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Germany – Europe's leader in science



AN INITIATIVE OF THE

Federal Ministry
of Education
and Research

Research in
Germany



Land of Ideas

Message of Greeting



The world is facing major challenges. Future-oriented solutions to issues of climate protection, civil security or our future energy supplies can only be found on the basis of comprehensive research and the innovative development of technologies. Germany cooperates closely with its partners in this crucial task. The Federal Government laid the foundations for successful research and development funding in 2006 in its interdepartmental High-Tech Strategy for Germany. This ensures a dynamic interaction between science and industry and improves the framework conditions for new developments; it promotes talent and is the foundation for qualified jobs. In its further development of the High-Tech Strategy, the Federal Government is focusing on global forward-looking projects of the 21st century. We have to act in particular in the fields of climate protection and resource conservation, energy, health, mobility and security.

Expenditure on research and development has therefore been increased continually. The Federal Government is investing a total of 12 billion euros in education and research in the ongoing legislative period – more than ever before. Germany is thus highlighting its commitment to finding the answers to the most urgent issues of our time.

This brochure provides information on groundbreaking scientific projects and contains detailed reports on innovation in Germany. It presents research areas and the work of world-class researchers in Germany. Exchanges and cooperation between experts ensure quality and progress worldwide.

Become part of this fascinating process! Discover how you can realise your ideas in Germany, the leading science country in Europe! I would be pleased to welcome you to Germany soon.

A handwritten signature in black ink, which appears to read 'Annette Schavan'.

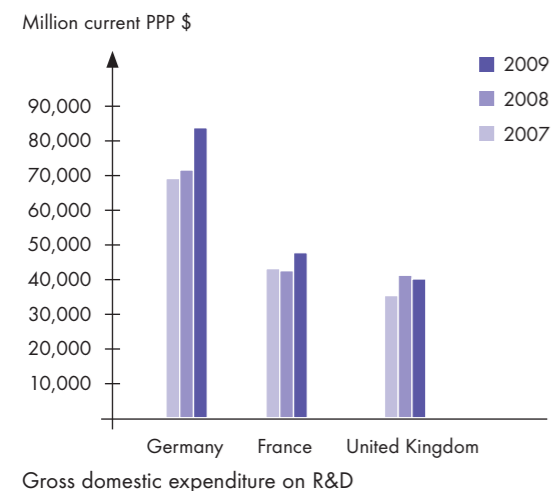
Prof. Dr. Annette Schavan, Member of the Bundestag
Federal Minister of Education and Research

Reshaping the World – One Idea at a Time

Innovation – It’s a State of Mind

Climate change, globalised crime, diminishing natural resources and new health threats – today’s challenges are complex and often daunting. Germany is already hard at work, searching for innovative approaches to tackle these and many other difficult issues. Researchers are developing zero-emissions cars and better photovoltaics, next-generation forensics and neurochips that help develop new medicines for epilepsy and Alzheimer’s. These are only a few examples of the broad range of research and development underway in the country.

Innovation is Germany’s great strength. The country generates more patents in nanotechnology, biomedicine and medical technology than any other in Europe: around 10 per cent of all Nobel laureates worldwide have hailed from Germany. The country continues to be a global leader in automotive and mechanical engineering as well as environmental science, and is internationally competitive in other fields such as optical, process and microsystems technology as well as neuroscience and



OECD Main Science and Technology Indicators:
Vol. 2010/2, OECD 2011, Vol. 2009/2, OECD 2010, Vol. 2008/2, OECD 2008

biotechnology. High quality standards, cutting-edge products and highly efficient production technology have made Germany the second-largest exporter in the world, and the European leader in attractiveness for foreign investments.

The airbag, the radio-controlled clock and the MP3 format are just three examples of the plethora of groundbreaking German discoveries and inventions. The country has actively and consistently invested in its research and development capabilities and continues to do so. In 2009, Germany spent 67 billion euros on R&D, more than any other country in Europe. Companies created more than 10,000 new jobs in R&D in 2010, bringing the total to 340,000 and offering new opportunities to talented scientists and engineers.

A Great Place to Learn

The foundation of scientific work is a solid education, and Germany is an attractive place to study and conduct research. The country’s universities are among the best in the world and they are working hard to become even better. As part of this effort, research universities have formed so-called Clusters of Excellence where they connect with leading research institutes and businesses for joint research projects that capitalise on the strengths of the different partners. The clusters are supported by the Federal Government’s Initiative for Excellence. The Federal Ministry of Education and Research (BMBF) has also created the Leading-Edge Cluster competition, which supports selected clusters as they strive to compete with the best in the world. Furthermore, it aims to increase international research cooperation and to enhance the international appeal of leading German universities. As a result, young scientists have the opportunity to work at the cutting edge of research in their fields in Germany.

Universities are also expanding their international research cooperation. They offer a growing number of academic programmes taught in English and actively support international



German researchers are innovation leaders. Not only in the field of DNA research.

students and researchers in their efforts to adjust to life in Germany. There are currently almost 250,000 foreign students in Germany, making it the third most popular country in the world for those studying abroad. Many of them are supported by the German Academic Exchange Service (DAAD). The country offers a myriad of opportunities in R&D ranging from basic research at one of the Max Planck Society institutes to high-tech product development at world-renowned companies.

Bringing Science and Industry Together

With the High-Tech Strategy, BMBF is promoting the cooperation between science and industry in order to increase knowledge and technology transfer. BMBF supports the creation of strategic partnerships and innovation alliances as well as research networks. BMBF has defined so-called “future projects”, which pursue certain goals for scientific, technological and societal development over a period of 10 to 15 years, taking a forward-looking approach within the European and global context. The specific projects are chosen based on an extensive foresight process. Examples are an intelligent redesign of the energy supply, renewable resources as an alternative to oil, and one million electric vehicles in Germany by 2020.

Innovation takes place throughout the world. In an increasingly globalised R&D environment, international cooperation is paramount to success. With its Strategy for the Internationalisation of Science and Research, BMBF supports universities, research institutes and businesses in their efforts to strengthen their international ties and promotes Germany abroad as an excellent place for science, research and innovation. A special

focus of this is the promotion of closer cooperation with developing and newly industrialising countries, which will be key partners in tomorrow’s global economy.

From Good Ideas to Great Products

Germany is not just an innovation leader. The country is also an industrial powerhouse. Swiftly turning scientific discoveries and innovation into marketable products and processes is crucial to Germany’s economic success. Many companies conduct their own research, but they often also rely on the support of universities and other research institutions. This is particularly true of small and medium-sized enterprises, which are the backbone of the German economy and a driving force of innovation in the country. They are very open to new ideas and, due to their size, are able to react flexibly to changing conditions and emerging market opportunities. This gives them an edge in situations where innovating quickly is essential for success.

All of these companies can draw on the expertise of numerous world-renowned places of research and development. Among them are the Helmholtz Association of German Research Centres, the Gottfried Wilhelm Leibniz Scientific Community and the Fraunhofer Society. They all focus on different fields of the applied sciences that are often the basis of innovative products and start-up companies.

Covering the fields of climate and resource protection, energy, health, mobility and security, the following pages will give you a sense of the diversity and excellence of research underway in the “Land of Ideas”.



"Our Climate Research Shapes Tomorrow's Urban Strategies"

Thi Cam Nhung Pham, PhD student
BTU Cottbus

Thi Cam Nhung Pham is currently earning her PhD in Environmental and Resource Management at Brandenburg University of Technology (BTU) in Cottbus. Her work focuses on the integration of climate change adaptation into urban planning in Vietnam. She specifically examines the use of Strategic Environmental Assessment (SEA), a tool for incorporating environmental considerations into policies, plans and programmes.

What was it like for you to combine family and professional life while working in Germany?

When I received the DAAD scholarship to earn my PhD in Germany, my friends were concerned that I wouldn't be able to combine family and career here. But I came to

Germany with my husband and our daughter and it was the right decision. My daughter loves to go to the Kindergarten every day and it allows me to concentrate on my research. She is learning German and I hope that she will study in Germany one day.

Did your father's involvement with research in Germany shape your image of the country as a place for research and in general?

My father earned his PhD in Germany a long time ago and I always heard stories about German culture and about the things he learned here as a student. I was affected by his love and respect for Germany, which is why I earned my master's degree here and why I am back again now.

Understanding, Adapting and Preventing Climate Change

Climate and Resource Protection Research in Germany

Heatwaves, storms and rising sea levels – climate change is one of the greatest challenges humanity is facing today. If left unabated, it will have a profound impact on the way we live and will threaten the livelihood of countless people around the world. At the same time there is a growing demand for diminishing fossil fuel reserves, which could lead to a serious energy crisis in the near future.

Germany is taking action. As part of its National Sustainability Strategy, the Federal Government has created an ambitious plan to preserve resources and protect the climate. With the Integrated Energy and Climate Protection Programme (IEKP), the country has pledged to reduce greenhouse gas emissions by 40 per cent from 1990 levels by 2020 if other states take similarly bold action. By the same year, the Federal Government also wants to double energy productivity in Germany compared to 1990 levels and double raw material productivity. It is also working towards establishing a sustainable energy supply for the country by pushing to increase the share of renewable energy to 30 per cent of the electricity consumed in Germany by 2020. In order to achieve these ambitious goals, the IEKP is promoting more efficient power stations and buildings, intelligent electricity meters, biofuels and fuel-efficient vehicles.

The High-Tech Strategy on Climate Protection is taking a multi-tier approach to the problem. A better understanding of climate change is essential, thus one focus is the development of reliable interim and long-term climate projections and predictions. Especially the modelling of precipitation, radiation and cloud processes still require intensive investigation. New research aircrafts and the Neumayer III research station in Antarctica (page 9) provide valuable data for this.

Climate change is already taking place and, while efforts to prevent an aggravation are vital, research must also support our efforts to adapt to the situation. A prerequisite for such an adaptation, however, is having comprehensive information about

the regional effects of climate change so technological solutions for adaptive measures can be developed. One such project specific to Germany is KLIWAS – Impacts of Climate Change on Waterways and Navigation – Searching for Options of Adaptation.

A major challenge will be to provide a growing world population with enough food, renewable resources and energy in the face of changing climatic conditions and to do so without further compounding climate change. The National Research Strategy BioEconomy 2030 maps out a path towards a natural-cycle-oriented bio-based economy in accordance with technology and the environment. The strategy is driven by the vision for a structural change from an oil-based to a bio-based economy.

The challenges of climate change bear opportunities as well. The world market for environmental technologies was estimated to be 1 trillion euros in 2005, and Germany has long been a leader in the production of environmental technology. The Federal Government has recognised this and passed the Environmental Technology Master Plan. Its objective is to better tap future markets in three areas with tremendous potential: water, raw materials and climate protection (including renewable energy). These areas will later be complemented with further activities. The plan is based on the Environmental Technologies Road Map 2020. A first visible result of the Master Plan is the German Water Partnership platform, which brings together researchers, companies and associations and is intended to support the export efforts of German businesses. The Federal Government is supporting the development of many innovative technologies like biodegradable plastics, wind and solar power systems, new battery technologies and electric vehicles, biorefineries, photovoltaics and energy-efficient construction to name but a few.

Germany's researchers are addressing climate change on all levels in order to understand the phenomenon, adapt to it and prevent its most devastating effects.

Using Biomass Efficiently and Sustainably

In November 2010 the Federal Government agreed on the National Research Strategy BioEconomy 2030. One of its cornerstones is the development of biorefineries that produce chemicals from biomass instead of petroleum. The newly founded Fraunhofer Center for Chemical-Biotechnological Processes CBP at Leuna will provide a test and demonstration site for the development and upscaling of different biorefinery concepts.

The centre will focus on the sustainability of processes and procedures along the whole value creation chain of products based on renewable resources. It will develop energy and resource-efficient processes minimising waste and reducing or preventing CO₂ emissions. The goal is a facility that can process any plant or its parts as well as other biomass and turn them into useful chemicals, fuel, electricity and heat. Projects will focus on bio-based olefins and related compounds, microalgae as a resource for biomass and high-value products, the development of new technical enzymes, the conversion of lignocelluloses into chemical products, sustainable goods made from vegetable oils, as well as the utilisation of residual biomass for biogas generation and hydrothermal energy. The biorefinery test site will begin operation in mid-2012.

www.cbp.fraunhofer.de



Sustainable Water Systems for the Future



With more than eight million inhabitants, the Peruvian capital Lima is a fast-growing future megacity. One of the biggest challenges the city faces is a shortage of drinking water, aggravated by climate change. Lima has an annual mean precipitation of only 9 mm and obtains most of its drinking water from the

Rímac River flowing from the Andean mountains, which has seasonally fluctuating water levels.

The German-Peruvian project LiWa (Sustainable Water and Wastewater Management in Urban Growth Centres Coping with Climate Change – Concepts for Lima Metropolitana, Peru) is developing a methodology and tools to facilitate sustainable management of water systems in megacities. LiWa is using climate modelling and macromodelling of the entire water system to evaluate different options for water and wastewater management. The project also considers the role that the energy system and water pricing structures play in the system and develops suitable methods for involving stakeholders in government, business, science and society. Capacity-building measures support sustainable water management through knowledge transfer. The findings of LiWa are expected to provide helpful insights for the implementation of similar projects in other cities and regions.

www.lima-water.de

Informing Decision Makers About Climate Change



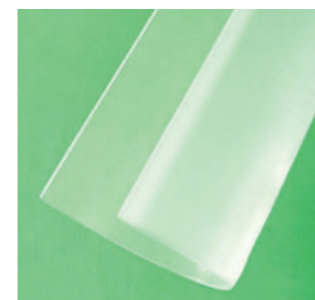
Climate change plays a role in many policy and business considerations, but those in leadership positions often lack the necessary expertise to make informed choices. The Climate Service Center (CSC) provides customers with scientific data and the findings of current climate research. The information provided is sector-specific and tailored to the needs of clients who are decision makers in business, politics and academia, especially in the fields of agriculture, construction, finance and tourism. The centre primarily responds to specific inquiries and provides relevant expert answers. It also brings universities, research institutions, climate consultants and business partners together in a joint network. CSC facilitates cooperation by organising expert workshops and by collaborating with international groups that investigate climate change. It is a link between climate researchers and decision makers in Germany.

www.climate-service-center.de

Biodegradable Plastics

Plastics are durable, cheap to make and ubiquitous. And they practically last forever. This has turned them into one of the biggest rubbish problems on the planet. Plastics composed of polyhydroxybutyrates (PHBs) could be an environmentally friendly alternative. The materials are non-toxic, completely biodegradable, and their production consumes about 50 per cent less petroleum than conventional plastics. Unfortunately, these natural polymers are generated by microorganisms, which makes them expensive. Now researchers from the Technische Universität München and BASF have developed a way to produce these PHBs and the resulting plastics synthetically. Their new method is expected to be significantly cheaper and makes PHB-based plastics competitive with traditional ones. For their discovery, the scientists were awarded the research prize of the Philip Morris Foundation.

www.makro.ch.tum.de



A New Antarctic Research Station with Innovative Design

The German research base Neumayer Station III is the first building in Antarctica that consists of a platform connected to a structure below the snow surface. An innovative hydraulic support system makes it possible to lift the 2,300-ton construction on a regular basis as the snow surface rises. The two-story building located on top of the platform provides ideal working and living conditions for summer and winter crews.

The scientific observatories for meteorology, air chemistry and geophysics are among the most modern facilities of their kind in Antarctica. The unique data records they obtain are regularly fed into global networks and are an essential contribution to climate research as well as to geophysical studies. The station is a logistics base for deep field expeditions with tracked vehicles and for scientific missions with aircraft. The Neumayer Station III has been operational since February 2009. Its innovative and environmentally sound design has unequivocally proven itself, and its state-of-the-art research facilities have become an essential part of international scientific and logistics cooperation on the continent.

www.awi.de



"Conducting Energy Research to Fuel Policy"

Aaron Leopold, PhD student

University of Kassel

Aaron Leopold is currently completing his PhD at the University of Kassel and the Helmholtz Centre for Environmental Research (UFZ). His work in political economy focuses on first-generation biofuels programmes in Brazil, the European Union and the United States in the wake of the "food versus fuel" controversy.

In your field, a global approach to research is very important. Did Germany provide you with opportunities to conduct research internationally?

For my doctoral studies, I received a scholarship through the Helmholtz Interdisciplinary Graduate School for Environmental Research (HIGRADE). Part of the funding was

for a research stay in Brazil to study how and by whom biofuels are really governed there. This field research proved essential for the success of my PhD project.

Could you imagine extending your stay in Germany?

While finalising my PhD, I am currently working via the BMBF-funded "Fair Fuels?" project at the FU Berlin. Here I am continuing my work on biofuels by investigating the transnational influences of the EU and Brazil on African agricultural production, specifically related to biofuels. Research aside, I really enjoy living in Germany. I like the people, especially their sense of humour, and I have no plans to leave any time soon.

Clean, Reliable and Sustainable

German Energy Research

The availability of reliable and affordable energy has been the basis of industrial development, prosperity and our modern way of life. For the past 150 years, that energy has been largely derived from fossil fuels. But oil, gas and coal are finite resources, and as the world's hunger for them grows, they are starting to become scarce. Aside from the specific pollution they generate, fossil fuels are also a major cause of climate change, one of the biggest challenges facing humanity in this century. Finding more efficient ways to use the energy resources of our planet and developing sustainable alternatives to fossil fuels is paramount. The Federal Government attaches great importance to this topic and is providing about 1.27 billion euros for energy-related research in 2010/2011. In August 2011 it launched the 6th Energy Research Programme, which emphasises Energy Storage, (Smart) Grids and Energy Efficiency among others as central topics in the coming years.

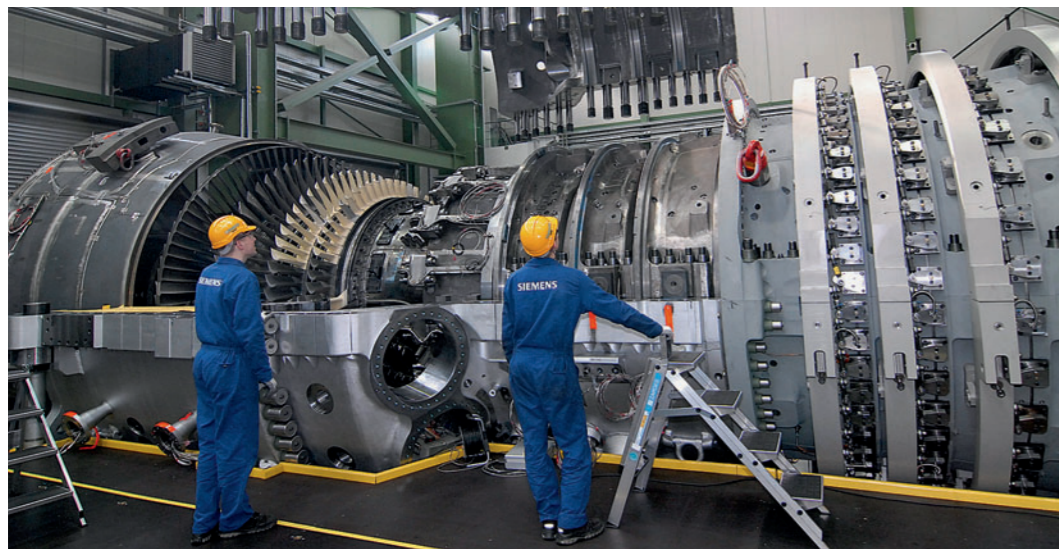
The BMBF funding concept Basic Energy Research 2020+ focuses on long-term basic research to develop new technological options. It supports research related to highly efficient energy generation, conversion, storage, end use and transport. Aside from technology, aspects such as user behaviour and entire energy systems will be investigated.

With Bioenergy 2021 – Increasing the use of renewable resources, the Federal Government supports the investigation of ways to use biomass as a sustainable fuel source. The new German Biomass Research Centre (DBFZ) studies technological, ecological and economic issues related to biomass use in energy production. Several institutions of the Helmholtz Association participate in the Research Programme Renewable Energies, which has a focus on photovoltaics. The SiThinSolar project (page 13) is a part of these efforts. Breakthroughs in those technologies will help to increase the share of renewables in the country's energy mix.

As a long-term option, the funding concept supports research in nuclear fusion as a clean and potentially abundant source of energy. China, the European Union, India, Japan, Korea, Russia and the United States have already joined forces on the ITER project to prove that fusion can be a viable source of energy and to design and operate the first fusion power plant.

The Energy Research Programme also supports approaches that aim to reduce fossil fuel consumption in the short term. As such, it funds efforts to improve the energy efficiency of existing technologies, specifically through the development of better power stations, combined heat and power as well as district heating, fuel cell and hydrogen technologies, efficient use of electricity and electricity storage systems, energy-optimised construction and energy efficiency in industry, commerce, trade and services. An example of such research bearing fruit is the biggest gas turbine in the world, which was recently built in Germany (page 12). The development of carbon dioxide capture and storage systems can contribute to a reduction of CO₂ emissions as well.

Close cooperation between universities, leading research institutes, industry and the Federal Government is key to Germany's success in this area and will be a vital factor in coping with the energy challenges of the 21st century.



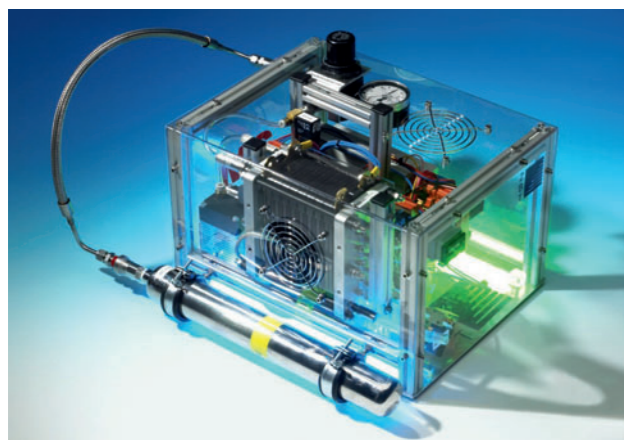
The World's Biggest, Most Powerful Gas Turbine

Siemens has built the biggest and most powerful gas turbine in the world. More than 13 metres long and 5 metres high, it weighs 444 metric tons – more than an Airbus A380. The turbine generates 375 megawatts of power. Coupled with a steam turbine in combined cycle mode, its output increases to more than 570 megawatts – enough electricity for a city the size of Berlin. But possibly even more impressive, since the SGT5-8000H has been installed at the combined cycle power plant (CCPP)

Irsching 4 in the summer of 2011, that facility achieves a world record efficiency of more than 60 percent in commercial operation. Compared to today's state-of-the-art CCPPs, this represents an annual CO₂ emissions reduction of 45,000 metric tons – approximately the equivalent of more than 10,000 mid-size cars each travelling 20,000 kilometres per year.

www.siemens.com/entry/cc/de/turbine.htm

Taking Carbon Nanotube Research to the Next Level

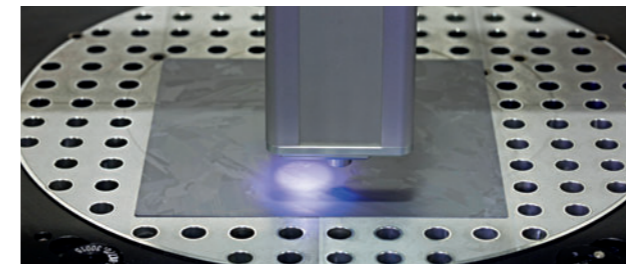


They are stronger than steel, make plastic components stronger, lighter and conductive and can even lead to more efficient batteries. They offer new possibilities for designing displays, com-

puter memory and better wind turbines, car mudguards or sports equipment: carbon nanotubes (CNT). There are numerous potential applications for these cylindrical carbon structures but a lot of research and development remains to be done, which is why BMBF supports the Innovation Alliance Carbon Nanotubes (Inno.CNT). The alliance initially comprised around 90 renowned partners from both academia and the private sector who cooperated on 27 affiliated projects, ranging from research on basic technologies to applications related to energy and the environment, mobility, electronics and lightweight construction. Improved bipolar plates and optimised electrodes for fuel cells are part of Inno.CNT's energy-related work. The alliance is also working on innovative inks for photovoltaics, which will require less or no silver. This would reduce the production cost and help make solar cells a competitive alternative to fossil fuels.

www.inno-cnt.de

Thinner Silicon Wafers for More Effective Solar Cells



Solar power is a very promising source of renewable energy. Each year, about 1,000 kilowatt hours of energy from the sun shine on every square metre in Germany – the equivalent of about 100 litres of heating oil. But in order for the technology to be more widely adopted, the photovoltaic cells themselves have to become cheaper. The SiThinSolar project helps to achieve this

by developing more efficient and economical manufacturing processes for silicon-based solar cells. Since the silicon material is a major cost factor, the main focuses of the project are thinner silicon wafers and their use in solar cell manufacturing. The wafers used for crystalline solar cells currently have an average thickness of 0.18 millimetres. Manufacturers want to reduce that to 0.1 millimetres and simultaneously increase energy efficiency to more than 20 per cent. To make such advances possible, the SiThinSolar researchers are studying the material properties as well as the microstructure of silicon material and wafers. Furthermore, the scientists are working to improve the lamination process and analyse the durability and long-term reliability of solar modules.

www.iwm.fraunhofer.de/sithinsolar

Advancing OLED Technology



Organic light-emitting diodes (OLEDs) are highly efficient light sources. They generate virtually no heat, consume very little raw material, are mercury-free and can be used in many innovative ways – a clean and sustainable technology with a lot of potential. The So-Light project, a joint project of 11 German companies and research institutes, will accelerate the development of signage and specialised lighting solutions based on OLED technology. The project covers developments along the whole value chain – including materials such as new redox dopants, transport materials and triplet-emitter concepts as well as new optical technologies for light guiding and process technologies for small molecule OLEDs. Another significant part of the project is the field-testing of prototypes and efforts to apply OLED technology to special uses such as cars, architecture and the backlighting of large displays. The overall goal of So-Light is to help secure a leading position for Germany in the fast-growing worldwide OLED business by accelerating development and time to market.

www.so-light.de

Custom Biofuels

The Tailor-Made Fuels from Biomass (TMFB) Cluster of Excellence seeks to identify innovative, custom-tailored ways to convert plant material into value-added products, especially fuels and fuel components. It evaluates their potential for use in modern combustion systems, which are based on optimal fuel properties – both at the macroscopic and the molecular level. TMFB also seeks to optimise the processes involved in synthesising these new fuels. In order to accomplish these objectives, the RWTH Aachen University-based group is taking a holistic approach and considering chemo- and biocatalysis, process technology, combustion research and engine development in its research efforts. Several TMFB fuels have already been identified that make an almost soot-free diesel combustion possible. In the long term, the synthetic fuels developed by TMFB could lead to more efficient and pollutant-free combustion technologies and help to reduce Germany's dependence on fossil fuels.



www.fuelcenter.rwth-aachen.de



“Medical Research to Improve Our Quality of Life”

Shamima Akhtar, PhD student
IMCAR/RWTH Aachen University

Shamima Akhtar is a PhD student at the Institute of Molecular Cardiovascular Research (IMCAR) at RWTH Aachen University and a DAAD scholarship recipient. Her research focuses on visualising plaque ruptures of atherosclerotic lesions using molecular imaging techniques.

You have studied and conducted research in various areas of cell and molecular biology. Why did you choose cardiovascular research in particular for your doctoral work?

In India we don't have a lot of opportunities to work in this field. There, the focus tends to be on infectious diseases since those are what people are affected by most. But due to an increasingly Western lifestyle, cardiovascular diseases are a growing problem in In-

dia as well. My aim is to develop a model of plaque rupture in mice and to study the different factors responsible for this rupture. Furthermore, my studies raise the question on how we can use this imaging technology to diagnose it.

What special research opportunities has RWTH Aachen University given you?

Here at IMCAR, we have 2-photon microscopy instruments, which allow me to conduct life cell imaging in vivo. We also have intravital microscopy and ultrasound for mice, and all of these resources are available to me. Technology like this is very rare and my specific research work would be impossible without it.

Healthier, Better Lives

Medical Research in Germany

First it was bird flu, then swine flu. Only a few decades ago, diseases like these two types of influenza might have remained local phenomena. But in today's interconnected world, an outbreak in a specific country can become a threat to people halfway around the world within days. Advanced medical research is essential for protecting the population, both locally and globally. Like many industrialised countries, Germany also faces challenges related to its ageing population. Diseases like asthma, cancer or osteoporosis are a growing problem. These are just some of the health issues facing Germany today.

The Federal Government is proactively addressing these and other questions through a diverse set of medical research projects and programmes. Overall, BMBF is funding health research with around 5.5 billion euros from 2011 to 2014. The new health research programme focuses on fundamental areas, investigating lifestyle diseases being one of the central features. The government is founding German centres of health research that will combine the work of universities and other research institutions in this field and turn their findings into treatments more quickly.

Prevention and nutritional research is another main focus of the programme. A better understanding of the impact of nutrition, physical fitness and the environment on the activity of genes can help to unravel what causes lifestyle diseases like diabetes or atherosclerosis and how they can be prevented. Under BMBF's national prevention strategy, all relevant approaches in this field, ranging from epidemiology to epigenetics, are being integrated. The programme also emphasises advances in the fundamental understanding of the basic mechanisms of disease and on applying these findings to the development of personalised medicine. This will be of particular benefit to those affected by rare diseases and will help improve the quality of life of Germany's ageing population.

In its efforts to combat lifestyle diseases, the German government has not lost sight of pressing problems elsewhere in

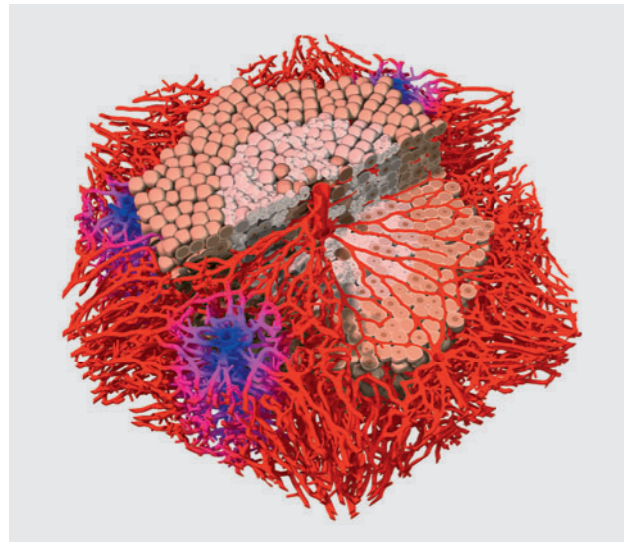
the world. As part of the High-Tech Strategy, BMBF supports cooperation and research related to the so-called neglected tropical diseases. Examples are leprosy, malaria, Buruli ulcer or dengue fever, which continue to have a devastating effect on many parts of the tropical world.

The medical and public health sector as a whole is an important economic factor in Germany. It constitutes 10.6 per cent of the GDP and employs more than 4.4 million people, which makes it bigger than the automotive industry. The German medical technology industry is both very innovative and successful. It employs 170,000 people in more than 11,000 medical technology companies, making Germany a leader in the field. BMBF has pooled its funding activities in this area in the Medical Technology Action Plan, which focuses on molecular imaging in medicine and medical technology for regenerative medicine as well as for rehabilitation and care.

The pharmaceutical industry is a cornerstone of the German economy. That is why the country has also launched the Pharmaceuticals Initiative for Germany, which supports R&D work on new medicines and will help to close the gaps in the value-added chain in order to turn scientific discoveries into viable drugs more effectively. BMBF will provide more than 800 million euros in funding to the Pharmaceuticals Initiative. Ten million euros will go towards strengthening production in Germany in a public-private partnership.

The Federal Government is supporting a wide range of medical technology, medicine and public health research projects and this support bears fruit through technological innovation, medical breakthroughs and new scientific discoveries. The country is strongly committed to maintaining this support and to its role as a research leader in the field.

Building a Mathematical Organ



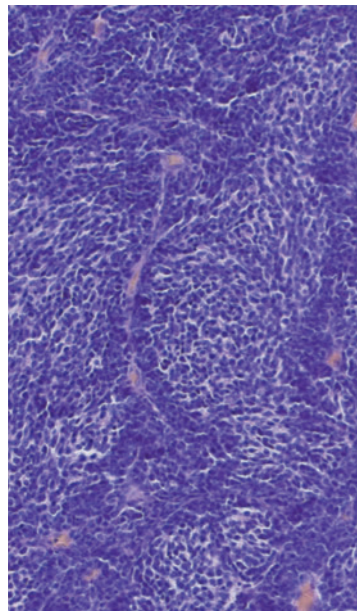
The Virtual Liver Network aims to create a mathematical model that represents the physiology, morphology and function of the human liver. The BMBF-funded project will integrate data from the subcellular level to the entire organ. It is the first project

worldwide that is attempting to build a truly multi-scale computer model of a complete organ.

The network is composed of 70 research groups across Germany and connects with other research groups and international initiatives to complement its work. The research effort is divided into three major areas: “The Liver Cell” maps and determines the processes that take place within liver cells. “Beyond the Cell” investigates the mechanisms involved in the communication between cells and the basic functions of the liver. “Integration and Translation” combines the models across these different levels of liver organisation and function – so-called multi-scale modelling – and connects this basic science research to clinically relevant questions. When completed, this model could help scientists better understand how diseases affect the liver and predict the effect of medications on the organ. This could reduce the need for extensive experimentation and help determine the dosage needed for an individual patient, thus optimising the effectiveness of the drugs and minimising side effects.

www.virtual-liver.de

Fighting Cancer Globally

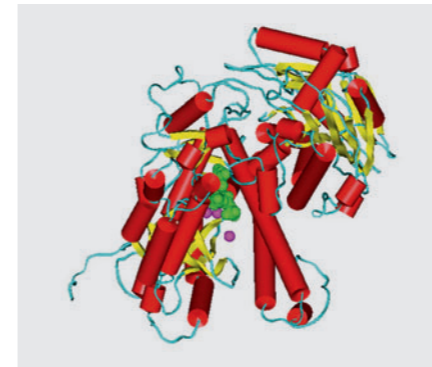


Cancer is caused by genetic changes that turn normal body cells into cancer cells. However, these genetic changes vary significantly depending on the type of cancer. That is why the International Cancer Genome Consortium (ICGC) has set out to obtain a comprehensive description of genomic, transcriptomic and epigenomic changes in 50 different tumour types, which are medically relevant throughout the world. This knowledge is essential in order to understand the complex molecular processes that lead to cancer initiation and that maintain a tumour once it is established, and to devise methods to prevent, diagnose and treat it. The ICGC is the biggest and most ambitious biomedical research project since the human genome project. Germany contributes to it by taking the lead on the investigation of three types of cancer: early-onset prostate cancer, malignant lymphoma and paediatric brain tumours – the primary cause of cancer mortality among children.

The PedBrain Tumor project focuses on the two most common paediatric brain tumours, the medulloblastoma and the pilocytic astrocytoma. Based on their investigation, the researchers expect to develop new therapies and to be able to stratify patients for risk-adopted treatments as well as to provide markers that will predict a patient’s response to a specific therapy. Together, BMBF and German Cancer Aid (Deutsche Krebshilfe e.V.) are providing 15 million euros in funding for the project over a five-year period.

www.icgc.org, www.pedbraintumor.org

Examining the Skin and Treating Skin Disease



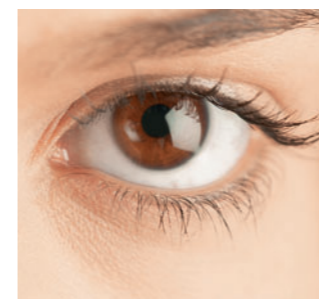
Actinic keratosis is an early-stage skin cancer associated with frequent exposure to the sun and characterised by scaly, thick patches of skin. Its later stage, squamous cell carcinoma, is a frequent cause of death among organ transplant recipients. The BMBF joint project NanoDerm aims to develop a topical therapeutic agent for actinic keratosis. The main obstacles for such treatment are a lack of highly efficient agents and the scaly, crusty skin, which impairs drug absorption. The researchers solved the problem through the molecular modelling of innovative agents. Next, they combined the agent with lipid nanoparticles to improve skin penetration. Another outgrowth of the NanoDerm project is ParaScan 1, a prototype of the first device for skin cancer diagnostics based on the principle of paresthetic spectroscopy. The company “parelectrics” has been founded to market the technology.

www.parelectrics.com

Restoring Vision with an Electronic Chip

In Germany alone, there are about 130,000 blind people. A quarter of them suffer from retinitis pigmentosa or macular degeneration. Thanks to an innovation by Retina Implant AG, these people may soon be able to regain some vision. Building on research that was initiated by the Universities of Tübingen and Regensburg and funded by BMBF, the company has developed a camera chip that can be implanted below the retina. The 3 mm chip sends electric signals to the retina, allowing patients to recognise basic shapes and even letters again, once the brain has adapted. So far, 16 blind patients have received the implants. The researchers hope to bring the world’s first fully functioning electronic retinal implant to the market by 2012.

www.retina-implant.de



German-Ghanaian Cooperation Combats Tropical Diseases

The Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR) is a biomedical research centre jointly run by the Ghanaian Ministry of Health, Kwame Nkrumah University of Science and Technology in Kumasi, and the Bernhard Nocht Institute for Tropical Medicine (BNITM) in Hamburg. It serves as a modern platform for international research to control tropical diseases including malaria, tuberculosis and Buruli ulcer. In 2006, KCCR became the host of one of seven African research centres equipped by the Bill and Melinda Gates Foundation to conduct malaria vaccine trials. One focus of BNITM’s activities at KCCR is the identification of genetic factors that influence infectious diseases. As part of this research, thousands of malaria and tuberculosis patients have been studied within the framework of the National Genome Research Network. In 2007, microbiological facilities including a BSL3 laboratory were established in order to perform advanced bacteriological, virological and parasitological diagnostics to identify as yet unrecognised causes of childhood disease in Africa.

www.kccr-ghana.org



“Researching Mobility Close to the Final Frontier”

Dr Gabriella Gaias, researcher

DLR, Weßling

Gabriella Vittoria Maria Gaias is a researcher in the Space Flight Technology division of the German Aerospace Center (DLR). Her work is related to the guidance, navigation and control system of satellites. She currently participates in the operations of the PRISMA Formation Flying mission, a technology demonstrator mission composed of two small satellites intended to undertake autonomous formation flight.

What influenced your initial decision to apply for a scholarship in Germany?

Germany is one of the leading countries in formation flying. In fact, all space missions that involve formation flying and that are currently underway are German projects or comprise a major German involvement.

So if you work in my field, then Germany is the best place to be.

Which experiences conducting research in Germany influenced your decision to extend your professional tenure beyond your DAAD scholarship?

Being part of a research department at DLR gives me the opportunity to conduct research with a degree of freedom that I would otherwise only have at a university. At the same time, it provides me with the resources and industry contacts that only a space agency can offer. Working here, you also get to see some of your research work applied, which is rather rare in my field. And it is a very nice, comfortable place to work.

Moving the World in New Ways

Mobility Research in Germany

The world is on the move, more than ever before. People and goods are travelling around the world on an unprecedented scale thanks to modern cars, trucks, trains, ships and aeroplanes. But this increased mobility is the source of a myriad of global challenges as well. The significant increase in the number of passenger cars has led to massive traffic congestion, particularly in fast-growing megacities of many newly industrialised countries. The pollution generated by our increased mobility contributes significantly to climate change. Similarly, road and air traffic safety are major issues.

The future of mobility will have to be fast, comfortable and safe but also environmentally sound and efficient. This can only be achieved with research and innovation on all levels. Mobility has to be rethought from scratch. Germany is at the forefront of that research in a broad range of fields from better fuels and propulsion systems to traffic management and satellite technology.

The Federal Government is supporting innovation on many levels, starting with the National Development Plan (NEP) for Electric Mobility, which aims to have a million electric vehicles on Germany's roads by 2020 (page 20). In order to achieve this, a National Platform for Electric Mobility was established in May 2009 with experts from industry, academia and social organisations developing strategic recommendations for the Federal Government. However, major technological hurdles still have to be overcome. This is why BMBF focuses its support on two key areas: battery technology and new electric vehicle concepts, which stress energy efficiency, safety and reliability. Together with the Fraunhofer Society, BMBF has also launched the Drive-E programme, which encourages students to choose a career in electric mobility. All in all, the Federal Government is funding the NEP with 500 million euros from the economic stimulus package, and will continue its support on a similar level over the coming years. As part of these activities, BMBF will contribute to funding electric mobility with about 100 million euros per year.

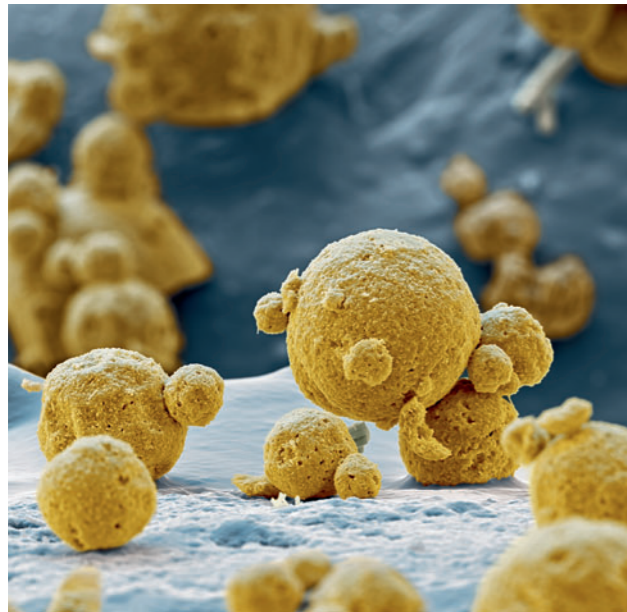
In addition, traffic planning is essential for the future of mobility. That is true on the roads, where interactive traffic information systems like simTD (page 21) can prevent traffic congestion and improve road safety. But it also applies to the skies where the European research agenda ACARE-Vision 2020 and the German Aviation Research Programme IV (LuFo IV) are investigating ways to harmonise infrastructure and air-traffic processes to make civil aviation more efficient, reliable and safe. The programme also aims to make air traffic more environmentally friendly. Technical innovations related to propulsion and flight physics are expected to reduce noise as well as to improve fuel efficiency and reduce CO₂ emissions by 50 per cent.

Even higher up in the sky, German space technology is playing a crucial role in European space exploration. As part of its High-Tech Strategy, the Federal Government invested a total of 3.6 billion euros between 2006 and 2009 in this area alone. German space technology is at the forefront in the field of climate protection, earth surveillance and navigation. As part of the European Data Relay Satellite System (EDRS), the country is also taking the lead in satellite communication, contributing an optical high-speed communication technology that is unique in the world.

Back on earth, the Federal Government's research programme Shipping and Marine Technology for the 21st Century is working to increase the energy efficiency of ships, to make their serial production more flexible and to develop better cargo-handling processes.

In Germany, academia, policymakers and industry are working together to pave the way for an environmentally friendly and energy-efficient mobility and for a sustainable future.

Better Battery Technology for a Greener Future



Batteries are the heart and soul of green energy technology but they still have limitations. Certain electric cars may have zero emissions but they are hindered by limited range and battery technology that loses charge over time, effectively wasting

energy. Similarly, wind power facilities generate green energy but would be far more efficient if unused electricity could be stored reliably and efficiently. To address these challenges, BMBF has created the innovation alliance Lithium-Ion Battery LIB 2015. Its objective is the development of highly efficient and innovative high-capacity batteries on the basis of lithium-ion technology. The innovation alliance is composed of major industry partners and many small and medium-sized enterprises as well as universities and research centres. The broad range of partners will make it possible to conduct research on every aspect of the value creation chain. Starting with fundamental research, the group will develop suitable materials and manufacturing processes in order to produce the next generation of battery cell technology. In a second step, the battery cells will be combined with an intelligent battery management system.

BMBF is supporting LIB 2015 with 60 million euros over a four-year period. LIB 2015 has secured additional industry investments: BASF SE, Robert Bosch GmbH, Evonik Industries AG and Volkswagen AG have pledged an additional 360 million euros for battery R&D.

www.lib2015.de

Rethinking the Automobile



Electric vehicles can make a major contribution to the reduction of CO₂ emissions and thus help combat climate change. That is why the Federal Government wants to make Germany a leading market for electric mobility and put one million electric cars on Germany's roads by 2020. Groundbreaking innovations and a complete rethinking of the automobile will be necessary in order to accomplish this. The joint project e performance intends

to do just that: it will not electrify existing vehicles but develop a completely new vehicle design. This will begin with the conceptual design and construction of the vehicle including everything from the power train to vehicle safety and on-board electronics. All these components have to be tuned in order to assure performance, range, reliability and safety all at the same time – qualities that are indispensable if electric vehicles are to become commercially viable. The immediate goal is to design and build a prototype vehicle, which will allow researchers to gain additional insights needed for potential future mass production.

The comprehensive approach taken by e performance is only possible due to the participation of major industry partners like Audi AG and Robert Bosch GmbH as well as RWTH Aachen University. Additional support comes from several other universities and Fraunhofer Institutes. BMBF is funding the project with 22 million euros over a three-year period.

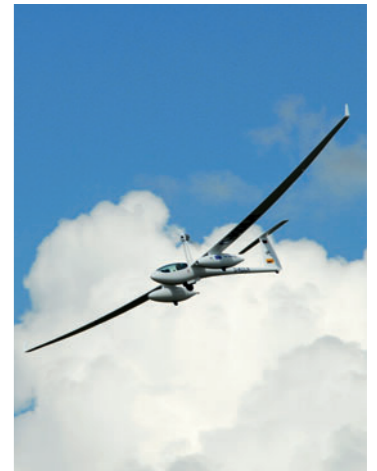
www.audi.de/eperf/brand/de.html

Fuel Cells for Greener Aviation

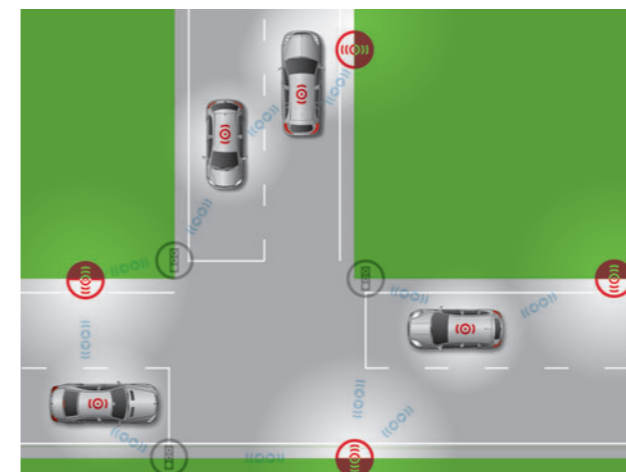
The Antares motor glider is the world's first piloted aircraft capable of taking off that is powered by fuel cells. At the plane's core is an ultra-efficient fuel cell, developed by the German Aerospace Center (DLR), which uses hydrogen as its fuel. In an electrochemical reaction with the oxygen in the ambient air, this hydrogen is converted into water, generating electricity, which powers the aircraft. This happens without combustion or pollution, and if the hydrogen was created using renewable energy, the plane's operation is completely CO₂ emissions-free. The initial plane was the Antares DLR-H2, which had a range of 750 kilometres and could fly for about five hours. Its successor, the

Antares-H3, will take to the skies in 2011. It will have an extended range of 6,000 kilometres and will be able to fly for 50 hours. The Antares motor gliders are flying laboratories intended to test the safety and reliability of a fuel cell propulsion system. The immediate goal of the project is not a fuel-cell-powered passenger jet, however. Instead, the fuel cells could be an alternative source of on-board power replacing the aircraft auxiliary power unit (APU), a combustion engine that provides electricity for the plane's operation when the main engines are not running.

www.dlr.de



Cars Communicate to Make Roads Safer



The objective of the sim^{TD} project (Safe and Intelligent Mobility – Test Field Germany) is to provide motorists with instant road information to make driving safer and reduce traffic congestion. It does so by combining WLAN-based technology

with second- and third-generation mobile phone technology (GSM, GPRS, UMTS). Specifically, vehicles will be equipped with Communication Control Units and Vehicle Application Units. This will enable them to communicate with other vehicles and transportation infrastructure about road and traffic conditions and to process incoming data to inform the driver via a Human Machine Interface. sim^{TD} also includes ITS roadside stations, which gather and relay information. The entire system is monitored from the ITS Central Station – the sim^{TD} control centre. Sim^{TD} will provide drivers with a variety of vital information for the first time. It will alert drivers to obstacles on the road or adverse road conditions. Furthermore, it will not only indicate traffic jams but also warn drivers just before they reach one to avoid rear end collisions. As a motorist approaches a traffic light, the system can alert him that the light is about to change, preventing sudden, unexpected stops that can just as easily lead to accidents.

www.simtd.de



“Cybercrime Research Far Beyond My Expectations”

Dr Tatiana Tropina, researcher

Max Planck Institute for Foreign and International Criminal Law, Freiburg

Tatiana Tropina is Senior Researcher/Network Coordinator Eastern Europe at the Cybercrime Research Institute and a researcher at the Max Planck Institute for Foreign and International Criminal Law in Freiburg. Her research focuses on new policy and legal measures to fight cybercrime as well as capacity building in both the public and private sector.

What made you want to conduct research in Germany?

While I was still writing my PhD thesis in Russia, I already knew that the most famous cybercrime researchers work in Germany. I was reading their books and quoting them in my work. And suddenly they became my mentors. At the Max Planck Institute I have access to the best library in the world for

this subject while also being in a very exciting and nurturing research environment. The Cybercrime Research Institute offers me mobility, visibility, credibility as well as high-level projects. The dynamic work attitude provides new challenges and lets me expand my research experience all the time.

Did working in Germany live up to your expectations?

It has gone far beyond my expectations. When I applied for my fellowship at the Alexander von Humboldt Foundation, I never would have dreamt that I would be invited to lecture at NATO or draft one of the main discussion papers on cybercrime for a Global Symposium for Regulators of the International Telecommunication Union.

Innovation for Public Safety

German Security Research

Organised crime, terrorism, cyber attacks and natural disasters – they all threaten our security and they are on the rise. We live in a highly interconnected world with countless goods and people crossing borders and continents every day. Our modern society relies increasingly on sophisticated infrastructure like power grids, water supply or telecommunications networks, which need to be protected. If major disasters happen – natural or man-made – we need effective measures in place to cope with them and to minimise or even prevent the harm and loss of lives they cause.

The Research Programme for Civil Security of the Federal Government aims to increase civil security without infringing on the rights and freedoms of the citizens. The 7th EU Research Framework Programme funds civil security research with a similar objective on the European level. Bilateral research cooperations exist between Germany and – among others – the United States, France and Israel respectively. France and Germany, for example, are promoting joint projects by partners from both countries on the topics Securing the Logistics Chain and Biometrics.

The Research Programme for Civil Security focuses on technology but also on innovative organisational approaches and strategies for action. It entails scenario-based research and will develop new, innovative systems based on existing and emerging technologies. Among the potential applications will be the quick and reliable identification of people, an equally swift mobile identification of hazardous substances, pattern recognition as well as security and rescue capacity building. Since 2007, BMBF has provided more than 180 million euros in funding for the programme.

A crucial consideration in all research endeavours related to security is the balance between security measures and personal freedom. The Research Programme for Civil Security stresses dialogue and transparency in order to assure that the society

understands the usefulness of security measures. At the same time, feedback can help to optimise them. One of the tools within Germany’s High-Tech Strategy are innovation platforms, which bring together project participants who are active in a common area of research for civil security. With a multitude of views and specialities, they contribute to an interactive forum for discussion about the entire innovation process – ranging from current projects to suitable framework conditions for the implementation of the findings to relevant research topics for the future. Among those innovation platforms are The Protection of Transport Infrastructures, which includes air, rail, sea and road-related projects, as well as Rescue and Protection of People, which focuses on crisis management through rescue and security measures, care for the injured and effective emergency medical care on-site. The innovation platform Societal Dimensions of Civil Security Research, which was launched in December 2010, is intended to utilise the synergies between the ongoing security research projects in order to advance both the scientific discourse as well as the transfer of research findings to their users and the public.

Aside from Federal Government funding, the initial success of the Research Programme for Civil Security has already led to additional financial support by corporate partners for 42 joint projects. They have contributed approximately 41 million euros so far. One focus of the research is on the development of mobile detectors to quickly identify explosives, poisons, weapons and germs. New automatic early-warning and evacuation systems help to better organise the evacuation of crowds from stadiums or train stations in an orderly, safe manner.

Security technology and concepts are an opportunity for German business as well. Security products are a fast-growing industry that generates 10 billion euros a year in revenues in Germany alone. The demand for security-related products and services “Made in Germany” creates new jobs and promotes the competitiveness of the German economy.

Improved Detection, Retrieval and Analysis of Latent Fingerprints



Fingerprints located and collected at crime scenes for subsequent analysis have been valuable sources of potential evidence for law enforcement for a long time. However, in the process of visualising them using conventional techniques (e.g. chemical development agents), other valuable information such as DNA

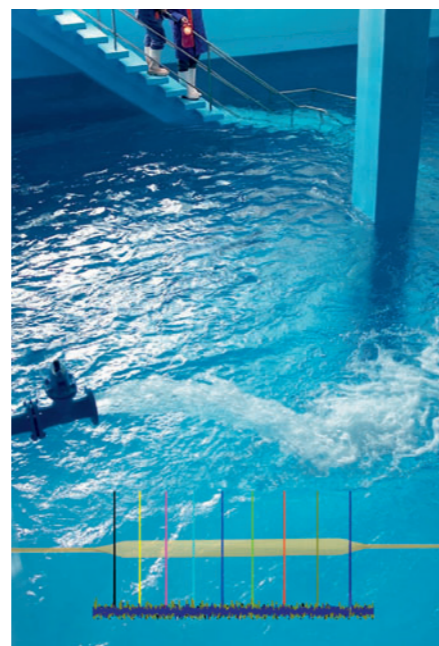
traces might be lost. Consequently, the Digi-Dak (Digital Dactyloscopy) project, a cooperation of several academic and business partners supported by BMBF, is developing improved optical methods for faster, comprehensive localisation and acquisition of fingerprints. In particular, the project is investigating and improving pattern recognition technologies for fingerprints captured using new contactless optical 3D surface sensor technology. Another challenging objective is the determination of the age of fingerprints as well as the analysis of superimposed prints.

Digi-Dak is optimising existing methods of pattern recognition and creating new ones. It is also adapting suitable sensor technologies and investigating methods of data processing and classification. The project is developing complex, realistic test scenarios in order to comprehensively evaluate and optimise the pattern recognition techniques. Throughout all aspects of the project, the legal framework, particularly privacy and data protection, is a vital consideration within the design process.

<http://omen.cs.uni-magdeburg.de/digi-dak>

Protecting Our Drinking Water

Poisonous substances in the drinking water supply are a major potential threat to the population that could be exploited by criminals and terrorists. In order to protect people from harm, the joint Israeli-German project IRLSENS (infrared laser-based fibre-optic sensor system for drinking water monitoring) is developing a fast and autonomous detection system that is able to register almost all dangerous chemicals. The new system's main focus is the detection of pesticides like DDT and other chlorinated hydrocarbons such as chloroform within seconds, allowing utility operators to take measures almost instantly.



IRLSSENS combines innovations in the area of laser- and fibre-based infrared analysis. The system will have an ultra-fast detection mode and no moving mechanical components and will make remote, fibre-based measurements beyond the range of acoustic frequencies possible for the first time. As a result, it will be less susceptible to acoustic interference (e.g. vibration) than existing systems and will offer high sensitivity, even in harsh environmental conditions. The new technology will also be suitable for automation, making maintenance easier. Initially, a demonstration unit will be set up in waterworks in order to conduct test measurements under realistic conditions. Subsequently, drinking water contamination scenarios will help select other suitable places to install the system.

www.iaf.fraunhofer.de

Advanced Communication Technology for Rescuers



When catastrophic events occur that injure a large number of people, one of the biggest initial challenges for rescue teams is to compensate for the lack of precise information. Emergency hotlines tend to be inundated with calls, which often provide conflicting information. On location, rescuers need to gather intelligence and pass it along to the control centre while also conducting triage.

The ALARM project aims to improve the response to such events by enabling better communication. At the core of ALARM is a central IT platform, which uses a range of wireless communication technologies like UMTS, GPRS and WiMax. The emergency responders use portable devices to communicate with the control centre and hospitals via an ad-hoc wireless network. This way, they can collect data on-site and receive information and directions at the same time. Another aspect of ALARM will be an electronic mobile triage system that uses RFID tags to track victims and their conditions in order to determine more efficiently who requires care most urgently. ALARM will also include telemedicine applications, which will allow rescuers to consult doctors who are off-site, in particular specialists at a hospital. It will also make it possible to remotely monitor the vitals of patients while they are being transported to the hospital.

www.alarm-projekt.de

Assuring Secure and Efficient Shipping

An uninterrupted supply chain is vital to the world's economies and societies, especially for export-oriented countries like Germany. But the prospect of shipping containers that could be used to commit terror attacks or criminal activities threatens that supply chain. That is why BMBF supports the ECSIT project as part of the Federal Government's Research Programme for Civil Security initiative. The project investigates innovative ways to improve security, e.g. through non-invasive inspection of containers at the port of departure. ECSIT will explore demonstration systems for the detection of radioactive material and fast X-ray-based imaging processes to identify illegal and dangerous goods in sea freight containers. The advanced non-intrusive inspection prototype will be optimally integrated into the port logistics processes to provide a high throughput scanning capacity.



Together with other research projects supported by BMBF, ECSIT contributes to the development of an innovative, multi-layered, risk-based cargo security approach, which will provide enhanced security and the least possible impact on the lawful flow of goods. Another promising concept under investigation originates from the field of 3D X-ray imaging technology and

will be adapted to this new field of use. New port procedures and processes will be researched to avoid impeding ongoing port operations. Furthermore, existing security systems and sources of information, e.g. freight documents, will be integrated into the overall concept.

www.ecsit-security.de



Study and Research in Germany

The Research in Germany portal is an information platform and contact point for all looking to find out more about Germany’s research landscape and its latest research achievements. Practical information supports foreign scientists and researchers in their decision to collaborate with German research organisations or to complete a research stay in Germany.

Come and discover our extensive range of information:

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Phone: +49 (0)228 30815-210
www.leibniz-gemeinschaft.de

German Academy of Science and Engineering
Phone: +49 (0)89 520309-0
www.acatech.de

Research Funding

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www.bmbf.de

German Academic Exchange Service (DAAD)
Phone: +49 (0)228 882-0
www.daad.org

Alexander von Humboldt Foundation
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www.humboldt-foundation.de

German Research Foundation (DFG)
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Kompetenznetze Deutschland – networking for innovation
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Portrait of Prof. Dr Annette Schavan
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and Research

Climate Protection

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Lignocellulose from straw can be used as a
raw material.
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The Rímac River just upstream of the water
abstraction point.
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CSC climate experts explain climate
simulations visualised on the Climate Globe.
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Polymer plate from PHB.
© WACKER-Chair of Macromolecular
Chemistry – TU München

Neumayer Station III – the new central
research base of the Alfred Wegener Institute
for Polar and Marine Research (AWI) in
Antarctica. The station was commissioned
on 20 February 2009.
© Daniel Steinhage, AWI

Energy

Portrait of Aaron Leopold
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SGT5-8000H – the world’s largest and most
powerful gas turbine.
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Fuel cell system.
© The fuel cell research center ZBT,
Duisburg

Multicrystalline silicon wafer in the topog-
raphy and thickness measurement device.
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Novaled’s OLED luminaire Victory –
a concept study with ten warm white light
OLEDs on 25 cm² active area.
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Investigation of future biofuels in the
high-pressure combustion chamber of
the Cluster of Excellence.
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Health

Portrait of Shamima Akhtar
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The figure shows a three-dimensional
representation of a typical model state
(an individual lobule) of the 3D liver model
a few hours after intoxication with carbon
tetrachloride.
© Hoehme et al., PNAS, 107(23), 10371,
www.msysbio.com

Medulloblastoma with nodular-desmoplastic
histology. Tumours of this histopathological
variant almost universally show activation of
the embryonal Sonic Hedgehog signalling
cascade, e.g. by underlying mutations of
the PTCH gene, one example where the
histological subtype already points towards
a specific cancer-related pathway driving
the tumour.
© Dr Stefan Pfister

Model of human polymerase- α – closed
form binding desoxythymidine triphosphate
(dTTP, green) via divalent cations (pink).
In cooperation with Prof. Höltje, Düsseldorf.

Retinachip
© Retina Implant AG, photos.com

Field studies at the Kumasi Centre
for Collaborative Research in Tropical
Medicine (KCCR) in Ghana.
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Mobility

Portrait of Dr Gabriella Gaia
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Reliable power on the go – embedding
lithium ions in a metal oxide crystal
framework makes batteries and storage
batteries safer.
© BASF

Audi e performance: electrification of
the future.
© AUDI AG

Antares DLR-H2: the world’s first piloted
aircraft capable of taking off using only
power from fuel cells.
© DLR

sim^{TP} Car-to-X Communication Channels.
© sim^{TP}

Security

Portrait of Dr Tatiana Tropina
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3D representation of a latent fingerprint
acquired using a contact-less high-
resolution surface measurement device.
© Research Group on Multimedia and
Security, Department of Technical and
Operational Information Systems, Faculty
of Computer Science, Otto-von-Guericke-
University Magdeburg

Joint German-Israeli research project for the
protection of drinking water. The emission
of a tunable semiconductor laser is coupled
into a glass fibre which is partly located in a
water reservoir. The immersed part of the
fibre is flattened to allow optical interaction
of the laser light with hazardous agents
in the water. Such contaminations can be
detected via their characteristic absorption
spectra.
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ALARM-handheld. Ruggedised handheld
made by PSION.
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Container Terminal Bremerhaven
“Wilhelm Kaisen”.
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