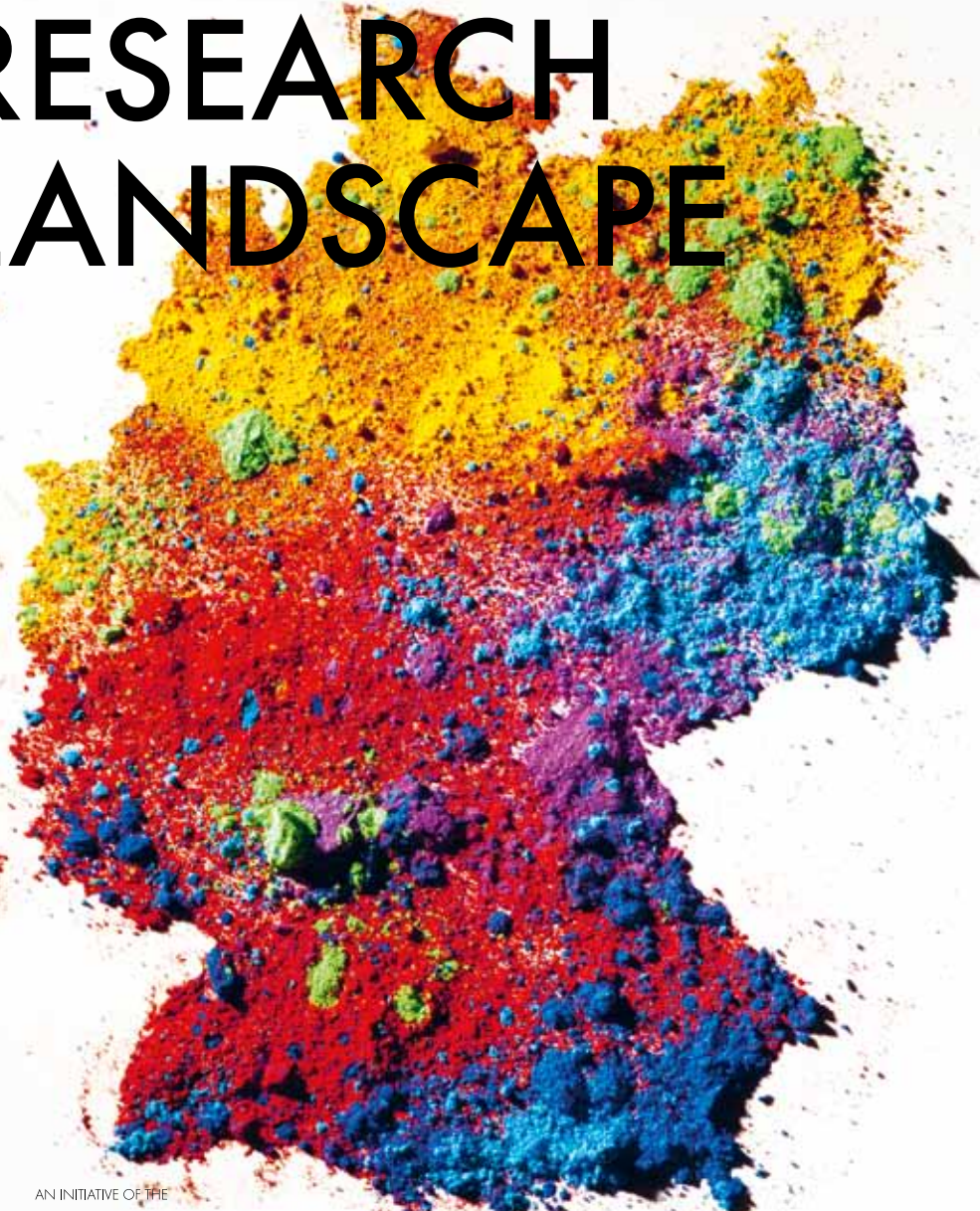




# THE GERMAN RESEARCH LANDSCAPE



AN INITIATIVE OF THE



Federal Ministry  
of Education  
and Research

Research in  
Germany



Land of Ideas



# DISCOVER THE LAND OF IDEAS

From the fuel cell to the MP3 player – German inventions have changed people’s lives. At the same time, research and development (R&D) are what keep a successful economy going. And currently face global challenges such as climate change and poverty. As a country, Germany is one of the world’s top investors in R&D.

“The German Research Landscape” shows who is behind this: universities and research institutes, Federal and state institutions and companies committed to research. Together, these partners form a research infrastructure of international significance. Here, academics from all over the world are offered first-class working conditions and international research institutions and businesses can find partners and options for networking.

Enjoy discovering the German research landscape!



DtAD/Volker Lamert



DtAD/Dörthe Hagemuth



DtAD/Jan Zipper



DFK GmbH/Dr. Jan Abitz

GET IN TOUCH



[www.research-in-germany.org](http://www.research-in-germany.org)



[facebook.com/research.in.germany](https://facebook.com/research.in.germany)



[twitter.com/ResearchGermany](https://twitter.com/ResearchGermany)



Bayer AG

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An overview of the German research landscape: Germany is among the most innovative countries and attaches great importance to networking and excellence.

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The core of German research: Industry and service providers are responsible for the majority of investments in research and development.

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# RESEARCH IN GERMANY

Outstanding, innovative, open-minded – research in Germany has a superb reputation all over the world. It is a research community shaped by universities, research institutions and extensive research by industry. The research covers a broad range of different fields, with the special focus on future-oriented topics. Germany is one of the countries worldwide that invest the most in research and development.



Key technologies of tomorrow: Forschungszentrum Jülich focusses primarily on energy and the environment as well as on IT and brain research.

#### FACTS AND FIGURES

**More than 1,000** public and publicly funded institutions for science, research and development

Almost **600 research and innovation networks** and clusters

**614,000 staff** in R&D including 358,000 researchers

More than **47,000 patent registrations worldwide** (5th place)

Expenditure on R&D: **90.3 billion euros**, or **2.9%** of GDP

## Who researches what?

More than **90 billion euros** – that is the massive sum being invested in research and development (R&D) in Germany. The funding partly goes to projects in universities, non-university research institutions and government research labs. Industry accounts for the largest share of R&D.

### RECORD INVESTMENTS IN RESEARCH

The **German private sector is the main investor** when it comes to looking for new methods, products and applications. In fact, it contributes more than two thirds of total R&D funding in Germany. 2015 saw a record 62.4 billion euros invested. The most important client: the German automotive industry. It spent almost 22 billion euros on research. The main focus is on electromobility as well as connected and autonomous driving. High-grade electronics, mechanical engineering and chemical and pharmaceutical industries are traditionally research-intensive sectors. At present, German industry is specifically researching information and communication technology as well as energy, climate and environmental technologies.

### BROAD RANGE OF RESEARCH

**Higher education institutions** are further important players in German research. They spend more than 15 billion euros to this end, conducting research across the entire spectrum of science. Basic research plays as important a role as applications-oriented research. This also applies to collaborative projects with companies or research institutes.

### INTERDISCIPLINARY AND INTERNATIONAL

One special characteristic of R&D in Germany is the **non-university research institutes**. These largely belong to the four major, internationally renowned research organisations, namely the Max Planck Society, Fraunhofer-Gesellschaft, Helmholtz Association and Leibniz Association. Their R&D activities range from applications-oriented research to basic research in all fields and disciplines. The organisations tend to conduct interdisciplinary research with an international focus and often in collaboration with academic or private-sector partners. Like the large science academies, which also count as non-university research institutes, the big four are registered as non-profit organisations and receive government funding.

Together with **the Federal and state (Länder) research institutions** and other research institutions, such as archives, libraries and specialist information centres, publicly financed non-university research organisations commit about 12.5 billion euros annually to R&D.

### R & D 2015

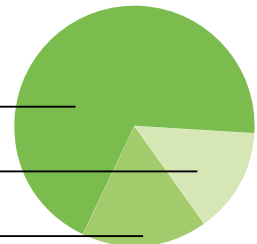
Internal expenditure  
by sector in %

**69%** Private sector  
businesses

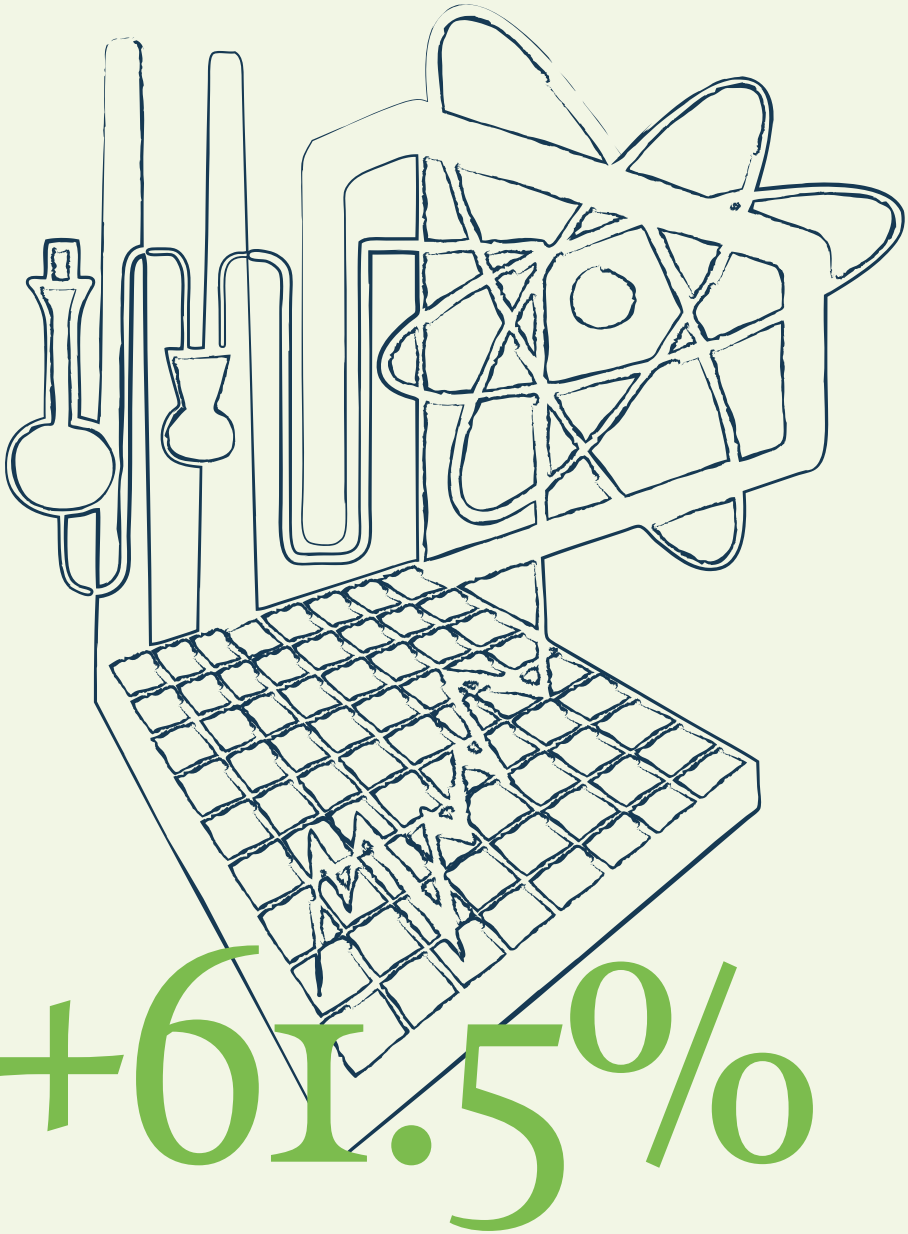
**17%** Higher education  
sector

**14%** Public sector

Source: Destatis, 2017







# +61.5%

is the rise in funding committed to R&D in Germany since 2005.

This places Germany among the world top 10 countries in terms of investments in R&D as a proportion of GDP.



Nina Luethy/IfUf

## Finding solutions for tomorrow's world

The key objectives of government research policies are:

- To find solutions to global challenges,
- To boost Germany's competitive edge and
- To secure future-proof jobs.

There are a series of research policy instruments designed to help achieve this. One of the most important is **the new cross-departmental High-Tech**

**Strategy.** The goal is to move Germany further down the path to becoming the global innovation leader. The way: By finding creative answers to the urgent challenges of today, whether sustainable urban planning, eco-friendly energy sources, personalised medicine or the digital society. The idea is to speed up the process of turning scientific insights into applications.

For this to happen, science and industry, and this includes small and medium-sized enterprises (SMEs), must work closely together. Such collaborations are explicitly supported for example in the fields of electro-mobility or digital manufacturing. And when it comes to the big picture, things do not stop at national borders. Global

### FACTS AND FIGURES

**Around 49,000** scientists from abroad **receive funding in Germany**

Cooperation agreements on scientific-technological **collaboration with about 50 different countries**

In the last decade, 60% of German academics spent **an extended period of time abroad**

**1 billion euros** is the Federal government expenditure on R&D supporting international scientific organisations and inter-government research institutes



DAAD/Volker Lammert (2)



Close cooperation between the private sector and scientists is explicitly supported.

challenges call for international efforts. Which is why the new High-Tech Strategy focusses on European and international collaboration.

### INTERNATIONAL NETWORKS

This is the focus of the Federal government's **internationalisation strategy**. It seeks not only to strengthen scientific excellence through worldwide collaboration and forge strong international links between science and industry. The strategy is also intended to better master global challenges such as climate change, healthcare and food supplies – together with European and international partners. And it is a success: Since 2009 the number of research projects with international partners receiving funding from the Federal

Ministry of Education and Research has more than doubled. There is above all strong cooperation with the **European Research Area**. More synergies, more coherence and more bridges built – these are the central objectives.

The goals are also in line with the European Framework Programme **Horizon 2020**. The world's largest funding programme for research and innovation supports projects that cover the entire development chain – from basic research through to preparing products ready for market. Funding is available for higher education institutions, research institutes and companies. Germany contributes to the financing and benefits from the funding for research projects.

## Strong public funding

Germany is one of the leading countries for research and science. This is thanks, not least, to the distinct system of **government research funding**, which finances infrastructure and institutions, but also supports outstanding academics. Together with the private sector, government is the biggest source of funding for research in Germany. Almost 30 per cent of investments in R&D are financed from tax money. Thus Germany is among those nations worldwide whose governments invest the most in R&D – both in absolute terms and as a proportion of GDP.

### WHAT IS FUNDED?

In Germany, the Federal government and the 16 federal states (Länder) share responsibility for funding education, science and research. There are three instruments for this:

- **Institutional funding:** This focuses first and foremost on basic equipment as well as on staff salaries and materials budgets for the research organisations and universities. Investments in new buildings or new purchases of research equipment or infrastructure likewise come under this category. More than a third of government research support is spent on institutional funding.

- **Project funding:** This type of financing relates to specific, fixed-term projects and is allocated via special funding programmes. Project funding is provided to drive improvements in study programmes and teaching, for example. It also supports joint research projects between academics, researchers and SMEs in particular, or goes towards projects with international participation.

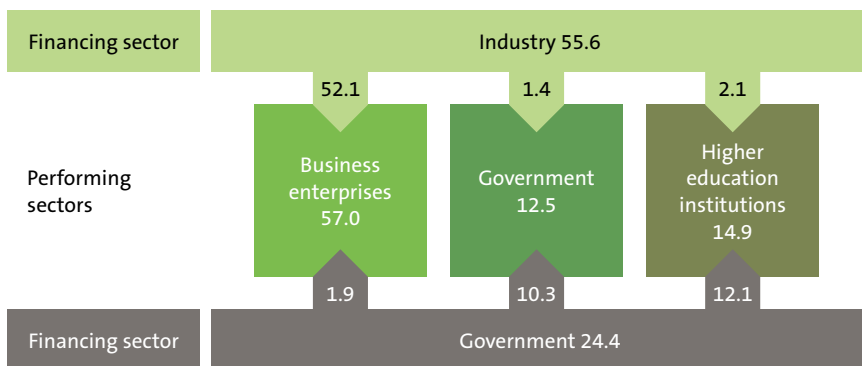
- **Departmental research funding:** Policymakers and public administrations need scientific support and advice themselves. Commissioned research is required to facilitate this. Primarily, of course, it is the government's own research institutions which the federal ministries or state (Länder) authorities contract for research assignments; however other research institutions can also be commissioned with R&D projects.

### SUPPORTING ACADEMICS

Direct government funding is not available for individual researchers. Instead, these can seek support from research funding organisations (which primarily draw on public-sector finance) such as the German Research Foundation, the German Academic Exchange Service or the Alexander von Humboldt Foundation. These organisations have specially tailored programmes for international (young) academics, for international collaborations or for the support of (joint) research projects.



**GROSS DOMESTIC EXPENDITURE ON R&D IN 2014** in billion euros



Funding is also provided by private non-profit organisations (0.3 billion euros) and foreign institutions (4.2 billion euros). Total funds: 84.5 billion euros.

Source: OECD (2017), deviations in the sums due to rounding

# German Houses of Research and Innovation

The future of humanity is urban. Already, half of the world's population live in towns and cities. In just a few decades, that ratio will rise to more than two thirds. Cities play a key role in tackling environmental challenges, but what should the cities of the future be like? At the German Center for Research and Innovation (GCRI) in New York, academics, urban planners, architects and decision-makers gathered to exchange ideas on "Smart Cities and Urban Development". Six German research networks were invited to present their ideas for a resource-efficient, environmentally-compatible city of the future. Their goal? To share their ideas and to gain strong partners in the US, too.

The GCRI is one of five German Houses of Research and Innovation which, alongside New York, are located in Moscow, New Delhi, Tokyo and São Paulo respectively. They all see themselves as platforms for exchanging information about the German research and innovation world, and they showcase the research achievements of German academia and German companies that carry out research. In addition, here international academics, entrepreneurs or academic organisations can get advice and support in the initiation of collaborations, information about funding options and points of contact in Germany. And naturally, the German Houses of Research and Innovation also offer plenty of facts about the multifaceted world of research in Germany.

[www.germaninnovation.info](http://www.germaninnovation.info)





Global reach: German universities are not only active in international collaborations; many also offer opportunities to study abroad.



DAD/Valter Lamerici, DAAD/Christian Lind Otto

## Ambassadors of German research abroad

German research and science makes thorough use of international exchange and cooperation. And it's accessible – around the globe. For example, the **German Houses of Research and Innovation** form a network that brings international academics into contact with German research and helps to form new hubs.

With liaison offices in ten countries, **German universities** have expanded their representation worldwide. What's more, there are over 34,000 collaborative undertakings in place with universities worldwide. Many universities also offer opportunities to study abroad or are involved in setting up universities that follow the German

model. German universities are also regular guests at all the important educational fairs abroad.

The four big internationally renowned **non-university research organisations** – the Max Planck Society, the Fraunhofer-Gesellschaft, the Helmholtz Association and the Leibniz Association – are all represented worldwide with international offices, representative offices, affiliated international research centres or international platforms such as the Max Planck Centers.

The **Alexander von Humboldt Foundation** and the research funding organisation **German Research Foundation (DFG)** also have offices abroad. The **German Academic Exchange Service (DAAD)** maintains its own network of 15 branches and 57 information centres in 59 countries, and has posted around 450 lecturers to universities worldwide.

# UNIVERSITIES

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They are among the best in the world and are attracting an ever greater number of foreign students. German higher education institutions, and not only those in the big cities, prioritise first-rate research and teaching and emphasise their international character.





Independent working:  
The “unity of research  
and teaching” plays  
an important role at  
German higher edu-  
cation institutions.

#### FACTS AND FIGURES

**399 higher education institutions** (including 222 universities of applied sciences)

**685,000 staff** in total, including 385,000 academic staff

**2.8 million students** in total

Expenditure on R&D:  
**15.4 million euros** (2015)

**[www.hrk.de](http://www.hrk.de)**



Ekkehart Bussenius/buif, Tim Wagner/laif, Arnold Manscher/laif, Nikada/Cerity/imagoe

**H**eidelberg University is the oldest university in Germany – and at the same time a vibrant hub of science: Teaching started in three faculties way back in 1386. Today, the university has 12 faculties with over 30,000 students and 5,000 academics active in teaching and research. Heidelberg is one of Germany’s most successful universities. There are currently three Nobel Prize laureates among its professors – in total, no less than 11 professors from the university have received this, the highest of scholarly honours.

#### TRADITION AND DIVERSITY

In other words, Heidelberg University takes its rightful place in the list of Germany’s internationally renowned **top universities**. Its successes are based on the long tradition of values which make academic quality possible in the first place: namely the **unity of research and teaching** and the guarantee of **scientific freedom**, both qualities that shape the face of German universities and make them so special. Scholar Wilhelm von Humboldt (1767–1835) restructured education in Germany at the beginning of the 19th century



Modern architecture, innovative curricula: Technical University of Munich (on the l.), Goethe University Frankfurt.



Open to new ideas:  
An important principle  
is the freedom of  
academic thought.



“What we need is diversity  
in teaching and  
research, people from all  
over the world,  
with different ethnic roots,  
religions, gender  
and cultural identities.”

**PROF. DR. PETER-ANDRÉ ALT**, President of Freie Universität Berlin,  
in his speech at the March for Science 2017



International in architectural terms, too: The eye-catching Philological Library at Freie Universität Berlin was designed by British star architect Norman Foster.

Nilada/Getty Images, Daniel Rosenthal/haif, DAD/Dorthe Hagerguth

and founded today's Humboldt-Universität zu Berlin in line with his ideas. As Humboldt himself stated, it became "the mother of all modern universities".

Today, these standards that Humboldt set for ideal education no longer apply just to the universities. Most of the **universities of applied sciences** established from the 1970s onwards today conduct research and expand their curricula. They now cater to almost one million students. In universities, the focus tends to be on basic research and applied sciences, and classes usually have a focus on research. By contrast, research in universities of applied sciences normally concentrates on applying teaching in practice.

## PRACTICAL EDUCATION

This can also be seen from one of the newest academic institutions in Germany, Hochschule Emden/Leer. Founded in 2009, this university of applied sciences scores high with an interdisciplinary curriculum, an international approach and strong links to the region. It sees itself as an intermediary between science and business: It has its own technology transfer office. Research focusses on topics such as energy efficiency in manufacturing, promoting good health and industrial informatics. Hochschule Emden/Leer cooperates with other universities and companies in the region. Not only the teaching benefits from the research and the link to practical applications, but so do the students who wish to start up their own businesses.



## The International Research Training Group “Diversity”

A prime example of innovative and international teaching and research at German higher education institutions is the International Research Training Group (IRTG) “Diversity: Mediating Difference in Transcultural Spaces”. The topic: cultural diversity in European and North American societies.

Two countries, three universities and nine departments are involved, meaning the doctoral programme is itself highly diverse regarding fields and nationalities. Professor Ursula Lehmkuhl of the Department of International History at Trier University initiated the research training group and is its spokesperson. Also on board are Saarland University and Université de Montréal in Canada.

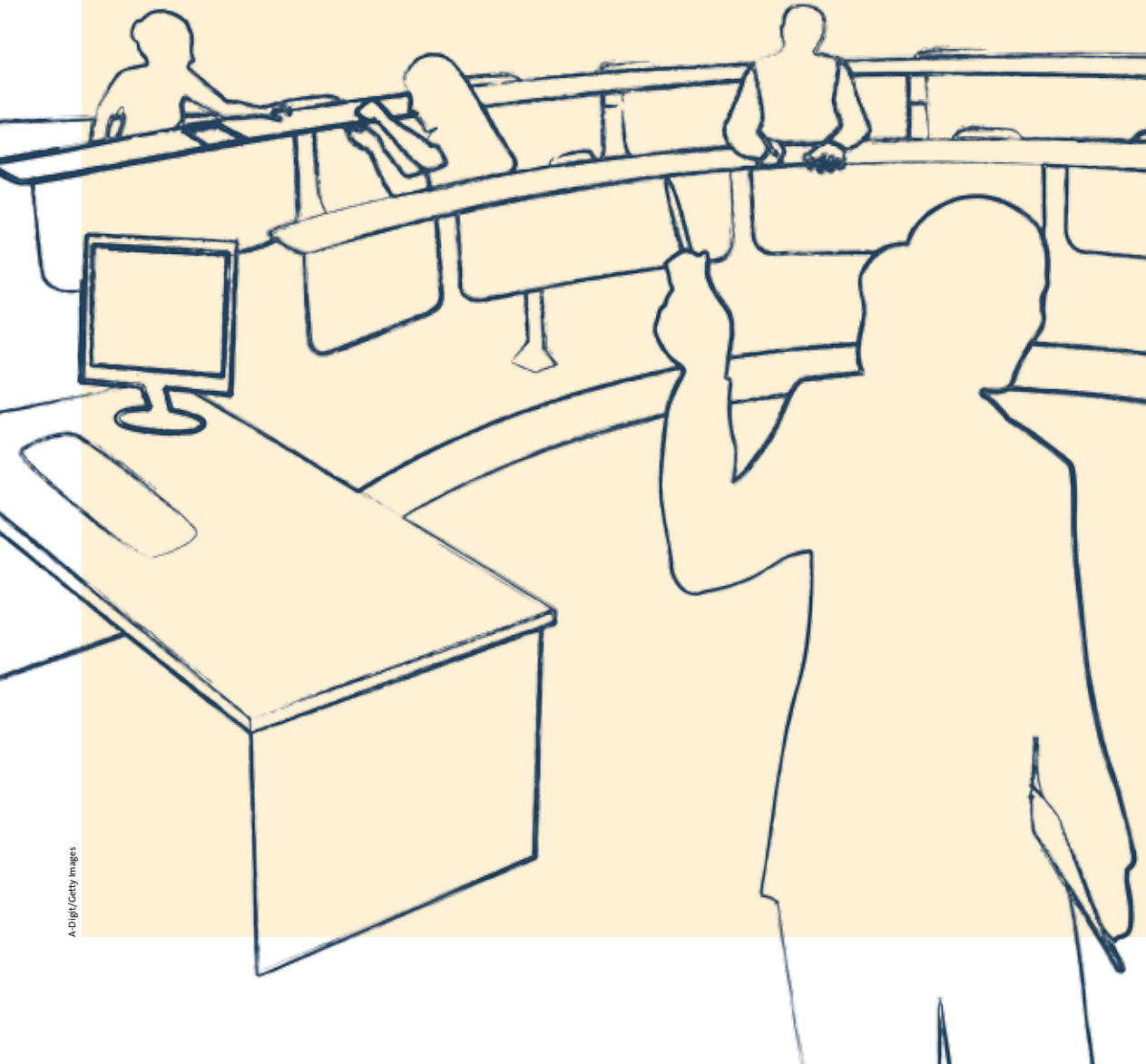
Deutsche Forschungsgemeinschaft (DFG, the German Research Foundation) has financed the research training group since 2013. On both sides of the Atlantic, 20 doctoral students, eight postdocs and more than 60 academics are studying aspects of cultural diversity. “It really enriches our research and education,” comments the Canadian spokesman for IRTG, Professor Laurence McFalls of Université de Montréal, thanks to “the change in perspective” and the “intensive exchange” – interdisciplinary and international research at its best.

[www.irtg-diversity.com](http://www.irtg-diversity.com)

# 399

**INSTITUTIONS OF HIGHER  
EDUCATION**

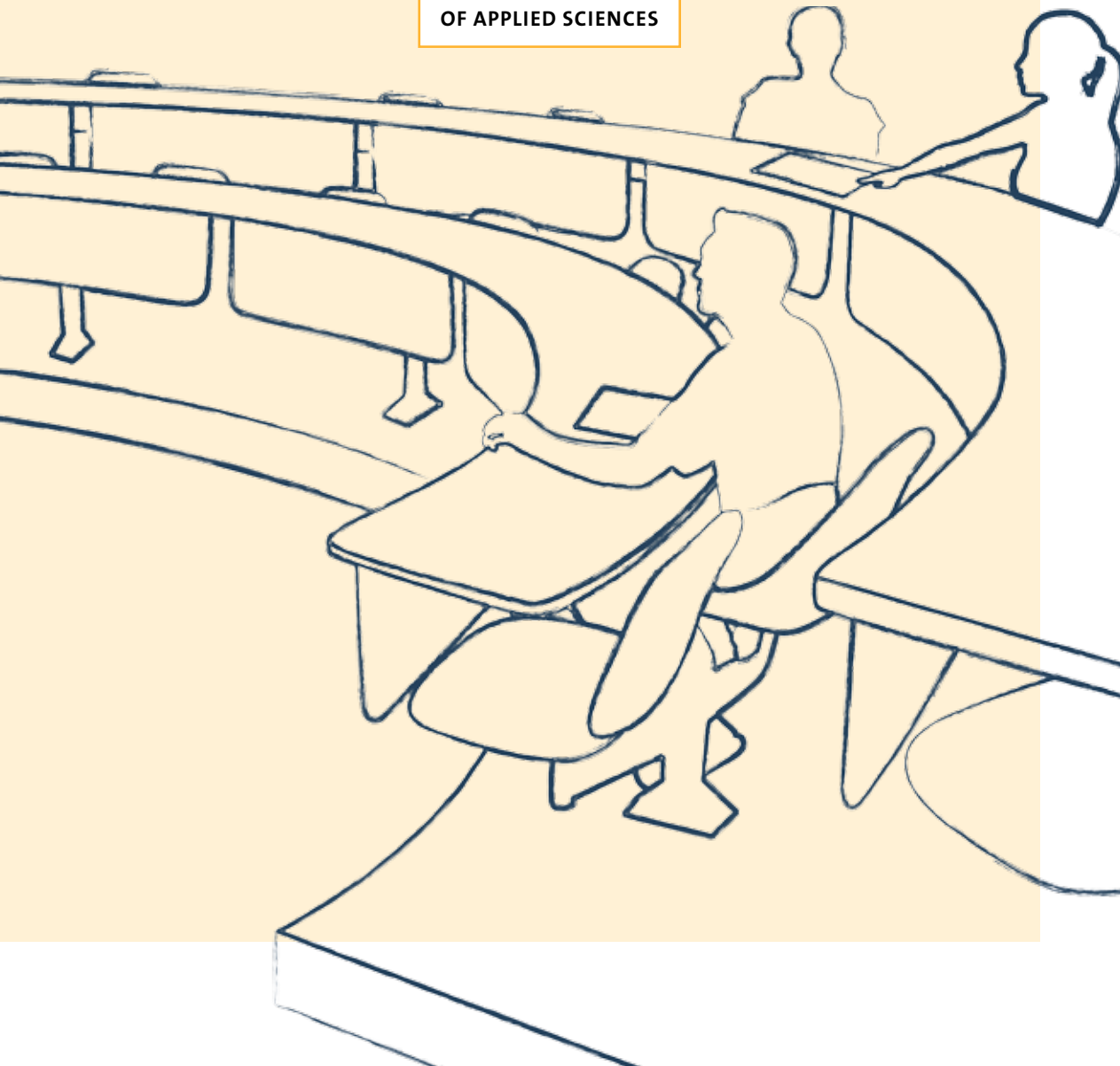
Universities, universities  
of applied sciences and film,  
art and music colleges  
form the vibrant face of higher  
education in Germany.



119  
UNIVERSITIES

58  
FILM, ART AND  
MUSIC COLLEGES

222  
UNIVERSITIES  
OF APPLIED SCIENCES





Better thanks to exchange: German academic policymakers know well that international collaboration expands horizons, and therefore consciously support it.

### INTERNATIONAL & COSMOPOLITAN

More than **42,000 international academics** teach and research at German higher education institutions

Just short of **360,000 students from abroad** are enrolled in Germany

About **34,000 international collaborations** in 150 different countries currently involve German higher education institutions

### TECHNICAL UNIVERSITIES

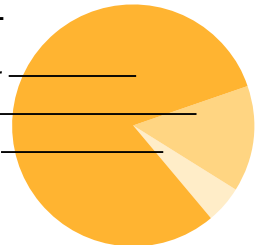
Another special feature of the German university world is the **technical universities** and colleges. The 18 German technical universities focus on engineering disciplines, with the spectrum ranging from architecture to industrial engineering. The leading technical universities are grouped under the label TU9 and include the Karlsruhe Institute of Technology, or KIT for short. The so-called KIT Centres conduct research on key issues, such as energy, humans and technology and climate and environment.

The major technical universities are outstanding research institutes: Four of the 14 universities that were awarded by the Excellence Initiative for their institutional strategies were technical universities.

### R&D INTERNAL EXPENDITURE

- 81% Public sector
- 14% Industry
- 5% International

Source: BMBF



DAAD/Dorthe Hagenboth, Simone Fries, DAAD/Norbert Hüttermann, Ute Grabowsky/Getty Images





Analogue and digital: Modern teaching takes both paths. The picture shows the library at University Halle-Wittenberg.



Attractive courses: Among students from abroad, Germany is the most popular study destination after the USA, Great Britain and France.

## INTERNATIONAL FOCUS

Science needs freedom and the exchange across borders. No country can solve global issues such as climate change, combatting poverty or sustainable energy supplies on its own. Which is why internationalisation is a key aspect at German universities, too. Important steps have already been taken: About 300 German universities collaborate with international academic institutions in 150 countries on more than 34,000 different projects. German study programmes abroad play a special role here. One example for such cooperations is the German University of Technology (GUTech) in Oman, one of more than 80 German transnational education projects. It was founded in 2007 with support from RWTH Aachen University, on whose curriculum its study programme

is modelled. With great success: Companies in the region are eager to hire GUTech graduates because of their research-based, practical education and their high level of independence.

## OPEN FOR INTERNATIONAL TALENT

An increasing number of international academics are teaching and conducting research in Germany. Every tenth academic at German higher education institutions, or more than 42,000 scientists, come from abroad. And Germany is one of the most popular destinations for international students. Worldwide almost every tenth student studying abroad chooses to enrol at a German university. At the same time, 140,000 Germans study abroad, which again fosters international exchange.



Strong practical links: Teaching at German universities of applied sciences focusses on possible applications.



Ute Grabowsky/Getty Images, dpa/Arne Dieder

## INVESTING IN INNOVATION

German universities have been very successful in extending their international profile, boosting innovative research and offering attractive study programmes. This is not least the result of massive investments by the Federal government and the states (Länder). For example, the billions invested by the **Excellence Initiative** have had a tangible impact: Graduate schools, excellence clusters and future projects have enriched the university landscape, given research a real boost and created outstanding education facilities for young researchers. Now, this successful programme is being continued in the form of the **Excellence Strategy**. It is again investing in cutting-edge university research while supporting excellence clusters and excellence universities, with annual funding totalling 533 million euros.

Small and medium-sized universities as well as universities of applied sciences also receive

support. With their strong regional roots, they are innovation engines for their respective state. The federal/state initiative **Innovative Hochschule** will commit up to 550 million euros over the next decade to promote the research-driven transfer of ideas, knowledge and technology.

As a rule, complex research areas which involve high research risks and hold great potential for groundbreaking innovation require the collaboration of several partners. The **Research Campus** funding initiative therefore supports long-term projects involving collaboration between science and industry.

The topics range from new methods for diagnosing infectious diseases to innovative manufacturing technologies. Each of the nine selected research campuses can expect to receive up to 2 million euros in funding each year.



# Our agenda centres on increasing our international reach



**PROF. DR. DR. H. C. MULT. WOLFGANG A. HERRMANN,** Technical University of Munich (TUM), longest-serving university rector in Germany

***Professor Herrmann, your university is among the most successful in the world. What's the secret behind the success?***

The secret is quite simply appointing only the best. You have to choose carefully and make attractive offers. And you have to support interdisciplinary curricula and research, as what is truly new lies hidden in the interfaces between the disciplines.

***What part does internationalisation play in that success?***

Our agenda centres on it, as it brings together the strengths of different cultures. At present, 24 per cent of our students come from abroad. Since 2006 we have appointed 140 international professors, and of the tenure-track professors, 52 per cent are academics from abroad.

***Where do you see TUM ten years from now?***

We will have consolidated TUM's leading position in the German university rankings and it will have risen sharply through the international rankings. TUM's fields of study will include strong social sciences that interconnect with the technological disciplines.

# NON- UNIVERSITY RESEARCH

Independent basic research,  
applied science with a high degree  
of innovation and experiments  
with unique large-scale equipment:  
Non-university research institutes  
in Germany offer ideal conditions  
for top-level research and enjoy  
international standing.





Aerodynamic tests in a wind tunnel: The German Aerospace Center (DLR) in Cologne has facilities that are unique in Europe.

# MAX PLANCK SOCIETY

Insight must precede application:  
The desire to get to the bottom of  
things drives the Max Planck Society,  
Germany's generator of Nobel  
Prize winners.

## FACTS AND FIGURES



MAX-PLANCK-GESELLSCHAFT

**84 research institutes**  
(including 5 institutes,  
1 branch abroad)

Roughly **23,000 staff**  
(approx. 6,500 scientists)

Almost **every second** scientist  
comes from outside Germany

**4,500 research projects**  
in 120 countries

Annual budget: approx.  
**1.9 billion euros** (2017)

**[www.mpg.de](http://www.mpg.de)**

**I**t was a revolution. A law that had been set in stone for more than a century was smashed to pieces. A threshold had been crossed. Professor Stefan Hell and his team had done it. Up until then optical microscopes had not been able to distinguish objects less than 200 nanometres apart. This was the resolution limit expressed in a formula devised by Ernst Abbe in 1873. This formula defines the boundaries of research for biologists and medics – and it is even chiselled into stone at a memorial in Jena.

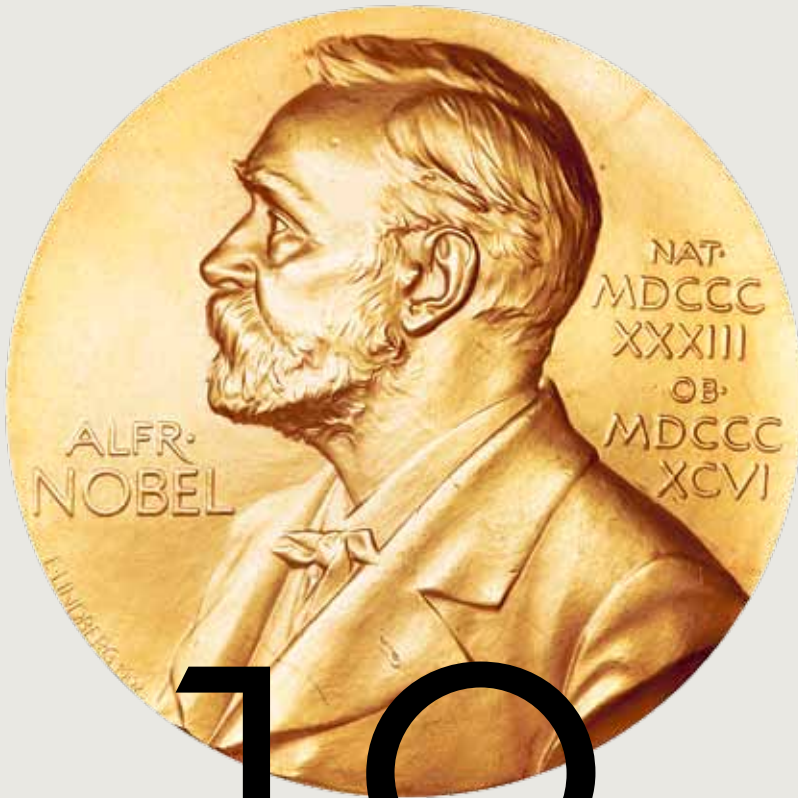
But Hell and his team got around this by means of a trick. They separated adjacent fluorescent molecules by switching them on and off sequentially. For this revolutionary idea, from which they went on to develop STED (the abbreviation stands for Stimulated Emission Depletion) microscopy, Hell received the Nobel Prize for Chemistry in 2014. This method makes it possible to produce images that are 100 times sharper than those using traditional optical microscopy. It achieves a resolution of 1 nanometre – which corresponds to one millionth of a millimetre.

Hell is the director of the Max Planck Institute (MPI) for Biophysical Chemistry in Göttingen. The Institute is one of the Max Planck Society's 84 research institutes that work independently.



Tania Reinicke/laif

Top research with a focus on the basics: This is the mission of the research society named after Max Planck, the founding father of quantum physics. Photo: fusion experiment at the Max Planck Institute for Plasma Physics.



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## NOBEL PRIZE WINNERS

Since 1948, the year when the Max Planck Society was established, 18 scientists from its ranks have received the greatest honour for scientists – the Nobel Prize.





dpa/Felix Kestele, p. 32, dpa/Heritage-Auctions

Original thinker and Nobel Prize winner: Stefan Hell, Head of the Max Planck Institute in Göttingen, succeeded in opening up a door leading to the nanocosmos with his persistent research.

They focus on basic research, often taking an interdisciplinary approach, in the following fields:

- Life sciences,
- Natural sciences and
- Humanities and social sciences.

### TOP SCIENTISTS

What distinguishes the Max Planck Institutes is that they are established in line with Harnack's principle. It is named after Alfred Harnack, the first president of the Kaiser Wilhelm Society which was established in 1911 and was the precursor to the Max Planck Society. The aim is to recruit the world's best and most creative scientists to the society. The Max Planck Institutes are then set up as suits their research interests and needs. **At the heart of this principle is absolute freedom of research.** Heads of institutes enjoy the best-possible working conditions and are given a free hand in choosing their staff, subject matter and cooperation partners. Nowadays, the institutes are no longer always established around individual researchers and more value is placed on interdisciplinarity and international collaboration than was the case 100 years ago. Yet the same principle still applies to choosing outstanding researchers with a focus on the best minds, and they are given a free hand in how they use resources.

### THE MISSION

It is basic research to which the Max Planck Institutes are committed. They research the inside of elementary particles and the origins of the universe. They work on the molecular building blocks of life, investigating ecosystems and the specific

conditions underlying them, explore the changes resulting from global migration and compare international legal systems. Whatever their particular focus, the Max Planck Institutes are always committed to fields of research that are particularly innovative.

The range of work covered by the Max Planck Society continues to grow, with new institutes being established and existing ones being rededicated in order to find the answers to scientific questions for tomorrow. The Max Planck Society has the scope to be able to react quickly to new scientific developments.

#### INTERNATIONAL ORIENTATION

In view of such research conditions it is no wonder that the Max Planck Institutes attract so many top international players. **Almost half of the scientists and more than half of the institutes' junior and visiting scientists come from abroad.** The number of postdoctoral researchers with foreign passports even stands at over 70 per cent.

Yet it is not only the teams that are international. Max Planck Institutes are part of international networks; their scientists exchange ideas with colleagues all over the world and they are involved in more than 4,500 projects with some 5,000 international partners in 120 countries.

#### THE NEXT GENERATION

The efforts made by the institutes to encourage the upcoming generation also have an international focus. Every second doctoral student at the 66 International Max Planck Research Schools (IMPRS) comes from abroad. Each of the graduate schools is located at one of the Max Planck Institutes and collaborates closely with universities and other research institutions which also have an

"I decided to come here because I found the curricula of the IMPRS not only exciting from the scientific point of view but also interesting and challenging. It offers both theoretical work and experimentation."

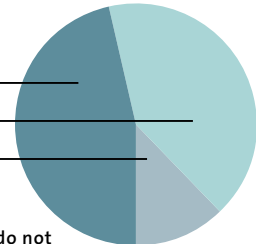
**ISRAEL BARRANTES** wrote his doctoral thesis at the International Max Planck Research School for Advanced Methods in Process and Systems Engineering, Magdeburg

#### BUDGET

46% Federal

41% Länder

12% Third party



(Individual figures do not add up to 100% due to rounding)

Source: Max Planck Society

“

## A fantastic framework for our research project

print, Johann Schumacher/Getty Images



**DR. MIRIAM LIEDVOGEL**  
Max Planck Research Group Leader  
“Behavioural Genomics”

***Dr. Liedvogel, at the Max Planck Institute for Evolutionary Biology you investigate birds' migratory behaviour. What do you find so fascinating about it?***

What I find particularly fascinating are young birds on their first long-distance migratory flight. They fly thousands of kilometres to a wintering site they have never been to before – without the help of their parents, but with remarkable accuracy! We want to understand which genes are responsible for letting the bird know how to find its wintering site and which signalling pathways play a role.

***What makes a Max Planck Research Group a good place for your work?***

It offers us a fantastic framework for our interdisciplinary project. That includes the infrastructure and expertise with which the institute supports us. Moreover, we have the greatest possible independence to pursue our specific research questions.

***How important to you is international exchange?***

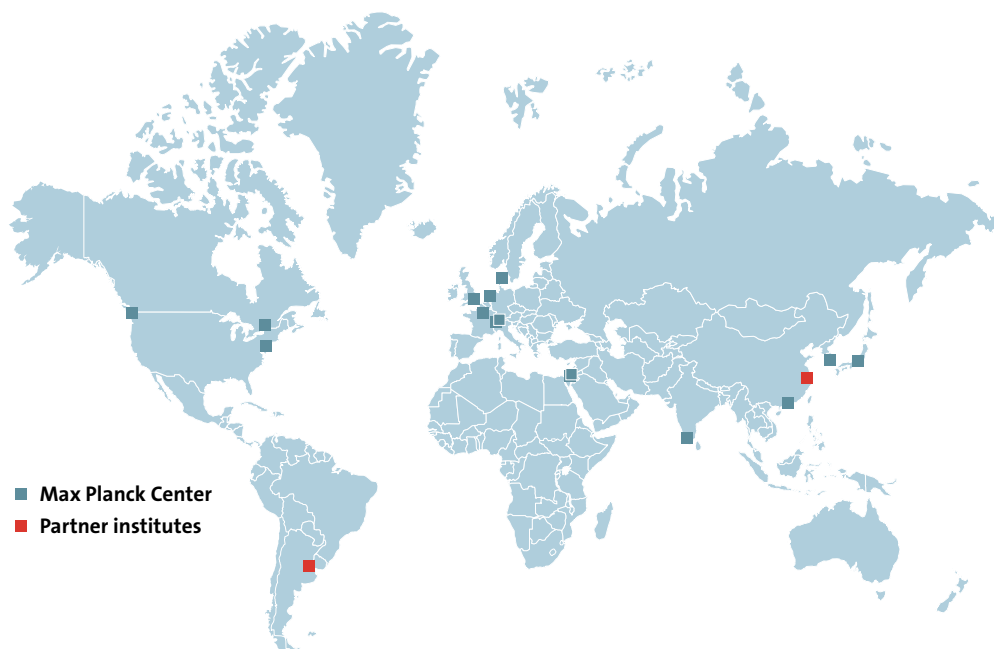
Bird migration is a global phenomenon; national borders pose no barriers for birds. Breeding and wintering areas are often located on different continents, meaning that international cooperation is essential for our work, both in the field and in the lab.

”



A. Esler/NPP

International networking in astrophysics – the researchers working on the CRESST experiment are looking for dark matter. They are part of a European research network managed by the Max Planck Institute for Physics, Munich.



The Max Planck Centers constitute a platform for international scientific collaborative programmes. They pool the expertise of the Max Planck Institutes involved and that of their international partners, enable the joint use of research facilities, support postdoc exchanges and host workshops.

international focus. Here next-generation scientists can enjoy first-class conditions. The students are part of a group and have access to the relevant institutes' infrastructures.

#### Max Planck Institutes abroad

Bibliotheca Hertziana in Rome, Italy

Art History Institute in Florence, Italy

Max Planck Institute for Psycholinguistics in Nijmegen, Netherlands

Max Planck Florida Institute, USA

Max Planck Institute Luxembourg for International, European and Regulatory Procedural Law, Luxemburg

Around one third of the 3,300 doctoral students at a Max Planck Institute are enrolled at an IMPRS. Particularly gifted young scientists with (international) experience as postdoctoral researchers can apply for a position as leader of a Max Planck Research Group. **Being in charge of such a group they can research independently**, manage a team and administer budgets. The Max Planck Society has set up some 120 research groups. These provide aspiring scientists with a chance to prove themselves and open up excellent career opportunities.

# FRAUNHOFER- GESELLSCHAFT

Dedicated to the future: When something needs to work, the researchers at the Fraunhofer Institutes are the people to call. After all, Fraunhofer is the largest research organisation for application-oriented research in Europe.





Specialists in high-tech:  
At Fraunhofer, the focus is primarily on innovations – although always with a focus on the needs of the individual.

#### FACTS AND FIGURES

## Fraunhofer

**69 Fraunhofer Institutes**  
and research facilities  
in Germany

Over **24,000 staff**, including  
more than 9,000 scientists and  
scientific staff

More than **900 international  
researchers**

Research centres, representa-  
tive offices and senior  
advisors in **Europe, North  
and South America, Asia,  
the Middle East and Africa**

Annual budget: approx.  
**2.4 billion euros** (2017)

[www.fraunhofer.de](http://www.fraunhofer.de)

In all their tasks, the researchers at the Fraunhofer Institutes are looking to the future. Whether the subject is the tactile internet, smart manufacturing, cyber-security research or new technologies for the energy transition: They address the issues of today for the technologies of tomorrow with an eye to practical applications. **69 institutes and research centres** in Germany take this problem-oriented and application-based approach in researching the themes of:

- Health and environment,
- Security and protection,
- Communication and knowledge,
- Mobility and transport,
- Energy and resources and
- Production and supply of services.

With more than 24,000 employees and a research budget of 2.4 billion euros, the Fraunhofer-Gesellschaft is the **leading organisation for applied research in Europe**. It is named after the researcher, inventor and entrepreneur from Munich, **Joseph von Fraunhofer (1787–1826)**. He carried out ground-breaking work in researching optics, and at the same time developed successful new products.

### THE TASK

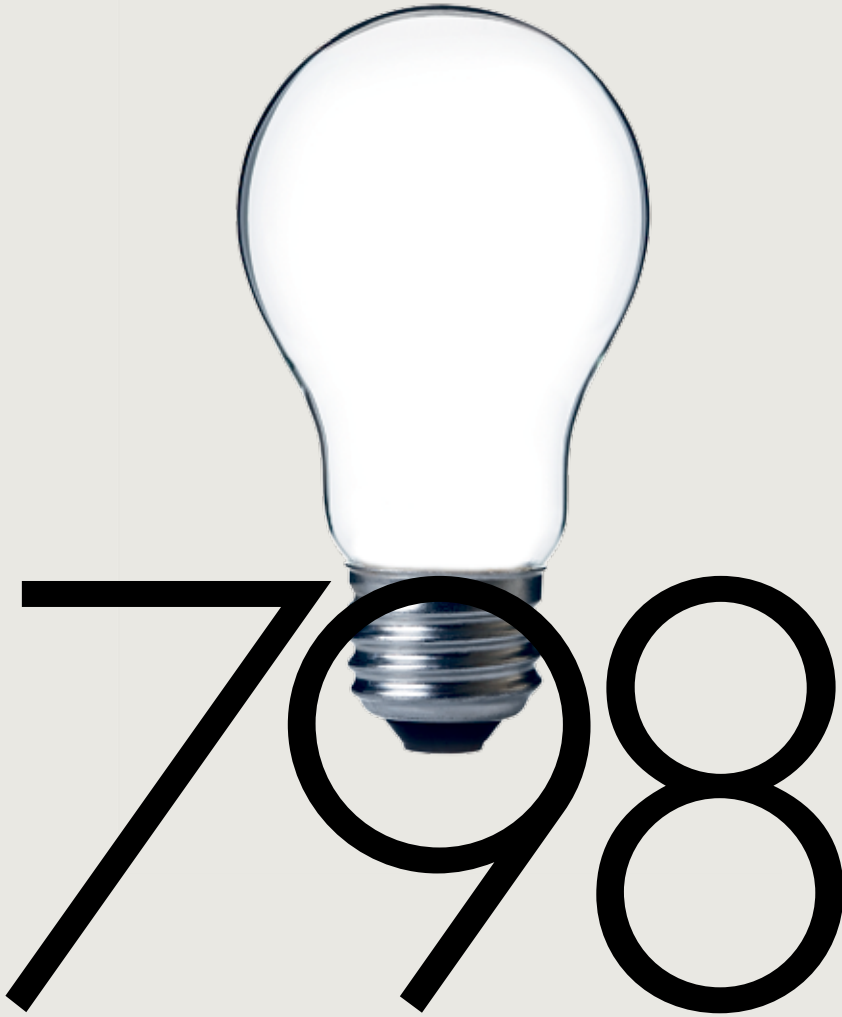
Research for practical application was Joseph von Fraunhofer's guiding principle, and the Fraunhofer-Gesellschaft feels bound by this too. The Fraunhofer Institutes work for clients in business as well as for the Federal and state (Länder) governments. The aim is to make academic findings usable for customised products and applications. To this end, the Fraunhofer Institutes can draw on the expertise of international teams of experienced developers and creative minds, as well as on their own research departments.



00440/Voller Lammert, p. 41; T. Kimura/Getty Images

Key technologies: The Fraunhofer Institute for High-Frequency Physics and Radar Techniques FHR is one of the biggest radar research institutes in Europe.





## INVENTIONS A YEAR

Fraunhofer is one of the top 20 patent applicants to the German Patent and Trade Mark Office and is among the 50 most active applicants to the European Patent Office. Small wonder that in 2017 Fraunhofer placed third among the Reuters top 25 Global Innovators.



dpa/Daniel Karmann

The Fraunhofer-Gesellschaft is primarily funded through commissioned research. More than two thirds of the assignments come from industrial and service-sector companies, but publicly funded research projects are also covered. The basic funding is provided by the Federal and state (Länder) governments.

### RESEARCH AIMED AT PRACTICAL APPLICATIONS

When science becomes practical, it translates into business. This works particularly well when Fraunhofer researchers found their own companies. The Fraunhofer Venture department supports this and is dedicated exclusively to company foundations, start-ups, investors and the participating Fraunhofer Institutes. In 2015 alone, Fraunhofer Venture supported 27 company founders, 24 of whom came directly from within the ranks of the Fraunhofer-Gesellschaft. The focus here is on technology transfer to business.

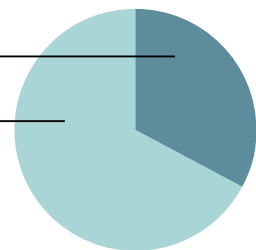
We can make this work: This is the principle according to which the men and women at the Fraunhofer-Gesellschaft work. They tackle their tasks with determination and an inquiring mind.


### BUDGET

33% Federal and Länder

67% Project revenue

Source: Fraunhofer





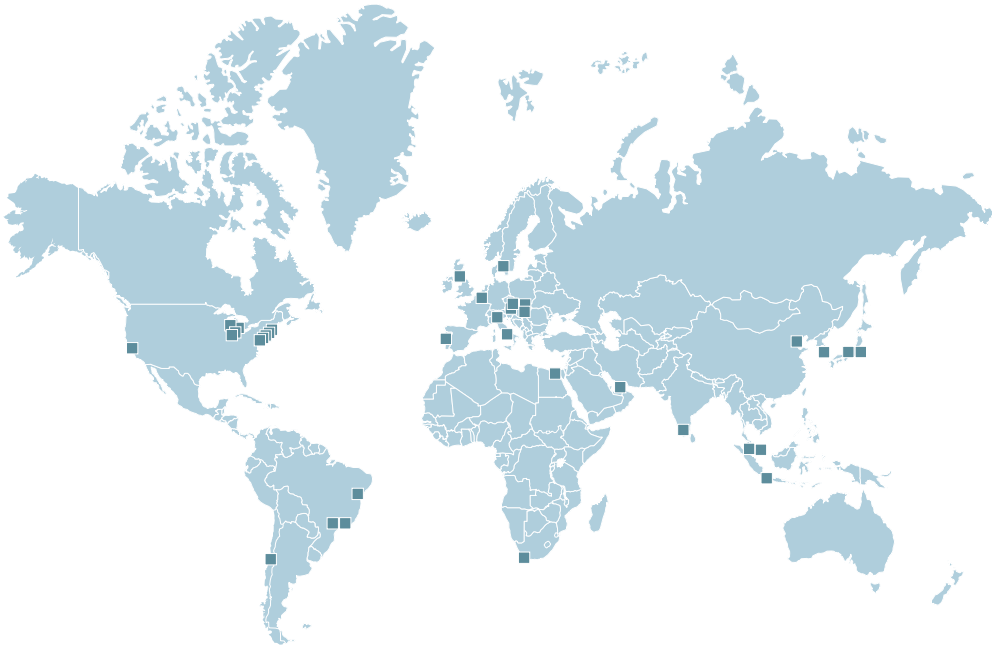
## Ceragen – Power out of the Box

Persistence pays off: The team at the Fraunhofer Institute for Ceramic Technologies and Systems, IKTS, based in Dresden and with Professor Alexander Michaelis as its director, had been working on the development of a high-temperature fuel cell (SOFC) for ten years. Then came the breakthrough. A total of 15 million euros in research funding and intensive research work had been committed to this project. The researchers wanted to improve the conventional, expensive fuel cells, which generally have only a short life span, so that they can be used sensibly and at low cost.

The new fuel cell is long-lasting, efficient and ideal for use in local energy generation. For example in a detached family home. The system, which has been christened “Ceragen”, consists of a modified fuel cell and a heat accumulator, and can generate power and heat from natural gas.

The Fraunhofer-Gesellschaft provided the initial funding. To date, prototypes of a 100-watt high-temperature fuel cell device are available and close to series production, and these have already been tested successfully by customers. The future has begun.

[www.ceragen.org](http://www.ceragen.org)



### Fraunhofer locations worldwide

#### North America

Boston  
Cambridge  
East Lansing  
Hamilton  
London, Ontario  
Maryland  
Newark  
Plymouth  
San José  
Storrs, Connecticut

#### South America

Campinas  
Salvador, Bahia  
Santiago  
São Paulo

#### Africa

Stellenbosch

#### Near and Middle East

Cairo  
Dubai

#### Asia

Ampang  
Bangalore  
Beijing  
Jakarta  
Sendai  
Seoul  
Singapore  
Tokyo


#### Europe

Bolzano  
Brussels  
Budapest  
Ercolano  
Glasgow  
Gothenburg  
Graz  
Porto  
Vienna  
Žilina

Fraunhofer is now a shareholder in 85 different companies. These include, for example, the winner of the 2014 Deutscher Zukunftspreis, the German President's Award for Innovation in Science and Technology, Prolupin GmbH. The company was praised for its innovative process of producing vegetarian and vegan dishes using lupine seeds.

### INTERNATIONAL COLLABORATIONS

The Fraunhofer-Gesellschaft has subsidiaries in Europe as well as North and South America. At the centre of the European activities is the office in Brussels, which acts as an interface between Fraunhofer and the European institutions. Access to local markets abroad is provided through the Fraunhofer Representative Offices and Fraunhofer Senior Advisors, which are represented worldwide. In addition, Fraunhofer is involved in numerous strategic collaborations with excellent international partners, such as the Dutch Diagnostic Image Analysis Group (DIAG), which is based at the Radboud University Medical Centre in Nijmegen. This is one of the world's leading research groups for computer-based medical recognition and diagnosis. In 2015, Fraunhofer generated revenue of almost 300 million euros abroad.



## Inventions that change the world

No other German research organisation can boast as many inventions and patents as the Fraunhofer-Gesellschaft. One of the most outstanding inventions was created by Karlheinz Brandenburg and his team at the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen. It was here that the MP3 process was developed and marketed from 1987. MP3 compresses and stores music – and revolutionised the music market and the way we listen to music today. An MP3 file requires only around ten per cent of the storage of the original. It became an international success story.

Today Brandenburg, a mathematician and electrical engineer, is director of the Fraunhofer Institute for Digital Media Technology in Ilmenau. Here, he also passes on his knowledge to the next generation at the Ilmenau University of Technology.

“ That’s the biggest success Fraunhofer has ever had. ”

**PROF. DR.-ING. KARLHEINZ BRANDENBURG,**  
co-developer of the MP3 music format and director of  
the Fraunhofer Institute for Digital Media Technology



ESA/DLR/FU Berlin (G. Neukum)

Fascinating play of colours in the universe: A topographic pictorial map of the Tharsis Tholus volcano complex on Mars, taken with a special camera by the German Aerospace Center.

# HELMHOLTZ ASSOCIATION

Investigating unknown worlds: Those who have big goals need effective tools. The Helmholtz Association uses high-performance infrastructure and unique large-scale research equipment.

## FACTS AND FIGURES



**18 independent research centres** (1 associate institute)

Approx. **39,000 staff**, including roughly 22,500 scientists and scientific staff

**8,000 PhD students; 10,000 international researchers**

**International collaborations** all over the world

**Research networks in Germany**, especially with universities

Annual budget:  
**4.5 billion euros** (2017)

**[www.helmholtz.de](http://www.helmholtz.de)**

**T**he highest mountain in our solar system is three times the height of Mount Everest – around 27 kilometres. Olympus Mons is to be found on our neighbouring planet, Mars. We can see precisely what the volcano looks like and what makes up the landscape of Mars from spectacular shots taken by the High Resolution Stereo Camera (HRSC) belonging to the German Aerospace Center (DLR). The device circles the planet on the ESA space probe Mars Express, and each day it delivers at least one photo of the red planet. This enables the researchers to draw conclusions about the geological changes and the development of Mars and its volcanoes.

The German Aerospace Center is one of **18 independent research institutes** that have joined forces under the umbrella of the Helmholtz Association of German Research Centres.

With 39,000 employees and an annual budget of around 4.5 billion euros, the Helmholtz Association is **the largest scientific organisation in Germany**. The association is named after the great German polymath and naturalist Hermann von Helmholtz (1821–1894).



Thomas Ernting, HA-Hessen-Agentur GmbH

Super-fast energy-saver: the high-performance L-CSC computer at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt.

The research centres within the Helmholtz Association focus on natural sciences, biology and medicine, and work in six fields of research:

- Energy,
- Earth and the environment,
- Health,
- Aviation, space travel and transport,
- Key technologies and
- Materials.

### THE TASK

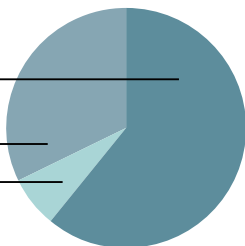
Helmholtz works on **long-term research goals**. The core concept here is the preservation and improvement of the basis for human life. The researchers in the association help to decode the complex systems that define and shape humanity and the environment. And they develop answers to the major, pressing issues facing society, science and the economy: What will the energy supply of tomorrow look like? How can resources be used sustainably? What therapies can be found for previously incurable diseases?

### WORKING WITH LARGE-SCALE EQUIPMENT

Their specialty: The autonomous research institutes develop, build and operate complex **research infrastructures**. The large-scale equipment they use includes accelerator systems, telescopes, research ships and high-performance computers, which Helmholtz makes available to scientists all over the world. And the interest from the international research community is immense: In 2015 alone, more than 9,000 scientists from abroad were able to exchange ideas and make use of the infrastructures of the Helmholtz Centres.

### BUDGET

- 64% Federal and Länder
- 31% Third party
- 5% Others



Source:  
Helmholtz Association





“

## We observe electrons at work

Dr. DAAO/Yeller Jannert



**PROF. DR. FRANCESCA CALEGARI**  
Head of the Attosecond Science  
division at DESY, Deutsches Elektronen-  
Synchrotron

***Professor Calegari, what is attosecond physics and why are you interested in these short timescales?***

An attosecond is one quintillionth of a second – that is 18 zeros behind the point. An attosecond to a second is as a second to the age of the universe. Attosecond physics means we can observe electrons at work. Having access to this incredibly short timescale allows the origin of fundamental physical and chemical processes – activated by the light-matter interaction – to finally be revealed.

***What do you aim to achieve with your research?***

I am interested in investigating ultrafast processes in biorelevant molecules. With the help of attosecond laser pulses, we have been able to image in real-time the ultrafast electronic motion occurring in amino acids – the basic building blocks of proteins – after interaction with light. In the long term, we're hoping not only to observe the electrons but also to guide them, with the aim of controlling the outcomes of a biochemical reaction. This research has potential outcomes in medicine and pharmaceutical applications.

***What is special about working at a Helmholtz Centre?***

DESY offers an extremely attractive, interdisciplinary research environment. Here, I can collaborate with groups from a range of fields and use different light sources, such as FLASH and the European XFEL, for my experiments. I can investigate biorelevant molecules from various points of view.

”



8,038

PHD STUDENTS SUPPORTED

Strategic talent management plays an important role for the Helmholtz Association. There is a new offering in the form of the Helmholtz International Research Schools, each focused on a scientific topic, which will launch in 2018.



DAD/Volker Lamerik, p. 50: DustyPixel/Getty Images

Attractive conditions for talents: The Helmholtz Association also makes targeted offerings to students, trainees, children and teenagers.

### OPPORTUNITIES FOR YOUNG SCIENTISTS

The utmost priority is given to fostering up-and-coming scientific talent. The association's talent management team gives particularly strong support to PhD students, postdoctoral researchers and future managers. Helmholtz offers its early career researchers attractive qualification opportunities:

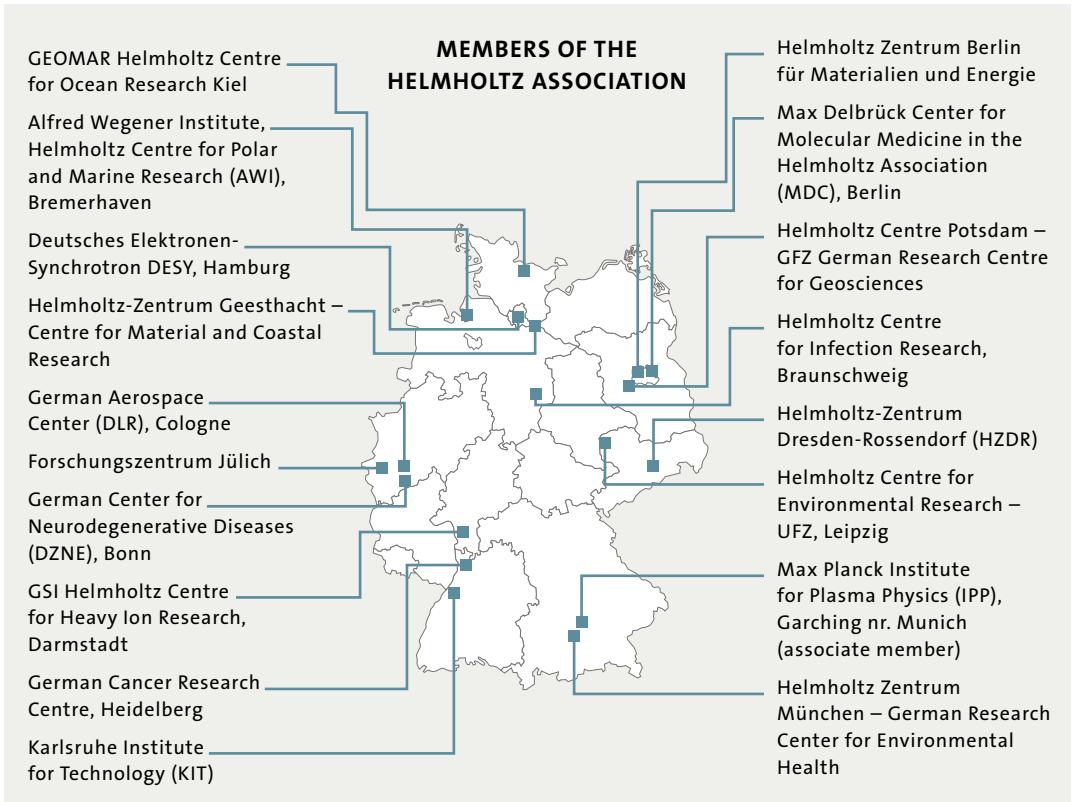
- Structured doctoral courses in almost 100 graduate schools and colleges,
- A postdoc programme for support immediately after the doctorate,
- More than 200 junior research groups for top (international) talents,
- Helmholtz Professorships (W2/W3 programmes) to acquire and support excellent up-and-coming female scientists,
- The recruitment initiative aimed at bringing internationally renowned researchers to the Helmholtz Centres.

### HELMHOLTZ INTERNATIONAL RESEARCH SCHOOLS

For young international scientists, there will soon be a very special opportunity. In 2017, the **Helmholtz International Research Schools** will be advertised for the first time. They offer a structured doctoral programme run jointly by the Helmholtz Centres, foreign partners and German university partners. Here, the PhD students get outstanding specialist training that lays the foundations for a future career and is character-forming as well. It's scheduled to kick off in 2018.



Racetrack for particles: The petawatt laser PENELOPE, a medical particle accelerator, is set up in the ELBE – Center for High-Power Radiation Sources at the Helmholtz-Zentrum Dresden-Rossendorf.



### TRANSLATION INTO PRACTICE

The work of Germany's largest scientific organisation goes further than researching the fundamental elements of the major challenges of the day. The Helmholtz Association also aims to apply and implement the findings and solutions in practice, and thus, more specifically, to translate research into usable products and services. In order to achieve this, Helmholtz issues licences, for example, facilitates the use of research infrastructure and also fosters collaboration and commissioned research right through to establishing start-ups.

In 2015 alone, there were **21 spin-offs from the Helmholtz Centres**, with scientists founding their own companies using a technology they developed. In total, the Association can proudly look back on almost 120 successful company foundations since 2005.

# LEIBNIZ ASSOCIATION

Theoria cum praxi: The desire to use science to the benefit and good of humankind was formulated by Gottfried Wilhelm Leibniz back in 1700. The research organisation that bears his name demonstrates every day just how relevant this principle still is, even today.

## FACTS AND FIGURES

*Leibniz*  
Leibniz  
Association

**91 independent institutes**

More than **18,500 staff**  
(including 9,500 researchers)

Roughly **2,000 international  
researchers**

Annual budget: more than  
**1.7 billion euros** (2017)

**[www.leibniz-association.eu](http://www.leibniz-association.eu)**

One of eight research museums in the Leibniz Association: The Senckenberg Museum in Frankfurt am Main is one of Germany's largest museums of natural history.





**T**he window onto science opens punctually at 10 a.m. The Zoological Research Museum Alexander Koenig in Bonn is a member of the Leibniz Association and engages in species-related biodiversity research. Its scientists have collected more than five million specimens of all kinds of species from all over the world – from small mammals from the Palaearctic to the world’s largest reference collection of cellar spiders. The collection includes an invaluable database of life and is essential to research into biodiversity. And this treasure trove does not lie hidden somewhere. Everybody can look at – and experience – it, namely in the permanent exhibition on the living environments of our “Blue Planet” or in special exhibitions such as the one on a “Success Story of Evolution – Spiders and Scorpions”.

Anybody who likes arachnids – and anyone who is afraid of them – can examine these little (and not so little) eight-legged creatures close up – in everything from a model of a 100-fold enlargement of the money spider *Walckenaeria acuminata* to the Brazilian tarantula – one of the largest species of spiders in the world. The information on offer, including lectures, wall charts and video clips, explains the world of arachnids, provides an introduction to research highlights, points out the medical benefits for the human race and reports on the love lives of spiders.

### THE BRIEF

It is not only the eight research museums in the Leibniz Association that aim to make research accessible to the wider public. The research conducted by other institutes in the total of **91 independent research institutes** is also guided by the same principles of quality and social relevance that were advanced by Leibniz more



Shot by Scott/Getty Images, p.55; Simon Belcher/Getty Images

A broad field: The Leibniz scientists investigate subjects such as biodiversity – as well as peace studies, contemporary history and education.





# 10

## FUTURE-ORIENTED PROJECTS

With the Leibniz Roadmap for Research Infrastructures the Leibniz Association has presented a plan for the future in order to continue producing excellent research at the highest level.

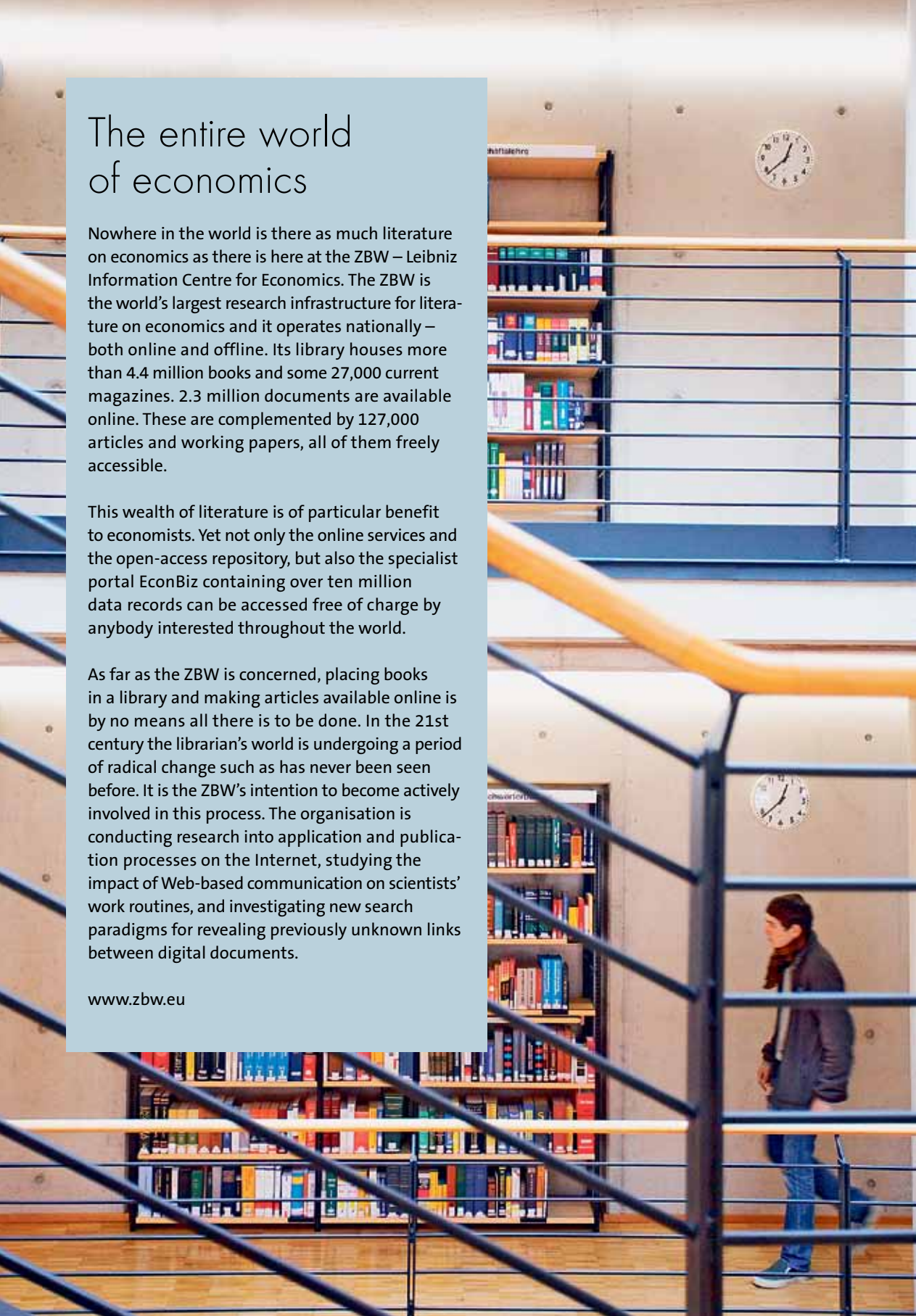
# The entire world of economics

Nowhere in the world is there as much literature on economics as there is here at the ZBW – Leibniz Information Centre for Economics. The ZBW is the world's largest research infrastructure for literature on economics and it operates nationally – both online and offline. Its library houses more than 4.4 million books and some 27,000 current magazines. 2.3 million documents are available online. These are complemented by 127,000 articles and working papers, all of them freely accessible.

This wealth of literature is of particular benefit to economists. Yet not only the online services and the open-access repository, but also the specialist portal EconBiz containing over ten million data records can be accessed free of charge by anybody interested throughout the world.

As far as the ZBW is concerned, placing books in a library and making articles available online is by no means all there is to be done. In the 21st century the librarian's world is undergoing a period of radical change such as has never been seen before. It is the ZBW's intention to become actively involved in this process. The organisation is conducting research into application and publication processes on the Internet, studying the impact of Web-based communication on scientists' work routines, and investigating new search paradigms for revealing previously unknown links between digital documents.

[www.zbw.eu](http://www.zbw.eu)

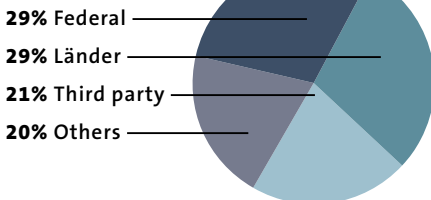




DAD/Christian Iord Otto, p. 58, Stefan Vorbeck

A tight-knit international network: The Leibniz Association engages in global collaboration – with around 20% of its scientists coming from abroad.

#### BUDGET



Source: Leibniz Association

than 300 years ago. The scope of their research ranges from the natural sciences, engineering and environmental sciences to economics, space science, social sciences and the humanities.

The focus of the Leibniz Association is on **knowledge transfer**. It advises and informs representatives of politics, science, business and the general public. The institutions in the Leibniz Association are concerned with **basic research, applied research and research-based infrastructures**. It is this wide range of subjects and research approaches that makes the Leibniz model so very appealing – to top international researchers, too.

Leibniz boasts five kinds of research infrastructures:

- Information infrastructures such as archives and libraries to manage information of all kinds,
- The collections in its research museums such as the Senckenberg collections of recent and fossilised animals and plants with 38.5 million specimens,
- Surveys, cohorts and panels, i.e. large-scale data collection for social statistics and studies on parts of our society,
- Classic large equipment and research platforms such as the solar telescope GREGOR in Tenerife and
- Social research infrastructures, i.e. conference and meeting centres in which scientists can exchange information in their own specialist areas and initiate new projects.

#### THE ROADMAP

The **Leibniz Roadmap for Research Infrastructures** is the Leibniz Association's way of planning the future. So that excellent research will still be possible in 10 to 15 years' time, the research infrastructures need to be assessed and expanded. The roadmap contains concepts for research infrastructures which the Leibniz Association has prioritised as part of an internal process. The selection

criteria: The relevant concepts should allow for excellent scientific work, be socially relevant, of significant importance to the scientific community and be user-oriented. Ten projects with the objective of complementing and enriching the research infrastructures of the future were chosen. Four of the Leibniz concepts were selected for the list of the national Roadmap for Research Infrastructures; three others have been included in the roadmap of the European Strategy Forum on Research Infrastructures (ESFRI).

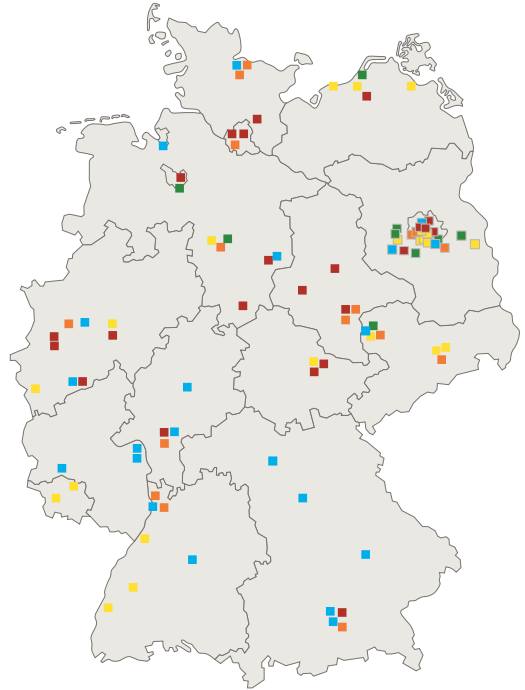
### THE NEXT GENERATION OF SCIENTISTS

Training the next generation of scientists is an important aspect of the Leibniz Association's mission. There are some 3,800 doctoral students working at the institutes. On top of this, the Leibniz Association is committed to structured graduate training, principally at its 30 **Leibniz Graduate Schools**. To this end, the Leibniz institutes collaborate closely with universities. In total, Leibniz is engaged in more than 140 graduate schools.

### COOPERATION AND NETWORKING

Leibniz also collaborates closely with universities on research. There are some 20 networks of Leibniz Institutes and university facilities working together on an interdisciplinary basis as the **Leibniz ScienceCampi**.

Various Leibniz Institutes are affiliated in 12 **Leibniz Research Alliances** and concentrate on subjects of great scientific and social relevance. For instance, scientists at 22 Leibniz Institutes are investigating the "Crises in a Globalised World". The focus of this research alliance is on financial market and debt crises, food crises, environmental crises and crises in political systems. The institutes also cooperate as part of **Leibniz Networks** on focal topics or key technologies such as nanotechnology and citizen science. These networks see themselves as a central point of contact for their fields of research not only within the Leibniz Association, but also for the worlds of politics, media and business and for their sponsors.



### Leibniz Institutes stand for a broad spectrum of science

- Humanities and educational research
- Economics and social sciences, space sciences
- Life sciences
- Mathematical sciences, natural sciences and engineering sciences
- Environmental sciences



A unique research profile: The Leibniz Institute of Tropospheric Research in Leipzig has made aerosols, minute airborne particles and clouds, and important elements of the atmosphere, the focus of its work.



DAM/Jan Zapfner

Excellent teams: More than 1,900 scholars conduct research under the single roof of the Union of the German Academies of Sciences and Humanities.

# ACADEMIES

Bring all the most intelligent people together in one and the same place. That was Plato's idea over 2,400 years ago, when he identified the Akademos grove as the ideal place for his philosophers' school. And to this day it is at the core of the idea of a community of thinkers – the academy.

**G**ermany's first scholarly society was founded as long ago as 1652. The **Deutsche Akademie der Naturforscher Leopoldina** is thus the oldest scientific and medical academy in the world. It has been the German National Academy of Sciences since 2008. Yet there are many other academies in Germany, too. They include the **Union of the German Academies of Sciences and Humanities**, which is an association of eight state (Länder) academies. Then there is the National Academy of Science and Engineering, **acatech**, which represents the technical sciences, at home and abroad. And since the beginning of the new millennium the **Junge Akademie** has represented new scholarly talent. The key tasks of the academies are to coordinate long-term basic research projects, to advise policymakers and the public on issues relating to our futures, and to support interdisciplinary dialogue by organising symposia and events.

## FACTS AND FIGURES



**8 academies** in the Union with more than 1,900 scientists and scholars

Approx. **900 staff** on the Academies' Programme

Annual budget of the Academies' Programme:  
**64.8 million euros** (2017)

[www.akademienunion.de](http://www.akademienunion.de)

## Union of the German Academies of Sciences and Humanities

**Eight academies** have joined forces to form this union. They represent more than 1,900 member scientists who are among the best in their

” We document  
our cultural  
heritage



**PROF. DR. DR. DR. MED. HANNS HATT**  
President of the Union of the German  
Academies of Sciences and Humanities

***Professor Hatt, what does it mean to be  
President of the Union of the German Academies  
of Sciences and Humanities?***

It is a great honour to represent the eight venerable academies of sciences and humanities. More than 1,900 outstanding scholars from a variety of fields are members of these institutions. Our goal is also to further strengthen cooperation between the academies.

***What is special about the Academies' Programme?***

The Academies' Programme is unique worldwide. It includes almost 150 long-term basic research projects in the humanities. They are dedicated to retrieving, preserving and interpreting documents of our own cultural heritage – and that of other cultures. In this way, it makes a key contribution to documenting our cultural heritage and showing how it is relevant to society today.

***What does the Union intend to achieve  
in the next few years?***

It is the task of academics to advise society and policymakers on major challenges, such as migration, climate change and energy. It is imperative that expertise in the social sciences and humanities become more strongly involved in this process. And such expertise is especially well represented at our academies.

”







DAD/Jan Zappner, p. 64, DAD/Jan Zappner

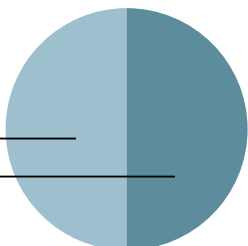
Focussing on cultural heritage: The Union coordinates Germany's largest research programme in the humanities and social sciences.

#### BUDGET

50% Federal

50% Länder

Source: BMBF



respective fields. In particular, they conduct **basic research in the humanities and social sciences**, projects that require endurance. The tradition of the academies dates back in part well into the 18th century. The latest member of the Union is the Academy of Sciences and Humanities in Hamburg, which was founded by Hamburg civil society in 2004.

The **Academies' Programme** ranges from the Goethe Dictionary and the edition of Alexander von Humboldt's manuscripts to basic research on the role of culture in early expansions of humans. It is the largest programme of research in the humanities in the Federal Republic of Germany and draws on funding of almost 65 million euros for a total of 144 research projects. The goal: to catalogue, secure and represent Germany's cultural heritage.

#### THE EIGHT ACADEMIES IN THE UNION ARE:

- Berlin-Brandenburg Academy of Sciences and Humanities (1992/1700),
- Göttingen Academy of Sciences and Humanities (1751),
- Bavarian Academy of Sciences and Humanities (1759),
- Saxon Academy of Sciences in Leipzig (1846),
- Heidelberg Academy of Sciences and Humanities (1909),
- Academy of Sciences and Literature, Mainz (1949),
- North Rhine-Westphalian Academy of Sciences, Humanities and the Arts (1970),
- Academy of Sciences and Humanities in Hamburg (2004).

# Leopoldina

“Exploring nature for the glory of God and the good of mankind” was the mission of Johann Lorenz Bausch, Johann Michael Fehr, Georg Balthasar Metzger and Georg Balthasar Wohlfahrt when, in 1652 in the Free Imperial City of Schweinfurt, they founded the Academia Naturae Curiosorum, the world’s first scientific and medical academy. The Deutsche Akademie der Naturforscher Leopoldina sought to bring together the leading academic scholars of the day in order to debate scientific questions, insights and findings across the disciplines and to the benefit of society.

That remains the case to this day. More than 1,500 outstanding scientists from over 30 countries, among them 35 Nobel Laureates, work in this interdisciplinary and international tradition. Each of them was nominated for membership solely on account of his or her significant scholarly achievements. The Leopoldina is now located in Halle in Saxony-Anhalt. **It is the world’s oldest continuously existing academy of the natural sciences.**

## DIALOGUE OF THE ACADEMIES

Since 2008, the Leopoldina has been the German National Academy of Sciences. It is thus the voice of German science in the international dialogue between academies. The Leopoldina has a global network of international partners such as the Royal Society in Great Britain or the Indian National Science Academy. The Leopoldina not only represents German scientists on the international committees, but also shares its findings with policymakers and the public. Together with the science academies of the G7 and G20 member states, it advises the heads of state and government at their annual summit meetings, for example.

### FACTS AND FIGURES



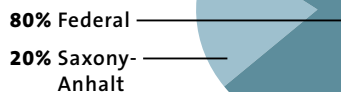
More than **1,500 members**, including more than 500 international scientists and scholars

**Close relations** with science academies on all continents

Annual budget:  
**10.5 million euros** (2017)

[www.leopoldina.org](http://www.leopoldina.org)

### BUDGET



Source: Leopoldina



7,600

## OUTSTANDING SCHOLARS

Since its foundation back in 1652, more than 7,600 outstanding scholars have been nominated members of the Leopoldina. Among them were, for example, Marie Curie, Charles Darwin, Albert Einstein, Johann Wolfgang von Goethe, Alexander von Humboldt and Max Planck.

## Die Junge Akademie

The Junge Akademie, founded in 2000 by the Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities, is the world's very first academy for early career researchers. The 50 young researchers from across all disciplines rotate: Every year, ten new nominees replace ten members who withdraw. During their five-year membership of the Junge Akademie, each member has access to a research budget of some 35,000 euros for joint projects. Taking their cue from the Junge Akademie, there are now academies for young scientists in numerous countries. In fact, in 2008 the **Global Young Academy** was founded, with the Junge Akademie taking an advisory role in the process.

## acatech

acatech, the National Academy of Science and Engineering, sees itself as a “working academy”. It has almost 500 members from academies, universities, research institutes and companies they collaborate in ten topic networks that address research and technology-policy issues of tomorrow. **acatech views itself as a network that links science and business.** Scientists and experts from the business sector work together closely. Their objective: to provide independent, science-based consulting geared to public welfare for policy-makers, businesses and the public. The topic networks at acatech are interdisciplinary in structure and have a practical focus. They address issues of future industrial applications, as well as economic, ecological and social opportunities and risks. The topics range from the reliability of complex socio-technological systems or the analysis of the development of the energy systems of tomorrow to questions of possible obstacles to innovation in nanotechnology.

### FACTS AND FIGURES



Die Junge Akademie

**50 members**, each with a research budget of 35,000 euros

**9 research groups**

**[www.diejungeakademie.de](http://www.diejungeakademie.de)**

### BUDGET



Source: Junge Akademie

### FACTS AND FIGURES



NATIONAL ACADEMY OF SCIENCE AND ENGINEERING

Approx. **500 members**

**23 research projects**, collaboration with research institutions and companies

Annual budget: approx.

**12.5 million euros** (2016)

**[www.acatech.de](http://www.acatech.de)**

### BUDGET



Source: acatech



DMAAD/Jean Zappinger

Forever changing: After five years each, ten members withdraw from the Junge Akademie and are replaced by ten newly appointed young researchers. Total membership remains constant at 50.

# GOVERNMENT RESEARCH INSTITUTIONS

Are tattoos dangerous? When does noise cause illness? What can be done so that fish swim upstream again? Scientists in government research institutions are exploring such issues that potentially affect us all. And the insights they gain often lead to recommendations for the policymakers.

Need habitats close to nature:  
Only 50 years ago, lapwings were a common sight in fields and meadows around Germany. Today they are an endangered species.





Sandra Staunbridge/Getty Images

#### FACTS AND FIGURES

More than **40 federal institutions** with R&D responsibilities

More than **150 state (Länder) research institutes**

**24,400 staff** (including 11,300 R&D personnel and 5,400 research staff)

Internal expenditure:

**3.1 billion euros** in total, for R&D: 1.3 billion euros (2015)

**B**ird monitoring is one of the tasks of the Federal Agency for Nature Conservation (BfN) in Bonn. This field of research, conducted with the assistance of many volunteers and nature conservation associations, has provided proof of a dramatic development: Many birds indigenous to Germany are now endangered species. For example, the total lapwing population has fallen by 80 per cent since 1990. And whinchats, black-tailed godwits, skylarks and partridges are also becoming an increasingly rare sight. The main reason: intensive farming. The BfN tests how protecting species and agriculture can be harmonised: In a project being realised by the Nature And Biodiversity Conservation Union (NABU) to protect lapwings, farmers make part of their land available as long-term breeding spots for the birds. With this **nationwide project**, the researchers seek to find out which protection measures work best and how funding can be most efficiently applied. They can then make recommendations for action by the state ministries and authorities, nature conservationists and farmers alike.

# “ We shouldn't underestimate the well-known pathogens



**PROF. DR. LOTHAR H. WIELER,**  
President of the Robert Koch  
Institute, microbiologist and  
veterinary doctor

## ***Professor Wieler, are infectious diseases still a threat today?***

The Robert Koch Institute is strongly involved in infection prevention, for example when it comes to plans to combat new pathogens. And we shouldn't underestimate the well-known pathogens. Some flu seasons claim more than 20,000 lives in Germany. We also work very closely with the states and health authorities to identify outbreaks of illnesses at an early date as it is important that such diseases get tackled locally.

## ***What urgent tasks will the Robert Koch Institute tackle in the future?***

We will, for example, use novel computer algorithms to expand and improve surveillance measures used in infection prevention. With regard to health monitoring, we go to more than 300 locations in Germany every few years as part of our large long-term studies and examine children and adults in these places. In the process, we are constantly fine-tuning the methods we use.







D&amp;AD/Jan Jacob Hoffmann

Prime science: The government research institutions offer scientists an attractive working environment.

### COOPERATING WITH THE MINISTRIES

The BfN is one of over **40 federal research institutions** that specifically pursue research on questions raised by policymakers and public authorities. More than 8,500 scientists make forecasts that give an early warning of pending problems, or they study the effects of ongoing initiatives. In this way they provide the scientific insights that the Federal government needs in order to take well-founded decisions. The scientists concern themselves with current issues, such as:

- The impact of modern technologies,
- Health and nutrition,
- Mobility and urban development,
- The environment, energy and climate protection and
- Changed working and living conditions.

If for example, there are increasing incidents of measles, or there is the risk of a dangerous virus spreading, then the Robert Koch Institute in Berlin advises the Federal Ministry of Health and gives doctors and experts tips on how to combat the diseases. In the event of allergies against textiles or resistances to antibiotics, it is the Federal Institute for Risk Assessment (BfR) in Berlin that intervenes and warns the public.

### RESEARCH AT THE STATE LEVEL

At the state (Länder) level, there are another 150 or more research institutions with more than 6,000 staff members supporting the respective state governments. Here, again, scientists conduct research on all the relevant social and economic issues. The experts look for contemporary solutions in the fields of photovoltaics, battery technologies, energy systems and renewable energy sources, for example.



Experiments with mobile robot systems:  
The DFKI staff are experts in the future field of AI.

The German Research Center for Artificial Intelligence (DFKI) for example seeks to develop innovative softwares. It is one of the world's leading research centres in the field of AI. The DFKI is a public private partnership with the states of Bremen, Rhineland-Palatinate and Saarland as shareholders. In 29 years, the DFKI has spun off more than 78 companies and created some 2,500 new jobs. Its latest success is very sporty: Team B-Human, a joint research project between the University of Bremen and the DFKI, won the German Football Robot Championships for the eighth time in a row. The team is, incidentally, five times world champion in the same discipline.

#### **VAST NETWORK**

The **government research institutions' infrastructure** is in part among the best worldwide and open to external research groups, too.

The goal: to boost interaction between everyone involved in the German research and innovation community – and shed light on issues of science policy from many different angles.

Deutscher Wetterdienst (DWD) for example relies not only on government research staff, but also on scientists from LMU Munich and the universities of Hamburg, Frankfurt, Bonn and Cologne, the FU Berlin as well as the Max Planck Institute for Meteorology and the Max Planck Institute for Human Development. The goal: to try to improve weather forecasting and climate monitoring. For example, they simulate rain drop growth in a cumulus cloud or show how a field of clouds develops. The DWD sees itself primarily as an information provider: The researchers investigate the weather to help DWD improve its weather warnings and support the quality of decisions by policymakers, local authorities and business.



## Strengthening bees

Bee populations are suffering from both climate change and the bee parasite varroa, in combination with attacks by viruses. There have been heavy losses. The “SmartBees” project is designed to preserve the diversity of threatened European honey bees using ultra-modern molecular-level methods and careful breeding. Professor Kaspar Bienefeld, Director of the Institute for Bee Research Hohen Neuendorf e. V. (LIB) in Brandenburg coordinates the project. SmartBees is a joint project by 16 partners from universities, research institutes and corporations from a total of 11 European countries.

The LIB is itself the product of successful cooperation. The long-standing research establishment is funded by the states of Brandenburg, Saxony-Anhalt, Saxony, Thuringia and Berlin. Representatives of beekeeper associations and scientists are also represented in the not-for-profit organisation. With a strong practical focus, the institute addresses different aspects of bee research: on breeding and preserving the bee populations, on molecular microbiology, on honey analysis and on projects to protect wild bees and honey bees.

[www.honigbiene.de](http://www.honigbiene.de)

# PRIVATE SECTOR

The private sector in Germany is one of the world leaders in research. It invests billions in research and development and relies on a global network of research facilities, all dedicated to finding solutions for products and processes for the industry of tomorrow.

## FACTS AND FIGURES

More than **416,000** research staff

**Distribution of the internal industrial research budget:**  
10% small enterprises (up to 249 employees), 5% medium-sized enterprises (250–499), 85% large enterprises (more than 499 employees)

**R&D expenditure** by the private sector as a proportion of GDP: 2.1%

Annual budget for R&D: approx. **62.4 billion euros** (2015)

Industry 4.0 is fast becoming a reality, with virtual and real production processes interacting.







Bayer AG, Arthur Pease/Siemens AG, IBSF

**T**he robot softly circles the patient. An arm positions the X-ray tube with great precision. A second robot arm shifts the flat detector into the right position. Then the scanner carefully explores that part of the body on which the doctor wants greater details – irrespective of whether the usual 2D X-ray image is required, natural 3D imagery, or images in real-time on a fluorescent screen. The Siemens Multitom Rax is the world's very first Twin-Robotic X-ray scanner. With its Siemens Healthineers, Siemens is active in the field of healthcare. The company's main business fields also include wind power and renewables, mobility

and the digital factory. In this way, the technology titan covers many of the topics which German companies are working on intensively at present.

The researchers are firmly focussed on the central challenges of today: How can we become independent of mineral oil by using clean technologies such as hydrogen or algae-based oil? What will mobility look like tomorrow? Be it small start-ups, small and medium-sized enterprises (SMEs) or global players such as Volkswagen – the German private sector is deeply involved in research into practical and fundamental issues.



Image-generating processes in medicine: New technologies enable treatment methods that are more precise.

Innovation as the basis:  
Research and development are key in the pharma industry.

### EN ROUTE TO INDUSTRY 4.0

Germany is one of the top 5 industrialised nations worldwide when it comes to the volume of private sector investments in research and development (R&D). **The sector accounts for more than two thirds of total R&D expenditure**, namely more than 62 billion euros in 2015. Particularly active are companies in the following areas:

- Information and communications technologies,
- Energy, climate and environmental technologies,
- Automotive and transport technologies.

At present, researchers in many companies are addressing the topic of Industry 4.0: Digitally networked systems connect production facilities using modern information and communication technologies. German corporations have hardly concerned themselves with any other development as closely as they have with digitisation. This is also true of the heavyweight in industrial research: the automotive industry, which commits almost 22 billion euros to inhouse research. It allocates another 10 billion euros to research contracts for external service providers. The electronics, chemical and pharmaceutical industries are also major investors in R&D.



More road safety: Assistance systems with video, radar and laser sensors incorporate high-tech into everyday life.

Not only industrial corporations rely on research to advance: Freelance, scientific and technological service providers invest almost as much as does classical mechanical engineering. A typical example of such a young company that is heavy on research is IT service provider CarMedialab. In only a few years its engineers transformed the company into a market leader in teleradiology. The technology supports the automotive industry in developing and improving electronic control systems.

### LEADING IN THE WORLD

On an international comparison, German industry is right at the forefront of things. **The leading company worldwide in the R&D investment tables is carmaker Volkswagen.** It spends more than 13.6 billion euros on R&D. In the same rankings, Daimler, Robert Bosch, BMW, Siemens and Bayer are all among the top 30 corporations worldwide. Many companies conduct research abroad and some even have their own global networks, such as German automotive component supplier Continental. It develops its products at 146 different locations worldwide.

### COMPANIES WITH THE HIGHEST R&D EXPENDITURE IN GERMANY

in million euros (2015/16)

<b>Volkswagen</b>	13,612
<b>Daimler</b>	6,529
<b>Robert Bosch</b>	5,202
<b>BMW</b>	5,169
<b>Siemens</b>	4,820
<b>Bayer</b>	4,436
<b>C. H. Boehringer Sohn</b>	3,004
<b>SAP</b>	2,689
<b>Continental</b>	2,528
<b>BASF</b>	1,914

Source: EU R&D Scoreboard 2016





416,000

women and men (full time equivalents) worked in 2015 in  
the research sections of private companies in Germany, up almost  
12 per cent on the year.

” Borders have never played a role in research



**PROF. DR. ERIC HAAKSMA,**  
Research Director Germany,  
Boehringer Ingelheim Pharma  
GmbH & Co. KG

***Professor Haaksma, what diseases will be real challenges in the future?***

The population's average age is rising. Age-related diseases will therefore remain in focus. Moreover, the consequences of eating the wrong food and of a Western lifestyle are becoming ever more problematic.

***What does Boehringer therefore concentrate on in its research?***

Our five core areas are: respiratory, cardio-metabolic, neuropsychiatric and immune system diseases as well as cancer. Moreover, we are busy exploring new technologies and fields of therapy. Regenerative medicine could, for example, in future lead to diabetes being healed or helping recovery after a heart attack.

***How important is international cooperation in this regard?***

We need to be where new methods and technologies arise – worldwide. We work with scientists and companies all over the world. Scouting teams are constantly on the look-out for the best new partners to stimulate R&D. After all, borders have never played a role in research.





Bosch, Bayer AG

Internationally successful: German companies are among the world top 5 in terms of patent, utility model and industrial design applications.

Big players: Alongside the automobile and electronics sectors, the chemical and pharma industries are among the major investors in R&D.



Thanks to its strong research abilities, Germany is also among the world top 5 in terms of patent, utility model and industrial design applications. The world's top applicants include Siemens, Bosch and BASF, not to mention family-owned Schaeffler and automotive component supplier ZF Friedrichshafen.

#### **HIDDEN CHAMPIONS AND START-UPS**

Not only corporations conduct much research. SMEs invest almost 15 per cent of their internal R&D expenditure or 9.1 billion euros. Above all

the **mid-sized mechanical engineering, pharma and IT service companies** have a strong research focus. Among them there are many hidden champions, unknown world market leaders, such as software developer TeamViewer or 3D printing expert EOS. Among start-ups, IT plays a key role, with every fifth one being a digital newcomer, with their business models centring, for example, on apps, online commerce or web design. And there are support programmes to help them lock into venture capital from private equity investors.



# ABOUT THE INITIATIVE “RESEARCH IN GERMANY – LAND OF IDEAS”

The Federal Ministry of Education and Research (BMBF) launched the initiative to “Promote Innovation and Research in Germany” in 2006. Since then various measures and events have been organised under the brand “Research in Germany – Land of Ideas” to present German innovation and research worldwide. The initiative also seeks to build strategic partnerships with institutions outside Germany.

The BMBF has also established the Research Marketing Alliance, a joint dialogue initiative for research, education, business and politics. This alliance aims to further strengthen connectivity between the actors of the German research,

education and innovation system and to fully exploit the potential for individual and joint communication activities under the “Research in Germany” brand umbrella.

This and many other “Research in Germany” publications are available at [www.research-in-germany.org/downloads](http://www.research-in-germany.org/downloads)

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**Note** The DAAD places special emphasis on using language that treats women and men equally. The grammatical male form is occasionally used alone in this publication purely as a means of improving legibility. Naturally, these terms are meant in a gender-neutral way.

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AN INITIATIVE OF THE



Federal Ministry  
of Education  
and Research

Research in  
Germany



Land of Ideas