ANNUAL REPORT 2015

THE HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

HELMHOLTZ ASSOCIATION
20 years

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NOTE ON THE REPORTING PERIOD:

The Helmholtz Annual Report 2015 describes developments at the Helmholtz Association between 2014 and 1 November 2015. The performance record is based solely on the 2014 calendar year. The Annual Report can be downloaded as a PDF at www.helmholtz.de/en/gb15.

Cover image: (in the numbers) KIT/Radwanul Hasan Siddique; DLR; IPP; Irina Tuschenko/Fotolia; H. Müller-Elsner/DESY; J. Ruschel/DZNE

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

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

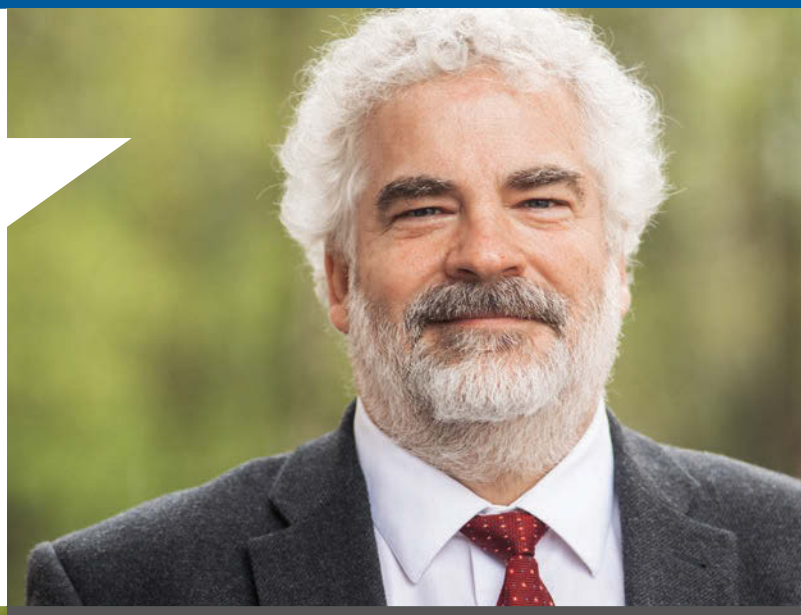
We are committed to shaping our shared future by combining research and technological developments with innovative applications and prevention strategies.

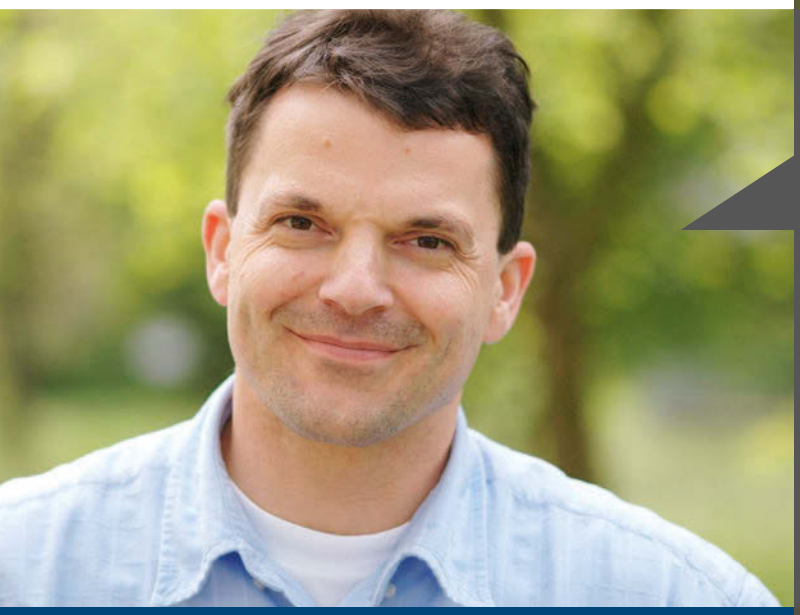
That is our mission.

DIVERSITY

“Think big, act big – the Helmholtz Association’s motto, which refers to its mission to develop and operate large-scale research facilities for the scientific community, summarises our project perfectly. The Helmholtz International Beamline for Extreme Fields (HIBEF) at the XFEL will make it possible to conduct experiments that we have never seen before. The combination of brilliant X-ray light and high-power lasers will provide us with deeper insights into the structure of matter.”

PROFESSOR THOMAS COWAN
from the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) directs the international users’ consortium supporting the construction of the HIBEF station at the HED Instrument of the European XFEL





“Because the pathogens that cause infectious diseases are becoming increasingly resistant to antibiotics, we need to find new antibacterial substances. In our search we’re concentrating on substances taken from microorganisms. These naturally occurring products are an ideal source because they have been optimised for their molecular targets through millions of years of evolution. However, researchers must do more than just characterise them. In most cases these substances need to be optimised for a safe and effective use in humans.”

PROFESSOR ROLF MÜLLER
is the managing director of the Helmholtz Institute for Pharmaceutical Research Saarland (HIPS) and heads its Department of Microbial Natural Products

“Biomass, with its capacity to produce food, energy and materials, has been an important foundation of our lives since time immemorial. To maintain this harmony with nature, we need to develop new technologies and manage limited resources with great foresight. Our bioliq process uses the waste and by-products of agriculture and forestry to produce high-quality synthetic fuels and basic chemical products.”

PROFESSOR NICOLAUS DAHMEN
coordinates, as senior scientist, the bioliq-related research at the Karlsruhe Institute of Technology (KIT)

“Even as a child I was fascinated by flight and by the technology that allowed us to overcome our natural limitations. One thing that preoccupies me is that aircraft can also be a burden on people when the noise they make robs them of their sleep. The idea of eliminating noise with anti-noise is one of my passions. After first trying out loudspeakers, which were able to reduce engine noise but weighed too much, we now know that compressed air that is blown into engines can cut the perceived volume of noise by 50 per cent.”

PROFESSOR LARS ENGHARDT
directs the Division of Engine Acoustics at the DLR Institute of Propulsion Technology

“Our aim is to cure chronic lung diseases such as COPD and pulmonary fibrosis in the future. For this purpose we’re attempting to gain a more detailed understanding of the underlying molecular mechanisms in order to influence them in a targeted fashion. Together with colleagues from the University of Western Australia and University College London, we’ve launched the UHU research network so that we can study regenerative therapeutic approaches using a wide range of expertise.”

DR. DR. MELANIE KÖNIGSHOFF
directs the Young Investigators’ Group “Lung Repair and Regeneration” at the Comprehensive Pneumology Center (CPC)/Institute of Lung Biology (ILBD) at the Helmholtz Zentrum München

“Satellite missions are crucial to understanding the Earth system. Earth observation data has amazing potential. A few years ago, for example, no one would have dreamt that insights into climate change could be gained from measurements of gravity. I’m thrilled that our CHAMP satellite has initiated an entire generation of gravity field missions. The successor missions GRACE and GRACE Follow-On are also based on this concept.”

PROFESSOR FRANK FLECHTNER
directs the Global Geomonitoring and Gravity Field Section of the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences; he is conducting the GRACE Follow-On mission in conjunction with NASA

FOREWORD

Professor Otmar D. Wiestler, President as of 1 September 2015

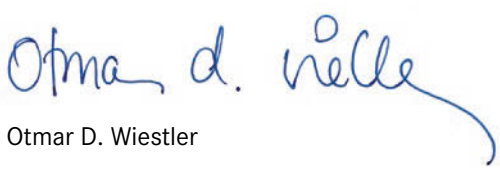
AN INTERCONNECTED FUTURE

Dear Reader,

Our mission and goal is to help solve complex scientific problems. Thanks to the diversity of Helmholtz research, we can take a cross-disciplinary approach, with individual centres and research programmes involved in collaborative projects. Because of the large number of disciplines working together under one roof and the exceptional research infrastructure that many Helmholtz centres are developing and operating, we have the resources and ability to address particularly demanding issues.

Due to its size and interdisciplinary structures, the Helmholtz Association is probably the only research institution in Germany that is able to cover the full innovation cycle, from idea to innovation, from basic research to practical application. Outstanding basic research is essential for any effort to meet the great challenges of the future with truly original solutions. It is the engine that produces the results that we then feed into the innovation chain. Concentrated in forward-looking research programmes, basic research must be driven by the curiosity of brilliant scientists, who are the Helmholtz centres' most valuable capital.

Despite our centres' size and disciplinary diversity, we are unable to shoulder many projects on our own and must rely instead on alliances with strong partners from the research community and industry. Universities play a special role in these alliances. Thanks to a recent amendment to German law, it is now easier for federal and state governments to fund long-term ties between universities and non-university institutions. These changes will further bolster our collaborations with universities. We owe a debt of gratitude to my predecessor, Jürgen Mlynek, for the wealth of experience that the Helmholtz Association can now draw on when structuring these different forms of collaboration, and I will systematically continue this strategy myself.



Otmar D. Wiestler

Professor Jürgen Mlynek, President until 31 August 2015

IN AN OUTSTANDING POSITION TO FULFIL OUR MISSION

Dear Reader,

This year the Helmholtz Association is celebrating its twentieth anniversary. Since its inception it has evolved from a loosely affiliated group of independent research centres into a powerful organisation that conducts research on behalf of society. The Helmholtz Association aims to find solutions to the major challenges of our age, whether climate change, common diseases or the transition to a clean energy economy. In terms of its research themes and collaborative structures, it has developed more dynamically than any other scientific organisation in Germany. In keeping with its social mission, it has repeatedly succeeded in launching internationally visible alliances that bring together its expertise on clearly defined issues. This much can be said of the Helmholtz Association today: it has come to occupy a central position in the research community.

Since I assumed the presidency in 2005, the association has not only continued to develop both thematically and organisationally, it has also grown in size. We have added four new centres during this time: the Helmholtz-Zentrum Berlin für Materialien und Energie, the newly founded German Center for Neurodegenerative Diseases, the Helmholtz-Zentrum Dresden-Rossendorf and GEOMAR Helmholtz Centre for Ocean Research Kiel. The much richer diversity of topics that the association now addresses is a source of great pleasure to me.

On 1 September 2015, after ten years at the head of the association, I turned over the Helmholtz presidency to Otmar D. Wiestler. I wish him much success and good fortune for his duties as the new president. At the same time, I would like to thank all my colleagues for contributing to the further development of the Helmholtz Association. I would also like to express my thanks to the representatives of the federal and state governments for their ongoing support and to our many partners for their trust and cooperation. On the following pages I will describe the most important milestones of 2014.

I hope you enjoy the read,

Jürgen Mlynek

PRESIDENT'S REPORT

2014

23 April 2014
The German Cancer Research Center celebrates its 50th anniversary in Heidelberg with Chancellor Angela Merkel as guest of honour

28 May 2014
ESA astronaut Alexander Gerst begins a 165-day mission on the International Space Station

10 June 2014
Establishment of the Helmholtz Institute Münster as an excellence centre for battery research

10 Nov 2014
Launch of the National Cohort – Germany's largest health study

An important milestone in this reporting period was the Helmholtz Association's twentieth anniversary – reason enough not only to look back and take stock, but, above all, to look forward. What can we learn from the past twenty years and apply to our future? What course was set in 2014 and what paths should we take in the years to come?

In 1995 the Helmholtz Association of German Research Centres was formed as the successor to the Arbeitsgemeinschaft der Großforschungseinrichtungen (Consortium of Large-Scale Research Facilities). In 2001 it was officially registered as an association with independent members. A central element of the reforms that took place during this time was the introduction of programme-oriented funding (POF) as a joint evaluation and financing system.

Cutting-edge research and quality assurance

POF encourages the centres to collaborate in interdisciplinary research programmes, sets transparent quality standards and promotes competition as well as cooperation. The research programmes are based on the strategic guidelines that the Helmholtz Association discusses with government representatives at five-year intervals. Although the centres initially expressed concern that POF could restrict their academic freedom, it has proved to be an effective quality-assurance instrument for excellent research. Internationally recognised experts review Helmholtz research at five-year intervals. The most recent round of evaluations – the third so far – was successfully completed in 2014. At this time the experts confirmed the strategic relevance and outstanding quality of all six research fields.

POF acquitted itself well in all three evaluations, and the Helmholtz Association has continued to develop it in line with the continuously changing research system. On behalf of the Federal Ministry of Education and Research, the German Council of Science and Humanities has examined whether POF can be more precisely adapted to this research system, and it began evaluating POF itself in April 2014. An additional focus of the evaluation was the Helmholtz Association's role in the national and international research system. In October 2015 the Council of Science and Humanities adopted its recommendations; the individual aspects are currently being reviewed.

One of the Helmholtz Association's special features as a scientific organisation is its ability to successfully reconcile strategically relevant research with outstanding international research. That the association is on the right track is shown by the third Helmholtz-associated Nobel Prize in its recent history. In 2014 Stefan Hell, department director at the Max Planck Institute for Biophysical Chemistry and head of the Optical Nanoscopy Division of the German Cancer Research Center (a Helmholtz member), was presented with the Nobel Prize in Chemistry for overcoming the physical limits of light microscopy and obtaining a much sharper image of living cells. But researchers in all of the association's research fields won numerous prestigious awards during the year. Particularly noteworthy is the work of Emmanuelle Charpentier from the Helmholtz Centre for Infection Research, who developed a method for exchanging

12 Nov 2014

The Philae lander from the Rosetta probe touches down on the comet 67P/Churyumov-Gerasimenko

10 Dec 2014

Stefan Hell, a department director at the Max Planck Institute for Biophysical Chemistry and a division head at the German Cancer Research Center, wins the Nobel Prize in Chemistry

2015

3/5 Feb 2015

The DLR school labs in Cologne and Göttingen each welcome their 50,000th student

10 Feb 2015

Celebration in Russia: the Helmholtz Moscow office marks its tenth anniversary

targeted sections of genetic material and garnered a number of highly reputed awards for this innovation. In addition, Helmholtz researchers were awarded a total of 17 grants from the European Research Council within the call 2014. The high quality of Helmholtz research is also reflected in the number of papers published by its scientists: taking all its publications into account, the Helmholtz Association ranked sixth worldwide on the 2014 Nature Index of the Nature Publishing Group. This index is based on publications in 68 journals selected by two independent panels of scientists from the fields of physics, chemistry, environmental science and the life sciences.

Between 2016 and 2020, the federal government will continue the Joint Initiative for Research and Innovation as the Joint Initiative III with annual funding increases of 3 per cent. Against this background, the Helmholtz Association was able to set an important course in its research policy in 2014. Thanks to the government's support in the Joint Initiative III period, the association will be able to expand funding for its 30 research programmes by around 700 million euros. This sum will be used, among other things, to launch up to 15 interdisciplinary activities that span its various research fields – e.g., structural biology as a joint activity in the fields of health and matter research, and large-scale data management as a joint project for all six research fields. In order to further expand and more dynamically structure its research portfolio, the Helmholtz Association plans to fund up to five projects during the Joint Initiative III period that will address key future topics.

Unique research infrastructure

An important component of the Helmholtz mission is to provide the scientific community with research infrastructure. Designing, constructing and operating large-scale research facilities is one of the association's core competencies. The association has achieved important objectives in this area as well. After a nine-year construction period, the Wendelstein 7-X nuclear fusion facility has now been completed at the Greifswald site of the Max Planck Institute of Plasma Physics – an associate member of the Helmholtz Association. In 2014 preparations began for the facility's operational phase. At the same time, construction of XFEL – the European free-electron X-ray laser – continued at the Deutsches Elektronen-Synchrotron DESY in Hamburg, with individual modules now in place. The XFEL generates ultrashort X-ray flashes at a rate of 27,000 times per second, with a brilliance that is a billion times greater than that of the best conventional X-ray source. XFEL scientists have successfully tested the first ultrafast X-ray detector to be used for experimentation purposes. The Facility for Antiproton and Ion Research (FAIR) is scheduled to be built outside Darmstadt, but planning and execution have been delayed. A commission of experts was charged with evaluating FAIR in February 2015 and recommended that the project be continued. Their restrictions and proposals are currently being reviewed by the responsible bodies at GSI GmbH and FAIR GmbH.

In 2011 the Helmholtz Association for the first time drafted a road map describing the centres' strategic plans for large-scale research facilities. In this document it enumerated the most important research infrastructure for the strategic implementation of its scientific portfolio. The roadmap has now been updated to reflect the results of the 2013–2014 programme reviews. At the national and international levels, the Helmholtz Association will participate in designing facilities that match its range of expertise and from which it can expect added scientific value for its research programmes in the future.

From research to application

As part of the extended Joint Initiative for Research and Innovation, the Helmholtz Association will deepen its already substantial commitment to technology transfer. It undertook important steps to this end in 2014. For

26 Feb 2015

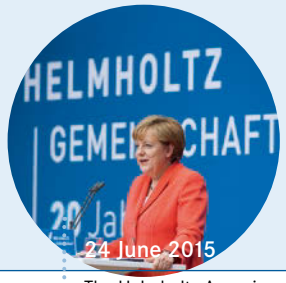
Ten years of butterfly monitoring: volunteers in this citizen science project have registered over two million butterflies

23 April 2015

The Berlin Institute of Health is established as a corporation under public law

13 June 2015

The Philae lander awakens from a seven-month slumber and transmits data from the comet 67P/Churyumov-Gerasimenko to Earth



24 June 2015

The Helmholtz Association celebrates its 20th anniversary at a festive event with Chancellor Angela Merkel

1 Sept 2015

Otmar D. Wiestler assumes the office of president

example, its technology transfer offices can now apply for additional financing from the Innovation Fund of the Helmholtz Centres. If their applications are successful, they will receive long-term funding that will allow them to professionalise their work, initiate their own projects or create technology transfer bonus systems. In the Joint Initiative III period, the Helmholtz Association intends to double the share of the Initiative and Networking Fund that is apportioned to the instruments of technology transfer. In addition, it plans to establish up to ten joint Helmholtz Innovation Labs with industry.

A dynamically developing research system

An additional strategic focus is the association's collaboration with external partners. The member centres have been investing in institutional partnerships, research alliances and joint young scientist programmes with universities (e.g., the Helmholtz Young Investigators Groups). In addition, the Helmholtz Association has established a variety of long-term strategic partnerships, which it further developed in 2014. One special form of institutional partnership is the Helmholtz institutes. Here a Helmholtz centre establishes a branch on a university campus where its members and university staff work. These institutes provide a foundation for close long-term collaborations on specific topics. In 2014 the Helmholtz Institute Münster – which focuses on battery research – became the seventh such partnership to be founded together with a university. In addition, three Helmholtz institutes received new buildings, and the first research projects were launched at the Berlin Institute of Health, jointly operated by the Charité and the Max Delbrück Center for Molecular Medicine in the Helmholtz Association. The federal state of Berlin has now passed legislation making the institute an independent body under public law, thus giving it a sound legal footing.

Strategic talent management

Excellent conditions and research facilities are crucial for carrying out cutting-edge research. But they are just one part of the formula. A research organisation's most important asset is its staff, and it must work to attract the best minds in the world. This is why the Helmholtz Association has continued its recruitment initiative. A total of 118 million euros has been earmarked for the 2013–2017 period in order to hire outstanding international researchers, particularly in the field of energy research, and also to increase the proportion of women in top scientific positions. In 2014 alone, fourteen female scientists were hired for W3 positions, eight through this recruitment initiative.
Just as important as attracting the best minds is the systematic training of staff. Since 2007 the Helmholtz Management Academy has prepared research and administrative staff for the challenges of leadership positions, drawing participants not only from its own ranks, but also from partner organisations. Its programmes have been continually optimised in recent years. In 2014, a total of 120 individuals from the various target groups took part in the Helmholtz Academy's programmes. Within the framework of these programmes, the association also offers mentoring and coaching, for which it created a pool of 26 coaches in 2014. A look at the heads of the member centres shows the academy's successful track record: so far four academy graduates have worked their way up to serve as administrative directors of Helmholtz centres.

Thus, just as our living conditions change, so too do the expectations that society has of research. And just as social and political developments are driving research, so too does research drive social developments through its findings. Now and in the future, the Helmholtz Association will do everything in its power to fulfil its mission and goals in the German research system, not only as a comprehensive knowledge producer and fair partner, but also as an operator of outstanding research facilities and an attractive employer.

SCIENTIFIC PRIZES AND AWARDS

2014 NOBEL PRIZE IN CHEMISTRY

Stefan Hell, a department director at the Max Planck Institute for Biophysical Chemistry in Göttingen and a division head at the DKFZ, was awarded the 2014 Nobel Prize in Chemistry for developing super-resolved fluorescence microscopy. Using a light microscope, he succeeded in obtaining images of structures ten times smaller than was previously possible. Stefan Hell shared the Nobel Prize, worth 875,000 euros, with his American colleagues Eric Betzig from the Howard Hughes Medical Institute in Ashburn and William E. Moerner from Stanford University.

SCIENTIFIC PRIZES

Awards and prizes have increased the visibility of the outstanding researchers at the Helmholtz Association. The examples listed here highlight the achievements of scientists at different stages in their careers (in alphabetic order).

Alexander von Humboldt professorship: Tiffany Knight (UFZ); Breakthrough Prize in Life Sciences: Emmanuelle Charpentier (HZI); Curt Meyer Memorial Prize: Jane Holland (MDC); European Research Council Consolidator Grant: Alexander Westphal, Walter Winter (both DESY), Markus Feuerer, Hai-Kun Liu (both DKFZ), André Fischer (DZNE), Dirk Sachse, Thomas Walter (both GFZ), Joe Dzubiella (HZB), Martin Weides (KIT); European Research Council Starting Grant: Kai Ronald Schmidt-Hoberg (DESY), Lena Maier-Hein (DKFZ), Jan Marienhagen, Pitter Huesgen (both Forschungszentrum Jülich), Henriette Uhlenhaut (HMGU), Baris Tursun, Michela Di Virgilio (both MDC)

Heinz Maier-Leibnitz Prize: Pavel Levkin (KIT), Xiaoxiang Zhu (DLR); Heinz and Joachim Gretz Doctoral Dissertation Award of the Hydrogen Society of Hamburg: Julian Jepsen (HZG); Heidelberg Molecular Life Sciences Investigator Award: Hellmut Augustin, Roland Eils (both DKFZ); Linda and Jack Gill Distinguished Scientist Award: Matthias Tschöp (HMGU); Louis Jeantet Prize for Medicine: Emmanuelle Charpentier (HZI); Young Scientist Award of the Behnken-Berger Foundation: Karl Zeil (HZDR); Princess of Asturias Award: Emmanuelle Charpentier (HZI)

European Research Council Proof of Concept: Pavel Levkin, Christian Koos, Alexander Nesterov-Müller, Jan Korvink (all KIT), Francesca Spagnoli (MDC); Ernst Jung Prize for Medicine: Emmanuelle Charpentier (HZI); Female Independency Award: Michela Di Virgilio (MDC); Freigeist Fellowship of the Volkswagen Foundation: Tristan Petit (HZB); Gottfried Wilhelm Leibniz Prize 2015: Henry Chapman (DESY); Gay-Lussac Humboldt Research Award 2014: Volker Meyer (UFZ); Georg Sachs Prize of the German Society for Materials: Sergio Amancio (HZG)

RESEARCH FIELD ENERGY

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

MISSION

Helmholtz scientists involved in the field of energy research work to secure an economically, ecologically and socially sustainable supply of energy. They examine conversion, distribution, storage and utilisation technologies and take climatic and environmental impacts into account. One important goal is to replace fossil and nuclear fuels with climate-neutral energy sources and develop solutions for a sustainable energy system. For this purpose, they seek to determine the potential of renewables, such as solar, biomass and geothermal energy. Researchers also work on increasing the efficiency of conventional power plants. Finally, the Helmholtz Association pursues the long-term goal of developing nuclear fusion as a new energy source, and it boasts outstanding expertise in the area of nuclear safety and final repository research.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

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

- Energy Efficiency, Materials and Resources
- Renewable Energies
- Storage and Cross-Linked Infrastructures
- Future Information Technology
- Technology, Innovation and Society
- Nuclear Waste Management, Safety and Radiation Research
- Nuclear Fusion

OUTLOOK

The *Energiewende*, or energy transition, is one of the greatest challenges facing present and future generations. In its 6th Energy Research Programme, the German government concentrates on renewable energy, energy efficiency, energy storage and grid technologies. The Helmholtz Association emphatically supports this strategy and significantly contributes to its implementation by focusing its expertise and experience in various programmes. In addition, it closes research gaps and conducts basic and application-oriented research. It complements its technological research with socioeconomic studies in order to ensure that all social, economic and political aspects are included in its overall goal of improving the energy system.

PROGRAMMES IN THE FUNDING PERIOD 2015–2019

Energy Efficiency, Materials and Resources

The goal of the energy transition for 2050 is to halve primary energy consumption and achieve an 80 to 95 per cent reduction in greenhouse gas emissions compared to 1990 levels. For this purpose, process chains, resources, materials development, process engineering and energy conversion processes will be studied, interlinked and optimised. In addition, the flexibility required to restructure the energy supply will be improved with respect to fuel types, energy provision and infrastructure.

Renewable Energies

Renewable sources will supply the lion's share of energy in the future. The goal is to exploit the various primary energy sources, such as solar, wind, biomass and geothermal energy

Karlsruhe Institute of Technology (KIT)

The solar power storage park at KIT is the largest in Germany and part of the Energy Lab 2.0. *Image: KIT*

ENERGY LAB 2.0 – A SMART PLATFORM FOR ENERGY TRANSITION

The transition to a clean energy economy is challenging scientists in many ways. In order to implement an energy supply that is based primarily on renewable sources, many questions need to be answered. The Energy Lab 2.0 at the Karlsruhe Institute of Technology (KIT) will provide important input. Launched in October 2014, this smart platform aims at investigating the interaction between the components of future energy systems. The project is part of the Helmholtz Association's overall energy strategy. By 2018, the partners plan to build a simulation and control centre and a network of energy technology facilities at KIT, an electrolysis test centre at the Forschungszentrum Jülich and a facility to test power-to-heat concepts at the German Aerospace Center in Stuttgart.

The network will link characteristic components of electricity, heat and syngas production with various energy storage technologies and energy consumers. For this purpose, existing large-scale test facilities at KIT will be integrated into the Energy Lab 2.0, including the solar power storage park, the bioliq pilot plant and selected energy consumers. The network will be complemented by electrical, electrochemical and chemical storage systems as well as by a flexible-fuel and flexibile-load gas turbine with a generator. The simulation and control centre at KIT will connect all the components of the network via information and communication technologies to form a smart energy system. This combination of facilities will make the resulting infrastructure the first of its kind in Europe.

In the long term, the Energy Lab 2.0 will integrate external test facilities and, in collaboration with industry, large-scale external components of energy systems, such as wind farms, geothermal plants, conventional power plants and large industrial consumers. The scientists involved in the Energy Lab 2.0 will initially develop grid stabilisation tools and approaches in model form. They will use an experimentation field featuring all the relevant system components on a smaller scale as well as a test field for electrical grid components with real-time simulations. Validation will be carried out on the network level. In a third stage, the results will be used to simulate real energy systems and analyse these systems from a variety of perspectives, including that of grid stability.

Additional examples from this research field »

in an efficient, cost-effective manner and to develop optimal technologies for centralised and decentralised applications. The strategic research focuses in this programme lie on scientific issues that require highly complex, long-term investigations utilising the large-scale facilities of the participating Helmholtz centres.

Storage and Cross-Linked Infrastructures

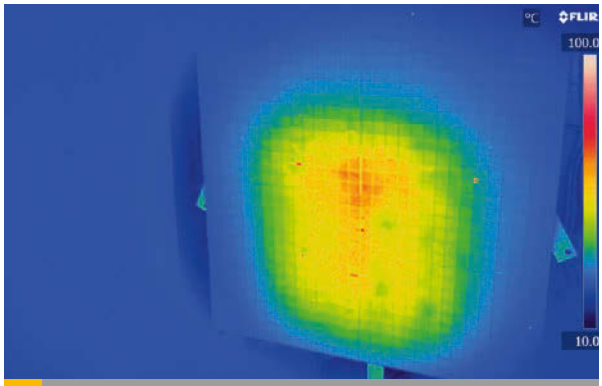
In order to ensure a successful transition to an energy supply based primarily on renewable sources, highly volatile energy needs to be stored in accordance with demand and infrastructure for the different energy sources needs to be optimised and integrated more effectively. The programme encompasses studies of energy storage, energy conversion technologies and energy infrastructure. It combines R&D projects on thermal, electrical and chemical energy storage with process development and includes the analysis of distribution and storage infrastructure.

Static mixers like the one shown in this picture mix fluid flows directly in pipe systems.
Image: Michael Voigt/HZDR

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

ULTRAFAST X-RAY TOMOGRAPHY REVEALS BUBBLE DISPERSION

Researchers at the HZDR have rendered the flow processes in static mixers visible for the first time. These components (e.g., helical blades) are used by the chemical industry to mix substances, above all gas and liquids, directly in pipes. With the help of ultrafast X-ray tomography, the researchers demonstrated that in pipes containing helical elements, flow turbulence and centrifugal forces competed, influencing the mixing and the bubble dispersion. The findings could improve mixer design.



Thermogram of the ELISE calorimeter, which measures the energy content of the generated particle beams.
Image: IPP

Max Planck Institute for Plasma Physics (IPP)

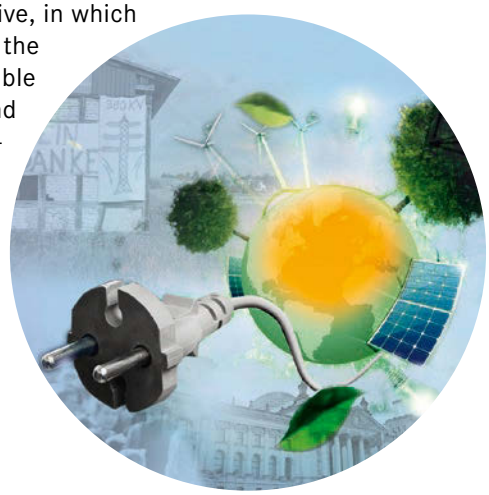
A HEATING SYSTEM FOR THE ITER FUSION TEST REACTOR

Two powerful, 16 megawatt particle beams will heat the ITER plasma to an ignition temperature of 100 million degrees. The heating system is currently being developed at the ELISE test rig at the Max Planck Institute for Plasma Physics in Garching. Its centrepiece is a new type of high-frequency ion source, which is gradually taking ELISE into new orders of magnitude. In one-hour pulses, the ion source now delivers 20-second ion beams of world-record quality every three minutes. The beams are one metre in diameter, homogeneous, stable and nine amperes strong.

Helmholtz Centre for Environmental Research – UFZ

ENERGY ECONOMISTS JOIN THE DEBATE

In 2014 UFZ economists continued to study the market and systems integration of renewable energy in Germany, as well as the EU-wide integration of national energy policies. In addition to their scholarly work, they repeatedly joined the public debate via diverse communication channels. One such channel was the policy briefs published by the Helmholtz ENERGY-TRANS initiative, in which the experts discussed the framing of the Renewable Energy Sources Act and the option of introducing capacity payments to guarantee a secure energy supply.



ENERGY-TRANS focuses on the transition to a clean energy regime and the demands it is placing on the European energy system.
Image: ENERGY-TRANS (collage: modus: medien + kommunikation gmbh)

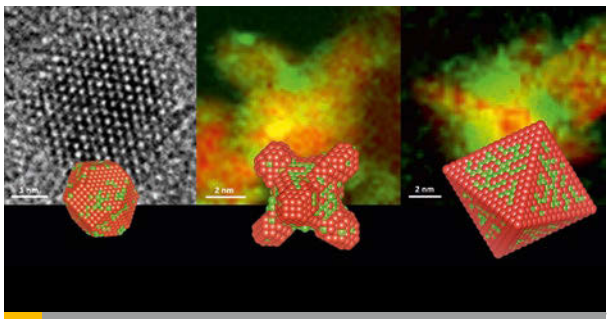
PROGRAMMES IN THE FUNDING PERIOD 2015–2019

Future Information Technology

Taking innovative research approaches, this programme will develop new components and architectural concepts to increase the computing power, data storage density and data transmission rates of information technology while significantly reducing the demand for electrical energy.

Technology, Innovation and Society

The programme encompasses the systematic investigation of the diverse interfaces between technology, innovation and society with the goal of supporting decision-making in government, economy and society. To this end, it pools expertise in energy systems analysis, technology impact assessment and policy consulting.



Using ultrahigh-resolution electron microscopy, researchers in Berlin and Jülich have shown that the crystalline growth of a new type of catalyst particle for fuel cells unfolds in several stages. *Image: Forschungszentrum Jülich/TU Berlin*

Forschungszentrum Jülich

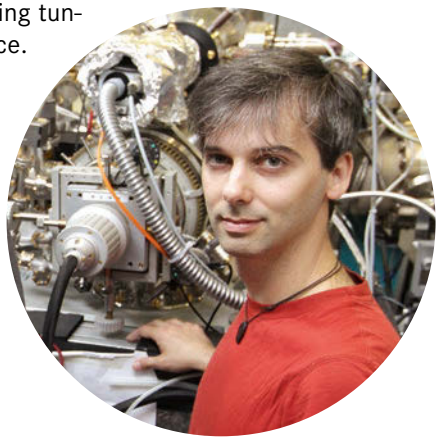
SOLVING THE MYSTERY OF A LOW-PLATINUM NANOCATALYST

New types of nanoparticle catalysts could reduce the cost of fuel cells. A catalyst developed by researchers in Jülich and Berlin requires only one tenth of the usual amount of platinum. Until now, it was unclear how the octahedral shape of the particles and the special distribution of the elements emerge. Using ultrahigh-resolution electron microscopy, the researchers showed that the crystalline growth takes place in different stages. The findings could help to lengthen the lifespan of fuel cells.

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

SPIN FILTERS FOR SPINTRONIC ELEMENTS

Research teams from Paris, Madrid and the Berlin-based HZB have observed for the first time how the magnetic domains at the interfaces between spintronic components influence each other. Measurements taken at the photon source BESSY II show that so-called spin filters form between the outer ferromagnetic layers and the inner anti-ferromagnetic insulating layer, influencing tunnelling magnetoresistance. These findings are helping to explain important processes in spintronic components currently being developed for future information technologies.



HZB physicist Sergio Valencia examining samples at a BESSY II beamline. *Image: HZB*

The Gross Schönebeck geothermal research platform. *Image: GFZ*

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

USING DEEP GEOTHERMAL ENERGY IN THE NORTH GERMAN BASIN

At the Gross Schönebeck research platform, researchers from the GFZ's International Centre for Geothermal Research have been investigating the development of the productivity of thermal water from depths of more than four kilometres. The measurement data thus acquired correspond to findings based on models of combined hydraulic, thermal, mechanical and chemical processes. Such comprehensive characterisations are opening up new potential for the geothermal use of the fissured, porous reservoir rocks found throughout the North German Basin.

Nuclear Waste Management, Safety and Radiation Research

This programme implements persuasive, technically coherent research strategies that support the nationally targeted project of phasing out nuclear power. It concentrates on problems relating to the final disposal of radioactive waste, nuclear reactor safety and the complete phase-out of nuclear power.

Nuclear Fusion

As a nearly inexhaustible, safe and CO_2-free source of energy, fusion has the potential to make a significant contribution to meeting the world's growing energy needs by mid-century. The goal of this programme is to provide a foundation for the development and construction of a fusion power plant. Two central projects that will continue to dominate fusion research over the next 20 to 30 years are ITER and Wendelstein 7-X.

RESEARCH FIELD EARTH AND ENVIRONMENT

PROFESSOR PETER M. HERZIG
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Earth and Environment,
GEOMAR Helmholtz Centre for Ocean Research Kiel

MISSION

The Helmholtz scientists involved in the research field Earth and Environment examine the basic functions of the Earth system and the interactions between society and nature. They focus on expanding and interconnecting long-term observation systems, improving predictions and making findings quickly available to society. They formulate knowledge-based policy recommendations on how the Earth's resources can be used in a sustainable fashion without destroying the foundations of life. For example, REKLIM, a Helmholtz climate initiative, is bringing together the expertise of nine Helmholtz centres in order to improve regional and global climate models. Another important goal is to establish and operate infrastructure and facilities such as the HALO research aircraft and the TERENO network, for which terrestrial observatories have been set up 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 IN THE CURRENT FUNDING PERIOD

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

- Geosystem: The Changing Earth
- Marine, Coastal and Polar Systems
- Oceans
- 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 in shared interdisciplinary activities. This strategy is leading to new alliances and facilitating the expansion of Earth observation and knowledge systems as well as integrated modelling approaches. The interdisciplinary "Earth System Knowledge Platform – Observation, Information and Transfer" is integrating the knowledge acquired by all of the centres in this research field as well as by their partners. Its goal is to help society to cope with the complex challenges brought about by changes in the Earth system.

PROGRAMMES IN THE FUNDING PERIOD 2014–2018

Geosystem: The Changing Earth

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

Marine, Coastal and Polar Systems

This programme concentrates on a variety of issues, including changes in the Arctic and Antarctic, the interac-

Kai T. Lohbeck examining a culture of *Emiliania huxleyi* in a bottle in the GEOMAR lab. *Image: Maike Nicolai/GEOMAR*

GEOMAR Helmholtz Centre for Ocean Research Kiel

ADAPTING TO CLIMATE CHANGE IN THE OCEAN

The most important unicellular calcifying alga in the world, *Emiliania huxleyi,* is capable of simultaneously adapting to the acidification of the oceans and rising water temperatures. Scientists from the GEOMAR Helmholtz Centre for Ocean Research Kiel and the Thünen Institute of Sea Fisheries have demonstrated its adaptive capability in an unprecedented evolution experiment. With their study the researchers have disproved the widespread assumption that evolutionary adaptations to both these aspects of climate change interfere with each other. "Even though the experiment was conducted under laboratory conditions, it clearly showed the great adaptive potential of *Emiliania huxleyi,*" says Lothar Schlüter, the study's first author. "Proof has been provided. Forecasts about the oceans of the future must definitely consider such adaptive changes." For their experiments the scientists used and propagated a single cell of *Emiliania huxleyi* from the Raunefjord in Norway. Over the course of a year (corresponding to around 460 algae generations), five cultures were exposed to a variety of temperatures and carbon dioxide conditions. At high water temperatures, the adapted populations grew significantly faster than the non-adapted ones, regardless of the water's carbon dioxide content. In a sub-experiment, the researchers were surprised to find that the cultures which had been simultaneously exposed to the highest CO_2 value and the highest temperatures for one year were also the quickest to adapt when temperatures were raised again.
Additional studies are underway. "In our labs we are now conducting the longest-running and most complex experiment on this question in the world," says Thorsten Reusch, head of Marine Ecology at GEOMAR. The results will be integrated into biogeochemical models for calculating the future productivity of oceans and the limits of carbon storage. The insights gained into evolutionary adaptation have also been incorporated into a study of future phytoplankton species shifts.

Additional examples from this research field

tion between these changes and the global climate and polar ecosystems, vulnerable coasts and shelf seas, the polar perspective of Earth system analysis, and the interplay between science and society. It provides insights into climate variability and regional climate change, sea-level change as an element of risk analysis within the Earth system, and the transformation of coastal and polar ecosystems. The programme is also providing a scientific foundation for the assessment of the social and economic consequences of climate change in the places where we live. Work on the topic "Interaction between Science and Society" is examining how research findings can be effectively integrated into information and decision-making processes in society as a whole.

Oceans

Oceans cover 70 per cent of the Earth's surface. Deep oceans, in particular, are difficult to access and remain largely unstudied. This interdisciplinary programme will examine the physical, chemical, biological and geological pro-

This six-metre tower is located directly on the Dead Sea and is the lowest-elevation meteorological monitoring station in the world. Its instruments measure radiation, evaporation and heat. *Image: KIT/Ulrich Corsmeier*

Karlsruhe Institute of Technology (KIT)

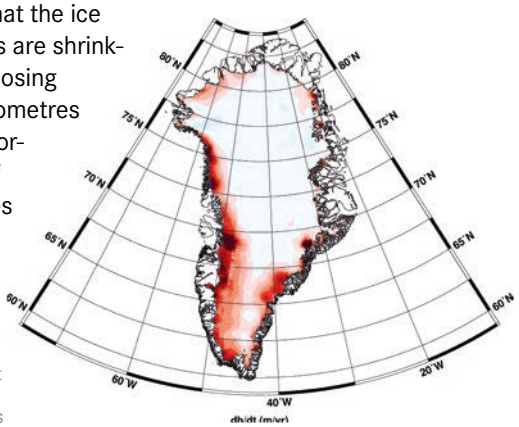
CHANGE IN THE DEAD SEA VALLEY

The water level of the Dead Sea has been falling dramatically for decades. Researchers involved in the HEADS measurement campaign assess the role played by evaporation, the vapour level, and local wind systems. They have found that water evaporation in the Dead Sea Valley varies seasonally and in response to meteorological conditions. The measurement campaign is part of "DESERVE – Dead Sea Research Venue", a Helmholtz virtual institute that is coordinated by KIT and brings together scientists from Germany, Jordan, Israel, and Palestine.

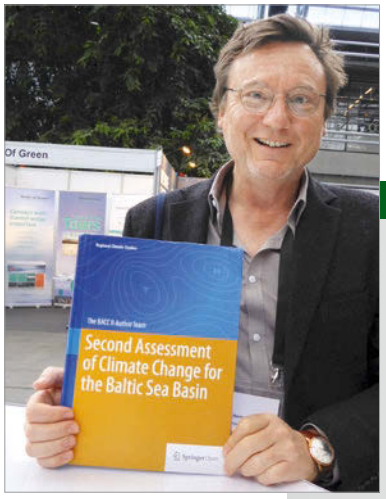
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI)

SHRINKING GLACIERS IN GREENLAND AND ANTARCTICA

In order to evaluate the extent of climate change in the polar regions, scientists require reliable data, including measurements of glacial ice loss. With the help of the ESA satellite CryoSat-2, glaciologists from the Alfred Wegener Institute have created the first comprehensive elevation maps of the Greenland and Antarctic ice sheets. Using these maps, they have demonstrated that the ice sheets in both regions are shrinking at a record pace, losing approx. 500 cubic kilometres of ice per year. This corresponds to a layer of ice around 600 metres thick covering the entire area of Hamburg.



Changes in the elevation of the Greenland ice sheet from January 2011 to January 2014; red: glaciers that have lost volume, blue: glaciers that have grown. *Map: Helm et al.*



Marcus Reckermann, head of the International Baltic Earth Secretariat at HZG. *Image: HZG*

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)

PUBLICATION ON CLIMATE CHANGE IN THE BALTIC REGION

In April 2015, the regional climate report "Second Assessment of Climate Change for the Baltic Sea Basin" was published in open access form. The report was coordinated by the HZG's International Baltic Earth Secretariat, and 141 authors from twelve countries contributed. In 25 chapters it discusses changes since the last ice age with a focus on the past 200 years, projections up to 2100 and potential impacts on nature. The publication elucidates not only socioeconomic factors such as land use, agriculture and cities, but also the causes of regional climate change.

cesses in oceans as well as the interactions between these processes and the ocean floor and the atmosphere. Its goal is to investigate the role of the ocean in climate change, human impact on marine ecosystems, the possible use of the oceans' biological, mineral and energy resources, and the potential risks of geodynamic processes in the oceans and deep seas.

Atmosphere and Climate

The goal of this programme is to better understand the function of the atmosphere within the climate system. To this end scientists are carrying out extensive measurements of atmospheric parameters, performing laboratory tests and creating numerical models of processes that play an important role in the atmosphere. Focuses include high-resolution satellite measurements of tropospheric trace gases, studies of the role of the middle atmosphere

Researchers at the Helmholtz Zentrum München have deciphered the large genome of bread wheat. *Image: Irina Tischenko/Fotolia*

Helmholtz Zentrum München – German Research Center for Environmental Health

THE LARGE WHEAT GENOME: KEY FOR OUR FUTURE

Wheat is one of the most widely planted crops in the world. Researchers led by Klaus Mayer at the Helmholtz Zentrum München have now gained important new insight into the grain's genetic makeup. The team learned that the wheat genome is five times larger than the human genome. One peculiarity: it is polyploid containing three distinct sub-genomes. The scientists were able to decode these sub-genomes and acquire a new understanding of their complex interactions. Their findings explain the plant's great adaptability.

Scientists at UFZ have developed a method for cost-effectively removing chemicals from groundwater. *Image: André Künzelmann/UFZ*

Helmholtz Centre for Environmental Research – UFZ

A BACTERIUM THAT CLEANS GROUNDWATER

At many industrial sites around the world, chemicals such as benzene and methyl tert-butyl ether (MTBE) contaminate the groundwater. UFZ researchers have now isolated a bacterium called *Aquincola tertiaricarbonis* that can break down such pollutants. With the help of this bacterium, they have developed an environmentally and economically competitive purification process that is now ready to market. The process is already being used on the site of the large-scale ecological Leuna project, where a facility capable of purifying 500,000 litres of contaminated groundwater each day began operating in 2014.

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

WHERE DOES THE ICE ON GREENLAND COME FROM?

Researchers from GFZ have discovered that the ice on Greenland was able to form due to processes deep in the interior of the Earth. The extensive glaciation of the Arctic did not begin until around 2.7 million years ago – which is fairly recent in geological time. Hot rock rising from the Earth's mantle lifted Greenland so high that the mountain peaks reached into colder altitudes of the atmosphere. Tectonic movement also pushed Greenland far enough north to significantly reduce its exposure to solar radiation in winter. The extent of this northward migration was increased by a shift in the Earth's axis.

The Watkins Mountains in southern East Greenland featuring Greenland's highest peak, Gunbjørn Fjeld (3,700 m above sea level). *Image: Peter Japsen, GEUS*

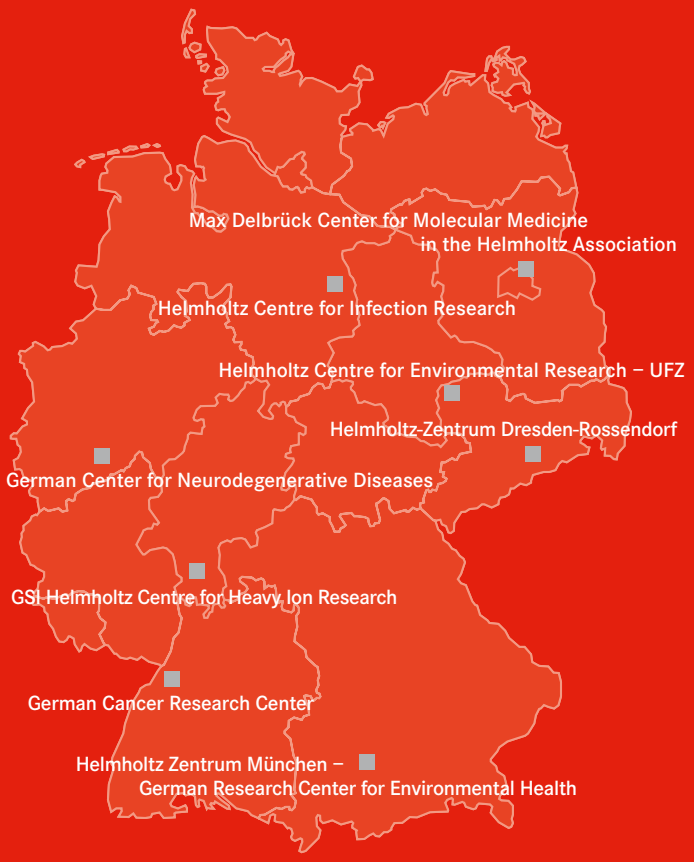
within the climate system, the variability of biogenic emissions and the use of atmospheric water isotopes for a better understanding of the water cycle.

Terrestrial Environment

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

RESEARCH FIELD HEALTH

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



MISSION

The scientists involved in health research at the Helmholtz Association are studying the causes and development of major common diseases such as cancer, cardiovascular, metabolic disease, pulmonary and infectious disease, allergies and disorders of the nervous system. Building on a strong foundation of basic research, they aim to elaborate evidence-based methods for the prevention, diagnosis, early detection and individualised treatment of common diseases. Research into complex and often chronic illnesses requires interdisciplinary approaches, which are being pursued by the Helmholtz centres in cooperation with partners from medical schools, other research organisations and industry. In addition, as a partner to the German Centres of Health Research, which were founded by the Federal Ministry of Education and Research, the Helmholtz Association is working to make research findings more rapidly available for clinical applications and individualised medicine.

PROMGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Eight Helmholtz centres are collaborating in the field of health research. In the current programme period, they bundle their expertise in the following five programmes:

- Cancer Research
- Cardiovascular and Metabolic Diseases
- Infection Research
- Disorders of the Nervous System
- Genetic and Environmental Influences on Common Diseases

OUTLOOK

The long-term goal of Helmholtz health research is to improve medical care and quality of life for the population into old age. For this reason the Helmholtz health centres regularly check to see whether they should be investigating additional diseases such as mental disorders, and they are also taking steps to integrate prevention research into their research programmes. The “National Cohort” health study, which the association has initiated, will continue to lay the foundation for new approaches to assessing individual risk factors and developing personalised prevention strategies. In all these activities, the ongoing discourse between scientists and physicians will play a vital role in enabling a quick translation of research findings into clinical practice.

PROGRAMMES IN THE FUNDING PERIOD 2014–2018

Cancer Research

The goal of this programme is to significantly improve the prevention, early detection, diagnosis and treatment of cancer. To this end it is developing new diagnostic and individualised therapeutic procedures on the basis of molecular, cell-biological, immunological and radiophysical findings and technologies. It will continue to translate basic research findings into clinical applications in collaboration with strategic partners. Here a key role will be played by the National Centre for Tumour Diseases (NCT) and the nationally active German Consortium for Translational Cancer Research (DKTK).

Helmholtz Zentrum München – German Research Center for Environmental Health

A small drop of blood is all that is needed to take part in the Fr1da study. *Image: Helmholtz Zentrum München*

FR1DA STUDY: DETECTING DIABETES IN CHILDREN BEFORE ITS ONSET

Around 30,000 children in Germany currently suffer from the chronic metabolic disorder type 1 diabetes. Every year more than 2,400 young patients join their ranks, with these yearly figures on the rise. The disease is often diagnosed after a life-threatening imbalance of sugar levels in the blood and drastically changes the daily routines of the people affected.
Anette-Gabriele Ziegler, director of the Institute of Diabetes Research, Helmholtz Zentrum München, launched the Fr1da screening study to counter these developments. "Our goal is to offer an early detection examination to all children in Bavaria between the ages of two and five," she says. The aim of the new screening procedure is to detect the disease at an early stage, enabling parents to make timely preparations before symptoms appear. Fr1da was made possible by the findings of scientists from the Helmholtz Zentrum München, who demonstrated that in type 1 diabetes, diabetes-specific antibodies are detectable in the blood months or even years before the disease's onset. These findings led to the development of a simple blood test.

"With the Fr1da study we are taking a new approach to preventive health care in Bavaria," says Melanie Huml, Bavarian health minister and sponsor of the study. Fr1da has also drawn attention outside Bavaria. Due to its groundbreaking implications, JDRF, the American foundation for type 1 diabetes research, has contributed around one million dollars to the study.
In addition to preventing life-threatening metabolic imbalances, the initiators hope to find answers to a number of other questions. First of all, the Fr1da figures will be compared to other data, including place of residence, diet and caesarean rates. As Ziegler explains, "This will allow us to learn more about the causes of type 1 diabetes, which are still largely unknown." Dealing with this problem is becoming increasingly urgent – every year the number of new cases grows by 6 per cent. Another objective is to facilitate prevention studies like the Fr1da Insulin Intervention Study for Fr1da children, who are given a vaccine in order to delay or prevent the onset of the disease. Initial studies based on orally administered insulin are already yielding promising results.

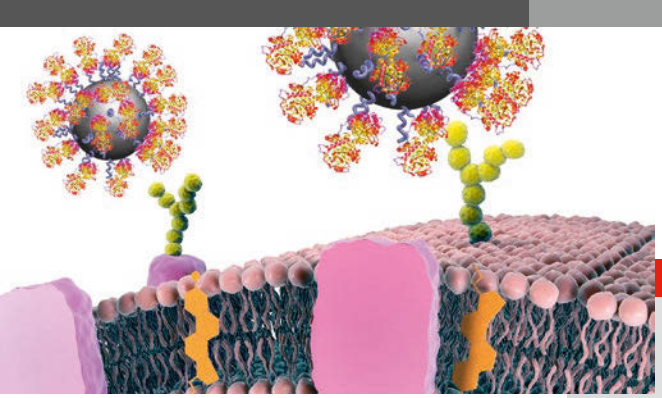
Additional examples from this research field »

Cardiovascular and Metabolic Diseases

This programme focuses on the causes and pathophysiological links of cardiovascular and metabolic disease, which are studied at the cellular, genetic and epigenetic levels. In addition, it investigates the interaction between these factors and environmental causes. The findings will be used to develop new diagnostic, preventive and therapeutic strategies. The programme takes a translational approach to the issue with the goal of transforming new results into clinical applications as quickly as possible.

Infection Research

This programme concentrates on the molecular mechanisms responsible for the development and course of infectious diseases. Knowledge of the interactions between hosts and pathogens is providing a foundation for the elaboration of new prevention and treatment strategies. Focuses include the study of newly emerging infectious diseases, the identification of new drugs to overcome pathogen resistance, the relationship between infection and age, as well as diagnostics for personalised therapies. An important role is also played



With the help of proteins, researchers can produce nanoparticles that bind to specific cancer cells. *Image: CBNI, UCD*

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

ANTIBODIES FROM THE DESERT AS GUIDES TO DISEASED CELLS

New nanoparticles have the potential to track down tumours under real conditions. Researchers at NanoTracking, a Helmholtz virtual institute at the HZDR, have combined these particles with fragments of a particular antibody that occurs only in camels and llamas. Experiments using human blood serum have shown that under conditions similar to those in the human body the particles bind to the epidermal growth factor receptor – a molecule that is overexpressed in various tumour entities. This allows the diseased cells to be found more easily.

A mask can be used to fix a patient's head in place and target a brain tumour more precisely. 4D computer tomography is also able to detect tumour movements in the body. *Image: GSI*

GSI Helmholtz Centre for Heavy Ion Research

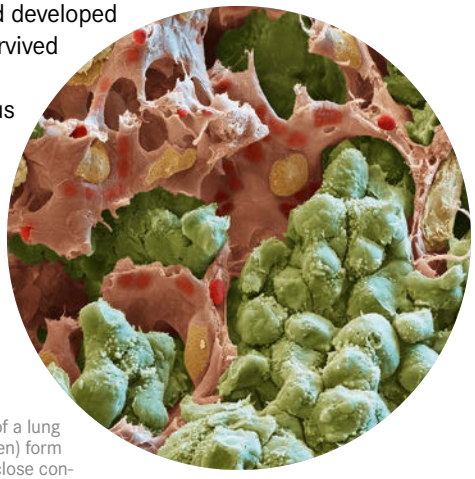
TUMOUR THERAPY IN FOUR DIMENSIONS

Due to a patient's breathing and digestive functions, tumours in the internal organs such as the lungs or the liver are always in motion. They can shift in all three spatial directions and even twist or tilt. GSI scientists are developing a new method that takes these tumour movements into account during ion beam therapy. With the help of 4D computer tomography, scientists can factor in temporal changes in the tumour's position during irradiation.

German Cancer Research Center (DKFZ)

CONTROLLING METASTASIS WITH BLOOD VESSEL LINING CELLS

At the DKFZ, Helmut Augustin and his colleagues are looking for ways to use combination therapies to prevent cancer metastases from developing. To this end they have combined a low-dose chemotherapy with an antibody against a regulatory protein found in the cells lining blood vessel walls. Mice treated using this method developed fewer metastases and survived longer. The therapy combats metastases in various ways: it prevents blood vessels from nourishing the newly emerging secondary tumours and at the same time blocks the recruitment of cancer-promoting immune cells.

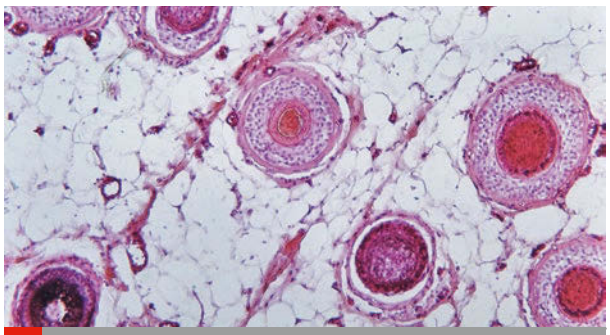


A scanning electron micrograph of a lung metastasis: the tumour cells (green) form solid tumour nodules that are in close contact with the surrounding capillaries (red). *Image: Oliver Meckes, Eye of Science/ H. Augustin, DKFZ*

by post-infection diseases such as cancer, metabolic dysfunction, neurodegeneration and chronic infections.

Disorders of the Nervous System

The goal of this programme is to study the causes of nervous system disorders and to create more efficient methods for their prevention, diagnosis, treatment and care. Research is focused above all on major neurodegenerative diseases such as Alzheimer's and Parkinson's, but also addresses less common disorders such as Huntington's chorea, amyotrophic lateral sclerosis and prion diseases. In addition, scientists are studying disorders that may in part be based on similar pathological processes or that are often associated with the well-known neurodegenerative diseases. In order to develop better strategies for diagnosis, treatment and care, it is necessary to learn



This oblique histological section of the human scalp shows hair follicles cut at different heights. *Image: Rollroboter*

Helmholtz Centre for Infection Research (HZI)

VACCINATION CREAM

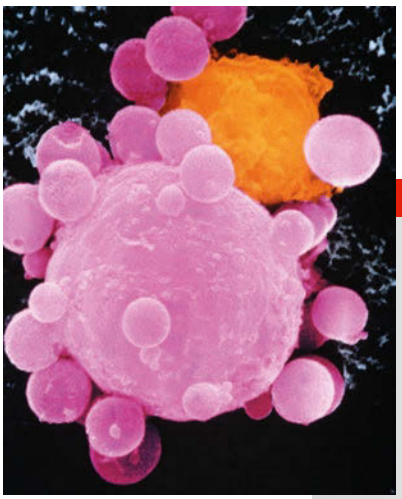
Vaccines are traditionally introduced into the body by injection, but alternatives have long been sought due to this method's drawbacks. Researchers at the Helmholtz Centre for Infection Research have now shown that it is possible to administer vaccines via hair follicles in order to trigger immune responses. Packaged in nanoparticles, the vaccines can penetrate the skin without damaging it. These findings could make a vaccination cream possible in the long term.

German Center for Neurodegenerative Diseases (DZNE)

REGENERATING DAMAGED NERVE CELLS

Spinal cord injuries rarely heal because neurons do not regenerate spontaneously. Scar tissue and molecular processes inside the nerve prevent the long nerve fibres from growing. Scientists at the DZNE in Bonn have now demonstrated in animal studies that the cancer drug epothilone reduces scarring in spinal cord injuries and activates the growth of injured nerve cells. Both promote neuronal regeneration and improve motor skills in animals.

This cross-section of a rat's spinal cord shows the components in different colours: axons are red, neural interconnections green and motor neurons blue. *Image: Jörg Ruschel/DZNE*



Immune cell (lymphocyte) attacking a cancer cell. *Image: Liepins/SPL/Agentur Focus*

Max Delbrück Center for Molecular Medicine in the Helmholtz Association

STRENGTHENING THE IMMUNE SYSTEM AGAINST CANCER

The immune system distinguishes between what is foreign and what is part of the body. It recognizes and destroys only exogenous structures. Although cancer cells often have surface characteristics that identify them as pathologically altered, the immune system does not recognize them as foreign to the body or mount an attack. MDC and Charité researchers led by Thomas Blankenstein have been able to arm the immune system's T-cells in the laboratory to enable them to specifically detect and destroy human cancer cells.

more about disease mechanisms and the brain's response to a disease.

Genetic and Environmental Influences on Common Diseases

This programme focuses on the major common diseases diabetes, pulmonary illness and allergies. Like cardiovascular disease, cancer and disorders of the nervous system, these diseases have diverse causes and result from the interplay between genetics, environmental factors and personal lifestyles. Due to changing living conditions and longer life expectancies, they are becoming increasingly prevalent. This programme is concerned with the influence of genes and environmental factors on human health. It is essential to clarify the interactions between the organism and environmental factors in order to develop strategies and procedures for the personalised prevention, early detection, diagnosis and treatment of chronic diseases.

RESEARCH FIELD AERONAUTICS, SPACE AND TRANSPORT

PROFESSOR JOHANN-DIETRICH WÖRNER (UNTIL 30 JUNE 2015)
PROFESSOR PASCALE EHRENFREUND (FROM 15 AUGUST 2015)
Vice-President of the Helmholtz Association,
Coordinator of the Research Field Aeronautics, Space and Transport,
German Aerospace Center

MISSION

The scientists involved in aeronautics, space and transport research address the major challenges facing our society in the fields of mobility, information systems, communication, resource management, the environment and safety. They develop concepts and solutions and provide advice for policymakers. The German Aerospace Center (DLR) is Germany's national centre for aeronautics and aerospace research. On behalf of the German government and in its capacity as the German space agency, it is responsible for research within the framework of the national aerospace programme and for Germany's contribution to the European Space Agency (ESA). The Helmholtz DLR@UNI Alliance provides a framework for content-based partnerships between universities and selected DLR facilities throughout Germany. The DLR also works closely with other Helmholtz research centres, particularly in the research fields Energy and Earth and Environment, and collaborates with the private sector on a project basis.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

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

- Aeronautics
- Space
- Transport

OUTLOOK

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

PROGRAMMES IN THE FUNDING PERIOD 2014–2018

Aeronautics

The significant increase in air transport over recent decades is likely to continue. In Europe, policymakers, representatives of industry and scientists have already agreed on a common research agenda that establishes basic conditions for Helmholtz research. Its goals are an expansion of the capacity of the air transport system, greater cost-effectiveness on the developmental and operational levels, the reduction of aircraft noise and harmful emissions, the enhanced attractiveness of air travel for passengers, and higher safety standards. Within this framework researchers are working on concrete developments for the next generation of aircraft and are investigating ideas and concepts for future air transport systems. A key aspect of the research agenda is its holistic perspective. At the same time, the

First comet landing: On 12 November 2014, the Rosetta space probe set down its Philae lander on the comet 67P/Churyumov-Gerasimenko, where the lander gathered data about the celestial body. *Image: ESA-C. Carreau/ ATG medialab*

German Aerospace Center (DLR)

EUROPE'S COMET HUNTER PROBES THE ORIGINS OF LIFE

In recent months no other large-scale scientific project has drawn as much attention as the European Rosetta mission, which has been investigating one of the oldest, most primitive celestial bodies, the comet 67P/Churyumov-Gerasimenko. The mission consists of an orbiter and the Philae lander. The DLR constructed key elements of the lander and the instruments it is carrying. It is also directing the Philae project and running the lander control centre. DLR scientists prepared the difficult and unprecedented landing on the comet and implemented it in collaboration with the European Space Agency (ESA). The DLR Institute of Planetary Research is responsible for three lander instruments which are taking measurements that should provide insights into the origins of our solar system.
The spacecraft began its journey ten years ago, on 2 March 2004. While on route to its ultimate destination, the mother ship carried out several complex manoeuvres (taking it past Earth three times and once past Mars). These gave it sufficient momentum for the long haul out to the comet. In July 2011 Rosetta was put into sleep mode due to the fact that, at 800 million kilometres from the Sun, its solar cells could no longer generate sufficient electricity for important functions. On 20 January 2014 Rosetta was successfully woken up and in August 2014 it entered an orbit around the comet. The first measurements it took involved mapping the comet's uneven surface in order to locate a suitable landing site. On 12 November the Philae lander separated from the mother ship and headed for the comet's surface. However, on making initial ground contact, the lander bounced back off because its anchoring harpoons failed to trigger. After three hops the lander finally settled in what was initially an unknown position. Although it was able to begin taking measurements, its location in the shadow of a cliff meant that its solar collectors could not produce as much energy as hoped, and on 15 November it again went into sleep mode. There was consequently a great sense of relief on Earth when, on 13 June 2015, Philae reported back from its shadowy landing site and began sending data homeward.
Philae and Rosetta were accompanying the comet to the point where it passed closest to the sun in August 2015. At this stage in its mission, scientists are hoping to learn more about the origins of life, above all if they are able to detect amino acids in gas chromatograms.

Additional examples from this research field »

Helmholtz programme is placing a strong emphasis on application-oriented research. The four research topics covered in this programme address the basic sectors of civil aviation: aeroplanes, helicopters, propulsion systems and air traffic/air safety. In addition, research is being conducted into numerical simulation technologies, testing facilities and aspects of environmental research relevant to aviation. This work is being carried out primarily in interdisciplinary projects. One example of the research fields' holistic perspective is the establishment of DLR Air Transportation Systems.

Space

The overarching objective of space research at the DLR is to develop socially beneficial applications for astronautics. Scientific insights gained from the investigation of the Earth and the universe and research under space conditions inform commercial ventures and government projects. In this context precedence is given to the broader needs of society, and our research accordingly addresses topics such as the swift response to crises, the provision of precise navigation systems, rapid data acquisition, climate monitoring systems, land use geared to the preservation

Inlet of the air collection chamber at the DLR turbine testing facility with circular microphone antenna. *Image: DLR (CC-BY 3.0)*

German Aerospace Center (DLR)

HIGH PRESSURE TO COMBAT AIRCRAFT NOISE

Compressed air blown into an aircraft engine can significantly reduce rotor noise. DLR researchers have now developed a process that involves blowing air through several perforated rings behind the rotor. The air introduced in this fashion generates alternating forces that act on the guide vanes behind the main rotor and, provided the air supply is precisely controlled, result in active noise cancellation. In a world first, this development has enabled researchers to reduce the perceived volume of the particularly annoying rotor-stator noise by half.

German Aerospace Center (DLR)

CLIMATE RESEARCH ABOVE BRAZIL'S RAINFOREST

Thunderclouds above the rainforest influence the climate. In autumn 2014 the DLR's HALO research aircraft conducted measurements in Brazil's Amazon region. As part of a collaborative project involving a number of German environmental and climate research institutions, HALO gathered data that will provide insights into how trace elements are transported up through these towering clouds and how burning off land influences cloud characteristics and precipitation. DLR researchers contributed to the project by providing measurements of trace gases, aerosols and ice particles.

HALO with its nose mast in front of a thundercloud. *Image: DLR (CC-BY 3.0)*

The software developed by DLR researchers to check rail networks is operated using a device that fits into a small suitcase. *Image: DLR (CC-BY 3.0)*

German Aerospace Center (DLR)

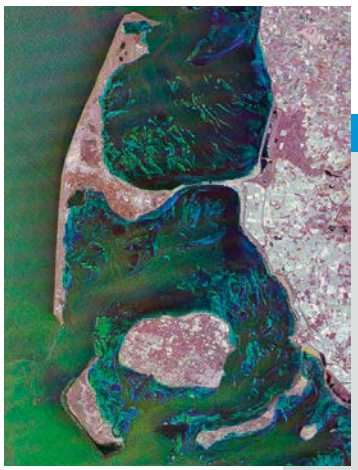
INSPECTION TOUR WITH MINIMAL LUGGAGE

Germany's rail network needs to be monitored regularly. During these checks, lines need to be closed, which is laborious and costly for the railway operator. Transport researchers at the DLR have now found a way to pack the required measuring technology into a small suitcase. Equipped with a microphone, camera and sensors, this suitcase can be carried on normal trains and used, for example, to measure vibrations and noise levels. Damage to tracks can thereby be detected with far less effort than was previously required. Moreover, the software can be installed as a smart phone app that transmits location data to a server.

of resources, and civil security. The work of the DLR is supported by a modern infrastructure that is constantly being adapted to researchers' needs. It aims to develop innovative technologies, systems and operating procedures that will improve the competitiveness of German industry as regards astronautic applications and markets. The programme is oriented towards the German government's space strategy and has been tasked with developing the required technological foundations for new space missions and the collection and analysis of data. Research topics include Earth observation, communications, navigation, space exploration, research under space conditions, space transport and space systems technology, including robotics.

Transport

Ensuring mobility in the future is a central challenge. For many years now, the capacity of transport systems for pas-



The island of Sylt seen through radar eyes, in this case using TerraSAR-X satellite. *Image: DLR*

German Aerospace Center (DLR)

TIDELAND IN THREE DIMENSIONS

Tides and rough weather bring constant change to the Wadden Sea, or Wattenmeer. Radar interferometry is helping researchers to trace the topography of this tideland. The data they are gathering are important both for monitoring this sensitive ecosystem and for shipping. The DLR has been commissioned by the Federal Institute of Hydrology to investigate how the tideland can be mapped from the air using radar. The advantage of using radar instead of laser measurements is that radar can scan a larger area during each flyover, which makes mapping 10 to 20 times faster.

Structures made of fibre-reinforced polymers can be repaired quickly and efficiently with the help of a mobile repair station. *Image: DLR/Frank Eppler*

German Aerospace Center (DLR)

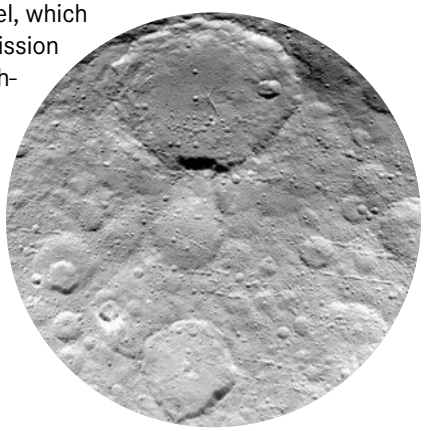
PATCHES FOR POLYMERS

A new concept for repairing structures made of fibre-reinforced polymers could make such materials more economically viable in aircraft and vehicle manufacturing. The idea involves using a laser to remove damaged material and then applying a kind of band-aid by means of sheet metal warmed by induction. This method allows the patch to be pressed onto the affected areas using the effects of heat and pressure. Repairing damage to polymer structures has hitherto entailed their complete replacement. The repair concept was selected as one of the best innovations to be presented at the JEC Americas Composite Show & Conference in Houston, USA.

German Aerospace Center (DLR)

VIRTUAL FLIGHT OVER THE DWARF PLANET CERES

On 6 June 2015, planetary researchers at the DLR released a film showing a scenic flight over the icy dwarf planet Ceres. The film was made using 80 photographs of Ceres taken from the Dawn orbiter. The virtual flight, which shows a planetary body more than 335 million kilometres from Earth, takes viewers across crater landscapes, light patches and extensive plains. The film-makers used the images of Ceres to create a three-dimensional terrain model, which is being refined as the mission progresses. DLR researchers are also responsible for producing cartographic surveys of the dwarf planet.



The surface of the dwarf planet, photographed on 23 May 2015 from the Dawn orbiter at a distance of 5,100 kilometres and with a resolution of 480 metres per pixel. *Image: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA*

sengers and goods has been expanding. However, there has been an ongoing conflict between the individual desire for unlimited mobility, on the one hand, and overburdened transport systems, the negative effects of traffic on people and the environment, and the high number of accident victims, on the other. The world requires modern transport systems for people and goods that are economically, ecologically and socially sustainable over the long term. The DLR's transport experts are utilising the extensive potential for synergies between aviation, astronautic and energy research in order to respond to these challenges. Research and development in this area is focusing on ground-based vehicles, traffic management, the traffic system and the interdisciplinary topics electric mobility and urban mobility. Scientists are developing concepts for next-generation cars, utility vehicles and trains with the aim of reducing energy use and noise and improving safety and comfort.

RESEARCH FIELD MATTER

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

MISSION

Helmholtz researchers explore the constituent parts of matter and the forces operating between them on a wide range of levels, from elementary particles to complex functional materials to the systems and structures in the universe. Their work provides the basis not only for a better understanding of our universe but also for the design of materials and active substances used in medicine and industry. Important areas of research include the development, construction and operation of research infrastructure and large-scale scientific devices. For all the areas of this research field, the Helmholtz Association provides researchers from Germany and abroad with access to a variety of unique, large-scale scientific facilities, including detectors, complex data acquisition systems and particle accelerators. When completed, the European XFEL and the Facility for Antiproton and Ion Research (FAIR) will be the first radiation sources in Germany operated by the international research community.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Seven Helmholtz centres are currently working together in three programmes dedicated to research into matter:

- Matter and the Universe
- From Matter to Materials and Life
- Matter and Technologies

OUTLOOK

The field of matter research was launched with a thematically oriented structure in the third period of programme-oriented funding by the Helmholtz Association. The association's large-scale research infrastructure and scientific facilities have been assigned to the relevant programme themes, and these research facilities form the foundation of scientific work within the research field. Strategic considerations regarding the use of research facilities play an important role in the way the association functions, which is reflected in the development of thematic strategies by the Helmholtz centres. For example, the second programme saw the development of a roadmap for neutron research as well as preparatory work on the development of roadmaps for research into astroparticles and photons. The field of matter research has thereby initiated a process to coordinate strategic development across the association's centres in the coming years in order to ensure that synergies between their research plans are identified and optimally utilised.

PROGRAMMES IN THE FUNDING PERIOD 2015–2019

Matter and the Universe

This programme combines particle and astroparticle physics, the physics of hadrons and nuclei, and atomic and plasma physics in order to answer fundamental questions about the origin, structure and development of the universe. It also investigates the basic building blocks of matter, their interactions and the genesis of complex structures. These research questions are being explored by Helmholtz scientists in the context of large-scale international collaborations. In the three Helmholtz alliances "Physics at the Terascale", "Extreme Densities and Temperatures – Cosmic Matter in the Laboratory" and "Astroparticle Physics", the scientists are

Deutsches Elektronen-Synchrotron (DESY)

Acceleration physicist Jens Osterhoff and his team use the electron beam generated by the FLASH accelerator at DESY to conduct experiments with plasma cells. *Image: H. Müller-Elsner/DESY*

SETTING ACCELERATION RECORDS WITH PLASMA WAVES

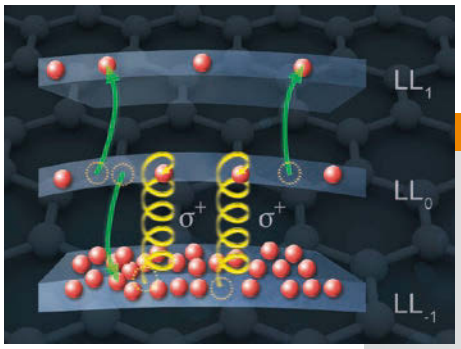
Large-scale devices are crucial to cutting-edge research. However, in the future some of these devices may well be smaller, more compact and yet at the same time enormously powerful. Today's particle accelerators, for example, which are often several kilometres long, could be made smaller by a technology that is based on an exotic state of matter – plasma. The atoms in plasma are split into positively charged ions and negatively charged electrons that can move about freely. Scientists can already generate plasma waves that are able to accelerate electrons to energies of billions of electron volts.
These developments are the focus of research being undertaken by working groups from the Deutsches Elektronen-Synchrotron (DESY) and the University of Hamburg. The groups are collaborating within the framework of LAOLA – the Laboratory for Laser and Beam-Driven Plasma Acceleration. "We want to develop plasma accelerators that are ready for application," says Florian Grüner, LAOLA spokesman. "We are currently carrying out basic research aimed at generating stable, controllable, high-quality electron beams." Such beams will be required, for example, to operate the X-ray free-electron lasers of the future, which will be several metres long instead of several kilometres. "Our goal is to build the first 'table-top FEL' – a free-electron laser the size of a compact laboratory," Grüner adds. "In the next four to five years we want to show that such a device can function in principle. That would be a major breakthrough."
For this to happen, the accelerator physicists must first acquire basic knowledge about processes that take place in femtoseconds – one billionth of one millionth of a second. These processes occur in a plasma in which extremely high forces act between particles and waves moving at almost the speed of light. This is no easy task, says Ralph Aßmann, who is developing the new accelerator technologies with his group. "We have experts studying ultrafast processes and specialists for high-power lasers and focused electron beams. We have decades of experience in accelerator construction. But although we have repeatedly set new acceleration records with plasma cells, we are still unable to control or steer these processes with sufficient precision – which means we can't use them."

Additional examples from this research field »

able to take advantage of networks with colleagues from other research facilities, universities and Max Planck institutes. The collaborations are also providing researchers with access to unique large-scale facilities and infrastructure, including not only the Large Hadron Collider (LHC) at CERN – the world's most powerful particle accelerator – and the GSI accelerator complex, but also numerous large-scale detectors, underground laboratories and observatories that allow them to look deep into the cosmos.

From Matter to Materials and Life

In this programme, researchers use state-of-the-art radiation sources to investigate the structures, dynamic processes and functions of matter and materials. Their work involves close collaboration with universities and industry. Research focuses include transitional states in solids, molecules and biological systems, complex matter, tailored intelligent functional materials and the design of new materials for the energy sector, transport systems and informa-



Auger scattering in graphene causes a redistribution of electrons. *Image: Michael Voigt/HZDR*

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

MAGNETIC FIELDS AND LASERS COAX A SECRET OUT OF GRAPHENE

For the first time, researchers at the HZDR have used a magnetic field to investigate the dynamics of electrons in graphene. With the help of a laser they excited the negatively charged particles to a particular energy level and in the process discovered that the very energy level into which the laser was constantly pumping new electrons emptied. This effect is caused by collisions between the electrons. The discovery could facilitate the development of a laser that can produce light with freely adjustable wavelengths in the infrared and terahertz range.

Scientists are using the particle detector on the International Space Station to investigate the origin and nature of cosmic rays. *Image: NASA*

Karlsruhe Institute of Technology (KIT)

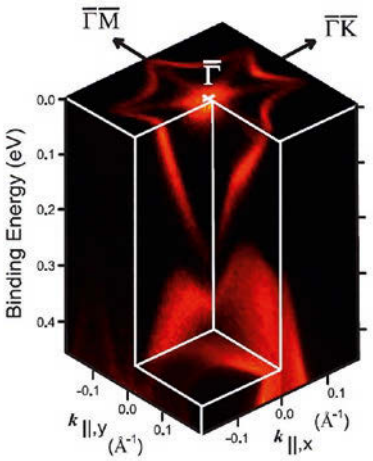
NEW INSIGHTS INTO COSMIC RAYS

High-energy particles reaching the Earth provide important information about the universe. In order to determine the original composition and energy of these particles, they need to be measured with a detector outside the atmosphere. This is the task of the AMS (Alpha Magnetic Spectrometer) particle detector that was installed on the International Space Station in May 2011. Using AMS data, a group of young scientists from the Karlsruhe Institute of Technology was able to determine the total flux of electrons and positrons.

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

SHEDDING LIGHT ON TOPOLOGICAL INSULATORS

Topological insulators function as insulators in their interior but are highly conductive on their surfaces. It is this property that makes them interesting candidates for use in new information technologies. A team at the HZB has now examined the role played by the direction of electron movement within topographical insulators and has observed the spin of these electrons for the first time. When significantly shorter light pulses become available through the planned upgrade of the BESSY II photon source to BESSY-VSR, the team also hopes to investigate the dynamics of these electrons and thereby gain a proper understanding of the exotic behaviour of these new materials.



In topological insulators electrons behave like light. *Image: HZB*

tion technologies. A further goal is to improve the molecular structure and thus the properties of active substances. International research groups and collaborating partners are given access to photon, neutron and ion sources, high magnetic field laboratories and high-performance lasers. This research infrastructure includes ANKA, BER II, BESSY II, ELBE, FLASH, GEMS, HLD, IBC, JCNS and PETRA III, as well as the international facilities in which the Helmholtz Association is participating such as the European XFEL and the Facility for Antiproton and Ion Research (FAIR).

Matter and Technologies

This programme is a new initiative designed to pool the technological know-how of the different Helmholtz centres and to further develop the research field in strategic terms.

The experimental storage ring at the GSI Helmholtz Centre for Heavy Ion Research. *Image: J. Mai/GSI*

GSI Helmholtz Centre for Heavy Ion Research

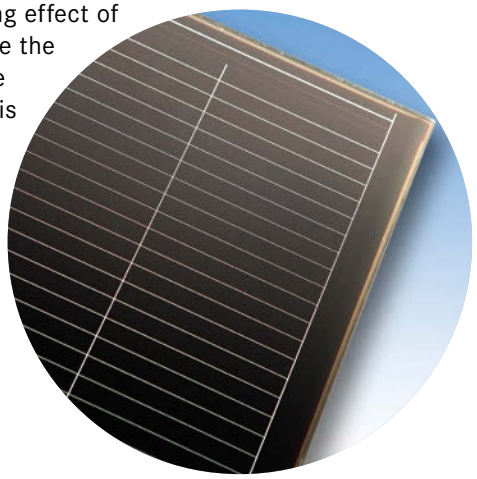
FUNDAMENTALS OF PHYSICS CONFIRMED

Using the GSI experimental storage ring, an international research team has verified two fundamental theories in physics: Einstein's special theory of relativity and the theory of quantum electrodynamics. Experiments with lithium ions confirmed with unprecedented precision the time dilation at high velocities that is predicted by the theory of relativity. In addition, the team provided the first direct proof of a spectral line in highly charged bismuth ions, thereby validating a prediction made by quantum electrodynamics.

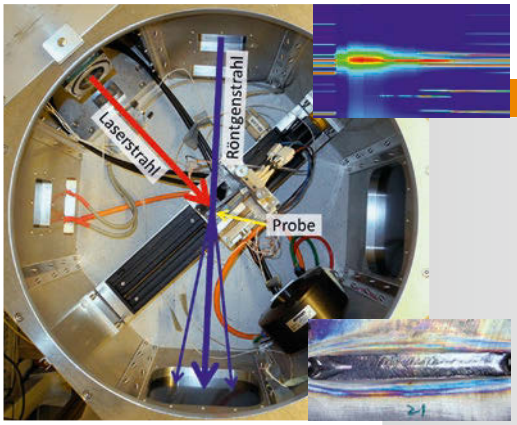
Forschungszentrum Jülich

BRIGHT SPOT FOR SOLAR CELLS

Researchers at Jülich have gained a direct view of the light propagation in a thin-film solar cell in which periodic nanostructures capture sunlight particularly efficiently. The scientists used scanning near-field optical microscopy and the quantum mechanical tunnelling effect of light in order to make the captured light visible from the outside. This new method could help improve solar cells and optoelectronic components.



Thin-film solar cell. *Image: Forschungszentrum Jülich*



Chamber for in-situ laser welding in an X-ray beam; above: time-resolved diffraction, below: weld seam. *Image: HZG*

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)

LASER WELDING: NEW INSIGHTS FROM IN-SITU EXPERIMENTS WITH SYNCHROTRON RADIATION

Today laser welding is a standard industrial technique that offers many advantages. However, further research and development is needed to make this technique compatible with new materials such as light TiAl alloys. In an unprecedented experiment using the HZG beamlines at PETRA III, researchers were able to examine for the first time changes to the material structure during the laser welding of TiAl. The information that this experiment yielded on phase transitions and internal stresses is facilitating a deeper understanding and optimisation of this process.

Challenges and goals in this context include the exploration and development of new accelerator technologies and the development of detector systems for a broad range of applications. Researchers are also focusing on the further development of high-performance computers and data storage. An additional aim is to expand knowledge transfer between the Helmholtz centres, other research organisations and industry while also strengthening the ties between the individual research fields within the association. The new programme structure is creating numerous interfaces between the programmes and programme themes in the field of matter research. The Helmholtz Association's large-scale scientific facilities, in particular, offer numerous synergies. Using them requires thematic coordination and generates concrete cooperation within the framework of large-scale collaborations.

RESEARCH FIELD KEY TECHNOLOGIES

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

MISSION

Research in the field of key technologies focuses on the investigation and development of technologies that can contribute to dealing with major social challenges. The individual research programmes cover the entire range from fundamental research to application and involve interdisciplinary collaboration. Our state-of-the-art research infrastructures are constantly being further developed as the result of our work and are made available to members of the wider research community. This research field aims to provide impetus for innovation, thereby helping to maintain Germany's leading position as a location for science. To this end we are dynamically developing the existing programmes in this field in a dialogue with the scientific community, government, society and industry.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Three Helmholtz centres are involved in key technologies research, which comprises nine programmes:

- Supercomputing & Big Data
- Future Information Technology
- Science and Technology of Nanosystems
- Advanced Engineering Materials
- BioSoft: Fundamentals for Future Technologies in the Fields of Soft Matter and Life Sciences
- BioInterfaces in Technology and Medicine
- Decoding the Human Brain
- Key Technologies for the Bioeconomy
- Technology, Innovation and Society

OUTLOOK

This research field addresses central scientific topics that will play a decisive role in developments in three key disciplines in the coming decades – information technologies, materials sciences and life sciences. The highly successful research programmes pursued during the previous funding period are being continued and strengthened. The integration of multidisciplinary approaches – as seen, for example, by linking technology and medicine, simulation and big data, supercomputing and brain research, as well as microbial biotechnology and plant sciences – is laying the foundations for novel solutions in the field of key technologies.

PROGRAMMES IN THE FUNDING PERIOD 2015–2019

Supercomputing & Big Data

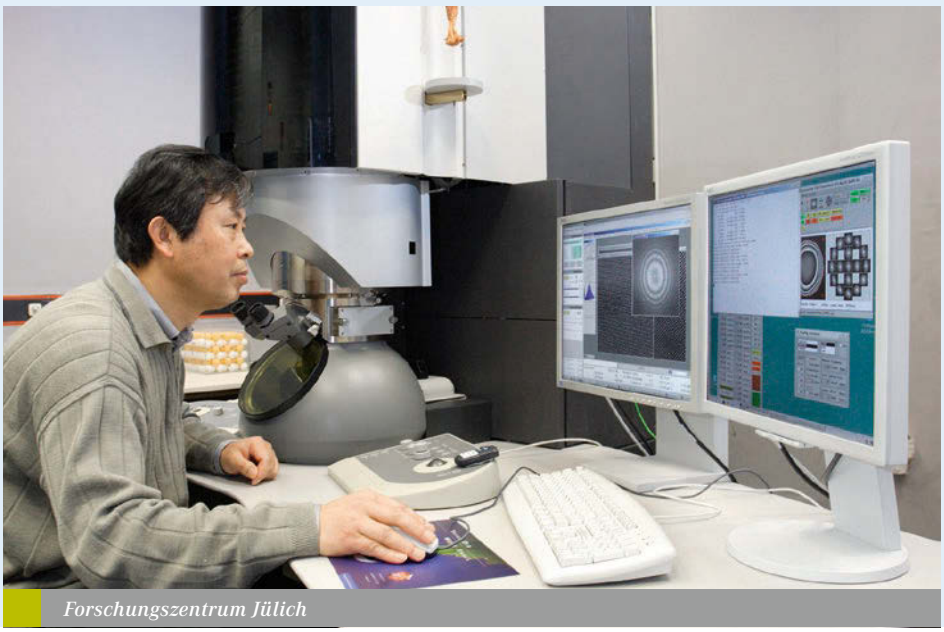
The aim of this programme is to make available the tools and infrastructure required for high-performance computing and the management and analysis of a large volume of data. The constantly growing complexity of systems and processes investigated by scientists is reflected in the increasing demands being placed on analytical systems and methods.

Future Information Technology

This is a physics and material sciences-based programme focusing on the development of a new understanding of future information technology and control of electronically phenomena that can be exploited for the processing of information with a very low expenditure of energy.

Science and Technology of Nanosystems

The goal of this programme is to develop new technologies for the synthesis and functionalisation of nanostructured



Forschungszentrum Jülich

Chunlin Jia from Jülich's Ernst Ruska-Centre, a contributor to the study, working with the TITAN electron microscope.
Image: Forschungszentrum Jülich

BREAKTHROUGH IN ELECTRON MICROSCOPY: CRYSTAL STRUCTURE IN THREE DIMENSIONS

With the help of an ultra-high-resolution electron microscope, it is possible to reconstruct crystal structures three-dimensionally down to the last atom. This feat was recently achieved by scientists from Forschungszentrum Jülich, the Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C) and China's Xi'an Jiaotong University. The process is especially well suited for the complete spatial mapping of radiation-sensitive samples, which would be quickly destroyed by a high-energy measurement beam.
The surface of nanoparticles determines their physical and technical properties to a much larger extent than is the case with other materials. Now the team of scientists has succeeded for the first time in calculating the spatial arrangement of the atoms in nanoparticles using a single image from an electron microscope.
The comparatively short data acquisition time involved could even make it possible in the future to observe the transient intermediate steps involved in chemical reactions. Moreover, the "gentle" measurement procedure allows the detection of not only heavy but also light chemical elements.

For the new 3D measuring process, a thin crystalline specimen is positioned in the microscope such that the atoms at the intersections of the crystal lattice lie exactly on top of one another, forming columns along the observation axes. These atom columns are later only visible as bright spots on the microscopic image. A special imaging mode is used to improve the signal/ background ratio, rendering visible subtle variations that show the researchers the location of the individual atoms in the columns along the beam trajectory. To reconstruct the spatial structure, the scientists compare the image with calculations made on a computer. They then gradually match the calculated model crystal to the image from the electron microscope until optimal correspondence is achieved. In order to verify the uniqueness of their results, the scientists performed extensive statistical tests. These showed that the method is not only sensitive enough to detect each individual atom, but also to differentiate between the elements making up the crystal.

Additional examples from this research field

materials and nanoparticles. Researchers are working on the development of novel process technologies designed to manufacture and structure nanomaterials with specific characteristics.

Advanced Engineering Materials

The focus of this programme is to develop customised alloys for lightweight construction and process technologies for a wide range of applications, such as extremely lightweight construction, heat-resistant high-performance components and medical implants. The new, functionalised materials are primarily utilised in membrane technologies for CO_2 separation and water purification, as well as in hydrogen production and storage.

BioSoft

The properties and interactions of molecules determine the characteristics and functions of the systems they form, such as living cells or cell clusters. Research in this field will provide the knowledge required for the fabrication of functional nanoscale

The JUQUEEN supercomputer at Forschungszentrum Jülich. *Image: Forschungszentrum Jülich.*

Forschungszentrum Jülich

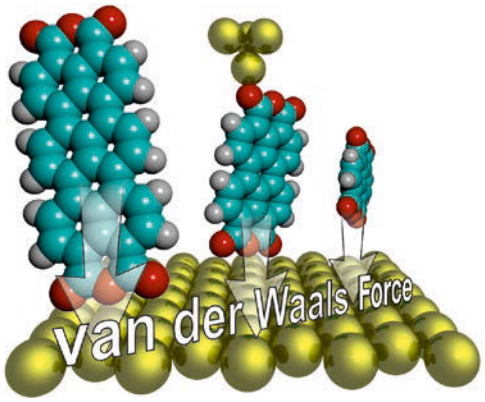
SUPERCOMPUTER CONFIRMS OUR VIEW OF THE WORLD

The only reason that atomic nuclei have the properties that make our world possible is that the neutron is very slightly heavier than the proton. A European team of scientists that includes Jülich researchers has now calculated the tiny difference in mass using Jülich's JUQUEEN supercomputer. Their findings have been published in *Science* and are regarded by many physicists as a milestone and as confirming the theory of the strong interaction – one of the building blocks of the Standard Model of particle physics.

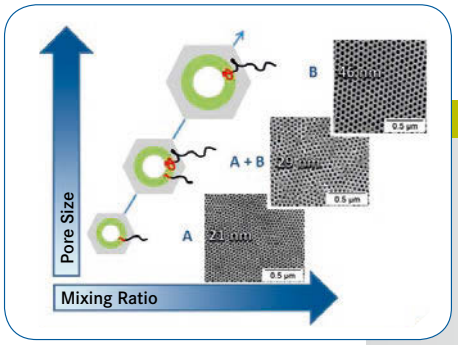
Forschungszentrum Jülich

REMEASURING THE VAN DER WAALS FORCE

The van der Waals forces are responsible for the fact that even molecules with saturated bonds still attract one another. In other words, these forces act like a sort of quantum glue on matter. Jülich scientists have now used a new measuring technique to determine how strongly they bind individual molecules to a surface. With an atomic force microscope, they demonstrated that the forces not only increase with molecular size but do so disproportionately. Their findings could contribute to the improvement of fundamental simulation methods.



Schematic experimental setup: when different types of molecules are removed from a metal surface the van der Waals forces can be determined using frequency changes at the tip of the atomic force microscope. *Image: Forschungszentrum Jülich*



Mixing two block copolymers results in a mean pore size in the membrane with a linear dependence on the mixing ratio. *Image: HZG*

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)

NEW POSSIBILITIES IN THE DESIGN OF BLOCK COPOLYMER MEMBRANES

Until now, it has been necessary to synthesise a tailored block copolymer for every isoporous membrane with a particular pore size. At the HZG Institute of Polymer Research, membrane researchers have now developed a time-saving and surprisingly simple method that enables them to achieve the desired pore size by simply mixing two block copolymers in a linear mixing ratio.

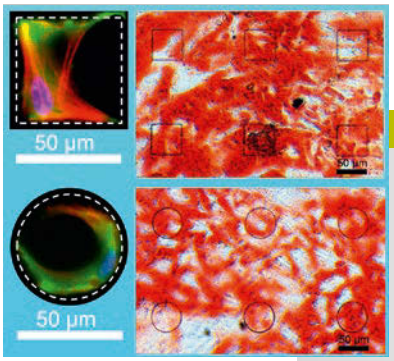
materials, the controlled manipulation of the flow properties of complex liquids, and the development of molecular active substances.

Biointerfaces in Technology and Medicine

Active biomaterials are becoming increasingly important in regenerative medicine, biological medical technology and biotechnical procedures. This programme deals with the entire developmental chain from biomaterials to toxicological and immunological evaluation up to and including the design of implants and controlled drug delivery systems.

Decoding the Human Brain

The aim of this programme is to deploy innovative imaging techniques in order to develop a structurally and functionally realistic multimodal model of the human brain for basic and translationally oriented research. Due to the complexity of the brain and the extensive changes during the life span,



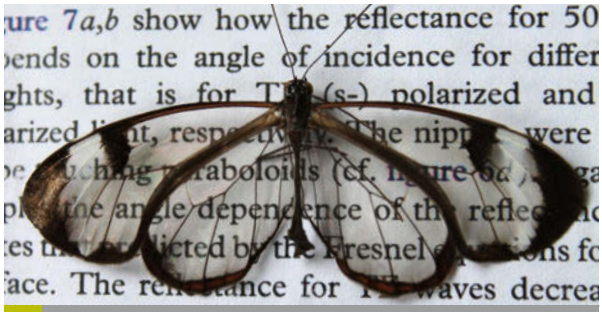
The spatial organisation of the stem cells in accordance with the geometry of the micro-indentations (left) influences cellular processes. This can be seen in the density of bone-cell formation (right). *Image: HZG*

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)

REGULATION OF STEM CELLS VIA MICRO-STRUCTURED POLYMER SURFACES

At the HZG Institute of Biomaterial Science, scientists have developed a polymer surface featuring micro-indentations of different depths that are able to regulate the characteristics and functions of stem cells. Working with human mesenchymal stem cells (precursor cells of connective tissue), they found that, in contrast to a circular arrangement, quadratic structuring of such indentations supports not only cell division and tissue formation but also the development of bone cells. These findings provide useful information for the design of medical implants that promote the body's own tissue regeneration.

In contrast to other transparent surfaces, the wings of the glasswing butterfly (*Greta oto*) barely reflect any light at all. *Image: KIT/Radwanul Hasan Siddique*



Karlsruhe Institute of Technology (KIT)

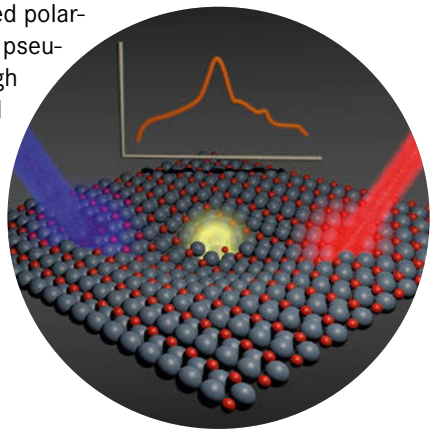
LIMITED WING REFLECTION MAKES BUTTERFLIES ALMOST INVISIBLE

Anyone who uses a mobile phone is familiar with the way reflected sunlight obscures the display. Now, it seems that a remedy to this problem was found in nature. The transparent wings of the glasswing butterfly barely reflect any light at all, making the butterfly invisible to predators. Scientists at the Karlsruhe Institute of Technology have discovered that this lack of reflection is due to the effect of irregularly arranged, pillar-like nanostructures on the surface of the butterfly's wings. The researchers were able to reproduce this effect in theoretical experiments.

Karlsruhe Institute of Technology (KIT)

PSEUDOPARTICLES TRAVEL THROUGH PHOTOACTIVE MATERIAL

Processes converting light into storable energy can contribute decisively to a sustainable energy supply. Researchers at the Karlsruhe Institute of Technology (KIT) have now discovered the mechanism involved in an important step in such processes. In cooperation with scientists from the Fritz Haber Institute in Berlin and Aalto University in Helsinki, Finland, they studied the formation of so-called polarons in zinc oxide. These pseudoparticles travel through the photoactive material until they are converted into electrical or chemical energy at a boundary layer.



Scientists investigated the formation and movement of so-called polarons in the photoactive material zinc oxide. *Image: Patrick Rinke/ Aalto University*

this goal can only be achieved by using high-performance computers.

Key Technologies for the Bioeconomy

This programme focuses on the development of future technologies that can be used to develop a sustainable bioeconomy. The work on industrial biotechnology concentrates on the biobased production of chemicals, pharmaceuticals and proteins using microbial and enzymatic processes. The research in the field of plant science will help to improve the quality of plant biomass and produce plant-based chemicals and materials.

Technology, Innovation and Society

The programme encompasses the systematic investigation of the diverse interfaces between technology, innovation and society with the goal of supporting decision-making in government, economy, and society. To this end, it pools expertise in energy systems analysis, technology impact assessment, and policy consulting.

PERFORMANCE RECORD

The Helmholtz Association's mission is to conduct forward-looking research that contributes to solving the major and pressing problems of science, society and industry. The Helmholtz Association is the largest scientific organisation in Germany with around 38,000 staff members at 18 research centres and a total annual budget of 4.24 billion euros. Approximately 70 per cent of its funds are provided by Germany's federal and state governments at a ratio of 90 to 10. The centres raise around 30 per cent of the total budget themselves in the form of third-party funding. The association uses these funds to carry out cutting-edge research. The following pages present a range of informative indicators showing the Helmholtz Association's performance and potential.

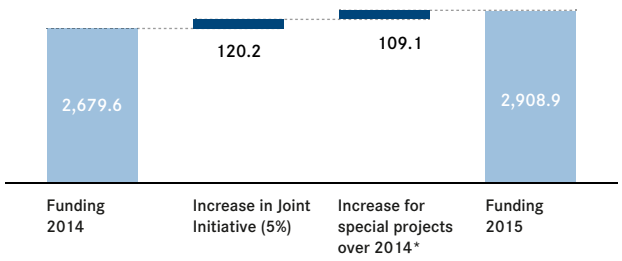
RESOURCES

Core funding for the Helmholtz Association for fiscal year 2015 increased to around 2.91 billion euros from approx. 2.68 billion euros during the previous year.

Development of resources

Growth 2014–2015

in million € (federal and state governments)

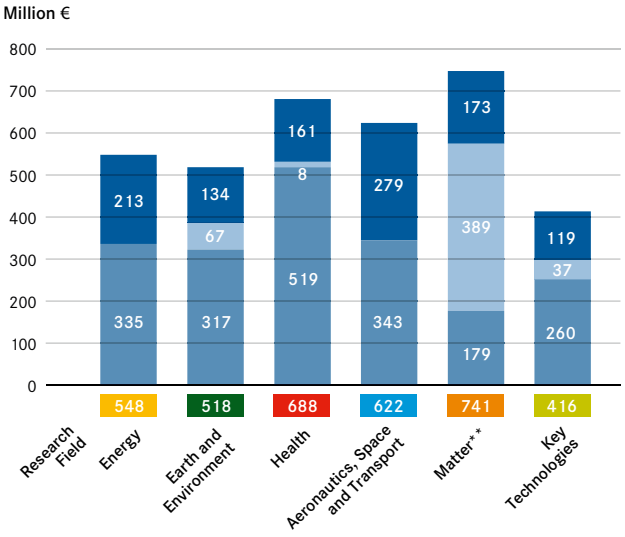


*Including the German Centres for Health Research, financed by the federal and state governments, the Berlin Institute of Health (€100.6 million) and special financing from the federal government for the new building of the Berlin Institute for Medical Systems Biology (€2 million), the Little Scientists' House (€1 million) and the new building of the German Center for Neurodegenerative Diseases (€5.5 million)

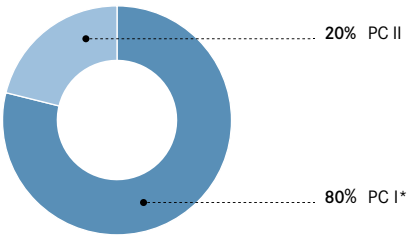
This growth is a result of the 5 per cent increase in funding from the Joint Initiative for Research and Innovation II and the expansion of certain special projects that receive additional financing from the state and federal governments. These projects include in particular the German Centres for Health Research, which are currently being established and expanded and are set to be completed by 2015.
At first glance, it may appear that, with the exception of the research field Key Technologies, overall financial resources are spread equally across all of the research fields, but in fact the resources allocated to the research field Matter are invested primarily in research infrastructure and user platforms (Performance Category II, or PC II). As a whole, in-house research in the Helmholtz Association's 30 research programmes (Performance Category I, or PC I) accounts for the predominant share of the allocated funds.

2014 budget showing core and third-party funding for the research fields

(including funds for the non-programme-linked research used to expand existing research programmes)



PC I* and PC II without third-party funds



Third party funds
PC II
PC I*

* including the portfolio topics, the Helmholtz institutes and the Helmholtz share of both the German Centres for Health Research and the Cancer Information Service
** "Structure of Matter" until 31 December 2014

The bar chart shows core and third-party financing as actual costs for 2014. Actual costs are funds that were in fact used by the research centres during the year under review.

Currently around 20 per cent of resources are allocated to research infrastructure and user platforms. This share, which has remained relatively constant over the past ten

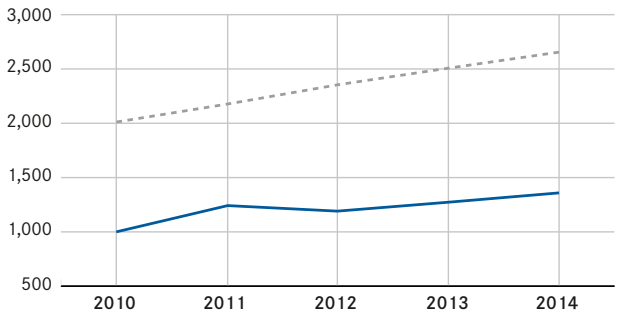
DR. ROLF ZETTL
Managing Director of the
Helmholtz Association

years, is expected to increase slightly when two additional large-scale facilities (the European XFEL free-electron laser and the FAIR accelerator facility) are put into operation.

Third-party funding

In addition to core financing, a substantial amount of third-party funding – raised primarily in competitions – is available to the Helmholtz centres. In 2014 the Helmholtz Association acquired third-party funds totalling 1.33 billion euros, representing an increase of 5 per cent over the previous year.

Third-party funds



[1] Project sponsorships have been fully factored in since 2011 (amounting to around 202 million euros in 2014).

Sources: Progress Reports of the Helmholtz Centres, 2010–2014

The grants acquired through the EU's Framework Programmes (including "Horizon 2020") represent a particularly important share of third-party funding. Part of the funding in 2014 came from projects that had received such grants in recent years.

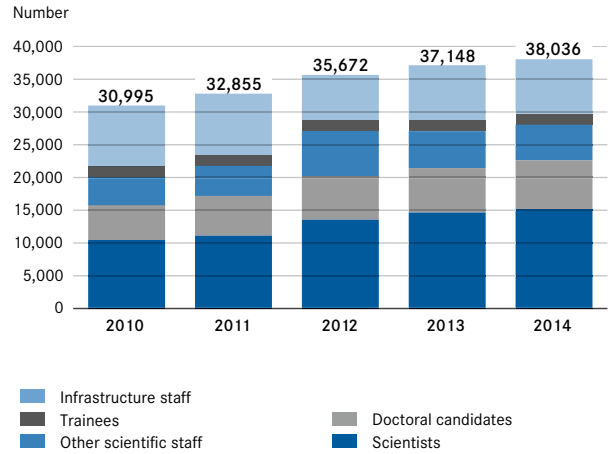
Acquired EU research funds

in T€	2010	2011	2012	2013	2014
Funds from the EU for research and development	118,477	146,188	126,936	122,612	132,888

The Helmholtz Centres participated in 140 projects that were newly funded by the European Framework Programme (FP). Compared to the previous year, this represents a 51 per cent decline, which is attributable to the end of the 7th FP and the start of Horizon 2020. In 2013 only a small number of the EU's calls for project proposals were of relevance to the Helmholtz centres. As a result, only a small number of projects were newly funded under the 7th FP in 2014. In addition, the first calls for proposals for Horizon 2020 were not issued until December 2013.

Staff developments

Staff developments



The constantly increasing availability of financial resources has made it possible to expand staff at the Helmholtz centres. However, these additional financial resources must cover all the increases in the costs of staffing (effects of labour agreements) and material items, which in some cases exceed budgetary growth. For this reason, staff expansion lags behind that of resources and is concentrated in the centres that pursue activities that receive special funding (particularly the German Centres for Health Research). The growth rates of recent years could not be sustained because in the past they were bolstered by a variety of special effects (integration of the Helmholtz-Zentrum Dresden-Rossendorf in 2011 and GEOMAR Helmholtz Centre for Ocean Research Kiel in 2012). Staff growth was relatively uniform across the different personnel categories.

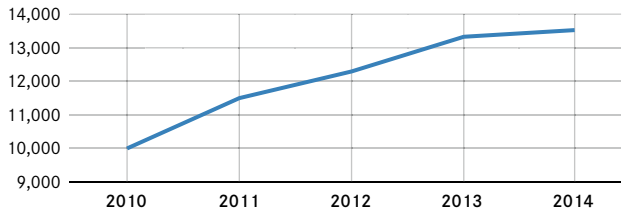
Detailed information on the Helmholtz Association's resources can be found on pages 40/41, broken down by research field and research centre.

SCIENTIFIC PERFORMANCE

Research performance

Publications are a key measure of scientific productivity and there was once again a clear increase in the number of publications by Helmholtz scientists. In 2014, a total of 13,549 papers were published in ISI or SCOPUS-indexed scientific journals. The number of publications grew by 2 per cent over the previous year and by a total of 35 per cent compared to 2010.

ISI or SCOPUS-indexed publications



A good measure of the quality of research findings is the number of times they are published in prestigious journals. The Nature Publishing Group releases a ranking of the top 200 research organisations worldwide. Known as the Nature Index, this ranking is based on publications in 68 journals that are independently selected by two panels of scientists from the fields of physics, chemistry, environmental science and the life sciences. In 2014 the Helmholtz Association ranked sixth. The table shows the Nature Index for the period 1 January 2014 to 31 December 2014.

Nature Index 2014

Rank	Institution	No. of Articles
1	French National Centre for Scientific Research (CNRS), France	4,894
2	Chinese Academy of Sciences (CAS), China	3,114
3	Max Planck Society, Germany	2,944
4	Harvard University, USA	2,612
5	Spanish National Research Council (CSIC), Spain	1,773
6	Helmholtz Association, Germany	1,613
7	Massachusetts Institute of Technology (MIT), USA	1,475
8	University of Cambridge, UK	1,379
9	Pierre and Marie Curie University (UPMC) – Paris 6, France	1,364
10	Stanford University (SU), USA	1,263

User platforms

Along with scientific performance, an important question for the Helmholtz Association is the extent to which it has fulfilled its mission to provide researchers with access to its unique research facilities. In 2014 availability decreased slightly compared to 2013 because the BER II research reactor was temporarily shut down and it was also necessary to deactivate the PETRA II storage ring-based X-ray source in order to construct the PETRA III Extension. A direct comparison with the previous year is possible only to a limited degree because in 2014 the research field Earth and Environment had already entered its new programme period and large-scale facilities were reallocated due to the new programme structure.

Helmholtz Association research facilities

Type of use		Actual value 2013	Actual value 2014*
Availability		79.6%	72.6%
Utilisation	Internal Helmholtz scientists	33.4%	31.8%
	External scientists	63.5%	68.1%

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

National collaboration

In addition to international collaborations, research networks in Germany, especially those with universities, are extremely important for the Helmholtz centres. The extent to which these ties have been expanded is shown by the increase in the number of joint professorial appointments and by the association's participation in the programmes of both the German Research Foundation and the Excellence Initiative (generally with universities).

Joint appointments

	2010	2011	2012	2013	2014
Joint appointments with universities, W2 and W3 staff	319	374	452	499	554

German Research Foundation (DFG)

	2010	2011	2012	2013	2014
Research centres	1	1	2	2	1
Collaborative research centres	61	64	68	67	62
Priority programmes	50	52	52	49	42
Research units	56	62	58	61	55

The DFG table illustrates the success of the Helmholtz centres in the competitions held by the DFG. The count only includes projects in which the participating researchers noted their Helmholtz affiliation in their applications. In a number of cases, Helmholtz researchers who were appointed to positions jointly with universities applied for projects with other scientists within the scope of their university activities. If these projects are also included, the figures for 2014 increase to 96 collaborative research centres, 52 priority programmes and 70 research units.

Participation in the Excellence Initiative

	Excellence clusters	Graduate schools	Institutional concepts
1st phase	13	15	3
2nd phase	19	17	8

International exchange

The Helmholtz Association's research facilities are open to scientists from around the world. In 2014 a total of 7,476 researchers came to the Helmholtz centres from other countries in order to exchange scientific ideas and take advantage of the research opportunities these centres offer. The decline of 12 per cent is attributable to the shutdown of PETRA III, which resulted in fewer foreign researchers visiting the DESY than in the previous year.

Foreign scientists at the Helmholtz centres

	2010	2011	2012	2013	2014
Postgraduate	1,192	1,425	1,705	1,921	1,950
Postdoctoral	825	940	1,103	1,267	1,279
Experienced scientists/ university teachers	1,677	1,680	2,175	2,477	2,305
Guest scientists	2,406	3,153	2,577	2,669	1,721
No categorisation possible/no information	167	165	205	189	221
Total	**6,267**	**7,363**	**7,765**	**8,523**	**7,476**

Talent management

Promoting young scientists is another key component of the Helmholtz Association's strategy for the future. Junior research groups are supported directly by the Helmholtz centres or by grants from the Initiative and Networking Fund. The goal is to foster the early scientific independence of talented young researchers and to offer them reliable career planning. A total of 42 per cent of the Helmholtz Young Investigators Groups and 32 per cent of other junior research groups are now led by women.

Junior research groups

		Total	Women
Junior research group leaders	**Leaders of Helmholtz Young Investigators Groups** (funded by the Initiative and Networking Fund within the framework of the Helmholtz Young Investigators Group programme)	98	41
	Leaders of other junior research groups (e. g., junior research groups at the centres, Emmy Noether groups, etc.)	128	41

The Helmholtz Association has also been systematically expanding its programmes to promote doctoral candidates. It has increased the number of graduate and research schools in order to provide as many candidates as possible with a structured education based on defined quality standards. The success of these activities is reflected in the 10 per cent increase in completed doctoral degrees in 2014 compared to the previous year.

Doctoral work

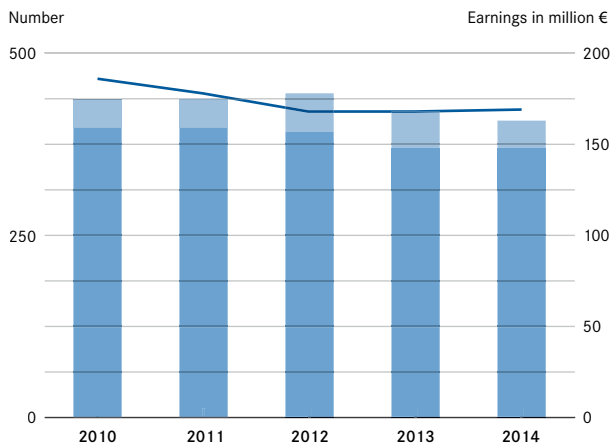
	31.12.10	31.12.11	31.12.12	31.12.13	31.12.14
Number of funded graduate and research schools*	49	75	84	95	116
Number of supervised doctoral candidates**	5,320	6,062	6,635	6,789	7,446
Number of completed dissertations	783	822	803	964	1,059

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

Technology transfer

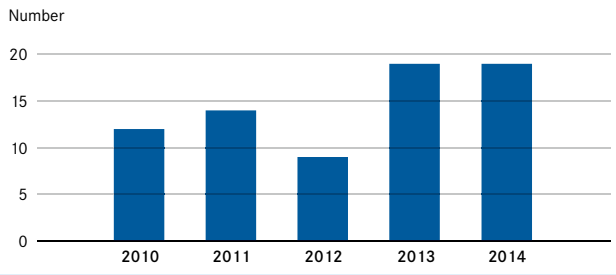
Making research findings available to industry and society is an important part of the Helmholtz Association's mission. In recent years it has therefore invested heavily in the area of technology transfer, especially (at the association level) in the establishment of a validation fund. Grants from this fund make it possible to refine certain research findings to the point where they can be marketed. The steady number of patent applications establishing a claim to priority is attributable to the increasing professionalisation of the association's technology transfer offices, which – more selectively than in the past – are supporting projects that can be expected to have commercial success.

Technology transfer



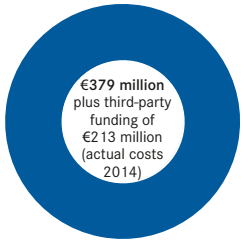
A variety of instruments and incentives are available from both the centres and the association to promote research spin-offs. Support is also provided to the newly formed companies themselves, e. g., through exchange platforms with industry. This area will be expanded in the future.

Research spin-offs



COSTS AND STAFF

Structure of the research field Energy
Target costs of core financing 2014: 379 million euros



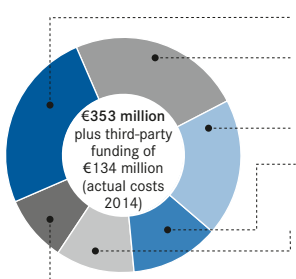
In 2014 the research field Energy was divided into the following programmes*:

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

* The research field Energy was still in the second period of programme-oriented funding in 2014 and the programme structure is portrayed accordingly. Because three research fields had already entered the third period in 2014 and there were shifts between all the research fields, the target values for energy research were newly approved at the research-field level.

Source: Progress Report of the Centres 2014

Structure of the research field Earth and Environment
Target costs of core financing 2014: 353 million euros

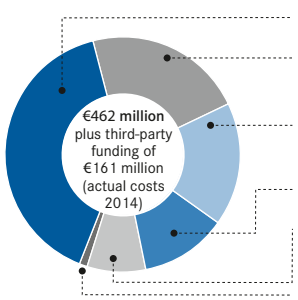


- 25% Terrestrial Environment
- 24% Marine, Coastal and Polar Systems
- 19% PC II*
- 12% Geosystem: The Changing Earth
- 11% Atmosphere and Climate
- 9% Oceans: From the Deep Sea to the Atmosphere

* MESI (GFZ); POLARSTERN, HEINCKE, Neumayer Station III (AWI); ALKOR, POSEIDON (GEOMAR)

Source: Progress Report of the Centres 2014

Structure of the research field Health
Target costs of core financing 2014: 462 million euros*



- 40% Cancer Research
- 22% Genetic and Environmental Influences on Common Diseases
- 17% Disorders of Nervous System
- 12% Infection Research
- 8% Cardiovascular and Metabolic Diseases
- 1% PC II – National Cohort

* Plus funds of €59 million for the Helmholtz share of the German Centres for Health Research and the Berlin Institute of Health

Source: Progress Report of the Centres 2014

COSTS AND STAFF

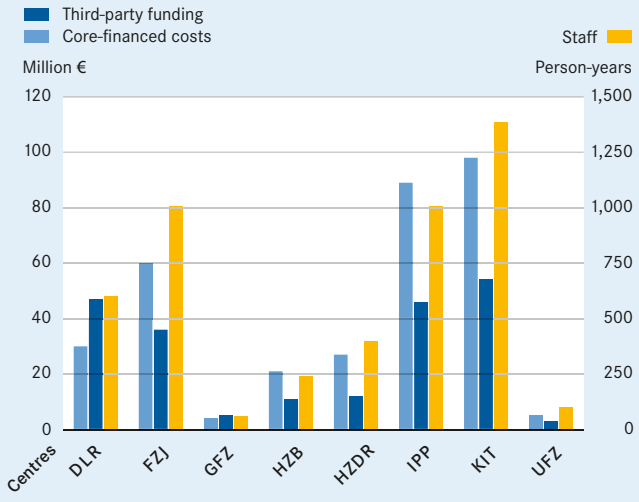
COSTS AND STAFF 2014 for the Helmholtz Association, overview	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff PYs [1]
Research fields, total[2]	2,453,748	1,079,387	3,533,135	31,050
Non-programme-linked research, total[3]	15,649	37,794	53,443	205
Special tasks, total[4]	11,620	9,480	21,100	169
Project sponsorships, total		202,078	202,078	1,991
Helmholtz Association, total	**2,481,017**	**1,328,739**	**3,809,756**	**33,415**[5]

All amounts in thousands of euros. [1]Person-years. [2]In addition to the six research fields, this category includes the funds for portfolio topics, the Helmholtz institutes and the Helmholtz share of the German Centres for Health Research. [3]The funds for non-programme-linked research can amount to a maximum of 20 per cent of all acquired programme funding. If the centres use these funds to strengthen existing research programmes, they are assigned directly to the costs of the respective programmes. [4]Mainly involving the dismantling of nuclear facilities. [5]Expressed as natural persons, the Helmholtz Association has 38,036 employees.

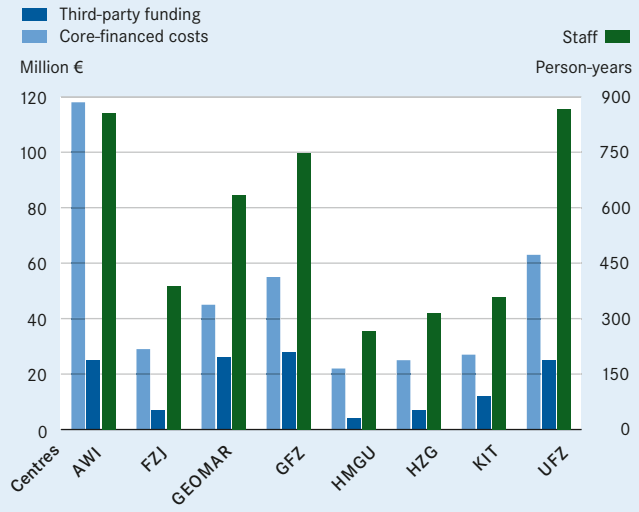
Research Field Energy	Core-financed actual costs T€	Third-party funds T€	Total T€	Total staff PYs [1]
German Aerospace Center (DLR)	30,488	46,988	77,476	601
Forschungszentrum Jülich (FZJ)	59,975	35,784	95,759	1,007
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	21,025	10,709	31,734	242
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	26,714	12,213	38,927	398
Helmholtz Centre for Environmental Research (UFZ)	5,357	2,840	8,197	101
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	3,625	4,736	8,360	63
Karlsruhe Institute of Technology (KIT)	98,197	54,197	152,394	1,385
Max Planck Institute for Plasma Physics (IPP)	89,478	45,825	135,303	1,007
Research Field Energy, total	**334,859**	**213,292**	**548,151**	**4,804**
Research Field Earth and Environment				
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	118,518	25,319	143,837	857
Forschungszentrum Jülich (FZJ)	29,334	6,891	36,225	389
GEOMAR Helmholtz Centre for Ocean Research Kiel	44,919	25,935	70,854	633
Helmholtz Centre for Environmental Research (UFZ)	63,018	24,872	87,890	868
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	24,739	7,012	31,751	315
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	21,928	3,968	25,896	267
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	55,476	28,056	83,532	748
Karlsruhe Institute of Technology (KIT)	26,512	11,880	38,392	357
Research Field Earth and Environment, total	**384,444**	**133,933**	**518,377**	**4,434**
Research Field Health				
German Cancer Research Center (DKFZ)	154,066	62,576	216,642	2,330
German Center for Neurodegenerative Diseases (DZNE)	68,825	6,167	74,992	682
GSI Helmholtz Centre for Heavy Ion Research	4,759	967	5,726	76
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	18,780	3,094	21,874	183
Helmholtz Centre for Infection Research (HZI)	57,420	32,660	90,080	831
Helmholtz Centre for Environmental Research (UFZ)	4,692	531	5,224	54
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	124,867	33,100	157,967	1,694
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	94,215	21,862	116,077	1,052
Research Field Health, total	**527,624**	**160,957**	**688,581**	**6,902**
Research Field Aeronautics, Space and Transport				
German Aerospace Center (DLR)	342,799	279,478	622,277	5,143
Research Field Aeronautics, Space and Transport, total	**342,799**	**279,478**	**622,277**	**5,143**
Research Field Matter[6]				
Deutsches Elektronen-Synchrotron (DESY)	216,485	92,912	309,397	2,107
Forschungszentrum Jülich (FZJ)	49,563	9,204	58,767	533
GSI Helmholtz Centre for Heavy Ion Research	115,752	44,093	159,845	1,453
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	90,957	7,098	98,055	669
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	38,564	7,335	45,899	393
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	10,128	1,243	11,371	92
Karlsruhe Institute of Technology (KIT)	45,878	11,035	56,913	451
Research Field Matter[6], total	**567,327**	**172,920**	**740,247**	**5,698**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	154,565	57,858	212,423	2,067
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	39,273	13,687	52,960	521
Karlsruhe Institute of Technology (KIT)	102,857	47,262	150,119	1,481
Research Field Key Technologies, total	**296,695**	**118,807**	**415,502**	**4,069**

[6] "Structure of Matter" until 31 December 2014

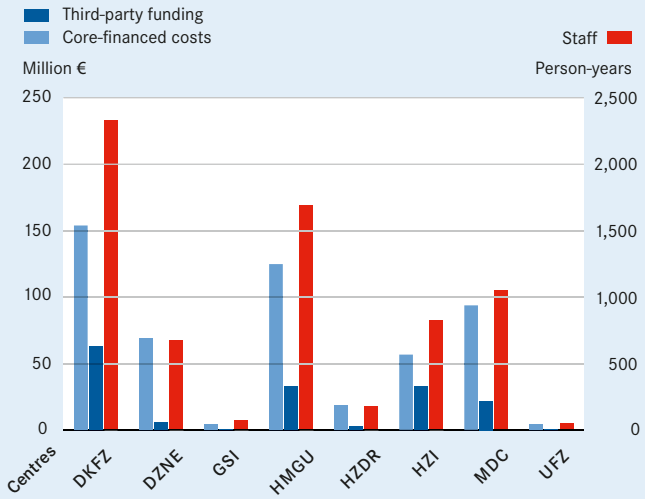
Research Field Energy



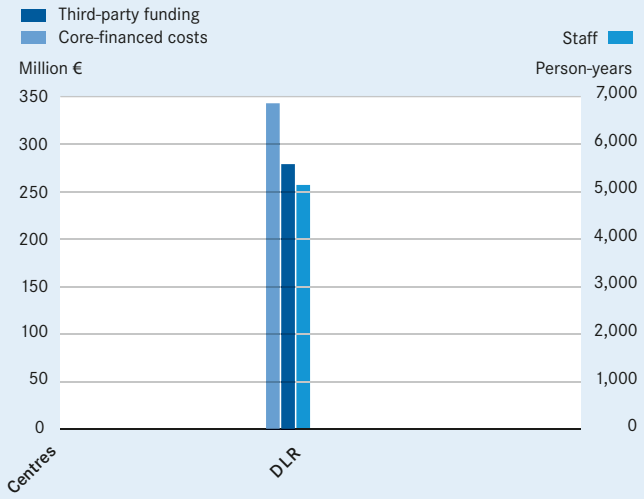
Research Field Earth and Environment



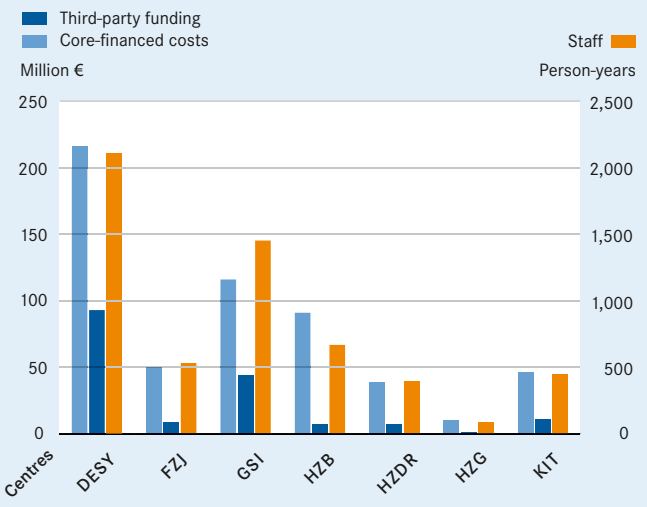
Research Field Health



Research Field Aeronautics, Space and Transport

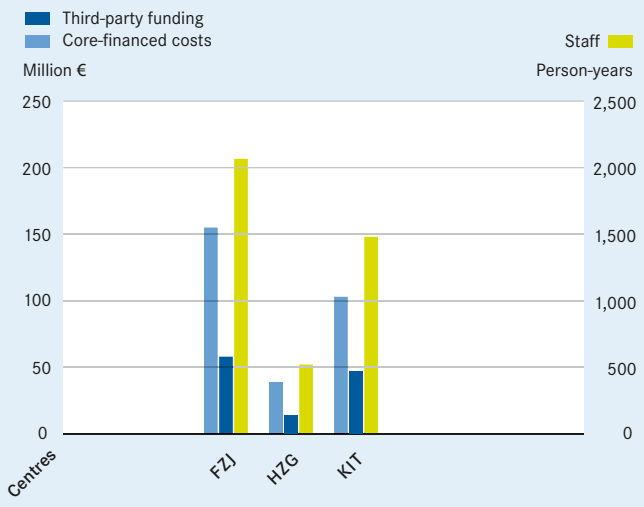


Research Field Matter*

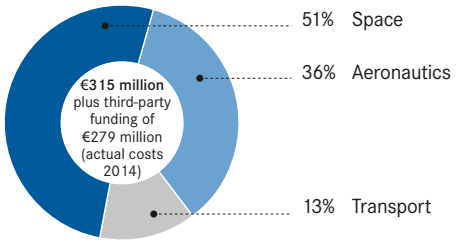


* "Structure of Matter" until 31 December 2014

Research Field Key Technologies

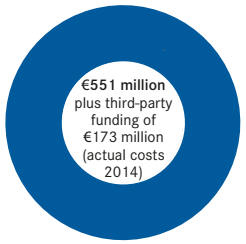


Structure of the research field Aeronautics, Space and Transport
Target costs of core financing 2014: 315 million euros



Source: Progress Report of the Centres 2014

Structure of the research field Matter*
Target costs of core financing 2014: 551 million euros



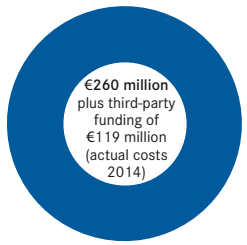
In 2014 the research field Matter was divided into the following programmes*:

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

*Until 31 December 2014 this research field was called "Structure of Matter". The research field Matter was still in the second period of programme-oriented funding in 2014 and the programme structure is portrayed accordingly. Because three research fields had already entered the third period in 2014 and there were shifts between all the research fields, the target values for matter research were newly approved at the research-field level.

Source: Progress Report of the Centres 2014

Structure of the research field Key Technologies
Target costs of core financing 2014: 260 million euros



In 2014 the research field Key Technologies was divided into the following programmes*:

- Supercomputing
- Future Information Technology
- NANOMICRO
- Functional Material Systems
- BioSoft
- BioInterfaces
- Technology, Innovation and Society

*The research field Key Technologies was still in the second period of programme-oriented funding in 2014 and the programme structure is portrayed accordingly. Because three research fields had already entered the third period in 2014 and there were shifts between all the research fields, the target values for key technologies research were newly approved at the research-field level.

Source: Progress Report of the Centres 2014

2014

COSTS AND STAFF BY CENTRE

The Helmholtz Association's annual budget consists of core financing and third-party funding. A total of 90 per cent of core financing is provided by the federal government and 10 per cent comes from the federal states in which the member centres are located. The centres raise around 30 per cent of the total budget themselves in the form of third-party funding. Due to the Helmholtz Association's strategic focus on six research fields, the total budget is broken down for the fiscal year 2014 according to research field and centre. This overview is supplemented by information on the number of staff members expressed in person-years.

Costs and staff by centre, 2014

	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff PYs [1]
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	118,518	25,319	143,837	857
Deutsches Elektronen-Synchrotron (DESY)	216,485	92,912	309,397	2,107
German Cancer Research Center (DKFZ)	154,066	62,576	216,642	2,330
German Aerospace Center (DLR)	373,287	326,466	699,753	5,744
German Center for Neurodegenerative Diseases (DZNE)	68,825	6,167	74,992	682
Forschungszentrum Jülich (FZJ)	293,437	109,737	403,174	3,996
GEOMAR Helmholtz Centre for Ocean Research Kiel	44,919	25,935	70,854	633
GSI Helmholtz Centre for Heavy Ion Research	120,511	45,060	165,571	1,529
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	111,982	17,807	129,789	911
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	84,058	22,642	106,700	974
Helmholtz Centre for Infection Research (HZI)	74,140	21,942	96,082	928
Helmholtz Centre for Environmental Research (UFZ)	57,420	32,660	90,080	831
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	73,067	28,243	101,310	1,023
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	146,795	37,068	183,863	1,961
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	59,101	32,792	91,893	811
Karlsruhe Institute of Technology (KIT)	273,444	124,374	397,818	3,674
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	94,215	21,862	116,077	1,052
Max Planck Institute for Plasma Physics (IPP)	89,478	45,825	135,303	1,007
Non-programme-linked research	**15,649**	**37,794**	**53,443**	**205**
Special tasks[2]	**11,620**	**9,480**	**21,100**	**169**
Project sponsorships		**202,078**	**202,078**	**1,991**
Helmholtz Association, total	**2,481,017**	**1,328,739**	**3,809,756**	**33,415**

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

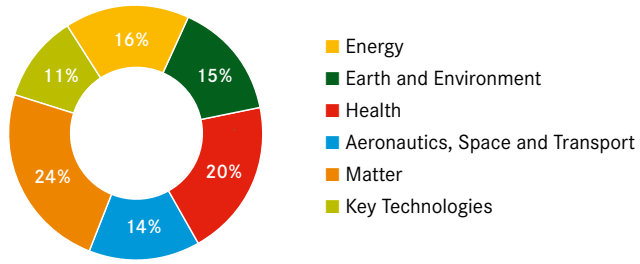
THIRD ROUND OF PROGRAMME-ORIENTED FUNDING, 2015–2019

In 2015 the third period of programme-oriented funding began for all the research fields and their programmes. The financing recommendations for 2015 – resulting from the review by the Helmholtz Senate – are shown for all the research fields below.

Target costs of programme-oriented funding 2015: 2,426 million euros

	Target costs 2015 in million €
Energy	397
Earth and Environment	368
Health*	482
Aeronautics, Space and Transport	331
Matter	576
Key Technologies	272
Total	**2,426**

* Not including the German Centres for Health Research and the Berlin Institute of Health



JOINT INITIATIVE FOR RESEARCH AND INNOVATION

The Joint Initiative for Research and Innovation guarantees the Helmholtz Association and other non-university research organisations a budget with increases of 5 per cent per year until 2015. The report on the following pages describes how the Helmholtz Association and its member centres are fulfilling the initiative's objectives.

With the Joint Initiative for Research and Innovation, the German federal and state governments have created optimal conditions for developing the participating research organisations. The Helmholtz Association has been systematically taking advantage of this additional scope to expand its research portfolio in accordance with its mission, to cultivate networks within the national and international research communities, to recruit and develop skilled staff and to improve technology transfer.

New, strategically relevant research topics

The Helmholtz Association is committed to conducting socially relevant research and addressing the major challenges facing society, science and industry today. To fulfil this mission, at five-year intervals the association systematically reviews the portfolio of research topics that are core-financed within the framework of programme-oriented funding. An additional factor influencing its new programme structure is the comprehensive thematic planning process that began in all of the association's research fields in 2010. Sixteen of these new research topics were allocated funding from the Joint Initiative for Research and Innovation so that the work on these topics could begin before the start of the new 2014/15 programme period.
In 2014 experts strategically evaluated the programme proposals for the research fields Energy, Matter and Key Technologies and made recommendations for the future direction of research. Overall, the experts confirmed the high strategic relevance of Helmholtz research to society, science and industry. All of the evaluated programmes are characterised by an extremely high quality, which in some fields is unique in the world. The new cross-programme initiative "Energy System 2050" is aiming to develop technological solutions for the successful integration of renewable energies into the energy system. For this purpose, it is carrying out technology-oriented investigations that are being supplemented in the research field Energy by the comprehensive cross-programme analysis of energy systems. In the research field Matter, DESY researcher Henry Chapman developed a method for determining the atomic-scale structure of complex biomolecules in their natural environment. Known as serial femtosecond crystallography, it uses X-ray lasers such as the European XFEL and has been refined to the point where it is ready for application. For this achievement Chapman received the 2015 Leibniz Prize. In the research field Key Technologies, the new programme "Key Technologies for the Bioeconomy" is seeking to optimise biological resources in the framework of a comprehensive sustainable bioeconomy concept.

Pooling expertise through alliances in the research system

Science thrives on collaboration and the exchange of ideas. The Helmholtz Association has used funding from the Joint Initiative for Research and Innovation to establish a wide range of collaborative models, from temporary networks in which project partners pursue a common goal at different locations to permanent structures such as the Helmholtz institutes. The Joint Initiative has made it possible to provide targeted support for these new structures. The association's most important partners in these efforts are the German universities, which through joint projects financed by the Helmholtz Association benefit from Joint Initiative funds themselves. In many cases, the Helmholtz Initiative and Networking Fund provides start-up assistance for network-building initiatives through its own funding instruments. In the Helmholtz alliances and virtual institutes, the Helmholtz centres pool expertise with universities and

non-university partners in order to achieve rapid progress and international visibility in strategically important research areas. The Helmholtz ENERGY-TRANS alliance was successfully evaluated in November 2014 and is expected to play a pioneering role as regards the future focus of the research programme "Technology, Innovation and Society". This alliance brings together researchers from a variety of disciplines at KIT, the Forschungszentrum Jülich, DLR, UFZ, the universities of Stuttgart, Magdeburg and Münster, the FU Berlin and the Centre for European Economic Research in Mannheim. Within the holistic approach the researchers have adopted, the energy system is viewed as a sociotechnical system and consideration is given to the technical infrastructural requirements of the energy transition and to the interaction between these requirements and the social environment. In contrast to the Helmholtz alliances, the Helmholtz virtual institutes are smaller, flexible structures that are meant to address specific research topics in cooperation with university partners and to draw on international expertise. From the Initiative and Networking Fund they receive annual funding of up to 600,000 euros for a three to five-year period. This support is supplemented by grants from the centres, meaning that the research projects can be financed with up to 900,000 euros per year. These models demonstrate that creating networks within the research system continues to be a core element of the Helmholtz strategy. The Berlin Institute of Health is the most recent example of a regional collaboration that combines the cutting-edge research being carried out at the Helmholtz centres and German universities.

New impetus from international networks

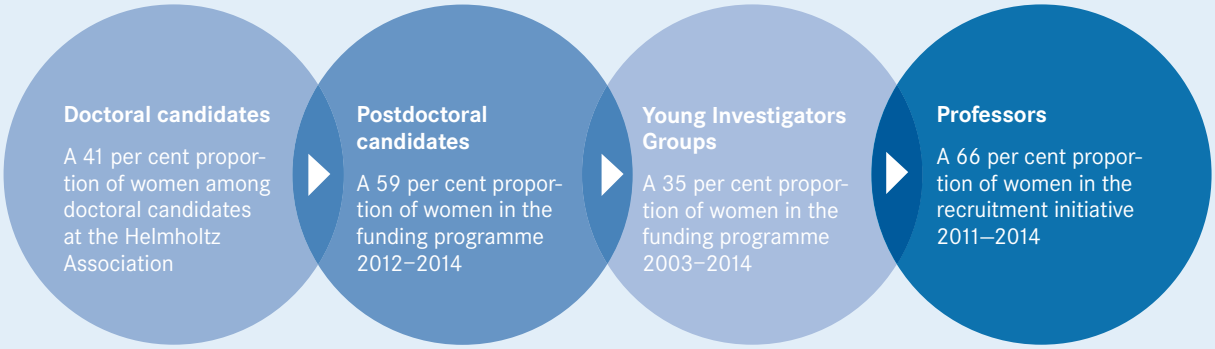
A large number of Helmholtz networks have an international scope, as do many of the Helmholtz alliances and virtual institutes. In 2014 the Helmholtz Association continued its successful joint funding programme with the Chinese Academy of Sciences (CAS). Since 2012, the association has cooperated with the CAS to finance German-Chinese research projects that have a significant value for society. Five projects were selected from the research fields Earth and Environment, Health, Matter, Key Technologies and Aeronautics, Space and Transport. The Helmholtz Association and the CAS will support these projects with up to 155,000 euros annually for three years. In 2012 the Helmholtz Association established the Helmholtz International Fellow Award to provide a foundation for new collaborations with scientific institutes abroad. It is presented to outstanding researchers and science managers outside Germany who have excelled in fields of relevance to the association. In addition to receiving prize money of 20,000 euros, the scientists are invited to participate in flexible research stays at one or more of the Helmholtz centres and to give talks at the Helmholtz Academy. So far a total of 48 individuals have been awarded the prize.

Talent management: attracting and promoting the best staff

Research organisations benefit in special ways from the creativity and quality of their staff. Attracting, promoting and retaining the best people remains a top priority at the Helmholtz Association. The Joint Initiative for Research and Innovation has created additional scope to rapidly implement measures. As part of its recruitment initiative, the Helmholtz Association is using part of the budgetary increases from the Joint Initiative to attract top scientists, particularly top female scientists. A total of 118 million euros has been earmarked for this purpose for 2013–2017. For its scientific personnel the Helmholtz Association has established a fixed quota system based on a "cascading" model. The goal of the system is to acquire more women for leadership positions above and beyond those hired through the association's recruitment initiative. In this model the targeted participation rate for women at a specific stage in their career is determined by the proportion of women in the previous career stage. With this combination of clearly formulated objectives and expanded capacities, the Helmholtz Association is continuing its determined effort to recruit more women scientists.

In addition to recruiting top scientists, the association has expanded its efforts to promote young researchers. It funds graduate and research schools at the Helmholtz centres as a way of establishing structured graduate education throughout the country, and it also makes grants available through the proven Helmholtz Young Investigators Groups. Furthermore, in 2014 the association issued a third call for applications for the Helmholtz Postdoc Programme. The 19

More women in leadership positions through support along the talent chain



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

candidates selected for grants receive up to 300,000 euros for a two to three-year period in order to establish themselves in their respective research fields. Thanks to the Joint Initiative for Research and Innovation, a well-rounded funding portfolio has emerged that covers all the important links in the talent chain, from doctoral candidate to professor. The association pursues a two-pronged strategy for every stage of a scientist's career: opening up prospects for the best scientists through additional capacities and providing these scientists with ongoing training. A key role is played by the Helmholtz Management Academy and the Helmholtz mentoring programmes. Finally, as part of the "Helmholtz & Friends" network, the association is fostering long-term ties among academy participants and recipients of grants from the Initiative and Network Fund and is thus laying the foundation for a network of current and former Helmholtz leaders.

Additional efforts to improve knowledge and technology transfer

In April 2014, the Helmholtz Association adopted a key-issues paper dealing with the strategic optimisation of technology transfer. On the basis of this paper, it developed, among other things, two new measures that were incorporated into "Helmholtz im Innovationsgeschehen" ("Helmholtz in the Innovation Process") – a paper that describes a variety of obligations the association has defined for itself within the scope of the Joint Initiative. From 2016 on, innovation funds at the Helmholtz centres will contribute to professionalising and expanding the transfer offices' capacity for action and to establishing incentive mechanisms at the centre level. The association will also support so-called Helmholtz Innovation Labs as a new platform for the exchange of ideas with the business community. Finally, in 2014 the association drew up a key-issues paper to enhance knowledge transfer at the centres. This paper was adopted in June 2015 and is providing a basis for best-practice collections, monitoring methods and future support activities.

Helmholtz has continued its successful activities and dialogue platforms to support technology transfer. In June 2014 the Helmholtz Validation Fund was evaluated with its portfolio of 21 projects. Based on recommendations by external experts, the association will continue the fund from 2016 to 2020 with a budget that is nearly twice as large. The commercial success of a number of its projects, which have brought in millions of euros, contributed to the positive assessment. In addition, for the second year in a row, the association reported 19 research spin-offs, meaning that it once again achieved the record it set in 2013. Since 2005, Helmholtz researchers have founded 118 companies, more than half of which received Helmholtz Enterprise funding. In 2014 the association also continued its collaboration with the Life Science Incubator and the Lead Discovery Center.

The Start-up Days were held for a second time in 2014 in cooperation with other non-university research organisations. Their goal is to provide aspiring start-ups with a platform for exchanging ideas and obtaining information. At the 2014 Innovation Days, 200 experts from research, industry and finance met to learn more about the 40 best technologies and ideas for start-ups and to explore possibilities for collaboration. In addition, the Helmholtz Association organised the sixth CTO Circle, which brings together the presidents of German scientific organisations and the scientific directors of research-oriented companies. Finally, in 2014 the association held two Research Days: one with Bosch in May and the other with Magna in November. Within the framework of this open innovation event, an industrial partner is given a highly concentrated introduction to diverse technologies from several Helmholtz centres and possible collaborations can be coordinated directly on the working level.

CENTRAL BODIES

As of 1 November 2015

PRESIDENT

Professor Jürgen Mlynek (until 31 Aug 2015)
Professor Otmar D. Wiestler (from 1 Sept 2015)

VICE-PRESIDENTS

Scientific Vice-President,
Coordinator of the Research Field Energy
Professor Holger Hanselka, President of the Karlsruhe Institute of Technology

Scientific Vice-President, Coordinator of the Research Field Earth and Environment
Professor Peter M. Herzig, Director of GEOMAR Helmholtz Centre for Ocean Research Kiel

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

Scientific Vice-President,
Coordinator of the Research Field Aeronautics, Space and Transport
Professor Johann-Dietrich Wörner
(until 30 June 2015);
Professor Pascale Ehrenfreund
(from 15 Aug 2015), Chair of the Executive Board, German Aerospace Center (DLR)

Scientific Vice-President,
Coordinator of the Research Field Matter
Professor Helmut Dosch, Chairman of the Board of Directors, Deutsches Elektronen-Synchrotron DESY

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

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

Administrative Vice-President
Ursula Weyrich, Administrative Director of the GSI Helmholtz Centre for Heavy Ion Research

MANAGING DIRECTOR

Dr. Rolf Zettl

SENATE

ELECTED MEMBERS

Dr. Siegfried Dais, Partner at Robert Bosch Industrietreuhand KG, Stuttgart

Dr. Heike Hanagarth, former member of the Management Board for Technology and Environment at Deutsche Bahn AG, Berlin

Professor Jürgen Klenner, former Senior Vice-President, Structure & Flight Physics, EADS Toulouse, France

Martina Koederitz, General Manager of IBM Deutschland, Austria and Switzerland, Ehningen

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

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

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

Hildegard Müller, Chairwoman of the General Executive Management Board, German Association of Energy and Water Industries (BDEW), Berlin

Professor Wolfgang Plischke, former Management Board Member at Bayer AG and Head of Bayer Healthcare

Professor Konrad Samwer, Göttingen University

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

Professor Babette Simon, Chief Medical Officer and Chairperson of Mainz University Medical Center

EX OFFICIO SENATE MEMBERS

Ilse Aigner, Bavarian Minister of Economic Affairs and Media, Energy and Technology, Munich

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

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

Michael Kretschmer, Member of the German Bundestag, Berlin

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

Matthias Machnig, State Secretary, Federal Ministry of Economic Affairs and Energy, Berlin

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

René Röspel, Member of the German Bundestag, Berlin

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

Professor Johanna Wanka, Federal Minister of Education and Research, Berlin

Professor Otmar D. Wiestler, President of the Helmholtz Association, Berlin

GUESTS

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

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

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

Professor Pascale Ehrenfreund, Vice-President of the Helmholtz Association, Chair of the Executive Board, German Aerospace Center (DLR), Cologne

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

Professor Peter M. Herzig, Vice-President of the Helmholtz Association, Director of the GEOMAR Helmholtz Centre for Ocean Research Kiel

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

Professor Matthias Kleiner, President of the Leibniz Association, Berlin

Elsbeth Lesner, Representative of the Staff and Works Councils of the Helmholtz Centres, Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

Professor Wolfgang Marquardt, Vice-President of the Helmholtz Association, Chairman of the Board of Directors, Forschungszentrum Jülich

Professor Manfred Prenzel, Chairman of the German Council of Science and Humanities, Cologne

Professor Martin Stratmann, President of the Max Planck Society for the Advancement of the Sciences, Munich

Professor Hans Ströher, Vice-Chairman of the Scientific-Technical Councils of the Helmholtz Centres, Forschungszentrum Jülich

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

Ursula Weyrich, Vice-President of the Helmholtz Association, Administrative Director of the GSI Helmholtz Centre for Heavy Ion Research

Dr. Rolf Zettl, Managing Director of the Helmholtz Association

SENATE COMMISSIONS

PERMANENT MEMBERS

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

Research Field Earth and Environment
Professor Susanne Crewell, Institute of Geophysics and Meteorology, Cologne University

Research Field Health
Professor Irmgard Sinning, Director of the Heidelberg University Biochemistry Centre

Research Field Aeronautics, Space and Transport
N.N.

Research Field Matter
Professor Gisela Anton, Chair of Experimental Physics, Friedrich-Alexander University, Erlangen-Nuremberg

Research Field Key Technologies
Professor Dieter Jahn, former Senior Vice-President of Science Relations and Innovation Management, BASF, Ludwigshafen

Federal Government Representative
Ulrich Schüller, Federal Ministry of Education and Research, Bonn

Representatives of the Federal States
Michael Kleiner, Ministry of Science, Research and Art of the State of Baden-Württemberg, Stuttgart
Annette Storsberg, Ministry of Innovation, Science and Research of the State of North Rhine-Westphalia, Düsseldorf

FIELD-SPECIFIC FEDERAL GOVERNMENT REPRESENTATIVES

Research Field Energy
N.N.

Research Field Earth and Environment
Wilfried Kraus, Federal Ministry of Education and Research, Bonn

Research Field Health
Bärbel Brumme-Bothe, Federal Ministry of Education and Research, Berlin

Research Field Aeronautics, Space and Transport
Holger Schlienkamp, Federal Ministry of Economic Affairs and Energy, Berlin

Research Field Matter
Dr. Beatrix Vierkorn-Rudolph, Federal Ministry of Education and Research, Bonn

Research Field Key Technologies
Dr. Herbert Zeisel, Federal Ministry of Education and Research, Bonn

ASSEMBLY OF MEMBERS

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, SdöR*
Professor Karin Lochte, Director,
Dr. Karsten Wurr, Administrative Director

Deutsches Elektronen-Synchrotron DESY, SdpR*
Professor Helmut Dosch,
Chairman of the Board of Directors,
Christian Harringa, Acting Director of Administration

Forschungszentrum Jülich GmbH*
Professor Wolfgang Marquardt,
Chairman of the Board of Directors,
Karsten Beneke,
Vice-Chairman of the Board of Directors

GEOMAR Helmholtz Centre for Ocean Research Kiel, SdöR
Professor Peter M. Herzig, Director,
Michael Wagner, Administrative Director

German Aerospace Center e.V.*
Professor Pascale Ehrenfreund,
Chair of the Executive Board,
Klaus Hamacher, Vice-Chairman of the Executive Board

German Cancer Research Center, SdöR*
Professor Michael Boutros,
Acting Chairman of the Management Board,
Professor Josef Puchta,
Administrative-Commercial Director

German Center for Neurodegenerative Diseases e.V.* (DZNE)
Professor Pierluigi Nicotera, Scientific Director,
Dr. Sabine Helling-Moegen,
Administrative Director

GSI Helmholtz Centre for Heavy Ion Research GmbH*
Professor Karlheinz Langanke,
Interim Scientific Director,
Ursula Weyrich, Administrative Director

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

Helmholtz Centre for Infection Research GmbH*
Professor Dirk Heinz, Scientific Director,
Franziska Broer, Administrative Director

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, SdöR*
Professor Reinhard F.J. Hüttl,
Scientific Executive Director and Spokesman for the Executive Board,
Dr. Stefan Schwartze, Administrative Director

Helmholtz-Zentrum Berlin für Materialien und Energie GmbH*
Professor Anke Rita Kaysser-Pyzalla,
Scientific Director,
Thomas Frederking, Administrative Director

Helmholtz-Zentrum Dresden-Rossendorf e.V.*
Professor Roland Sauerbrey,
Scientific Director,
Professor Peter Joehnk, Administrative Director

Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research GmbH*
Professor Wolfgang Kaysser, Scientific Director,
Michael Ganß, Administrative Director

Helmholtz Zentrum München – German Research Center for Environmental Health GmbH*
Professor Günther Wess, Scientific Director,
Dr. Nikolaus Blum, Administrative Director

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

Max Delbrück Center for Molecular Medicine in the Helmholtz Association, KdöR*
Professor Thomas Sommer, Acting Scientific Director and Chairman of the Foundation Board,
Dr. Heike Wolke, Administrative Director

Max Planck Institute for Plasma Physics (associate member)
Professor Sibylle Günter, Scientific Director,
Dr. Josef Schweinzer, Administrative Director

*Abbreviations: SdöR: foundation under public law; SdpR: foundation under private law; KdöR: public body; e.V.: registered association; GmbH: limited liability company

HELMHOLTZ ASSOCIATION GOVERNANCE STRUCTURE

COMMITTEE OF FUNDING BODIES

The Committee of Funding Bodies – made up of the federal government and the host states – defines research policy guidelines for the individual research fields for a period of several years. It also appoints members to the Helmholtz Senate.

SENATE

Together with the Assembly of Members, the Senate, which is made up of external experts, is the Helmholtz Association's central decision-making body. It consists of both ex-officio members – representatives of the federal and state governments, the German Bundestag and scientific organisations – and public figures from science and industry. The latter are elected for three years. The Senate deliberates on all matters of importance and is responsible for electing the president and the vice-presidents.

SENATE COMMISSIONS

The Senate has established Senate Commissions to prepare programme financing (based on programme reviews) and investment prioritisation. The Senate Commissions consist of permanent members – ex officio representatives of the federal and state authorities and external experts for the six research fields – as well as temporary members for the specific research field under discussion.

PRESIDENT AND PRESIDENTIAL COMMITTEE

PRESIDENT

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

VICE-PRESIDENTS

The president is supported, advised and represented by eight vice-presidents. The six scientific vice-presidents serve simultaneously as coordinators of the six research fields. The two administrative vice-presidents represent the association's administrative arm.

MANAGING DIRECTOR

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

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

HEAD OFFICE

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

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

RESEARCH FIELDS

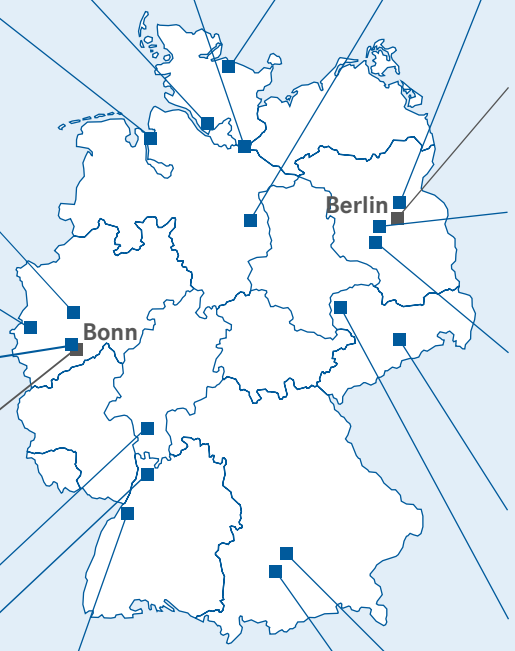
In the six research fields, which conduct their work on the basis of programme-oriented funding, Helmholtz scientists carry out cross-centre research with external partners in international interdisciplinary collaborations.

ASSEMBLY OF MEMBERS

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

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

LOCATION OF THE RESEARCH CENTRES



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

Deutsches
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www.desy.de

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As of 1 November 2015

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