HELMHOLTZ
INVESTIGATING UNKNOWN WORLDS

ANNUAL REPORT 2016

THE HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

HELMHOLTZ GEMEINSCHAFT

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NOTE ON THE REPORTING PERIOD:

The Helmholtz Annual Report 2016 describes developments at the Helmholtz Association from 2015 to 1 September 2016. The performance record is based solely on the 2015 calendar year. The Annual Report can be downloaded as a PDF at www.helmholtz.de/en/gb16.

Cover image:
(left to right) DESY; Thomas Steuer; Uli Kunz; DLR; HZG; IPP; (background) RMIKKA/ClickHere/Milosz_G, shutterstock

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.

We seek to attract and promote the best people and offer our staff a unique scientific environment and comprehensive support in all stages of their development.

That is our mission.

FOREWORD

Professor Otmar D. Wiestler, president

HELMHOLTZ – INVESTIGATING UNKNOWN WORLDS

Dear Reader,

Whether in the area of climate change, energy policy or common diseases, the mission and the objective of the Helmholtz Association is to solve some of the major challenges facing society today. In a number of fields we maintain research infrastructure that is considered outstanding by national and international standards and that our top-class researchers from different disciplines can use to conduct their unique research. We develop innovative solutions at the individual Helmholtz centres and in close collaboration with external partners from science, business, society and politics.

One of our particular strengths is the interdisciplinary nature and systems expertise of our research, which gives us the ability to cover the entire innovation chain. On the basis of cutting-edge fundamental research, we systematically pursue the insights gained by our researchers and translate them into applications over the long term. Successful applications in turn provide new impulses for basic research. This transfer of knowledge requires curious, creative and outstanding scientists, of whom we are extremely proud.

The future we face is full of challenges but also of great opportunities. We currently see significant and rapid developments, for example, in the fields of information systems, big data and energy. Our future strategy which we have jointly developed addresses these and other grand challenges. The years 2016 and 2017 are marked by important decisions. On the following pages, we would like to look back on the achievements and developments of the past year.

I wish you informative and engaging hours with our report,

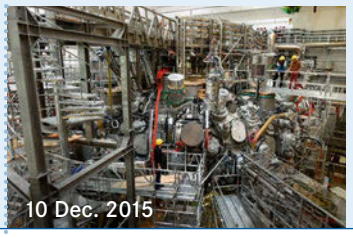
Otmar D. Wiestler

PRESIDENT'S REPORT

2015

6 Oct. 2015
HZI celebrates the 50th anniversary of its research facilities in the Braunschweig district of Stöckheim

30 Nov. 2015
The UN Climate Change Conference begins in Paris and is a great success for climate activists and researchers



10 Dec. 2015
The Wendelstein 7-X fusion device begins operations

11 Dec. 2015
Leibniz Prize awarded to Frank Bradke (DZNE) and Emmanuelle Charpentier (HZI)

On 1 September 2015, after ten years as the Helmholtz Association's president, Jürgen Mlynek passed the reins to his successor, Otmar D. Wiestler. The following pages present the first annual review by our new president, focusing on the eventful year 2015, and summarise the many challenges of the future.

The Helmholtz Association has an important mission. It is making a key contribution to solving the challenges of the present and the future. Its goal is to actively shape the future through cutting-edge research and thus to preserve and enhance the foundations of human life over the long term. During the tenure of my predecessor, Jürgen Mlynek, a strong foundation was laid for this work. When I visited the association's centres at the start of my tenure in autumn 2015, I was able to witness the extraordinary ways in which Helmholtz is working on its many research topics along the innovation chain, from basic research and R&D to applications and back again. The exciting impressions I gained from these visits left me extremely optimistic for the future.

The extension of the Joint Initiative for Research and Innovation in 2014, which guarantees us annual 3 per cent funding increases until 2020, provides a solid foundation for maintaining and expanding the Helmholtz Association's capacities. It has opened up the necessary scope for action and development. This applies both to the content of our work and to human resources. The path we have taken thus far has been highly successful. In its most recent evaluation, the Joint Science Conference justifiably described the Joint Initiative as a "successful model for sustained collective action by the federal and state governments".

Cutting-edge research

The high quality of the research at the various Helmholtz centres is reflected in the many prestigious awards presented to our scientists. For example, Frank Bradke from the German Center for Neurodegenerative Diseases received the 2016 Leibniz Prize for his pioneering research in the field of regenerative neurobiology. An additional recipient of this award was Emmanuelle Charpentier, who has recently left the Helmholtz Association to join the Berlin-based Max Planck Institute for Infection Biology. In 2015 Helmholtz researcher Henry Chapman from the Deutsches Elektronen-Synchrotron DESY garnered one of the Leibniz Prizes. Also worth noting is the successful nomination of yet another Helmholtz scientist – Tiffany Knight – for an Alexander von Humboldt Professorship. Ms. Knight joined both the Helmholtz Centre for Environmental Research – UFZ and the Martin Luther University Halle-Wittenberg on 1 July 2015.

It is not only at the national level that Helmholtz researchers belong to the research elite. They are also highly respected internationally. For example, in the last call for proposals by the European Research Council, a total of sixteen grants – seven Starting Grants and nine Consolidator Grants – went to Helmholtz scientists. In the last round of calls in the Seventh Research Framework Programme, Helmholtz scientists received nine grants from these two funding programmes. In addition, the Helmholtz Association took eighth place on the Nature Index, thus defending its top 10 ranking.

Talent management

Our goal is to offer our outstanding staff ideal opportunities for professional development at every stage of their career, whether they work in research or administration. One important instrument in this area is the Helmholtz Management Academy. In 2015, a total of 87 Helmholtz staff members completed one of its modules. Jörg Wadzack, who became chancellor of Otto-von-Guericke University Magdeburg just a few months ago, is one example.

2016

21 Dec. 2015

Acceleration of the first electrons at the European XFEL at DESY

22 Feb. 2016

Start of the World Biodiversity Council in Kuala Lumpur. Like the World Climate Summit, it is attended by numerous Helmholtz researchers

31 April 2016

Helmholtz Managing Director Rolf Zettl leaves for the Berlin Institute of Health

18 May 2016

During Chancellor Angela Merkel's visit to the DLR and ESA in Cologne, news is released that Alexander Gerst will become the first German ISS commander and fly another mission in space

Of course, we are also attempting to convince established external scientists and administrators of the Helmholtz Association's merits. For the 2013–2017 period, approximately 118 million euros have been made available for this purpose within the framework of our recruitment initiative. Between 2012 and 2015, a total of 70 outstanding recruitment proposals were approved.
One especially important objective is to increase the number of women among senior scientists at the full professor level. Of the 31 appointments made within the initiative thus far, 20 have been women. In 2015, we welcomed several excellent female scientists to the Helmholtz Association, including Simone Techert, Sara Gleeson and Simone Raoux. These new appointments are enriching Helmholtz research and show that we are a highly attractive employer for top researchers from around the world.

Infrastructure

An important focus of the Helmholtz mission is to develop and operate large-scale research infrastructure and to make this infrastructure available to the national and international research communities. A milestone reached in this area over the past year was the launch of Wendelstein 7-X at the Max Planck Institute of Plasma Physics in Greifswald (an associated member of the Helmholtz Association) on 6 December 2015. Wendelstein 7-X – the world's largest stellarator device – is opening up an entirely new dimension of fusion research.
During the construction of the Facility for Antiproton and Ion Research (FAIR), significant changes were made to project management. The GSI Helmholtz Centre for Heavy Ion Research and FAIR GmbH assumed key positions on the joint scientific, technical and administrative boards. These changes have provided an ideal foundation to move ahead with the proposed merger of FAIR GmbH and GSI to form an "international Helmholtz centre". Helmholtz-Zentrum Geesthacht – Centre for Materials and Coastal Research has had a major success with the launch of the new Mistral supercomputer for climate simulations, located at the German Climate Computing Center in Hamburg. Climate research also plays a prominent role at other Helmholtz facilities. For example, researchers from the Alfred Wegner Institute for Polar Research (AWI) have managed to reconstruct environmental conditions in the Antarctic Ocean over the last 30,000 years, and GEOMAR scientists have shown that the frequency of extreme ("super") El Niños will increase due to global warming.
The Helmholtz Association has participated as coordinator in three of the four "Kopernikus" projects, which deal with the Energiewende, or energy transition, and are funded by the German federal government. This involvement is proof that Helmholtz is a national leader in this area as well and intends to remain so in the future. Its energy researchers are contributing to fascinating developments both large and small that will help to promote the efficient, environmentally friendly use of energy. This category includes the storage systems developed at the Karlsruhe Institute of Technology (KIT), as well as significant increases in the efficiency of solar cells designed at the Helmholtz-Zentrum Berlin (HZB). In addition, researchers at HZB and DESY have succeeded in creating new types of catalysts for the chemical storage of solar energy.
During the past year, the Helmholtz Association was also able to present impressive results in the field of aeronautics, space and transport research. The German Aerospace Center (DLR) is one of the organisations using the new parabolicflight aircraft that was fashioned from the A310-304 VIP "Chancellor Airbus" and is unique in Europe. While the MASCOT lander is currently making its way to its final destination, the asteroid Ryugu, the Dawn probe has already arrived: it has been orbiting the dwarf planet Ceres since 6 March and has travelled to within 375 kilometres of the asteroid.
An additional milestone is the successful establishment of the National Center for Tumor Diseases in Heidelberg and Dresden with substantial additive funds – an important step towards more actively promoting research in the field of personalised cancer medicine at a leading international level. But our research activities focus not only on cancer, but also on other common diseases. Laboratory tests at the German Center for Neurodegenerative Diseases have laid the foundation for a promising clinical trial involving Alzheimer's patients.

9 June 2016
The DLR Institute of Communications and Navigation celebrates its 50th anniversary

14 June 2016
The scientific centre of the CTA Observatory moves to Germany

16 June 2016
The DLR Institute of Communications and Navigation celebrates its 50th anniversary

1 Aug. 2016
Franziska Broer becomes the Helmholtz Association's new managing director

Social responsibility

The G7 meeting this year impressively demonstrated that the world's leading industrial nations regard the fight against climate change and the protection of the seas as important tasks for the future. With its outstanding work in the field of Earth and environmental research, the Helmholtz Association is making a valuable contribution to meeting these challenges. This was demonstrated, for example, by our scientists' participation in the World Climate Summit in Paris and the consulting services we provided to the German government on current climate policy in the run-up to the meeting.

In addition to climate change, participants in the G7 meeting identified antibiotic resistance as a major international problem. Thanks to the Helmholtz Institute for Pharmaceutical Research Saarland, the Helmholtz Association is ideally positioned in this field. The events marking the 50th anniversary of the Helmholtz Centre for Infection Research in Braunschweig also showed that we have outstanding experts in this field who today rank among the top scientists worldwide.

In view of the dramatic developments over the past year, we are also taking responsibility in another area of society. Together with the German Federal Employment Agency, we have launched a refugee initiative and are actively contributing to integrating a group of people who have been expelled from their home countries or have been forced to leave due to war. Many of our centres are involved. I would particularly like to thank all of our staff members who have ensured locally that the refugees are being given a new chance in Germany and that integration is being made easier for them.

Helmholtz as a strategic partner

The recent continuation of the Excellence Initiative sent a strong signal to German universities confirming their strategic importance within our scientific community. The Helmholtz Association will continue to offer these universities diverse forms of long-term support. Together we can maintain and strengthen Germany's world-class research system. The Helmholtz institutes, which are founded jointly with university partners, will continue to be an integral part of the Helmholtz strategy and will be further expanded in the future. However, to meet all the major challenges facing us, we must think beyond national borders. An important part of our research mission is to establish and expand partnerships with other countries so as to address the global dimension of many social problems. In 2015, for example, we celebrated 50 years of German-Israeli diplomatic relations together with our Israeli partners. Science has always played a special role in this context. In recent decades it has served both as a stable bridge between the two countries and as a communication platform. With the help of the German Cancer Research Center's MOST programme, which just celebrated its 40th anniversary, the Helmholtz Association is making an important contribution to preserving this tradition.

Our future

In order to work over the long term to meet the major challenges facing us, we need one thing above all: adaptability. We must constantly identify, take up and pursue new research fields, which will allow us to evolve. Scientific curiosity always goes hand in hand with institutional change. These principles will guide us in the future – just as they have throughout our eventful history. In October 2015 the German Council of Science and Humanities presented us with the paper "Recommendations for the Further Development of Programme-Oriented Funding". We are taking this valuable input into account as we consider the future orientation of the association. One focus of the discussions currently taking place at various levels is the aim and need for the Helmholtz Association to further expand its systems expertise and strengthen the scientific impact of topics important for the future. The individual research fields will be further strengthened and should evolve in a forward-looking process.

In 2016 we will decide how this vision should be strategically implemented. The centres will be the driving force. Thanks to the great potential of our staff, our systems expertise and our outstanding infrastructure, in the coming years we will continue to play a prominent role in many key areas of science.

TEN YEARS OF THE JOINT INITIATIVE FOR RESEARCH AND INNOVATION

For the period 2015–2020, the Joint Initiative for Research and Innovation guarantees the Helmholtz Association and other non-university research organisations a budget with increases of 3 per cent per year. The report on the following pages describes how, in the initiative's previous period up to 2015, the Helmholtz Association and its member centres fulfilled the initiative's various 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 systematically used 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.

The Helmholtz Association is committed to conducting socially relevant research to address the major challenges facing society, science and industry today. Core-financed research is organised into programmes that reflect this mission. In the initiative's first two periods, the association continued to focus its research portfolio on socially relevant research objectives. Alternative energy, supercomputing and the impact of global warming are firmly established topics in the association's range of research programmes, as are the development of new antibiotics and cancer therapies, autonomous driving and nanotechnologies. When implementing research policy objectives, the Helmholtz Association has proved a reliable partner to political leaders.

The association's track record of successful research over the past decade includes three Nobel Prizes, ten Leibniz Prizes, 81 ERC grants, substantial contributions to Excellence Initiative projects and the recruitment of a large number of outstanding international researchers. The strength of Helmholtz research is attested by top positions in two important bibliometric rankings (Nature Publishing Group) that reflect the scientific performance of the top two hundred research organisations worldwide. It is also shown by the central role the association has played in internationally visible projects such as the Rosetta/Philae mission to explore the origins of our solar system.

In its recent paper "Recommendations for the Further Development of Programme-Oriented Funding at the Helmholtz Association", the German Council of Science and Humanities confirmed: "Since its inception, the Helmholtz Association has undergone a dynamic process of development. … Thanks primarily to the introduction of programme-oriented funding, it has established itself as a stakeholder capable of strategy formulation and implementation and has forged close ties with other stakeholders in the German research system."

New, strategically relevant research fields

In all six of its research fields, the association investigates successfully reviewed topics that focus on questions of importance for our collective future. Over the last decade the Helmholtz Association has undergone an extremely dynamic development. A merger of the Research Center Karlsruhe and the Technical University Karlsruhe resulted in the Karlsruhe Institute of Technology, the German Center for Neurodegenerative Diseases and the Berlin Institute of Health were founded, and the Helmholtz-Zentrum Dresden-Rossendorf and the GEOMAR Helmholtz Centre for Ocean Research were admitted to the association. Seven Helmholtz institutes were co-established with universities to address important future fields such as battery research. Thanks to funding from the Joint Initiative for Research and Innovation, the Helmholtz centres active in health research have invested heavily in translational research. By establishing local translational centres together with university hospitals, the association has created infrastructural platforms at all

the Helmholtz health centres that are significantly accelerating the transfer of relevant findings from basic research into clinical applications. These platforms include the National Center for Tumor Diseases at the German Cancer Research Center in Heidelberg (with a new partner facility in Dresden), the Centre for Experimental and Clinical Infection Research (TWINCORE) at the Helmholtz Centre for Infection Research, the Diabetes Study Centre and the Comprehensive Pneumology Center at Helmholtz Zentrum München, as well as the Experimental and Clinical Research Center at the Max Delbrück Center for Molecular Medicine in the Helmholtz Association. The research findings are being used to develop new strategies for diagnosis, prevention and therapy – entirely in keeping with the translational approach, which involves transforming results as quickly as possible into clinical applications.

An example of translational research: therapeutic approaches to diabetes

Via a complex network of signalling molecules, the stomach, intestine and pancreas communicate directly with the brain – and vice versa. In patients suffering from diabetes or obesity, this interaction is disrupted. New therapeutic approaches target this disruption. Surgical treatments of obesity such as gastric bypasses lead to improved blood sugar levels in patients even before they lose weight. Scientists at the Helmholtz Zentrum München led by Matthias Tschöp achieved the same effect by placing a tube or sleeve in part of the small intestine to inhibit its function instead of performing a complex operation. The advantage of this method is that it is much less invasive and can be reversed. Tschöp and his team also discovered that sensitivity to the intestinal hormone GLP-1 (glucagon-like peptide 1) played a key role in the effectiveness of the surgical procedure. In future, a related hormone test could make it possible to individually tailor surgical methods.

Networks

Over the past decade, the international research activities of the Helmholtz Association and its centres have expanded significantly and become more systematic and intense. In the international arena, the association has single-mindedly pursued the goal of entering into long-term cooperative projects with strategically important partners. Today there are lively collaborations with Russia, China, Canada and Israel. The association has also established long-term partnerships with the business community in order to promote the transfer of knowledge and technology. Its large-scale research facilities are a crystallisation point for internationalisation efforts and thus an important part of its mission. The appeal of these platforms is shown not least by the many visiting scientists who travel to Germany to carry out their scientific projects using Helmholtz's unique research infrastructure.

Equal opportunity

The promotion of women is one of the goals the Helmholtz Association systematically pursued in both periods of the Joint Initiative. Its diverse activities to support women focus on three major fields of action: recruitment, development and network-building. The development of W3 professorial appointments has been especially gratifying: the proportion of women among new appointments increased from 26 per cent in 2008 to 42 per cent in 2015. A glance at absolute figures reveals steady growth, especially over the last five years. The Helmholtz Association is thus making an important contribution to fulfilling target quotas in this area.

Talent management

Attracting, fostering and facilitating the further development of the best talents is an important part of the Helmholtz strategy. In addition to funding young scientists at the Helmholtz centres, the association has designed overarching instruments within the framework of the Initiative and Networking Fund and is supporting these instruments with substantial funding from the Joint Initiative for Research and Innovation. These funding instruments have become part of a comprehensive strategic talent management system that offers attractive conditions to talented young researchers at every stage of their careers. Successful initiatives such as the Helmholtz Young Investigators Groups for top international talent and the W2/W3 programme to attract and support excellent young female researchers will be continued in the future. The expansion of the Helmholtz Academy as a unique provider of science-specific management training rounds off our talent management offerings.

RECRUITMENT INITIATIVE

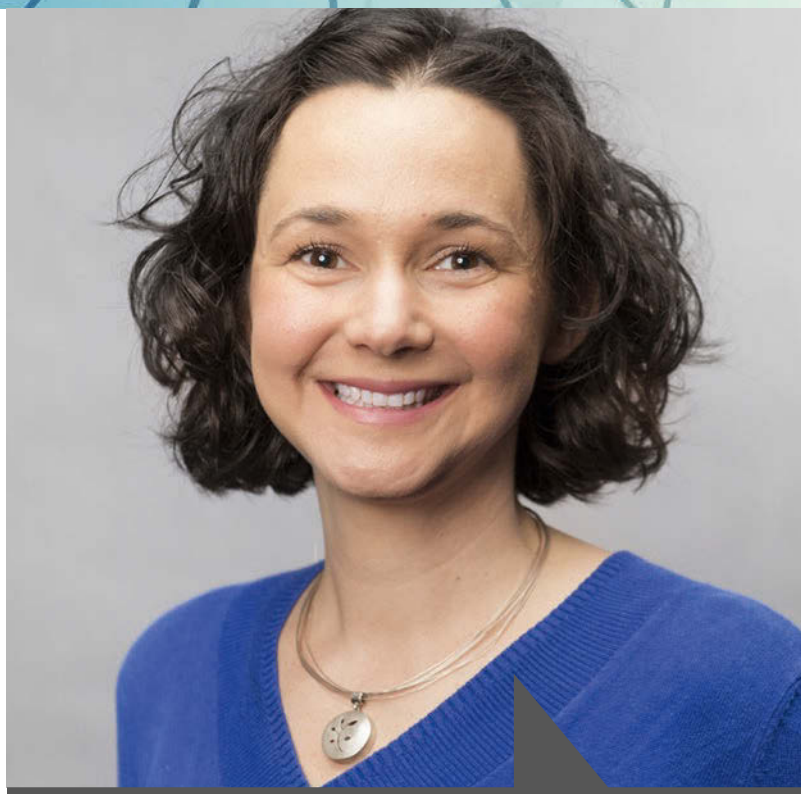
Leadership positions in science help to define the image of every research institution. Because the Helmholtz Association makes appointments jointly with universities, such positions also serve as an important link between the Helmholtz Association as a non-university research organisation and its university partners. In recent years the association has managed to attract many outstanding young scientists, in part through successful instruments such as the Initiative and Networking Fund, the Helmholtz Young Investigators Groups and W2/W3 positions for excellent female professors.

Targeted recruitment of top researchers

The Helmholtz Association's recruitment initiative is an additional, highly effective measure. It was developed in 2012 and is part of a general strategy for talent management. Among other things, it aims to recruit staff in an active, strategically oriented fashion and to increase staff diversification, especially as regards gender and international makeup. For this purpose, the Helmholtz Association is explicitly devoting part of its annual funding increase from the Joint Initiative for Research and Innovation to attracting top researchers, especially women.

Numerous new appointments

For the 2013–2017 period, 118 million euros have been made available for recruitment. Between 2012 and 2015, a total of 70 recruitment proposals were approved. The strategy of actively and systematically recruiting international staff has paid off: as of late 2015, negotiations were underway to hire 52 world-class researchers as part of the initiative, including 33 women. To date, 30 appointments have been made and 20 of the new appointees are women.



"I appreciate the freedom and flexibility that this funding provides. It allowed me to initiate several new research projects simultaneously as soon as I started the position. I expect that the support I am receiving today will make me competitive for third-party funding in the future. As a new arrival to the UFZ, I was impressed with how efficiently the purchasing and hiring processes have gone. UFZ has excellent administrative coordination and they are very welcoming to foreigners joining the institution."

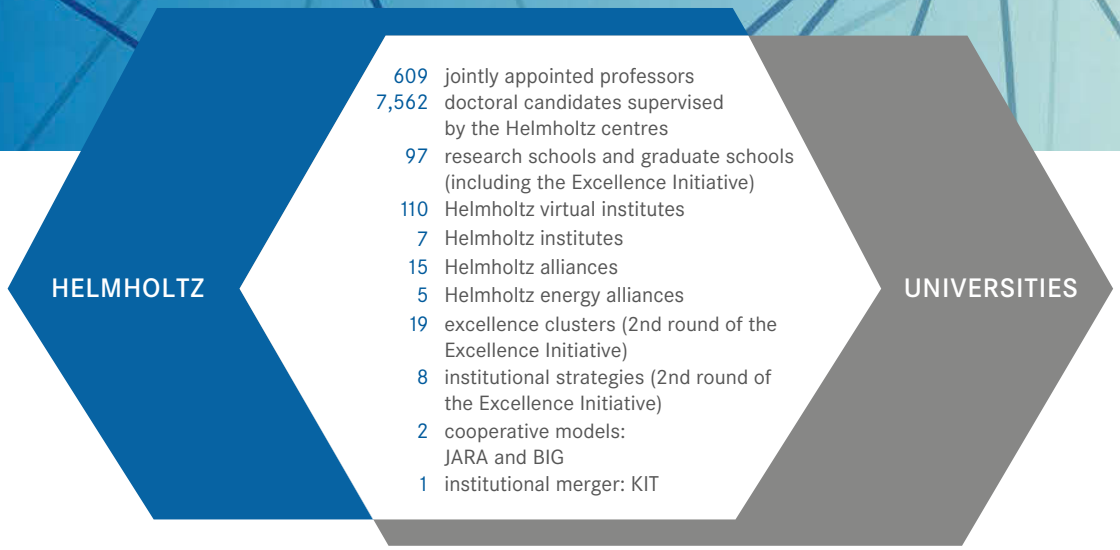
PROFESSOR TIFFANY KNIGHT
Head of the Spatial Interaction Ecology working group at the Helmholtz Centre for Environmental Research – UFZ

“I’m excited about the opportunity to investigate new energy materials at the HZB and especially about the infrastructure at the BESSY II synchrotron and the new EMIL [Energy Materials In-Situ Lab] at BESSY II. My plans for the coming years include completing EMIL, using it intensively for research into energy materials and launching industrial collaborations.”

PROFESSOR SIMONE RAOUX
Head of the Institute for Nanospectroscopy at Helmholtz Zentrum Berlin (HZB)

“I joined the GeoForschungsZentrum Potsdam from a top university because I wanted to establish a wide-ranging interdisciplinary research programme with a long time line. Support from the recruitment initiative has allowed me to assemble an exciting group of young researchers from a variety of backgrounds to work together on the dynamics of Earth’s surface. What has struck me most is the potential for far-reaching, comprehensive work on the dynamics of planet Earth as a system.”

PROFESSOR NIELS HOVIUS
Head of the Geomorphology section of Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences



Helmholtz and universities: linked by people, projects and institutions (2015 reporting year)

OUR COOPERATIONS

The goal of the Joint Initiative for Research and Innovation – the creation of a closely knit network of research institutions united by common research interests – is also one of the strategic goals of the Helmholtz Association.
Thus, collaborations – especially those with universities – have been constantly expanded in recent years. In addition, new models have been developed: on the one hand, large-scale permanent mergers and cooperative projects such as the Karlsruhe Institute of Technology, the Berlin Institute of Health, the Jülich Aachen Research Alliance and the Helmholtz institutes; on the other, flexible dynamic collaborations such as the Helmholtz alliances and the Helmholtz virtual institutes. In addition, the Helmholtz Association has co-founded and is playing a key role in all of the German Centres for Health Research. A large number of other specific collaborative forms bring together the complementary strengths of the Helmholtz centres and their regional partners. They focus, for example, on the use of research infrastructure or the promotion of young scientists.
The Helmholtz institutes lend a special intensity to the strategic partnerships between the Helmholtz centres and universities. By establishing a branch of a Helmholtz centre on a university campus, they lay the foundation for permanent close cooperation in specific areas of research. The Helmholtz institutes receive institutional funding of five million euros a year and appoint senior scientists jointly with their partner universities. The association's special contribution to these emerging networks lies in its ability to combine thematically relevant research expertise with substantial methodological and organisational support for large-scale projects. Seven Helmholtz institutes have now been launched and preparations are underway to establish new ones.
In the Helmholtz alliances, universities, Helmholtz centres and other non-university partners use their pooled expertise to achieve rapid progress and international visibility in strategically important research areas. Such alliances have their own management structures. They develop targeted approaches to supporting young scientists and fostering equal opportunity. The total volume of funding per alliance is approximately five million euros a year over a five-year period. All told, the association is supporting 15 alliances and an additional five energy alliances.
The Helmholtz virtual institutes are smaller, more flexible networks with university partners. They address specific research topics and draw on international expertise. These institutes do not necessarily result in long-term structures, but more closely resemble projects. For a three to five-year period, they receive up to 600,000 euros a year from the Initiative and Networking Fund, supplemented by funding from the centres. Since the inception of this instrument, 110 virtual institutes have been funded.

KNOWLEDGE AND TECHNOLOGY TRANSFER

Helmholtz research provides important impact for many areas of life, including the fields of medicine, climate research, energy and environmental protection. The long-term investigation of pressing problems makes possible not only the transfer of knowledge to other stakeholders in society, but also disruptive innovations. One of the Helmholtz Association's main advantages is that it can cover the entire innovation chain, from basic research to applications. Technology transfer plays an important role in helping scientists to share results with industry partners. In 2015 the successes in this field were once again demonstrated by many examples from the 18 technology transfer offices at the Helmholtz centres. The achievements include awards and financing for our high-tech start-ups (e.g. the NRW Innovation Award for the SenseUp spin-off at Forschungszentrum Jülich), license agreements (e.g. with the DLR's MIRO Lab, a Validation Fund project) as well as numerous collaborations (e.g. the strategic partnership between Bayer and DKFZ). The following figures also underscore the successes:

- The number of spin-offs has increased markedly over the past three years, reaching the record level of 21 in 2015. Since 1995, around 200 companies have been founded by the Helmholtz Association. The failure rate is still below 10 per cent.
- Revenue from partnerships with industry has remained relatively constant at approximately 150 million euros – though this revenue has risen slightly since 2013, when key figures were more strictly defined. In addition, interactions with the business community, whether in the form of strategic partnerships, funded innovation projects or the industrial use of research infrastructure, have increased.
- By contrast, income from licenses and options has proved highly volatile. In 2012 and 2013, it increased to 20 million euros, mainly due to one-off effects, but in 2015 it dropped to 11.7 million euros with the expiration of highly profitable licenses. Nevertheless, higher income is once again expected for the coming years – from such sources as a successfully licensed validation project.

The association intensively supports the centres' activities with a variety of measures, including different types of events, internal funding instruments and strategic frameworks.

- In 2015 the Helmholtz Association adopted key-issues papers dealing with the strategic optimisation of technology transfer and of knowledge transfer. With these papers, it has gained a comprehensive transfer strategy. The central elements of this strategy were established in 2015 in keeping with "Helmholtz in the Innovation Process", a paper describing the obligations the Association has defined for itself within the scope of the Joint Initiative. In order to increase and incentivise the transfer of research results to the wider society, the association is planning initiatives that will enhance the positive effects of research and make them more visible. It can already point to many outstanding examples of such initiatives, including the Cancer Information Service and the Earth System Knowledge Platform. Others will follow.
- Various events at the association level – particularly the Helmholtz Research Days, the Innovation Days and the Start-up Days – are designed to foster the exchange of ideas with industry. The Innovation Days and Start-up Days have been held at the initiative of the Helmholtz Association since 2012 and 2013, respectively, in cooperation with the Max Planck Society, the Leibniz Association and the Fraunhofer Society – all participants in the Joint Initiative.
- The established funding instruments "Helmholtz Enterprise" (start-up support) and the Helmholtz Validation Fund (support for the application-oriented development of research results) have been supplemented by two new instruments. In April 2016 seven projects were selected from a total of 23 applicants for establishing new "Helmholtz Innovation Labs". On an annual basis, this instrument will make 2.4 million euros available to user platforms, joint labs and strategic partnerships with industry. This amount is supplemented by grants from the centres (at least 50 per cent of total funding) or by contributions from industry. In addition, in early 2016 the first Innovation Funds of the Helmholtz Centres were set up at nine selected centres. An annual budget of 2.4 million euros has been earmarked for this purpose, and additional funding is being provided by the centres themselves. This institutionally funded initiative, which will make it possible to finance internal innovation projects, covers the areas of innovation culture, incentivisation and the professionalisation of the transfer process.

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 energy research are working to secure an economically, ecologically, and socially sustainable supply of energy. They study conversion, distribution, storage, and utilisation technologies while taking climatic and environmental impacts into account. One important goal is to replace fossil and nuclear fuels with climate-neutral energy sources and to develop solutions for a sustainable energy system. For this purpose, researchers seek to determine the potential of renewables, such as solar, biomass and geothermal energy. They also work to increase the efficiency of conventional power plants. Moreover, 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 makes a significant contribution to its implementation by pooling its expertise and experience in various programmes. In addition, it closes research gaps and carries out basic and application-oriented research. It supplements its technological research by socioeconomic studies in order to ensure that all social, economic, and political aspects are included in its overall goal of improving the energy system.

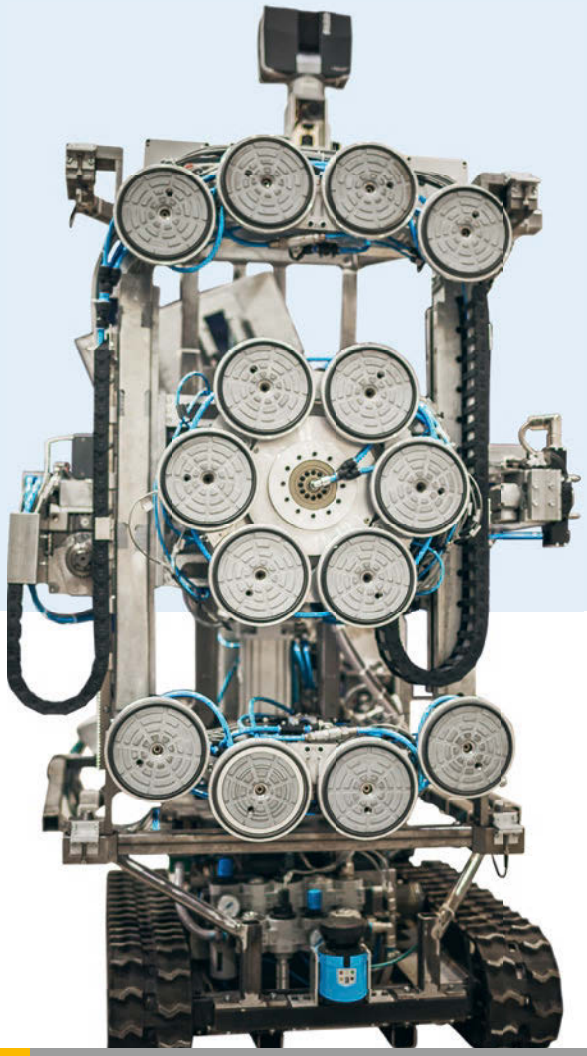
PROGRAMMES IN THE FUNDING PERIOD 2015-2019

Energy Efficiency, Materials and Resources

The target of the energy transition is to reduce primary energy consumption by half by 2050 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 are being studied, interlinked and optimised. In addition, the flexibility required to restructure energy supply needs to be improved with respect to fuel types, energy provision and infrastructure.

Renewable Energies

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



Robots measure the radioactivity of surfaces in power plants and decontaminate these surfaces autonomously. *Image: KIT*

SECURING EXPERTISE IN CORE TECHNOLOGIES

A central element of Germany's energiewende, or energy transition, is the safe decommissioning of nuclear facilities, which poses tremendous challenges for science, technology and industry. KIT has founded the Competence Center for Decommissioning in order to maintain expertise on the decommissioning of nuclear facilities and to expand this expertise at a practical level. This Center is part of the Helmholtz programme "Nuclear Waste Management, Safety and Radiation Research" (NUSAFE).
The decommissioning of nuclear facilities encompasses innovative decommissioning technologies, the radiological characterization of contaminated plant components, decontamination and conditioning technologies, and the protection of the staff, population, and the environment against exposure to radiation. Additional important elements are the management of complex processes, analysis of political and social conditions, and strategies for appropriately involving and informing the public. The newly founded KIT Center is able to draw on extensive expertise and a highly effective infrastructure. Emphasis is placed on professional training and continuing education of young scientists and engineers in this field over the long term. In 2008, KIT established a professorship for decommissioning of conventional and nuclear facilities – the only one of its kind in Germany. The KIT-affiliated AREVA Nuclear Professional School also offers a continuing education programme in this field.
The Competence Center for Decommissioning is part of the Cluster for the Decommissioning of Nuclear Facilities established in February 2016. This Cluster pools the expertise of five partners from three countries to provide a more stable foundation for professional training. Its founding members are KIT as coordinator, the Karlsruhe Cooperative State University, Stuttgart University with its Institute of Nuclear Technology and Energy Systems and its Materials Testing Institute, the Paul Scherrer Institute in Switzerland, the Institute for Transuranium Elements in Karlsruhe, and the Institute for Reference Materials and Measurements in Belgium. The latter two institutes are part of the European Commission's Joint Research Center.

Karlsruhe Institute of Technology (KIT)

Additional examples from this research field

cient, cost-effective way 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 investigation using 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 according to demand, and the infrastructure required for the different energy sources must be optimised and more effectively interlinked. The programme encompasses studies of energy storage and conversion technologies as well as energy infrastructure. It combines R&D projects on thermal, electrical and chemical energy storage with process development and studies of distribution and storage infrastructure.

The first hydrogen plasma in Wendelstein 7-X. *Image: IPP*

Max Planck Institute for Plasma Physics (IPP)

WENDELSTEIN 7-X FUSION DEVICE IN OPERATION

On 3 February 2016, after nine years of construction, the first hydrogen plasma began to glow in the Wendelstein 7-X fusion device at the Max Planck Institute for Plasma Physics in Greifswald. At the push of a button, chancellor Angela Merkel caused a microwave heating pulse to transform a tiny amount of gas into an ultra-thin plasma that reached temperatures of 10 million degrees. Following the device's launch with helium plasma in December 2015, the way is now clear for further experimentation. Wendelstein 7-X is the world's largest stellarator and will be used to study the suitability of this type of device as a power plant.

A physicist preparing a liquid metal battery for measurements. *Image: HZDR/O. Killig*

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

LIQUID METAL CELL DEVELOPED ON A LABORATORY SCALE

A new type of battery consisting of three stably stratified liquid layers is considered a promising candidate for the large-scale stationary storage of electrical energy. It uses abundant and thus inexpensive materials and can potentially be charged and discharged as often as desired. The HZDR prototype relies on a top layer of sodium as anode, a bottom layer of bismuth as cathode, and a molten salt mixture sandwiched between them as ionic conductor. The cell needs elevated temperatures to operate, but delivers exceptionally high current densities.

German Aerospace Center (DLR)

NEW IDEAS FOR LIGHTER AND MORE STABLE ROTOR BLADES

How can wind plants produce electricity more efficiently in future? In the Smart Blades project, researchers from the Research Alliance for Wind Energy, cooperating with the DLR, the Fraunhofer Institute for Wind Energy and Energy System Technology, and the ForWind university research centre, have developed intelligent rotor blades that can adapt to natural wind conditions. One technology makes use of blades that can passively adjust to wind speed using, for example, a bend-twist coupling. Another involves mounting active control elements such as movable trailing edges on rotor blades in order to allow them to respond to different aerodynamic loads and to use the wind turbine more efficiently.

Movable flaps on the leading and trailing edges of rotor blades makes them more flexible. *Image: DLR (CC BY 3.0)*

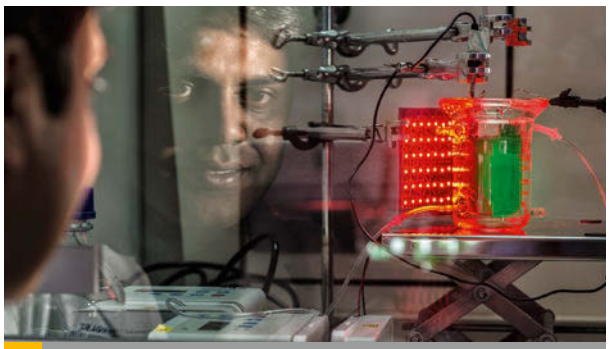
PROGRAMMES IN THE FUNDING PERIOD 2015–2019

Future Information Technology

Using innovative research approaches, this programme aims to 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 processes in government, the economy and society. For this purpose, it brings together expertise in energy system analysis, technology impact assessment and policy consulting.



In Babu Halan's laboratory experiments, light and water were used to produce a current of 50 microamps with a voltage of just a few millivolts. Cyanobacteria are responsible for this electricity flow. *Image: Künzelmann/UFZ*

Helmholtz Centre for Environmental Research – UFZ

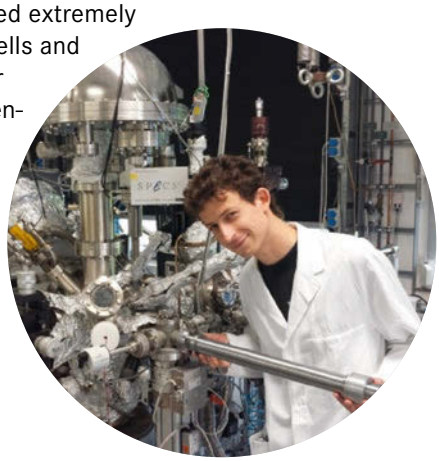
PHOTOSYNTHESIS FOR A SUSTAINABLE ENERGY SUPPLY

Hydrogen could play an important role in replacing fossil fuels. UFZ scientists are now using cyanobacteria to obtain hydrogen. With the help of sunlight, these single-cell organisms can produce electricity and hydrogen from water. They usually harness sunlight for their metabolic processes in order to multiply and grow. The researchers are now working on ways to selectively shift their metabolism towards the production of hydrogen as an energy source – an approach that is more cost-effective and climate-friendly than previously tested alternatives.

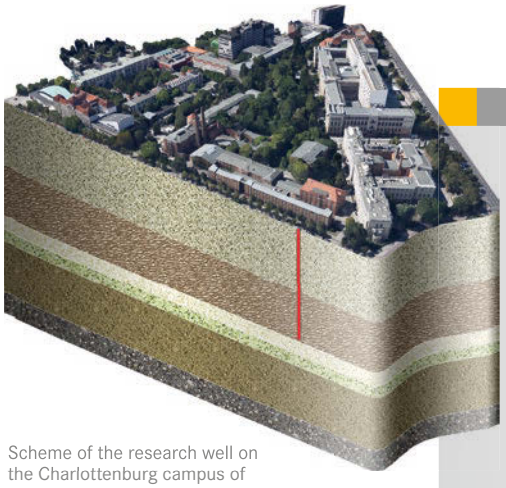
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

NEW EFFICIENCY RECORD FOR HYDROGEN PRODUCED FROM SUNLIGHT

In order to chemically store energy from the sun, working groups at the HZB are developing complex material systems that use sunlight to break down water into oxygen and hydrogen. In summer 2015, an international team succeeded in substantially increasing the efficiency of direct solar water splitting. For this purpose they used extremely powerful tandem solar cells and selectively modified their surfaces. The new efficiency record is 14 per cent, well above the previous record of 12.4 per cent, held for 17 years.



Matthias May systematically modified the samples' surfaces to maximise efficiency: *Image: HZB*



Scheme of the research well on the Charlottenburg campus of Technische Universität Berlin. *Image: Guido Blöcher, GFZ, using Google Earth.*

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

THERMAL ENERGY STORAGE FOR CITY DISTRICTS

For years a major part of the energy supply of the German Parliament in Berlin has been recovered heat and chill from the seasonal storage systems in the underground. But what about entire city districts? This is where ATES (Aquifer Thermal Energy Storage) comes in, a project run by the GFZ, Technische Universität Berlin and Universität der Künste Berlin. GFZ has completed drilling a research well in the heart of Berlin that extends down 500 metres to layers of the Earth that contain salt water called aquifers. A research facility was established to investigate options for seasonal storage of heat from cogeneration plants, solar installations and other sources. With reliable concepts for the thermal supply of urban quarters ATES will contribute to the further development of this environmental friendly technology.

Nuclear Waste Management, Safety and Radiation Research

This programme pursues technically coherent, effective research strategies that support the national goal of phasing out nuclear power. It concentrates on problems related 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 CO2-free energy source, fusion has the potential to contribute significantly to meeting the world's growing energy needs by mid-century. The goal of this programme is to provide a foundation for developing and constructing a fusion power plant. ITER and Wendelstein 7-X are two of the central projects that will continue to dominate fusion research over the next 20 to 30 years.

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 field of Earth and environmental research 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 pooling the expertise of nine Helmholtz centres in an effort 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 framework 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 field of Earth and environmental research. 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 all these challenges, the field of Earth and environmental research will continue to pool the capacities of the participating centres in joint interdisciplinary activities. This strategy is leading to new alliances and facilitating the expansion of Earth observation and knowledge systems and 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 sustainable use of the investigated underground resource. To attain these goals the programme relies on 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 interaction between these changes and the global climate and polar

The ROPOS deep sea robot on its way to the ocean floor with the camera system developed at GEOMAR. *Image: Björn Kurtenbach*

GEOMAR Helmholtz Centre for Ocean Research Kiel

A VIRTUAL WALK ON THE OCEAN FLOOR

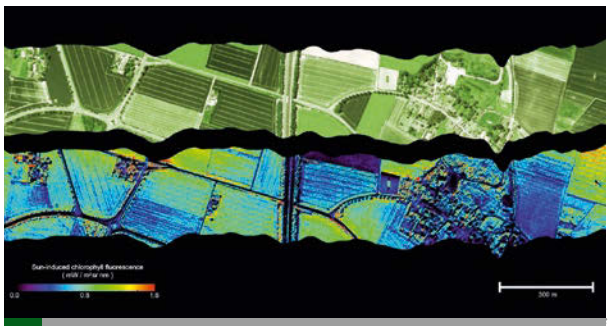
At some sites on the ocean floor water is emitted that can reach temperatures of 400 degrees Celsius and is rich in minerals and sulphur. In most cases these hydrothermal vents form near mid-ocean ridges and on submarine volcanoes. The minerals deposited around them create chimney-like structures called black smokers. Hydrothermal vents are potential sources of raw materials. In addition, they are home to unique ecosystems and teach us a great deal about processes on the ocean floor.
Under the supervision of GEOMAR, an international research team has surveyed a hydrothermal field with centimetre accuracy for the very first time. The field is located at a depth of around 1,100 metres in the crater of Niua South Volcano north of Tonga.
The FALKOR research vessel operated by the Schmidt Ocean Institute served as a platform for the work. To conduct the surveys, the research team used ROPOS, a Canadian-built remotely operated vehicle (ROV). ROPOS was equipped with a camera system specially developed at GEOMAR. In a complex procedure, the cameras photographed and filmed the hydrothermal vents from all angles, making it possible to take a virtual "walk" between the black smokers. "A high-performance computer on board the vessel created a digital 3D model of the entire landscape from the more than 200,000 images. This enabled us to take targeted samples of the ocean floor," says expedition leader Tom Kwasnitschka from GEOMAR.
The digital model will now be further refined and made available for additional studies. "This method will allow us to take virtual walks on the ocean floor after completion of the expedition. Colleagues who were not on board will also have the opportunity to study the Niua South field," explains Kwasnitschka.
During the expedition the vehicle's dives were transmitted live via the internet. In addition, the team repeatedly fielded questions from interested audiences worldwide, with live satellite links to lectures in Germany, Canada and the United States.

Additional examples from this research field

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 assessing the social and economic consequences of climate change in our living environments. 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 is examining the physical, chemical, biological and geological processes in oceans as well as the interactions between these processes and the ocean floor and the atmosphere. Its goal is to investi-



Green does not always mean healthy – the lower aerial image, based on measurement data from the HyPlant spectrometer, shows fluorescence emissions coded by colour, with the different shades reflecting current photosynthesis rates and stress levels. *Image: Forschungszentrum Jülich*

Forschungszentrum Jülich

ESA TO FOCUS ON PLANT RESEARCH

The Flex satellite of the European Space Agency (ESA) will be launched in around six years and will collect global data on plant productivity. Its core component is the HyPlant spectrometer, co-developed and tested by plant researchers at Forschungszentrum Jülich. The instrument measures the fluorescence signal emitted by plants and is thus a reliable indicator of when they are under stress and perform less photosynthesis due to unfavourable environmental conditions such as drought. The Flex data could help to optimise the cultivation and harvesting of crops.

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

BILLIONS OF JUVENILE FISH UNDER ARCTIC SEA ICE

Belugas, narwhal and ringed seal have one thing in common: their favourite food is Arctic cod. The fish is one of the most important species in the Arctic Ocean. It was previously unknown how large its stocks are under sea ice, but now AWI biologists have managed to catch Arctic cod directly under the ice using a special net and to determine its distribution. According to their findings, several billion cod, primarily juvenile fish, could live under the ice cover. For these creatures, the ice labyrinth is a source of food and shelter.

The Arctic cod *(Boreogadus saida)* in its icy habitat. *Image: Hauke Flores,* AWI

Dr. Wilhelm Petersen and Martina Gehrung calibrating a FerryBox. *Image: HZG*

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

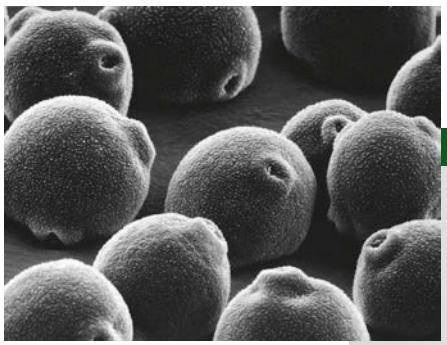
USING FERRYBOX DATA TO EVALUATE MODELS

FerryBox measurement systems have been installed on ferries and cargo ships in the North Sea to obtain high time-resolution surface data, including measures of water temperature and salinity along shipping routes. Scientists from the HZG and the Federal Maritime and Hydrographic Agency have compared the FerryBox data (along the Immingham–Cuxhaven route) with the results of models and discovered that these models underestimated salinity. The FerryBox data can thus help to improve hydrodynamic models of the North Sea.

gate 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, the role of the middle atmosphere in the climate system, the variability of biogenic emissions and the use of atmospheric water isotopes to gain a better understanding of the water cycle.



Low-molecular-weight pollen substances – here, from birch – can cause allergic reactions via B cells. *Image: Professor Jeroen Buters, Institute for Allergy Research/ Helmholtz Zentrum München*

Helmholtz Zentrum München – German Research Center for Environmental Health

NON-ALLERGENIC POLLEN COMPOUNDS CAN INTENSIFY ALLERGIES

Scientists at the Helmholtz Zentrum München have discovered the mechanism by which non-allergenic pollen compounds intensify allergies. In addition to allergens, low-molecular-weight compounds can cause B cells to increase the production of immunoglobulin E. The researchers hope not only to develop new treatments, but also to determine whether climate change alters the composition of pollen and influences its aggressiveness.

In 2010 access to clean water was declared a human right. The WWQA pre-study was launched to explore requirements to design more effective water policies and to ensure the enforcement of this right. *Image: Künzelmann/UFZ*

Helmholtz Centre for Environmental Research – UFZ

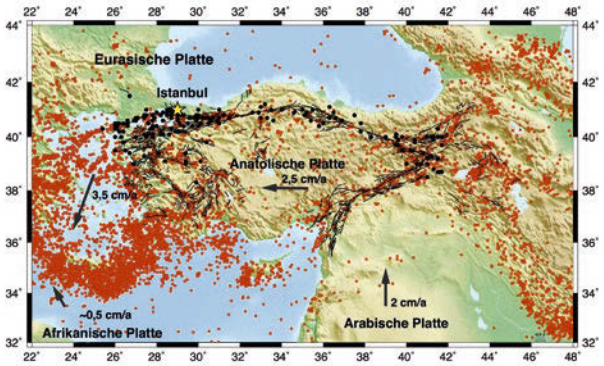
IMPROVING WATER QUALITY WORLDWIDE

For two years scientists from the UFZ and the University of Kassel analysed data and developed a methodology to assess the quality of rivers and lakes and consequences of water degradation worldwide. On 19 May 2016 they presented the initial findings of the World Water Quality Assessment (WWQA) pre-study. The WWQA seeks not only to describe the current situation but also to close data gaps, identify the causes of pollution, show consequences and define policy options. The ultimate goal is to improve water quality worldwide.

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

EARTHQUAKE RISK FOR ISTANBUL

A large earthquake will one day hit Istanbul, but no one knows when or with what magnitude. GFZ scientists are now helping with estimates. They are creating a catalogue of historical seismicity for the North Anatolian Fault Zone which goes back 2,300 years. According to the data, a megaquake of magnitude 8 is likely, but only in the zone's eastern section. In the west, where Istanbul is located, major earthquakes are expected but none with a magnitude of more than 7.5. Nevertheless, even earthquakes of this strength can be devastating. Now, at least, there is a basis for risk assessment.



The Anatolian Plate and the North Anatolian Fault Zone. *Image: Dorina Domigall, GFZ*

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 as 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 illnesses such as cardiovascular, metabolic, pulmonary and infectious disease, cancer, allergies and disorders of the nervous system. Building on a strong foundation of basic research, their joint objective is 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 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.

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

Eight Helmholtz centres collaborate in the field of health research. In the current programme period, they are active 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

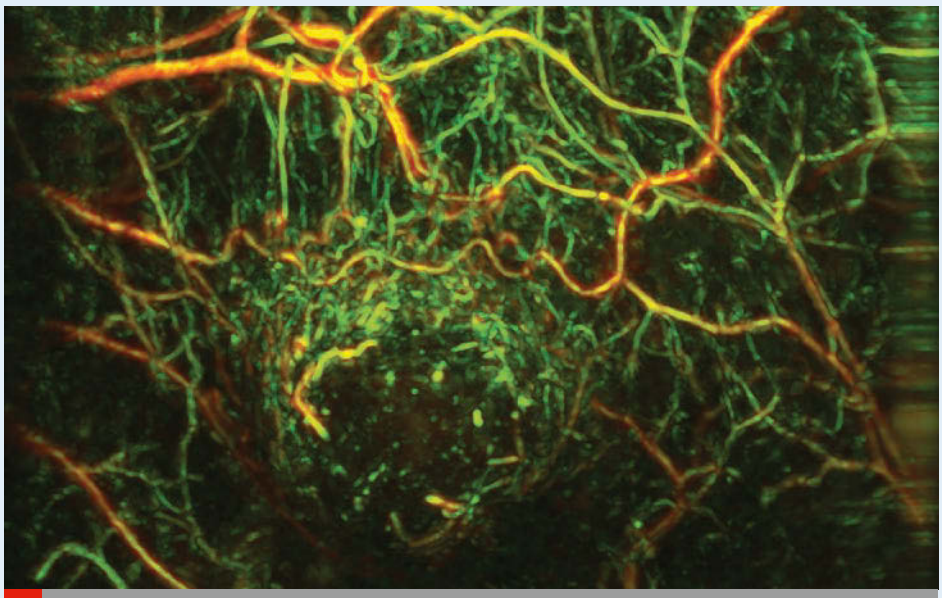
OUTLOOK

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 investigate 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 provide a foundation for new approaches to assessing individual risk factors and developing personalised prevention strategies. Now and in the future, in all these activities, the ongoing discourse between scientists and physicians will play a vital role in enabling the quick translation of research findings into clinical practice.

PROGRAMMES IN THE FUNDING PERIOD 2014–1018

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 radio-physical findings and technologies. It aims to push ahead with the translation of basic research findings into clinical applications in collaboration with strategic partners. Here a key role is played by the National Center for Tumor Diseases (NCT) Heidelberg and the nationally active German Consortium for Translational Cancer Research (DKTK).



Helmholtz Zentrum München – German Research Center for Environmental Health

As shown here, physicians can use MSOT technology to monitor tumours and the surrounding vessels without exposing patients to radiation or performing surgery. *Image: Institute of Biological and Medical Imaging, Helmholtz Zentrum München*

PRECISE 3D IMAGES OF THE BODY IN REAL-TIME

A team of scientists from the Helmholtz Zentrum München has developed a technology to analyse the molecular and physiological properties of tissues in real time and in three dimensions. It enables them, for example, to monitor the spread of drugs through the body and to determine the oxygen saturation of blood and tissues non-invasively.
These advances have been made possible by multispectral optoacoustic tomography (MSOT). This imaging technique uses weak laser pulses to slightly warm the target tissue. As a result, the tissue briefly expands and generates ultrasonic signals, which the scientists detect with corresponding sensors and translate into 3D images. This enables them to monitor the development of diseases such as cancer directly in patients without surgery or radiation exposure. “MSOT has demonstrated initial success in detecting lymph node metastases in melanoma patients,” says Vasilis Ntziachristos, director of the Institute for Biological and Medical Imaging and professor of Biological Imaging at the Technical University of Munich. “Thanks to MSOT, we can now detect cancer without surgery.” Further clinical studies are currently underway in a variety of application fields, including breast and thyroid cancer and peripheral atherosclerosis.
MSOT is also providing the basis for two research spin-offs at the Helmholtz Zentrum München. iThera Medical GmbH, founded in 2010, and DermaSight, which is set to begin operations in the end of 2016, will produce detailed live images of the human body. In 2014, iThera won the “Start-up” category of the German Innovation Awards. “These two spin-offs show how scientists can succeed in quickly translating research findings into social and economic benefits,” says Günther Wess, scientific director of the Helmholtz Zentrum München.
In early 2016, Ntziachristos received his second prestigious ERC Advanced Grant to continue developing MSOT. In the future, he and his team hope to develop a low-cost portable device for the point-of-care diagnosis of patients and will also attempt to depict inflammatory, metabolic and neurobiological processes in real time.

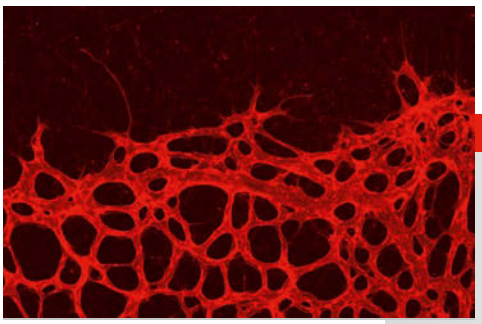
Additional examples from this research field

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 are used to develop new diagnostic, preventive and therapeutic strategies. The programme takes a translational approach to the topic 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 strategies for prevention and treatment. 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



New capillaries forming at the edge of a mouse retina. *Image: Véronique Gebala*

Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)

NEW BLOOD VESSELS REQUIRE PRESSURE TO FORM

When capillaries sprout from existing blood vessels, they initially consist of a series of individual cells without an internal cavity. The team led by MDC researcher Holger Gerhardt has discovered that blood presses the membrane of vascular cells inward, forming a continuous hollow tube. As this infolding spreads into the cell, it actively pushes back smaller branches using protein fibres. The newly discovered process could explain pathological angiogenesis in cancer and diabetes.

Patients undergoing radon therapy in the Healing Gallery in Bad Gestein. *Image: Gasteinertal Tourismus GmbH*

GSI Helmholtz Centre for Heavy Ion Research

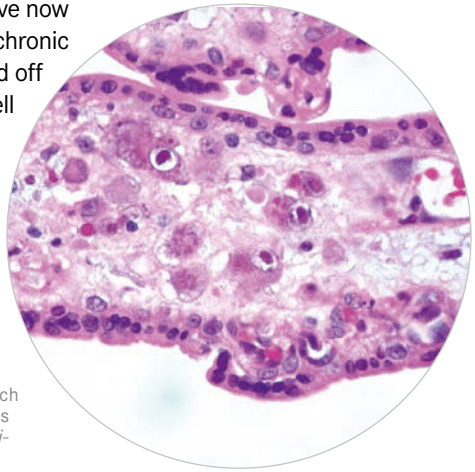
THE MECHANISM BEHIND RADON THERAPY

The GREWIS project, funded by the Federal Ministry of Education and Research and supervised by GSI researchers, is studying the effects and risks of radon therapy. Patients undergo radon therapy to treat chronic inflammatory diseases of the musculoskeletal system, the respiratory tract and the skin. The project aims to explain the largely unknown mechanism inhibiting inflammation and to better assess the cancer risk of low doses of radon.

Helmholtz Centre for Infection Research (HZI)

HERPESVIRUSES DO NOT UNDERMINE IMMUNE PROTECTION IN OLD AGE

Most people carry the cytomegalovirus, which is a member of the herpes family. After an infection, it stays in the body for life. It was previously unclear whether this chronic infection permanently weakened the immune defense against new pathogens, thus impairing immune protection in old age. In a study involving old mice, researchers at the HZI under group leader Luka Cicin-Sain have now shown that animals with chronic herpes infections can fend off new pathogens just as well as animals that do not carry the virus.

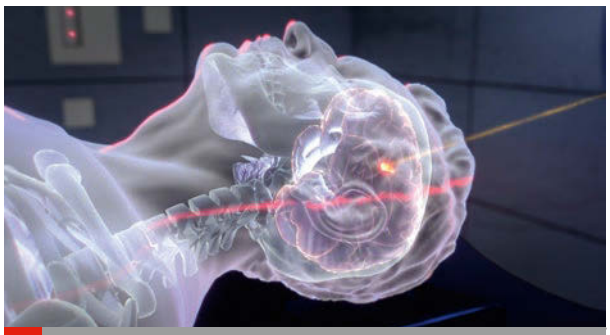


Placental tissue section in which a cytomegalovirus infection has caused placentitis. *Image: Wikimedia Commons/Ed Uthman*

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



Proton therapy is well suited to treat brain tumours due to its great precision. *Image: HZDR*

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

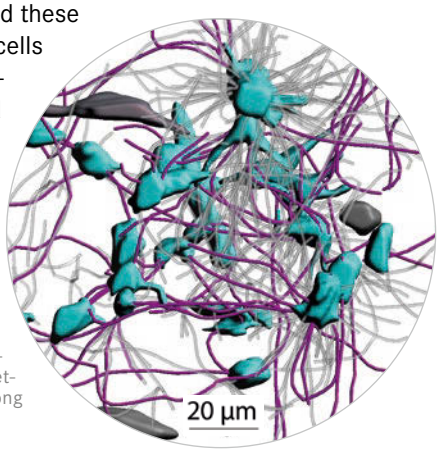
PRECISELY DESTROYING TUMOURS

Due to its great precision, irradiation with protons is considered a particularly gentle form of radiation therapy. However, up to now it has not been possible to accurately monitor the penetration depth of protons during treatment. Researchers at the OncoRay research centre and the HZDR in Dresden have now managed to do so for the first time. Using a slit camera, they were able to measure the gamma radiation when protons decelerate. In future, the improved precision will make cancer treatment possible in highly sensitive parts of the body.

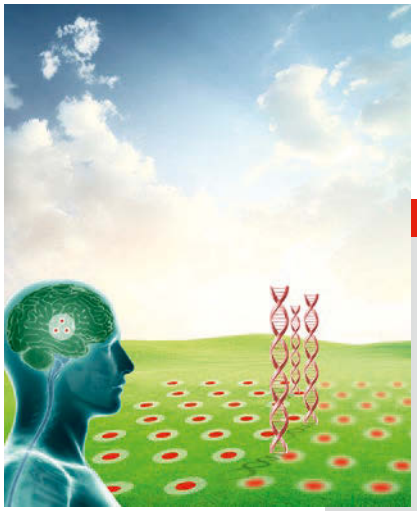
German Cancer Research Center (DKFZ)

PREVENTING NETWORKS OF CANCER CELLS

Scientists cooperating with Frank Winkler from the DKFZ and Heidelberg University Hospital have shown that the tumour cells of extremely malignant glioblastoma are connected by long cell extensions. The brain tumour cells communicate through this network, protecting themselves from damage inflicted by treatment. When researchers blocked these connections, the cancer cells invaded the brain less aggressively and responded better to radiation therapy. The researchers published their findings in *Nature.*



3D representation of a glioblastoma: the cancer cells in the network (blue) are connected by long microtubes (pink). The tumour cells and microtubes outside the network are shown in dark gray and light gray, respectively. *Image: M. Osswald/DKFZ*



Risk gene for Alzheimer's influences orientation behaviour. *Image: Bureau BlauwGeel*

German Center for Neurodegenerative Diseases (DZNE)

ALZHEIMER RISK INFLUENCES BRAIN NAVIGATION SYSTEM

DZNE researchers have discovered unusual activity in the entorhinal cortex of young adults with a genetically increased risk of Alzheimer's disease (ApoE4 carriers). This region of the brain plays an important role in spatial navigation. The affected individuals' orientation behaviour in a virtual landscape was demonstrated to be altered. In other words, the orientation problems typical of Alzheimer's could make themselves known in subtle ways long before clinical symptoms appear.

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 deals 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 PASCALE EHRENFREUND
Vice-President of the Helmholtz Association,
Coordinator of Aeronautics, Space and Transport Research,
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 policy-makers. The German Aerospace Center (DLR) is Germany's national centre for aeronautics and aerospace research. On behalf of the German government and in its capacity as the German space agency, it is responsible for research within the framework of the national aerospace programme and for Germany's contribution to the European Space Agency (ESA).

PROGRAMME STRUCTURE IN THE CURRENT FUNDING PERIOD

The German Aerospace Center is the only Helmholtz centre active in the field of aeronautics, space and transport research. Its work is divided into 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, DLR established an internal maritime safety research group in order to pool and expand research at the various DLR institutes. Activities in this area will be supported by the positively evaluated portfolio proposal "R&D and Real-Time Services for Maritime Safety". The results of the United Nations Climate Change Conference in Paris have also presented science with a variety of challenges. The goal of limiting global warming to less than two degrees Celsius compared to pre-industrial levels will require fundamental research programmes, new technologies and detailed evaluation of climate data. Eco-efficient aviation and Earth observation systems can make valuable contributions in this area.

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 at the developmental and operational levels, a reduction of aircraft noise and harmful emissions, 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 investigating ideas and concepts for future air transport systems. A key aspect of the research agenda is its comprehensive perspective. At the same time, the Helmholtz pro-

Atmospheric researchers based in Kiruna in north Sweden conducted coordinated measurement flights using the HALO and Falcon research aircraft. *Image: DLR/Andreas Minikin (CC-BY 3.0)*

German Aerospace Center (DLR)

MEASUREMENT FLIGHTS FOR CLIMATE RESEARCH

Between December 2015 and March 2016, researchers from DLR and the Karlsruhe Institute of Technology (KIT), along with other national and international partners, conducted a series of measurements above the Arctic Circle in order to investigate climate change and its effects on the polar atmosphere. The measurements were carried out using one of the world's best-equipped research aircraft: the Gulfstream G550 HALO (High Altitude Long Range Research Aircraft). From their base at Kiruna in north Sweden, the climate researchers flew measurement flights with HALO throughout the Arctic winter in order to study "hitherto" insufficiently understood aspects of cloud physics in polar regions and trace gas transport.
Ozone has a particularly powerful effect on the climate in the tropopause region, the transitional layer between the troposphere and the stratosphere, which is located at an altitude from 8 to 16 kilometres. Due to the increase in carbon dioxide emissions into the atmosphere, temperatures on the ground and in the troposphere are rising, whereas in the stratosphere they are decreasing. Particularly in the Arctic this can lead to the increased formation of polar stratospheric clouds, which contribute to the depletion of the protective ozone layer. While a large ozone hole regularly forms above the Antarctic during spring in the southern hemisphere, ozone depletion in northern polar region usually is less severe. However, this was not the case in the winter of 2015/16, when an increased formation of stratospheric clouds contributed to a significant depletion of the ozone layer already evident at the beginning of March.
The HALO research aircraft is based on a joint initiative of German environmental and climate research institutions. HALO is funded by contributions from the German Federal Ministry of Education and Research, the German Research Foundation (DFG), the Helmholtz Association, the Max Planck Society, the Leibniz Association, the Free State of Bavaria, the Karlsruhe Institute of Technology, the GFZ German Research Centre for Geosciences, Forschungszentrum Jülich and the German Aerospace Center.

Additional examples from this research field

gramme places a strong emphasis on application-oriented research. Four research topics 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 above all in interdisciplinary projects. One example of the comprehensive perspective of this research field is the establishment of the DLR Air Transportation Systems facility.

Space

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

When landing autonomously, the aircraft's flight control system need to compensate for the accelerated flow of air above the ground vehicle. *Image: DLR (CC-BY 3.0)*

German Aerospace Center (DLR)

AUTONOMOUS LANDING AT FULL SPEED

An unmanned, electric, autonomous aircraft travelling at 75 kilometres per hour lands gently on the roof of a moving car. For the first time, researchers at the DLR have successfully demonstrated technology developed for this purpose. The system is designed for civil applications in the fields of remote sensing and communication and could be applied to ultra-light solar-powered aircraft to supplement Earth observation efforts using conventional satellite systems. With its landing gear removed, the aircraft has significantly increased payload capacity.

German Aerospace Center (DLR)

EU:CROPIS – FRESH VEGETABLES IN SPACE

Astronauts travelling to the Moon or Mars would certainly welcome the addition of fresh food to their diet. This is why the Eu:CROPIS mission is planning to launch a satellite into space in 2017 that will operate two greenhouses under lunar and Martian gravitational conditions. On board, the C.R.O.P. (combined regenerative organic-food production) filter system developed by the DLR will convert synthetic urine into fertilizer for tomato plants. A second algae-based system will deliver oxygen and remove excess ammonia.

As a test for tomato plants: different gravitational conditions are created inside the satellite by varying its rotation. *Image: DLR (CC-BY 3.0)*

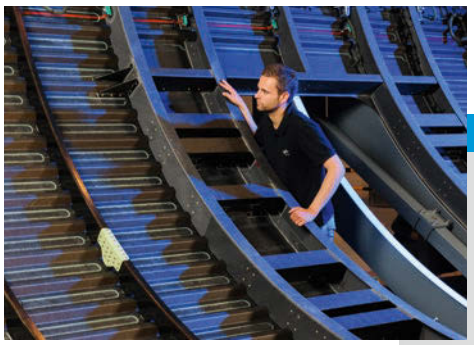
The MASCOT lander – no bigger than a shoe box – will carry four instruments down to the surface of the Ryugu asteroid. *Image: DLR (CC-BY 3.0)*

German Aerospace Center (DLR)

MASCOT – LANDING ON AN ASTEROID

MASCOT (Mobile Asteroid Surface Scout) has been on its way to the asteroid Ryugu (1999 JU3) since 3 December 2014. The lander is scheduled to reach its destination on board the Japanese Hayabusa 2 probe and touch down on the asteroid's surface in 2018. It is equipped with a total of four measuring instruments: a radiometer, a camera, a spectrometer and a magnetometer. The mission will gather data from several locations on one asteroid for the first time in history. To this end MASCOT will use an internal swing arm to hop from one location to the next.

land use geared to the preservation of resources, and civil security. The work of the DLR is supported by a modern infrastructure that is constantly being adapted to the needs of researchers. 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.



A door surround structure in a fuselage shell with an integrated structural health monitoring network. *Image: DLR (CC BY 3.0)*

German Aerospace Center (DLR)

STRUCTURAL HEALTH MONITORING DETECTS DAMAGE TO AIRCRAFT COMPONENTS

Carbon fibre reinforced polymers (CFRP) are increasingly being used in the construction aircraft to make them lighter, more comfortable and more economical. In order to make these aircraft even safer and facilitate their maintenance, the DLR has built a large aircraft component from CFRP. The fuselage section is equipped with integrated sensors that function like a nervous system, providing information about the extent and location of damage. The advantage offered by this system lies in the fact that defective parts do not have to be removed and extensively examined, which simplifies maintenance and repairs.

Photo of one train passing another at a speed of around 230 kilometres an hour. *Image: DLR (CC-BY 3.0)*

German Aerospace Center (DLR)

QUICKER JOURNEYS WITH VIRTUAL COUPLING

Virtual coupling refers to a method by which trains are connected via wireless communication rather than physical links. This offers the advantage that passengers can reach their destinations in a shorter period of time without having to change trains. In addition, the capacity limits of railway lines can be increased without the need for additional infrastructure. In April 2016 DLR researchers tested such a system using two Frecciarossa high-speed trains provided by the Italian rail company Trenitalia. Over several nights they tested the communication between two trains with directional antennas fitted at the front on the rail link between Naples and Rome.

German Aerospace Center (DLR)

RAINFOREST ON THE RADAR

In February 2016 DLR scientists conducted numerous measurement flights in the central African country of Gabon in order to determine the condition of the rainforest there. In the process they employed advanced radar technology. The data obtained will help researchers to improve climate models and better understand global warming. The study was carried out in cooperation with the European Space Agency (ESA) and the French, Gabonese and US national aerospace research centres.

With its rectangular cabin and large floor openings, the twin-engine turboprop Do 228-212 aircraft is particularly well suited for the use of the special camera and radar systems. *Image: DLR (CC BY 3.0)*

Transport

Ensuring mobility in the future is a central challenge. For many years now, the capacity of transport systems for passengers and goods has been expanding. However, there is 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 large number of accident victims, on the other. The world requires modern transport systems for people and goods that are sustainable over the long term from an economic, ecological and social perspective. Transport experts at the DLR are utilising the extensive potential for synergies between aviation, astronautic and energy research to respond to these challenges. Research and development in this area are focusing on ground-based vehicles, traffic management and the traffic system as well as on the cross-sectional topics electric-powered mobility and urban mobility. Scientists are developing concepts for next-generation cars, utility vehicles and trains with the aim of reducing both 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

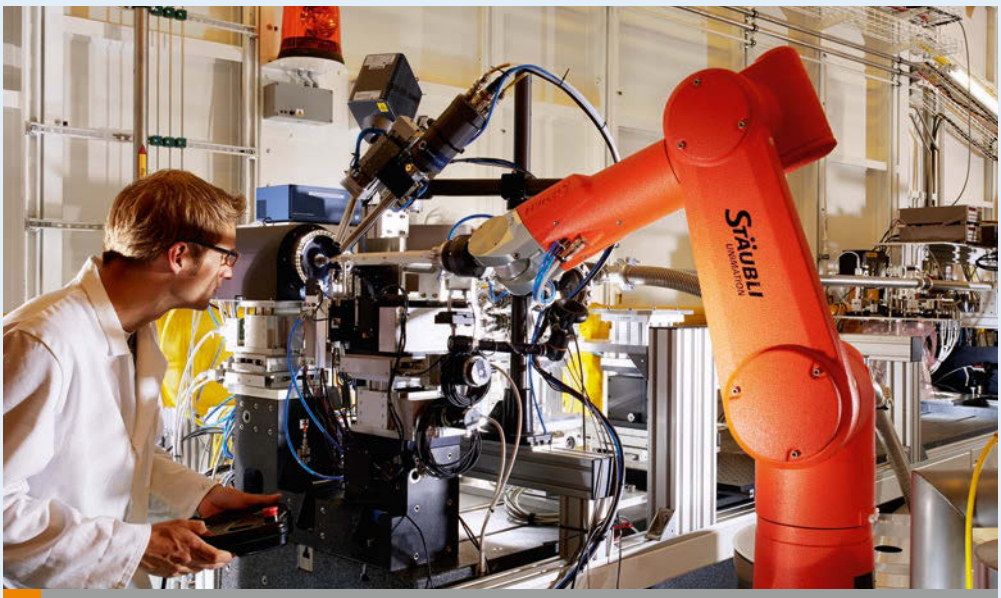
OUTLOOK

The Helmholtz Association launched the field of matter research with its thematically oriented structure in the third period of programme-oriented funding. 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 the scientific work within the research field. Strategic considerations regarding the research facilities are of great importance and are reflected in the development of thematic strategies by the Helmholtz centres. For example, the second programme period 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 able to take advantage of networks with colleagues from other research



Deutsches Elektronen-Synchrotron (DESY)

The P11 beamline at DESY's PETRA III X-ray light source is specially designed for diffraction experiments with biological samples. *Image: Heiner Müller-Elsner/DESY*

A PROMISING APPROACH IN THE FIGHT AGAINST HOSPITAL GERMS

Antibiotic-resistant bacteria are a growing problem, especially in hospitals. Conventional antibiotics are often ineffective against so-called methicillin-resistant Staphylococcus aureus bacteria (MRSA). Resistance is increasing due to the use of antibiotics in industrial livestock farming and other factors. Together with colleagues in Brazil and China, researchers in Hamburg working with the DESY's X-ray light sources have developed a promising method of outsmarting hospital germs that are resistant to antibiotics. Instead of attacking the MRSA bacteria directly, the scientists intervene in a metabolic pathway that is vital to the survival of the germs. "Conventional drugs block a particular function of the bacterium," explains Christian Betzel from the University of Hamburg, who is conducting research at the Laboratory for Structural Biology of Infection and Inflammation on the DESY campus. "However, bacteria can then find a way round this blockade, thereby becoming resistant to the drug in question." To overcome this problem, the researchers working with Betzel and Carsten Wrenger from the University of Sao Paulo are skilfully intervening in the vitamin B1 pathway of the staphylococci without actually blocking it.

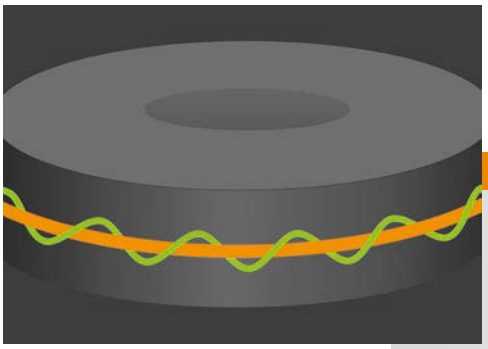
In order to achieve this, they have determined the precise atomic structure of one of the enzymes involved. The scientists "feed" this enzyme with a custom-made, apparently useful substance. However, this so-called substrate is slightly modified so that it differs from its natural version. As a result, the vitamin B1 produced is actually useless to the bacteria. "It's a way of tricking the organism," explains Betzel. "We give it something that it believes it needs in a slightly modified form so that it is ultimately unable to use it." Vitamin B1 is particularly suited to this approach for two reasons. "The vitamin B1 pathway is essential. There are no alternatives," say Markus Perbandt, co-author of the study. "Moreover, the human body does not have any similar enzymes, which is extremely important for the avoidance of cross reactions." Using knowledge of the precise atomic structure of a biomolecule to custom-design an active substance is not only relevant to the fight against hospital germs, but may also prove an effective means of combating other pathogens.

Additional examples from this research field »

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 GSI accelerator complex and the Large Hadron Collider (LHC) at CERN – the world's most powerful particle accelerator – 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 information technologies.

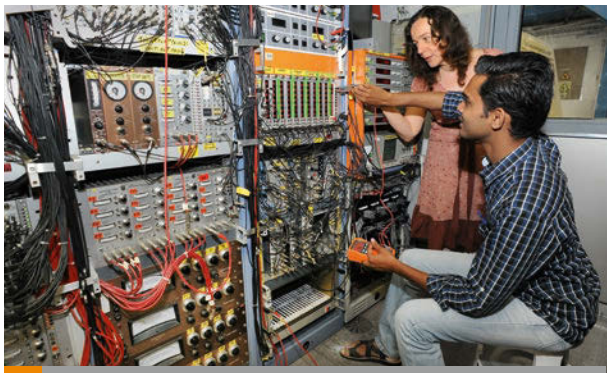


The second path winds around the first one. It can carry additional packets of electrons, which emit the light pulses used in experiments. *Image: HZB*

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

BESSY II ELECTRON HIGHWAY GETS A SECOND LANE

The BESSY II electron storage ring at the HZB can now be operated with not just one but two simultaneous electron paths. By precisely tuning the magnetic components involved, physicists can create an additional stable path along which packets of electrons orbit, emitting light pulses at the device's experiment stations. This could provide future users with the option of selecting light pulses from either path for their experiments. This development represents a further milestone in the HZB's pioneering BESSY-VSR project.



Final preparations: experiment director Dr Sophia Heinz and student Devaraja Malligenahalli from the Manipal Centre for Natural Sciences working on the electronics of the experimental apparatus. *Image: G. Otto, GSI*

GSI Helmholtz Centre for Heavy Ion Research

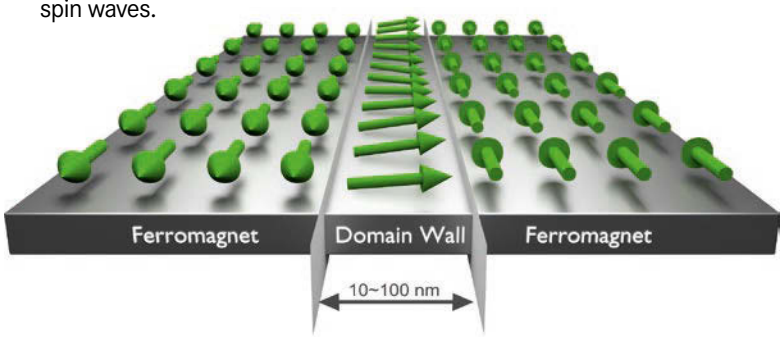
NEW ATOMIC NUCLEI DISCOVERED

An international research team has managed to produce four new heavy atomic nuclei: one isotope of berkelium, one of neptunium and two isotopes of americium. These nuclei decay after a few milliseconds or seconds depending on the isotope. The products of this decay can be separated and analysed using special filters composed of electrical and magnetic fields generated at the GSI research facility. By detecting all the decay products, researchers were able to identify the new isotopes.

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

STEERING SPIN WAVES WITH DOMAIN WALLS

In future, spin waves could provide the basis for faster and more energy-efficient information processing. These information carriers are based on the intrinsic angular momentum, or spin, of electrons. Until now, controlling them at the nanolevel has required a great deal of energy. Researchers at the HZDR have managed to steer spin waves in a targeted fashion for the first time with the help of so-called domain walls. Using small magnetic fields, they have succeeded in manipulating these boundary areas between differently magnetised domains and hence the spin wave propagation – a key step towards the creation of nanocircuits based on spin waves.



The spin wave remains trapped in the domain wall (centre), allowing its propagation path to be controlled in a targeted way. *Diagram: HZDR/H. Schultheiß*

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 European XFEL, the Facility for Antiproton and Ion Research (FAIR) and the other international facilities in which the Helmholtz Association is participating.

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. Challenges and goals in this context include the exploration and

This composite image shows the numerous particles of an air shower hitting the detector field in the centre of the LOFAR telescope in Exloo in the Netherlands. *Image: ASTRON/KIT*

Karlsruhe Institute of Technology (KIT)

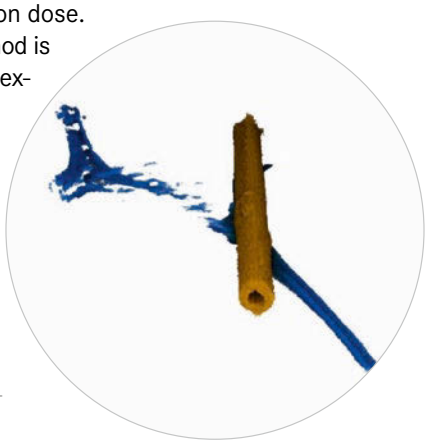
NEW TECHNIQUE FOR DETECTING COSMIC RADIATION

When high-energy cosmic rays hit the Earth's atmosphere, they generate "air showers" made up of secondary particles and electromagnetic radiation. Measuring these cascades of particles provides scientists with information about the properties of the primary particles involved. With the help of radio antennas at the LOFAR (Low Frequency Array) radio telescope and the Pierre Auger Observatory, researchers have demonstrated that the energy and elemental composition of the primary particles can be determined with a high degree of precision using the CoREAS simulation code developed at KIT. This represents a highly promising step towards determining the origins of such particles.

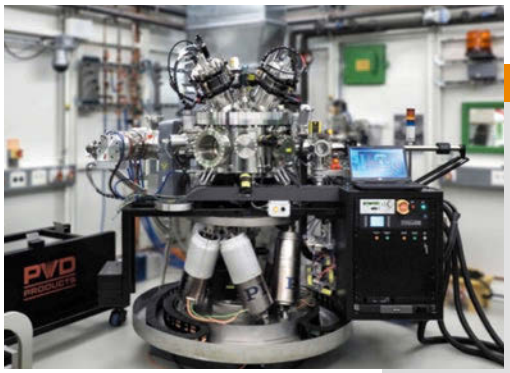
Forschungszentrum Jülich

SETTING A NEW STANDARD FOR 3D IMAGES OF THE NANOWORLD

Scientists at the Ernst Ruska-Centre, which is jointly operated by Forschungszentrum Jülich and RWTH Aachen, used a transmission electron microscope to record about 3,500 images in 3.5 seconds. The series of images served as the basis for a 3D tomographic reconstruction. The recording of such image sequences has "hitherto" taken between 10 and 60 minutes and required 10 times the electron dose. This gentler recording method is particularly suitable for the examination of cells, bacteria and viruses. In addition, it allows chemical reactions and electrical switching phenomena to be visualised in real time and in three dimensions.



3D tomographic reconstruction of a nanotube (orange) on a supporting layer of carbon (blue). *Image: Migunov, V. et al Sci. Rep.5, 14516, 2015 (CC BY 4.0)*



Chamber for the in-situ examination of thin-film growth using the X-ray beam at the HZG HEMS beamline at PETRA III. *Image: HZG*

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

IMPROVING TOOLS BY ANALYSING THE FILM GROWTH OF THIN COATINGS *IN SITU*

The thin coatings applied to high-performance milling, turning and drilling tools make these products particularly durable. Scientists at the HZG, working with Swedish colleagues, have now developed a special chamber for the *in situ* examination of the growth of these hard layers. Using the HEMS beamline at PETRA III, they conducted experiments with high-energy X-rays during the coating process. The studies are providing valuable information on the dynamics of film growth and on ways to optimise the parameters for the production of coatings.

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 Key Technologies Research,
Forschungszentrum Jülich

THE MISSION

Research in the field of key technologies focuses on the investigation and development of technologies that can contribute to solving the major challenges facing society today. The individual research programmes run the gamut from fundamental research to concrete applications and involve interdisciplinary collaboration. Our state-of-the-art research facilities 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 position as a leading centre of 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 issues that in the coming decades will play an important role in developments in three key disciplines – information technologies, materials sciences and life sciences. The highly successful research programmes pursued during the previous funding period will be continued and strengthened. The integration of multidisciplinary approaches – as seen, for example, in the pairing of technology with medicine, simulation with big data, supercomputing with brain research, and microbial biotechnology with 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

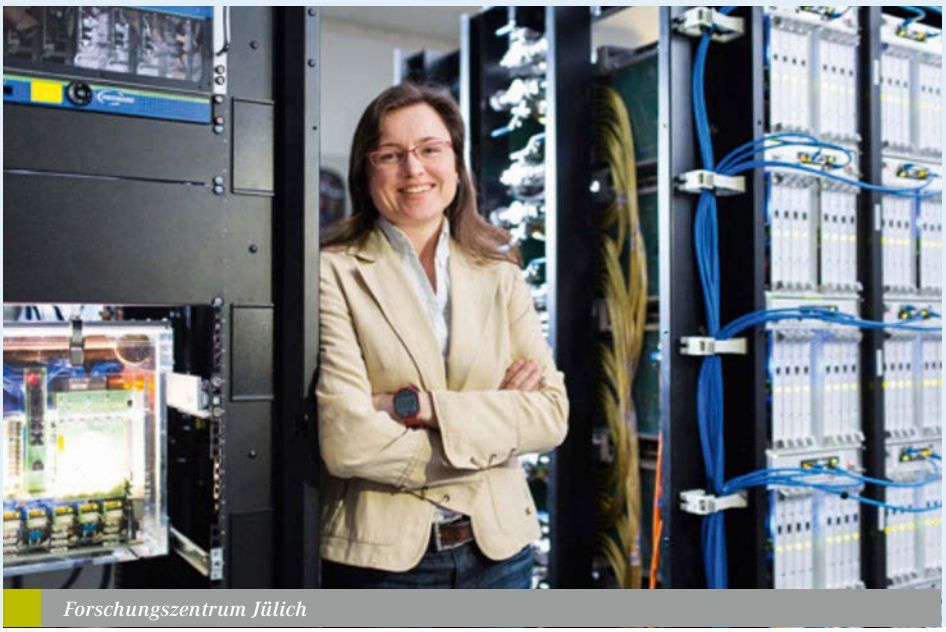
The aim of this programme is to make available the tools and infrastructure required for high-performance computing and the management and analysis of large quantities of data. The constantly growing complexity of systems and processes investigated by scientists is reflected in the increasing demands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

Future Information Technology

Using innovative approaches, this programme aims to develop new building components and architectural concepts in order to increase the processing power, data storage densities and transmission rates of information technologies while at the same time significantly reducing the amount of electrical energy they require.

Science and Technology of Nanosystems

This goal of this programme is to create new technologies for



The networker: Dr Estela Suarez from Jülich Supercomputing Centre (JSC) is coordinating the large-scale European project DEEP/DEEP-ER. *Image: Forschungszentrum Jülich*

EN ROUTE TO THE NEXT GENERATION OF SUPERCOMPUTERS

At CeBIT 2016 in Hannover, Forschungszentrum Jülich presented a new computer architecture for next-generation supercomputers, the result of the EU research project DEEP (Dynamical Exascale Entry Platform) coordinated by Jülich Supercomputing Centre. The computer is based on the "cluster-booster" concept and uses an innovative, highly efficient cooling system. Jülich and its partners have thereby taken a further step along the road to an exascale computer that will be able to perform over one quintillion computing operations per second. The cluster-booster concept functions like a turbocharger in a combustion engine, with the booster accelerating the cluster component. A cluster of high-performance multicore processors executes the complex parts of a programme. Simple programme elements, by contrast, are implemented by booster modules that consist of simple processor cores. These cores can calculate less complicated tasks in a much more energy-efficient manner.
The prototype showcased in Hannover featured a particularly innovative cooling system, a so-called GreenICE booster. The electronic assemblies are immersed in a special liquid that evaporates at a temperature of just 40 degrees Celsius. The phase transition from liquid to gaseous maximises the cooling effect. As a result, no waste heat is released into the environment and the energy requirements for cooling are cut to around 1 percent of overall system consumption.
In a successor project dubbed DEEP-ER (DEEP-Extended Reach), which is also being funded by the EU and coordinated by Jülich, researchers are aiming to develop a highly efficient system for data input and output. This would be particularly useful for applications such as climate simulations that involve vast amounts of data because here data bottlenecks can develop that slow down the entire system. The second challenge being taken on in the DEEP-ER project is to make the computers of the future more reliable. There is a risk that the sheer number of components in exascale computers could result in several failures per hour with current hardware. To ensure that application programmes do not lose their interim results and data, DEEP-ER researchers are aiming to develop tools that employ simple methods to enable programmes to continue running.

Additional examples from this research field

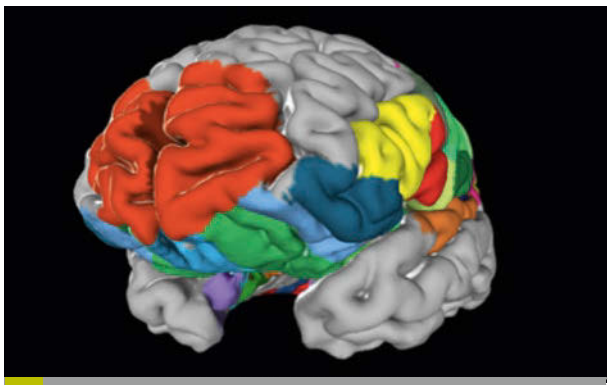
the synthesis and functionalisation of nanostructural materials and nanoparticles. Researchers are working on the development of new process technologies designed to manufacture and structure nanomaterials with specific characteristics.

Advanced Engineering Materials

The focus of this programme is to develop customised lightweight construction alloys 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 developed by researchers are used above all in membrane technologies for CO_2 separation and water purification, as well as in hydrogen production and storage.

BioSoft

The properties and interactions of molecular structures determine the characteristics and functions of the systems they form, such as living cells or cell groups. Research in this field is providing the knowledge required for the manufacture of functional



JuBrain: a three-dimensional atlas of the human brain comprising probability maps of cytoarchitecture. *Image: Forschungszentrum Jülich*

Forschungszentrum Jülich

NEW INSIGHTS INTO THE GENESIS OF DEPRESSION

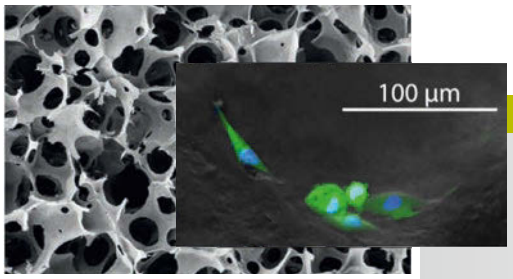
Depression is linked to organic changes in the brain. Jülich neuroscientists have now shown that in people suffering from depression the volume of a particular part of the brain, the medial frontal pole, is reduced. To conduct their study, the scientists used the three-dimensional JuBrain digital brain atlas, which comprises maps of over 200 areas of the brain. Within the framework of the Human Brain Project, JuBrain is being further developed into a multimodal brain model, based in part on insights into the genetic features of the brain's regions and cells.

Forschungszentrum Jülich

RERAMS WITH LONG-TERM STABILITY

Memristive cells, or ReRAMS, could in future provide the basis of fast and effective computer memories. However, this technology has still not been perfected. A team of researchers from Forschungszentrum Jülich and RWTH Aachen University have now discovered how storage cells that rapidly lose data can be distinguished microscopically from those with long-term stability. In the process they also found a way to make storage cells error-resistant. It is based on a storage layer for oxygen ions that can slow down and possibly completely suppress the error-producing process.

A view into an atomic force microscope at the Oxide Cluster, where layers of materials for storage cells are produced and studied in an ultrahigh vacuum. *Image: Forschungszentrum Jülich*



SEM image of the pore structure of a 3D architectured hydrogel (ArcGel) and the adhesion of hMSC to the ArcGel surface after 24 hours. *Images: HZG*

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

BONE REGENERATION WITH HYDROGELS

Bone material that has been damaged or lost does not always regenerate by itself. In cooperation with researchers from Berlin and Rostock, the Institute of Biomaterial Science at HZG has introduced soft 3D architectured hydrogels based on gelatine and lysine that enable bone to heal completely in only a few weeks. Regeneration is achieved by residual cells that migrate into the material in vivo. In this process, cell differentiation and cell proliferation are supported i. a. by cell adhesion sites and a growing of the pores while the material degrades.

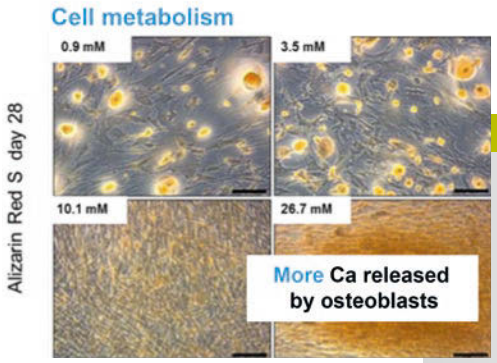
nanoscale materials, the controlled manipulation of the flow properties of complex liquids, and the development of active molecular substances.

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 to the design of implants and controlled drug delivery systems.

Decoding the Human Brain

The aim of this programme is to deploy innovative imaging techniques 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 many changes it undergoes over



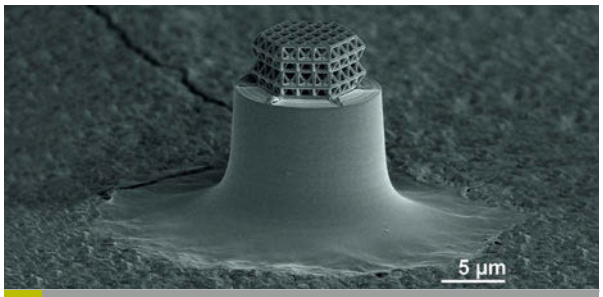
A study of calcium production in cultures in which bone-forming and bone-degrading cells are incubated together. Alizarin dye was used to make the calcium visible. In monocultures the tolerable magnesium concentration is ca. 10 mM. *Image: reprinted from publication Wu et al. 2015, Acta Biomaterialia 27, 295-304.*

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

MAGNESIUM AFFECTS GROWTH AND DIFFERENTIATION OF BONE CELLS

Scientists at HZG have conducted a pioneering study of the effect of magnesium implants on bone growth. The researchers used a cell-culture model in which bone-forming and bone-degrading cells were incubated together. Combined in this way, the cells tolerate higher concentrations of magnesium than in monocultures and communicate with one another differently. The result is an overall increase in the number of bone-forming cells, which in turn deposit more calcium, thereby contributing to bone regeneration. The study shows on a molecular level how an optimised release of magnesium can assist in the healing process.

The world's smallest lattice structure is only visible under an electron microscope. The struts have a diameter of 0.2 micrometres. The total size of the structure is around 10 micrometres. *Image: J. Bauer/KIT*



Karlsruhe Institute of Technology (KIT)

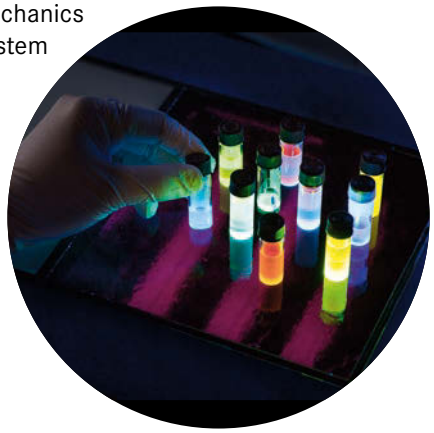
WORLD'S SMALLEST LATTICE STRUCTURE

KIT scientists have created the world's smallest manmade lattice structure. Consisting of carbon with a glassy consistency, the struts are less than one micrometre long and 200 nanometres in diameter. The basic structure was created using 3D laser lithography and then shrunk and vitrified by means of pyrolysis. Due to its tiny dimensions, the structure exhibits previously unattained strength-to-density ratios. Possible applications include microelectronics and optical components.

Karlsruhe Institute of Technology (KIT)

HOW COPPER MAKES ORGANIC LIGHT-EMITTING DIODES MORE EFFICIENT

The use of copper as a fluorescent substance allows for the manufacture of inexpensive, environmentally friendly organic light-emitting diodes (OLEDs). So-called thermally active delayed fluorescence ensures a high light yield. Scientists from KIT, KIT spinoff CYNORA GmbH, and the University of St Andrews in the UK have now measured the speed of the underlying quantum mechanics phenomenon of intersystem crossing in a copper complex. The results of this fundamental research will help to enhance the OLEDs' energy efficiency.



Thanks to knowledge of their quantum mechanics properties, dyes can be customised for use in organic light-emitting diodes. *Image: KIT*

a lifetime, this goal can only be realised with the help of 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 being done on industrial biotechnology centres on the biobased production of chemicals, pharmaceuticals and proteins using microbial and enzymatic processes. The agronomists involved in the programme are helping to improve the quality of plant biomass and produce plant-based chemicals and materials.

Technology, Innovation and Society

This programme systematically investigates the diverse interfaces between technology, innovation and society with the goal of supporting decision-making processes in government, the economy and society. To this end it brings together expertise from the fields of 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 Germany's largest scientific organisation, with 38,237 staff members at 18 research centres and a total annual budget of 4.45 billion euros. Approximately 70 per cent of its funds are provided by Germany's federal and state governments at a ratio of 9 to 1. 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.

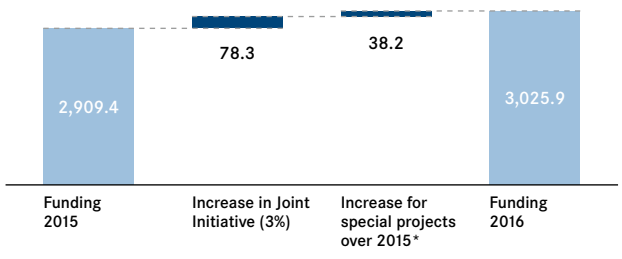
RESOURCES

Core funding for the Helmholtz Association for fiscal year 2016 increased to around 3.03 billion euros from approximately 2.91 billion euros the previous year.

Development of resources

Growth 2015–2016

in million € (federal and state governments)

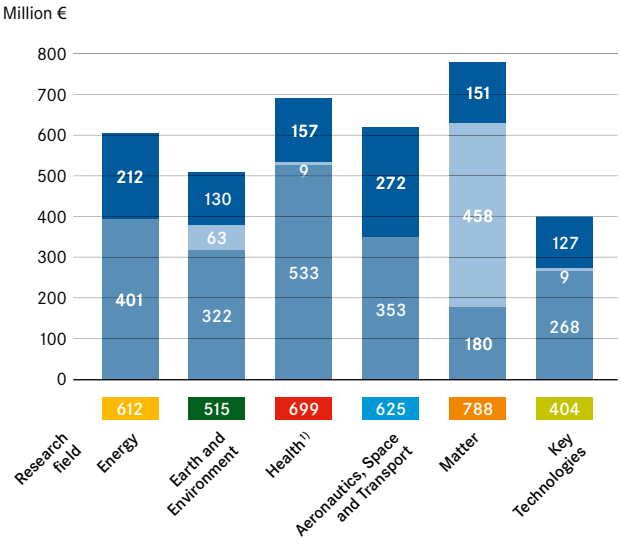


* Additional funds made available to the National Center for Tumor Diseases, the Drug Research and Functional Genomics Centre, the European XFEL project and the new building for the Berlin Institute for Medical Systems Biology

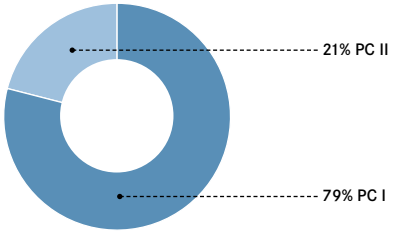
This growth is a result of the 3 per cent increase in funding from the Joint Initiative for Research and Innovation III, which is financed entirely by the federal government and amounted to 78 million euros in 2016. In addition, a number of special projects that receive additional funding from the state and federal governments have continued to grow.

At first glance, it may appear that, with the exception of the field of key technologies research, overall financial resources are spread equally across all of the research fields, but a closer examination shows that the resources allocated to the field of matter research are invested primarily in research infrastructure and user platforms (Performance Category II, or PC I). As a whole, in-house research in the Helmholtz Association's 32 research programmes (Performance Category I, or PC I) accounts for the predominant share of the allocated funds.

2015 budget showing core and third-party funding for the research fields



PC 1 and PC II without third-party funds



Third-party funds[2]
PC II
PC I

[1] Including the Helmholtz share of both the German Centres for Health Research and the Berlin Institute of Health
[2] Only third-party funds that are directly attributed to the research fields

The bar chart shows core and third-party financing as actual costs for 2015. Actual costs are funds that were in fact used by the research centres during the year under review.

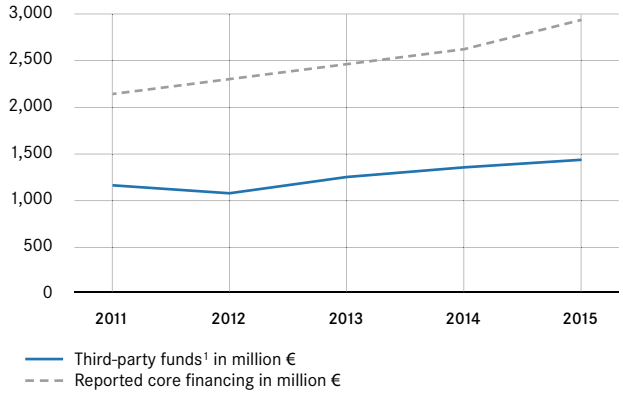
FRANZISKA BROER
Managing Director of the
Helmholtz Association

Currently around 21 per cent of resources are allocated to research infrastructure and user platforms. This share, which has remained relatively constant over the past ten 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 2015 the Helmholtz Association acquired third-party funding totalling 1.43 billion euros, representing an increase of 8 per cent over the previous year.

Third-party funds



[1] Project sponsorships have been included in full since 2011 (approx. 218 million euros in 2015).

Sources: Progress Reports of the Helmholtz Centres, 2011–2015

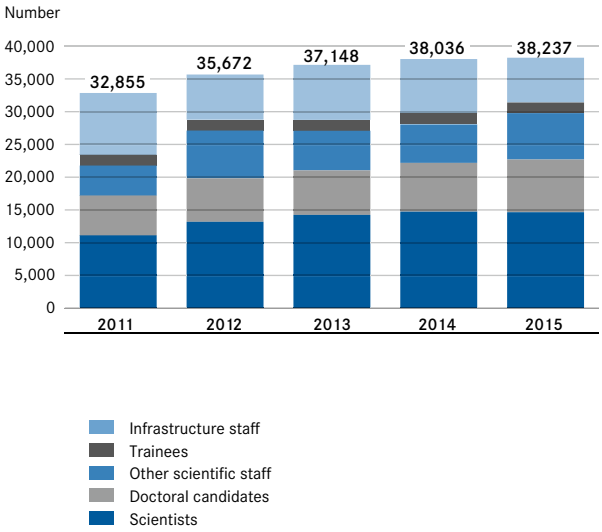
The EU grants acquired through the Horizon 2020 programme represent a particularly important share of third-party funding. The Helmholtz Centres participated in 268 projects that were newly funded by this European research programme in 2015 – almost twice as many as in 2014. This increase is attributable to the expiration of the previous research programme and the start of Horizon 2020. All told, the level of funding has remained roughly the same as the previous year. Part of the funding in the year under review came from projects that had received grants in recent years.

Acquired EU research funds

in T€	2011	2012	2013	2014	2015
Funds from the EU for research and development	146,188	126,936	122,612	132,888	133,047

Staff developments

Staff developments



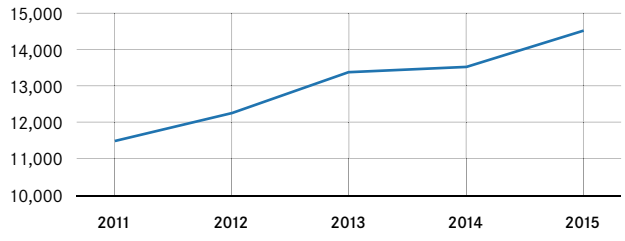
In 2015, as in the previous year, the increase in the funding that the Helmholtz Association received from the Joint Initiative for Research and Innovation went hand in hand with an increase in the number of staff at the Helmholtz centres to 38,237.
Detailed information on the Helmholtz Association's resources and a breakdown by research field and research centre can be found on pages 42–43.

SCIENTIFIC PERFORMANCE

Research performance

Publications are a key measure of scientific productivity and they continued to grow in number in the year under review. In 2015, a total of 14,488 papers by Helmholtz scientists were published in ISI or SCOPUS-indexed scientific journals. The number of publications grew by 7 per cent over the previous year and by a total of 26 per cent compared to 2011.

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, it is based on publications in 68 journals that are independently selected as the most important by two panels of scientists from the fields of physics, chemistry, environmental science and the life sciences. In 2015, as in the previous year, the Helmholtz Association defended its sixth-place ranking. The table shows the Nature Index for the period 1 January 2015 to 31 December 2015.

Nature Index 2015

Rank	Institution	No. of Articles
1	French National Centre for Scientific Research (CNRS), France	4,937
2	Chinese Academy of Sciences (CAS), China	3,449
3	Max Planck Society, Germany	3,110
4	Harvard University, US	2,622
5	Spanish National Research Council (CSIC), Spain	1,667
6	Helmholtz Association, Germany	1,663
7	Massachusetts Institute of Technology (MIT), US	1,627
8	University of Cambridge, UK	1,568
9	Stanford University (SU), US	1,514
10	Pierre and Marie Curie University (UPMC) – Paris 6, France	1,472

User platforms

Along with scientific performance, an important issue for the Helmholtz Association is the extent to which it has fulfilled its mission to provide researchers with access to its unique research facilities. Availability increased in 2015 and scientists were able to use the research facilities for almost the entire year. More than two-thirds of the users of large-scale devices were external scientists. A direct comparison with 2014 is possible only to a limited degree because in the previous year the field of matter research and the field of key technologies research were still in the old programme period and large-scale facilities were either discontinued or added due to the new programme structure.

Helmholtz Association research facilities

	Type of use	Actual value 2014	Actual value 2015*
Availability		72.6%	94.6%
Utilisation	Internal Helmholtz scientists	31.9%	29.4%
	External scientists	68.1&	70.6%

* The table shows average values for all the large-scale devices at the Helmholtz Association. Average availability refers to the number of days per year 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 units of capacity measurement are 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 (generally with universities) in the programmes of both the German Research Foundation and the Excellence Initiative.

Joint appointments

	2011	2012	2013	2014	2015
Joint appointments with universities, W2 and W3 staff	374	452	499	554	609

German Research Foundation (DFG)

Number in the year	2011	2012	2013	2014	2015
Research centres	1	2	2	1	1
Collaborative research centres	64	68	67	62	65
Priority programmes	52	52	49	42	44
Research units	62	58	61	55	49

Under certain conditions, Helmholtz researchers can obtain funding from the DFG. In such cases the Helmholtz centres serve as important strategic partners to universities when submitting DFG applications – especially for initiatives that establish long-term structures. The table above, showing participation in the coordinated DFG programmes, 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 within the scope of their university activities. If these projects are also counted, the figures for 2015 increase to two research centres, 100 collaborative research centres, 55 priority programmes and 63 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. A total of 9,286 international researchers came to the Helmholtz centres to exchange scientific ideas and to take advantage of the research opportunities these centres had to offer. This figure represents an increase of 24 per cent over the previous year.

Foreign scientists at the Helmholtz centres

	2011	2012	2013	2014	2015
Total	**7,363**	**7,765**	**8,523**	**7,476**	**9,286**

Equal opportunity

A look at the appointments to W3 professorships over the first two periods of the Joint Initiative shows a very positive development: the proportion of women among new appointments increased from 14 per cent in 2011 to 42 per cent in 2015. A look at absolute figures also demonstrates the strong growth over the last five years. In 2015 the increase in the share of new female appointees to W3 positions was due primarily to the successes of the recruitment initiative, which was responsible for six of the sixteen new female professors. The Helmholtz Association is thus making an important contribution to fulfilling target quotas in this area.

Equal opportunity

	2011	2012	2013	2014	2015
New W3 appointments	29	39	41	43	38
Women	4	10	10	14	16
Proportion of women	14%	26%	24%	33%	42%

Talent management

Fostering the development of young scientists is central to securing both the Helmholtz Association's future and the viability of Germany as a centre of research and science. It is therefore part of the association's mission. In the first two periods of the Joint Initiative, in addition to advancing the careers of young scientists at the Helmholtz centres, the association designed overarching funding instruments within the framework of the Initiative and Networking Fund and supported these instruments with substantial funding from the Joint Initiative. These instruments have become part of a comprehensive strategic talent management system that offers attractive conditions to talented young researchers at every stage of their careers. The opportunities include structured PhD education in graduate and research schools, a postdoc programme to support researchers directly after completion of their PhDs, the Helmholtz Young Investigators Groups for top international talent, the W2/W3 programme to attract and promote outstanding young female scientists, and the recruitment initiative to bring internationally acclaimed researchers to the association.

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)	80	36
	Leaders of other junior research groups (e.g. junior research groups at the centres, Emmy Noether groups)	127	44

The Helmholtz Association has also systematically expanded its programmes to support doctoral candidates. It has increased the number of graduate and research schools in order to provide as many doctoral candidates as possible with a structured education based on defined quality standards. The success of these activities is reflected in the 15 per cent increase in completed doctoral degrees in 2015 compared to the previous year.

Doctoral work

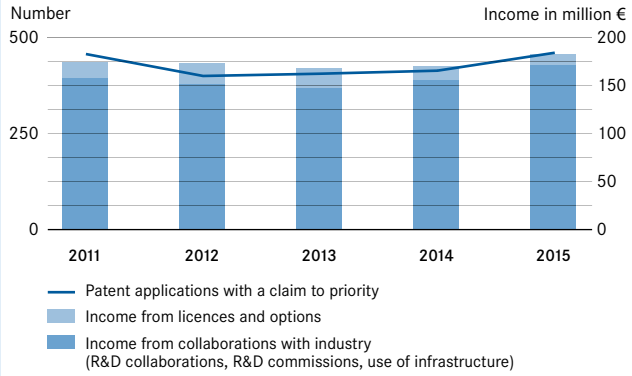
	31.12.11	31.12.12	31.12.13	31.12.14	31.12.15
Number of funded graduate and research schools*	75	84	95	116	97
Number of supervised doctoral candidates**	6,062	6,635	6,789	7,446	8,044
Number of completed doctoral degrees	822	803	964	1,059	1,219

* Including 12 graduate schools supported by the DFG
** Including candidates who use the Helmholtz Association's research infrastructure

Technology transfer

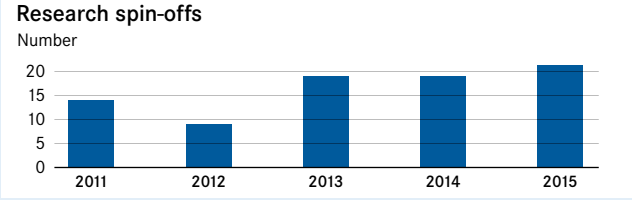
Making research findings available to industry and society is an important part of the Helmholtz Association's mission. Over the last few years, a variety of new instruments and platforms have been established in order to promote technology transfer, including the Helmholtz Validation Fund, the Helmholtz Innovation Labs and the Innovation Funds of the Helmholtz Centres. Revenues from collaborations with industry have remained relatively constant; taking into account the stricter definition of key figures introduced in 2013, there has even been a slight increase. Income from licenses and options has been volatile and ranged between 12 and 20 million euros. The number of patent applications has remained relatively constant at 400, which is attributable to a more stringent selection process focusing on commercial success.

Technology transfer



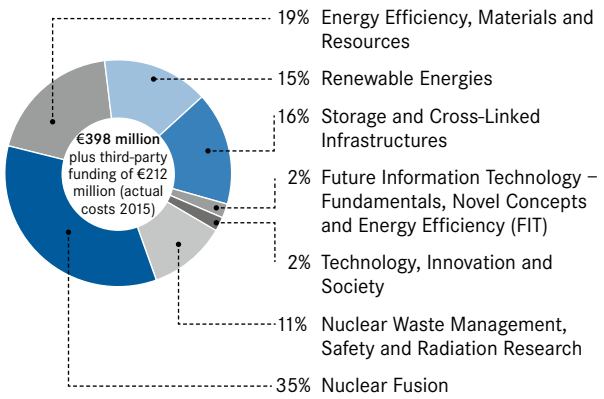
Recent years have seen an increase in the number of research spin-offs. This is due to the expanded activities of the centres, the greater use of EXIST funds and the internal "Helmholtz Enterprise" funding instrument. The vibrant start-up activity at KIT made a major contribution to the record number of 21 spin-offs in 2015.

Research spin-offs



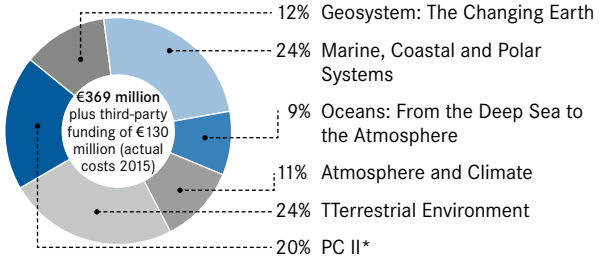
COSTS AND STAFF

Structure of the Research Field Energy
Target costs of core financing 2015: 398 million euros



Source: Progress Report of the Centres 2015

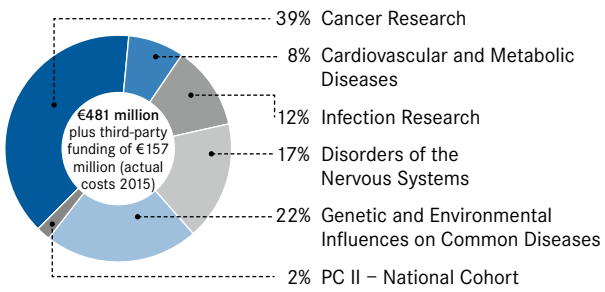
Structure of the Research Field Earth and Environment
Target costs of core financing 2015: 369 million euros



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

Source: Progress Report of the Centres 2015

Structure of the Research Field Health
Target costs of core financing 2015: 481 million euros*



*Plus funds of €74 million for the Helmholtz share of the German Centres for Health Research, the Berlin Institute of Health and the expansion of the National Center for Tumor Diseases

Source: Progress Report of the Centres 2015

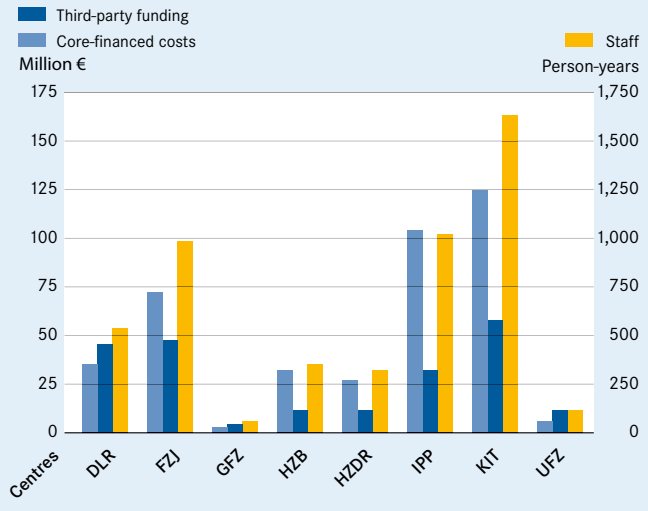
COSTS AND STAFF

COSTS AND STAFF 2015 for the Helmholtz Association, overview	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff PYs[1]
Research fields, total[2]	2,595,772	1,047,867	3,643,639	30,726
Non-programme-linked research, total[3]	4,051	30,587	34,638	203
Special tasks, total[4]	11,606	10,478	22,084	89
Project sponsorships, total		218,234	218,234	2,079
Redirected third-party funds, total		120,336	120,336	
Helmholtz Association, total	**2,611,429**	**1,427,502**	**4,038,931**	**33,097[5]**

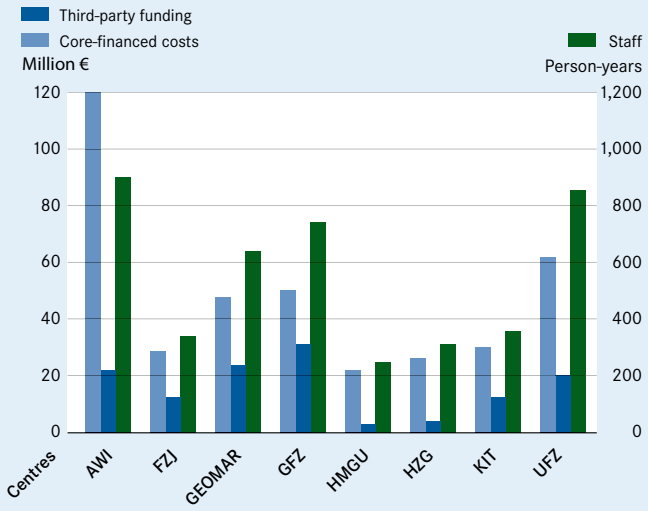
All amounts in thousands of euros. [1]Person-years. [2] In addition to the six research fields, this category includes the Helmholtz share of the German Centres for Health Research. [3]The funds for non-programme-linked research can amount to a maximum of 20 per cent of all acquired programme funding. If the centres use these funds to expand existing research programmes, they are assigned directly to the costs of the respective programmes. [4]Mainly involving the decommissioning of nuclear facilities. [5]Expressed as natural persons, the Helmholtz Association has 38,237 employees.

Research Field Energy	Core-financed actual costs T€	Third-party funds T€	Total T€	Total staff PY[1]
German Aerospace Center (DLR)	29,892	44,317	74,209	604
Forschungszentrum Jülich (FZJ)	70,835	46,047	116,882	989
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	34,009	9,938	43,947	349
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	27,562	9,686	37,248	339
Helmholtz Centre for Environmental Research (UFZ)	5,192	3,431	8,623	102
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	3,172	3,876	7,048	52
Karlsruhe Institute of Technology (KIT)	125,386	62,988	188,374	1,632
Max Planck Institute for Plasma Physics (IPP)	104,544	31,262	135,806	1,005
Research Field Energy, total	**400,592**	**211,545**	**612,137**	**5,072**
Research Field Earth and Environment				
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	119,912	21,189	141,101	903
Forschungszentrum Jülich (FZJ)	28,205	12,390	40,595	351
GEOMAR Helmholtz Centre for Ocean Research Kiel	46,874	23,974	70,848	632
Helmholtz Centre for Environmental Research (UFZ)	62,426	20,042	82,468	841
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	25,538	5,095	30,633	311
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	21,090	4,176	25,266	268
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	51,288	30,612	81,900	754
Karlsruhe Institute of Technology (KIT)	29,536	12,652	42,188	367
Research Field Earth and Environment, total	**384,869**	**130,130**	**514,999**	**4,427**
Research Field Health				
German Cancer Research Center (DKFZ)	168,041	59,565	227,606	2,357
German Center for Neurodegenerative Diseases (DZNE)	66,189	8,489	74,678	766
GSI Helmholtz Centre for Heavy Ion Research	5,072	1,234	6,306	72
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	18,161	2,100	20,261	180
Helmholtz Centre for Infection Research (HZI)	59,410	32,686	92,096	812
Helmholtz Centre for Environmental Research (UFZ)	4,547	523	5,070	54
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	131,095	28,248	159,343	1,682
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	89,720	23,936	113,656	1,093
Research Field Health, total	**542,235**	**156,781**	**699,016**	**7,016**
Research Field Aeronautics, Space and Transport				
German Aerospace Center (DLR)	352,891	271,734	624,625	5,192
Research Field Aeronautics, Space and Transport, total	**352,891**	**271,734**	**624,625**	**5,192**
Research Field Matter				
Deutsches Elektronen-Synchrotron (DESY)	239,983	86,418	326,401	2,131
Forschungszentrum Jülich (FZJ)	50,120	14,651	64,771	477
GSI Helmholtz Centre for Heavy Ion Research (GSI)	125,493	26,292	151,785	1,372
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	119,595	5,230	124,825	574
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	43,579	4,884	48,463	369
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	9,602	1,365	10,967	80
Karlsruhe Institute of Technology (KIT)	49,506	11,698	61,204	477
Research Field Matter, total	**637,878**	**150,538**	**788,416**	**5,480**
Research Field Key Technologies				
Forschungszentrum Jülich (FZJ)	153,932	75,644	229,576	1,911
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	38,827	10,480	49,307	481
Karlsruhe Institute of Technology (KIT)	84,548	41,015	125,563	1,147
Research Field Key Technologies, total	**277,307**	**127,139**	**404,446**	**3,539**

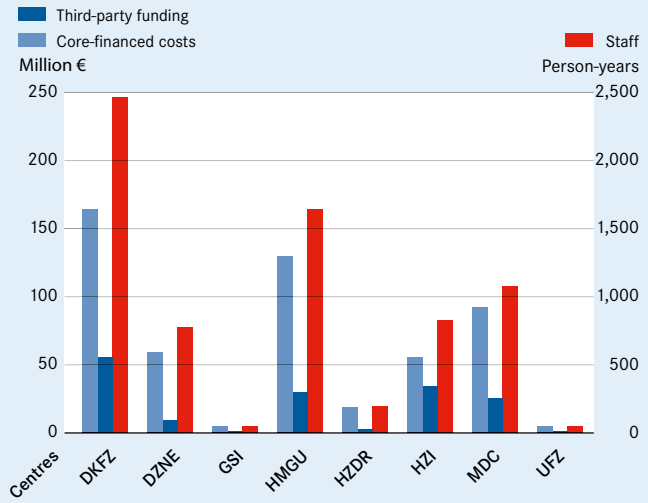
Research Field Energy



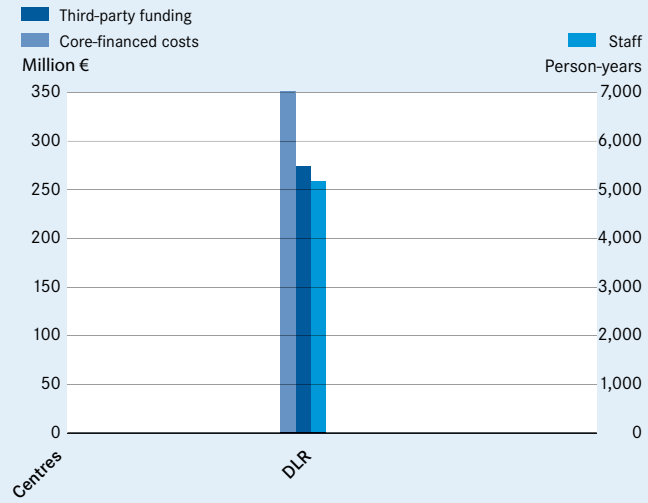
Research Field Earth and Environment



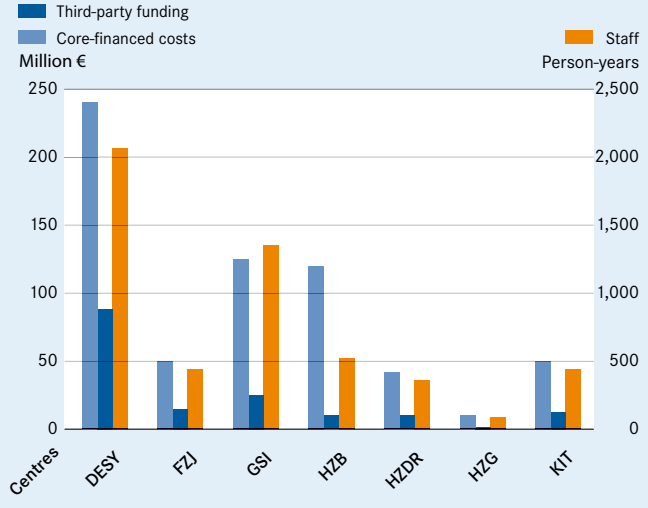
Research Field Health



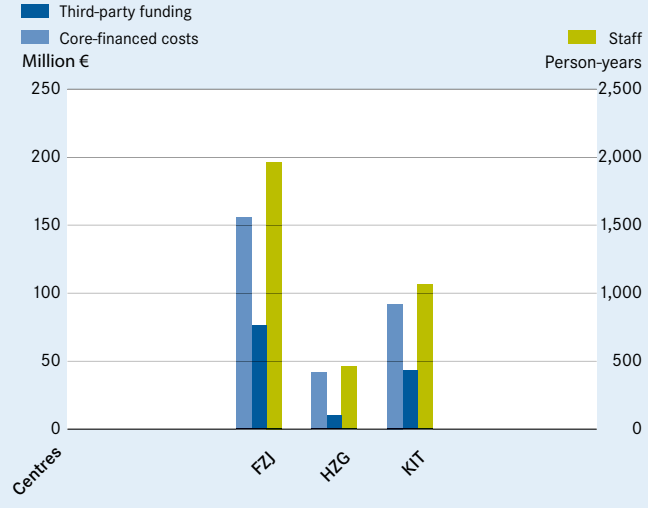
Research Field Aeronautics, Space and Transport



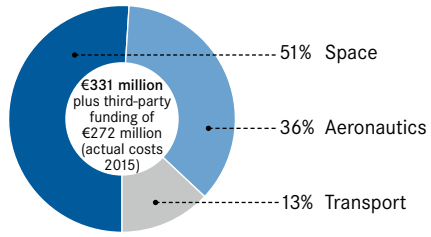
Research Field Matter



Research Field Key Technologies

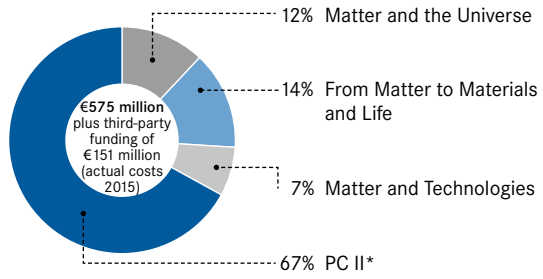


Structure of the Research Field Aeronautics, Space and Transport
Target costs of core financing 2015: 331 million euros



Source: Progress Report of the Centres 2015

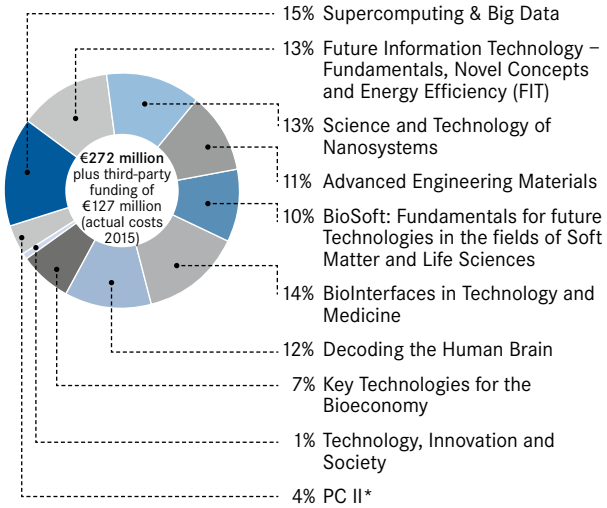
Structure of the Research Field Matter
Target costs of core financing 2015: 575 million euros



*TIER II, FLASH, PETRA III and PC II under development – XFEL (DESY); GridKa (KIT); JCNS (FZJ); BER II and BESSY (HZB); ELBE, HLD and IBC (HZDR); GEMS (HZG); PC II under development – FAIR (GSI)

Source: Progress Report of the Centres 2015

Structure of the Research Field Key Technologies
Target costs of core financing 2015: 272 million euros



* Karlsruhe Nano Micro Facility (KIT)

Source: Progress Report of the Centres 2015

2015

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, here the total budget is broken down for the fiscal year 2015 according to research field and centre. This overview is supplemented by information on the number of staff expressed in person-years.

Costs and staff by centre, 2015

	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)	119,912	21,189	141,101	903
Deutsches Elektronen-Synchrotron (DESY)	239,983	86,418	326,401	2,131
German Cancer Research Center (DKFZ)	168,041	59,565	227,606	2,357
German Aerospace Center (DLR)	382,783	316,051	698,834	5,796
German Center for Neurodegenerative Diseases (DZNE)	66,189	8,489	74,678	766
Forschungszentrum Jülich (FZJ)	303,092	148,732	451,824	3,728
GEOMAR Helmholtz Centre for Ocean Research Kiel	46,874	23,974	70,848	632
GSI Helmholtz Centre for Heavy Ion Research (GSI)	130,565	27,526	158,091	1,444
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	153,604	15,168	168,772	923
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	89,302	16,670	105,972	888
Helmholtz Centre for Infection Research (HZI)	59,410	32,686	92,096	812
Helmholtz Centre for Environmental Research (UFZ)	72,165	23,996	96,161	997
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	73,967	16,940	90,907	872
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	152,185	32,424	184,609	1,950
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	54,460	34,488	88,948	806
Karlsruhe Institute of Technology (KIT)	288,976	128,353	417,329	3,623
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	89,720	23,936	113,656	1,093
Max Planck Institute for Plasma Physics (IPP)	104,544	31,262	135,806	1,005
Non-programme-linked research	**4,051**	**30,587**	**34,638**	**203**
Special tasks[2]	**11,606**	**10,478**	**22,084**	**89**
Project sponsorships		**218,234**	**218,234**	**2,079**
Redirected third-party funds		**120,336**	**120,336**	
Helmholtz Association, total	**2,611,429**	**1,427,502**	**4,038,931**	**33,097**

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

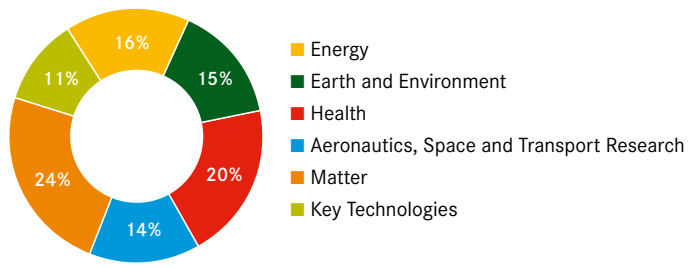
THIRD ROUND OF PROGRAMME-ORIENTED FUNDING

All of the research fields and their programmes are currently in the third period of programme-oriented funding. The financing recommendations for 2016, which the Helmholtz Senate made on the basis of its evaluations, are shown for all of the research fields in the following table.

Target costs of programme-oriented funding 2016: 2,521 million euros

	Target costs 2016 in million €
Energy	413
Earth and Environment	383
Health*	496
Aeronautics, Space and Transport	341
Matter	608
Key Technologies	279
Total	**2,521**

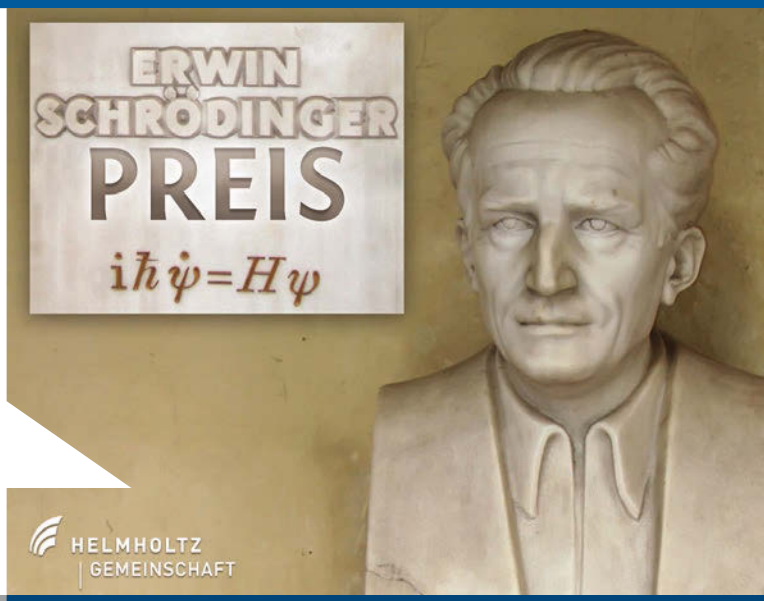
* Not including the German Centres for Health Research and the Berlin Institute of Health



SCIENTIFIC PRIZES AND AWARDS

2016 ERWIN SCHRÖDINGER PRIZE

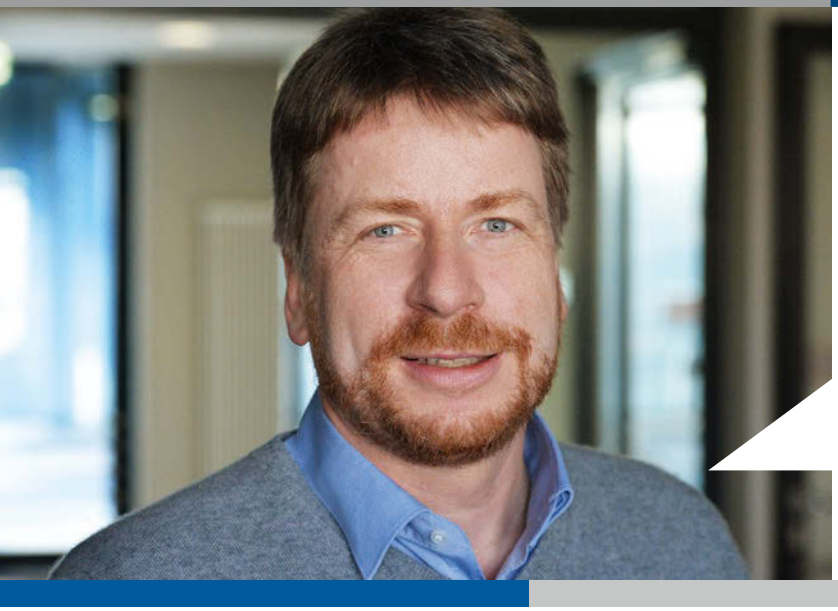
Christopher Barner-Kowollik, Martin Bastmeyer and Martin Wegener from the Karlsruhe Institute of Technology have won the 2016 Erwin Schrödinger Prize. Worth 50,000 euros, this award recognises outstanding scientific achievements and technological innovations at the interface between various disciplines in medicine, the natural sciences and engineering. The work must involve representatives of at least two disciplines. This year's winners are being honoured for their work in the field of 3D technology.



SCIENTIFIC PRIZES

Awards and prizes increase 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.

ERC grants: **Isaac Boxx (DLR)**, Hendrick Fuchs (FZJ), **Stefan Gröschel (DKFZ)**, Susanne Häussler (HZI), **Matthias Heikenwälder (HMGU)**, Irmela Jeremias (HMGU), **Christian Koos (KIT)**, Jan Gerrit Korvink (KIT), **Pavel Levkin (KIT)**, Yuri A. Litvinov (GSI), **Samir Lounis (FZJ)**, Alexander Nesterov-Müller (KIT), **James Poulet (MDC)**, Daniel Razansky (HMGU), **Ulf Riebesell (GEOMAR)**, Hans Stroeher (FZJ), **Kerstin Tackmann (DESY)**, Matthias Tschoep (HMGU), and **Vasilis Tziachristos (HMGU)**



2016 LEIBNIZ PRIZE

Molecular biologist Frank Bradke (pictured), group leader at DZNE and professor of neurobiology at the University of Bonn, has been awarded the Gottfried Wilhelm Leibniz Prize, worth 2.5 million euros. The prize was also presented to microbiologist Emmanuelle Charpentier, who in January 2016 left the HZI's headquarters in Braunschweig to join the Berlin-based Max Planck Institute for Infection Biology.

CENTRAL BODIES

As of 1 September 2016

PRESIDENT

Professor Otmar D. Wiestler

VICE-PRESIDENTS

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

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

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

Scientific Vice-President,
Coordinator of the Field of Aeronautics, Space and Transport Research
Professor Pascale Ehrenfreund, Chair of the Executive Board, German Aerospace Center (DLR)

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

Scientific Vice-President,
Coordinator of the Field of Key Technologies Research
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 (until 29 February 2016)

Franziska Broer (from 1 August 2016)

SENATE

ELECTED MEMBERS

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

Dr. Heike Hanagarth, former Head of the Technology and Environment Division at Deutsche Bahn AG, Berlin

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

Martina Koederitz, Chief Executive of IBM Deutschland GmbH, 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, Chief Operating Officer Grid & Infrastructure, innogy SE, Essen

Professor Wolfgang Plischke, former Management Board Member of 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 Chair of the University Medical Center at Johannes Gutenberg University Mainz

EX OFFICIO SENATE MEMBERS

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

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

Professor Horst Hippler, President of the German Rector's Conference, Bonn

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

René Röspel, Member of the German Bundestag, Berlin

Svenja Schulze, Minister for Innovation, Science and Research of the State of North Rhine-Westphalia, Düsseldorf

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

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

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

Franziska Broer, Managing Director of the Helmholtz Association, Berlin

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

Professor Pascale Ehrenfreund, Vice-President of the Helmholtz Association, Chair of the Executive Board, German Aerospace Center, 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 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 Reimund Neugebauer, President of the Fraunhofer-Gesellschaft, Munich

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

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

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

Dr. Katrin Wendt-Potthoff, Vice-Chairperson of the Committee of Scientific-Technical Councils of the Helmholtz-Centres, Helmholtz Centre for Environmental Research – UFZ, Magdeburg

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 Center for Heavy Ion Research

SENATE COMMISSIONS

PERMANENT MEMBERS

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

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

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

Aeronautics, Space and Transport Research
John Lewis, Director Strategy & Business Development, Telespazio VEGA Deutschland GmbH, Darmstadt

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

Key Technologies Research
Dr. Stephan Fischer, Director of Software Development, TRUMPF GmbH + Co. KG, Ditzingen

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

Representatives of the Federal States
Dr. Simone Schwanitz, Ministry of Science, Research and Art of the State of Baden-Württemberg, Stuttgart

Annette Storsberg, Head of Division, Ministry of Innovation, Science and Research of the State of North Rhine-Westphalia, Düsseldorf

FIELD-SPECIFIC FEDERAL GOVERNMENT REPRESENTATIVES

Energy Research
Dr. Frank Heidrich, Head of Division, Federal Ministry for Economic Affairs and Energy, Berlin

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

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

Aeronautics, Space and Transport Research
Holger Schlienkamp, Head of Division, Federal Ministry for Economic Affairs and Energy, Berlin

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

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

MEMBERS' ASSEMBLY

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, 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
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 and Scientific Director until 31 Oct 2016),
Professor Michael Baumann (from 1 Nov 2016), 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,
Professor Heike Graßmann, Administrative Director

Helmholtz Centre for Infection Research GmbH*
Professor Dirk Heinz, Scientific Director,
N. N., 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. Alfons Enhsen, Technical 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, SdöR*
Professor Martin Lohse,
Chair of the Board of Directors,
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 – adopts research policy guidelines for the individual research fields for a period of several years. It also appoints members to the Helmholtz Senate.

SENATE

Together with the Members' Assembly, the Senate, which is made up of external experts, is the Helmholtz Association's central decision-making body. It consists of both ex-officio members – representatives of the federal and state governments, the German Bundestag and scientific organisations – and figures from science and industry. The latter are elected for three years. The Senate deliberates on all 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 set investment priorities. The Senate Commissions consist not only of its permanent members – ex officio representatives of the federal and state authorities and external experts for the six research fields – but also of temporary members for the specific research field under discussion.

PRESIDENT AND PRESIDENTIAL COMMITTEE

PRESIDENT

A full-time president heads the Helmholtz Association and represents it externally. He or she moderates the dialogue between science, industry and government and is responsible for preparing and implementing the Senate's recommendations regarding programme-oriented funding. The president coordinates 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.

MEMBERS' ASSEMBLY

The Helmholtz Association is a registered association comprising 17 legally independent research centres and one associate institute. Together with the Senate, the association's central body is the Members' Assembly, to which the scientific and administrative directors of each member centre belong. The Members' Assembly is responsible for all the tasks performed by the association. It defines the framework for the cross-centre development of both strategies and programmes and makes 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
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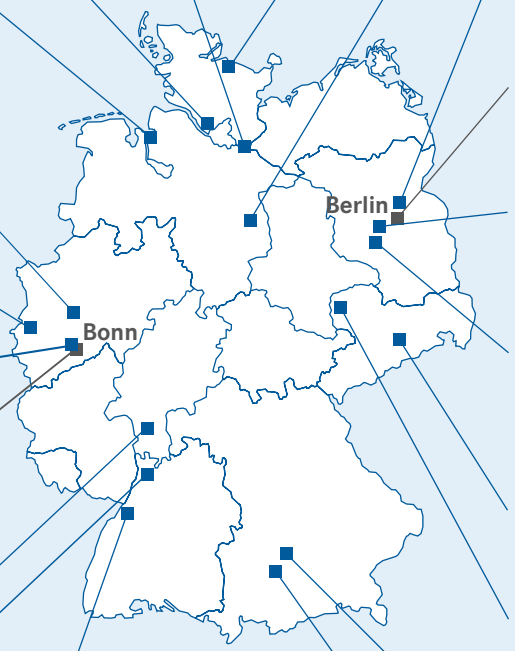
- Helmholtz Zentrum München – German Research Center for Environmental Health
- Karlsruhe Institute of Technology
- Max Delbrück Center for Molecular Medicine in the Helmholtz Association
- Max Planck Institute for Plasma Physics (associate member)

LOCATION OF THE RESEARCH CENTRES



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www.hzg.de

Deutsches
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