HELMHOLTZ

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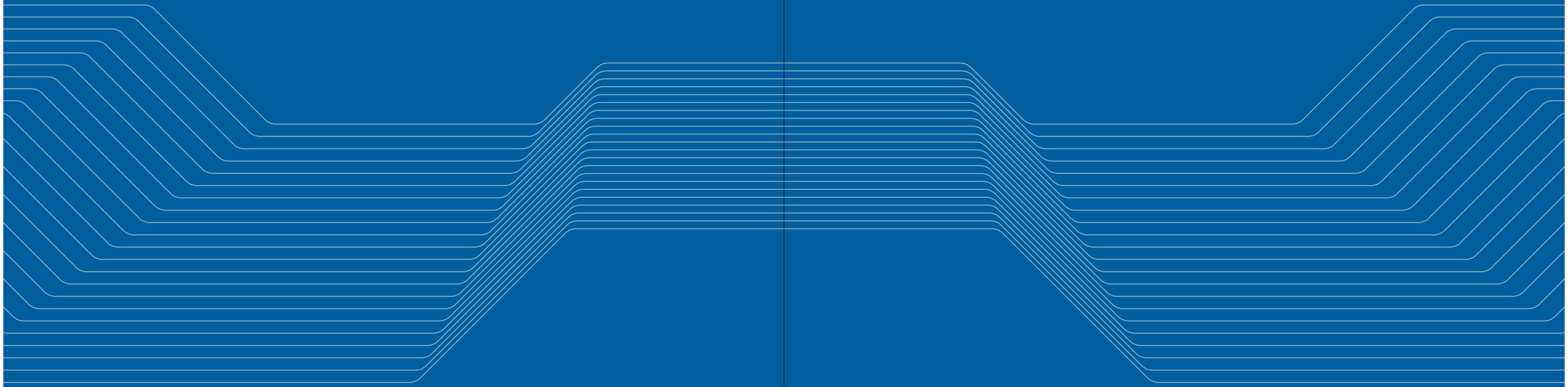
RESEARCH FOR GRAND CHALLENGES



FOREWORD

Here at Helmholtz, we conduct research into the major questions of our time. These challenges include the digital revolution, climate change, the energy transition, transport in the future, the origins of our universe, and the battle against widespread diseases. Our research plays a key role in identifying reliable answers that benefit society, science, and the economy.

We do this by conducting top-level, interdisciplinary research at our 19 Research Centers, which cooperate with leading research institutions at the national and international level. These Centers give the world's leading experts access to our unique research infrastructures. The most important pillar for Helmholtz are our more than 40,000 highly motivated employees, who ask the right questions and continually seek new ways to address the major challenges we face.

The digital transformation and the rapid developments it leads to are among the most crucial issues of our time. We are able to research these issues extensively at Helmholtz, because we already possess an incredible depth of expertise in this key area for the future: We know that this opens up a wide range of opportunities for nearly every aspect of life, and will be defining new priorities in the coming years.

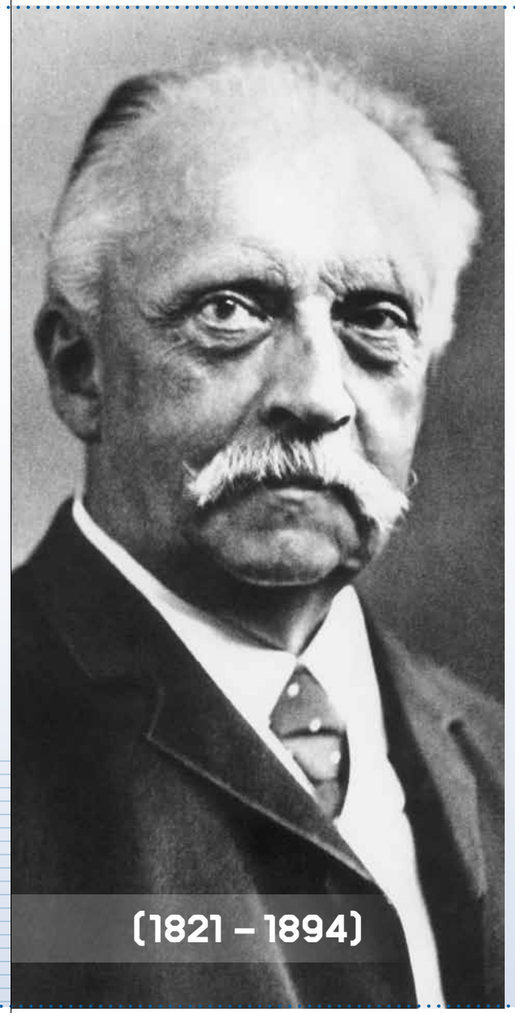
Sharing our knowledge in a more effective way and transforming what we learn into beneficial products and services is an important concern for us. To this end, Helmholtz supports a close, ongoing exchange of ideas with the public, industry, and politics – allowing us to make a significant contribution toward boosting Germany's capacity for innovation in the process.

In this brochure, we would like to offer you a closer insight into our work. Thank you very much for your interest, and we hope you enjoy reading about Helmholtz!

Otmar D. Wiestler
President of the Helmholtz Association

OUR MISSION

- **We contribute** to solving the grand challenges facing society, science, and the economy by conducting top-level research as part of strategic programs in the fields of Energy, Earth and Environment, Health, Information, Matter, and Aeronautics, Space and Transport.
- **We research** highly complex systems using our large-scale facilities and scientific infrastructures, and cooperate with national and international partners in the process.
- **We shape** our future by combining research and technological advancements with prospects for innovative applications and services for tomorrow's world.
- **We attract** and promote the best talents by offering them a unique scientific environment and ongoing support throughout every stage of their career.



A POLYMATH WITH A SENSE FOR THE PRACTICAL

The Helmholtz Association is named after **HERMANN VON HELMHOLTZ**, one of the greatest scientists of the 19th century, with good reason.

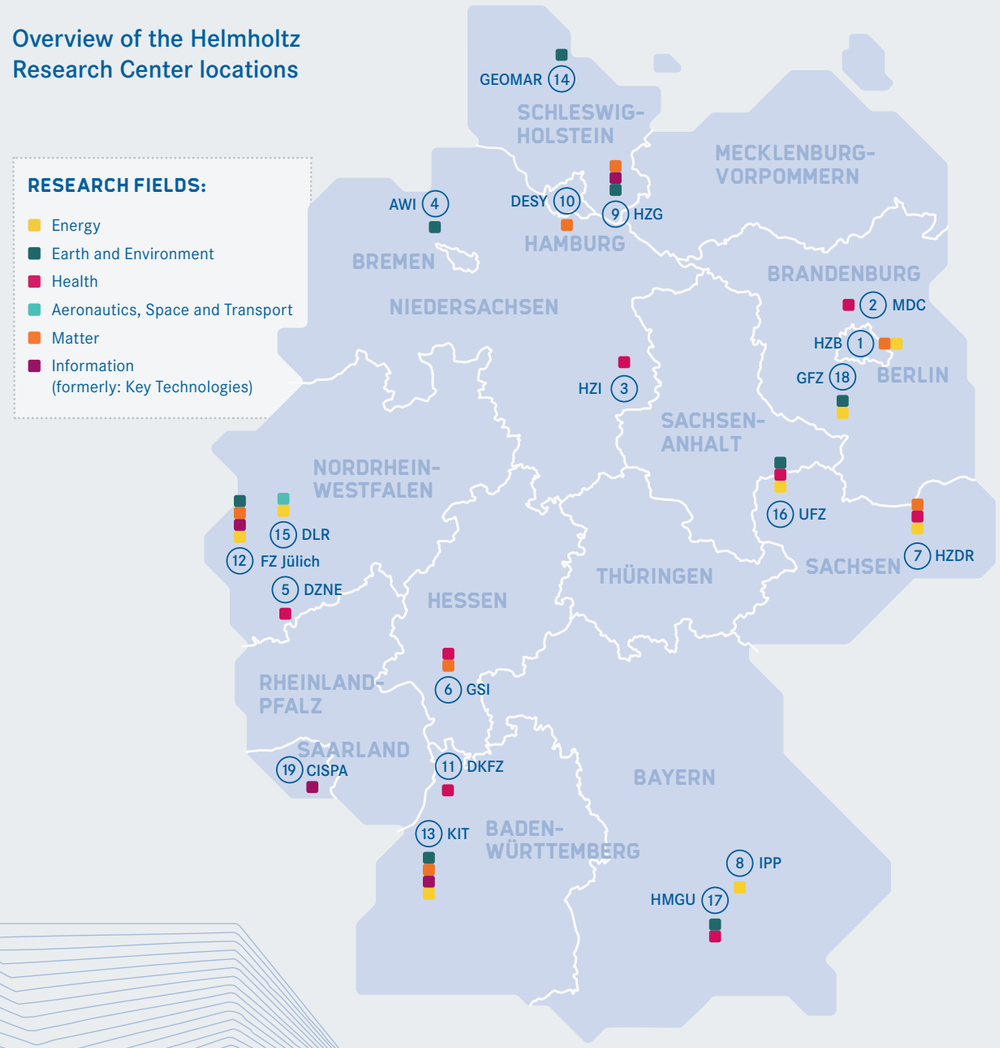
Hermann von Helmholtz is synonymous with the diversity of scientific research and embracing technological practice. He was one of the last true polymaths.

Helmholtz was a proponent of a natural science approach that spanned the disciplines of medicine, physics, and chemistry. His groundbreaking research and developments combined theory, experiments, and practical applications.

He also founded the German Imperial Physical-Technical Institute and served as its first president. The Imperial Institute was the world's first center of scientific research that was not part of a university and can, therefore, be considered a forerunner of the Helmholtz Association.

19 CENTERS – ONE ASSOCIATION

Overview of the Helmholtz Research Center locations



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

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

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

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

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

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

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

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

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

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

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

12 JÜLICH
FORSCHUNGSZENTRUM JÜLICH
www.fz-juelich.de

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

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

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

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

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

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

19 SAARBRÜCKEN
HELMHOLTZ CENTER FOR INFORMATION SECURITY – CISPA
www.cispa.saarland

RESEARCH

Our six Research Fields focus on the grand and pressing challenges facing our society. Helmholtz develops sustainable solutions for the future and covers the entire spectrum from basic to application-oriented research.

ENERGY

The Research Field Energy focuses on the energy transition. We develop system solutions that aim to link the power, heat, and transport sectors in the best possible way, thereby providing a sustainable supply of energy. In addition, we develop the basic principles for a fusion power plant and conduct research into new storage and conversion concepts, as well as innovative technologies that will make it possible to provide renewable energy at affordable costs.

HEALTH

We examine the complex causes behind important widespread diseases such as cancer, diabetes, and dementia. The Research Field Health also develops new strategies focusing on effective prevention, timely diagnosis, and efficient, personalized treatment. We respond to new diseases and developments in the health care sector in a flexible way.

EARTH & ENVIRONMENT

The Research Field Earth and Environment research field investigates the causes and consequences of climate change as well as the relationship between nature and our society. It aims to help preserve the natural basis for our existence over the long term. We also conduct research into the causes and impacts of natural risks and changes occurring within ecosystems.

MATTER

We examine the structures, mechanisms, and functionalities of matter, materials, and biological systems. The Research Field's scope extends from basic physics research, which is carried out within unique research infrastructures, to issues with a technological and application-based focus – for example, involving various materials.

INFORMATION

Research in the field of information is becoming increasingly important in view of the ongoing digitalization of science, the economy, and society. We are keeping pace with this development by applying holistic approaches to conceptual, technical, and sociological aspects of information.

AERONAUTICS, SPACE & TRANSPORT

We develop new, environmentally compatible technologies for the mobility sector of the future. While the Space division uses new satellite missions to research changes in our climate here on Earth, the Aeronautics and Transport divisions create virtual models for vehicles that will enable them to be designed more efficiently and integrated into our mobility system more effectively.

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

RESEARCH AND INFRASTRUCTURE

Helmholtz offers scientists outstanding conditions for conducting their research, from accelerator systems, to research vessels, to supercomputers. We believe that large-scale research facilities enable essential scientific advancements that help us tackle the global challenges we face as a society.

One of the core elements of the Helmholtz mission is developing, constructing, and operating complex research facilities for researchers from around the world – and this is one of the unique features that sets us apart. Imagining and implementing new, complex infrastructures will only be possible using technological development of the highest caliber. Our research facilities exemplify our cooperation with universities and research institutions both in Germany and abroad. Over 10,000 visiting scientists and international scientific staff from more than 30 countries work at Helmholtz's research facilities each year.

A few examples include the European XFEL, the most powerful X-ray laser in the world, satellites and spacecraft used for atmospheric research and monitoring conditions on Earth, and supercomputers and research stations such as Neumayer Station III in the Antarctic. Thanks to its large, complex research infrastructures, Helmholtz offers unique opportunities for scientists from around the world.

Image at upper left: The beamlines of the European XFEL X-ray laser transport the laser beams to the instruments in the experiment hall.

Image at upper right: Plasma vessel of the ASDEX Upgrade at the Max Planck Institute of Plasma Physics (IPP)

Bottom image: The Polarstern research vessel regularly journeys to the polar regions.

THE BEST INFRASTRUCTURE FOR TOP-LEVEL RESEARCH

4.67
billion euros
overall budget

1.30
billion euros
third-party funding

147.4
million euros
EU funding
obtained

> 400
patents
each year

THE BEST INFRASTRUCTURE FOR TOP-LEVEL RESEARCH

6
Research Fields

19
Helmholtz Centers

11
Helmholtz Institutes

190
spin-offs
(since 2005)

PEOPLE AT HELMHOLTZ

EXPLORING ICE, OCEAN DEPTHS, AND THE SKIES WITH HELMHOLTZ. WORKING FOR OUR CLIMATE AND BIODIVERSITY. IT'S SIMPLY A MUST.

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

RESEARCH FREEDOM, INTERDISCIPLINARITY AND SUPPORT FOR TRANSLATING FUNDAMENTAL RESEARCH INTO PRACTICAL APPLICATIONS. THIS IS WHAT I LIKE MOST AT HELMHOLTZ.

PAVEL LEVKIN
Karlsruhe Institutw of Technology (KIT)

AT HELMHOLTZ, WE FIND INNOVATIVE WAYS TO TREAT AND PROTECT THE LUNGS OF PREMATURE BABIES.

ANNE HILGENDORFF
Helmholtz Zentrum München –
German Research Center for Environmental Health (HMGU)

AT HELMHOLTZ, WE RAPIDLY IMPLEMENT EXTRAORDINARY, GRAND, AND DARING IDEAS – FOR THE LONG TERM. THAT'S WHAT I CALL RESEARCH FREEDOM.

MARTIN WINTER
Helmholtz Institute Münster –
„Ionics in Energy Storage", Forschungszentrum Jülich

IT'S EXCITING TO BE ABLE TO WORK WITH THE WORLD'S BEST, MOST SENSITIVE ROBOTS HERE AND TEACH THEM NEW COGNITIVE SKILLS.

DONGHEUI LEE
German Aerospace Center (DLR)

HELMHOLTZ OFFERS STRONG SUPPORT TO DEVELOP AND PURSUE A RESEARCH PROGRAM WITH A LONG-TERM PERSPECTIVE AND WORLD-BEST FACILITIES TO CARRY THIS OUT.

HENRY CHAPMAN
Deutsches Eletronen-Synchrotron DESY

DISCOVERING AND PROMOTING TALENT

Providing support for exceptional skills early on, and continually fostering the careers of talented employees – Helmholtz sees these as key tasks for the future. We provide the top talent of tomorrow with scientific and management training.

At Helmholtz, promoting talent is part of every career stage and starts with high school and university students. Graduate schools and post-graduate programs offer an excellent framework for structured doctoral training. The new Helmholtz International Research Schools are a special highlight of the Association's global exchange. The support provided by Helmholtz's extremely well-established Young Investigators Group program helps young talent gain early academic independence. Our talent management program sets further priorities:

- Our Association-wide Mentoring Program provides postdocs with a range of opportunities to help them focus their careers early on, while our Career Centers at the Helmholtz Centers offer training and advice for their professional development.
- Helmholtz supports the recruitment of outstanding female scientists – both in terms of initial appointments as well as when it comes to attracting female researchers at the international level.
- The Helmholtz Academy has supported the Association's managers in developing their leadership skills for over ten years. It also offers mentoring, coaching, and networking opportunities.
- All of our measures and instruments take into account the cross-cutting topics of equal opportunities, internationalization, and the transfer of knowledge and technology.

*Taking soil water samples in an accessible underground chamber

TOP TALENT FOR TOP-LEVEL RESEARCH

681
joint appointments with universities

225
Young Investigators Groups (since 2002)

41%
proportion of women

30
school labs

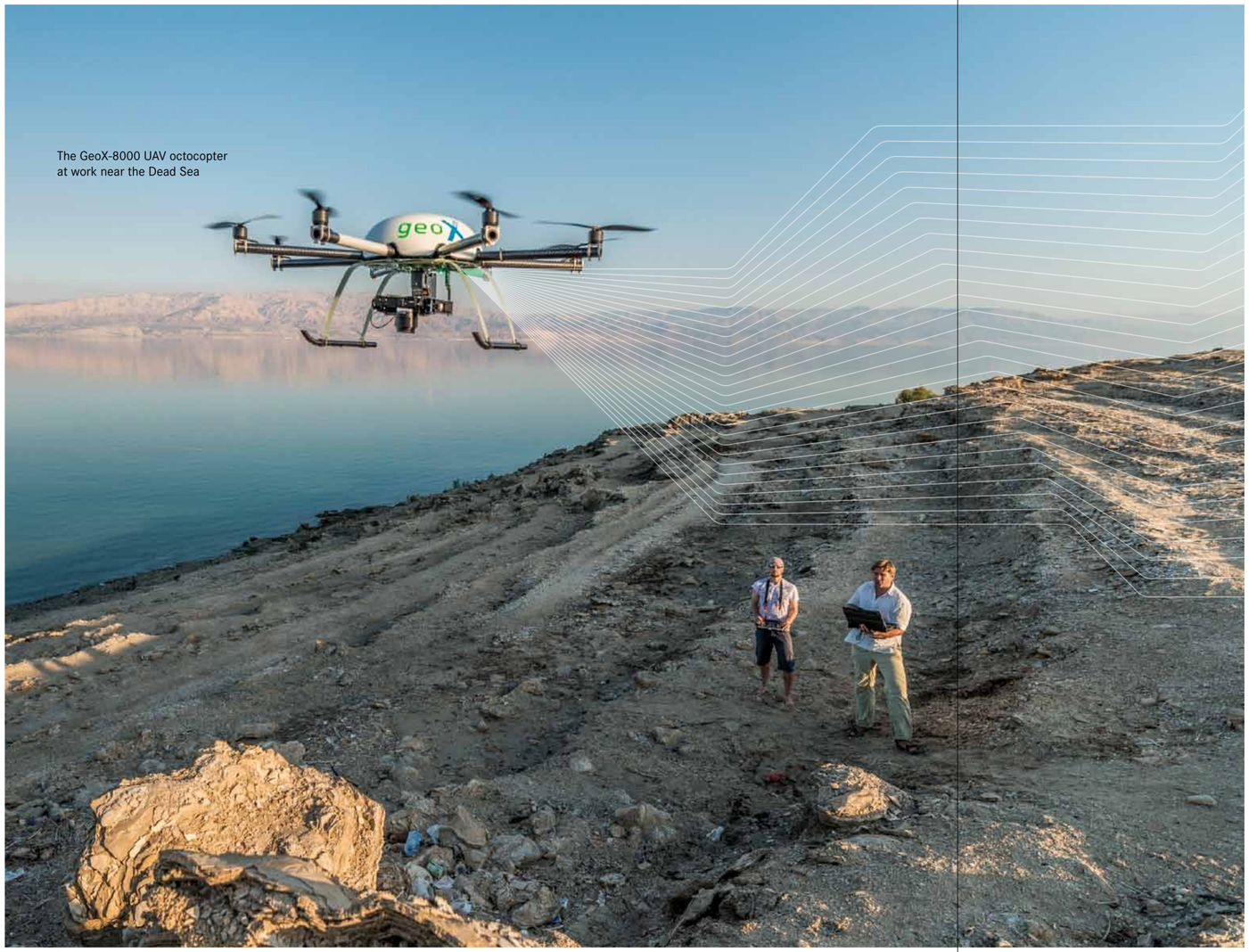
TOP TALENT FOR TOP-LEVEL RESEARCH

40,355
employees

22,684
scientific staff

6,537
international scientific staff

8,614
doctoral candidates



The GeoX-8000 UAV octocopter at work near the Dead Sea

INTERNATIONAL COOPERATION

Science is globally connected. Vibrant partnerships across national borders are the only way we will be able to tackle major challenges such as climate change, widespread diseases, or the question of where we will source our energy in the future.

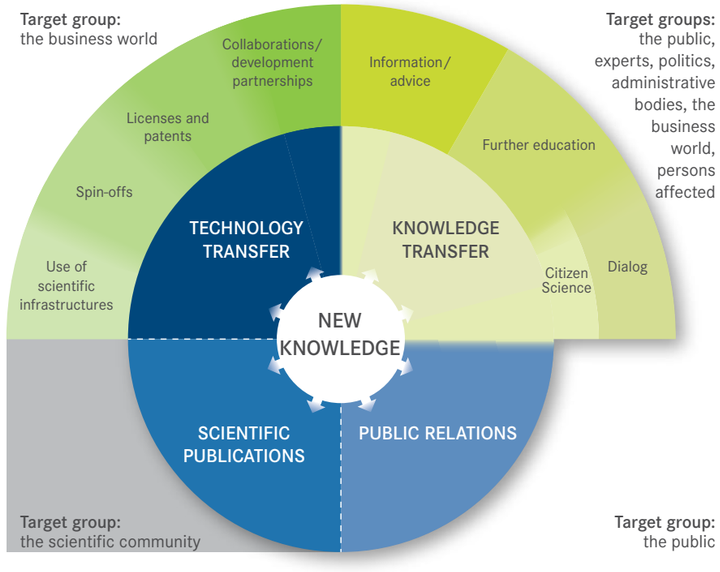
The Helmholtz Centers cooperate with the best research institutions internationally and involve top-level researchers in their work. Our outstanding research infrastructures attract talented scientists from every corner of the world. Because this is a place where creative minds not only find unique research and working conditions – they can also participate in numerous international partnerships. In this way, Helmholtz fosters international cooperation and research of the very highest caliber. These are our four main goals:

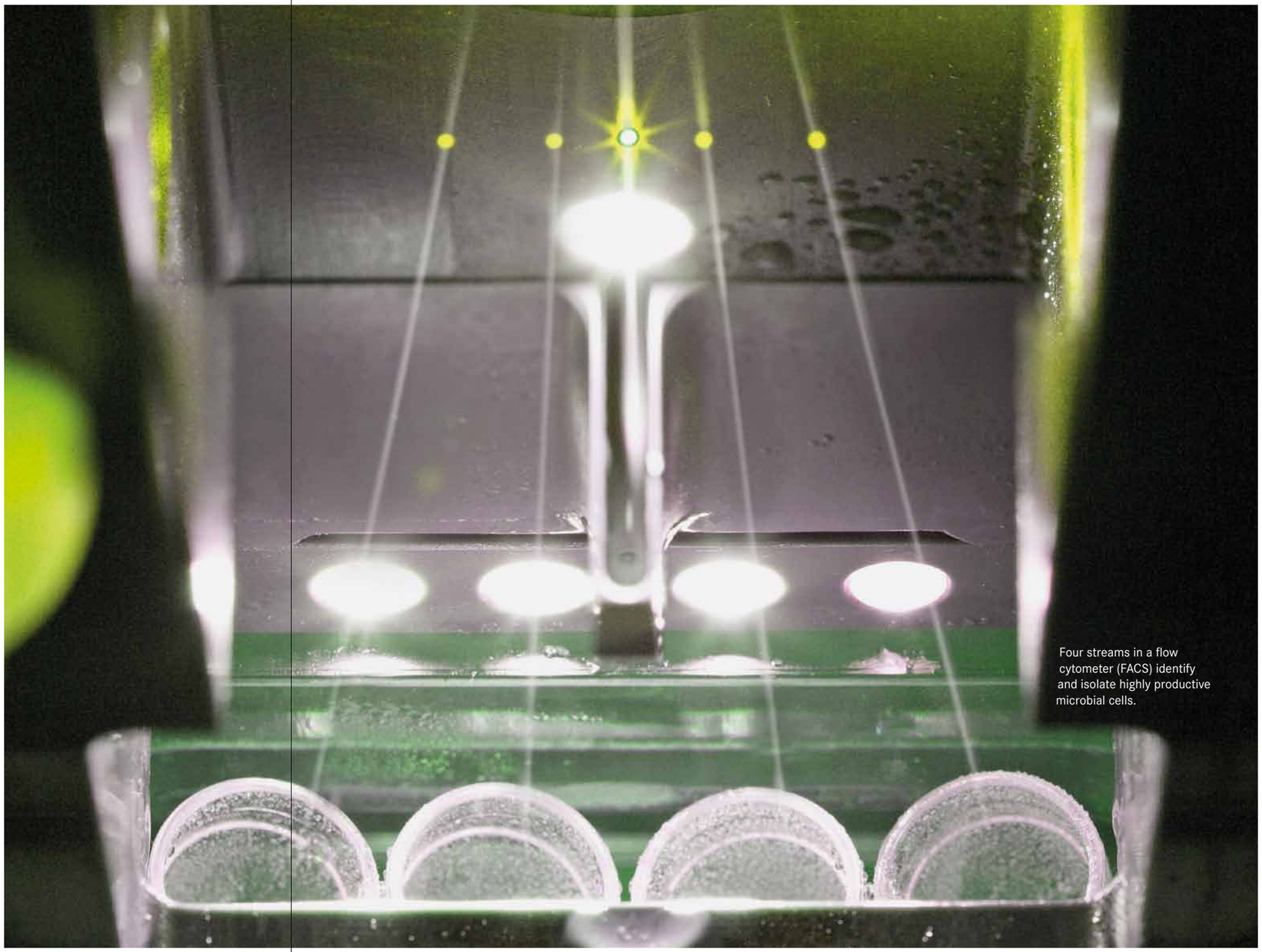
- Conduct cutting-edge research at the European level: We actively participate in European partnerships, utilize synergies with European research institutions, and coordinate strategically important joint and flagship projects.
- Expand international strategic partnerships: Helmholtz continually expands its scientific partnerships with the aim of working with the best researchers and giving them access to unique infrastructures and our cutting-edge research.
- Attract talent from all over the world: Helmholtz is an attractive partner and employer for top talent and researchers from every corner of the world – and especially for outstanding female scientists.
- Science diplomacy – building bridges through research: We support the development of effective scientific systems worldwide. We use our global network and our role as an intermediary to make a significant contribution to German science diplomacy.

INNOVATION & TRANSFER

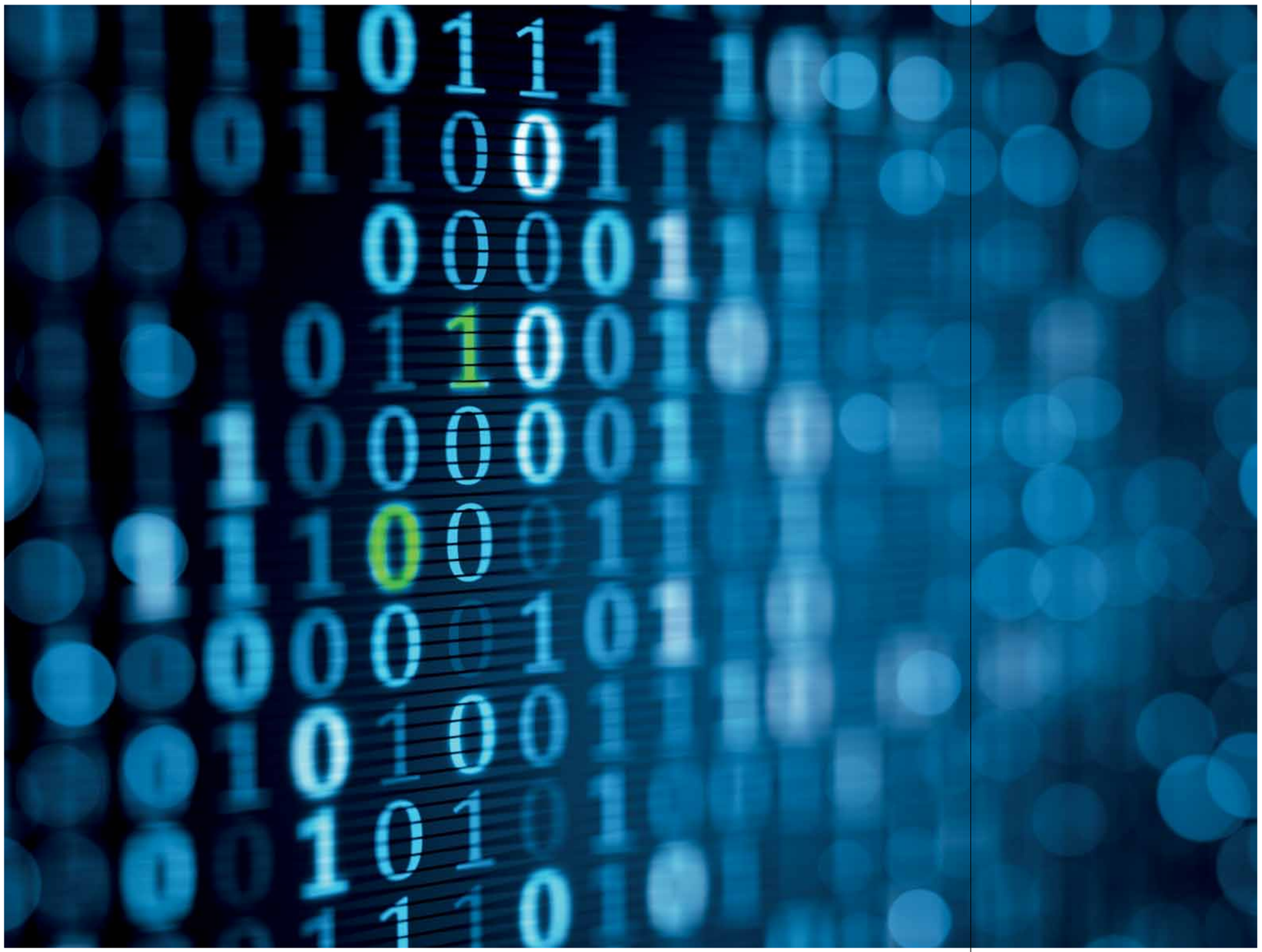
New knowledge can only benefit society and the economy if it is transferred and therefore made usable. For this reason, transferring knowledge and technology and promoting innovations are of extraordinary importance to us.

We use numerous channels to transfer knowledge between Helmholtz research and society: These include the provision of information and advice, the field of further education, or as part of dialog formats to promote exchange with the public, politics, and administrative bodies. Our technology transfer activities translate the findings of our research into usable products and services. Thanks to active innovation management at our Centers and internal funding programs within the Association, we thereby assume a key role in bringing innovations to life.





Four streams in a flow cytometer (FACS) identify and isolate highly productive microbial cells.



INFORMATION & DATA SCIENCE

Recent developments in the area of digital information processing and the analysis of complex data open up completely new possibilities for science and research, but also present us with huge challenges.

The rapidly developing field of information and data science is one of the most strategically important focal points for Helmholtz's ongoing development. And we already have extensive expertise in this area: As an operator of large-scale research infrastructures, we process enormous quantities of data and have expertise in the areas of supercomputing, chip and memory development, simulation, artificial intelligence (AI), and robotics. We want to take a coordinated approach to further expanding this expertise in the coming years.

Our Information & Data Science incubator is one example of the strength we currently possess in this area and our future prospects for continued development. In this think-tank, we develop innovative concepts and recommendations for action in highly relevant fields, such as machine learning and AI as well as image recognition and processing. We promote close links between research data and respective infrastructures and set up platforms that will significantly strengthen our effectiveness in these core technologies and serve as connections for national and international partners.

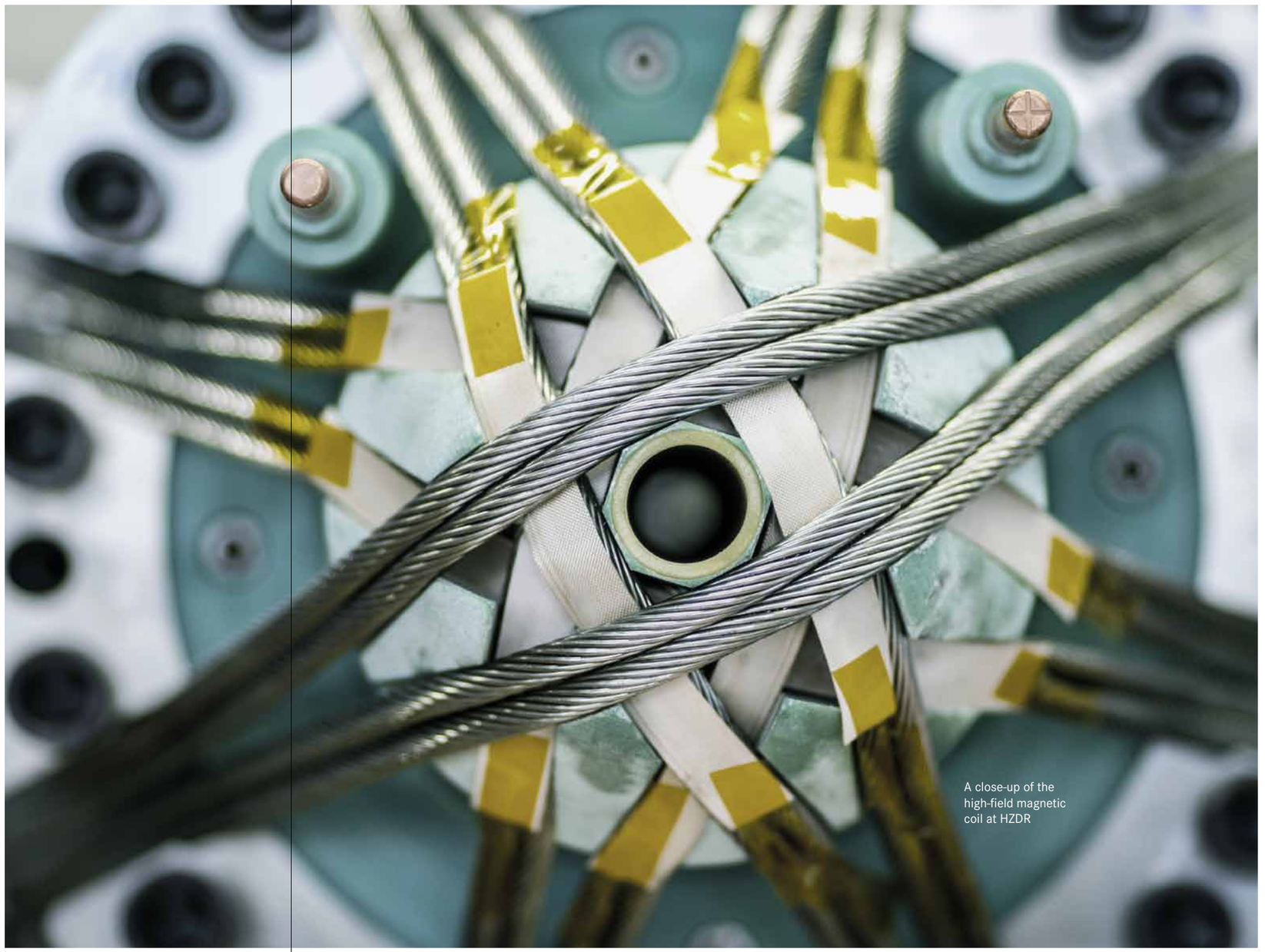
In the coming years, we will also train a new generation of data scientists in the Helmholtz Information & Data Science Schools: Researchers who specialize in extracting information from large sets of data and work at the interface between statistics, computer science, data analytics, and software engineering. They will combine innovative methods of studying data with outstanding, domain-specific expertise, taking the field of information and data science to a new level at Helmholtz.

PARTNERSHIPS

We rely on strong partners as we work together to master the challenges of the present and the future.

In many cases, top-level research can only succeed if it is based on partnerships and close networks that extend across organizational and national borders. To this end, we work with universities, research institutions, and companies and link together various areas of expertise and infrastructures:

- Our partnerships serve as fertile ground for the development of world-class research locations of the highest caliber in Germany, such as the Karlsruhe Institute of Technology (KIT) and the science park on the DESY Campus.
- We participate in large, interdisciplinary consortia, including the German Centers for Health Research (DZG) and the Copernicus projects on the energy transition. These efforts place a concerted focus on topics of national significance and produce results and applications more rapidly.
- All of the Helmholtz Centers are closely linked with partner universities via joint appointments and the mentoring of doctoral students. Many of our partnerships – such as the Jülich Aachen Research Alliance (JARA) – are firmly established at the institutional level. At the Helmholtz Institutes, of which there are now eleven, the Helmholtz Centers and partner universities also collaborate directly on the respective university campuses.
- Seven new DLR institutes use a diverse range of approaches to cooperate with universities in fields that will be significant in the future.
- Our Centers provide access to excellent large-scale facilities, research infrastructures, and data. Each year, they attract about 4,500 visiting scientists. In many cases this lays the foundation for long-term partnerships and research relationships.



A close-up of the high-field magnetic coil at HZDR

IMPRINT

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