research in Shenyang, China, to achieve this breakthrough, which utilises the process of corrosion. They placed noble metals such as gold and platinum in an acidic solution, precisely controlling the resulting corrosion so that a network of porous channels only a few atoms wide was etched into the metal. They then filled the channels with a conductive liquid such as a saline solution or a diluted acid. The result is a hybrid material consisting of metal and liquid in which ions dissolved in the liquid can move freely and transport electric signals. The application of an external voltage produces an electric space-charge layer in the metal surfaces – an effect similar to the space-charge zones in semiconducting elements used in microelectronics. Surprisingly, the application of an external electrical signal provides control of the mechanical properties of the new material.

Upon request, the strength of the material can be doubled. Alternatively, the material is most malleable in its weak and ductile state. Up to now these results have been confined to the laboratory, but the researchers are already envisaging applications. In principle, when subjected to stress, the material can even generate electrical signals itself, which in turn affect its mechanical properties. The material could thus spontaneously enhance its local strength in areas carrying enhanced load, thus preventing or even healing damage caused by cracking.

www.helmholtz.de/en/gb12-neues-nanomaterial

This scanning electron microscope image reveals the nanoscale pore structure of the material. *Photo: HZG*

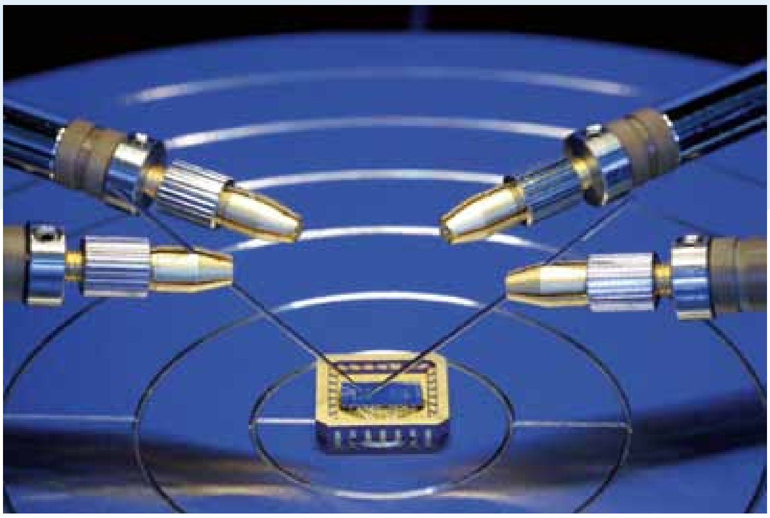


Rainer Waser at a special scanning tunnelling microscope that he uses to investigate electronic materials for new types of storage components such as memristors. *Photo: Forschungszentrum Jülich*

COMPUTERS AND THE ENERGY FACTOR

Forschungszentrum Jülich Information and communications technologies account for more than 10 percent of the total energy consumed by Germany – and this figure is increasing. Jülich researchers are working on energy-efficient solutions on different levels: from tiny components to computer architectures and the energy management in supercomputer centres. Scientists headed by Professor Rainer Waser from the Peter Grünberg Institute at Jülich are developing memristors – tiny electronic components whose resistance can be switched from high to low using ultra-short voltage pulses. The energy required to write to these new memories is less than a thousandth of that required by today's flash memories, used for example in USB flash drives. Waser is convinced that memristors could compete with resistors in the future. One of their advantages lies in the fact that they combine the working memory and the actual processing unit, which are normally physically separated. Transferring data between these two components requires an enormous amount of energy, which could be saved. Scientists at the Jülich Supercomputing Centre (JSC) are collaborating with companies such as IBM and Intel with the aim of producing computers by 2020 that are a thousand times faster than today's supercomputers but do not use any more energy. "This means that we must increase energy efficiency a thousand times over, for example, by improving access to working memory and mass storage as well as input and output units," says Dr. Thomas Fieseler, head of technology at JSC. Jülich supercomputer experts already tested parts of such an IBM energy-efficient computer architecture in 2011. In the "Fit4Green" project, researchers then developed software that allows them to perform different tasks, or "jobs", on a supercomputer in a way that requires between 6 and 16 percent less energy.

» **www.helmholtz.de/en/gb12-rechnen-energie**



Jülich researchers use this measuring device to determine the electronic properties of the chips they are developing for energy-efficient information technology. *Photo: Forschungszentrum Jülich*

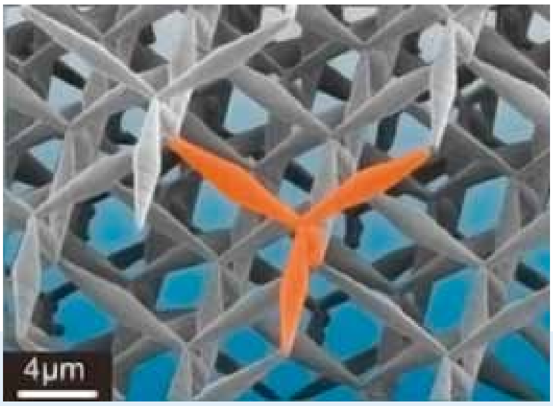
KIT researchers led by Professor Mario Ruben have used the principle of self-organisation to construct a nanomagnet switch that could in theory increase storage density. The switch uses single magnetic molecules embedded on nanotubes made of carbon.

NANOMAGNET SWITCHES THAT ASSEMBLE THEMSELVES

Karlsruhe Institute of Technology Computer hard drives store information in the form of magnetic structures. The finer these magnetic structures are, the greater the density of data and thus their storage capacity. In 2011 KIT scientists led by Professor Mario Ruben at the Institute of Nanotechnology (INT) working with experts from Grenoble and Strasbourg constructed a nanomagnet switch that could generate significantly finer structures than had previously been possible. A particularly clever idea was to employ the same principle of self-organisation as commonly found in natural processes. The researchers applied adhesion principles to the magnet molecules in such a way that the latter docked onto a nanotube in the desired position. The resulting magnetic switch consists not of silicon, metals, oxides or semiconductors, but of carbon nanotubes and organic molecules. The molecules used in this process contain a single atom of the metal terbium, which introduces magnetism into the system. The terbium atom is embedded in the organic material and reacts to even the tiniest external magnetic field. When electrical current flows through the carbon nanotubes, it is altered to such a degree that this change can be read externally as a signal. This effect could make it possible to generate greater storage densities as well as new types of structural elements for quantum computers. However, at present the nanomagnet switch only functions at temperatures close to absolute zero, and the scientists are now working on ways to apply the same principle at higher temperatures.

www.helmholtz.de/en/gb12-nano-magnetschalter

Post-doctoral fellow Svetlana Klyatskaya from Mario Ruben's team investigates the new structural elements at extremely low temperatures using the SQUID magnetometer. *Photo: Martin Lober/KIT*



This stable four-pronged structure (coloured orange) is the basic element of the pentamode metamaterial. These structures are interconnected to produce a three-dimensional diamond-like structure that results in a malleable material. *Photo: CFN/KIT*

RAW MATERIAL FOR ACOUSTIC CLOAKING

Karlsruhe Institute of Technology A new class of materials has been produced by a research team led by Professor Martin Wegener at the Karlsruhe Institute of Technology (KIT). Using a technique they developed themselves, the researchers have succeeded in generating a so-called metafluid with unusual acoustic properties. These properties are determined by the mechanical behaviour of a material, which is expressed in terms of compression and shear parameters. For example, water in a cylinder can hardly be compressed, but it can be stirred with a spoon in all directions (shearing). If all five shear parameters of a material equal zero, as is the case with water, it is characterised as a pentamode material. A solid material that exhibits the same parameters as water is described as a pentamode metafluid.

"The Karlsruhe prototype was manufactured from a polymer," explains Dr. Muamer Kadic. To produce the prototype, the team used dip-in laser writing, a method derived from the direct laser writing technique developed by the firm Nanoscribe in the KIT incubator. With this method, the researchers were able to manufacture elements shaped like sugar loaves from the polymer and to arrange them in a three-dimensional crystalline structure. Within this structure the "sugar loaves" touch one another only at their tips and thus form an extremely light and open matrix. The mechanical behaviour of the material is determined by the acuteness and length of the individual sugar loaves.

Producing such a material is a challenge. As Dr. Kadic explains, "On the one hand, we have to be able to construct tiny sugar loaves in the nanometre range and connect them to one another at the correct angle. On the other hand, the entire structure must ultimately be as large as possible. The material itself makes up only 1 percent of the entire volume, and the resulting composite is therefore extremely light."

The new pentamode metamaterial has made it possible for the first time to influence acoustic waves selectively in three dimensions. This has already been achieved with optical waves with the help of natural materials. This development could well open the way for realising numerous ideas in the fields of transformation acoustics, such as inaudibility cloaks, acoustic prisms and new loudspeaker concepts.

» **www.helmholtz.de/en/gb12-akustische-tarnkappen**

Diploma candidate Tiemo Bückmann loading the dip-in laser writing device that is used to generate the desired metastructures in the material. *Photo: CFN/KIT*

RESEARCH FIELD STRUCTURE OF MATTER

Goals

Helmholtz research on the structure of matter explores the building blocks 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 a variety of large-scale scientific facilities that in many cases are unique, including detectors, data acquisition systems and particle accelerators for synchrotron-radiation, neutron and ion sources. Two planned facilities will create research infrastructure in Germany that is unrivalled in the world: the European X-ray laser XFEL, which is being built by the Deutsches Elektronen-Synchrotron DESY in collaboration with European partners, and the Facility for Antiproton and Ion Research (FAIR), which will be constructed with international partners at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. The Helmholtz Alliances “Physics at the Terascale”, “Extreme Densities and Temperatures – Cosmic Matter in the Laboratory” and “Astroparticle Physics” have brought together expertise from Helmholtz centres, universities and Max Planck institutes. Platforms such as CFEL, HIC for FAIR, KNMF, NanoLab, EMSC and CSSB are further strengthening these ties with universities and research centres from Germany and abroad.

Programme structure in the funding period 2010-2014

Seven Helmholtz centres work together on research into the structure of matter: the Deutsches Elektronen-Synchrotron DESY, the Forschungszentrum Jülich, the GSI Helmholtz Centre for Heavy Ion Research, the Helmholtz-Zentrum Berlin für Materialien und Energie, the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, and the Karlsruhe Institute of Technology (KIT). Scientists investigating the structure of matter work within four programmes:

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

Outlook

Preparations are currently underway to reorganise research on the structure of matter into three programmes, which are to be put in place in 2015. All disciplines related to basic research – particle and astroparticle physics, physics of hadrons and nuclei, and atomic and plasma physics – will be combined in the “Matter and the Universe” programme. In the second programme, “From Matter to Materials and Life”, the operators of modern radiation sources will work closely with an international user community from the natural sciences, engineering and medicine to develop new materials and active substances and to investigate phenomena in condensed matter, electromagnetic plasmas and biological systems. The third programme, “Matter and Technologies”, will focus on new technological concepts for fields such as particle acceleration, detector systems and the optimisation of high-performance computing and data storage. The goal of this restructuring process is to strengthen synergies and to develop enabling technologies for the world of tomorrow.

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

Florin Radu inspecting a BaTiO3 sample in the ALICE diffractometer. *Photo: HZB*

LOCATING THE ELUSIVE

Helmholtz-Zentrum Berlin für Materialien und Energie
Scientists at the Helmholtz-Zentrum Berlin (HZB), working with colleagues from France and the UK, have discovered that two normally incompatible properties can be manifested simultaneously, even at room temperature. They have demonstrated this phenomenon on thin layers of ferroelectric barium titanate covered with ferromagnetic iron or cobalt atoms. Using the HZB's synchrotron radiation source BESSY II, researchers have observed that the interface between the two materials exhibit both ferroelectric and ferromagnetic behaviour. "When you apply an external voltage, it reverses the polarisation of the barium titanate film, which in turn influences its magnetisation," says HZB researcher Dr. Sergio Valencia. This quality lends the material great potential as a storage medium. "Until now, information has been written on storage media by applying an external magnetic field, a process that requires a great deal of energy. If we can couple ferroelectric and ferromagnetic qualities strongly enough, it could be possible to influence magnetic orientation using an electric field and thereby save over 90 percent of the energy normally required," explains Valencia. When these two properties are only weakly coupled, the storage medium that can be developed is based on four rather than two ground states.
» **www.helmholtz.de/en/gb12-fluechtiges-fassen**

"With its particle accelerators and photon, neutron and ion sources, the Helmholtz Association is able to provide national and international researchers with infrastructure and facilities that in many cases are unique in the world. Fundamental research conducted at these facilities fuels technological development and provides the foundation for knowledge that can help to solve current problems in our society and environment. One example is the development of new types of materials with tailored mechanical, electronic and thermal properties."

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

In this experiment, DESY researchers monitored and optimised the production of organic solar cells.
Photo: Heiner Müller-Elsner/DESY

DESY RESEARCH INTO FLEXIBLE SOLAR CELL FILMS

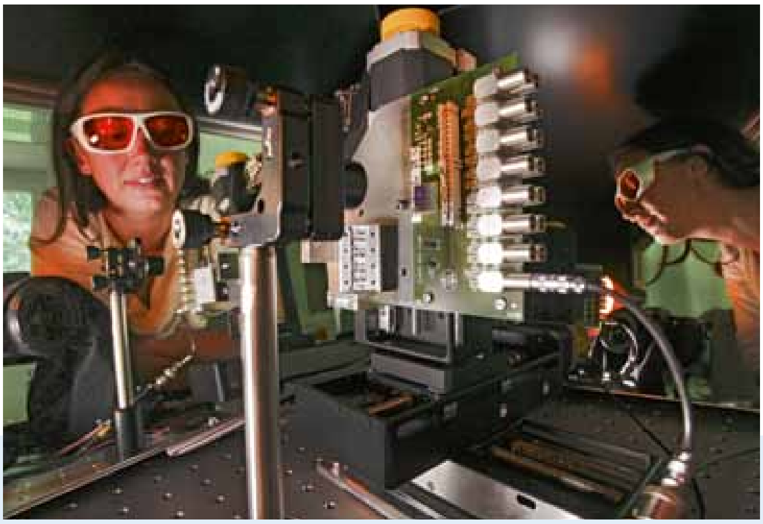
Deutsches Elektronen-Synchrotron DESY Flexible and cheap plastic solar cells could be enormously practical. However, prototypes have so far lacked the necessary efficiency and durability. One sticking point is the metallic contacts that conduct electricity out of the solar cells. The better these are, the more energy that can be "harvested". Using X-ray radiation from the PETRA III facility, a team led by DESY researcher Dr. Stephan Roth is currently investigating how metal and plastic bond. The solar cell prototypes are supplied by the Munich University of Technology and are coated at the DESY using a special technique known as sputtering. In this particular case, fast inert gas ions collide with a gold film and shoot out individual atoms that then collide with the organic solar cell. Some of these atoms are etched into the plastic while others remain on the surface and congregate to form nanometre-sized islands – the "germ cells" of the contacts.

"The intensive and extremely fine X-ray beams generated by PETRA III enable us to monitor the entire process in detail," explains Roth. "No other method would allow us to do so." As if watching a slide show, the experts observe how the nano-islands form, which helps them to understand how the production process can be optimised.

This work has also revealed that gold atoms can penetrate into the plastic solar cells, a discovery that may help to increase the efficiency of these cells in the future. As Roth explains, "This is an effect observed for the first time at DESY in this type of in-situ experiment. It has been confirmed using X-ray reflectometry. It should help us to increase the efficiency of organic solar cells in the future."

www.helmholtz.de/en/gb12-solarzellfolien

For this experiment, special layers were created within the solar cells. They were then brought into contact with gold atoms.
Photo: Heiner Müller-Elsner/DESY



Experimental setup for the development of the PET scanner. *Photo: DESY*

NANOPARTICLES IMPROVE CATALYSERS

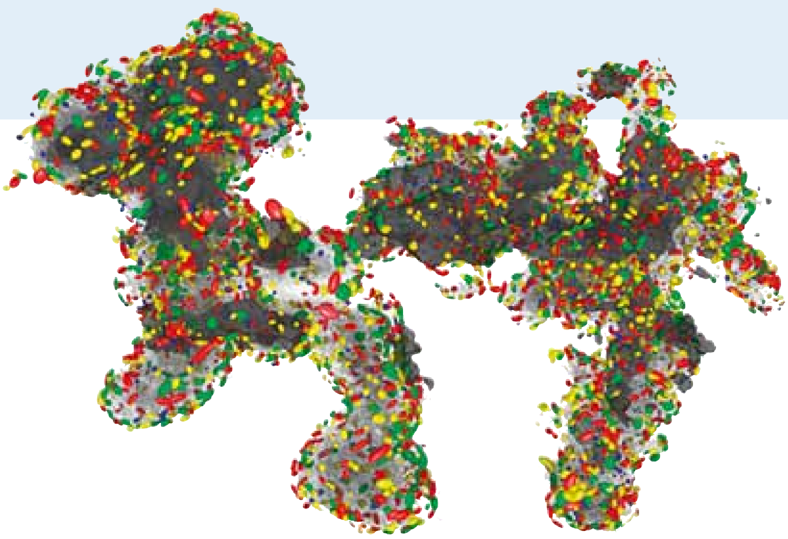
Helmholtz-Zentrum Berlin für Materialien und Energie
In fuel cells, catalysers ensure that hydrogen and oxygen react to form water, thereby releasing energy. Since platinum catalysers are very expensive, lower cost alternatives are being developed that can offer a particularly large "active surface". One way of doing this is to apply catalytically active nanoparticles to a base material. Working in collaboration with the German Federal Institute for Materials Research and Testing, HZB scientists led by Dr. Ingo Manke and Dr. Roman Grothausmann have now gained insight into the structure and effect of such a catalyser. Using electron tomography, the group has produced the first ever three-dimensional representations of nanometre-sized catalyser particles made of ruthenium. Their work entailed taking pictures from different angles with an electron microscope and then using the results to compute high-resolution 3D images. For this purpose, the group also developed new computation techniques in order to analyse the chemically active surface of the particles and its effect. Catalysers of this type have the potential for use above all in fuel-cell powered vehicles.

www.helmholtz.de/en/gb12-nanopartikel

PARTICLE EXPERTISE YIELDS BENEFITS FOR MEDICINE

Deutsches Elektronen-Synchrotron DESY The highly sensitive specialised sensors that physicist Dr. Erika Garutti develops are in fact intended for future particle detectors. However, it recently occurred to her that this technology could also be of use for PET diagnostics. The result has been a European research project involving DESY and CERN as well as three clinics. PET scanners are used, among other things, for the early diagnosis of tumours. Physicians give patients a sugar compound marked with a weakly radioactive substance. The sugar is absorbed by cancer cells, and as the radioactive substance decays it gives off light that is detected by sensors. This data then provides the basis for an image produced on a computer. "Our new sensors have the potential to help create significantly clearer PET images," explains Garutti. "Alternatively, their sensitivity could allow for a significant decrease in the patient's radiation exposure." The researchers have already constructed a prototype that demonstrates that the sensors can function in this medical context. They are now working on a miniature detector that can be attached to the end of a gastric tube for the early diagnosis of pancreatic cancer. Initial clinical trials are scheduled for 2014.

www.helmholtz.de/en/gb12-teilchen-expertise



Representation of catalyser nanoparticles. The particles (coloured) adhere to a base material (grey). The initial image is recorded using electron tomography and the data is then processed using newly developed algorithms to generate the final representation. *Photo: HZB*

Volker Lindenstruth co-developed the concept for a mainframe computer with significantly lower space and energy requirements. *Photo: G. Otto/GSI*

RACKED COMPUTERS

GSI Helmholtz Centre for Heavy Ion Research To conduct research, scientists require maximum computing power, which normally uses a great deal of energy. As a rule around half of this energy is needed for cooling due to the heat generated by microprocessors. In addition, a great deal of space is required for the cabinets in which computers are housed in order to avoid cross-heating between devices. GSI has now adopted a new type of architecture that saves both energy and space. The novel concept, which has been dubbed the “e-cube”, was developed by both Professor Volker Lindenstruth, head of the IT department of the GSI, and Professor Horst Stöcker, the centre’s scientific director. The system uses water to cool the computer cabinets so that hardly any ambient heat is emitted. Since no additional ventilators are necessary, only an additional 5 percent of the electricity used to run the computers is required for cooling. Furthermore, thanks to the lack of waste heat, the 96 computer cabinets can be stacked very compactly in a high rack, thus saving construction and operating costs. Compared with the best conventional systems, the new concept saves the GSI 350,000 euros annually in electricity costs. This concept will also be used in the cube-shaped building for the FAIR international accelerator centre. The building will be completed at the GSI in 2014. The centre will contain up to 800 computer cabinets arranged in extremely compact stacks.

www.helmholtz.de/en/gb12-rechner-hochregal

Inside the MiniCube computing centre at GSI: thanks to the innovative cooling system, the computers can be stacked in the type of high bay racking normally found in warehouses. *Photo: G. Otto/GSI*

"Indium arsenide is characterised by extremely high electron mobility. The electrons flit through the material 30 times quicker than through a silicon wafer, which means the material can be used to produce faster components." **DR. SLAWOMIR PRUCNAL,** HZDR

INDIUM ARSENIDE QUANTUM DOTS FOR FAST PROCESSORS

Helmholtz-Zentrum Dresden-Rossendorf Throughout the world, researchers are looking for new ways to increase the performance of microchips. HZDR scientists led by Dr. Slawomir Prucnal and Dr. Wolfgang Skorupa have now succeeded in generating quantum dots made of indium arsenide on silicon wafers. Noteworthy is the fact that the processes they use are already employed in the production of semiconductors. "Indium arsenide is characterised by extremely high electron mobility," explains Prucnal, a postdoctoral researcher. The electrons shoot through the material 30 times quicker than through a silicon wafer, which means the material can be used to produce faster components. "Moreover, the process requires only a low operation voltage," adds Skorupa, head of the Semiconducting Materials Division. "As a result, less electricity is required and heat loss is significantly reduced."

The indium arsenide quantum dots are produced on freestanding silicon columns and are shaped like miniscule pyramids. These pyramids are around 100 nanometres high and have edges measuring between 40 and 80 nanometres. When a voltage is applied to this configuration, it behaves like a diode.

In order to manufacture the quantum dots from indium arsenide, the researchers use ion implantation and short-term annealing, both of which are employed in "doping" in the semiconductor industry. Using the HZDR's ion accelerator, they implant arsenic and indium ions in the surface of the silicon. A novel aspect of this approach is the generation of quantum dots in the millisecond range by means of liquid-phase processing. As a semiconducting material, indium arsenide also has potential applications for optoelectronics, in which electrical signals are converted into light. The researchers are therefore also testing other semiconducting compounds such as indium phosphide and gallium arsenide, which radiate light at shorter wavelengths and are therefore better suited to photonic applications.

» **www.helmholtz.de/en/gb12-flinke-prozessoren**

In order to produce quantum dots from indium arsenide, researchers use the ion accelerator at the HZDR's ion radiation centre. The photo shows the six-megavolt ion accelerator, which was funded by the EU as part of the EFRE programme. *Photo: Oliver Killig/HZDR*

THE HELMHOLTZ ASSOCIATION IN FACTS AND FIGURES

PERFORMANCE RECORD

During the 2011 reporting period, the Helmholtz Association once again implemented strategically important measures to increase the quality, efficiency and productivity of its research activities. It not only launched and carried out numerous new projects, but, as in years past, experienced a period of solid growth that is reflected in the relevant performance indicators. The figures for the 2011 reporting period are based on data from the 17 centres that were members in 2011.[1]

In 2011, the 17[1] Helmholtz centres received 2.203 billion euros in funding from the federal government and federal states. In 2012, funding will amount to 2.380 billion euros, representing an increase of 8 percent over fiscal 2011. In addition to institutional funding, the research centres raised 1.227 billion euros in third-party funds in 2011. As regards the third-party funding acquired through collaborations with industry, the association was particularly successful in application-oriented research fields. Its success can be taken as a clear sign of the attractiveness of Helmholtz research for industrial partners. In the area of basic research, a growing amount of funding has been acquired in competitions organised by the funding programmes of entities such as the EU, the German Research Foundation (DFG), and federal and regional ministries. The Helmholtz Association's mission is to conduct high-level research that contributes to solving the major challenges and pressing problems of the day. To ensure that this mission is optimally fulfilled, the association has embraced scientific competition. Internally, this competition informs programme-oriented funding, the financing of investments in strategic expansion, and the instruments of the Initiative and Networking Fund. The scientific performance indicators compiled in the context of programme-oriented funding represent selected aspects of research that are characteristic of the association's work.

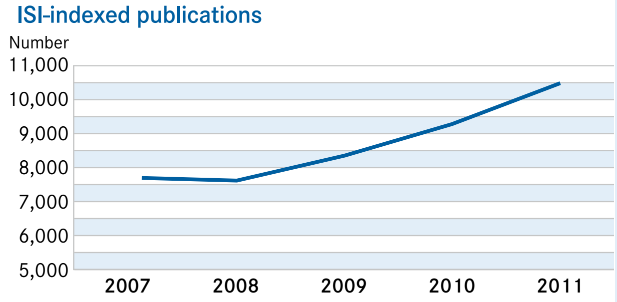
[1] The Helmholtz Association had 17 members in 2011 and 18 members in 2012. The most recent addition was the GEOMAR Helmholtz Centre for Ocean Research Kiel, which joined the association on 1 January 2012. The Helmholtz-Zentrum Dresden-Rossendorf (HZDR) was admitted in 2011. The expenses incurred by GEOMAR will be reported in the "Performance Record" of the Annual Report 2013.

DR. ROLF ZETTL
Managing Director of the
Helmholtz Association

SCIENTIFIC PERFORMANCE

Publications

- In 2011, 10,491 publications appeared in ISI-indexed scientific journals and a further 2,564 refereed publications appeared in other outlets.
- The number of ISI-indexed publications increased by 13 percent over the previous year and by a total of 36 percent over the past five years.



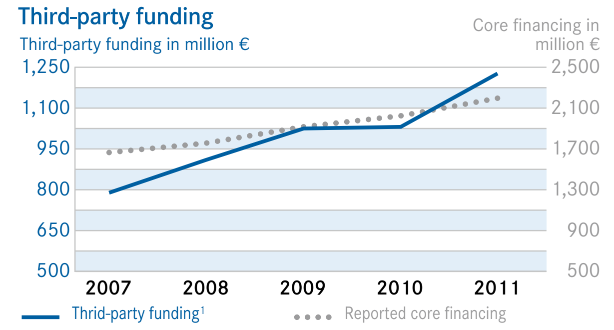
Sources: Progress Reports of the Helmholtz Centres, 2007 to 2011

Collaborations

- In 2011, the Helmholtz centres participated in 5,490 scientific collaborations and 3,081 collaborations with industry. Due to the admission of the new Helmholtz member centre HZDR and a changed counting system, we are not including a chart of the collaborations over the past few years since the annual figures are not directly comparable.
- In 2011, 240 research projects took part in the coordinated funding programmes of the German Research Foundation (DFG), compared to 248 for 2010.
- As of 31 December 2011, 374 Helmholtz scientists held W2 or W3 professorships at universities, an increase of 17 percent over the previous year.

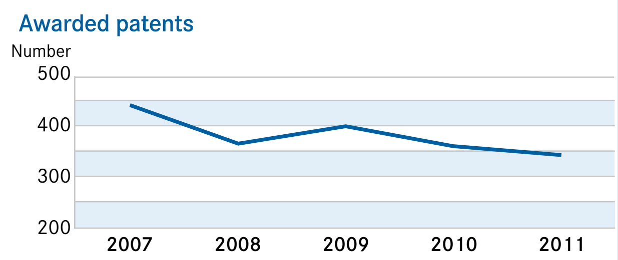
Third-party funding

- In 2011 the Helmholtz Association received approximately 134 million euros in EU funding, an increase of 18 percent over the previous year. This success has secured the association a leading position amongst German scientific organisations.
- In 2011, the association raised third-party funds of 1,227 million[1] euros, representing an increase of 19 percent over 2010, when it acquired 1,031 million euros in third-party funding.
- Over the past five years, third-party funding has grown more than twofold, or at an average annual rate of 12 percent.



Sources: Progress Reports of the Helmholtz Centres, 2007 to 2011

Technology transfer

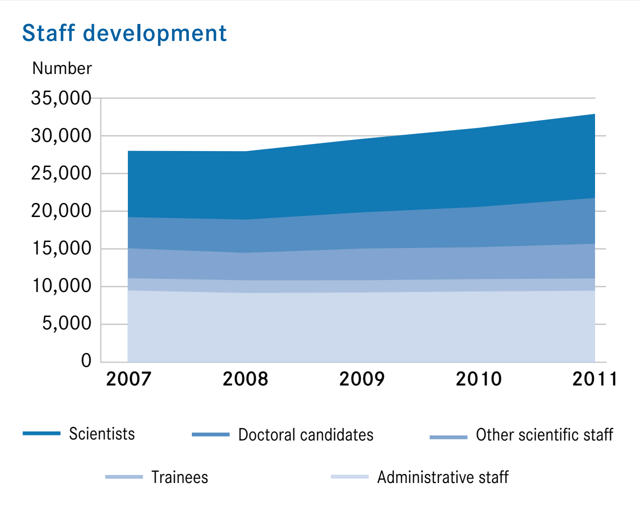


Sources: Progress Reports of the Helmholtz Centres, 2007 to 2011

- A total of 347 patents were awarded in the reporting period, compared to an average of 385 for the previous years. The slight decline in patent applications in 2008 and 2009 is now being seen in the figures for 2011 due to the slow processing times at the patent offices. In 2010 the number of patent applications once again rose robustly.
- Over the last five years, the Helmholtz Association has launched 55 research spin-offs, including 14 in 2011. These figures demonstrate its solid performance in a competitive environment.

[1] Project sponsorships will be taken into account starting in 2011 (approx. 121 million euros). The Helmholtz institutes and the Helmholtz share of the German Centres for Health Research contribute about 0.9 million euros to third-party funding.

STAFF



Scientific staff

In 2011 the Helmholtz Association had a total of 32,855 employees (2010: 30,995), of whom 11,121 were scientists (2010: 10,458), 6,062 were supervised PhD candidates (2010: 5,320) and 1,617 were trainees (2010: 1,627). A total of 14,055 employees (2010: 13,590) worked in technical and administrative fields.

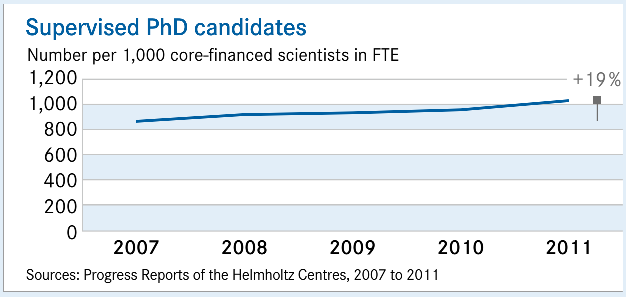
Equal opportunity

In 2011 the share of female scientists remained constant at 24 percent; the percentage of young female scientists decreased in 2011 to 37 percent from 38 percent during the previous year. The proportion of women working in research management is continuing to grow at both the institutional and departmental levels. All told, the share of women currently holding managerial positions in research, administration and technical fields stands at 20 percent, compared to 19 percent for the previous year.

Young scientists

- In 2011, 6,062 doctoral candidates completed dissertations at the Helmholtz centres, supervised by their scientific staff. This marks a 14 percent increase over the 5,320 dissertations written in 2010. Over the past five years, the number of completed dissertations has increased by 47 percent or at an average rate of 10 percent per year.

The ratio of core-financed scientists to PhD students is approximately 1 to 1. This ratio has increased by 19 percent over the past five years.



Sources: Progress Reports of the Helmholtz Centres, 2007 to 2011

- A total of 1,829 post-doctoral candidates worked at the Helmholtz Association in 2011. Over the past five years, this number has increased by 25 percent (an average rate of 6 percent per year).
- In 2011, 18 Helmholtz scientists were awarded junior professorships.
- Helmholtz centres currently work together with 75 DFG graduate schools. This represents a 53 percent increase over the previous year.
- Helmholtz centres are currently participating in 56 “Marie Curie Actions” within the EU’s programme to promote young scientists. During the past five years there has been a 10 percent annual increase in the number of these grants.
- Over the past five years, the number of Helmholtz Young Investigators’ Groups, including the groups established by the centres themselves, has increased from 133 to 166.
- In 2011, the Helmholtz Association provided vocational training for 1,617 trainees. The trainee-staff ratio was 6.0 percent (excluding doctoral candidates).
- With its 25 School Labs and the “Little Scientists' House” initiative, which caters to a network of more than 22,000 day-care centres, the Helmholtz Association is ensuring the long-term support of young researchers.

International exchange at the Helmholtz Association

The large number of guests who came to the research centres in 2010 to exchange ideas and work in the research facilities demonstrates the appeal that the centres continue to hold for foreign scientists. Around 6,300 scientists from around the world took advantage of the research opportunities at the Helmholtz centres – an 8 percent increase over the previous year.

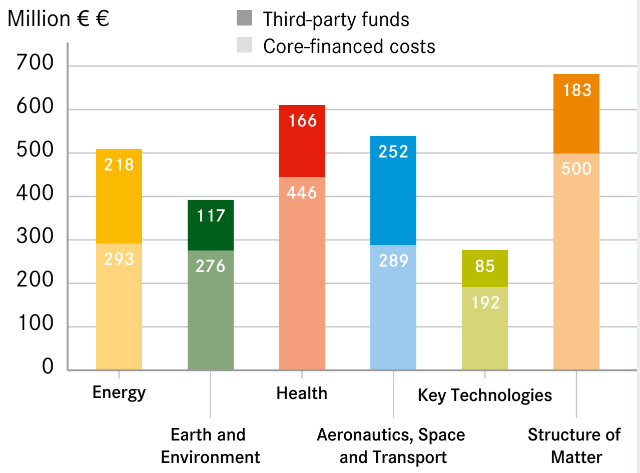
COSTS AND STAFF

Programme-oriented funding

The Helmholtz Association's annual budget consists of core financing and third-party funding. Ninety percent of core financing is provided by the federal government and 10 percent comes from the federal states in which the member centres are located. The centres raise around 30 percent of the total budget themselves in the form of third-party funding. The Annual Report shows these core-financed and third-party-financed costs for the 2011 reporting period. Due to the Helmholtz Association's strategic focus on six research fields, total costs are broken down according to research field and centre. This overview is supplemented by information on the number of staff members, expressed as full-time equivalents (for both the centres and research fields). The overview also includes the 46 million euros in costs attributable to the Helmholtz institutes and the Helmholtz Association's share of the German Centres for Health Research. The contribution to the third-party funding amounts to 0.9 million euros.

The core concept behind programme-oriented funding is the provision of financing on the basis of strategic reviews. The advantage of linking funding to research programmes is that it allows scientists to enter into cross-institutional and cross-disciplinary collaborations. For the five-year duration of the programmes, the level of funding is based on the results of the strategic programme reviews. Additional funding for so-called non-programme-linked research is made available to Helmholtz centres so that they can address new scientific topics, implement new research approaches, expand expertise and prepare for important strategic projects. The level of this funding is tied to the success of the centres in the review process and amounts to 20 percent of the total programme funding acquired. If the centres choose to use this funding to advance innovative approaches within the existing research programmes, the funding is directly allocated to the costs of the respective programmes. If the centres use the funding to initiate new projects and develop new thematic fields, it is reported separately under the heading of non-programme-linked research.

2011 budget showing core and third-party financing for the research fields
(including funds for non-programme-linked research used to strengthen existing research fields)



Costs and staff by centre, 2011	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total stuff PYs[1]
Alfred Wegener Institute for Polar and Marine Research (AWI)	96,759	21,714	118,473	782
Deutsches Elektronen-Synchrotron DESY	205,378	117,909	323,287	1,792
German Cancer Research Center (DKFZ)	119,622	57,331	176,953	2,011
German Aerospace Center (DLR)	310,193	302,048	612,241	4,772
German Center for Neurodegenerative Diseases (DZNE)	58,805	820	59,625	420
Forschungszentrum Jülich (FZJ)	240,850	105,178	346,028	3,223
GSI Helmholtz Centre for Heavy Ion Research (GSI)	101,188	16,511	117,699	1,068
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	93,482	12,336	105,818	919
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	67,091	23,947	91,038	886
Helmholtz Centre for Infection Research (HZI)	45,886	24,152	70,038	552
Helmholtz Centre for Environmental Research (UFZ)	51,602	32,842	84,444	857
Helmholtz-Zentrum Geesthacht (HZG)	54,140	20,708	74,848	681
Helmholtz Zentrum München (HMGU)	124,199	41,965	166,164	1,643
Helmholtz Centre Potsdam (GFZ)	45,978	42,096	88,074	775
Karlsruhe Institute of Technology (KIT)[2]	227,507	135,672	363,179	3,583
Max Delbrück Center for Molecular Medicine (MDC)	61,093	24,939	86,032	890
Max Planck Institute for Plasma Physics (IPP)	93,091	40,269	133,360	1,066
Non-programme-linked research	**37,744**	**77,643**	**115,387**	**433**
Special tasks[3] and project sponsorships	**47,995**	**129,235**	**177,230**	**2,215**
Helmholtz Association, total	**2,082,603**	**1,227,315**	**3,309,918**	**28,568[4]**

[1] Person-years (full-time equivalents). [2] Share of KIT's Division of Large-Scale Research. [3] Mainly involving the dismantling of nuclear facilities.
[4] Expressed as natural persons, the Helmholtz Association has 32,855 employees.

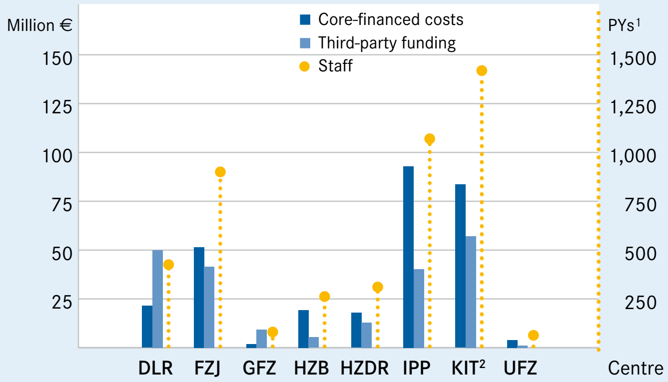
COSTS AND STAFF 2011 for the Helmholtz Association, overview	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total staff PYs [1]
Research fields, total[2]	1,996,864	1,020,437	3,017,301	25,920
Non-programme-linked research, total[3]	37,744	77,643	115,387	433
Special tasks[4] and project sponsorships, total	47,995	129,235	177,230	2,215
Helmholtz Association, total	**2,082,603**	**1,227,315**	**3,309,918**	**28,568** [5]

[1] Person-years (full-time equivalents). [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 percent 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 programme.
[4] Mainly involving the dismantling of nuclear facilities. [5] Expressed as natural persons, the Helmholtz Association has 32,855 employees.

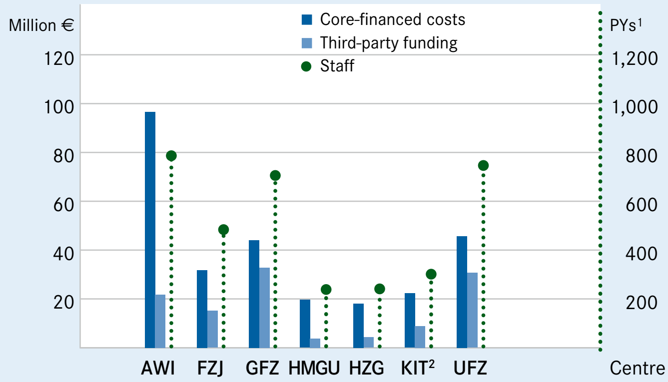
	Actual core-financed costs T€	Third-party funds T€	Total budget T€	Total staff PYs [1]
Research Field Energy				
German Aerospace Center (DLR)	21,485	50,021	71,506	420
Forschungszentrum Jülich (FZJ)	51,623	41,663	93,286	896
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	19,316	5,302	24,618	256
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	17,920	12,881	30,801	305
Helmholtz Centre for Environmental Research (UFZ)	3,806	1,181	4,987	57
Helmholtz Centre Potsdam (GFZ)	1,952	9,305	11,257	74
Karlsruhe Institute of Technology (KIT)[6]	83,718	57,226	140,944	1,416
Max Planck Institute for Plasma Physics (IPP)	93,091	40,269	133,360	1,066
Research Field Energy, total	**292,911**	**217,848**	**510,759**	**4,490**
Research Field Earth and Environment				
Alfred Wegener Institute for Polar and Marine Research (AWI)	96,759	21,714	118,473	782
Forschungszentrum Jülich (FZJ)	31,811	15,267	47,078	479
Helmholtz Centre for Environmental Research (UFZ)	43,756	30,709	74,465	742
Helmholtz-Zentrum Geesthacht (HZG)	18,118	4,296	22,414	236
Helmholtz Zentrum München (HMGU)	19,509	3,690	23,199	233
Helmholtz Centre Potsdam (GFZ)	44,026	32,791	76,817	701
Karlsruhe Institute of Technology (KIT)[6]	22,262	8,823	31,085	299
Research Field Earth and Environment, total	**276,241**	**117,290**	**393,531**	**3,472**
Research Field Health				
German Cancer Research Center (DKFZ)	119,622	57,331	176,953	2,011
German Center for Neurodegenerative Diseases (DZNE)	58,805	820	59,625	420
Forschungszentrum Jülich (FZJ)	26,922	5,351	32,273	326
GSI Helmholtz Centre for Heavy Ion Research (GSI)	3,692	1,797	5,489	80
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	14,191	2,721	16,912	168
Helmholtz Centre for Infection Research (HZI)	45,886	24,152	70,038	552
Helmholtz Centre for Environmental Research (UFZ)	4,040	952	4,992	58
Helmholtz-Zentrum Geesthacht (HZG)	7,546	9,258	16,804	132
Helmholtz Zentrum München (HMGU)	104,690	38,275	142,965	1,410
Max Delbrück Center for Molecular Medicine (MDC)	61,093	24,939	86,032	890
Research Field Health, total	**446,487**	**165,596**	**612,083**	**6,047**
Research Field Aeronautics, Space and Transport				
German Aerospace Center (DLR)	288,708	252,027	540,735	4,352
Research Field Aeronautics, Space and Transport, total	**288,708**	**252,027**	**540,735**	**4,352**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	81,965	32,557	114,522	1,046
Helmholtz-Zentrum Geesthacht (HZG)	21,327	5,404	26,731	248
Karlsruhe Institute of Technology (KIT)[6]	88,766	46,682	135,448	1,395
Research Field Key Technologies, total	**192,058**	**84,643**	**276,701**	**2,689**
Research Field Structure of Matter				
Deutsches Elektronen-Synchrotron DESY	205,378	117,909	323,287	1,792
Forschungszentrum Jülich (FZJ)	48,529	10,340	58,869	476
GSI Helmholtz Centre for Heavy Ion Research (GSI)	97,496	14,714	112,210	988
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	74,166	7,034	81,200	663
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	34,980	8,345	43,325	413
Helmholtz-Zentrum Geesthacht (HZG)	7,149	1,750	8,899	65
Karlsruhe Institute of Technology (KIT)[6]	32,761	22,941	55,702	473
Research Field Structure of Matter, total	**500,459**	**183,033**	**683,492**	**4,870**

[6] Share of the KIT's Division of Large-Scale Research.

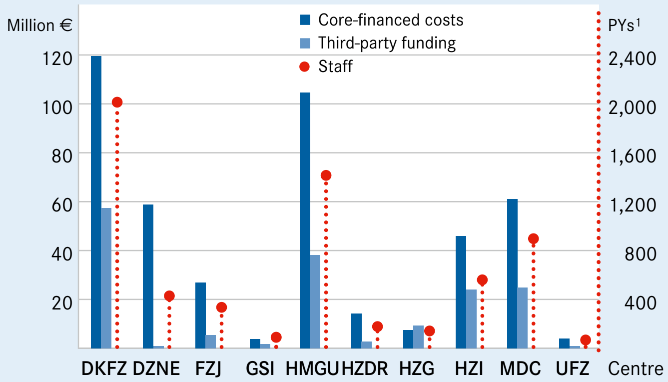
Research Field Energy



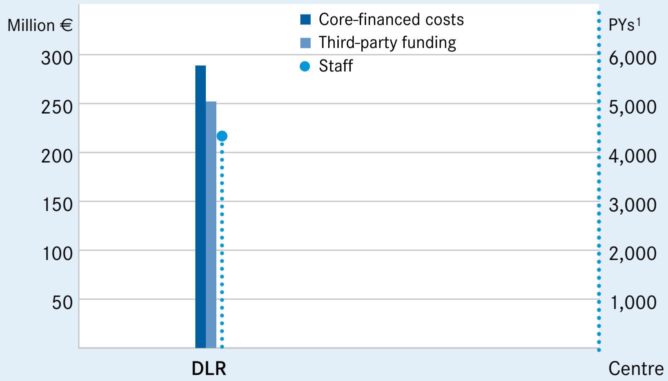
Research Field Earth and Environment



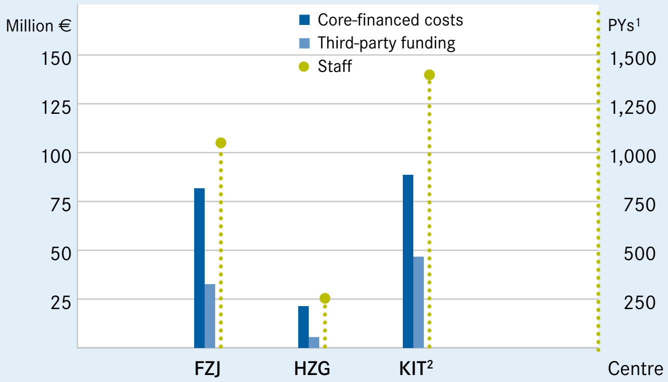
Research Field Health



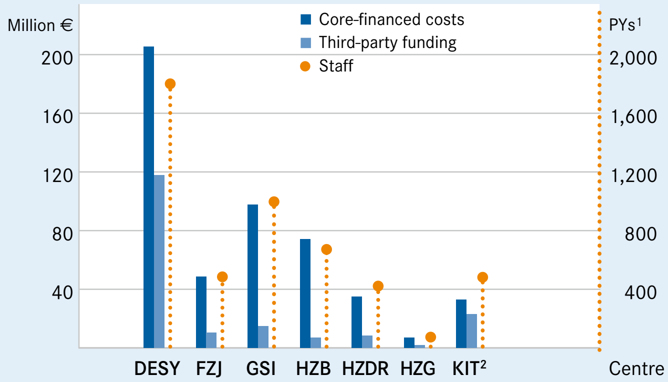
Research Field Aeronautics, Space and Transport



Research Field Key Technologies



Research Field Structure of Matter



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

SCIENCE AWARDS

Science awards reflect the scientific excellence of the research done at the Helmholtz Association. Last year researchers from the Helmholtz centres once again won numerous important and prestigious prizes.

Alfried Krupp Prize: Professor Christian Koos, KIT; German Innovation Prize in Medicine of the Herbert Worch Foundation: Professor Peter Tass, Forschungszentrum Jülich; ERC Advanced Grant: Professor Gary Lewin, Professor Thomas Jentsch, Dr. Zsuzsanna Izsvák (all from the MDC), Professor Michael Boutros, DKFZ, Professor Bruno Kyewski, DKFZ; ERC Starting Grant: Dr. Luka Cicin-Sain, HZI, Professor Emad Flear Aziz, HZB, Dr. Andriy Luzhetskyy, HZI, Professor Michael Gotthardt, MDC, Dr. Jan-Erik Siemens, MDC, Professor Paul Kögerler, Forschungszentrum Jülich, Dr. Markus Schubert, HZDR, Dr. Vigo Heissmeyer, Helmholtz Zentrum München; Research Award of the Eva Luise and Horst Köhler Foundation: Professor Christof von Kalle, DKFZ; FRP.NRW Award: Dr. Marc von Hobe, Forschungszentrum Jülich; Gay-Lussac Humboldt Prize: Professor Volker Schomerus, DESY; Google Faculty Research Award: Professor Peter Sanders, Dr. Martin Nöllenburg, KIT; Google Focused Research Award: Professor Dorothea Wagner, Professor Peter Sanders, KIT, together with Professor Hannah Bast, Freiburg University; Gottfried Wilhelm Leibniz Prize: Professor Nikolaus Rajewsky, MDC, Professor Ulf Riebesell, GEOMAR, Professor Peter Sanders, KIT; Hector Research Award: Professor Hilbert von Löhneysen, KIT; Humboldt Research Award: Professor Leone Spiccia, KIT, Professor Richard Gerard Milner, DESY; K. J. Zülch Prize of the Gertrud Reemtsma Foundation: Professor Thomas Gasser, DZNE; Körber Prize: Professor Stefan Hell, DKFZ; State Research Award of Baden-Württemberg 2011: Professor Peter Sanders, KIT; Lautenschläger Research Prize: Professor Joachim Wittbrodt, KIT; m4 Award: Professor Dolores J. Schendel, Dr. Joel Schick, Helmholtz Zentrum München; Mega-Grant of the Russian Government: Professor Alexey Ustinov, KIT; Meyenburg Prize: Professor Stefan Hell, DKFZ; Potamkin Prize of the American Academy of Neurology: Professor Eckhard Mandelkow, Professor Eva-Maria Mandelkow, DZNE; Rapid Response Innovation Award: Professor Peter Tass, Forschungszentrum Jülich, together with Dr. Wassilios Meißner, University of Bordeaux; Richtzenhain Award: Professor Stephan Herzig, DKFZ; National Award of the Russian Federation for Achievements in Science and Technology: Professor Boris Sharkov, FAIR; Animal Protection Research Award of the Federal Ministry for Nutrition, Agriculture and Consumer Protection: Professor Claus-Michael Lehr, Dr. Eva-Maria Collnot, Fransisca Leonard, Helmholtz Institute for Pharmaceutical Research, Saarland, and Saarland University; Tsungming Tu Award: Professor Harald zur Hausen, DKFZ; UNESCO-l'Oreal for Women in Science: Katja Herzog, MDC; Wilhelm Conrad Röntgen Prize: Dr. Tobias Bäuerle, DKFZ; Wolf Prize for Physics: Professor Knut Urban, Forschungszentrum Jülich, Professor Maximilian Haider, KIT; etc.

You can find the complete list at:
» **www.helmholtz.de/en/awards2012**

2012 ERWIN SCHRÖDINGER PRIZE

Professor Patrick van der Smagt from the German Aerospace Center and Professor John P. Donoghue from Brown University in the US have won the 2012 Erwin Schrödinger Prize for developing a new type of prosthetic arm that paraplegics can control using brain signals. The collaboration between the DLR's Institute for Robotics and Mechanics, where Patrick van Smagt is conducting research, and the Department of Neuroscience, the workplace of John P. Donoghue, began several years ago and has led to the development of a globally unique support system that allows paraplegics to control a robotic arm using only their thoughts. To build the system, the researchers developed learning-enabled software that translates signals from the patient's brain into control commands for the arm. In 2011 a female patient who had been paralysed from the neck down for 15 years managed to use the arm to insert a straw into her mouth and drink by herself for the first time since her stroke. Extensive training was unnecessary. The patient only had to imagine moving her own arms in the same way, which generated signals in the motor cortex of her brain. A small implant in her skull, co-developed with Brown University, transmitted these signals to a computer, where they were transformed into the desired control commands by a learning algorithm that the researchers have continuously optimised.

"During these experiments it is of course crucial that the robot does not pose a danger to the test person," says Van der Smagt. Safety is ensured by sensors on the robot's arm, which constantly check whether the arm makes unwanted contact with the environment. If this occurs, a special programme immediately intervenes, causing the robotic arm to go slack within milliseconds. This technological breakthrough attracted international attention and has great potential to simplify the lives of people with disabilities.

» **www.helmholtz.de/en/schroedinger-prize-2012**

HELMHOLTZ ASSOCIATION GOVERNANCE STRUCTURE

COMMITTEE OF FINANCING PARTNERS

The Committee of Financing Partners – 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 senate members.

SENATE

Together with the Members' Assembly, the Senate, which is made up of external experts, is the Helmholtz Association's central decision-making body. It consists of both ex officio members – representatives of the federal government, the federal states, the German Bundestag and scientific organisations – and individuals from science and industry who are elected for three years. The Senate discusses important decisions 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 the setting of investment priorities. In all six research fields, the Senate Commissions consist of both ex officio permanent members – representatives of the federal government and federal states – and external experts. They also include temporary members who provide advice on 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 the development of multidisciplinary programmes, the cross-centre controlling system and the articulation of the association's overall strategy.

VICE-PRESIDENTS

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

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 Presidential Committee of the Helmholtz Association consists of the president, 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 Environment | Health | Aeronautics, Space and Transport | Key Technologies | Structure of Matter

RESEARCH FIELDS

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

MEMBERS' ASSEMBLY

The Helmholtz Association is a registered association whose members comprise 17 legally independent research centres and one associated institute. Together with the Senate, the association's central body is the Members' Assembly, which consists of the scientific and administrative directors of the member centres. The Members' Assembly is responsible for all the tasks performed by the registered association. It defines the framework for the cross-centre development of programmes and strategy and makes recommendations regarding the election of the president and Senate members.

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

CENTRAL BODIES

PRESIDENT

Professor Jürgen Mlynek

VICE-PRESIDENTS

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

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

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

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

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

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

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

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

MANAGING DIRECTOR

Dr. Rolf Zettl

SENATE

ELECTED MEMBERS

Professor Andreas Barner, Chairman of the Board of Managing Directors, Head of Pharmacology R&D and Medicine, Boehringer Ingelheim GmbH, Ingelheim

Professor Katharina Kohse-Höinghaus, Chemistry Department, Bielefeld University

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

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

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

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

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

Professor Robert Rosner, University of Chicago, US

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

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

Professor Babette Simon, President of the University of Oldenburg

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

EX OFFICO SENATE MEMBERS

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

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

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

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 Science Council, Cologne

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Professor Andreas Wahner, Vice-Chairman of the Committee of Scientific-Technical Councils, Forschungszentrum Jülich

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Cornelia Lanz, Administrative Director

Max Planck Institute for Plasma Physics (associate member)

Professor Sibylle Günter, Scientific Director,
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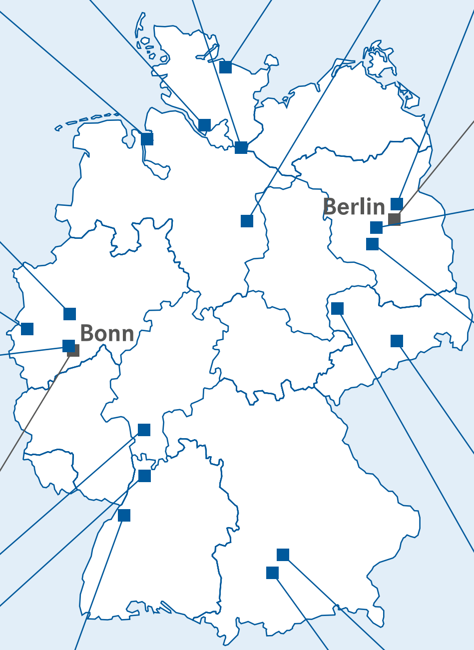
*Abbreviations:
SdöR: Foundation under public law
SdpR: Foundation under private law
KdöR: Public body
e.V.: Registered association
GmbH: Limited liability company

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 for
Polar and Marine Research**
www.awi.de

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

Forschungszentrum Jülich
www.fz-juelich.de

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

Association Headquarters, Bonn
www.helmholtz.de

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

**German Cancer
Research Center**
www.dkfz.de

Karlsruhe 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 Office Berlin
www.helmholtz.de

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

**Helmholtz Centre Potsdam –
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www.gfz-potsdam.de

Helmholtz-Zentrum Dresden-Rossendorf
www.hzdr.de

**Helmholtz Centre for
Environmental Research – UFZ**
Leipzig (headquarters)
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

MEMBER CENTRES

ALFRED WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH

Directorate: Professor Karin Lochte, Director,
Dr. Heike Wolke, Administrative Director
Members of the Directorate:
Professor Ralf Tiedemann, Professor Karen Helen Wiltshire
Am Handelshafen 12, 27570 Bremerhaven
Telephone +49 471 4831-0, telefax +49 471 4831-1149
E-mail info@awi.de, www.awi.de

DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY

Directorate: Professor Helmut Dosch, Chairman of the Directorate, Christian Scherf, Director of Administration, Dr. Reinhard Brinkmann, Director of the Accelerator Division, Professor Joachim Mnich, Director of High-Energy Physics and Astroparticle Physics, Professor Christian Stegmann, Representative of the Directorate in Zeuthen, Professor Edgar Weckert, Director of Photon Science
Notkestraße 85, 22607 Hamburg
Telephone +49 40 8998-0, telefax +49 40 8998-3282
E-mail desyinfo@desy.de, www.desy.de

GERMAN CANCER RESEARCH CENTER

Management Board: Professor Otmar D. Wiestler, Chairman and Scientific Director,
Professor Josef Puchta, Administrative-Commercial Director
Im Neuenheimer Feld 280, 69120 Heidelberg
Telephone +49 6221 42-0, telefax +49 6221 42-2995
E-mail presse@dkfz.de, www.dkfz.de

GERMAN AEROSPACE CENTER

Executive Board: Professor Johann-Dietrich Wörner, Chairman of the Executive Board,
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Members of the Executive Board: Dr. Gerd Gruppe, Professor Rolf Henke, Professor Hansjörg Dittus, Professor Ulrich Wagner
Linder Höhe, 51147 Köln
Telephone +49 2203 601-0, telefax +49 2203 67310
E-mail kommunikation@DLR.de, www.DLR.de

GERMAN CENTER FOR NEURODEGENERATIVE DISEASES (DZNE)

Executive Board: Professor Pierluigi Nicotera, Scientific Director and Chairman of the Executive Board,
Ursula Weyrich, Administrative Director
Ludwig-Erhard-Allee 2, 53175 Bonn
Telephone +49 228 43302-0, telefax +49 228 43302-279
E-mail information@dzne.de, www.dzne.de

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Board of Directors: Professor Achim Bachem, Chairman of the Board of Directors,
Karsten Beneke, Vice-Chairman of the Board of Directors,
Members of the Board:
Professor Harald Bolt, Professor Sebastian M. Schmidt
Wilhelm-Johnen-Straße, 52428 Jülich
Telephone +49 2461 61-0, telefax +49 2461 61-8100
E-mail info@fz-juelich.de, www.fz-juelich.de

GSI HELMHOLTZ CENTRE FOR HEAVY ION RESEARCH

Management Board: Professor Horst Stöcker, Scientific Director,
Peter Hassenbach, Administrative Director,
Planckstraße 1, 64291 Darmstadt
Telephone +49 6159 71-0, telefax +49 6159 71-2785
E-mail info@gsi.de, www.gsi.de

GEOMAR HELMHOLTZ CENTRE FOR OCEAN RESEARCH KIEL

Directorate: Professor Peter M. Herzig, Director,
Michael Wagner, Administrative Director
Wischhofstraße 1-3, 24148 Kiel
Telephone +49 431 600-0, telefax +49 431 600-2805
E-Mail info@geomar.de, www.geomar.de

HELMHOLTZ-ZENTRUM BERLIN FÜR MATERIALIEN UND ENERGIE

Board of Directors: Professor Anke Rita Kaysser-Pyzalla, Scientific Director,
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Hahn-Meitner-Platz 1, 14109 Berlin
Telephone +49 30 8062-0, telefax +49 30 8062-42181
E-mail info@helmholtz-berlin.de, www.helmholtz-berlin.de

As of September 2012

HELMHOLTZ-ZENTRUM DRESDEN-ROSSENDORF

Board of Directors: Professor Roland Sauerbrey, Scientific Director, Professor Peter Joehnk, Administrative Director
Bautzner Landstraße 400, 01328 Dresden
Telephone +49 351 260-0, telefax +49 351 269-0461
E-mail kontakt@hzdr.de, www.hzdr.de

HELMHOLTZ CENTRE FOR INFECTION RESEARCH

Executive Management: Professor Dirk Heinz, Scientific Director, Ulf Richter, Administrative Director
Inhoffenstraße 7, 38124 Braunschweig
Telephone +49 531 6181-0, telefax +49 531 6181-2655
E-mail info@helmholtz-hzi.de, www.helmholtz-hzi.de

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Executive Management: Professor Georg Teutsch, Scientific Director, Dr. Heike Graßmann, Administrative Director
Permoserstraße 15, 04318 Leipzig
Telephone +49 341 235-0, telefax +49 341 235-450819
E-mail info@ufz.de, www.ufz.de

HELMHOLTZ-ZENTRUM GEESTHACHT CENTRE FOR MATERIALS AND COASTAL RESEARCH

Board of Directors: Professor Wolfgang Kaysser, Scientific Director, Michael Ganß, Administrative Director
Max-Planck-Straße 1, 21502 Geesthacht
Telephone +49 4152 87-0, telefax +49 4152 87-1403
E-mail presse@hzg.de, www.hzg.de

HELMHOLTZ ZENTRUM MÜNCHEN GERMAN RESEARCH CENTER FOR ENVIRONMENTAL HEALTH

Board of Directors: Professor Günther Wess, Scientific Director, Dr. Nikolaus Blum, Administrative Director
Ingolstädter Landstraße 1, 85764 Neuherberg
Telephone +49 89 3187-0, telefax +49 89 3187-3322
E-mail presse@helmholtz-muenchen.de, www.helmholtz-muenchen.de

HELMHOLTZ CENTRE POTSDAM – GFZ GERMAN RESEARCH CENTRE FOR GEOSCIENCES

Executive Board: Professor Reinhard F.J. Hüttl, Scientific Director and Spokesman for the Executive Board, Dr. Stefan Schwartze, Administrative Director
Telegrafenberg, 14473 Potsdam
Telephone +49 331 288-0, telefax +49 331 288-1600
E-mail presse@gfz-potsdam.de, www.gfz-potsdam.de

KARLSRUHE INSTITUTE OF TECHNOLOGY

Presidential Committee: Professor Eberhard Umbach, President, Vice-Presidents: Dr. Elke Luise Barnstedt, Dr. Ulrich Breuer, Dr. Peter Fritz, Professor Detlef Löhe
Kaiserstraße 12, 76131 Karlsruhe
Campus Nord:
Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen
Telephone +49 721 608-0, telefax +49 721 608-44290
E-mail info@kit.edu, www.kit.edu

MAX DELBRÜCK CENTER FOR MOLECULAR MEDICINE (MDC) BERLIN-BUCH

Board of Directors: Professor Walter Rosenthal, Scientific Director and Chairman of the Board, Cornelia Lanz, Administrative Director
Robert-Rössle-Straße 10, 13125 Berlin-Buch
Telephone +49 30 9406-0, telefax +49 30 949-4161
E-mail presse@mdc-berlin.de, www.mdc-berlin.de

MAX PLANCK INSTITUTE FOR PLASMA PHYSICS

(associate member)
Directorate: Professor Sibylle Günter, Scientific Director, Christina Wenninger-Mrozek, Administrative Director, Members of the Directorate: Professor Thomas Klinger, Professor Hartmut Zohm
Boltzmannstraße 2, 85748 Garching
Telephone +49 89 3299-01, telefax +49 89 3299-2200
E-mail info@ipp.mpg.de, www.ipp.mpg.de

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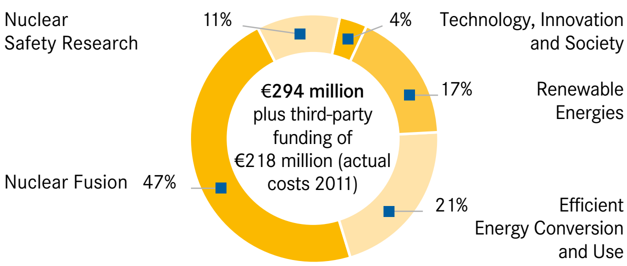
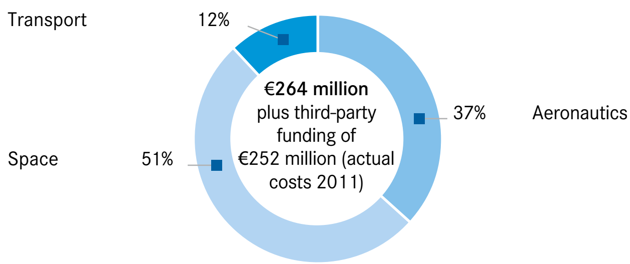
Structure of the research field Energy
Target costs of core financing 2011: 294 million euros*
(incl. share of non-programme-linked research)



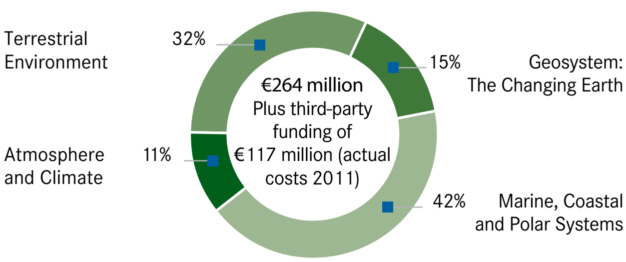
*No target costs are available in this research field for the HZDR.
Plus portfolio funds of 6 million euros.

Structure of the research field Aeronautics, Space and Transport
Target costs of core financing 2011: 264 million euros*
(incl. share of non-programme-linked research)



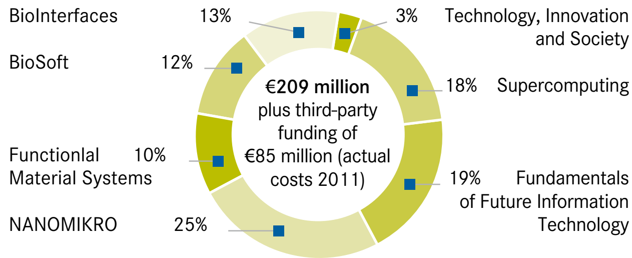
*Plus portfolio funds of 3 million euros.

Structure of the research field Earth and Environment
Target costs of core financing 2011: 264 million euros*
(incl. share of non-programme-linked research)



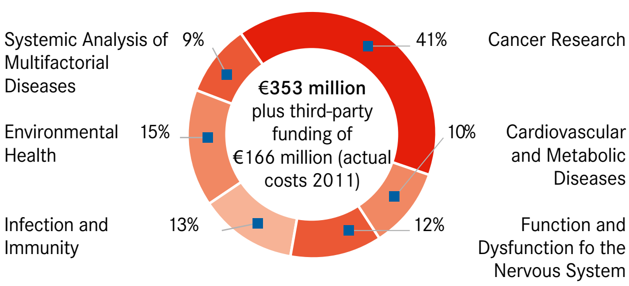
*Plus portfolio funds of 5 million euros.

Structure of the research field Key Technologies
Target costs of core financing 2011: 209 million euros*
(incl. share of non-programme-linked research)



*Plus funds of 3 million euros for the Helmholtz Institute Ulm.
Plus portfolio funds of 4 million euros.

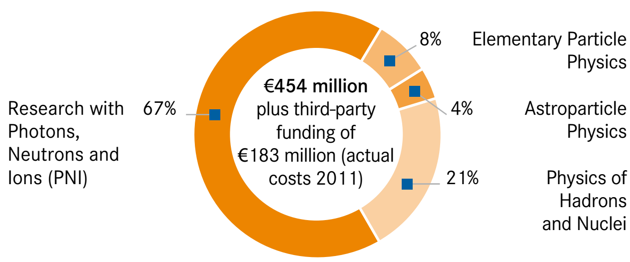
Structure of the research field Health
Target costs of core financing 2011: 353 million euros*
(incl. share of non-programme-linked research)



*Plus the "Neurodegenerative Diseases" programme currently being set up at the DZNE: 63 million euros.
Plus funding for the German Centres for Health Research and the Helmholtz Institute Saarbrucken of 33 million euros.
No target costs are available in this research field for the HZDR.
Plus portfolio funds of 4 million euros.

Source: Progress Report of the Centres 2011.

Structure of the research field Structure of Matter
Target costs of core financing 2011: 454 million euros*
(incl. share of non-programme-linked research)



*No target costs are available in this research field for the HZDR.
Plus funds of 9 million euros for the Helmholtz Institutes of Mainz and Jena.
Plus portfolio funds of 3 million euros.

Source: Progress Report of the Centres 2011