BRIGHT MINDS
FOR A BRIGHT FUTURE

ANNUAL REPORT 2007
HELMHOLTZ ASSOCIATION OF GERMAN RESEARCH CENTRES

From the Research Fields

ENERGY
EARTH AND ENVIRONMENT
HEALTH
KEY TECHNOLOGIES
STRUCTURE OF MATTER
TRANSPORT AND SPACE

Research in Germany
Land of Ideas

HELMHOLTZ
ASSOCIATION

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COVER

DR. DOMINIQUE DE FIGUEIREDO GOMES, GKSS, HEAD OF THE YOUNG INVESTIGATORS GROUP "POLYOXAL-BASED NANOCOMPOSITES" DEVELOPS POLYMERS WITH SPECIAL PROPERTIES.
More details on page 47.

We contribute to solving grand challenges which face society, science and industry by performing top-rate research in strategic programmes in the fields of Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space.

We research systems of great complexity with our large-scale facilities and scientific infrastructure and in cooperation with national and international partners.

We contribute to shaping our future by combining research and technology development with perspectives for innovative applications and provisions for tomorrow's world.

That is our Mission.

HELMHOLTZ
ASSOCIATION

PROFESSOR DR. JÜRGEN MLYNEK
President of the Helmholtz Association

BRIGHT MINDS FOR A BRIGHT FUTURE

Dear Readers,

“Bright Minds for a Bright Future” is the motto for this year’s annual report. After all, it’s people who do the research and scientists who define and implement the strategic goals of Helmholtz research, in dialogue with politicians. They identify the grand challenges that face science, society and industry, and search for solutions built on a solid scientific foundation. The Pact for Research and Innovation that we made with the federal and state governments carries forward our commitment to young scientists and researchers, and to equal opportunity. With the budgetary increase that the politicians promised to make available to us in the Pact, we can maintain our high research standards and also finance many additional measures and investments in the field of talent management.
For example, please read about what we are doing to give young scientists more than just a lab desk and state-of-the art equipment. In fact, we offer independence, an exciting and stimulating working environment, and the opportunity for staff to advance their skills and abilities by systematically engaging in continuing training measures. Yet, talent management is not the sole preserve of our young researchers: it actually extends across all our staff and aims to enable them to fully develop their potential in the Helmholtz Association, from trainees and apprentices all the way through to the highest executives, who have a particularly responsible role to play in the Helmholtz Association. In the past, they mainly acquired their skills and competencies through experience. But, we now additionally offer systematic support at the Helmholtz Management Academy, with training tailor-made to meet the needs of scientists.

Our 2007 Annual Report not only presents the six Research Fields, but also introduces our readers to some of the best young scientists and investigators, along with their projects. Selecting these was such a difficult task, because we were simply unable to include many highly-interesting research groups due to a lack of space. You will perhaps hear of these through other channels, because we are absolutely convinced that those who succeed at the Helmholtz Association have a very good chance of being noticed.
We cannot measure the value of scientific knowledge in euros. But we nevertheless respect the resources that have been made available to us and use them as efficiently as possible. So, please do take a look at our facts and figures, at our organisation charts and our performance record to see how we meet our Mission, namely to secure the future by engaging in research. I would like to take this opportunity to thank all the staff of the Helmholtz Association for their work and great commitment and dedication in the past year.

I wish you all an interesting and enjoyable read.

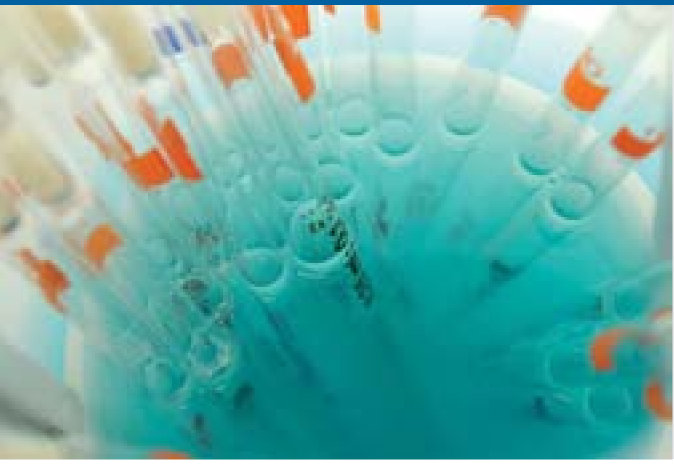
OUR PEOPLE ARE OUR STRENGTH

The Helmholtz Association is continuing to develop. We are establishing new forms of cooperation, are reaching out abroad, and are recruiting the world's best staff to fulfil our Mission: Top-rate research to secure the future.

Last year, the German science and research system continued to gain momentum, with the Initiative for Excellence and the High-Tech-Strategy providing a real boost, while the dynamic impetus delivered by the Pact for Research and Innovation played its part in enabling us to achieve our goals more quickly. In particular, we were able to carry forward and accelerate our networking with universities and research institutions at home and abroad, as well as with industry. And we developed new measures to create a comprehensive talent management system. The results of the Initiative for Excellence demonstrated that the Helmholtz Association and the universities already cooperate excellently with each other; to date, eight Research Schools, nine Excellence Clusters and three Future Concepts put forward by universities and their partner Helmholtz Centres have been selected for funding by the Initiative.

Creating strategic partnerships

The University of Karlsruhe and the Research Center Karlsruhe plan to join forces in just such a partnership, namely the Karlsruhe Institute of Technology (KIT). Their goal: to advance to the peak of international energy research and nanoscience. The RWTH Aachen and the Forschungszentrum Jülich has set its sights on forming the Jülich-Aachen Research Alliance (JARA) – a quality leap in research and teaching that will also extend beyond the second round of the Initiative for Excellence. This alliance will play a piloting role in the promising future research fields of neurosciences, information technology, and simulation sciences, thereby highlighting the potential that lies in partnerships between university and non-university research. In the future, the Helmholtz Association will engage even more in further novel forms of strategic collaboration of this kind. Indeed, the Initiative and Networking Fund will trigger



Based on the funding recommendations made by internationally-appointed review panels, the Helmholtz Association is the only German research organisation to award all its research funding solely through competition.
PROFESSOR DR. JÜRGEN MLYNEK

developments that enable us to reach our strategic goals more quickly, for example, by funding major research alliances, Virtual Institutes, and engaging in new forms of talent management. The annual budgetary increase of three per cent that politicians guaranteed in the Pact for Research and Innovation enabled us to substantially strengthen the Initiative and Networking Fund (p. 72ff.).
For example, the Helmholtz Alliance "Physics at the Terascale" involves German high-energy physicists from 17 universities and two Helmholtz Centres (DESY and the Research Center Karlsruhe) concentrating and packaging their competencies, thereby manifestly integrating the German particle physics community into projects like the Large Hadron Collider at CERN. While researchers from four Helmholtz Centres, universities and industrial companies are developing ceramic membranes at the Helmholtz Alliance MEM-BRAIN with which fossil power stations could be operated more efficiently in the future, and with practically zero emissions.
Using funds from the Initiative and Networking Fund, we also launched important Helmholtz Initiatives in medical-biological research. Molecular biologists from the field of systems biology are working together with computer scientists and medical scientists to investigate the origin of cardiovascular, brain and nervous system diseases, and of cancer. Their work ranges from molecular processes at cell level through to complex clinical pictures. The expansion of translational research represents one of the particularly important strategic topics of the Helmholtz Association. Hence, the National Centre for Tumour Diseases (NCT) is being established in Heidelberg with the support of the German Cancer Research Center, while similar such centres are also being set up at the Helmholtz sites in Berlin, Braunschweig and Munich. The Berlin-Brandenburg Centre for Regenerative Therapies (BCRT) is a joint research institution, established by the Charité University Medicine Berlin and the Helmholtz Association. It brings together 23 new research groups from more than 15 research institutions in the region to fathom out the potential that lies in regenerative therapies. Under the High-Tech Strategy, the Helmholtz Association supports the federal government in the Research Union. Represented by its President, the Helmholtz Association has the lead role in the project to create a national energy research initiative. Because this will enable us to accelerate the development of low-emission technologies, so that we can secure our future energy supply and simultaneously achieve the climate protection goals.

Strategic thinking

Last autumn, an intensive discussion process ended with us agreeing on a strategy to underlie all our goals and objectives, always with our Mission in the foreground: We contribute to solving the grand challenges of the future, such as our future energy supply, climate change or public health. Basic research within the Helmholtz Association plays an important role in this respect. From a long-term perspective, this research builds the foundation for progress. Because truly new insights can only be gained when complex phenomena are understood from the base up.
The large-scale facilities and technology platforms that we develop, establish and operate form an essential part of our Mission. By performing these activities, we contribute to ensuring that Germany remains an attractive centre of science and research, including for the international community.

Globally unique large-scale facilities, like the European X-Ray Electron Laser XFEL or the Facility for Antiproton and Ion Research FAIR, will actually substantially enhance this appeal. The go-ahead for the XFEL at DESY was given in Hamburg in June 2007, while in November 2007 construction work commenced on FAIR at the GSI in Darmstadt. Of course, Germany's taxpayers are not alone in financing these two large-scale facilities, because many European and non-European countries are paying their share.

In the European research landscape, the Helmholtz Association is known for its excellent competence in establishing and operating large-scale facilities. This is also shown, for example, by the above-average success achieved in the EU's ESFRI Programme (European Strategic Forum für Research Infrastructures). Helmholtz Centres are involved in 16 of the 36 projects on the ESFRI roadmap. ESFRI identifies key large-scale facilities for the European Research Area. Our office in Brussels supports the Helmholtz scientists when positioning themselves in the European Research Area and does important work in this respect, as recently positively evaluated by a review panel.

New governance and the next round of programme-oriented funding

At the beginning of 2007, we placed the Helmholtz Association's governance structure on a broader basis. Each research field is now represented on the Executive Committee by a Vice-President, while two additional Vice-Presidents have been appointed for administrative and human resources topics. Now strengthened, we are well prepared for the next round of programme-oriented funding. Based on the funding recommendations made by internationally-appointed review panels, the Helmholtz Association in the only German research organisation to award all of its research funding solely through competition. The first half of 2008 will see the Research Fields Transport and Space, Health, and Earth and Environment evaluated, followed in 2009 by Key Technologies, Structure of Matter and Energy.

Sharing identity, making the most of synergies

The Helmholtz Association is becoming increasingly well-known among decision-makers in industry and politics. By sharing a common identity and presenting our brand, we generate added-value for each and every Helmholtz Centre. A key step involves renaming these as Helmholtz Research Centres. Only then will the success of one centre radiate across all its sister centres. Two centres have already taken on a new name: the Helmholtz Centre for Infection Research – formerly the GBF – and the Helmholtz Centre for Environmental Research – UFZ. This has already had a remarkable effect on the general public and the political sphere. The GSF and the GKSS already have plans to rename themselves soon, and the Hahn-Meitner-Institut Berlin will take on a Helmholtz name in the course of merging with the Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung (BESSY). A new name also provides a real opportunity to communicate the core research areas through the new name. Our Mission also involves building bridges to application. "Research with an impact" was our motto last year. The technology transfer offices at our centres have developed a funding instrument called Helmholtz Enterprise which enables us to efficiently support enterprising researchers who wish to launch a spin-off or start-up in their first year of entrepreneurial independence. The Helmholtz Enterprise Programme is also financed from the Initiative and Networking Fund.

Helmholtz Research stands for top-level scientific research of high relevance for society.
PROFESSOR DR. JÜRGEN MLYNEK

Reaching out to the world

The Helmholtz Association not only maintains its own offices in Brussels, China and Russia to intensify its contacts in these markets. Helmholtz researchers cooperate with partners on all continents. The Helmholtz Association deepens these international contacts and initiates new collaborations, such as with Russia, China and Canada. This means developing new forms of cooperation, such as the "Indo-German Science Center for Infectious Diseases" that we opened in April 2007. The Helmholtz Centre for Infection Research, the Hannover Medical School (MHH) and the Indian Council of Medical Research (IMCR) are working together on this project to study the pathogens of infectious diseases.

Our motto: Bright minds for a bright future

The Mission of the Helmholtz Association lives from the people that incorporate it, "our" people. This is why we chose "Bright minds for a bright future" as our motto this year. Our scientists and researchers exemplify this by investing their heart and soul, their minds and ideas, and their enthusiasm into the research they perform, and I would like to take this opportunity to thank them for this great commitment.
We repeatedly focus particular attention on our young researchers and scientists. This is why we developed programmes to promote young researchers and to ease their entry into a career in science (see p. 10f.) and to ensure that career and family remain compatible.
Our staff in the administration, in the workshops and in the laboratories also contribute their manifold talents to the benefit of the Association. With our carefully planned talent management programme, we aim to enable each and every member of our staff to fully develop their personal potential. Young trainees and apprentices at the Helmholtz Centres not only learn a profession at the very highest level, but also additionally develop technical components and win prizes in state competitions. Here, too, we have made a financial commitment from Initiative and Networking Fund budget, so that the teaching workshops meet state-of-the-art standards. Finally, autumn this year saw the Helmholtz Management Academy open its doors. In its pilot phase, 30 young managers will be able to prepare for executive positions by systematically learning the principles of good management.
Highly-qualified and mobile people can today choose where and under what conditions they work. We want to be the employer of choice in this respect. Staff who join us will find clever and inspiring colleagues, outstanding equipment, technical and administrative support, and opportunities to develop and gain further qualifications. We can only offer permanent positions to very few staff members. However, all our staff should experience their period at Helmholtz as a time of professional and personal advancement, a time that opens up new doors for them.

TALENT MANAGEMENT

TALENT FOR THE FUTURE

The Helmholtz Association attaches great importance to excellent talent management. It has developed a strategy to promote talent at all levels.

Young scientists and researchers are the future leaders of science. Even now they contribute significantly to the research findings of the Helmholtz Centres. The Helmholtz Association has developed a strategy for talent management which it is now putting into practice, partly financed by the Initiative and Networking Fund. The programme supports the Centres in setting new impulses and high standards in initial and continuing training.

Young Investigators Groups

One of the core elements is the establishment of young investigators groups. These are targeted at junior researchers two to six years after they have been conferred their doctorate. Successful candidates lead their own research group and can at the same time acquire the qualifications for a higher academic career. The Helmholtz Association offers them working conditions that are unique in Germany: early scientific independence and a tenure track option following positive evaluation. At present, 68 Helmholtz Young Investigators Groups are being funded with a total of more than 36m euros. We plan to increase this number to around 100 groups in the coming years.

Graduate Schools and Helmholtz Research Schools

Graduate Schools and Helmholtz Research Schools give doctoral students the opportunity to work on their theses in an outstanding research-oriented environment and qualify for a career in science or industry. The Graduate Schools are open to all the doctoral students of a centre and provide all the requisite training under one roof. They provide a structured, interdisciplinary doctoral training that extends beyond the individual doctoral field and also enables students to acquire essential key competencies. Helmholtz Research Schools are smaller joint ventures with universities and are aimed at

At the Helmholtz Centres new impulses and high standards are being set in initial and continuing training.

highly-talented doctoral students. At the Research Schools they work on a collaborative Helmholtz-university project in groups with a specific scientific focus. The competitive procedure in which the Research Schools are selected guarantees that a particularly high standard is upheld.

Helmholtz Management Academy

Talent management at the Helmholtz Association goes beyond the usual target group of undergraduates and postdocs. In spring 2007, the Association launched its Helmholtz Management Academy to give its managers an even better grounding in the tasks and challenges of research management. The programme not only offers courses for young researchers and junior managers from the administrative field. It also includes options for the Helmholtz Association executive: board members, managing directors, programme spokespersons and directors of institutes. The Malik Management Zentrum St. Gallen, a leading provider of management consulting and education, is responsible for the content and methodology of the training courses.

Promotion of Women and the Compatibility of Career and Family

Talent management must keep in mind that the number of women in senior positions is on the increase and ensure that a career in research is compatible with family life. The Helmholtz Association has established the Network Mentoring Programme for young women in research and administration. Since 2005, up to 20 participants per year are supported in their career development by senior managers from other Helmholtz Centres. To facilitate re-entry into science and research careers after a family break, the Helmholtz Association has committed itself to systematically creating career re-entry positions and to adopting measures for flexible working hours for all of its staff members.

Vocational Training

In addition to various qualification levels for young scientists, the Helmholtz Association also offers a broad range of vocational training. In all, 1,613 young people worked as trainees and apprentices at the Helmholtz Centres in 2006. This was well above the average for non-university research institutions in Germany.

School Labs and the “Tiny Tots Science Corner”

Long before vocational training in science becomes an option, the Helmholtz Association specifically aims to encourage children and young people to develop an interest in the natural sciences and technology. A success story in this respect is the establishment of School Labs in the Helmholtz Centres, now at a total of 22 sites. The School Labs have received funding from the Helmholtz Association’s Initiative and Networking Fund totalling 6.5m euros. More than 40,000 pupils visit the Labs each year. In cooperation with the management consulting firm McKinsey & Company, the Siemens AG und the Dietmar Hopp Foundation, the Helmholtz Association has launched the nationwide initiative “Tiny Tots Science Corner” to give all children in day-care facilities the opportunity to experience the natural sciences and technology first-hand. The initiative has currently reached agreements with 28 networks through which we can reach about 100,000 children across Germany.

THE SIX RESEARCH FIELDS

Scientists working at the Helmholtz Association have a great deal of freedom to carry out their own research projects. They bring in new ideas, putting them into practice with enthusiasm and creativity, whether in energy research or particle physics, neurosciences or environmental research. The Helmholtz Association is particularly committed to promoting young scientists and researchers. The following pages introduce you to some of them along with the projects they are engaged in.

RESEARCH FIELD ENERGY

PROF. DR. EBERHARD UMBACH
Helmholtz Vice-President representing the Research Field Energy, Forschungszentrum Karlsruhe

"Energy research is public research aimed at securing our future. This means that we must continue to develop all sources of energy equally, because who can tell today what energy mix will be the right one to have in two or five decades' time."

GOALS AND ROLES

The challenge of reconciling a safe, secure and economically viable energy supply with measures to protect the climate and conserve resources will dominate research in years to come. On the one hand, the economy cannot develop successfully without an ample energy supply – and, what's more, in the face of a growing worldwide demand for energy. On the other hand, fossil resources are in limited supply. Furthermore, it is well known that their combustion produces environmentally harmful emissions and that these in turn contribute decisively to anthropogenic climate change. This is why society needs new and sustainable solutions to meet its energy demand. The Research Field is working on finding the answers. Energy research ensures that the needs of present and future generations are met by developing new technologies. This is why it is long-term forward-looking research. Energy research is a key element of national public research strategies and a driving force for economically competitive innovation.

The energy research performed in the Helmholtz Association aims to avert foreseeable global energy supply bottlenecks and to improve the disposal of wastes, residues and emissions. On the one hand, our scientists and researchers set out by exploring the potential offered by renewable resources, such as solar, biomass or geothermal energy, and, on the other, concentrate on raising the efficiency of conventional power stations. By engaging in nuclear safety research, we also contribute to ensuring that nuclear reactors can be run safely and explore options for disposing of radioactive wastes. Our research on using nuclear fusion to generate power also represents a major engineering challenge, which we are tackling in cooperation with international partners so that we can also tap into this energy source in the future.

PROGRAMME STRUCTURE

Six Helmholtz Research Centres work together in the Research Field Energy: The Deutsches Zentrum für Luft- und Raumfahrt, the Forschungszentrum Karlsruhe, the Forschungszentrum Jülich, the GFZ Geo-ForschungsZentrum Potsdam, the Hahn-Meitner-Institut Berlin, and the Max Planck Institute for Plasma Physics. Scientists collaborate in four programmes:

- **Renewable Energies**
- **Nuclear Fusion**
- **Nuclear Safety Research**
- **Efficient Energy Conversion**

These programmes are led by major interdisciplinary research teams equipped with large-scale facilities, test-beds for major components, high-performance analysis systems and supercomputing capacities. The choice of research topics also takes account of how roles and responsibilities have been assigned in agreement with partners in science and industry.

The dialogue initiated by the leading umbrella organisations of industry and science has produced a consensus view, namely that no sensible energy option should be abandoned at this stage. Since only then will the power industry be able to address its two central challenges: ever dwindling resources and the risks associated with waste disposal.

AXEL WIDENHORN COMBINES GAS TURBINES AND FUEL CELLS AND SO IS ABLE TO RAISE THE ELECTRICAL EFFICIENCY OF A POWER GENERATOR TO 60 PER CENT. Photo: DLR

PROJECTS

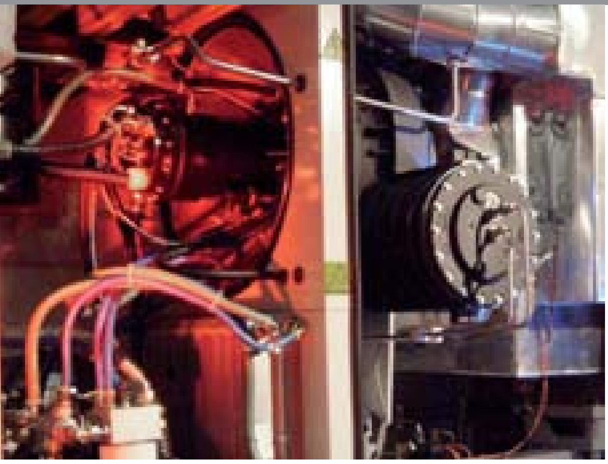
Deutsches Zentrum für Luft- und Raumfahrt

ENTERING NEW TERRAIN IN POWER STATION CONSTRUCTION

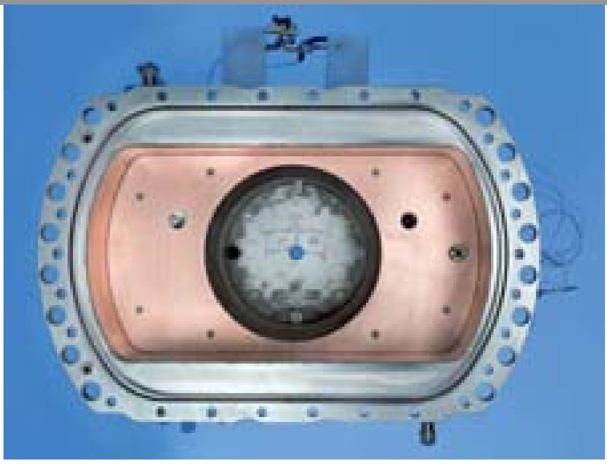
One of the greatest available sources of energy lies in further increasing energy efficiency. This also applies to power station construction. Researchers from the DLR want to improve the use of natural gas by combining gas turbines and fuel cells. Industry has also shown a strong interest and companies have come on board. Whenever Axel Widenhorn turns on the gas turbine in his lab, he's looking to get more out of the utilized fuel than is the case at present. "Power stations in the lower megawatt range currently use much less than half the energy they have been fed with to produce electricity," explains the engineer from the DLR Institute of Combustion Technology in Stuttgart. Widenhorn heads a young group there that is developing the combustion technology for a power station that combines gas turbine and fuel cell to create a hybrid technology. He aims to raise the electrical efficiency level to 60 per cent. Although large central power stations use the energy similarly efficiently for generating electricity, the remaining 40 per cent is lost as waste heat released into the air. By contrast, a small, decentralised power station that only has one hundredth of the capacity is able to use this waste thermal energy to heat flats and buildings. So, a hybrid power station would be efficient both in power generation and in using the residual heat. "In a hybrid power station, the gas turbine and the fuel cell support each other," explains Axel Widenhorn, "which enables us to raise the efficiency level." The fuel cell not only generates electricity but also the 800°C hot waste gases used to drive the gas turbine. In turn, the gas turbine produces electricity plus compressed air which is fed into the fuel cell along with the fuel. This means squaring the circle. The result is that the electrical efficiency rate increases by up to 15 percentage points over that of the fuel cell, the best individual component. That this project promises success can be seen in the interest that industrial partners are showing in the Helmholtz Virtual Institute "Hybrid power station: gas turbine, SOFC fuel cell, and system regulation." In addition to Axel Widenhorn's group, the DLR Institute of Technical Thermodynamics and the Institute of Aircraft Propulsion Systems at the University of Stuttgart, Siemens Fuel Cells and Energie Baden-Württemberg are also working on the project. The Virtual Institute forms the basis for structured cooperation between the partners. The core engineering competencies needed in the field of gas turbines, high-temperature fuel cells and regulators for successful implementation are strategically joined together, thereby concentrating the specific strengths of the partner institutes.

> In a hybrid power station, the gas turbine and the fuel cell support each other, which enables us to raise the efficiency level.

Scientists at the Virtual Institute organise the cooperation practically like a real-life institute. They have a coordinator and regular team meetings. Furthermore, researchers also take on external responsibilities, for example, to raise additional external funds. "When I switch on my computer, I can immediately see which colleagues are available, even if they are not working in the same building," enthuses Widenhorn.



THE MICRO GAS TURBINES STILL NEED TO BE ELABORATELY OPTIMISED FOR THE HYBRID POWER STATION AND THEN HARMONISED WITH THE FUEL CELL. Photo: DLR



LOOKING INTO THE ION SOURCE AT THE IPP: CHARGED PARTICLES ARE GENERATED HERE AND ARE THEN BROUGHT UP TO THEIR HIGH SPEEDS BY AN ACCELERATOR LATTICE. Photo: Graul/IPP

The engineers are entering new terrain in numerous areas. They have to develop innovative plant and operational concepts for the hybrid power station. The combustion processes and air-fuel mixtures that occur in the hybrid power station have not yet been studied in detail. In fact, regulation of the hybrid power station still presents the scientists with a number of major challenges. After being switched on, the fuel cell needs hours before it reaches full load. While the gas turbine starts up within a few seconds. This means that after the power station is activated, the gas turbine initially has to run without its symbiotic partner, the “fuel cell”. Engineers first of all design the regulator on the computer using a virtual power station.

> Regulation of the hybrid power station still presents the scientists with a number of major challenges, which is why it is tested on the computer in a virtual power station.

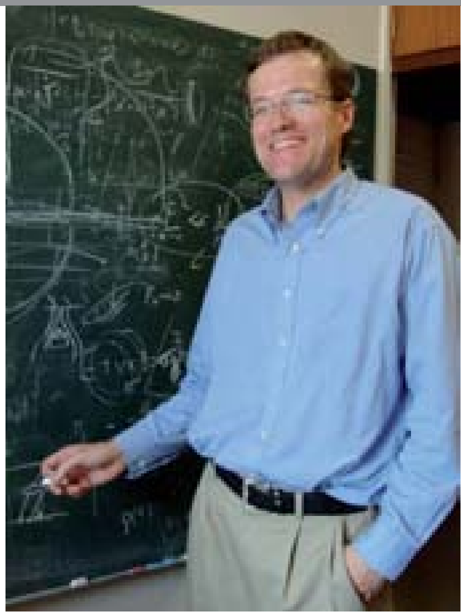
“We do this to develop control concepts for each individual phase. Not only for switching it on, for example, but also for switching it off, for load changes and, of course, for emergency stop situations,” explains Axel Widenhorn. In the next step, he and his colleagues test the regulator in the lab system. If the research power station works in the lab, Energie Baden-Württemberg plans to build a demonstrator using the new technology in five years’ time. With a capacity of some four megawatts, it would be able to provide a small town of 4,000 inhabitants with electricity and some heating.

DR. MICHAEL FUHS

Max Planck Institute for Plasma Physics

HEATING FOR THE FUSION REACTOR

What has been working since time immemorial in the Sun at temperatures of just 6 million degrees Celsius calls for great effort on Earth. Because it’s much more difficult to initiate and maintain nuclear fusion here. First of all, the hydrogen plasma has to be heated up to more than 100 million degrees. Scientists from the Max Planck Institute for Plasma Physics (IPP) in Garching have upgraded such a heating system for the extreme requirements of the test reactor ITER. In 2006, Dr. Eckehart Speth, Dr. Hans-Dieter Falter, Dr. Peter Franzen, Dr. Ursel Fantz and Dr. Werner Kraus were presented with the Erwin Schrödinger Prize, the Science Prize awarded by the Stifterverband für die Deutsche WIssenschaft (the joint initiative of German industry to promote science and higher education), which is worth 50,000 euros.
The high-frequency plasma source that they developed is also able to accelerate negatively-charged ion particles and so can introduce more energy into the plasma than its predecessors could. These results have now convinced ITER. The novel ion source has been selected as the plasma heater for the test reactor which is just being built in Cadarache, France. IPP



KLAUS HALLATSCHEK MODELS HOW WILD TURBULENCE EVENTS CAN JOIN FORCES TO CREATE CALMER FLOWS.
Photo: Graul/IPP

Max Planck Institute for Plasma Physics

GETTING TO THE BOTTOM OF TURBULENCE

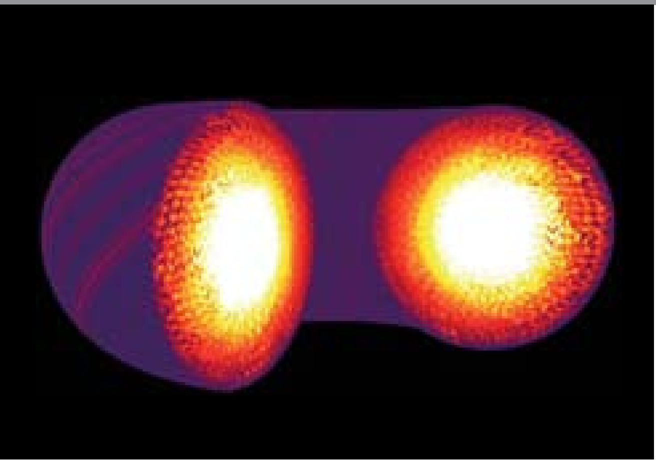
Dr. Klaus Hallatschek's computers live quite a turbulent life – and this is meant in the truest sense of the word. The theoretical physicist from the Max Planck Institute for Plasma Physics (IPP), an associate member of the Helmholtz Association, is trying to gain a detailed understanding of what actually underlies the phenomenon of turbulence. His findings and insights could be used in future fusion power stations. Using powerful magnetic fields, these aim to enclose a hydrogen plasma that is heated up to several hundred millions of degrees in a kind of magnetic cage. At temperatures like these the hydrogen nuclei fuse to form helium thus generating efficient and environmentally-friendly energy.

When gases or fluids move, however, turbulence often occurs. So when a river's flow is impeded by a bridge's pier, the smooth flow turns into turbulence full of eddies and ripples. Turbulence also occurs in the hot and completely ionised hydrogen gas (plasma) of a fusion reactor, a result of the enormous differences in temperature in the tyre-shaped plasma. "Temperatures of up to 300 million degrees are found right in the middle," explains Hallatschek. "It's much cooler at the edges, perhaps even only as warm as one million degrees." This results in convection transporting the hot plasma from the inside to the colder outer areas, a process that is by no means smooth but rather highly turbulent. "This turbulence is very disruptive, it hampers the plasma's confinement in the magnetic field and reduces the thermal insulation in the reactor," says Hallatschek. "To balance this out, we would need larger and so much more expensive plants." However, there is an effect that helps the researchers with their work. Because under certain circumstances during a fusion experiment, smaller eddies were able to join together to former larger flows.

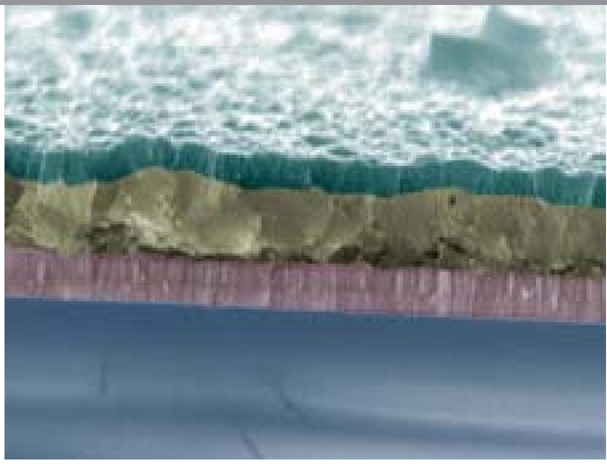
Such zonal flows also occur elsewhere – for example on the giant gaseous planet of Jupiter. "Jupiter is hot inside and cold outside," explains Klaus Hallatschek. "Turbulence also occurs there that transports the internal heat outwards." And there are zonal flows that form from many small eddies. We can recognise these on Jupiter in the form of the planet's typical rings. The brown rings correspond with low pressure areas, the white rings are high pressure areas.

> This turbulence is very disruptive and hampers the plasma's confinement in the magnetic field and reduces the thermal insulation in the reactor.

"The zonal flows reduce the turbulence by tearing apart the eddies," says the IPP physicist. "This leads to less heat being transported." Similar phenomena have already been observed in experiments, such as at the ASDEX fusion experiment in Garching. This is where the so-called H-Regime (High-Confinement Regime) was discovered in 1982. A special magnetic field array, the "divertor", steers the outer fringe layer of the plasma into separate chambers from where the plasma particles are pumped off. This fringe layer has hardly any turbulence and so can serve the plasma as a real thermal insulation layer.



COMPUTER SIMULATIONS SHOW HOW LARGE-SCALE FLOWS START TO DISSOLVE THE TURBULENCES IN A FUSION PLASMA. Photo: IPP



THIN-FILM CELLS MADE OF COPPER-INDIUM-SULPHIDE ARE MUCH CHEAPER BUT ALSO LESS EFFICIENT THAN SILICON CELLS. Photo: HMI

The scientists now want to use similar effects for the major international project called "ITER". ITER (Latin for "the path") is being built in Cadarache in southern France over the coming few years and is expected to become operational in 2018. The plans are for the 30 metre high plant to become the first to ignite plasma and to produce a power-generating fusion fire – and so finally demonstrate that nuclear fusion can serve humanity as a source of energy.

> The zonal flows do as they please. If we want to control them, we need a much better understanding of them.

The plasma's thermal insulation is the key in this respect. The researchers hope to optimise this insulation by specifically using zonal flows in the plasma. The problem is that "the zonal flows do as they please," says Hallatschek, "and if we want to control them, we need a much better understanding." It is just this understanding that the physicists are seeking to extend – by carrying out complex simulations on supercomputers.
And possibly, Hallatschek's research findings will one day also be transferred from fusion reactors on Earth to the gaseous planets out in space. Because a basic knowledge of the zonal flows could also help planetary researchers gain a better understanding of the climate activities on Jupiter.

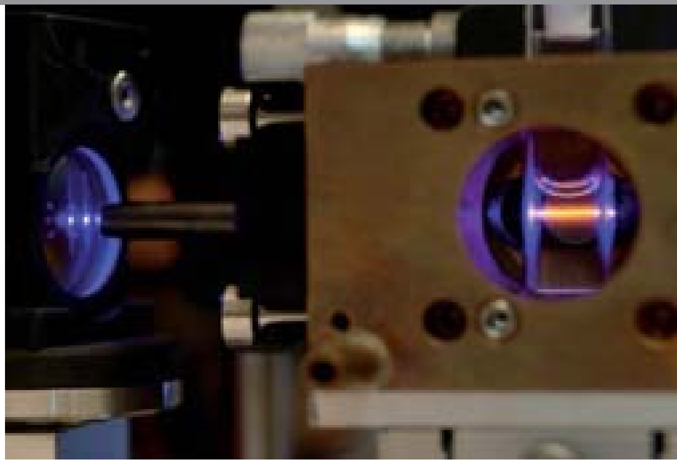
FRANK GROTELÜSCHEN

Hahn-Meitner-Institut Berlin

OPTIMISING SOLAR CELLS AND CUTTING THEIR PRODUCTION COSTS

Dr. Eveline Rudigier from the Hahn-Meitner-Institut Berlin demonstrated in her PhD thesis how the production of solar cells can be improved. The 32-year-old young researcher received the Shell-She-Study Award for her work. "Previously, the optimisation of thin-film solar cells was above all based on experience," reports Rudigier. "But we need a deeper understanding for industrial production."
This is why she studied the phase formation of the complex material copper-indium-sulphide (CIS) system and showed how the quality of light-absorbing layers is connected with the quality of the final solar cells. "Eventually, I was able to demonstrate that the process can also be controlled during the production stage by means of raman spectroscopy."
This non-destructive method reduces the rejection rate, raises the yield and so is also of great economic interest. As a result, Eveline Rudigier was able to register a patent for this application.

HMI



WITH THE HELP OF FLUORESCENT SPECTROSCOPY, JUST A FEW MOLECULES OF A SUBSTANCE ARE ENOUGH TO RECEIVE A CLEAR SIGNAL. Photo: Forschungszentrum Karlsruhe

Forschungszentrum Karlsruhe

SAFETY RESEARCH WITH LASER LIGHT

His working clothes are as yellow as a sunflower. When Dr. Thorsten Stumpf enters the controlled area of the Institute for Nuclear Waste Disposal at the Research Center in Karlsruhe, he pulls over his overalls and slips into his special shoes and then enters a world in which strict security measures apply. Stumpf is studying how radioactive waste products from nuclear power plants react with their environment in the long-term when they are finally disposed in salt deposits, or in granite and other geological formations deep beneath the earth surface.

> Only when I understand what reactions take place there and know the stability of the reaction products, only then will I be able to draw truly reliable conclusions. Because the laws of nature will also apply in 100,000 years' time.

Of course, good estimates on this have long been available, but Stumpf wants to have a deeper understanding. Because the chemistry of radioactive metals from the group of actinides, which include plutonium, americium and also curium, has so far remained largely unexplored. This is why most transport calculations are based on so-called distribution coefficients that are determined experimentally from radionuclide concentrations in the solid and fluid phase. However, these values can only be extrapolated with a certain degree of uncertainty over longer time periods, such as millions of years. What happens at molecular level and how radioactive atoms react in detail with their environment in the final deposit site are questions that still remain to be explained. "Only when I understand what reactions take place there and I know the stability of the reaction products, only then will I be able to draw truly reliable conclusions. Because the laws of nature will also apply in 100,000 years' time," says Stumpf.

> Fluorescent spectroscopy is a fantastic method for obtaining structural information and it even allows us to work with samples that contain just a few molecules of radioactive material.

It's dark and cool in the lab. Laser systems are at work here with which the researchers are able to follow the reactions very closely. Because some actinides have a special characteristic: they are fluorescent. The laser makes the samples light up and the emitted light contains detailed information, both on the reaction progress over time and on the energy levels, and, in particular, on the structure of the compound that was created. "Fluorescent spectroscopy is a fantastic method for obtaining structural information and it even allows us to work with samples that contain just a few molecules of radioactive material," explains the radiochemist. With conventional spectroscopic methods, the concentrations would have to be much higher, namely by a factor of hundreds of millions.
The lifetime of fluorescence tells the researchers how many water molecules surround an actinide atom. Only when the actinide has been fully incorporated into the host lattice of the surrounding material will the hydration shell have disappeared

THORSTEN STUMPF HAS TO PREPARE MOST OF THE SAMPLES IN A GLOVE BOX FOR LATER MEASUREMENTS IN THE LASER LAB. Photo: Forschungszentrum Karlsruhe

DMITRY NAUMENKO (LEFT) STUDYING THE RESIDUAL STRESS OF ALUMINIUM OXIDE FILMS BY MEANS OF RAMAN / FLUORESCENCE SPECTROSCOPY. Photo: Forschungszentrum Jülich

and the lifetime of the fluorescence have become very long. And not only the various compounds, but also the exact geometrical positions into which the radioactive atom was integrated can be deduced from the spectra.

Stumpf and his team mainly work with curium, an actinide element whose special fluorescent characteristics allow the most detailed conclusions. For example, curium atoms can be used as atomic probes to study chemical reactions, even at ultra-small concentrations. The radiotoxicity of the nuclear wastes produced by nuclear power generation will be dominated over long time periods by plutonium and americium. However, americium and curium are chemically very similar: both elements are trivalent and even the ionic radius is identical. Plutonium, too, is also very probably “reduced” in the deep geological formations of the final deposit site, so that it then chemically resembles curium as well. Curium is also convenient to work with, because it hardly radiates on account of its half-life of 340,000 years.

So what do the experiments show? Curium can indeed be firmly incorporated into minerals. Firmly embedded in the crystal structure there, the radioactive actinides can be kept far away from the ecosphere for very long periods of time.

DR. ANTONIA RÖTGER

Forschungszentrum Jülich

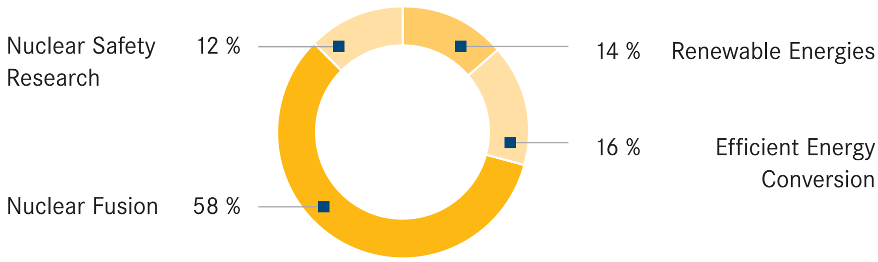
PROTECTIVE FILMS FOR HIGH-TEMPERATURE COMPONENTS

Turbines and power engineering components not only have to withstand high mechanical loads, but also heat. The latter results in accelerated corrosion which limits the components’ lifespan. Moreover, the application conditions for the turbine materials are going to be even more severe in the future. This is because making energy sources more efficient means carrying out combustion processes at much higher temperatures. To stop the corrosion attack novel, protective coatings are being developed by Dr. Dmitry Naumenko at the Institute of Energy Research at the Forschungszentrum Jülich.

Born in the Ukraine, Dr. Naumenko is an expert in extreme conditions which even special alloys are not capable of coping with. He studies the chemical processes during corrosion and develops methods whereby controlled oxidation is used to make protective coatings on the components more effective. In particular, he is now working on new coatings for the highly-efficient, low-emission power stations of the future. In these, the combustion is carried out with pure oxygen and the resulting CO_2 is filtered directly from the flue gas. At the new Helmholtz Alliance “MEM-BRAIN”, ceramic membranes are now being developed that rely on coatings like these as substrates. Funded by the German Research Foundation’s Emmy Noether Programme, Naumenko will continue his research project with four colleagues over the next five years. arö

Structure of the Research Field Energy
Core-financed Costs 2006: 152m euros

The Research Field Energy additionally receives 109m euros for a total budget of 261m euros.



THE PROGRAMMES

Renewable Energies

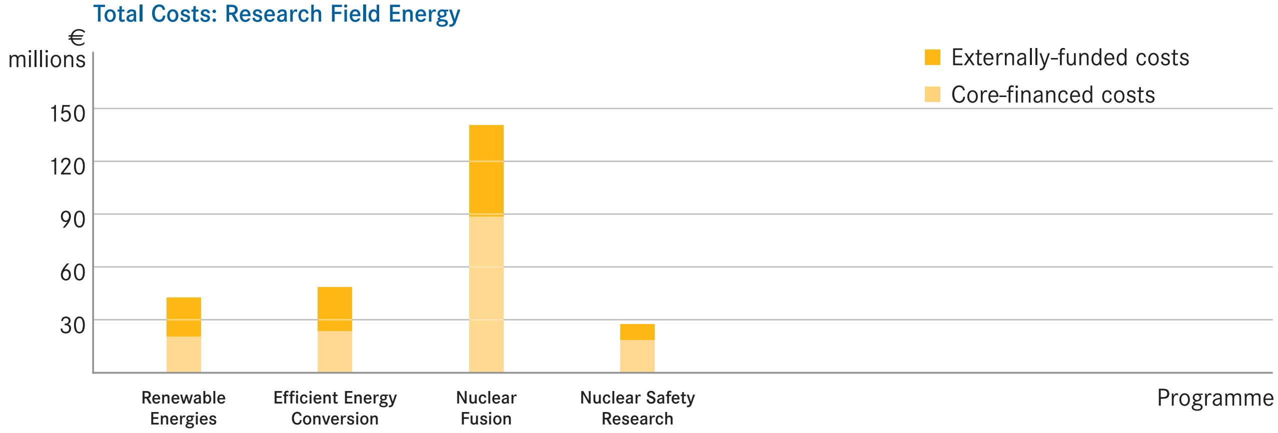
Renewables based on solar, geothermal and biomass energies are thought to epitomise sustainability, since they are not only inexhaustible but are additionally CO_2 neutral, and so do not further aggravate the greenhouse effect. This is why we attach particular importance to studying renewable energy sources and developing economically feasible technologies.

Future research must, in particular, aim to lower costs. Wind power converters and solar collectors have already developed far and are being commercially marketed – supported by national launch programmes. By contrast, the costs of photovoltaics continue to be too high – even under large-scale series production. New approaches, especially in the field of thin film technologies, have opened up a stronger commercial role for this technology. This is also the aim of the research done on power generated by geothermal energy from low temperature resources and on the development of major solar-thermal power stations. In these plants, mirrors capture the sunlight, generate process heat in a collector, and use this to produce electricity. They are being developed in the Helmholtz Association and are currently undergoing large-scale testing in Almeria, Spain. This is why the programme includes a systems analysis element to assess both the potential that renewables offer and the strategies for bringing them into more general use.

Efficient Energy Conversion

Carbon-based, fossil fuels such as crude oil, natural gas or coal will continue to dominate energy supplies for decades to come. In addition, a substantial proportion of the future alternative energy sources, such as synthetic gases or synfuels made of biomass, for example, will be converted into electricity in power stations. Using these offers great potential for protecting the climate and conserving resources. This potential lies in raising the efficiency of the conversion technologies. This is where the Efficient Energy Conversion programme sets in. It explores new technologies for power stations and fuel cells, and studies the use of superconductivity in the electricity-generating industry. Key topics include new components and solutions for high-performance gas turbines which are capable, for example, of substantially increasing their efficiency levels. Fuel cell research sees further developments in solid oxide fuel cells equipped with ceramic electrolytes and in low-temperature fuel cells, particularly the direct methanol cell, which is important for mobile applications. Research on new superconducting current limiters and also on superconducting components for the power grid delivers highly promising solutions for transmitting power in the future with practically zero energy losses.

Total Costs: Research Field Energy



Nuclear Fusion

Nuclear fusion is a prime example of public long-term forward-planning research. Only as from the second half of our century and beyond could a fusion reactor actually generate power, and so permanently resolve at least some of humankind's energy problems. The immense cost of research and development means that this goal can only be achieved in collaboration with national and international partners. Consequently, Helmholtz fusion research forms an integral part of the EURATOM Fusion Programme.

The Helmholtz research priorities agreed with our international partners focus on contributing to creating ITER, a tokamak experiment, and on building the European-supported large-scale German stellarator experiment WENDELSTEIN 7-X. Tokamak and stellarator are two different concepts for confining hot fusion plasma in a magnetic field. ITER aims to demonstrate that fusion-based power generation is technically feasible. The experiment additionally aspires to provide the data needed for building a demonstrator power plant. The WENDELSTEIN 7-X stellarator experiment aims to show that the stellarator concept is also a suitable option for a fusion power plant. The Helmholtz Association supports this strategic master plan by conducting additional, smaller experiments and developing technologies and new materials to prepare components for a demonstrator power plant.

Nuclear Safety Research

In 2006, nuclear power stations in Germany generated around 167.4 billion kilowatt hours of electric power and so covered 26.3 per cent of the country's power demand and 50.3 per cent of the base load demand. Research on the safety of nuclear reactors and on the safe disposal of nuclear waste is consequently absolutely indispensable. And this will continue to apply in the future. Under a strategically-planned, forward-looking research policy in Germany, nuclear technology and engineering know-how will continue to be needed for decades to come, even if nuclear energy is abandoned as a power source. The work performed by the Helmholtz Association's Nuclear Safety Research Programme ensures that broad-based expert knowledge remains available in all areas relating to the safety of nuclear reactors and to the security of nuclear waste disposal, in accordance with the international state of science and technology, and that German researchers continue to play an active part in all relevant international projects, bodies and committees, and decisively contribute to these.

RESEARCH FIELD EARTH AND ENVIRONMENT

PROF. DR. GEORG TEUTSCH
Helmholtz Vice-President representing the Research Field Earth and Environment, Helmholtz Centre for Environmental Research – UFZ

"Balanced and hence robust solutions for tackling the environmental problems of our day call for cross-disciplinary, scientifically excellent research approaches which, in particular, take account of social factors as well. The Research Field Earth and Environment uniquely combines these key competencies for such system solutions."

GOALS AND ROLES

The 20th century saw the relationship between humankind and nature change fundamentally. Non-natural factors have since impacted life on Earth with a previously unknown intensity. This was mainly triggered by population growth and the development and application of new technologies. Both increase the demand for resources. In particular, the rapidly-growing consumption of fossil resources contributes to our planet's climatic equilibrium becoming in danger falling out of synch, which would put Earth's global ecological stability at risk.

To develop sustainable solutions, we first need a better and closer understanding of the fundamental functions of System Earth and of how human society and nature interact. This is a key goal of the earth and environment research done in the Helmholtz Association. Researchers are also working on describing the consequences of the complex changes to earth and the environment as precisely as possible so that objective decision-making aids can be made available to decision-makers in politics and society. Another core area involves contributing to economic development. According to new scenarios, environmental technologies in Germany could increase their proportion of the turnover produced by all branches of industry from 4 to 16 per cent by 2030 and so become an important driving force for growth. Research projects that not only span the programmes but also integrate the centres and other institutions are becoming ever more important in the Helmholtz Association. For example, six centres are working together in the Integrated Earth Observing System – Helmholtz-EOS – to study and address complex questions of ice and ocean research, water cycle, disaster management, and land surface processes. Working within the initiative on "Risk Habitat Megacity", five centres are cooperating with the UN organisation ECLAC/CEPAL to study strategies for sustainable development in megacities and conurbations. A Helmholtz network of five centres has also formed to address the field of systems analysis and technology impact assessment, another area that extends across the research fields. A further example of research cooperation beyond institutional borders involves the German Marine Research Consortium (Konsortium Deutsche Meeresforschung – KDM) in which eleven research institutes from the Helmholtz Association, the Leibniz Association and the universities have joined forces.

PROGRAMME STRUCTURE

Nine Helmholtz Centres are actively involved in the Research Field Earth and Environment:
The Alfred Wegener Institute for Polar und Marine Research, the GFZ GeoForschungsZentrum Potsdam, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the Helmholtz Centre for Environmental Research – UFZ, the Helmholtz Centre for Infection Research, the GKSS Research Centre Geesthacht, the GSF – National Research Center for Environment and Health plus the Deutsches Zentrum für Luft- und Raumfahrt as an associated research institute. Environmental and System Earth research focuses on addressing the grand challenges that national and international bodies have identified. Natural disasters, climate fluctuation and climate change, water – availability and dynamics of clean water, sustainable use of resources, biodiversity and ecological stability plus the socio-political dimension of global change. The research field addresses these central tasks of earth and environment research in six programmes:

- **Geosystem: The Changing Earth**
- **Atmosphere and Climate**
- **Marine, Coastal and Polar Systems**
- **Biogeosystems: Dynamics, Adaptation and Adjustment**
- **Sustainable Use of Landscapes**
- **Sustainable Development and Technology**

None of these research tasks can be viewed in isolation from each other, since all the elements and processes of the various spheres are closely connected with each other in System Earth. To meet these dynamics, scientists working within the Research Field Earth and Environment not only collaborate with each other but also with colleagues from other research fields, for example, when studying the environmental impact on human health or using satellite data for modelling environmental processes. Beyond this, particular importance attaches to cooperation with partners outside the Helmholtz Association, at national and international level.

ON BOARD A RESEARCH VESSEL, BARBARA NIEHOFF CAN IMMEDIATELY EXAMINE THE ZOOPLANKTON SAMPLES. Photo: Alfred Wegener Institute

PROJECTS

Alfred Wegener Institute for Polar and Marine Research

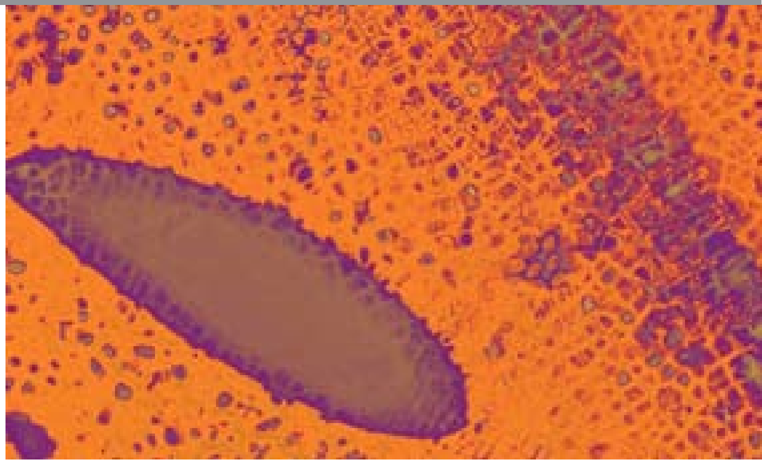
FLOATING LIFE

Dr. Barbara Niehoff is studying the key species of marine plankton communities to find out what strategies they use to be able to respond to changes in food supply or temperature. Her results contribute to assessing how climate change influences marine ecosystems. Even as a young girl, Barbara Niehoff was an active nature conservationist, for example, protecting the resting and breeding grounds of birds. The transition to marine biology occurred gradually during her studies. "The animals living in the Wattenmeer mudflats, off Sylt, where I wrote my Diplom thesis, genuinely fascinated me," she remembers.
Today, Barbara Niehoff is an expert for the ecology of plankton organisms in the polar seas, the North Atlantic and the North Sea.
Around six years ago, the biologist returned from the famous Woods Hole Oceanographic Institution on the US East Coast to take up her research at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven. As a Young Investigators Group Leader she built up her own team, which focuses on understanding the trophic interactions among plankton organisms. At the same time, she gained her postdoctoral habilitation (venia legendi) at the University of Bremen, where she now gives lectures regularly.
Plankton (Greek for "wandering or drifting") is the generic term for all organisms that are unable to swim against the water currents and so just let themselves be carried along. Plankton includes metre-long jellyfish as well as tiny algae and bacteria, plus the larvae of many fish or urchin species. Copepods, which are found in all the world's oceans, are one of the most important animal plankton (zooplankton) groups.
Copepods are just as numerous in the sea as are insects on land, and play a major role in the ecosystem. They are a vital food source for many organisms, including commercially important fish species and even whales. The copepods themselves mostly feed on the single-cell algae (phytoplankton) that float in the upper, sun-drenched water layers, where they bind carbon dioxide from the atmosphere by means of photosynthesis. Some of this CO_2 then sinks down into the deep with the copepods' faecal pellets. The question of "who eats who?" is thus even connected to what drives the oceans' "carbon pump" and crucial for our understanding of ecosystem functioning.

> *Temora longicornis*, a copepod species which is very common in the North Sea, generally eats everything – even its own eggs if need be, for example when only few algae can be found in the water.

A major part of the scientific work is performed on board the research vessels. Using large nets, Niehoff and her staff collect the zooplankton specimens and already start studying them on board, counting the eggs and measuring the sacs, in which some species store fat as an energy reserve for overwintering. Especially in Polar regions, this means working long hours in the cold – often on deck of a lurching ship. Further analyses are then conducted in the lab on "terra firma", to determine, for examples, the animal's nitrogen and carbon content, fatty acid composition, and metabolic activities. Niehoff is then able to reconstruct what the animals have

COPEPODS ARE TRANSPARENT, WHICH ALLOWS THE BIOLOGISTS TO STUDY EGG NUMBER AND OIL SACS.
Photo: Alfred Wegener Institute



THE AERIAL IMAGE SHOWS THE GEOMETRIC STRUCTURES, THE WATER COURSES AND THE LAKES ON SAMOILOV ISLAND IN NORTHERN SIBERIA. DRY AREAS APPEAR ORANGE.
Photo: Alfred Wegener Institute

been feeding on and compare this with their reproduction success. “*Temora longicornis*”, a copepod species which is very common in the North Sea, generally eats everything – even its own eggs if need be, for example when only few algae can be found in the water.”

> Increasingly, thermophile species are migrating to this habitat and so are competing for food, which could in turn change the predator-prey structure in the ecosystem.

Species such as *T. longicornis*, which respond highly flexibly to feeding conditions, act as a buffer in the oceanic food web. In future, they might become even more important, because climate change is also beginning to have an effect in the North Sea. Increasingly, thermophile species are migrating to this habitat and are competing for food, which could in turn change the predator-prey structure in the ecosystem. “We know only very little about this,” says Niehoff. This is an extremely relevant research field for the future. DR. ANTONIA RÖTGER

Alfred Wegener Institute for Polar and Marine Research

SUBTERRANEAN THAW

Climate change is also making itself much more noticeable in the higher latitudes around the polar areas. How rising temperatures also change the cycles in the permafrost ground is being examined by Young Investigators Group Leader Dr. Julia Boike and her team at the Alfred Wegener Institute for Polar and Marine Research. She is analysing data at the AWI branch in Potsdam that she has collected on her long expeditions in the Siberian tundra. For example, she is examining the water and energy cycles in the upper layers of the soils, which regulate the release of methane, a greenhouse gas. “We can already observe how changes in the climate system, such as heavier summer precipitations and higher average temperatures, influence the physical and biological processes in the soil,” she says. Because the upper layers are meanwhile thawing out much earlier in the year, and the vegetation phases are becoming longer. “We study the water and energy cycles in the permafrost landscape, ranging from areas in the metre scale through to larger structures in the kilometre scale,” says Boike. These results allow us to make more reliable forecasts on how the thaw in the tundra could impact the global climate in the future.
arö

THOMAS WALTER AT THE FOOT OF THE ACTIVE MERAPI VOLCANO IN CENTRAL JAVA, INDONESIA. Photo: GFZ

GFZ GeoForschungsZentrum Potsdam

PLAYING STRESS PING-PONG IN THE EARTH CRUST

Indonesia, early May 2006. The Merapi Volcano is spewing hot, grey ashes. More than 22,000 slope dwellers are evacuated, some all the way to Yogyakarta in the safe south. But exactly how safe is “the south”? The earth is also shaking here. On 27 May, an earthquake destroyed large parts of the province. Several thousand people died, probably including many of those who had earlier been evacuated. But that was not the end of it. The earthquake was directly followed by Merapi becoming more active again. Volcanologist Dr. Thomas Walter from the GFZ GeoForschungsZentrum Potsdam is trying to find out whether the two events are inter-related. In autumn 2005, he took charge of a Young Investigators Group on volcano tectonics, one of the few research teams worldwide to preoccupy themselves with the ping-pong game between magma mass changes and the movement of crustal rock. The scientists want to understand the disaster in two respects. “We’re checking whether and how volcanic eruptions and earthquakes influence each other and what mechanisms play a role.”
The two natural events mostly become simultaneously active in areas where the tectonic plates meet, move away from or overlay each other. Enormous stresses exist there. “To reduce these, the Earth repeatedly shakes itself back into place,” says Walter.
At the same time, the stress levels shift in the crust and the nearby magma reserves respond. “Occasionally, the two phenomena give each other a little kick.” A subterranean power struggle that fascinates Walter.
Actually, he had planned to study mineralogy, “inspired by his grandfather, a passionate collector.” Eventually, geology won the day. On an academic year in Hawaii, he discovered his penchant for volcanological research and subsequently did his doctorate at GEOMAR in Kiel with a thesis on landslides in the Canary Islands.
He was then drawn back to the United States again. At a satellite ground station run by the University of Miami, he was able to observe volcanoes from space. “Even though not that much happens on the surface, when a volcanic area lifts by just one centimetre the satellite radar can see this.”
The Emmy Noether Programme funded by the German Research Foundation (DFG) eventually took Walter to Potsdam, where he does his research today and supervises several doctoral students.

> We’re checking whether and how volcanic eruptions and earthquakes influence each other and what mechanisms play a role.

The eyes in space are still among his most important instruments. Earthquake measurements, gravity measurements, structural studies in the field, and computational modelling all serve to complement the researcher’s toolbox. Furthermore, Walter and his team simulate volcanic scenarios in lab experiments. “We only find out that something is really happening underneath our feet when several sensors start to register changes.” This great methodological breadth also convinced the Geologische Vereinigung. And so, last year, the geological society awarded the young researcher with the Hans Cloos

WALTER'S TEAM STUDIES THE SULPHUROUS OUTGASES FROM THE LASTARRIA VOLCANO IN CHILE. Photo: Walter/GFZ

ASTRID KIENDLER-SCHARR IN FRONT OF THE PLANT CHAMBERS IN WHICH SHE EXAMINES THE SUBSTANCES THAT PLANTS EMIT OR ABSORB. Photo: Forschungszentrum Jülich

Prize for internationally outstanding contributions to science. In Chile, for example, Walter's team discovered a new giant volcano that is a kind of natural laboratory. Located east of the town of Antofagasta, close to the border with Argentina,

> Even though not so much happens on the surface, when a volcanic area lifts by just one centimetre the satellite radar can clearly see this.

the ground lifts over 1000 square kilometres. "Ten years ago, no volcanic activity was known here. After several strong earthquakes, a system developed here in a short period of time that is now more active than the Yellowstone Volcano in the United States." However, Walter cannot see any acute threat or danger: although the magma is flowing quite quickly at three kilometres per year, it is currently only moving horizontally and at a depth of ten kilometres beneath the crust. In contrast to Merapi. Following last year's earthquake, it began to become really active. The volume and daily number of emissions increased in leaps and bounds. A dangerous search for the geological reasons? "The traffic presented a much greater threat than did working on the volcano."
Now the scientists want to find out whether the volcano is triggered by occasional seismic waves, the permanently transformed tensions or even completely different mechanisms. "Once we know this, we will perhaps be able at some time to improve the predictions." And the risk for people and infrastructure could decrease. CORNELIA REICHERT

Forschungszentrum Jülich

COUNTERING BIOGENIC PARTICULATES

Plant breathing generates aerosols via various intermediate steps. These aerosols are practically as small as the fine particulates produced by industrial incineration processes. In the latter case, they have been proven to be unhealthy and harmful. "By contrast, the question of how aerosols of biogenic, i.e. natural, origin are generated and affect our health, cloud formation and climate still remains largely unexplained," says Dr. Astrid Kiendler-Scharr from the Forschungszentrum Jülich, where the young scientist, who returned from Silicon Valley three years ago, is in charge of the research group on "Stable isotopes in aerosols".

> How aerosols of biogenic, i.e. natural, origin are generated and affect our health, cloud formation and climate still remains largely unexplained.

"I want to study how much fine particulate produced by natural processes actually exists," she explains. Working in the plant chambers, for example, the physicist and mother of two examines the substances that plants emit under controlled conditions and how these react with the ozone produced by car exhaust gases. She then uses the data to develop concepts on reducing environmental pollution. mf

CONCENTRATION-DEPTH PROFILES OF SELECTED SUBSTANCES IN GROUNDWATER ARE MEASURED USING A DIRECT-PUSH MACHINE. Photo: Künzelmann/UFZ

Helmholtz Centre for Environmental Research – UFZ

SECRETS OF THE SUBSURFACE

The condition of ecosystems and biodiversity also depends on the availability and quality of water. Human intervention and natural processes affect an ecosystem's water and matter cycles. For example, the quality and availability of water in river catchment areas can be changed by nutrient discharges from farming and agriculture, pollutant input from contaminated sites, and changes to the natural course of surface waters. Sustainable farming therefore needs to build on a sound knowledge and understanding of the interactions taking place in the water and matter balance of ecosystems. These interactions remain inadequately understood to this very day. Reasons for this include the fact that it is still only partly possible to reliably record matter and water fluxes. This means that it is also difficult to design sustainable land use and water management measures and to make any predictions.

To counter these challenges, the Helmholtz Centre for Environmental Research – UFZ created the research platform MOSAIC to investigate, monitor and control ecosystems. MOSAIC stands for "Model Drive Site Assessment, Information and Control", thereby expressing that it not only aims for model-based subsurface investigations but also that the data can be used to control environmental processes. By combining and developing technologies from the fields of drilling, measurement and analytical techniques, MOSAIC makes it possible to perform field-scale studies of a new quality in terms of the efficiency and speed of high-resolution investigations of complex subsurface structures.

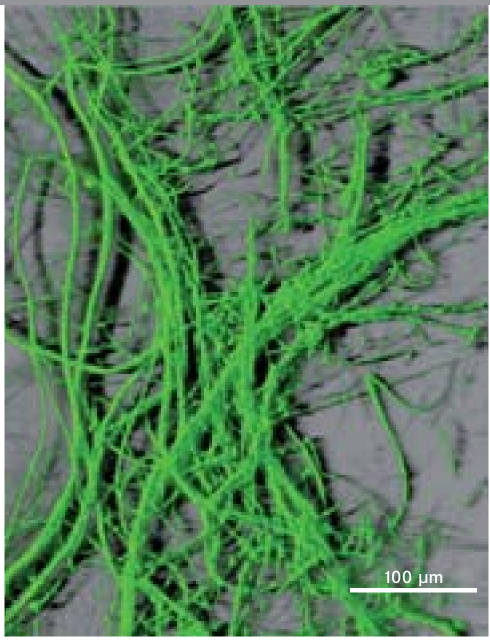
MOSAIC helps in developing methods for decision-support and process control that also meet the relevant legal frameworks. "However, it's not just about a specific technology, we also aim to intelligently combine and advance various technologies. Because each method has its advantages and disadvantages," says Dr. Ulrike Werban, a junior scientist working at the UFZ. This is why the Helmholtz researchers are also working on a combination of direct-push technologies – a comparatively new field – and geophysical methods. This novel approach raises the quality of the results and substantially accelerates the investigations. In fact, MOSAIC not only serves interdisciplinary research, but also technology transfer, for example, by putting new monitoring and exploration technologies into practice.

A UFZ pilot project is being carried out in the Jahna flood plain near Riesa, Saxony, to determine groundwater quality. Direct-push equipment is being used to measure depth profiles of concentrations of selected substances in the groundwater.

> However, it's not just about a specific technology, we also aim to intelligently combine and advance various technologies. Because each method has its advantages and disadvantages.

This enables the scientists to examine the subsurface much faster and cheaper than with conventional drilling methods. Although an extensive network of groundwater monitoring wells exists in Saxony, the new method enables a much closer look at the particular problems there. And this is necessary because the EU Water Framework Directive requires measures to be drawn up by 2009 for water bodies affected by quality problems.

RESEARCHERS COMBINE SEVERAL METHODS FOR A COMPREHENSIVE AND COST-EFFECTIVE EXPLORATION.
Photo: Künzelmann/UFZ



LASER SCANNING MICROSCOPY IMAGE OF THE FUSARIUM OXYSPORUM MYCELIUM.
Photo: Dr. Neu/UFZ

The pilot project is only one of many applications. Regardless of whether it's dealing with volatile hydrocarbons near Vienna or of precisely localising a benzene plume beneath a former refinery plant, the direct-push technology has proven itself in various UFZ campaigns over recent months. But the technology also opens up completely new opportunities for biologists and soil scientists for examining dykes, including flood protection measures. So, the researchers meanwhile spend a lot of time on the road with their equipment, so as to fill in the remaining white areas on the maps of the subsurface.

> The new method enables a much closer look at the particular problems there. And this is necessary because the EU Water Framework Directive requires measures to be drawn up by 2009 for water bodies affected by quality problems.

DR. CARSTEN LEVEN-PFISTER I DR. PETER DIETRICH

Helmholtz Centre for Environmental Research – UFZ

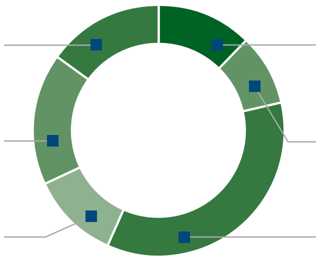
TAKING A FUNGAL TRIP THROUGH THE SOIL

The rehabilitation of polluted soils often relies on the help of bacteria. However, this requires that micro-organisms are indeed able to reach the irregularly spread contaminations in the soil. Even mobile bacteria often fail when they come across obstacles. In contrast to bacteria, however, soil-based fungi with their extensive and up to 100 metres per gramme long hyphae can easily travel through the soil and so pave the way for the bacteria. Environmental microbiologists from the Helmholtz Centre for Environmental Research – UFZ have shown in lab trials that this mycelium – much like a highway network – can transport the pollutant-degrading soil-based bacteria and so improve their access to the pollutants in the soil. The same applies to mycorrhiza fungi which replace the root hairs of trees in a kind of symbiotic association, through which they are fed with photosynthetic products. Sunlight then indirectly serves as an energy source for transporting the bacteria. The new findings help accelerate pollutant degradation in the soil and so rehabilitate contaminated areas more quickly. The "fungal highway" is then perhaps not only the world's largest, but also the only one that helps return nature back to her original state.

DR. LUKAS Y. WICK

Structure of the Research Field Earth and Environment
Core-financed Costs 2006: 227m euros

The Research Field Earth and Environment additionally receives 68m euros, for a total budget of 296m euros.



THE PROGRAMMES

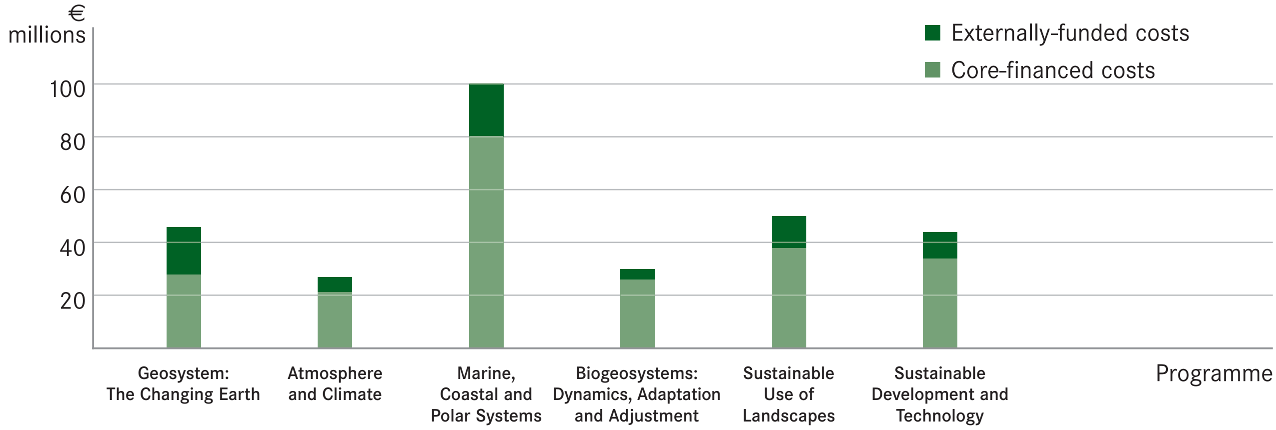
Geosystem: The Changing Earth
This programme focuses on analysing the physical and chemical processes taking place within System Earth and how geosphere, atmosphere, hydrosphere and biosphere interact. Scientists study and model the relevant geoprocesses so as to assess the state of System Earth and to identify changing trends. They do this by building a global observation infrastructure and by exploring the inner Earth. Near Earth satellites, airborne recording systems, an Earth-embracing network of geophysical and geodetic stations, mobile instrument arrays plus the analytical and experimental infrastructure at the participating research centres merge to form an observation system which is itself integrated into national and international collaborative structures. Besides studying Earth's magnetic and gravity fields, the key research topics are natural resources and material cycles, climate variability and the human environment, plus prevention of and forward-planning strategies for natural disasters, and the use of subterranean space, for example, for storing carbon dioxide.

Atmosphere and Climate
The atmosphere is the key determinant of environmental conditions on Earth. Research in this programme analyses the atmosphere's state and changes, as well as the complex interactions taking place within the atmosphere and with adjacent spheres. The scientists also study how human activities impact the chemical composition of the atmosphere and, consequently, the climate. To enable them to predict global and regional climate changes, the participating scientists not only analyse chemical and microphysical processes but also feedback mechanisms. Major experiments, such as an international field campaign on atmosphere research, are currently being carried out. Earth observation satellites, such as ENVISAT, deliver informative data. Through this work, the Atmosphere and Climate programme contributes substantially to the topics of "Climate variability and climate change" and "Water – cycle and availability".

Marine, Coastal and Polar Systems
The biological and geological nature of global marine systems and coastal regions is the object of research conducted in this programme. Special emphasis attaches to studying polar regions. The processes and interactions taking place within these systems are particularly decisive for the global climate. The research efforts concentrate on acute changes in key regions, such as permafrost areas, and on global changes that can be deduced from studying natural archives, such as the ocean floor or polar ice. The programme's main objective is to create a model system to help predict developments. This model aims to simultaneously depict firstly how the cryosphere, the oceans and the marine biological and geological chemospheres influence climate and biodiversity and, secondly, how energy and materials flow in the various space and time scales. Taking this model system as a starting point, scenarios can be developed for the management and sustainable use of the marine environment, and especially of coastal regions.

Biogeosystems: Dynamics, Adaptation and Adjustment
This programme investigates how biogeosystems (for example, agricultural regions or managed forests) respond to human intervention and environmental change. The researchers do this by studying elementary components like soils, microor-

Total Costs: Research Field Earth and Environment



ganisms, flora and groundwater and how these interact. In their work, the scientists identify the critical factors and analyse reaction mechanisms and patterns. This makes the early recognition of negative developments in biogeosystems possible and so provides the chance to develop methods to counteract them. This research programme is responsible for contributing to the protection and sustainable use of biogeosystems.

Sustainable Use of Landscapes

Many landscapes have been affected by human use. This research programme has been commissioned to study the effects and consequences. The areas studied differ greatly, ranging from urban, densely settled and intensively used areas via contaminated former opencast mining areas through to semi-natural areas that are only used for extensive, i.e. non-intensive cultivation. This produces a broad range of research topics extending from basic research on biodiversity and ecological stability through to questions of resource management, and, particularly, in this respect, water cycles and water treatment. In addition, the scientists examine how climate change will affect land usage. These studies also take socio-economic and legal questions into consideration.

Sustainable Development and Technology

The grand challenges of environmental research, such as “sustainable use of resources”, “water – availability and dynamics”, and the “socio-political dimension of global change” can only be mastered with new technologies. This research programme develops technologies that are able to make anthropogenic material flows, such as water, carbon, wastes, and building materials manageable, are able to conserve resources, to reduce emissions, and to facilitate the regeneration of natural resources. The combination of socio-economic systems research with technology impact assessment and cooperation with other research fields and programmes makes it possible to offer integrated strategies for sustainable development. The Sustainable Development and Technology programme centralises the conceptional and systems-analytical activities of the Helmholtz Association so that the guiding principle of sustainable development is able to provide a practicable basis for all stakeholders.

RESEARCH FIELD HEALTH

PROF. DR. OTMAR D. WIESTLER
Helmholtz Vice-President representing the Research Field Health, German Cancer Research Center

"If we want to make real advances in the treatment of the major common diseases, we have to resolutely transfer our excellent basic research into clinical applications."

GOALS AND ROLES

Health research faces major challenges. Despite enormous progress in science and research, only one third of all human diseases can be treated at cause, and are therefore curable. This is why the Research Field Health wants to understand the causes of complex diseases and to develop new prevention, diagnosis and therapy strategies. When setting its priorities, the research field additionally takes account of the fact that the range of diseases is shifting as a result of changing life-styles and an aging population.
Work in the Research Field Heath focuses particularly on frequently diagnosed, severe illnesses, such as cardiovascular diseases or cancer. Efficiently transferring basic research findings, particularly by interlinking research and clinic ever more closely, remains a key health research objective within the Helmholtz Association and spans all programmes. The goal is to work closely with clinics and partners from industry in order to transfer research findings into practical application. This is why the Berlin-Brandenburg Centre for Regenerative Therapies (BCRT) was opened last November as a joint venture with the Charité. The new centre unites 23 institutions, including the Helmholtz Association members Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch and GKSS Research Centre Geesthacht. Physicians and scientists involved in basic research work hand-in-hand on developing methods for stimulating and using the body's own regenerative capacities. This involves, inter alia, therapies based on engineered tissue and cell aggregations, for example, using immune cells and also stem cell research and biomaterials research. Cellular therapies are already being used with success in cases of major cartilage damage, severe viral and cancer diseases. Future fields of application are thought to include cardiac insufficiency, liver failure, cerebral apoplexy, more commonly known as stroke, as well as bone defects and immune diseases.
The German Cancer Research Center, supported by the charity German Cancer Aid (Deutsche Krebshilfe), and in cooperation with the University Hospital and the Thorax Clinic in Heidelberg, is establishing the National Center for Tumour Diseases in Heidelberg. Basic and clinical researchers work hand-in-hand at this translational centre. The GSF – National Research Center for Environment and Health in Munich plans to establish a translational centre together with the Ludwig Maximilian University Munich and a clinic operator that will concentrate particularly on lung and respiratory diseases. The Helmholtz Centre GSF will introduce its unique combination of environmental and health research into the translational centre. Furthermore, a facility is being established at the Helmholtz Centre for Infection Research, in cooperation with the Hannover Medical School (MHH), dedicated to combining basic research with clinical application in order to develop new vaccines.

PROGRAMME STRUCTURE

Ten Helmholtz Centres cooperate in the Research Field Health. These include the Helmholtz Centre for Infection Research, the German Cancer Research Center, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the GKSS Research Centre Geesthacht, the GSF – National Research Center for Environment and Health, the Gesellschaft für Schwerionenforschung, the Hahn-Meitner-Institut Berlin and the Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch plus the Helmholtz Centre for Environmental Research – UFZ. The scientists and researchers are working on six programmes:

- Cancer Research
- Cardiovascular and Metabolic Disease Research
- Function and Dysfunction of the Nervous System
- Infection and Immunity
- Environmental Health
- Comparative Genome Research
- Still under establishment: Regenerative Medicine

ANA MARTIN-VILLALBA HAS ALREADY RECEIVED NUMEROUS AWARDS FOR HER GROUNDBREAKING RESEARCH ON NERVE CELLS. Photo: de Andres/Helmholtz

PROJECTS

German Cancer Research Center

THE SELF-HEALING HIGHWAY

Wounds heal, but not severed nerve cords. This dogma no longer applies, now that neuroscientists have discovered and released the molecular brakes of nerve regeneration.

A highway that links up brain and body – is how Dr. Ana Martin-Villalba (35), neuroscientist at the German Cancer Research Center, describes the spinal cord. It's a fitting image, because, until recently, neurobiologists believed that just as a breach in a highway does not sometime mend on its own, it was just as unlikely for a spinal cord to be able to regenerate itself following an injury. Three years ago, however, Martin-Villalba managed to get the ends of the highway to grow towards each other as if by magic, albeit only in a lab mouse: the severed spinal cord nerves of laboratory mice grew together so well that the paraplegic mice were able to walk and even swim again.

The trick used by the Spanish-born scientist was to stop a process that actually performs valuable work in the event of an injury. Because so much "debris" lies around after a spinal cord injury: broken cells, scar tissue, and loads of inhibitors and signalling cues that "clear up" the accident site by making the displaced cells commit suicide. It would seem that CD95-L is a particularly hard-working member of the clean-up team. The signal molecule also causes the nerve cells to die and so prevents regeneration. As soon as CD95-L contacts the cell surface, the internal DNA starts to dissolve and the cell dies. Unfortunately, this also applies to nerve cells.

It seemed only logical to hypothesise that intercepting the CD95-L could have a positive effect on the regenerative ability of the nerve cells. And after four weeks of treatment with an antibody against the CD95 ligands, Martin-Villalba's mice did indeed start walking again.

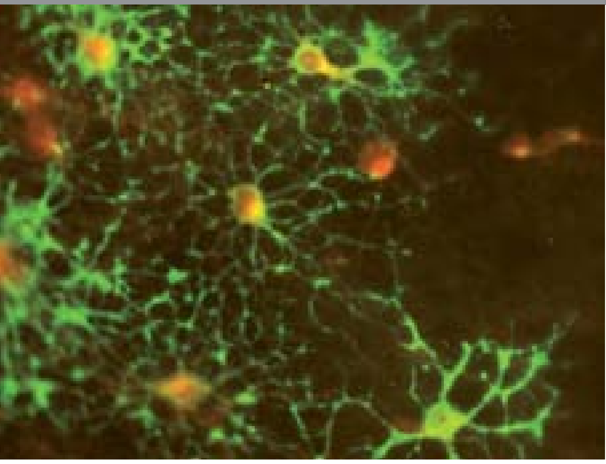
A eureka moment that only few researchers get to experience. "But such moments are always short-lived, because the real work starts from then," she says. Meanwhile, Martin-Villalba is also thinking well beyond CD95-L. Because if paraplegic patients are to be healed, then it's not enough just to inhibit this cue, that's for sure: Chondroitinase is needed, for example, to make the scar tissue permeable again, so that the nerve cells can

> It's not enough just to inhibit a cue, a whole cocktail of substances is always needed to enable nerve cells to grow again.

grow through the tissue. Nogo/Ng-R66 blocks the inhibitors released by the destroyed nerve fibres. And nanomaterials could create a kind of basis for the regenerating nerve cell to attach itself to. And then there are agents that regulate the inflammatory reaction or accelerate the regenerative ability of nerve cells, such as cAMP or ROK inhibitors. Eventually, this could mean that patients get a kind of cocktail of these substances, says Martin-Villalba.

"However, we first have to learn much more about the pathophysiology of spinal cord injuries and about how the various components interact."

Martin-Villalba is aware of how closely her work is being followed by paraplegic, stroke or brain tumour patients. And she repeatedly gets letters asking for help. "That's a very difficult



OLIGODENDROCYTES MADE VISIBLE WITH FLUORESCENT COLOURING SURROUND THE NERVE CELLS IN THE SPINAL CORD WITH A PROTECTIVE COVERING. Photo: Martin-Villalba/DKFZ

3D IMAGE OF THE BLOOD VESSELS IN A PIG KIDNEY USING CONTRAST-ENHANCED COMPUTER TOMOGRAPHY. Photo: Kießling/DKFZ/Hallscheid/University of Heidelberg

part of my work, because these questions repeatedly make it clear to me how far away we still are from actually being able to help all these patients," sighs Martin-Villalba. "I truly wish that I could open up options for a treatment. But right now, we are still at the level of basic research." Nevertheless, the

> We're still a long way from being able to really help patients, because we're still doing pure basic research.

medical scientist advises Apogenix GmbH, a biotech company that plans to carry forward the CD95 research through to therapeutic application. "I hope that we manage to achieve this one day..." SASCHA KARBERG

German Cancer Research Center

CANCER IN HIGH RESOLUTION

Knowing more means being able to heal better. The work done by Dr. Fabian Kießling, who is researching and advancing molecular imaging methods at the Department of Medical Physics at the German Cancer Research Center, also plays its part here. The 34-year-old medical scientist has improved computer tomography to such an extent that doctors are even able to recognise hair-sized blood vessels in a tumour that are thinner than one tenth of a millimetre. This now enables medical scientists to precisely check whether treatments that cut the tumour off from the bloodstream are successful.

Such high-resolution images make it possible "to respond quickly and to adjust the therapy, if necessary," says Kießling. But the researchers at the German Cancer Research Center will also be able to study more precisely how a tumour develops and links up with the bloodstream.

To get even better images, Kießling not only optimises techniques such as magnetic resonance imaging, ultrasonic imaging or computer tomography, but also the contrasting agents that are injected into the patient to make the tissue visible – thereby cooperating with companies like Siemens, Merck, Pfizer, Bayer-Schering, Ferropharm or Bracco. skar

FRANK ROSENBAUER (STANDING) IS STUDYING THE ROLE THAT GENETIC SWITCHES PLAY IN THE DEVELOPMENT OF LEUKAEMIA. Photo: Ausserhofer/Helmholtz

Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

GENETIC RESEARCH TRACKING DOWN LEUKAEMIA

Life for most white blood cells ends after 8 to 12 days. By this time, they have finished all their tasks and are broken down again. Red blood cells and thrombocytes or platelets also have a limited lifespan. This is why blood stem cells in the bone marrow have to constantly produce new precursor cells from which the various blood cell lines develop. If cell production gets out of synch, the immature cells continue to grow uncontrolled and leukaemia develops. Dr. Frank Rosenbauer of the Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch is studying the genetic regulation of blood cell development and why these regulating programmes sometimes derail.

> The goal is to reverse the immature cancer cells so that they stop their uncontrolled growth.

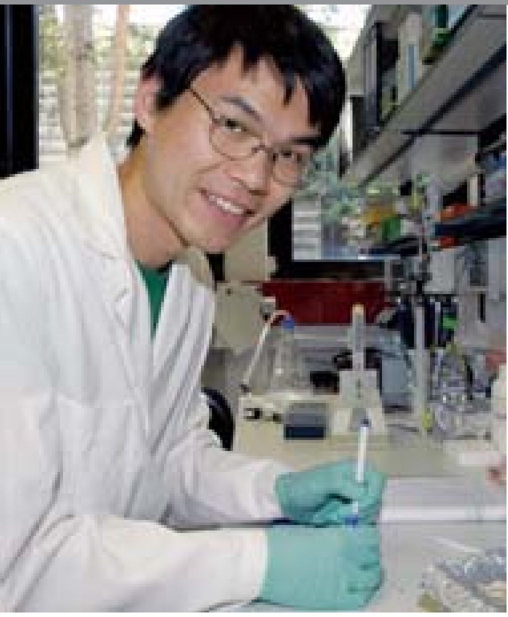
"Researchers are currently aware of around 20 genetic switches that regulate the development of the various blood cells," explains the young biologist. Previously, Rosenbauer had succeeded in identifying one of the key switches for the genetic regulator PU.1. There, he showed that the super switch URE does not simply turn the genetic switch PU.1 on or off, but rather regulates it very precisely. As a result, certain precursor cells then develop into the two major blood cell lines of B- and T-cells. However, if the URE is missing, leukaemia develops. This may also be the case with the gene IRF8. In healthy people, IRF8 triggers the cell's defence programme which makes defective cells commit suicide. In 80 per cent of the patients suffering from acute or chronic leukaemia, this gene is deregulated. Why this happens is still unclear. Rosenbauer and his staff want to find out how the gene can be turned on again in order to reactive the cell's defence programme.

"DNA methylation", which modifies DNA by attaching methyl groups, also has an impact on the renewal and maturation of the blood cells. "This is currently one of the hot topics in stem cell research," says Rosenbauer. Using mice, he is studying the role played by this chemical process in the formation of cancer stem cells. In some diseases of the haemopoitec (blood-building) system, sections of the DNA are "deactivated" by the methyl groups. "However, there are reagents that cancel out this DNA methylation and these are already being tested on some cancer patients. The goal is to reverse the immature cancer cells so that they mature and stop their uncontrolled growth."

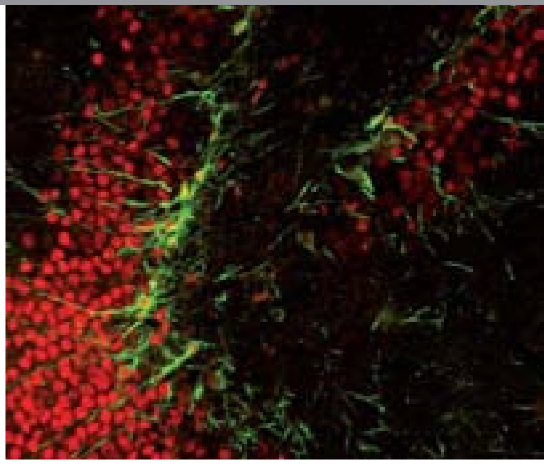
Frank Rosenbauer also wants to explain how exactly the development of the various blood lines from blood stem cells is regulated. "Blood stem cells themselves initially produce macrophages," he explains. Macrophages (literally "big eaters") are defensive cells that disintegrate the pathogens. "In order to produce B- or T-cells, however, the genes that cause the stem cells to produce macrophages first have to be switched off. Only then do the genes that are responsible for ensuring that the blood stem cells develop into B- or T-cells switch themselves on. We want to find out whether the genes are already switched off in the stem cells or only in the precursor cells."

This is based on the hypothesis that cancer is already programmed in the stem cells. Should this prove to be the case, it could also have consequences for cancer therapy.

BARBARA BACHTLER



DIETER CHICHUNG LIE WORKS WITH MOUSE STEM CELLS TO GAIN A BETTER UNDERSTANDING OF NEURODEGENERATIVE DISEASES LIKE PARKINSON'S DISEASE. Photo: GSF



DETECTION OF NEWBORN CELLS IN THE ADULT MOUSE BRAIN: NEWLY-FORMED NERVE CELLS IN A MOUSE HIPPOCAMPUS SHOWN IN GREEN. Photo: Lie/GSF

GSF – National Research Center for Environment and Health

SIGNALS FOR REGENERATION

It begins almost imperceptibly, initially with unspecific symptoms. Many of those affected have bouts of depression and withdraw from their friends. When their physical mobility is later impeded, demonstrated for example by their handwriting, this is indeed an indication of Parkinson's Disease. The symptoms occur because certain neurons in the brain die off. These cells produce the neurotransmitter dopamine, which is responsible for controlling motor skills. When the first signs of the disease become noticeable, 50 to 60 per cent of these cells will already have died. And this loss continues, resulting in the patients becoming even less mobile.

> Our long-term goal is to influence stem cells in the brain in such a way that they replace dopamine-producing cells.

"Our long-term goal is to influence stem cells in the brain in such a way that they replace the dopamine-producing cells," says Dr. Dieter Chichung Lie from the GSF-National Research Centre for Environment and Health in Munich. The neuroscientist's research team has already been able to show that stem cells exist in the affected part of the brain, the so-called substantia nigra. Even in adults, these cells are still capable of dividing and forming various kinds of nerve cells. Up to the 1990s, it had, by contrast, been assumed that this was only possible during embryonic development and shortly after birth. However, the stem cells identified by Lie's group only form certain types of brain cells. These are unable to balance out the lack of dopamine in the affected brain region. In experiments with stem cell cultures, the researchers succeeded in influencing the cells' development to such an extent that they at least showed some characteristics of dopamine-producing cells.

Lie's main interest is in the question of what signals instruct the stem cells in the brain to form new neurons or to continue to remain dormant. With his Young Investigators Group he is studying how a certain family of proteins called "Wnt" control stem cells in the adult brain. Their recent results suggest that the Wnt proteins both keep stem cells dormant and provide the signal for them to mature. The important question is now to understand how Wnt proteins can influence such opposing processes.

In the organism, signals for rest and maturation have to be closely coordinated. The function of the hippocampus, a brain structure with a central role in learning and memory formation, seems to depend on the generation of new neurons from stem cells. For example, if the number of new neurons is low this can negatively affect learning and memory performance. If, on the other hand, too many stem cells develop, the reserves are exhausted too quickly. In addition, stronger cell division could also result in tumours developing.

The balance between rest and generation of new neurons from stem cells may also be crucial for the treatment of diseases like Parkinson's or Alzheimer's that involve the loss of brain cells. The possibility of getting the existing stem cells to replace the damaged neurons would be a starting point for a new therapy against these presently incurable diseases.

PATRICK EICKEMEIER

WORKING IN THE LAB LIKE A DETECTIVE, DIRK MENCHE HAS RETRACED THE SYNTHETIC PATHWAY OF AN EFFECTIVE, NATURAL ANTIBIOTIC. Photo: HZI

Helmholtz Centre for Infection Research

BEATING RESISTANT BACTERIA WITH THE CHEMICAL MACE

Antibiotics help doctors treat many of the old infectious diseases to which humans are susceptible. However, bacteria have developed a resistance to the old weapons. Researchers at the Helmholtz Centre for Infection Research in Braunschweig are now developing new ones.

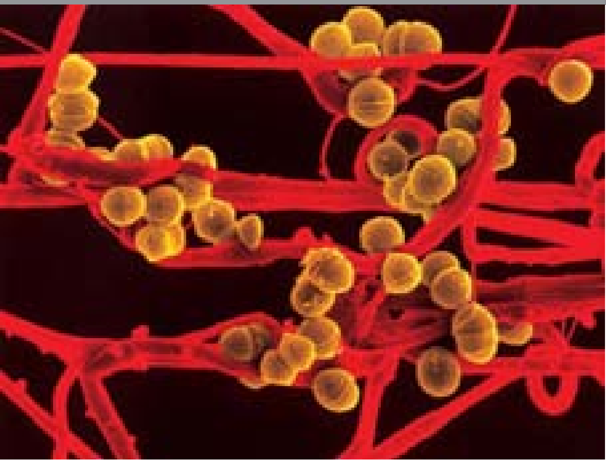
Around three million people in Europe infect themselves every year with resistant germs against which conventional antibiotics like penicillin are powerless. Some 50,000 of these patients die as a result. The fault often lies in the careless use of antibiotics. In countries like Italy, antibiotics can be obtained from the chemist's, without a prescription. This is why the germs are constantly under selective pressure. If, out of ignorance, the patient does not take the full course of treatment down to the very last tablet, there is a greater probability of resistant germs forming and spreading. As a consequence, in Italy, almost half of the examined infections with *streptococcus pneumoniae* can no longer be treated with penicillin. And even in Germany, this already applies to some six per cent of infections.

In the coming few years, doctors will increasingly stand helpless at the sickbeds, if new antibiotics are not developed quickly – such as archazolid, for example. Dr. Dirk Menche from the Helmholtz Centre for Infection Research in Braunschweig is now transferring the substance obtained from the myxobacterium *archangium gephyra* to the field of application, because the Young Investigators Group Leader was able to reproduce the antibiotic in the lab. "To date, this is the first and only synthetic pathway," says the chemical scientist with pride, although he did not know for a long time whether the synthetic approach would really succeed as he hoped. Because the complicated molecule is made up of a multiple unsaturated polyketide-macrolactone, a thiazol side chain and eight stereocentres – eight semi-rings with additions. The synthesis is particularly important because the three-dimensional shape of the archazolid is now known.

> The synthetic pathway is still too long for industrial production, but we have nevertheless received the first informal inquiries.

This is one of the prerequisites for carrying forward this type of antibiotic and for gaining a better understanding of the effects and mechanisms of drug action. So, Menche examines how the shape of the molecule influences its function. This is why he combines structural analysis methods, such as nuclear magnetic resonance (NMR) imaging, with chemical analysis and synthetic methods.

However, the synthetic pathway is still too long for industrial production. "Nevertheless, the first informal inquiries have been received from pharmaceuticals companies," says Menche. For archazolid is one of the "most potent and most selective" inhibitors of certain transport proteins, the so-called V-ATpases. These normally supply all kinds of transport processes with energy, through the cell membranes. If they don't work properly, illnesses like osteoporosis, renal acidosis, and even cancer can arise. Because archazolids inhibit the V-ATpases, even



ELECTRON MICROSCOPE IMAGE OF A STREPTOCOCCI CULTURE THAT OFTEN DEVELOPS MULTIPLE RESISTANCES. Photo: HZI

IGOR TETKO LETS THE COMPUTER SIMULATE HOW THE ACTIVE AGENTS ACT IN THE BODY. Photo: GSF

low concentrations can prevent growth and division of a whole series of cell types. Menche's research team is now working on simplified but equally potent archazolid variants. "One part of the molecule's side chain is not needed for the biological function and can be omitted," he reports.

> Due to our experience with archazolid, we have already been able to develop the first simplified and more stable etnangien variants and have already filed a patent registration for a highly-promising compound.

Conveniently, Menche's arduously developed synthetic pathway can also be used for other antibiotics. These include, for example, etnangien, which inhibits bacterial RNA polymerase, which is of vital importance to the survival of microbes. Although a drug already exists that combats this RNA polymerase, the bacteria have often become resistant to it – but not to etnangien, says Menche: "Due to our experience with archazolid, we have already been able to develop the first simplified and more stable etnangien variants and have already filed a patent registration for a highly-promising compound."

SASCHA KARBERG

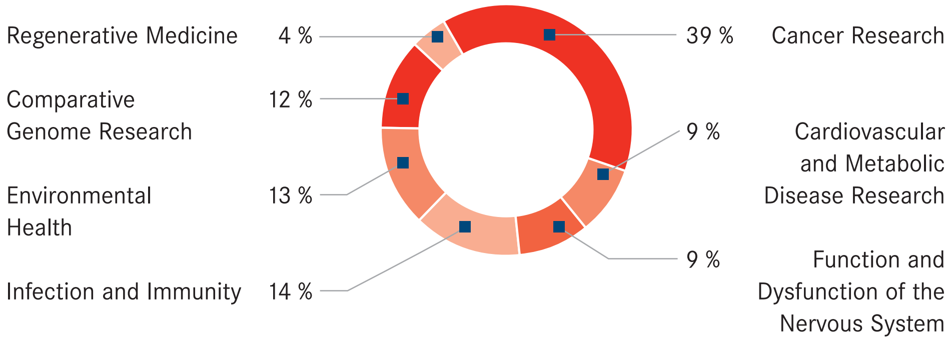
GSF – National Research Center for Environment and Health

PUTTING PILLS TO THE TEST

In the search for new agents, drugs manufacturers today spend about twice as much as they did just ten years ago. But this has not resulted in many more drugs being approved each year. Often the candidate agents fail the expensive clinical studies. In order to avoid such failures, companies are trying in advance to select the most promising candidates from the enormous number of possible agents. But how can they be found? Of course, it's not possible to experimentally check up to 10^{24} various molecules (that is billions times billions of molecules). "But it can be done with the help of computers," says Dr. Igor Tetko from the GSF – National Research Center for Environment and Health in Munich. The bioinformatician develops programmes that simulate the specific chemical and biological properties of a molecule on the basis of its descriptors. With the help of these models it is possible to predict whether a substance is absorbed and distributed by the body and whether it is possibly toxic. This can spare drugs manufacturers from unpleasant surprises when testing new drugs and agents in clinics. pei

Structure of the Research Field Health
Core-financed Costs 2006: 203m euros

The Research Field Health additionally receives 84m euros, for a total budget of 287m euros.



THE PROGRAMMES

Cancer Research

Cancer is a particularly severe and complex disease, often associated with a long-drawn-out course and with serious psycho-social consequences for patients and relatives. In Germany, around 425,000 people are diagnosed with cancer each year, with more than half dying of the disease. Treating cancer is also very expensive. The research aims to significantly improve cancer prevention, early recognition, diagnosis and treatment. To this end, researchers analyse the signalling pathways of tumour cells, explore the genetic roots of the disease and identify risk factors that lead to cancer. One of the programme's focuses addresses the development and application of innovative diagnostic and therapeutic methods based on molecular, cell biological, histological and radiophysical techniques. Other key research areas aim to explain the role of the immune system in cancer and to study cancer-relevant viruses.

Cardiovascular and Metabolic Disease Research

Cardiovascular diseases are the most frequent cause of death in western industrialised nations. Major risk factors are high blood pressure, diabetes and obesity. These are among the most common and widespread diseases and are responsible for massive expenditure within the public health system. To stem the incidence of these diseases in the long-term, scientists study the causes of vascular diseases and high blood pressure, of heart and kidney disease, and of metabolic diseases, such as diabetes and adiposity. In addition, they develop new ways of preventing, diagnosing and treating such illnesses. To achieve their goals, researchers use various methodological approaches based on genetics, genomics and bioinformatics, cell biology, and epidemiology.

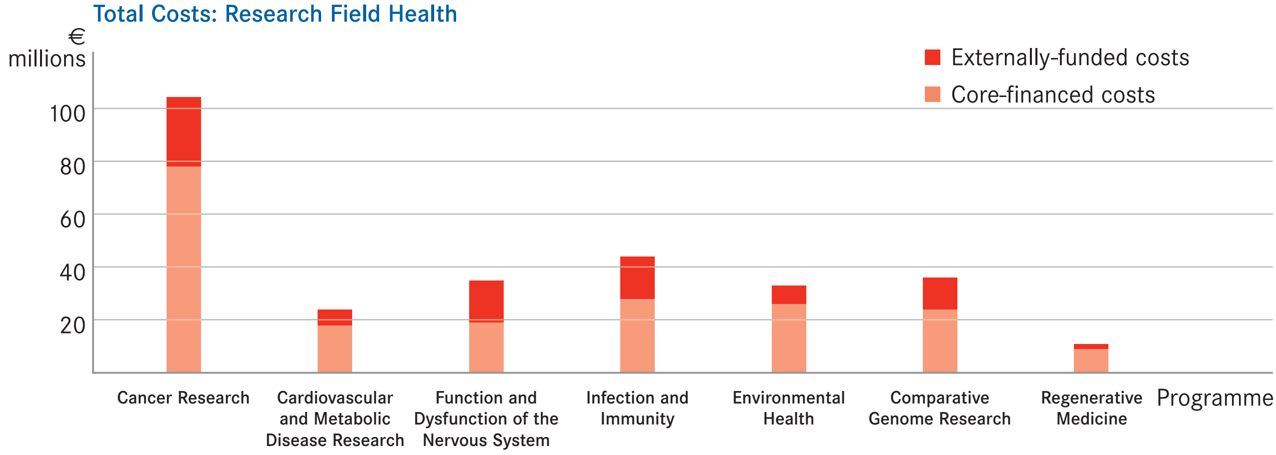
Function and Dysfunction of the Nervous System

As human life expectancy increases, neurological and psychiatric illnesses start to play an ever more important role. Neurosciences research at the Helmholtz Association contributes to extending our knowledge of the causes of these diseases by performing basic research. The research concentrates on degenerative diseases of the motor neuron system, such as Parkinson's, the retina, and diseases of the brain in general, such as Alzheimer's, epilepsy or cognitive function disorders resulting from strokes or brain tumours. To analyse the relevant mechanisms, it is necessary to look closely and specifically at the individual signal-transmitting molecules and cells and, sometimes to examine the neural system as a whole. The scientists use large-scale facilities to analyse normal and pathologically transformed mechanisms in the living human brain and apply cutting edge techniques from genomic research and cell biology.

Infection and Immunity

More than 17 million people die of infectious diseases every year – that is one third of all deaths worldwide. In view of the growing threat posed by such diseases, the research seeks to understand the fundamental mechanisms of infection and immunity. Researchers study the causes of pathogenic organisms and analyse the development of immunity in order to gain more knowledge about the molecular and cellular processes occurring in the course of an infection. Parallel to this, they analyse the fundamental mechanisms used by hosts to prevent or control infections. Based on these findings, they are able to draw up new strategies for combating infectious diseases and also develop immune-therapy based

Total Costs: Research Field Health



strategies for treating other chronic diseases, such as auto-immune disorders and cancer.

Environmental Health

Human health depends on complex states of equilibrium which, on the one hand, can be genetically determined and, on the other, can be influenced by the environment. How strongly do environmental factors affect human health? What molecular and cellular mechanisms underlie these disorders? What new preventative and therapeutic strategies can we derive from this? Answering questions like these is the key goal of the research done in this programme. The work focuses on common diseases, such as inflammations of the respiratory tract, allergies and cancer, whose formation is significantly influenced by environmental toxic agents, such as particulate airborne pollutants (aerosols), chemicals and ionising radiation. The scientists take two approaches. Firstly, they look at the toxic agent to identify it and to understand its disease-triggering mechanism so that they can develop risk assessment and risk reduction strategies. Secondly, they consider the diseases themselves and study their developmental mechanisms to find out what kind of role environmental factors play in all this.

Comparative Genome Research

Understanding health and illness at cellular level is the key task performed by comparative genome research. To explain the molecular causes of diseases, scientists initially sequence the genomes of model systems, such as the mouse, and transfer their findings to analogous mechanisms in the human genome. The results are collected and analysed in databases. Proteome research complements the knowledge acquired on the genetic components of diseases by contributing information on gene products, the proteins, and on their intercellular, disease-relevant interactions. Scientists from this programme contribute significantly to the National Human Genome Research Network.

Regenerative Medicine

Growing life expectancy in industrialised countries results in the incidence of age-typical diseases associated with functional disorders or failure of cells, tissues or organs increasing. This is why therapeutic methods developed by the field of regenerative medicine are becoming ever more important. Helmholtz scientists are developing materials, methods and systems for the field of regenerative medicine that can be used in tissue engineering and organ replacement systems. The goal is to get the closest possible insight into the role played by the natural models and to support or even replace diseased organs. Furthermore, researchers are attempting to improve the interface between technology and organism, for instance, through neural coupling.

RESEARCH FIELD KEY TECHNOLOGIES

PROF. DR. ACHIM BACHEM
Helmholtz Vice-President representing the Research Field Key Technologies, Forschungszentrum Jülich

"In a modern industrial society like Germany, jobs and prosperity depend on continuous innovation. This is why researching the scientific principles and foundations of future key technologies are absolutely indispensable for our long-term sustainability."

GOALS AND ROLES

The Helmholtz Research Field explores key technologies that open up new fields of engineering and offer great innovative potential for science, industry and society. In this research field, scientists from the Helmholtz Association concentrate on technologies that are particularly complex, that promise to develop new methods and solutions for other research fields, or that are of particular interest for industrial application. This includes, in particular, nanotechnology, microsystems technology, advanced engineering materials and scientific computing. Promising technologies initially undergo fundamental and multidisciplinary examination. Where major potential for applications emerges, the research is continuously deepened until the technology's suitability for concrete fields of application is known. The exploration of key technologies builds on a broad scientific basis that is then resolutely fostered and cultivated. This is done to prevent attention focusing too early on just a few potential applications, through which other opportunities might be overlooked.
The work performed by the research field continues to include assessing new technologies on behalf of society to identify their inherent opportunities and risks.

PROGRAMME STRUCTURE

Three Helmholtz Centres collaborate in the Research Field Key Technologies: the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, and the GKSS Research Centre Geesthacht. The research field plays a horizontal, cross-disciplinary role by placing high-performance computing capacities at the disposal of internal and external users. Within the Helmholtz Association, the Research Field Key Technologies is responsible for the materials research. This research is conducted in various Helmholtz research fields, with each field addressing specific aspects in accordance with its problem-solving competence. The scientists perform their research in four programmes:

- Scientific Computing
- Information Technology with Nanoelectronic Systems
- Nano and Microsystems
- Advanced Engineering Materials

Characteristic features include close cooperation with industry and coordinating networks that interlink research institutes and companies. The research field unites the shared interests of science and industry so that they can act in concert within the European Union and on the international stage. Our staff are the first point of contact for companies and associations, and advise political decision-makers on the risks and opportunities associated with new technologies. Wherever existing competencies complement each other, they are used for cross-programme cooperation. A typical example is provided by molecular electronics, located at the interface between information technology and nanotechnology. Other Helmholtz research fields, such as Energy, Transport and Space, Health, and Earth and Environment, also benefit from the work done by and on Key Technologies.

STEFAN LINDEN PRODUCES MICROSTRUCTURES WITH UNUSUAL OPTICAL PROPERTIES. Photo: Forschungszentrum Karlsruhe

PROJECTS

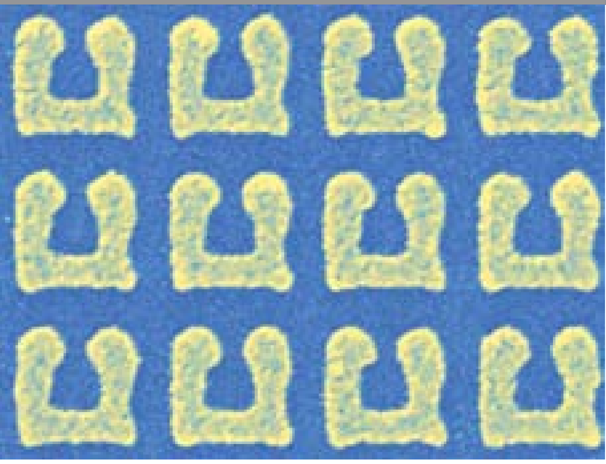
Forschungszentrum Karlsruhe

NEW OPTICS WITH ARTIFICIAL ATOMS

If anyone, dwarf Mime from the Nibelungen saga used to be the only one to know how to forge a cloak of invisibility. Magical fabrics like these would have had to be able to steer light around the object and so refract light in exactly the opposite direction to what conventional materials do. And to do this, "invisible materials" would have had to respond to both the magnetic and the electrical fields of the radiated light waves. Such materials do not exist in nature, but a start has been made in the lab: Dr. Stefan Linden from the Institute of Nanotechnology at the Research Center Karlsruhe researches metamaterials with unusual optical properties. He does this by building structures made of artificial "atoms" that look much like horseshoes or intricate nets under the electron microscope.

> These "artificial atoms" affect light like tiny electromagnetic oscillating circuits.

Linden started as a postdoc under Prof. Dr. Martin Wegener of the University of Karlsruhe (TH). He wanted to try out what the theoretician Costa Soukoulis of Iowa State University had proposed, namely to use tiny electromagnetic oscillating circuits to manipulate light in such a way that the effective refractive index becomes negative. This had already worked using microwaves whose wavelengths lie in the centimetre range. To use this effect for much shorter light wavelengths as well, Linden had to generate oscillating circuit structures on a substrate that repeat once every few hundred nanometres. "I had already gained some experience with electron beam lithography, which was no problem – and later I was astonished to find that no-one had done this before us," remembers Linden. He still collaborates closely with Wegener, but meanwhile, as the leader of a Helmholtz-University Young Investigators Group, with three doctoral students and three Diplom students.
A polymer film is first applied to a glass substrate into which the "artificial atoms" are inscribed with an electron beam. After developing these, layers of gold or silver and magnesium fluoride are deposited. These "artificial atoms" affect the light like tiny electromagnetic oscillating circuits. The light stimulates them and reradiates an electromagnetic wave, after a time-lapse. This can lead to a very strange phenomenon. When a light pulse passes through the sample, physicists observe that the maximum of the passing pulse appears behind the sample before the peak of the entering pulse has reached the front. "The pulse deforms in the sample itself, because the various wavelengths pass through the material at different speeds. At the same time, the passing pulse is still causally connected to the entering pulse," explains Linden. The negative refraction effect is still strongest in a wavelength of 1500 nanometres, i.e. in the infrared range. The present record lies at the red end of the visible spectrum, at 780 nanometres.
To get light with even shorter wavelengths to "reverse" refract, the structures would have to be substantially scaled down once more. In addition, only individual layers have been studied so far. To identify the "right" materials, it would be necessary to apply several layers one after the other. However, this



THE STRUCTURES MADE OF GOLD ARE AROUND 0.5 MICROMETRES IN SIZE AND WORK LIKE AN OSCILLATING CIRCUIT CONSISTING OF CAPACITOR AND COIL. Photo: Linden/Forschungszentrum Karlsruhe

KNITTING WITH POLYMERS IS THE ART THAT CHEMICAL ENGINEER DOMINIQUE DE FIGUEIREDO GOMES WANT TO PERFECT. Photo: GKSS

would involve extremely high losses, because only around 70 per cent of the light is transmitted through a layer, and in the case of sequentially switched layers this multiplies quickly. "It might be possible to balance this out with an optical amplifier, but that still needs to be developed first," believes Linden. "All this is currently pure basic research," emphasises the physicist, but he can already see some applications on the horizon, for example, perfect lenses. Because optical lenses made of conventional materials can only resolve objects that are larger than a light wavelength, while lenses made of metamaterials

> While optical lenses made of conventional materials only resolve objects that are larger than a light wavelength, lenses made of metamaterials could be "perfect".

could be "perfect". This means a light microscope with 10,000 fold magnification would be possible in principle. And invisible cloaks? Linden can't help a smile. "In principle, it's conceivable," he admits. Of course, this would call for other complex problems to be solved. In addition, a cloak such as Harry Potter wore to secretly quarry through the library cannot be produced. Because the optical properties are the same in both directions, users would also be cut off optically from the outside world, i.e. would be blind to all intents and purposes.

DR. ANTONIA RÖTGER

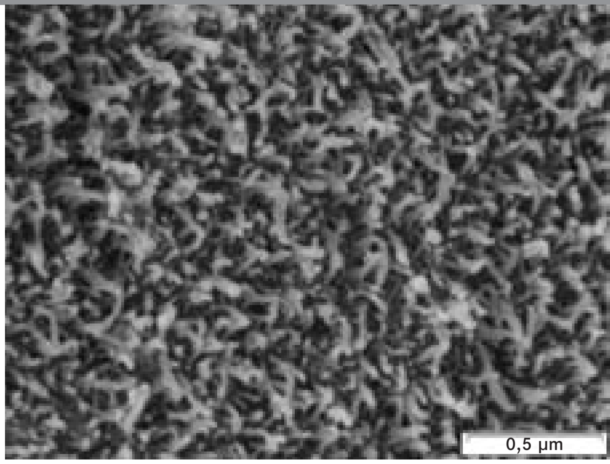
GKSS Research Centre Geesthacht

JACK OF ALL TRADES FROM THE POLYMER LAB

A young researcher at the GKSS Research Centre Geesthacht is developing artificial materials with very special properties. Her work opens up opportunities in high-tech industries that are among the economy's growth drivers.

A warped plastic bottle lying in the scorching sun exemplifies the problem. Many plastics cannot stand high temperatures. And it's better to keep them away from aggressive chemicals. However, no such precautionary measures are needed for the materials that come from the Young Investigators Group on "Polyoxazol-based nanocomposites" headed by Dr. Dominique de Figueiredo Gomes. The chemical engineer fine-tunes her materials for applications in high-tech industries. She uses nanoparticles to make the extremely light materials hard, resilient and chemically active. The carbon atoms that have been stringed together in a polymer create chains that intertwine and so hold together like a ball of wool. "The special alignment of the atoms as rings explains part of the special properties," explains the leader of the Young Investigators Group. Furthermore, nitrogen atoms have been integrated at certain points, expressed in the name given to the polymer group that she studied: "azol".

The breakthrough came when she succeeded in producing a plastic from these that contains long chains, a requirement for producing mechanically stable membranes of the kind that are absolutely essential for many applications.



FINELY STRUCTURED LIKE A CARPET, THAT'S WHAT A NANOCOMPOSITE LOOKS LIKE UNDER AN ELECTRON MICROSCOPE. Photo: Prause/GKSS

By attaching further chemical groups to the chain, Dominique de Figueiredo Gomes was able to experiment with these and could later progressively modify the material in many respects. The polymer now dissolves in organic solvents, making it easier to process. "We meanwhile see that it can withstand many aggressive chemicals and temperatures up to 500 degrees – quite a feat for plastics," says the scientist who was born in Brazil, came to Germany around six years ago and now has a family here.

The chemical engineer spends a lot of her time working on chemical synthesis and has been adding silicate nanoparticles to the polymer network for quite a while, work that calls for great precision, intuition and experience. "It's a compound made of silicon and oxygen that makes the plastic more mechanically resilient," she says.

> It now withstands many aggressive chemicals and temperatures up to 500 degrees – quite a feat for plastics.

In the future, she also wants to use carbon nanotubes. Her cooperation partner at the Hamburg University of Technology (TUHH) has already been doing intensive work on these. This will enable the plastic to develop new functions, including the ability to act as a catalyst, i.e. to facilitate the energy-generating reaction of hydrogen and oxygen to form water in a fuel cell. However, using nanoparticles and polymers is no easy matter, because they do not combine easily. This is why Gomes first has to modify the surface of the tiny items. If she's successful, her plastic will become highly interesting for industry. She is convinced that she will then find a company to manufacture it. Because the special properties mean that the material is not only suitable for fuel cells, but also for light-weight engineering and as anti-corrosive coatings for magnesium sheets.

> She uses nanoparticles to make the extremely light materials hard, resilient and chemically active.

Since her novel material is light and at the same time resilient, components made of the new plastic will weigh less than if they had been made with conventional materials. "That saves energy," explains Gomes. The new material could also be used as an innovative material in high-tech industries, such as the automotive and aircraft industries. DR. MICHAEL FUHS

FELIX WOLF INTEGRATES SMALL SENSOR PROGRAMMES INTO COMPUTER THE CODE. THESE PROGRAMMES ANALYSE WEAKNESSES AND HELP PROGRAMMERS TO IMPROVE THE CODE. Photo: Forschungszentrum Jülich

EVEN SIMULATING A SMALL BLOOD PUMP IS INCREDIBLY COMPLEX, BUT CAN BE DONE IN JUST ONE THIRD OF THE TIME THROUGH COLLABORATION BETWEEN PERFORMANCE ANALYSTS AND DOMAIN SCIENTISTS. Photo: MicroMedCardiovascular, Inc.

Forschungszentrum Jülich

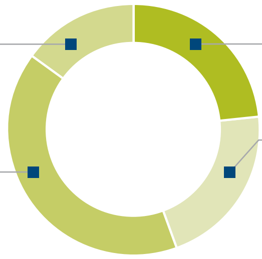
FASTER COMPUTING THROUGH IMPROVED COOPERATION

The performance of scientific supercomputers is increasing at a tremendous pace. However, existing software often fails to make full use of the computing capacity. Scientists at Forschungszentrum Jülich are therefore developing a method that identifies time-consuming bottlenecks in computer programmes. The magic word is “cooperative work”.
The 16,000 processors in the JUBL supercomputer at Forschungszentrum Jülich have to work together, much like the staff in a company. The better they harmonise with each other, the more efficiently they achieve a result. This is why Prof. Dr. Felix Wolf, who heads the Young Investigators Group on “Performance Analysis of Parallel Programmes” in Jülich, is analysing the procedures and workflows in the computer. “Modern computers often use only a few percent of their capacity,” says Felix Wolf explaining his motivation. As computers become increasingly complex, the problem is intensified. More and more processors have to simultaneously execute subprogrammes and, from time to time, exchange their data. “This is exactly where the problems start for many programmes,” says the computer scientist. Programmers have to integrate the work-sharing between the processors into the code. “Valuable compute time is lost if one processor needs input from another so that it can continue computing but doesn’t get this input in time.” Besides diagnosis functionality, the Helmholtz Virtual Institute “High-Productivity Supercomputing”, which Felix Wolf coordinates, also aims to optimise programmes for parallel computers. Apart from Forschungszentrum Jülich, the other partners in the Virtual Institute are RWTH Aachen University, Dresden University of Technology (TU), and the University of Tennessee. The great potential to be found in optimising the software is shown by the simulation programme developed by Wolf’s cooperation partner Marek Behr from RWTH Aachen University. He uses the JUBL supercomputer to calculate the geometry of blood pumps. These miraculous inventions, no bigger than a finger, are implanted into the human body and when pumping must not destroy the sensitive blood cells. This is why the computer has to calculate how the many small particles flow in the blood. In the past year, Felix Wolf and his staff were already able to reduce the required compute time to just one third. They also assume that there is still plenty of room for improvement.
To enhance the analysis functions, Felix Wolf is incorporating a special kind of sensor into the simulation programme. “These again are small programmes that log tiny performance-relevant events of the individual processors for each computational step,” he explains. His programme package SCALASCA (Scalable Performance Analysis of Large-Scale Applications) analyses the data. Programmers can then use these results to improve the code for the next version. A large proportion of the diagnosis software available today cannot yet analyse programmes that use all the processors of Jülich’s supercomputer. By contrast, SCALASCA is now also able to take a closer look at software that can utilise all 16,000 of the processors. This means that programmers can now get the best out of JUBL and other new generation supercomputers.

DR. MICHAEL FUHS

Structure of the Research Field Key Technologies
Core-financed Costs 2006: 80m euros

The Research Field Key Technologies additionally receives 26m euros, for a total budget of 106m euros.



THE PROGRAMMES

Scientific Computing

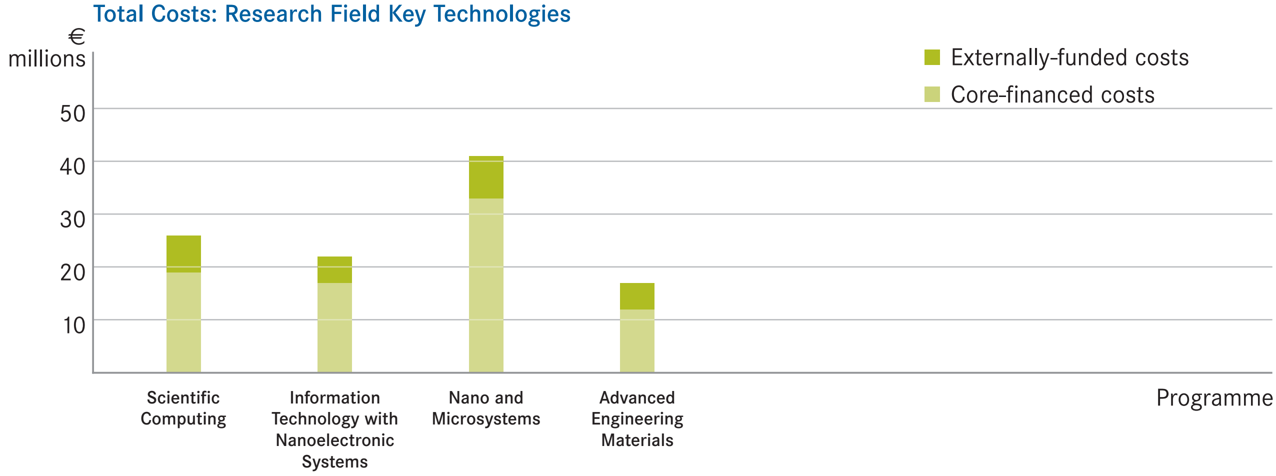
The term scientific computing generically describes important research tools that involve processing large volumes of data or modelling complex systems. Focusing on high-performance and GRID computing, the programme provides indispensable infrastructures for German science and research. Experts at the John von Neumann Institute for Computing in Jülich (NIC) and at the Grid Computing Centre in Karlsruhe work on improving methods, tools and applications, and support numerous internal and external users from other research fields and institutions.

The research programme has been commissioned with creating and operating the very latest and most efficient generation of high-performance computers. As from autumn 2007, the Forschungszentrum Jülich will have one of the world's fastest scientific supercomputing facilities. The researchers develop parallel algorithms plus new programming and visualisation techniques. A particular challenge lies in meaningfully managing and processing the ever-growing flows of data produced by particle accelerators and satellites. The modern concept of grid computing, in which computers are linked up to form functional nets, makes it possible to analyse even greater volumes of data. The computer network GridKA is also being established at the Research Center Karlsruhe and will, as from 2007, process a substantial share of the data delivered by the Large Hadron Collider (LHC) located at the European Research Centre CERN, for which it will also be linked up with computer centres in other countries.

Information Technology with Nanoelectronic Systems

Semiconductor components are becoming ever smaller, but the limits of miniaturisation have not been reached yet. The research performed in this programme anticipates industrial developments and studies quantum-electronic, magneto-electronic, ferroelectric and molecular nanostructures. Highest-frequency electronics and bioelectrical signal processing also belong to this programme area. The scientists conduct basic research on materials and on the processes taking place there, study information processing in logic devices, information storage in Random Access Memories (RAM) and mass storage media, plus the transmission of information to chip and system level, and also develop new sensors.

Total Costs: Research Field Key Technologies



Nano and Microsystems

While microsystems technology already comes very close to the field of practical application, a great deal of basic research and theory is still needed for nanotechnology. These two fields, theory and practice, merge in this programme. For example, scientists work on developing new microsystems structures made of polymers, metals or ceramics that are capable of carrying out functions that silicon-based microsystems cannot perform. Such novel materials and technologies are capable of triggering innovations. Scientists also design microtechnical components and systems for selected fields of application, mostly in cooperation with industry, such as for microoptics, micro-process engineering, gas analysis, microfluidics and the life sciences.

Nanotechnology is considered one of the key technologies of the century. The potential applications for inorganic, organic and bioorganic nanostructured systems are highly promising and have only just begun to be examined. On the one hand, this involves understanding the essential processes so that the next step can develop materials with completely new properties and characteristics, some of which will certainly interest industry. The researchers also intend to use technical materials to develop biological functional units under controlled conditions. They plan to position nano-production-plants at the interface between microtechnology and nanotechnology in which nanostructured systems can be industrially manufactured with tailor-made properties. The idea is to transfer research findings from lab to application and so facilitate the development of new products.

Advanced Engineering Materials

New materials and material systems, such as composite materials for the sustained and efficient exploitation of resources and energy and for applications in medical engineering, are the topics of the research work conducted in this programme. In this respect, activities focus on two fields offering major potential for applications. On the one hand, these are metallic materials needed for lightweight engineering applications in fields of transport and energy engineering and, on the other, advanced engineering polymer systems for applications in lightweight engineering, chemical process engineering and energy engineering, plus medical engineering and technology. In the long term, these materials are to complement or replace traditional materials and so open the way to new solutions. Working in close cooperation with industry, Helmholtz scientists are studying fundamental questions of alloy and polymer development, processing and finishing, and component and process trialling and testing. Computer simulation and material properties modelling also play key roles in developing new materials systems.

RESEARCH FIELD STRUCTURE OF MATTER

PROF. DR. ALBRECHT WAGNER
Helmholtz Vice-President representing the Research Field Structure of Matter, Deutsches Elektronen-Synchrotron DESY

"We research what holds the universe together at its innermost folds, studying the cosmos with particles from the universe and examine the structure of matter, from molecule to crystal. We do this by developing, building and operating unique large-scale facilities, together with national and international partners. By understanding the fundamental questions, we create the foundation for future developments."

GOALS AND ROLES

From inconceivably small elementary particles through to the structure of the universe: this Helmholtz Research Field studies and explores matter and forces that act on it in completely different orders of magnitude. Attention not only focuses on the large and the small, but also on the complex phenomena caused by the interaction of myriads of atoms in liquids and solids. This also calls for basic research to produce insights that make it possible to design novel materials with tailor-made electronic, mechanical or thermal properties.

A particular strength of our research lies in the large-scale facilities that we operate and have at our disposal for our science and research. Whether particle accelerators, synchrotron radiation or neutron sources, these major and in some cases unique scientific infrastructures are used by numerous researchers from both home and abroad. The planned X-ray laser XFEL now being built at the Deutsches Elektronen-Synchrotron DESY in cooperation with European partners will create an X-ray source whose maximum performance is 10 billion times higher than any previously built facility. Another large-scale instrument is being created at the Gesellschaft für Schwerionenforschung in Darmstadt. The Facility for Antiproton and Ion Research (FAIR) is a next generation accelerator that will deliver ion beams of a previously unparalleled intensity with very high energies.

As part of the new funding for Helmholtz Alliances, a network was created in 2007 to research the topic of "Physics at the Terascale". This network engages in top-flight research at the limit of achievable accelerator energies in order to study the nature of matter and the forces acting shortly after the big bang. Particle physicists from two Helmholtz Centres – the Deutsches Elektronen-Synchrotron DESY and the Forschungszentrum Karlsruhe – joined forces with colleagues from a total of 17 universities and the Max Planck Institute for Physics in Munich to this end. The Initiative and Networking Fund will fund this Helmholtz Alliance over the next five years with a total of 25m euros. The alliance helps concentrate scientific expertise in this field in Germany and incorporates the universities as strong partners.

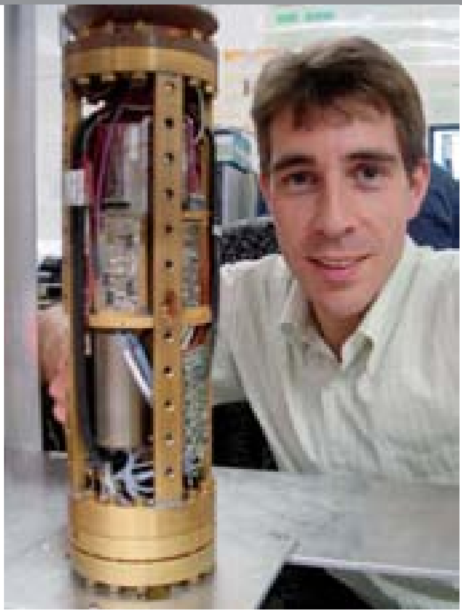
The research field sees promoting young researchers and scientists as a key responsibility. This particular commitment is also reflected in the great appeal that the research field has for young researchers. In fact, one third of all Helmholtz Young Investigators Groups are based at the Structure of Matter.

PROGRAMME STRUCTURE

Six Helmholtz Centres collaborate in the Research Field Structure of Matter: the Deutsches Elektronen-Synchrotron DESY, the Forschungszentrum Jülich, the Forschungszentrum Karlsruhe, the GKSS Research Centre Geesthacht, the Gesellschaft für Schwerionenforschung and the Hahn-Meitner-Institut Berlin. The scientists work in five programmes:

- Elementary Particle Physics
- Astroparticle Physics
- Physics of Hadrons and Nuclei
- Condensed Matter Physics
- Large-Scale Facilities for Research with Photons, Neutrons and Ions

All programmes rely on the close interaction between theory and experiment. Some of the programmes are scientifically and technologically interlinked, while the general goal is to advance the development of scientific infrastructures and large-scale facilities, to use them efficiently and to give users the best possible support, in order to maintain the leading role played in this field by Helmholtz and its national and international partners.



KLAUS BLAUM CATCHES CHARGED ATOMS IN CLEVERLY-DESIGNED TRAPS SO THAT HE CAN TAKE PRECISE MEASUREMENTS. Photo: GSI

PROJECTS

Gesellschaft für Schwerionenforschung

IONS CAUGHT IN A TRAP

Why are we made of matter and not antimatter? How do stars manage to produce ultra-heavy elements like lead and uranium? Dr. Klaus Blaum is addressing major questions like these with a small device. The physicist from Mainz uses ion trap facilities. Their centrepiece, the Penning Trap, is no larger than bobbin and is capable of capturing individual ions – charged atoms – so that Blaum and his team can measure them very accurately. Before they can capture and store the ions, however, the scientists first have to produce them. They do this with a heavy ion beam, for example, that hits a target and kicks out a swarm of charged, short-lived atoms. The problem is that the ions are initially much too fast to be able to lock them in the bobbin-sized trap. So, Klaus Blaum has to slow them down, which he does by sending them through a gas cell, for example. “Just think of it as running full tilt into a group of people,” is how the physicist describes it. “You gradually come to a standstill, at the very latest after you’ve bumped into the third person.” The fast ions go through much the same experience. They collide with helium atoms in the gas cell. With each collision they lose momentum or kinetic energy, until after several hundred such “close encounters” they come more or less to a halt. Now the ion trap can come into play. “We use strong electromagnetic fields to capture the individual ions,” says Blaum, “and then we allow them to float freely in space.” These are ideal conditions for measuring the ions and for determining their mass, lifetime and magnetic spin. Blaum explains: “These factors let us characterise a particle very much like you can with somebody’s fingerprint.”

To determine these factors, the physicists measure the frequency with which the ion oscillates in its trap. The principle is as follows: With each circuit, the charged particle triggers a tiny “image current” in a special detector. Blaum’s team have now made this detection technique so precise that it can even measure currents of just one femto-ampere, i.e. less than one billionth of the current of a watch’s button cell. This method even enables us to precisely “weigh” the ions. Science needs to know the precise mass values of the various isotopes so that we can understand, for example, how heavy elements above iron are “baked” inside stars or how an accelerator generates extreme elements, such as darmstadtium (atomic number 110), discovered at the Gesellschaft für Schwerionenforschung (GSI) in 1994.

> We use strong electromagnetic fields to capture the individual ions.

In another experiment, researchers in Mainz are trying to identify the magnetic properties of the proton. In several years, Klaus Blaum plans a spectacular extension: “Working with the future GSI accelerator FAIR, we want to carry out the same experiment with antiprotons.” Klaus Blaum would like to lock these antiprotons in his trap and then measure their magnetic spin, in order to be able to compare it with the proton. If he finds any differences, the physicist would be on the trail of the long sought-after imbalance between matter and antimatter – and so in hot pursuit of the answer as to why space is full of matter, while hardly any antimatter seems to exist.

FRANK GROTELÜSCHEN

PARTICLE PHYSICIST ERIKA GARUTTI BUILDS HIGHLY SENSITIVE SENSORS FOR THE INTERNATIONAL LINEAR COLLIDER THAT WILL BE BUILT IN A GLOBAL JOINT EFFORT. Photo: DESY

ONE OF 40 LAYERS FOR A PROTOTYPE ENERGY SENSOR: THE "EYES" ARE MADE OF PLASTIC DISKS THAT CONVERT PARTICLE ENERGY INTO LIGHT. Photo: DESY

Deutsches Elektronen-Synchrotron DESY

HIGH-PRECISION ENERGY SENSOR

Erika Garutti holds a tiny chip between her fingers. It looks like a tiny, rectangular piece of broken mirror. Then the Italian points to a fridge-sized block: "8,000 of these chips have been installed there. It's the prototype for a novel type of particle detector." The new detector will be the centrepiece of one of the greatest scientific machines of all times – the International Linear Collider (ILC). Hundreds of physicists are working all around the world on the plans for this giant which will help to answer fundamental questions of physics: How do particles obtain their mass? And how do they relate to the forces that act between them?

> A calorimeter with several millions of channels is planned for the ILC. That would not have been possible with the old technology.

The heartbeat of the ILC is made up of two particle accelerators, each twelve kilometres long. They fire electrons straight at their antiparticles, the positrons. When they collide, the particles annihilate each other to form an extremely dense flash of energy from which new, unknown particles can be created. The higher the energy of the electrons and positrons, the fiercer the collision force – and the more exotic and heavier the particles that are generated. With a collision force of up to one Tera-electronvolt (TeV) the ILC aims to outdo the previous record holder, LEP in Geneva, by a factor of five. Hopefully, the ILC will be able to generate and precisely examine previously hypothetical particles like the Higgs boson and SUSY particles.

The physicists want to observe these exotic particles with enormous detectors made up of millions of sensors. Garutti's team is trying to decisively enhance one of these sensors. "The particles created during the collision decay into lots of fragments that fly off in all directions," she explains. "We are attempting to measure the trajectories of the secondary particles as precisely as possible. Only then can we reconstruct which primary particles were formed in the collision." Specifically, Garutti is working on an energy sensor, the calorimeter. In this sensor, secondary particles shoot through special plastic disks (scintillators), which convert the particle energy into light. "The light allows us to draw conclusions about the energy of the originally generated particles," explains Garutti. Previously, relatively large photomultipliers based on tube technology were used for this purpose. Garutti's team is now developing light sensors based on tiny silicon chips. "This enables us to reduce the size of sensors. A calorimeter with several millions of channels is planned for the ILC," says Garutti. "That would not be possible with the old technology." The physicist has already successfully tested her prototype. "Now we above all have to see how these sensors can be produced on an industrial scale." Yet, the researcher has also set her sights on another field of application – medicine. She wants to use her silicon chips to enhance a method of diagnosis called PET. This involves patients being fed with the radioactively marked sugar molecules that tumour cells prefer to metabolise. Inside the tumour, the molecules radiate gamma rays which can be detected by the tubes. Garutti now wants to replace the large tubes with small silicon sensors. "We hope we can then enhance the spatial resolution and so localise the tumour more exactly," she says. FRANK GROTELÜSCHEN

LAKE USES EXPERIMENTS ON THE NEUTRON SCATTERING INSTRUMENT TO GAIN INSIGHTS INTO MAGNETIC PATTERNS. Photo: HMI

Hahn-Meitner-Institut Berlin

MAGNETIC PATTERNS

When the building blocks of matter interact with each other in an unusual way, this can result in strange and exotic material properties developing. Many of these interactions are still not fully understood. However, Prof. Dr. Bella Lake aims to lift the veil with the help of strong magnetic fields and neutron scattering.

The young British physicist has often visited the Hahn-Meitner-Institut (HMI) in Berlin over recent years. HMI director Michael Steiner recruited her in the United States, where she was already an Assistant Professor at the Iowa State University, and brought her back to Germany to take a position as a Helmholtz Young Investigators Group Leader at the Helmholtz Centre. Lake agreed, because she would be able use neutron beams to examine her samples under strong magnetic fields and at low temperatures, a unique combination that provides insights into magnetic patterns: “I used to have to travel for all the experiments, but now I only occasionally need to do so,” says Lake.

> I want to understand how the transition from a one-dimensional to a three-dimensional magnet works.

Bella Lake above all studies the magnetic interactions between the building blocks of matter that are arranged in her samples in practically perfect regularity. She investigates them with neutrons from the HMI research reactor. As the neutrons fly through the sample, they pass part of their energy on to the so-called spins of the crystal’s electrons, which can probably be best imagined as minuscule bar magnets. By observing how the neutrons are diverted and how their energy changes, Lake is not only able to identify the internal magnetic patterns, but also the interactions between the spins. Her results are of importance to all areas of physics, and this is why they not only appear in specialist journals, but also occasionally in “Nature” and “Science” as well.

“Normally, magnetic forces act in all three dimensions, but there are crystals in which they only affect each other along a single dimension,” explains Lake. The inside of such quantum magnets can best be imagined as chains of pearls made of minute bar magnets. Although each pearl affects its neighbours, it does not affect the pearls of other chains. “I want to understand how the transition from a one-dimensional to a three-dimensional magnet works,” says Lake, “because this will also enable us to test the predictions made by quantum mechanics.” But Lake also wants to find out why a certain class of structurally complex ceramic substances suddenly become superconducting at temperatures below minus 140°C, thereby conducting electricity with zero resistance. In contrast to “normal” superconductivity found in some metals at minus 260°C, no real explanation has been found yet for this “high-temperature” superconductivity. This also explains why it is so difficult to specifically enhance these brittle materials for technical applications. Several physicists believe that the superconductivity could be an overriding phenomenon that remains hidden when the material is in its normal state. So Lake now plans to examine this less complex, normal state by observing samples in strong magnetic fields.

TRANSPORTING THE CENTREPIECE OF THE KATRIN SPECTROMETER FROM THE CARGO SHIP TO THE RESEARCH CENTER KARLSRUHE NEEDED TO BE INCH PERFECT. Photo: Forschungszentrum Karlsruhe

ONLY AT LOW TEMPERATURES AND IN HIGH MAGNETIC FIELDS DO THE QUANTUM PHYSICAL EFFECTS APPEAR THAT BELLA LAKE WANTS TO OBSERVE. Photo: Boeck/TU Berlin

In the crystal, these fields generate regular arrangements of tornado-like magnetic vortices and initially only disrupt the superconductivity where magnetic vortices exist. The stronger the field, the greater the number of vortices that appear, resulting eventually in the superconductivity collapsing completely.

> Initially, I thought that this is a really big responsibility, but now I enjoy having my own team.

During beamtime, Lake and her staff work particularly intensively – the time when the neutrons radiate through the crystal samples is particularly precious. Her team recently got new members and is now almost complete: Dr. Nazmul Islam grows the crystals and his colleague, Dr. Tatiana Guidi, works with Lake on setting up the neutron experiments, while Bella Lake also supervises one doctoral student, and possibly another in the near future. In addition, she gives lectures at the TU Berlin where she holds a joint position as Junior Professor. “Initially, I thought that this is a really big responsibility, but now I enjoy having my own team. My people complement each other perfectly, and I see five as the ideal number for working together efficiently.” DR. ANTONIA RÖTGER

Forschungszentrum Karlsruhe

WEIGHING GHOSTLY PARTICLES

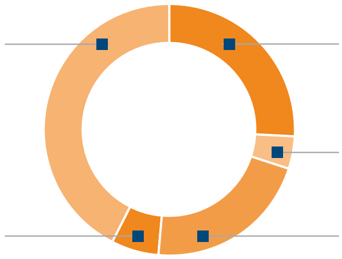
“Accompanying an absolutely unique experiment from initial planning through to final results is what every neutrino physicist hopes for. And if this – as in the case of KATRIN – takes 15 years, so be it,” says Dr. Markus Steidl, a young researcher at the Karlsruhe Tritium Neutrino Experiment KATRIN. Since writing his Diploma thesis in 1994, the physicist has remained true to the Research Center in Karlsruhe, because this is where he can fulfil this dream. He is currently developing a special detector for the set of neutrino scales and is coordinating the work with partners from the University of Washington in Seattle.

Neutrinos are the second most common yet most baffling particles in the universe. Because these “ghostly particles” escape direct measurement, which means that not even their mass is known. Nevertheless, it is highly likely that they – on account of their sheer numbers alone – play a decisive role in the development of the universe.

KATRIN uses the decay of the hydrogen isotope tritium into a helium isotope, where an electron plus a single neutrino is emitted. In this process, the total energy of the decay is known precisely, allowing conclusions as to the neutrino mass to be drawn from the electrons’ measured end-point-energy. Steidl, who is currently working part-time under the parental leave programme, is already looking forward to 2010: “If everything goes to plan, we will be able use the scales to weigh neutrinos for the very first time.” arö

Structure of the Research Field Structure of Matter
Core-financed Costs 2006: 321m euros

The Research Field Structure of Matter additionally receives 30m euros, for a total budget of 351m euros.



THE PROGRAMMES

Elementary Particle Physics

This programme studies the basic building blocks of matter and the forces acting between them. Among other goals, the scientists aim to gain an understanding of the evolution of the early universe. The origin of mass, the unification of all fundamental forces at extremely high energies, and unifying quantum physics with the general theory of relativity all rank among the truly grand challenges of physics. The scientists also search for traces of new particles and for the supersymmetry partners of all presently known particles. Besides the accelerator capacities, scientists also have access to high-performance computers for analysing data and modelling questions of theoretical physics. The Grid Computing Centre Karlsruhe (GridKA) being built at the Forschungszentrum Karlsruhe will provide a high-performance computer facility that is internationally networked and capable of analysing the large data volumes produced by the Large Hadron Collider (LHC) at the European Research Centre CERN.

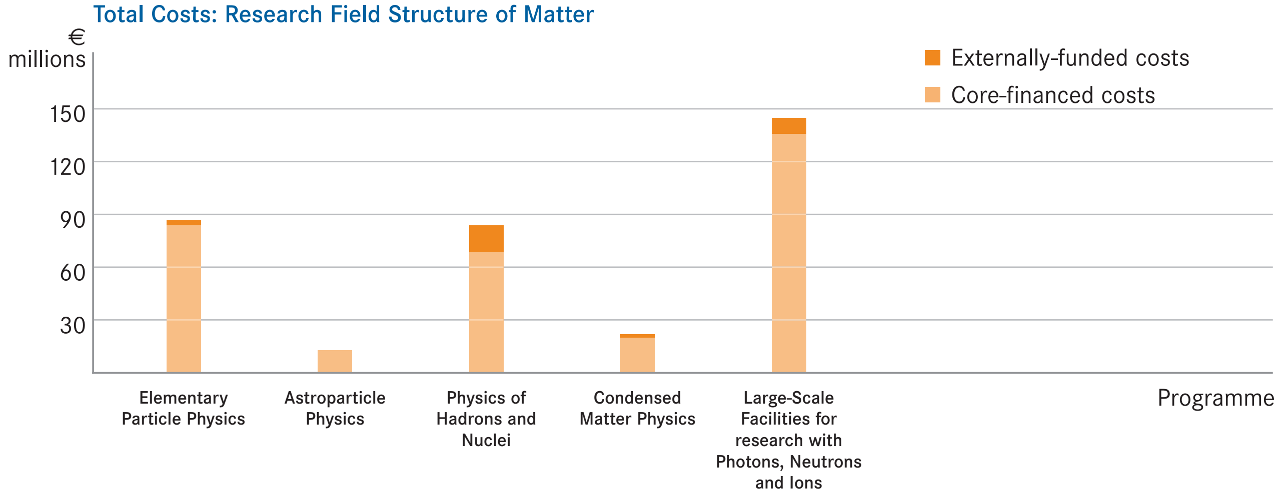
Astroparticle Physics

Astroparticle physics is a relatively young interdisciplinary research area that combines our knowledge of the smallest building blocks with our understanding of the largest structures of the universe. Astroparticle physicists study the sources of cosmic rays and the mechanisms of cosmic accelerators. They explore beyond the range of classical wave-length observation to find out what space actually looks like, because it is constantly "inundated" with cosmic radiation. At the same time, researchers from this programme investigate the so-called dark matter, whose presence could previously only be inferred from its gravitational effect. The programme has three core focuses: studying cosmic rays at high energies (Pierre Auger Observatory, Argentina), using neutrino telescopes to search for high-energy neutrinos from astrophysical sources (AMANDA II and Icecube, Antarctic), and determining the neutrino mass to a cosmologically relevant degree of precision (KATRIN, Karlsruhe). To achieve these goals, the research field has to develop, build and operate large-scale detector arrays with an efficient infrastructure. And sometimes these are located far away from existing labs.

Physics of Hadrons and Nuclei

Hadrons, nuclei and protons are made up of quarks that are bound together through strong interaction. Scientists in the Physics of Hadrons and Nuclei programme concentrate mainly on the following topics: quark confinement in hadrons, the spontaneous breaking of chiral symmetry, the origin of hadron mass, properties of the nuclear many-particle systems, exotic nuclei at the limits of stability, generation of super-heavy elements, the behaviour of extended nuclear matter in astrophysical objects such as neutron stars and supernovae. The search for previously unknown forms of matter is also a research topic. In addressing these questions, the programme uses experiments carried out on the large-scale facilities operated by the Gesellschaft für Schwerionenforschung (GSI) and the Forschungszentrum Jülich. The planned Facility for Antiproton and Ion Research (FAIR) to be built at the GSI in cooperation with international partners will provide a next-generation particle accelerator. FAIR will deliver ion beams with which it is possible to generate exotic atomic nuclei or antiprotons for further experiments, for instance to explore the nature of quark-gluon-plasmas or forms of matter that shaped the beginning of the

Total Costs: Research Field Structure of Matter



universe. Helmholtz research in this programme also contributes significantly to present and future research activities at CERN.

Condensed Matter Physics

The Condensed Matter programme studies the characteristics of solids and liquids in great detail. Scientists investigate the interactions between electrons and atoms that determine the mechanical, thermal, electronic, magnetic and optical properties of matter. The focus is on many-particle systems that also demonstrate new complex properties, such as nanosystems, for example, which form the transition from atoms to solids and so possess novel characteristics and properties.
The programme's main goal is to explore new and unusual states of solids, soft matter, thin films and boundary layers. The programme benefits from large-scale facilities with neutron, ion and synchrotron radiation. Scientists also use spectroscopic methods, thermodynamic and transport metrology, high-resolution electron microscopy, plus supercomputers that enable them to carry out theoretical modelling and computer simulations. From 2009, the programme will move to the Research Field Key Technologies.

Large-Scale Facilities for Research with Photons, Neutrons and Ions

This programme unites large-scale facilities that are particularly important for many fields, such as nuclear and molecular physics, plasma physics and the physics of condensed matter, structural molecular biology, chemistry and material sciences, earth and environmental research, as well as engineering. The programme research concentrates on using existing photon, neutron and ion sources efficiently and on continually adapting these to the changing needs of the user communities.
Some new developments deserve special mention. The Free Electron Laser FLASH at the Deutsches Elektronen-Synchrotron DESY now generates radiation in the soft x-ray range. At the same time, the European x-ray laser XFEL is being established there and will, as from 2013, deliver x-ray flashes with an extremely high intensity. This will then make it possible, for example, to film the very fast reactions taking place in chemical and biological systems and to unravel the atomic details of molecules. Moreover, the world's strongest magnet for neutron experiments is being built at the Hahn-Meitner-Institut Berlin. This unique sample environment in combination with a neutron source promises great advances in material research, such as in gaining a fundamental understanding of high-temperature superconductivity.

RESEARCH FIELD TRANSPORT AND SPACE

PROF. DR. JOHANN-DIETRICH WÖRNER
Helmholtz Vice-President representing the Research Field Transport and Space, Deutsches Zentrum für Luft- und Raumfahrt

"In the long term, we will only be able to meet the human desire for mobility, communication, safety and security, plus effective environmental management by putting technological solutions produced by aeronautics, astronautics and transport research into practice and by using synergies to meet the demands and requirements of society."

GOALS AND ROLES

Mobility, communication and information form the backbone of a modern society. However, its demand-focused development is limited by capacity bottlenecks, increasing environmental burdens, and stricter safety and security standards. This explains why scientists at the Research Field Transport and Space are looking for new concepts and technical solutions and are passing on their advice to political decision-makers. At the same time, space engineering and space technology are being used to gain fundamental knowledge and insights on Space and Earth.
The Deutsches Zentrum für Luft- und Raumfahrt (DLR) is responsible for the Research Field Transport and Space and at the same time serves as the hub of Germany's aerospace research. In its capacity as the German Space Agency, the DLR is the lead organisation for research conducted within the scope of the German Space Programme and coordinates Germany's participation in the programmes run by the European Space Agency (ESA). The eight DLR sites in Germany are located in various federal states and are closely networked with neighbouring universities and non-university research institutions. At the same time, the DLR collaborates closely with other Helmholtz Centres and research fields.

PROGRAMME STRUCTURE

DLR researchers collaborate in three programmes:

- Transport
- Aeronautics
- Space

The work done in these programmes is characterised by their organisational and thematic integration under the umbrella of the DLR. This means that researchers working in all three programmes can draw directly on the shared core competencies that they need, for example, in aerodynamics, propulsion technology, atmospheric technology, structural and design engineering, in robotics and mechatronics, in sensor technology and data processing. Indeed, synergies also emerge wherever questions of aeronautical and terrestrial transport research combine with space engineering research topics. Typical areas include positioning, navigation, telecommunications and remote sensing systems. A classic example of how these synergies benefit society and industry involves the monitoring of ecological contexts, where scientists working on topics like climate, pollutants or noise pool the data they have gained from orbital, airborne and terrestrial Earth observation to enhance their research.

A CAMERA RECORDS THE DRIVER'S ACTIONS AND LINE OF VISION WHILE TRAVELLING IN REAL-LIFE TRAFFIC. Photo: DLR

PROJECTS

Deutsches Zentrum für Luft- und Raumfahrt

JOINING TRAFFIC MADE EASY

New technologies can support the driver by taking over parts of the driving. However, at the moment these systems are not well accepted. One reason for this is that many systems do not take into account the respective traffic situation. Psychologists and engineers from the Virtual Institute "Human Automation" want to change this.

Travelling along the right-hand lane of the motorway. Automatic Cruise Control (ACC) maintains a desired speed and keeps a safe distance to the car ahead. In many situations this is a comfortable option for the driver. But as the traffic becomes heavier, and cars keep cutting in, the system brakes, annoying the driver. "It's at moments like these that drivers switch off the essentially useful aid, because it does not respond to the traffic situation and reduce the distance," says Prof. Mark Vollrath, explaining his criticism. This is why Vollrath and colleagues from the DLR Institute of Transportation Systems in Braunschweig are researching more intelligent, adaptive systems.

Psychologists and engineers from the DLR joined forces with the Institute of Automotive Engineering at the RWTH Aachen University and the Interdisciplinary Centre for Traffic Sciences Würzburg to establish the Virtual Institute on "Human Automation in Traffic". Initially, says coordinator Mark Vollrath, they focused solely on just one traffic situation: entering the motorway and filtering into the oncoming traffic. It's not as complex as city traffic, but much more difficult than situations that available systems already manage.

First of all, traffic psychologists have to find out when drivers become stressed and respond incorrectly. On the one hand, they analyse the driver and driving behaviour of test subjects in specific situations in the driving simulator. And, on the other, they analyse behaviour in real-life traffic with the research vehicle ViewCar.

The first results confirm that the scientists are right to develop situation adaptable systems. Because the mistakes that drivers make depend on the level of traffic.

> We are now also able to quantify at what objectively-measurable traffic volume the system has to react.

At low traffic levels, drivers become careless. This is why a system must give only minimum support and warnings in this situation so that they do not become even more careless. At medium traffic intensities, drivers make the most mistakes. They have to keep their distance to the vehicle ahead, while, at the same time, keeping the traffic next to them in sight and mind, recognising the proper gap to merge, and then braking or accelerating as necessary. In this situation, assistance systems which take over parts of the driving may be helpful. At very high traffic levels, cars drive so slowly that enough gaps appear.

In qualitative terms, the results are no surprise. "However, we can now also quantify at what objectively-measurable traffic level the system has to react," explains Mark Vollrath. Hence, he and his colleagues are able to design a system that initially adapts to the various traffic situations. In the next step, they aim to enable the system to even predict the driver's behaviour

A DRIVING SIMULATOR HELPS PSYCHOLOGISTS TEST HOW ASSISTANCE SYSTEMS SUPPORT DRIVERS. Photo: DLR

SHIPPING EMISSIONS HAVE LARGELY ESCAPED NOTICE, ALTHOUGH THEY ARE SUBSTANTIAL, AS A DLR STUDY SHOWS. Photo: Fesseler/Helmholtz

on the basis of gaze direction in order to prevent unnecessary actions and warnings occurring.
The engineers involved in the collaborative project are developing a method to automatically measure the three different traffic levels. It uses laser and radar scanners attached to the research vehicle ViewCar. At the same time, psychologists are working with the driving simulator to study which assistance systems are feasible and best support the driver. No decision has been reached yet as whether a filtering-in assistance system should, in certain situations, automatically brake or accelerate, or whether the system should only show the driver the proper gap to take, or whether it should, plainly and simply, warn the driver if the situation becomes precarious. The filtering-in systems developed at the DLR are to be installed in a car that will be able and allowed to travel in real traffic in three years' time.

> Before cars of the future are able to drive autonomously, plenty still remains to be done with assistance systems that usefully support drivers in various situations.

But Mark Vollrath is already thinking one step ahead. He believes it is possible for cars of the future to drive autonomously – including joining traffic automatically and speed regulation. "But until that happens, plenty still remains to be done with the assistance systems that usefully support drivers in the various situations." DR. MICHAEL FUHS

Deutsches Zentrum für Luft- und Raumfahrt

SHIPPING SCENARIOS

CO_2 emissions from shipping are of the same order as published CO_2 estimates for aviation. This is documented in studies carried out by the Institute of Atmospheric Physics at the Deutsches Zentrum für Luft- und Raumfahrt where Dr. Veronika Eyring heads a Helmholtz-University Young Investigators Group. The group works together with the University of Bremen to study the impact of shipping on atmospheric composition and climate in a research project called SeaKLIM (Einfluss von Schiffsemissionen auf Atmosphäre und Klima).
Their results show that ship engines emitted around 800m tonnes of CO_2 or 2.7 per cent of all anthropogenic CO_2 emissions in 2000; the proportion of nitrogen oxides (NO_x) lies at 15 per cent and of sulphur dioxide (SO_2) at 8 per cent. In addition, the annual fuel consumption of international shipping increased by a factor of 4.3 to meanwhile around 280m tonnes in the period from 1950 to 2000.
The research group demonstrated in various scenarios that the CO_2 and SO_2 emissions from shipping could double over today's rate by 2050, but that the situation could also be much improved by taking appropriate measures and introducing effective strategies. Yet, if no action is taken, the nitrogen dioxide emissions could exceed the present-day levels from worldwide road traffic by 2050. DLR

CHRISTIANE VOIGT TAKES MEASUREMENTS OF TRACE GASES AND PARTICLES WITH INSTRUMENTS ON THE DLR RESEARCH AIRCRAFT. Photo: DLR

Deutsches Zentrum für Luft- und Raumfahrt

ENVIRONMENTAL PROTECTION MEETS AIR TRAFFIC

In the field of air traffic, even relatively simple measures can help reduce the harmful effects of aviation on the climate. A young DLR scientist is now searching for such solutions.
Observations from space show a criss-cross of white lines extending over western Europe on some days. On an annual average, aircraft contrails cover about 0.5 per cent of the sky in northern mid-latitudes. Water vapour emitted by aircraft becomes visible in the cold atmosphere when it condenses and forms tiny ice crystals.

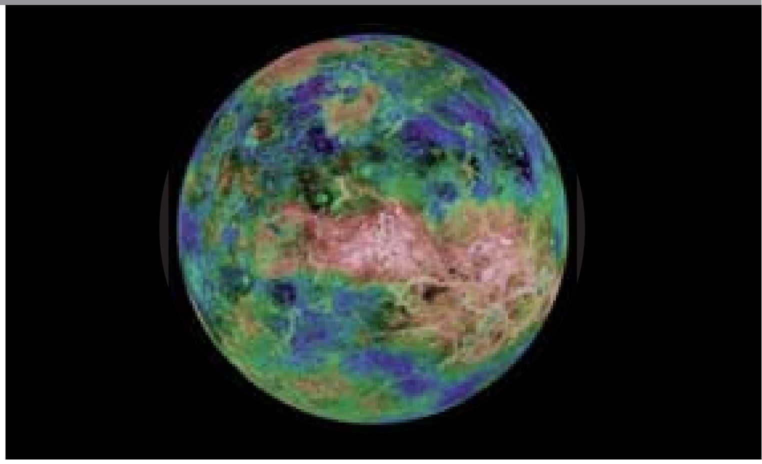
> We were able to detect increased amounts of reactive nitrogen compounds in the ice crystals.

"How these ice crystals interact with other aircraft exhausts and thereby change the climate has not yet been studied," explains Dr. Christiane Voigt from the DLR Institute of Atmospheric Physics in Oberpfaffenhofen. The young physicist recently became leader of a Young Investigators Group that cooperates with the University of Mainz and the Max Planck Institute of Chemistry in a research project called AEROTROP (Impact of Aircraft Emissions on the heteROgeneous chemistry of the TROPopause region). The research group takes a closer look at the environmental effects of air traffic.
A well-known greenhouse gas emitted by aircraft is carbon dioxide, produced by kerosene combustion in the aircraft engines. Aviation carbon dioxide emissions solely contribute one to two per cent to the global warming. "But the contribution of the sum of aircraft emissions is much higher," Christiane Voigt points out.
Two to eight per cent of the total anthropogenic radiative forcing, which contributes to the so-called greenhouse effect, is currently caused by air traffic. And the trend is increasing, because aviation is a growth industry. Since 1990, the transport capacity by passenger air traffic has almost doubled.
Besides carbon dioxide, the researchers' main concerns are contrails and nitrogen oxides emitted by aircraft. Nitrogen oxides emitted at cruise altitudes between 8 km and 12 km produce the greenhouse gas ozone. Ozone interacts with thermal long-wave radiation from the earth surface leading to a warming of the atmosphere. The radiative forcing through ozone resulting from aircraft nitrogen oxide emissions is of similar magnitude to the carbon dioxide effect.
Besides producing ozone, nitrogen oxides from aircraft also trigger other processes in the atmosphere. For example, they can lead to reductions in the lifetime of the greenhouse gas methane and they can be processed in clouds. Large uncertainties remain in the exact quantification of aircraft induced ozone changes and their climate impact. To reduce such uncertainties and to understand the underlying processes is the topic of Christiane Voigt's research.

> We want to calculate the climate impact of present and future air traffic at different flight altitudes.

Recently, Voigt and her colleagues made a surprising discovery on research flights over northern Germany. "We were

AIR TRAFFIC HAS DOUBLED SINCE 1990 AND WILL CONTINUE TO GROW. AT PRESENT, AIRCRAFT EMISSIONS CONTRIBUTE WITH 2 TO 8% TO THE TOTAL ANTHROPOGENIC RADIATIVE FORCING. Poto: DLR



IN THE 1990s, THE MAGELLAN PROBE SURVEYED VENUS: PLAINS ARE SHOWN GREEN AND BLUE, MOUNTAINS PINK. Photo: NASA/JPL/USGS

able to detect increased amounts of reactive nitrogen compounds in the ice crystals in young contrails," explains Christiane Voigt. The uptake of reactive nitrogen compounds in ice particles reduces nitrogen oxide concentration in the ambient air hence ozone production is slowed down.
In the future, Christiane Voigt and her Young Investigators Group want to study these unknown processes in more detail. In collaboration with German and international partners, she plans to perform aircraft measurements in contrails, in natural cirrus clouds and in the cloud free atmosphere with the new German research aircraft HALO (High Altitude Long Range). Aircraft exhaust will directly be probed by chasing other aircraft. These measurements will provide an extensive dataset on aircraft emissions and contrails for process studies and global modelling. "We want to calculate the climate impact of present and future air traffic at different cruise altitudes," explains Christiane Voigt. In three years, the AEROTROP scientists want to find out flight altitudes with a low effect on the environment It is possible that the research findings could then help to reduce the climate impact of air traffic through mitigation: simply by adjusting the flight altitudes.

DR. MICHAEL FUHS

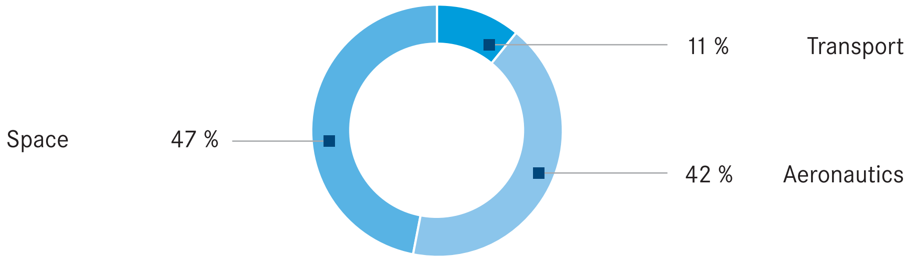
Deutsches Zentrum für Luft- und Raumfahrt

BEHIND THE VEIL OF VENUS

Venus is hot, with an average temperature of 460° Celsius: And even at the peaks of its highest mountains, it's only around 30° cooler. However, we do not know very much more about the surface of Venus, because the planet is shrouded by an around 100km thick veil, made of almost pure carbon dioxide that is opaque to most light frequencies. Dr. Jörn Helbert from the Institute of Planetary Research at the Deutsches Zentrum für Luft- und Raumfahrt is now taking a look behind this veil. Because the ESA Venus-Express probe has been orbiting the planet for a good 12 months and is equipped with the VIRTIS spectrometer, partly developed at the DLR in Berlin. Helbert and his colleagues have built a data pipeline for automatically analysing the data produced by VIRTIS. The spectrometer has a total of 120 optical channels that work with precise electromagnetic frequencies. Three of these channels look all the way through the tiny "optical windows" of the greenhouse layers down to the surface. From the thermal signals that are emitted from the ground, Helbert is able to measure the exact surface temperature and to scan the morphology. In particular, he now wants to find out whether Venus has any active volcanoes that continue changing the face of the planet today. And he can even complement his measurements with data supplied by the US Messenger probe as it flies past Venus on its way to Mercury – "a unique opportunity," believes the planetary expert. arö

Structure of the Research Field Transport and Space
Core-financed Costs 2006: 110m euros

The Research Field Transport and Space additionally receives 157m euros, for a total budget of 266m euros.



THE PROGRAMMES

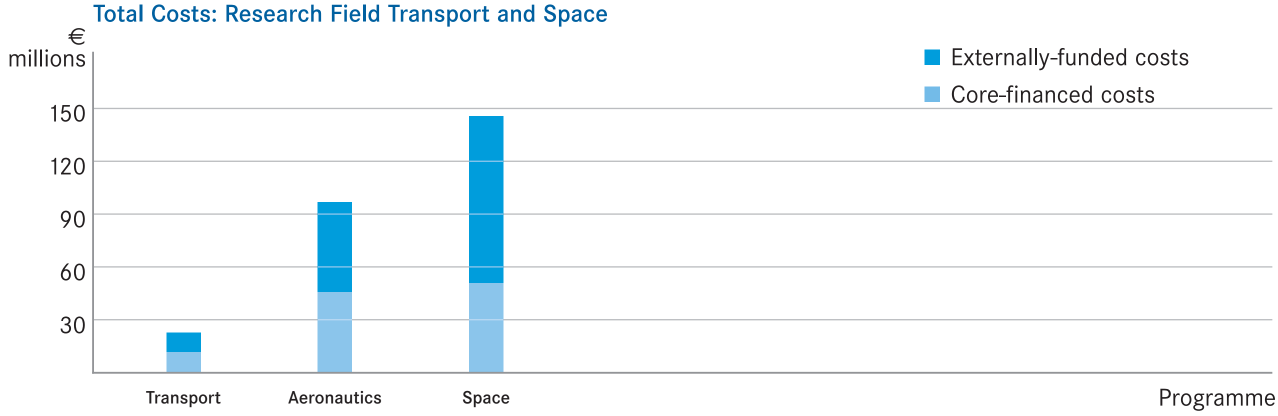
Transport

Even today, the transport system already often struggles to cope with the volumes of traffic that pass through it and cannot really accommodate any more traffic. This chronic overload increasingly jeopardises the competitiveness of the German and European economy. High traffic volumes also affect the environment, reduce people's quality of life, and clearly bear substantial risks of hazards and accidents. Hence, the Transport programme targets three overriding goals: maintaining mobility, protecting the environment and conserving resources, and improving safety levels. To achieve these goals, the DLR develops problem-solving approaches on ground-based vehicles, traffic management and the transport system. Indeed, scientists are addressing questions of traffic and transport in an approach that is unique in Germany, interlinking specific transport expertise with existing competencies from the fields of aeronautics, space and energy research. How can vehicle structures and automotive energy systems be optimised? How can the various resistances and wear and tear best be minimised? How can comfort levels be enhanced while simultaneously reducing environmental impact? These are the central questions for research and studies on road and rail vehicles of the next generation and beyond. This work focuses on individualised (personal) assistance systems that aim to further increase safety levels and to provide traffic users with situation-dependent assistance. Innovative road, rail and airport management solutions contribute to improving the effectiveness and efficiency of infrastructure usage. Traffic management systems and tailor-made decision aids provide key support for the emergency services in the event of major incidents or disasters. Traffic development and environmental aspects are viewed integrally, under consideration of their respective interactions, thereby embarking on new paths in the study of the transport system.

Aeronautics

European integration clearly shapes the aviation industry today. This is why the Aeronautics programme attaches importance to driving forward its networking with European partners, and especially with its French and Dutch partner organisations ONERA and NLR. The programme currently focuses on advancing and optimising cargo planes in cooperation with ONERA, on developing flight guidance technology in cooperation with the NLR, and on expanding the DLR-NLR wind tunnel network by integrating the wind tunnels operated by ONERA. In terms of content, this research has set its sights on the following strategic goals: raising safety standards, reducing aircraft noise and emissions, improving the cost-effectiveness and efficiency of the air transport system. The work on fixed-wing aircraft has been concentrated under the umbrella of DLR/ONERA

Total Costs: Research Field Transport and Space



Aircraft Research. While the helicopter research conducted under the heading of DLR/ONERA Rotorcraft Research focuses particularly on expanding the flight envelope by ensuring safe flight conditions, even under difficult weather conditions, and, at the same time, aims to improve the environmental compatibility of this air transport system. Another topic addresses efficient and environmentally-friendly propulsion systems. The research topic air traffic management involves research into safe and efficient air traffic control, especially at and in the vicinity of airports. Aviation and environment research is a horizontal, interdisciplinary topic. Scientists concentrate on air traffic with low pollutant and noise emissions, and questions of wake vortices.

Space

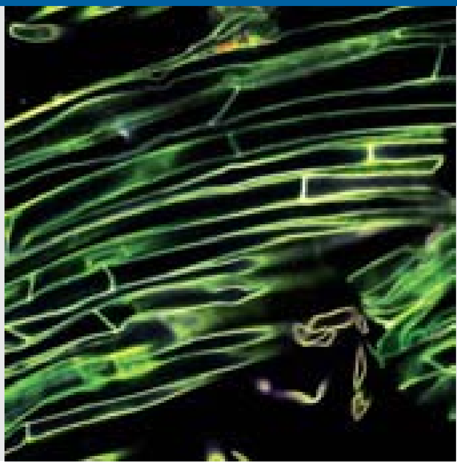
Among its various responsibilities, the Space research programme also contributes to creating a foundation for designing and operating new satellites whose data play an indispensable role today in meteorology, environmental monitoring, disaster prevention and management, and in resource management, mobility and peacekeeping. The six programme topics are integrated into the German Space Programme. In the field of Earth observation, the DLR is the only European institution to address satellite remote sensing "end to end", i.e. from sensor definition via realisation through to data reception and processing. Research on communication and navigation includes the optimisation of mobile, satellite-based broadband communications and the development and operability of GALILEO, the European satellite navigation system. Space transport is another research topic that aims to secure Europe’s access to space. Sharing the work with European partners, the researchers concentrate on rocket propulsion systems, especially thrust chamber technologies, high-temperature fibre ceramics and aerothermodynamics. The rocket propulsion tests performed at the DLR are a key part of the Ariane programme. Space exploration, especially into how the planetary system developed, and the search for water deposits and traces of life on other planets is a further space research topic. Research under space conditions essentially addresses questions relating to the efficient operation of the International Space Station (ISS). Space flight systems engineering is the sixth and final topic and rounds off the programme in technological terms. Research on this involves developing remote-controlled, partly self-sufficient robots that can be used in space, whilst also having applications in industry.

THE ERWIN SCHRÖDINGER PRIZE
THE SCIENCE PRIZE OF THE STIFTERVERBAND

HOW BACTERIA OPTIMISE THEIR STRATEGIES

An interdisciplinary research team from the GSF – National Research Center for Environment and Health, the University of Bonn, and the TU München have gained pioneering insights into how bacterial communities communicate.

In recognition of their work on analysing bacterial strategies in complex, natural environments, the team has been awarded the Erwin Schrödinger Prize – the Science Prize of the joint initiative of German industry to promote science and higher education (Stifterverband für die Deutsche Wissenschaft). This annual prize is worth 50,000 euros and is alternately financed by the Stifterverband and the Helmholtz Association. “The prize highlights research findings produced in close collaboration between participating disciplines,” emphasised Prof. Dr. Jürgen Mlynek. The collaboration in this project is an absolutely exemplary case. The prizewinners come from the fields of biology and mathematics and have worked together to establish a completely new, forward-looking theory on bacterial communication that can be applied to both medical and ecological questions. Bacteria do “communicate” with each other. They send chemical messengers that are picked up by their conspecifics. But what do they actually talk about? And how do they then realise what they have to do? Bacterial communities are capable of astonishingly complex, collective actions. For example, they are able to form biofilms or to produce substances helping them to survive under adverse conditions. Originally, the microbial communication was discovered in the lab under greatly simplified conditions. Cultures of the bioluminescent bacterium *Vibrio fischeri* begin to light up when they reach a specific cell density (quorum). The cells apparently conceive released signal molecules as the trigger signal for the cooperative chemical luminescence reaction which is dependent on the cell density (quorum sensing). However, this explanation does have a weakness. Cells that spare their metabolism also profit from the bioluminescence of their conspecifics. This would mean that such “cheaters” sooner or later reproduce more quickly and so lead to the downfall of the cooperative phenomenon. The alternative explanation works without cooperation: The concentration of signal molecules could also simply inform the bacteria of how much free space is available in their direct environment (diffusion sensing).



MICROCOLONIES OF BACTERIA COMMUNICATE THROUGH SIGNALLING MOLECULES: THE PRODUCERS OF THESE SIGNALLING MOLECULES LIGHT UP RED, WITH NON-STIMULATED SENSORY CELLS GREEN AND STIMULATED CELLS YELLOW. Photo: GSF Department of Microbe-Plant-Interaction

However, both theories ignore the importance of the bacteria's spatial distribution in their habitat. Now, a group of biomathematicians and biologists from the GSF, the TU München and the University of Bonn has shown that bacteria use an overriding strategy in complex, natural environments. Only in simple extreme cases can this strategy be reduced to diffusion sensing or quorum sensing. With this overall strategy, "efficiency sensing", bacteria can determine whether it is actually worth their while to invest their energy in the environment so as to produce and release antibiotics or form a biofilm.
The scientists examined the habitat on root surfaces in the soil, the rhizosphere. An interwoven, highly-complex, small-area mixture of solids, gels, fluids and gases exists here in which countless organisms "chat" with everybody and anybody. Dr. Burkhard Hense and Dr. Christina Kuttler from the GSF Institute of Biomathematics and Biometry collaborated closely with Prof. Dr. Anton Hartmann and Dr. Michael Rothballer from the GSF Department of Microbe-Plant-Interaction (AMP), with Prof. Dr. Johannes Müller from the TU München and with theoretical biologist Dr. Jan-Ulrich Kreft from the University of Bonn to model this example.
Hense and Kuttler were able to show that communication in the rhizosphere not only depends on the cell density or the size of the living space, but also strongly on the spatial distribution of the bacteria. The microbes always sense a mixture of cell density, cell distribution and diffusion limitation from the spatial conditions, and the precise circumstances determine which aspect eventually prevails. The cheater problem is solved by the closely-related organisms living together in clonal microcolonies on the root surfaces. As relatives are located very closely, the cooperation is "worth it" from a genetic perspective, and strangers remain largely excluded.
"The prizewinners have thus presented a theory for the first time that shows the great benefit and manifold functions of bacterial communication. And their theory can now be applied to a wide range of medical and ecological problems," writes one of the expert referees who evaluated the work. This particularly successful kind of interdisciplinary collaboration opens up new perspectives on the field of bacterial communication and, in the long term, is likely to reveal new ways of specifically intervening in the bacterial messaging system. For example, in farming, to support certain soil bacteria, or in medicine, where it could be used to prevent the formation of biofilms in the case of bacterial infections.

THE PRIZEWINNERS

Dr. Burkhard A. Hense and Dr. Christina Kuttler,
GSF/Institute of Biomathematics and Biometry
Prof. Dr. Johannes Müller, TU München, Centre for Mathematical Sciences and GSF/Institute of Biomathematics and Biometry
Dr. Michael Rothballer and Prof. Dr. Anton Hartmann,
GSF/Department of Microbe-Plant-Interaction
Dr. Jan-Ulrich Kreft, University of Bonn, Theoretical Biology

PEOPLE AND FINANCES

The following pages document how we invest our resources. Our staff are our most important resource. It is their ideas, creativity, dedication and commitment that drive science and research forward.

PARTNER IN THE PACT FOR RESEARCH AND INNOVATION

The Helmholtz Association is committed to making its contribution to growth and prosperity as set out in its Mission. The Initiative and Networking Fund plays a crucial role.

Excellence through competition, research that benefits science and society equally, plus strong strategic partnerships. These are the key resources with which the Helmholtz Association aims to achieve the goals of the Pact for Research and Innovation. At the same time, we are additionally intensifying our support for young researchers, are opening up career paths in the Helmholtz Association.

Building on the reliable planning basis provided by the Pact's guaranteed funding for the period up to 2010, the Helmholtz Association launched a number of measures that aim to implement this concept with particular quality. On the one hand, the measures will be put into practice with the core budget provided by the system of programme-oriented funding. On the other, they will also include new schemes financed by a further funding instrument: The Initiative and Networking Fund.

Assuring quality, instilling impetus

In many ways, the Initiative and Networking Fund complements the grant procedures established in the programme-oriented funding system. This applies both in respect of term and topic. Firstly, the Fund opens the way for responding immediately and flexibly and for providing impulses wherever strategic research goals need to be met quickly. Secondly, structural innovations, like closer networking with partner institutions at home and abroad, can be specifically supported by the Initiative and Networking Fund to drive developments forward. Indeed, the Pact for Research and Innovation has made it possible to strengthen the Fund by increasing the available budget to 42m euros in 2007 and then to 57m euros in 2008.

The key innovation in 2006 is to be seen in the new Helmholtz Alliances funding line, which has set itself a double objective, namely to achieve strategic goals and to encourage structural innovations. Up to 7.5m euros per Alliance and year are available, half funded by the Initiative Fund and half by the partner consortium.

Excellence through competition

Essentially, the Pact for Research and Innovation aims to assure outstanding quality in research. The Helmholtz Association turns this objective into reality by awarding funds almost exclusively through competition. This competitive principle applies both to the core budget of the Helmholtz Centres provided via the programme-oriented funding system and to the grants awarded by the Initiative and Networking Fund. Project quality is assured through peer review. In 2006 alone, the Calls for Proposals issued under the Initiative and Networking Fund involved more than 200 largely international, honorary experts serving on the review panels as referees for the Helmholtz Association.

Benefiting science and society

Equipped with funds from the Pact for Research and Innovation and in accordance with its Mission, the Helmholtz Association studies and investigates topic fields of great social relevance. The new Berlin-Brandenburg Center for Regenerative Therapies is but one example from the field of public health. The centre is jointly run by the Charité University Medicine Berlin and the Helmholtz Association, which invested 10m euros in the project. Once again, this demonstrates the Helmholtz Association's strength in addressing future topics across and beyond disciplinary and institutional borders.

The federal and state governments decided rightly on which path to take in science and research when they launched the Pact for Research and Innovation. Photo shows: Federal Research Minister Dr. Annette Schavan at the Alfred Wegener Institute

Another major project from the Research Field Health highlights the Helmholtz Association's particular capacity for pursuing novel methods across the various disciplines. The Helmholtz Initiative on Systems Biology sets out to explore the causes of complex diseases in a holistic approach and to develop new therapy lines. This centre-embracing, interdisciplinary research project aims to take a systematic approach to explaining cellular processes so that a deeper insight can be gained into the origin and development of common diseases of the cardiovascular system, the brain, and the nervous system, as well as cancer. The result will contribute to advancing the diagnosis, prevention and therapy of these diseases. The initiative will receive some 24m euros of financial support from the Initiative and Networking Fund between 2007 to 2011. The Helmholtz Centres and their project partners will additionally invest around the same amount in the form of matching funds.

> The key innovation in 2006 is to be seen in the new Helmholtz Alliances funding line, which has set itself a double objective, namely to achieve strategic goals and to encourage structural innovations.

The Helmholtz Association also invests funds from the Pact for Research and Innovation in the Research Field Energy to solve problems that are essential to our society. Faced by climate change and the fact that we will not be able to stop using fossil fuels over the next few decades, it is technologies for emission-free power stations that top the list of the advances that need to be made. Hence, scientists from four Helmholtz Centres (Forschungszentrum Jülich, GKSS Research Centre Geesthacht, Deutsches Elektronen-Synchrotron DESY, Hahn-Meitner-Institut Berlin) have created an alliance with partners from German and international universities and from industry to develop ceramic membranes that are able to filter out harmful substances and carbon dioxide from coal-fired power stations and so reduce the emissions. This Helmholtz Alliance will receive a total of around 22m euros over its three-year term.

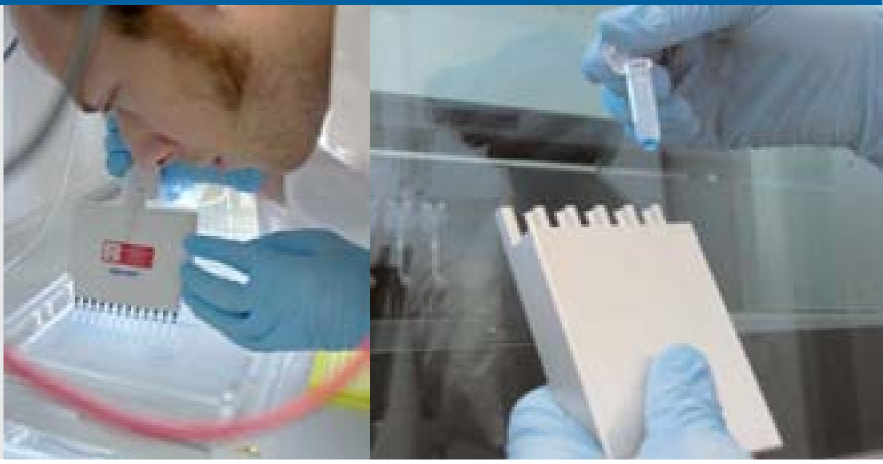
Building strong partnerships

The Helmholtz Association is a strong partner of the universities. The Association attaches great importance to engaging in strategic partnerships in core research areas and to training young scientists and researchers. Quality not quantity is the criterion by which success is measured. Indeed, this is also confirmed by the successes that we are able to share with others.

> The Association attaches great importance to engaging in strategic partnerships in core research areas and to training young scientists and researchers.

Helmholtz Association Centres made a substantial contribution as major partners in both rounds of the Initiative for Excellence. The first Call for Proposals saw four Graduate Schools, six Excellence Clusters and one Future Concept approved as collaborative projects with the University of Karlsruhe. In the second round, six Graduate Schools and three Excellence Clusters were successful, as were two Future Concepts, one in collaboration with the University of Heidelberg and the other with the RWTH Aachen.

With the Future Concept approved for the Karlsruhe Institute of Technology (KIT), the research capacities of the participating institutions – Excellence University and national Helmholtz Centre – are currently being united to create thematically-focused Centres and Core Areas under the Initiative for Excellence. In energy research, optics and nanosciences, KIT not only aims to offer top-flight research and excellent academic training, but also intends to serve as an outstanding centre of lifelong learning, of extensive continuing training, and of scientist and researcher exchange. Measures to interlink the supervisory and executive management bodies are now being prepared so as to establish a basis for the strategic partnership, in particular, a coordinated and harmonised appointments policy and a comprehensive package of measures to promote young scientists and researchers.



Promoting cooperation

The Helmholtz Association is pursuing innovative paths in the Initiative for Excellence and with the funding instruments of the Initiative and Networking Fund, in order to intermesh the universities with the centres even more closely in terms of content and organisation. The new funding line of Helmholtz Alliances also contributes particularly to this. An outstanding example is provided by the Helmholtz Alliance on “Physics at the Terascale” that was approved in May 2007. Under the group leadership of DESY, this alliance unites the key activities performed by the German particle physics community in connection with the experiments that are now beginning on the Large Hadron Collider at CERN, Geneva. In turn, this gives the German institutions a united front in their work on the international stage. Besides DESY, the other group members are the Research Center Karlsruhe, a Max Planck Institute and 17 universities.

The Helmholtz Association’s Virtual Institutes represent a special form of cooperation in which scientists and researchers join up with each other to form multi-locational and cross-institutional teams that then collaboratively address research topics, supported by start-up funding from the Initiative and Networking Fund of between 250,000 and 300,000 euros per year over a term of three years. A substantial proportion of these funds benefit the participating universities.

> The Helmholtz Association’s Virtual Institutes represent a special form of cooperation in which scientists and researchers join up with each other to form multi-locational and cross-institutional teams.

Ten new Virtual Institutes were founded in 2006. This means that a total of 77 such collaborations have been funded by the Helmholtz Association since 2003, when the first call for proposals for this funding programme was announced. That such investments do pay off has been confirmed by the express willingness of partners to continue the cooperation, even beyond the end of the Helmholtz funding term. A survey of project coordinators saw more than half the participants report that they had already raised further external funds with their Virtual Institute partners. Indeed, the Virtual Institute on “Virtual Reality 3D-Reconstruction Modelling of Objects” is one of the most outstanding examples in this respect. In fact, its institutional sponsors, Deutsches Zentrum für Luft- und Raumfahrt and TU München, plus the Cluster on “Cognitive Technical Systems”, successfully competed in the Initiative for Excellence launched by federal government and the federal states.

Large-scale facilities as focal points for cooperation

One of the centrepieces of the Helmholtz Association Mission focuses on advancing the development of large-scale facilities. On the one hand, the Helmholtz Association conducts its own research in this area and, on the other, in its capacity as a partner in these large-scale facilities, it contributes substantially to enhancing Germany’s scientific infrastructure and to internationalising German science and research. The prime major international projects include the European Free-Electron X-Ray Laser (XFEL) (construction start date: June 2007) and the particle accelerator FAIR. The Helmholtz Centres participating in these two projects in Hamburg and Darmstadt have also been commissioned with leading both projects forward. However, Germany’s taxpayers are not alone in financing these two facilities. Germany is paying around 60 per cent of the total costs of around 1 billion euros for the XFEL project in Hamburg. European partners pay the remainder. Top-flight researchers from all around the world will come to Germany to work on XFEL.

The Helmholtz Centre for heavy ion research, GSI, in Darmstadt is the ideal location for FAIR. It already has accelerators that are capable of feeding FAIR with fast particles from which exotic nuclei and antiprotons can then be generated for the physicists’ experiments. Germany will pay around 75 per cent of the FAIR costs, i.e. around another billion euros. Our European partners and India will provide the remaining 25 per cent. But, the Helmholtz Association also plays its part in large-scale facilities located outside Germany. For example, it contributes the German share to ITER, an experimental reactor being built in Cadarache, France, thereby promoting cooperation in the

The Pact for Research and Innovation gives research the necessary freedom for its further development. As a partner in this innovation offensive, the Helmholtz Association is, in return, committed to contributing to growth and prosperity: this means a concentration on excellence, on new forms of cooperation and networking, on supporting young scientists, as well as on developing new approaches for fostering innovation.

international community of fusion scientists. ITER will test whether generating energy through nuclear fusion is technically possible and economically viable.

International networking

By cooperating with partners in the European Research Area, the Helmholtz Association has been able to record some extraordinary successes. In fact, the success rate for proposals submitted by Helmholtz scientists to the 6th Research Framework Programme came to around 36 per cent, in contrast to the European average of around 22 per cent and the national average of 24 per cent. Most research funds were raised in the fields of health and research infrastructures, followed by aerospace research.

However, the Helmholtz Association also initiates projects that extend beyond the EU as well as important international partnerships, such as in India, Russia and China. Initially, these activities are pursued on a smaller scale, albeit that they then serve as door openers for larger and long-term projects.

> By cooperating with partners in the European Research Area, the Helmholtz Association has been able to record some extraordinary successes.

The Russian Foundation for Basic Research (RFBR) and the Helmholtz Association signed a joint funding agreement for German-Russian research groups in September 2006. Four Helmholtz-Russian-Joint-Research Groups will be established each year between 2007 and 2010 to intensify scientific cooperation between the Helmholtz Centres and Russian scientific research organisations and universities. To achieve this, Russian and German research capacities have been concentrated to form Centres of Excellence of international visibility and of great appeal to researchers all around the world.

To support the exchange of scientists and cooperation between China and Germany, the China Scholarship Council (CSC) and the Helmholtz Association reached an agreement last year on funding young Chinese scientists and researchers. The Helmholtz Association Centres have invited applications for 50 doctoral and postdoctoral student positions, with the doctoral students either gaining their doctorate in China or at a German university. They will be jointly selected by German scientists and the CSC.

Discovering, promoting and supporting talents

Helmholtz Association initiatives on promoting young scientists and researchers set high standards and so put one of the key objectives of the Pact for Research and Innovation into practice. The Initiative and Networking Fund itself sets important trends in this field.

The broad range of funding lines includes the Young Investigators Group programme. This offers applicants from home and abroad – who have held a doctorate for between two and six years and who have submitted the best proposals – the opportunity to set up and head their own research groups, to gain early scientific independence, plus the option of a tenured position. The latter is unique in Germany. Helmholtz Graduate Schools and Helmholtz Research Schools have been set up at the Helmholtz Centres to support researchers who are still in their doctoral stage. The Research Schools offer thematically-focused doctoral groups and the Graduate Schools a cross-disciplinary structure under one roof. Both schools serve to assure that high quality doctoral theses continue to be produced in the Helmholtz Association.

However, activities aimed at promoting young scientists and researchers also extend beyond the usual target groups of doctoral and postdoctoral students. The newly-established Helmholtz Academy for Science Management promotes careers in science management. On the other hand, special funding of 10m euros was approved at the beginning of 2007 to advance the vocational training offered at the research centres. And last but not least, the Helmholtz Association is one of the few institutions that also supports pre-academic research careers, namely through its initiatives “Tiny Tots Science Corner” for kindergarten kids and “School Labs” for school pupils.

PERFORMANCE RECORD 2006

In addition to the institutional funding provided by federal government and the federal states totalling 1.653 billion euros, the Helmholtz Centres additionally raised external funds worth 696 million euros in total in 2006.

The external funds raised in the applications-oriented research fields largely originate from cooperation with business and industry, while the external funding generated by the more basic research-oriented fields comes mostly from research grants won in competition with other organisations, for example in funding programmes run by the European Union, the German Research Foundation (DFG) or the ministries. The relatively high amount of external funding confirms the great appeal that Helmholtz research has for science and industry.

With the introduction of programme-oriented funding, the Helmholtz Centres began to systematically catalogue programme progress not only on the basis of activity reports, but also on that of quantitative success indicators.

This involves each programme being reviewed by external experts. Depending on the programme's respective roles and goals, the criteria and benchmarks that indicate how successful the work of a specific programme has been will differ from case to case. However, certain common aspects can generally be seen as characteristic of successful work. They above all include scientific excellence, as well as engaging in cooperation with industry and promoting young academics.

Some of our achievements, for example, in developing and delivering concrete solutions to problems faced by society, cannot, however, be adequately represented in rigid and inflexible schemata. Contributions of these kinds are best illustrated by concrete examples, such as those presented in the first part of this annual report.

The Helmholtz Association concentrates its resources in programmes to perform top-rate research in its research fields: Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space.

Scientific Excellence

- 12,000 scientific publications – two thirds of which appearing in ISI-cited specialist journals (2006)
- 1,500 books published in 2006
- Up to 50 habilitations and 70 Helmholtz researchers appointed to professorships at universities (W2/W3 grades) every year
- 5,700 collaborative research projects; participation in 95 DFG Priority Programmes and 86 Collaborative Research Centres (SFBs)

Partner of Industry

- Helmholtz scientists annually register 400 patents and have property rights on a total of 10,300 patents.
- They sign around 400 licence agreements each year and have an annual licence revenue of 11 million euros.
- 2006 saw seven companies established as spin-offs by Helmholtz researchers.
- The Helmholtz Association cooperates with industry in more than 2,000 collaborative projects – one third also involving international partners.
- A total 696 million euros in external funds was raised in 2006.

Promoting Young Academics

- Some 3,800 doctoral students supervised in 2006.
- In addition, there were 1,440 post-docs, and 132 young investigators groups, 68 of which with funding from the Initiative and Networking Fund.
- Helmholtz Centres involved in 40 DFG Research Training Groups.
- Centre participation in 65 Marie Curie measures.
- A total of twelve junior professors in 2006.
- Around 1,000 Helmholtz scientists delivered 2,850 semester credit hours of teaching at universities (summer semester 2005/2006).
- The Helmholtz Association promotes continuous, uninterrupted research by supporting young scientists through family-friendly measures (childcare services, career re-entry programmes).
- It operates 22 School Labs and the “Tiny Tots Science Corner” initiative to ensure that we develop young researchers for the future.
- In 2006 1,613 trainees and apprentices were trained at the Helmholtz Association. This corresponds to 7.1 per cent of the total staff (excluding doctoral students).

Staff

Scientific Staff

The Helmholtz Association has a total of 26,500 staff, of which 8,000 are scientists and researchers, and 3,800 are supervised doctoral students. Just under 50 per cent of our staff work in areas of science and research.

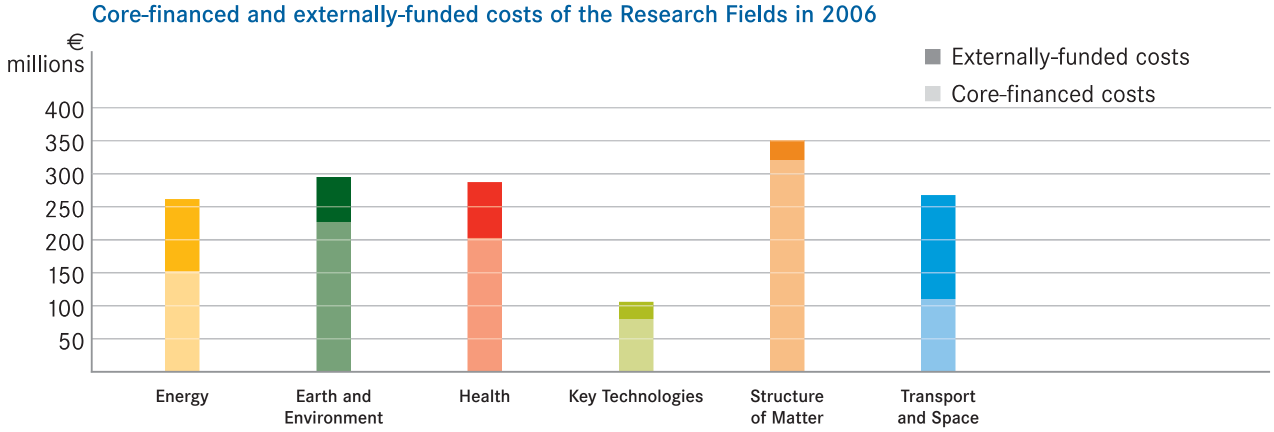
Proportion of Women

Women account for 20 per cent of all scientists and researchers at Helmholtz. However, 36 per cent of our young researchers and investigators are women. And, the number of women working as heads of institutes or departments is showing an upward trend. Women hold a 14 per cent share of the management positions in the scientific, technical, and administrative fields. Women fill 13 per cent of the science management positions at Helmholtz. 23 per cent of the 60 newly-appointed science management positions were taken by women in 2006.

Guests at the Helmholtz Association

In 2006, the Helmholtz Association was once again able to welcome numerous guests on research visits. In fact, more than 3,700 scientists and researchers from all around the world came to use the research opportunities that are available at the Helmholtz Centres. The leading countries of origin were Russia with more than 500 scientists, Poland (350), plus China and Italy (each of which sent more than 200 scientists; all figures date from 2005).

Core-financed and externally-funded costs of the Research Fields in 2006



PROGRAMME-ORIENTED FUNDING

Since the introduction of programme-oriented funding, the Helmholtz Association has made the costs and human resources of each programme transparent, beginning in 2003.
Programme-oriented funding is the principle on which research funding in the Helmholtz Association is based. This means doing science in line with the Helmholtz Research Programmes and involves scientists and researchers cooperating across institutional and disciplinary borders. But it also means Helmholtz Centres and Programmes competing for research budgets which are set for each programme term on the basis of strategic-programmatic peer reviews.

Non-programme-bound research

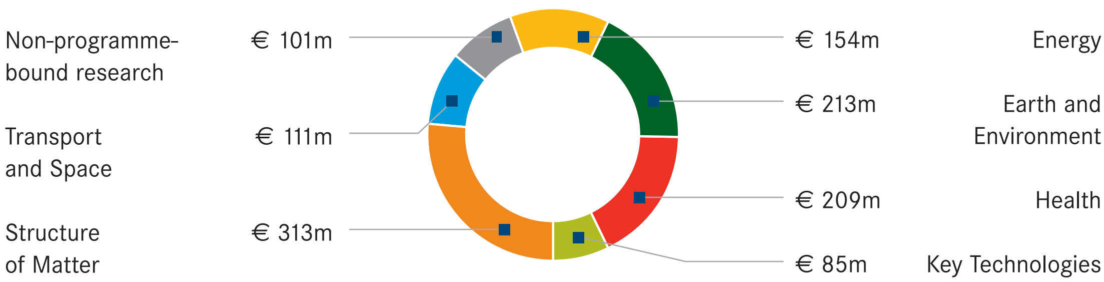
The Helmholtz Centres use a system of non-programme-bound research to address new scientific questions and new approaches to research, to expand knowledge and science and to prepare significant strategic projects. The funding available to this non-programme-bound research is dependent on how successful the centres' individual programmes are in the competition for their programme-oriented funding; because the non-programme-bound research budget is calculated as 20 per cent of the total programme funds which centres raise.

Special tasks

The term "special tasks" stands for work done by the centres independently of their scientific research role and objective. Typical examples of special tasks include the vocational training of young people in a wide range of technical and commercial occupations or the performance of special scientific-technical and administrative management assignments on behalf of federal government (Bund) and federal state (Länder) ministries.

Costs of the Helmholtz Association 2007

Planned core-financed R&D costs for 2007, financed within the scope of programme-oriented funding.



COSTS AND STAFF OF THE HELMHOLTZ ASSOCIATION 2006

The total costs are made up of the core-financed and externally-funded costs. They are shown arranged by Research Fields and Helmholtz Centres. The total staff capacity of the Helmholtz Association is shown parallel to this.

	Sum	AWI	DESY	DKFZ	DLR***	FZJ**	FZK	GFZ
Costs 1) of the Helmholtz Association								
Costs 1) for research and development	**1,606**	87	140	92	315	209	198	59
Infrastructure - costs 1)	**536**	18	65	33	80	111	62	12
Special tasks - costs 1)	**207**	1	2	5	73	15	38	1
Sum: costs 1) (programme-oriented funding)	**2,349**	**106**	**207**	**130**	**468**	**334**	**297**	**72**
Staff 2) of the Helmholtz Association								
Staff 2) for research and development	**13,968**	655	987	1,323	2,635	1,558	1,932	410
Infrastructure - staff 2)	**5,882**	129	575	280	994	1,245	866	116
Special tasks - staff 2)	**2,692**	34	127	138	881	351	568	40
Sum: staff 2) (programme-oriented funding)	**22,542***	**818**	**1,688**	**1,742**	**4,510**	**3,154**	**3,365**	**566**
Breakdown of the costs and staff for research and development arranged by Research Fields								
Energy								
Total costs 1)	**261**				28	52	53	14
Total staff 2)	**1,935**				194	455	505	24
Earth and Environment								
Total costs 1)	**296**	84				28	54	44
Total staff 2)	**2,599**	599				290	530	370
Health								
Total costs 1)	**287**			82		24	15	
Total staff 2)	**3,369**			1,162		216	158	
Key Technologies								
Total costs 1)	**106**					45	44	
Total staff 2)	**896**					259	485	
Structure of Matter								
Total costs 1)	**351**		140			60	32	
Total staff 2)	**2,462**		987			333	254	
Transport and Space								
Total costs 1)	**266**				266			
Total staff 2)	**2,234**				2,234			
Non-programme-bound research								
Total costs 1)	**39**	3		11	20	0.4		1
Total staff 2)	**473**	56		162	207	4		17
Costs 1) for research and development	**1,606**	**87**	**140**	**92**	**315**	**209**	**198**	**59**
Staff 2) for research and development	**13,968**	**655**	**987**	**1,323**	**2,635**	**1,558**	**1,932**	**410**

* In terms of natural persons, the Helmholtz Association employs 26,558 staff.

** In addition, the FZJ received 6.5m euros for the "Biotechnology" Programme, which is exclusively funded by the state of North Rhine-Westphalia.

1) in million euros (rounded figures)

2) in FTEs (full-time equivalents)

GKSS	GSF	GSI	HMI	HZI	IPP	MDC	UFZ	
								Costs 1) of the Helmholtz Association
54	91	69	55	40	100	50	48	Costs 1) for research and development
13	25	27	18	10	34	12	16	Infrastructure - costs 1)
17	43	0.5	3	1	6	1	1	Special tasks - costs 1)
84	**158**	**97**	**75**	**52**	**140**	**63**	**65**	**Sum: costs 1) (programme-oriented funding)**
								Staff 2) of the Helmholtz Association
432	993	652	406	369	605	527	485	Staff 2) for research and development
173	303	253	192	107	320	162	170	Infrastructure - staff 2)
53	244	32	72	35	35	35	49	Special tasks - staff 2)
657	**1,540**	**937**	**670**	**511**	**960**	**723**	**703**	**Sum: staff 2) (programme-oriented funding)**
								Breakdown of the costs and staff for research and development arranged by Research Fields
								Energy
			15		99			Total costs 1)
			164		593			Total staff 2)
								Earth and Environment
15	17			8			45	Total costs 1)
152	177			33			448	Total staff 2)
								Health
6	74	2	1	32		49	2	Total costs 1)
73	816	33	16	334		527	34	Total staff 2)
								Key Technologies
17								Total costs 1)
152								Total staff 2)
								Structure of Matter
15		67	38					Total costs 1)
44		619	226					Total staff 2)
								Transport and Space
								Total costs 1)
								Total staff 2)
								Non-programme-bound research
1				0.3	0.6	0.5	0.1	Total costs 1)
11				2	12		3	Total staff 2)
54	**91**	**69**	**55**	**40**	**100**	**50**	**48**	**Costs 1) for research and development**
432	**993**	**652**	**406**	**369**	**605**	**527**	**485**	**Staff 2) for research and development**

*** In addition to the programme-oriented funding of the Helmholtz Association, the DLR additionally receives institutional funding from other sources each year (e.g. BMVg, special grants) that has not been considered here amounting to approx. 40m euros.

EXECUTIVE COMMITTEE AND CENTRAL BODIES

President

President
Prof. Dr. Jürgen Mlynek

Executive Committee

Vice-President for the Research Field Energy
Prof. Dr. Eberhard Umbach, Chairman of the Executive Board, Forschungszentrum Karlsruhe

Vice-President for the Research Field Earth and Environment
Prof. Dr. Georg Teutsch, Scientific Director, Helmholtz Centre for Environmental Research – UFZ

Vice-President for the Research Field Health
Prof. Dr. Otmar D. Wiestler, Chairman of the Management Board, German Cancer Research Center

Vice-President for the Research Field Key Technologies
Prof. Dr. Achim Bachem, Chairman of the Board of Directors, Forschungszentrum Jülich

Vice-President for the Research Field Structure of Matter
Prof. Dr. Albrecht Wagner, Chairman of the Board of Directors, Deutsches Elektronen-Synchrotron DESY

Vice-President for the Research Field Transport and Space
Prof. Dr. Johann-Dietrich Wörner, Chairman of the Executive Board, Deutsches Zentrum für Luft- und Raumfahrt

Administrative Vice-President
Klaus Hamacher, Vice-Chairman of the Executive Board, Deutsches Zentrum für Luft- und Raumfahrt

Administrative Vice-President
Dr. Bernhard Raiser, Administrative Executive Board, GFZ GeoForschungsZentrum Potsdam

Members of the Senate

ELECTED MEMBERS

Prof. Dr. Max M. Burger
Chairman Novartis Science Board, Novartis International AG, Basel/Switzerland

Prof. Dr. Ralph Eichler, President of the ETH, Zurich/Switzerland

Prof. Dr. Ellen Ivers-Tiffée, University of Karlsruhe, Institute of Materials for Electrical Engineering

Prof. Dr. Joachim Milberg, Chairman of the Supervisory Board, BMW Group, Munich

Dr. Detlef Müller-Wiesner, Senior Vice-President of EADS Corporate Research Center, France

Prof. Dr. Mary Osborn, Max Planck Institute for Biophysical Chemistry, Göttingen

Prof. Dr. Peter Paul, Brookhaven National Laboratory, Upton/USA

Prof. Dr. Klaus Töpfer, former Under Secretary General and Executive Director of the Environment Programme of the United Nations

Dr. Bärbel Voigtsberger, Managing Director, inocermic GmbH, Hermsdorf

Prof. Dr. Ulrich Wagner, Technical University Munich, Chair of Institute for Energy Economy and Application Technology

Prof. Dr. Claus Weyrich, former member of the Cooperate Executive Committee, Siemens AG, Munich

Prof. Dr. Alexander J. B. Zehnder
President of the ETH Board, ETH Centre, Zurich/Switzerland

EX OFFICIO SENATE MEMBERS

Prof. Dr. Peter Frankenberg, Minister for Science, Research and the Arts of the State of Baden-Württemberg, Stuttgart

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

Dr. Robert Heller, Councillor of State, Department of Finances of the City of Hamburg

Michael Kretschmer, Member of the German Bundestag, Berlin

Prof. Dr. Jürgen Mlynek, President of the Helmholtz Association

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SCIENCE PRIZES FOR SCIENTISTS AND RESEARCHERS FROM THE HELMHOLTZ ASSOCIATION

A | **Acta Materialia Gold Medal**
Prof. Dr. Herbert Gleiter (2007), Forschungszentrum Karlsruhe

B | **Karl Heinz Beckurts-Preis**
Prof. Dr. Knut Urban, Prof. Harald Rose (2006, with partners), Forschungszentrum Jülich

BioFuture, winner of the BMBF competition
Prof. Dr. Erich Wanker (2006), Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

Felix Burda Award, Category „Medical Prevention"
Prof. Dr. Hermann Brenner (2006), German Cancer Research Center

C | **Communicator-Preis**
Team headed by
Prof. Dr. Heinrich Miller (2007), Alfred Wegener Institute for Polar and Marine Research

D | **Descartes Prize for Research from the European Union**
Prof. Dr. Martin Wegener (2006), **Dr. Stefan Linden**, Forschungszentrum Karlsruhe

Descartes Prize for Research from the European Union
Dr. Christian Sattler/Sollab (2007, with partners), Deutsches Zentrum für Luft- und Raumfahrt

German Cancer Award 2006
Prof. Dr. Martin Göttlicher, GSF – National Research Center for Environment and Health

German Cancer Award 2007
Prof. Dr. Achim Leutz, Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch
Prof. Dr. Lutz Gissmann, German Cancer Research Center

E | **The Paul Ehrlich and Ludwig Darmstaedter Prize for Young Researchers**
Dr. Ana Martin-Villalba (2006), German Cancer Research Center

European Young Investigator Award (EURYI)
Dr. Klaus Hallatschek (2006), Max Planck Institute for Plasma Physics

European Young Investigator Award (EURYI)
Dr. Dieter Chichung Lie (2006), GSF – National Research Center for Environment and Health

European Young Investigator Award (EURYI)
Dr. Igor Gornyi (2006), Forschungszentrum Karlsruhe

F | **Federation of European Biochemical Societies Letters Young Investigator Award**
Dr. Theresia Stradal (2006), Helmholtz Centre for Infection Research

Humboldt Research Award
Prof. R.T. Lahey, jun. (2005/2006), Forschungszentrum Karlsruhe

Research Prize for Oncology from the H.W.&J.-Hector-Stiftung
Dr. Selma Ugurel (2006), German Cancer Research Center

G | **Go-Bio competition, Federal Minister of Education and Research**
Dr. Igor V. Tetko (2006), GSF-National Research Center for Environment and Health

H | **Hansen Family Prize for special contributions to biology and medicine**
Prof. Dr. Magdalena Götz (2006), GSF – National Research Center for Environment and Health

Mechthild Harf Award
Prof. Dr. Hans-Jochem Kolb (2006), GSF – National Research Center for Environment and Health

Von Hippel Award (Materials Research Society)
Prof. Dr. Knut Urban (2006), Forschungszentrum Jülich

I | **Imagining the Future (Roche Applied Science 2006), 1st prize in competition**
Prof. Dr. Jan Buer, Helmholtz Centre for Infection Research

J | **Japan Prize, Category "Innovative Devices Inspired by Basic Research"**
Prof. Dr. Peter Grünberg (2007, with partners), Forschungszentrum Jülich

Young Academy of the Berlin-Brandenburg Academy of Sciences and Humanities and the German Academy of Natural Scientists Leopoldina, membership and prize
Prof. Dr. Anke Jentsch (2007), Helmholtz Centre for Environmental Research – UFZ

Awards endowed with over 10,000 euros in the years 2006/2007, status as of 30.6.2007*

L | **Lehrpreis from the State Rheinland-Pfalz**
Dr. Klaus Blaum (2007), Gesellschaft für Schwerionenforschung

Gottfried Wilhelm Leibniz Prize from the German Research Foundation
Prof. Dr. Gerald Haug (2006), GFZ GeoForschungsZentrum Potsdam

Gottfried Wilhelm Leibniz Prize from the German Research Foundation
Prof. Dr. Magdalena Götz (2006), GSF – National Research Center for Environment and Health

N | **NaT-Working Award from the Robert Bosch Stiftung**
HIGH school of Science & Education @ the AWI, Alfred Wegener Institute for Polar and Marine Research

Novartis-Preis für therapierelevante pharmakologische Forschung
Prof. Dr. Frank Lyko (2007), German Cancer Research Center

P | **Robert Pfleger Research Prize**
Prof. Dr. Karl Zilles (2006), Forschungszentrum Jülich

R | **Walther und Christine Richtzenhain-Preis**
Dr. Fabian Kießling und **Dr. Ana Martin-Villalba** (2006), German Cancer Research Center, **Prof. Dr. Clemens A. Schmitt** (2006), Max Delbrueck Center for Molecular Medicine (MDC) Berlin-Buch

S | **Dr. Emil-Salzer-Preis of the State Baden-Württemberg**
Dr. Fabian Kießling (2006), German Cancer Research Center

Erwin Schrödinger Prize
Dr. Eckehart Speth, Dr. Hans-Dieter Falter, Dr. Peter Franzen, Dr. habil. Ursel Fantz and **Dr. Werner Kraus** (2006), Max Planck Institute for Plasma Physics

Dr. Willmar Schwabe Award from the Society for Medicinal Plant Research
Prof. Dr. Thomas Efferth (2006), German Cancer Research Center

Joachim-Siebeneicher-Promotions-preis für biomedizinische Forschung
Dr. Beate Straub (2006), German Cancer Research Center

T | **Technical Achievement Award from the International Partnership for the Hydrogen Economy IPHE**
Dr. Christian Sattler/Sollab (2006), Deutsches Zentrum für Luft- und Raumfahrt

W | **Felix-Wankel-Animal-Welfare-Research-Award**
Dr. Kristin Schirmer (2007), Helmholtz Centre for Environmental Research – UFZ

Wolf Prize
Prof. Dr. Peter Grünberg (2007, with partners),Forschungszentrum Jülich

Carl Zeiss Research Award
Prof. Dr. Martin Wegener, Prof. Dr. Kurt Busch (2006), Forschungszentrum Karlsruhe

Johann Georg Zimmermann Research Prize
Dr. Michael Boutros (2007), German Cancer Research Center

* NEW: NOBEL PRIZE IN PHYSICS 2007
Prof. Dr. Peter Grünberg (Forschungszentrum Jülich);
Prof. Albert Fert (University of Paris)

THE AWARD WINNERS OF THE HELMHOLTZ-HUMBOLDT RESEARCH PRIZE AWARDED BY THE HELMHOLTZ ASSOCIATION 2006/2007

Hendrikus Granzier
Washington State University, Pullman, USA (2006)
Francis Halzen
University of Wisconsin, Madison, USA (2006)
Marie-Louise Saboungi
Centre de Recherche sur la Matière Divise, Orléans, Frankreich (2007)
Holly J. Stein
Colorado State University, Fort Collins, USA (2007)
Laszlo Tora
Centre National de la Recherche Scientifique (CNRS), Illkirch-Cedex (2006)
Yogendra Pathak Viyogi
Institute of Physics, Bhubaneswar, Indien (2006)

THE GOVERNANCE STRUCTURE OF THE HELMHOLTZ ASSOCIATION

COMMITTEE OF FINANCING PARTNERS

The Committee of Financing Partners – federal government and host states – defines the research policy requirements, including the research fields, for a term of several years and appoints the members of the Senate.

SENATE

Besides the Assembly of Members, the externally appointed Senate is the central decision-making body of the Helmholtz Association. The members are "ex officio" representatives of federal and state authorities, parliament and science organisations, as well as public figures from science and industry who are elected for three years. The Senate consults on all major decisions, and elects the president and vice-presidents.

SENATE COMMISSION

The Senate established a Senate Commission which prepares its deliberations on the funding of the programmes, basing its decisions on the results of the programme evaluations, and its decision on investment prioritization, The Senate Commission is made up of permanent members – "ex officio" representatives of federal and state authorities – as well as experts covering the spectrum of the six research fields, and also alternating members depending on the research field under discussion.

PRESIDENT

A full-time president heads the Helmholtz Association and represents it externally. He takes on a leading role in the dialogue between science, industry and politics. He is responsible for preparing and implementing the senate's recommendations on programme-oriented funding. He coordinates the development of programmes for the research fields, the cross-centre controlling system, and the development of the association's general strategy.

VICE-PRESIDENTS

Eight vice-presidents support, advise and represent the president in the fulfilment of his duties. The six scientific vice-presidents are also the coordinators of the six research fields. A further two vice-presidents come from the centres' administrative bodies.

HEAD OFFICE

The Head Office supports the president and vice-presidents in the fulfilment of their duties.

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

RESEARCH FIELDS

Helmholtz scientists work in six, centre-overlapping research fields financed within the framework of programme-oriented funding. Their cross-centre research is performed with external partners in interdisciplinary and international collaborations.

ASSEMBLY OF MEMBERS

The Helmholtz Association is a registered association. Besides the Senate, the Assembly of Members is the central decision-making body of the association. The members are the scientific-technical and administrative directors of the member centres. The Assembly of Members is responsible for all of the association's tasks. It defines the framework for the cross-centre development of strategies and programmes, and has the right of proposal for the election of the president and members of the senate.

- Alfred-Wegener-Institut für Polar- und Meeresforschung
- Deutsches Elektronen-Synchrotron DESY
- Deutsches Krebsforschungszentrum
- Deutsches Zentrum für Luft- und Raumfahrt
- Forschungszentrum Jülich
- Forschungszentrum Karlsruhe
- GFZ GeoForschungsZentrum Potsdam
- Gesellschaft für Schwerionenforschung
- GKSS-Forschungszentrum Geesthacht
- GSF-Forschungszentrum für Umwelt und Gesundheit
- Hahn-Meitner-Institut Berlin
- Helmholtz-Zentrum für Infektionsforschung
- Helmholtz-Zentrum für Umweltforschung – UFZ
- Max-Delbrück-Centrum für Molekulare Medizin (MDC) Berlin-Buch
- Max-Planck-Institut für Plasmaphysik (Associate Member)

SITES OF THE HELMHOLTZ RESEARCH CENTRES

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www.gkss.de

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www.desy.de

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www.awi.de

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www.dlr.de

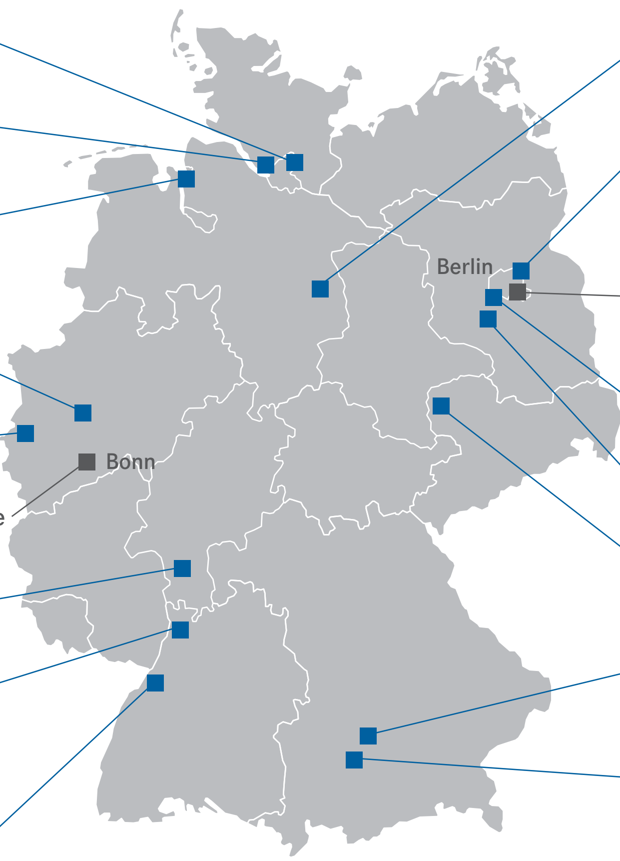
Forschungszentrum Jülich
www.fz-juelich.de

Helmholtz Association Reg. Office Head Office Bonn
www.helmholtz.de

Gesellschaft für Schwerionenforschung
www.gsi.de

German Cancer Research Center
www.dkfz.de

Forschungszentrum Karlsruhe
www.fzk.de



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

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

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www.helmholtz.de

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www.hmi.de

GFZ GeoForschungsZentrum Potsdam
www.gfz-potsdam.de

Helmholtz Centre for Environmental Research – UFZ
www.ufz.de

Max Planck Institute for Plasma Physics
www.ipp.mpg.de

GSF – National Research Center for Environment and Health
www.gsf.de

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Am Handelshafen 12, 27570 Bremerhaven
Telefon +49 471 4831-0, Telefax +49 471 4831-1149
E-Mail info@awi.de, www.awi.de

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E-Mail desyinfo@desy.de, www.desy.de

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E-Mail presse@dkfz.de, www.dkfz.de

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Telefon +49 6159 71-0, Telefax +49 6159 71-2785
E-Mail info@gsi.de, www.gsi.de

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DIRECTORATE: Prof. Dr. Wolfgang Kaysser, Scientific Director, Michael Ganß, Administrative Director

Max-Planck-Straße 1, 21502 Geesthacht
Telefon +49 4152 87-0, Telefax +49 4152 87-1403
E-Mail presse@gkss.de, www.gkss.de

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E-Mail oea@gsf.de, www.gsf.de

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E-Mail info@hmi.de, www.hmi.de

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Telefon +49 531 6181-0, Telefax +49 531 6181-2655
E-Mail kontakt@helmholtz-hzi.de, www.helmholtz-hzi.de

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DIRECTORATE: Prof. Dr. Georg Teutsch, Scientific Director, Dr. Andreas Schmidt, Administrative Director

Permoserstraße 15, 04318 Leipzig
Telefon +49 341 235-0, Telefax +49 341 235-2791
E-Mail info@ufz.de, www.ufz.de

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Robert-Rössle-Straße 10, 13125 Berlin-Buch
Telefon +49 30 9406-0, Telefax +49 30 949-4161
E-Mail presse@mdc-berlin.de, www.mdc-berlin.de

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Boltzmannstraße 2, 85748 Garching
Telefon +49 89 3299-01, Telefax +49 89 3299-2200
E-Mail info@ipp.mpg.de, www.ipp.mpg.de

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Helmholtz Association Registered Office
Ahrstrasse 45, 53175 Bonn, Germany
Tel. +49 228 30818-0, Fax +49 228 30818-30

Helmholtz Association
Communications and Media Relations
Berlin Office
Anna-Louisa-Karsch-Strasse 2, 10178 Berlin, Germany
Tel. +49 30 206329-0, Fax +49 30 206329-60
E-mail info@helmholtz.de, www.helmholtz.de

V.i.S.d.P.
Thomas Gazlig

Edited by
Dr. Angela Bittner (project leader)
Dr. Antonia Rötger (scientific editor)
Authors' abbr.: arö (Dr. Antonia Rötger),
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skar (Sascha Karberg)

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Helmholtz Association Registered Office
Ahrstrasse 45, 53175 Bonn, Germany