HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

ANNUAL REPORT 2017

THE HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTERS

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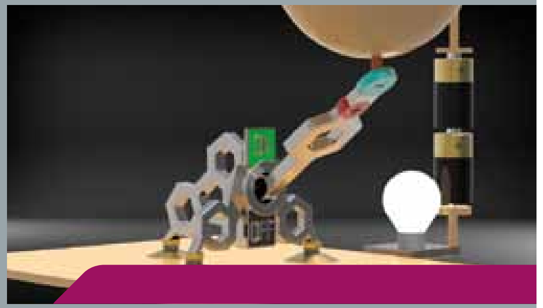

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NOTE ON THE REPORTING PERIOD:
The Helmholtz Annual Report 2017 describes developments at the Helmholtz Association from 2016 to 1 September 2017. The performance record is based solely on the 2016 calendar year. The Annual Report can be downloaded as a PDF at www.helmholtz.de/en/gb17.

Cover image: Helmholtz Association (collage); kentoh/shutterstock (background image)

MISSION

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

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 general support in all stages of their development.

That is our mission.

FOREWORD

Professor Otmar D. Wiestler,
president

HELMHOLTZ –
FROM DATA TO KNOWLEDGE

Dear Reader,

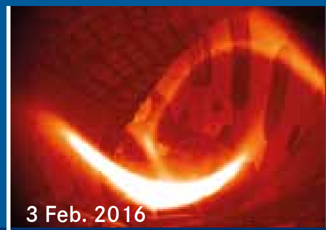
The goal of the Helmholtz Association is to find solutions to the major challenges of our time though cutting-edge interdisciplinary research. At our world-class centers and research facilities, outstanding scientists are formulating answers to questions that are changing our lives. Their research focuses on the causes and treatment of major common diseases, the origin of our universe, the future of mobility and sustainable energy provision, and the complex field of information science and digitization.
Our systems expertise covers the entire innovation chain, from basic research to applications. Together with our mission-driven approach to research, this makes us a key player in the world of science and an important partner to business, society and government. An integral part of our self-understanding is the idea that the major issues of our time can be solved only through collaboration and a strongly interdisciplinary approach. We are building on strategic partnerships in and outside the science system and will continue to pursue this strategy consistently in the future. Top-notch research originates in bright minds. We are proud of our staff, who are the foundation of our work. One of our most important objectives is to provide them with an attractive, family-friendly and scientifically challenging environment. After all, we are firmly convinced that our success will depend on attracting the most talented scientists from all over the world to our association in particular and to Germany as a whole.
Over the last few months we have attached particular importance to further developing the strategic focus of our research community and redefining the objectives of our research. As a result of this work, we are bringing a wide range of impressive scientific questions to the evaluations for the next round of program-oriented funding. On the following pages, we would like to give you a glimpse of current research projects and invite you to take a closer look at an exciting future with us.

I wish you interesting reading,

Otmar D. Wiestler

PRESIDENT'S REPORT

2016



3 Feb. 2016
First hydrogen plasma in Wendelstein 7-X at the IPP in Greifswald

23 Sept. 2016
Presentation of the Erwin Schrödinger Prize for 3D cell culturing

29 Sept. 2016
Emission-free travel: maiden flight of the HY4, a four-seater electric passenger plane

30 Sept. 2016
At 13:19 Central European Time, the Rosetta probe sends its last signal to Earth

For the Helmholtz Association, 2016 was a year of reorientation and crucial junctures. On the following pages, the president looks back on an eventful year and provides a glimpse of the future.

The main objective of the Helmholtz Association is to contribute to solving society's major challenges through cutting-edge research. We hope to actively shape the future of our country in particular and the world as a whole and to preserve and enhance the foundations of human life.
The unique strength of the Helmholtz Association and its centers is their ability to pool a high degree of interdisciplinary expertise, ranging from basic to application-oriented research. This approach is founded on outstanding basic research. Without its findings, innovative developments would not be possible. However, adopting the results of this research and gradually translating them into applications is no less important than directing the findings from the application phase back into the laboratory. At the Helmholtz Association, all stages of this cycle are covered. Our extensive systems expertise is an important prerequisite for fulfilling our mission.
The Helmholtz Association offers its staff excellent research conditions. We are working tirelessly to improve them so that we can attract the best minds to our organization. In addition to our research infrastructure, our creative staff are our most valuable asset. One key task is to further expand and continually optimize our comprehensive talent management system.
A dynamic community lives from the ongoing exchange of ideas and from discussions on the best solution. The close ties within the six research fields, among the centers and programs, as well as across disciplinary, institutional and national boundaries, are a fundamental aspect of our work. This network was a key theme in last year's strategic reflections. One of the central questions we are facing is how we can have the greatest scientific impact in all of our six research fields. The ongoing internationalization of the Helmholtz Association is a matter of special interest to me. In this context, one important milestone in 2016 was the finalization of a cooperation agreement between the Helmholtz Association and the Weizmann Institute of Science in Israel. The first concrete project to result from this agreement is the Weizmann-Helmholtz Laboratory for Laser Matter Interaction. As part of this project, the Helmholtz-Zentrum Dresden-Rossendorf and the Weizmann Institute will work together to develop new approaches to laser physics and to advance socially relevant applications in fields such as cancer therapies and diagnostics. All of the participants can be proud of the launch of the first joint lab in the Israeli city of Rehovot in April 2017.

THE ASSOCIATION'S STRATEGIC FOCUS

The recommendations submitted by the German Council of Science and Humanities after evaluating program-oriented funding have been incorporated into the Helmholtz Association's strategic development. In close collaboration with all of our centers, we have succeeded in further developing our research fields and more closely aligning their programs to the needs of society. One stimulus for the new focus is the desire to promote strategic future-oriented topics. These will provide important impetus for the positioning of the association's research fields and will receive around 80 million euros in support from the Initiative and Networking Fund. As I see it, the association's great potential is also shown by the impressive projects proposed in the first round of selections. I am confident that the five future topics thus selected will provide us with great long-term momentum.
One topic that will have enormous importance in the future is data-driven research and development. The rapidly evolving field of information and data science poses one of the greatest challenges for the entire science system and is affecting all levels of the Helmholtz Association – the centers, the research fields, the research programs and the overarching association level. With its outstanding expertise and powerful research infrastructure, the Helmholtz Association

6/7 Oct. 2016
First discussions on setting up the Information and Data Science Incubator

Oct.–Dec. 2016
Launch of the Kopernikus projects for the energy transition

31 Oct. 2016
Opening of the Energy Materials In-Situ Laboratory Berlin (EMIL) at the HZB's BESSY II

21 Nov. 2016
30th anniversary of the Cancer Information Service

23 Nov. 2016
Founding of the Hopp Children's Tumor Center at NCT Heidelberg

2017

Jan.–March 2017
25th anniversary celebrations of UFZ, MDC, GFZ and HZDR

15 March 2017
Chancellor Merkel inaugurates the new building at DZNE headquarters in Bonn

23 March 2017
Launch of Synlight, the world's largest artificial sun, at the DLR in Jülich

is excellently positioned in this field. Its capabilities cover a wide spectrum, including supercomputing, chip and memory development, computer science, software programs, modeling, simulation, artificial intelligence and robotics. In addition, it has highly comprehensive, complex data sets in all research fields classifiable as big data.
Our goal is to intelligently pool this expertise and to combine it in new ways so as to position the Helmholtz Association as an engine for innovation for information and data science. This is why we launched the Information and Data Science Incubator in 2016. Participants include top experts from all centers and research fields, who are working to create innovative interdisciplinary approaches and implement them in pilot projects. The incubator is also focused on structural issues and will develop interactive formats, innovative concepts and interaction models in a strategic process.
This new innovation platform is receiving significant start-up funding from the Initiative and Networking Fund. Another important goal is to create a new generation of multidisciplinary information experts, who are needed in all fields

HELMHOLTZ AS A STRATEGIC PARTNER IN THE SCIENCE SYSTEM

The Helmholtz Association cannot solve the major challenges in its research fields working on its own. It requires strong partners and shared goals. Through strategic partnerships, we are therefore intensifying collaboration with top universities, research facilities and companies. The motivation for these alliances is simple: complementary partners benefit from each other's knowledge and exceptional networks and can strengthen and systematically enhance their own scientific excellence. In addition, the Helmholtz centers are providing their partners with access to large-scale devices, research infrastructure and data. They are therefore making an important contribution to improving Germany's competitiveness as a center of science and innovation.
At the **Helmholtz Innovation Labs**, scientists from the Helmholtz Association are pursuing research and development with partners from the business community. The spectrum is broad. In the Open Innovation Labs, the research centers collaborate with one or more companies on a specific topic in a pre-competitive context. In User Innovation Labs, on the other hand, the focus is on the application- and user-oriented development of products and technology. Both strategies have a long-term horizon and go far beyond simple contract research and the previously used instruments of technology transfer. The Helmholtz Innovation Labs reflect the association's broad range of research. Seven new labs were launched in late 2016 and draw on a variety of fields: simulation, gene therapy, materials science, telecommunications technologies, robotics, the bioeconomy and the construction industry. They are characterized by their special combination of basic and application-oriented research. All have the potential to evolve into showcase projects at their centers and in the technology transfer landscape in Germany. For a maximum of five years, the Helmholtz Innovation Labs are financed by the Initiative and Networking Fund, the Helmholtz centers and participating companies. Afterward they are expected to support themselves with funds from third-parties, spin-offs or industry partners.
Strategic partnerships between the Helmholtz centers and universities are a pillar of the German science system. Helmholtz Institutes have emerged as a particularly interesting form of institutional partnership between a Helmholtz center and partner university in a forward-oriented research field. A **Helmholtz Institute** on a university campus provides a foundation for permanent close collaboration. Thanks to their ties to other relevant partner institutions at the local and national levels, these institutes become important focal points in their scientific disciplines. As a result, they attract talented scientists from around the world. To my great pleasure, the Helmholtz Association decided to launch two additional Helmholtz Institutes in 2016. The Helmholtz Institute for RNA-Based Infection Research (HIRI) is a joint venture between the Helmholtz Centre for Infection Research in Braunschweig and the Julius Maximilian University of Würzburg. The Helmholtz Institute for Functional Marine Biodiversity (HIFMB) was established in Oldenburg by the Alfred Wegener Institute for Polar and Marine Research and the University of Oldenburg. In addition, in 2017, we decided to found the Helmholtz Institute for Translational Oncology (HI-TRON) and the Helmholtz Institute for Metabolic, Adiposity and Vascular Research (HI-MAG) on the basis of the highly positive evaluations of their applications. As a result, the Helmholtz Association now runs a total of eleven Helmholtz Institutes, with a few already international leaders in their fields. In 2016, following the example of the Helmholtz Institutes and working with partners from the world of science, business and government, the German Aerospace Center (DLR) laid the foundation for a new type of strategic partnership – the **DLR Institute**. With an additional 42 million euros in funding from the federal government and 4.2 million euros from the federal states, the DLR has set up six of these new partnerships: the Institute for Applied Informatics, the Gas Turbine Test and Simulation Center, the Institute for the Protection of Maritime Infrastructures, the Institute of Data Science, the Institute for Software Research and Simulation, and the Next Energy Institute. They round off DLR's existing expertise in a focused way and create clear added value for the DLR's subject-specific, subject-strategic and overall strategic goals.

RECRUITMENT AND CAREER DEVELOPMENT AS A KEY FUTURE OBJECTIVE

A further aim of these activities is to attract the best minds to the Helmholtz Association. I am especially pleased that among our staff there are many recipients of prestigious awards. For example, in 2017, both the materials researcher Britta Nestler from the Karlsruhe Institute of Technology and Jörg Vogel, founding director of the HIRI, won the Leibniz Prize, an honor that in 2016 was bestowed upon Frank Bradke from the German Center for Neurodegenerative Diseases. The year 2017 also saw the diabetes researcher Matthias Tschöp from the Helmholtz Zentrum München win the Hansen Family Award, presented by the Bayer Science & Education Foundation. He shared this prize with Professor Jens Brüning from Cologne. As twenty-six European Research Council grants show, we also have a large number of excellent researchers capable of competing successfully at the European level. Ralf Bartenschlager, employed by both the DKFZ and Heidelberg University Hospital, won the highly acclaimed Lasker Award, while Wolfgang Wernsdorfer from the Karlsruhe Institute of Technology (KIT) received a Humboldt professorship.
Nevertheless, we want to and must continue intensifying our work in this area in order to attract exceptional talent. The core elements of our talent management strategy include programs tailored for different target groups at all stages of their careers, attractive recruitment offers, a mix of academic funding and clearly defined career prospects, and the ongoing professionalization of management at all levels.

The majority of the more than 8,000 doctoral students who are trained by the Helmholtz Association in cooperation with universities are integrated into its graduate schools and research schools, where they receive an excellent scientific education. The more than 2,600 postdoctoral researchers employed at the Helmholtz centers benefit from a broad portfolio of support services such as counseling, coaching and mentoring. In this area we would like to do even more on the association level and are therefore supporting the establishment and expansion, at our centers, of Helmholtz Career Development Centers for Researchers (HCDCRs).

In recognition of groundbreaking findings in the field of gut-brain signaling, Professor Matthias Tschöp, director of the Helmholtz Diabetes Center at the Helmholtz Zentrum München, was presented with the 75,000-euro Family Hansen Award by the Bayer Science & Education Foundation. He shared the honor with Professor Jens Brüning from Cologne.

With the Helmholtz Young Investigators Groups, we offer highly talented postdoctoral researchers from all over the world the opportunity to set up and direct a research group at a Helmholtz center. These junior research teams provide young scientists with early independence, a minimum budget of 1.8 million euros over a six-year period and reliable career prospects with an option for tenure at one of our centers. As of 2016, the association had provided support for a total of 209 Helmholtz Young Investigators Groups.
In 2017, the Helmholtz Management Academy looked back on ten years of successful work. Its leadership and management programs, geared specifically toward science, continue to be unique and are being developed and improved on an

22 April 2017
The March for Science is held in many cities around the world

26 April 2017
Founding of the international WHELMI laser lab in Rehovot

4 May 2017
XFEL, the largest X-ray laser in the world, generates its first laser light

ongoing basis. In 2016, a total of 87 participants attended and successfully completed the programs, which are tailored to five different target groups. In addition, we have introduced a process to further develop the academy.

COMMITMENT TO REFUGEES

In my view, talent management means taking social responsibility. In 2016, a large number of people were once again forced to leave their home countries and seek a new professional future in Germany. In cooperation with the Federal Employment Agency, the Helmholtz Association has given them access to scientific, technical and scientific training and employment. More than 160 refugees have found new prospects at one of the Helmholtz centers – as trainees, students, interns, doctoral candidates or permanent staff members.

RESEARCH INFRASTRUCTURE

The best scientists will choose the Helmholtz Association only if they find outstanding research conditions at our centers. With complex, large-scale research infrastructure, the Helmholtz Association offers unique opportunities in many fields. Last year we reached additional important milestones. After three years of construction, the Energy Materials In-Situ Laboratory (EMIL) was completed at the Helmholtz-Zentrum Berlin – an excellent example of collaboration between the Helmholtz Association and the Max Planck Society . This new laboratory complex for energy materials research, which was built at the BESSY II synchrotron in the Adlershof district of Berlin, was inaugurated on 31 October 2016 in the presence of Federal Research Minister Johanna Wanka.
One special highlight was the production of the first hydrogen plasma in the Wendelstein 7-X fusion device at the Max Planck Institute for Plasma Physics in Greifswald. The ceremony took place on 3 February 2016 and was attended by the federal chancellor. As the largest stellarator-type fusion device in the world, Wendelstein 7-X forms the heart of a unique project. The launch of the European XFEL, in which eleven countries are participating, is an excellent example of successful European collaboration. We expect its operation to lead to groundbreaking innovations in a variety of fields in the future. Unique research infrastructure, highly qualified staff and international interdisciplinary cooperation – these are the conditions that will enable us to tackle our future tasks with confidence and courage. The challenges facing the world are immense. We will do our best to help meet them.

THE HELMHOLTZ INFORMATION & DATA SCIENCE INCUBATOR

The enormous amount of data that is currently being produced by research is opening up entirely new prospects for science. The Helmholtz Information & Data Science Incubator was founded to pool the Helmholtz Association's outstanding expertise.

Data-based research is developing at breakneck speed. Whether it is in Earth system research, in which satellites provide enormous amounts of data, or in medicine and genetics or in transport research, it poses one of the greatest future challenges for both the Helmholtz Association and the entire science system. Groundbreaking developments in digital information processing and analyses of complex data are opening up entirely new possibilities and opportunities for science.
The Helmholtz Association is already ideally positioned in the field of information research. The broad spectrum covers supercomputing, "big data" analytics and handling, chip and memory development, computer science, software development, modeling, simulation, artificial intelligence and robotics. Undreamed-of potential lies not only in the individual disciplines, but also in the interplay between them.
Innovative interdisciplinary approaches are crucial to achieving a new quality of data analysis and integration. This is why the president of the Helmholtz Association has established the Helmholtz Information & Data Science Incubator. It consists of leading scientists from all six research fields and external experts from research-based companies and will pool the association's outstanding expertise and enormous treasure troves of data. The Helmholtz Information & Data Science Incubator is

- an agile, innovative group of important information disseminators and top-notch professionals who identify attractive topics, introduce these into the association and jointly investigate them over the long term.
- a forum for unique new ideas and an incubator for pioneering, disruptive pilot projects.
- a think tank that will provide new impetus to develop the association's research portfolio and structures.

On the one hand, the incubator will develop processes through which innovative topics can be identified, explored and directed into study on a continual, long-term basis. On the other hand, it will promote the investigation of large-scale research topics in which Helmholtz is already a national or international leader or has the potential to become one in the future. An additional focus is on training and the development of technology platforms. In order to ensure that the Helmholtz Association and the German research system as a whole keep their leading international position in these areas, the incubator will pursue the central task of training a new generation of information experts. To this end, it will develop proposals for establishing a Helmholtz Data Science Academy that spans and interconnects all disciplines. In addition, it will focus on issues that are considered important by social and political actors.
The Helmholtz Association is thus aiming to position itself as a formative force in these future-oriented research fields. It will develop powerful concepts and strategies for action and continuously provide opportunities and platforms for national and international partners. It will strengthen existing expertise and help ensure that German science achieves and retains a top international position in the field of information and data science. Together with numerous partners, it will also make an important contribution to the planned national infrastructure for research data.

RECRUITMENT INITIATIVE

Leadership positions in science help raise the profile of every research institution. The joint appointments made with universities serve as an important link between the Helmholtz Association as a non-university research organization and its university partners. In recent years the Helmholtz Association has managed to attract many outstanding scientists. Funding instruments such as the Initiative and Networking Fund, the Helmholtz Young Investigators Groups and the W2/W3 positions for excellent female professors have played an important role.

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 an overarching talent management strategy. Its central goal is to recruit outstanding new staff in an active, strategically oriented fashion. The Helmholtz Association desires a broadly diversified staff and is specifically devoting part of the annual funding increase from the Joint Initiative for Research and Innovation to recruting top female researchers.

NUMEROUS NEW APPOINTMENTS

A total of 118 million euros has been made available to the recruitment initiative for the 2013–2017 period. In 2016, 13 appointments were made and seven of the appointees were women. Since the initiative was launched in 2012, a total of 41 appointments have been made and 25 new hires have been women. There will probably be 51 appointments in all. Because the initiative has proved a great success, the Helmholtz Association plans to relaunch this instrument in the coming years in the form of a recruitment initiative exclusively for top female researchers.

“At the Helmholtz Zentrum München, I found a highly specialized, collaborative environment to pursue my research. The close collaboration with the Rechts der Isar Hospital, affiliated with the Technical University of Munich, is enabling me to apply the latest research findings directly at the clinic for the well-being of patients. Thanks to this unique combination, we will be able to develop new therapies in the future that are individually tailored to patients.”

PROFESSOR JULIANE WINKELMANN

Director of the Institute of Neurogenomics at the Helmholtz Zentrum München – German Research Center for Environmental Health

“It's a privilege to be able to conduct research at the Alfred Wegener Institute, one of the world's leading polar research institutes with unique logistical resources. The close ties to the University of Bremen will enable me to better identify and train talented young scientists and maintain our academic excellence and freedom. With the extensive funding from the Helmholtz recruitment initiative, I have been able to launch innovative research projects and create better future prospects for my section.”

PROFESSOR CHRISTIAN HAAS

Head of the Sea Ice Physics Section of the Alfred Wegener Institute for Polar and Marine Research and Professor of Arctic and Antarctic Sea Ice Geophysics and Remote Sensing at the University of Bremen

“I joined DESY because here I find the ideal combination of light facilities and scientific areas of research. The Helmholtz recruitment initiative allowed me to get a top position and to start a new group of young and motivated researchers; I was really thrilled by the freedom provided by this level of funding. DESY offers a unique and exciting environment and I can already envision that a new class of ground-breaking experiments in attosecond science will be triggered by the possibility to interact with the numerous resident research groups.”

PROF. DR. FRANCESCA CALEGARI

Director of the Attosecond Science Division of DESY und Professor of Physics at the University of Hamburg

EQUAL OPPORTUNITY

Equal opportunity for men and women is one of the Helmholtz Association's core values. It is firmly rooted in the association's mission and is an integral part of its strategy to recruit the best and brightest minds at all stages of their careers. After all, cutting-edge research is only possible if the most talented people receive the right positions regardless of gender. This is why diversity – with a special focus on equal opportunity – is an important part of the association's talent management program. It is an interdisciplinary topic that is systematically incorporated into all of its programs and activities, such as the funding lines of the Initiative and Networking Fund.
In 2006, the Helmholtz Association signed the Equal Opportunity Offensive for Men and Women in Science, initiated by German science organizations. In addition, it adopted an internal five-point program whose provisions continue to be actively implemented today.
Since 2009, the research-oriented equality standards of the German Research Foundation have served as an additional reference point in this field. The Helmholtz Association is a partner in the National Pact for Women in STEM Professions (i. e. science, technology, engineering and mathematics). As part of the commitment it has made for the pact period beginning in 2016, it has once again pledged to specifically recruit highly qualified female scientists and to fill more leadership positions with women.
In order to make significant progress in the promotion of equal opportunity, the association is focusing on three main areas of action:

1. Recruiting the best female scientists at all levels
2. Developing top female talent
3. Building networks among these women scientists

Equal opportunity can only be achieved by providing individual support and encouragement for women, by ensuring a high level of compatibility between work and family life, and by further developing the organizational culture of a research community. The recruitment figures of recent years clearly demonstrate that the Helmholtz Association's activities have borne fruit. Nevertheless, enormous efforts are still needed to ensure that more women obtain and retain leadership positions.

W2/W3 program for outstanding female scientists

48 grants since 2016

Initiatives promoting equal opportunity: share of women

Postdoc program	44 %
Young Investigators	35 %
Recruitment initiative	61 %

"Taking the Lead" mentoring program for young women leaders

300 participants since 2005

Quota for female experts

30 percent minimum for female experts in all evaluations and selection competitions

INNOVATION AND TECHNOLOGY TRANSFER – PART OF THE HELMHOLTZ ASSOCIATION'S MISSION

The Helmholtz Association does not pursue scientific progress for its own sake. An important part of its mission is to find solutions to the great challenges of our time – e.g. treatments for major common diseases, strategies for a sustainable energy supply and the development of new materials for industry. Innovation and knowledge transfer are thus of crucial importance in our research community.
In many cases, we cover the entire chain, from outstanding basic research to applications, and thus serve as key partners in the national and international innovation system. The Helmholtz centers have long played an active role in technology transfer – including, for example, the commercialization of research findings. In addition, they offer many initiatives and established platforms to share and exchange knowledge with society.
As a result, the research conducted at the Helmholtz centers has led to a large number of products. In the last four years alone, there have been 77 high-tech research spin-offs. The Helmholtz Association is involved in more than 2,000 collaborations with companies, including many long-term strategic alliances. These close ties to the business community are illustrated by the increased use of research infrastructure by industry and SMEs, as well as by the large number of publicly funded collaborative projects. The dynamic activities in this field are also reflected in the more than 400 patent applications and 1,500 active license agreements in 2016 alone.
Knowledge transfer has a tremendous impact on society: the frequently used information services, for example, provide information and foster a dialogue with both the public in general and selected target groups. School labs bring young people into contact with science at an early age.
In strategic key-issues papers dealing with knowledge and technology transfer, the Helmholtz Association has recently developed and implemented numerous measures and defined important guidelines. In addition, in late 2016, a new working group completed a position paper on knowledge transfer. These efforts are making possible new methods for assessing impacts on society. Last year the association expanded its portfolio of previous transfer instruments (e.g. the Helmholtz Enterprise program for research spin-offs and the Helmholtz Validation Fund for the application-oriented development of research findings) to include two new funding initiatives. As part of the Helmholtz Innovation Labs, seven experimentation spaces were founded in the period to 2017 for collaborations with SMEs and industry. In addition, in 2016, nine institutionally funded Innovation Funds were launched at the Helmholtz centers. These make it possible, in particular, to support internal innovation projects.
In addition to dialogue platforms at the center level, the Helmholtz Association last year continued two successfully established event formats at the association level. The first was the Research Days and Foresight Workshops with companies such as Daimler and Huawei. These events brought together researchers from the various centers with company experts. The second was the Start-up Days, a joint event that in 2016 was held for the fourth time with non-university research organizations and that provided around 100 potential start-up founders with a unique format for the exchange of ideas and further education.
Innovation and technology transfer will continue to play an important role at the Helmholtz Association in the future. In early 2017, the association issued calls for a proof-of-concept initiative together with the Fraunhofer Society and university hospitals. It also published calls for projects designed to promote knowledge transfer. In addition, the topic is currently on the president's agenda and is highlighted in the Helmholtz Association's strategy as one of four important joint strategic initiatives. In order to further innovation and technology transfer, the strategy has defined five ambitious goals:

1. Launch development partnerships and collaborations with the business community.
2. Secure a leading position when it comes to the benchmarking of relevant technology transfer characteristics.
3. Create optimal conditions for technology transfer and strengthen a culture of innovation.
4. Exchange ideas with business and society as an elementary aspect of the Helmholtz Association's mission.
5. Enhance knowledge transfer and use new interactive and participatory formats.

RESEARCH FIELD ENERGY

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

MISSION

Helmholtz scientists involved in the field of energy research are working to secure an economically, ecologically and socially sustainable supply of energy. They are examining conversion, distribution, storage and utilization 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 they are seeking to determine the potential of renewables such as solar, biomass and geothermal energy. Researchers are also working to increase the efficiency of conventional power plants. Finally, the Helmholtz Association is pursuing the long-term goal of developing nuclear fusion as a new energy source, and it boasts outstanding expertise in the field of nuclear safety and final repository research.

PROGRAM STRUCTURE IN THE CURRENT FUNDING PERIOD

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

- 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 is concentrating on renewable energy, energy efficiency, energy storage and grid technologies. The Helmholtz Association emphatically supports this strategy and is making a significant contribution to its implementation by focusing its expertise and experience in various programs. In addition, it is closing research gaps and carrying out basic and application-oriented research. It is supplementing its technological research with socioeconomic studies in order to ensure that all social, economic and political aspects are included in its overall goal of transforming the energy system.

PROGRAMS IN THE FUNDING PERIOD 2015–2019

Energy Efficiency, Materials and Resources

The target of the energy transition is to cut primary energy consumption in half by 2050 and achieve an 80 to 95 per cent reduction in greenhouse gas emissions over 1990 levels. For this purpose, process chains, resources, materials development, process engineering and energy conversion processes are being studied, interlinked and optimized. In addition, the flexibility required to restructure the energy supply needs to be improved with respect to fuel types, energy provision and infrastructure.

Renewable Energies

Renewable sources are intended to supply the lion's share of energy. The goal is to exploit the various primary energy sources such as solar, wind, biomass and geothermal in an efficient, cost-effective way and to develop optimal technologies for centralized and decentralized applications. The strategic research focuses in this program revolve around scientific issues that require highly complex, long-term investigations using the large-scale facilities of the participating Helmholtz centers.

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 optimized and more effectively interlinked. This program encompasses the study 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 encompasses the study of distribution and storage infrastructure.

A glimpse inside the plasma vessel of the ASDEX Upgrade fusion device in Garching.
Photo: IPP Volker Rohde

WANTED: CONTINUOUS OPERATION

The objective of fusion research is to develop a new source of energy by fusing light atomic nuclei. In February 2016, the Wendelstein 7-X fusion device at the Max Planck Institute for Plasma Physics (IPP) in Greifswald produced the first hydrogen plasma. This device is intended to show that stellarator systems can operate continuously. Tokamak fusion devices – which operate in pulse mode – are also well on the way to achieving continuous operation. Tests are currently being conducted at the Tokamak ASDEX Upgrade device at the IPP in Garching. Because the fusion fire in later power plants will ignite at temperatures of more than one hundred million degrees, the fuel – a thin hydrogen plasma – must not come into contact with the cold vessel walls. Confined in magnetic fields, it floats virtually contact-free in a ring-shaped vacuum chamber. Tokamaks like the ASDEX Upgrade and the international ITER test reactor, which is under construction in Cadarache, France, create the magnetic cage by means of a ring-shaped, coil-generated field. This is combined with the field of an electric current within the plasma. The helical field lines then generate the desired magnetic cage. The plasma current is induced in pulse mode by a transformer coil within the plasma. This is why the entire system operates in pulses – a shortcoming of the otherwise so successful tokamak design. The matter is entirely different with stellarator systems such as Wendelstein 7-X. In this case, continuous operation is possible because the entire field is generated solely by complex-shaped coils – and thus without the plasma current.

To achieve this in a tokamak, the plasma current cannot be generated by a transformer in pulsed mode, but must be produced continuously by injecting high-frequency waves or particle beams. Plasma is capable of producing electric current on its own in the presence of pressure differences, and this property can be used to achieve longer pulses. In the best-case scenario, it could be possible to operate this type of advanced tokamak in steady state. Members of the ASDEX Upgrade team have already succeeded in producing the 800-kiloampere electric current for several seconds in specially controlled discharges within the plasma. They did so without the help of the transformer and thus under conditions that also prevail in an ITER test reactor or demonstration plant. This means that longer pulses are also within reach for tokamaks.

Additional examples from this research field »

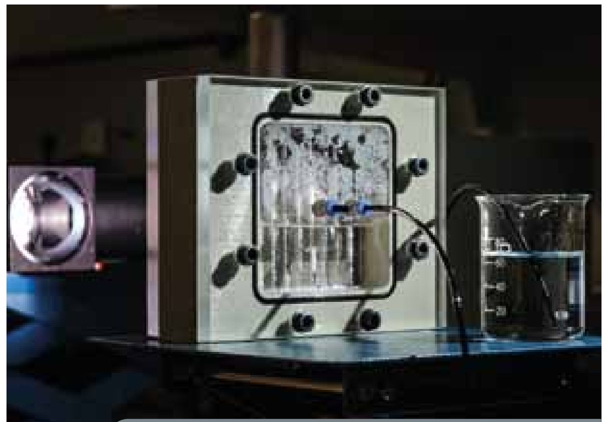
Nanoparticles of silicon dioxide trap light.
Image: Adv. Opt. Mat. 5/2017

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

ULTRATHIN CIGSE SOLAR CELLS: NANOSTRUCTURES INCREASE EFFICIENCY

Ultrathin CIGSe solar cells save material and energy in production. However, they are less efficient than standard CIGSe cells because they absorb less light. As an HZB research group has demonstrated in cooperation with a Dutch team, a nanostructure of silicon oxide particles on the back of the cell can "trap" light and direct it back into the cell. As a result, the best ultrathin CIGSe cells are now nearly as efficient as the record-setting CIGSe cells of standard thickness.

Test setup of a prototype for photoelectrochemical water splitting.
Photo: Forschungszentrum Jülich/ Tobias Dyck



Forschungszentrum Jülich

ARTIFICIAL PHOTOSYNTHESIS

Jülich researchers have developed a compact component that can capture solar energy like a plant and store it in the form of an energy-rich substance. Duplicated and interconnected, these components form an artificial photosynthesis system. With the help of sunlight, water is split into oxygen and hydrogen inside the components. The hydrogen stores energy, which is then used as required - either as a fuel for fuel-cell cars, fuel gas for turbines, or for the synthesis of materials.

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

A CLEAR VIEW OF THE SUBSURFACE OF THE SCHORFHEIDE HEATH

Geothermal research in the North German Basin has taken a major step forward thanks to a seismic survey campaign carried out by the GFZ: "The data promise to provide crisp, unexpectedly detailed images of deep geological structures under the Schorfheide heath," says Professor Charlotte Krawczyk, director of the GFZ's Geophysics Department. Over a period of approximately four weeks, a fleet of 21-ton vibrator trucks traversed the 64-square-kilometer survey area. A total of 38,880 geophones detected and digitally recorded the sound waves they generated. Analysis of the data will be completed by late 2017 at the GFZ in Potsdam.

The 21-ton vibrator vehicles produced seismic waves that were recorded by geophones.
Photo: GGD

Scientists on board the DLR Falcon measured the composition of exhaust gas from the DC-8.
Photo: NASA

German Aerospace Center (DLR)

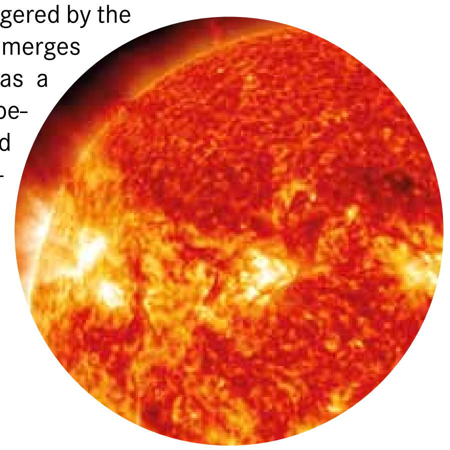
BIOFUELS REDUCE AIR POLLUTANTS

A fuel blend of 50 percent biofuel and 50 percent kerosene reduces soot particle emissions from aircraft engines by 50 to 70 percent. This was shown by joint research flights conducted by NASA, the German Aerospace Center and the National Research Council of Canada. More than ten different instruments were used to measure exhaust composition from behind the plane. The results revealed that biofuels not only reduce emissions in the vicinity of airports, but also make flights more climate-friendly.

Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

ARE PLANETS SETTING THE SUN'S PACE?

The sun's magnetic activity is caused by the so-called alpha-omega dynamo. Surprisingly, the eleven-year cycle coincides closely with the period in which the planets Venus, Earth and Jupiter come into alignment. HZDR researchers have offered a new theory to explain how the planets' extremely weak tidal forces could synchronize the solar dynamo. Triggered by the Tayler instability, which emerges in the sun's hot plasma as a result of the interaction between electric current and its magnetic field, the alpha effect oscillates in unison with the planets.



The polarity of the sun's magnetic field is reversed approximately every eleven years, at which time solar activity peaks. *Photo:NASA*

The ambitious transition to a climate-friendly energy supply is underway in all federal states, but there are considerable regional differences. *Photo: André Künzelmann/UFZ*

Helmholtz Centre for Environmental Research – UFZ

THE ENERGY TRANSITION PATCHWORK

The ambitious transition to a climate-friendly energy supply is full swing in all of Germany's federal states, but considerable regional differences remain. These have now been identified by UFZ scientists in a detailed study of the spatial structure of Germany's energy supply. As part of the study, the scientists created an energy transition map that clearly charts the leaders and stragglers among all of Germany's 12,066 municipalities. The map also shows how Germany can continue to fulfill its role as global standard setter in the future.

PROGRAMS IN THE
FUNDING PERIOD 2015–2019

Future Information Technology

Using innovative research approaches, this program 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

This program 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.

Nuclear Waste Management, Safety and Radiation Research

This program 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 CO_2-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 program 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 REINHARD F. J. HÜTTL
Vice-President of the Helmholtz Association,
Coordinator of the Field of Earth and Environment Research,
GFZ German Research Centre for Geosciences

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 nature and society. 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 centers in order to improve regional and global climate models. Another important goal is to establish and operate infrastructure and facilities such as the HALO research aircraft and the TERENO network, for which terrestrial observatories have been set up in four selected regions in Germany. As part of the COSYNA project, a long-term observation system will be set up for the German North Sea and later extended to Arctic coastal waters.

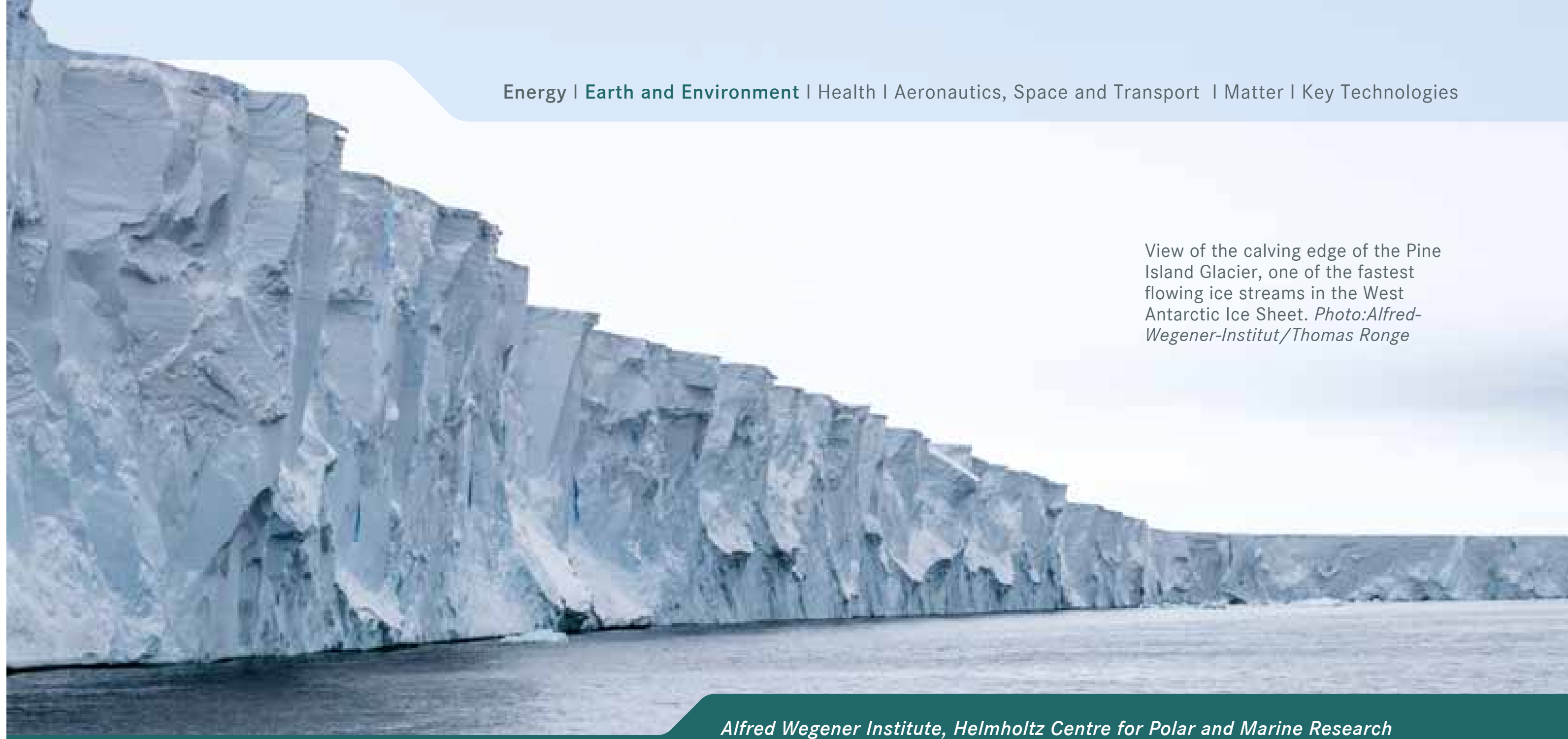
PROGRAM STRUCTURE IN THE CURRENT FUNDING PERIOD

Eight Helmholtz centers are currently participating in the field of Earth and environmental research. Work is carried out in five programs:

- 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 centers in joint interdisciplinary activities. This strategy is leading to new alliances and facilitating the expansion of Earth observation and knowledge systems and integrated modeling approaches. The interdisciplinary "Earth System Knowledge Platform – Observation, Information and Transfer" is integrating the knowledge acquired by all of the centers and their partners in this research field. Its goal is to help society cope with the complex challenges brought about by changes in the Earth system.



View of the calving edge of the Pine Island Glacier, one of the fastest flowing ice streams in the West Antarctic Ice Sheet. *Photo:Alfred-Wegener-Institut/Thomas Ronge*

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

A RISE OF TWO DEGREES WILL ENDANGER THE WEST ANTARCTIC ICE SHEET

The Antarctic and Greenland are covered by ice sheets that store more than two-thirds of the Earth's fresh water. As temperatures rise, ice masses melt and the global sea level rises, threatening coastal regions. Today the Antarctic is already contributing 0.4 millimeters to the annual sea-level rise. However, as the current World Climate Report makes clear, the development of ice masses in the Antarctic is still insufficiently understood. For this reason, climate modelers from the Alfred Wegener Institute have analyzed changes to the Antarctic ice sheet and applied their findings to future projections.

"Our study identifies critical temperature limits in the Southern Ocean not only for the last interglacial period around 125,000 years ago, but also for the future. If ocean temperatures increase by more than two degrees Celsius compared to today's levels, the West Antarctic Ice Sheet will disappear. As a result, the Antarctic will make a drastically increased contribution of three to five meters to sea-level rise," explains AWI climate scientist Johannes Sutter.

This rise will occur if the climate continues to warm as in the past. "In a 'business-as-usual' global warming scenario," says Sutter, "the West Antarctic ice masses could completely disappear in the next thousand years." According to model calculations, ice masses shrink in two phases. The first leads to a retreat of the ice shelf – the ice masses in the Antarctic's coastal regions. If the ice shelf disappears, the flow of the inland ice masses behind the shelf accelerates and more ice enters the ocean. As a result, the glaciers continue to retreat and only reach a stable intermediate state once a mountain ridge under the ice slows the ice's retreat. According to the model, if the ocean temperature continues to rise or the grounding line of the ice reaches a steeply ascending subsurface, the glaciers will continue to retreat even after attaining the first stable intermediate stage. This will ultimately lead to the complete collapse of the West Antarctic Ice Sheet. "In reconstructions of sea-level rise during the last interglacial period, there were also two peaks. The behavior of the West Antarctic in our newly developed model could provide an explanation for this," says Sutter.

Additional examples from this research field »

PROGRAMS IN THE FUNDING PERIOD 2014–2018

Geosystem: The Changing Earth

This program analyses processes in the geosphere and their interaction with the hydrosphere, atmosphere and biosphere. Goals include monitoring, modeling, understanding and evaluating key processes, creating solutions and strategies to prevent disasters and developing geotechnologies for the utilization of subterranean space. To attain these goals the program relies on satellite missions, airborne systems, global geophysical and geodetic networks, regional observatories, deep drilling rigs and mobile instrument pools.

Marine, Coastal and Polar Systems

This program concentrates on a variety of topics, including changes in the Arctic and Antarctic, the interaction between these changes and the global climate and polar ecosystems, vulnerable coasts and shelf seas, the polar perspective of Earth system analysis, and the interplay between science and society. It provides insights into climate variability and regional climate change, sea-level change as an element of risk analysis within the Earth system, and the transformation of coastal and polar ecosystems. The program is also providing a scientific foundation for assessing the social and economic consequences of climate change in our living environments. Research into the interaction between science and society focuses on how 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 reach and remain largely unstudied. This interdisciplinary program 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

The light rail vehicle with the AERO-TRAM logo and the set of instruments over its cab has made a total of 6,228 test trips in Karlsruhe. Photo: Patrick Langer, KIT

Karlsruhe Institute of Technology (KIT)

AERO-TRAM COMPLETES MEASUREMENTS

The AERO-TRAM has covered around 200,000 kilometers since 2009. On 6,228 measurement trips in the Karlsruhe tram network, the vehicle, which is equipped with numerous instruments, has collected data on the concentrations of various pollutants. The project, which was carried out by climate researchers from the Karlsruhe Institute of Technology in cooperation with the Karlsruhe transport authorities, is now coming to an end. One of its many findings: the concentration of nitrogen oxide decreases by around 70 percent when the tram leaves the center of Karlsruhe and enters the surrounding area. Thanks to the measurement system's design, it is easily transferable to other urban areas.

GEOMAR Helmholtz Centre for Ocean Research Kiel

ANIMAL COMMUNITIES IN THE DEEP SEA

Hot springs in the deep sea are home to highly specialized communities of animal species. These ecosystems are often hundreds of kilometers apart and it is still unclear how the larvae of the resident species move from one to another. With the help of computer models and the genetic analysis of mussels, an international interdisciplinary research team supervised by the GEOMAR Helmholtz Center for Ocean Research Kiel has demonstrated the existence of previously undetected intermediate stops for the larva in the deep sea.

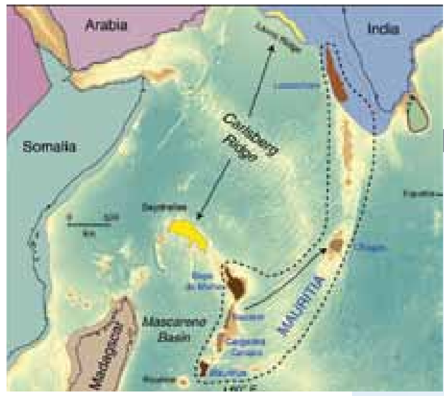
Deep sea mussel at a black smoker.
Photo: GEOMAR

Increased concentrations of NO leads to improved plant growth (left 0 ppm NO, right 3.0 ppm NO).
Photo: Helmholtz Zentrum München

Helmholtz Zentrum München – German Research Center for Environmental Health

FIXATION OF NITRIC OXIDE IN PLANTS

Nitrogen oxides are produced in combustion and other processes and irritate the mucous membranes in the respiratory organs and the eyes. Researchers from the Helmholtz Zentrum München have discovered for the first time that plants can absorb nitric oxide directly from the air and fix it in their metabolism. As a result, they make an even greater contribution than previously thought to improving air quality in cities with high nitrogen concentrations.



The dotted black line indicates the area in which fragments of the sunken continent of Mauritia are suspected to exist in the Earth's crust. *Source: Nature Communications; doi:10.1038/ncomms14086 (CC BY)*

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

ANCIENT CONTINENT UNDER THE TROPICAL ISLAND OF MAURITIUS

At an age of nine million years, the volcanic island of Mauritius is quite young from a geological perspective. However, its rock contains tiny pieces of an ancient continent that connected Madagascar to India approximately 90 million years ago. A team of researchers led by Trond H. Torsvik confirmed an earlier hypothesis by studying grains of the semiprecious stone zircon that were extracted from volcanic trachyte. The samples were analyzed at the secondary ion mass spectrometry (SIMS) laboratory of the GFZ German Research Centre for Geosciences. According to their study, the zircons are more than two billion years old.

Scientists are using 47 artificial streams to study the effects of pesticides on flowing waters and the species living in them.
Photo: Künzelmann/UFZ

Helmholtz Centre for Environmental Research – UFZ

STREAM EXPERIMENT: FROM THE LAB INTO THE OPEN AIR

In natural communities, toxic substances often have a harmful effect at far lower concentrations than in the laboratory. In a variety of increasingly complex test systems, researchers at the UFZ are therefore studying the effects of environmental chemicals on cells and individual organisms, in nanocosms with one or two species, as well as in microcosms and mesocosms containing complex communities. The Leipzig Stream Experiment is one such mesocosm. It makes it possible to quantify chemical effects and validate risk assessment models.

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

THE "CLOCKWORK OCEAN" EXPEDITION

Small ocean vortices play a key role in energy transport and seaweed growth in the ocean. However, it is only recently that computer models have been able to simulate these eddies and that detailed observations have existed. Working with five other institutions, the HZG carried out the Clockwork Ocean expedition in the Baltic Sea in order to track down these largely unknown, short-lived phenomena. In addition to airplanes and ships, the expedition made use of a zeppelin for the first time in coastal and marine research. It enabled the researchers to measure the vortices from formation to disappearance at previously unachieved resolutions.

The zeppelin was deployed south of Bornholm. *Photo: HZG*

PROGRAMS IN THE FUNDING PERIOD 2015–2019

investigate the role of oceans 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 program 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.

Terrestrial Environment

The goal of this program 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 emphasizing selected regions and landscapes because it is here that environmental problems become directly visible and management options can be identified. Program 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 modeling.

RESEARCH FIELD HEALTH

PROFESSOR PIERLUIGI NICOTERA
Vice-President of the Helmholtz Association,
Coordinator of the Field of Health Research,
German Center for Neurodegenerative Diseases
(DZNE), Bonn

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 shared objective is to elaborate methods for the evidence-based prevention, diagnosis, early detection and individualized treatment of common diseases. Research into complex and often chronic illnesses requires interdisciplinary approaches, which are being pursued by the Helmholtz centers in cooperation with partners from medical schools, other research organizations and industry. In addition, as a partner to the German Centres for 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 individualized medicine.

PROGRAM STRUCTURE IN THE CURRENT FUNDING PERIOD

Eight Helmholtz centers collaborate in the field of health research. In the current program period, they are active in the following five programs:

- 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 centers regularly review whether they should be investigating additional diseases such as mental disorders. In addition, they are taking steps to integrate prevention research into their research programs. 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 personalized prevention strategies. Now and in the future, the ongoing discourse between scientists and physicians will play a vital role in all these activities in enabling the quick translation of research findings into clinical practice.

PROGRAMS IN THE FUNDING PERIOD 2014–1018

Cancer Research

The goal of this program is to significantly improve the prevention, early detection, diagnosis and treatment of cancer. To this end it is developing new diagnostic and individualized therapeutic procedures on the basis of molecular, cell-biological, immunological and radio-physical findings and technologies. It is pushing 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) and the nationally active German Consortium for Translational Cancer Research (DKTK).

Nerve fibers in a human brain.
Image: DZNE

German Center for Neurodegenerative Diseases (DZNE)

EARLY CEREBROSPINAL FLUID MARKERS FOR ALZHEIMER'S DISEASE

So far there is no way to detect Alzheimer's disease in its initial stage. A diagnosis can only be made once the symptoms of dementia – e.g. memory problems – become evident, at which point the brain may already be irreparably damaged. Now, though, researchers from the German Center for Neurodegenerative Diseases (DZNE) and the Medical Center of the University of Munich have tracked down markers in cerebrospinal fluid that could lead to an early diagnosis of the disease.
As part of the international research initiative "Dominantly Inherited Alzheimer Network," the scientists investigated the cerebrospinal fluid of individuals with a hereditary predisposition to Alzheimer's. In this case, the onset of dementia can be predicted with great precision due to their family background. Cerebrospinal fluid flows through the brain and spinal cord and can be extracted by lumbar puncture. An analysis showed that the level of the TREM2 protein increased almost five years before the expected onset of dementia. The protein is segregated by the brain's scavenger cells – the microglia – and its increased concentration suggests that these cells have become active and an immune response is underway. However, at the time of the study, the majority of the 127 subjects had no symptoms of dementia or at most exhibited only slight cognitive impairments.
"These results demonstrate that in the hereditary form of Alzheimer's, inflammation occurs in the brain long before dementia becomes evident," says Christian Haass, spokesman for the DZNE branch in Munich. "We also found similar reactions in the much more common, sporadic form of Alzheimer's. In this respect, the TREM2 value could be a marker that allows us to track immune activity as Alzheimer progresses, regardless of whether it is genetically caused or not. There are indications that this immune response has a protective function and slows the course of the disease. We are thus searching for drugs that would boost the activity of the microglia, which attack harmful proteins that are deposited around nerve cells."

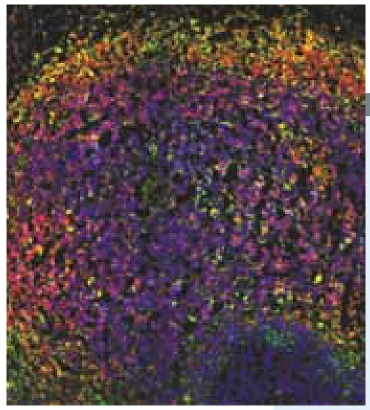
Additional examples from this research field »

Cardiovascular and Metabolic Diseases

This program 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 program takes a translational approach to the topic with the goal of transforming new results into clinical applications as quickly as possible.

Infection Research

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



Immunofluorescence of a cutaneous T-cell lymphoma.
Photo: Blood/Anne Schröder, Karin Müller-Decker

German Cancer Research Center (DKFZ)

PSORIASIS DRUG SLOWS DOWN CANCER OF THEIMMUNE SYSTEM

Sézary syndrome arises from degenerate T-cells in the immune system in the skin. In this malignant disease, the cancer cells lose the ability to respond to signals that initiate programmed cell death, or apoptosis. Scientists at the German Cancer Research Center have now tested an agent called dimethyl fumarate (DMF), which restores this ability. The drug, which has already been approved for the treatment of psoriasis, slowed down the growth and especially the metastatic spread of tumors. DMF is now being tested for its efficacy against Sézary syndrome in a clinical phase II trial.

UFZ scientists are investigating how environmental influences on pregnant women affect their newborns' risk of allergy. *Photo: André Künzelmann/UFZ*

Helmholtz Centre for Environmental Research – UFZ

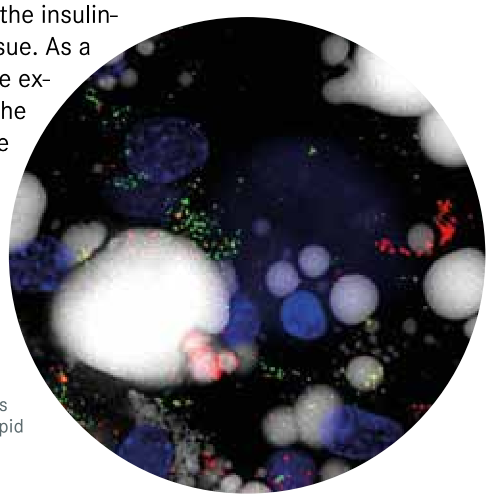
PHTHALATES INCREASE ALLERGY RISK IN CHILDREN

Phthalates can affect our hormonal system and thereby have undesirable effects on metabolism or fertility. But that is not all. A current study by the UFZ and DKFZ shows that they can also intervene in the immune system and significantly increase allergy risk. This means that children face a greater risk of developing allergic asthma if their mothers are exposed to especially high levels of phthalates during pregnancy and breastfeeding. The starting and endpoint of the translational study was the mother-child cohort from the LINA study.

Max Delbrück Center for Molecular Medicine (MDC)

OBESITY RESULTS FROM INSULIN-SENSITIVE FAT CELLS

Thomas Willnow, a researcher at the Max Delbrück Center for Molecular Medicine in the Helmholtz Association, has shown that the protein SORLA influences the metabolic balance of adipose tissue. SORLA marks Alzheimer's proteins in the brain; in fat cells, it flags the insulin receptor for recycling. This means that, on the one hand, it protects against Alzheimer's deposits and, on the other, it increase the insulin-sensitivity of adipose tissue. As a result, adipose cells store excessive amounts of fat: the more SORLA people have in their fat, the more overweight they will be. Mice with too much SORLA gained extreme amounts of weight after eating fast food.



Fat cells with a marked insulin receptor (red), early endosomes (green), cell nuclei (blue) and lipid droplets (white).
Image: Vanessa Schmidt/MDC

Many strains of the hospital bacterium *Staphylococcus aureus* are resistant to common antibiotics.
Image: HZI/Manfred Rohde

Helmholtz Centre for Infection Research (HZI)

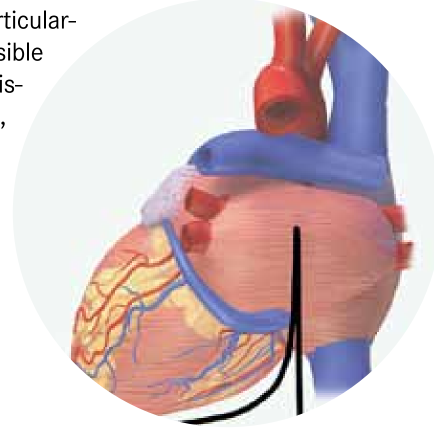
DEFEATING MULTIRESISTANT PATHOGENS

Due to the increased antibiotic resistance of pathogens, many common antibiotics are no longer effective today. Anti-virulence strategies offer an alternative. Their goal is to cripple so-called virulence factors through drugs. Virulence factors are the tools used by pathogens to infect the host. In mice studies, HZI researchers found that the interplay between the bacteria and the immune system affected the formation of these tools and therefore needed to be taken into account in anti-virulence therapies.

GSI Helmholtz Centre for Heavy Ion Research

ION TREATMENT OF CARDIAC ARRHYTHMIA

GSI researchers have tested a non-invasive method that could make it possible to treat cardiac arrhythmia with carbon ions in the future. It promises to be gentler and potentially more effective than treatment with a catheter. One key advantage is that ions can penetrate to any desired depth. Because the left ventricular wall of the heart is particularly thick, it is often impossible to effectively destroy tissue there with catheters, even if this is precisely the spot where patients with severe problems need to be treated.



Carbon ions can have an effect deep in tissue.
Image: Blausen.com staff. CC BY 3.0, remix by GSI

Excess weight affects the genome.
Image: Fotolia/Leigh Prather

Helmholtz Zentrum München – German Research Center for Environmental Health

WORLD'S LARGEST STUDY OF EPIGENETICS AND OBESITY

Weight gained during the holidays shows up not only on your hips, but also in your DNA. This is the finding of a major international study of around 10,000 people coordinated by the Helmholtz Zentrum München. The study showed that an increased body mass index, or BMI, leads to epigenetic changes at almost 200 loci of the genome. It is above all the genes responsible for lipid metabolism and substrate transport that are affected, in addition to those related to inflammation. The study provides insight into the signaling pathways affected by obesity.

PROGRAM IN THE FUNDING PERIOD 2014–2018

fection diseases such as cancer, metabolic dysfunction, neurodegeneration and chronic infections.

Disorders of the Nervous System

The goal of this program 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 primarily 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 diseases that may in part be based on similar pathological processes or that are often associated with well-known neurodegenerative diseases. In order to develop better strategies for diagnosis, treatment and care, it is necessary to learn more about the mechanisms of a disease and the brain's response.

Genetic and Environmental Influences on Common Diseases

This program focuses on major common diseases such as 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 of genetics, environmental factors and personal lifestyles. Due to changing living conditions and longer life expectancies, they are becoming increasingly prevalent. The program 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 personalized 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 the Field 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 policymakers. The German Aerospace Center (DLR) is Germany's national centre for aeronautics and aerospace research. On behalf of the German government and in its capacity as the German space agency, it is responsible for research within the framework of the national aerospace program and for Germany's contribution to the European Space Agency (ESA).

PROGRAM 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 programs:

- Aeronautics
- Space
- Transport

OUTLOOK

In addition to the ever-evolving study of the previous research topics, scientists will collaborate with industry on research projects devoted to aircraft simulation, next-generation rail-based vehicles and robot development. In mid-2011, the DLR established an internal maritime safety research group in order to pool and expand research at the various DLR institutes. 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 programs, new technologies and detailed evaluation of climate data. Eco-efficient aviation and Earth observation systems can make valuable contributions in this area.

DLR scientist Dr. Ramon Mata Calvo with the THRUST transmission terminal developed by the DLR's Institute of Communications and Navigation and used during the long-distance experiment at the DLR facility in Weilheim. *Photo: DLR/Bernd Müller*

WORLD RECORD IN DATA TRANSMISSION VIA LASER

Researchers at the German Aerospace Center (DLR) have set a new record in data transmission using lasers: 1.72 terabits across a distance of 10.45 kilometers in free space, which corresponds to a transmission of 45 DVDs per second. This opens up the possibility of providing broadband Internet services for large parts of Western Europe's rural areas that are still under-served. In densely populated regions, fiber-optic links and other terrestrial systems already offer high transmission rates. However, such systems are unavailable outside metropolitan centers. Providing broadband services via geostationary satellites in such regions would contribute to the process of urbanization.
Scientists involved in the DLR project THRUST (Terabit-throughput optical satellite system technology) have developed an innovative transmission technology for next-generation communications satellites. The idea behind THRUST is to connect the satellites to the terrestrial Internet via a laser link, and the goal is to achieve a data throughput of more than one terabit per second. Communication with users will be carried out in the Ka-band, a standard radio frequency for satellite communications. By setting the new record, the scientists have shown that the vision of wireless optical data transmission in the terabit range is a real possibility.
The experiments made use of a fiber-optic transmission system developed by the Fraunhofer Heinrich Hertz Institute, which operates at wavelengths of around 1,550 nanometers. This system was integrated into the DLR's newly developed free-space optical transmission system. In the wake of their world record, the main focus of the DLR scientists is now on the stability of the optical link. Interruptions to the connection lasting only ten milliseconds can lead to a loss of several gigabits of data. In the next phase, the scientists will therefore be taking measurements to help them better understand the effect of the atmosphere on signal precision. This understanding will in the long term facilitate stable laser communication with satellites.

Additional examples from this research field »

PROGRAMS IN THE FUNDING PERIOD 2014–2018

Aeronautics

Das starke Wachstum des Luftverkehrs im vergangenen Jahr- 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 program places a strong emphasis on application-oriented research. Four research topics address the basic sectors of civil aviation: airplanes, 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 the 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, land use

Test intersection in Braunschweig.
Photo: DLR (CC-BY 3.0)

German Aerospace Center (DLR)

TESTING GROUND FOR AUTOMATED DRIVING

In the future, new driver-assistance systems and automated and networked driving will be tested on 280 kilometers of roadway in Lower Saxony. The state of Lower Saxony and the DLR are investing five million euros in structuring the testing ground for these systems. Following a highly precise mapping of the route, devices will be installed with which vehicle-to-infrastructure technologies (Car2X) can be further developed. This will facilitate the development of functions such as cooperative lane-changing and the equipping of vehicles with traffic-jam alerters.

German Aerospace Center (DLR)

SATELLITE COMMUNICATION FROM PERENNIAL ICE

The German Antarctic receiving station GARS O'Higgins, operated by the DLR, has been receiving data and sending commands to satellites for the last 25 years. Now the facility is set to be modernized at a cost of 2.5 million euros. The satellites with which the station communicates include the radar-based TerraSAR-X and TanDEM-X. It received a third of all the data used for the 3D elevation model of the Earth and will receive a substantially larger quantity of data for the Tandem-L radar mission currently proposed by the one of the Helmholtz alliances.

The DLR's receiving station GARS O'Higgins in the Antarctic has been operating for 25 years. The nine-meter antenna can receive satellite data even under the most extreme storm conditions.
Photo: DLR (CC-BY 3.0)

Flexible rail concept: the individual wagons are combined with one or two end cars to form a complete locomotive.
Photo: DLR

German Aerospace Center (DLR)

FREIGHT TRAINS OF THE FUTURE

With NGT CARGO, transport researchers have developed an innovative and holistic concept for freight transport by rail. The automatically driven freight trains will be made up of individual cars and powerful locomotives. The system will enable the flexible, rapid and reliable transport of a vast range of goods with a limited use of resources. The intelligent cars are equipped with individual electric motors and can travel the final kilometers to the respective customer automatically and autonomously.

The DLR research aircraft ATRA has tested noise-reduced approaches at Germany's largest airport in Frankfurt.
Image: DLR (CC-BY 3.0)

German Aerospace Center (DLR)

QUIETER LANDING

DLR researchers have developed the pilot assistance system LNAS (low noise augmentation system) to make aircraft landings quieter. To land with a minimum amount of noise, planes need to be flown with a consistently low level of thrust. LNAS shows pilots the ideal vertical approach profile and the optimal moments at which the landing flaps and the undercarriage need to be deployed. The system has been tested by the DLR in conjunction with the Umwelthaus Kelsterbach in Frankfurt, the headquarters of a forum promoting dialogue between the airline industry and local residents.

The bumps on the pectoral fins of the humpback whale reduce stalling.
Image: Fotolia/Andreas Meyer

German Aerospace Center (DLR)

MORE EFFICIENT WITH BUMPS

The pectoral fins of the humpback whale have distinctive bulges on their front edge. This organic structure has proved a source of inspiration for DLR researchers in their endeavor to design new helicopter blades. They used the basic physical principle behind the bumps on the whale's fins to devise a solution for the problem of dynamic stall. This phenomenon is caused by the detachment of airflow from the surface over which it is moving and decreases the operational performance of helicopters and airplanes. The use of this solution to influence airflow on wind turbines was awarded the Göttingen Innovation Prize.

German Aerospace Center (DLR)

LUNAR MISSION ON ETNA

The deep sea and celestial bodies confront researchers with similar challenges. For instance, the rovers used on both deep-sea and space missions need to work autonomously in environments that are difficult to access. In a Helmholtz alliance coordinated by the Alfred Wegener Institute (AWI), 16 partners from research institutions, universities and companies joined forces in the Robex (Robotic Exploration under Extreme Conditions) project to develop technologies suited this task. The DLR conducted experiments on Mount Etna in Sicily and used a rover to position instruments and take seismic measurements in the moon-like landscape.

Image: DLR (CC-BY 3.0)

PROGRAMS IN THE
FUNDING PERIOD 2015–2019

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 program is oriented towards the German government's space strategy and has been tasked with developing the required technological foundations for new space missions and the collection and analysis of data. Research topics include Earth observation, communications, navigation, space exploration, research under space conditions, space transport and space systems technology, including robotics.

Transport

Ensuring mobility in the future is a central challenge. For many years now, the capacity of transport systems for 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 utilizing 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 Field of Matter Research,
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.

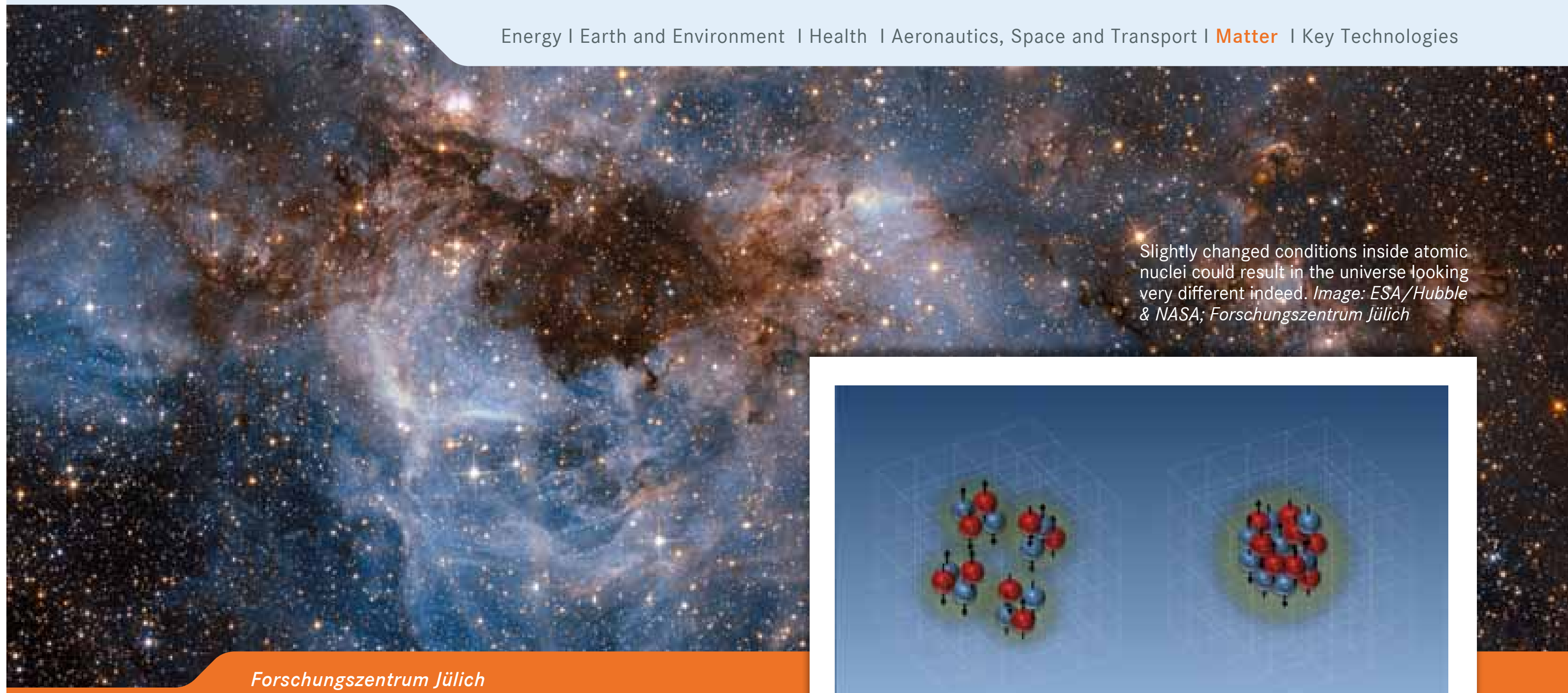
PROGRAM STRUCTURE IN THE CURRENT FUNDING PERIOD

Seven Helmholtz centers are currently working together in three programs 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 program-oriented funding. The association's large-scale research infrastructure and scientific facilities have been assigned to the relevant program 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 centers. For example, the second program 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.



Slightly changed conditions inside atomic nuclei could result in the universe looking very different indeed. *Image: ESA/Hubble & NASA; Forschungszentrum Jülich*

Forschungszentrum Jülich

SURPRISING INSIGHTS INTO THE WORLD OF ATOMIC NUCLEI

Computer simulations offer a completely new tool for understanding more precisely the relationship between the structure of atomic nuclei and the forces at work within them. Now a new computer simulation has provided insights into how neutrons and protons join together to form atomic nuclei. A minimal change to just one of the simulation parameters has fundamental effects on the structure of the nuclei. It follows that under only slightly changed conditions the universe could look very different from the way it does now. This is the result of a study by scientists from Bonn, Jülich, Bochum and two American universities.
Atomic nuclei consist of positively charged protons and electrically neutral neutrons. The precise arrangement of neutrons in the nucleus varies. In some atoms the nuclei are made up of so-called clusters, groups of two protons and two neutrons also referred to as alpha particles. In other atoms, such alpha particles are not observed at all. When two alpha particles come together in an atomic nucleus, they reciprocally influence one another. In other words, they interact. When the positions of the protons and neutrons in the two alpha particles do not change in relation to one another during this process, this interaction is referred to as "local." When the relative positions do change, the interaction is described as "non-local." In the simulations the researchers varied the "mixture ratio" between local and non-local interactions, adding an increasing proportion of local interactions.
The results were surprising. Once a certain mixture ratio was reached, the state of the nuclear material changed fundamentally. Metaphorically speaking, the many-particle system of protons and neutrons passed from a gaseous to a liquid state. In a gaseous state the material is made of non-interacting alpha particles, whereas in a liquid state the alpha particles coalesce into droplets. The mixture ratio at which the phase transition takes place depends on the size of the nucleus. A further insight provided by the study was that in nature the bonding characteristics within nuclei are very close to an instability not previously observed. If the parameter that determines the relative quantities of local and non-local interactions is varied even slightly, the universe has the potential to look very different.

Additional examples from this research field

PROGRAMS IN THE FUNDING PERIOD 2015–2019

Matter and the Universe

This program 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 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 program, 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. A further goal is to improve the molecular structure and thus the properties of active substances. International research groups and collaborating partners are given

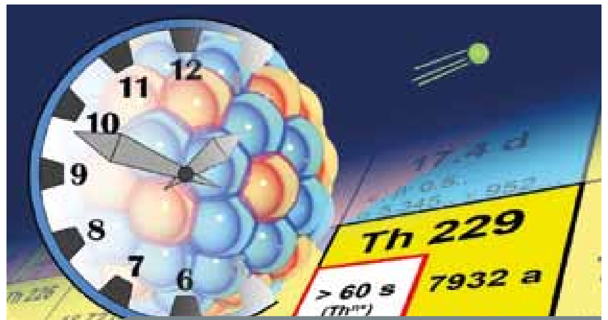
These quadropole magnets were produced in the Budker Institute in Novosibirsk. Photo: M. Setzpfand/HZB

Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

77 MAGNETS FOR BERLINPRO

In the project bERLinPro, the HZB is developing a novel electron accelerator that can recover part of the kinetic energy of electrons. Now an "electron optics" system has been installed. This involved the highly precise mounting of 77 large magnets to guide and focus the electron beam. These magnets also ensure that, after passing through the accelerator, the electron bunches merge so precisely that their energy is made available for the acceleration of subsequent bunches. bERLinPro is scheduled to go into operation at the end of 2019.

Graphic representation of the atomic clock. *Image: Christoph Düllmann, GSI/JGU Mainz*



GSI Helmholtz Centre for Heavy Ion Research

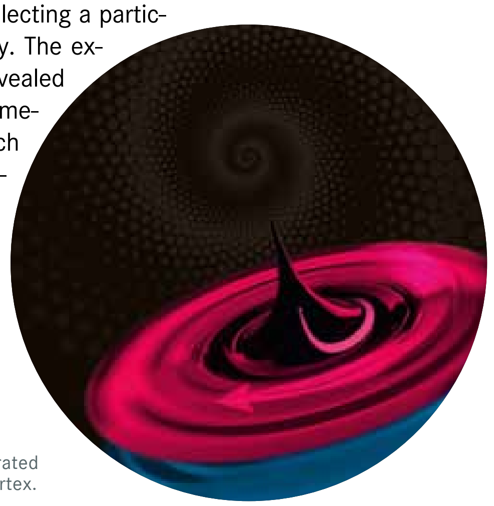
MEASURING TIME USING THE OSCILLATIONS OF ATOMIC NUCLEI

An important step in the development of a highly precise atomic clock has been achieved with the identification of the thorium isomer Th-229m in an experiment in which the GSI and the Helmholtz Institute Mainz participated. At present, the most precise atomic clock in the world is accurate to within a single second in 20 billion years. The excitation state that has now been measured for the first time could enhance this level of accuracy by a factor of around ten. Possible applications for the atomic clock include the search for dark matter and gravitational waves and the verification of a temporal variation of physical constants. Physics World included the discovery in its "2016 Top Ten Breakthroughs of the Year."

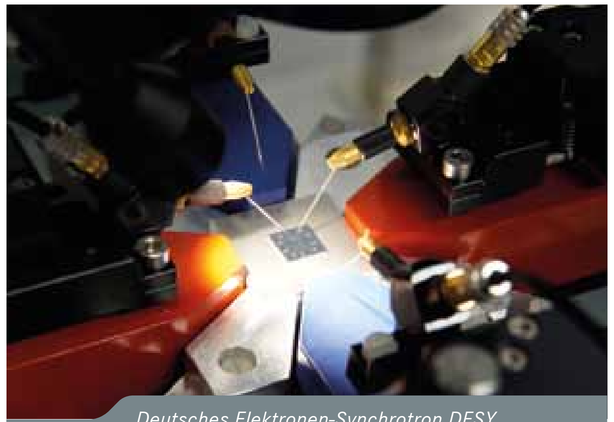
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

SHORT SPIN WAVES FOR INFORMATION PROCESSING

The use of spin waves as an alternative to electrons in the computer chips of the future will require wavelengths in the nanometer range. HZDR researchers have come up with a clever design comprising two wafer-thin metal disks that excite electron spins in a magnetic vortex such that an extremely short wave is produced. This wavelength can be precisely adjusted by selecting a particular excitation frequency. The experiments have also revealed an astounding phenomenon: the speed at which these spin waves propagate is highly dependent on the direction of spin.



Bespoke spin waves are generated in the center of a magnetic vortex. *Image: HZDR*



The characteristics of the microstructured, multilayer sensor systems allow them to be tailored to a wide range of applications in fields such as computing and automotive engineering. *Photo: KaiSchlage/DESY*

Deutsches Elektronen-Synchrotron DESY

MAGNETIC SENSORS FOR INDUSTRIAL USE

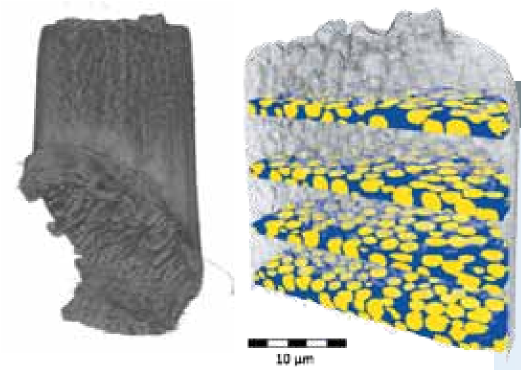
DESY researchers have discovered a method for producing a new generation of magnetic sensors. This new development will significantly extend the functionality of such sensors, which is limited by conventional production methods, and thereby allow sensors to be individually tailored to a wide range of new applications. Financing from the Helmholtz Validation Fund will make it possible to further develop the new sensors for commercial use. Magnetic sensors have a variety of applications in the fields of computing and automotive technology, and are used, for instance, to measure wheel rotation in ABS systems.

Karlsruhe Institute of Technology (KIT)

KATRIN TO MEASURE THE MASS OF NEUTRINOS

Neutrinos are the most common particles with mass in the universe and have an extremely low mass. The study of these odd entities leads to fundamental questions in the fields of particle physics and cosmology. The Karlsruhe Tritium Neutrino Experiment KATRIN will be the first facility in the world capable of directly measuring the hitherto unknown mass of these elementary particles. The measurement process is based on extremely precise spectroscopy of the highest energy electrons from the beta decay of tritium. In October 2016, electrons were guided through the experiment's 70-meter-long beam line for the first time.

Professor Oliver Kraft, Professor Guido Drexlin, Professor Johannes Blümer (all KIT), Professor Ernst-Wilhelm Otten, University of Mainz, and Professor Hamish Robertson, University of Washington, Seattle, turn on KATRIN's "first light." *Photo: KIT*



Nanotomography experiments at the HZG Beamline P05 at PETRA III: Reconstructed (l.) and segmented (r.) volumes of a sample of photonic zirconia glass. *Image: HZG*

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

X-RAY NANOTOMOGRAPHY OF PHOTONIC GLASSES

Photonic glasses belong to a class of materials used, for example, in thermal-insulation coatings. Photonic qualities such as reflectivity depend on a homogeneous packing density of spheres across the entire layer thickness of up to 100 µm. X-ray nanotomography allows for non-destructive characterization of these materials at the required resolution, which in turn provides important information for the optimization of manufacturing and treatment processes.

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 program is a new initiative designed to pool the technological know-how of the different Helmholtz centers and to further develop the research field in strategic terms. Challenges and goals in this context include the exploration and development of new accelerator technologies and the development of detector systems for a broad range of applications. Researchers are also focusing on the further development of high-performance computers and data storage. An additional aim is to expand knowledge transfer between the Helmholtz centers, other research organisations and industry while also strengthening the ties between the individual research fields within the association.

The new program structure is creating numerous interfaces between the programs and program 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

(IN THE FUTURE: RESEARCH FIELD INFORMATION)

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

MISSION

The field of key technologies research (in the future to be called the field of information research) focuses on the investigation and development of technologies that can contribute to solving the major challenges facing society today. The individual research programs 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 center of science. To this end we are dynamically developing the existing programmes in this field in a dialog with the scientific community, government, society and industry.

PROGRAM STRUCTURE IN THE CURRENT FUNDING PERIOD

Three Helmholtz centers are involved in key technologies research, which comprises nine programs:

- 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 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. In the future, Helmholtz scientists working in this research field will be taking a holistic approach to fundamental concepts relating to information, its processing and use.

PROGRAMS IN THE FUNDING PERIOD 2015–2019

Supercomputing & Big Data
The aim of this program 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 program 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 program is to create new technologies for the

A 3D printing technique developed at the KIT can produce complex and highly precise glass structures. *Photo: KIT*

GLASS FROM A PRINTER

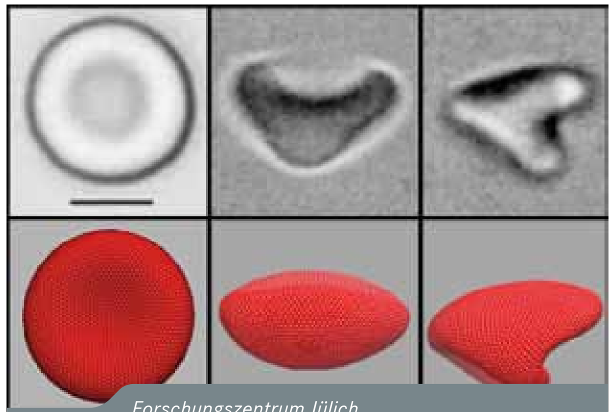
Glass is one of humankind's oldest construction materials and was already used in ancient Egypt and Rome. An interdisciplinary team led by mechanical engineer Bastian E. Rapp at the Karlsruhe Institute of Technology has now developed a process by which glass can be produced using 3D printing.
The researchers mix nanoparticles of high-purity quartz glass with a small quantity of liquid polymer and harden the mixture with light at specific points by means of stereolithography. The material that is still liquid is then washed out in a solvent bath, leaving only the desired structure. The polymer that remains mixed into the glass structure is subsequently removed by heating.
Prior to this breakthrough, it was possible to apply the different techniques of 3-D printing to polymers and metals but not to glass. When glass was worked into structures, for instance by melting it and applying it as a liquid with a nozzle, the result was a very rough surface – the material was porous and contained voids. The new method is an innovation in the field of materials processing and makes it possible to create finished pieces of high-purity quartz glass with all its unique chemical and physical properties. The structures made by the scientists at KIT exhibit resolutions on a scale of only a few micrometers (one micrometer is one thousandth of a millimeter), while the overall dimensions of the objects are on a scale of several centimeters.
The possible applications of 3D-printed glass are manifold. The technique could be used to produce complex optical components for next-generation computers as well as lenses for spectacles and laptop cameras. It also offers a way of producing extremely small analytical systems composed of miniature glass tubes for biological and medical technologies.
The development of the 3D-printed glass is a result of the "NanoMatFutur" young scientist funding scheme run by the German Federal Ministry for Education and Research to support the development of innovative materials for industry and society.

Additional examples from this research field »

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 customized 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, functionalized 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: Fundamentals for Future Technologies in the Fields of Soft Matter and Life Sciences
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 provid-



Microscopic images (top) and the results of simulations (bottom) of red blood cells in shear flow. *Image: Forschungszentrum Jülich*

Forschungszentrum Jülich

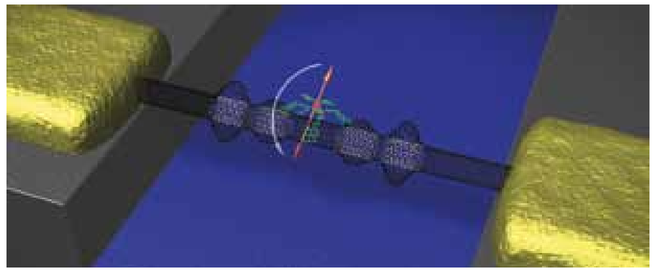
RED BLOOD CELLS AND THEIR DIVERSE SHAPES

One of the causes of circulatory problems can be a change in the viscosity of the blood. Scientists from Forschungszentrum Jülich and the University of Montpellier have discovered that the deformability of red blood cells has a decisive influence on the fluidity of blood. In a stress-free state, erythrocytes are shaped like a discus with a thickened rim. In experiments and computer simulations, the scientists found other forms. They are now recommending that research into medical conditions that influence the deformability of blood cells should take account of their findings.

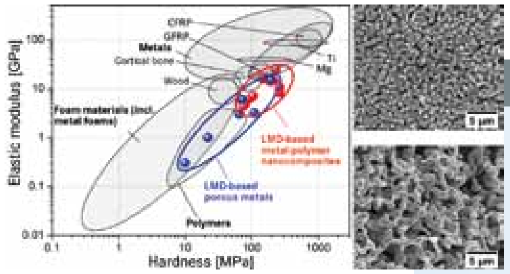
Karlsruhe Institute of Technology (KIT)

FLIPPING OVER THE SPIN

The Einstein-de Haas effect, which shows that magnetism stems from the angular momentum of electrons, is considered to be the macroscopic evidence of electron spin. Researchers at the Karlsruhe Institute of Technology (KIT) and the Institut NÉEL at the CNRS in Grenoble have now examined this effect for the first time at the level of a single spin – that of a quantum magnet. The results of their research have led them to coin the term “Quantum Einstein-de Haas effect,” which they observed by attaching a magnetic molecule to a carbon nanotube and measuring the current flowing through this arrangement while varying the external magnetic field.



The mechanical properties of the carbon nanotube (black) cause the spin (orange) of a molecule (green and red) to flip over. *Image: Christian Grupe/KIT*

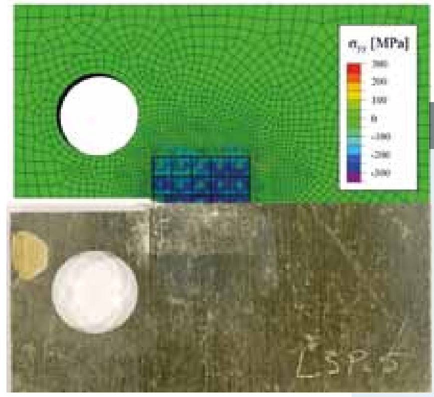


The network structure of the porous titanium can be observed through an electron microscope. The polymer-infiltrated substance occupies a previously empty spot on the map of the mechanical properties of structural materials. *Image: HZG*

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

AS HARD AS STEEL, BUT A HUNDRED TIMES MORE FLEXIBLE

Hard materials are in most cases also very rigid. This can be a problem, for example, in bone implants, which need to be flexible. A new type of composite material that can overcome this problem has now been developed by scientists at the HZG's Materials Mechanics division and their colleagues from the Hamburg University of Technology. Composites made of porous titanium and a polymer exhibit a high degree of flexibility despite their hardness, which is comparable to that of steel.



Residual compressive stress (middle blue area) can hinder cracking. Top: simulation of residual stress distribution. Bottom: laboratory sample of aircraft aluminum alloy with crack (proceeding from the left). Center: area treated with laser shock peening. *Image: HZG*

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

USING RESIDUAL STRESS FOR SAFE FLYING

Laser shock peening (LSP) facilitates the targeted application of residual compressive stress in light-weight structures. This technology can be used to overcome crack initiations and crack propagation in safety-relevant components. In order to devise a tailored residual stress profile that can meet these requirements, scientists at the HZG investigated the LSP process using experimental and numerical methods supported in part by artificial neuronal networks. Initial results have shown a 400 percent increase in fatigue resistance compared to non-modified samples.

These three-dimensional structures at atomic resolution show that the proteins amylin (green), beta-amyloid (red) and alpha-synuclein (orange) – which are bound to the beta-wrapin protein (gray and black) – are very similar. *Image: FZ Jülich/Wolfgang Hoyer*

Forschungszentrum Jülich

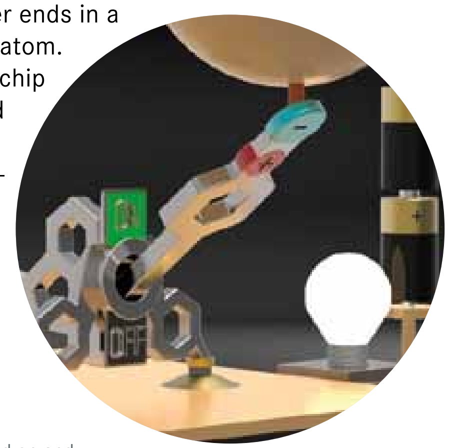
NEW APPROACH TO TREATING DIABETES AND ALZHEIMER'S

Amyloid deposits in the Langerhans islets of the pancreas are believed to be a potential cause of type II diabetes mellitus. Researchers from the Heinrich Heine University Düsseldorf and the Forschungszentrum Jülich have now shown that the binding protein beta-wrapin HI18 can suppress the formation of amyloid deposits. This suggests that beta-wrapin might be able not only to counteract the development of diabetes but also to inhibit the development of Alzheimer's dementia and Parkinson's disease. This discovery was based on magnetic resonance imaging that produced a three-dimensional structure of amylin at an atomic level.

Karlsruhe Institute of Technology (KIT)

A RELIABLE MOLECULAR TOGGLE SWITCH

The ongoing development of nanotechnology is constantly breaking miniaturization records. Now scientists at KIT have devised a molecular toggle switch that can be turned on and off and, more importantly, remains in the selected position. The basic structure of the switch consists of a few carbon atoms. Three sulfur atoms form the feet, which are fixed to a smooth gold surface. The toggle lever ends in a nitrile group with a nitrogen atom. In the future the space on a chip needed for one silicon-based circuit could accommodate as many as one hundred molecular switches.



The molecular contact can be switched on and off both mechanically and electrostatically. *Image: KIT*

PROGRAMS IN THE FUNDING PERIOD 2015–2019

ing the knowledge required for the manufacture of functional 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 program 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 program 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 lifetime, this goal can only be realized with the help of high-performance computers.

Key Technologies for the Bioeconomy

DThis program focuses on the development of future technologies that can be used to develop a sustainable bioeconomy. The work being done on industrial biotechnology centers on the biobased production of chemicals, pharmaceuticals and proteins using microbial and enzymatic processes. The agronomists involved in the program are helping to improve the quality of plant biomass and produce plant-based chemicals and materials.

Technology, Innovation and Society

This program 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

FRANZISKA BROER
Managing Director of the Helmholtz Association

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 organization, with 38,733 staff members at 18 research centers and a total annual budget of 4.38 billion euros. Approximately 70 percent of its funds are provided by Germany's federal and state governments at a ratio of 9 to 1. The centers raise around 30 percent 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.

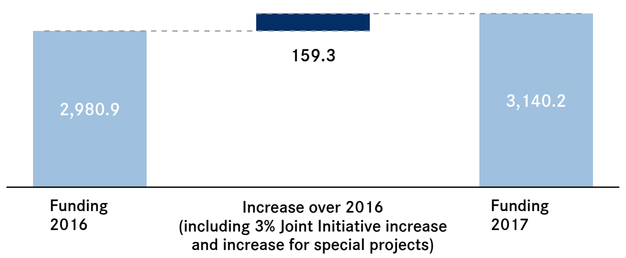
RESOURCES

Core funding for the Helmholtz Association for fiscal year 2017 increased to around 3.14 billion euros from approximately 2.98 billion euros the previous year.

DEVELOPMENT OF RESOURCES

Growth 2016–2017

in million € (federal and state governments)

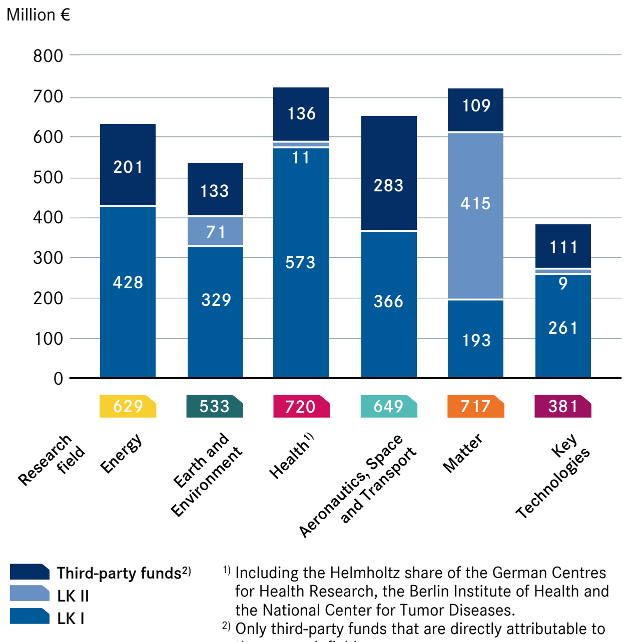


* additional funds made available to the National Center for Tumor Diseases, the Drug Research and Functional Genomics Centre, the Helgoland Bluehouse and six new DLR Institutes

This growth is essentially a result of the 3 percent increase from the Joint Initiative for Research and Innovation III, which is financed entirely by the federal government, and the increase for certain special projects that received additional funding from the state and federal governments.

At first glance, it may appear that, with the exception of the field of key technologies research, overall financial resources are spread evenly 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 programs (Performance Category I, or PC I) accounts for the predominant share of the allocated funds.

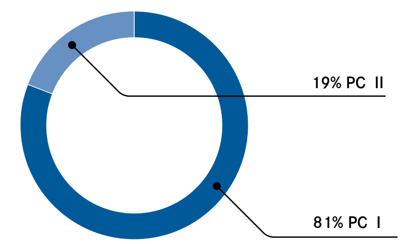
2016 budget showing core and third-party funding for the research fields



[1] Including the Helmholtz share of the German Centres for Health Research, the Berlin Institute of Health and the National Center for Tumor Diseases.
[2] Only third-party funds that are directly attributable to the research fields.

The bar chart shows core and third-party funding as actual costs for 2016. Actual costs are funds that were in fact used by the research centers during the year under review.

Relationship between PC 1 and PC II without third-party funds

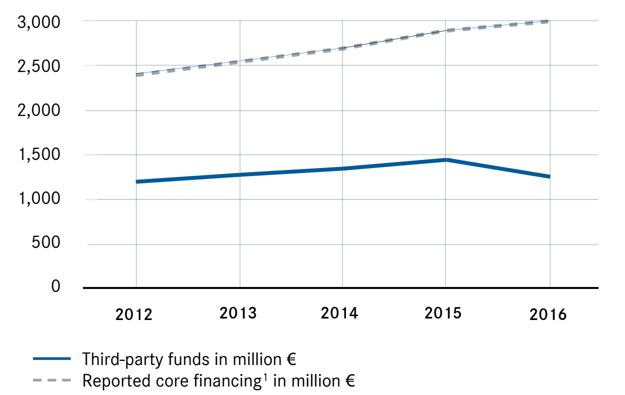


Currently around 19 percent of resources are allocated to research infrastructure and user platforms. This share, which has remained relatively constant over the past ten years, is expected to increase slightly as a result of the launch of two additional large-scale facilities: the European XFEL free-electron laser, which began operations in early September, and the FAIR accelerator facility, which will follow in a few years' time.

THIRD-PARTY FUNDING

In addition to core financing, a substantial amount of third-party funding – raised primarily in external competitions – is available to the Helmholtz centers. In 2016 the Helmholtz Association acquired third-party funding worth 1.24 billion euros (including 235 million euros in project sponsorships). This represents a decrease of 30 million euros, due in particular to the approaching end of the major investment projects XFEL and the Petra III Extension at DESY.

Third-party funds



[1] The figures for 2015 do not include the Berlin Institute of Health, which accounts for 44 million euros, because it had its own budget from 2016 on and is currently no longer part of the overall Helmholtz budget.

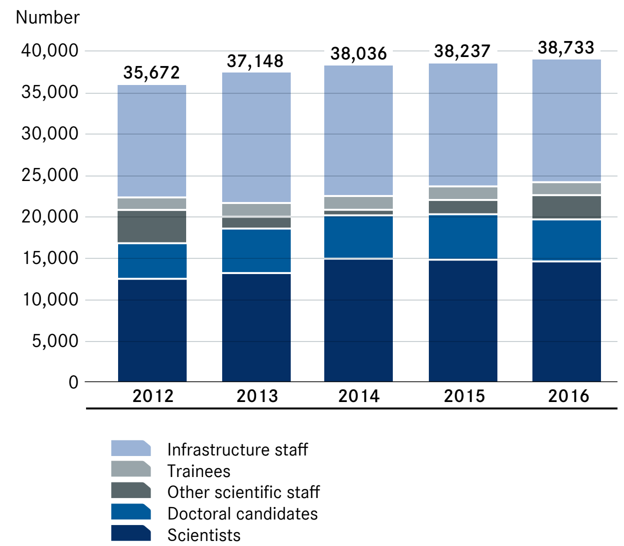
In 2016 the strength of the Helmholtz Association's research on a European level was demonstrated by its success not only in the Seventh Framework Program but also in Horizon 2020, in which the association is now the No. 1 grant recipient. The Helmholtz centers participated in 252 projects that were newly funded by this European research program and received total funding of 123 million euros.

Acquired EU research funds

in T€	2012	2013	2014	2015	2016
Funds from the EU for research and development	126,936	122,612	132,888	133,033	123,223

STAFF DEVELOPMENTS

STAFF DEVELOPMENTS



In 2016, 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 staff growth at the Helmholtz centers, with employee numbers rising to 38,733. In addition, the centers are currently supervising 2,949 doctoral candidates. Although these candidates have no employment contracts with the centers, they use the Helmholtz Association's research infrastructure.

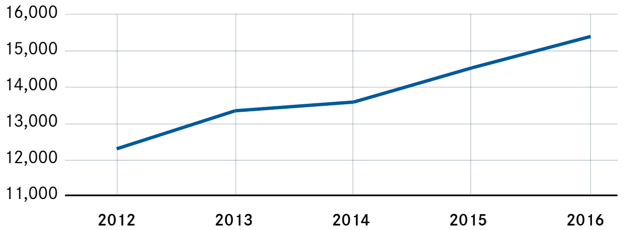
Detailed information about the Helmholtz Association's resources and a breakdown by research field and research center can be found on pages 42–43.

SCIENTIFIC PERFORMANCE

RESEARCH PERFORMANCE

Publications are a key measure of scientific productivity. In terms of their quantity, strong growth was once again evident in the year under review. In 2016, a total of 15,346 papers were published in ISI or Scopus-indexed scientific journals. The number of publications grew by 6 percent over the previous year and by a total of 25 percent compared to 2012.

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 organizations worldwide. The "Nature Index" 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. The Helmholtz Association has ranked among the top ten international institutions for years. The table shows the Nature Index for the period 1 March 2016 to 28 February 2017.

Nature Index 2016/2017

Rank	Institution	No. of Articles
1	French National Centre for Scientific Research (CNRS), France	4,734
2	Chinese Academy of Sciences (CAS), China	3,471
3	Max Planck Society, Germany	3,176
4	Harvard University, USA	2,542
5	Spanish National Research Council (CSIC), Spain	1,718
6	Massachusetts Institute of Technology (MIT), USA	1,694
7	Helmholtz Association, Germany	1,627
8	University of Cambridge, UK	1,523
9	Stanford University (SU), USA	1,453
10	Pierre and Marie Curie University (UPMC), France	1,444

USER PLATFORMS

Together with scientific performance, an important yardstick for the Helmholtz Association is the extent to which it is fulfilling its mission to provide researchers with access to its unique research facilities. In the year under review, use of its large-scale devices by external researchers increased over the previous year.

Helmholtz Association research facilities

	Type of use	Actual value 2015	Actual value 2016
Availability		94.6%	94.3%
Utilization	Internal Helmholtz scientists	29.4%	27.1%
	External scientists	70.6%	72.8%

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 percent. Average utilization is the share of the total available capacity that was actually used by scientists. The units of capacity measurement are device-specific. Taken together, internal and external use total a maximum of 100 percent.

The Helmholtz Association's research facilities are open to scientists from around the world. A total of 10,176 international researchers came to the Helmholtz centers to exchange scientific ideas and to take advantage of the research opportunities the centers had to offer. This figure represents an increase of 10 percent over the previous year.

Foreign scientists at the Helmholtz centers

	2012	2013	2014	2015	2016
Total	**7,765**	**8,523**	**7,476**	**9,286**	**10,176**

NATIONAL COLLABORATION

Alongside international collaboration, research networks in Germany, especially those with universities, are extremely important for the Helmholtz centers. 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 programs of both the German Research Foundation and the Excellence Initiative.

Joint appointments

	2012	2013	2014	2015	2016
Joint appointments with universities, W2 and W3 staff	452	499	554	609	644

German Research Foundation (DFG)

Number in the year	2012	2013	2014	2015	2016
Research Centers	2	2	1	1	1
Collaborative Research Centers	68	67	62	65	69
Priority Programs	52	49	42	44	51
Research Units	58	61	55	49	46

Under certain conditions, Helmholtz researchers can obtain funding from the DFG. In such cases the Helmholtz centers serve as important strategic partners to universities when applications are submitted to the DFG – especially for structural initiatives. The table above, which shows participation in the DFG's coordinated programs, illustrates the success of the Helmholtz centers in competitions held by the DFG. The count only includes projects in which the participating researchers noted their Helmholtz affiliation in their applications. In some 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 2016 increase as follows: 2 Research Centers, 113 Collaborative Research Centers, 58 Priority Programs and 56 Research Units.

Participation in the Excellence Initiative

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

EQUAL OPPORTUNITY

An examination of the appointments to W3 professorships in the first two periods of the Joint Initiative reveals a highly positive development: whereas the proportion of women among new appointees was 26 percent in 2012, it rose to 35 percent in 2016. Over the last five years, the absolute figures show strong growth as well.

Equal opportunity

	2012	2013	2014	2015	2016
New W3 appointments	39	41	43	38	40
Women	10	10	14	16	14
Proportion of women	26%	24%	33%	42%	35%

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 center 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 centers, the association developed overarching funding instruments within the framework of the Initiative and Networking Fund and supported these instruments with substantial funding from the Joint Initiative. The instruments have evolved into 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 program to support researchers directly after completion of their PhDs, the Helmholtz Young Investigators Groups for top international talent, the W2/W3 program 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 program)	78	32
	Leaders of other junior research groups (e. g. junior research groups at the centers, Emmy Noether groups)	137	48

The Helmholtz Association is also systematically expanding its activities to support doctoral candidates. It has increased the number of graduate and research schools in order to provide a large number of doctoral candidates with a structured education based on defined quality standards.

Doctoral work

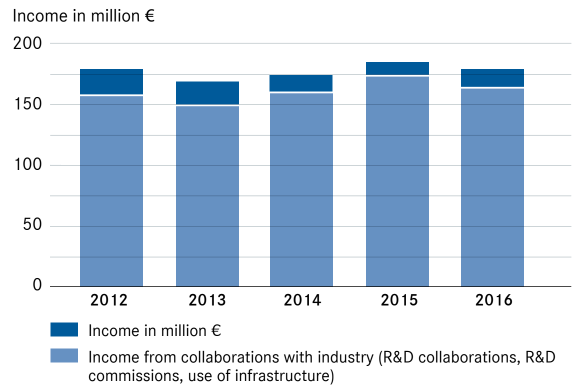
	31.12.12	31.12.13	31.12.14	31.12.15	31.12.16
Number of funded graduate and research schools	84	95	116	97	104
Number of supervised doctoral candidates	6.635	6.789	7.446	8.044	8.054
Number of completed doctoral degrees	803	964	1.059	1.219	1.041

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

TECHNOLOGY TRANSFER

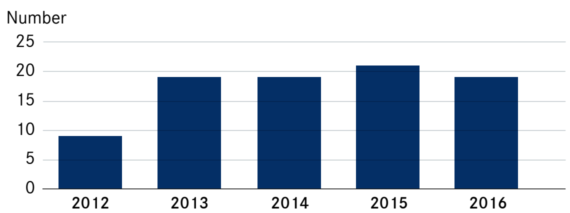
Making research findings available to industry and society is an important part of the Helmholtz Association's mission. Over the last few years, a variety of new instruments and platforms have been established to promote technology transfer, including the Helmholtz Validation Fund, the Helmholtz Innovation Labs and the Innovation Funds of the Helmholtz Centers. Revenues from collaborations with industry have remained relatively constant. Income from licenses and options has been volatile and ranged between 12 and 20 million euros. The number of patent applications has also remained relatively constant at 404, which is attributable to the more stringent selection process focusing on commercial success.

Technology transfer

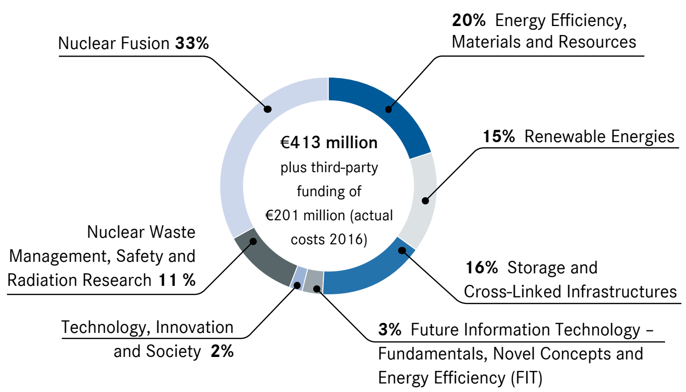


There were 19 research spin-offs, in line with the numbers achieved over the last few years.

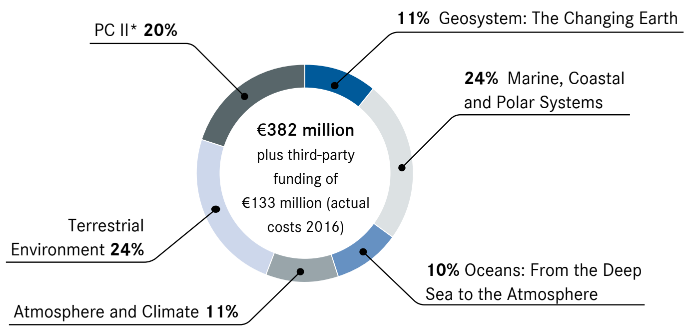
Research spin-offs



Structure of the field of energy research
Target costs of core financing 2016: 413 million euros

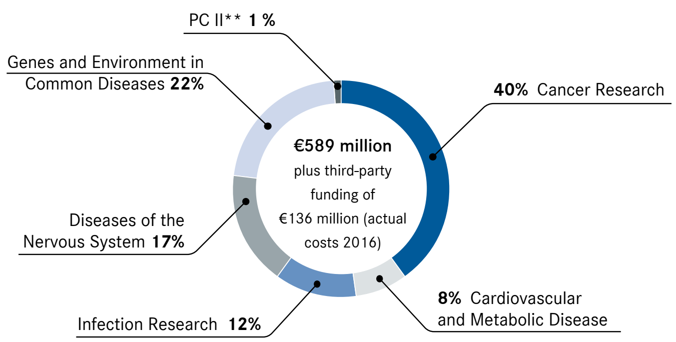


Structure of the field of Earth and environmental research
Target costs of core financing 2016: 382 million euros



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

Structure of the field of health research
Target costs of core financing 2016: 589 million euros*



* Including funds of €93 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

** National Cohort (DKFZ, HMGU, HZI, MDC)

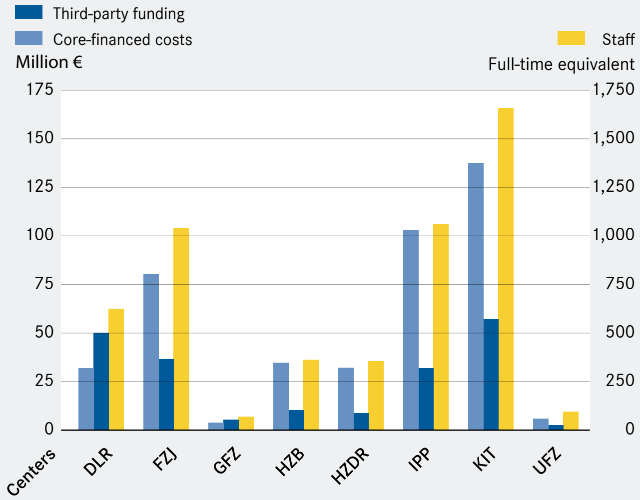
COSTS AND STAFF

COSTS AND STAFF 2016 for the Helmholtz Association, overview	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff FTE [1]
Research fields, total [2]	2,655,253	973,736	3,628,989	30,781
Non-program-linked research, total [3]	1,269	21,643	22,912	91
Special tasks,total [4]	11,455	7,645	19,100	86
Project sponsorships, total		235,253	235,253	2,167
Redirected third-party funds, total		181,950	181,950	
Helmholtz Association, total	**2,667,977**	**1,420,227**	**4,088,204**	**33,125** [5]

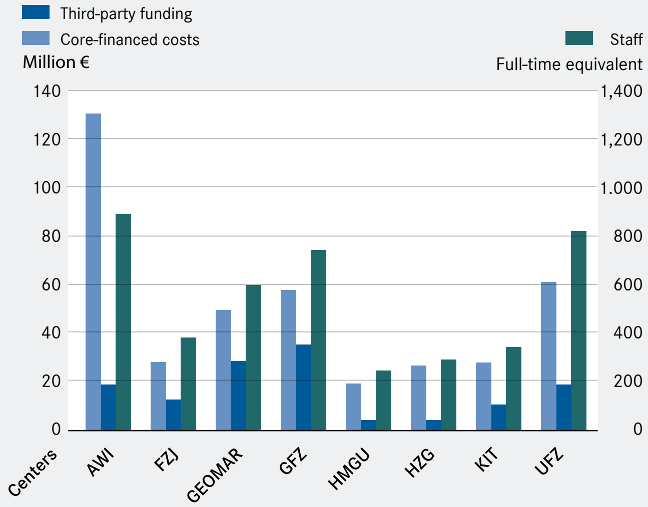
All amounts in thousands of euros. [1] Full-time equivalent [2] In addition to the six research fields, this category includes the Helmholtz share of the German Centres for Health Research, the Berlin Institute of Health and the expansion of the National Center for Tumor Diseases. [3] The funds for non-program-linked research amounts to a maximum of 20 percent of all acquired program funding. If these funds are used by the centers to expand existing research programs, they are assigned directly to the costs of the respective programs. [4] Mainly involving the decommissioning of nuclear facilities. [5] Expressed as natural persons, the Helmholtz Association has 38,733 employees.

	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff FTE [1]
Field of Energy Research				
German Aerospace Center (DLR)	31,251	50,424	81,675	618
Forschungszentrum Jülich (FZJ)	80,397	36,620	117,017	1,042
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	34,343	9,784	44,127	358
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	31,704	8,636	40,340	350
Helmholtz Centre for Environmental Research (UFZ)	5,660	2,483	8,143	94
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	3,345	4,867	8,212	63
Karlsruhe Institute of Technology (KIT)	137,936	56,746	194,682	1,663
Max Planck Institute for Plasma Physics (IPP)	102,936	31,748	134,684	1,061
Field of Energy Research, total	**427,572**	**201,308**	**628,880**	**5,249**
Field of Earth and Environmental Research				
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	130,153	18,619	148,772	888
Forschungszentrum Jülich (FZJ)	27,749	12,860	40,609	382
GEOMAR Helmholtz Centre for Ocean Research Kiel	49,282	28,129	77,411	593
Helmholtz Centre for Environmental Research (UFZ)	60,810	19,351	80,161	817
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	26,638	4,471	31,109	290
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	19,220	4,372	23,592	240
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	57,729	34,933	92,662	741
Karlsruhe Institute of Technology (KIT)	27,826	10,581	38,407	340
Field of Earth and Environmental Research, total	**399,407**	**133,316**	**532,723**	**4,291**
Field of Health Research				
German Cancer Research Center (DKFZ)	181,158	54,663	235,821	2,356
German Center for Neurodegenerative Diseases (DZNE)	68,993	10,934	79,927	772
GSI Helmholtz Centre for Heavy Ion Research (GSI)	4,674	1,516	6,190	73
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	19,524	2,165	21,689	188
Helmholtz Centre for Infection Research (HZI)	62,352	18,332	80,684	773
Helmholtz Centre for Environmental Research (UFZ)	4,526	300	4,826	47
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	150,868	25,813	176,681	1,737
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	92,328	22,245	114,573	1,136
Field of Health Research, total	**584,423**	**135,968**	**720,391**	**7,082**
Field of Aeronautics, Space and Transport Research				
German Aerospace Center (DLR)	365,355	283,240	648,595	5,191
Field of Aeronautics, Space and Transport Research, total	**365,355**	**283,240**	**648,595**	**5,191**
Field of Matter Research				
Deutsches Elektronen-Synchrotron (DESY)	247,970	58,438	306,408	2,129
Forschungszentrum Jülich (FZJ)	47,551	11,507	59,058	464
GSI Helmholtz Centre for Heavy Ion Research (GSI)	120,977	16,645	137,622	1,422
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	85,025	6,788	91,813	552
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	46,791	4,495	51,286	382
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	9,748	1,104	10,852	76
Karlsruhe Institute of Technology (KIT)	49,967	10,291	60,258	460
Field of Key Technologies Research, total	**608,029**	**109,268**	**717,297**	**5,485**
Field of Key Technologies Research				
Forschungszentrum Jülich (FZJ)	147,417	61,394	208,811	1,915
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	40,458	11,247	51,705	470
Karlsruhe Institute of Technology (KIT)	82,592	37,995	120.587	1,098
Field of Key Technologies Research, total	**270,467**	**110,636**	**381,103**	**3,483**

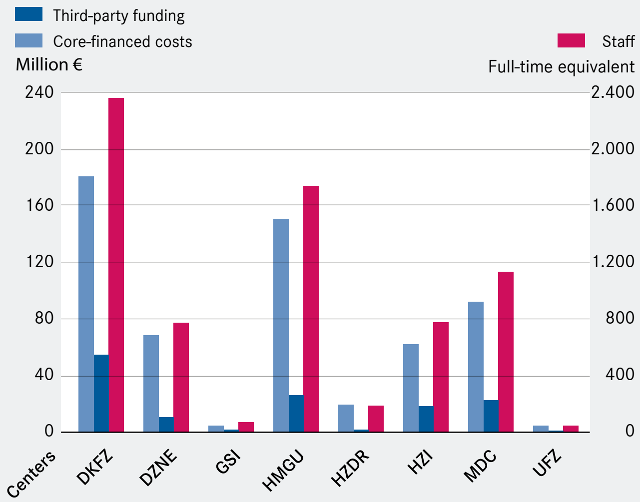
Field of Energy Research



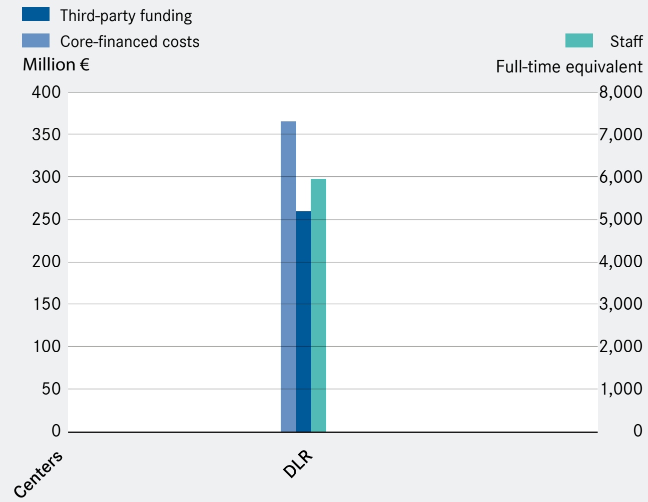
Field of Earth and Environmental Research



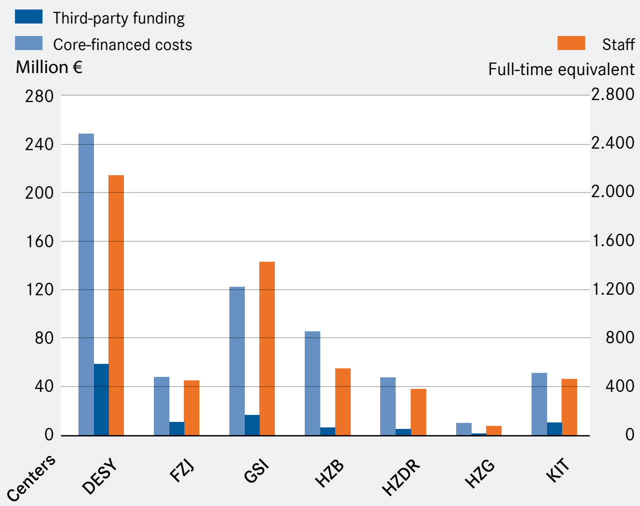
Field of Health Research



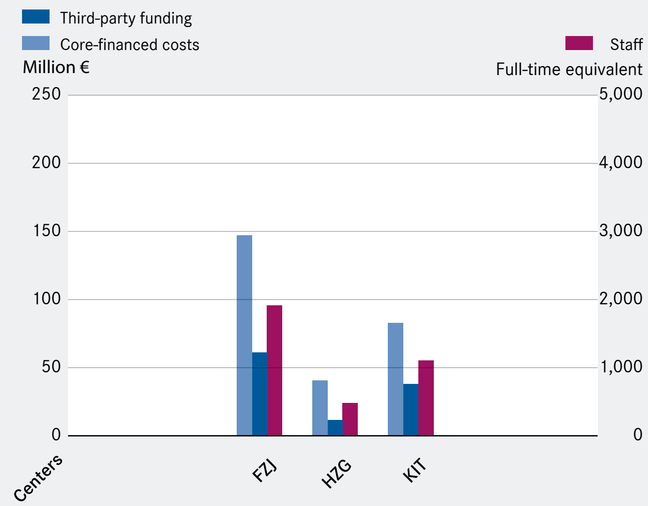
Field of Aeronautics, Space and Transport Research



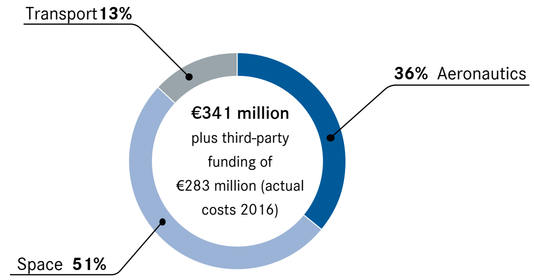
Field of Matter Research



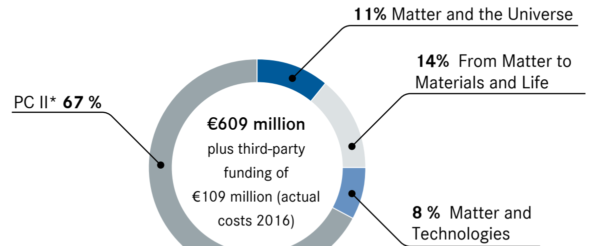
Field of Key Technologies Research



Structure of the field of aeronautics, space and transport research
Target costs of core financing 2016: 341 million euros

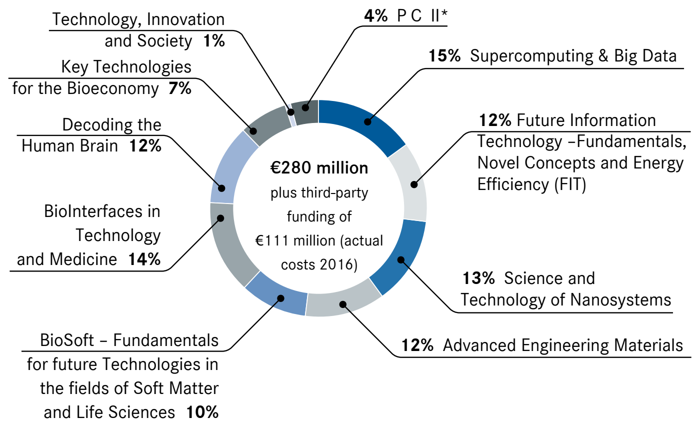


Structure of the field of matter research
Target costs of core financing 2016: 609 million euros



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

Structure of the field of key technologies research
Target costs of core financing 2016: 280 million euros



* KNMF (KIT)

2016

COSTS AND STAFF BY CENTER

The Helmholtz Association's annual budget consists of core financing and third-party funding. A total of 90 percent of core financing is provided by the federal government and 10 percent comes from the federal states in which the member centers are located. The centers raise around 30 percent of the total budget themselves in the form of third-party funding. Due to the Helmholtz Association's strategic focus on six research fields, actual costs are listed by research field and center for the 2016 reporting period. The overview is supplemented by information on the number of staff expressed in person-years. In addition, the circle charts on pages 42–43 show allocations to the programs in each research field on the basis of target costs.

Costs and staff by center, 2016	Actual core-financed costs T€	Third-party funds T€	Total T€	Total staff FTE 1)
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI)	130,153	18,619	148,772	888
Deutsches Elektronen-Synchrotron (DESY)	247,970	58,438	306,408	2,129
German Cancer Research Center (DKFZ)	181,158	54,663	235,821	2,356
German Aerospace Center (DLR)	396.606	333,664	730,270	5,809
German Center for Neurodegenerative Diseases (DZNE)	68,993	10,934	79,927	772
Forschungszentrum Jülich (FZJ)	303,114	122,381	425,495	3,803
GEOMAR Helmholtz Centre for Ocean Research Kiel	49,282	28,129	77,411	593
GSI Helmholtz Centre for Heavy Ion Research (GSI)	125,651	18,161	143,812	1,495
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	119,368	16,572	135,940	910
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	98,019	15,296	113,315	920
Helmholtz Centre for Infection Research (HZI)	62,352	18,332	80,684	773
Helmholtz Centre for Environmental Research (UFZ)	70,996	22,134	93,130	958
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)	76,844	16,822	93,666	836
Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU)	170,088	30,185	200,273	1,977
Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences	61,074	39,800	100,874	804
Karlsruhe Institute of Technology (KIT)	298.321	115,613	413,934	3,561
Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)	92,328	22.245	114.573	1.136
Max Planck Institute for Plasma Physics (IPP)	102,936	31,748	134,684	1,061
Non-program-linked research	**1,269**	**21,643**	**22,912**	**91**
Special tasks2)	**11,455**	**7,645**	**19,100**	**86**
Project sponsorships		**235,253**	**235,253**	**2,167**
Redirected third-party funds		**181.950**	**181,950**	
Helmholtz Association, total	**2,667,977**	**1,420,227**	**4,088,204**	**33,125**

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

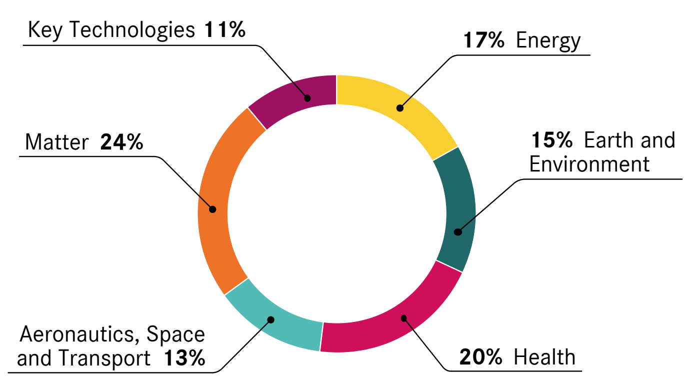
THIRD ROUND OF PROGRAM-ORIENTED FUNDING

By 2017, all of the research fields and their programs had entered the third period of program-oriented funding. The financing recommendations for 2017, 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 program-oriented funding 2017: 2,600 million euros

	Target costs 2017 in Mio. €
Energy	430
Earth and Environment	396
Health*	511
Aeronautics, Space and Transport	352
Matter	627
Key Technologies	284
Total	**2,600**

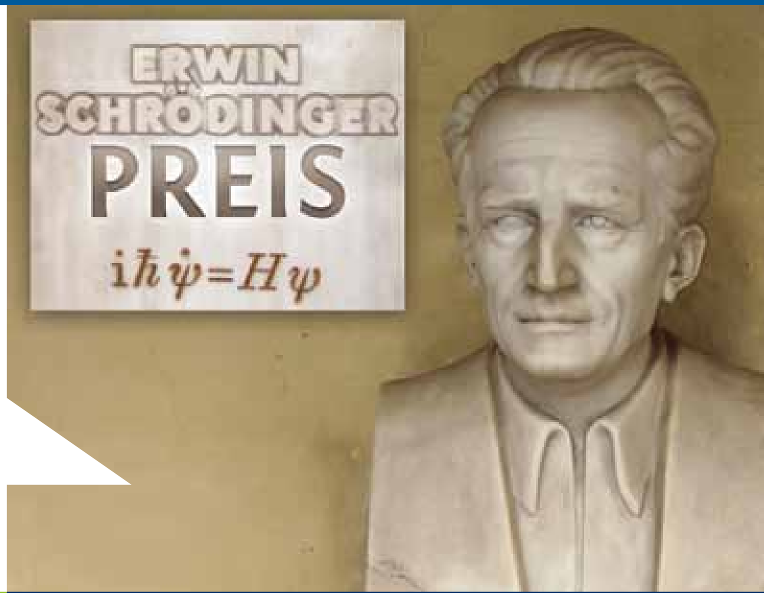
* Not including the German Centres for Health Research, the Berlin Institute of Health and the National Center of Tumor Diseases



SCIENTIFIC PRIZES AND AWARDS

2017 ERWIN SCHRÖDINGER PRIZE

In 2017, the “Stifterverband Science Award – Erwin Schrödinger Prize,” worth 50,000 euros, was shared equally by Fabian Theis and Carsten Marr from the Helmholtz Zentrum München, Tim Schroeder from ETH Zurich and Laleh Haghverdi from the EMBL, Cambridge, UK. The scientists were honored for the joint study “Computational single cell profiling quantified plasticity during blood stem cell differentiation.” The Erwin Schrödinger Prize recognizes innovative achievements at the interface between various disciplines in medicine, the natural sciences and engineering.



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: Corinna Hoose (KIT), Gaetano Garguilo (MDC), Philipp Junker (MDC), Annika Jahnke (UFZ), Luka Cicin-Sain (HZI), Caspar Ohnmacht (HMGU), Christian Koos (KIT), Jan Gerrit Korvink (KIT), Alexander Schmidt (DESY), Aurelio Telemann (DKFZ), Stefan Remy (DZNE), Wolfgang Hoyer (FZJ), Susanne Häussler (HZI), Dennis Hofheinz (KIT), Tobias Dick (DKFZ), Hans-Reimer Rodewald (DKFZ), Thomas Sunn Pedersen (IPP), Thoralf Niendorf (MDC), Holger Puchta (KIT), Wolfgang Wernsdorfer (KIT), Thom Laepple (AWI)

2017 LEIBNIZ PRIZE

Britta Nestler from the Karlsruhe Institute of Technology has received the 2017 Leibniz Prize for her work in computer-assisted materials research. Together with her team, she created an extensive modular software package that models microstructures under various multiphysical influences. The package was optimized for use on supercomputers. With the help of the software, companies can, for example, extend the service life of brake discs or calculate the propagation of fluids in biomembranes for medical diagnostics.

CENTRAL BODIES

As of 1 September 2017

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 Reinhard F. J. Hüttl, Scientific Executive Director,Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Scientific Vice-President,
Coordinator of the Field of Health Research
Professor Pierluigi Nicotera, Scientific Director,German Center for Neurodegenerative Diseases (DZNE)

Scientific Vice-President,
Coordinator of the Field of Aeronautics, Space and Transport Research
Professor Pascale Ehrenfreund, 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
Dr. Ulrich Breuer, Vice-President for Finance and Business Affairs at the Karlsruhe Institute of Technology

Administrative Vice-President
Professor Heike Graßmann, Administrative Director,Helmholtz Centre for Environmental Research – UFZ

MANAGING DIRECTOR

Franziska Broer

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 Monika Henzinger, Professor of Computer Science, University of Vienna, Austria

Professor Rolf-Dieter Heuer, President of the Deutsche Physikalische Gesellschaft, Bad Honnef

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

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 Dierk Raabe, Executive Director, Max Planck Institute for Iron Research, Düsseldorf

Professor Sabine Werner, Professor of Cell Biology, Institute of Molecular Health Science, ETH Zurich, Switzerland

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 Councilor, 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

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

Dr. Ulrich Breuer, Vice-President of the Helmholtz Association, Administrative Director of the Karlsruhe Institute for Technology

Professor Martina Brockmeier, Chairperson of the German Council of Science and Humanities, Cologne

Franziska Broer, Managing Director of the Helmholtz Association, Berlin

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

Professor Heike Graßmann, Vice-President of the Helmholtz Association, Administrative Director of the Helmholtz Centre for Environmental Research – UFZ, Leipzig

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

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

Professor Matthias Kleiner, President of the Leibniz Association, Berlin

Elsbeth Lesner, Representative of the Staff and Works Councils of the Helmholtz Centers, 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 Pierluigi Nicotera, Vice-President of the Helmholtz Association, Scientific Director of the German Centre for Neurodegenerative Diseases, Bonn

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

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

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

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 Monika Sester, Institute of Cartography and Geoinformatics, Leibniz University, Hanover

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

Aeronautics, Space and Transport Research
John Lewis, Director of Strategy and 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, Head 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, Head of Division, Ministry of Science, Research and Art of the State of Baden-Württemberg, Stuttgart

N.N., 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. Volkmar Dietz, Head of Section, Federal Ministry of Education and Research, Bonn

Key Technologies Research
Dr. Herbert Zeisel, Head of Division, 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

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

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

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

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

GSI Helmholtz Centre for Heavy Ion Research GmbH*
Professor Paolo Giubellino, Scientific Director,
Ursula Weyrich, Administrative Director

Helmholtz-Zentrum Berlin für Materialien und Energie GmbH*
Professor Bernd Rech, Acting 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

Helmholtz Centre for Infection Research GmbH*
Professor Dirk Heinz, Scientific Director,
Dr. Michael Strätz, Acting Administrative Director

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

Karlsruhe Institute of Technology, KdöR*
Professor Holger Hanselka, President,
Dr. Ulrich Breuer and Christine von Vangerow, Administrative Vice-Presidents

Max Delbrück Center for Molecular Medicine in the Helmholtz Association, SdöR*
Professor Martin Lohse, Chair of the Board of Directors and Scientific Director,
Dr. Heike Wolke, Administrative Director

Max Planck Institute for Plasma Physics
(associate member)
Professor Sibylle Günter, Chair of the Board of Directors and 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 organizations – 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 COMMISSION

The Senate has established a Senate Commission to prepare program financing (based on program reviews) and set investment priorities. The Senate Commission consists not only of permanent members – ex officio representatives of the federal and state authorities and external experts for the six research fields – but also of temporary members for the specific research field under discussion

PRESIDENT AND EXECUTIVE COMMITTEE

PRESIDENT

A full-time president heads the Helmholtz Association and represents it externally. He or she moderates the dialogue between the world of science, industry and government and is responsible for preparing and implementing the Senate's recommendations on program funding. The president coordinates the development of programs across research fields and oversees cross-center 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 affairs, 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 (in the future: Information)

RESEARCH FIELDS

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

MEMBERS' ASSEMBLY

The Helmholtz Association is a registered association comprising 17 legally independent research centers 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 center belong.

The Members' Assembly is responsible for all the tasks performed by the association. It defines the framework for the cross-center development of both strategies and programs 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
- German Cancer Research Center
- German Aerospace Center (DLR)
- German Center for Neurodegenerative Diseases (DZNE)
- Forschungszentrum Jülich
- GEOMAR Helmholtz Centre for Ocean Research Kiel
- GSI Helmholtz Centre for Heavy Ion Research
- Helmholtz-Zentrum Berlin für Materialien und Energie
- Helmholtz-Zentrum Dresden-Rossendorf
- Helmholtz Centre for Infection Research
- Helmholtz Centre for Environmental Research – UFZ
- Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research
- Helmholtz Zentrum München – German Research Center for Environmental Health
- Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences
- Karlsruhe Institute of Technology
- Max Delbrück Center for Molecular Medicine in the Helmholtz Association
- Max Planck Institute for Plasma Physics (associate member)

LOCATION OF THE RESEARCH CENTERS

1 BERLIN
HELMHOLTZ-ZENTRUM BERLIN FÜR MATERIALIEN UND ENERGIE (HZB)
www.helmholtz-berlin.de

2 BERLIN-BUCH
MAX DELBRÜCK CENTER FOR MOLECULAR MEDICINE IN THE HELMHOLTZ ASSOCIATION (MDC)
www.mdc-berlin.de

3 BRUNSWICK
HELMHOLTZ CENTRE FOR INFECTION RESEARCH (HZI)
www.helmholtz-hzi.de

4 BREMERHAVEN
HELMHOLTZ CENTRE FOR POLAR AND MARINE RESEARCH (AWI)
www.awi.de

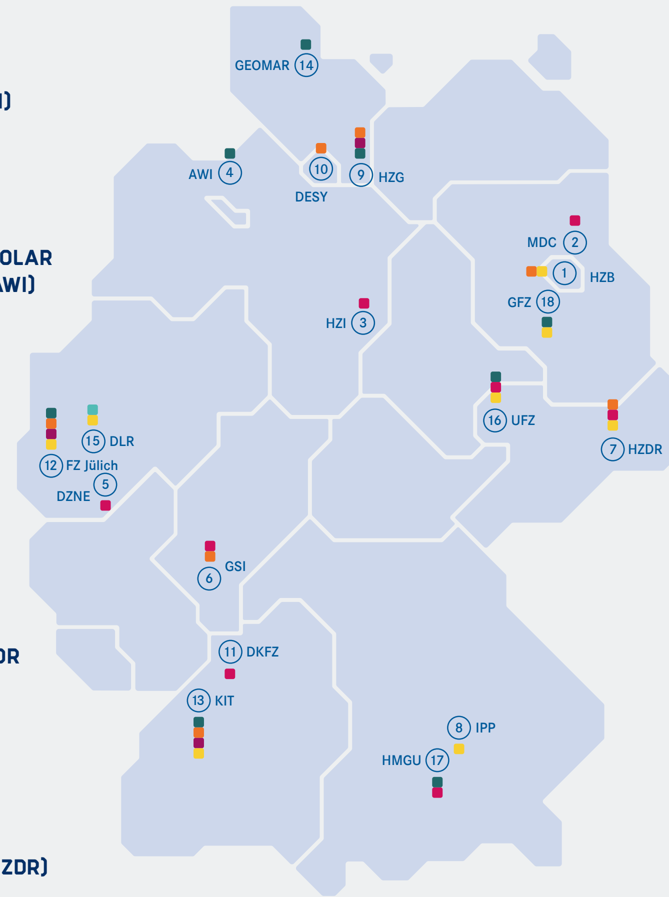
5 BONN
GERMAN CENTER FOR NEURODEGENERATIVE DISEASES (DZNE)
www.dzne.de

6 DARMSTADT
GSI HELMHOLTZ CENTRE FOR HEAVY ION RESEARCH
www.gsi.de

7 DRESDEN
HELMHOLTZ-ZENTRUM DRESDEN-ROSSENDORF (HZDR)
www.hzdr.de

8 GARCHING
MAX PLANCK INSTITUTE FOR PLASMA PHYSICS (IPP, ASSOCIATE MEMBER)
www.ipp.mpg.de

9 GEESTHACHT
HELMHOLTZ-ZENTRUM GEESTHACHT CENTRE FOR MATERIALS AND COASTAL RESEARCH (HZG)
www.hzg.de



10 HAMBURG
DEUTSCHES ELEKTRONEN-SYNCHROTON DESY
www.desy.de

11 HEIDELBERG
GERMAN CANCER RESEARCH CENTER (DKFZ)
www.dkfz.de

12 JÜLICH
FORSCHUNGSZENTRUM JÜLICH
www.fz-juelich.de

13 KARLSRUHE
KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT)
www.kit.edu

14 KIEL
GEOMAR HELMHOLTZ CENTRE FOR OCEAN RESEARCH KIEL
www.geomar.de

15 COLOGNE
GERMAN AEROSPACE CENTER (DLR)
www.dlr.de

16 LEIPZIG
HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ
www.ufz.de

17 MUNICH
HELMHOLTZ ZENTRUM MÜNCHEN – GERMAN RESEARCH CENTER FOR ENVIRONMENTAL HEALTH
www.helmholtz-muenchen.de

18 POTSDAM
HELMHOLTZ CENTRE POTSDAM – GFZ GERMAN RESEARCH CENTRE FOR GEOSCIENCES
www.gfz-potsdam.de

MEMBER CENTERS OF THE HELMHOLTZ ASSOCIATION

As of September 2017

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Directorate: Professor Karin Lochte, Director, Dr. Karsten Wurr, Administrative Director
Members of the Directorate: Professor Uwe Nixdorf, Professor Karen Helen Wiltshire
Am Handelshafen 12, 27570 Bremerhaven
Telephone 0471 4831-0, fax 0471 4831-1149
E-mail info@awi.de, www.awi.de

Deutsches Elektronen-Synchrotron DESY

Board of Directors: Professor Helmut Dosch, Chairman of the Board of Directors, Christian Harringa, Director of Administration, Dr. Reinhard Brinkmann, Director of the Accelerator Division, Professor Joachim Mnich, Director of Particle Physics and Astroparticle Physics, Professor Christian Stegmann, Representative of the Board of Directors in Zeuthen, Professor Edgar Weckert, Director of Photon Science
Notkestraße 85, 22607 Hamburg
Telephone 040 8998-0, fax 040 8998-3282
E-mail desyinfo@desy.de, www.desy.de

Forschungszentrum Jülich

Board of Directors: Professor Wolfgang Marquardt, Chairman of the Board of Directors, Karsten Beneke, Vice-Chairman of the Board of Directors,
Members of the Board: Professor Harald Bolt, Professor Sebastian M. Schmidt
Wilhelm-Johnen-Straße, 52428 Jülich
Telephone 02461 61-0, fax 02461 61-8100
E-mail info@fz-juelich.de, www.fz-juelich.de

GEOMAR Helmholtz Centre for Ocean Research Kiel

Board of Directors: Professor Peter M. Herzig, Director, Michael Wagner, Administrative Director
Wischhofstraße 1–3, 24148 Kiel
Telephone 0431 600-0, fax 0431 600-2805
E-Mail info@geomar.de, www.geomar.de

German Aerospace Center

Executive Board: Professor Pascale Ehrenfreund, Chair of the Executive Board,Klaus Hamacher, Vice-Chairman of the Executive Board,
Members of the Executive Board: Professor Hansjörg Dittus, Dr. Gerd Gruppe, Professor Rolf Henke, Professor Karsten Lemmer
Linder Höhe, 51147 Köln
Telephone 02203 601-0, fax 02203 67310
E-mail contact-dir@dlr.de, www.dlr.de

German Cancer Research Center

Management Board: Professor Michael Baumann, Chairman and Scientific Director, Professor Josef Puchta, Administrative Director
Im Neuenheimer Feld 280, 69120 Heidelberg
Telephone 06221 42-0, fax 06221 42-2995
E-mail presse@dkfz.de, www.dkfz.de

German Center for Neurodegenerative Diseases (DZNE)

Executive Board: Professor Pierluigi Nicotera, Scientific Director and Chairman of the Executive Board, Dr. Sabine Helling-Moegen, Administrative Director
Ludwig-Erhard-Allee 2, 53175 Bonn
Telephone 0228 43302-0, fax 0228 43302-279
E-mail information@dzne.de, www.dzne.de

GSI Helmholtzzentrum für Schwerionenforschung

Management Board: Professor Paolo Giubellino, Scientific Managing Director, Ursula Weyrich, Administrative Managing Director, Jörg Blaurock, Technical Managing Director
Planckstraße 1, 64291 Darmstadt
Telephone 06159 71-0, fax 06159 71-2785
E-mail info@gsi.de, www.gsi.de

Helmholtz Centre for Environmental Research – UFZ

Executive Management: Professor Georg Teutsch, Scientific Director, Dr. Heike Graßmann, Administrative Director
Permoserstraße 15, 04318 Leipzig
Telephone 0341 235-0, fax 0341 235-451269
E-mail info@ufz.de, www.ufz.de

Helmholtz Centre for Infection Research

Executive Management: Professor Dirk Heinz, Scientific Director, Dr. Michael Strätz, Acting Administrative Director
Inhoffenstraße 7, 38124 Braunschweig
Telephone 0531 6181-0, fax 0531 6181-2655
E-mail info@helmholtz-hzi.de, www.helmholtz-hzi.de

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Executive Board: Professor Reinhard F. J. Hüttl, Scientific Director and Spokesman for the Executive Board, Dr. Stefan Schwartze, Administrative Director
Telegrafenberg, 14473 Potsdam
Telephone 0331 288-0, fax 0331 288-1600
E-mail presse@gfz-potsdam.de, www.gfz-potsdam.de

Helmholtz-Zentrum Berlin für Materialien und Energie

Board of Directors: Professor Bernd Rech, Acting Scientific Director, Thomas Frederking, Administrative Director
Hahn-Meitner-Platz 1, 14109 Berlin
Telephone 030 8062-0, fax 030 8062-42181
E-mail info@helmholtz-berlin.de, www.helmholtz-berlin.de

Helmholtz-Zentrum Dresden-Rossendorf

Board of Directors: Professor Roland Sauerbrey, Scientific Director, Professor Peter Joehnk, Administrative Director
Bautzner Landstraße 400, 01328 Dresden
Telephone: 0351 260-0, fax: 0351 269-0461
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