Karlsruhe Institute of Technology

Annual Report 2022 of Karlsruhe Institute of Technology

KIT – The Research University in the Helmholtz Association

Mission

We create and impart knowledge for the society and the environment.

From fundamental research to application, we excel in a broad range of disciplines, i.e. natural sciences, engineering sciences, economics as well as the humanities and social sciences.

We make significant contributions to the global challenges of humankind in the fields of energy, mobility, and information.

Being a big science institution, we take part in international competition and hold a leading position in Europe.

We offer research-based study programs to prepare our students for responsible positions in society, industry, and science.

Our innovation efforts build a bridge between important scientific findings and their application for the benefit of society, economic prosperity, and the preservation of our natural basis of life.

Our working together and our management culture are characterized by mutual respect, cooperation, confidence, and subsidiarity. An inspiring work environment as well as cultural diversity characterize and enrich the life and work at KIT.

Employees 2022

Total:	9,905
Teaching and research:	5,704
Professors:	402
Foreign scientists and researchers	1,531
Infrastructure and services:	4,201
Trainees:	368

Students

Winter semester 2022/2023:	22,373

Budget 2022 in Million Euros

Total:	1,122.9
Federal funds:	331.7
State funds:	319.6
Third-party funds:	471.6

Karlsruhe Institute of Technology – The Research University in the Helmholtz Association – stands for research excellence and outstanding academic education. It also drives innovation by making use of the synergies created by the merger of a state university with a national large-scale research center 13 years ago.

In our annual report, we look back on the challenging and eventful year of 2022 and present to you some of its highlights. Fascinating developments from research, teaching, and innovation are awaiting you. From the research field, for example, we report on the next steps towards the production of solid-state batteries, the path to CO_2-neutral flying, and developments aimed at improving data security on smartphones. Not only have we dedicated separate chapters to our activities relating to both digitalization and sustainability, but we have revalued these subjects by implementing an entire Executive Board portfolio on January 1, 2023 for this thematic complex. We are delighted that Professor Dr. Kora Kristof has become our new Vice President for Digitalization and Sustainability so that we are able to devote even greater attention to these topics.

These were not the only changes in the Executive Board in 2022: As of January 1, the "Innovation and International Affairs" portfolio was expanded and is now established as "Transfer and International Affairs." At the end of the year, the "Human Resources and Law" portfolio was dissolved and its previous tasks were bundled together with those of the "Business Affairs and Finance" group in the new administrative "Finance, Human Resources and Infrastructure" portfolio as of January 1, 2023.

Fortunately, as the Coronavirus pandemic subsided, we were able to restart classroom study activities. The current energy shortage, however, is once again challenging our adaptability and creativity. We are positive that we will also master this task by employing meaningful measures.

We were delighted that researchers of KIT received numerous awards in 2022 – amongst them one Alexander von Humboldt Professorship, two Leibniz Prizes, and one State Research Award. A total of eleven ERC grants were obtained. The awards and the conferral of honorary positions show that KIT is well prepared for a successful future thanks to the achievements and commitment of its outstanding students, its employees in science and administration, and its professors.

On behalf of the Executive Board of KIT, I express my sincere thanks to our political partners, our partners in research and industry, the KIT Supervisory Board, and the members of KIT for last year's trusting, intense, and successful collaboration.

I cordially invite you to take your time to read and leaf through this annual report. I hope you will enjoy looking back on the year 2022 at KIT – The Research University in the Helmholtz Association. Enjoy reading!

Yours,

Professor Dr.-Ing. Holger Hanselka
President of KIT

CONTENT

A RETROSPECTIVE VIEW OF KIT

In February 2021, the federal and state governments signed an administrative agreement, on the basis of which the 2nd KIT Further Development Act was adopted by the Landtag of Baden-Württemberg. KIT then initiated the KIT 2.0 implementation project, which is embedded in the KIT 2025 Strategy. In close cooperation with the federal and state governments, the project teams revised many processes and basic principles, such as the Joint KIT Statutes and the KIT Financial Statutes, enabling KIT to play to its strengths in research, teaching, and transfer even better than before.

In order to give KIT and the ministries sufficient lead time to prepare for the implementation of the innovations

3

stipulated in the act, transitional periods were allowed for some issues until the new legal framework was fully applicable. The transition took place as planned on January 1, 2023. The implementation project is scheduled to end in December 2023. In the meantime, the new opportunities for KIT should be brought to life.

As part of the strategic development, the KIT bodies adopted two new action areas in 2022: Digitalization and Sustainability now complement the KIT 2025 Strategy. Moreover, the former "Innovation" action area was extended to include Transfer. Technology transfer is thus supplemented by knowledge transfer and linked to the innovation strategy.

Also within the framework of the KIT 2025 Strategy, the Executive Board has launched the "New Work" model project. Here, KIT tests the potentials of new approaches to the work environment of tomorrow and considers the different perspectives of people, workplace, technology, and organization.

The "New Work" project is about hybrid working and leadership, about new spatial concepts, platforms, and tools, but above all, it is about the employees' perspective, as they are invited to actively shape the future of work at KIT. In five pilot projects that ended in March 2023, the participants tested new aspects of the "New Work" approach.

Challenges

2022 will probably go down in history as the "year of crises." In media coverage, the Coronavirus pandemic – which was classified as endemic in early 2023 – was replaced by headlines about the war of aggression in Ukraine. As a result, the world plunged into food, gas, and energy crises, which, in turn caused inflation, the extent of which had not been seen for a long time. Not to mention the climate crisis, the solution to which is still not in sight and that had partially been eclipsed by the other crises for quite a while. In any case, the hoped-for "normalization" after the last two years dominated by Covid-19 has failed to materialize.

At the beginning of 2022, here was still no relief in sight with regard to the Coronavirus situation. The federal and state governments had agreed in early January on additional measures to respond to the tense pandemic situation while keeping the most important system-relevant public sectors running.

At the beginning of 2022, face masks were still mandatory in the workplace. 4

In order to reduce contacts at the workplace and on the way to and from work, KIT established a comprehensive work-from-home system. If this was not possible because of the individual employee's work situation, face masks had to be worn during travel and at staff meetings. Finally, on March 20, the obligation to work from home stipulated by infection control was eliminated, and KIT returned to normal routine. However, because of a newly concluded Service Agreement, up to 40 percent of the work could continue to be done from home – where possible.

In the course of the year, the state-imposed rules on infection control then ceased to apply, and the Corona Ordinance on Academic Education Operations issued by the Baden-Württemberg Ministry of Science also expired.

Thanks to the commitment and flexibility of KIT employees and students, KIT has emerged even stronger from this crisis – for example, by expanding digitalization in many applications. In many fields, these challenges have led to rethinking and driven new processes and structures: Digitalization could be advanced in research and teaching, but also in the fields of administration and infrastructure. With the tools for virtual and hybrid events since introduced as standard, time and other resources can be saved. Last but not least, the possibility of doing some of the work at home allows for more flexible work arrangements and improves the work-life balance.

5 Hybrid events proved successful during the Coronavirus pandemic and were integrated into normal workday routine after that.

With the energy crisis looming, the federal government passed several regulations that public institutions such as KIT must comply with. Similarly, the state of Baden-Württemberg has committed itself to do its utmost to reduce heat and electricity consumption in the state-owned

buildings and facilities, and has called on the universities to contribute as much as they can in achieving the goal.

Based on these regulations and in response to high energy prices, KIT took a number of actions. Thus, face-to-face operation was discontinued between December 24, 2022 and January 8, 2023 based on a Service Agreement. KIT's central technical infrastructure unit has taken further measures to save energy (see page 91). Here again, all involved parties acted thoughtfully and with foresight.

The energy crisis also had an impact on how research was perceived: The development of energy and resource-saving technologies became an even greater focus of society. The trust of the Germans in science and research remained high in 2022: In the science barometer published by "Wissenschaft im Dialog", 62 percent of the respondents said they trusted science and research either somewhat or strongly. When asked in which area research should mainly focus on in the future, 51 percent of the respondents chose the topic "climate and energy", which proved to be the hands-down favorite.

Studies

Starting with the summer semester 2022, classroom teaching became the rule again at KIT after three semesters of online-studies and one hybrid semester. The Federal Infection Protection Act no longer imposed restrictions on university studies. Thus, the general Coronavirus regulations of the state of Baden-Württemberg were applicable. Checks on every participant's 3G status (vaccinated, tested, recovered) in classroom events and mandatory face masks in lecture halls and public spaces have become a thing of the past. In view of the risk of infection, KIT recommended to continue infection protection and, for example, for people at KIT to voluntarily wear a mask while pursuing one's studies indoors where distances cannot be kept. Here, the Executive Board appealed to personal responsibility, mutual respect, and tolerance of all persons working or studying at KIT.

The first semester welcome for students in the winter semester 2022/2023 was offered as a hybrid event.

In order to give students a good restart after four Covid-19 semesters and to make up for any learning deficits, the state of Baden-Württemberg set up a special program for all state-owned universities and academies. With a total of EUR 28 million, of which KIT received about EUR 1.95 million, additional services were developed to accelerate the return to normality. With the additional funds, the Baden-Württemberg Ministry of Science, Research, and the Arts supported the universities in developing tailor-made measures and offers for dealing with the specific problems of students from the pandemic period.

At KIT, all eleven KIT departments as well as several central units offered a total of 146 additional measures within the framework of this program, 88 percent of which were classroom events, eight percent hybrid events, and four percent purely online events. These events included options such as additional coaching, tutorials, practical courses, learning cafés, or supervised learning rooms. On the one hand, they were intended to support students in learning the contents of study programs. On the other hand, they should help to better connect students with each other and thus help them to help themselves. In addition, they promoted the acquisition of key qualifications that go beyond the existing offerings.

KIT Launches Diversity Offensive

In order to fulfill its responsibilities as a public institution and employer, KIT has set itself the goal of creating a barrier-free and non-discriminatory working, teaching, and learning environment, where respectful cooperation is possible. Diversity Management is a cross-organizational task involving all KIT employees.

With the adoption of a "Diversity Statement" and by signing the "Diversity Charter" employer initiative in 2022, KIT has put the handling of the diversity of its almost 10,000 employees on a new footing. It is the objective of holistic diversity management to systematically promote the potential and talents of employees, to benefit from the heterogeneous composition of work groups with their diverse perspectives and imaginative solutions to problems, and to attract the best minds to KIT.

The focus of KIT's Diversity Statement is the development of everybody's performance potential.

The Diversity Statement is deliberately addressed to all KIT employees and at the same time emphasizes two strategic priorities: Internationalization and the promotion of equal opportunities for women and men.

Individuals from more than 120 countries are doing research and are teaching, working, and studying at KIT. KIT emphasizes the importance of cultural diversity for life and work in its internationalization strategy adopted in 2018. The variety of cultures and nationalities promotes understanding, tolerance, and appreciation for each other as well as trust in each other. Cultural and international diversity promotes the expertise, creativity, and curiosity of all persons at KIT. Internationalization is their common task.

Professor Holger Hanselka, President of KIT, personally lit a beacon of diversity: He acted as a patron of the Karlsruhe Christopher Street Day on June 4, 2022.

Equal Opportunities

Efforts to strengthen equal opportunities for men and women across KIT are reflected, among others, in three projects that have been implemented as part of KIT's Excellence Strategy since 2019.

The "Gender Equity 1" project uses a variety of formats to drive cultural change toward greater equality of opportunity. A total of 14 discipline-specific equal opportunity activities has been funded since fall 2021. They cover a wide range of activities, from recruitment at various career stages to the establishment of networks for female scientists, as well as the analysis and optimization of working conditions from an equal opportunities perspective. In addition, a "metaforum" was held in 2022 to reflect on the experience of the activities to date.

The "Gender Equity 2" program, in contrast, concentrates on attracting female professors by increasing the attractiveness of KIT for female scientists. Since the project began in 2019, 13 outstanding female scientists have received additional financial support through the Gender Equity 2 appointment budget. Moreover, a Female Academics Network is being set up in this project. It is intended to recruit highly-qualified female scientists and to strengthen the visibility of young female scientists in particular.

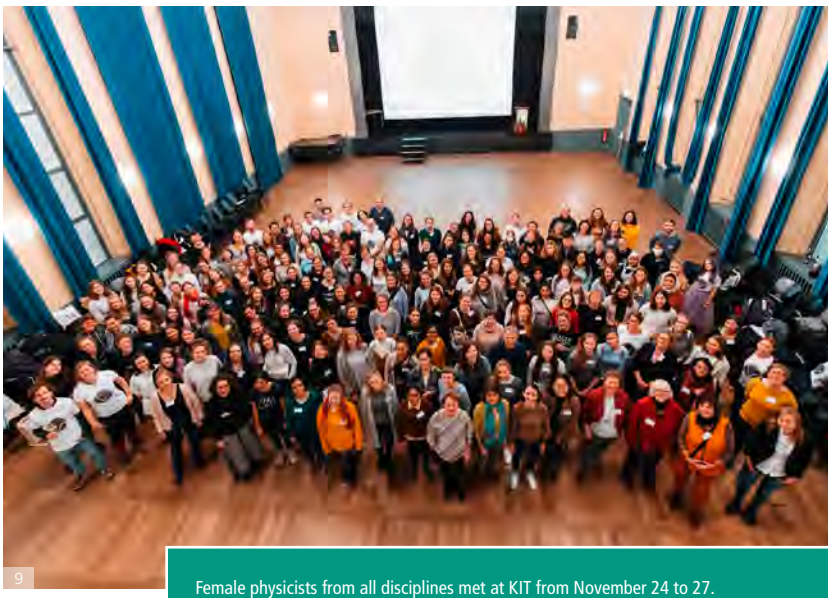
In its ambitious "100 Professorships Program", KIT intends to create one hundred additional professorships within ten years based on the existing core funding – with a target share of 40 percent women among newly appointed professors. It should contribute significantly to ensuring that at least every fifth professorship at KIT will be held by a woman by 2030. In this context, KIT creates three kinds of professorships: The so-called Otto Lehmann Professorships are intended to recruit top international researchers for KIT. In a second package, KIT will create Real World Lab Professorships. These are tandem professorships, where one of them deals with technological aspects and the other with the humanities and social science perspective. The third professorship package is the

so-called KIT Excellent Tenure project. KIT Excellent Tenure combines the qualification paths to professorship, namely junior research group leadership and a junior professorship or a tenure-track professorship, in order to make KIT more attractive for young scientists and to create reliable career paths.

The fact that active recruitment and gender-appropriate appointment procedures at KIT have brought about a positive evolution for equal opportunities at KIT is evident from the appointments: Women accounted for 32 percent of the appointments in 2022. Overall, the percentage of female professors at KIT thus has increased from less than 11 percent 10 years ago to 18 percent in 2022.

The visibility of women at KIT was highlighted by two special events in 2022: June 2022 saw the inaugural KIT Women Professors Forum (WPF). WPF was established by female professors from various departments at KIT and sees itself as both a community and a strategic platform for the female professors at KIT.

In November 2022, KIT hosted the 26th Conference of Women in Physics: About 280 female physicists of all disciplines and career levels met in Karlsruhe to attend a scientific conference. The participants had the opportunity to delve into different areas of physics or deepen their knowledge. Moreover, events were offered covering the topics of career prospects, equal opportunities, work-life balance, and career management. Since the quota of women studying physics is stagnating in Germany, an extensive program for schoolgirls was on the agenda to get girls enthusiastic about natural sciences.



9 Female physicists from all disciplines met at KIT from November 24 to 27.

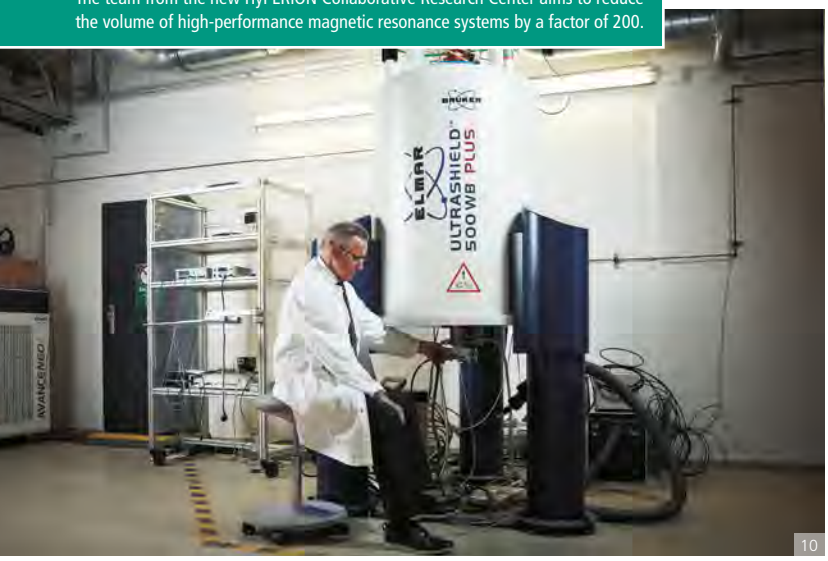
Collaborative Research Centers and Transregios

The German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) approved the funding of Collaborative Research Centers (CRCs) for a period of up to twelve years. In these long-term research institutions, scientists work together on an interdisciplinary university research program. Transregios (TRRs) are CRCs for which several universities jointly apply. In 2022, KIT succeeded in acquiring funds for two new CRCs. What is more, two TRRs, where KIT has the spokesperson role, were extended and a CRC of the University of Freiburg, in which KIT is involved, was newly approved.

In the **HyPERiON CRC** (High Performance Compact Magnetic Resonance), which had been approved for an initial period of four years in 2022 and which is coordinated by KIT, researchers from KIT and the universities of Kaiserslautern, Constance, and Stuttgart are jointly developing technology for compact high-performance magnetic resonance units. Its spokesperson is Professor Jan G. Korvink of KIT's Institute of Microstructure Technology. Magnetic resonance is both the most chemically specific and the most versatile measurement method for acquiring detailed information on the structure and function of molecular matter. This makes it the fundamental technology for characterizations in chemical, biological or materials research. However, its widespread use is hindered by its low sensitivity and the relatively high level of specialization required for working with it. The goal of the HyPERiON Collaborative Research Center is to improve the sensitivity, resilience, and usability of

magnetic resonance in equal measure. To achieve these goals, the CRC is focusing on the miniaturization of all components involved in magnetic resonance technology.

The team from the new HyPERiON Collaborative Research Center aims to reduce the volume of high-performance magnetic resonance systems by a factor of 200.



10

Complex materials based on rare earths are important for many high-tech applications, such as permanent magnets or computer screens. The chemistry of molecular and nanoscale rare-earth compounds and their physical properties are being studied by the new CRC "**4f for Future**". KIT coordinates the network, with participation of the Philipps-Universität of Marburg, LMU Munich, and the University of Tübingen. The interdisciplinary network will start on January 1, 2023 and will be funded for four years with more than EUR 10 million. Its spokesperson is Professor Peter Roesky of KIT's Institute for Inorganic Chemistry. Researchers are studying the synthetic pathways and physical properties of new molecular and nanoscale rare-earth compounds with the goal of developing materials with unprecedented optical and magnetic properties.

11

Thulium is one of the rare-earth metals. The chemistry and physical properties of rare-earth compounds are being studied by the new CRC "4f for Future".

The DFG will fund the "**Phenomenological Elementary Particle Physics after the Higgs Discovery**" CRC for four more years. Its spokesperson is Professor Gudrun Heinrich of KIT's Institute for Theoretical Physics. The researchers from KIT, RWTH Aachen University, and the University of Siegen are interested in a deeper understanding of the fundamental concepts underlying the so-called "Standard Model" of particle physics, which describes the interactions of all elementary particles in a mathematically conclusive way. With the discovery of the Higgs boson, this model was experimentally confirmed ten years ago. However, the Standard Model cannot answer such questions as the nature of dark matter, the asymmetry between matter and antimatter, or the reason for the smallness of neutrino masses. Synergies are being created in the TRR to address the search for a more comprehensive theory from complementary directions, with the objective of extending the Standard Model. For example, new connections are being made between flavor physics and the phenomenology of high-energy accelerators. The aim is pave the way in the search for a possible "new physics" beyond the Standard Model.

In addition, the DFG extended the "**Turbulent, chemically reacting multiphase flows near walls**" TRR for a third funding period. These flows can be found in a variety of processes in nature and technology. These include forest fires, for example, but also processes in energy conversion in which the transfer of heat, momentum, and masses as well as chemical reaction processes are influenced by the interaction between a fluid and a wall. The goals of the TRR are to gain an understanding of these mechanisms and to develop technologies based on them. This includes the synergistic use of experiments, theory, modeling, and numerical simulation. The KIT groups in-

volved are particularly concerned with chemical processes for the prevention of fires and the reduction of emissions harmful to the climate and the environment. The spokesperson role has been assigned to the TU Darmstadt; KIT's participant is Professor Olaf Deutschmann of the Institute for Chemical Technology and Polymer Chemistry.

KIT is also involved in another new CRC that started in 2022: The aim of the "**ECOSENSE**" CRC, headed by the University of Freiburg, is a faster and more accurate detection and prediction of critical changes in forest ecosystems due to climate change. KIT participates with its Institute of Microstructure Technology and its Institute of Meteorology and Climate Research.

Anniversaries in 2022

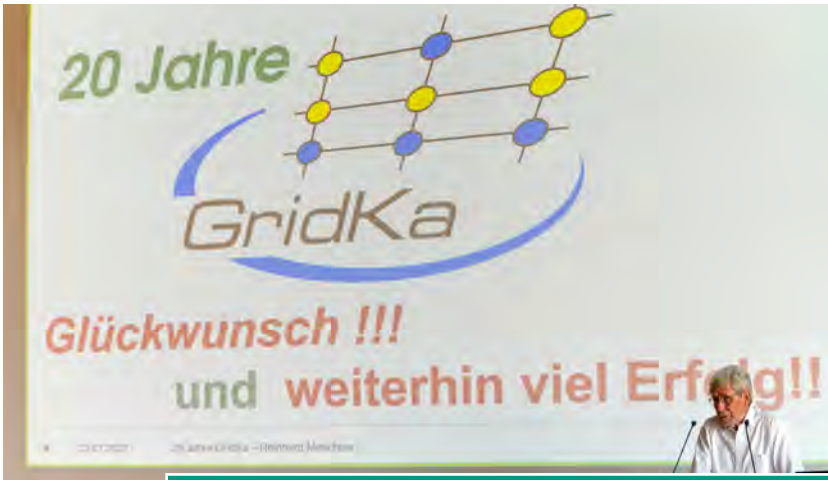
1972 was the year in which computer science history was written in Karlsruhe. A lot of effort and pioneering spirit were necessary to officially institutionalize the subject area "Informatics", which was new at that time, at the former University of Karlsruhe, a predecessor institution of KIT. Thus, the first **Department of Informatics** at a German university was founded in Karlsruhe. Three years earlier, in 1969, the Institute for Informatics had been founded there, and the "Informatics" study program had been established. The KIT department celebrated its 50th anniversary on October 20, 2022 with a festive colloquium held in KIT's Tulla lecture hall.

12 On October 20, 2022, the Department of Informatics celebrated its 50th anniversary.

The KIT **Department of Economics and Management** also celebrated its 50th anniversary in 2022. Until the summer semester of 1972, the Department of Economics was part of the Faculty of Humanities and Social Sciences at the former University of Karlsruhe. When the Business Engineering study program became increasingly popular in the early 1970s, there was a strong desire to establish a separate department. Intensive discussions finally led to the foundation of the Department of Economics and Management in the winter semester of 1972/73.

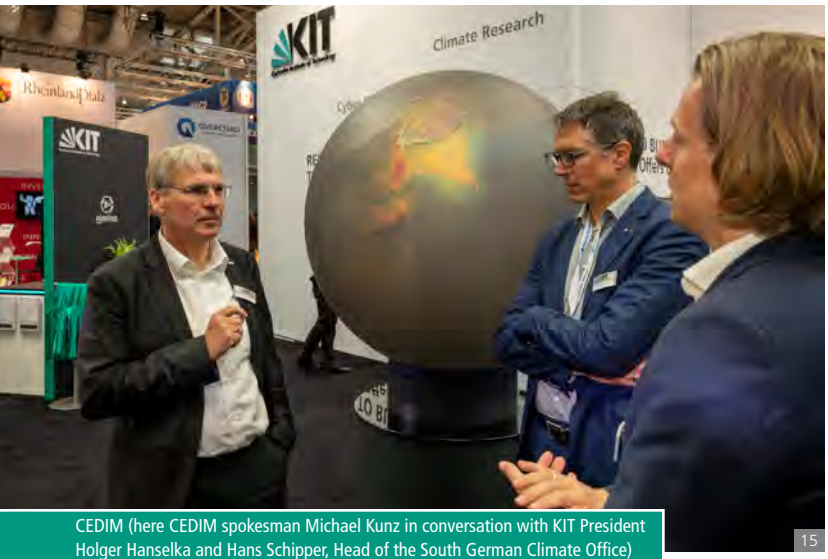
13 The KIT Department of Economics and Management also celebrated its 50th anniversary in 2022.

In July 2022, KIT's Steinbuch Centre for Computing celebrated the 20-year success story of the **Grid Computing Centre Karlsruhe GridKa**. The data and analysis center for Particle and Astroparticle Physics is one of the major research infrastructures at KIT and, as an international user facility, serves all four experiments (ATLAS, ALICE, CMS, and LHCb) of the Large Hadron Collider of CERN in Geneva as well as other international particle physics experiments with German participation.



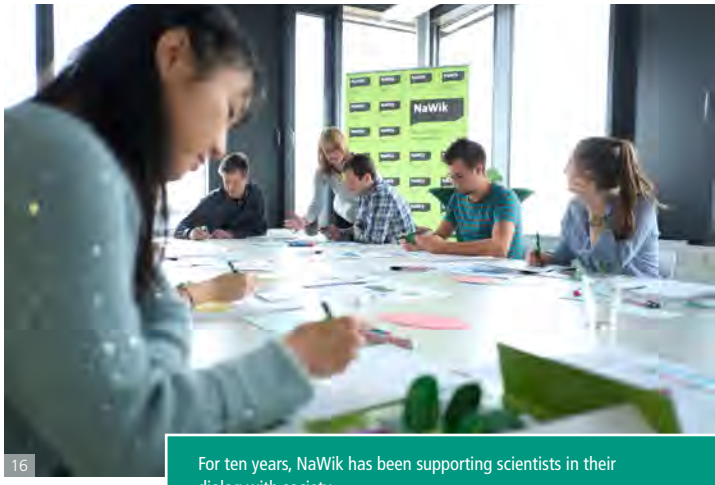
14 For 20 years, GridKa has operated as a data and analysis center for particle and astroparticle physics.

The **Center for Disaster Management and Risk Reduction Technology**, also known as **CEDIM**, celebrated its 20th anniversary in 2022. CEDIM is an interdisciplinary research facility at KIT that performs research on the thematic issue around disasters, risks, and security. It was established to better understand natural and man-made risks. CEDIM is dedicated to the earlier detection and better management of these risks. CEDIM was founded in 2002 as a virtual institute between the GFZ (Deutsches GeoForschungsZentrum – German Research Centre for Geosciences) and the former University of Karlsruhe. The former Karlsruhe Research Center also joined in 2007. When KIT was founded in 2009, CEDIM continued as a joint institution of KIT and GFZ and then passed into the sole responsibility of KIT in 2016.



15 CEDIM (here CEDIM spokesman Michael Kunz in conversation with KIT President Holger Hanselka and Hans Schipper, Head of the South German Climate Office) also celebrated its 20th anniversary in 2022.

Ten years ago, the Klaus Tschira Foundation and KIT founded the **National Institute for Science Communication (NaWik)** to strengthen the dialog between science and society. Today, the idea fueling the foundation of NaWik is more relevant than ever: Enabling researchers to enter into successful dialogs with society. To this end, NaWik offers eleven different seminar types and 33 dedicated lecturers for practical further training that can be attended in the form of virtual or classroom sessions. Researchers learn to communicate their methods and results in a dialog-oriented manner – be it by speech, in writing, or via social media. Ten years after its founding, NaWik is a **beacon** of further education in science communication in Germany. A distinguishing feature of NaWik is the fact that it evaluates its own activities and those of other organizations through accompanying scientific research, and thus is committed to high quality standards in science communication. With its own team, it also contributes to the research on science communication in Germany.



16 For ten years, NaWik has been supporting scientists in their dialog with society.

High-ranking Visitors from Politics

On March 28, 2022, Baden-Württemberg's Minister-President Winfried Kretschmann, Theresia Bauer (then Minister of Science, Research, and the Arts), and Dr. Nicole Hoffmeister-Kraut, Minister of Economic Affairs, Labour and Tourism) came to visit KIT for the opening ceremony of the Research Factory on Campus East. Here, KIT and Fraunhofer-Gesellschaft are conducting research in close collaboration with industrial partners on how to apply artificial intelligence to the digitalization of production processes. At the Karlsruhe Research Factory, KIT's wbk Institute of Production Science collaborates with the Fraunhofer Institute of Optronics, System Technologies, and Image Exploitation and the Fraunhofer Institute for Chemical Technology to achieve a common goal: The rapid industrialization of production processes – from

17 Opening ceremony for the Karlsruhe Research Factory: Baden-Württemberg's Minister-President Winfried Kretschmann, Minister Dr. Nicole Hoffmeister-Kraut, and Theresia Bauer (then Minister).

knowledge-oriented fundamental research via practical optimization and industrialization in collaborative research projects to transfer to commercial use in Baden-Württemberg.

KIT's Energy Lab 2.0 is Europe's largest research infrastructure for renewable energy and sector coupling. With the goal of climate neutrality in mind, researchers have built a detailed "digital twin" of the German energy system. Real integration of future technologies such as solar parks, grid storage or power-to-X plants, helps them to use this twin for virtually testing the energy system of the future with all its components. Federal Minister of Education and Research Bettina Stark-Watzinger launched the simulation on October 28, 2022, at KIT's Campus North. The Minister was accompanied during her visit by Michael Theurer, Undersecretary of State with the Federal Ministry for Digital and Transport.

18

Federal Minister of Education and Research Bettina Stark-Watzinger launched the simulation in Energy Lab 2.0 at KIT.

Building batteries 24/7, analyzing thousands of interfaces, autonomously evaluating the results with the help of artificial intelligence, and then immediately planning the next experiment: A new facility at the POLiS Cluster of Excellence handles materials development fully automatically and digitally. The autonomous research laboratory, which has been established as a collaboration between KIT, the University of Ulm, and the Helmholtz Institute Ulm, has now gone into operation. For the launch in Ulm on February 10, 2022, Theresia Bauer, then Baden-Württemberg Minister of Science, was also present. In the POLiS (Post Lithium Storage) Cluster of Excellence, KIT, the University of Ulm, and the Center for Solar Energy and Hydrogen Research Baden-Württemberg and the University of Gießen as associated partners, bundle their expertise.


19

Tenure-track professor Helge Stein explains POLiS, the new materials acceleration platform, to Theresia Bauer, then Minister of Science, Research, and the Arts.

Successful Acquisition of ERC Grants

Researchers at KIT acquired eleven coveted ERC grants in 2022. By the end of the year, KIT received three Advanced Grants, three Consolidator Grants, and five Starting Grants.

The ERC Advanced Grants are an initiative of the European Research Council (ERC) with the aim to fund recognized top scientists who have demonstrated outstanding scientific performance and who want to open up new research areas.

With the PRICOM (PRInted COMputing) project, Professor Mehdi Tahoori of the Institute of Computer Engineering intends to enable the market penetration of fast, inexpensive, and reliable (mini-)computers for consumers and in personalized medicine. PRICOM focuses on the development of new computer architectures that are based on the principle of additive manufacturing instead of silicon chips.


20

Mehdi Tahoori received an ERC Advanced Grant for his PRICOM project.

An ERC Advanced Grant was awarded to Alexey Ustinov for his Milli-Q project.

Stefanie Dehnen brought along her Advanced Grant for the BiCMat project from Marburg to Karlsruhe.

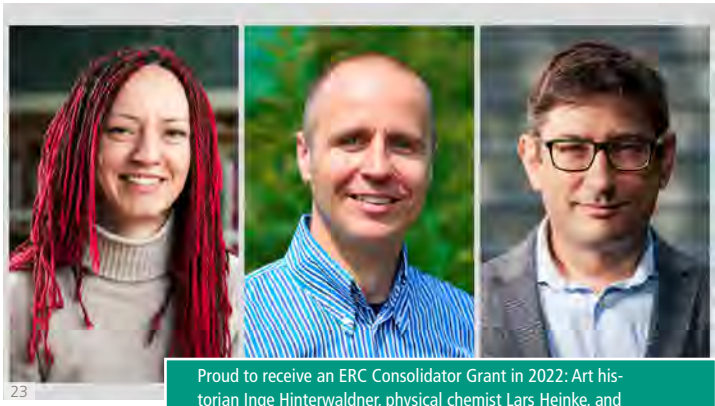
Professor Alexey Ustinov from the Physikalisches Institut has dedicated his work to the development of a new generation of superconducting quantum bits. In the Milli-Q (Millimeter-Wave Superconducting Quantum Circuits) project, so-called qubits are to be further developed so that they operate more stably and energy-efficiently in the future, taking quantum computing to a new level.

Professor Stefanie Dehnen obtained an ERC Advanced Grant in 2022, when she was still working at Philipps-Universität Marburg. In October 2022, she became Executive Director of KIT's Institute of Nanotechnology. In the funded BiCMat project, she is dedicated to the synthesis and application of bismuth-based nanostructures to provide the basis for the development of novel and advanced materials.

With its ERC Consolidator Grants, the ERC funds projects of outstanding researchers who received their doctorate seven to twelve years ago and whose own, independent research group is in its consolidation phase.

Professor Christoph Kirchlechner of the Institute for Applied Materials, is investigating the effect of hydrogen embrittlement, which is fatal for a future hydrogen economy, in his TRITIME project (Isolation, Observation, and Quantification of Mechanisms Responsible for Hydrogen Embrittlement Using TRItium-based microMEchanics). Using high-resolution research methods, he wants to gain a better understanding of how and why metals lose their strength when they come into contact with hydrogen.

The DYONCON project (Dynamic Ions in Nanoconfinement for Porous Membranes with Ultrarapid Gas Permeation Control) of Dr. Lars Heinke, Institute of Functional Interfaces, addresses – and even goes beyond – urgent issues in materials research. In his project, he wants to demonstrate that mobile ions in pores of nanometer size have unprecedented functionality and are thus able to improve electrochemical technologies for energy storage, sensors, and signal processing.



Proud to receive an ERC Consolidator Grant in 2022: Art historian Inge Hinterwaldner, physical chemist Lars Heinke, and materials scientist Christoph Kirchlechner (from left).

In her COSE project (Coded Secrets: Artistic Interventions in Digital Fabrics), Professor Inge Hinterwaldner of the Institute for History of Art and Architecture, studies online art, that is computer-based artistic artifacts detected on the Internet. Her interdisciplinary team will combine phenomenological-hermeneutic methods with approaches of media, games, and code research, software forensics, and visual design.

ERC Starting Grants aim to support excellent young scientists and researchers at the beginning of their independent career who wish to establish their own research team.

In 2022, five young KIT researchers each received a Starting Grant: Dr. Dominic Bresser, Helmholtz Institute Ulm, Professor Johannes Brumm, Institute of Economics, Dr. Julian Quinting, Institute of Meteorology and Climate Research, Tenure-track Professor Katharina Scherf, Institute for Applied Biosciences, and Junior Professor Matti Schneider, Institute of Engineering Mechanics (see pages 66/67).

Prestigious Awards for KIT Scientists

Every day 40,000 trains run on the various routes of the German rail network, and nearly 600 airplanes roll along the runways at the Frankfurt airport alone. For the most part, these traffic flows are regulated by computers. The interaction between the computer and communications systems and the trains or aircraft has to go smoothly. Professor André Platzer's research is about making such computer assistance systems extremely safe. In 2022, the

expert in theoretical information science, came to KIT as a Humboldt Professor for artificial intelligence (see also page 114).

Pascal Friederich, Tenure-track Professor at KIT's Institute of Nanotechnology received a Heinz Maier-Leibnitz Prize, which is awarded by the German Research Foundation (DFG). The prize is considered the most important award for young scientists in Germany. In his interdisciplinary work, Pascal Friederich focuses on the use of artificial intelligence in material simulation, virtual material design, and autonomous experimental platforms for automatic material recognition (see also page 115).

Professor Anke-Susanne Müller of KIT's Institute for Beam Physics and Technology, received the 2022 Baden-Württemberg State Research Award. The state thus honors the top physicist for her achievements in basic research. With her team, Anke-Susanne Müller makes groundbreaking contributions to enhancing the stability, compactness, and energy efficiency of particle accelerators (see also page 116).

The SECUSO research group (Security, Usability, and Society) of KIT was awarded with the Federal Consumer Protection Award by the German Consumer Protection Foundation (DSV). The researchers developed simple, user-friendly concepts and tools to help users of online services, apps, and software maintain their privacy and data security. The foundation of the Federation of German Consumer Organizations confers this award on exceptional consumer protection projects (see also pages 30/31).

Peter Mayer, representing KIT's SECUSO research group, receives the Federal Consumer Protection Award from Federal Minister for Consumer Protection Steffi Lemke.

KIT was granted the first national ESD (Education for Sustainable Development) Award in the "Places of ESD" category for its large variety of sustainability-related education offers and activities. As a place for sustainable thinking and acting, KIT enables young people to contribute to sustainable developments in society, industry, and science.

Going up: With an energy- and resource-efficient addition atop a building, an interdisciplinary team from KIT has won an international university building contest. Their RoofKIT project won the 2021/22 Solar Decathlon Europe, the world's biggest university competition for sustainable urban building and living (see also page 51).

Nobody has ever measured the methane emissions from oil rigs in the North Sea. Wanting to know more, young KIT researcher Dr. Christian Scharun developed an algorithm that uses satellite data to determine greenhouse gas emissions more accurately and efficiently. He won the national final of FameLab, an international competition for science communication, for his presentation of his research.

KIT's climate researcher Christian Scharun wins FameLab Germany contest.

Events

KIT hosted a multitude of events in order to contribute to the transfer of knowledge to society.

Recognize fraudulent websites, watch modern agricultural robots at work, find out about a research-related course of study in which digitalization and sustainability can be thought together, or talk to founders: Exciting insights into digital opportunities, research methods, and new technologies were displayed by KIT at the Night of Digitalization on July 1, 2022.

At the Night of Digitalization in Karlsruhe, visitors could learn about digital research methods and new technologies at KIT.

The Covid-19 pandemic and the climate crisis have increased the desire of citizens to participate in science. Science is also more in demand than ever when it comes to topics such as energy supply or digitalization. The dialog between science and society plays a decisive role in the development of sustainable and future-proof solutions. This was the topic of the Year of Science "Nachgefragt!" (Participate!) proclaimed by the Federal Ministry of Education and Research. The importance of citizen participation for research processes and the role of science communication were therefore also the focus of KIT's Annual Celebration on March 18, 2022.

27 The Annual Celebration adopted the title of the Year of Science 2022 "Nachgefragt!" (Participate!). Holger Hanselka spoke about the importance of knowledge transfer.

Fascinating large-format images from basic research were presented by the KIT Elementary Particle and Astroparticle Physics Center from July 16 to August 10, 2022, as part of the EFFEKTE science series at Karlsruhe's Kronenplatz. A supporting program with experiments, panel discussions, and lectures for people of all ages accompanied the exhibition throughout its duration. KIT was also involved in many other "Science Tuesdays" throughout the year in the EFFEKTE science series. With EFFEKTE, the municipality of Karlsruhe offers a science festival and a popular science lecture series in alternating years.

28 Images from basic research were shown by the KIT Elementary Particle and Astroparticle Physics Center at Karlsruhe's Kronenplatz.

The "KIT im Rathaus" (KIT at City Hall) series of events is intended to introduce exciting, interdisciplinary research done by KIT to the public twice a year. This series of events is coordinated by KIT's ZAK | Centre for Cultural and General Studies. In February 2022, the Mathematics in Sciences, Engineering, and Economics Center of KIT presented itself. Due to the Coronavirus restrictions, the event took place virtually. In July 2022, the Humans and

Technology Center of KIT presented its research work at the interfaces between society and technology.

Researchers at KIT are analyzing how society and technology interact. They presented their work at "KIT im Rathaus." 29

The TEDxKIT lecture event on November 25 in the KIT ceremonial hall on Campus South was entitled "Breaking the Rules". In our everyday life we follow rules, some are laid down in legislation, others are natural and many apply quite naturally in society, although they are not written down anywhere. Rules give structure to us as human beings and to our life together, but they can also restrict us in some areas of life. What happens if you deliberately or even purposefully break these rules? If you do something extreme to free yourself from an environment full of rigid rules and create something new? If breaking the rules leads to achieving something special in life that you could never have imagined? TEDxKIT 2022 gave people a platform and stage to talk about why they broke rules, what ideas they could advance by this, how this changed their lives and the lives of others.

The title of the TEDxKIT event 2022 was "Breaking the Rules". 30

Changes in the Executive Board

The earlier portfolio of Human Resources and Law will not be reoccupied after the appointment of Vice President Christine von Vangerow expired on December 31, 2022. The duties of "Human Resources and Law" will be assigned to the Executive Board member responsible for Business Affairs and Finance and combined into the extended, new "Finance, Human Resources and Infrastructure" portfolio, headed since January 1, 2023 by Michael Ganß, former Vice President of Business Affairs and Finance.

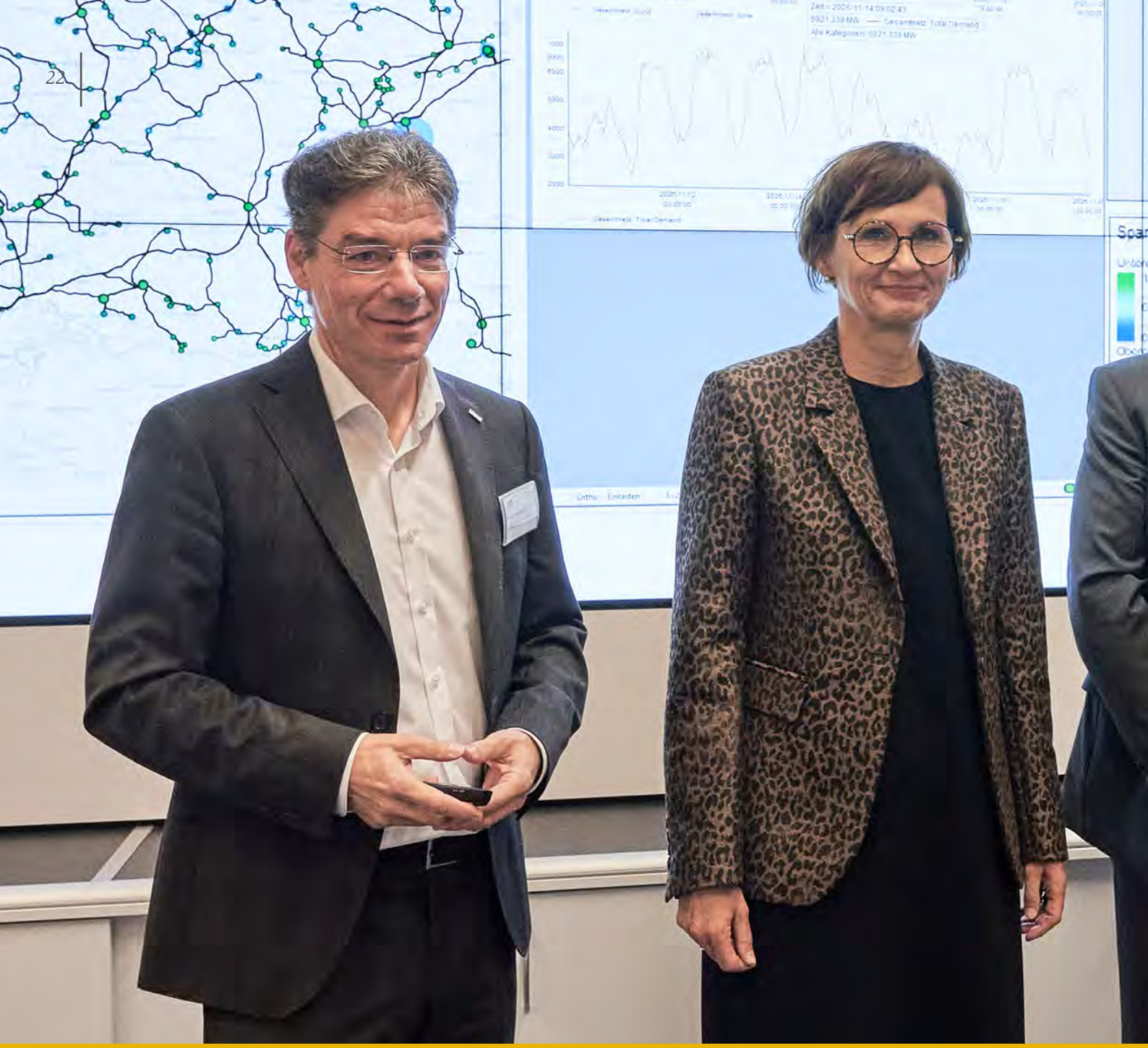
Digitalization and sustainability are inseparable at KIT. They are linked together in many ways and affect our core tasks of research, teaching, and innovation just as much as the administrative and infrastructure sectors. On January 1, 2023, the new portfolio of Digitalization and Sustainability was established on the Executive Board.

Kora Kristof, new Vice President for Digitalization and Sustainability, here captured in conversation with Holger Hanselka, President of KIT, took office on March 1, 2023. 31

With an overwhelming majority, the KIT Senate confirmed the unanimous decision by the Supervisory Board to elect Professor Kora Kristof as Vice President for Digitalization and Sustainability at KIT in July 2022. Kora Kristof previously headed the Sustainability Strategies, Sustainable Resource Use, Instruments department at Germany's Federal Environment Agency. She will begin her six-year term of office as the new Vice President on March 1, 2023.

The KIT Executive Board in 2022: Alexander Wanner, Michael Ganß, Thomas Hirth, Holger Hanselka, Christine von Vangerow, and Oliver Kraft (from left to right).

32



RESEARCH

With the goal of climate neutrality in mind, researchers in Energy Lab 2.0 at KIT have built a detailed "digital twin" of the German energy system. Integration of future technologies, such as solar parks, grid storage, and power-to-X plants, allows them to use this twin to virtually test the energy system of the future with all its components. Federal Minister of Education and Research Bettina Stark-Watzinger launched the simulation on October 28, 2022. She was accompanied by Michael Theurer, Undersecretary of State with the Federal Minister for Digital and Transport.

Energy Lab 2.0 is Europe's largest research infrastructure for renewable energy and sector coupling. It uses highly

efficient models to simulate of the interaction of electrical, thermal, and chemical energy sources. The researchers at Energy Lab 2.0 want to find out how a climate-neutral and resilient energy system should be constructed and how it can be managed in a safe and stable manner. The simulation is based on renewable energy and a closed carbon cycle, forming an energy system that should be a reality in 2045 according to the plans of the German government.

Energy Lab 2.0 covers the entire spectrum from basic research to finished prototypes. Industrial partners can use the sophisticated simulation tools provided by the lab to test the energy system components from their own development or from collaborative projects in a realistic environment. For policymakers, in turn, Energy Lab 2.0 serves as a real-world laboratory: They can quickly examine how the loss of gas supplies from Russia can be cushioned by renewable energy or by energy savings, for example, or how a ramp-up of the hydrogen economy should be organized from a technical point of view.

During the coming years, a new generation of professionals will learn here how to steer the networked energy system of the future safely through dark doldrums and attacks by cybercriminals.

34


39


40


41


44


45

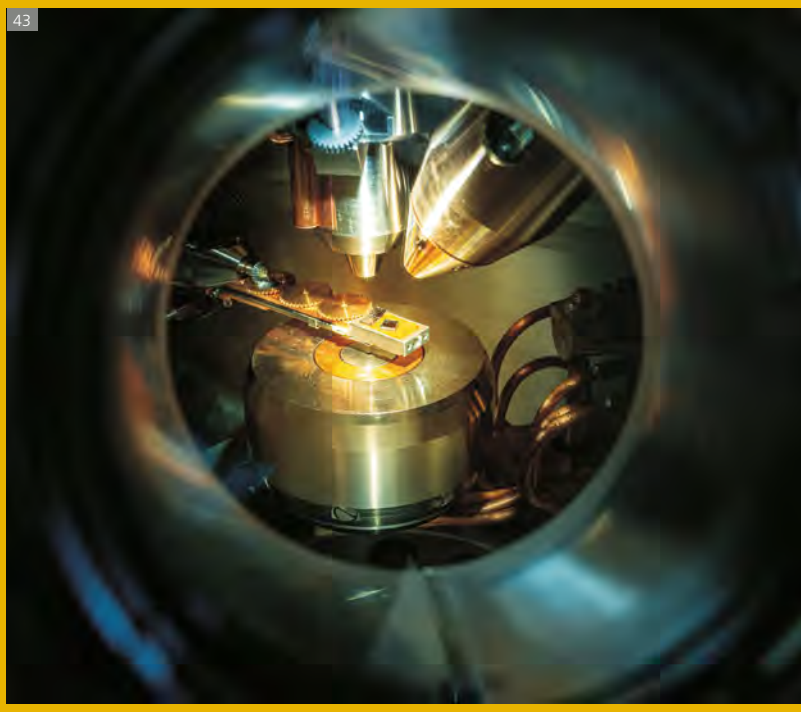

46

35


36


38


37


43

42


48


47

FROM OPTIMIZATION TO RECYCLING

Transdisciplinary Battery Research for the Energy Transition

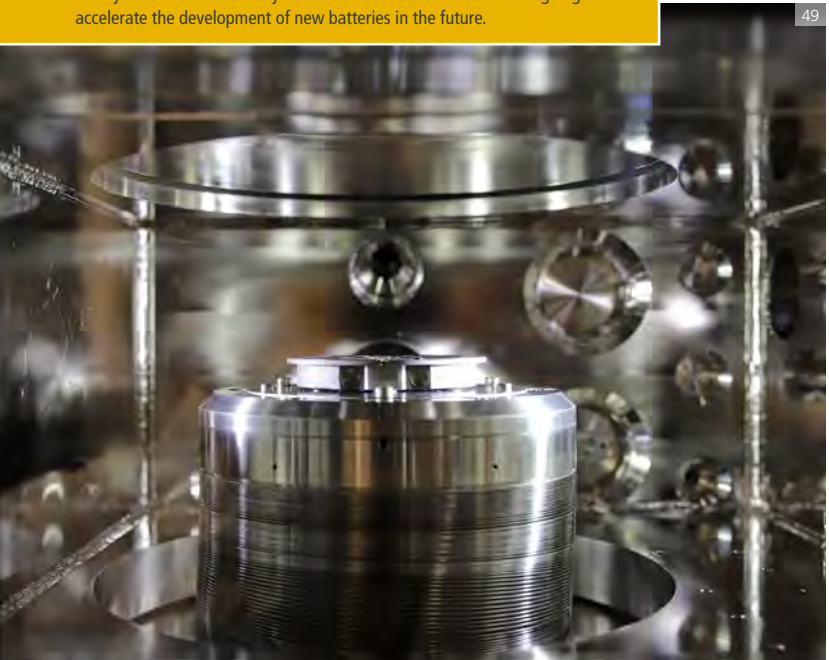
From materials research via production technology and cell development to entire energy storage systems, KIT scientists in battery research use an integrative research approach that covers the entire value chain. Using a practical approach and working in close cooperation with industry, they are looking for innovative solutions to contribute to the energy transition.

High-tech Research Facility in the POLiS Cluster of Excellence

Novel powerful and sustainable batteries are needed for the traffic and energy transition. With current methods, it takes decades from the idea to the finished product. A new high-tech facility at the Helmholtz Institute Ulm (HIU) as part of POLiS will accelerate this process in the future. The autonomous research laboratory, established as a collaboration between KIT's HIU and the University of Ulm, handles materials development automatically and digitally. This makes it possible to synthesize and assemble batteries and their individual components automatically, start measurements, and evaluate them in a fully automated manner. Based on the available data, the AI-based facility can even decide which experiment to be conducted next.

Battery research is characterized by the search for the ideal combination of materials, their composition, and process technologies. Using classical methods, it would take thousands of years to test all possible variations with all materials. The new facility is able to test several hundred of these variations a day. Besides the acceleration obtained by automation, the combination of algorithms and AI can achieve an additional optimization that is ten times faster and battery concepts can thus be brought to market faster and at lower cost. The facility represents the world's first fully integrated platform for accelerated research on electrochemical energy storage.

A fully automated laboratory at the POLiS Cluster of Excellence is going to accelerate the development of new batteries in the future. 49



FestBatt Cluster of Competence

Increased safety, more storage capacities, shorter charging times – solid-state batteries are to surpass conventional lithium-ion batteries in almost every performance parameter. The FestBatt battery cluster of competence, with participation of KIT researchers, has laid the foundation for this technology and is now developing entire battery systems and production methods in a second funding phase. This enhancement of the lithium-ion battery might give electromobility a decisive boost in the future, as solid-state batteries do not require liquid and flammable electrolytes and their chemical composition allows higher energy densities and shorter charging times. In addition, toxic and rare materials are no longer required.

FestBatt is now starting its second funding phase, which focuses on the development of cell components and entire solid-state battery cells based on promising electrolytes, as well as material and process technologies for their production. The characterization platform coordinated by KIT will, among other things, characterize contact and boundary surfaces on complex multiphase systems. FestBatt pools the expertise of 17 scientific institutions, coordinated by the University of Gießen. The Federal Ministry of Education and Research is funding the project with approx. EUR 23 million.

LiBinfinity

The sustainability of electric mobility largely depends on the batteries. They contain important resources, such as lithium, cobalt, nickel, and manganese. More than 90% of the materials used in lithium-ion batteries can be recycled. The recently launched LiBinfinity project, in which KIT is significantly involved, goes far beyond and

aims to develop a holistic recycling concept for lithium-ion batteries (LiB).

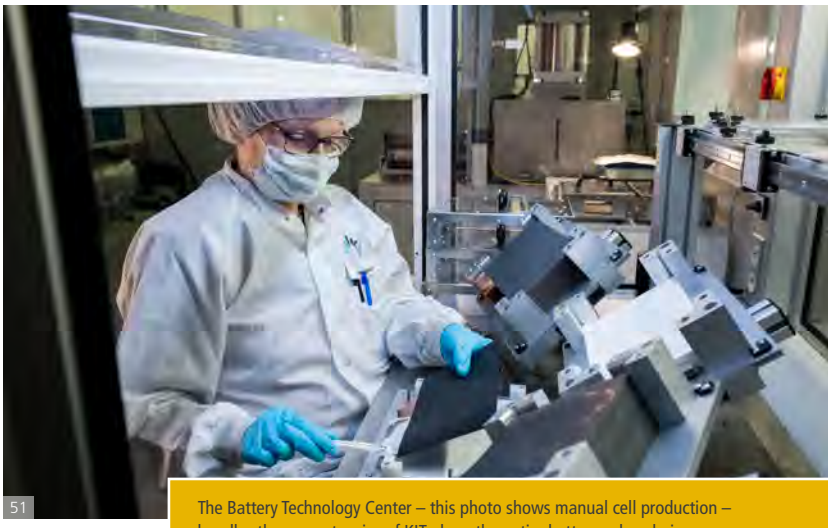
Within LiBinfinity, partners from research and industry are working out an approach that will extend from logistics concepts to the reuse of recycled materials in the life cycle of the battery. A mechano-hydrometallurgical process without any energy-intensive process steps but with higher recycling rates is transferred from the laboratory to a scale relevant for industry. Materials that cannot be separated mechanically are split at comparably low temperatures with the help of water and chemicals.

In LiBinfinity, KIT's task is to see whether the recycled or recovered materials are suited for the manufacture of new batteries. Materials for batteries – especially cathode materials – must meet stringent requirements that have a significant impact on the efficiency, reliability, lifetime, and cost of the batteries. The Federal Ministry for Economic Affairs and Climate Action funds LiBinfinity with nearly EUR 17 million, of which about EUR 1.2 million go to KIT.

MEFBatt Research Project

Batteries with solid electrolytes promise longer ranges for electromobility, quicker charging and greater safety overall. In the MEFBatt research project, scientists of KIT take the next step to enable mass production. In a pilot plant, the manufacturing process of electrodes for solid-state batteries will be investigated and optimized in preparation of industrial series production.

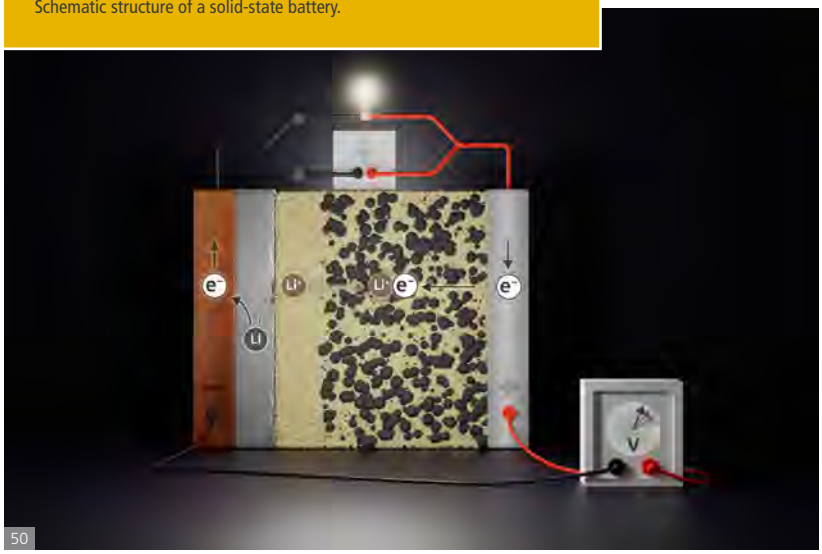
A solid-state battery is made of electrodes and a separator, the former liquid electrolyte being replaced by an ion-conducting solid-state electrolyte. In the production of electrodes for solid-state batteries, the previous electrolyte-impregnated polymer separator is replaced by an extremely thin solid electrolyte layer. To achieve this, a special facility employs an innovative multilayer coating process in which the cathode layer is used as a carrier layer to mechanically stabilize the sensitive solid-state separator. The Federal Ministry of Education and Research is funding the project with approx. EUR 600,000.



51

The Battery Technology Center – this photo shows manual cell production – bundles the competencies of KIT along the entire battery value chain.

Schematic structure of a solid-state battery.



50

MOBILITY

No-emission Flying?

Which technologies are needed to make flying climate-neutral? One option would be the use of synthetic fuels, which would have to be produced in large quantities. KIT is involved in two major international research projects aimed at producing kerosene, the fuel for jet aircraft, in a climate-neutral manner.

KEROGREEN

Organizing air transport in a CO_2-neutral way is a major challenge: "Batteries, hydrogen, and hybrid solutions are unsuitable due to their low energy density," says Professor Peter Pfeifer of KIT's Institute for Micro Process Engineering and one of the spokespersons of the EU KEROGREEN project. "Biofuels, on the other hand, require large crop areas, and thus compete with food production and the natural habitat." To make CO_2-neutral flying nonetheless possible, Pfeifer and the partners involved in KEROGREEN have found another way: the production of kerosene from air and water. "The use of renewables and CO_2 from the atmosphere creates a closed carbon cycle. We can even keep the existing infrastructure for storage, transport, refueling of aircraft and, what is even more important, jet engine technology can remain unchanged." Furthermore, synthetic green kerosene, emits no sulfur and less soot, and NO_4 emissions are minimized. The new manufacturing process is also particularly resource-friendly because no rare raw materials are used.

To be able to produce the fuel in sufficient quantities, the partners in the EU KEROGREEN project have developed within four and a half years a scalable process based on a new plasma technology that fits into a container module. The Dutch Institute for Fundamental Energy Research in Eindhoven coordinated this work; a research facility was built at KIT.

The process consists of three steps: The CO_2 from the ambient air is first fed into a reactor where it is broken down into carbon monoxide (CO) and oxygen by a plasma generated by microwave radiation. Then, the oxygen is removed while a part of the CO is used in a second reactor to produce hydrogen from water. This hydrogen and the remaining CO (the combination is referred to as synthesis gas, or syngas) are converted to hydrocarbons in a third reactor using Fischer-Tropsch synthesis. High-molecular-weight hydrocarbons that cannot be used for the production of kerosene are cracked in the process at the plant. The resulting product is the basic component of fuels commonly used in aviation. This raw material can then be refined into the desired kerosene or stored for later use as energy storage material. According to the researchers, plants in the megawatt range are conceivable with plasma technology. It is also suitable for use in small-scale, decentralized production.

The KEROGREEN research facility with its plasma reactor is located on the KIT Campus North.

CARE-O-SENE

Seven partners from South Africa and Germany are participating in the CARE-O-SENE project aimed at producing kerosene sustainably from green hydrogen and carbon monoxide from the air.

The focus of this application-oriented project is the development of next-generation resource-saving catalysts for the so-called Fischer-Tropsch synthesis (FTS). In this process, hydrogen and carbon monoxide are converted to hydrocarbons and water under high pressure

53

In the international CARE-O-SENE project, researchers are developing tailor-made Fischer-Tropsch catalysts for the production of sustainable kerosene.

and high temperatures. These hydrocarbons, in a slightly modified form, are then the basis of kerosene.

"The catalysts have to become more efficient, more selective, and more durable," says Professor Jan-Dierk Grunwaldt of KIT's Institute of Catalysis Research and Technology and chairman of the Research with Synchrotron Radiation Committee. To develop an optimal design, he and his team study the structures and behavior of the cobalt catalysts used in FTS under real process conditions – at a temperature of more than 200 degrees and a pressure of more than 20 bar.

For their investigations, the team employs methods from synchrotron research: They use high-energy photons to investigate the chemical state of the individual metal particles by means of X-ray absorption spectroscopy on the one hand and the structures of the entire catalyst by means of X-ray diffraction on the other hand. "This allows us for the first time to watch FTS catalysts at work during operation – even down to the molecular level," says Dr. Anna Zimina, head of the CATACT measurement line at the KIT Light Source.

The measurements not only provide information on disruptive structural changes occurring during the chemical reaction, but the resulting data flow into theoretical models and sustainability calculations. On this basis, the researchers can make predictions about how the catalyst will change and what adjustments will be necessary to make the industrial process stable, environmentally sustainable, and economical.

The German Federal Ministry of Education and Research is funding the international CARE-O-SENE (Catalyst Research for Sustainable Kerosene) project as an important component to the national hydrogen strategy with EUR 30 million of which KIT will receive about EUR five million. Part of this goes to the University of Cape Town as a subcontractor.

DATA SECURITY AND FRAUDULENT EMAILS

SECUSO Research Group Develops Concepts and Tools for Safer Online Use

Day by day, we all are feeding our smartphones with large volumes of data: We have conversations by talking or texting, we store photos, and videos, and we plan appointments and manage our contacts. Access to this data, some of which is highly sensitive, requires so-called authorizations. For example, any app accessing the camera needs authorization to do so. During installation or in other contexts, however, many apps request authorizations to access private smartphone data, although this is not required for their functionality.

Some weather apps or QR code scanners, for instance, request access to the address book or to private photos. Moreover, many apps include so-called trackers that continuously collect data, analyze the user behavior, and create profiles of persons without them being aware of this. The data collected can be used for targeted advertising, but may also be stolen by hackers.

Apps Range from Pedometers to Password Generators

The "Privacy Friendly Apps" (PFAs) developed by KIT's research group SECUSO (Security – Usability – Society) guarantee more privacy. The research group headed by Professor Melanie Volkamer is affiliated with KIT's Institute of Applied Informatics and Formal Description Methods. Students are significantly involved in the development of PFAs for Android smartphones. More than 30 apps for Android phones have been developed so far. PFAs are offered in the following areas: tools, fitness and health, games, and security (including flashlight), to-do-list, pedometer, active break, Sudoku, mental arithmetic trainer, password generator, and WiFi manager.

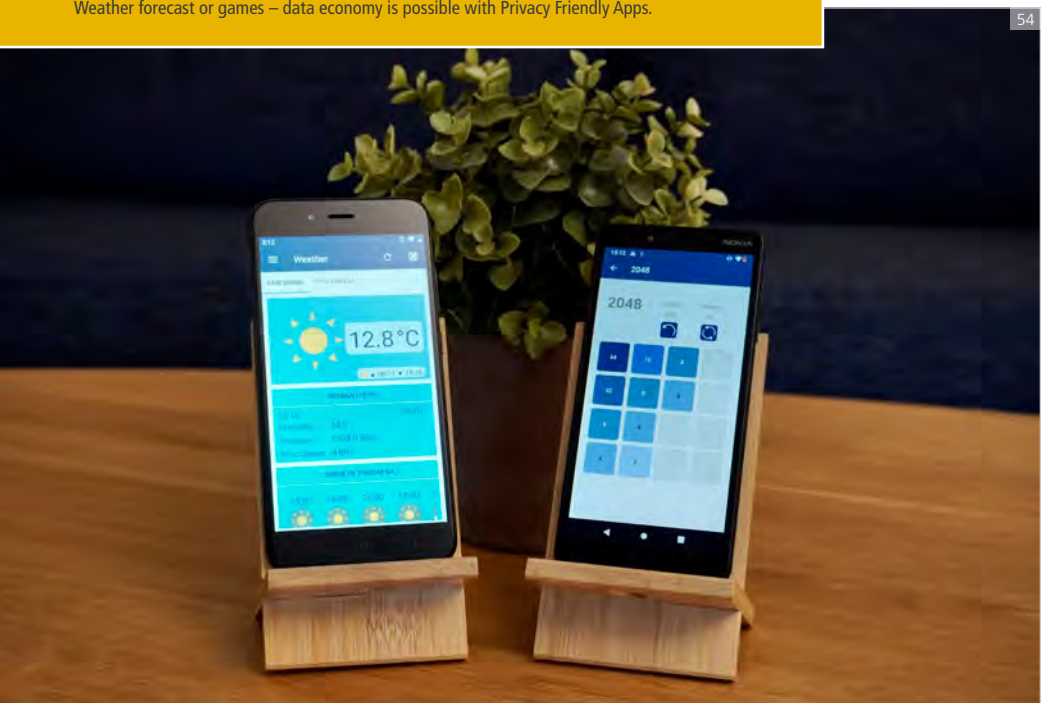
These apps request authorizations required for their functionality only and do not contain any tracking mechanisms. This means that they do not collect user data. The data collected is stored locally on the smartphone only. Clearly defined data will be transmitted to third providers only if this is absolutely necessary for the functionality of the app.

The SECUSO research group does not have access to the users' data. Furthermore, depending on the app, additional measures are implemented to protect users' privacy, such as blocking screenshots or recordings if sensitive data are involved, and encrypting databases. The source code of each PFA is publicly available on the GitHub platform so that it is possible to verify that the apps meet the conditions described above.

Digital Autonomy Award

For these "Privacy Friendly Apps", SECUSO has been granted the "Digital Autonomy Award" conferred for the first time in 2022 by the Digital Autonomy Hub Competence Center. The Competence Center coordinates an interdisciplinary network of 43 institutes and organizations and is funded by the Federal Ministry of Education and Research under the program "Miteinander durch Innovation" (togetherness through innovation). The Digital Autonomy Award honors innovative digital solutions that enable users to deal with their data, devices, and applications in a reflective and self-determined manner. The goal of the award is to make novel approaches in human-technology interaction more visible.

Weather forecast or games – data economy is possible with Privacy Friendly Apps.



54

55 The SECUSO research group team develops apps that access only the data required for their functionality.

Dealing with Fraudulent E-mails

Internet scammers use various strategies to harm online users. A popular and widespread method is to send messages with fraudulent content. Messages can be harmful in different ways: The message may ask to make money transfers or calls to chargeable numbers, but it may also contain harmful links or dangerous attachments. These messages can be sent as e-mails or in any other message format. Dangerous links in e-mails are often referred to as phishing e-mails.

To better understand the "fraudulent messages" form of attack and learn how to protect oneself, the SECUSO research group has developed awareness, education, and training measures that make it easy for Internet users to learn how to better recognize fraudulent messages such as phishing e-mails or postings on social networks. This includes, for example, checking the URL before clicking a link, verifying the e-mail address of the sender, and avoiding the opening of dangerous attachments.

Since online criminals are constantly changing and refining their methods, the KIT researchers are committed to constantly developing their NoPhish concept. Moreover, new formats are being tested; an example is the Security Teaching & Awareness Robot STAR that will make people more aware of phishing attacks during events in the future.

Federal Consumer Protection Award

For the development of simple, user-friendly concepts and tools to help users of online services, apps, and software maintain their privacy and data security, SECUSO was honored with the Federal Consumer Protection Award by the German Consumer Protection Foundation. The foundation hands out this award to people and organizations that conduct ambitious projects on any level with the aim to fight for the rights and interests of consumers on a full-time or voluntary basis. The award honors outstanding commitment and courageous dedication to consumer protection. It is SECUSO's goal to raise the general understanding of IT security and make it available to everyone. The research group therefore offers free, generally understandable information on preventing fraudulent messages and on keeping user accounts safe with secure passwords.

CLIMATE AND ENVIRONMENT

Water Budget in Times of Climate Change

How does climate change affect the water budget, especially in Germany? Research projects at KIT investigate the consequences for our water resources and the groundwater table as well as flood events.

Flood Events Are Becoming More Frequent and More Severe

The July 2021 flood in the Eifel region was one of the five worst and costliest natural disasters in Europe in the past 50 years. More than 180 people lost their lives, and well over 10,000 buildings were damaged. Critical infrastructure, such as electrical grids, water supply networks, bridges, rail lines and roads, was partially or completely destroyed. Only one week after the event, the Center for Disaster Management and Risk Reduction Technology (CEDIM) at KIT presented an initial study on the flood disaster in Rhineland-Palatinate and North Rhine-Westphalia. With an interdisciplinary team, bringing together members from multiple KIT institutes, investigations were made on the combinations of factors that contributed to this disaster: "We studied how precipitation, evaporation processes, water flow, and runoff led to this flooding," says Dr. Susanna Mohr, General Manager of CEDIM.

The estimated amount of water that flowed through the Ahr river in the 2021 flood was comparable to that of the historic floods of 1804 and 1910. However, the measured water levels were considerably higher at several locations in 2021 because cars and trucks, trailers, trash containers, and construction materials had piled up around bridges.

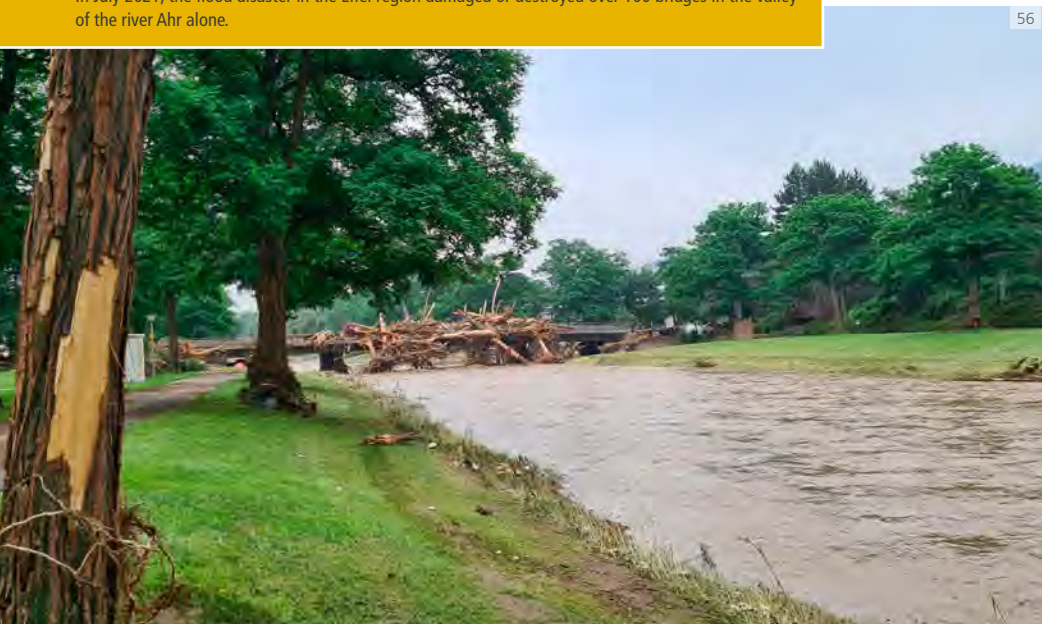
The KIT researchers simulated the flood event under various climatic boundary conditions. "The intensity of such precipitation events increases by about seven percent with each degree of warming. The simulations show that the amount of precipitation is already eleven percent higher than in pre-industrial conditions," says Dr. Patrick Ludwig of KIT's Institute of Meteorology and Climate Research. In addition, such extreme events will cover greater areas, last longer and occur more often.

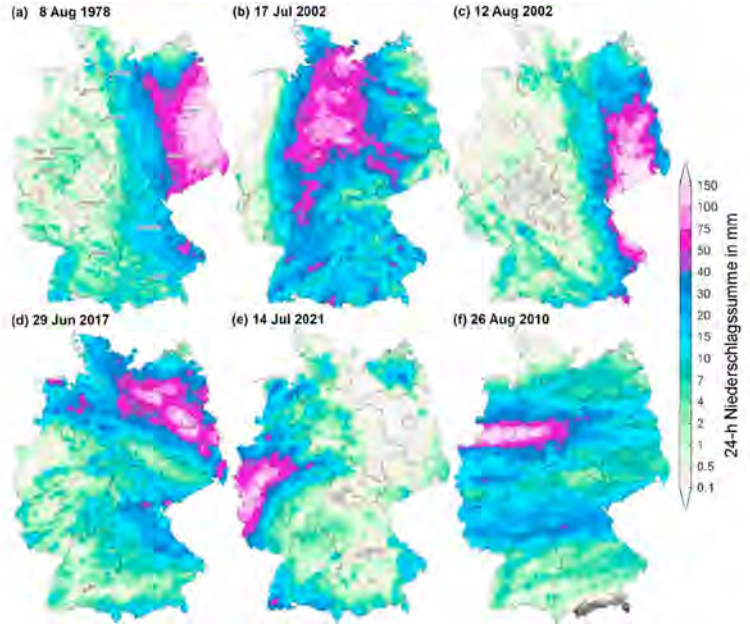
Groundwater Level Bound to Fall in Germany

Experts from KIT and the Federal Institute for Geosciences and Natural Resources used AI-based forecast models to find out how climate change will affect groundwater resources in Germany in the 21st century. They applied deep learning methods to assess, on the basis of existing groundwater data from all over Germany, the development of groundwater levels for different locations for various climate scenarios as defined in the fifth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC). These scenarios included an assumed increase of the global mean temperature by less than two degrees Celsius until 2100, the target defined by the Paris Climate Agreement, a moderate rise (plus 2.6 degrees), and the so-called business-as-usual scenario that is based on the absence of any climate protection measures and would lead to a warming of up to five degrees compared to the pre-industrial level. "Our scientific study exclusively covered direct climatic impacts and changes. Anthropogenic factors, such as groundwater extraction, were not considered," says Andreas Wunsch of KIT's Institute of Applied Geosciences.

According to the experts, all three climate scenarios studied will result in more or less strong developments

In July 2021, the flood disaster in the Eifel region damaged or destroyed over 100 bridges in the valley of the river Ahr alone.





57 The six most severe precipitation events in Germany from 1951 to 2021 (data: DWD, HYRAS-DE; graphics: Bernhard Mühr / CEDIM). The ranking is based on the size of the affected area depending on a certain precipitation intensity (≥ 50-year events). The July 2021 precipitation event ranks fifth.

with droughts, falling groundwater levels, and changed water availability. While less pronounced and quantitatively more moderate trends were obtained for the two more optimistic scenarios, the experts found a trend towards significantly falling groundwater levels at most locations for the most intense of the three warming scenarios. Future negative impacts will be particularly visible in North and East Germany, where the respective trends are already developing. In these areas, there is a risk of extended periods with low groundwater levels, particularly by the end of the century.

Database on Water Resources in Germany

What are the consequences of droughts for the environment? What are the effects of heavy rainfall? How do the water levels of rivers change? Hydrological datasets, i.e., those on groundwater levels, water runoff or precipitation, can help answer these and other questions related to the water balance and the impacts of climate change. Although Germany operates one of the most extensive hydro-meteorological measurement networks worldwide, such a consistent dataset, known as CAMELS (Catchment Attributes and MEteorology for Large-sample Studies) does not exist for this country yet.

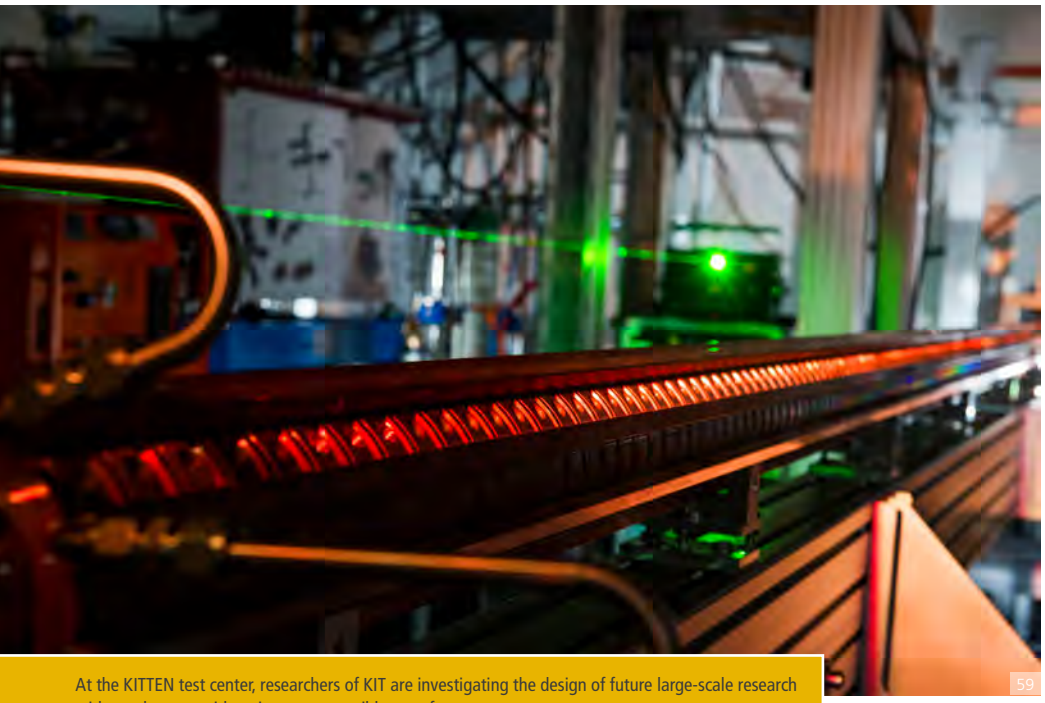
"With the CAMELS-DE-dataset, we want to facilitate analyses in hydrology across all federal states in Germany," says Dr. Ralf Loritz of KIT's Institute for Water and River Basin Management, who is setting up the database together with partners from Germany. "After all, federal state or national borders are always tied to new responsibilities and often limited data availability for environmental sciences. This inhibits hydrological research."

CAMELS datasets combine landscape features such as land utilization, geology and soil properties with hydrological and meteorological time series, e.g. for water levels and runoff as well as precipitation, temperature, and evaporation. Thus, they provide the opportunity to compare models and data analyses for a variety of heterogeneous landscape settings.

58 Researchers are pooling water data to better investigate the effects of climate change on the water balance in Germany.

DESIGNING LARGE ACCELERATORS FOR ENERGY EFFICIENCY AND SUSTAINABILITY

New KITTEN Test Center Helps in the Energy-responsible Development of Future Research Infrastructures



At the KITTEN test center, researchers of KIT are investigating the design of future large-scale research with accelerators with a view to responsible use of energy.

Modern particle accelerators can speed subatomic particles such as electrons and atomic nuclei up to nearly the speed of light, enabling researchers to study the smallest of particles and their interactions. That makes accelerators key research tools in physics, chemistry, biology, medicine, or in the materials sciences. Be it future energy supplies, climate change mitigation, mobility transition, identification of ideal material compositions or cancer therapy – researchers need high-performance infrastructures to meet the associated challenges. At the same time, the operation of these facilities should be as energy-efficient as possible. To this end, researchers of KIT at the KITTEN test center – KITTEN stands for KIT Testfeld für Energieeffizienz und Netzstabilität (KIT Test Center for Energy Efficiency and Grid Stability) – are investigating how the operation of such accelerator facilities can be as energy-efficient and sustainable as possible.

To optimize the energy footprint of accelerators, KIT has merged the KARA accelerator test facility and Energy Lab 2.0 activities in the KITTEN test center. The aim is to incorporate the energy efficiency and sustainability concepts of individual components and the overall system into both currently operated and planned facilities. The test center features, among other things, a photovoltaic system on the roof of the accelerator building, innovative cooling systems, and an AI-based real-time optimization of its operation.

KARA (Karlsruhe Research Accelerator) features a storage ring and a light source for experiments involving electron beams and intense electromagnetic synchrotron radiation to provide deep insights into matter, biological structures, and materials. The Energy Lab 2.0 reality lab at KIT, which is unique in Germany, explores, among other things, how a successful energy transition can be achieved and what the energy system of the future will look like. The researchers investigate the possibilities of coupling the different sectors such as electricity, heat, and mobility with each other to gain insights into the sustainable transformation of our energy system, a major factor for the success of climate change mitigation.

The researchers jointly tackle the global energy challenges and promote novel approaches for current and future research projects focused on sustainable energy solutions ranging from individual components to entire systems.

KITTEN is embedded in the Accelerator Technology Platform (ATP) at KIT, which works to develop accelerator technologies of the future. The ATP's task is to come up with new designs for the large-scale research infrastructures of the future, and to operate them. It is a hub where academia and industry can efficiently develop technologies that are relevant for accelerators.

PLANT BREEDING

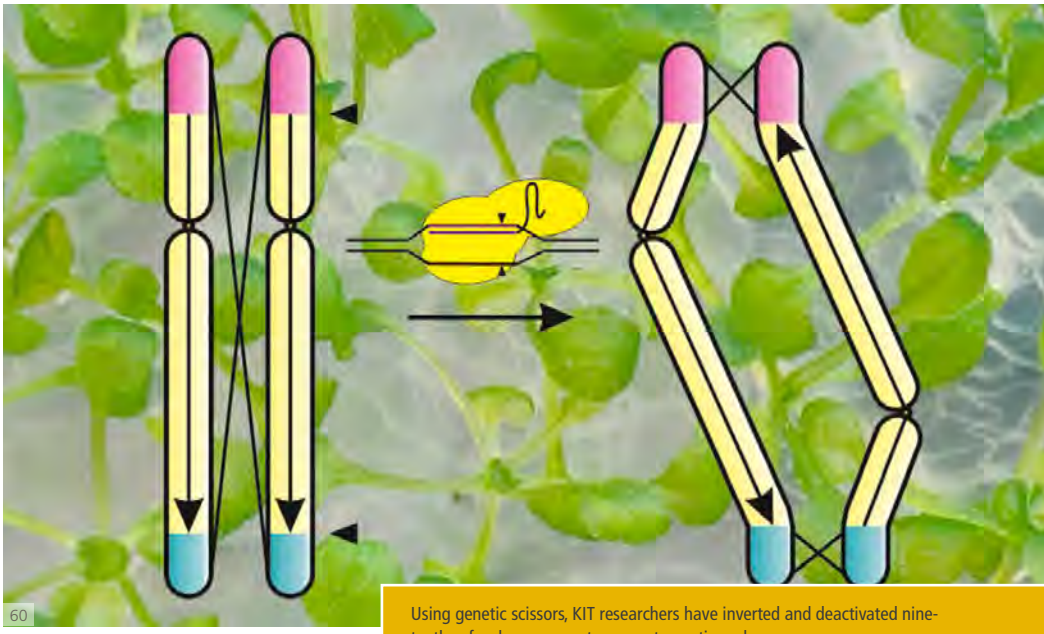
Using “Invisible” Chromosomes to Pass on Packages of Positive Traits

Targeted editing, insertion or suppression of genes in plants is possible with CRISPR/Cas molecular scissors (CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, Cas is short for CRISPR-associated). This method can be used to make plants more resistant to pests, diseases or environmental influences. In recent years, researchers at KIT’s Botanical Institute succeeded for the first time in using CRISPR/Cas not only to edit genes, but also to change the structure of chromosomes. Genes are linearly arranged along chromosomes. By changing their sequence, it was possible to show how good traits in plants can be separated from bad ones.

Now the researchers have been able to prevent the genetic exchange that is normally part of the hereditary process but can break the links between traits. They shut down a chromosome almost completely, making it seem invisible, so that all traits on that chromosome could be passed on in a package. Until now, if a plant’s traits were to be passed on together, the genes for those traits needed to be close to each other on the same chromosome. If such genes are spread farther apart on a chromosome, they are usually separated during inheritance, so a desired trait can be lost during the breeding process.

In their research, the scientists followed nature’s example: These reversals, or inversions – a kind of genetic invisibility – also occur frequently on a smaller scale in wild and cultivated plants. They have learned from nature and have applied and extended their knowledge about the natural process.

In collaboration with the Leibniz Institute of Plant Genetics and Crop Plant Research in Gatersleben, the researchers of KIT’s Botanical Institute, which has been renamed Joseph-Gottlieb Kölreuter Institut for Plant Sciences on January 1, 2023, inverted nine-tenths of a chromosome in the model organism Arabidopsis thaliana (thale cress). Only at the ends of the chromosome did the genes retain their original sequence. With these fragments, the chromosome can be passed on to the next generation just like the other chromosomes and is not completely lost.



60

Using genetic scissors, KIT researchers have inverted and deactivated nine-tenths of a chromosome to prevent genetic exchange.

To breed crops efficiently, it is important to combine as many desired traits as possible in one plant. Plant breeders want their products to taste good, have as many vitamins as possible and also be resistant to disease. The new method is well suited to support these goals in the future.

USING LIGHT TO DISTRIBUTE QUANTUM INFORMATION

Novel Material with Promising Properties for Quantum Computers and Networks

Quantum information will revolutionize not only research and industry, but also our everyday lives. Among other things, it promises enormous progress in the simulation of materials and processes, which will push the development of new medical substances, the improvement of batteries, transport planning, and secure information and communication.

Light is also well-suited for distributing quantum information quickly, efficiently, and securely. Researchers of KIT, Strasbourg University, Chimie ParisTech, and the French national research center CNRS have now achieved major progress in the development of materials for using light to process quantum information. The researchers have identified a promising type of material that can effectively achieve this: A europium molecule containing nuclear spins. Europium, a rare-earth metal, can store, process, and distribute quantum states to make practical applications possible.

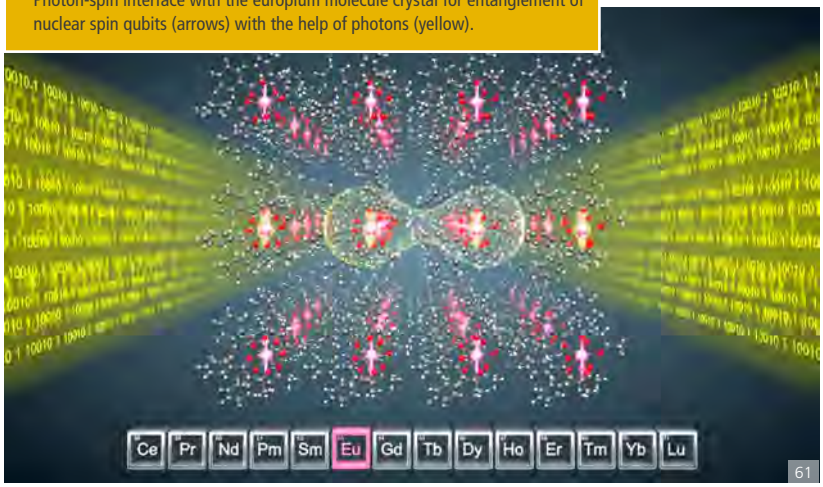
A quantum bit (qubit) can assume many different states between 0 and 1 at the same time. This so-called quantum superposition enables massive parallel processing of data. As a result, the computing capacity of quantum computers will increase exponentially compared to digital computers. To carry out computing operations, however, the superposition states of a qubit must persist for a certain time. In quantum research, this is referred to as coherence lifetime. Nuclear spins, i.e. angular momentums of atomic nuclei, in molecules enable superposition states with long coherence lifetimes, because nuclear spins are shielded effectively from the environment so that they protect the qubits against external impacts.

To execute useful quantum operations, many qubits entangled by quantum mechanics are required. For this entanglement, the qubits must be able to interact with each other. The europium ions in molecules can couple via electric stray fields, thus enabling future entanglement and, hence, quantum information processing. As the molecules are structured with atom precision and arranged in exact crystals, a high qubit density can be reached.

Another aspect relevant to practical application is the addressability of individual qubits. Optical addressing increases the readout speed and interfering electrical feeds can be avoided. Frequency separation makes it possible to individually address a number of molecules. Compared to previous projects, this novel material achieves optical coherence in a molecular material that is about a thousand times better. In this way, targeted optical manipulation of nuclear spin states is possible.

Light is also well-suited for distributing quantum information over long distances, e.g. to connect quantum computers or to securely transmit information. This also might be achieved by future integration of the novel europium molecule in photonic structures to enhance transitions – an important step towards quantum communication architectures with rare-earth molecules as the basis for a quantum Internet.

Photon-spin interface with the europium molecule crystal for entanglement of nuclear spin qubits (arrows) with the help of photons (yellow).



GERMANY-WIDE PILOT PROJECT

Coronavirus Detection in Wastewater

Coronaviruses can be detected in wastewater several days before first disease symptoms develop in community members. On this basis, it is possible to determine the number of infections more quickly, analyze the infection situation more precisely, and identify new Covid-19 variants and their spread at an earlier stage. The project network ESI-CorA (systematic monitoring of SARS-CoV-2 in wastewater) coordinated at KIT now plans to leverage these potentials and to find out whether and how a wastewater-based Covid-19 early warning system can be implemented in Germany.

62 Future systematic wastewater monitoring might contribute to more quickly detecting the spread of virus variants and mutations.

48 locations across Germany successively joined the pilot project that started in February 2022 and was scheduled for a duration of one year. At these locations, mixed water samples will be taken from the inflow of sewage treatment plants twice a week and over a period of 24 hours. After processing, the samples will be subjected to PCR testing. Then, the results will be linked to pandemic data of the local health authorities and incorporated in the assessment of the pandemic situation.

The process to determine the frequency and dynamics of SARS-CoV-2 viruses based on municipal wastewater samples has already been tested successfully in Germany within the framework of specific research projects funded by the Federal Ministry of Education and Research. It will not only help better estimate the real number of infections, but also contribute to a faster detection of the spread of variants and mutations compared to testing of individuals.

As part of the project, researchers will analyze comparable results to find out which methods might be suited for nationwide monitoring and which data would have to be collected to detect coronaviruses in wastewater of complex composition. A particular challenge for the scientists is to further improve the quality of sampling, laboratory analysis, and data evaluation.

Since October 2022, the test results from the 48 ESI-CorA locations have been incorporated into the wastewater monitoring system of the nationwide "pandemic radar" that gathers information on the current state of the coronavirus pandemic in Germany. Such an area-wide early warning system against Covid-19 has already been deployed in the Netherlands, Canada, and Australia. It would also be suited for other pathogens, such as polio or influenza viruses.

The project is funded by the European Union with about EUR 3.7 million under the ESI (Emergency Support Instrument) program. From KIT, the coordinating Project Management Agency Karlsruhe (PTKA) and the Engler-Bunte Institute are involved. Consortium partners are the German Environment Agency, the Robert Koch Institute, and the Technical University of Darmstadt.

GEOTHERMAL ENERGY IS INDISPENSABLE FOR TRANSFORMING THE HEATING SECTOR

Joint Roadmap for Sustainable Heat Supply

Half of municipal heating is envisaged to come from climate-neutral sources by 2030. Deep geothermal energy (at depths of between 400 and 5,000 meters) can contribute to reaching this goal, as it ensures stable and weather-independent energy supply on a local level and needs little space in populated areas. A joint roadmap of centers of the Helmholtz Association, including KIT, and the Fraunhofer Society now shows that deep geothermal energy has market potential in Germany and that its expanded use could provide more than a quarter of Germany's annual heat consumption (more than 300 terawatt hours).

The roadmap contains five recommendations for a timely expansion of geothermal energy supply into the German heating market. First, there is a need for clearly defined expansion targets. But financial instruments for inter-municipal risk compensation for companies and municipalities also are necessary to reduce exploration risk. Moreover, investment in key technologies such as drilling methods and reservoir management are required to achieve large-scale industrial exploration. Education and training of a skilled workforce is also required because the growing geothermal energy industry would create a large number of jobs. Not least, dialog with citizens is important because managing societal challenges requires acceptance by society.

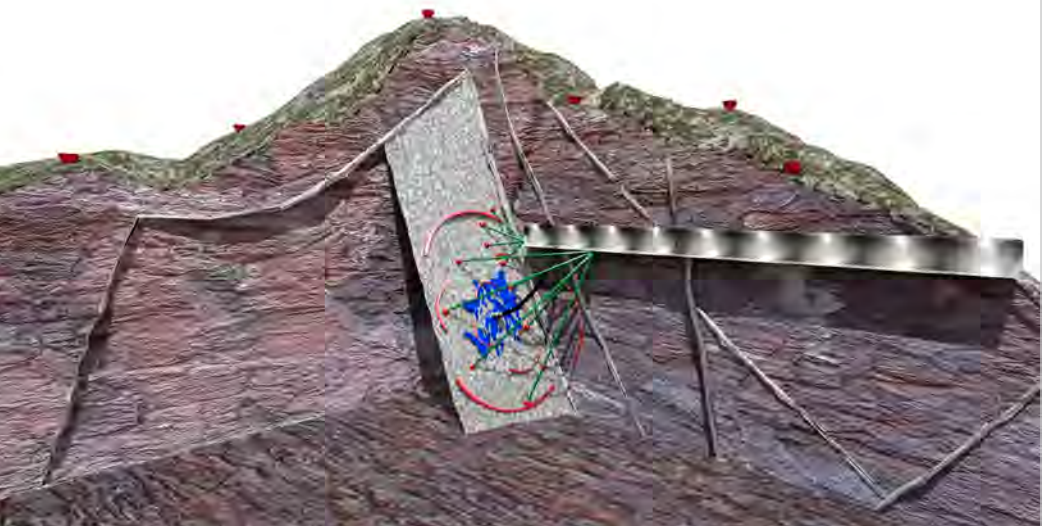
To reach the expansion goal of more than 300 terawatt hours, suitable technologies need to be developed. The future underground research laboratory GeoLaB, coordinated by KIT, is a joint initiative of KIT, the German Research Centre for Geosciences in Potsdam, and the Helmholtz Centre for Environmental Research in Leipzig. GeoLaB should provide insights that will be of crucial importance to the safe and ecologically sustainable use of geothermal energy and other subsurface resources.

Subsurface local heat sources and potential storage systems exist in broad areas of Germany. In urban spaces, demand and local supply will have to be balanced. KIT is now working on the development of the required storage technology in its Helmholtz research infrastructure DeepStor. An essential element is the regional heating concept developed in cooperation with citizens.

The heating sector accounts for 56 percent of the national energy demand. The roadmap discusses the contribution of geothermal energy to the transformation of the heating sector. The focus is on hydrothermal reservoirs, i.e. thermal water-bearing rocks at depths between 400 and 5,000 meters. As a heat source for district heating networks, hydrothermal geothermal energy – combined with large-scale heat pumps – theoretically could supply around a quarter of Germany's total heat demand. That would be about 300 terawatt hours annually with an installed capacity of 70 gigawatts.

GeoLaB is a generic geoscientific underground laboratory in crystalline bedrock. Research is aimed at a safe and ecologically sustainable use of major geothermal energy resources in Germany.

63



FUTURE-PROOF UTILITY AND SUPPLY SYSTEMS

More Resilience for Critical Infrastructures

Critical infrastructures such as power grids or traffic routes are increasingly characterized by digitalization, which enables flexible and efficient real-time control of these systems. The drawback, however, is that they become more vulnerable to disruptions and attacks, such as cyberattacks. In a decentralized energy system, which primarily relies on regenerative energy sources, the failure of individual components as well as time and weather-dependent fluctuations in energy supply may jeopardize energy security.

The RESIS (Resilient and Smart Infrastructure Systems) workgroup at KIT's Institute for Thermal Energy Technology and Safety explores how energy systems and other critical infrastructures can be designed in a sustainable and at the same time resilient way. RESIS is also a member of CEDIM – Center for Disaster Management and Risk Reduction Technology at KIT. Resilience of a technical system means that it does not fail completely, even under a very heavy workload or despite the occurrence of disruptions, but is still able to maintain critical functions and to quickly become fully operational again.

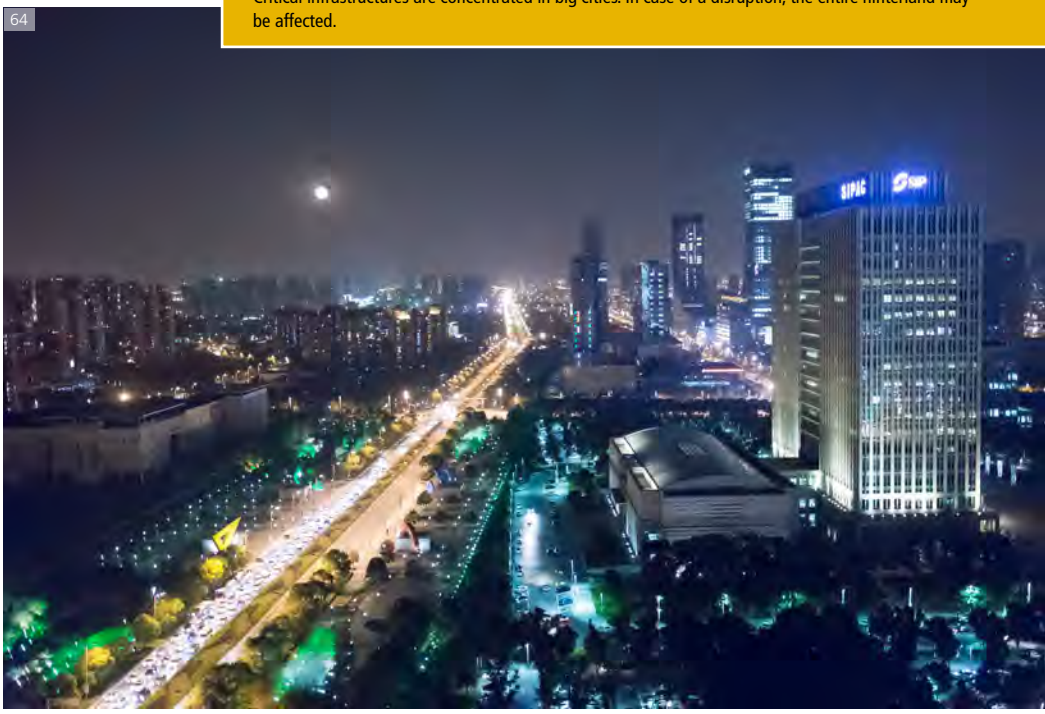
Ongoing planning of future critical infrastructures must allow for new system-dependent risks and major uncertainties in a systematic way. In terms of energy supply, for example, this means that the power grid is becoming increasingly important as the energy and mobility transition proceeds. This utility system, in turn, depends on information and communication networks.

It is, however, difficult to forecast how the threats emerging from new network structures and constraints such as the consequences of global warming, the structure of the population, or the power, heat, and traffic demands will evolve in the future. The RESIS research team is trying to find out what robust solutions might look like with major uncertainties looming in the background. They use simulation models, artificial intelligence, mathematics, and insights from social and economic sciences. A central factor in this process is a platform that simulates load scenarios under various constraints, thus allowing to analyze the interaction between different subsystems, i.e. systemic risks.

To increase the resilience of energy supply, systems such as microgrids can be integrated. Microgrids consist of many small and intelligent energy cells that not only contribute to stabilizing the grid, but are also able to work autonomously for a certain period of time. In this way, the energy supply of critical infrastructures, such as hospitals, pharmacies, and fire stations, can be distributed to different microgrids.

Besides the technical factors, the researchers increasingly factor in social aspects. Critical infrastructures depend on the population's trust; preventive strategies need broad acceptance from society.

64 Critical infrastructures are concentrated in big cities. In case of a disruption, the entire hinterland may be affected.



COLORED FAÇADES INCREASE ACCEPTANCE

Importance of Wood as Sustainable Building Material for Cities

The study's reference project is the Vinzent residential and office building, a wood hybrid design under construction in Munich that features a colorful planted façade.

Wood's return to urban construction harks back to artisanal skills and aesthetic principles from the era before concrete and steel. However, this does not mean a renaissance of idyllic villages with half-timbered houses. The requirements of present-day urban planning are to form entirely new connections with the structural principles of timber construction. Precisely because timber construction is becoming more and more prominent in social discourse, it needs to reinvent itself in order to assume and maintain a new place, especially in cities.

Wood as a building material is deeply rooted in the cultural memory of many regions. A study by the Institute for Building Design and Technology shows that wood has a promising future as a building material. Considering the cultural, technical, and design aspects of building with wood, the study examines how timber construction can make a comeback in cities. It identifies three megatrends driving the new boom in timber construction: ecology and environment, mechanization and digitalization, and new housing.

For the first of these, wood stands out as a natural material with its favorable carbon and energy footprints, high degree of recyclability, low emissions, and relatively good availability. In mechanization and digitalization, timber construction is seeing major advances such as the combination of the design and production (CNC) processes and new surface finishing methods. Moreover, for the third megatrend, new housing, wood is proving itself superior to other building materials in that it can often be used to produce prefabricated modules that can be installed with corresponding efficiency in projects like the densification of existing neighborhoods.

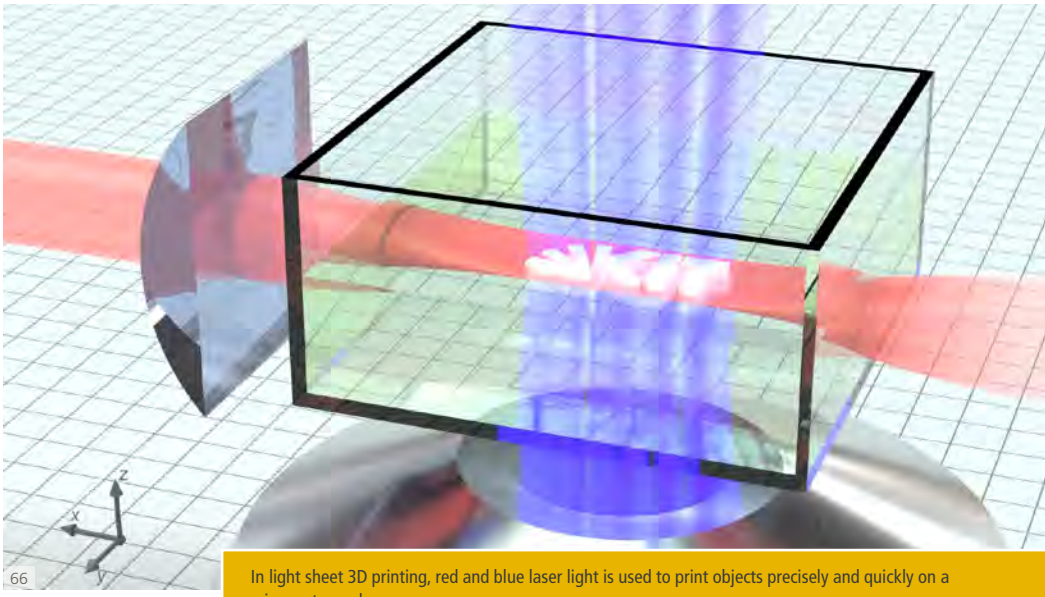
The study focuses on wooden façades. The KIT researchers describe the transition from linear to planar structural elements and advocate plywood surfaces and laminated timber ceilings, for example in the form of cladding as well as structural rather than chemical wood protection, ecologically sound planting schemes – and more color. Color inspires acceptance and facilitates the conceptual integration of wooden structures into established urban neighborhoods. In addition, modern colored wood stains, which pose no health hazards, protect the wood against harmful environmental factors such as exhaust fumes, ultraviolet radiation, and fungi.

The reference project of the study commissioned and financed by the Munich-based project developer Bauwerk is the Vinzent residential and office building, a wood hybrid design under construction in Munich that is going to house 56 apartments and offices when completed in 2024. The building's appearance is characterized by its colored façade made of spruce and incorporating numerous design details, and an adjoining, self-sustaining network of plants.

"3D MATTER MADE TO ORDER" CLUSTER OF EXCELLENCE

Fast-as-lightning 3D Microprinting with Two Lasers

Stereolithography 3D printing is currently one of the most popular additive manufacturing processes for plastics, both in private and industrial applications. In stereolithography, the layers of a 3D object are projected one by one into a container filled with resin. The resin is cured by UV light. However, previous stereolithography methods are slow and their resolution is too low. Light-sheet 3D printing, which is used by researchers in the Cluster of Excellence "3D Matter Made to Order," is a fast and high-resolution alternative.



66

In light sheet 3D printing, red and blue laser light is used to print objects precisely and quickly on a micrometer scale.

In light-sheet 3D printing, blue light is projected into a container filled with liquid resin. The blue light pre-activates the resin. In a second stage, a red laser beam provides the additional energy needed to cure the resin. However, fast 3D printing is only possible with resins that quickly return from the pre-activated state to their original state. Only then can the next layer be printed. Consequently, the return time dictates the waiting time between two successive layers and thus the printing speed. For the resin used by the researchers of KIT's Institute of Applied Physics, the return time was less than 100 microseconds, which allows for high printing speeds.

To take advantage of this new resin, the researchers built a special 3D printer. In this printer, blue laser diodes are used to project images into the liquid resin using a high-resolution display with a high frame rate. The red laser is formed into a thin "light sheet" beam and crosses the blue beam vertically in the resin. With this arrangement, the team was able to 3D print micrometer-sized parts in a few hundred milliseconds, i.e. in the blink of an eye. However, it is not meant to stop there: With more sensitive resins, it would be possible to use LEDs instead of lasers in a 3D printer. In the future, the scientists want to print 3D structures that are centimeters in size, while maintaining micrometer resolution and high printing speeds.

In the Cluster of Excellence "3D Matter Made to Order," scientists from KIT and Heidelberg University are conducting interdisciplinary research on innovative technologies and materials for digitally scalable additive manufacturing to improve the precision, speed, and performance of 3D printing. In addition to being funded as a Cluster of Excellence under the Excellence Strategy Competition of the German federal and state governments, "3D Matter Made to Order" receives funds from the Carl Zeiss Foundation.

FROM GREENHOUSE GAS TO A HIGH-TECH RESOURCE

The New NECOC Facility Produces Carbon out of CO_2 in the Ambient Air

The NECOC process combines three process steps from greenhouse gas to useful resource.

According to the latest climate report by the Intergovernmental Panel on Climate Change (IPCC), simply reducing CO_2 emissions is not enough to meet the Paris climate target. To reach the international 1.5-degree target, already emitted CO_2 must be removed from the atmosphere and permanently stored. In the research project NECOC (short for: NEgative CarbOn Dioxide to Carbon), partners KIT, INERATEC, and Climeworks are developing a process to remove the greenhouse gas CO_2 from the atmosphere and convert it into fine-grained carbon, also called carbon black, using a highly innovative process.

This high-tech raw material is used for the production of batteries, building materials, colors, and in the agricultural sector. So far, carbon has been produced largely from fossil resources, such as crude oil in a carbon black factory. In this process, however, the greenhouse gas CO_2 is formed. With NECOC, carbon can be produced in a process that emits no CO_2 and is therefore sustainable. If this carbon remains permanently bound, negative emissions are successfully combined with a component of the post-fossil resource supply as part of a future carbon management strategy.
The NECOC process combines three steps from greenhouse gas to useful resource.

The first step involves an adsorber to separate CO_2 from the ambient air. In the second step, this gas is transferred to a microstructured reactor, where it reacts with sustainably produced hydrogen from a connected electrolyzer. Its components, carbon and oxygen, form new bonds and the CO_2 transforms into methane and water. The third step is called methane pyrolysis in which the methane flows through a vertical bubble column reactor filled with liquid tin. The methane molecules are split, creating carbon and hydrogen, which, in turn, can be returned to split CO_2. The only remaining part is carbon, which floats on the tin as micro granular powder that can be taken off mechanically on a regular basis. Changing process parameters like the temperature level allows the production of different carbon modifications like graphite, carbon black, or even graphene.

In the first project phase, the research team constructed a container-sized test facility, which is operational. In continuous operation, this first-phase installation removes two kilograms of CO_2 from the ambient air in one day and turns it into 0.5 kilogram of solid carbon.

The start of the test installation is an important milestone for the NECOC project and marks the end of the first funding phase. In a second project phase, the NECOC procedure will now be scaled up and optimized for expansion. The Federal Ministry for Economic Affairs and Climate Action is funding the project with EUR 1.5 million.

CLIMATE RESEARCH

Ultrafine Dust Might Cause Weather Extremes

According to the latest reports of the Intergovernmental Panel on Climate Change, IPCC for short, weather extremes, such as droughts and strong precipitation, will increase in the future. So far, climate researchers have attributed these changes to an increasing carbon dioxide concentration and the higher water vapor capacity of a warming atmosphere. However, as carbon dioxide has a long lifetime and its spatial distribution is therefore quite homogeneous, this theory cannot satisfactorily explain the variability in the distribution and occurrence of extreme weather events without taking into account the hydrological cycle.

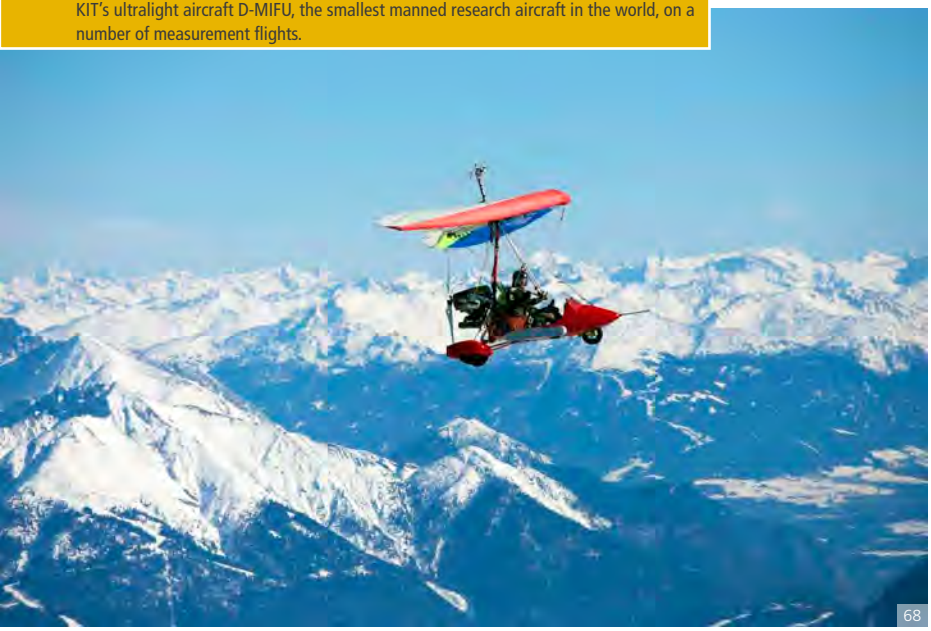
Researchers from the Atmospheric Environmental Research Division of KIT's Institute of Meteorology and Climate Research, the Campus Alpine in Garmisch-Partenkirchen, argue that ultrafine particles between a few and 100 nanometers in size are produced by the combustion of fossil fuels and significantly contribute to extreme weather events because they act as condensation nuclei and have a regional, short-term impact on cloud physics. Using conventional cloud formation models, they can show that the increase in ultrafine particles results in the formation of more and smaller droplets. As a result, water stays in the atmosphere much longer, rain is initially suppressed, and an additional energy reservoir develops in the middle troposphere, which promotes extreme precipitation. A heterogeneous distribution of nanoparticle pollution is a possible explanation for the big regional differences of extreme weather events.

So far, the impact of ultrafine particles on cloud formation has rarely been observed directly. For this reason, researchers used data on the amount and distribution of ultrafine dust in the Earth's atmosphere and on changes in the hydrological cycle. They found that in many areas of the Earth, an increase in particle numbers correlated with regionally changed precipitation patterns. This could be encountered above the Mediterranean Sea, Australia, or Mongolia.

This finding is based on an extensive measurement series with small airplanes that produced what is probably the biggest dataset of its type over a period of 20 years. The data cover historically reconstructable emissions and well-documented regional climate changes in areas of Asia, Central America, Europe, and Australia.

At certain locations, they found up to 150,000 particles/cm³ compared to about 1,000 particles 40 years ago. These extreme concentrations could be attributed to power plants, refineries or ship traffic and quite often – and in particular – to large incineration plants with the latest exhaust gas technology.

Dr. Wolfgang Junkermann of the Institute of Meteorology and Climate Research piloted KIT's ultralight aircraft D-MIFU, the smallest manned research aircraft in the world, on a number of measurement flights.



68

COMBINATION OF EFFICIENCY AND VERSATILITY

Highly Efficient Tandem Solar Cells for Thin-film Photovoltaics

Perovskite solar cells have made astounding progress over the past decade. Their efficiency is now comparable to that of well-established silicon solar cells. Perovskites are innovative materials with a special crystal structure. The more electricity they generate per unit of surface area, the more attractive solar cells are for consumers.

The efficiency of solar cells can be increased by stacking two or more cells. Jointly with partners in the EU-funded PERCISTAND project, researchers from KIT have produced perovskite/CIS tandem solar cells with an efficiency of nearly 25 percent – the highest value achieved thus far with this technology. If each of the stacked solar cells is particularly efficient at absorbing light from a different part of the solar spectrum, inherent losses can be reduced, which translates into an efficiency boost. Efficiency is a measure of how much of the incident light is converted into electricity. Thanks to their versatility, perovskite solar cells make outstanding components for such tandems.

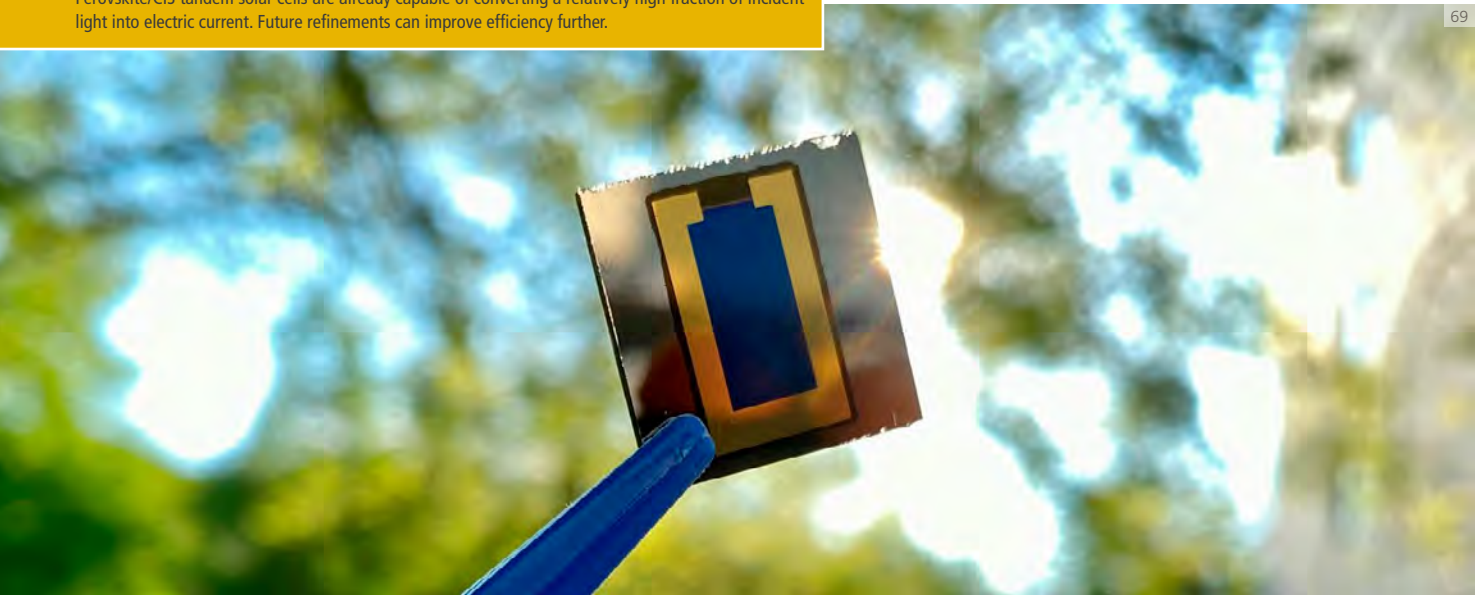
Combining perovskites with other materials such as copper-indium-diselenide (CIS) or copper-indium-gallium-diselenide (CIGS) promises further benefits. Such combinations will make it possible to produce flexible and light tandem solar cells that can be installed not only on buildings but also on vehicles and portable equipment. Such solar cells could even be folded or rolled up for storage and extended when needed, for example on blinds or awnings to provide shade and generate electricity at the same time.

This efficiency achieved for this technology is the first high efficiency level reached at all with a nearly gallium-free copper-indium diselenide solar cell in a tandem. Reducing the amount of gallium results in a narrow band gap of approximately one electron volt (eV), which is very close to the ideal value of 0.96 eV for the lower solar cell in a tandem.

The band gap is a material characteristic that determines the part of the solar spectrum a solar cell can absorb to generate electricity. In a monolithic tandem solar cell, the band gaps must be such that the two cells can produce similar currents to achieve maximum efficiency. If the lower cell's band gap changes, the upper cell's band gap must be adjusted to the change, and vice versa.

To adjust the band gap for efficient tandem integration, typically perovskites with high bromine content are used. However, this often leads to voltage drops and phase instability. Since the KIT researchers and their partners use CIS solar cells with a narrow band gap at the base of their tandems, they can produce their upper cells using perovskites with low bromine content, which results in cells that are more stable and efficient.

Perovskite/CIS tandem solar cells are already capable of converting a relatively high fraction of incident light into electric current. Future refinements can improve efficiency further.



69

TRAINING PROGRAM FOR ATHLETES

Top Performance in Sports through Mindfulness Training

Exuberant joy and great disappointment – emotions are part of the fascination of sports events. Emotions also have a significant influence on the performance of athletes: Those who can control their emotions, are more successful. For this reason, many top athletes are training their mindfulness. Studies by KIT researchers in the Institute of Sports and Sports Science (IfSS) revealed that the ability to maintain concentration and control emotions can be developed just like muscles.

Exercises to train mindfulness have an effect similar to that of strength training: Regular training enhances mental strength. Mindfulness means to concentrate on the present moment, i.e. to consciously perceive body sensations, thoughts, and feelings without assessing them. Emotions, such as joy, anger, fear, or helplessness, are noticeable on the physical and mental levels and influence performance. Living in the here and now helps people get out of their circles of worries, overcome difficult emotions, and consciously experience the most important moments of life.

Athletes who are able to reduce their own assessments and increase their acceptance of the current situation, become emotionally more stable. Those, who are emotionally stable, tend to assess situations more optimistically instead of concentrating on difficulties. Prominent examples of successful athletes through mindfulness training are Novak Djokovic in tennis, Steve Kerr and Kobe Bryant in basketball, or Malaika Mihambo in long jump. Basketball coach Phil Jackson, who won a total of eleven NBA championships with the Chicago Bulls and Los Angeles Lakers, used mindfulness training as his "secret weapon."

Mindfulness training includes concentration exercises, such as breathing methods, as well as techniques to observe one's own thoughts and feelings without being ruled by them. The objective is to make life more mindful in all of its facets, including work and sports.

The IfSS scientists have published a program to train mindfulness for professional and hobby athletes – alone or in groups. The eight program units contain practical exercises as well as information on their backgrounds and effects.

70

Remaining focused under stress and relaxed in competition: KIT researchers have developed a program to enhance psychic fitness.

TEACHING

In the 2022/23 winter semester, the number of KIT students totaled 22,373, a little more than in the previous year. The proportion of international students decreased slightly to 20.3%, while the share of female students remained constant at 29.4%.

Two new study programs have been established at KIT for the 2022/23 winter semester: The Medical Engineering bachelor's program at KIT's Department of Electrical Engineering and Information Technology prepares students for new technology trends and challenges in the industrial and clinical development of medical products. At KIT's Department of Civil Engineering, Geo- and Environmental Sciences, the

71

master's program "Technology and Management in Construction" offers an in-depth, practice- and research-oriented education for the typical fields of activity in the context of the construction, operation, and deconstruction of structures.

During Campus Day in May and at the state-wide studies information day in November 2022, pupils were invited to catch up on study and training opportunities at KIT. Employees and student representatives of the eleven KIT departments and many central institutions, such as Student Advisory Services, advised and informed interested youngsters on study opportunities and contributed interesting facts about studying. Numerous virtual and on-site information events and lectures as well as institute tours offered a detailed insight into studies and training at KIT.

Since the summer semester of 2022, prospective students can register and apply at KIT via an online portal in an entirely digital application and admission procedure. If all requirements are met, admission to the study program is also granted electronically via the portal. This simplifies the process for applicants and saves resources.


72

73

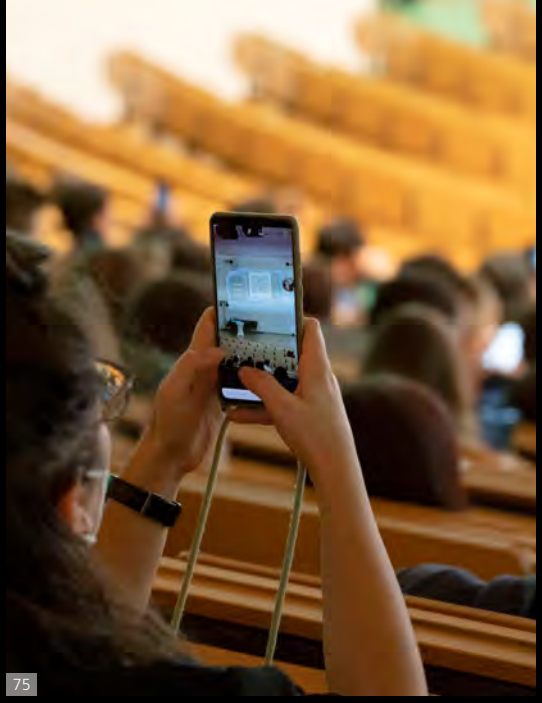

74


77


81

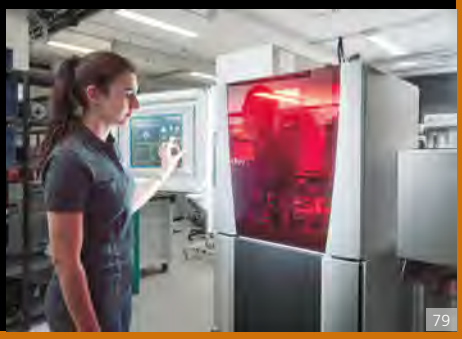

82


83


75


76


78


79


80

85


84


86

SUCCESSFUL CROSS-BORDER EDUCATION OF ENGINEERS

German-French Double-degree Program Celebrates Its 25th Anniversary

In 2022, KIT in Germany and École Nationale Supérieure d'Arts et Métiers in France, two leading institutions in engineering research, education, and innovation, celebrated the 25th anniversary of their German-French double-degree program in mechanical engineering and engineering sciences.

In 1997, the then University of Karlsruhe, today's KIT, and Arts et Métiers decided to offer a German-French double diploma program in mechanical engineering and engineering sciences. Since then, more than 850 mechanical and business engineers have graduated and benefited from the experience and networking activities of this long international collaboration.

The program is about both scientific and cultural exchange. Advantages of the double degree: Studies take place in two different education systems, with students spending half of the time in France and half of the time in Germany. In this way, they can improve their language skills, in particular their knowledge of scientific and technical terms in the other language. They also get acquainted with the culture and the ways of living and working in the neighboring country. Together with their fellow students, they can establish a cross-border network based on several years of joint studies. Not least, the students are conferred degrees recognized in both labor markets.

The collaboration between Art et Métiers on the Metz campus and KIT that has been successful for 25 years now is of great importance to French-German relations and a united Europe. International collaboration and joint research activities are a strong basis for the future and for enabling coming generations to master the major challenges of our times, especially across borders.

Excellent science is not conceivable without cross-border collaboration. The graduates of this double-degree program benefit from the long years of successful binational collaboration. 2022 also marks the 5th anniversary of the French-German Institute for Industry of the Future. It provides a collaborative French-German platform on which scholars, researchers, industry representatives, startups, and students can meet. In addition, the Institute is supposed to strengthen research, innovation, and academic education for the industry of the future.

More than 850 mechanical and business engineers have graduated and taken advantage of this double-degree program.

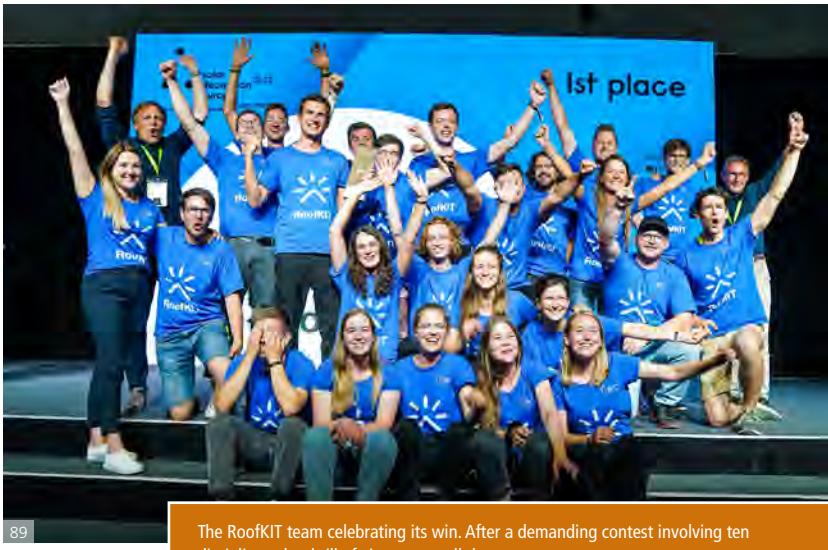
ENERGY-EFFICIENT AND RECYCLABLE

KIT Team Wins University Building Contest

Going up: With an energy- and resource-efficient rooftop addition, an interdisciplinary team from KIT succeeded in an international university building contest. Their RoofKIT project won the Solar Decathlon Europe 21/22, the world's biggest university competition for sustainable urban building and living. The team of researchers, students, and external collaborators built a full-size demonstration unit on the Solar Campus in Wuppertal.

With traditional methods, the construction industry consumes large amounts of energy resources and produces tons of waste. In times of climate change, resource shortages, and growing demand for housing, how can architecture do justice to its responsibility toward society? KIT's interdisciplinary RoofKIT team looked into this question and came to the conclusion that designs and buildings need to harmonize with natural and technical cycles. The task of the RoofKIT team was to convert previously unused roofs of buildings into usable spaces.

To show how houses can be built in an energy- and resource-efficient, recyclable and socially cohesive manner, the team headed by Dirk Hebel, Professor for Sustainable Construction, and Andreas Wagner, Professor for Building Services, designed an additional story for a 19th-century building, Café ADA, in the historic center of Wuppertal, and built a full-size demonstration unit. On the last day of the competition that involved 10 disciplines, architecture and innovation were the decisive factors for the jury to declare RoofKIT the winner at the closing ceremony on June 24. The VIRTUe team from Eindhoven took second place, and third place was shared by AuRA from Grenoble and SUM from Delft. The university competition, held in Germany for the first time and sponsored by the Federal Ministry for Economic Affairs and Climate Action, hosted a total of 16 teams from ten countries who came to Wuppertal to plan, build, and operate solar buildings with a neutral or even positive energy balance.



89 The RoofKIT team celebrating its win. After a demanding contest involving ten disciplines, the thrill of victory was all the greater.

In November 2022, the demonstration object was dismantled in Wuppertal and re-erected on KIT's Campus South. For the next three years, it will be available for visiting and for various research projects.

The RoofKIT team planned, designed, and built an energy-efficient, recyclable building: The addition of a story to a 19th century building.

88

OUTSTANDING EDUCATIONAL INITIATIVES HONORED

"National Award – Education for Sustainable Development" for KIT

Johannes Orphal (left), Executive Board's Officer for Climate Protection and Sustainability, and Senja Post, Scientific Director of ZAK, accepting "National Award – Education for Sustainable Development" presented by Undersecretary of State Jens Brandenburg.

90

The Karlsruhe School of Sustainability, an additional course on sustainable development, the campus garden, and the mobile participation laboratory "MobiLab": KIT offers a number of sustainability-related courses and activities. As a place for sustainable thinking and acting, KIT enables young people to contribute to sustainable developments in society, industry, and science.

KIT was granted the first "National Award – Education for Sustainable Development" (ESD) in the "Places of ESD" category for its large variety of sustainability-related education offers and activities. The award is offered by the Federal Ministry of Education and Research and the German UNESCO Commission. The prize money in the amount of EUR 10,000 will be used to extend the program of the week-long project called "Spring Academy of Sustainability" (formerly "Spring Sustainability Days").

KIT integrates education for sustainable development in its academic portfolio and imparts not only application-oriented knowledge and skills but also theories and methods. The goal is to strengthen individual acting with sustainability in mind. Sustainable thinking and acting are required to master challenges, such as climate change or long-term and socially equitable use of natural resources.

All eight KIT Centers, including the KIT Climate and Environment Center, the KIT Energy Center, and the KIT Humans and Technology Center, conduct interdisciplinary research into aspects of sustainability. Their results make valuable contributions to 10 of the 17 sustainable development goals of the United Nations. ZAK | Centre for Cultural and General Studies offers interdisciplinary courses to all students and gives them the opportunity to acquire additional sustainability-related skills.

Other institutions of KIT, such as the Academy for Responsible Research, Teaching, and Innovation (ARRTI), systematically enhance awareness of social responsibility. The Karlsruhe Transformation Center for Sustainability and Cultural Change offers advice, training, participation, and accompanying research for transformation projects beyond science. The activities of KIT's Center for the Education of Teachers and cooperation with the Sinsheim Climate Arena are aimed at turning teaching degree students into multipliers for sustainable development education.

The "National Award – Education for Sustainable Development" is presented under the UNESCO program "Education for Sustainable Development – Implementing Global Sustainability Goals" (BNE 2030). It honors outstanding German ESD actors and initiatives that broadly transfer ESD to society. A jury of representatives of science, industry, public life, and civil society selected a total of ten winners in four categories in 2022.

ACCOMMODATION FOR STUDENTS

New Student Residence of Schroff Foundations Inaugurated

Accommodations are in short supply and very expensive in Karlsruhe. Students, especially, find it difficult to obtain affordable housing. To provide help, the Schroff Foundations donated EUR 1 million to Studentenwohnheim des Karlsruher Instituts für Technologie (KIT) e.V. (Student Residences Association of KIT) for the construction of a new student residence in the Karlsruhe Oststadt district.

Construction of the new residence on Hagsfelder Allee 25 with a total floor area of about 3,900 m² took one and a half years and was completed in March 2022. Total construction costs amounted to EUR 9.5 million. The construction work was carried out by HEBERGER Hoch-, Tief- und Ingenieurbau GmbH.

The new student residence is located close to KIT's Campus South and offers 103 furnished rooms with a bathroom each, shared kitchens, common rooms, and one balcony per floor. Additionally, washing and drying rooms are provided on each corridor as well as learning and event rooms with a bar/kitchen, a garden terrace with a barbecue, WiFi in the whole building, and 100 bicycle stands.

The new student residence is named after Ingrid and Gunter Schroff, who established the Schroff Foundations in 1984 from their private assets on the occasion of the 25th anniversary of their corporate group. The goal of the foundations is to use entrepreneurial success for relevant scientific and social needs.

92 April 4, 2022 was the inauguration day of the new Schroff Kolleg student residence, for which the Schroff Foundations provided EUR one million.

"Studentenwohnheim des Karlsruher Instituts für Technologie (KIT) e.V." is a private residence provider in Karlsruhe. Residences managed by Studentenwohnheim e.V. are the "Hans-Dickmann-Kolleg" (HaDiKo) with 1,102 rooms, into which Schroff-Kolleg has been incorporated organizationally, the so-called "Insterburg" with 144 rooms, the "Hans-Freudenberg-Kolleg" with 100 rooms and the "Kolleg am Ring" with 34 rooms. Hence, Studentenwohnheim e. V. is the second largest provider of student residences in Karlsruhe after the Studierendenwerk and the largest private provider of student accommodation in Germany.

Happy about the new residence: Bodo Baumann, student representative and Director of HaDiKo, Ingrid Schroff, Chairperson of the Schroff Foundations and Honorary Senator of KIT, Susanne Schroff, Vice-Chairperson of the foundations, and Olaf Dössel, Chairperson of Studentenwohnheim e. V. (from left to right).

91

INNOVATION

Electric drives, batteries, hydrogen technology, autonomous vehicles: KIT and the automotive and industrial supplier Schaeffler have been cooperating for years on the mobility solutions of the future. Schaeffler is already present at KIT with its “SHARE am KIT” (SHARE stands for Schaeffler Hub for Advanced Research) research center. In this collaborative model, called “Industry on Campus,” Schaeffler and the KIT Mobility Systems Center are working as a team.

Now a strategic partnership aims to strengthen their efforts to develop and deploy new technologies and ideas for the mobility of tomorrow;

93

the partners signed an agreement in Karlsruhe on July 4, 2022.

Joint research and teaching at SHARE am KIT began in 2012. Since then 205 students and 30 doctoral candidates have completed their degrees there. All told, about 450 students have availed themselves of the center's diverse offerings.

In large joint projects with other partners, researchers work on technologies for the future of mobility. For example, the completed SmartLoad research project resulted in innovative methods to improve the reliability of highly automated electric vehicles.

Current examples of joint research include the multi-institute projects AgiloDrive and AgiloBat involving the KIT Mobility Systems Center and the KIT Energy Center. The aim is to improve the production of electric motors (AgiloDrive) and battery cells (AgiloBat) for electric mobility and other applications. In both projects, researchers seek to make production more flexible, more economical in small lots, and more efficient and agile through automation.


94


95

96


101

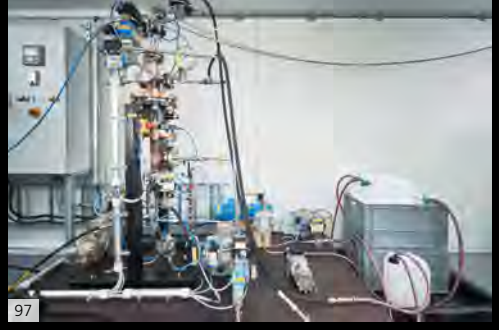

102


103


104

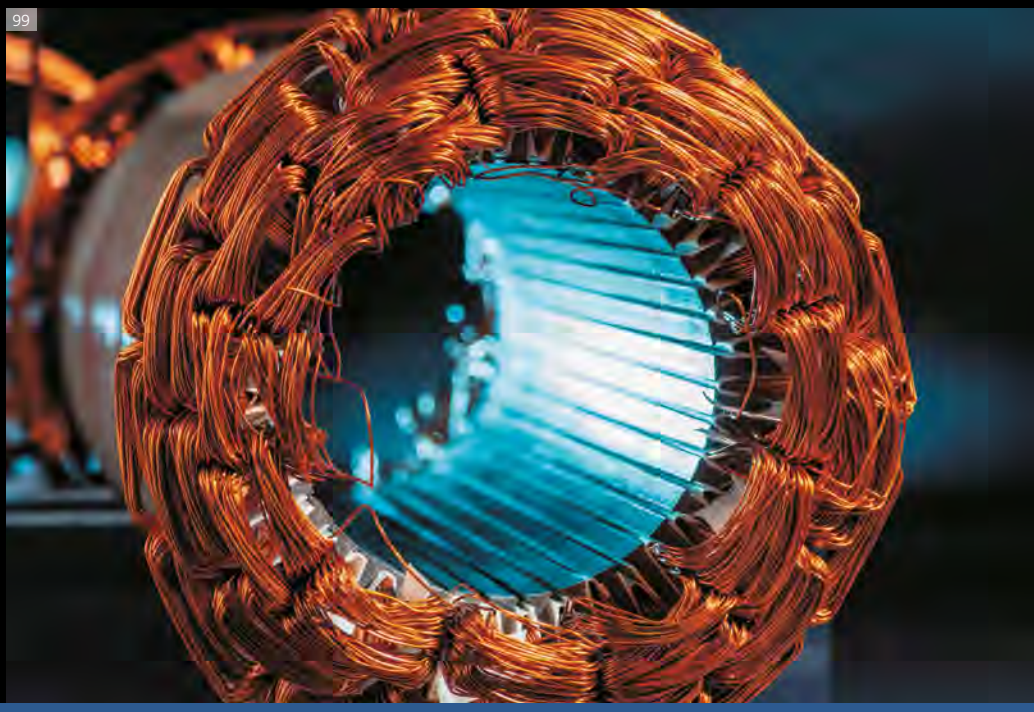

107


108


97


100

98


99


105


106


109

110

RAPIDLY INDUSTRIALIZING PRODUCTION PROCESSES

Karlsruhe Research Factory Opens on Campus East

At the Karlsruhe Research Factory, a new development and demonstration center, KIT's wbk Institute of Production Science, the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB), and the Fraunhofer Institute for Chemical Technology (ICT) are collaborating to quickly transfer theoretical knowledge to profitable industrial applications and services.

From basic research to practical optimization and industrialization in joint research projects to transitioning to commercial application in Baden-Württemberg, their shared goal is to industrialize production processes quickly. Their research work, which is based on close cooperation with partners in industry, focuses on the digitalization of production and the potential of artificial intelligence.

The Research Factory is a place for collaboration between science and industry and an outstanding setting for testing new approaches and putting them directly into practice. This is demonstrated by current research projects in electric mobility, lightweight construction, and Industry 4.0, and by projects investigating key production-related challenges for businesses, such as shorter product life cycles, customized products, and the increasing use of new technologies.

For electric mobility, research is concentrating on high-efficiency electric traction motors, high-performance batteries with variable cell layouts, and the cost-effective production of fuel cells. Additive manufacturing techniques, the resource-efficient use of materials, and the production of hydrogen tanks are the focus of current research work in lightweight manufacturing. In Industry 4.0, the potential of end-to-end digital process chains and artificial intelligence is being researched across multiple domains, along with concrete technical solutions such as the concept of value stream kinematics, which enables the implementation of this potential in a real production environment.

In the Research Factory, companies and researchers will work together on issues that are key to the future competitiveness of our economy. Thus it will bolster the unique industrial ecosystem in Baden-Württemberg, helping it to meet the challenges of transformation. The close cooperation between science and industry will turn promising approaches into innovative solutions for manufacturing companies and the mechanical and plant engineering sectors.

With the Karlsruhe Research Factory for AI-integrated Production, KIT and the Fraunhofer-Gesellschaft are making an important contribution to cementing Germany's position as a leading industrial country. The factory is where the latest findings in artificial intelligence and machine learning combine with the classical engineering sciences to explore practical applications on the cutting-edge field of smart production.

Opening ceremony for the Karlsruhe Research Factory with Baden-Württemberg's Minister-President Winfried Kretschmann, Nicole Hoffmeister-Kraut (Minister of Economic Affairs, Labor, and Tourism, left) and Theresia Bauer (then Minister of Science, Research, and the Arts).


111

SCIENCE UP CLOSE

TRIANGEL Open Space Dedicated – a New Meeting Place in Karlsruhe

Experiencing the latest scientific developments up close, talking to astute entrepreneurs, or just enjoying a coffee: People in Karlsruhe can do all these things at KIT's TRIANGEL Open Space on Kronenplatz square. Due to the pandemic, this new center for innovation, startups, and knowledge transfer where representatives from academia, business, and civil society have been coming together since 2021, was officially dedicated in 2022. There was a lot to discover during TRIANGEL's first week: Interactive science exhibits, keynote talks, panel discussions, and a presentation on understanding and shaping the future.

As the research university in the Helmholtz Association, KIT creates and imparts knowledge to benefit society and the environment. Dialogue with the public is very important to this mission, and TRIANGEL's location in the heart of the city facilitates contacts between KIT's scientists, students and start-ups, and the people of Karlsruhe and partners in business and civil society.

In addition to hosting exhibitions that bring scientific concepts closer to the general public, TRIANGEL is a place where innovation teams and start-ups can meet people and get direct feedback on their ideas and prototypes. The Open Space also has room for workshops, lectures, readings, panel discussions and even cultural events. And its café provides a comfortable atmosphere for networking, working on innovative ideas, or simply relaxing with one's beverage of choice.

In April 2022, the Stifterverband (a joint initiative of companies and foundations that promotes education, science, and innovation) designated the TRIANGEL Open Space a "Hochschulperle" (literally, a university pearl), a designation honoring "future-oriented learning spaces."

Hydrogen Knowledge Week

The KIT Energy Center and TRIANGEL Open Space presented technologies for the future of the energy transition during Hydrogen Knowledge Week. The program, which examined the fascinating world of hydrogen from various perspectives, included lectures, discussions, exhibits, and a laboratory with hands-on experiments for schoolchildren. It addressed the role hydrogen can play in supplying energy sustainably. Researchers at KIT are working on a wide variety of solutions involving hydrogen to drive the energy transition. They presented their technologies to the general public during the event.

112 On Kronenplatz square in Karlsruhe, KIT opened TRIANGEL Open Space, a new platform for dialogue with the public.

Discussion on Science in Times of Crisis

At a dialogue event entitled "Coronakrise, Klimakrise, Energiekrise: Was erwarten wir von der Wissenschaft?" (Covid crisis, climate crisis, energy crisis: What do we expect from science?), members of the public had the opportunity to talk with each other and with KIT researchers about what they expect from science when it comes to dealing with crises as individuals and as a society. Many people place great hopes in scientific expertise, while others are suspicious of it. Dialogue between scientists and the public is essential, especially in difficult times. The event concluded with the formulation of ideas and wishes for KIT's research and for science in general.

RESOURCE-SAVING AND CARBON-NEUTRAL

New Electrolysis Processes for Sustainable Chemical Production

Basic chemicals, which are needed as raw materials for a wide range of products such as medicines and detergents, can currently be produced only with enormous inputs of energy and raw materials. In many cases, this still includes fossil fuels. The extraction of chemical substances alone requires high temperatures, expensive catalysts made of precious metals and, in some cases, environmentally harmful feedstocks.

With special electrolysis processes for the production of fine chemicals, the ETOS (Electrification of Technical Organic Syntheses) future cluster jointly led by KIT aims to make significant contributions to the decarbonization of the chemical industry. Researchers are developing more sustainable processes that will cut resource consumption in the chemical industry and reduce carbon dioxide emissions.

Electrolysis processes are to be adapted for industrial-scale use in a way that reduces the consumption of energy and raw materials. The focus is on the production of fine chemicals, which are the basic materials used to produce many products. Until now, fine chemicals could only be produced with starting materials that are environmentally harmful in some cases (e.g. oxidants containing heavy metals), at high temperatures, and with expensive catalysts made of precious metals such as palladium or platinum.

The research employs organic electrosynthesis, which has rarely been used in industry. This method uses electric current to convert organic compounds into the desired chemical products. The objective is to apply the technique to the development of customized, ecologically beneficial, and economically attractive methods for specific production processes. If they use electricity from renewable sources, the new methods will be an important step toward carbon-neutral chemical production.

In the ETOS project, KIT researchers are involved in the experimental and model-based analysis and optimization of electrodes and cells and the additive manufacturing of structured reactors. They are working on process design, on scaling up the processes, and on assessing large-scale plant operation. Experts in AI-assisted molecular screening are also taking part in the project.

ETOS will be the first major technology platform to drive the transfer of electroorganic synthesis from the laboratory to industrial scale and, on this basis, to develop approaches and key technologies for sustainable, robust, and future-proof processes and products.

The ETOS future cluster of Johannes Gutenberg University in Mainz and KIT is one of seven winners in the "Clusters4Future" competition of Germany's Federal Ministry of Education and Research. Also involved in ETOS are the Technical University of Kaiserslautern, the Technical University of Darmstadt, the Fraunhofer Institute for Microengineering and Microsystems, and 15 industrial partners including BASF, Boehringer Ingelheim, Merck, Bayer, and Evonik. For the first funding period from 2023 to 2025, ETOS will receive approximately EUR 15 million; another EUR 5 million will be provided by industrial partners.

Carbon-neutral chemical production: Researchers in the ETOS project aim to achieve this goal with electricity from renewable energy.

RAISING AWARENESS AND PROVIDING MOTIVATION AND SUPPORT

HAFIS, the Helmholtz Academy for Intrapreneurship

Problems translating scientific excellence into products and services are often related to a deficient understanding of markets due to inadequate customer orientation, risk aversion and fear of failure in territory with which researchers are unfamiliar.

In the Helmholtz transfer campaign, the Helmholtz Association provides funding for joint projects to implement research results with high practical relevance, to establish and expand assistance programs for founders, and to provide entrepreneurship education at the Helmholtz centers. Solutions to problems will start with the researchers themselves, through raising their awareness and providing motivation and support in the Helmholtz Transfer Academies.

Specific training modules will teach the scientists systematic innovation management and promote the acquisition of innovation and entrepreneurship skills. Above all, the program will facilitate discussions among founders about best practices and provide digital tools, training, and events for researchers interested in founding a company.

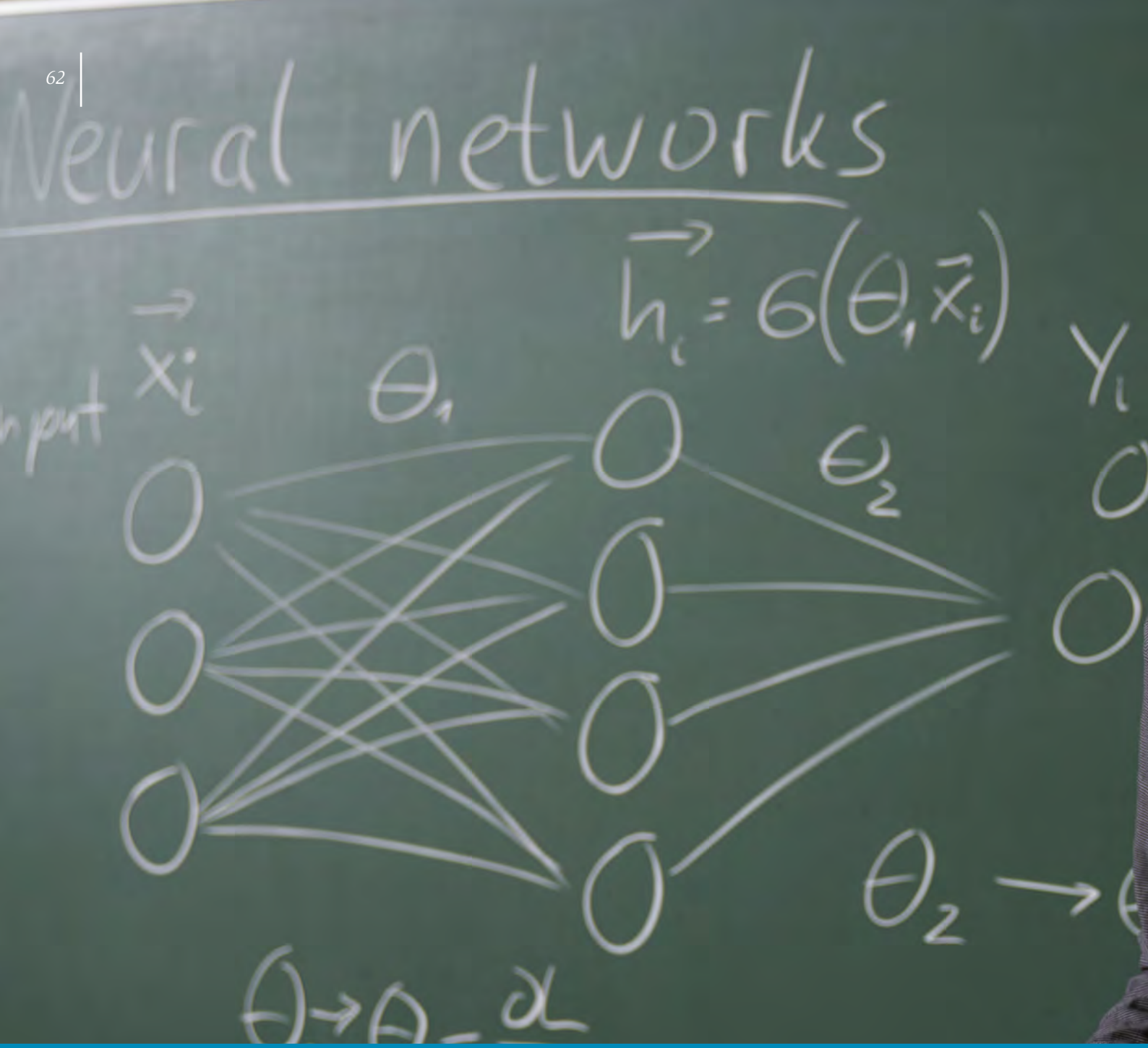
The aim of the Helmholtz Academy for Intrapreneurship (HAFIS), in which KIT, Forschungszentrum Jülich, GSI Helmholtzzentrum für Schwerionenforschung, and Helmholtz-Zentrum Dresden-Rossendorf are participating, is to strengthen entrepreneurial thinking and action among researchers and thus enhance transfer activities within the Helmholtz Association. HAFIS focuses on project-based learning and practical implementation. For the researchers, this means self-motivated learning during their own projects.

The Academy builds on the participants' existing research results, skills and interests, and it supports them in identifying and implementing suitable project ideas. HAFIS maintains a broad spectrum of transfer formats; projects can range from knowledge and technology transfer to startups.

The HAFIS course lasts nine months and is offered simultaneously at the participating centers. Cross-center milestone events provide venues for dialogue and networking. Local coaches accompany the participants in identifying and implementing their transfer projects. They also teach methodological skills when needed in a project.

The aim of the new Helmholtz Academy for Intrapreneurship (HAFIS) is to strengthen entrepreneurial thinking and action among researchers and enhance knowledge transfer.

External experts contribute their expertise on methods and industries, ensuring a better understanding of the target groups and markets. The schedule is continually adjusted to ensure that the program adapts to the needs of the participants, with empowerment and project results going hand in hand.



PROMOTING YOUNG TALENT

Attracting excellent young scientists and providing them with postdoctoral support are of great strategic importance to KIT. KIT devotes special attention to its young scientists, supporting them extensively, consistently and with high priority to further increase its appeal to the best young researchers from Germany and abroad.

Tenure-track professorships ease the path to professorship with greater transparency and easier planning by allowing a direct transition to a tenured professorship after a successful trial period. Of the 31 junior professorships at KIT, 22 include a tenure track. Of the latter, six are held by women.

115

Eight tenure track professorships were filled in 2022 alone. In 2019, there were only five tenure-track professorships at KIT.

As part of the University of Excellence program, the Young Investigator Group Preparation Program (YIG Prep Pro) was launched at KIT. Its purpose is to recruit high-caliber postdocs, preferably with an international background, who are interested in establishing themselves at KIT and attracting talent to set up junior research groups. After a two-stage selection process, postdocs are inducted into the program in a new position at KIT or can stay at their current institution. They receive support in the application process for a junior research group.

There have been 275 applicants from 55 countries since the program's inception in 2019, and KIT has gained a total of 53 fellows. Ten new fellows were recruited during the fourth selection round in 2022. The selection rate in the highly competitive process is 19 percent, and 27 women (51 percent) were inducted into the program. Its share of foreign researchers is 62 percent.

116


117


122


123


124


115


118


119


120


121


125


126


127

OUTSTANDING QUALIFICATIONS

13 New Junior Research Groups at KIT

The objective of KIT's excellence and third-party funding strategy is to attract outstanding young scientists and to help promising young researchers get established through premium junior research group funding raised in competitive processes. Through these funding programs, 13 new junior research groups were established at KIT in 2022.

Emmy Noether Junior Research Groups

Emmy Noether junior research groups, a funding instrument of the German Research Foundation, support young, highly qualified scientists and untenured junior professors in an early phase of their scientific careers.

In her Emmy Noether project, "Numerical methods for non-linear, random, and dynamic multiscale problems," Junior Professor Barbara Verfürth from the Institute for Applied and Numerical Mathematics investigates the numerical analysis of computational methods for partial differential equations.

With her Emmy Noether junior research group "Directionality in quantum systems," Professor Anja Metelmann from the Institute for Theoretical Condensed Matter Physics is investigating the interactions between two quantum systems, new concepts for special systems, and potential applications such as quantum-limited amplifiers.

With his Emmy Noether Group, "Directional Architecture in Tensegrity Systems: Towards 'Bone & Muscle' Metamaterials," Dr. Jens Bauer from the Institute of Nanotechnology is working to coalesce tensegrity principles and directional material, structure, and function designs into an architectural concept for a novel class of multifunctional tensegrity metamaterials.

Felix Kahlhöfer, Junior Professor at the Institute for Theoretical Particle Physics, is working with his Emmy Noether group "Methods and tools for the analysis and interpretation of experiments and cosmological observations to detect dark matter" to survey the tools available for analyzing and interpreting dark matter signals and how to apply them.

In the Emmy Noether project "Multi-model nowcasting and short-term forecasting of the spread of infectious diseases," Dr. Johannes Bracher from the Institute of Economics is developing new methods to enable modeling of complex dependency structures and accounting for reporting delays.

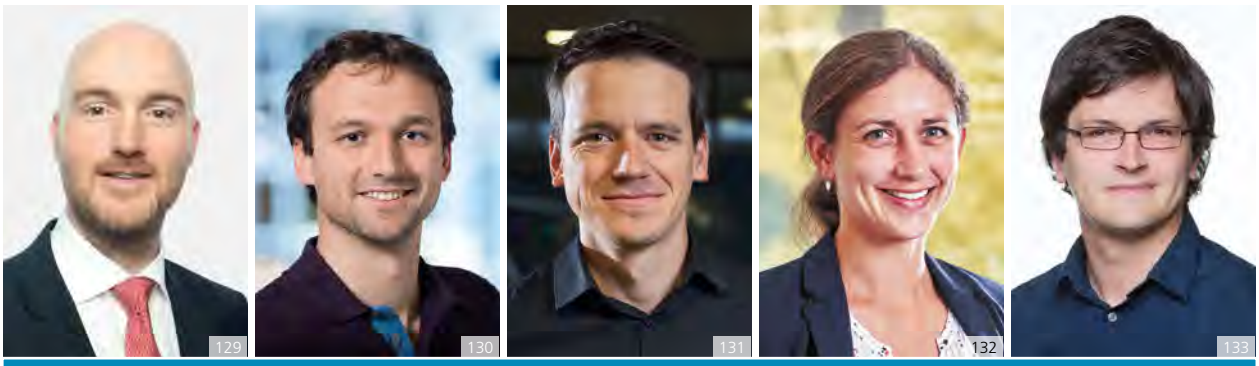
ERC Starting Grant

Starting Grants from the European Research Council (ERC) support outstanding young scientists at the start of independent careers. ERC Starting Grants provide up to EUR 1.5 million over a period of five years.

In his research project "SOLG (Stochastic Overlapping Generations Models) for Policy," Professor Johannes Brumm from the Institute of Economics is investigating how long-term fiscal policy measures distribute resources and risks between generations.

Matti Schneider, a junior professor of computational micromechanics at the Institute of Engineering Mechanics, simulates the properties of industrially relevant materials in his

Junior research group leaders can apply with the Council for Research and Promotion of Young Scientists for designation of their groups as KIT junior research groups.



Five young researchers at KIT won ERC Starting Grants in 2022: Dominic Bresser, Johannes Brumm, Julian Quinting, Katharina Scherf and Matti Schneider (from the left).

ERC-funded project, "BeyondRVE." His new method offers the promise of technological advances in precise and efficient material simulations for microstructures.

With his electrochemical energy storage materials research group, Dr. Dominic Bresser from Helmholtz Institute Ulm is working on the RACER (highly Redox-active Atomic Centers in Electrode materials for Rechargeable batteries) project to develop materials and technologies for electrochemical energy storage devices.

In her research project "GLUTENOMICS – tracking gluten immunoreactive peptides from the grain to the gut and beyond," Katharina Scherf, a tenure-track professor at the Institute for Applied Biosciences, is analyzing the molecular gluten components that occur in the human body following the consumption of grain products.

In his research project "ASPIRE – Advancing Subseasonal Predictions at Reduced computational Effort," Dr. Julian Quinting from the Institute of Meteorology and Climate Research – Department Troposphere Research is working to improve weather forecasts while reducing computational effort and thus costs and energy consumption.

Helmholtz Junior Research Groups

Dr. Benjamin Schäfer from the Institute for Automation and Applied Informatics began work on "Data-driven analysis of complex systems" (DRACOS) with his Helmholtz junior research group in 2022. Their work combines exploratory data analysis, physical modeling and machine learning methods.

BMBF Junior Research Groups

Dr. Florian Strauß from the Institute of Nanotechnology heads the BMBF junior research group "Tailored Electrolytes for Lithium Solid-State Batteries" (MELLi) and develops solid electrolytes with the desired properties for use in high-performance solid-state batteries.

VolkswagenStiftung

VolkswagenStiftung promotes science and technology in research and higher education. It facilitates research projects in pioneering fields and helps scientific institutions improve the structural frameworks for their work.

Dr. Susanne Benz began her work on "Large-scale assessment of the effects of sustainable heat recycling in the shallow sub-surface on above-ground temperature" as a Freigeist Fellow at the Institute of Photogrammetry and Remote Sensing in 2022. She combines (big) data science with geodata to investigate the impact of urbanization and climate change on society and the environment.

DOCTORAL WORK AT KIT

EU and Baden-Württemberg Provide Funding for Doctoral Students


134

The European Union and Baden-Württemberg fund the education of doctoral students with a variety of programs.

KIT provides extensive support for the doctoral studies of its young scientists and participates in German and international training programs in support of this objective. In 2022 the State of Baden-Württemberg funded cooperative PhD research groups, and four doctoral networks were launched with funds from the European Union.

Baden-Württemberg's Ministry of Science, Research, and the Arts funds cooperative PhD research groups in which universities and universities of applied sciences participate. This new program will enable 10 to 15 doctoral candidates to work together in a cross-institutional environment and gain scientific qualifications.

In cooperation with the University of Karlsruhe, the KATE support program for accessibility through AI-based assistive technologies started at KIT. The program aims to improve autonomy and participation for people with special needs by using assistance systems based on artificial intelligence.

In cooperation with Pforzheim University, KIT secured funding for the "KLIREC" (Climate, Resources, and Circular Economy – Interrelations, Synergies, and Tradeoffs) doctoral program, which focuses on the challenges of climate protection and the responsible use of natural resources at the interface between scientific-technological and socioeconomic perspectives.

The Marie Skłodowska-Curie Actions are a European Union reference program for doctoral education and postdoctoral training. International research consortia of at least three European institutions can apply.

In the "CO2Valorize: Valorization of CO_2 for Low Carbon Cement" program, researchers investigate how the emissions of cement production, which causes 8 percent of worldwide CO_2 emissions, can be drastically reduced.

"CLOUD DOC: CLOUD Doctoral Network" is a program in which twelve European institutions are involved in investigations of the role played by the formation of aerosol nuclei in atmospheric aerosols, clouds and the climate.

"RAICAM: Robotics and Artificial Intelligence for Critical Asset Monitoring" is a project whose objective is the development of technologies to improve the usefulness of mobile robots for inspection and maintenance.

"HIPO: Integrated High-Speed Power Systems for Industry and Mobile Applications" is a joint project with industrial partners to investigate the use of electric drive systems in the transition to low-emission production.

OPERATIONAL FRAMEWORK AND ORIENTATION

Guidelines for Doctoral Programs at KIT

The theme "good science, good leadership, good work" – along with good research practices – is taken very seriously at KIT, where there is a long tradition of systematic quality assurance in doctoral programs. The Guidelines for the Doctorate at KIT provide an overview of the various normative operational frameworks relevant to doctoral programs, and orientation for doctoral researchers and their supervisors.

The guidelines were drawn up in a process involving the participation of all relevant stakeholder groups at KIT, the KHYS (Karlsruhe House of Young Scientists) steering committee, the boards of the conventions of doctoral researchers, the deans' circle, the ombudsperson for safeguarding good research practice, the Higher Education Law and Academic Affairs Business Unit, the Staff Council, the Executive Board, and the KIT Senate; they were adopted by the Executive Board on October 24, 2022.

In particular, the guidelines take into account the German Research Foundation's Code of Conduct implemented in the KIT Statutes for Safeguarding Good Research Practice, the Doctoral Guidelines of the Helmholtz Association, and the KIT 2025 Strategy. The Guidelines for the Doctorate at KIT apply to all KIT doctoral researchers, irrespective of their discipline, funding, and research location. They reflect the responsibility KIT assumes for its doctoral researchers.

The Guidelines for the Doctorate at KIT aim to provide transparency and orientation, bring about a shared understanding of definitions and responsibilities, and describe the essential stages in the doctoral process and the relevant regulatory frameworks. Further aims include raising awareness of the mutual responsibility of doctoral researchers and supervisors, describing the basic elements for successful outcomes in the doctoral phase, and avoiding conflicts.

KIT provides comprehensive, consistent and high-priority support for the doctoral work of its young researchers, who collectively make important contributions to research, teaching and innovation. Earning a doctorate is the first phase of an independent scientific career and involves accomplishing an independent and substantive scientific achievement.

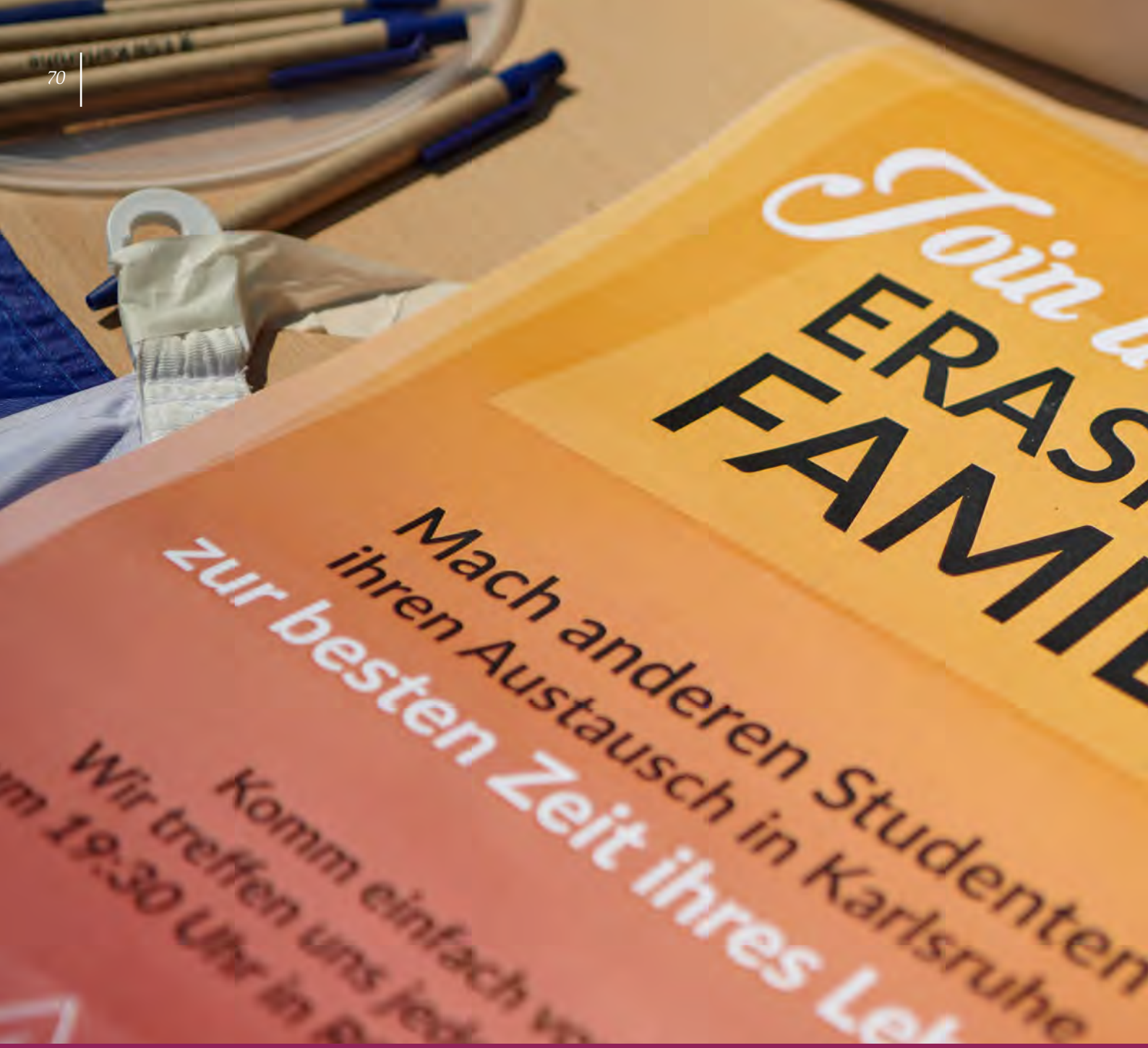
135

The Guidelines for the Doctorate at KIT formulate the fundamental elements for successful outcomes in the doctoral phase.

The doctoral phase is a training phase at a high scientific level, offering many opportunities for personal and professional development. Along with the central organization for promoting young researchers, KHYS, KIT departments, institutes and doctoral programs provide these diverse offerings with outstanding research and partnership opportunities.

For example, KHYS offers an extended training program, "Fit for your next career step," which is tailored to the specific needs of the doctoral phase.

As part of KIT's excellence strategy, doctoral programs are an important element of providing optimum conditions for doctoral researchers. They provide a chance to earn a doctorate in an interdisciplinary research environment with a structured training and supervision strategy.



INTERNATIONAL AFFAIRS

KIT views active networking – in Europe and worldwide – as a strategic mission for achieving its goals in research, teaching, and knowledge transfer. In Europe, its geographical location on the Upper Rhine affords a unique opportunity for promoting cross-border dialogue and exchanges with partners in France and Switzerland.

The university associations Eucor and EPICUR enjoy high visibility within Europe and offer diverse opportunities for collaboration. Such collaboration can be seen in joint research projects, study programs, transfer activities, and bridge professorships.

136

Eucor – The European Campus is a three-nation association of five universities in the Upper Rhine Region. Its members are the universities of Basel, Freiburg, Haute-Alsace, Strasbourg, and KIT. The universities pool the expertise of 15,000 researchers, 13,500 doctoral students, and 117,000 students. Eucor established four new binational professorships in 2022. The first was a quantum computing professorship shared by KIT and the University of Strasbourg. The cross-border character of this professorship is the first of its kind in Europe.

Over 30 years of successful cooperation among the Eucor partners played an important role in the founding of the EPICUR initiative in 2019, which aims to establish new teaching and learning formats for students with five more partner universities.

EPICUR has set a goal of increasing student mobility to 50 percent by 2026. This will require creative and innovative solutions, for example in terms of uniform standards for microcredentials and general crediting of previous work.

Eucor and EPICUR also play an important role in KIT's ability to perform its strategic missions and shape the European scientific and educational landscape.


137


138


139


142

143


147


148

149


140


141

144


145

146


150


151

KTUR: KNOWLEDGE TRANSFER UPPER RHINE

Tri-national Pilot Project Improves Cooperation in the Upper Rhine Region

New arrangements for cooperation, cross-border founding programs, and a long-term knowledge transfer network in the three-country region where Germany, France, and Switzerland come together: That summarizes the successful Knowledge Transfer Upper Rhine project (KTUR). Twelve university partners set the project in motion under the leadership of KIT, with many regional companies and trade associations as partners.

153

The project partners presented their results at an event in the Tulla auditorium in September 2022. Professor Thomas Hirth, Vice President Transfer and International Affairs at KIT, greeted the guests.

Working with its German, French and Swiss partners, KIT has been advancing the transfer of public research to companies in the Upper Rhine region since the fall of 2019. The KTUR project's objective is to promote cross-border research and development collaboration between academia and industry by sharing knowledge and skills. The project team established novel forums for participants to communicate and get acquainted, and new arrangements for collaboration. In the new network, participants from academia and industry can confront the challenges facing society, such as the energy transition and climate change, and initiate relevant innovation projects.

In addition, the participating universities developed joint tri-national programs for startups, and training and innovation events. They also created an online platform, KTUR Innovation X, which gives companies quick and easy access to technologies from the entire region and provides a central point of contact for various research, start-up and knowledge transfer activities. The intensified dialogue has helped to establish an international, multi-university network that involves all relevant transfer actors: Researchers, scientists, intermediaries (e.g. chambers of industry and commerce), startups, and established companies. The project partners presented their results in September 2022.

"For future-proof innovations, we need to collaborate and exchange knowledge internationally, and organize knowledge and technology transfer in the Upper Rhine region tri-nationally, to create entirely new synergies," said Professor Thomas Hirth, Vice President Transfer and International Affairs at KIT.

Knowledge Transfer Upper Rhine (KTUR) is a tri-national project for improving knowledge and technology transfer; it includes partners from Switzerland, France, and Germany.

152

EUROPEAN UNIVERSITIES

EPICUR Receives Follow-on Financing

The aim of the European university alliance EPICUR (European Partnership for an Innovative Campus Unifying Regions) is to create an attractive and innovative European university for a new generation of students in Europe. At KIT, EPICUR has thus far included three projects: EPICUR Education, EPICUR Research, and EPIDI (European Partnership for Innovation in Distant Internships). It has a special focus on interaction with the public.

154

The European university alliance EPICUR brings together nine partners from seven countries.

In mid-2022, EPICUR was successful in the new European Commission call for proposals for the European Universities initiative in the Erasmus+ program to provide follow-on financing for EPICUR Education; the alliance's total budget for EPICUR Education through October 2026 is EUR 14.4 million, with EUR 2 million allocated to KIT. The university network plans to develop innovative teaching and learning opportunities with transdisciplinary programs, address global problems, drive the digital transformation (particularly in teaching), and establish a multi-university EPICUR campus with attractive options for physical and virtual mobility.

In the EPICUR alliance, KIT will bring its expertise in other networks to the table and act to strengthen the regional networks. In addition, KIT and the other partners will work to strengthen the regions from within, including innovative teaching and learning formats in which business and civil society actors are involved. Another focus of KIT's activities in EPICUR will be promoting entrepreneurial thinking among students.

EPICUR aims to empower and assist a new generation of European citizens in taking constructive and sustainable approaches to the problems facing society. "With Eucor as an associated partner, both alliances can now work side by side on the implementation of the knowledge quadrangle of research, teaching, innovation, and transfer into society and exploit synergies," said Professor Thomas Hirth, Vice President Transfer and International Affairs at KIT. Michael Zacherle, EPICUR Project Coordinator at KIT, added: "With the second funding phase, we are changing from the exemplary pilot project to consistent anchoring of our offers at the nine member universities."

The nine university partners in the EPICUR alliance are Adam Mickiewicz University (Poznań, Poland), the University of Amsterdam (Netherlands), Aristotle University of Thessaloniki (Greece), the University of Freiburg (Germany), the University of Haute-Alsace (France), Karlsruhe Institute of Technology, KIT (Germany), the University of Natural Resources and Life Sciences (Vienna, Austria), the University of Southern Denmark (Odense, Denmark), and the University of Strasbourg (France).

GERMAN-FRENCH RESEARCH AND INNOVATION AGENDA

Strategic Partnership with Communauté Grenoble Alpes

155

The Université Grenoble Alpes and KIT are intensifying their cooperation with a strategic partnership.

In a joint German-French research and innovation agenda, France and Germany have committed themselves to expanding and intensifying their cooperation in energy and artificial intelligence.

In this context, KIT as a prominent actor in the Research Field Energy at the Helmholtz Association, the Université Grenoble Alpes (UGA), and CEA Liten in Grenoble are in the process of exploring the potential for a strategic cooperation.

The new forward-looking subjects build on many years of collaboration in quantum technology between Grenoble and Karlsruhe. KIT has also been working for many years with the UGA on four double-degree programs in physics, electrical engineering and information technology, business engineering, and informatics.

A delegation of scientists and leading executives from Grenoble visited KIT in June 2022 to learn about KIT's main research interests in energy and artificial intelligence. Promising prospects for joint research and innovation activities were identified in energy system design, hydrogen, fuel cells, batteries and artificial intelligence where, in addition to KIT and the UGA, the CEA can also make important contributions.

The CEA has been an important research partner for KIT for many years. UGA and CEA Liten are partners in the Communauté Grenoble Alpes. Together with seven other French universities, the Université Grenoble Alpes won recognition in the Excellence Initiative in 2021.

KIT researchers headed by Professor Thomas Hirth, Vice President Transfer and International Affairs, paid a return visit in January 2023 to bring the research subjects into sharper focus and discuss further steps to flesh out the plans for cooperation.

156

A delegation from the Université Grenoble Alpes visited KIT in June 2022.

WAR IN UKRAINE

Welcoming Refugees at KIT

Various crises and wars kept the world on edge again in 2022. While the focus at the beginning of the year was still on Afghanistan after the Taliban takeover, the war in Ukraine quickly became the center of attention. Researchers and students from Ukraine are also among the refugees who receive advice and assistance from the International Affairs Business Unit (INTL) at KIT.

INTL quickly created a central information portal to provide fast and easy access to relevant information for the refugees. In addition to hundreds of inquiries from refugees interested in becoming students, there were also inquiries from Ukrainian researchers or from hosts at KIT who were looking for financial assistance. Six people were employed through different funding programs at KIT. With a view to endangered and displaced researchers, the Philipp Schwartz Initiative of the Alexander von Humboldt Foundation added a special call for applications from Ukraine at short notice; as a result, two researchers were able to come to KIT in 2022 and continue their scientific work.

For many prospective students forced to flee from Ukraine, language barriers and a lack of knowledge about the German educational and university system were the main barriers to taking up studies. Many students from third countries, who were forced by the war to give up their studies in Ukraine, contacted KIT. Beginning studies in Germany is relatively difficult for them; in most cases they are only granted temporary residence permits, making preparation for studies correspondingly complicated.

For refugee students, KIT offers language courses with support from DAAD and the Christian Bürkert Stiftung. It also maintains a fund to provide financial support in personal emergencies. The Coordination Office for Refugees at INTL provides various support services. With help from Ukrainian- and Arabic-speaking working students, it advises and informs people seeking help in their native language. The office also organizes online events to provide basic information about the Studienkolleg and beginning study, and an in-person event on the KIT campus in cooperation with the educational coordinator from the Karlsruhe Landratsamt (district administrative office). Connections with various organizations in Karlsruhe and its district ensure that the Coordination Office is well informed about the different programs for refugees and can also pass on information of its own to this target group.

157

KIT quickly set up an information portal to support refugees from Ukraine with relevant information.

KIT AS AN EMPLOYER

With 9,905 employees, KIT is one of the largest employers in the Karlsruhe technology region. Its workforce comprises 5,704 scientific and 4,201 administrative and technical staff. Women make up 39 percent of the workforce. There are 1,786 foreign citizens, mostly scientific staff, employed at KIT. KIT employs 402 professors and executive scientists, of whom 35 were new appointees in 2022.

Moreover, there are 368 young people receiving vocational training for over 25 professions at KIT; this includes people studying at Baden-Württemberg Cooperative State University, preparing for their future jobs in twelve study programs. Their three-

158

year study program combines scientific theory with on-the-job practice.

Increasingly, KIT encounters difficulties finding suitable skilled professionals and sparking their interest in the variety of jobs available at KIT. The search for qualified IT specialists is a particular challenge. In response, KIT positioned itself as an attractive employer in a 2022 marketing campaign specifically targeting IT professionals. Working with an agency, it placed online advertisements that led interested people via a link to a landing page created for the campaign. Along with testimonials from IT employees and a description of KIT's benefits, the landing page presented a selection of the IT jobs available at KIT.

During the campaign, the click counts revealed a high level of interest in KIT's advertisements and the landing page. In the future, other marketing campaigns will be developed for staff recruiting, in particular for professions with a shortage of skilled workers, to draw the attention of suitable candidates to KIT as an attractive employer.


159

160


163


164


165


168


169


170

161

162

166

167

171

IMPLEMENTATION KIT 2.0

Joint KIT Statutes

With the adoption of the second KIT Further Development Act on February 4, 2021, existing separations between the large-scale research sector and the university sector were abolished. The new law dissolved the two sectors and replaced them with large-scale research and university responsibilities. Now KIT's professors in particular, but also all researchers, can in principle take on both responsibilities, and KIT now has a uniform legal framework based on state law, and a single staff. Furthermore, the internal decision-making processes in the bodies and committees were harmonized.

With the adoption of the law, the implementation process for the new regulations began in April 2021 with the Implementation KIT 2.0 project, part of the KIT 2025 Strategy with eleven work packages. The project is scheduled to end in December 2023; by then the new capabilities will be brought to life at KIT by the launch and follow-up activities.

The second KIT Further Development Act has resulted in many organizational changes at KIT. The legislation also stipulated that these changes would have to be set out in greater detail in the Joint KIT Statutes, meaning a revision of the latter was required.

The Joint KIT Statutes are KIT's constitution. They regulate all aspects of its organization, such as who may participate in KIT Senate elections, the structure of the institutes, and the duties of the various officers. Another reason for the importance of the new Joint KIT Statutes is that they are the basis for new appointments to KIT's committees, which have also been changed.

The revised Joint KIT Statutes based on the second KIT Further Development Act and the fourth revision of the German framework legislation regulating universities (Hochschulrahmenänderungsgesetz) were unanimously approved by the KIT Senate on February 21, 2022.

The adoption of the Joint KIT Statutes by the KIT Senate and its approval by the funding agencies gave the go-ahead for elections in the second half of 2022, enabling the committees to be reconstituted on time by January 1, 2023. With the approval by Baden Württemberg's Ministry of Science, Research, and the Arts in consultation with the German Federal Ministry of Education and Research, the previous Joint KIT Statutes from 2013 have been superseded.

It was then possible in 2022 to organize elections to several KIT committees, including the KIT Senate, the KIT department councils, the division councils, and the program commissions. With the harmonization of the status groups, the barriers between the committees can now be further removed.

The newly elected and constituted committees began their work in January 2023.

The Joint KIT Statutes were revised as part of the Implementation KIT 2.0 project.

172

EQUAL OPPORTUNITY

Conclusion of Survey to Evaluate the Current Situation of Female Professors

From February 2021 to November 2022, the Survey to Evaluate the Current Situation of Female Professors was conducted as a strategic equal opportunity project on the initiative of the president of KIT. The survey's purpose was to collect and analyze information on the general conditions under which female professors work at KIT, with direct involvement of the affected professors. KIT commissioned the Center of Excellence Women and Science (CEWS) to perform the survey and received advice from an internal steering committee.

173

The Human Resources Development and Vocational Training Business Unit's equal opportunity and diversity management staff investigated the circumstances of women professors at KIT.

The survey had three parts: Internal KIT information on the professors recruited to W1 positions with tenure track or W3 positions between 2015 and 2020, an online survey of all KIT professors (response rate 50.4 percent), and in-depth interviews with several female professors.

The evaluation of the internal KIT data revealed no gender pay gap for the professors appointed between 2015 and 2020, neither in salary and benefits nor in access to resources. There were only minimal differences in treatment of the genders, in some categories to the benefit of women professors. For example, in the online survey and the interviews, there was praise for the good atmosphere in appointment negotiations, and responses indicated that women were considered as often as men for offices and functions (e.g. on committees). However, there were also some specific suggestions for improvement.

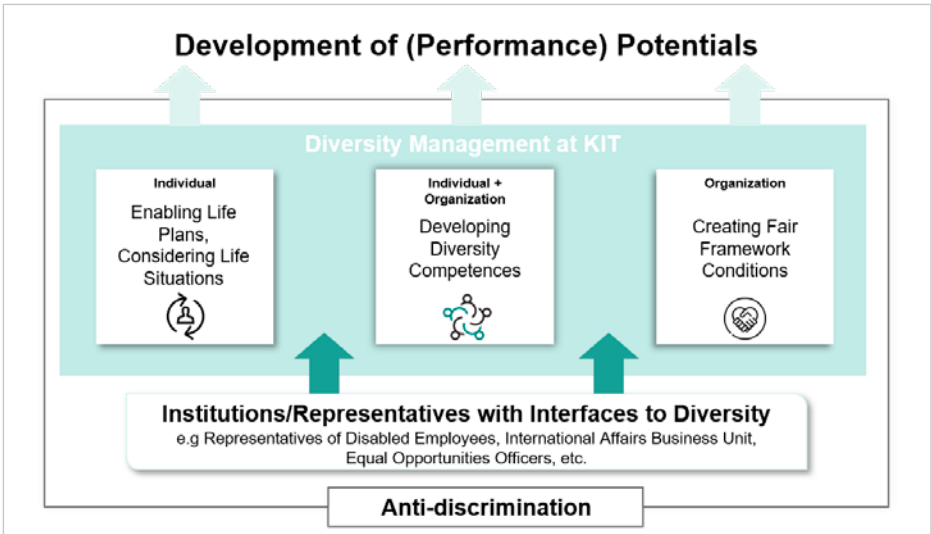
Based on these suggestions, CEWS made various recommendations in its final report; these were discussed with the steering committee. The recommendations concerned data collection and monitoring; salary and benefits; human, financial and material resources; management positions and committee activities; working and organizational conditions; and experiences or observations of discrimination. In the next step, the recommendations will be internally prioritized and formulated more specifically, and appropriate measures will be initiated.

After three years, and again after six years, the survey will be repeated to monitor the effectiveness of the measures taken.

STRENGTH IN DIVERSITY

Diversity Statement Adopted, Diversity Charter Signed

Many people, each with different backgrounds, attitudes and experiences, work at KIT. Appreciation for the diversity of its workforce is important to KIT's success. Strengthening diversity, especially by promoting equal opportunity for men and women, is an important cross-sectional task and a universal guiding principle in all action areas.



175

KIT's Diversity Statement emphasizes three key themes.

It is important to KIT to provide its staff with a supportive research environment and an appreciative workplace culture and to ensure that they have the opportunity to participate regardless of their gender, age or origin. The KIT Diversity Statement, which addresses all employees, was adopted in support of these goals in May 2022.

The Diversity Statement gives special priority to promoting equal opportunity for men and women, and to the International Affairs action area. It focuses on three main themes: Enabling different ways of life and respecting the situations in which people live, establishing equitable conditions, and developing diversity skills. Many measures already in place at KIT are related to these themes, including flexible working hours, systematic and transparent selection processes and the ongoing offer of workshops on unconscious bias.

In August 2022, KIT signed the Diversity Charter, a declaration of its commitment to recognize, promote and embrace the diversity of its employees and partners – and not least to publicly demonstrate the importance KIT attaches to this matter.

charta der **vielfalt**
For diversity in the world of work
SIGNED

Appreciation for the diversity of its workforce is important to KIT's success.

174

PROSPECTS FOR PERMANENT SCIENTIFIC STAFF

Career Planning System Implemented

A career planning system for permanently employed scientific staff has been developed at KIT to describe career paths other than professorships. Its aim is to identify attractive career development prospects at an early stage, promote systematic skills development, and visibly acknowledge scientists' outstanding performance both within and outside of KIT.

The system will be designed and implemented independently by each of the five KIT divisions. The European Commission's Framework for Research Careers was taken as a model for three career levels: Recognized scientists, established scientists and distinguished scientists.

The recognized scientists group includes all scientists who have successfully completed the tenure-track conversion process. They often assume long-term duties in research, teaching and innovation, have relatively long professional histories at KIT, and are important to KIT for their role in preserving and transferring knowledge. Approximately a quarter of the permanently employed scientists can reach the established scientist level if they satisfy a number of professional criteria, such as a visible and professionally responsible role in a long-term research project or a leading role in acquiring and managing projects. Active researchers with outstanding international reputations and particularly with charisma and external visibility are recognized as distinguished scientists.

177

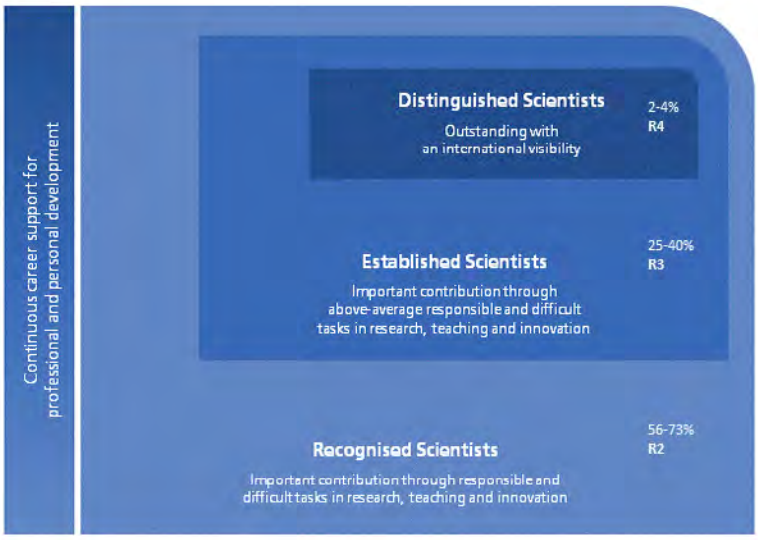
KIT offers career paths other than professorships for permanently employed scientific staff.

The incentives for the different career levels (e.g. access to networks and committees, equipment budgets or assignments abroad) are tailored to each individual and financed by the respective institute.

To ensure that the system is fairly and transparently implemented at KIT, a systematic selection process has been defined for the established and distinguished scientists. There are comprehensive supporting materials such as guidelines to help managers with the career development of their permanently employed scientists.

KIT used the European Commission's Framework for Research Careers as a model for three career levels for scientists.

176



LIFE AT KIT

In the series of events entitled “KIT im Rathaus” (KIT at City Hall), the KIT Centers take turns presenting their current research, giving the public an opportunity to get acquainted with current interdisciplinary research at KIT.

From biomedicine to climate research to economics, mathematics is needed everywhere and is of fundamental importance as the basis of natural science and modern technology. Scientists from MathSEE, the KIT Center for Mathematics in Sciences, Engineering, and Economics, presented their work and their current research projects on February 7, 2022. Due to the pandemic, the event could only be held

178

as a livestream on the YouTube channel of the ZAK | Centre for Cultural and General Studies, which coordinates the series.

Forward-looking themes such as digitalization, the energy transition and mobility are directly linked to technologies and innovations. The public has diverse expectations of scientists, and diverse views of the consequences of technological progress. The KIT Humans and Technology Center focuses on this interface between society and academia. It connects the work of KIT researchers who investigate the interactions between people and their high-tech world from social, ethical, cultural, economic, and legal perspectives. “KIT im Rathaus” gave interested members of the public an opportunity to get acquainted with this exciting field of research at a science slam on July 18, 2022.

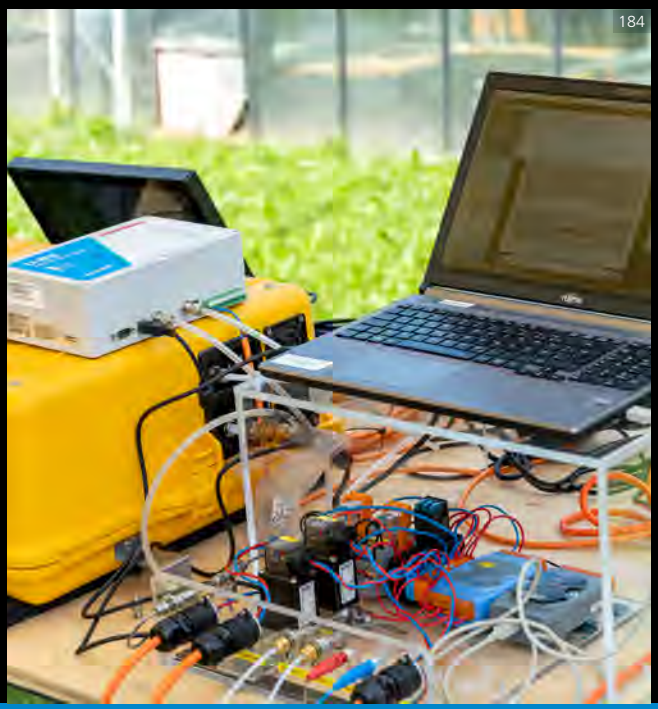
In addition, the MobiLab was open to visitors in front of the Karlsruhe City Hall. The MobiLab is a mobile participation lab in tiny-house format and serves as a platform for dialogue between scientists and the public.

179


180


185

183


184


186

189

190

181


182

188


187


193


191


192

BETWEEN HEAVEN AND EARTH

Open House at Campus Alpine – Climate Research in Garmisch-Partenkirchen

To understand the causes and effects of climate change, scientists at KIT's Campus Alpin are exploring changes in the atmosphere, the water balance, and living conditions for vegetation and humans. At the open house in Garmisch-Partenkirchen on July 16, 2022, they shared insights into their research with the public.

Many visitors busied themselves with questions such as "Can trees be bad for your health?", "How is wind measured with a laser?" or "Would you rather use land to grow food or to build a factory for solar panels?" The title of the event, Between Heaven and Earth – Climate Research in Garmisch-Partenkirchen, was symbolic of the facility's wide range of research topics.

The consequences of the climate crisis were at issue that day in a panel discussion entitled "Climate – Tourism – Farming." Climate change is being felt more strongly in the tourism areas of the Alpine foothills at the base of Germany's highest mountain, the Zugspitze, than in other parts of the country. For example, the winters are getting shorter and the snow line is rising ever higher. The impact of climate change on tourism and on forestry and agriculture is the most important challenge facing the region in the future.

Researchers from the Institute of Meteorology and Climate Research (IMK-IFU) at KIT's Campus Alpine in Garmisch-Partenkirchen have been investigating the key problems in environmental research for 68 years. They use measurements and modeling to analyze the biogeochemical and physical processes involved in the interactions of climate, vegetation, soils and water, for example in the emission or reduction of greenhouse gases.

They also investigate the effects of global climate change on water availability and vegetation in climate-sensitive regions such as mountains, agricultural areas, arid regions and cities. And they consider the interaction between humans and land use to find solutions for sustainable land use under future climatic conditions.

With laboratories in Garmisch-Partenkirchen and atop the Zugspitze, a scientific greenhouse, a computing cluster for climate modeling, and several stations in the TERENO national environmental research network, the IMK-IFU has an extensive research infrastructure. As a consortium partner in the Schneefernerhaus environmental research station on the Zugspitze, the institute plays a key role in the early detection of changes in the climate and atmospheric structure.

Many visitors took advantage of the opportunity to engage with issues of climate research during the open house at KIT's Campus Alpine.


194

SAFEGUARDING THE ENERGY SUPPLY

Cutting Energy Consumption at KIT

To ensure uninterrupted utility service during the energy crisis, the German government has adopted several regulations; public institutions such as KIT are obligated to comply with them. During a crisis summit about the gas supply on July 25, 2022, the state of Baden-Württemberg pledged in a five-point plan to make every effort to lower the heat and electricity consumption of its agencies and institutions. Accordingly, it called on the universities to do their part to achieve these goals. In response to these regulations, and due to the high energy prices, KIT has taken various actions.

A key measure concerned the buildings on KIT's four campuses in Karlsruhe at the turn of the year: From December 24, 2022, to January 7, 2023, the buildings' heating systems were set to operate at the lowest level at which there was no risk of freezing. Normal work in the buildings was no longer possible. Only essential staff were present, such as those responsible for safety and security. Employees who did not want to take vacation were able to work from home or, if that was not possible, in a few KIT buildings that were heated. The Studierendenwerk concurred with this measure and closed the Adenauerring canteen and cafeteria. In-person classes were not affected by the measure.

For the implementation of this centrally ordained Christmas break, KIT's Karlsruhe office and the Staff Council concluded a service agreement that set out the necessary formal requirements, e.g. expanded remote work.

KIT's central technical facilities took further actions to cut energy consumption.

- Outdoor lighting was reduced during the winter.
- Shared areas in non-residence buildings, e.g. corridors, lobbies and stairwells, were no longer heated.
- Work areas could only be heated to an air temperature of 19 degrees Celsius.
- Peripheral tankless water heaters had to be switched off unless there were urgent operational reasons (such as occupational safety) to the contrary.

To achieve KIT's reduction targets, Facility Management compiled information to help everybody contribute to reaching the targets, including tips on correct heating and ventilation and on reducing power consumption.

Conserving energy was on everybody's mind due to the energy crisis and high energy prices.

195

FROM JUNIOR PROFESSOR TO LEIBNIZ PRIZEWINNER

KIT Women Professors Forum, the New Network of Leading Women Scientists

Even women who are already successful in the highly competitive scientific community need visibility to fully realize their potential. The KIT Women Professors Forum (WPF) has stepped up to help women scientists do that. With the WPF, KIT is showing how to recruit and retain more excellent women researchers in the sciences and provide them with support even at the professorship level. Many support programs are only directed at women below that level.

More women professors are needed, especially in the STEM disciplines. With strong foundations in its two gender equity programs and other excellence initiatives, KIT is underscoring this strategic goal. KIT's 100 Professorships Program envisions a 40 percent share of women among new professorship appointments. But equally important is a culture of opportunity within KIT itself.

The KIT Women Professors Forum assumes an important role in this regard. As a place for self-understanding and dialogue, the forum will strengthen the community and increase the visibility of KIT's top female scientists, thus promoting their career success in research, teaching, and innovation.

It is not only women professors who will benefit from a cultural shift toward more equal opportunity, because equal opportunity also means a good working atmosphere, clearly defined processes and a respectful way of dealing with each other.

The KIT Women Professors Forum, which was established in 2021 but only made its first public appearance in 2022 after pandemic-related delays, sees itself as both a community and a strategic platform for KIT's 62 female professors.

Among the goals of the network, which was inspired by WPFs at ETH Zurich and MIT in Boston, are informal exchanges and mutual support, increased involvement of women professors in relevant committees and decision-making processes, having a say in the implementation of KIT's diversity strategy, and networking with similar initiatives in Germany and abroad. Forum members will be organizing a variety of regular and unscheduled activities such as lunchtime talks, discussion panels, and excursions.

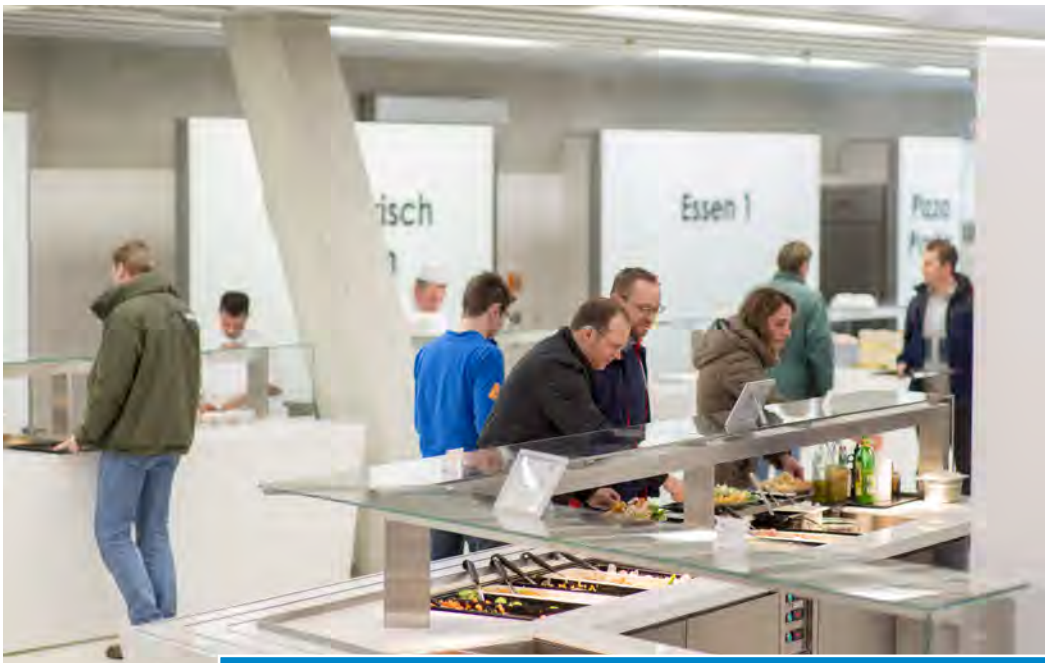
Kick-off event for the KIT Women Professors Forum, the new network of leading female scientists setting an example for equal opportunity at universities.

196

SUSTAINABLE PROCESS CHAIN

Healthy Food at Canteen and from Event Catering

When it comes to healthy eating and different dishes every day, the canteen on KIT's Campus North is the place to go. The team there is increasingly turning to sustainably produced local products. Its healthy menu has earned the canteen the Job&Fit certificate from the German Nutrition Society (DGE). Every day employees can choose a Job&Fit dish at Campus North; the dishes are usually vegetarian and low in sugar, salt and fat. All dishes and products are identified in the menu with an appropriate logo.



197 The canteen on Campus North offers a Job&Fit dish every day.

Each such selection corresponds to DGE's quality standards for food in canteens. Several quality categories are checked: Food for lunches and snacks (quality and frequency), meal planning and production, hygiene, legal framework, quality management system and atmosphere.

The event catering service also offers a completely vegetarian menu. It makes its deliveries with an electric vehicle that has a hygienic cargo space suitable for transporting food; it is designed according to the requirements and regulations of the German food hygiene ordinance.

Many other measures underscore the importance of sustainability along the process chains.

Single-use packaging consists of sugar cane fiber, a biomaterial not previously used. The packaging material is light but very sturdy. It is also water-resistant and can be used with hot or cold foods.

As an alternative to the sustainable single-use packaging, the canteen also supplies high-quality reusable dishes that employees can use to take their meals with them. Thus the first step toward sustainable packaging has been taken, with a further reduction in the amount of packaging waste.

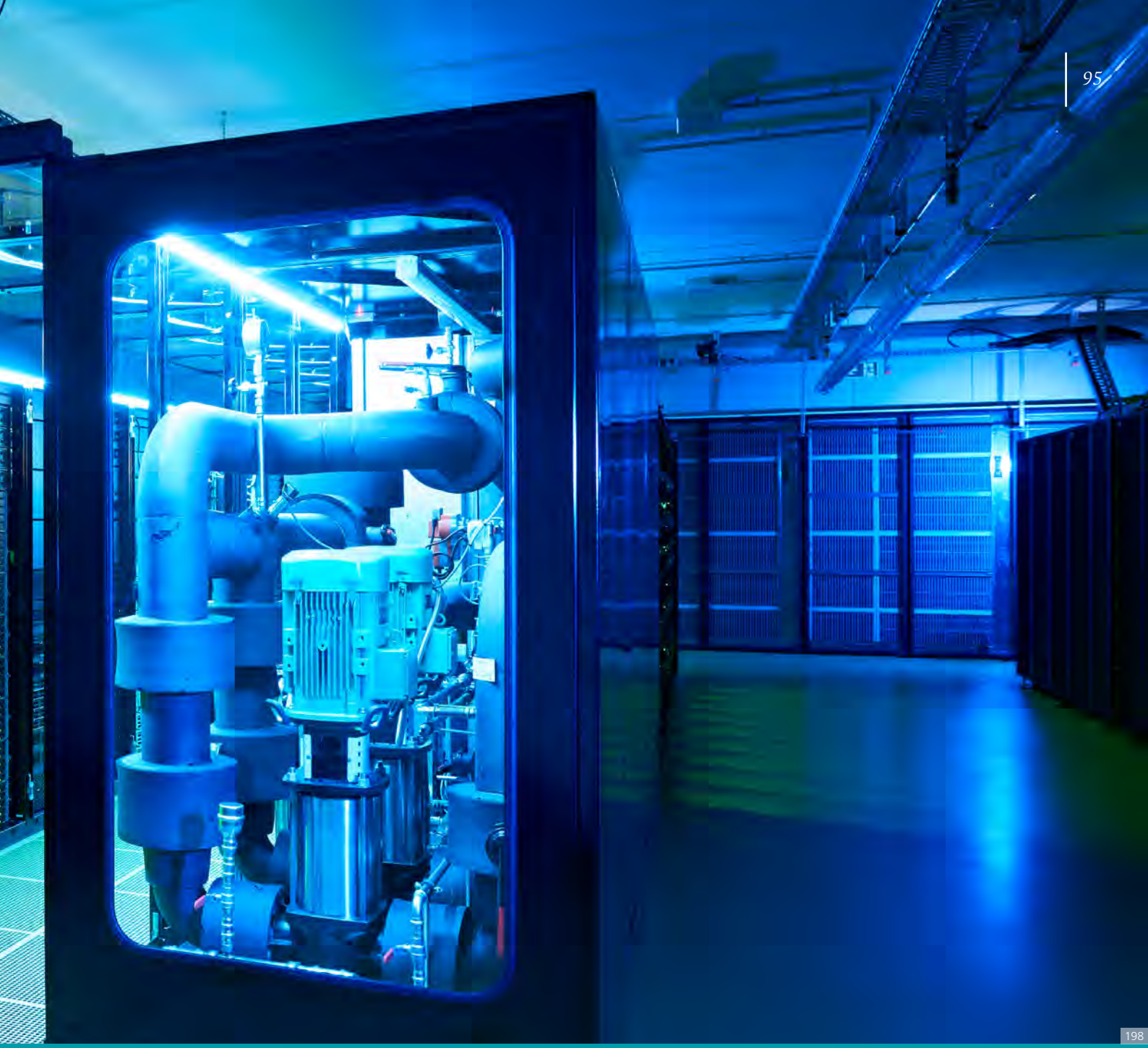
Furthermore, the canteen on Campus North switched its entire selection in the bistro and the guest canteen to organic coffee at the beginning of 2022. The coffee is hand-picked and certified organic by the Rainforest Alliance. It comes from Africa and Central and South America. The producer trains the coffee growers in agricultural techniques that they can use to counter the effects of climate change.

JOB&FIT
Mit Genuss zum Erfolg!

DIGITALIZATION

A strategy paper on digitalization as an action area was prepared in 2021. After discussion at meetings of the Executive Board and the KIT Senate, the Supervisory Board adopted it as the ninth chapter of the KIT Strategy on March 9, 2022.

Digitalization facilitates the work done at KIT and is a cornerstone of competitiveness. KIT is actively shaping the digital transformation, with all employees and students integrated in to the process. This new action area defines the strategic objectives and measures to be taken for digitalization at KIT.



198

KIT views digitalization as a tool that enables outstanding research achievements at the highest international level and a vibrant culture of innovation and transfer. Moreover, KIT is committed to operating and refining state-of-the-art infrastructure for digital data processing and distribution.

KIT exploits the opportunities afforded by digitalization to ensure excellent teaching and successful study outcomes. Students at KIT are empowered to research, work, communicate, and act in a world of globalized and networked media.

Increased digitalization is making the core tasks, procedures, and processes in KIT's administration more transparent and efficient. Designed to facilitate accessibility, inclusion and internationalization, the digital workspace at KIT enables flexible ways to work, with the concept of "new work" playing an increasingly important role.

Information security and data protection are crucial to successful digitalization; at KIT they are implemented in a holistic and coordinated manner.


199


203


204

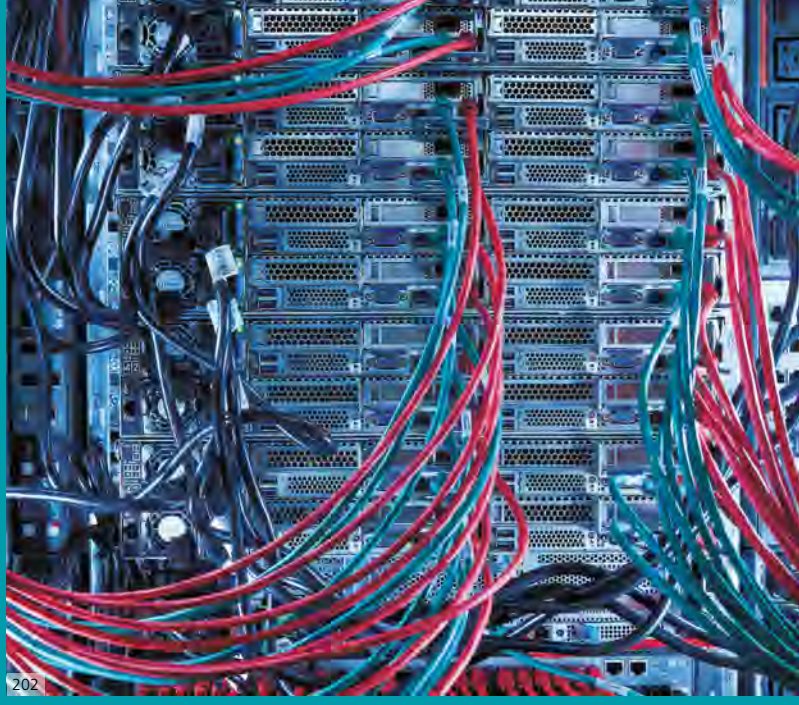

206


208


209


200


201


202

205

207


211


213


210


212

NEW WORK

New Approaches to the Future of Work at KIT

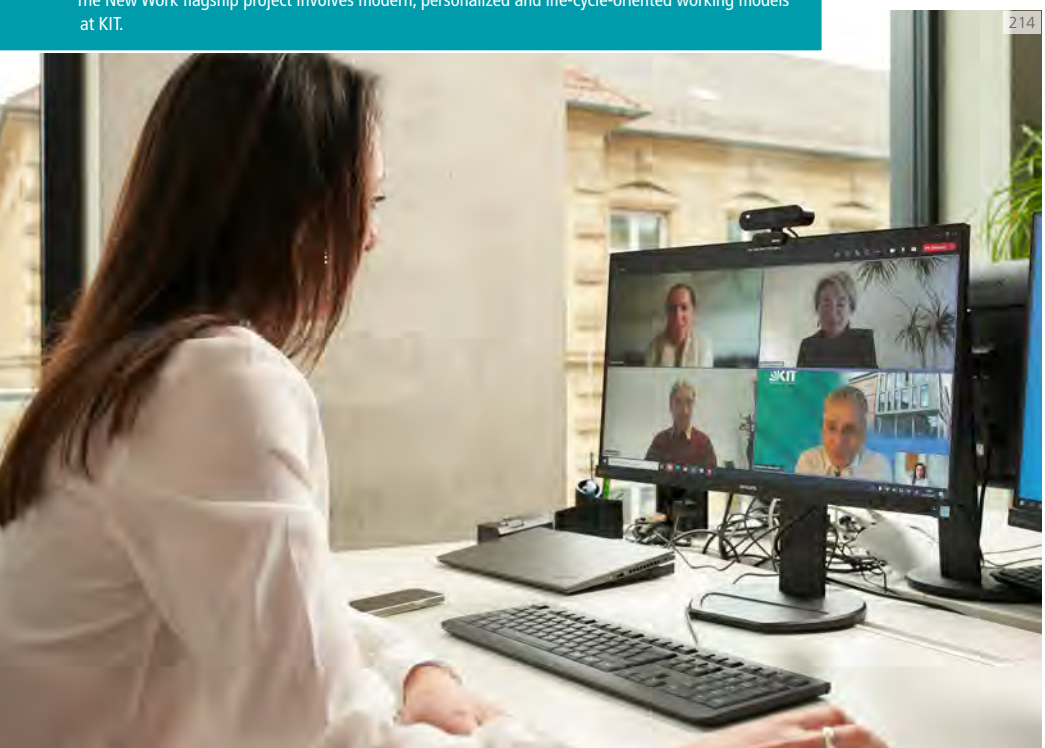
"We have launched the New Work project to shape the workplace of tomorrow, to make it more versatile and more responsive to our employees' needs and the realities of their lives. In the KIT 2025 Strategy, we are testing the potential of new approaches, considering the aspects of people, workplaces, technology and organization," said KIT President Professor Holger Hanselka in describing the framework of the New Work project.

The New Work project is about much more than organizing daily work with offices at home and mobility. It includes modern, personalized and life-cycle-oriented models for working hours and workplaces, and agile, project-oriented, digital and location-independent forms of work. It develops and refines new approaches to organizing work and promotes resource-conserving ways of using space.

New Work aims to provide for open discourse and ongoing dialogue throughout KIT, involving as many employees as possible, to closely follow the development of the new organization and document the needs of employees from all levels and status groups. In the first subproject in 2021, the project team analyzed the existing situation, which included conducting an employee survey in which some 3,500 people took part, and interviewed internal and external stakeholders. The second subproject involved the implementation of short-term measures and recommendations focusing on people, workplaces, technology and organization. Unexploited synergies of mobile work and space use at KIT were also addressed in the discussions.

The third subproject began with the selection and launch of five pilot projects covering different aspects of New Work. The Steinbuch Centre for Computing is testing a flexible office concept including flat hierarchies, agile process models and a new collaboration platform. IPEK, the Institute of Product Engineering, is working on a shared desk model with temporary workstations and acoustic optimization. International Affairs is developing a space use concept for a property undergoing renovation. The Institute of Applied Informatics and Formal Description Methods is testing a pool room concept for agile and digital work in a hybrid workplace, and the Institute for Automation and Applied Informatics is investigating the social aspects of agile and flexible work methods. The pilot projects started in March 2022 and will last 12 months.

The New Work flagship project involves modern, personalized and life-cycle-oriented working models at KIT.



DIGITALIZING SCIENCE

KIT in Eleven National Research Data Infrastructure Consortia

Research data play a key role in the sciences, and data volumes are increasing rapidly in all scientific fields. Existing data sets are seen as an important basis for new insights, but the scientific community often has difficulty getting access to them. Germany's national and state governments are setting up the National Research Data Infrastructure (NFDI) to address this problem. The purpose of the NFDI is to systematically tap into sources of scientific data and ensure their long-term security and availability.

215

KIT has been involved in 11 of the 28 NFDI-funded consortia, including NFDI4Energy since 2022.

Key elements of the NFDI are consortia in which users and providers of research data cooperate with information infrastructure institutions. A non-profit association based in Karlsruhe, NFDI e.V., was founded by the governments of Germany and its 16 states to coordinate these activities. The association and the NFDI consortia are working together to shape the future of research data management in Germany.

York Sure-Vetter, formerly a professor at KIT's Institute of Applied Informatics and Formal Description Methods, has been director of the NFDI since March 2020. The directorate also heads NFDI e.V.

Three new consortia with KIT participation began to receive state and federal funding in 2022: NFDI4Energy, NFDIxCS, and Base4NFDI.

The energy transition involves increasing digitalization of the energy sector; building and controlling the networked and climate-neutral energy systems of the future will require vast amounts of data. The consortium NFDI4Energy (National Research Data Infrastructure for the Interdisciplinary Energy System Research) aims to simplify exchanging and accessing such data, thus accelerating the research process.

The main goal of the NFDIxCS (National Research Data Infrastructure for and with Computer Science) consortium is to identify, define and deploy services for storing complex domain-specific data objects from diverse computer science sub-domains. This means standardized storage not only of the data and their associated metadata, but also of the corresponding software, context and execution information.

Through broad-based cooperation across scientific domains and infrastructure providers, Base4NFDI (Basic Services for NFDI) aims to identify and exploit synergies in the scientific data infrastructure. NFDI-wide basic services have the potential to serve most or all consortia. Base4NFDI will support services in the three phases of initialization, integration and ramping up for productive operation.

With a total of 28 funded consortia, the NFDI has been fully established since 2022; KIT is a partner in eleven of the consortia.

ONLINE AND HYBRID TEACHING

Supporting Modern Teaching Formats

Online and hybrid teaching formats have been increasingly in the spotlight in recent years. During the pandemic, students were directed to KIT's online offerings to make in-person attendance at on-campus courses unnecessary.

Even when on-campus teaching became possible again, many in-person events were also offered online. Instructors could then teach classes as planned, while students could take part without being physically present. Lecture halls became places of learning that included both in-person students and those participating online.

Now about a third of the lectures at KIT take place as hybrid events, complementing the portfolio of course offerings that includes in-person formats as well as electronic learning materials and purely online formats.

The implementation of digitalization in teaching can only succeed in the long term and throughout the university if it is perceived as a shared mission by all responsible actors, programs and people, and is coordinated accordingly.
In the planning, creation, and publication of e-learning offerings, instructors receive assistance from various KIT business units, including advice on performing, disseminating and archiving recorded lectures, live streams, video productions, and the like.

From a didactic perspective, the digitalization of teaching will involve a number of changes. Digital techniques and methods can enable other forms of collaboration, but they sometimes require changes in forms and channels of communication. Depending on the event type, content, group size, and learning objective, e-learning solutions can differ widely.

Both teachers and students at KIT have been mostly positive in their assessment of the online and hybrid offerings. For students, they offer more flexibility in organizing their studies. The possibilities for interactive participation via chats or quizzes and online teaching evaluations have been well received.

About a third of the lectures at KIT are offered as hybrid events.

216

INFORMATION SECURITY AND DATA PROTECTION

New Guideline for Appointing Contact Persons

KIT has a social and legal obligation to ensure data protection and information security; this is reflected in the General Data Protection Regulation (GDPR) and in Baden-Württemberg's administrative regulation on information security. Data protection and information security must be guaranteed in the planning and execution of KIT's core tasks in research, teaching and innovation.

217

Positions for data protection and information security contact persons were established for all organizational units at KIT, and their responsibilities were clearly defined in a new guideline.

On the basis of an Executive Board guideline approved in November 2019, positions for data protection and information security contact persons were established in 2020 for all organizational units. Many parts of this guideline were revised in 2022; the amended guideline, "Richtlinie zu Ansprechpersonen für Datenschutz und Informationssicherheit in den Organisationseinheiten des Karlsruher Instituts für Technologie" (guideline on contact persons for data protection and information security at Karlsruhe Institute of Technology), took effect following an Executive Board resolution in November 2022. By adopting the revised guideline, the Executive Board fulfilled its responsibility for data protection and information security.

The amended guideline improves the capability of data protection and information security measures, especially in KIT's five divisions. It also clarifies the task description of the contact persons for information security, making it easier to estimate the effort and expense of the associated tasks. Furthermore, the appointment mechanisms were changed so that they can accommodate different organizational structures, including those extending beyond organizational units.

Among the responsibilities of the data protection and information security contact persons are ongoing assessments of the conformity of data processing procedures with data protection and information security regulations, and advising management and employees in their spheres of responsibility. In particular cases, such as the assertion of data subject rights, data protection breaches, or application of data protection principles in processes or projects in which personal data or confidential information is processed, the contact persons coordinate the communication between the concerned entities.

The contact persons are not actually responsible for implementing data protection and information security measures. Instead, management retains responsibility for ensuring data protection and information security within the various spheres of responsibility.

SUSTAINABILITY

KIT is committed to setting an example by applying the principles of sustainability to its own actions and by contributing to sustainable development through its research, teaching and transfer activities, and in its operations. To define this commitment, the Sustainability action area was developed for the KIT 2025 Strategy. It names goals and measures through which KIT can make a meaningful contribution to the sustainable transformation of our society and of its own organization.

Digitalization and sustainability are inseparable at KIT. They are intertwined in many ways and affect its activities everywhere. It is at precisely this inter-

218

face that the KIT Executive Board established a new portfolio, Digitalization and Sustainability, to anchor responsibility for these issues at the highest management level. An important part of the transformation at KIT is the energy and climate protection strategy embedded in its overall strategy; it records the status quo and identifies higher-level measures.

To provide support for the diverse and far-reaching transformation processes needed to make our society future-proof and sustainable, the Karlsruhe Transformation Center for Sustainability and Cultural Change was officially inaugurated in February 2022 with funding from Baden-Württemberg's Ministry of Science, Research, and the Arts.

Furthermore, as a place of learning, KIT was recognized with the first Education for Sustainable Development Award by the Federal Ministry of Education and Research (BMBF) and the German Commission for UNESCO. While presenting the award, the BMBF's Undersecretary of State, Dr. Jens Brandenburg, highlighted KIT's awareness-raising and educational activities for young people as an important contribution to a more sustainable future.


219


225


223


224


226

228


229


230


220


221

222

227


231


233


232

SUSTAINABILITY IN RESEARCH

Responsibility, Transformation and Cultural Change

In performing its three core tasks (research, teaching, and innovation), KIT contributes to sustainable development. In doing so, it places particular emphasis on transfers to science, business, politics and civil society. KIT scientists from many disciplines gain important insights into pressing sustainability-related issues and support efforts to achieve global sustainability goals.

Helmholtz Energy

From basic research to applications, the Research Field Energy at the Helmholtz Association, operating since 2022 under the brand Helmholtz Energy, establishes the scientific basis for an economically and socially sound, climate-neutral energy supply. The researchers in its interdisciplinary programs develop forward-looking solutions for the energy transition in Germany and for the sustainable transformation of the energy supply worldwide.

The Helmholtz Energy Office at KIT (previously the coordination office for the Research Field Energy at the Helmholtz Association) supports Professor Holger Hanselka, President of KIT, with his duties as Vice President of the Research Field Energy and looks after the Helmholtz Energy platform, which provides support for cross-program and cross-center networking.
Russia's war of aggression against Ukraine has exposed Germany's dependence on imported fossil fuels like natural gas, oil and coal for its energy supply. The resulting geopolitical disruptions challenge our society to expedite its independence in terms of energy and raw material supplies while not losing sight of its climate neutrality goals.

Helmholtz Energy is embracing its social responsibility. With its partners in politics and business, Helmholtz Energy aims to systematically accelerate key research activities to ensure a safe energy supply through rapid transfers of key technologies and expertise. In direct response to the Russian war of aggression, Helmholtz Energy has developed four initiatives:

- Accelerated transfer of the next generation of solar cells to mass production
- Geotechnologies for a turning point in Germany's energy supply
- Helmholtz platform for designing robust energy systems and supplies of raw materials
- Conserving raw materials through flexible and lasting measures to close cycles

As a contribution to the turning point, the initiatives are being funded with EUR 25 million from the Joint Initiative for Research and Innovation and will accelerate the development of technologies to commercial viability within three to five years. KIT is involved in all four initiatives.

Helmholtz Energy establishes the scientific basis for an economically and socially sound, climate-neutral energy supply.

Sustainability and Cultural Change

Our society faces diverse and far-reaching transformation processes that will shift our economy and our way of life toward future-proof and sustainable models in all economic sectors and aspects of life. To support this transformation process, KIT founded the Karlsruhe Transformation Center for Sustainability and Cultural Change (KAT) in 2022.

235

KAT is part of KIT's Institute for Technology Assessment and Systems Analysis, which has a 25-year history of internationally recognized sustainability research.

KAT links science and practice in seven action areas: Research, education, advice, communication and networking, reflection and contemplation, experimental spaces, and innovation and action, building bridges between knowledge and action.

KAT is part of KIT's Institute for Technology Assessment and Systems Analysis, which has a 25-year history of internationally recognized sustainability research. It has gathered considerable experience with real-world laboratories and has received several awards for its District Future – Urban Lab, a real-world lab. KAT will be further expanded in the years ahead to become an effective engine of the sustainability transformation with visibility in Germany and abroad.

The recently launched research project "Universities in society – Real-world experiments of transformative learning and research for a culture of sustainability" (KuNaH) aims to establish and test an integrative research and development approach to a culture of sustainability at universities. The central question it will address is how a culture of sustainability at universities can be conceptualized and described as an integrative aspect of a sustainability transformation and how it can be investigated and stimulated through real-world university experiments.

KAT is involved in conducting stakeholder and environmental analyses and in implementing KIT's strategy. Its focus is on the cooperative conception and implementation of real-world experiments at KIT in the fields of "Guiding principles for sustainability at KIT" and "Sustainability in innovation management and knowledge transfer" with relevant stakeholders at KIT. KAT also plays a key role in accompanying the real-world experiments at the partner universities.

In recent years, a wide range of initiatives and approaches have been developed and tested at German universities to implement sustainable development as a guiding principle. Even though new knowledge, ideas, and methods for implementation at universities could be elaborated in this way, there is still a lack of integrative approaches that systematically bring together the various academic action areas as a whole-institution approach and promote a comprehensive culture of sustainability at universities. This is where KuNaH comes in.

SUSTAINABILITY IN TEACHING

NaProIng Project Introduces Sustainability Issues to Engineering Studies

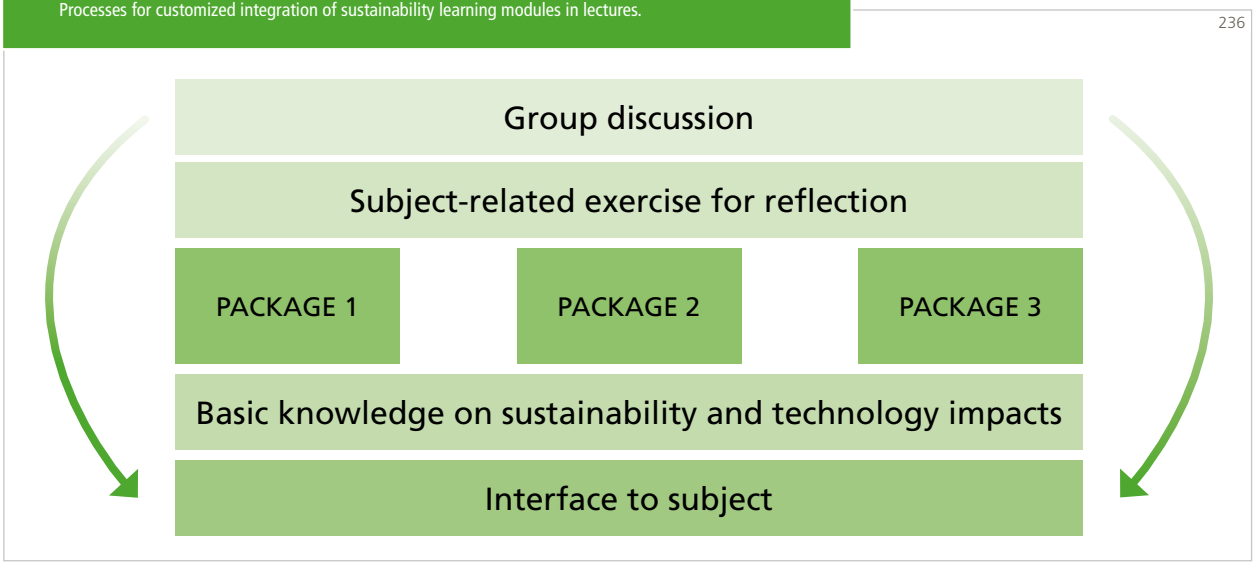
Sustainable products need engineers with a sustainability-oriented education. A constantly changing and highly diversified education provides students with a wealth of specialized knowledge and a variety of methods for developing and refining technological solutions. Because of diversification and technological complexity, their education focuses mainly on technical feasibility, developing and improving functionality, and robust products and innovations. Once they are employed in industry, the only additions to their toolboxes are usually methods, which tend to focus on balancing robustness and cost-effectiveness with regard to use and production. Key methodological skills for the development of sustainable products are generally not part of their education or their professional activity; at best they are acquired out of self-interest.

This is where the NaProIng project comes in. Its aim is to quickly develop and provide tools and key skills for educating engineers in the development of sustainable products. To shorten the long lead time for developing and introducing new study programs and credentials, this program has developed modules that can be integrated into existing study programs and lectures.

The modules spread the teaching of sustainability over three levels. First, sustainability is described as a normative guiding principle and integrative umbrella concept and is historically reviewed. Then the module on sustainability and business addresses the diverse challenges of sustainable business activity. Such challenges include strategic business management and overarching sustainability assessments and communication. The final module focuses on specific interface points for engineering students, using concrete examples to discuss approaches to sustainable materials, the circular economy, and principles of ecological product development. With this comprehensive overview of sustainability, students should later be able integrate it into their everyday work.

As a first step, compulsory lectures from the bachelor's program in mechanical engineering provide entry points for the sustainability learning modules. These learning modules were developed and in some cases tested in consultation with the instructors. In the following steps, these modules were condensed and encapsulated so they can also be used as scripts for MOOC video implementation.

Processes for customized integration of sustainability learning modules in lectures.



SUSTAINABILITY IN TRANSFER

Photovoltaics, Sustainability, and Digitalization

Novel Electronic Components

Solar Park 2.0, a joint project coordinated by KIT, was launched in July 2022. Its innovative circuits, novel power electronics, and AI-supported optimization are expected to increase the yield and service life of large solar parks and reduce their operating costs.

To maximize the efficiency of a photovoltaic module, it has to work close to its maximum power point (MPP), where its output is highest. However, the MPP changes with the temperature, the sun's position and other factors, so the voltage has to be adjusted continuously for optimum operation. For this purpose, the KIT-patented HiLEM (High Efficiency Low Effort MPPT) circuit is used in the Solar Park 2.0 project.

237

German Chancellor Olaf Scholz visited the KIT booth in the Future Hub at Hannover Messe 2022, where KIT presented the results of its research on sustainability and digitalization.

Printable Adhesive for Solar Modules

A conductive and printable adhesive will make it possible to use printing technology to produce solar modules. In a joint project, researchers at KIT and PROTAVIC INTERNATIONAL have developed such an adhesive and are bringing it to market. The special adhesive is expected to greatly simplify the production of photovoltaic modules while also reducing the amount of energy and materials consumed. This adhesive technology makes soldered connections a thing of the past.

The circuitry for the solar modules will be printed onto them at low temperatures. This will make it possible to mass-produce new cell technologies, such as perovskite tandem solar cells with higher efficiency. A complex mix of materials makes it possible to use the simple adhesive technology.

The technology also has considerable potential for other applications, such as the production of electronic devices such as smartphones and notebooks. The printable adhesive for solar modules won the transfer prize at KIT's NEULAND innovation contest.

Sustainability and Digitalization at the Hannover Messe

Bringing sustainability and digitalization into a single context was also a common theme of KIT's exhibits at Hannover Messe 2022. Climate forecasting and risk prevention, data security and artificial intelligence, energy transition and the circular economy were the subjects KIT presented at its two main booths in the trade fair's Future Hub and Energy Solutions venues. KIT also presented current mobility research projects at the Baden-Württemberg International booth. Digital technologies can contribute to sustainable development, through resource-efficient production or networked mobility, for example. Conversely, digitalization also needs to be implemented sustainably.

PRIZES, HONORS, AWARDS AND APPOINTMENTS

KIT and KIT Freundeskreis und Fördergesellschaft e.V. (KFG) awarded the 2022 Heinrich Hertz Guest Professorship to Professor Reinhard Genzel, director of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, and winner of the 2020 Nobel Prize in Physics. In October 2022 he held a public lecture about galaxies and black holes in the crowded auditorium at KIT, presenting the latest measurements of massive black holes in galactic centers and discussing their consequences for the origin of black holes in the early universe. In addition to his public lecture, Genzel held a seminar for students at KIT. With the Heinrich Hertz Guest Professorship, every year KFG and KIT honor prominent figures in

academia, industry, politics, and culture for their scientific and cultural achievements and contributions. KFG, which promotes research, teaching, innovation, and academic life at KIT, founded the guest professorship in 1987 on the occasion of the 100th anniversary of the experimental proof of electromagnetic waves by the physicist Heinrich Hertz at Universität Karlsruhe (TH), a predecessor institution of KIT.

The 2022 Julius Wess Award from the KIT Elementary Particle and Astroparticle Physics Center (KCETA) was awarded in December 2022 to Elena Aprile, a renowned astroparticle physicist and professor at Columbia University in New York.

Professor Aprile is a member of the American Academy of Arts and Sciences and the National Academy of Sciences in the United States. Since 2002, she has been the spokesperson for the international XENON Dark Matter Collaboration, which she founded and in which KIT participates. She received the award in recognition of her groundbreaking scientific achievements in the search for dark matter and in particular for the development of highly sensitive detectors.


239


240


244


245

249

251


250

241


242


243


246


247


248


252


254


253

ALEXANDER VON HUMBOLDT PROFESSORSHIP FOR ANDRÉ PLATZER

Top IT Researcher and Winner of Germany's Best-funded Research Prize Comes to KIT

André Platzer, an expert in theoretical information science, was awarded an Alexander von Humboldt Professorship in 2022. At up to EUR 5 million, it is Germany's best-funded international research prize. With this award, the Alexander von Humboldt Foundation recognizes leading international researchers of all disciplines who have previously been working abroad. They are expected to conduct cutting-edge research at German universities on a long-term basis. The award is financed by Germany's Federal Ministry of Education and Research.

Traffic flows in railway networks or at airports are mainly controlled by computers, and the interactions between the computer and communications systems and the trains and aircraft have to go smoothly. André Platzer's research is about making such computer assistance systems extremely safe. Platzer, an expert in theoretical information science, is now a Humboldt Professor at KIT.

Cyber-physical systems (CPS), in which mechanical components are connected using networks and modern information technology, enable the management and control of complex systems and infrastructure. Platzer studies how logic and programming can ensure trouble-free interaction between computers and communications systems and moving physical components. Only when this is achieved can CPS maximize safety and efficiency while also saving time.

Platzer developed the logical principles for KeYmaera X, an open-source tool used in the community to provide proof of a system's correctness. In government and industrial collaborations, this applied fundamental research by Platzer has led to major improvements in the safety of CPS in rail and air transport and medical robotics.

At KIT, Platzer has assumed the Alexander von Humboldt Professorship for Logic of Autonomous Dynamical Systems and heads the new Institute for Reliability of Autonomous Dynamical Systems, which seeks synergies for the application of reliable CPS in other fields. He has been teaching at Carnegie Mellon University in Pittsburgh in the United States since 2008. For his dissertation, he won the ACM Doctoral Dissertation Honorable Mention Award. As early as 2009–10, he was listed among the top ten young researchers in the field of artificial intelligence by Popular Science magazine and IEEE Intelligent Systems.

Immediately after earning his doctorate in computer science from the University of Oldenburg in 2008, André Platzer was appointed assistant professor of computer science at the prestigious Carnegie Mellon University. He was appointed associate professor in 2014 and full professor in 2020. In 2015 he was a guest professor at Cornell University in Ithaca in the United States, and he worked at the Technical University of Munich in 2019 as a Humboldt research fellow and DFG Mercator fellow.

André Platzer's research focuses on secure computer assistance systems.

AWARD FOR YOUNG SCIENTISTS FROM GERMAN RESEARCH FOUNDATION

Pascal Friederich Receives Heinz Maier-Leibnitz Prize

Pascal Friederich, Tenure-track Professor at KIT, received a Heinz Maier-Leibnitz Prize from the German Research Foundation (DFG) in 2022. The prize is the most important award for young scientists in Germany. His interdisciplinary research focuses on the use of artificial intelligence in materials simulations, virtual material design, and autonomous experimental platforms for the automated identification of materials. The objective is to drastically shorten the development times for high-performance materials such as those used in efficient energy storage systems and medical applications.

256

Pascal Friederich, Tenure-track Professor at KIT's Institute of Theoretical Informatics, was awarded a Heinz Maier-Leibnitz Prize by the DFG.

The DFG awards the Heinz Maier-Leibnitz Prize in recognition of outstanding achievements by researchers at early stages in their careers. The prize includes EUR 20,000 to assist the researchers in furthering their scientific careers. Ten researchers won the Leibnitz Prize in 2022. The prize is named after Heinz Maier-Leibnitz, a physics professor who was president of the DFG from 1974 to 1979.

Friederich is a tenure-track professor at the Institute of Theoretical Informatics at KIT and an associate group leader at the Institute of Nanotechnology (also at KIT). He also heads the AiMat (Artificial Intelligence for Materials Sciences) research group, which is concerned with data-based predictions of material properties, computer-assisted materials design, machine learning for materials simulations at atomic scales, and combining artificial intelligence methods with laboratory experiments. In view of the increasing demand for high-performance materials and their wide range of potential applications, the importance of these topics is growing steadily.

In his doctoral research at KIT, after receiving his bachelor's and master's degrees in physics at KIT, Friederich developed a new method for computing material properties that will enable the design of new organic semiconductors. As a visiting researcher at the Georgia Institute of Technology and a Marie Curie Fellow at Harvard University (both in the United States), and at the University of Toronto in Canada, he developed machine learning methods for use in various disciplines. He is the author of numerous publications in prestigious scientific journals.

STATE RESEARCH AWARD FOR ANKE-SUSANNE MÜLLER

Baden-Württemberg's Best-funded Research Prize Goes to Expert Accelerator Researcher at KIT

Professor Anke-Susanne Müller, Institute for Beam Physics and Technology, received the 2022 Baden-Württemberg State Research Award in recognition of her achievements in basic research. Müller and her team have made pioneering contributions to improve the stability, compactness and energy efficiency of particle accelerators. The award, which includes EUR 100,000, is the most highly endowed research prize awarded by a German state.

Müller has achieved a leading position in the field of accelerator research worldwide. She and her team at KIT have laid the foundations that make new particle accelerator designs conceivable. As a pioneer in the development and use of precision electron beam and photon pulse diagnostics, Müller conducts research that plays a key role in developing the accelerators of the future. Such accelerators promise to revolutionize tumor therapy and the refinement of materials.

Müller and her team in the Accelerator Technology Platform, a research network at KIT, are pioneers in the precision measurement and modeling of non-equilibrium particle beams. Among other things, they have developed hardware and software components to control particle beams with assistance from artificial intelligence. Müller was the driving force behind these technological advances and the physical insights they enabled. Many accelerators in Europe have already benefited from them.

At the Institute for Beam Physics and Technology, Müller and her multidisciplinary team have made pioneering contributions to the generation of high-intensity, ultrashort electron bunches in particle accelerators. The objective of their work is to control the nonlinear dynamics of electron beams. The challenge is to understand and control the behavior of compact, highly charged relativistic particle bunches in external fields.

Anke-Susanne Müller was appointed the founding director of KIT's Institute for Beam Physics and Technology in 2016. Prior to that appointment, she became Professor of Accelerator Physics at the KIT Department of Physics in 2013. From 2012 to 2016, she was a member of the board of directors of the ANKA synchrotron radiation source at KIT. She began her scientific career studying physics at Johannes Gutenberg University (JGU) in Mainz and subsequently earned her doctorate at the European Organization for Nuclear Research (CERN) in Geneva and JGU. Her first postdoctoral position was at CERN; she moved to KIT in 2002, where she led a Helmholtz Young Investigators Group from 2007 to 2013.

Professor Anke-Susanne Müller won Baden-Württemberg's State Research Award in 2022.

Other Prizes, Honors, Awards, and Appointments

People

■ Researchers working with materials scientist **Professor Dr. Jarir Aktaa**, Institute for Applied Materials, along with colleagues from Forschungszentrum Jülich, received the first SOFT Innovation Prize for outstanding fusion technology research at the 32nd Symposium on Fusion Technology in Dubrovnik.


258

■ The Baden Architecture Prize in the Design Award category went to **Lama Alkadi** and two other students from the KIT Department of Architecture for their design for a hygiene pavilion.

■ Baden-Württemberg's state government appointed **Professor Dr. Almut Arneth**, Institute of Meteorology and Climate Research, to its new climate advisory council.

■ In addition, **Almut Arneth** and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ The Technical University of Darmstadt honored **Professor Dr. Jürgen Becker**, Institute for Information Processing Technology, with the 2022 Robert Piloty Prize for his pioneering research in the field of information and communications technology.

■ **Dr. Jonas Böhler** won this year's Award for the Best Ph. D. Thesis on Security and Trust Management from the European Research Consortium for Informatics and Mathematics for his dissertation written at the Institute of Theoretical Informatics.

■ **Dr. Dominic Bresser**, Helmholtz Institute Ulm, is one of four researchers to receive the 30th Carus Prize from the city of Schweinfurt.


259

■ And **Dominic Bresser** and four other KIT researchers received an ERC Starting Grant.

■ **Professor Dr. Johannes Brumm**, Institute of Economics, and four other KIT researchers received an ERC Starting Grant.

■ The Baden Architecture Prize in the Design Award category went to **Fabrizio Canessa** and two other students from the KIT Department of Architecture for their design for a hygiene pavilion.

■ The Association of Applied Mathematics and Mechanics (GAMM) appointed **Dr. Fabian Castelli**, junior researcher at the Institute of Thermal Process Engineering, as a GAMM Junior for the years 2022 to 2024.


260

■ **Professor Dr. Luisa de Cola**, Institute of Nanotechnology, was granted a Doctorado Honoris Causa degree by Universidad Internacional Menéndez Pelayo in Santander, Spain.

■ **Professor Dr. Reinhard Fischer**, Institute for Applied Biosciences, and Professor Dr. Natalia Requena, Joseph-Gottlieb Kölreuter Institut for Plant Sciences, were designated honorary professors by the Institute of Microbial Technology at Amity University in India.

■ **Tenure-track Professor Dr. Pascal Friederich**, Institute of Nanotechnology, received a Heinz Maier-Leibnitz Prize from the German Research Foundation.

■ **Professor Dr. Nico Goldscheider**, Institute of Applied Geosciences, is the new chairman of the Hydrogeology section of the German Geological Society – Geological Association.

■ **Professor Dr. Armin Grunwald**, Institute for Technology Assessment and Systems Analysis, is a member of the new Sustainability Commission at the German Research Foundation.

■ **Dr. Amir-Abbas Haghighirad**, Institute for Quantum Materials and Technologies, and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ The International Society of Information Fusion elected **Professor Dr. Uwe Hanebeck**, Institute for Anthropomatics and Robotics, as its vice president for 2022 and president for 2023.


261

■ **Dr. Dirk Hauschild**, Institute for Photon Science and Synchrotron Radiation, received the Yasutaka Takata Award at the HAXPES 2022 Conference; the award recognizes researchers who apply hard X-ray photoelectron spectroscopy.

■ The European Research Council honored **Assistant Professor Dr. Lars Heinke**, Institute of Functional Interfaces, and two other KIT researchers with Consolidator Grants.

■ **Professor Dr. Martin Heilmaier**, Institute for Applied Materials, was elected as one of the two presidents of the German Materials Society at its annual convention.

■ The European Research Council honored **Professor Dr. Inge Hinterwaldner**, Institute for History of Art and Architecture, and two other KIT researchers with Consolidator Grants.


262

■ The VDI Society Chemical and Process Engineering awarded a medal to **Professor Dr. Thomas Hirth**, Vice President Transfer and International Affairs at KIT, for his contributions to the advancement of science and innovation.

■ **Professor Dr. Marlis Hochbruck**, Institute for Applied and Numerical Mathematics, will be on the scientific advisory board of the Oberwolfach Research Institute for Mathematics from 2023.


263

■ The International Science Council appointed **Dr. Alik Ismail-Zadeh**, a geophysicist at the Institute of Applied Geosciences, as a Fellow for his contributions to the promotion of science as a global public good.

■ **Professor Dr. Jürgen Janek,** Institute of Nanotechnology, was honored with the Greve Prize by the National Academy of Sciences Leopoldina. He is Scientific Director of KIT's Battery and Electrochemistry Laboratory (BELLA) and a professor at the University of Gießen.


264

■ In addition, **Jürgen Janek** and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ Baden-Württemberg's energy minister Thekla Walker appointed **Professor Dr. Thomas Jordan**, Institute for Thermal Energy Technology and Safety, to a new council for the development of the hydrogen roadmap.

■ **Dr. Merve Kabukcuoglu**, Institute for Photon Science and Synchrotron Radiation, received a prize from the editorial committee of the journal Crystals for her presentation at the 7th European Conference on Crystal Growth (ECCG7) in Paris.

■ The professional association Optica – Advancing Optics and Photonics Worldwide awarded an Amplify grant to **Ngei Katumo**, Institute of Microstructure Technology.


265

■ The European Research Council honored **Professor Dr. Christoph Kirchlechner**, Institute for Applied Materials, and two other KIT researchers with Consolidator Grants.


266

■ The Deutsche Meteorologische Gesellschaft (German weather society) awarded the Alfred Wegener Medal to **Professor Dr. Christoph Kottmeier**, former head of the Institute of Meteorology and Climate Research.

■ **Dr. Janina Krell-Rösch**, Institute of Sports and Sports Science, received this year's Alzheimer Award from the Journal of Alzheimer's Disease for her contributions together with Yonas Geda of the Barrow Neurological Institute in the United States.

■ For her fundamental contributions to the study of dark matter, **Dr. Belina von Krosigk**, Institute for Astroparticle Physics, was awarded the Hertha Sponer Prize by the German Physical Society.

■ Professor Dr. Senja Post, Institute of Technology Futures, and **Monika Landgraf**, Strategic Corporate Development and Communications, were appointed to the advisory board of the Science Communication transfer unit.

■ **Professor Dr. Gisela Lanza**, wbk Institute of Production Science, was elected a member of the National Academy of Sciences Leopoldina.


267

■ **Dr. Sebastian Lins**, Institute of Applied Informatics and Formal Description Methods, won the ACM SIGMIS Doctoral Dissertation Award for his dissertation.

■ The German Society for Biomedical Engineering awarded **Dr. Giorgio Luongo**, Institute of Biomedical Engineering, third place in the competition for the Klee Prize for practical developments in the field of medical technology.

■ **Markus Matz**, Institute for Chemical Technology and Polymer Chemistry, received the 2022 Herbert Knauer Science Award for his work on nuclear magnetic resonance as a detection method for liquid chromatography.

■ **Dr. Jan Masell**, Feodor Lynen Research Fellow at the Institute for Theoretical Solid-State Physics, received a Young Scientist Award from the European Magnetism Association.


268

■ **Professor Dr. Anke-Susanne Müller**, Institute for Beam Physics and Technology, received the 2022 Baden-Württemberg State Research Award.

■ **Adrian Münch**, Research Center for Steel, Timber, and Masonry, received the Schöck Bau-Innovationspreis for his master's thesis on the design and evaluation of optimized truss girders with cast steel nodes for warehouse construction.

■ **Professor Dr. Petra Nieken**, Institute of Management, and her co-authors received the prize for the best article in The Leadership Quarterly in 2021.


269

■ **Professor Dr. Gerd Ulrich Nienhaus**, Institute of Applied Physics, was appointed a Fellow of the US-based Biophysical Society for his outstanding scientific achievements in the field of biophysics.

■ **Professor Dr. Stefano Passerini**, Helmholtz Institute Ulm, received the Electrochemical Society's Alessandro Volta Medal in Atlanta, USA, for his outstanding work in electrochemical and solid-state research.

■ In addition, **Stefano Passerini** and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ **Professor Dr. Dmitry Pelinovsky**, McMaster University, Canada, received the prestigious Humboldt Research Award. As a result of the award, he conducted research at KIT's Institute for Analysis from January to July 2022.

■ Arbeitgeberverband Südwestmetall, an employers' association, honored **Dr. Sina Peukert**, wbk Institute of Production Science, with a prize for her dissertation.


270

■ **Professor Dr. Senja Post**, Institute of Technology Futures, and Monika Landgraf, Strategic Corporate Development and Communications, were appointed to the advisory board of the Science Communication transfer unit.


271

■ **Professor Dr. Holger Puchta**, Joseph-Gottlieb Kölreuter Institut for Plant Sciences, and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ Balliol College at the University of Oxford, UK, appointed **Professor Dr. Clemens Puppe**, Institute of Economics, an Oliver Smithies Visiting Fellow.


272

■ **Dr. Julian Quinting**, Institute of Meteorology and Climate Research, and four other KIT researchers received an ERC Starting Grant.

■ **Camila Suliani Raota**, Institute for Advanced Membrane Technology, won first prize for her lecture on "Breaking the wall of Purifying Water with Sunlight" at Falling Walls Lab in Heidelberg.

■ Professor Dr. Reinhard Fischer, Institute for Applied Biosciences, and **Professor Dr. Natalia Requena**, Joseph-Gottlieb Kölreuter Institut for Plant Sciences, were designated honorary professors by the Institute of Microbial Technology at Amity University in India.

■ The Josef Wund Stiftung conferred the Undine Award on Professor Dr. Andrea Iris Schäfer, Institute for Advanced Membrane Technology, and **Professor Dr. Bryce Richards**, Institute of Microstructure Technology.

■ **Professor Dr. Peter Roesky**, Institute for Inorganic Chemistry, received the 2022 Frank H. Spedding Award for his scientific contributions in the field of rare earths.

■ In addition, **Peter Roesky** was selected as a scout for the Alexander von Humboldt Foundation's Henriette Herz Scouting Programme.

■ **Dr. Alina Roitberg**, Institute for Anthropomatics and Robotics, was one of six researchers in the Helmholtz Association to win the Helmholtz Doctoral Prize in 2022.

■ The German Academic Exchange Service appointed **Dr. Klaus Rümmele**, International Affairs, to its funding programs working group from 2023 to 2028.

■ The Baden Architecture Prize in the Design Award category went to **Andrea Santos** and two other students from the KIT Department of Architecture for their design for a hygiene pavilion.

■ **Professor Dr. Wilhelm Schabel**, Institute of Thermal Process Engineering, won the Excellence in Drying award for his work on thin film drying.


273

■ In addition, the University of Cambridge, UK, appointed **Wilhelm Schabel** an Edwards Fellow.

■ The Josef Wund Stiftung conferred the Undine Award on **Professor Dr. Andrea Iris Schäfer**, Institute for Advanced Membrane Technology, and Professor Dr. Bryce Richards, Institute of Microstructure Technology.


274

■ The expert group on transforming the automotive industry at the Federal Ministry for Economic Affairs and Climate Action elected **Professor Dr. Ina Schaefer**, Institute of Information Security and Dependability, as its chairwoman.

■ **Dr. Christian Scharun**, Institute of Meteorology and Climate Research, won the national final of the FameLab science contest in Bielefeld.

■ The International Association for Cereal Science and Technology awarded the 2022 Harald Perten Prize to **Tenure-track Professor Dr. Katharina Scherf**, Institute for Applied Biosciences.


275

■ And **Katharina Scherf** and four other KIT researchers received an ERC Starting Grant.

■ **Christopher Schiller**, now a doctoral researcher at Freie Universität Berlin, received the GBIF Young Researchers Award from the Global Biodiversity Information Facility for an AI-based tool to predict plant characteristics, which he developed while working on his master's thesis at the Institute of Geography and Geoecology.

■ The Deutsche Meteorologische Gesellschaft (German weather society) elected **Dr. Hans Schipper**, South German Climate Office, to chair its new expert committee on climate communication.


276

■ **Professor Dr. Jörg Schmalian**, Institute for Theoretical Condensed Matter Physics and Institute for Quantum Materials and Technologies, is one of three winners of the 2022 John Bardeen Prize from the International Conference on the Materials and Mechanisms of Superconductivity.


277

■ The American Meteorological Society honored **Professor Dr. Hans Peter Schmid**, Institute of Meteorology and Climate Research, with its Award for Outstanding Achievement in Biometeorology.

■ **Junior Professor Dr. Matti Schneider**, Institute of Engineering Mechanics, won the Richard von Mises Prize from the Association of Applied Mathematics and Mechanics for his work on computational micromechanics.

■ And **Matti Schneider** and four other KIT researchers received an ERC Starting Grant.

■ Bioinformatics **Professor Dr. Alexandros Stamatakis**, KIT Institute of Theoretical Informatics and Heidelberg Institute for Theoretical Studies, received funding from the European Commission for a European Research Area Chair.


278

■ In addition, **Alexandros Stamatakis** and five other KIT researchers are among the Highly Cited Researchers of 2022.

■ **Tenure-track Professor Dr. Helge Stein**, Institute of Physical Chemistry and Helmholtz Institute Ulm, received a Masao Horiba Award Honorable Mention for his research on the accelerated identification and development of new battery materials.

■ **Professor Dr. Ali Sunyaev**, Institute of Applied Informatics and Formal Description Methods, was appointed spokesman for the information systems department at the Gesellschaft für Informatik.


279

■ The European Research Council awarded an Advanced Grant to **Professor Dr. Mehdi Tahoori**, Institute of Computer Engineering.

■ **Professor Dr. Alexey Ustinov**, Physikalisches Institut, was also awarded an Advanced Grant by the European Research Council.

■ The Computer Science Department at TU Dortmund University conferred an honorary doctorate on **Professor Dr. Dorothea Wagner**, Institute of Theoretical Informatics.


280

■ In addition, **Dorothea Wagner** was confirmed through January 2023 in her position as chairwoman of the Council of Science and Humanities.

■ **Professor Dr. Alexander Waibel**, Institute for Anthropomatics and Robotics, was appointed a Fellow by the International Speech Communication Association for his work in the field of speech communication.

■ **Dr. Sebastian Weber**, Institute for Chemical Technology and Polymer Chemistry and Institute of Catalysis Research and Technology, won the European Young Chemists' Award PhD level gold medal. He is now at hte GmbH in Heidelberg.

■ **Professor Dr. Wolfgang Wernsdorfer**, Physikalisches Institut, was inducted into the French Académie des Sciences.


281

■ The Academy of Sciences and Literature in Mainz elected **Professor Dr. Manfred Wilhelm**, Institute for Chemical Technology and Polymer Chemistry, as a full member of its Class of Mathematics and Natural Sciences.

■ The "academics" job portal honored **Tenure-track Professor Dr. Philipp Willke**, Physikalisches Institut, as the 2021 junior researcher of the year.

■ The Alexander von Humboldt Foundation awarded a Humboldt Research Award to **Ji-Cheng Zhao**, Minta Martin Professor of Engineering and Department Chair of Materials Science and Engineering at the University of Maryland, USA. During his research period in Germany, he will work with professors Peter Gumbsch of KIT and Dierk Raabe of the Max-Planck-Institut für Eisenforschung.

■ **Professor Dr. Thomas Zwick**, Institute of Radio Frequency Engineering and Electronics, was granted an honorary doctorate by the Electrical Engineering and Informatics Department at the Budapest University of Technology and Economics.


282

Institutions

■ When the first National Award – Education for Sustainable Development was presented, **KIT** won an award in the Places of ESD category for its wide range of sustainability-related courses and activities.

■ Child-friendliness prize for "Balu und Du": The city of Karlsruhe honored KIT's **mentoring program**, which is coordinated by ZAK | Centre for Cultural and General Studies, with its 2022 prize for child-friendliness.

■ The **NEWood** project by the KIT Department of Architecture won the German Sustainable Building Council's Sustainability Challenge in the research category.

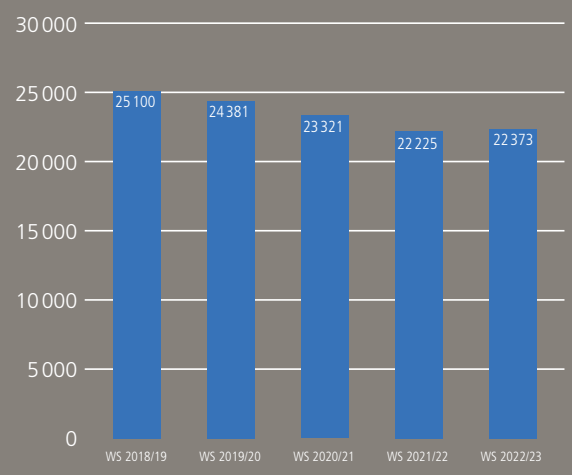
■ The **RoofKIT** project won the Solar Decathlon Europe 21/22, the world's biggest university competition for sustainable urban building and living.

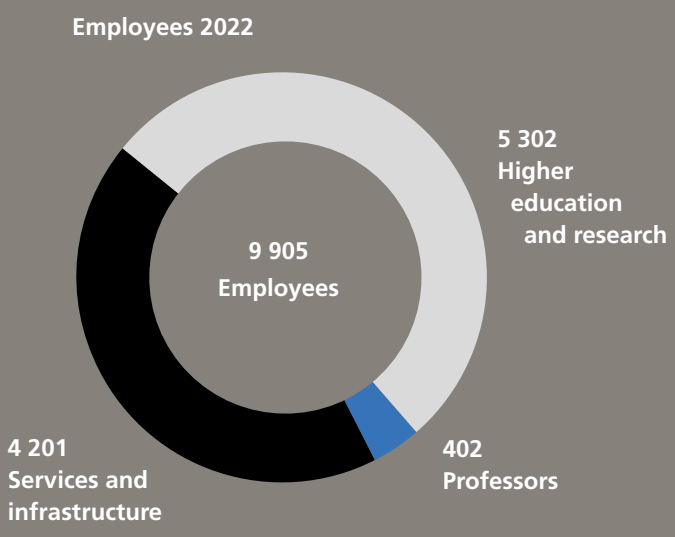
■ KIT's **SECUSO** (SECurity, USability and SOciety) research group received the first Digital Autonomy Award.

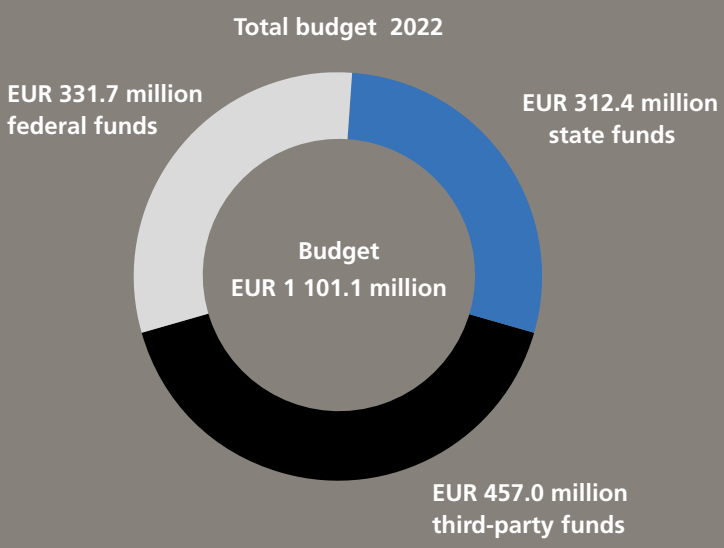
■ The **SECUSO** research group also received the Federal Consumer Protection Award from the German Consumer Protection Foundation.

FACTS AND FIGURES

Number of students



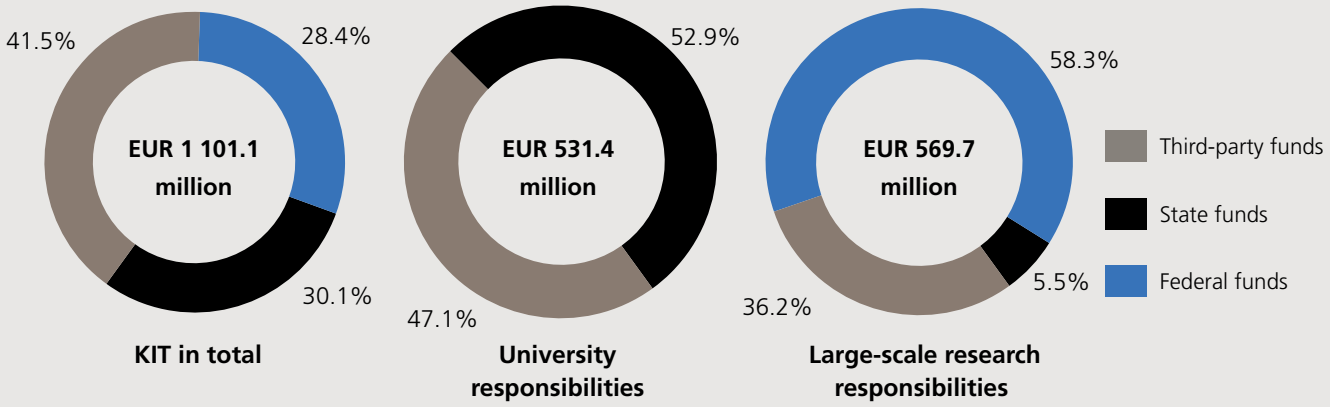

Employees 2022
9 905
Employees
5 302
Higher
education
and research
402
Professors
4 201
Services and
infrastructure


Total budget 2022
Budget
EUR 1 101.1 million
EUR 331.7 million
federal funds
EUR 312.4 million
state funds
EUR 457.0 million
third-party funds

CONTENT

FUNDING

Federal, State, and Third-party Funds Acquired



Sources of Funding

KIT in Total

In million euros	2018	2019	2020	2021	2022
Income in total	880.9	951.3	955.8	1 071.4	1 101.1
Third-party funds	338.0	369.7	388.4	432.7	457.0
State funds	263.0	271.4	278.5	305.0	312.4
Federal funds	279.9	310.2	288.9	333.7	331.7

University Responsibilities

In million euros	2018	2019	2020	2021	2022
Income in total	440.3	466.7	480.4	510.1	531.4
Third-party funds	206.5	224.4	230.9	237.0	250.4
State funds	233.8	242.3	249.5	273.1	281.0
Federal funds*	0.0	0.0	0.0	0.0	0.0

* Federal funds for university responsibilities are included in the third-party funds, as they are granted for special projects rather than for basic funding.

Large-scale Research Responsibilities

In million euros	2017	2018	2019	2020	2021
Income in total	440.6	484.6	475.4	561.3	569.7
Third-party funds	131.5	145.3	157.5	195.7	206.0
State funds	29.2	29.1	29.0	31.9	31.4
Federal funds	279.9	310.2	288.9	333.7	331.7

Federal and state funds for large-scale research responsibilities also include the revenues/outstanding sums from the previous year.

Sources of Third-party Funding

KIT in Total

In million euros	2018	2019	2020	2021	2022
Third-party funding in total	338.0	369.7	388.4	432.8	457.0
Third-party funding by DFG, incl. CRC	51.4	59.9	53.6	63.9	70.6
Third-party funding by EU	25.2	28.5	30.9	26.4	43.3
Third-party funding by Fed. and State	129.2	142.6	169.1	195.0	205.0
Other income	132.2	138.7	134.8	147.5	138.1

University Responsibilities*

In million euros	2018	2019	2020	2021	2022
Third-party funding in total	206.5	224.4	230.9	237.0	250.4
Third-party funding by DFG, incl. CRC	42.9	45.1	41.3	47.1	47.5
Third-party funding by EU	9.6	11.0	11.9	8.6	13.2
Third-party funding by Fed. and State	83.0	91.2	105.9	108.2	114.8
Other income	71.0	77.1	71.8	73.1	74.9

* Third-party funds shall be all income and allowances granted for university responsibilities under the University Funding Agreement I in addition to basic funding.

Large-scale Research Responsibilities

In million euros	2018	2019	2020	2021	2022
Third-party funding in total	131.5	145.3	157.5	195.8	206.6
Third-party funding by DFG, incl. CRC	8.5	14.8	12.3	16.8	23.1
Third-party funding by EU	15.6	17.5	19.0	17.8	30.1
Third-party funding by Fed. and State	46.2	51.4	63.2	86.8	90.2
Other income	61.2	61.6	63.0	74.4	63.2

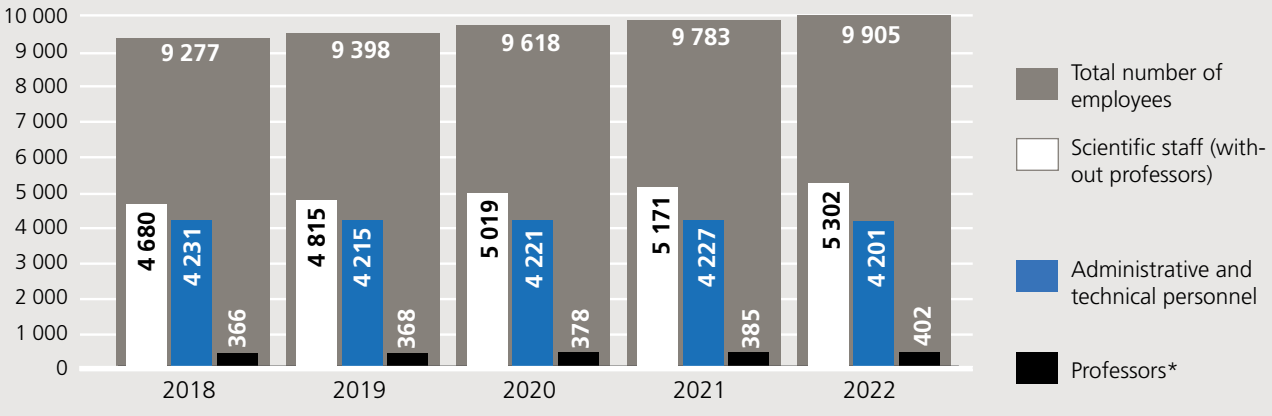
Use of Funds

In million euros	KIT in Total	University Responsibilities	Large-scale Research Responsibilities
Expenses in total	1 101.1	531.4	569.7
Investments in total	112.8	42.4	70.4
of these, major investments	17.8	0.0	17.8
of these, ongoing investments	95.0	42.4	52.6
Personnel expenses	672.7	370.3	302.4
Material expenses	315.6	118.7	196.9

PERSONNEL INFORMATION

KIT Staff in Total

Staff (headcount)	2018	2019	2020	2021	2022
Total number of employees	9 277	9 398	9 618	9 783	9 905
of these, female employees	3 454	3 553	3 636	3 754	3 857
Professors*	366	368	378	385	402
of these, female professors	51	54	59	63	72
of these, junior professors	9	11	17	24	31
of these, female junior professors	3	3	5	8	9
of these, international professors	39	43	44	46	50
of these, endowed professors	7	6	10	9	8
Scientific staff (without professors)	4 680	4 815	5 019	5 171	5 302
of these, female scientists	1 255	1 317	1 385	1 478	1 570
of these, staff financed from third-party funds	2 421	2 446	2 543	2 614	2 652
of these, international employees	1 035	1 135	1 240	1 359	1 481
of these, employment contracts of limited duration	3 612	3 737	3 925	4 049	4 141
of these, part-time employees	1 587	1 605	1 634	1 638	1 670
Administrative and technical personnel	4 231	4 215	4 221	4 227	4 201
of these, female staff	2 148	2 182	2 192	2 213	2 215
of these, staff financed from third-party funds	785	751	679	713	759
of these, international employees	212	223	237	246	255
of these, employment contracts of limited duration	894	845	859	876	870
of these, part-time employees	1 101	1 149	1 172	1 169	1 204
of these, trainees and students of Baden-Württemberg Cooperative State University	396	371	370	367	368
of these, female trainees and students	154	140	140	136	135
Trainees' share in the total number of employees [%]	4	4	4	4	4



* Professors, junior professors, and executive scientists receiving W-type salary according to Article 14 KIT Act.

Habilitations

	2018	2019	2020	2021	2022
Total	7	12	9	14	12
Men	7	10	7	12	9
Women	0	2	2	2	3

Appointments to W-3 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Mike Barth, Division III	Vernetzte sichere Automatisierungstechnik	Hochschule Pforzheim
Prof. Dr. Stefanie Dehnen, Division V	Informationsbasiertes Materialdesign und Nanowissenschaften	Philipps-Universität Marburg
Prof. Dr. Tobias Düser, Division III	Produktentwicklung und Antriebssysteme	AVL Deutschland GmbH
Prof. Dr. Kathrin Gerling, Division II	Mensch-Maschine-Interaktion und Barrierefreiheit	KU Leuven
Prof. Dr. Alexander Grünberger, Division I	Mikrosysteme in der Bioverfahrenstechnik	Universität Bielefeld
Prof. Dr. Corinna Harmening, Division IV	Geodätische Sensorsysteme	Technische Universität Wien
Prof. Dr. Michael Janoschka, Division IV	Regionalwissenschaft	Universität Leipzig
Prof. Dr. Luise Kärger, Division III	Digitalisierung im Leichtbau	KIT
Prof. Dr. Caroline Karmann, Division IV	Architecture and Intelligent Living	École polytechnique fédérale de Lausanne
Prof. Dr. Fabian Krüger, Division II	Empirische Wirtschaftsforschung	KIT
Prof. Dr. Daniel Lang, Division II	Reallaborforschung Gestalten	Leuphana Universität Lüneburg
Prof. Dr. Sanja Lazarova-Molnar, Division II	Angewandte Informatik für Energiesysteme	University of Southern Denmark
Prof. Dr. Anja Metelmann, Division V	Quantencomputing	Freie Universität Berlin
Prof. Dr. Jan Niehues, Division II	AI for Language Technologies	Maastricht University
Prof. Dr. André Platzer, Division II	Logik Autonomer Dynamischer Systeme	Carnegie Mellon University
Prof. Dr. Peter Rost, Division III	Verfahren der Nachrichtentechnik	Nokia Bell Labs
Prof. Dr. Nadine Rühr, Division IV	Climatic Ecophysiology	KIT

➔

PERSONNEL INFORMATION

➔ Appointments to W-3 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Ina Schaefer, Division II	Software Engineering	Technische Universität Braunschweig
Prof. Dr. Frank Simon, Division V	Prozessdatenverarbeitung und Elektronik	Max-Planck-Institut für Physik
Prof. Dr. Oliver Stein, Division I	Simulation reaktiver Thermo-Fluid-Systeme	Universität Stuttgart
Prof. Dr. Alexey Vinel, Division II	Kooperative autonome Systeme im Reallabor	Universität Passau
Prof. Dr. Lars Windelband, Division II	Berufspädagogik	Pädagogische Hochschule Schwäbisch-Gmünd

Appointment to W-2 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Adrian Hillenbrand, Division II	Volkswirtschaftslehre, insbesondere Experimentalökonomie für Marktdesign	Max-Planck-Institut zur Erforschung von Gemeinschaftsgütern

Appointment to W-1 University Professor at KIT

Name, division	Professorship	Previous employer institution
Tenure-track Prof. Dr. Giovanni De Carne, Division III	Echtzeitsysteme in der Energietechnik	KIT
Jun. Prof. Dr. Christian Grams, Division IV	Meteorologie	KIT
Tenure-track Prof. Dr. Felix Kahlhöfer, Division V	Theoretische Teilchenphysik	RWTH Aachen
Tenure-track Prof. Dr. Manuel Krannich, Division V	Geometrie	Westfälische Wilhelms-Universität Münster
Tenure-track Prof. Dr. Sebastian Krumscheid, Division V	Uncertainty Quantification	RWTH Aachen
Tenure-track Prof. Dr. Rudolf Lioutikov, Division II	Maschinelles Lernen und Robotik	KIT
Jun. Prof. Dr. Rania Rayyes, Division III	Hoch wandlungsfähiges, flächen- und raumbewegliches System für die Produktion	TU Braunschweig
Jun. Prof. Dr. Maike Schwammberger, Division II	Modellierung und Analyse im Mobility Software Engineering	Carl von Ossietzky Universität Oldenburg
Jun. Prof. Dr. Jan Stühmer, Division II	Maschinelles Lernen	Samsung AI Center Cambridge
Tenure-track Prof. Dr. Barbara Verfürth, Division V	Numerik partieller Differentialgleichungen	KIT

➔

➔ Appointment to W-1 University Professor at KIT

Name, division	Professorship	Previous employer institution
Tenure-track Prof. Dr. Philip Willke, Division V	Quantenkontrolle von Spins auf Oberflächen	KIT
Tenure-track Prof. Dr. Moritz Wolf, Division I	Katalysatormaterialien für die Energiewende	Forschungszentrum Jülich GmbH

Appointments to Apl. Professor and Honorarprofessor

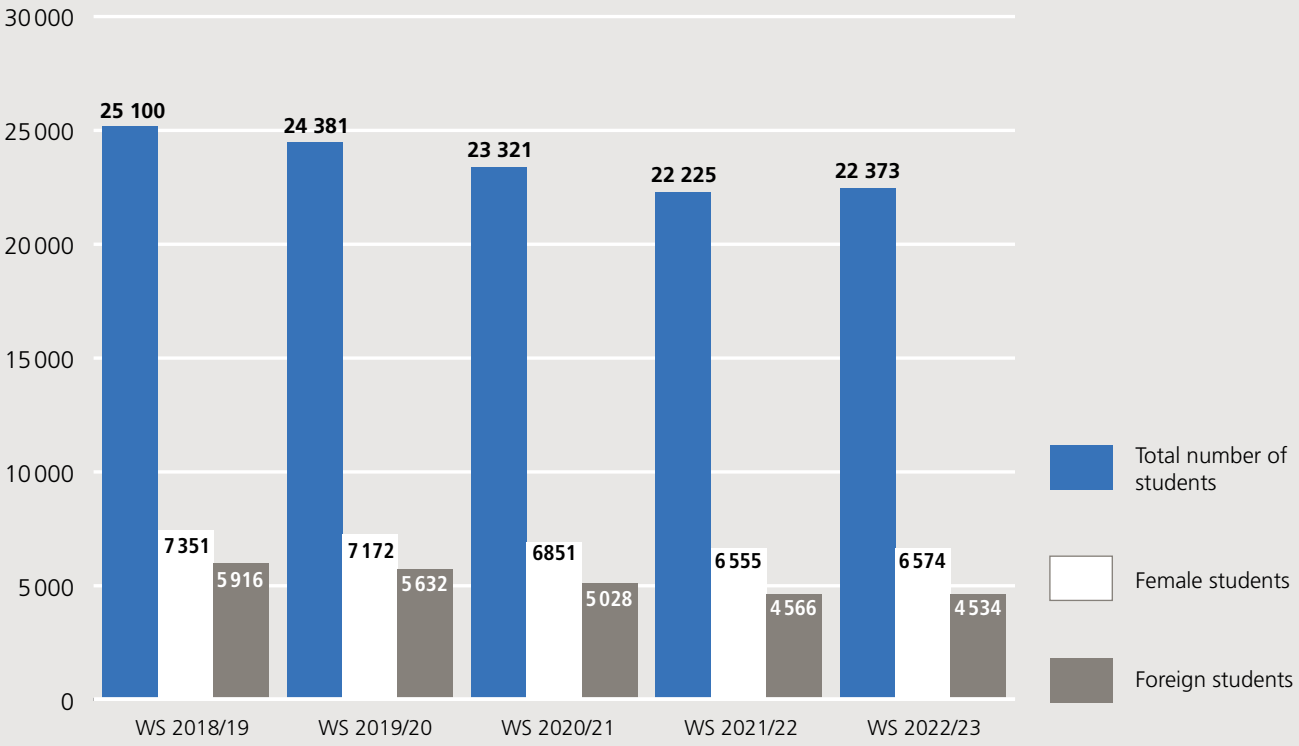
Name	Type	KIT department	Division
Prof. Dr. Jürgen Dahlhaus	Honorarprofessor	CIW	Division I
Prof. Dr. Thomas Herlan	Honorarprofessor	MACH	Division III
Prof. Dr. Wilhelm Pfleging	APL Professor	MACH	Division III
Prof. Dr. Matthias Reinschmidt	Honorarprofessor	CHEM-BIO	Division I
Prof. Dr. Günter Schell	APL Professor	MACH	Division III
Prof. Dr. Pradyumn Kumar Shukla	APL Professor	WIWI	Division II
Prof. Dr. Andreas Siebe	Honorarprofessor	MACH	Division III
Prof. Dr. Ingo Sieber	APL Professor	MACH	Division III
Prof. Dr. Björn-Martin Sinnhuber	APL Professor	PHYSIK	Division V

Emeriti/Retirements

Name	KIT Institute	Division
Prof. Dr. Olaf Dössel	Institute of Biomedical Engineering	Division III
Prof. Dr. Michael Feindt	Institute of Experimental Particle Physics	Division V
Prof. Dr. Horst Hahn	Institute of Nanotechnology	Division V
Prof. Dr. Frans Klinkhamer	Institute for Theoretical Physics	Division V
Prof. Dr. Stefano Passerini	Helmholtz Institute Ulm for Electrochemical Energy Storage	Division I
Prof. Dr. Nikolaos Zarzalis	Engler-Bunte Institute	Division I

STUDENTS

Students in Total



Students and Desired Degrees

Desired degree	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22	WS 2022/23
Bachelor	13 810	13 495	13 086	12 454	12 329
Master	9 313	8 955	8 548	8 089	7 928
Teacher (secondary and vocational schools)	918	952	964	960	959
Doctorate	457	441	355	325	720
State examination	6	0	0	0	0
Diploma	50	32	22	4	0
Studienkolleg	214	185	148	114	168
No degree*	332	321	198	279	269
Total	**25 100**	**24 381**	**23 321**	**22 225**	**22 373**

*No degree: In particular exchange students, who do not aim at a degree at KIT.

Allocation of Students to Subject Groups

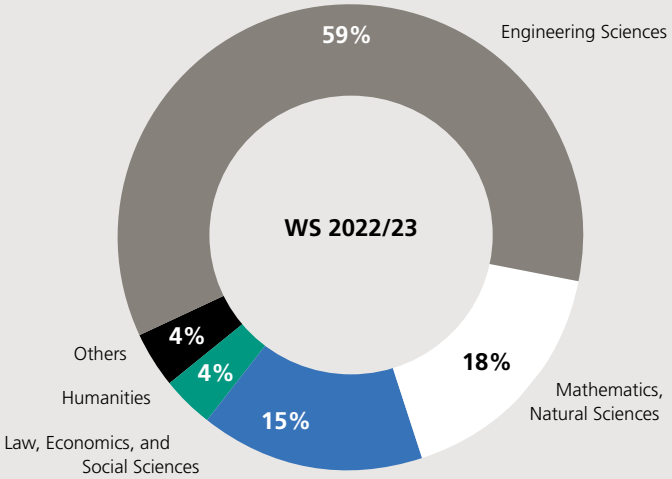
Subject group	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22	WS 2022/23
Engineering Sciences	15 303	14 729	14 025	13 170	13 170
Mathematics, Natural Sciences	4 156	4 042	3 933	3 841	4 098
Law, Economics, and Social Sciences	3 835	3 833	3 678	3 571	3 467
Humanities	889	877	830	818	866
Others	917	900	855	825	772
Total	**25 100**	**24 381**	**23 321**	**22 225**	**22 373**

Allocation of Foreign Students* to Subject Groups

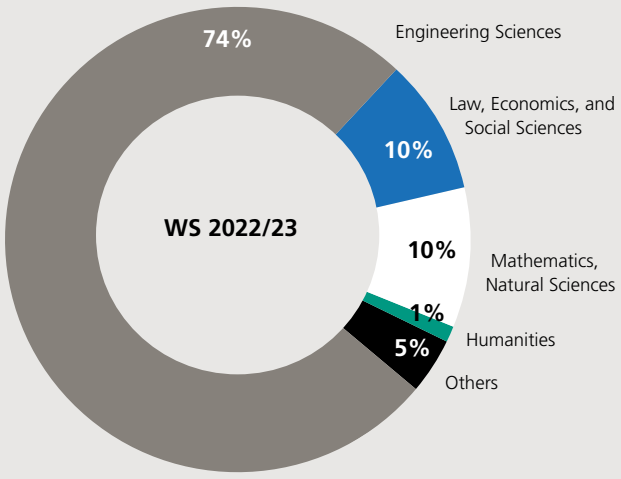
Subject group	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22	WS 2022/23
Engineering Sciences	4 565	4 267	3 819	3 400	3 337
Mathematics, Natural Sciences	473	507	472	445	476
Law, Economics, and Social Sciences	515	529	487	486	446
Humanities	79	78	61	57	64
Others	284	251	189	178	211
Total	**5 916**	**5 632**	**5 028**	**4 566**	**4 534**

*Foreign students: Not of German nationality

Allocation of Students to Subject Groups

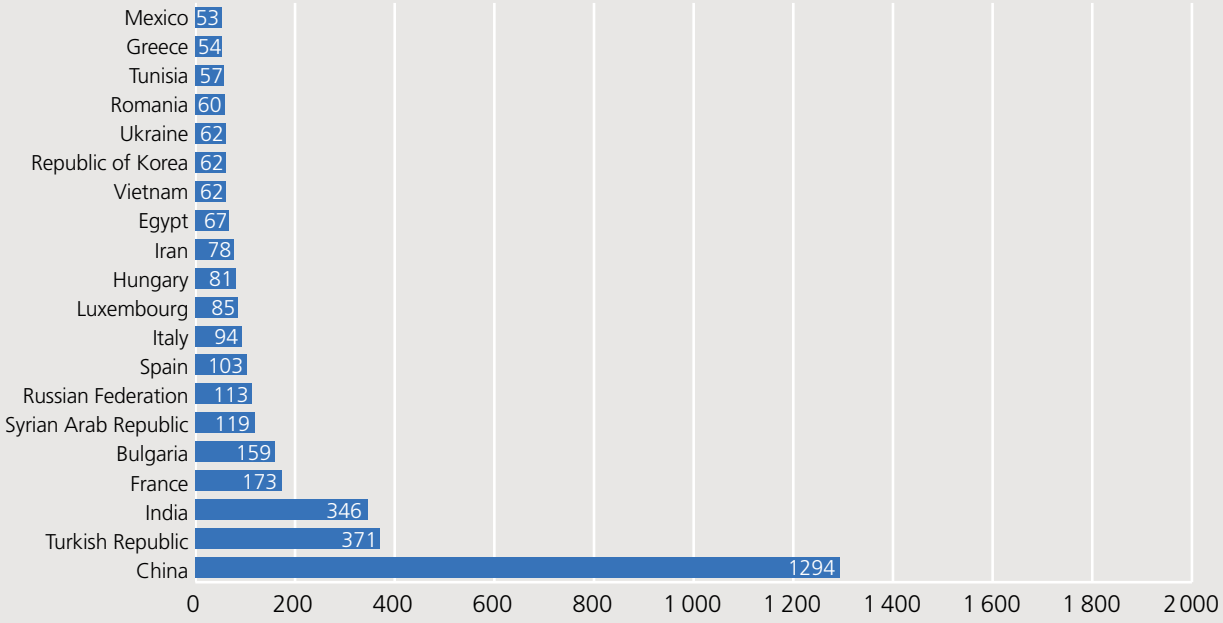


Allocation of Foreign Students to Subject Groups



STUDENTS

Home Countries of Foreign Students (Top 20 of 127)

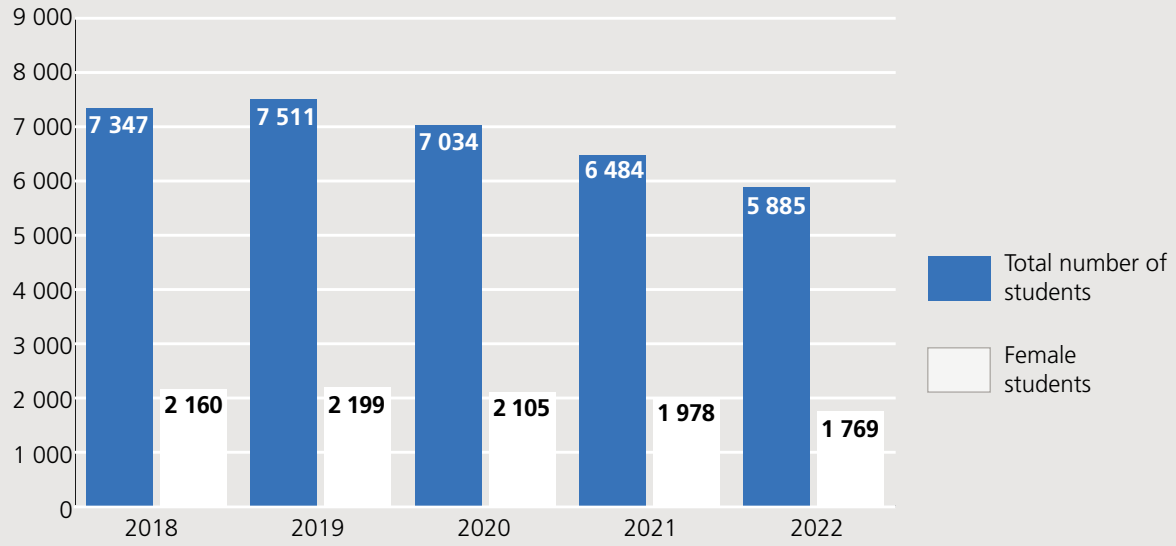


Student Beginners and Degrees Targeted in the 1st Semester*

Desired degree	2018	2019	2020	2021	2022
Bachelor	4 076	4 038	3 935	3 454	3 071
Master	2 765	2 924	2 602	2 596	2 403
Bachelor's degree in teaching at secondary schools	223	213	185	173	178
Bachelor's degree in teaching at vocational schools	28	16	17	12	8
Master's degree in teaching at secondary schools	0	33	50	83	81
Master's degree in teaching at vocational schools	15	27	22	22	17
Studienkolleg	240	260	223	144	127
Total	**7 347**	**7 511**	**7 034**	**6 484**	**5 885**

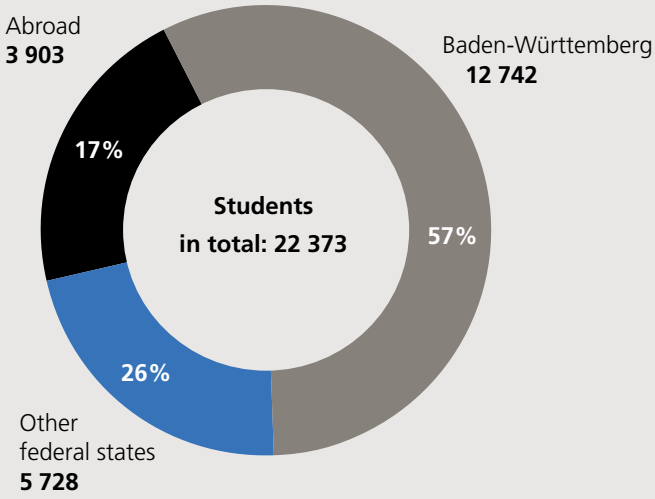
*Without doctoral students and exchange students, who do not pursue a degree at KIT.

Number of Student Beginners in the 1st Semester*



* Without doctoral students and exchange students, who do not pursue a degree at KIT.

Origin of Students in the 2022/23 Winter Semester*

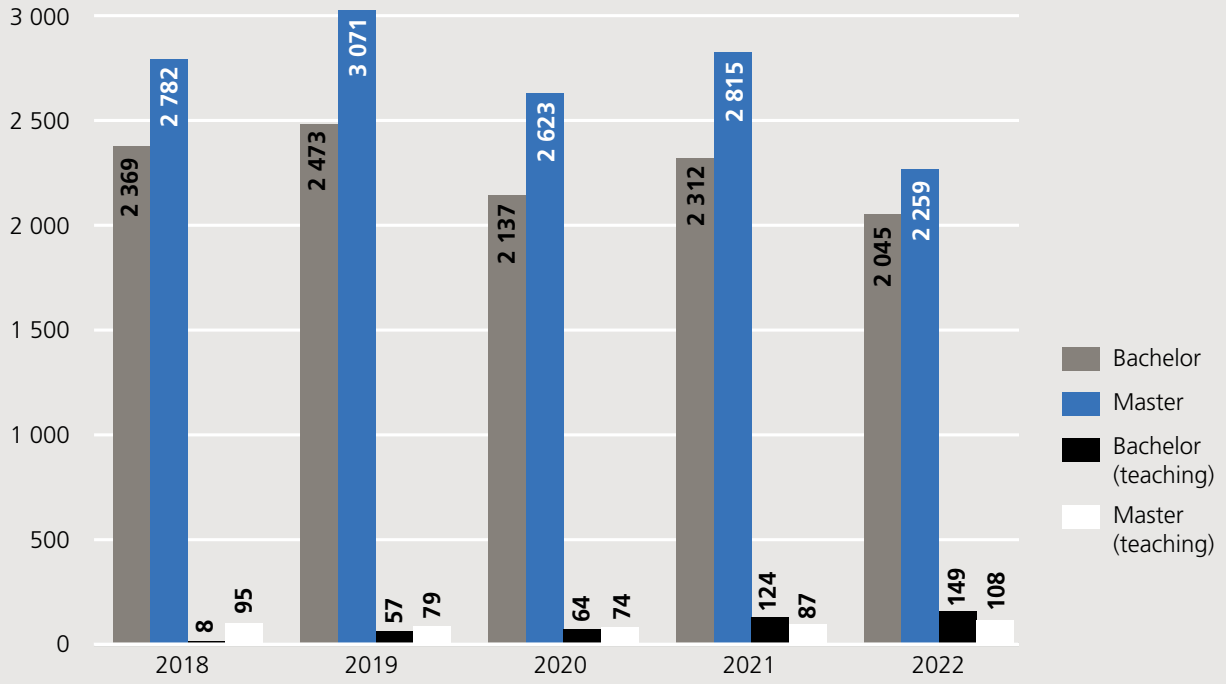


*Place of acquisition of university entrance qualification.

Region	Students
Karlsruhe city and district	3 717
Karlsruhe Regional Council District	3 545
Rest of Baden-Württemberg	5 479
Baden-Württemberg in total	12 742
Rhineland-Palatinate	1 774
Bavaria	953
North Rhine-Westphalia	891
Hesse	812
Lower Saxony	372
Other federal states	925
Germany without Baden-Württemberg	5 728
Asia	2 142
Europe	1 217
Africa	184
America	351
Australia and Oceania	8
Abroad	3 903
KIT in total	22 373

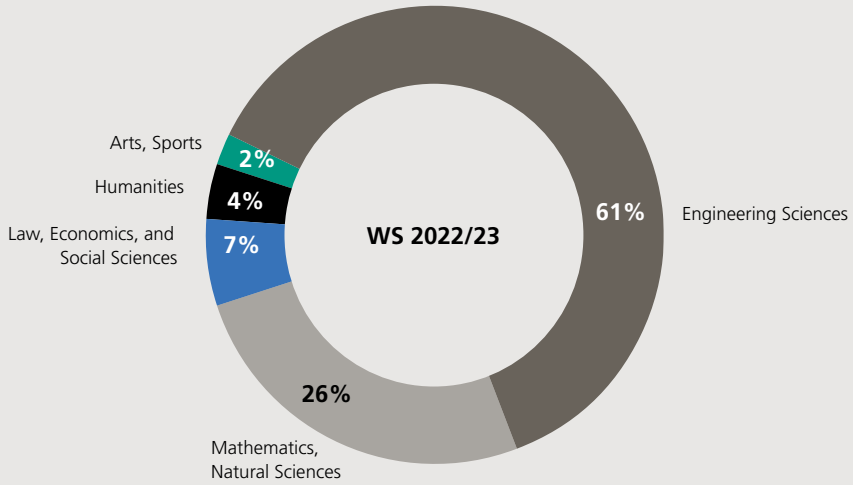
STUDENTS

Number of Graduates



Doctoral Candidates in the Different Subject Groups

Subject group	Male	Female	Non-binary	Total
Engineering Sciences	1 539	442	0	1 981
Mathematics, Natural Sciences	494	344	0	838
Law, Economics, and Social Sciences	140	80	0	220
Humanities	61	77	0	138
Arts, Sports	28	37	0	65
Total	**2 262**	**980**	**0**	**3 242**



Study Programs in the Area of Engineering Sciences

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Architektur	●	●			German-French Double Master *(École Nationale Supérieure d'Architecture de Strasbourg, France)*
Bauingenieurwesen	●	●			
Bioingenieurwesen	●	●			
Chemieingenieurwesen und Verfahrenstechnik	●	●			InnoEnergy Master's Program Energy Technologies *(IST Lisboa, Portugal; Uppsala Universitet, Sweden; INP Grenoble, France)*
Elektrotechnik und Informationstechnik	●	●			German-French Double Degrees B.Sc. and M.Sc. *(Institut National Polytechnique Grenoble, France)* ENTECH Master's Program *(IST Lisboa, Portugal; Uppsala Universitet, Sweden; INP Grenoble, France)* German-Hungarian Double Bachelor *(Budapest University of Technology and Economics, Hungary)*
Energy Engineering and Management				●	
Financial Engineering				●	
Funktionaler und Konstruktiver Ingenieurbau – Engineering Structures		●			
Geodäsie und Geoinformatik	●	●			German-French Double Master *(Institut National des Sciences Appliquées Strasbourg, France)*
Information Systems Engineering and Management				●	
Informatik	●	●	●		Double Master Informatics *(Institute National Polytechnique Grenoble, France)*
Management of Product Development				●	
Mobility Systems Engineering and Management				●	
Maschinenbau	●	●			German-French Bachelor's and Master's Program *(Arts et Métiers ParisTech, France)* German-French Bachelor's and Master's Program *(Institut National des Sciences Appliquées de Lyon, France)*

STUDENTS

➔ **Study Programs in the Area of Engineering Sciences**

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Maschinenbau	●	●			Dual Master's Program *(Korea Advanced Institute of Science and Technology, South Korea)* *Double Master Vehicle or Production Technology (CDHK, Tongji University, China)* *Dual Master's Program (Instituto Tecnológico de Buenos Aires, Argentina)* *InnoEnergy Master's Program Energy Technologies (IST Lisboa, Portugal; Uppsala Universitet, Sweden; INP Grenoble, France)* – cross-departmental
Materialwissenschaft und Werkstofftechnik	●	●			
Mechanical Engineering (International)	●				
Mechatronik und Informationstechnik	●	●			*German-Bulgarian Double Degree B.Sc. (Technical University of Sofia, Bulgaria)*
Medizintechnik	●				
Mobilität und Infrastruktur		●			
Naturwissenschaft und Technik			●		
Optics and Photonics		●			Doube Master's Program *(Aix Marseille Université, France; École Centrale de Marseille, France; Universitat de Barcelona, Spain; Tampere University of Technology, Finland; Vilnius University, Lithuania)*
Production and Operations Management				●	
Regionalwissenschaft		●			*German-Chilean Double Master's Program (Universidad de Concepción, Chile)* *German-Argentinian Double Master's Program (Universidad Tecnológica Nacional, Argentina)*
Remote Sensing and Geoinformatics		●			
Technologie und Management im Baubetrieb		●			
Water Science and Engineering		●			
Wirtschaftsinformatik	●	●			

Study Programs in the Area of Arts, Art Science

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Kunstgeschichte	●	●			

Study Programs in the Area of Mathematics, Natural Sciences

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Angewandte Geowissenschaften	●	●			
Biologie	●	●	●		
Chemie	●	●	●		
Chemische Biologie	●	●			
Geographie			●		
Geoökologie	●	●			
Geophysik/Geophysics	●	●			
Lebensmittelchemie	●	●			
Mathematik	●	●	●		
Meteorologie und Klimaphysik/ Meteorology and Climate Physics	●	●			
Physik	●	●	●		German-French Double Master *(Université Grenoble Alpes, France)*
Technomathematik	●	●			
Wirtschaftsmathematik	●	●			

STUDENTS

Study Programs in the Areas of Law, Economics, and Social Sciences

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Ingenieurpädagogik			●		
Ingenieurpädagogik für Ingenieurinnen und Ingenieure			●		
Pädagogik	●	●			
Technische Volkswirtschaftslehre	●	●			
Wirtschaftsingenieurwesen	●	●			German-French Double Master (M.Sc.) *(Institut National Polytechnique Grenoble, France)*

Study Programs in the Area of Sports

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Sport			●		
Sportwissenschaften	●	●			

Study Programs in the Area of the Humanities

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Europäische Kultur und Ideen-geschichte (European Studies)	●	●			
Germanistik / Deutsch	●	●	●		
Philosophie / Ethik			●		
Wissenschaft – Medien – Kommunikation	●	●			

RESEARCH

Coordinated Research Programs

Clusters of Excellence as Part of the Excellence Strategy Launched by the Federal and the State Governments

Spokesperson, institute, division	Title	Duration	Partner(s)
Prof. Dr. Maximilian Fichtner, Helmholtz Institute Ulm for Electrical Energy Storage, Division I Prof. Dr. Helmut Ehrenberg, Institute for Applied Materials, Division III	EXC 2154: POLiS – Post Lithium Storage Cluster of Excellence – Energiespeicherung jenseits von Lithium	01/2019 – 12/2025	Universität Ulm
Prof. Dr. Martin Wegener, Institute of Applied Physics, Division V	EXC 2082: 3D Designer Materialien / 3D Matter Made To Order	01/2019 – 12/2025	Ruprecht-Karls-Universität Heidelberg

Collaborative Research Centers with KIT Being the Coordinating University

Number	Title	Spokesperson	Duration
SFB 1173	Wellenphänomene: Analysis und Numerik	Prof. Dr. Marlis Hochbruck, Institute for Applied and Numerical Mathematics	2015 – 2023
SFB/TRR 257	Phänomenologische Elementarteilchenphysik nach der Higgs-Entdeckung	Prof. Dr. Gudrun Heinrich, Institute for Theoretical Physics	2019 – 2026
SFB 1441	Verfolgung der aktiven Zentren in heterogenen Katalysatoren für die Emissionskontrolle / Tracking the Active Site in Heterogeneous Catalysis for Emission Control (TrackAct)	Professor Dr. Jan-Dierk Grunwaldt, Institute for Chemical Technology and Polymer Chemistry	2021 – 2024
SFB 1527	High Performance Compact Magnetic Resonance – HyPERiON	Prof. Dr. Jan Gerrit Korvink, Institute of Microstructure Technology	2022 – 2026

The typical budget approved for a Collaborative Research Center/Transregio Project is about EUR 1 to 3 million per year of duration. The duration refers to the complete project. Partial projects at KIT may deviate.

DFG-funded Research Units of KIT with KIT Being the Coordinating University

Number	Title	Spokesperson	Duration
FOR 2383	Erfassung und Steuerung dynamischer lokaler Prozesszustände in Mikroreaktoren mittels neuer in-situ-Sensorik	Prof. Dr. Roland Dittmeyer, Institute for Micro Process Engineering	2016 – 2022
FOR 5230	Finanzmärkte und Friktionen – ein intermediärsbasierter Ansatz im Asset Pricing	Prof. Dr. Marliese Uhrig-Homburg, Institute for Finance, Banking, and Insurance	2021 – 2025
FOR 5339	KI-basierte Methodik für die schnelle Ertüchtigung unreifer Produktionsprozesse	Prof. Dr.-Ing. Jürgen Beyerer, Institute for Anthropomatics and Robotics	2022 – 2025

The typical budget approved for a DFG-funded research unit is about EUR 0.4 to 1.5 million per year of duration. The duration indicates the funding period approved to date and refers to the complete project. Partial projects at KIT may deviate.

RESEARCH

Collaborative Research Centers with Institutional Participation of KIT

Number	Title	Spokesperson / KIT participation	Duration
SFB-TRR 89/3	Invasives Rechnen (InvasIC)	Prof. Dr. Jürgen Teich, Friedrich-Alexander-Universität Erlangen-Nürnberg (Sprecher) Prof. Dr.-Ing. Jörg Henkel, Institut für Technische Informatik, KIT	2010 – 2022
SFB TRR 88/3	Kooperative Effekte in homo- und heterometallischen Komplexen (3MET)	Prof. Dr. Gereon Niedner-Schatteburg, TU Kaiserslautern (Sprecher) Prof. Dr. Manfred Kappes, Institut für Physikalische Chemie und Institut für Nanotechnologie, KIT	2011 – 2022
SFB TRR 150/3	Turbulent chemisch reagierende Mehrphasenströmungen in Wandnähe	Prof. Dr. Andreas Dreizler, TU Darmstadt (Sprecher) Prof. Dr. Olaf Deutschmann, Institut für Technische Chemie und Polymerchemie, KIT	2015 – 2026
SFB TRR 165/2	Waves to Weather: Wellen, Wolken, Wetter	Prof. Dr. George C. Craig, LMU München (Sprecher) Prof. Dr. Volkmar Wirth, JGU Mainz Prof. Dr. Peter Knippertz, Institut für Meteorologie und Klimaforschung, KIT	2015 – 2023
SFB-TRR 288/1	Elastic Tuning and Response of Electronic Quantum Phases of Matter (ELASTO-Q-MAT)	Prof. Dr. Roser Valentí, Universität Frankfurt (Sprecherin) Prof. Dr. Jairo Sinovar, JGU Mainz Prof. Dr. Jörg Schmalian, Institut für Theorie der Kondensierten Materie, KIT	2020 – 2024

The typical budget approved for a Collaborative Research Center/Transregio Porject is about EUR 1 to 3 million per year of duration. The duration refers to the complete project. Partial projects at KIT may deviate.

DFG-funded Research Units with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
FOR 1993	Multifunktionale Stoff- und Energie-wandlung	Prof. Dr. Burak Atakan, Universität Duisburg-Essen (Sprecher) Prof. Dr. Olaf Deutschmann, Institut für Technische Chemie und Polymerchemie, KIT Prof. Dr. Ulrich Maas, Dr. Robert Schießl, Institut für Technische Thermodynamik, KIT	2013 – 2022

➔

➔ DFG-funded Research Units with Institutional Participation of KIT

Number	Title	Spokesperson / KIT participation	Duration
FOR 2063	The Epistemology of the Large Hadron Collider	Prof. Dr. Gregor Schiemann, Bergische Universität Wuppertal (Sprecher) Prof. Dr. Rafaela Hillerbrand, Institut für Technikfolgenabschätzung und Systemanalyse, KIT	2016 – 2022
FOR 2325	Interactions at the Neurovascular Interface	Prof. Dr. Ralf H. Adams, Max-Planck-Institut für molekulare Biomedizin, Münster (Sprecher) Prof. Dr. Ferdinand le Noble, Zoologisches Institut, KIT	2016 – 2022
FOR 2337	Denitrification in Agricultural Soils: Integrated Control and Modelling at Various Scales (DASIM)	Prof. Dr. Christoph Müller, Justus-Liebig-Universität Gießen (Sprecher) Prof. Dr. Klaus Butterbach-Bahl, Institut für Meteorologie und Klimaforschung, KIT	2016 – 2022
FOR 2397	Multiskalen-Analyse komplexer Dreiphasensysteme	Prof. Dr. Thomas Turek, Technische Universität Clausthal (Sprecher) Prof. Dr. Ulrike Krewer Institut für Angewandte Materialien, KIT	2016 – 2023
FOR 2589	Zeitnahe Niederschlagsschätzung und -vorhersage	PD Dr. Silke Trömel, Rheinische Friedrich-Wilhelms-Universität Bonn (Sprecherin) Dr. Christian Chwala, Institut für Meteorologie und Klimaforschung, KIT	2018 – 2025
FOR 2730	Umweltveränderungen in Biodiversitäts-Hotspot-Ökosystemen Süd-Ecuadors: Systemantwort und Rückkopplungs-effekte (RESPECT)	Prof. Dr. Nina Farwig Philipps-Universität Marburg (Sprecherin) Prof. Dr. Wolfgang Wilcke, Institut für Geographie und Geoökologie, KIT	2018 – 2025
FOR 2820	Revisiting The Volcanic Impact on Atmosphere and Climate – Preparations for the Next Big Volcanic Eruption	Prof. Dr. Christian von Savigny, Universität Greifswald (Sprecher) Prof. Dr. Corinna Hoose, Dr. Gholamali Hoshyaripour, Dr. Bernhard Vogel, Institut für Meteorologie und Klimaforschung, KIT	2019 – 2025
FOR 2936	Klimawandel und Gesundheit in Afrika südlich der Sahara	Prof. Dr. Rainer Sauerborn, Universitätsklinikum Heidelberg (Sprecher) Prof. Dr. Harald Kunstmann, Institut für Meteorologie und Klimaforschung, KIT	2019 – 2022

➔

RESEARCH

➔ DFG-funded Research Units with Institutional Participation of KIT

Number	Title	Spokesperson / KIT participation	Duration
FOR 3010	Multifunktionale, grobkörnige, refraktäre Verbundwerkstoffe und Werkstoffverbunde für großvolumige Schlüssel-Bauteile in Hochtemperaturprozessen	Prof. Dr. Christos Aneziris, TU Bergakademie Freiberg (Sprecher) Dr. Torben Boll, Prof. Dr. Martin Heilmaier, Prof. Dr. Michael Hoffmann, Dr. Peter Franke, Prof. Dr. Hans Jürgen Seifert, Dr. Susanne Wagner Institut für Angewandte Materialien, KIT	2020 – 2023
FOR 5199	Suche nach Verletzung der Lepton-Familienzahl mit dem Mu3e-Experiment	Prof. Dr. André Schöning Universität Heidelberg (Sprecher) Prof. Dr. Ivan Peric, Institut für Prozessdatenverarbeitung und Elektrotechnik, KIT	2021 – 2025

The typical budget approved for a DFG-funded research unit amounts to about EUR 0.4 to 1.5 million per year of duration.
The duration refers to the complete project. Partial projects of KIT may deviate.

ERC Grants

Name, institute, division	Title of group	Duration
Dr. Dominic Bresser, Helmholtz-Institut Ulm für Elektrochemische Energiespeicherung, Division I	ERC Starting Grant RACER: Highly Redox-active Atomic Centers in Electrode Materials for Rechargeable Batteries	09/2022 – 08/2027
Prof. Dr. Johannes Brumm, Institut für Volkswirtschaftslehre, Division II	ERC Starting Grant SOLG for Policy: The Old, the Young, and the Uncertain Future: Using High-Dimensional Stochastic Overlapping-Generations Models to Evaluate Fiscal Policies that Shift Risk and Resources Across Generations	10/2022 – 09/2027
Prof. Dr. Stefanie Dehnen, Institut für Nanotechnologie, Division V	ERC Advanced Grant BICMat: Bismuth Cluster-Based Materials	06/2022 – 05/2027
Prof. Dr. Sylvia Erhardt, Zoologisches Institut (ZOO), Division I	ERC Consolidator Grant cenRNA – The role of RNA in centromere biology and genome integrity	07/2016 – 06/2022
Dr. Christian Greiner, Institut für Angewandte Materialien, Division III	ERC Consolidator Grant TriboKey – Deformation Mechanisms are the Key to Understanding and Tayloring Tribological Behaviour	09/2018 – 08/2024
Dr. Lars Heinke, Institut für Funktionelle Grenzflächen, Division I	ERC Consolidator Grant DYNOCON: Dynamic Ions under Nano-Confinement for Porous Membranes with Ultrafast Gas Permeation Control	07/2022 – 06/2027

➔

➔ ERC Grants

Name, institute, division	Title of group	Duration
Prof. Dr. Inge Hinterwaldner, Institut Kunst- und Baugeschichte, Division IV	ERC Consolidator Grant COSE: Coded Secrets: Artistic Interventions Hidden in the Digital Fabric	09/2022 – 08/2027
Prof. Dr. Corinna Hoose, Institut für Meteorologie und Klimaforschung, Division IV	ERC Starting Grant C2Phase – Closure of the Cloud Phase	04/2017 – 09/2023
Prof. Dr. Christoph Kirchlechner, Institut für Angewandte Materialien, Division III	ERC Consolidator Grant TRITIME: Isolation, observation and quantification of mechanisms responsible for hydrogen embrittlement by TRITIum based microMEchanics	11/2022 – 10/2027
Prof. Dr. Christian Koos, Institut für Photonik und Quantenelektronik, Division III	ERC Consolidator Grant TeraSHAPE – Terahertz Waveform Synthesis and Analysis Using Hybrid Photonic-Electronic Circuits	05/2018 – 01/2024
Prof. Dr. Jan G. Korvink und Dr. Benno Meier, Institut für Mikrostrukturtechnik, Division III Institut für Biologische Grenzflächen, Division I	ERC Synergie Grant Highly Informative Drug Screening by Overcoming NMR Restrictions	01/2021 – 12/2026
Prof. Dr. Holger Puchta, Botanisches Institut, Division I	ERC Advanced Grant CRISBREED – Multidimensional CRISPR/Cas Mediated Engineering of Plant Breeding	10/2017 – 09/2022
Prof. Dr. Peter Sanders, Institut für Theoretische Informatik, Division II	ERC Advanced Grant ScAlBox – Engineering Scalable Algorithms for the Basic Toolbox	01/2020 – 08/2025
TT-Prof. Dr. Katharina Scherf, Institut für Angewandte Biowissenschaften, Division I	ERC Starting Grant GLUTENOMICS: Tracking gluten immunoreactive peptides from the grain to the gut and beyond	09/2022 – 08/2027
Prof. Dr. Laurent Schmalen, Communications Engineering Lab, Division III	ERC Consolidator Grant Reinventing Energy Efficiency in Communication Networks	06/2021 – 05/2026
Jun. Prof. Dr. Matti Schneider; Institut für Technische Mechanik, Division III	ERC Starting Grant BeyondRVE: Beyond Representative Volume Elements for Random Heterogeneous Materials	07/2022 – 06/2027
Dr. Frank Schröder, Institut für Astroteilchenphysik, Division V	ERC Starting Grant PeV-Radio – Digital Radio Detectors for Galactic PeV Particles	02/2019 – 01/2024
Prof. Dr. Mehdi Baradaran Tahoori, Institut für Technische Informatik, Division II	ERC Advanced Grant PRICOM: Printed Computing: Enabling Extremely Low Cost Pervasive Near Sensor Computing	10/2022 – 09/2027

➔

➔ ERC Grants

Name, institute, division	Title of group	Duration
Prof. Dr. Alexey Ustinov, Physikalisches Institut, Division V	ERC Advanced Grant MILLI-Q: Millimetre-Wave Superconducting Quantum Circuits	10/2022 – 09/2027
Dr. Tonya Vitova, Institut für Nukleare Entsorgung, Division III	ERC Consolidator Grant Actinide Bond properties in gas, liquid and solid state	02/2021 – 01/2026
Prof. Dr. Wolfgang Wernsdorfer, Physikalisches Institut, Division V	ERC Advanced Grant MoQuOS – Molecular Quantum Opto – Spintronics	07/2017 – 06/2022

The total budget of an ERC Grant ranges from EUR 1.5 million (Starting Grant) to EUR 2.5 million (Advanced Grant).

Young Investigators Groups

Emmy Noether Junior Research Groups

Name, institute, division	Title of group	Duration
Dr. Jens Bauer, Institut für Nanotechnologie, Division V	Gerichtete Architektur in Tensegrity Fachwerken: Hin zu „Muskel-Knochen" Metamaterialien	08/2022 – 07/2028
Dr. Frank Biedermann, Institut für Nanotechnologie, Division V	In vitro und in vivo Sensing von (Bio)organischen Analyten mit neuartigen Hoch-Affinitätsrezeptoren	10/2016 – 12/2022
Dr. Manuel Hinterstein, Institut für Angewandte Materialien, Division III	BNT-BT als zukünftige bleifreie Funktionswerkstoffe für PTCR-, Aktor- und Sensoranwendungen	04/2016 – 09/2023
Dr. Alexander Hinz, Institut für Anorganische Chemie, Division I	Niedrig koordinierte Hauptgruppenelement-Verbindungen und deren Einsatz in der Aktivierung von H_2, CO, CO_2 sowie NH_3	07/2020 – 06/2026
Tenure-track Prof. Dr. Felix Kahlhöfer, Institut für Theoretische Teilchenphysik, Division V	Methoden und Werkzeuge für die Analyse und Interpretation von Experimenten und kosmologischen Beobachtungen zum Nachweis Dunkler Materie	04/2022 – 06/2023
Tenure-track Prof. Dr. Rudolf Lioutikov, Institut für Anthropomatik und Robotik, Division II	Intuitive Robot Intelligence: Efficiently Learning and Improving of Explainable Skills and Behaviors for Intuitive Human-Robot Interaction	04/2021 – 05/2027
Prof. Dr. Anja Metelmann, Institut für Theorie der Kondensierten Materie, Division V	Direktionalität in Quantensystemen	04/2022 – 03/2023

➔

➔ Emmy Noether Junior Research Groups (German Research Foundation)

Name, institute, division	Title of group	Duration
Dr. Nadine Katrin Rühr, Institut für Meteorologie und Klimaforschung, Division IV	Wälder aus der Balance: Die Auswirkungen von Dürre und Baumsterben auf den Kohlenstoff- und Wasserkreislauf (Fortführung 2)	10/2016 – 05/2022
Tenure-track Prof. Dr. Barbara Verfürth, Institut für Angewandte und Numerische Mathematik, Division V	Numerische Methoden für nichtlineare, zufällige und dynamische Mehrskalenprobleme	06/2022 – 09/2022
Dr. Belina von Krosigk, Institut für Astroteilchenphysik, Division V	Suchen nach Dunkler Materie jenseits des WIMPs und Verbesserung des Trigger und DAQ Systems von SuperCDMS SNOLAB (1. Förderperiode)	11/2021 – 06/2025
Tenure-track Prof. Dr. Philip Willke, Physikalisches Institut, Division V	Quantenkohärente Kontrolle atomarer und molekularer Spins auf Oberflächen	10/2020 – 09/2026
Dr. Karsten Woll, Institut für Angewandte Materialien, Division III	Gepulste Metallurgie an metallischen Dünnschichten	01/2017 – 07/2022

Average total budget of an Emmy Noether Group: EUR 1.2 million to 1.8 million plus valid program lump sum.

Helmholtz Young Investigators Groups

Name, institute, division	Title of group	Duration
Prof. Dr. Hartwig Anzt, Steinbuch Centre for Computing, Division II	Fixed-Point Methods for Numerics at Exascale (FiNE)	05/2017 – 04/2023
Dr. Anna Böhmer, Institut für Quantenmaterialien und Technologien, Division V	Strain Tuning of Correlated Electronic Phases	10/2017 – 09/2022
Tenure-track Prof. Dr. Giovanni De Carne, Institut für Technische Physik, Division III	Hybrid Networks: a multi-modal design for the future energy system	07/2021 – 06/2026
Prof. Dr. Torben Ferber, Institut für Experimentelle Teilchenphysik, Division V	Searches for Dark Matter and Axion-Like Particles at Belle II	01/2022 – 02/2024
Jun. Prof. Dr. Christian Grams, Institut für Meteorologie und Klimaforschung, Division IV	Sub-seasonal atmospheric predictability: understanding the role of diabatic outflow	10/2017 – 09/2022

➔

RESEARCH

➔ Helmholtz Young Investigators Groups

Name, institute, division	Title of group	Duration
Dr. Emma Järvinen, Institut für Meteorologie und Klimaforschung, Division IV	Solving the Cirrus Cloud Puzzle – Do Cirrus Warm or Cool Our Climate?	04/2020 – 03/2026
Dr. Martina Klose, Institut für Meteorologie und Klimaforschung, Division IV	A big unknown in the climate impact of atmospheric aerosol: Mineral soil dust	11/2020 – 10/2026
Dr. Benno Meier, Institut für Biologische Grenzflächen, Division I	Hyperpolarized Magnetic Resonance	03/2019 – 02/2025
Tenure-track Prof. Dr. Ulrich Wilhelm Paetzold, Institut für Mikrostrukturtechnik, Division III	Nanophotonics for Perovskite/Silicon Multijunction Solar Cells	05/2016 – 05/2022
Dr. Benjamin Schäfer, Institut für Automation und angewandte Informatik, Division II	Data-Driven Analysis of Complex Systems for a Sustainable Future	01/2022 – 12/2026
Dr. Manuel Tsotsalas, Institut für Funktionelle Grenzflächen, Division I	Hierarchically Structured Biomaterials	01/2016 – 12/2022

The annual budget of a group typically is EUR 1.25 to 1.8 million.

BMBF Junior Research Groups

Name, institute, division	Title of group	Duration
Dr. Simon Fleischmann, Helmholtz-Institut Ulm, Division I	InfinBat: Zwischenschicht-funktionalisierte Materialien für neuartige elektrochemische Interkalationsbatterien	11/2021 – 10/2026
Tenure-track Prof. Dr. Julia Maibach, Institut für Angewandte Materialien, Division III	InSEIde – Künstliche SEI: Grenzflächen in Lithium-Ionen Batterien verstehen und manipulieren	09/2017 – 09/2022
Dr. Florian Strauss, Institut für Nanotechnologie, Division V	Maßgeschneiderte Elektrolyte für Lithium Feststoffbatterien	03/2022 – 02/2027

The annual budget of a group typically is EUR 1.5 to 3.2 million.

Freigeist Fellowship

Name, institute, division	Title of group	Duration
Dr. Susanne Benz, Institut für Photogrammetrie und Fernerkundung, Division IV	Large scale assessment of the effects of sustainable heat recycling in the shallow sub-surface on above ground temperature	10/2022 – 09/2028

Typical total budget per group: EUR 1 to 2.2 million.

KIT Young Investigators Group

Name, institute, division	Title of group	Duration
Dr. Luise Kärger, Institut für Fahrzeugsystem-technik, Division III	Gewichtsoptimierte Fahrzeugstrukturen durch maßgeschneiderte Hochleistungsfaserverbunde (gefördert durch die Vector Stiftung)	07/2014 – 06/2022

The annual budget is EUR 80 000 plus a non-recurrent investment allowance in the amount of EUR 50 000.

Industry Fellowship (IF)

Name, institute, division	Title of group	Duration
Dr. Frederik Zanger, wbk Institut für Produktionstechnik, Division III	Optimierte Prozesse und Prozessketten für additiv gefertigte Bauteile (OptiPro²Addi)	10/2019 – 09/2022

KIT junior research groups in cooperation with industry, funding levels vary, at least 50% of the funds come from the industry partner.

Other Recognized KIT Young Investigators Groups (Junior Research Groups) and Funding

Name, institute, division	Title of group	Duration	Funding
Dr. Cihan Ates, Institut für Thermische Strömungsmaschinen, Division III	Machine Intelligence in Energy Systems (MAI)	03/2022 – 03/2024	DFG, Baden-Württemberg-Stiftung
Dr. Claudia Bizzarri, Institut für Organische Chemie, Division I	Künstliche Photosynthese	12/2021 – 08/2023	CRC/TRR and others
Dr. Dominic Bresser, Helmholtz-Institut Ulm, Division I	Neuartige Elektrodenmaterialien für Wiederaufladbare Elektrochemische Energiespeicher (NEW E²)	05/2017 – 04/2023	Vector Stiftung
Dr. Björn de Rijk, Institut für Analysis, Division V	Stability of Nonlinear Waves	08/2022 – 12/2024	CRC „Wellen-phänomene“; DFG

→

RESEARCH

➔ Other Recognized KIT Young Investigators Groups (Junior Research Groups) and Funding

Name, institute, division	Title of group	Duration	Funding
Dr. Azad M. Emin, Institut für Bio- and Lebensmitteltechnik, Division I	Extrusion of Biopolymeric Systems	08/2016 – 07/2022	DFG and others
Dr. Jan Haußmann, Institut für Produktentwicklung, Division III	Sensorbasierte Brennstoffzellenentwicklung	05/2022 – 11/2025	MWK
Dr. Robert Heinrich, Institut für Programmstrukturen and Datenorganisation, Division II	Quality-driven System Evolution	03/2018 – 04/2023	MWK and BMBF
Dr. Daniel Hoang, Institut für Finanzwirtschaft, Banken and Versicherungen, Division II	Unternehmensfinanzierung	10/2016 – 10/2022	DFG, Funk Stiftung
Dr. Sebastian Käfer, Institut für Angewandte Informatik and Formale Beschreibungsverfahren, Division II	Knowledge Graph-based Artificial Intelligence Systems	02/2021 – 12/2026	BMBF
Dr. Mathias Krause, Institut für Angewandte and Numerische Mathematik 2/ Institut für Mechanische Verfahrenstechnik and Mechanik, Division V and III	Lattice Boltzmann Research Group	05/2018 – 04/2024	DFG and others
Dr. Sebastian Lerch, Institut für Volkswirtschaftslehre – Statistik and Ökonometrie, Division II	Artificial Intelligence for Probabilistic Weather Forecasting	05/2021 – 03/2025	Vector Stiftung
Dr. Axel Loewe, Institut für Biomedizinische Technik, Division III	Computational Cardiac Modelling	11/2018 – 12/2024	DFG and MWK
Dr. Ralf Loritz, Institut für Wasser and Gewässerentwicklung, Division IV	Energy and information flows in hydrological systems	10/2022 – 03/2028	VW-Stiftung
Dr. Rainer Mandel, Institut für Analysis, Division V	Nichtlineare Helmholtzgleichungen	05/2017 – 06/2022	Junior research group within a CRC
Dr. Kathrin Menberg, Institut für Angewandte Geowissenschaften, Division IV	Nachhaltige Geoenergie	05/2022 – 09/2025	MWK and others

➔

➔ Other Recognized KIT Young Investigators Groups (Junior Research Groups) and Funding

Name, institute, division	Title of group	Duration	Funding
Dr. Klarissa Niedermeier, Institut für Thermische Energietechnik and Sicherheit, Division III	Wärmespeicher auf Flüssigmetallbasis – Schlüssel für CO_2-freie Hochtemperaturprozesse	04/2022 – 01/2024	BMWi
Dr. Claudia Niessner, Institut für Sport and Sportwissenschaft, Division II	Health Related Fitness and Physical Mobility in children, youth and young adulthood	12/2021 – 04/2024	MWK and others
Dr. Somidh Saha, Institut für Technikfolgenabschätzung and Systemanalyse, Division II	Sylvanus	08/2019 – 12/2024	BMBF and others
Dr. Thomas Sheppard, Institut für Technische Chemie and Polymerchemie, Division I	X-ray Microscopy in Catalysis	02/2020 – 03/2025	BMBF and others
Dr. Zbigniew Pianowski, Institut für Organische Chemie, Division I	Chemical Biology, Supramolecular Systems and Prebiotic Chemistry	11/2021 – 04/2022	DFG department
Dr. Alexander Stroh, Institut für Strömungsmechanik, Division III	Multiphase flows and heat transfer	05/2022 – 06/2025	DFG, BMBF
Dr. Ulrike van der Schaaf, Institut für Bio- and Lebensmitteltechnik, Division I	Interfacial properties of pectin-based biopolymers	10/2020 – 10/2022	Arbeitsgemeinschaft industrieller Forschungsvereinigungen
Dr. Barbara Verfürth, Institut für Angewandte and Numerische Mathematik, Division V	Numerical analysis of multiscale methods	02/2021 – 09/2022	CRC
Dr. Ruming Zhang, Institut für Angewandte and Numerische Mathematik, Division V	Waves in Periodic Structures	05/2021 – 01/2023	DFG Individual Research Grant
Dr. Christian Zillinger, Institut für Analysis, Division V	Stabilität and Instabilität in Flüssigkeiten and Materialien	08/2022 – 07/2024	CRC „Wellenphänomene“

RESEARCH

Junior Professorships

Name, institute, division	Area	Duration
Tenure-track Prof. Dr. Thomas Bläsius, Institut für Theoretische Informatik, Division II	Skalierbare Algorithmik und Verfahren für große Datenmengen	10/2020 – 09/2026
Tenure-track Prof. Dr. Giovanni De Carne, Institut für Technische Physik, Division III	Echtzeitsysteme in der Energietechnik	11/2022 – 11/2028
Tenure-track Prof. Moritz Dörstelmann, Institut Entwerfen und Bautechnik, Division IV	Digital Design and Fabrication	04/2021 – 03/2027
Tenure-track Prof. Dr. Yolita Eggeler, Laboratorium für Elektronenmikroskopie, Division V	Elektronenmikroskopie	10/2020 – 09/2026
Tenure-track Prof. Dr. Pascal Friederich, Institut für Theoretische Informatik, Division II	KI-Methoden in der Materialwissenschaft	12/2019 – 12/2025
Jun. Prof. Dr. Christian Grams, Institut für Meteorologie und Klimaforschung, Division IV	Meteorologie	02/2022 – 01/2028
Tenure-track Prof. Dr. Schirin Hanf, Institut für Anorganische Chemie, Division I	Fundamentale Anorganische Chemie: Nachhaltige Nutzung von Metallen	11/2021 – 10/2027
Tenure-track Prof. Dr. Lennart Hilbert, Zoologisches Institut, Division I	Systembiologie/Bioinformatik	10/2018 – 09/2024
Tenure-track Prof. Dr. Felix Kahlhöfer, Institut für Theoretische Teilchenphysik, Division V	Theoretische Teilchenphysik	04/2022 – 03/2028
Tenure-track Prof. Dr. Christoph Klahn, Institut für Mechanische Verfahrenstechnik und Mechanik, Division I	Prozessintensivierung in der Verfahrenstechnik durch Additive Fertigung	05/2021 – 05/2027
Tenure-track Prof. Dr. Britta Klopsch, Institut für Schulpädagogik und Didaktik, Division II	Schulpädagogik	04/2020 – 03/2026
Tenure-track Prof. Dr. Manuel Krannich, Institut für Algebra und Geometrie, Division V	Geometrie	04/2022 – 03/2028
Tenure-track Prof. Dr. Sebastian Krumscheid, Steinbuch Centre for Computing, Division V	Uncertainty Quantification	08/2022 – 08/2025

→

➔ Junior Professorships

Name, institute, division	Area	Duration
Tenure-track Prof. Dr. Xian Liao, Institut für Analysis, Division V	Analysis Partieller Differentialgleichungen	11/2018 – 07/2025
Tenure-track Prof. Dr. Rudolf Lioutikov, Institut für Anthropomatik und Robotik, Division II	Maschinelles Lernen und Robotik	12/2022 – 11/2028
Jun. Prof. Dr. Claudio Llosa Isenrich, Institut für Algebra und Geometrie, Division V	Geometrie	10/2020 – 09/2026
Jun. Prof. Dr. Reza Maalek, Institut für Technologie und Management im Baubetrieb, Division IV	Digital Engineering and Construction	11/2020 – 10/2026
Tenure-track Prof. Dr. Julia Maibach, Institut für Angewandte Materialien, Division III	Keramische Werkstoffe	11/2021 – 09/2022
Jun. Prof. Dr. Franziska Mathis-Ullrich, Institut für Anthropomatik und Robotik, Division II	Medizinrobotik	04/2019 – 04/2025
Tenure-track Prof. Dr. Ulrich Wilhelm Paetzold, Lichttechnisches Institut, Division III	Next Generation Photovoltaics	03/2021 – 02/2027
Jun. Prof. Dr. Rania Rayyes, Institut für Fördertechnik und Logistiksysteme, Division III	Hoch wandlungsfähiges, flächen- und raumbewegliches System für die Produktion	12/2022 – 12/2028
Tenure-track Prof. Dr. Katharina Scherf, Institut für Angewandte Biowissenschaften, Division I	Bioaktive und funktionelle Lebensmittelinhaltsstoffe	08/2019 – 07/2025
Jun. Prof. Dr. Matti Schneider, Institut für Technische Mechanik, Division III	Computational Micromechanics	09/2021 – 08/2023
Jun. Prof. Dr. Maike Schwammberger, Institut für Informationssicherheit und Verlässlichkeit, Division II	Modellierung und Analyse im Mobility Software Engineering	12/2022 – 12/2028
Tenure-track Prof. Dr. Helge Sören Stein, Institut für Physikalische Chemie, Division I	Angewandte Elektrochemie	06/2020 – 05/2026
Jun. Prof. Dr. Jan Stühmer, Institut für Anthropomatik und Robotik, Division II	Maschinelles Lernen	09/2022 – 08/2028

➔

➔ Junior Professorships

Name, institute, division	Area	Duration
Tenure-track Prof. Dr. Julian Thimme, Institut für Finanzwirtschaft, Banken und Versicherungen, Division II	Finance	08/2019 – 07/2025
Tenure-track Prof. Dr. Nevena Tomašević Institut für Angewandte Geowissen-schaften, Division IV	Allgemeine Geologie	04/2021 – 03/2027
Tenure-track Prof. Dr. Barbara Verfürth, Institut für Angewandte und Numerische Mathematik, Division V	Numerik partieller Differenzialgleichungen	02/2022 – 09/2022
Jun. Prof. Dr. Ingo Wagner, Institut für Schulpädagogik und Didaktik, Division II	Interdisziplinäre Didaktik der MINT-Fächer und des Sports	10/2018 – 09/2024
Tenure-track Prof. Dr. Philip Willke, Physikalisches Institut, Division V	Quantenkontrolle von Spins auf Oberflächen	05/2022 – 04/2028
Tenure-track Prof. Dr. Moritz Wolf, Engler-Bunte-Institut, Division I	Katalysatormaterialien für die Energiewende	05/2022 – 04/2028
Tenure-track Prof. Dr. Christian Wressnegger, Institut für Informationssicherheit und Verlässlichkeit, Division II	KI-Methoden in der IT-Sicherheit	12/2019 – 11/2025

Graduate Schools Funded by the German Research Foundation (DFG), Helmholtz Association (HGF) or Federal Ministry of Education and Research (BMBF)

Graduate School	Funded by	Spokesperson / participant	Duration
Graduate School „Electrochemical Energy Storage“	DFG	Prof. Dr. Jürgen Behm, Universität Ulm (Sprecher) apl. Prof. Christine Kranz, Universität Ulm (Co-Sprecherin) Prof. Dr. Rolf Schuster, Institut für Physikalische Chemie, KIT (Co-Sprecher)	2019 – 2025

➔

➔ Graduate Schools Funded by the German Research Foundation (DFG), Helmholtz Association (HGF) or Federal Ministry of Education and Research (BMBF)

Graduate School	Funded by	Spokesperson / participant	Duration
HEiKA Graduate School „Functional Materials“	DFG	Prof. Dr. Martin Wegener, Institut für Angewandte Physik/ Institut für Nanotechnologie, KIT (Sprecher) Prof. Dr. Uwe Bunz, Universität Heidelberg (Co-Sprecher)	2019 – 2025
HIDSS4Health: Helmholtz Information and Data Science School for Health	HGF	Prof. Dr. Ralf Mikut, Institut für Automation und angewandte Informatik, KIT	2019 – 2025
MPSP: Max Planck School of Photonics	BMBF	Prof. Dr. David Hunger, Physikalisches Institut, KIT Prof. Dr. Christian Koos, Institut für Mikrostrukturtechnologie, KIT Prof. Dr. Uli Lemmer, Lichttechnisches Institut, KIT Prof. Dr. Uli Nienhaus, Institut für Angewandte Physik, KIT Prof. Dr. Carsten Rockstuhl, Institut für Theoretische Festkörperphysik, KIT Prof. Dr. Martin Wegener, Institut für Angewandte Physik, KIT	2019 – 2025

Graduate Schools of KIT

Graduate School	Funded by	Spokesperson / participant	Duration
CyberSec: KIT Graduate School Cyber Security	Funded in the Framework of the Excellence Strategy	Tenure-track Prof. Dr. Christian Wressnegger, Institut für Informationssicherheit und Verlässlichkeit, KIT Prof. Dr. Thorsten Strufe, Institut für Informationssicherheit und Verlässlichkeit, KIT	2021 – 2026 funding duration 5 years
KCDS: KIT Graduate School Computational and Data Science	Funded in the Framework of the Excellence Strategy	Prof. Dr. Martin Frank, Steinbuch Centre for Computing, KIT	2021 – 2026 funding duration 5 years

➔

➔ **Graduate Schools of KIT**

Graduate Schools	Funded by	Spokesperson / participant	Duration
ENZo: KIT Graduate School Enabling Net Zero	Funded in the Framework of the Excellence Strategy	Prof. Dr.-Ing. Jörg Sauer, Institut für Katalyseforschung und -technologie, KIT	2021 – 2026 funding duration 5 years
KSQM: KIT Graduate School of Quantum Matter	Funded in the Framework of the Excellence Strategy	Prof. Dr. Markus Garst, Institut für Theoretische Festkörperphysik / Institut für QuantenMaterialien und Technologien, KIT	2021 – 2026 funding duration 5 years
UpGrade Mobility: KIT Graduate School UpGrade Mobility	Funded in the Framework of the Excellence Strategy	Prof. Dr. Frank Gauterin, Institut für Fahrzeugsystemtechnik, KIT	2021 – 2025 funding duration 5 years
CuKnow: KIT Graduate School Cultures of Knowledge	Funded in the Framework of the Excellence Strategy	Prof. Dr. Ingrid Ott, Institut für Volkswirtschaftslehre, KIT Prof. Dr. Darko Jekauc, Institut für Sport und Sportwissenschaft, KIT	2021 – 2025 funding duration 5 years
KSOP: Karlsruhe School of Optics & Photonics	KIT	Prof. Dr. Ulrich Lemmer, Lichttechnisches Institut, KIT	Since 2006 Meanwhile perpetuated
KSETA: Karlsruhe School of Elementary Particle and Astroparticle Physics: Science and Technology	KIT	Prof. Dr. Ulrich Nierste, Institut für Theoretische Teilchenphysik, KIT	Since 2012 Meanwhile perpetuated
GRACE: Graduate School for Climate and Environment	KIT	Prof. Dr.-Ing. Stefan Hinz, Institut für Photogrammetrie und Fernerkundung, KIT	Since 2011 Meanwhile perpetuated
BIF-IGS: BioInterfaces International Graduate School	KIT	Prof. Dr. Nicholas Foulkes, Institut für Biologische und Chemische Systeme – Biologische Informationsprozessierung, KIT	Since 2011 Meanwhile perpetuated

Research Training Groups Funded by the DFG or Helmholtz Association

Research training group	Funded by	Spokesperson / participant	Duration
Molecular Architectures for Fluorescent Cell Imaging	DFG	Prof. Dr. Hans-Achim Wagenknecht, Institut für Organische Chemie, KIT	2015 – 2024
Integrated Engineering of Continuous-Discontinuous Long Fiber Reinforced Polymer Structures	DFG	Prof. Dr. Thomas Böhlke, Institut für Technische Mechanik, KIT gemeinsam mit: University of Waterloo, University of Western Ontario, University of Windsor (alle Kanada)	2015 – 2024
Energy Status Data – Informatics Methods for its Collection, Analysis and Exploitation	DFG	Prof. Dr. Klemens Böhm, Institut für Programmstrukturen und Datenorganisation, KIT	2016 – 2025
Asymptotic Invariants and Limits of Groups and Spaces	DFG	Prof. Dr. Roman Sauer, Institut für Algebra und Geometrie, KIT gemeinsam mit: Prof. Dr. Anna Wienhard, Mathematisches Institut, Ruprecht-Karls-Universität Heidelberg	2016 – 2025
SiMET: Simulation Mechano-Electro-Thermal Processes in Lithium-Ion Batteries	DFG	Prof. Dr. Thomas Wetzel, Institut für Thermische Verfahrenstechnik, KIT	2017 – 2026
Tailored Scale-Bridging Approaches to Computational Nanoscience	DFG	Prof. Dr. Marcus Elstner, Institut für Physikalische Chemie, KIT	2019 – 2023
MatCom-ComMat: Materials Compounds from Composite Materials for Applications in Extreme Conditions	DFG	Prof. Dr. Martin Heilmaier, Institut für Angewandte Materialien, KIT	2020 – 2024
KD²School: Graduate School on Adaptive Systems	DFG	Prof. Dr. Christof Weinhardt, Institut für Wirtschaftsinformatik und Marketing, KIT	2021 – 2026
Helmholtz International Research School for Astroparticle Physics and Enabling Technologies (HIRSAP)	HGF	Prof. Dr. Ralph Engel, Institut für Astroteilchenphysik, KIT	2018 – 2024
Helmholtz Information and Data Science School for Health (HIDSS4HEALTH)	HGF	Prof. Dr. Ralf Mikut, Institute for Automation and Applied Informatics, KIT	2019 – 2025

Innovation

Innovation Characteristics

Year	Invention disclosures	Priority-establishing patent applications	Property rights (existing)	Royalties [million euros]	New companies (spinoffs)	Participation in spinoffs
2018	115	63	1 949	1.57	21 (7)	9
2019	97	40	1 889	1.27	50 (9)	9
2020	105	50	1 772	2.05	28 (7)	9
2021	120	51	1 677	4.42	37 (12)	9
2022	91	43	1 654	1.79	48 (18)	9

Establishments of New Companies

Spinoffs
aiCorn GmbH
Bolt Engineering GmbH
CaBIDI Drug Delivery UG
Ceprici
DishDetective GbR
FastCast Ceramics GbR
femfeel GmbH
I3motion gGmbH
Icodos GmbH
Inventife GbR
MonKI Solutions GmbH
Mosaic Grid Solutions GmbH
Nanoshape GmbH
Neocargo AG
SADEN GmbH
Semor.ai GbR
TeachIt UG
Turn.Energy GmbH

Startups
101 Schoolware GmbH
Agile Software Design GmbH
AISIO Ventures UG
Athene Assets UG
BitBloX UG
Block Space Ventures UG
Cellgrid UG
Charging Mobility UG
DareDevelop UG
DropEffect GmbH
Halotec Membrane UG
Kaverio GmbH
KUTI - IT UG
Lauser Media UG
Mable GmbH
MaDeCa Gbr
midpage.ai GmbH
MyVerse GmbH
OVAO Ventures GmbH
patena Technologies GmbH
Phaentrik GmbH
Player One GmbH
Primary Target GmbH

Startups
Refarm GmbH
Stellavert UG
Symp UG
Traggert GmbH
train & code GmbH
uCore Systems GmbH
WhackApps UG

AWARDS

External Awards

(see separate chapter of this Annual Report from page 110)

KIT Department Teaching Awards

KIT Department	Award winners
Architecture	Dr. Dr. Jesús Muñoz Morcillo
Civil Engineering, Geo- and Environmental Sciences	Dr. Elisabeth Eiche
Chemistry and Biosciences	Prof. Dr. Willem Klopper
Chemical and Process Engineering	Dr. Detlef Nattland and Janet Herold
Electrical Engineering and Information Technology	Prof. Dr. Marc Hiller
Humanities and Social Sciences	Jun. Prof. Dr. Ingo Wagner
Informatics	Dr. Yvonne Matz
Mechanical Engineering	Prof. Dr. Bettina Frohnapfel and Prof. Dr. Thomas Böhlke
Mathematics	Dr. Rafael Dahmen
Physics	Kirsten Eilert and Andreas Schubert
Economics and Management	Prof. Dr. Nora Szech

Awards for Doctoral Researchers

KIT Doctoral Awards

Name	Institute
Dr. rer. nat. Vincent Hahn	Institut für Angewandte Physik
Dr. rer. nat. Ansgar Pausch	Institut für Physikalische Chemie
Dr. rer. nat. Tanja Portele	Institut für Meteorologie und Klimaforschung – Atmosphärische Umweltforschung

Other Doctoral Awards

Name	Institute	Institution
Dr.-Ing. Gabriela Molinar	Institut für Technik der Informationsverarbeitung	Förderpreis der Friedrich und Elisabeth Boysen-Stiftung
Dr.-Ing. Sina Peukert	Institut für Produktionstechnik	Südwestmetall-Förderpreis
Dr.-Ing. Alina Roitberg	Institut für Anthropomatik und Robotik	Helmholtz-Promotionspreis 2022

MEDIA/PUBLICATIONS

Development of Visibility in the Media

	2018	2019	2020 *	2021	2022
Printed articles	20 133	24 739	17 837	20 384	21 452
Online articles	20 721	19 375	15 598	20 109	19 149

* Due to the pandemic, interest of the media mainly focused on medical issues / KIT has no Department of Medicine.

Publications

Publications in the year	2018	2019	2020	2021	2022
Publications of researchers of KIT	10 028	10 148	8 543	9 442	9 159
of these, books and proceedings	985	1 078	1 034	1 241	1 257
of these, articles in proceedings	1 465	1 385	1 064	1 349	1 175
of these, articles in journals	3 960	4 424	4 392	4 628	4 276
of these, in WoS- or Scopus-referenced journals	3 622	4 110	4 048	4 344	4 053
of these, open access articles	2 433	2 841	3 209	3 512	3 167

Rankings

National Rankings

		2018	2019	2020	2021	2022
Wirtschaftswoche	Electrical Engineering	2	3	5	5	5
	Informatics	1	2	4	4	4
	Mechanical Engineering	2	3	3	4	4
	Natural Sciences	7	8	10	9	8
	Business Engineering	2	2	2	2	3

International Rankings

		2018	2019	2020	2021	2022
National Taiwan University Ranking	International – Overall	216	228	251	249	276
	International – Natural Sciences	62	67	70	80	102
	International – Engineering Sciences	95	106	101	115	154
	National – Overall	19	19	21	20	25
	National – Natural Sciences	1	1	1	1	3
	National – Engineering Sciences	1	1	1	1	4
QS World University Rankings	International – Overall	116	124	131	136	141
	International – Natural Sciences	37	48	58	53	48
	International – Engineering Sciences & IT	51	59	68	70	56
	National – Overall	4	5	6	6	6
	National – Natural Sciences	4	3	4	3	3
	National – Engineering Sciences	4	4	4	4	4
Times Higher Education	International – Overall	135	175	201–250	180	189
	International – Natural Sciences	69	69	70	77	100
	International – Engineering Sciences	54	74	78	56	64
	National – Overall	14	20	19–23	18–20	19–20
	National – Natural Sciences	5	7	7	8	8
	National – Engineering Sciences	3	4	4	4	4
Academic Ranking of World Universities	International – Overall	201–300	201–300	201–300	201–300	201–300
	International – Natural Sciences	–	–	–	–	–
	International – Engineering Sciences	–	–	–	–	–
	National – Overall	15–20	11–21	11–19	11–20	11–20

SUSTAINABILITY

CO_2 Emissions Resulting from Energy Supply* of All KIT Campuses, Dual Reporting According to the Greenhouse Gas Protocol (GHGP) for Electrical Power

Campus North	2018	2019	2020	2021	2022
Use of natural gas for heat/cold/power	39 940	40 187	41 644	50 141	39 767
Power consumption (according to current supplier – market-specific)	12 559	10 499	9 309	7 141	11 251
Reference power (federal power mix – site-specific)	20 102	16 316	13 591	13 270	16 738

* All CO_2-equivalent emissions, including upstream chains

Campuses South, West, East	2018	2019	2020	2021	2022
Use of natural gas for heat/cold/power	373	450	548	635	338
Power consumption (according to current supplier – market-specific)	2 970	2 808	2 800	2 679	2 793
Reference power (federal power mix – site-specific)	28 875	24 840	21 900	22 795	23 765
District heat consumption	3 780	3 479	2 911	4 312	3 582

Campus Alpine	2018	2019	2020	2021	2022
Use of natural gas for heat/cold/power	403	440	384	410	343
Power consumption (according to current supplier – market-specific)	37	31	33	33	34
Reference power (federal power mix – site-specific)	360	272	257	284	290

Energy Consumption and Energy Production of KIT

Type of energy / Campus North	2018	2019	2020	2021	2022
Primary energy consumption (natural gas)* [GWh]	161.7	162.7	168.6	203	161
Electricity from the public grid* [GWh]	82.3	78.8	76.3	68	78.9
Installed el. capacity, cogeneration/trigeneration plants [MW]	13	13	13	13	13
Electricity produced by own cogeneration/trigeneration plants [GWh]	43.2	44.1	47	58.9	45.5
Installed photovoltaics capacity [MW]	1	1	1.2	1.2	1.4
Electricity produced by own photovoltaics facilities [GWh]	1.1	0.9	0.9	1.2	1.1
Heat produced* (excluding heat for thermal refrigeration plants) [GWh]	73.1	76.6	76	83	67
District heating from public grid [GWh]	–	–	–	–	–

* For CN, including third institutions on campus

Type of energy / Campuses South, West, East	2018	2019	2020	2021	2022
Primary energy consumption (natural gas) [GWh]	1.51	1.82	2.22	2.57	1.37
Electricity from the public grid [GWh]	55	54	50	47	49
Installed el. capacity, cogeneration/trigeneration plants [MW]	0.21	0.21	0.21	0.21	0.21
Electricity produced by own cogeneration/trigeneration plants [GWh]	0.48	0.59	0.72	0.83	0.44
Installed photovoltaics capacity [MW]	–	–	–	0.03	0.11
Electricity produced by own photovoltaics facilities [GWh]	–	–	–	–	–
Heat produced (excluding heat for thermal refrigeration plants) [GWh]	0.62	0.75	0.82	0.93	0.57
District heating from public grid [GWh]	45	49	41	49	41

Type of energy / Campus Alpine	2018	2019	2020	2021	2022
Primary energy consumption (natural gas) [GWh]	1.63	1.78	1.55	1.66	1.39
Electricity from the public grid [GWh]	0.69	0.59	0.59	0.59	0.60
Installed el. capacity, cogeneration/trigeneration plants [MW]	0.05	0.05	0.05	0.05	0.05
Electricity produced by own cogeneration/trigeneration plants [GWh]	0.37	0.38	0.41	0.39	0.33
Installed photovoltaics capacity [MW]	–	–	–	–	–
Electricity produced by own photovoltaics facilities [GWh]	–	–	–	–	–
Heat produced (excluding heat for thermal refrigeration plants) [GWh]	–	0.73	0.72	0.76	0.52
District heating from public grid [GWh]	–	–	–	–	–

Supply and Waste Management Services

Type of service / Campus North	2018	2019	2020	2021	2022
Electricity consumption KIT (excl. grid losses) [GWh]	79	77	74	82	76
Heat consumption KIT* [GWh]	38	40	35	42	35
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	42	42	40	38	39
Water supply [m³]	99 759	86 058	74 182	81 407	91 289
Compressed air generation [10^6 m³]	6.29	6.04	5.79	6.03	6.25
Wastewater disposal** [m³]	90 278	84 009	83 702	77 501	82 270
Waste disposal KIT**/*** [t]	19 978	12 370	4 664	4 073	5 515

* (excluding grid losses and without heat consumption of thermal refrigeration plants)
** For CN, including third institutions on campus
*** Quantities of residual waste CS, CW, CE, for recyclables CW, CE, and from 2018 for data-protected material on all campuses are lacking. Companies are not able to provide any weights of these wastes.

Type of service / Campuses South, West, East	2018	2019	2020	2021	2022
Electricity consumption KIT (excl. grid losses) [GWh]	55	54	50	47	49
Heat consumption KIT* [GWh]	45	49	41	49	41
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	50	51	46	44	45
Water supply [m³]	229 100	220 941	198 573	165 027	201 188
Waste disposal KIT**/*** [t]	899	1 629	1 125	1 115	1 001

* (excluding grid losses and without heat consumption of thermal refrigeration plants)
** For CN, including third institutions on campus
*** Quantities of residual waste CS, CW, CE, for recyclables CW, CE, and from 2018 for data-protected material on all campuses are lacking. Companies are not able to provide any weights of these wastes.

Type of service / Campus Alpine	2018	2019	2020	2021	2022
Electricity consumption KIT (excl. grid losses) [GWh]	1.06	0.97	0.99	0.98	0.93
Heat consumption KIT* [GWh]	–	0.73	0.73	0.78	0.53
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	–	0.70	0.65	0.71	0.58
Water supply [m³]	873	932	865	605	875

* (excluding grid losses and without heat consumption of thermal refrigeration plants)

Central Fleet of KIT Vehicles on CN, CS, CW, CE, Including Trucks for Transporting Loads and Special Vehicles

	2018	2019	2020	2021	2022
Vehicles (centrally administrated cars, mini-buses/vans, buses, trucks, special vehicles)	131	132	134	129	129
Vehicles with a combustion engine (of these, hybrid)	125	123	114 (1)	104 (8)	104 (9)
Battery vehicles	4	7	18	23	23
Fuel cell vehicles (H2 buses for KIT shuttle services)	2	2	2	2	2
Average CO_2 emission factor of the fleet [gCO_2/km]	167	166	147	136	133
Gasoline consumption of the fleet [l]	24 395	22 306	16 626	17 097	21 724
Diesel consumption of the fleet [l]	71 192	59 732	41 980	36 145	32 639
Hydrogen consumption of the fleet [kg]	4 231	5 039	1 830	6 567	5 734
Driven kilometers of the fleet	1 091 128	1 009 567	541 073	618 383	738 018
CO_2 emissions resulting from fuel use, including upstream chains [tCO_2 p.a.]	349	316	203	245	236

Use of Shared Cars

	2018	2019	2020	2021	2022
Trips	973	1 502	887	1 496	3 016
Km	259 240	457 560	216 533	384 259	771 274
CO_2 emissions [tCO_2 p.a.]	33	57	27	48	111
Company ebikes	n.a.	6	6	6	6

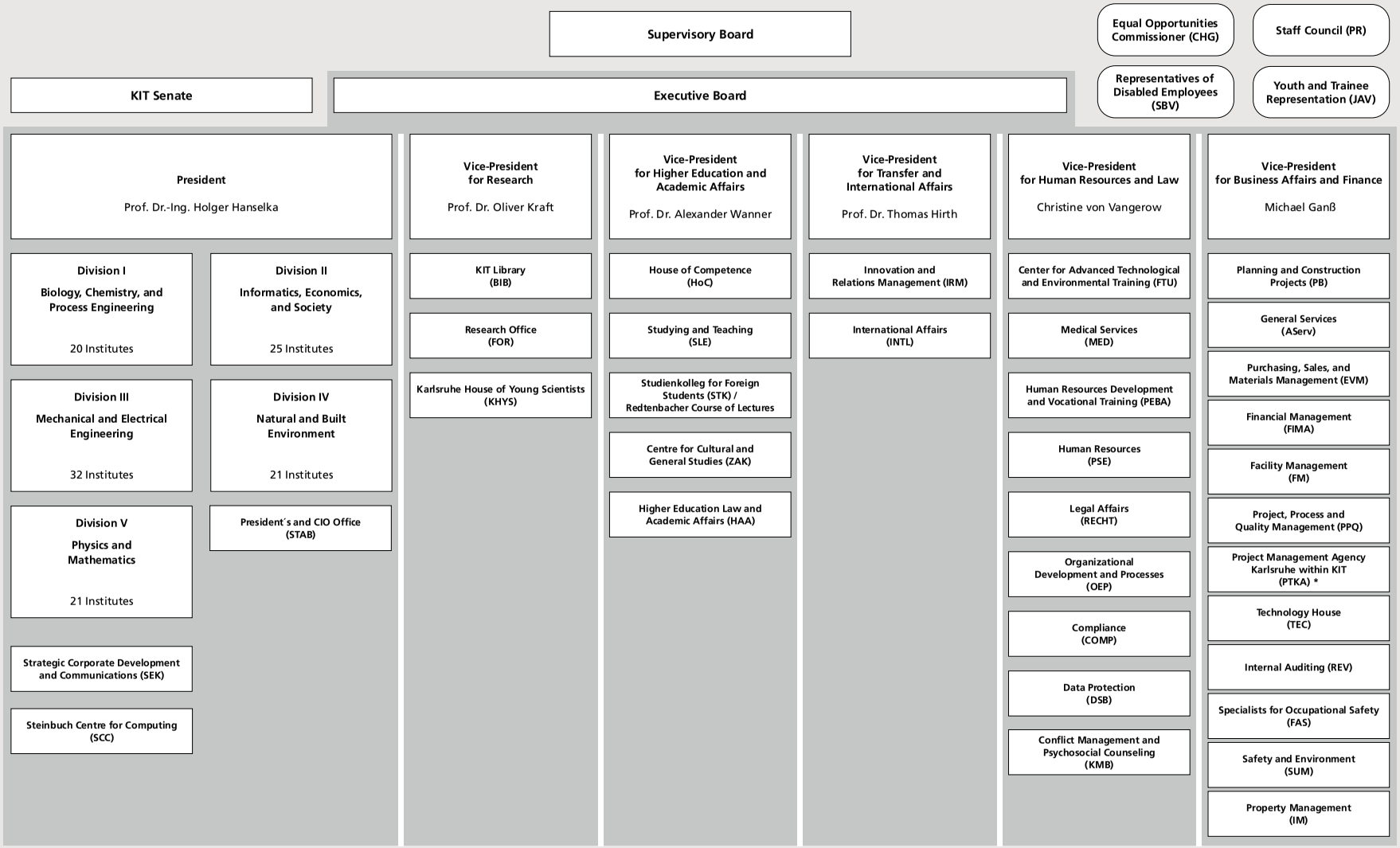
n.a. = not available

Areas

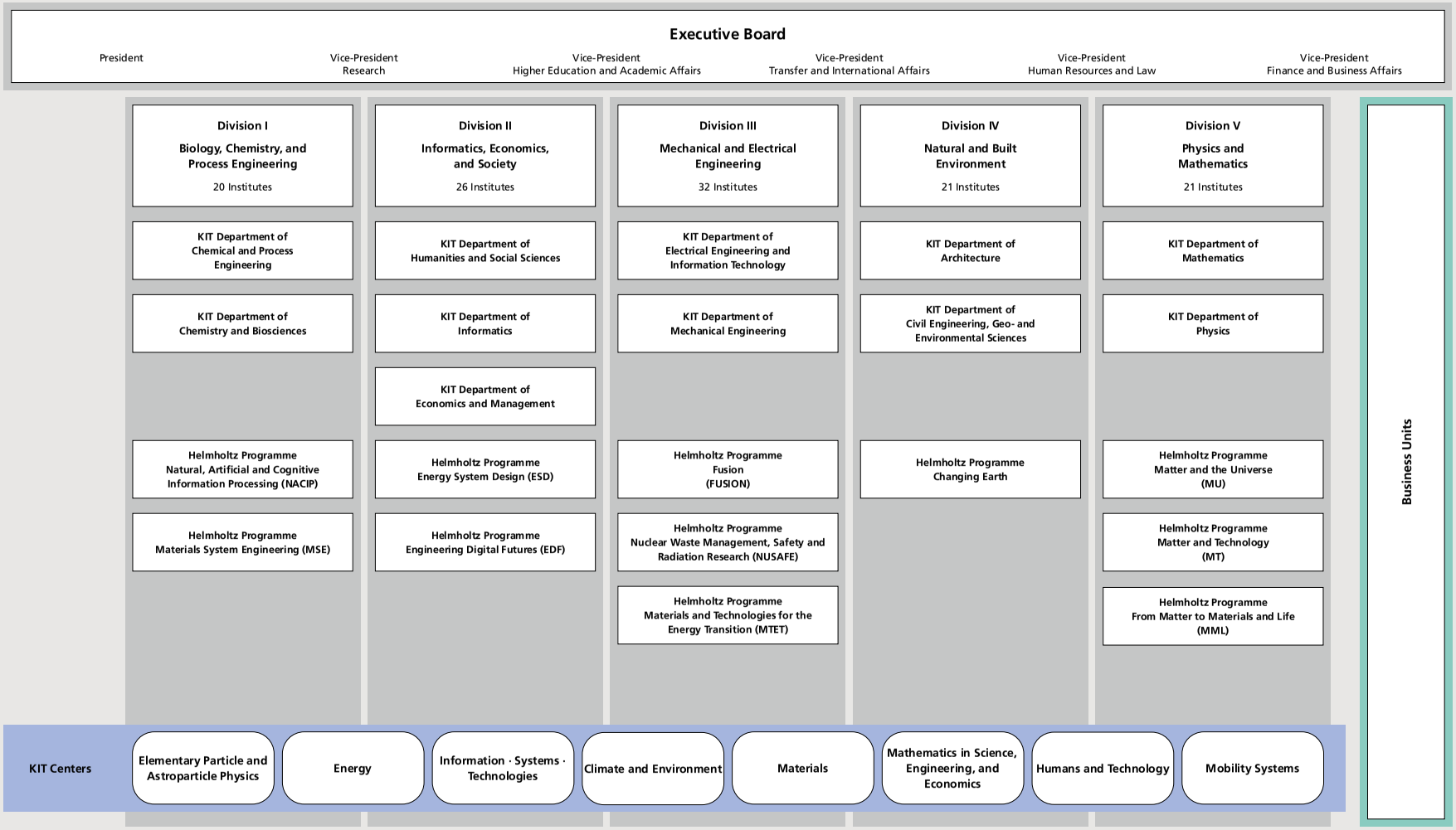
Type of area [m²]	KIT in total		Campus South*		Campus North**	
	[m²]	%	[m²]	%	[m²]	%
Office areas (including conference rooms, rooms for copiers and servers)	175 227	36.0%	101 109	35.0%	74 118	37.4%
Laboratories, workshops, experiment halls	172 451	35.4%	84 872	29.3%	87 579	44.2%
Storage and similar facilities	65 699	13.5%	37 126	12.8%	28 574	14.4%
Teaching and studies (lecture halls, seminar rooms, practice rooms)	56 694	11.6%	50 454	17.4%	6 240	3.2%
Library areas (central + decentralized libraries)	12 977	2.7%	11 641	4.0%	1 337	0.7%
Sports areas	4 248	0.9%	4 032	1.4%	217	0.1%
Total usable area	487 297	100.0%	289 233	100.0%	198 064	100.0%
of this, rented areas			19 504 m²		2 283 m²	

* incl. Campus East and Campus West
** incl. Campus Alpine

Organizational Structure



Science Organization



Issued by
Dr. Sabine Fodi, Dr. Joachim Hoffmann (responsible),
Executive Office and Strategy (STS),
Corporate Communications

Data and figures: Christiane von der Heide, STS, Strategic Controlling and Reporting

Photos (photographer/photo number): Albrecht, Lydia: 231, 232; Balzer, Manuel: 279; Bauwerk: 65; Bodenbender: 68; Bramsiepe, Amadeus: 10, 17, 18, 22, 23, 27, 29, 32, 33, 34, 35, 36, 38, 39, 40, 42, 43, 46, 48, 52, 62, 79, 80, 92, 94, 95, 97, 98, 102, 103, 104, 105, 106, 107, 110, 111, 113, 115, 118, 120, 124, 126, 127, 131, 132, 137, 138, 139, 142, 145, 147, 149, 164, 172, 185, 186, 187, 190, 193, 194, 196, 198, 201, 202, 204, 207, 208, 209, 218, 220, 227, 238, 240, 243, 248, 256, 260, 262, 269, 273, 275, 281; Braun, Zooey: 88, 89, 247; Breig, Markus: 2, 4, 5, 15, 23, 31, 37, 41, 44, 51, 58, 59, 64, 67, 72, 74, 81, 82, 86, 91, 96, 99, 112, 121, 123, 128, 134, 156, 159, 165, 167, 212, 215, 216, 219, 223, 225, 234, 235, 237, 263, 266, 267, 272, 277, 282; Brüderli, Frank: 130; Carambia, Tiziana: 53; Cordts, Anne: 21; Deutsche Stiftung Verbraucherschutz: 17; Djavadi, Daryoush: 28, 152, 153, 211, 233; Dominika Rogocka – Modus Medien Kommunikation Gmbh: 230; Drollinger, Andreas: 12, 261, 270; Eisenhans – stock.adobe.com: 203; EU: 258; Fabry, Andrea: 144, 170, 181, 197; Fabry, Pauline: 70; Fuge, Robert: 104, 228; Göttisheim, Sandra: 45, 47, 85, 87, 116, 117, 135, 189, 213, 214, 239, 242, 244, 245, 246, 249, 250, 251, 252, 253, 254, 257, 271, 276; Griesbaum, Thomas: 278; Toedter, Olaf: 236; Grupe, Christian: 61; Hahn, Vincent: 66; Hauser, Magali: 1, 7, 77, 78, 84, 122, 141, 150, 158, 160, 161, 162, 168, 169, 173, 174, 177, 180, 192, 199, 200, 222; Heid, Kira: 14, 157, 183, 184, 221, 265, 274; Heil, Katja: 101, 108, 109, 151; JLU/Elisa Monte: 50; Jonek, Sarah/Bielefeld Marketing GmbH: 25; Jungheim, Lisa: 65, 70, 71, 72, 73, 96, 97, 104, 125, 136, 143, 146, 229; KIT: 63; Kuhn, Dominik: 56; Kurt Kleemann – Fotolia: 205; Lober, Martin: 20; Lorenzi, Kevin: 255; Masell, Jan: 268; Meißner, Tanja: 6, 26, 71, 73, 75, 83, 93, 98, 119, 140, 163, 178, 182, 280; Messling, Daniel: 49; Mühr, Bernhard / CEDIM: 57; NaWik, Tim Wegner: 16; Olivier Le Moal – stock.adobe.com: 195; PEBA, KIT: 175, 176; Penati, Tim: 171; photocase / Emilia Maria Kühn: 154; Prevete, Riccardo: 148; privat: 129, 133, 259, 264; Rickel, Hans-Joachim / MBF: 90; Roesky, Peter: 11; Rönspies, Michelle: 60; Ruiz-Preciado, Marco A.: 69; SECUSO, KIT: 24, 54, 55; Strauch, Rabea: 9, 30; Sultanova, Anastasiya: 76, 217, 226; Université Grenoble Alpes / utopikphotos: 155; Wagner, Nena: 179; Weiermann, Chantale-Sophie: 171; Weissblick – stock.adobe.com: 206; Westermann, Irina: 114, 188; Zachmann, Gabi: 3, 23, 166, 191, 210, 224

Photos edited by: Lydia Albrecht, Anne Behrendt,
Allgemeine Services (AServ) – CrossMedia (CroM)

Translated by: Fachübersetzungen Hunger/Altmann GbR, 83026 Rosenheim
Proofread by: KIT Translation Services, INTL; Byron Spice

Layout: Nicole Gross, Allgemeine Services (AServ) – CrossMedia (CroM)

Printed by: Stober Medien GmbH, 76344 Eggenstein
Printed on 100% recycled paper
with the "Der Blaue Engel" (The blue angel) environmental label

Status: December 31, 2022

This print product was awarded the Blue Angel

www.blauer-engel.de/uz195

www.blauer-engel.de/uz195

Contact
Executive Office and Strategy (STS)
Head: Dr. Julia Winter
Phone: +49 (0) 721 608-41100

Issued by
Karlsruhe Institute of Technology (KIT)
President Professor Dr.-Ing. Holger Hanselka
Kaiserstraße 12
76131 Karlsruhe, Germany

Karlsruhe © KIT 2023

100 % recycled paper with the quality label "Der Blaue Engel"