Karlsruhe Institute of Technology

Annual Report 2021 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 applications, we excel in a broad range of disciplines, i.e. in natural sciences, engineering sciences, economics, and 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 2021

Total:	9,783
Teaching and research:	5,556
Professors:	385
Foreign scientists and researchers:	1,405
Infrastructure and services:	4,227
Trainees:	367

Students

Winter semester 2021/2022:	22,225

Budget 2021 in Million Euros

Total:	1,090.7
Federal funds:	333.7
State funds:	309.8
Third-party funds:	447.2

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 the best possible use of the synergies created by the merger of a state university with a national large-scale research center twelve years ago.

In our annual report, we look back on the challenging and eventful year of 2021 and present to you some of its highlights. From research, for example, we report on the agile production of batteries, innovative sensors in materials research and development, and the latest applications of artificial intelligence – in future mobility, for example. These and many other exciting results and developments in research, teaching, and innovation are awaiting you. In addition, we will dedicate a separate chapter to each of our activities relating to sustainability and digitalization.

Thanks to the great commitment and strong cohesion, KIT has continued to optimally respond to the ongoing coronavirus pandemic and its challenges for business routines, studies, and teaching at KIT. Through hybrid teaching, digital exams, the New Work project, and projects for equal opportunities and diversity, we are setting the course for a modern, attractive, and fair learning and working environment for everybody at KIT, even after the pandemic.

The pivotal role of human beings was highlighted in our first KIT Science Week; with the theme of "The Human Being in the Center of Learning Systems," an international symposium was combined with a colorful program for citizens, resulting in a fruitful dialog between science and society.

In 2021, we were pleased by numerous awards bestowed on researchers of KIT – including an Alexander von Humboldt Professorship and a Leibniz Prize. The awards and the conferral of honorary offices show that KIT is well prepared for a successful future thanks to the achievements and commitment of its outstanding students, 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 2021 at KIT – The Research University in the Helmholtz Association. May 2022 be just as exciting!
Enjoy reading.

Yours,

Professor Dr.-Ing. Holger Hanselka
President of KIT

CONTENT

A RETROSPECTIVE VIEW OF KIT

With the signing of a new administrative agreement between the federal and state governments, and the adoption of the 2nd KIT Further Development Act on February 3, 2021 by the Landtag of Baden-Württemberg, another step has been taken in KIT's growing together.

To exploit KIT's full potential in research, teaching, and innovation, the new act removes administrative hurdles and allows more flexibility in the use of funds and personnel. One visible expression of these changes is the abolition of its previously independent "University Sector" and "Large-scale Research Sector" parts. The federal and state governments have reached an administrative agreement on the new legal and financial framework.

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KIT will continue to fulfill the tasks of a university and a large-scale research center. The combination of university basic research and strategic Helmholtz research in one institution is part of the DNA of KIT. A new status function will be established for the scientific management staff. Its responsibilities may include both university and large-scale research responsibilities. All researchers will be able to take part equally in university and large-scale research responsibilities. Students will have the unique opportunity to be trained directly on large-scale research equipment - and in turn to provide impetus for large-scale research.

The Supervisory Board has commissioned the Executive Board to implement the new legal framework as part of the KIT 2.0 Implementation Project, which is embedded in the KIT 2025 Umbrella Strategy. The kick-off was in April 2021, and the project is scheduled to end in December 2022 with the termination of the statutory transition periods. Until then, many processes and basic principles, such as the Joint KIT Statutes or the KIT Financial Statutes, will be revised along eleven work packages. A close trilateral cooperation with the federal and state governments is essential.

KIT in the Coronavirus Pandemic

The year 2021 started the same way 2020 ended: KIT employees had to work from home whenever possible and not prevented by compelling internal reasons. The impact on the KIT routine could be managed only by the great commitment of the employees. The technical prerequisites were created by the Steinbuch Centre for Computing at KIT.

An organizational change was launched when on January 15, 2021, the Executive Board established the Corona Coordination Office as the central point of contact on this topic. This new office has been replacing the previous Coronavirus Crisis Team. In view of the "new normal" of the ongoing coronavirus pandemic, this means that decisions are made again by the regularly responsible units. The Corona Coordination Office follows on from the work of the Coronavirus Crisis Team and ensures that measures taken at the KIT in connection with the spread of the coronavirus are coordinated in compliance with the principle of subsidiarity. The newly established office continuously monitors the development of the situation, advises those responsible, and ensures that the relevant processes are being documented.

Masks and checks on one's 3G status (vaccinated, tested, recovered) were a familiar sight in 2021.

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After the Corona regulations of the state of Baden-Württemberg had been eased in summer, the obligation to work from home was lifted at KIT, and a return to the normal routine was possible again, albeit subject to compliance with social distancing rules and the obligation to wear face masks. However, the new version of the Infection Protection Act, which went into force on November 24, 2021, reintroduced the obligation to work from home, and even at the beginning of 2022, relief from the pandemic was not in sight.

For the students, a normal course of studies was out of the question. As in the previous winter semester, the lecture period of the 2021 summer semester at KIT started in April 2021 with online courses. The students were asked to make use of virtual offerings and, if possible, not to come to lectures or to study on campus.

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With the start of the winter semester in October 2021, after three online semesters, many lectures again took place on KIT's Campus South. At the same time, students were able to attend some of the face-to-face lectures

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The library and its learning spaces could be used again in the winter semester of 2021/2022 – albeit with restrictions.

online from other places. This simultaneous interactive participation in lectures via different media from different places is the principle behind hybrid teaching. The concept of hybrid teaching allows students to consider the infectious situation and decide for themselves how they want to take part. The lecturers were able to hold their courses as scheduled. With the new hybrid formats, participation remained possible for students who had not yet been fully vaccinated or were not allowed to participate face-to-face due to quarantine or symptoms typical of COVID-19. About one third of the lectures at KIT were offered as hybrid courses. They complemented the portfolio of teaching offerings, which continued to include face-to-face formats supplemented by electronic learning materials, as well as online-only formats.

"Fully vaccinated" or "recovered from COVID-19" were the statuses reported by over 90 percent of KIT students in an online survey (response rate 43 percent) in fall 2021.

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The opportunities for face-to-face studies were also subject to conditions and were accompanied by organizational challenges: For example, all participants in face-to-face events had to supply proof of their 3G status (vaccinated, tested, recovered). In addition, face masks were mandatory at these events if the minimum distance of 1.5 meters could not be maintained. Under these conditions, student learning spaces were again available.

The Future of Work Models and Studies

Working from home, online lectures, video conferencing - in the second year of COVID-19, it became clear that the latest surges in digitalization were not mere episodes but will permanently change our lives and work.

For example, the new hybrid formats in teaching can enable students to take part when they cannot be present. In addition, it is more possible to cater to students' different learning styles. Students were overwhelmingly positive about hybrid events.

The future of work design at KIT is the subject of the New Work project launched in 2021 and included as a lead project in the KIT 2025 strategy process. Aspects of New Work are the development of modern, individual, and life-cycle-oriented models for working time and workspace. The focus here is on agile, project-oriented, and digital location-independent forms of work. This is complemented by the development and continuous advancement of novel approaches to work organization, including resource-saving forms of space utilization.

This is linked to a KIT-wide, open discourse and continuous exchange with the broadest possible range of employees to document the needs of employees at all levels and status groups. In a survey conducted at the end of 2021, KIT employees had the opportunity to express their opinions on topics related to New Work. About 3500 employees took advantage of this opportunity.

An initial evaluation of the survey showed that of these, around 95 percent worked at least partially on a mobile basis during the pandemic, and around 44 percent worked from home completely for a longer period of time. Of those who worked at KIT all the time, the vast majority said that their workplace did not allow working from home or that they did not want to work from home. Two-thirds of respondents perceive mobile work as helping and promoting their work-life balance. When asked how much working from home their work allows and how much working from home they would like, half of the respondents say that their work allows working from home on four or more days per week. The employees' desire is to work from home on three or fewer days per week. More than half of the employees would share their workspace with others if this allowed them to increase working from home. 44 percent, however, do not want to do this.

KIT 2025 Umbrella Strategy

The KIT 2025 Umbrella Strategy sets the course for the development of KIT. Goals and measures are formulated in various areas of action and are being transferred into the KIT routine in the form of a project structure consisting of lead, implementation, and follow-up projects.

In 2021, Digitalization and Sustainability were added as two new areas of action to be included in the Umbrella Strategy.

In view of the importance of digitalization to the fulfillment of KIT's core tasks in research, teaching, and innovation as well as to an efficient and modern administration, KIT has submitted a strategy paper to be included as a new area of action in the KIT 2025 Umbrella Strategy. This was done under the leadership of Chief Information Officer President Holger Hanselka and Chief Digital Officer Dr. Julia Winter, with the support of the Digital Office as well as the KIT Bodies. The Digitalization area of action defines the strategic goals and measures for digitalization at KIT. The text of the area of action was agreed upon in 2021 and will be presented to the KIT Bodies in spring 2022.

For the Sustainability area of action, the goals and sub-goals will be formulated at the beginning of 2022, followed by the measures derived from them. In the fall of 2022, this area of action is to be adopted in the KIT Bodies.

In addition, the expansion of the Innovation area of action to the Transfer area of action was included in 2021. The schedule envisioned is similar to that for Sustainability.

Various projects within the framework of the KIT 2025 Umbrella Strategy were completed in 2021. For example, the follow-up project "Gender-equitable Language" came to a successful end with the publication of the guideline "Gender-equitable and Inclusive: Language and Visual Language of Diversity at the Karlsruhe Institute of Technology."

Research Infrastructures at KIT

KIT is involved in the setup and operation of large research infrastructures that are used by researchers far beyond KIT.

Research data play a key role in the sciences, and data volumes are increasing rapidly. Existing data sets are regarded as an important basis for new knowledge. However, these are often difficult for the scientific community to access. The federal and state governments are therefore establishing the National Research Data Infrastructure (NFDI), whose directorate is situated in Karlsruhe. In the NFDI, scientific data are to be systematically indexed, secured for the long term, and made accessible.

The central element is consortia, in which people who use research data and those who offer it cooperate with information infrastructure institutions. The Joint Science Conference (Gemeinsame Wissenschaftskonferenz – GWK) has now announced consortia that will be considered in a new funding round. KIT researchers are involved in five of the ten consortia funded this year.

NFDI4Earth tends to the digital needs of researchers in Earth system sciences. A multitude of sensor and simulation data in extremely high spatial, temporal, and thematic resolutions lead to rapidly increasing data volumes here.

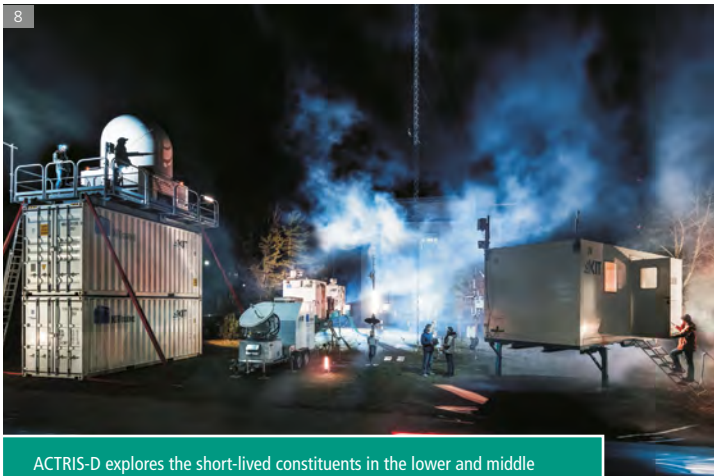
DAPHNE4NFDI is an initiative of researchers in the field of photon and neutron sciences. The consortium includes a large number of disciplines – from biology to pharmacy, engineering, physics and chemistry to geology and archaeology.

7 The NFDI4Earth consortium addresses the growing data volumes from Earth system sciences.

FAIRmat covers interests in experimental and theoretical condensed matter physics. This also includes chemical physics of solids, synthesis, characterization of material properties, and high-performance computing.

NFDI-MatWerk will focus on the research area of materials science and engineering. Digital mapping of materials, their structure and properties, and process and load history are the key challenges.

PUNCH4NFDI is the NFDI consortium of particle, astro, astroparticle, hadron, and nuclear physics. PUNCH (Particles, Universe, NuClei, and Hadrons) physics is concerned with the fundamental constituents of matter and their interactions, and their role in the formation of the largest structures in the universe – stars and galaxies.



8 ACTRIS-D explores the short-lived constituents in the lower and middle atmosphere.

Other consortia that involve KIT and that have been funded since 2020 are focused on chemistry (NFDI4Chem), engineering sciences (NFDI4Ing), and catalysis research (NFDI4Cat). The NFDI will fund up to 30 consortia in total.

Particulate matter, clouds, and most trace gases are short-lived components of the atmosphere. They are generally there for only a few hours or weeks, unlike long-lived greenhouse gases, such as methane and carbon dioxide, which remain in the atmosphere for decades or millennia. Nevertheless, they have a major impact on air quality and climate. For example, tiny, suspended particles reflect sunlight and thermal radiation or serve as nuclei for the formation of cloud droplets and ice crystals, which in turn can lead to precipitation. However, how much each of these diverse effects ultimately contributes is not yet sufficiently known.

By studying short-lived components of the atmosphere from the ground to the stratosphere, the German ACTRIS-D infrastructure – in which KIT is also involved - will help researchers to reduce uncertainties in the prediction of future climate. In doing so, they aim to gain new insights into the interactions between different climate processes and to evaluate measures to improve air quality and its impact on health and ecosystems. For its contribution to ACTRIS-D, KIT will receive about EUR 14 million to establish new measurement facilities for cloud research, significantly expand existing infrastructures, such as the AIDA cloud chamber and the atmospheric observatory in Garmisch-Partenkirchen and on the Zugspitze, and equip them with state-of-the-art measurement technology.

In July 2021, Theresia Bauer, Minister for Science, Research, and the Arts of Baden-Württemberg, handed over HoreKa, the Karlsruhe High Performance Computer, to KIT. HoreKa achieves a peak performance of 17 petaFLOPS, or 17 quadrillion computing operations per second – which is equivalent to the performance of about 150,000 laptops. The 15-million-euro supercomputer is thus one of the fastest in Europe. HoreKa ranked 52nd on the top 500 list of the world's fastest computers in 2021. At the same time, it is also world-class in terms of energy efficiency. Supercomputers require a lot of energy, but use it more efficiently than in conventional PCs and laptops. In terms of energy efficiency, HoreKa landed in 13th place in an international comparison in 2021.

9 Minister Theresia Bauer and Vice-President Oliver Kraft at the inauguration of the HoreKa supercomputer at KIT.

HoreKa is available to researchers from all over Germany. Thanks to the new supercomputer, they will be able to gain a more detailed understanding of complex natural and technical processes, particularly in Earth system science, materials science, energy and mobility research in engineering, and particle and astroparticle physics.

Funding Large-scale Coordinated Research Projects

The member states of the European Union want to achieve climate neutrality by 2050. To succeed, they must not only expand renewable energies, but also invest in energy storage systems. Development of the latter will be accelerated by the European research consortium StoRIES. The Helmholtz Institute Ulm (HIU), which was founded by KIT and Ulm University, coordinates this effort. Researchers from all over Europe with different research specialties will cooperate with industry to develop hybrid energy storage technologies. The European Commission funds StoRIES with almost EUR seven million, initially for four years, as part of the Horizon2020 Programme.

With the number of electric cars increasing significantly, the importance of charging infrastructures and concepts for grid security is also rising. If electric cars are charged primarily after having started work or at the end of the day, loads on the power grid will peak at these times. This could be avoided if charging occurs over the entire time cars are idle. According to a study commissioned by the German Federal Ministry for Digital and Transport, the average operating time of passenger cars is only 45 minutes per day. In the SKALE project, which started in 2021, KIT and its partners Robert Bosch GmbH and Power Innovation Stromversorgungstechnik GmbH are developing a scalable charging system with a photovoltaic system,

A scalable charging system with photovoltaic systems for electric cars is being developed in the SKALE project.

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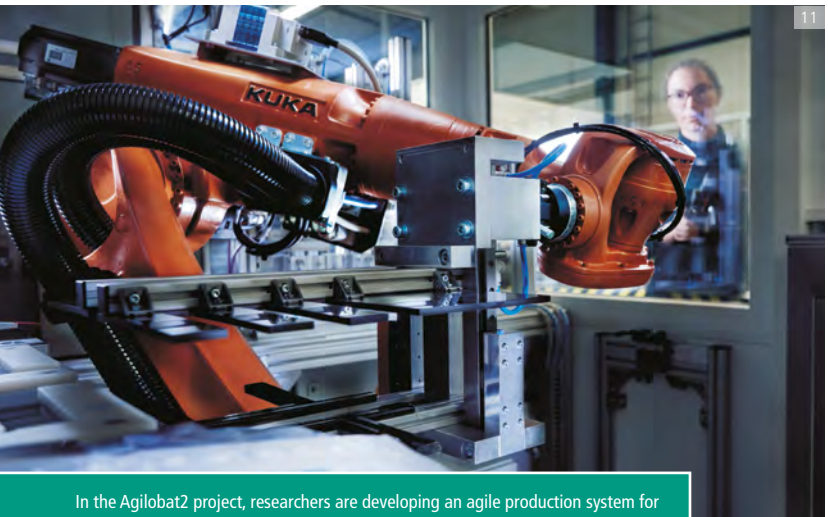
stationary lithium-ion storage, and medium-voltage grid connection. The German Federal Ministry for Economic Affairs and Climate Action is funding the SKALE research project with about EUR 4.3 million.

Flexible, adaptable cells are needed so that batteries such as those used for electromobility can be fitted precisely into awkward spaces and can store more energy. Today's lithium-ion cells, however, are manufactured in standardized formats and rigid systems. KIT researchers, together with partners from academia, are now developing an agile production system that will allow battery cells to be manufactured with complete flexibility in terms of format, material, and number of units. Launched in January 2021, the second stage of the project – AgiloBat2 – is funded by the German Federal Ministry of Education and Research with EUR 14.5 million.



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In the Agilobat2 project, researchers are developing an agile production system for battery manufacturing.

Fast and cost-effective, but also versatile and of high quality: These are the requirements for producing future battery cells. KIT coordinates the battery competence cluster Intelligent Battery Cell Production (InZePro). The cluster aims to optimize production systems holistically and make them more flexible in terms of quantities produced, format, material, and technology used. This can be achieved, for example, through cross-process, data-driven optimization and Industry 4.0 solutions. The BMBF is funding the InZePro competence cluster with around EUR 44 million.

Fluctuating demands, supply bottlenecks, individualized products – economically manufacturing products despite these dynamic changes is challenging for the vehicle and supplier industry. The Software-defined Manufacturing for the Vehicle and Supplier Industry (SDM4FZI) project is developing solutions for fast, flexible, and efficient production. Thirty companies are pooling their expertise in this project under the leadership of Robert Bosch GmbH, KIT, and the University of Stuttgart. The aim of the SDM4FZI project is to flexibly plan, control, and change individual components of production systems or even entire factories by decoupling software and hardware. This should enable automobile manufacturers to switch more quickly between models and products and also produce more variants. The basis for maximum adaptability is the strict separation between production hardware and the software that controls it. Software-defined manufacturing works with digital twins, i.e., virtual images of the existing hardware, so that proper software can be automatically derived, tested, and distributed. This saves development time, resources, energy, and, thus, costs. The German Federal Ministry for Economic Affairs and Climate Action is funding the project with around EUR 35 million.

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The Software-defined Manufacturing for the Vehicle and Supplier Industry (SDM4FZI) project is looking for solutions for future production in these industries.

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KIT's KD²Lab is part of the newly established Research Training Group KD²School – Design of Adaptive Systems for Economic Decisions.

The German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) supports collaborations of outstanding researchers who work on a common research task across different disciplines and places. The funding program, which is usually designed for a period of six years, supports the provision of the necessary staff and material equipment. The interdisciplinary research groups often contribute to the establishment of new fields of work.

In December 2021, the DFG announced that it would fund eight new groups, including the research group on Financial Markets and Frictions – An Intermediary-based Approach in Asset Pricing (Finanzmärkte und Friktionen – ein intermediärbasierter Ansatz im Asset Pricing), for which Professor Marliese Uhrig-Homburg from KIT is spokeswoman. The research group aims to gain new insights into the dynamics and structure of risk pricing of financial assets.

Promotion of Early-stage Researchers

To strengthen early-stage researchers, the DFG supports Research Training Groups (Graduiertenkollegs – GRK). In 2021, two KIT applications were successful.

In the new Interdisciplinary Research Training Group GRK 2739 KD2School – Design of Adaptive Systems for Economic Decisions, researchers are investigating how economic decision-making processes can be supported by IT-based systems in a context-dependent manner, such as by making people more productive and comfortable in their working environments. In particular, they investigate the question of how such systems must be designed so that they can adapt to the context of a decision-making situation and "improve themselves." The speaker of GRK 2739 is Professor Christof Weinhardt from KIT.

In addition, the DFG voted for the extension of GRK 2218 SiMET – Simulation of Mechanical-electrical-thermal Processes in Lithium-ion Batteries, whose spokesperson is Professor Thomas Wetzel from KIT. The members of the Research Training Group develop models and simulation methods that can be used, for example, to predict how differences in internal battery structures affect performance and aging behavior.

As part of its funding as a university of excellence, KIT was able to establish six KIT Graduate Schools in the GradeUp project in 2021 (see also page 61).

- The KIT Graduate School Cyber Security aims to bring together the various disciplines of cyber security research at KIT as well as their fields of application.

- The KIT Graduate School Cultures of Knowledge offers doctoral researchers the opportunity to experience the exploration of knowledge in a variety of scientific contexts and to broaden their academic background with interdisciplinary perspectives.

- The KIT Graduate School Enabling Net Zero aims to provide early-stage researchers with the necessary interdisciplinary knowledge and tools to work on applications that can make a visible contribution to the transformation of the energy system.

- The KIT Graduate School UpGrade Mobility offers support for mobility research and strengthens the ability of doctoral researchers for designing Future Mobility.

- The KIT Graduate School of Quantum Matter focuses on doctoral researchers doing research in the field of quantum materials and systems.

- The KIT Graduate School on Computational and Data Science provides interdisciplinary training for doctoral researchers who want to learn and develop methods of both model-driven and data-driven computer science.

In addition, young KIT researchers acquired funding for several junior research groups, including one Emmy Noether junior research group funded by the DFG for a period of six years, two junior research groups funded by the Helmholtz Association for five years, and one junior research group funded by the Federal Ministry of Education and Research for a period of five years (see also page 63).

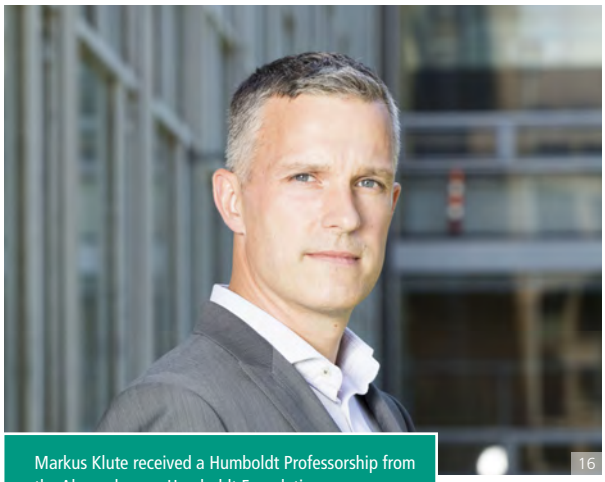
Enabling Net Zero (ENZo) is one of six Graduate Schools that KIT established with its funding as a university of excellence.

Awards and Prizes

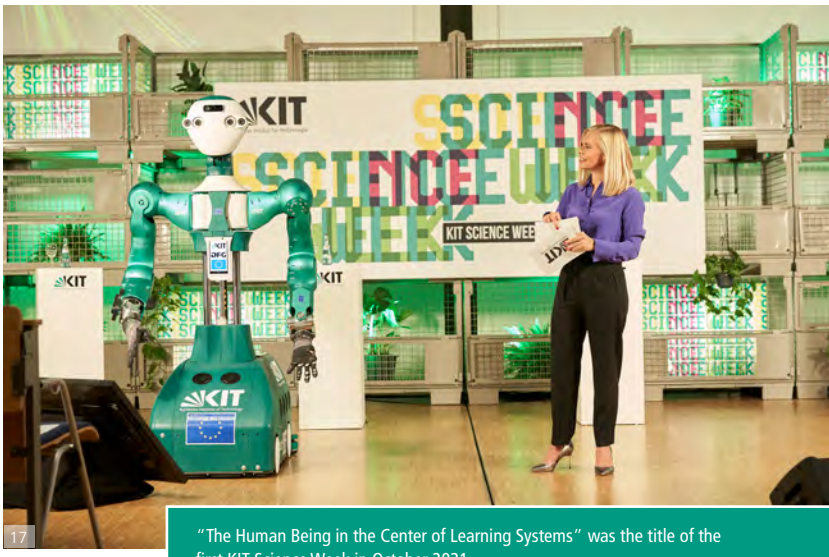
Professor Almut Arneth received the Gottfried Wilhelm Leibniz Prize 2022 of the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG). The DFG awarded Germany's most valuable science prize, worth EUR 2.5 million, to the scientist for her research on the influence of global environmental change on ecosystems. Her research on terrestrial ecosystems includes interactions between land and climate, the role of land use change in the climate system, and the links between ecosystem functions and biodiversity. The researcher regularly contributes her scientific ability as an author to national and international peer-reviewed reports.

Almut Arneth received one of the DFG's prestigious Gottfried Wilhelm Leibniz Prizes.

KIT brought another world-leading researcher to Germany. Particle physicist Professor Markus Klute has been selected for a Humboldt Professorship. He and his group contributed significantly to the discovery of the Higgs boson in 2012 at CERN near Geneva, where he also played a leading role in the Compact Muon Solenoid (CMS) experiment. His later measurements with the CMS were groundbreaking, providing a deeper understanding of the properties of the Higgs boson. In addition, the group established the use of modern machine learning techniques in high-energy physics. With this award, which is endowed with up to EUR five million, the Alexander von Humboldt Foundation honors outstanding researchers who have previously worked abroad. Another internationally renowned physicist, Professor Wolfgang Wernsdorfer, was appointed to KIT in 2016.



Markus Klute received a Humboldt Professorship from the Alexander von Humboldt Foundation. 16



17 "The Human Being in the Center of Learning Systems" was the title of the first KIT Science Week in October 2021.

Anniversaries/Celebrations and Events

Robots that help with assembly, assistance systems that support the diagnosis of diseases, and self-driving cars: Technologies that are capable of learning are increasingly part of our lives. Therefore, the first KIT Science Week under the title The Human Being in the Center of Learning Systems dealt with artificial intelligence. From October 5 to 10, 2021, KIT's new event format combined a high-level international scientific conference, where researchers discussed the development of trustworthy, graspable, adaptable, and human-inspired AI technologies, with intense dialogs with the interested public.

KIT Science Week is a new participation-oriented and interactive event that KIT and its partners launched as part of KIT's promotion as a university of excellence. Experts from science, economy, politics, and culture and citizens from the city and the region both were invited to participate in innovative online formats such as Massive Open Online Courses and Escape Rooms. On tours through KIT laboratories, in workshops, and during dialogs, citizens were able to experience artificial intelligence and its applications live. Panel discussions with prominent experts, citizen dialogs, ZAK Talks, and a TEDxKIT event offered the opportunity to ask questions and reflect on the opportunities and risks of learning systems. A combination of scientific congress and public events, the KIT Science Week engages both scientific experts and interested citizens. In the future, the KIT Science Week will take place every two years and address current scientific issues.

August 31, 2021 marked the 200th anniversary of the birth of Hermann von Helmholtz, the famous German scientist the Helmholtz Association was named after. A true polymath, Hermann von Helmholtz researched phenomena in optics, acoustics, geology, meteorology, and thermodynamics. He combined basic research with application and invented many instruments such as the ophthalmoscope, the Helmholtz resonator, the first electronic synthesizer, and an apparatus for measuring nerve conduction velocity.

In his honor, the Helmholtz Association dedicated many of its activities in 2021 to the theme of "200 Years of Helmholtz – Inspired by Challenges." The major scientific challenges of our time – the challenges researchers work on every day – were presented with the support of KIT.

KIT also contributed a week full of science themed "7 Days – 7 Questions – 7 Formats" to the Karlsruhe Science Festival EFFKETE. Instead of an open day, which could not take place because of the coronavirus pandemic, KIT offered interested people of all ages exciting insights into the world of research, teaching, and innovation with a diverse online program from June 12 to 18, 2021. The online offerings bundled on the web portal were supplemented by selected hybrid events, including a kickoff event on climate protection in front of the Triangel Open Space at Kronenplatz.

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"7 Days – 7 Questions – 7 Formats:" KIT contributed a week full of science to the Karlsruhe science festival EFFEKTE.

Live from the Energy Lab, the stream of KIT's first digital Annual Celebration started at 4 p.m. on April 22. Program items included a cinematic review of the years 2019 and 2020 by KIT President Professor Holger Hanselka, a panel discussion on "Bioeconomy – What Can It Do to Save the Climate," the presentation of department teaching awards, and a film on the implementation of digital teaching at KIT. Greetings were given by the federal and state science ministers Anja Karliczek and Theresia Bauer, as well as by the chair of the KIT Supervisory Board, Professor Michael Kaschke. Afterwards, there was the opportunity to network and inform oneself at a digital marketplace.

What traces do humans leave on their planet? In the summer semester of 2021, the Colloquium Fundamentale entitled "Anthropocene. The Ecological Question and the Human Being Who Asks It" dealt with literary, artistic, and cultural aspects of the ecological debate. Due to the coronavirus pandemic, the ZAK I Centre for Cultural and General Studies offered a five-part lecture series via livestream. In the winter semester that followed, the Colloquium Fundamentale was dedicated to the topic of "Science in Politics. Potentials and Problems of a Complex Relationship" through six lectures discussing how scientific knowledge can best be translated into political action.

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The newly appointed director of the ZAK I Centre for Cultural and General Studies, Senja Post, inaugurated the Colloquium Fundamentale in the winter semester.

President Holger Hanselka opened KIT's first digital Annual Celebration on April 22, 2021.

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Aspects of Sustainability

As an independent brains trust, the Science Platform for Climate Protection (Wissenschaftsplattform Klimaschutz - WPKS) supports the German government in the implementation and further development of the German long-term strategy for climate protection. The Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection appointed Professor Holger Hanselka, President of KIT, to the eight-member steering committee. The expertise available at KIT at the interfaces between the transport, heat, and energy sectors, on the monitoring of greenhouse gas emissions, on sustainable construction, and on the circular economy has already been incorporated into the work of the science platform. In February 2022, the first annual report of the WPKS was handed over to the Federal Minister of Education and Research Bettina Stark-Watzinger and State Secretary Dr. Patrick Graichen, Federal Ministry for Economic Affairs and Climate Action.

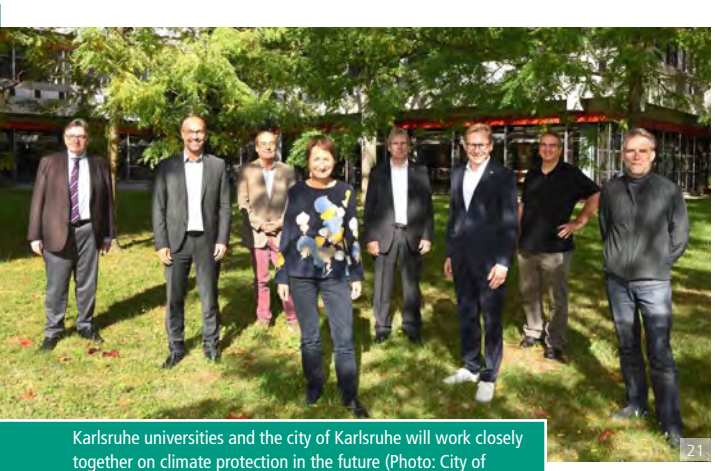
As one of the measures of the Karlsruhe Real-world Lab for Sustainable Climate Protection (Karlsruher Reallabor Nachhaltiger Klimaschutz - KARLA), the eight universities situated in Karlsruhe and the city of Karlsruhe concluded a climate pact. In the future, the partners intend to work

closely to implement the Paris climate protection goals, realizing concrete measures in their own academic and teaching routines, developing joint projects, and intensifying scientific exchange. The climate pact is an initiative that is unique in Germany.

Continuity and New Tasks in the Executive Board

In 2021, the KIT Bodies decided on changes in the portfolio of the Executive Board, which will become effective in the coming years.

In addition to technology transfer, the dialog between science and society is an increasingly important task. One of KIT's goals is to carry science into society and to identify initiatives for research, teaching, and innovation at KIT from public input. Interaction with society previously was addressed in KIT's successful application to become a University of Excellence in 2019.
KIT is now strengthening this commitment by a change in the responsibilities of Vice-President Professor Thomas Hirth, whose department of "Innovation and International Affairs" will be expanded to "Transfer and International Affairs." The change was effective January 1, 2022, with the start of Thomas Hirth's second term as Vice-President. The second term of Professor Oliver Kraft, KIT Vice-President for Research, also began on January 1, 2022. He has held the office of Vice-President since 2016. The focal points of his first term were the positioning of KIT for the excellence strategy and program-oriented funding in the Helmholtz Association.
In the year to come, there will be further changes in the Executive Board: The earlier portfolio of Human Resources and Law will not be reoccupied after the current appointment of Vice-President Christine von Vangerow expires December 31, 2022. Those duties will be assigned to Vice-President Michael Ganß, Executive Board member responsible for Business Affairs and Finance. Thus, the two administrative portfolios of the Executive Board of KIT will be combined in one portfolio and developed within the framework of a project starting at the beginning of 2022. In addition, in January 2023, the new portfolio of Digitalization and Sustainability will be established on the Executive Board.



21 Karlsruhe universities and the city of Karlsruhe will work closely together on climate protection in the future (Photo: City of Karlsruhe).

22 The KIT Executive Board in 2021: Alexander Wanner, Michael Ganß, Thomas Hirth, Holger Hanselka, Christine von Vangerow, and Oliver Kraft (from left to right).

RESEARCH

Attackers of the worldwide web, who act on behalf of states, semi-state organizations, or companies, have acquired vast know-how and enjoy nearly unlimited resources. At the same time, rapidly progressing digitalization of more areas of life and work is increasing the risks in cyberspace.

In February 2021, KIT established the independent "KASTEL – Institute of Information Security and Dependability," based on KIT's Competence Center for Applied Security Technology, also referred to as KASTEL. It had been one of three national competence centers for cybersecurity founded in 2011 within an initiative of the Federal Ministry of Education and Research.

KASTEL pursues a broad interdisciplinary approach. It pools all IT security competencies at KIT, including legal and social expertise, to better protect industry and society against an increasing number of cyberattacks. The growing complexity, interconnection, and processing speed of IT systems pose new security challenges, as do Industry 4.0 and the deployment of the 5G technology standard for cellular networks. KASTEL is addressing all of these topics.

The work of KASTEL has already resulted in numerous initiatives and innovations in the area of IT security. The blurry box method, a software that protects against industry espionage and sabotage, guarantees protection even when the protection mechanism is known to the attacker. It won the German IT Security Prize.

In the area of academic education, KASTEL has made security an integral constituent of KIT's informatics programs. In 2013, the first KASTEL certificate course was launched to convey the basics of cybersecurity. Moreover, the KIT Department of Informatics offers master's students an interdisciplinary specialization course in IT security.

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FROM PRODUCTION TO APPLICATION

Broad Research Spectrum Aims to Make Battery Cells More Efficient, Safe, and Flexible

Global battery research is gaining importance, as batteries are the key components for a number of technical developments in electric mobility, the use of renewable energy sources, and mobile end devices. To push battery research, KIT researchers from many different disciplines cooperate in networks and on projects.

AgiloBat2

The AgiloBat2 research project is aimed at developing a production system for flexible battery cells in a variety of formats, materials, and quantities. This will allow the batteries to fit into narrow and crooked spaces and to store more energy for such applications as electric mobility. Today's lithium-ion battery cells have been produced primarily in standardized formats and rigid systems. They also consist of rare elements, such as cobalt and nickel, whose costs fluctuate widely and whose supply is becoming increasingly critical. In cooperation with the Fraunhofer Institute for Chemical Technology, researchers from several KIT institutes are now working on innovative battery production approaches. The project is funded by the Federal Ministry of Education and Research (BMBF) with EUR 14.5 million.

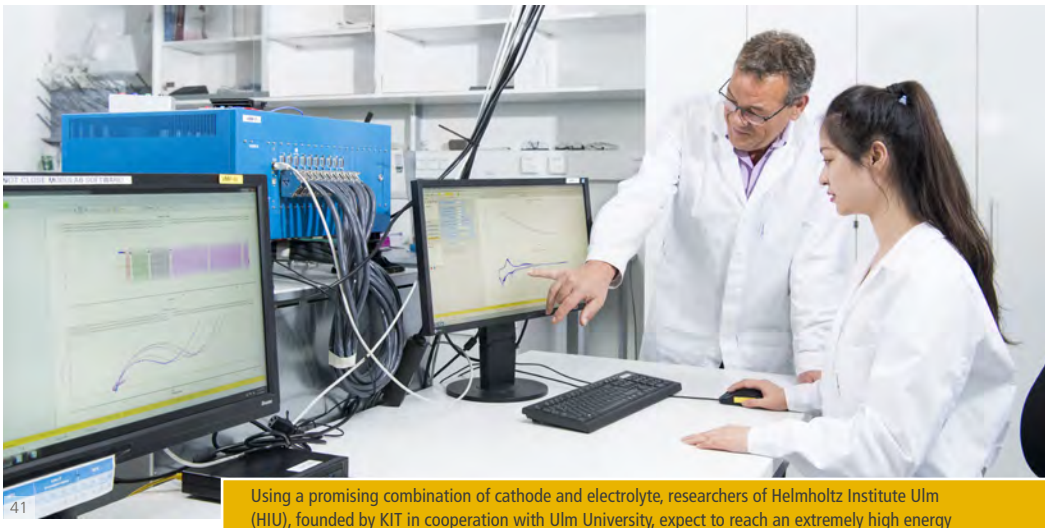
AQua Competence Cluster

In the AQua battery competence cluster, researchers optimize mass production of high-quality lithium-ion batteries by automatic error detection, thus ensuring advanced quality assurance and analytics in production. A new research platform will guarantee high quality at the lowest possible production cost. To find potential sources of error, all production steps, from the raw materials to the produced cell, are analyzed. Then, ongoing production is perfected and automated to achieve a consistently high quality in the end product. The new research platform is complemented by a data infrastructure to provide sustainable access to research data and analysis tools. This will be a pivotal contribution for ensuring quality and for transferring findings from battery research to production.

Record-breaking Lithium-Metal Cell

Currently, lithium-ion batteries are the most common solution for mobile power supply. In some applications, however, this technology reaches its limits. This is especially true for electric mobility, where lightweight, compact vehicles with long ranges are desired. Lithium-metal batteries may be an alternative. They are characterized by a high energy density, meaning that they store more energy in smaller masses or volumes. Still, stability is a problem, because electrode materials react with conventional electrolyte systems. Researchers of KIT and Helmholtz Institute Ulm (HIU) use a combination of materials that reach an extremely high energy density of 560 watt-hours per kilogram of the active materials, while retaining a very high capacity. The new lithium-metal battery consists of a nickel-rich cathode

Interior view of the SmartBatteryMaker of the AgiloBat2 project with the central robot and three production modules for stacking (left), contacting (center), and packaging (right).



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Using a promising combination of cathode and electrolyte, researchers of Helmholtz Institute Ulm (HIU), founded by KIT in cooperation with Ulm University, expect to reach an extremely high energy density.

that can store considerable energy per mass and a liquid electrolyte that maintains much of its capacity over many cycles.

ALANO Research Project for Safe Solid-state Batteries

In the ALANO project coordinated by BMW AG, industry and academic researchers are developing innovative concepts for the next generation of lithium batteries. Accumulators with a lithium-metal anode as a principal component and a solid electrolyte ensure safety and enhance energy density on the cell level, thus increasing the range of electric cars. The solid electrolyte in particular promises to increase safety. It is fire-resistant and cannot leak. The project also is studying various innovative lithium-metal-based anode concepts that promise to optimize the anode's reactivity, safety, and performance. KIT's researchers at HIU concentrate on electrochemical aspects. The ALANO project covers the entire process chain, from the choice of materials to the manufacture of components, to producing cells, to battery scaling, to recycling. BMBF funds ALANO under its "Battery 2020 Transfer" program.

Battery Competence Cluster InZePro

The future manufacture of battery cells must be rapid and inexpensive as well as flexible and of high product quality. The Cluster of Competence for Intelligent Battery Cell Production (InZePro) is aimed at perfecting production systems and making them more flexible in terms of quantity, format, material, and technology. First results have been obtained with respect to agile plant technology, digitalization of production steps and the entire production system, virtual production systems, and use of artificial intelligence in production. Projects cover all process steps of lithium-ion battery cell production. In this way, companies such as those in the automotive industry will be able to increase productivity even in times of volatile orders and high product variance and, at the same time, reduce costs and improve product quality. About 200 researchers from 28 German research institutions are involved in the InZePro cluster of competence, including five institutes of KIT. BMBF funds the project with a total of about EUR 44 million.

Optimization of the calendering process (adjustment of the properties of battery electrodes) with machine learning methods in the InZePro project.

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STABLE GRIDS AND CHARGING INFRASTRUCTURES

Energy Storage Systems for Stable Power Supply

StoRIES – Energy Storage Research in Europe

To reach its climate goals, the European Commission presented its European Green Deal in December 2019, which calls for achieving climate neutrality by 2050. The focus lies on transforming the energy sector to enable power production from renewable energy sources. However, this alone will not be sufficient, says Professor Stefano Passerini, Director of Helmholtz Institute Ulm (HIU): "To use the fluctuating renewable energy sources of wind and solar power on a large scale, we will need corresponding energy storage systems."

To accomplish this, the Green Deal includes coordinated research and development work in Europe, such as that pursued by the new research consortium StoRIES (Storage Research Infrastructure Eco-System). Researchers from all over Europe who specialize in different fields will work in close cooperation with industry to develop hybrid energy storage technologies. StoRIES is coordinated by HIU, which was established by KIT and Ulm University. The consortium began work officially on November 1, 2021.

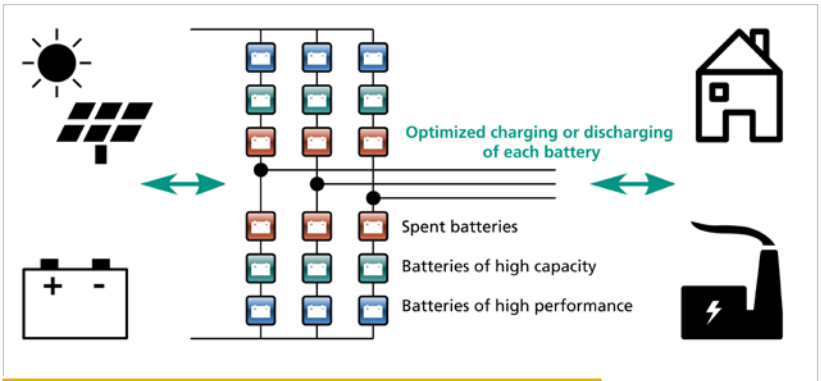
The most important technical goal of StoRIES is the development of all kinds of energy storage systems that will be powerful, persistent, sustainable, and inexpensive. At the moment, no energy storage technology is sufficiently flexible to meet all of these criteria. Another goal of the consortium is training the next generation of researchers, engineers, and specialists. The new consortium includes institutes of technology, universities, and industrial companies representing 17 partner institutions and 31 associated partners in 17 countries. Members of the European Energy Research Alliance and the European Association for Storage of Energy form the core of this new ecosystem. The European Commission is sponsoring StoRIES with about EUR 7 million for an initial four years under the Horizon 2020 programme.

The StoRIES research consortium will accelerate development of innovative hybrid energy storage systems.

LeMoStore – Stable Power Supply Based on Renewable Energy Sources

The share of renewable energy sources in the power supply mix is increasing. Because solar and wind power fluctuate as a function of time and weather, powerful energy storage systems are needed to ensure stable power supplies on the public grid.

The research project Service Life-optimized Integration of Modular Energy Storage Systems in the Grid, or LeMoStore for short, pursues an innovative approach. Several small battery modules based on different storage technologies will be combined flexibly and efficiently and will be connected to the power grid via a grid-compatible inverter. "Charging and discharging capacities are strategically divided to achieve a maximum service life of the battery modules and, at the same time, meet the specific requirements of the power grid," says Professor Marc Hiller, Member of the Board of KIT's Institute of Electrical Engineering.



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Schematic representation of the modular energy storage system of the LeMoStore project, together with renewable energy sources, large storage systems (left), and the power grid (right).

Researchers model an integrated system to figure out optimum energy distribution in real time. Within the framework of the project, the system is implemented in the form of a demonstrator. The power-hardware-in-the-loop infrastructure of KIT's Energy Lab 2.0 is used for testing it.

KIT's partners in LeMoStore are Aschaffenburg University of Applied Sciences and the companies of BMZ Germany GmbH and BATEMO GmbH. Associated partners are HBK – Hottinger Brüel und Kjær GmbH, Linde Material Handling GmbH, KION Battery Systems GmbH, and Mainsite GmbH & Co. KG. The project started on June 1, 2021, and is scheduled for a duration of three years. LeMoStore is funded by the Federal Ministry for Economic Affairs and Climate Action with about EUR 1.7 million.

SKALE – Scalable Charging System for Electric Vehicles

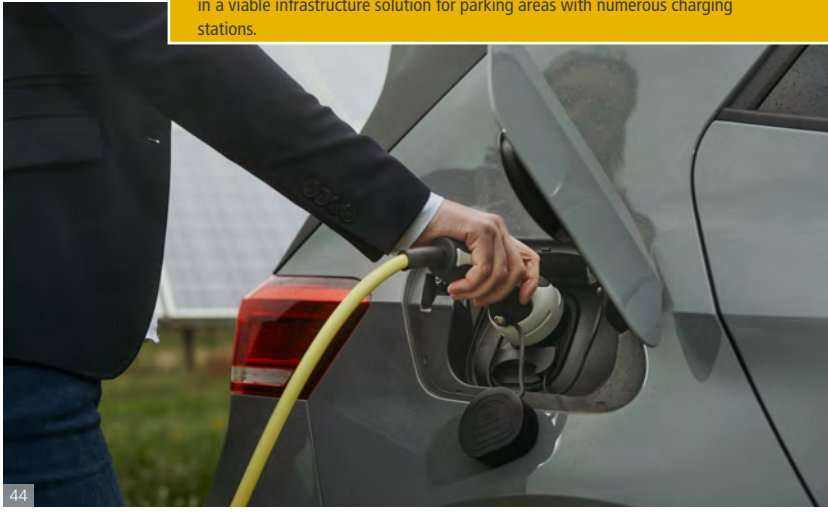
The rapidly growing number of electric vehicles has increased the importance of charging infrastructures and grid security concepts. Charging electric cars after the start or end of work will strain the power grid. Load peaks could be avoided, however, if cars could be charged during the entire time they are inactive. According to a study on behalf of the Federal Ministry of Transport, the mean operation time of cars is only 45 minutes per day. Within the SKALE project, KIT, Robert Bosch GmbH, and Power Innovation Stromversorgungstechnik GmbH are developing a scalable charging system that includes a photovoltaic facility, a stationary lithium-ion storage system, and a medium-voltage grid connection.

The research project covers the entire chain of energy flow and looks to enhance charging capacity and efficiency while reducing costs. The researchers are considering an array of constraints, from energy supply by the grid to need-tailored interim storage, distribution, and conversion, as well as feeding the energy back into the grid. "The new approach will result in a viable infrastructure solution for any parking areas with numerous charging stations. Decentralized energy sources will be integrated efficiently," says Professor Marc Hiller.

As part of SKALE, researchers will design a charging infrastructure demonstrator. The planned setup will include about ten charging stations, a photovoltaic facility with a peak power of about 100 kW, and a battery storage system with a capacity of about 50 kWh. The demonstrator will provide the first practical experience with respect to the setup and operation of a charging infrastructure.

The SKALE research project is funded at about EUR 4.3 million by the Federal Ministry for Economic Affairs and Climate Action. It started on January 1, 2022.

An innovative approach developed by the SKALE research project will result in a viable infrastructure solution for parking areas with numerous charging stations.



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METAMATERIALS, NANOPRINTERS, AND OPTICAL DIFFUSORS

New Materials from the 3D Matter Made to Order Cluster of Excellence

Within the Cluster of Excellence of 3D Matter Made to Order (3DMM2O), researchers of KIT and the University of Heidelberg are working on innovative technologies and materials for digital and scalable additive manufacturing processes that will make 3D printing more precise, rapid, and efficient. Their goal is to completely digitize 3D manufacture and materials processing from the molecule to the macrostructure. In addition to funds granted under the Excellence Competition of the Federation and the States, 3DMM2O receives funding by Carl Zeiss Foundation.

Sound Waves Traveling Backwards

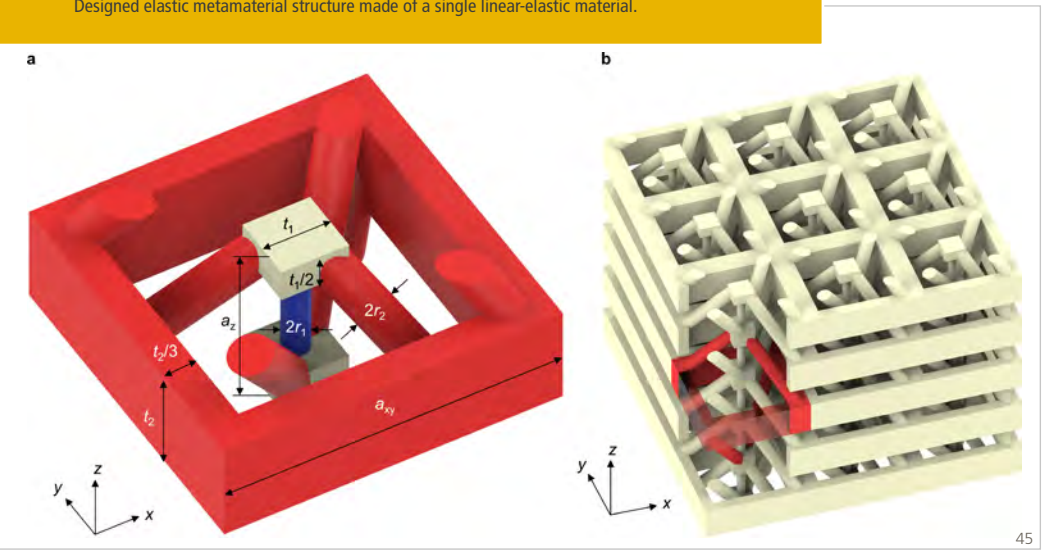
Acoustic waves in gases, liquids, and solids usually travel at an almost constant speed of sound. So-called rotons are an exception. Rotons are quasiparticles and behave similarly to free particles. Their speed of sound changes significantly with their wavelength; it is also possible that the waves travel backwards. Understanding and benefitting from quasiparticles such as rotons is one of the great challenges of quantum physics. So far, rotons have only been observed under special quantum-physical conditions at extremely low temperatures and have therefore been unsuitable for technical applications. This may change in the future. Researchers of KIT and the University of Heidelberg are working on artificial materials, so-called metamaterials, that "grow" rotons.

Metamaterials exhibit optical, acoustic, electrical, and magnetic properties that are not found in nature. They produce rotons without any quantum effects under normal ambient conditions and at almost random frequencies or wavelengths. These computer-designed metamaterials produced by ultra-precise 3D laser printing might be used in the future to manipulate sound waves in air or in materials in ways that have never been possible before, for example, to bounce them back, redirect them, or create echoes.

3D Laser Nanoprinters in the Form of Compact Desktop Devices

Today's 3D laser printers for three-dimensional microstructures and nanostructures have needed big and expensive laser systems. A focused laser beam is directed towards a light-sensitive liquid. At the focal point, the laser light turns a switch in special molecules and triggers a chemical reaction. This leads to local hardening of the material. By moving the focal point, micro- and nanostructures can be produced. The chemical reaction is based on two-photon absorption, meaning that two photons excite the molecule at the same time, which causes the desired chemical modification. However, this simultaneous excitation is exceedingly difficult, which is why complex pulsed laser systems are needed, resulting in laser printers with large dimensions. Researchers of KIT and the University of Heidelberg have now developed another process, the two-step process, which could make possible more compact printers. It uses small and inexpensive blue laser diodes and requires specific photoresists. In the first step, a photon shifts the molecule to an intermediate state. In the second step, a second photon moves the molecule from the intermediate state to the desired excited state and starts a chemical reaction. Unlike two-photon absorption, these steps do not have to happen at the same time. That makes it possible to use compact and low-power contin-

Designed elastic metamaterial structure made of a single linear-elastic material.



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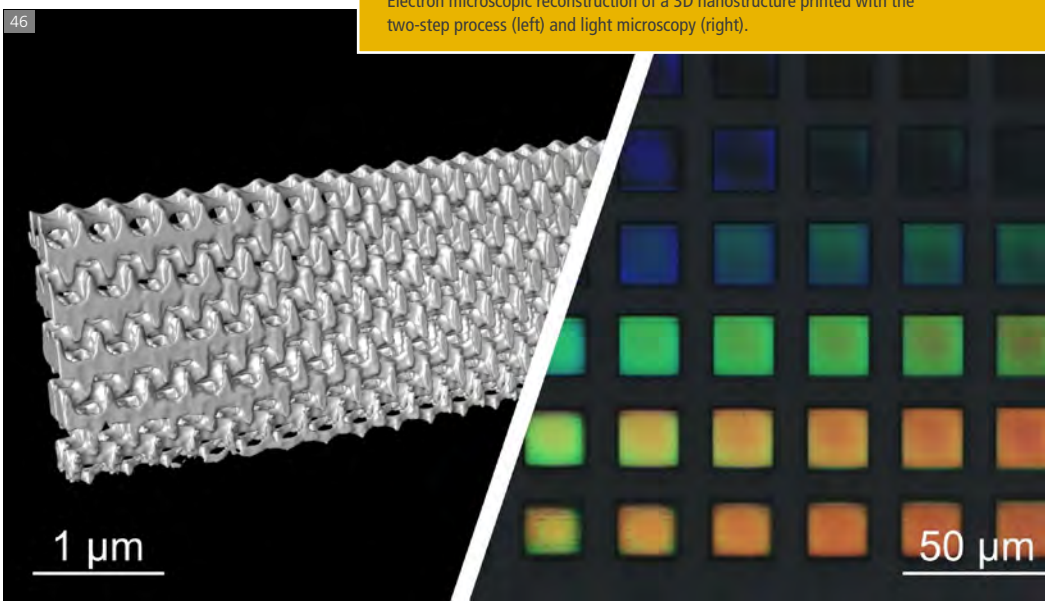
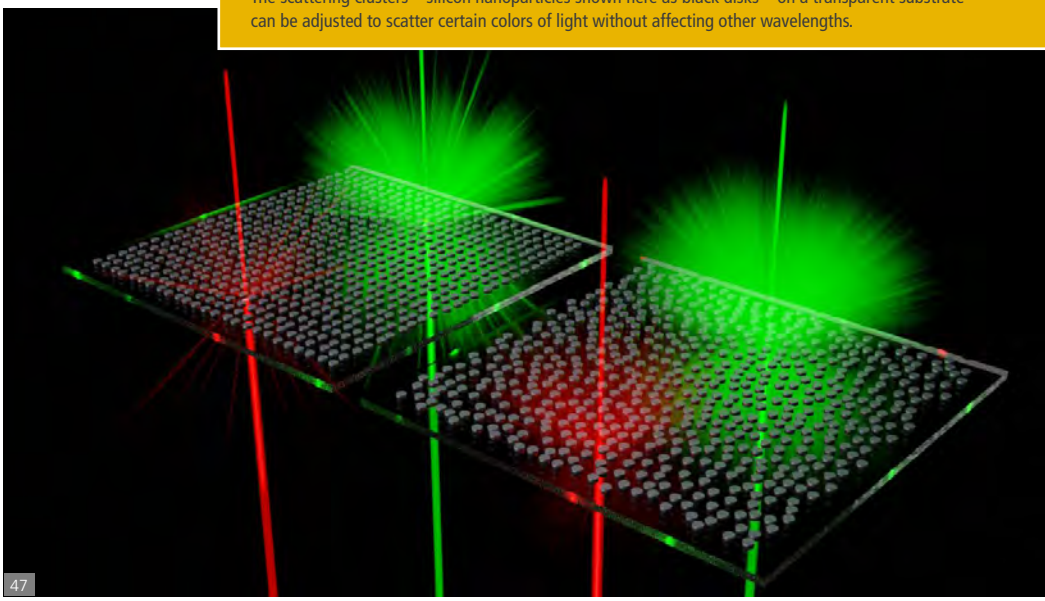


46 Electron microscopic reconstruction of a 3D nanostructure printed with the two-step process (left) and light microscopy (right).

uous-wave laser diodes. Once other components have been miniaturized, a 3D laser nanoprinter the size of a shoebox will be possible in the coming years.

Thinnest Optical Diffusor for New Applications

Photonics is considered a major driver in developing technologies for the 21st century. The challenge ahead is to miniaturize conventional optical elements, such as lenses, mirrors, prisms, or diffusors, and to enhance their performance with features only accessible in the realm of nanophotonics. This will lead to new applications, such as miniaturized sensors in autonomous vehicles or integrated photonic quantum computers. Researchers of KIT and the Friedrich Schiller University of Jena have succeeded in developing a diffusor using metamaterials made of silicon nanoparticles. Diffusors are disks that scatter incident light in all directions with the help of small scattering clusters. To overcome the bulkiness of conventional optical diffusors, a layer of specially designed silicon nanoparticles only 0.2 micrometers thick was applied to a substrate, where the particles are arranged in a disordered, but carefully planned manner. These nanoparticles are a hundred times thinner than a human hair and can be adjusted to interact with only certain wavelengths of light. The direction, color, and polarization of light can be controlled with this novel diffusor and the metasurfaces. This innovative technology may be used in transparent screens that can be looked at from both sides, holographic projectors, and augmented reality.



47 The scattering clusters – silicon nanoparticles shown here as black disks – on a transparent substrate can be adjusted to scatter certain colors of light without affecting other wavelengths.

CLIMATE AND ATMOSPHERE RESEARCH

About Infrastructures and Measurement Campaigns

ACTRIS – European Infrastructure for Atmosphere Research

Fine dust particles, clouds, and most trace gases are short-lived constituents of the atmosphere. Unlike long-lived greenhouse gases such as methane and carbon dioxide, which can remain in the atmosphere from tens to thousands of years, trace gases stay in the atmosphere for only a few hours or weeks. Still, they have a big impact on air quality and climate. For example, small, suspended particles reflect sunlight and thermal radiation. Or they can act as nuclei for the formation of cloud droplets and ice crystals, resulting in precipitation. The dimensions of these very different effects are not well understood.

Within the European research infrastructure ACTRIS (The Aerosol, Clouds and Trace Gases Research Infrastructure), many research institutions study short-lived atmospheric particles and extend Earth systems observation and research. More than 100 research institutions from 22 European countries comprise ACTRIS. Within ACTRIS, KIT is involved in two big research efforts: CIS and ACTRIS-D.

KIT handles the setup and management of the calibration center CIS – Centre for Cloud In-Situ Measurements. CIS is one of six European centers specialized in remote sensing and in-situ studies of aerosols, clouds, and trace gases.

49 ACTRIS researchers involved in the European infrastructure CIS use KIT's AIDA cloud simulation chamber to study the impacts of clouds on climate.

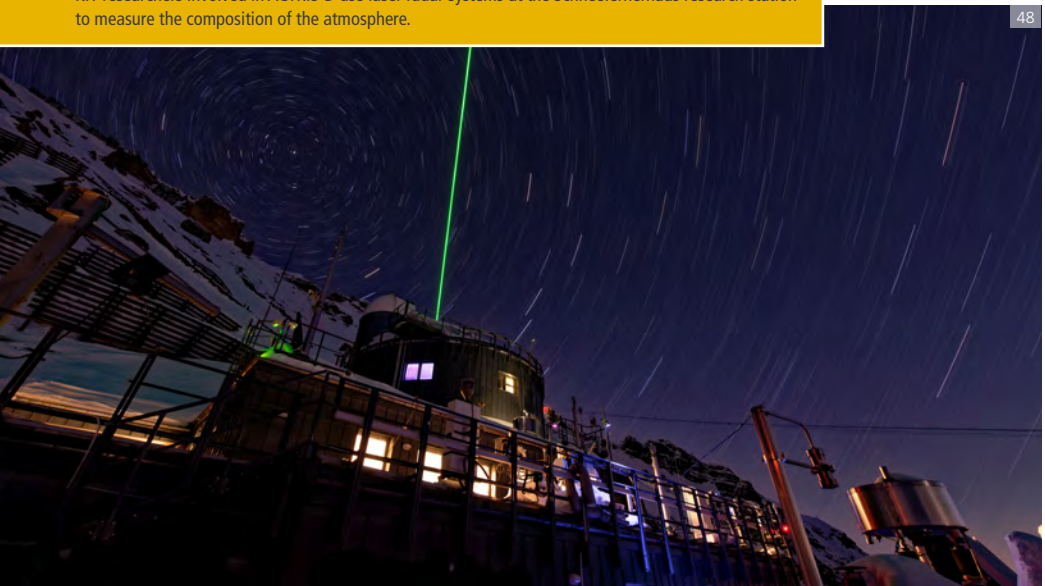
Clouds play an important role in the Earth's climate. "Clouds transport water and bring precipitation, they cool the Earth by reflecting incident sunlight, and wrap our planet like a blanket that prevents heat from being dissipated into space," says Dr. Kristina Höhler from KIT's Institute of Meteorology and Climate Research.

With the help of Europe-wide measurements, CIS will create a broad database to better understand the influence of cloud properties on climate. KIT coordinates the work of CIS. Its consortium partners are Leibniz Institute for Tropospheric Research in Leipzig, Sonnblick Observatory in Austria, and the University of Manchester in Great Britain.

ACTRIS-D conducts research into short-lived particles in the atmosphere, from the ground up to the stratosphere. It is aimed at reducing the uncertainties of future climate forecasts, obtaining new findings on interactions among different climate processes, and evaluating measures to improve air quality and its impacts on health and ecosystems.

As part of ACTRIS-D, KIT receives about EUR 14 million to set up new measurement facilities for cloud research and to equip existing

KIT researchers involved in ACTRIS-D use laser radar systems at the Schneefernerhaus research station to measure the composition of the atmosphere.



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infrastructures with the latest measurement technology for long-term operation. These infrastructures include the AIDA cloud chamber, the atmosphere observatory in Garmisch-Partenkirchen/Zugspitze, and the mobile KITcube platform.

"At KIT, we want to collect precise, quality-assured datasets for trace gases, aerosols, and clouds over longer terms. With them, important processes in the climate system can be studied and future changes will be detected and analyzed much better," says Dr. Ottmar Möhler from KIT's Institute of Meteorology and Climate Research.

Swabian MOSES – Measurement Campaign to Study Atmospheric Extreme Events

The number of extreme weather events, such as severe thunderstorms, hailstorms, and heat waves, have increased in Germany in recent years. They sometimes cause major economic and infrastructure damage. To study the impacts of meteorological and hydrological extremes on the Earth's environmental systems, nine research centers of the Helmholtz Association are setting up a mobile and modular observation system called MOSES (Modular Observation Solutions for Earth Systems) that will be fully operational by 2022.

The Swabian MOSES measurement campaign, which took several months, began in May 2021 in the Swabian Jura and the valley of the Neckar River in Baden-Württemberg.

"Due to its complex topography and geographical location, this region is quite frequently affected by severe thunderstorm events," says Professor Michael Kunz from the Institute of Meteorology and Climate Research. Swabian MOSES focused on two hydro-meteorological extremes – drought and heavy rainfall. Frequent occurrence of multi-week droughts in 2018 to 2020 caused groundwater levels to drop to historic lows last year, and extremely low water levels in many rivers caused significant restrictions on shipping, irrigation, and power plant cooling.

50 Setup of the KITcube precipitation radar to measure precipitation within a radius of 100 kilometers in the Swabian Jura/Neckar valley region.

During the measurement campaign, KIT used its mobile KITcube observatory, which supplies detailed information on the state of the atmosphere during the formation and development of thunderstorms. The KITcube includes a state-of-the-art cloud radar, a precipitation radar, a network of lidars to measure atmospheric airflows, weather balloons, and weather stations. KIT's novel mobile cloud chamber measures the number of ice-forming particles involved in precipitation and hail formation in thunder clouds. For the first time, KIT tested swarms of small probes. They reproduce wind conditions and paths of hailstones within a thunder cloud in order to better understand growth processes of precipitation particles, in particular of hail.

RANKING TOP IN SPEED AND ENERGY EFFICIENCY WORLDWIDE

Karlsruhe Supercomputer HoreKa Is among the Fifteen Fastest in Europe

High-performance computers make major contributions to solving some of society's most pressing challenges. This holds for energy and climate research as well as for materials science, medicine, or particle physics. The faster supercomputers can solve mathematical equations and process data, the more detailed and reliable the simulations they run will be.

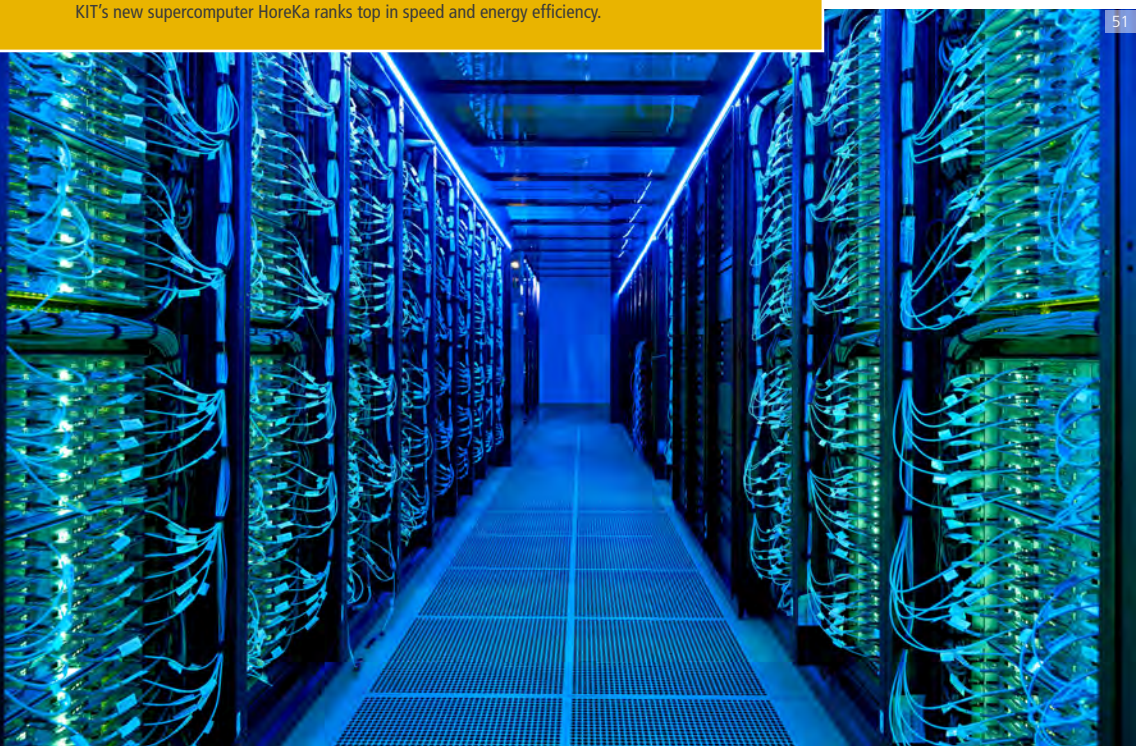
In many scientific disciplines, supercomputers have become indispensable for the researchers' daily work. At KIT, the very high computation capacity of the new Karlsruhe High-performance Computer (HoreKa) enables work in these areas. On July 30, 2021, Theresia Bauer, Baden-Württemberg Minister for Science, Research, and the Arts, handed the new 15-million-euro machine over to the scientific community. KIT had been chosen the previous year as a Center for National High-performance Computing.

HoreKa is among the fifteen fastest computers in Europe. In the top-500 list of fastest computers in the world, which is published twice a year, HoreKa ranked 52nd in 2021. Overall, HoreKa reaches a peak performance of 17 PetaFLOPs, which is equivalent to 17 quadrillion computing operations per second or the performance of about 150,000 laptops. HoreKa also is among the top computers in energy efficiency and reached 13th place in the Green500 list of the world's most energy-efficient supercomputers. Supercomputers require a lot of energy, but HoreKa uses it much more efficiently than conventional PCs and laptops. Its highly energy-efficient hot water-cooling system enables year-round cooling of the supercomputer with minimal energy consumption. In the colder months, the office space can be heated with the waste heat.

HoreKa is one of the most powerful and energy-efficient supercomputers and KIT is thus very well equipped for challenging tasks ahead.

HoreKa has a special configuration: It is a hybrid system that consists of two components. HoreKa-Green includes computing accelerators based on graphics processors (GPUs). HoreKa-Blue is based on standard processors (CPUs). The GPU-based accelerators, made by NVIDIA, achieve extremely high performance for certain computing operations that are very important to science, such as solving systems of equations or simulating neural networks in artificial intelligence. For other operations, the standard CPUs by Intel are better suited. The strengths of both architectures are combined in HoreKa to achieve maximum performance.

KIT's new supercomputer HoreKa ranks top in speed and energy efficiency.



QUANTUM COMPUTERS

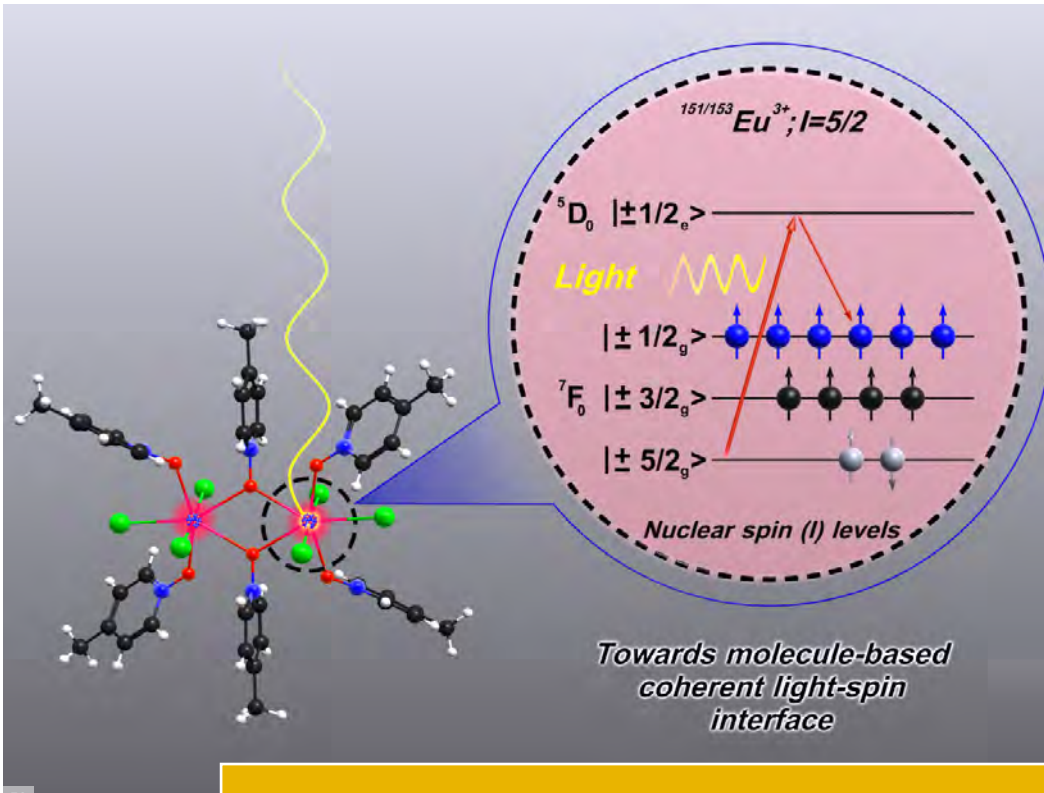
Computing with Qubits and Light

Drug development, communication, and climate forecasts: Processing information quickly and efficiently is crucial in many such areas. It is currently done with digital computers working with so-called bits. The state of a bit is either 0 or 1 – there is nothing in between. This largely limits the performance of digital computers, and it is becoming increasingly difficult and time-consuming to handle complex problems related to real-world tasks. Quantum computers, by contrast, use quantum bits to process information. A quantum bit (qubit) can be in many different states between 0 and 1 simultaneously due to a special quantum mechanical property referred to as a quantum superposition. Data can be processed in parallel, which increases the computing power of quantum computers compared to digital computers.

To develop quantum computers, the superposition states of a qubit should persist for a sufficient time, the so-called coherence lifetime. Nuclear spin levels in molecules can be used to create superposition states with long coherence lifetimes, because nuclear spins are shielded from the environment by external electronic orbitals, thus protecting the superposition states of a qubit from disturbing external influences.

However, a single qubit is not enough to build a quantum computer. To do so requires organizing many qubits to work together. Molecules represent ideal qubit systems, as they can be arranged in sufficiently large numbers as identical scalable units and can be addressed with light to run qubit operations. In addition, physical properties of molecules, such as emission or magnetic properties, can be tailored by changing their structures using chemical design principles. Researchers of KIT's Institute for Quantum Materials and Technologies and École nationale supérieure de chimie de Paris (Chimie ParisTech – CNRS) presented a nuclear spin-containing dimeric europium (III) molecule as a light-addressable qubit.

The molecule, which belongs to the rare-earth metals, is designed to luminesce when excited by ultraviolet light-absorbing ligands surrounding the center. After light absorption, the ligands transfer the light energy to the europium (III) center, thereby exciting it. Relaxation of the excited center to the ground state leads to light emission. The entire process is referred to as sensitized luminescence. The polarization of the nuclear spin levels can be detected. This enables the generation of light-addressable hyperfine qubits based on nuclear spin levels.



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The europium complex acting as qubit, in which the nuclear spin is read out with light.

SMART SYSTEMS THANKS TO NEW AI METHODS

Thanks to Artificial Intelligence, Smart Robot Systems and a Digital Pen Make Life Easier

Better Gripping with Intelligent Picking Robots

Production, warehouse, shipping – wherever goods are produced, stored, sorted, or packed, picking also takes place. This means that individual goods are removed from storage units, such as boxes or cartons, and recombined with other goods. Researchers from KIT, together with partners from Germany and Canada, work on new AI methods for picking robots with the FLAIROP (Federated Learning for Robot Picking) project. They investigate how to use training data from multiple stations of different companies without requiring participants to hand over sensitive company data.

At several picking stations, items are gripped and transferred by autonomous robots. The robots at each station are trained to grasp quite different items. Ultimately, they need to be able to grasp items from other stations they have not yet learned about. Federated learning is an approach to doing so that balances data diversity and data security in an industrial environment. The goal is to develop new, more powerful algorithms for the robust use of artificial intelligence in industry and logistics 4.0 while following data protection guidelines. FLAIROP is funded by the Canadian National Research Council and the German Federal Ministry for Economic Affairs and Climate Action.

Digital Pen Helps Persons Learn to Write

Handwriting is important in a knowledge-based society. Studies reveal that writing by hand leads to higher-quality text than typing. Within the framework of the German-French project "Kaligo-based Intelligent Handwriting Teacher" (KIHT) coordinated by KIT and funded by the Federal Ministry of Education and Research, a smart digital pen will be developed to help persons learn to write and connect them to digital media. Within this project, AI algorithms are studied for reconstruction of a writing trace and interpretation of handwriting.

The innovative learning device can be used for writing on paper. It is equipped with inertial sensors that capture the smallest changes on the three spatial axes and, therefore, calculate the pen's position in space. The smart digital pen can be connected to any mobile end device, including a tablet, and interacts with the mobile Kaligo app. With the help of this app, exercises can be adapted individually and data can be synchronized and secured automatically. Use of the smart digital pen together with computer programs can automatically support the learning of writing. In this way, teachers and parents are given more freedom for creative and communicative tasks. The smart learning device is supposed to benefit as many children as possible.

In the FLAIROP research project, autonomous robots grip and transfer items at several picking stations.

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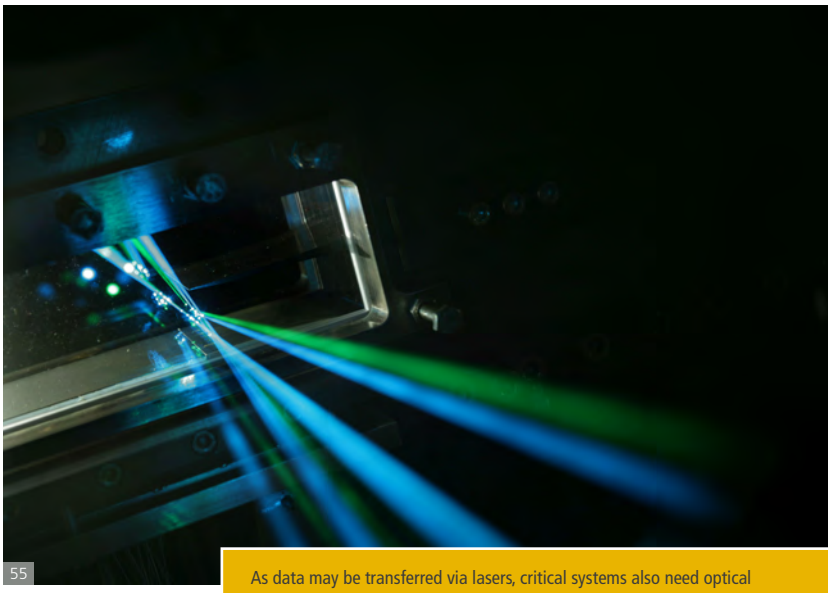
IT SECURITY

Beware of Computer Attacks with Laser Light

Cybercriminals attack computers with lasers – it sounds like a scene from the latest James Bond movie, but it could happen in reality. This was proven by researchers of KIT, Technische Universität Braunschweig, and Technische Universität Berlin within the LaserShark research project, which focuses on hidden communication via optical channels. Computers or networks in critical infrastructures, such as utility companies, the medical engineering sector, or traffic control systems, are often physically isolated to prevent access from outside. These "air-gapped" systems have neither wired nor wireless connections to the outside world. Earlier attempts to bypass such protection via electromagnetic, acoustic, or optical channels merely worked at short distances or low data rates. Often, they allow for data exfiltration only. The method used in the LaserShark project, however, can initiate dangerous attacks: With a directed laser beam, adversaries can introduce data into air-gapped systems and retrieve data without any other hardware being needed. This hidden optical communication uses light-emitting diodes incorporated in devices that display status messages, such as on printers or telephones. These LEDs can receive light, although they are not designed to do so.

By directing laser light to already installed LEDs and recording their response, researchers for the first time established a hidden optical communication channel over a distance of up to 25 meters. It can be used in both directions and can reach high data rates. Such an attack is possible in commercially available office devices used by companies, universities, and authorities. With



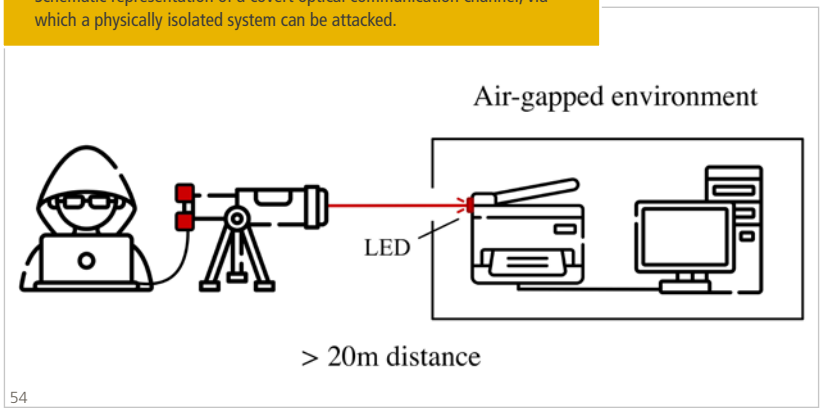
55 As data may be transferred via lasers, critical systems also need optical protection.

LaserShark, the researchers proved how important it is to optically protect critical IT systems in addition to taking conventional IT security measures.

To push research and enhance protection against covert optical communication, the researchers published the program code used in their experiments as well as the raw data of their measurements and their scripts on the LaserShark project website at: https://intellisec.de/research/lasershark.

LaserShark is a project in which the Intelligent Systems Security Group of KASTEL – Institute of Information Security and Dependability of KIT collaborates with researchers from Technische Universität Braunschweig and Technische Universität Berlin.

Schematic representation of a covert optical communication channel, via which a physically isolated system can be attacked.



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RESEARCH FOR FUTURE MOBILITY

Collaborations on New Methods and Processes for Data Acquisition in the Future Car

Automated vehicles are equipped with various sensors to capture information about themselves and their environment. 56

KIsSME Collaboration Project

Testing highly automated vehicles over millions of kilometers gives rise to large data volumes, as the vehicles are equipped with various sensors for analyzing their own status and their environment. These data volumes can reach four to eight terabytes per vehicle each day. Reducing the volume to save storage capacity, power, and evaluation expenditure while also compressing the data to enhance vehicle safety are the goals of KIsSME (artificial intelligence for selective near-real-time recording of scenario and maneuver data during tests of highly automated vehicles).

The scientists are developing algorithms, based on AI, which select data as they are collected during the driving mode and sort them into scenario catalogs. Within the collaboration, KIT supplies data from test drives and simulations. Measurements are made in public urban traffic as well as on the Baden-Württemberg Test Area for Autonomous Driving (TAF BW) in Karlsruhe. More data are obtained from simulations at a vehicle test bed of KIT. The Federal Ministry for Economic Affairs and Climate Action funds the project with EUR 6.5 million, of which about EUR 330,000 go to KIT.

SofDCar Research Project

Some of today's vehicles feature more than 100 electronic control units. The already high complexity of electrical and electronic systems and their architecture is bound to increase further but must remain manageable. The Software-Defined Car (SofDCar) project is carried out by KIT together with the University of Stuttgart, the Research Institute of Automotive Engineering and Vehicle Engines Stuttgart, and the FZI Research Center for Information Technology, an innovation partner of KIT. It is aimed at developing standardized rules and processes to ensure that electronic components of the vehicle interact smoothly, remain updatable, and are safe.

The goal of the SofDCar project is to establish rules and processes for controlling future software updates and upgrades as well as a consistent functional and IT security methodology to which they should adhere. This will prevent individual programs from interfering with each other. Proper functioning in the system shall be guaranteed without any errors. This will be the prerequisite for accelerating the development of new functions of the car and their safe use by drivers. The Innovation Campus Future Mobility of the University of Stuttgart and KIT with its focus on software-defined mobility is an ideal environment for innovative and interdisciplinary research. The project is funded by the Federal Ministry for Economic Affairs and Climate Action.

RESEARCH FOR FUTURE MANUFACTURING

AgiloDrive2 Studies Agile Production of Electric Motors

Although electric mobility is gaining importance, much is still uncertain for car manufacturers: What sales volumes can be expected? Which technologies are suitable? To answer these questions, scientists from three KIT institutes, the Schaeffler company, and 16 other industry partners have joined the AgiloDrive2 research project to study how electric motors can be manufactured flexibly and economically.

The research covers the development of robust product kits, efficient design methods, data-based technologies, and digital process chains. The goal is to implement an agile production system for electric traction motors as a real-world test.

A team from the Institute of Product Engineering will create a modular kit for the development of electric motors and develop a method for impact and risk analysis in early phases of product manufacture.

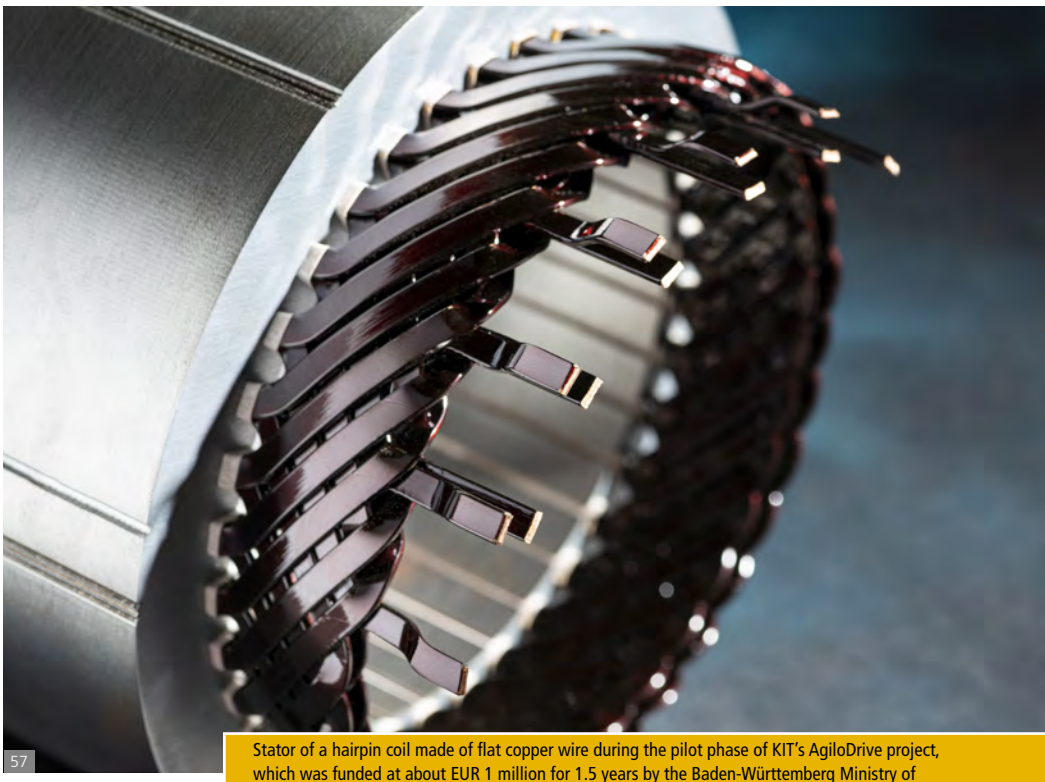
At the Institute of Electrical Engineering, scientists will develop digital process chains for the efficient design of electrical machines.

Together with its industry partners, the team from the wbk Institute of Production Science will develop a production kit for electric motors. Moreover, they will analyze and perfect processes needed to manufacture electric traction motors flexibly and economically.

The processes and technologies studied include classical handling and joining techniques, such as those used in magnet assembly, but also complex specialty processes, such as the insertion of hairpin coils made of flat copper wire. In addition, methods for data-based enhancement of production efficiency and flexible disassembly of electric motors are analyzed using the approach of value stream kinematics.

Collaboration between science and industry is expected to pay off for all project partners in both the short and long term. Schaeffler plans to transfer the findings to electric motor production at its factory in Bühl at project's end. With the new Karlsruhe Research Factory on KIT's Campus East and the Schaeffler Hub for Advanced Research (SHARE), KIT has already set up an infrastructure for research into sustainable mobility.

AgiloDrive2 started in 2021 and will be funded at EUR 16.4 million for three years (the total project amount is EUR 33.7 million) by the Federal Ministry for Economic Affairs and Climate Action.



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Stator of a hairpin coil made of flat copper wire during the pilot phase of KIT's AgiloDrive project, which was funded at about EUR 1 million for 1.5 years by the Baden-Württemberg Ministry of Economic Affairs, Labor, and Tourism.

CREDIBLE AND UNDERSTANDABLE CRISIS COMMUNICATION

Collaboration Project Studies Impacts of Health Information on Society in Times of an Epidemic Crisis

Among the most important sources for current communication on the pandemic are the websites of Robert Koch Institute. The MIRKKOMM project will study empirically whether such approaches reach the users. 58

The current Covid-19 pandemic clearly shows the importance of reliable and understandable information. But how would citizens like to be informed by authorities and media during a crisis? How well do messages from health institutions reach the public? How can information be processed understandably and credibly and how can it be disseminated effectively? Questions like these have gained importance during the pandemic.

They are now the focus of the new collaboration project MIRKKOMM – Multimodality in Risk and Crisis Communication. Its research covers multimodal forms of risk and crisis communication via different channels, including dashboards, brochures, new video formats, and visualizations. Experts from the Science Communication Department of KIT's Institute of Technology Futures participate in a subproject concentrating on how people receive multimodal crisis information and the cognitive and affective impacts of that information.

In times of crises, authorities and citizens are forced to make decisions on the basis of frequently uncertain and sometimes controversial information. Researchers will analyze which communication modes convey credibility and build up trust by means of an extensive laboratory study using eye tracking and knowledge tests as well as an online survey on the evaluation and acceptance of multimodal communication approaches.

Researchers will examine how citizens and staff of authorities receive multimodal crisis information and which cognitive and affective effects this information has on them. Researchers will identify the criteria used by citizens and authorities to evaluate the information, how these criteria influence their risk perception, and which action requirements they derive from this information. The goal is to develop offers tailored to the addressees and to eliminate deficiencies in the authorities' communication.

Altogether, the interdisciplinary MIRKKOMM project consists of eight subprojects. Experts in media and communication sciences, political science and law, psychology and informatics are involved. The project is scheduled for a duration of three years and funded with a total of EUR 2 million by the Federal Ministry of Education and Research under its program "Research for Civil Security." The funds granted to KIT's subproject total about EUR 418,000. MIRKKOMM is coordinated by the Federal Institute for Risk Assessment, an independent scientific institution that provides advice to the Federal Government.

MENTAL HEALTH OF CHILDREN HAS DECREASED

Effects of the Pandemic and Lockdown

According to the Motor Module Longitudinal Study (MoMo) of KIT and Karlsruhe University of Education, the mental health of children and adolescents decreased on average during the first Covid-caused lockdown in spring 2020.

To figure out the relationships of mental health, physical activity, and increased screen time, the team evaluated data collected in August 2018 and spring 2020.

In total, 1711 children and adolescents took part in MoMo. They answered questions relating to their physical activity and their psychic well-being. In the MoMo activity survey, they reported the number of days on which they had been physically active for at least 60 minutes – as recommended by the World Health Organization WHO – during a usual week and during a lockdown week.

To determine well-being, the researchers used the questionnaire of the EU-funded KIDSCREEN project, which is based on the five criteria of physiological well-being, psychic well-being, autonomy/parents, friends/social support, and school environment. Researchers analyzed the data using so-called cross-lag models, which reveal changes of mutual effects between two or more measurement times. The data were evaluated separately as a function of age and gender.

The average for children and adolescents is 50 points. Even before the pandemic, boys and girls in Germany scored values of 44 and 45 points, respectively, which were bad compared to the European average. Researchers found that these values further decreased during lockdown. In early 2021, mental health values were 40 for boys and 41 for girls.

In contrast, the physical activity of children who had good mental health before the lockdown actually improved during the lockdown. Children who ranked in the top five percent in terms of mental health prior to the pandemic increased their physical activity during the lockdown by half a day more than children belonging to the five percent with the worst mental health.

Researchers see mental health's effect on physical activity for children ages four to ten years, but not for children from 10 to 17, which they attributed to the latter's increased stress during home schooling.

The MoMo study revealed a relationship between mental well-being and physical activity during the lockdown in spring 2020.

COSMIC GHOST PARTICLES ON THE SCALES

Tracking down Neutrinos in the KATRIN Experiment with Virtual Reality

The view on KIT's Campus North into the main spectrometer of the KATRIN experiment to find the neutrino mass. 60

Neutrinos are the most abundant, lightest, and most mysterious elementary particles in our universe. They are lighter than electrons by several orders of magnitude. They have no electric charge and hardly interact with matter, which is why they are difficult to capture in experiments. In cosmology, they play a key role in the formation of large-scale structures. In particle physics, they have a special status, as their small mass suggests new physical processes beyond current theories. Without any measurement of the mass of neutrinos, our understanding of the universe will remain incomplete.

The Karlsruhe Tritium Neutrino Experiment KATRIN is designed to precisely find the mass of these mysterious particles for the first time ever. Researchers have now reached an important milestone in the investigation of neutrinos and their properties. Using the world's most sensitive scales, they succeeded in determining a new experimental upper limit of 0.8 electron volts for the neutrino mass. This is the most sensitive model-independent limit ever. Researchers enter the cosmologically and physically relevant mass range below one electron volt, where they assume the fundamental mass scale of neutrinos will be found.

To figure out the mass of neutrinos, KATRIN studies the beta decay of tritium, an unstable hydrogen isotope. The neutrino mass is determined from the energy distribution of the electrons produced by this decay. The 70 m long experimental facility has the world's most intensive tritium source as well as a huge spectrometer to measure the energies of the decay electrons with a precision unmatched to date.

Experiencing KATRIN

Usually, large-scale experiments of fundamental research, such as KATRIN, are hardly ever accessible to the public. This is because of special cleanliness requirements and safety regulations and, of course, because ongoing experiments must not be disturbed. Now, a new virtual reality application makes KATRIN accessible to the public. It combines photorealistic 360-degree views of the KATRIN setup with a virtual level.

Users are given direct insight into the interior of the facility and learn how the elementary particles move and behave in this large setup. Moreover, the application also enables the public to assume the role of a scientist and to interact with the experiment; for example, members of the public can change measurement variables during virtual operation. The VR application was developed in cooperation with the National Institute for Science Communication and funded by the Klaus Tschira Foundation.

HYDROGEN TECHNOLOGIES

KIT Participates in All Three German Lead Projects

Hydrogen technologies contribute to the success of the energy transition. Green hydrogen can help reduce greenhouse gas emissions and will be the key to Germany achieving climate neutrality by 2045. Hydrogen can be used as a fuel, auxiliary or basic material in industry, and it can be converted into power and heat for private buildings with the help of fuel cells. Trucks, trains, ships, and airplanes may be fueled with hydrogen. Hydrogen may also be used as a raw material for the production of synthetic fuels.

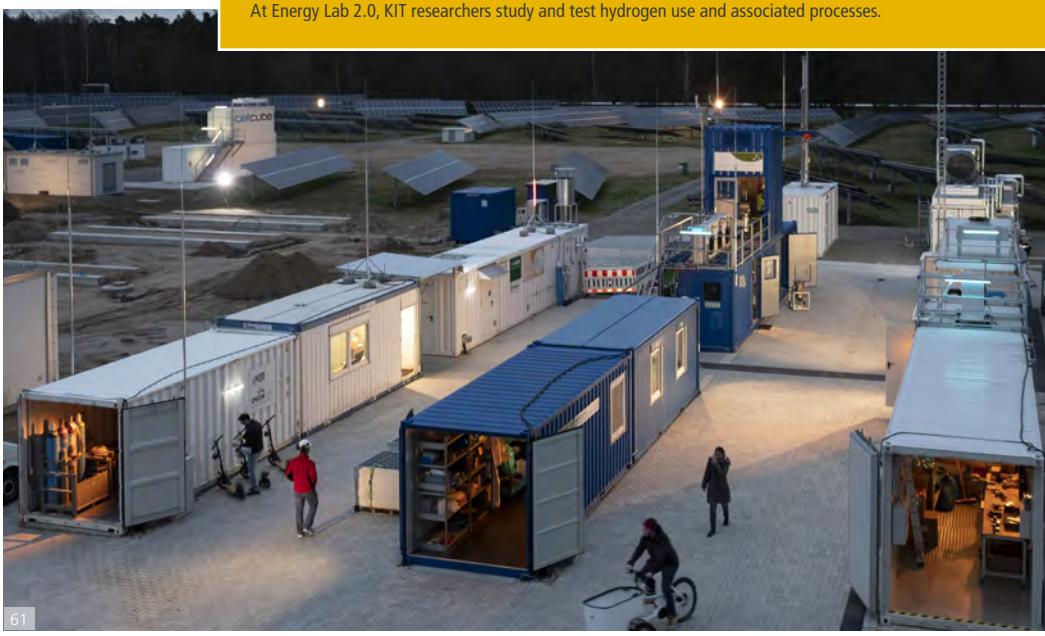
Last year, the Federal Ministry of Education and Research (BMBF) started a green hydrogen economy in Germany by launching a competition of ideas called "Hydrogen Republic of Germany." Following review of the submitted proposals, three lead projects were funded by BMBF at up to EUR 740 million. Researchers of KIT contribute their expertise to all of these projects. Together with partners from industry, science, and associations from all over Germany, they are working on the further development of the required technologies.

Green hydrogen can be produced from renewable energy sources by electrolysis. It can be applied as a fuel in many ways. Building plants, called electrolyzers, that generate hydrogen using electrical power, however, is complex and costly. The H_2Giga lead project focuses on the low-cost production of electrolyzers to cover Germany's need for green hydrogen. Within this project, KIT takes part in two collaborations to develop stacks of cells for high- and low-temperature electrolysis as well as the corresponding production processes and plants.

Thanks to the good wind conditions at sea and the high number of hours that generators can run at full loads, the offshore wind energy yield by far exceeds that on land. The H_2Mare lead project aims to use water electrolysis to produce hydrogen by making direct use of offshore wind energy without any connection to the grid. The goals are to reduce costs of green hydrogen and to increase economic efficiency.

Hydrogen is rarely used where it is produced. To cover the needs of Germany, major quantities must be transported or imported from wind- and sun-rich regions. For this reason, the lead project TransHyDE studies and develops transportation technologies and infrastructures for green hydrogen. At KIT's facilities, researchers can study and implement the complete chain from hydrogen liquefaction to the use of electrical devices in energy technology to fuel cell heating.

At Energy Lab 2.0, KIT researchers study and test hydrogen use and associated processes.



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TEACHING

In the 2021/22 winter semester, the number of KIT students totaled 22,225, about 4.7% less than in the previous year. The proportion of international students decreased slightly to 21%, while the share of female students remained constant at 29.5%.

For the Baden-Württemberg survey of graduates between 2018 and 2020, i.e., before the pandemic, all nine state universities, including KIT, requested their graduates to complete a standardized questionnaire. Answers were received from about 23,400 persons. The results reveal high satisfaction with studies in all subjects in Baden-Württemberg and at the respective universities. The survey of

graduates has been conducted regularly since 2013. All universities in Baden-Württemberg have taken part since 2017.

KIT graduates find a job within three months on average after completing their studies. Nearly all of them, about 95%, have a job within one year of graduation. The survey showed 38% of KIT graduates are highly satisfied or satisfied with their studies, 80% would attend KIT again and 75% would choose the same degree program.

In summer 2021, a KIT-organized study on special conditions during the pandemic found that, of all pandemic-related information services offered by KIT, students mainly used the circular mails and FAQ. Increased flexibility as a result of digital lectures was rated positively by most of them. The biggest challenges during studies were the lack of social contacts, self-motivation, and balancing studies with private life.

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OUTSTANDING QUALITY OF STUDIES AND TEACHING

KIT Retains Its Right to Accredit Its Study Programs

Study programs need to be accredited at regular intervals to affirm their quality. As a rule, this program accreditation is supported by an external agency. Only accredited universities that have their own internal quality management scheme for studies and teaching are allowed to accredit their study programs on their own. Internal quality management ensures that the program contents are of high quality and that study programs follow national and European regulations.

In 2014, KIT was one of the first universities in Germany to be granted the right to accredit its own programs. Six years later, its quality management for studies and teaching was evaluated by external experts with an excellent result. The group of experts usually consists of at least three professors from other universities who are experienced in quality assurance for academic education, and includes a representative of professional practice.

Following a positive recommendation by the experts, the accreditation council again granted KIT the accreditation right on January 26, 2021. KIT is allowed to thoroughly check its study programs on its own and to grant them the internationally recognized quality label for another eight years.

Repeated granting of the accreditation right shows that KIT's programs and internal quality management meet exacting standards. Moreover, it guarantees that study programs are aligned with KIT's research mission and that they pursue clearly defined qualification goals. Internal accreditation provides flexibility for the further development of academic education at KIT so students receive the best preparation for a rapidly changing labor market.

KIT's internal quality assurance system is based on the multi-step KIT-PLUS procedure that is designed in parallel with external program accreditation. With KIT-PLUS, KIT departments can systematically analyze and improve the quality of their programs together with internal and external stakeholders, including students. Analysis is based on various quality instruments created by KIT, such as surveys relating to the student lifecycle and structural data.

In 2021, KIT was once again granted the system accreditation right, allowing it to accredit its study programs on its own.

GRADUATE PROGRAM OF THE INNOVATION CAMPUS FUTURE MOBILITY

Help for Engineers-to-be during the Pandemic

The pandemic makes it more difficult for graduates to enter the labor market. Engineers-to-be are given the support they need by the Corona Graduate Program of the Innovation Campus Future Mobility (ICM) of the University of Stuttgart and KIT. Within this program, up to 80 graduates from both universities may be employed on a temporary basis to work on projects and enhance their qualifications. Quick admission and individual support are of major importance. In 2021, 25 graduates took part in the program. Baden-Württemberg's Minister for Science, Research, and the Arts Theresia Bauer met them virtually in July 2021 to learn about their experiences. In late 2021, the first candidates got jobs in industry.

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The Innovation Campus Future Mobility launched a project to support graduates during the pandemic.

The aim of the Corona Graduate Program is to provide the participants with further training and qualification to improve their perspectives during and after the pandemic. Graduates improve their scientific knowledge as well as their soft skills regarding applications for jobs, giving presentations, and managing projects. This occurs by means of an individual qualification program that is conceived by the ICM management together with the host institute at the university. The program also aims to counteract the shortage of skilled labor by using the pandemic as an opportunity for further qualification in the mobility and related production sectors. Through close-to-industry projects, graduates can make contacts. If they are offered a job, it will take priority over temporary employment under the program.

Approval and employment procedures are executed promptly so participants receive support rapidly. The first employment contracts were signed just one month after the launch of the program. In late 2021, around 55 places were still available in ICM's Graduate Program. It is also open to international graduates who were conferred their last university degree in Baden-Württemberg.

It is the goal of the ICM to develop pioneering technologies. Established in July 2019 with about EUR 65 million from the State of Baden-Württemberg, the ICM focuses on emission-free drive systems, digitally supported production and manufacturing technologies, and the networking of mobility. ICM wants to attract and support excellent early-stage researchers and to promote spinoffs.

CLOSE-TO-PRACTICE AND FUTURE-ORIENTED STUDIES

Groundbreaking for the New Mechatronics Learning and Application Center

At the new Mechatronics Learning and Application Center (LAZ) of KIT, students and teachers of mechanical and electrical engineering will gain insight into the complete engineering process from idea to the finished product. As of 2023, LAZ will offer rooms for students to study and work as well as project-oriented infrastructure, including a workshop for students, where new teaching concepts will be applied. The groundbreaking ceremony took place on November 15, 2021. In attendance were Dr. Frank Mentrup, Mayor of the City of Karlsruhe, KIT President Professor Holger Hanselka, Dr. Hans J. Reiter, Head of Department of the Baden-Württemberg State Ministry for Science, Research, and the Arts, Gisela Splett, State Secretary at the Baden-Württemberg Ministry of Finance, Dr. Thomas Schneider, Managing Director of Development of TRUMPF Werkzeugmaschinen, and Ursula Orth, Head of the Karlsruhe Office for Assets and Construction in Baden-Württemberg.

The LAZ will give students room to develop and implement ideas using state-of-the-art equipment in a modern learning and teaching environment. They can join research projects for product development and apply their theoretical knowledge when using modern equipment. Digital machine tools and up-to-date software will be available to construct and test. LAZ's project-oriented and cross-departmental approach will perfectly combine new teaching and learning concepts, research and innovation and will essentially contribute to the success of students of technical and engineering degree programs. LAZ will have two buildings, a workshop in front and a main five-story building. It will have a usable area of about 3000 m² with a lecture hall for 274 persons, modern teaching areas, a prototype workshop, and new communication and project spaces. The building will have a photovoltaics facility and will be certified based on the Federal Assessment System for Sustainable Building (BNB).

The building of LAZ is one of the campus development activities outlined in KIT's Master Plan 2030, which included the goal of better connecting the campus to the city center. It will fit perfectly with the existing institutes on eastern Kaiserstraße. Light will enter the basement through big windows, which will also allow citizens to look into the building. Thus, this new building will link KIT to the public.

The building's owner is the State of Baden-Württemberg, which is investing about EUR 20.4 million while KIT pays its share of EUR 1.5 million. In addition, KIT received a donation for the building from SEW-EURODRIVE. TRUMPF Werkzeugmaschinen also supplied funds and materials for LAZ. The equipment for LAZ will be financed by donations from another 150 sponsors, including alumni of KIT, companies, and foundations.

The first stone of LAZ was laid on November 15, 2021, by Frank Mentrup, Holger Hanselka, Hans J. Reiter, Gisela Splett, Thomas Schneider, and Ursula Orth (from left to right).

PARTNERSHIP FOR INNOVATIVE ELECTRONIC EXAMINATIONS

Collaboration Project on Digital Examinations

Digital examinations gained importance during the Covid-19 pandemic in particular. In their joint project "Partnership for Innovative Electronic Examinations" (PePP), universities in Baden-Württemberg analyze how to improve their usability. PePP is aimed at systematically exploring the unused potentials of electronic examinations for both students and teachers and at improving the exchange of expertise. PePP results from state-wide collaboration in the Network for Digitalization of Academic Education in Baden-Württemberg (HND-BW), the office of which is located at KIT. Alexander Wanner, KIT Vice-President for Higher Education, is spokesperson of the HND-BW steering group.

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The project "Partnership for Innovative Electronic Examinations" (PePP) of universities in Baden-Württemberg serves to explore the potentials of digital examinations.

In summer 2021, the Foundation for Innovation in Higher Education proposed the project for funding under the program "Strengthening Higher Education by Digitalization." PePP started on August 1, 2021, and is coordinated by the University of Freiburg. All universities located in Baden-Württemberg, the Center for University Didactics, and HND-BW are involved.

At three real-world labs, the universities develop didactically and technically innovative concepts for electronic examinations to enhance proficiencies, increase mobility and flexibility, and support student-centered exams. Clusters have been established to create educational incentives, support the qualification of teachers, and generate feedback on the quality of electronic examinations. The labs also consider legal aspects of the exams, as well as equal opportunity, inclusion, and acceptance issues. PePP includes a quality development and support concept and mechanisms for transferring know-how.

Several universities in Baden-Württemberg, including the KIT, are testing innovative types of examinations. Expertise and strengths are shared on a joint platform. The project contributes to digitalizing education, studies, and examinations at universities in Baden-Württemberg.

A first online meeting of about 100 participants from all over Germany in September 2021 marked the start of cross-university exchanges. The meeting focused on opportunities and challenges associated with digital examinations and on a discussion of solutions. Among the topics discussed were technical infrastructures for remote and electronic examinations, programming exams, e-assessments in graphic modeling, examination didactics, equal opportunities, and inclusion.

INNOVATION

After Hannover Messe had been canceled in 2020, it took place again virtually in 2021. KIT presented selected research and innovation highlights at the virtual "Future Hub" and "Energy Solutions" stands.

One of the exhibits at Future Hub focused on value stream kinematics. Whether it's automobile accessories or sports shoes, efficiently producing small quantities of custom-designed, high-quality industrial and consumer goods requires flexible processes. Value stream kinematics combines the high productivity and precision of specialized

machines with the flexibility and adaptability of industry robots.

Other highlights presented were nature-inspired nanostructures and microstructures for bionic surfaces, plant-inspired anti-reflective coatings of foils, and artificial intelligence for camera-based spindle control, or digital assembly assistants.

The Energy Solutions stand presented reFuels – an initiative to produce fuels for CO_2-neutral mobility. reFuels focuses on the composition, production, and use of regenerative fuels using the innovative infrastructures of KIT.

In addition, KIT presented the world's smallest and most energy-efficient transistor and digital power supplies with increased service life and reliability. Also presented was software developed by the startup greenventory, which makes it possible to produce energy supply and climate protection concepts more rapidly and with higher quality.


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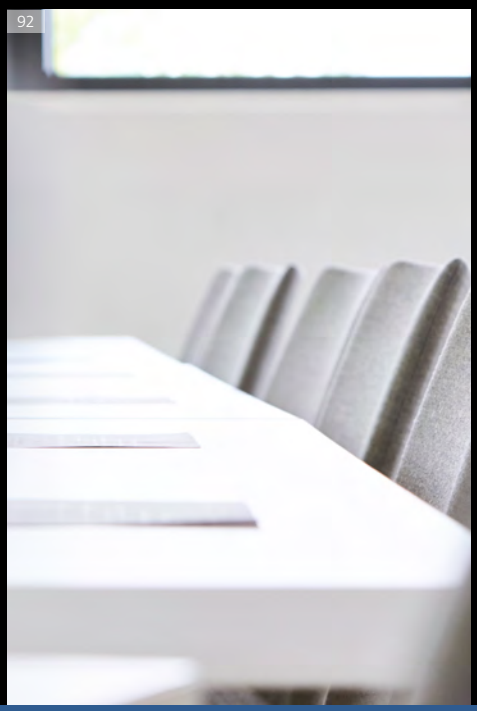
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A KIT INNOVATION USED BY MILLIONS WORLDWIDE

Efficient High-throughput Sample Preparation for Quicker PCR Tests

Extensive and repeated testing is part of the central strategy to fight the Covid-19 pandemic. PCR testing is now the most reliable method to detect an infection with SARS-CoV-2. PCR tests target fragments of the virus's genetic material. With polymerase chain reaction (PCR), the molecular structure of the genetic material can be examined precisely, and mutations of the Covid-19 pathogen can be discovered.

First, the genetic material contained in throat or nose swabs, i.e., nucleic acids from the DNA of SARS-CoV-2, must be cleaned and concentrated. Specially coated magnetic particles, to which the nucleic acids bind, are used for this purpose. To separate the magnetic particles in the sample container from the remaining material and extract the nucleic acids, a magnet is moved towards the sample container from outside. This is a time-consuming and labor-intensive process, and only few samples can be prepared manually each day.

KIT's Institute of Functional Interfaces (IFG) has automated this method and enhanced its efficiency using magnetizable and rotating metal rods. Professor Matthias Franzreb and Jonas Wohlgemuth developed this innovation. Their method manipulates the magnetic particles using metal rods, whose magnetic attraction can be switched on and off. In this way, the particles can be transported to another container for the next cleaning step. There, the DNA fragments are distributed again by rapid rotation, as if tiny stirrers were used.

The process is fast and fully automatic, with 96 rods operating simultaneously. Within 30 minutes, the genetic material from 96 samples can be isolated. One device can process more than 4000 samples a day. The KIT-developed principle of automatic and parallel manipulation and redistribution of magnetic particles for the isolation of nucleic acids was commercialized by PerkinElmer chemagen Technologie GmbH. In 2020, it sold more than 900 systems worldwide and represented about 25% of the market share in Germany for sample preparation for SARS-CoV-2 PCR testing.

This innovation is in more demand than ever these days. The patent, which is one of KIT's most profitable patents, was granted nearly 20 years ago. The outbreak of the Covid-19 pandemic enormously increased the demand for systems equipped with this technology. And this success story is not over yet. IFG is optimizing the method for automatic isolation of nucleic acids, as part of coordinated Helmholtz research under the Materials Systems Engineering Programme.

A method developed by Matthias Franzreb (left) and Jonas Wohlgemuth is accelerating PCR testing.

REGIONALLY AND INTERNATIONALLY SUCCESSFUL

Forward-looking Startup Activities in Innovation-oriented Research

The KIT Founders Forge is one of the biggest university-based startup centers in Germany. It pools all activities relating to startups and entrepreneurship at KIT. The new Global Horizon program (GHPro), funded under the EXIST program of the Federal Ministry for Economic Affairs and Climate Action (BMWK), is aimed at preparing young entrepreneurs for international markets. GHPro focuses on networking in the region and on increasing the number and quality of startups with an international focus. This focus may be due to the origin of the founders, the composition of the team, the partners involved, or the markets targeted, such as Chile or India.

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The KIT Founders Forge pools KIT's activities relating to startups and spinoffs.

Internationalization is being pushed by the DeepTechHub (DTH) Southwest set up by the universities of Mannheim, Heidelberg, and Karlsruhe. DTH combines the strengths and capabilities of the Karlsruhe Technology Region and the Rhine-Neckar Metropolitan Region. This promises to be an important hotspot for startups and entrepreneurship in Germany and Europe. DTH focuses on startups in the areas of work of the universities involved: Energy, mobility, digitalization, environment, and health. Development and establishment of the DeepTechHub are also funded under BMWK's EXIST program.

In spite of the lasting Covid-19 pandemic, 2021 was a successful year. 37 new businesses, including 12 spinoffs, were launched at KIT. Prominent examples are the technology startups thingsTHINKING and Ineratec. Ineratec began operation of its power-to-liquid facility for the production of sustainable e-fuels, the biggest facility of this kind in the world. Moreover, Ineratec won the Next Economy Award granted by the German Sustainability Award Foundation. KIT's startup thingsTHINKING focuses on processing human language irrespective of wording. Recently, it got additional funding of EUR 4.5 million to invest in the further development of the semantha® software.

The StartUpSecure KASTEL incubator, a startup initiative of the KIT Founders Forge funded by the Federal Ministry of Education and Research, is aimed at encouraging students and researchers to set up their own IT security business. The funding program is open to interested people and innovative startups from all over Germany and Baden-Württemberg in particular. One of the startups it supports is INLYSE. Its revolutionary AI technology protects companies against viruses, trojan attacks, and ransomware. StartUpSecure will be further extended until 2024.

SUCCESSFUL TOGETHER

10 Years Deutschlandstipendium at KIT

In the past ten years, more than 2,700 students of KIT received a Deutschlandstipendium.

In 2011, the Deutschlandstipendium (Germany scholarship) was granted to highly committed and talented students for the first time. Since then, more than 2,700 students have received the scholarships that are funded from generous donations. Deutschlandstipendium is the biggest scholarship program at KIT. In the 2021/2022 winter semester, 275 students received this financial support.

The Deutschlandstipendium scholarship is granted by KIT to socially committed students and students who have achieved outstanding study results. Half of the funding comes from private donors, such as companies, individuals, KIT alumni, foundations, and clubs. The other half is financed by the Federal Republic of Germany. Donations to KIT for the Deutschlandstipendium totaled about EUR 500,000 in 2021.

The scholarship is paid irrespective of the students' income or the status of their parents. It is not offset by the BAföG student grant. Scholarship holders receive EUR 300 per month for one year. In addition, they have contact with the donors, who will help the students when they seek employment or when writing their diploma or master's thesis.

Established or beginning students of all nationalities who have enrolled or who will start their studies at KIT may apply for the scholarship. The Deutschlandstipendium is designed to support students, whose earlier achievements provide reason to expect excellent future study results.

The criteria for granting the scholarship include success at school or university, social commitment in associations or university policy, in church or political organizations, as well as social work, family work, or work at a social institution. In addition, special biographic obstacles resulting from the family or cultural background will be considered, such as students who have children or were forced to flee their home countries.

With their donations for the Deutschlandstipendium, donors assume social responsibility and establish contacts with tomorrow's top executives. They benefit from KIT's selection procedure, which is the only one of this kind in Germany. When applying for the scholarship, students can give the name of a donor they would like to have. In this way, the donor can be sure that the scholarship holder is interested in his/her company.

CLIMATE-NEUTRAL, NETWORKED, SUSTAINABLE, AND AFFORDABLE

Developing New Technologies and Pooling Skills for Future Mobility

Innovation Campus Future Mobility

Future mobility will be environmentally friendly, networked, and automated. This will require the development of groundbreaking technologies for new services, innovative drivetrains and components, and new production methods. Pushing this transformation process is the goal of Innovation Campus Future Mobility (ICM), which pools mobility research and innovation capabilities of KIT and University of Stuttgart. The State of Baden-Württemberg recently decided to greatly extend the ICM and will provide another EUR 50 million in two packages during the next four years.

In addition to an executive professorship at the interface of IT and mechanical/automotive engineering, the program will establish six new cross-university junior professorships. Their junior research groups will bring together young researchers of engineering sciences, software development, natural and materials sciences. Outstanding researchers from abroad will be given the opportunity to work at the ICM. Moreover, KIT and the University of Stuttgart will advance academic education in engineering sciences.

In a second package, the state will fund innovative research, implementation, and startup projects on digitalized mobility and production, zero-emission mobility, and hydrogen-based technologies.

German Center for Future Mobility

Future mobility must be sustainable, climate-neutral, and affordable. The German Center for Future Mobility (DZM) started by the Federal Government pools expertise from science, industry, federation, states, and municipalities, develops concepts for future-oriented mobility, and offers a central platform for mobility ideas and research approaches. One of the offices of DZM is found in Karlsruhe. The first research project "Country to City Bridge – C2CBridge," which includes several Karlsruhe-based mobility institutions under the direction of KIT, will concentrate on how public passenger transport can efficiently and attractively bridge the gap between urban and rural areas.

103 Future mobility has many requirements: It must be sustainable, climate-neutral, networked, automated, and yet affordable.

The best transport system for rural areas differs from that of a city. In dense, urban spaces, transport systems must have a high capacity while consuming little space. In rural areas, by contrast, transport systems should reach even the remotest location. The broad interdisciplinary approach of C2CBridge is aimed at developing a need-tailored transport system. Researchers will study autonomous vehicles which operate individually and in a distributed way in rural areas but can be coupled in efficient networks when they enter the city.

The project partners include 15 institutes of KIT. Others are FZI Research Center for Information Technology, an innovation partner of KIT, Fraunhofer Society, Karlsruhe and Pforzheim Universities of Applied Sciences, Albtal-Verkehrs-Gesellschaft, PTV Group, and the City of Karlsruhe.

PROMOTING YOUNG TALENT

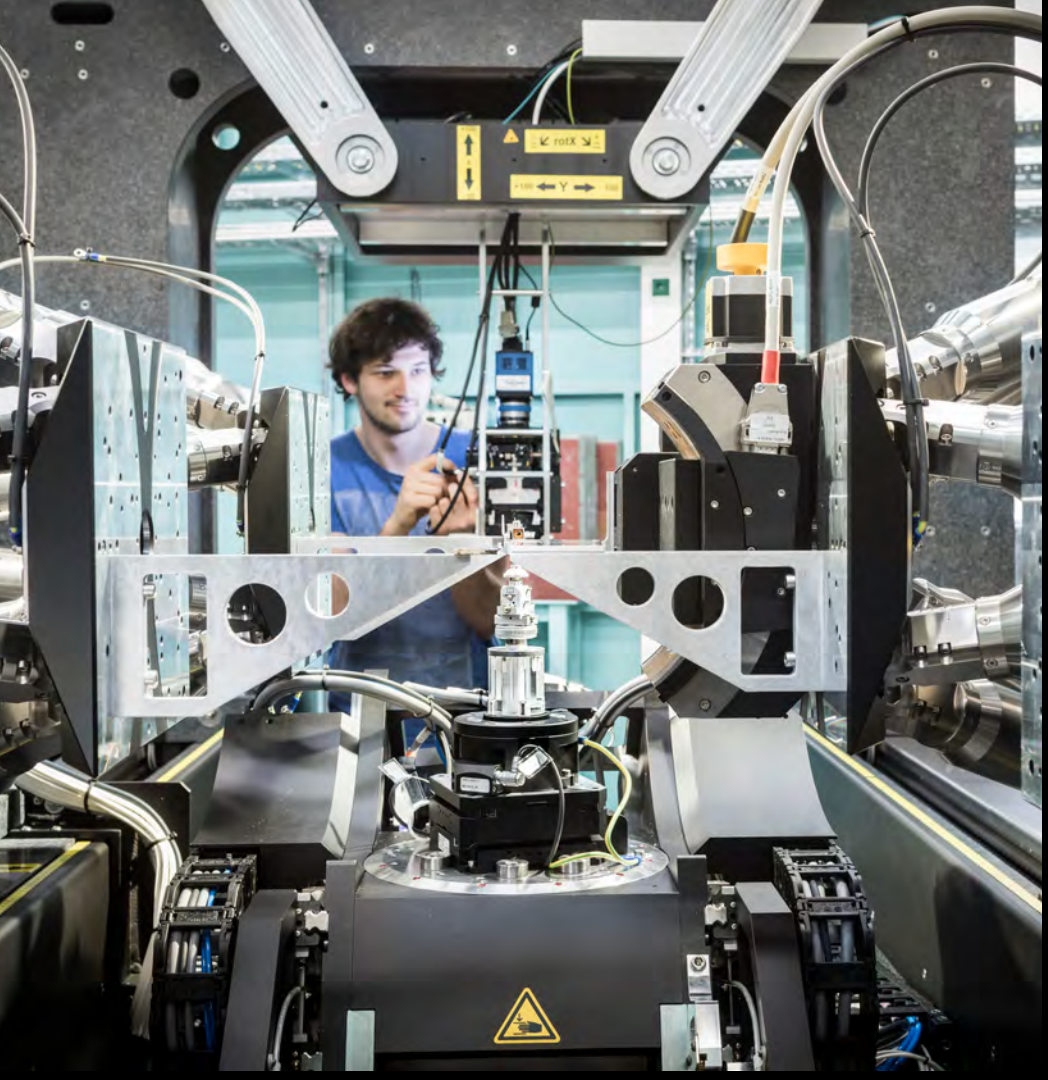
In times of a pandemic, methods for promoting young talent must be adapted as conditions continuously change. Karlsruhe House of Young Scientists, KHYS for short, is the central institution for promoting young talent at KIT. The efforts taken by KHYS to support early-stage researchers have turned out to be extremely valuable.

As the opportunities for international scientific exchange decreased, KHYS conceived a flexible program to execute smaller international networking projects despite travel restrictions. The goal was to enable young researchers to set up and strengthen

research networks with universities, industry, and other organizations abroad.

Pandemic restrictions also significantly delayed some doctorates. Employment contracts of doctoral researchers sometimes expired through no fault of their own prior to the completion of their doctoral requirements. Little, if any, follow-up funding was available. To enable researchers to complete their doctorates successfully, KHYS launched an emergency fund program.

At intervals of about three years, KIT regularly organizes surveys of doctoral researchers and primary supervisors. These surveys by KHYS review existing structures and processes of doctoral programs. The questionnaires cover supervision and support of doctoral researchers, work and research conditions, compatibility of family and doctorate studies and good research practice. The results of these evaluations help decide if doctoral programs comply with KIT's self-defined quality goals in promoting young talent.

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Fabian Resch an Alle
Zoom kann keine Kamera erkennen, aber das Technik Genie ist dran
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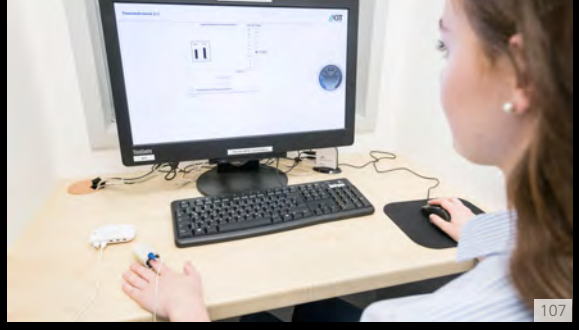
Decision&Design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SUPPORTING EARLY-STAGE RESEARCHERS

KIT Obtains Funding for Two Research Training Groups

The German Research Foundation (DFG) supports early-stage researchers by funding 17 new research training groups, including one at KIT. The new research training group at KIT started work in fall 2021 and will receive EUR 92 million for four and half years. In addition, DFG extended funding of 14 existing research training groups, including one at KIT.

New Research Training Group KD²School

The new interdisciplinary research training group GRK 2739 "KD²School – Designing Adaptive Systems for Economic Decision-making" focuses on how economic decision processes in industry and daily life can be supported by IT-based systems. The goal is to enhance the productivity and well-being of people in their work environment. In particular, the researchers will study how such systems can be designed to adapt to the context in which a decision must be made and enable the systems to "improve on their own." The relationship between economic decision-making and system design is the focus of the KD²School as it provides the basis for transforming static systems into dynamic, adaptive systems.

Doctoral researchers in economics, psychology, and computer sciences conduct and evaluate economic experimental studies at KIT's KD²Lab, the Cognitive Systems Lab and the Center for Advanced Imaging of the University of Bremen, and the Decisions in Immersive Systems Lab of the University of Gießen. The spokesperson of GRK 2739 is Professor Christof Weinhardt from KIT's Institute of Information Systems and Marketing.

SiMET Research Training Group Extended

The DFG extended funding of the research training group GRK 2218 "SiMET – Simulation of Mechani-co-electro-thermal Processes in Lithium-ion Batteries" until 2026. Spokesperson of this group is Professor Thomas Wetzel of KIT's Institute of Thermal Process Engineering. Doctoral researchers specializing in a variety of disciplines at KIT, the Offenburg University of Applied Sciences, and the Helmholtz Institute Ulm are developing multi-disciplinary models and simulation methods for lithium-ion batteries. Their work employs cross-scale and cross-discipline approaches. This encompasses a broad range of experimental parameterization and validation options.

The models cover a broad spectrum of approaches and allow researchers to simulate operational behavior under many conditions. This enables them to figure out how changes in the production process will affect cell properties and to enhance their understanding of damage effects and aging processes. These models and simulations will make it possible to predict how differences in the inner structure of batteries will affect their performance and operation and how they will behave as they age.

Experimental studies for the KD²School are among those conducted at KIT's KD²Lab.

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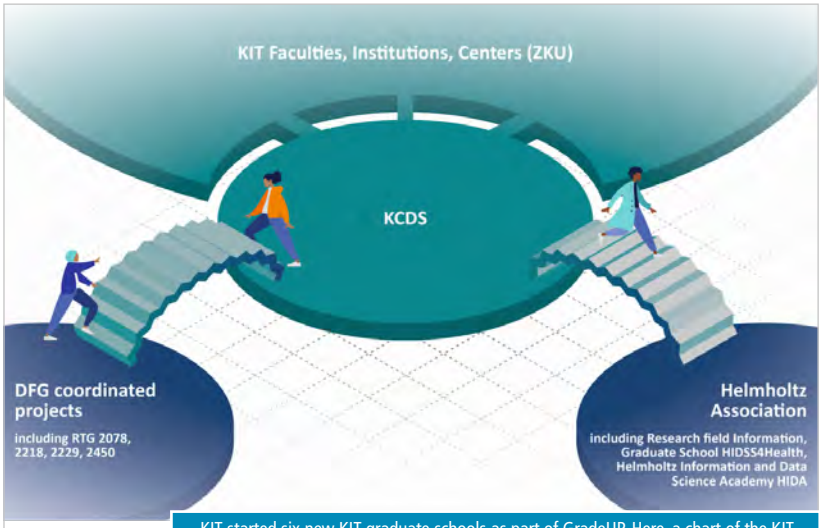
NEW PROGRAMS TO SUPPORT DOCTORAL RESEARCHERS

GradeUP Develops Interdisciplinary Qualification Opportunities

KIT intends to enhance its desirability as a technical university for excellent early-stage researchers. The plan includes optimizing the support for early-stage researchers, extending the range of subject-specific support programs, and improving the connections between these programs and with the Karlsruhe House of Young Scientists (KHYS).



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KIT started six new KIT graduate schools as part of GradeUP. Here, a chart of the KIT Graduate School of Computational and Data Science (KCDS) is shown as an example. Now, each KIT Center runs at least one graduate school.

To do so, KIT has implemented the Graduate School Support Program (GradeUP) for establishing graduate schools. GradeUP was part of "The Research University in the Helmholtz Association – Living the Change," a concept KIT submitted in its proposal to become a university of excellence.

GradeUP offers long-term funding for starting new KIT graduate schools that are directly affiliated to a KIT Center. It focuses on topics of strategic importance to KIT, its main activities, and the future fields of research named by KIT in its proposal.

In a first round of funding, two KIT graduate schools were selected and started work on January 1, 2021: The KIT Graduate School Cultures of Knowledge of the KIT Humans and Technology Center and the KIT Graduate School UpGrade Mobility of the KIT Mobility Systems Center. In the second round, another four proposals were approved: The KIT Graduate School of Quantum Matter of the KIT Center Materials in Technical and Life Sciences, the KIT Graduate School of Computational and Data Science of the KIT Center Mathematics in Sciences, Engineering, and Economics, the KIT Graduate School Enabling Net Zero of the KIT Energy Center, and the KIT Graduate School Cyber Security of the KIT Information Center. These four graduate schools began operation on August 1, 2021. Every KIT Center now runs at least one graduate school. Funding typically is for five years, provided that the school's interim evaluation is positive. The maximum amount of funding is EUR 250,000. In addition to these funds from the university of excellence budget, KHYS supports the schools with a five-year budget of EUR 50,000 per school for training courses on transferable skills. Each school thus can receive up to EUR 300,000.

To optimize the portfolio of KHYS, KIT has adopted the program "Strengthening Interaction of Graduate Structures" (StronG). It includes a package of measures to strengthen graduate support structures of KHYS in cooperation with the KIT graduate schools and other support programs. "Fit for your next career step" is an extended training program for career-specific skill development and career orientation for postdocs and doctoral researchers.

ENHANCING COLLABORATION

MathSEE's Bridge PhDs Advance Interdisciplinary Mathematical Research

The Bridge PhDs Program is aimed at promoting use of mathematical principles in natural sciences, engineering, and economics.

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Advancing interdisciplinary mathematical research is the focus of a new funding initiative of the KIT Center Mathematics in Sciences, Engineering, and Economics (MathSEE). The initiative "Bridge PhDs – Promoting Interdisciplinary Mathematical Research" aims to strengthen collaboration between mathematicians and researchers in applied sciences and to enhance the visibility of MathSEE as a strategic and interdisciplinary platform for KIT both internally and externally.

The goal is to support new interdisciplinary ideas with close collaborations between mathematicians and SEE researchers. Problem-solving ideas that extend beyond individual disciplines thus can receive funding and perhaps eventually result in something even bigger. It provides financial support for the passion for science, for mathematical research, for the solution of problems, and for producing a clear added value for society. Both scientific excellence and innovation potential will be considered when making funding decisions.

The Bridge PhDs are aimed at creating closer interaction of mathematics with natural sciences, engineering, and economics and at applying mathematical principles in these disciplines. Proposals must be submitted jointly by two groups of researchers, with one group working on mathematical methods, while others focus on applications. Project work will eventually lead to doctoral theses supervised by these interdisciplinary teams.

The KIT Center MathSEE has been one of eight strategic research units of KIT since 2018. It pools KIT's mathematical research activities. Creating MathSEE was the first step in enhancing the visibility of KIT's diverse mathematical research activities and making them accessible for a broad spectrum of scientific applications. The members collaborate on interdisciplinary research projects covering several method areas. MathSEE concentrates on fundamental research and the development of mathematical methods that advance understanding of societal challenges.

KIT JUNIOR RESEARCH GROUPS

Start of a Scientific Career

Support of early-stage researchers is a central priority of KIT. KIT has now introduced the "KIT-Nachwuchsgruppe" certificate for principal investigators of junior research groups.

Leaders of junior research groups may apply for a recognition of their group as "KIT-Nachwuchsgruppe" by KIT's Council for Research and Promotion of Young Scientists (CRYS). This recognition is generally required for researchers to apply for KIT Associate Fellow status with a KIT department. This status also is needed to take part in doctoral procedures and to become a member of KIT's Young Investigator Network (YIN). Funds for the principal investigator and other positions must have been acquired or the principal investigator must have been appointed in a competitive process. Recognition as KIT-Nachwuchsgruppe is confirmed by a certificate issued by the Executive Board.

121 After recognition as a KIT-Nachwuchsgruppe, principal investigators may apply for admission to the Young Investigator Network of KIT and the status of KIT Associate Fellow.

Having gotten funding from an available program, the KIT junior research group is recognized automatically when the principal investigator starts to work at KIT. KIT junior research groups may be Emmy Noether Junior Research Groups funded by DFG, Helmholtz Young Investigators Groups, BMBF Junior Research Groups, or teams led by holders of Starting or Consolidator Grants from the European Research Council.

In 2021, four new KIT junior research groups were approved, two of which are funded by the Helmholtz Association and one each by BMBF and DFG.

Funding for an Emmy Noether Junior Research Group for a duration of six years was granted by DFG to

- Dr. Rudolf Lioutikov, Institute for Anthropomatics and Robotics, with the group focusing on "Intuitive Robot Intelligence: Efficiently Learning and Improving of Explainable Skills and Behaviors for Intuitive Human-Robot Interaction."

Funding for a Helmholtz Young Investigators Group for five years was granted to

- Dr. Benjamin Schäfer, Institute for Automation and Applied Informatics, with his group on "Data-Driven Analysis of Complex Systems for a Sustainable Future (DRACOS)" and

- Dr. Giovanni De Carne, Institute for Technical Physics, for his group working on "Hybrid Networks: a multi-modal design for the future energy system."

Funds for a junior research group for five years were granted by BMBF to

- Dr. Simon Fleischmann, Helmholtz Institute Ulm for Electrochemical Energy Storage, for his group "InfinBat – Intermediate Layer-functionalized Materials for Novel Electrochemical Intercalation Batteries."

INTERNATIONAL AFFAIRS

Cultural diversity, international encounters, and worldwide cooperation with selected partners are strategic goals vigorously pursued by KIT even during the coronavirus pandemic. The new requirements were an incentive for the business unit International Affairs to develop new virtual presentations to promote collaborative projects and welcome students from abroad. For example, researchers were able to make use of online tools such as digital matchmaking, while young people were able to get virtual impressions of what a stay abroad would be like.

Nevertheless, staff members remain convinced of the importance of additional steps that might be possible once again in a more stable future. Hopes were high that

scientific workshops and alumni seminars on campus, hands-on training in laboratories, and joint face-to-face events will be practical again.

The great reliability and promising potential of KIT's international partnerships were on display in 2021. Examples are the European alliances Eucor - The European Campus, and EPICUR. Despite difficult conditions, they continued to be successful in the virtual networking of campus management and new teaching offers, the intensification of research cooperation in socially and economically relevant fields, such as sustainability and quantum technology, and the strengthening of equality, diversity, and inclusion.

Science is free, but not value-free. Standing up for this is part of KIT's self-conception. In the Helmholtz Association, in the German Rectors' Conference (Hochschulrektorenkonferenz – HRK), in the TU9 Alliance of the Nine Leading Technical Universities in Germany, and in European networks such as the Conference of European Schools for Advanced Engineering Education and Research CESAER, KIT is actively involved in the discussion on how institutions and researchers can act safely in collaborations around the globe and, at the same time, in science diplomacy.

This strengthened the ground on which many partnerships around the world were able to continue to flourish in 2021.


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ALLIANCES AND NETWORKS IN LATIN AMERICA

IECO – A Science Network as a Bridge between Germany and Chile

The Virtual Institute of Eco-Industrial Development (IECO) was founded in 2017 as part of the German-Chilean collaborative project to study eco-industrial development strategies – from fundamentals to applications – in different industrial contexts. In addition to KIT, the main partners are Universidad Austral de Chile (Valdivia), Universidad de Concepción, and Universidad de Chile (Santiago).

Eco-industrial development is a strategy for improving sustainability that focuses on the circular economy and on renewable energy. Industrial ecology seeks to apply ecosystem principles to the industrial sector, thereby mitigating its environmental impact. This approach is fundamental to activities in research, teaching, and transfer that KIT is developing in cooperation with the three Chilean universities.

In 2021, the four thematic focuses, "Sustainable Use of Water and Energy in an Urban Context," "Sustainable Conversion of Energy and Materials from Biomass," "Eco-industrial Use of Mineral Resources," and "Urban Eco-industrial Development in South America," were extended by a fifth focus entitled "Land Use and Industrial Sustainability."

Highlights in 2021 were the IECO Days in October. This included a panel on Green Hydrogen in which KIT's Vice-President for Transfer and International Affairs, Professor Thomas Hirth, participated. The event also produced an IECO Book of research results, which will be published in mid-2022; featured a startup workshop; and marked the launch of a monthly newsletter.

Together with the KIT Humans and Technology Center, an international lecture series was established, where speakers from Chile, Argentina, Ecuador, and other countries presented contributions on sustainability, sustainability criteria, and alternative concepts from the Global South.

IECO's partners in the field of industrial sustainability are the embassies of Germany and Chile, various research funding institutions, and chambers of commerce abroad. The virtual institute is part of the scientific task force preparing for Germany's joint presence as a host country at Exponor 2022, an international mining trade fair in Antofagasta, Chile, under the leadership of the German-Chilean Chamber of Commerce and the German Academic Exchange Service.

In the BMBF project BrineMine, Chilean and German researchers are developing a geothermal system for mineral extraction, supply of drinking water, and heat generation.

INTERNATIONAL RESEARCH FUNDING

KIT's International Excellence Fellowship Program Shows Positive Results

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Thomas Hirth (center), KIT Vice-President for Transfer and International Affairs, welcomed the IEG Fellows and their hosts.

In cutting-edge research, international cooperation and an exchange with the world's best researchers are both of great importance. At the end of 2020, KIT therefore announced the first "International Excellence Grants and Fellowships" (IEG) as part of the funding obtained for its excellence university proposal "The Research University in the Helmholtz Association I Living the Change."

With the IEG, KIT scientists can invite outstanding colleagues from abroad and thus strengthen their international cooperation and academic network. A total of 20 renowned foreign researchers, eight of them female researchers, were awarded an International Excellence Fellowship in 2021. The program is coordinated by the International Scholars & Welcome Office (IScO) of the KIT International Affairs business unit.

In 2021, despite pandemic conditions, 13 fellows were able to come to KIT and complete their stays. Every single arrival – from Europe, Australia, the USA, Latin America, Israel, or Japan – was prepared individually in spite of constantly changing residence regulations. In a video series that began with four videos in 2021, the fellows and their hosts at KIT reported on their experiences with the program. In doing so, the guests praised both the host researchers at KIT and the state-of-the-art equipment and infrastructure on campus as well as the smooth organization and individual support by the IScO team.

The Humboldt Regional Group Karlsruhe-Pforzheim began a monthly event series, the "International Excellence Talks," in May 2021. During these events, IEG fellows and Humboldt award winners present their current scientific findings and discuss them afterwards with KIT researchers and students. The online formats, the two face-to-face talks, and the subsequent informal exchange were well received. The International Excellence Fellowships thus promote not only the visibility of KIT but also community-building among researchers.

Personal encounters and exchanges in an informal atmosphere were also the focus of the welcome events held by KIT Vice-President for Transfer and International Affairs Professor Thomas Hirth for new fellows and their hosts to get to know each other better, establish interdisciplinary contacts, and exchange information on study projects and joint research projects. The fourth round of the program was announced at the end of 2021.

GERMAN SCHOOLS ABROAD

TU9-ING Week Offers Insights into STEM Courses of Study

To get prospective students interested in the STEM subjects (science, technology, engineering, and mathematics) Germany's leading technical universities organize the TU9-ING Week.

Under the motto "Shaping the Future with STEM – YOUR Studies for a More Sustainable World," the University of Stuttgart and KIT invited students to the TU9-ING Week in 2021. This event of TU9, the Alliance of Leading Technical Universities in Germany, has been taking place since 2011. Every year, two universities offer students attending German schools from all over the world an exclusive insight into study programs in engineering and natural sciences along with a socially relevant topic of the future. The 11th and 12th grade students usually receive a scholarship to make it possible for them to travel to the respective TU9 university and take part in the five-day program. The program is sponsored by the German Academic Exchange Service as part of the German Schools Abroad and Partner Schools support initiative and is funded by the German Federal Foreign Office.

The virtual STEM Trial Study Week took place for the second time in 2021. More than 35 students from all over the world were welcomed by Professor Thomas Hirth, Vice-President for Transfer and International Affairs of KIT, and Professor Hansgeorg Binz, Prorector for Teaching at the University of Stuttgart. The participants took part in institute and laboratory tours, lectures by scientists on STEM study contents and career perspectives, workshops, and visits to local companies.

Numerous other contributors from KIT participated in the TU9-ING Week. For example, KIT's International Buddy Program presented places worth seeing in Baden-Württemberg, the KIT-funded startup INERATEC invited students to a virtual company visit, and the Central Student Advisory Service and KIT Department of Chemical and Process Engineering introduced themselves. Other highlights were a workshop on humanoid robotics, where the participants learned about the work of the Research Group for High-performance Humanoid Technologies of the Institute for Anthropomatics and Robotics and were able to practice programming in a robot simulation, and a workshop on climate change and extreme weather events organized by the South German Climate Office at KIT. The Institute of Sports and Sports Science livened up the one-week trial with activity breaks.

STUDENT RESEARCH VISITS

The MINTernship Program 2021 – Virtual in Parts, Successful in Whole

Research visits abroad offer students the opportunity to gain new experiences, both professionally and personally. During the pandemic, it was not easy for KIT and its partner institutions in the MINTernship program to offer this form of practice-oriented mobility. And yet, despite the challenging conditions, five students from the KIT and five U.S. students successfully took part in 2021.

The program began in 2015. It supports student research visits promoting STEM (Science, Technology, Engineering, and Mathematics) subjects (in German MINT subjects, with MINT standing for Mathematics, Information Technology, Natural Sciences, and Technology) and international exchange at KIT and at selected partner universities abroad. Students from KIT stay at the University of North Carolina at Charlotte (UNCC) in the USA for six months, while students from UNCC, the University of Waterloo, and the Queensland University of Technology come to KIT for three- to six-month research visits.

Against the background of the pandemic in April 2021, the program initially started virtually in Karlsruhe for the KIT students under great uncertainties. The parties involved – the UNCC, the five selected fellows, and the Reinhard Frank Foundation as the main sponsor – were able to master the challenging situation by using digital tools and reaching agreements on the implementation of the online project work. Once the U.S. entry restrictions for research students from Germany were lifted, all students were able to fly to Charlotte and continue their projects on campus.

Because of the travel restrictions, KIT was unable to physically host the five UNCC 2021 fellows. Nevertheless, KIT created good virtual working conditions for the students from the partner university and offered a new digital companion program and cultural events. One highlight was the online city tour of Karlsruhe sights with later getting-to-know-you meetings in interactive break-out sessions. The students practiced teamwork in virtual space in an Escape Room. Although physically distributed over different continents, the group managed to solve all the puzzles together and free themselves. The joint cooking evening via Zoom including the preparation of homemade Schupfnudeln (a type of noodles made of potatoes) with sauerkraut was also a great success.

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The MINTernship program of KIT supports student research visits abroad and international exchange in the STEM subjects.

KIT AS AN EMPLOYER

With 9,783 employees, KIT is one of the largest employers in the Karlsruhe technology region. The staff consists of 5,556 scientific and 4,227 non-scientific members. Women are 38.4 percent of the total. KIT hosts 1,605 foreign employees, the majority of whom are scientific personnel. In addition, there are 385 professors and senior researchers, 21 of whom were appointed in 2021.

In 2020, the success rate in vocational training was again almost 100 percent. 13 KIT trainees finished their final examinations with "very good" grades and were honored by the Karlsruhe Chamber of Industry and Commerce for this achievement. Because

of the continuing coronavirus pandemic, online and hybrid formats for practical training once again were expanded and intensified for KIT's approximately 200 trainees.

Once company physicians were allowed to perform COVID-19 vaccinations, KIT Medical Services (MED) administered approximately 3,100 first and second COVID-19 vaccinations in summer 2021 in support of the federal government's vaccination strategy. Vaccinations alternated weekly between Campus South and Campus North.

Numerous dedicated employees from other organizational units supported MED in this extensive campaign. The much-requested annual flu vaccinations were carried out as usual by MED in October and November, with the COVID-19 vaccination campaign resuming in December after the Standing Committee on Vaccination (Ständige Impfkommission – STIKO) published its recommendations for booster vaccinations. 530 COVID-19 vaccinations, mostly booster vaccinations, were administered before the Christmas break. Vaccination campaigns will continue in 2022 as long as there is demand.


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DEVELOPING HUMAN RESOURCES

Highlights from the Human Resources Strategy

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Topical human resources management enables KIT to compete for the best minds.

To continue its excellence in research, teaching, and innovation, KIT must compete for the best minds. A key to success in this regard is topical human resources management, which adapts to developments in the labor market. This can include actions such as providing attractive, predictable career paths for scientific and science-supporting staff and developing innovative concepts for recruiting scientists, especially with a view to female and international candidates.

The Human Resources Strategy, which is based on an initiative by the Vice-President for Human Resources and Law, is intended to systematize the tools, processes, and offerings of KIT's supporting human resources units, align them with the times, and make them transparent. Further improvement in the work of human resources is needed if KIT is to remain an attractive employer and thus ensure its success in research, teaching, and innovation.

The Executive Board has identified seven main topics as particularly relevant for the development of a human resources strategy and split them up into subprojects.

Future Human Resources Topics

Work by interdisciplinary groups on the Human Resources Strategy and activities in the seven subprojects started in December 2019. In a participatory process, needs of the organization were identified. The first project results were communicated to affected groups to elicit feedback that could be incorporated into the subprojects.

In addition to feedback from interviews, an internal project advisory board regularly shared its perspective on the subprojects and provided impetus for the project work. Thus, from the very beginning, management and executives from science and from the central business units, as well as representatives from such bodies as the Staff Council, the Equal Opportunities Officers, and the Representatives of Disabled Employees, were involved in the development of the Human Resources Strategy. In this way, the concepts were repeatedly checked for their feasibility and acceptance at KIT.

The seven main topics of the Human Resources Strategy were split up into subprojects.

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Key Results of the Human Resources Strategy

Key results of the Human Resources Strategy include the systematization and topical alignment of the human resources management processes and offerings. For example, ideas were developed for filling positions as well as human resources planning, personnel recruitment activities, and employee and junior staff development.

By standardizing its offerings, the Human Resources Strategy ensures a greater transparency about internal development opportunities for employees from administration and technology. Through diverse services (e.g., toolboxes for managers and discussion formats such as annual performance reviews) it promotes a more active and binding role for management and executives in human resources planning and development. One example is the ability to fill vacant positions more quickly.

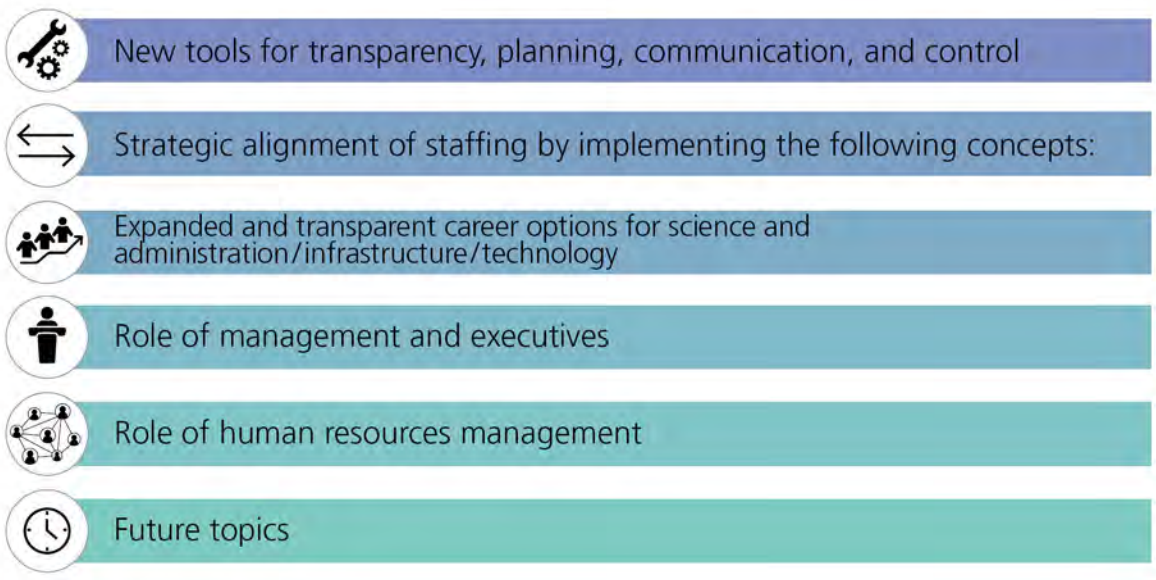
A human resources retreat for managers and executives makes possible joint discussions of human resources planning and development activities throughout the KIT.

Other focal points include future work and the introduction of a career system for permanent academic staff. Future topics for personnel work at KIT were named.

The work in the subprojects was completed in 2021 and the process of coordinating KIT's bodies began. Overall, the Human Resources Strategy project has shed light on personnel work at KIT and contributed to its further development.

Step-by-step implementation of the Human Resources Strategy began in spring 2022. A follow-up project on employer branding and relevant operational measures will be launched by the responsible organizational units.

The key results of the Human Resources Strategy will be implemented as part of the KIT routine.



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SUCCESSFUL PROJECT CONCLUSION

Highlights from the "Implementation of the Results of the Equal Opportunities Policy Evaluation" Project

Equal opportunity is an important cross-cutting issue at KIT and of great significance to achieving excellence in research, teaching, and innovation. The Center of Excellence Women and Science (CEWS), which is part of the Leibniz Institute for the Social Sciences, examined KIT's equal opportunity policy in 2018. Its recommendations for action were implemented in the project "Implementation of the Results of the Equal Opportunities Policy Evaluation," which was successfully completed in 2021. The results achieved include the following:

- A collective understanding of equal opportunity and its focus as an orientation for executives and equal opportunities staff was developed. This provides the basis for equal opportunity efforts and for the advancement of equal opportunity measures. The collective understanding thus will be of decisive significance to KIT in the future and will contribute to the important goal of increasing the proportion of women at KIT.

- Communication plans to increase appreciation of the need for equal opportunities were developed, as were communication plans for creating further synergies between central equal opportunity staff members.

- Extensive recommendations for changing governance were made to strengthen equal opportunity at the structural level. The relevant staff and stakeholders therefore were identified systematically and legal requirements were applied to the conditions prevailing at KIT.

- A newly developed gender competence concept highlights the teaching of gender-competent action. An important core element is the successfully launched online training for developing gender competence. Participants will deal with the meanings of gender, gender competence, and unconscious gender bias. The training is open to anybody interested; since 2021, participation has been mandatory for members of the first three executive levels of KIT as well as for internal members of appointment committees.

Overall, the goals of the project were achieved. Transparent and efficient regulations and processes for equal opportunity were created, further synergies between equal opportunity staff members were generated, broad awareness and appreciation for the topic were raised, and gender competence among the employees, especially at the management and executive levels, was increased. The initiatives from the project will be developed further in future projects and activities related to equal opportunity, such as measures in the new equal opportunity plan or in the university of excellence application.

At KIT, equal opportunity is the basis of excellence in research, teaching, and innovation.

EQUAL OPPORTUNITY AT KIT

Attracting Excellent Female Scientists

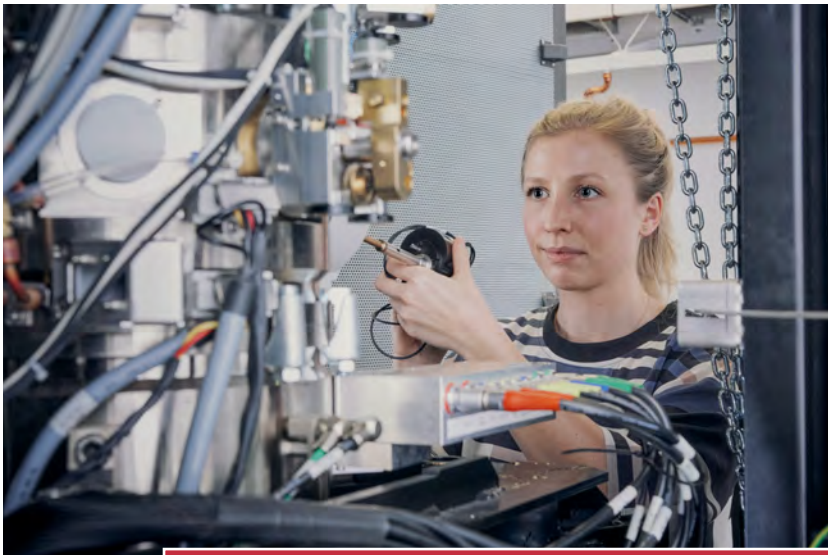
To achieve a cultural change favoring equal opportunity and thus increase KIT's attractiveness to excellent female scientists, KIT has undertaken numerous actions:

Gender Equity 1 (GE1) pursues the goal of a KIT-wide strengthening of equal opportunity: An important component of the project was a series of think tanks in 2020/21, where members of the five divisions and the central administration developed subject-specific equal opportunity topics. An important perspective was developed in a culture and vision workshop organized by the Executive Board and the Heads of Division. Areas of action for equal opportunity efforts and strategic cornerstones were defined there.

Since fall 2021, 14 subject-specific projects have been funded from GE1 resources. These range from recruitment methods for people at various stages of their careers to the establishment of networks for female scientists, as well as the analysis and optimization of working conditions from an equal opportunity perspective.

The 100 Professorships Program has set an ambitious goal for itself of filling 40 percent of new appointments with female professors and thus achieving a 20 percent share of women among university lecturers by 2023. Since 2017, the proportion of females accepting a professorship has increased from 20 to 34.5 percent in 2021, so KIT is well on its way to meeting the 20 percent target (16.4 percent in 2021).

The recruitment of female university professors is supported in the Gender Equity 2 (GE2) project as part of the university of excellence campaign by supplying an additional appointment budget explicitly to attract outstanding female professors. Since the start of the project in 2019, seven female university professors at KIT have been funded with a total of EUR 1,227,000. In addition, a Female Academics Network (FAN) is being set up in GE2. FAN encourages networking of female scientists at KIT, at national and international partner institutions, and among alumni from research, teaching, and innovation. Lecture series, mentoring, and research visits are part of that initiative. Strengthening the visibility of young female scientists is a particular emphasis. Close cooperation with the Women Professors Forum (WPF) at KIT is planned. The WPF was established in 2021 by female professors of KIT. Among its aims is increasing the visibility of excellent female scientists and encouraging them to network with each other.



161 In the Gender Equity 1 project, KIT has defined areas of action for equal opportunity efforts.

Since 2021, information on the working conditions for female professors at KIT has been gathered quantitatively and qualitatively and has been analyzed in the "Survey to Evaluate the Current Situation of Female Professors at KIT." In addition to internal analyses on payment structures, resources, and visibility, a survey of all female and male professors at KIT was conducted with external support. The results of the survey are expected in fall 2022.

LIFE AT KIT

In 2025, KIT will celebrate the 200th anniversary of the polytechnical school in Karlsruhe, which was founded on October 7, 1825. The school started small but quickly developed into an excellent institution and grew to become Technische Hochschule Karlsruhe in the second half of the 19th century. Ties with the Karlsruhe Nuclear Research Center (Kernforschungszentrum Karlsruhe), founded in 1956, were quickly established and extended until Universität Karlsruhe and Forschungszentrum Karlsruhe, which had emerged from Kernforschungszentrum Karlsruhe, merged in 2009 to form the Karlsruhe Institute of Technology.

The 200th birthday is a unique opportunity to look back upon these developments and discover stories about people and machines in research, teaching, and innovation. Planning for a successful celebration of the anniversary began in 2020 and involves not only KIT but the entire Karlsruhe technology region and the digital space.

At the KIT Archives, preparations have begun for a historic exhibition. The goal is to tell stories – based on one hundred objects – about KIT, its preceding institutions, and the people working there during the last two centuries. A central idea is to include relatives, alumni, and friends of KIT.

But which objects tell the stories of the people at KIT? The complex devices from experimental research or rather the simplified models of university teaching? Which objects embody innovation and its industrial application? Can everyday objects represent the history of KIT – like administrative objects or remnants of past construction? Or maybe the history of KIT is told by the numerous artworks and (technical) monuments? KIT staff members were called upon to actively help design the exhibition by suggesting objects that can tell the history of KIT from their perspective.

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LAUNCH OF A NEW EVENT FORMAT

AI Takes Center Stage at the KIT Science Week in Karlsruhe

At the beginning of October 2021, the first KIT Science Week with its motto of "The Human Being in the Center of Learning Systems" brought together about 9,000 people from science, industry, politics, and society, either digitally or in person, allowing them to get immersed in the world of artificial intelligence (AI). KIT combines an international scientific conference with public events into the KIT Science Week to strengthen its interaction with society. The format started successfully and will be repeated every two years.

Robots helping with assembly and civil protection. Assistant systems supporting disease diagnosis. Chatbots advising customers at a help center. Self-driving cars. All of these are learning systems and they appear in more areas of our lives. The KIT Science Week offered not only experts from science, economy, politics, and culture a chance for exchange, but also gave members of the public an opportunity to experience and shape artificial intelligence.

Visitors could take part in innovative online formats such as massive open online courses (MOOC) and escape rooms. They could experience AI and applications creating AI-based technology and innovation live during KIT lab tours, workshops, and dialog events. Panel discussions with prominent guests, citizen dialogs, ZAK talks, and a TEDxKIT event allowed them to ask questions and consider the opportunities and risks of learning systems.

Allowing anyone to take part in research, technologies, and innovation using their knowledge, interests, and experiences is an idea that fills the KIT Science Week on artificial Intelligence and learning systems with life. KIT researchers, teachers, and students intend to use the input they got from this event when setting their own research agendas. That is because finding out how to shape AI and the resulting learning systems in a way that benefits the society is something that needs to be done collectively.

The KIT Science Week format is a result of KIT's successful application for university of excellence funding. It uses ideas from KIT real-world labs, where the urban society can join KIT in testing and optimizing technologies and exploring topics such as autonomous driving, humanoid robotics, or sustainable climate protection.

The first KIT Science Week focused on the topic of "The Human Being in the Center of Learning Systems" with an international scientific conference and many other events.

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A WEEK OF SCIENCE AT KIT

7 Days – 7 Questions – 7 Formats

An "actual" open day with thousands of visitors was unfortunately not possible because of the pandemic. Instead, KIT created a diverse online program, embedded in the Karlsruhe science festival EFFEKTE, from June 12 to June 18, 2021. This program offered exciting insight into the world of research, teaching, and innovation to anyone interested. The online program was presented on a web portal and supplemented by selected hybrid events.

For each day of this week of science, a question and a highlight format were placed in the center of the program, which was organized by KIT event management. Whether it was playfully in a digital escape room ("How can math be fun?"), concisely in a streamed lunch lecture ("Are we nearly done with the energy transition?"), or with a focus on discussion in a clubhouse room ("Will we be able to drive without a license in the future?"), topics were presented in an entertaining and varied way. They were characterized by social relevance and references to KIT's strategic research and were developed in collaboration with all eight KIT Centers.

Two of the seven daily formats allowed visitors to register and come to the event in person in addition to the live stream. On the EFFEKTE stage in front of the TRIANGEL Open Space at Kronenplatz on June 12, the "Klimatalk KARLA" posed the question of how Karlsruhe could become climate neutral. Stakeholders of the Karlsruhe Real-world Lab for Sustainable Climate Protection (KARLA), which is operated in part by KIT and the city of Karlsruhe, were invited to the event. On June 16, that same stage became the location of a more competitive event: At "Falling Walls Lab Karlsruhe," students, young scientists, and entrepreneurs were each given three minutes to convince the audience and the jury of their fascinating ideas.

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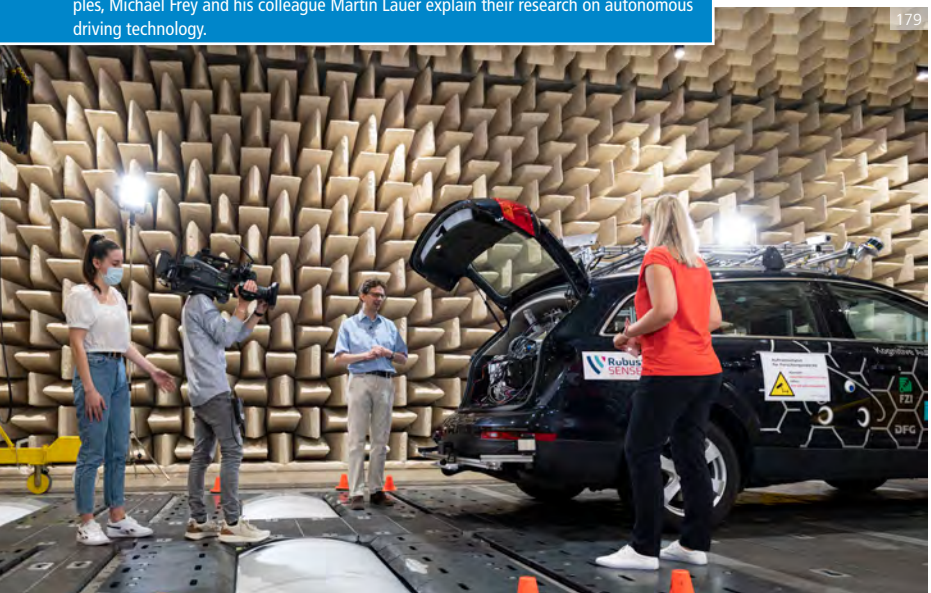
Mayor Frank Mentrup, KIT President Holger Hanselka, and representatives of Karlsruhe's scientific institutions inaugurated the science festival EFFEKTE.

In addition, this week of science at KIT offered visitors of all ages many possibilities to take part digitally, expanding upon the central question of the day and encouraging individual action. For instance, students met in a Student Science Café and explored the question of which materials will shape our lives in the future.

Another hybrid event was a playful knowledge transfer that happened during the seven days: In the "Campus Challenge," players were guided by an app on a rally across KIT Campus South, facing a fictional scenario in which they had to solve tasks to reactivate various power sources after a blackout.

Automotive daydreaming or almost reality: In a live stream including many video examples, Michael Frey and his colleague Martin Lauer explain their research on autonomous driving technology.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SHAPING THE WORLD OF TOMORROW

wiseUP Project Enables Knowledge Transfer for Student Volunteers

PerspektivenLABOR is a part of KIT's House of Competence offering students of all subjects an opportunity to become creators and designers for the world of tomorrow. The wiseUP project enables students engaged in volunteer work to receive knowledge transfers that support them as they prepare for future leadership roles in volunteering.

Student volunteers can work on matters regarding student unions, student representation, and student groups with consultations and personal coaching sessions at PerspektivenLABOR. For instance, they might learn what is required for students on the board of a student group, or what they might need to know as future leaders after their studies. This addresses future, current, and former student board members as well as future leaders in their upcoming professional life.

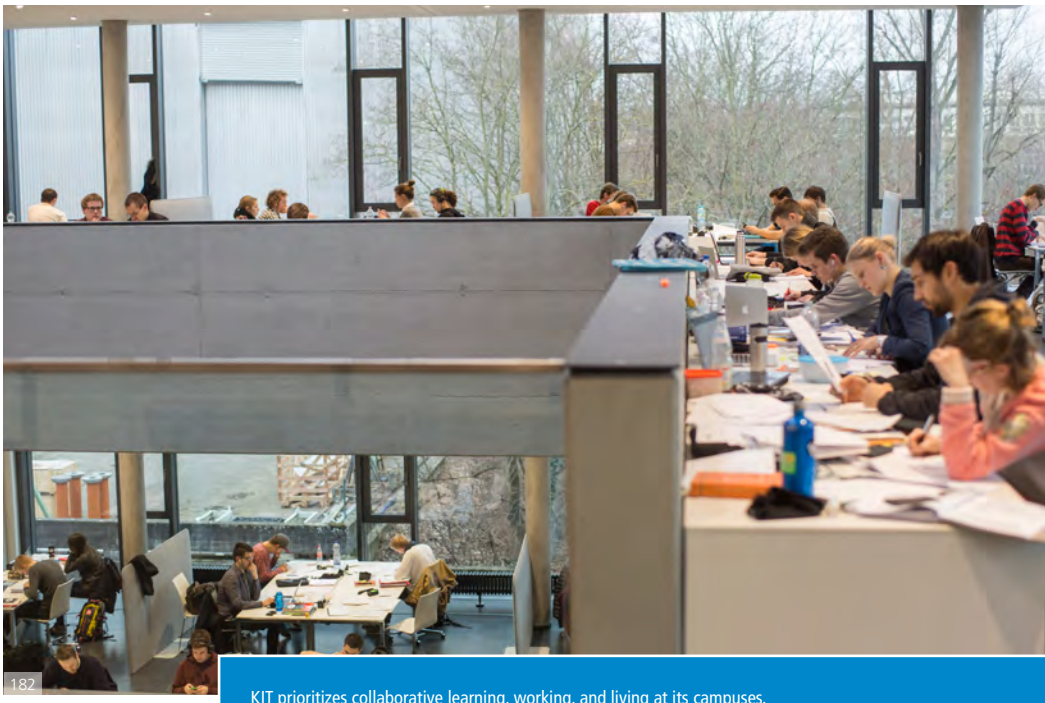
The wiseUP project analyzes these requirements to provide students with leadership knowledge and motivate them to join the next generation of leaders. This includes help in recruiting new members for student representation and student groups. Consultations, individual seminars, and coaching sessions address leadership responsibilities in volunteering. Students are supported as they develop as leaders and gather experience. Experts are part of team coaching sessions. Additionally, new and interested students can learn about volunteering during networking events, and podcasts enable active volunteers to share their experiences.

PerspektivenLABOR also offers numerous courses on a spectrum from personality development with future skills and digital ethics to networking, conflict management, and self-guidance ability. Customized training can address topics including how to lead online meetings, gender and diversity skills, agility, leadership skills, to communication, online and offline teambuilding, and emotional intelligence.

SUSTAINABLE CAMPUS DEVELOPMENT

A Marketplace of Knowledge

The research and teaching routine at KIT in 2021 was again shaped by the ongoing pandemic. Just as the year before, teaching was forced to switch to digital and hybrid formats on many occasions. At times, researchers and administrative staff worked from home. However, KIT is an in-person university that sees immense value in collective learning, working, and living on the campuses. It is a principle that influences research, teaching, and innovation throughout KIT. The ongoing digitalization of our society that accelerated greatly during the pandemic will challenge and perhaps cause changes in this principle. So, KIT is preparing to adapt teaching, learning, and work environments to these new conditions with an overarching project embedded in the Umbrella Strategy.



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KIT prioritizes collaborative learning, working, and living at its campuses.

At its core, KIT is still a "marketplace of knowledge," with people interacting in person, but increasingly these in-person interactions will be supplemented by online options. When being in the office or an auditorium is not essential, online formats will become more commonplace at KIT. The new, virtual world will enhance learning, working, and living at KIT but not replace in-person meetings and communication. This increased role of communication and interaction will be considered when replacing, expanding or otherwise altering the physical infrastructure, which continuously reflects changing requirements.

For instance, Germany's first 24-hour library opened in 2006 with close to 1,000 study stations, setting a new standard for students. In 2014, the new learning center added stations to support new forms of studying and living together at KIT. It has become clear that living and learning environments at KIT cannot be separated. Staff members as well as students need communication spaces outside of laboratories, workshops, and offices. The canteen, which opened in 2014 on Campus North, and the mathematics building, which reopened the following year after an energetical refurbishment on Campus South, implemented shared spaces for staff and students under one roof. Completely new possibilities will be added by the InformatiKOM and the Mechatronics Learning and Application Center currently under construction in the Karlsruhe city center, which will be open to the public. All new buildings convey how KIT continues to rely on communication in person, while digitalization helps to strengthen cooperation beyond traditional concepts.

Another extension of the campuses' open spaces – a pilot pavilion – is in its initial stages. By making digital data available out in the open, KIT will provide new, exciting spaces for mobile learning, working, and living.

SUSTAINABILITY

Promoting sustainable development and climate protection will require complex, long-term initiatives, institutional reorganization, and collaboration to make large contributions. At KIT, goals and measures were developed and enshrined in the 2022-2026 Structure and Development Plan with the involvement of diverse stakeholders.

After the appointment of a Climate Protection and Sustainability Representative of the Executive Board in 2020, this development continued in 2021 with the establishment of the Sustainability Office as a central point of contact for KIT's sustainability management. Additionally, an operational team inside

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the Facility Management business unit advocates for a sustainable infrastructure.

KIT collaborated with seven higher education institutions in Karlsruhe as well as the city administration to define collective climate protection targets and coordinate their actions. This climate package marks the first time that all higher education institutions in Karlsruhe have collaborated to reach the city's climate targets.

KIT contributes to knowledge transfer and political advice in the area of sustainability with its science platform on climate protection, among other projects.

A Round Table on Sustainability was created as a new means for internal discussion and awareness of sustainability topics among the scientific, administrative, and student bodies. In 2021, it offered insight into the latest high-level research on sustainability as well as specific topics such as sustainable construction, urban mining, and resource management in urban districts.

Regarding KIT's core tasks, exemplary lighthouse projects that support sustainable developments in society are presented on the following pages.

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LIGHTHOUSE PROJECTS IN SUSTAINABILITY RESEARCH

Participation, Transparency, and Resources

NaMaRes – District Resource Management in the Context of Sustainable City Development

There are more than half a million municipalities around the globe. While accounting for around two percent of the land surface, they consume more than 80 percent of all resources. The defined targets for sustainability can therefore only be met with sustainable development of municipalities.

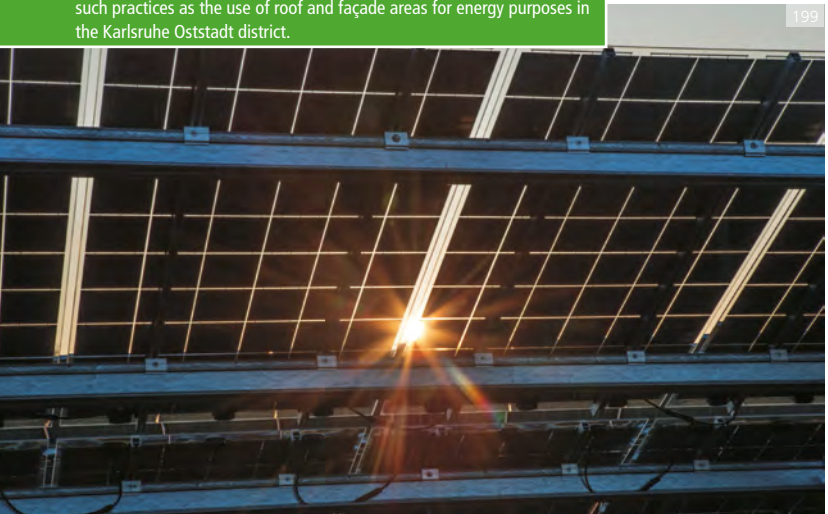
To support this approach, KIT launched the project NaMaRes. Its goal is the development of a web-based software and guidelines on how to assess the existing resources of districts and to help municipalities improve their communication, decision-making, and management.

An assessment of the current situation is necessary for a district development oriented toward resource efficiency and sustainability. Based on the assessment, concrete development goals and measures can be formulated, assessed, and implemented. This process is complex and loaded with conflicting goals, so expert monitoring and management is needed.

The researchers selected the Karlsruhe district Innenstadt-Ost as their study area because of its high degree of soil sealing. A particular focus was placed on analyzing existing and potential use of backyards, roofs, and façades as well as water and material flow. Several indicators were developed and analyzed for assessing the current state and estimating the maximum potential for improvement. The ecologic impact and costs of measures, such as extensive and intensive roof greening, use of roofs and façade surfaces for gathering photovoltaic and solar thermal energy, and the potential benefits of unsealing and revegetating soils, were calculated.

The three-year NaMaRes project started in April 2019. It is funded within the initiative RES:Z (resource-efficient districts) of the Federal Ministry of Education and Research and is expected to be continued in 2022 with a two-year implementation and consolidation phase with local partners.

The NaMaRes project of the Institute for Industrial Production examines such practices as the use of roof and façade areas for energy purposes in the Karlsruhe Oststadt district.



Karlsruhe Real-world Lab for Sustainable Climate Protection

Real-world labs can connect global challenges such as climate protection with everyday activities and translate them into things individuals can do to protect the climate. The Karlsruhe Real-world Lab for Sustainable Climate Protection (KARLA) examines, assesses, and supports climate protection measures, and especially their sustainable aspects, in Karlsruhe.

As is usual in real-world labs, KARLA pursues research, transformation, and education goals concurrently. So-called transformation experiments take center stage. These might include climate-friendly business travel, sustainable climate protection in the construction sector, specialists for climate protection, or climate-friendly cafeterias. Additionally, KARLA will examine the planned actions for climate protection in Karlsruhe and institutionalize climate protection. One of KARLA's actions was the "Klimapakt," a climate agreement between the eight local universities and the city of Karlsruhe that was negotiated in 2021 to set up exchanges and synergies about climate protection. The city of Karlsruhe and especially the KIT campuses make up the geographical scope of the reality lab. This means that KARLA also addresses climate protection directly at KIT.

The KARLA project of the Institute for Technology Assessment and Systems Analysis (ITAS) started in 2021 with 30 partners. It is initially funded for three years by the Ministry of Science, Research, and the Arts of the State of Baden-Württemberg (MWK).

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The mobile participation laboratory "MobiLab" offers a platform for exchange between science and society.

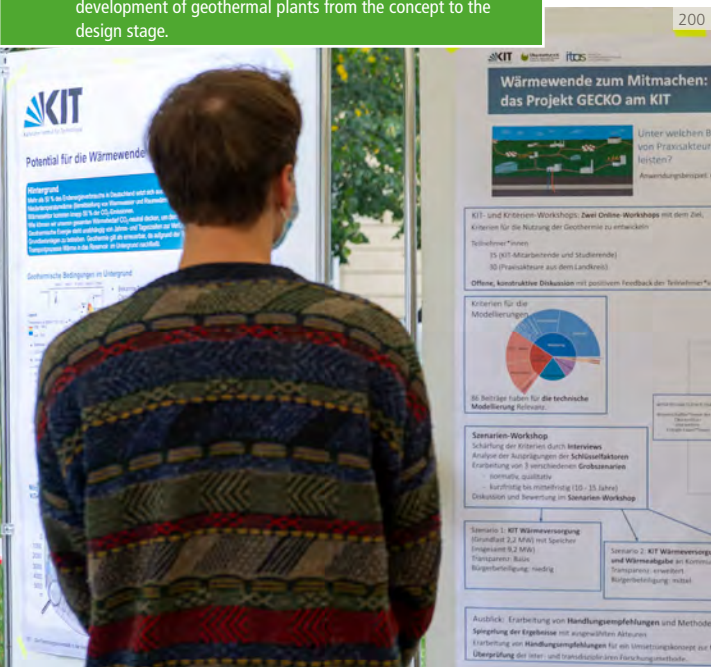
Sustainability through Participation

The "MobiLab," an initiative by ITAS and the KIT Humans and Technology Center, is a mobile participation laboratory that was set up in 2021 in the form of a tiny house. It serves as an exchange platform between science and society. It has many uses: For participative research, citizen science, science communication, and participation and dialog. MobiLab's most crucial benefit is that it allows research and dialog to happen anywhere. The concept of a multifunctional, mobile tiny house produced as sustainably as possible is one of a kind. MobiLab was used by KARLA at the Offerta consumer fair in the fall of 2021 for a dialog with citizens. It was also deployed at Baden-Württemberg's Energy Transition and Sustainability Days.

Geothermal Energy as Climate-neutral Heat Supply

With its potential to supply and store heat, deep geothermal energy could play a significant role in the transition toward a climate-neutral heat sector. A step in this direction is the development of new geothermal concepts for supplying heat, which could help with the balancing of supply and demand in different seasons. At KIT, about 40 experts from several disciplines and six different institutes are researching this technology and its safe usage as well as potential locations of geothermal systems.

In the GECKO project, stakeholder groups take part in the development of geothermal plants from the concept to the design stage.



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Despite strong consent for the energy transition, geothermal plants are often controversial. In the GECKO interdisciplinary project by KIT and Öko-Institut e.V. Freiburg, stakeholder groups are therefore involved in the entire development process of a geothermal plant, starting with the concept and ending with the design. During two workshops in the fall of 2020, more than 250 comments from citizens were gathered and divided into communicative and technical aspects. The need for transparency was most often mentioned. The researchers integrated around 150 technical aspects into possible usage models, connected them with corresponding transparency aspects, and summarized them in three scenarios for success. These were later presented to citizens in a scenario workshop in the fall of 2021.

KIT has gained very positive experiences with this kind of dialog, which lead to the promotion of this exchange not only at events such as Science Week but also in the real-world labs. Examples of this are the Real-world Lab Robotic Artificial Intelligence and the Karlsruhe Real-world Lab for Sustainable Climate Protection KARLA, both funded by MWK, and the Karlsruhe Transformation Center for Sustainability and Cultural Change (KAT). By 2025, four more real-world labs will be set up with funds of the excellence strategy. They will cover the topics of autonomous driving and help systems for people with disabilities.

LIGHTHOUSE PROJECTS IN TEACHING

Education for a Sustainable Development

For many years, the ZAK | Centre for Cultural and General Studies has been occupied with theoretical and conceptual perspectives on sustainability in its teaching modules, projects, and minor studies on sustainable development. ZAK offers all KIT students the opportunity to acquire application-oriented knowledge and skills.

During the Sustainability Spring Days, an event that has been taking place at KIT since 2017, up to 300 students explore how science can contribute to sustainable development with the help of lectures, workshops, and excursions. ZAK organizes the Sustainability Spring Days in cooperation with the KIT Institute for Technology Assessment and Systems Analysis and the Karlsruhe School of Sustainability. In 2021, the event took place digitally because of the pandemic. The opening keynote by Professor Maja Göpel, transformation researcher, political economist, and scientific director at THE NEW INSTITUTE in Hamburg, was streamed live to more than 1,000 viewers. Professor Göpel talked about the relationship between economy and ecology, the imperatives of sustainable economic activity, and the possibilities of a post-pandemic society. The Sustainability Spring Days at KIT were awarded with the statewide teaching prize "Hochschullehre für eine nachhaltige Entwicklung" (higher education teaching for sustainable development). This prize is funded by the Baden-Württemberg Ministry of Science, Research, and the Arts and the Ministry of the Environment, Climate Protection, and the Energy Sector.

On August 1, 2021, Professor Senja Post took over as scientific head of ZAK. The focus of her research is the relationship between science and society. She has a doctoral degree in communication science and currently studies the dynamics of public controversies about the environment, technology, and science. At ZAK, she plans to promote education for sustainable development. Implementing sustainable economies and new ways of living touches on countless conflicting goals: For example, the intended and non-intended effects of different technologies and conflicts between different sustainability goals themselves. These conflicts will become more of a focal point in the future of Education for a Sustainable Development at ZAK, allowing students to learn about the complexity of the issue and the heterogeneity of the proposed solutions and to contribute to the solution as future decision makers in research, industry, and society. Education for a Sustainable Development at ZAK hopes to counterbalance public debates on sustainability that are often characterized by reduction, generalization, emotionalism, and moralizing.

The ZAK | Centre for Cultural and General Studies offers all KIT students an opportunity to acquire application-oriented knowledge and skills.

LIGHTHOUSE PROJECTS IN INNOVATION

Expert Knowledge Transfer into Politics

The Federal Government has agreed on concrete and ambitious targets for the reduction of greenhouse gases in the energy, industry, construction, traffic, agriculture, land use, and forestry sectors. These targets are part of the Climate Protection Plan 2050, which outlines the German long-term strategy for climate protection. This plan enshrines the significance of research and innovation and includes a broad science-based support process. The urgency of climate protection and the changing aspects of national and European climate protection policies, especially in the last two years, make this plan more important than ever.

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KIT research activities – for instance, the Energy Lab 2.0, parts of which can be seen here – combine the sectors of traffic, heating, and energy and contribute to the WPKS platform.

"Wissenschaftsplattform Klimaschutz" (WPKS) is a scientific platform for climate protection that supports the Federal Government in implementing and developing the German long-term climate protection strategy. KIT is part of the group of selected research facilities of natural, social, economic, and engineering sciences, as well as law, that work together interdisciplinarily. The group regularly has exchanges with science, civil society, and politics, contributing to achievement of the national and international climate protection targets. The platform is controlled by a steering group of distinguished experts from different disciplines. The Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection appointed KIT President Professor Holger Hanselka as one of eight members of the steering group. He contributes a scientific technical perspective and a special focus on the intersection between the sectors of traffic, heating, and energy. KIT's expertise on greenhouse gas emissions monitoring, sustainable construction, and the circular economy has left its mark on the work of the science platform.

The work of the steering group ranges from statements (Climate policy demands for the economic policies during the Covid pandemic, July 2020) to reports (Behavioral changes during the Covid pandemic, May 2021), and guidelines (Good practice for ex-ante evaluation of climate protection measures, May 2021).

In February 2022, the first WPKS annual expert report was sent to the Federal Minister of Education and Research Bettina Stark-Watzinger and State Secretary Dr. Patrick Graichen of the Federal Ministry for Economic Affairs and Climate Action. The expert report presents recommendations to the Federal Government on implementing the European Green Deal and climate policy reform in Germany and highlights related research needs. Following the body's interdisciplinary composition, the recommended areas for action range from key technologies to agriculture and forestry. They even involve social aspects of the transformation.

DIGITALIZATION

In view of the importance of digitalization for the fulfillment of KIT's core tasks of research, teaching, and innovation as well as for an efficient and modern administration, KIT, under the leadership of Chief Information Officer President Holger Hanselka and Chief Digital Officer Dr. Julia Winter and with support by the KIT Bodies and the Digital Office, has submitted a strategy paper to be included as a new area of action in the KIT 2025 Umbrella Strategy. The action area of digitalization defines the strategic goals as well as measures for digitalization at KIT. Digitalization enables outstanding research at the highest international level and a vital innovation culture at KIT. Digital processes and services

for comprehensive documentation of the entire research process support good scientific practice and increase the transparency and traceability of research.

KIT uses digitalization to support successful studies and excellent teaching. It enables students to research, work, communicate, and act in a globalized and media-networked world.

Increased digitalization makes support for the core tasks, procedures, and processes in KIT's administration more transparent and efficient. This includes the availability of digital documents, digital file and document management, and digital processes.

The digital workspace at KIT also offers flexible ways of working. Here, the concept of New Work plays an increasingly important and significant role. Information security and data protection are fundamental prerequisites for successful digitalization. They exist throughout the KIT in a holistic and coordinated manner and throughout all of the steps for implementing the digitalization strategy.


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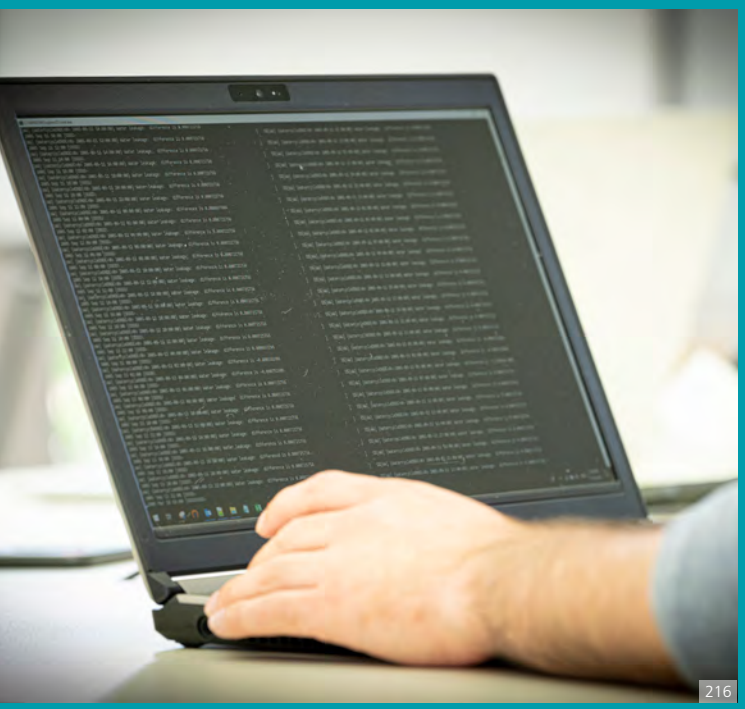
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STRATEGIC SUPPORT MEASURES

Funding for Digitalization Projects

The strategic digitalization goals of KIT are defined in the long-term information processing and supply strategy referred to as IV Strategy, the annually updated information processing and supply concept referred to as IV Concept, the forthcoming digitalization area of action, and the KIT 2025 Umbrella Strategy. Funds are provided in the digitalization sub-budget through the Executive Board's strategy fund to implement strategically important digitalization projects that support and accelerate these goals in all core tasks as well as in KIT's administration.

The strategy fund provides resources when other sources of funding, such as the basic budget or third-party funds, are not available. The relevant measures are funded for a limited period of time. Applications are submitted via the members of the Executive Board or the Heads of Division. In the run-up to submission, the IV Bodies support the preparation of the applications in regard to their schemes and content.

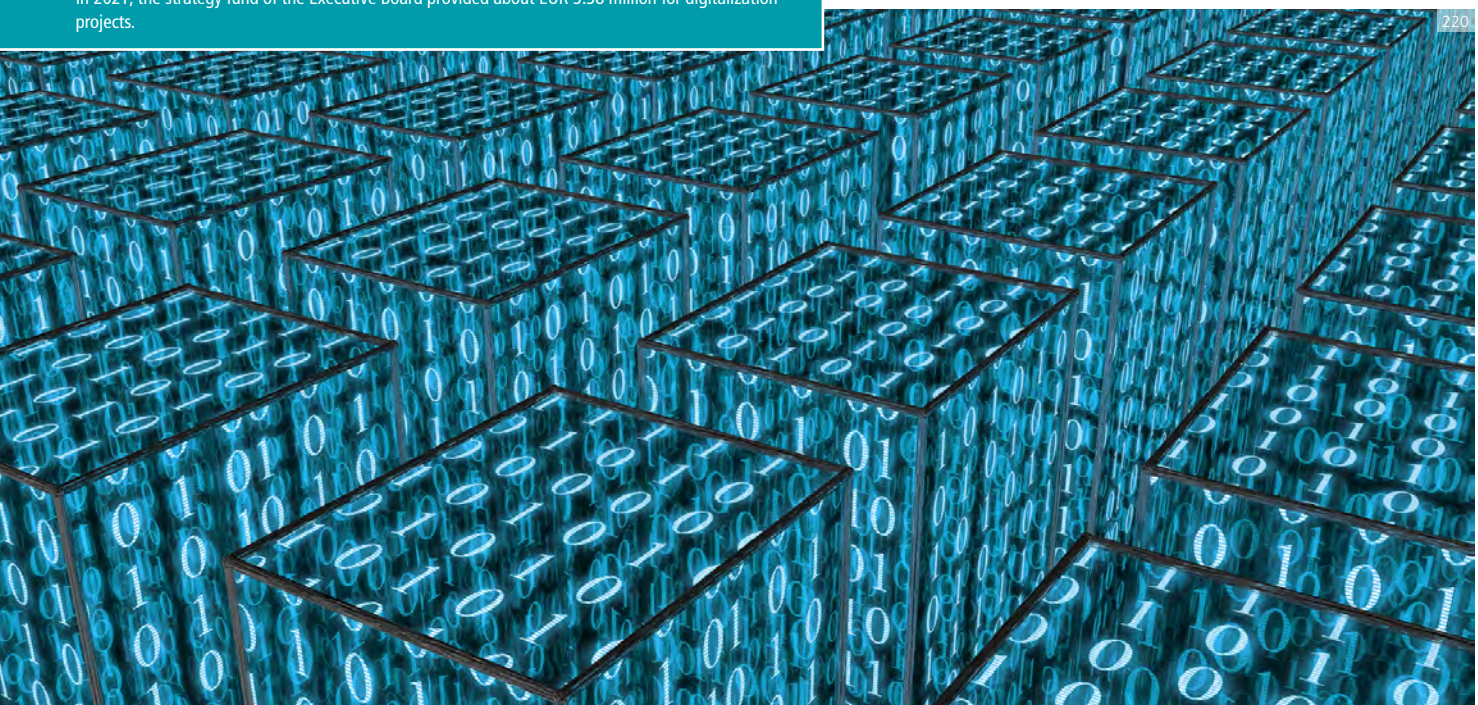
In 2021, the Executive Board approved 16 of 28 digitalization applications. Their budgets were in the range of EUR 20,000 to 450,000. In total, the strategy fund provided about 3.38 million euros for projects focusing on digitalization. Thirteen applications were financed from the digitalization sub-project and three from the teaching sub-budget.

Most of the resources provided by the strategy fund support digitalization projects as part of the core tasks of KIT: 54 percent are channeled into Research and Innovation; 27 percent go to Studying and Teaching. The remaining funds are distributed among Digital Foundations (10 percent) and Digitalization in Administration (9 percent).

The "DORA4KIT – Data Literacy" project, which aims to create awareness among KIT students for the topic of research data management and to impart professional skills in this area, is one of the projects supported by the strategy fund. Data literacy, the professional and sustainable handling of research data, is considered a key proficiency in the digital age. Its first milestone was the introduction of a learning module for the Department of Chemistry and Biosciences in the winter semester of 2021/2022. This module trains students to use the electronic lab book Chemotion in the first semester and at the same time increases their awareness of how research data should be handled.

Another project supported by the strategy fund is the "Video and Audio Kit for Hybrid Events," a mobile solution for rooms where permanently installed video technology is not efficient. The kits contain everything necessary to enable both face-to-face participants and participants connected via video conferencing software to take part in events through just a few simple steps.

In 2021, the strategy fund of the Executive Board provided about EUR 3.38 million for digitalization projects.



HOW WILL WE WORK IN THE FUTURE?

Lead Project "New Work" Has Started at KIT

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In the "New Work" project, KIT is exploring possible new forms of work.

"New Work" refers to a concept of more meaningful wage labor developed by the social philosopher Frithjof Bergmann in the 1980s. In October last year, the Executive Board of KIT launched a project of the same name based on this idea, which is scheduled to run until mid-2023. Within the larger context of implementing the Umbrella Strategy, the project will explore which forms of work would be good for KIT and its nearly 10,000 employees in the future.

KIT wants to develop the potential of New Work in four areas in particular: Humans, Workplace, Technology, and Organization. In the Humans area, the aim is to design a new kind of hybrid work – between office and "everywhere," between fixed working hours and "fully flexible" hours, between superiors enabling such work and loyal self-organization among colleagues – in such a way that makes possible greater efficiency and satisfaction. The Workplace area deals with the effects of New Work on space requirements, accommodation concepts, space concepts, and space management models. The goal of the Technology area is to provide high-performance IT infrastructure for long-term support of the process of adapting and expanding to digital forms of work. The Organization area is concerned with structure for the future of good work, i.e., labor law, data protection law, and social rules.

The project was initiated with a large number of interviews with representatives of different hierarchical levels in science and administration, with the Staff Council, and with students. This was supplemented by an online survey of all employees. Local pilot projects are scheduled for 2022. These test runs were selected from ideas contributed by the KIT organizational units.

The potential of New Work lies in an increased sense of autonomy, which can lead to increased work and life satisfaction, increased performance, reduced stress, and a reduced tendency to vacillate. Additional potential lies in a greater independence, improved work-life balance – for example by saving commuting time – fewer work interruptions, and better opportunities for concentrated work. On the other hand, there are risks such as a decrease in contacts among colleagues and resulting social isolation, excessive demands or overstrain due to a lack of structure, so-called interested self-endangerment, a merging of private and professional life because of constant availability, and excessive demands because of the use of multiple communication channels. The New Work lead project was begun to find the most suitable approach to work at KIT.

IT INFRASTRUCTURES IN THE CLOUD

With Transparency and Media Competence

Cloud services in information technology are on the rise not only in the private sphere, but also for institutions. This trend raises questions as to which resources must be kept available locally. Cloud services supply infrastructure, data storage, or applications in a cloud. Shifting parts of the IT infrastructure "off-campus" has a decisive impact on digital sovereignty, basic infrastructures, and personnel development. The shift creates new opportunities, but also new dependencies.

To develop innovative, secure, and legally compliant cloud solutions, "Zentren für Kommunikation und Informationsverarbeitung in Lehre und Forschung e.V. (ZKI)," the association of IT services centers in higher education institutions, universities, and research institutions in Germany, has established the ZKI Commission Cloud, in which KIT is represented. In 2021, the commission published guidelines for the introduction of cloud services at universities. The guidelines have both general rules and specific product-related recommendations for university executives, computing centers, and procurement units.

To support the digital transformation of administrative processes at universities, universities in the state of Baden-Württemberg have jointly created bwUni.digital. In several think tanks, they investigate many aspects of digital transformation. KIT coordinates one of these think tanks, which deals with the use of Microsoft 365 and associated data protection issues.

For many years, universities in Germany have had access to the products of the U.S. company Microsoft through a federal government umbrella agreement. Microsoft 365 includes MS Office programs such as Word and Excel, as well as the Teams tool for video conferencing.

Microsoft 365 makes it possible to work from any terminal, regardless of location. Microsoft data centers take care of data storage, which is accessed via the Internet. In October 2021, the think tank presented a report analyzing the current use of Microsoft 365 and ways to make its use legally compliant with the General Data Protection Regulation (GDPR).

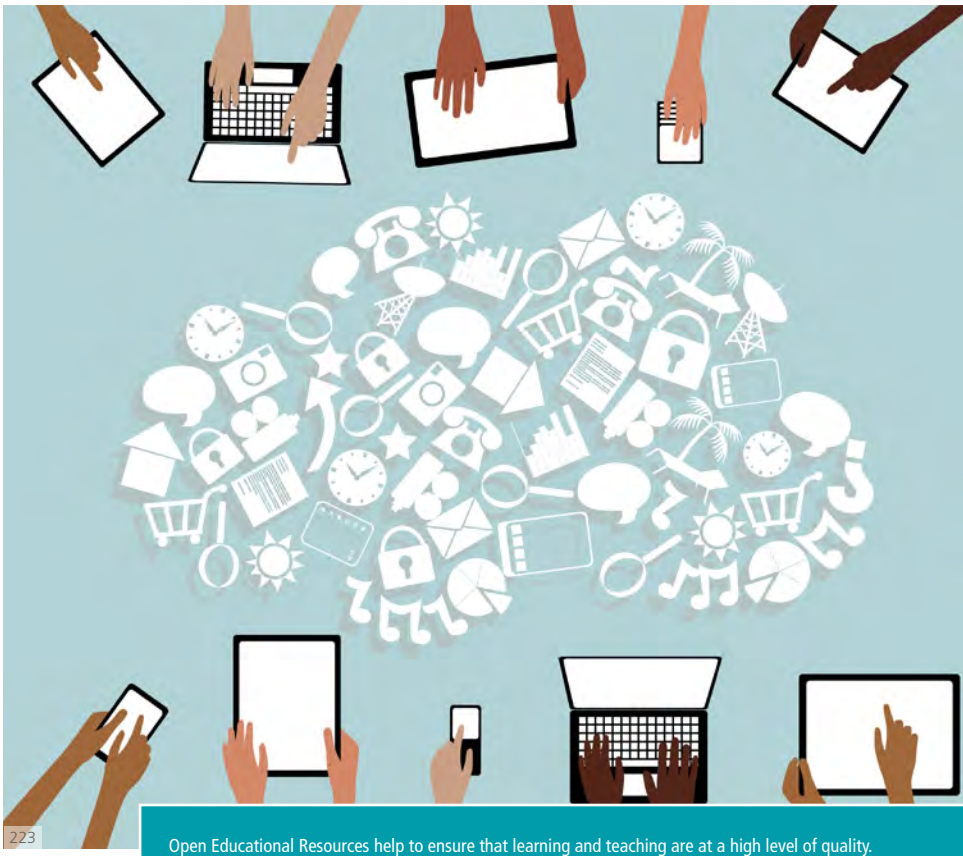
It concluded that the use of Microsoft 365 will probably require functional and content-related restrictions to reduce risks under the data protection law to an acceptable level. A detailed examination will be conducted in an implementation project launched in 2021, in which other universities are also involved.

The relocation of parts of the IT infrastructure to the cloud offers new opportunities, but also entails risks.

QUALITY ASSURANCE IN HIGHER EDUCATION

Open Educational Materials in Teaching

Methods of open science play an ever-increasing role both nationally and internationally and also affect decisions made by funding bodies. In science, the aim is to create free access not only to scientific literature (open access), but also to research data, laboratory reports, and other research processes. This is to ensure that research results still are accessible, transparent, and reusable, and that reliable knowledge is created. In the field of teaching, so-called Open Educational Resources play a comparable role.



223 Open Educational Resources help to ensure that learning and teaching are at a high level of quality.

According to the German Commission for UNESCO, "Open Educational Resources (OER) are educational materials of any kind and in any medium that are available under an open license. Such license allows free access as well as free use, editing, and redistribution by others without or with only minor restrictions. In this context, the authors themselves determine which rights of use they grant and which rights they reserve."

OER include courses or programs, course materials, graphics, modules, manuals for students, instructions for teachers, textbooks, research papers, videos, interactive materials such as simulations and role-playing exercises, databases, software, and applications. OER are always published under a free license that allows the use, redistribution, and modification of the copyrighted works.

OER are in line with the values and mission of KIT to create and communicate knowledge for society. For this reason, KIT adopted an OER policy in 2021.

KIT strives to ensure and enhance its high quality of teaching. It therefore supports the use of contemporary teaching and learning methods as well as the use of digital elements in teaching.

In this way, KIT actively contributes to a functioning OER community and a continuously growing pool of teaching materials by creating and publishing OER. Teachers at KIT should make their licensed scientific teaching content available digitally for academic education across universities and make use of the OER created by other teachers.

KIT is receptive to innovations from other universities and third-party providers for digitalizing learning and teaching. At KIT, several participants and central service facilities make it possible to conduct courses partially or completely online. These include the Library, the Center for Technology-Enhanced Learning, and the Steinbuch Centre for Computing.

PRIZES, HONORS, AWARDS, AND APPOINTMENTS

In 2021, the Executive Board and KIT Senate granted various titles of honor in accordance with pertinent regulations. Because of the pandemic, the award ceremonies will take place in summer 2022.

A Needle of Merit was granted to former Division Heads Professor Doris Wedlich and Dr. Karl Friedrich Ziegahn. Both were significantly involved in the establishment and further development of KIT. Doris Wedlich was awarded the Needle of Merit posthumously.

KIT honored Marc Angélil, Professor Emeritus of ETH Zurich, with a Medal of Merit for his close

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collaboration with the KIT Department of Architecture, his communication of university research activities to the broader public, and his support of KIT's participation in the 2021 International Architecture Exhibition at Venice. Professor Peter Gutzmer, contract lecturer and Honorary Professor at KIT, who worked as Chief Technology Officer and Deputy Chief Executive Officer at Schaeffler AG until his retirement, was awarded a Medal of Merit for his work to establish, develop, and grow the Schaeffler Hub for Advanced Research (SHARE) at KIT. Other Medals of Merit were granted to Dr. Theo Mayer, Vice President R&D and Innovation Polymers of Wacker Chemie AG, and Peter Summo, President of Wacker Polymers of Wacker Chemie AG, for their financial and technical support, assistance, and counseling of the KIT Department of Architecture on various projects, especially the new library of materials.

Hans Lenk, Professor Emeritus of KIT, was appointed Honorary Citizen of KIT for his long and outstanding work on behalf of KIT and his pioneering scientific work and research achievements in the philosophy and ethics of technology, which earned him international recognition.

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GOTTFRIED WILHELM LEIBNIZ PRIZE FOR ALMUT ARNETH

KIT's Ecosystems Researcher Receives Germany's Most Important Research Prize

The 2022 Gottfried Wilhelm Leibniz Prize of the German Research Foundation went to Almut Arneth. 242

Professor Almut Arneth from KIT was awarded the 2022 Gottfried Wilhelm Leibniz Prize by the German Research Foundation (DFG). Germany's highest research prize in the amount of EUR 2.5 million, the award honors the scientist for her research into the impact of global environmental change on ecosystems. With the inclusion of Almut Arneth, nine researchers of KIT have received a Leibniz Prize so far.

Since 2012, Almut Arneth has conducted research at the Atmospheric Environmental Research Division of the Institute of Meteorology and Climate Research and worked as a professor at the Institute of Geography and Geoecology of KIT. On KIT's Campus Alpine in Garmisch-Partenkirchen, she heads the Department of Ecosystem-Atmosphere-Interactions and the Global Land Ecosystems Modeling Group. Since 2016, she has been spokesperson of the Ecosystems topic of KIT's Climate and Environment Center.

Almut Arneth's research focuses on processes in terrestrial ecosystems under the impact of global environmental change. This includes interactions between land and climate, the role of changes in land use in the climate system, and relationships between ecosystems functions and biodiversity.

She contributes her scientific expertise to reports by both national and international expert groups. She was lead author, for instance, of the section on "Climate Change Mitigation" in the proceedings on biodiversity and climate change under the joint auspices of the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES). She also was coordinating lead author of the IPCC special report on climate change and land. In addition, Arneth co-authored the discussion paper on "Globale Biodiversität in der Krise – was können Deutschland und die EU degegen tun?" (Crisis of global biodiversity – what can Germany and the EU do?) published by the National Academy of Sciences Leopoldina.

Arneth and her team presented their latest findings in a number of scientific publications. They proved, for instance, that climate change after 2020 will massively reduce the chances of reaching many existing or proposed biodiversity goals. In 2021, Arneth again was ranked among those researchers whose publications were cited most frequently.

Apart from her research work, Almut Arneth is actively involved in the support of young scientists at KIT. Last year, she was one of the first scouts selected for the Henriette Herz Program by the Alexander von Humboldt Foundation. This gives her the opportunity to recruit excellent young scientists from abroad as Humboldt Research Fellows.

HUMBOLDT PROFESSORSHIP FOR TOP INTERNATIONAL RESEARCHER

Markus Klute Receives Germany's Most Highly Endowed International Research Award

KIT is bringing another world-leading researcher to Germany: Particle physicist Professor Markus Klute has been selected for a Humboldt Professorship. With this award, the Alexander von Humboldt Foundation honors outstanding researchers who have previously worked abroad. The German-born physicist conducted research at the renowned Massachusetts Institute of Technology (MIT) in the USA.

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Markus Klute from MIT has accepted the Humboldt Professorship at KIT.

Markus Klute and his group contributed significantly to the discovery of the Higgs boson in 2012 at CERN near Geneva. There, he played a leading role in the Compact Muon Solenoid (CMS) experiment. His later CMS measurements were also groundbreaking and provided a deeper understanding of the properties of the Higgs boson. Klute's group additionally established the use of modern machine learning techniques in high-energy physics. With more than 5000 participants from over 50 countries, the CMS experiment is one of the biggest international research projects ever. KIT has been involved in the research work there for 26 years now.

Klute focuses on particle physics at the highest energies. His work covers the design, construction, and commissioning of particle detectors as well as the analysis of collected data. To continue the search for subatomic particles that could help to explain the origin of the universe, he and other scientists need measurements that are even more precise than before. CERN is therefore upgrading its particle accelerator, the Large Hadron Collider (LHC). Starting in 2027, the High-Luminosity LHC project is expected to deliver far more data and, thus, more Higgs particles than was possible in the past.

With Markus Klute as a new Humboldt Professor, KIT intends to be a worldwide leader in the LHC program of CERN and to develop new collaborative projects for the KIT Elementary Particle and Astroparticle Physics Center KCETA and its KSETA graduate school.

Markus Klute has been a full professor at the Massachusetts Institute of Technology in the USA since 2020. He studied physics and mathematics at the University of Bonn and completed research stays as a doctoral student at CERN in Geneva, Switzerland, and at Fermilab near Chicago, USA. In 2004, he earned his doctorate in Bonn. As a postdoc, Klute went to MIT, became a research scientist there, and received a professorship at the University of Göttingen in 2008. In 2009, he returned to MIT, first as assistant, then as an associate professor. He is a Fellow of the American Physical Society, an expert reviewer for the National Science Foundation, and a member of the Scientific Advisory Board of the PRISMA+ Cluster of Excellence at the University of Mainz.

INTERNATIONAL FORUM FOR TALENT

Climate Researcher Christian Scharun Wins Falling Walls Lab Competition

Christian Scharun convinced the jury and audience to win the Falling Walls Lab competition in June 2021 in Karlsruhe. At the Falling Walls Lab, the world's upcoming talents, innovators, and creative minds present their great ideas, groundbreaking research projects, or ingenious business models. Scharun holds a doctoral degree and works at KIT's Institute of Meteorology and Climate Research.

In a three-minute presentation at the Falling Walls Lab, Christian Scharun spoke about his method to measure greenhouse gases more precisely and better understand their dispersion around the globe. He uses freely accessible data from satellites scanning the Earth's atmosphere and measuring the concentration of greenhouse gases. With the help of an algorithm, Scharun can allocate satellite data to emission hotspots, such as megacities or even individual factories. This provides structure to otherwise disordered measurement data and links them automatically with a geographical coordinate system. Christian Scharun studied mathematics and geography at KIT and earned his doctorate at the Institute of Meteorology and Climate Research. His doctoral thesis focused on greenhouse gas emissions from oil and gas rigs in the North Sea. It took the climate researcher three years to develop his algorithm. Now, it is theoretically possible to observe in real time the greenhouse gases that are being produced worldwide.

His win at the Falling Walls Lab in Karlsruhe qualified Christian Scharun to represent South Germany in the world's final in Berlin in November. At the Falling Walls Conference in Berlin, he won the "Scientific Breakthrough of the Year," which is the prize for young talents at the international Falling Walls Competition. About 1700 scientists from 89 countries participated in the worldwide competition. Christian Scharun reached 3rd place.

Every year from March to October, renowned academic institutions all over the world organize local Falling Walls Labs to demonstrate the quality, diversity, and passion of the most innovative minds of their regions. KIT, together with the University of Heidelberg, organizes the Falling Walls Lab for southwest Germany. KIT is responsible for the Falling Walls Lab in Karlsruhe.

The winner of the competition then participates in the final Falling Walls Lab in Berlin. The top three finalists win prize money as well as the opportunity to present their work on the big stage of the Falling Walls Conference, which coincides with the anniversary of the fall of the Berlin Wall.

Christian Scharun (center) received first prize from Thomas Hirth, Vice-President for Innovation and Transfer, at the Falling Walls Lab Karlsruhe. Julia Hagel presented the event.

OTHER PRIZES, HONORS, AWARDS, AND APPOINTMENTS

Persons

■ **Professor Dr. Almut Arneth**, Institute of Meteorology and Climate Research, and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.


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■ In addition, **Almut Arneth** was appointed member of the newly established Climate Experts Council of the State of Baden-Württemberg. The council will advise and support the state government and parliament in implementing the climate transition.

■ **Ruth Bartelmann**, KIT Department of Architecture, received one of the 2021 Sponsorship Awards for Students of the German Institute for Urban Architecture for her master's thesis "Werken und Wohnen – Potenziale des hybriden Stadthauses" (working and living – potentials of the hybrid townhouse).

■ The BNE University Network Baden-Württemberg honored **Richard Beecroft**, Institute for Technology Assessment and Systems Analysis, and three other members of KIT for their course "Frühlingstage der Nachhaltigkeit" (sustainability spring days) with the University Education for Sustainable Development Prize

■ **Dr. Thierry Olivier Bineli Betsi** from Botswana International University of Science and Technology was granted a Georg Forster Fellowship for experienced researchers by the Alexander von Humboldt Foundation. He will work at the Institute of Applied Geosciences.

■ **Dr. Frank Biedermann**, Institute of Nanotechnology, received a Life Science Bridge Award of the Aventis Foundation, which is aimed at enabling young researchers to start independent research as early as possible.

■ **Alexander Böhmländer**, Institute of Meteorology and Climate Research, received the 2021 Sparkasse Environmental Award for his master's thesis "A New Aerosol Payload for Unmanned Aerial Vehicles: Design and First Application for Ice-Nucleating Particle Measurements."

■ **Dr. Marion Börnhorst**, Institute for Chemical Technology and Polymer Chemistry, won the 2021 Friedrich and Elisabeth Boysen Prize for outstanding doctoral theses in the area of environmental technology with special consideration of engineering solutions for the reduction of pollutants, noise, and energy consumption.

■ The BNE University Network Baden-Württemberg honored **Ines Bott**, ZAK I Centre for Cultural and General Studies, and three other members of KIT for their course "Frühlingstage der Nachhaltigkeit" (sustainability spring days) with the University Education for Sustainable Development Prize.

■ **Dr. Dominic Bresser**, Helmholtz Institute Ulm, was awarded the 2021 Carus Medal by the National Academy of Sciences Leopoldina for his outstanding work in the area of battery research.


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■ In May 2021, **Dr. Miriam Brosi**, Institute for Beam Physics and Technology, received the 2020 Helmholtz Doctoral Prize in the research field of matter for her outstanding doctoral thesis "In-Depth Analysis of the Micro-Bunching Characteristics in Single and Multi-Bunch Operation at KARA."


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■ **Dr. Philip Brown**, Institute of Functional Interfaces, was granted the 2020 Sparkasse Environmental Award for his doctoral thesis. The award was presented in summer 2021.

■ **Professor Dr. Klaus Butterbach-Bah**l, Institute of Meteorology and Climate Research, and two other researchers of KIT were selected for the Henriette Herz Scouting Program by Alexander von Humboldt Foundation. As Humboldt scouts, they can now propose up to three talented researchers from abroad for a Humboldt research fellowship.

■ **Professor Dr. Michael Decker**, Head of Division II – Informatics, Economics, and Society, was elected Member of the National Academy of Science and Engineering (acatech).

■ **Professor Dr. Barbara Deml**, Institute for Human and Industrial Engineering, was elected Member of the National Academy of Science and Engineering (acatech).

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■ For his doctoral thesis written at the Institute for Human and Industrial Engineering, **Dr. Maximilian Dommermuth** was awarded the Dissertation Prize by the Academic Society for Work and Industrial Organization.

■ **Professor Dr. Helmut Ehrenberg**, Institute for Applied Materials, and two other members of KIT were appointed members of the advisory board "Batterieforschung Deutschland" (battery research in Germany) by the Federal Ministry of Education and Research.


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■ **Professor Dr. Sabine Enders**, Institute for Technical Thermodynamics and Refrigeration, was appointed chairperson of the working group Thermodynamics and Transport Properties of the European Federation of Chemical Engineering.

■ **Professor Dr. Ralph Engel**, Institute for Astroparticle Physics, was appointed Deputy Chairperson of the Particle Physics Section of the German Physical Society.


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■ **Professor Dr. Jürgen Fleischer**, wbk Institute of Production Science, and two other members of KIT were appointed members of the advisory board "Batterieforschung Deutschland" (battery research in Germany) by the Federal Ministry of Education and Research.

■ In May 2021, **Dr. Edouard Fouché**, Institute for Program Structures and Data Organization, received the 2020 Helmholtz Doctoral Prize in the research field of information for his outstanding doctoral thesis "Estimating Dependency, Monitoring and Knowledge Discovery in High-Dimensional Data Streams."

■ **Birte Froebus**, Institute for Technology and Management in Construction, was granted the WiN-Germany Award 2020/2021 by WiN -Women in Nuclear e.V. for outstanding achievements in nuclear research with her master's thesis "Untersuchungen zur Schildschwanzdichtung beim Rückholungskonzept "Schildvortrieb mit Teilflächenabbau" in der Schachtanlage Asse II" (studies of the shield tail seal for the retrieval concept "Shield advance with partial extraction" in the Asse II shaft facility).

■ **Professor Dr. Bettina Frohnapfel**, Institute of Fluid Mechanics, and two other researchers of KIT were selected for the Henriette Herz Scouting Program by Alexander von Humboldt Foundation. As Humboldt scouts, they can now propose up to three talented researchers from abroad for a Humboldt Research Fellowship.

■ **Denise Ganz**, Institute for History of Art and Architecture, received the 2021 University Prize of the City of Karlsruhe for her bachelor's thesis.

■ **Dr. Christian Grams**, Institute of Meteorology and Climate Research, was appointed ECMWF Fellow for three years by the European Centre for Medium-Range Weather Forecasts (ECMWF) starting January 1, 2021.

KIT Members of acatech – National Academy of Science and Engineering

Professor Dr. Dr. Albert Albers, Institute of Product Engineering
Professor Dr. Michael Decker, Division II – Informatics, Economics, and Society
Professor Dr. Barbara Deml, Institute for Human and Industrial Engineering
Professor Dr. Olaf Dössel, Institute of Biomedical Engineering
Professor Dr. Jürgen Fleischer, wbk Institute of Production Science
Professor Dr. Frank Gauterin, Institute of Vehicle System Technology
Professor Dr. Armin Grunwald, Institute for Technology Assessment and Systems Analysis
Professor em. Dr. Hermann H. Hahn, Institute for Water and River Basin Management
Professor Dr. Holger Hanselka, President of KIT
Professor Dr. Dr. Rafaela Hillerbrand, Institute for Technology Assessment and Systems Analysis
Professor Dr. Ellen Ivers-Tiffée, Institute for Applied Materials – Electrochemical Technologies
Professor Dr. Heike Petra Karbstein, Institute of Process Engineering in Life Sciences
Professor Dr. Gisela Lanza, wbk Institute of Production Science
Professor Dr. Hilbert von Löhneysen, Physikalisches Institut
Professor Dr. Jörn Müller-Quade, Institute of Information Security and Dependability
Professor Dr. Andrea A. Robitzki, Division I – Biology, Chemistry, and Process Engineering
Professor Dr. Helmar Schubert, Institute of Process Engineering in Life Sciences
Professor Dr. Peter Vortisch, Institute for Transport Studies
Professor Dr. Martin Wegener, Institute of Applied Physics
Professor em. Dr. Hartmut Weule, wbk Institute of Production Science
Professor em. Dr. Werner Wiesbeck, Institute of Radio Frequency Engineering and Electronics
Professor em. Dr. Sigmar Wittig, Institute of Thermal Turbomachinery
Professor Dr. Thomas Zwick, Institute of Radio Frequency Engineering and Electronics

■ Former President of German Parliament Wolfgang Schäuble appointed **Professor Dr. Armin Grunwald**, Institute for Technology Assessment and Systems Analysis, to be a member of the German Ethics Council. Since 2008, the German Ethics Council has advised the German government and parliament on ethical, social, scientific, medical, and legal matters associated with research and development, especially in the area of life sciences.


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■ The Committee for Research with Synchrotron Radiation elected **Professor Dr. Jan-Dierk Grunwaldt**, Institute for Technical Chemistry and Polymer Chemistry, as its chairperson.

■ **Professor Dr. Peter Gumbsch**, Institute for Applied Materials, was elected member of the selection committee for the Gottfried Wilhelm Leibniz Program of German Research Foundation until the end of 2027.


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■ **Dr. Frederik Haase**, Institute of Functional Interfaces, received a Liebig Grant from the Chemical Industry Fund.

■ **Dr. Amir-Abbas Haghighirad**, Institute for Quantum Materials and Technologies, and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.

■ President **Professor Dr.-Ing. Holger Hanselka** received the Made in Baden Award 2021 of Baden industry in the category of science and research.

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■ **Professor Dr. Andrea Hartwig**, Institute for Applied Biosciences, was appointed KIT representative and scientific member of the Expert Group High Level Roundtable on the Chemicals Strategy for Sustainability of the European Union.


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■ The German Bunsen Society for Physical Chemistry awarded the Nernst-Haber-Bodenstein Prize to **Dr. Lars Heinke**, Institute of Functional Interfaces. It is the most important prize for young physicists and chemists in Germany.


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■ **Professor Dr. Rafaela Hillerbrand**, Institute for Technology Assessment and Systems Analysis, was elected member of the National Academy of Science and Engineering (acatech).


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■ **Dr. Alexander Hinz**, Institute for Inorganic Chemistry, received the EurJIC-Wöhler-Young Investigator Prize of the Wöhler Association for Inorganic Chemistry and the European Journal of Inorganic Chemistry (EurJIC).

■ **Professor Dr. Thomas Hirth**, Vice-President for Transfer and International Affairs, was elected Deputy President of EUCOR – The European Campus for three years by the Assembly of the Boards of the member universities.


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■ **Professor Dr. Marlis Hochbruck**, Institute for Applied and Numerical Mathematics, was elected member of the Senate Committee for Strategic Projects of Leibniz Association for a term of four years.


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■ Professor Dr. Margarete Mühlleitner and **Professor Dr. Ulrich Husemann**, Institute of Experimental Particle Physics, were appointed members of the expert committee for the upcoming funding period starting in July 2021 by the German Federal Ministry of Education and Research. Ulrich Husemann, who is now in his second term of office, was elected co-chairperson of this renowned body.


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■ In addition, **Ulrich Husemann** was re-elected member of the executive council of the German Physical Society in the university section.

■ **Professor Dr. Jürgen Janek**, Institute of Nanotechnology, Scientific Director of the joint laboratory BELLA of KIT and BASF SE, and Head of a research group at the University of Gießen, and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.


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■ **Nikolaos Karastathis**, Institute for Astroparticle Physics, received the Award for the Best Contributed Talk for his presentation "Simulations of radio emission from air showers with CORSIKA 8" at the 37th International Cosmic Ray Conference.

■ **Professor Dr. Peter Knippertz**, Institute of Meteorology and Climate Research, and two other researchers of KIT were selected for the Henriette Herz Scouting Program by Alexander von Humboldt Foundation. As Humboldt scouts, they can now propose up to three talented researchers from abroad for a Humboldt Research Fellowship.


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■ **Professor Dr. Oliver Kraft**, Vice-President for Research, is member of the newly established council for technological sovereignty. This body of the Federal Ministry of Education and Research took up work on September 1, 2021 and will develop recommendations to strengthen the technological sovereignty of Germany and the European Union in central technological fields.


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■ **Professor Dr. Ulrike Krewer**, Institute for Applied Materials, and two other members of KIT were appointed elected members of the advisory board "Batterieforschung Deutschland" (battery research in Germany) by the Federal Ministry of Education and Research.

■ **Professor Dr. Harald Kunstmann**, Institute of Meteorology and Climate Research and Professor for Regional Climate and Hydrology at the University of Augsburg, received the 2021 Water Resources Prize of Rüdiger Kurt Bode Foundation for his work linking atmosphere/climate research and water research.


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■ In addition, **Harald Kunstmann** was appointed founding director of the new Center for Climate Resilience of the University of Augsburg.

■ **Monika Landgraf**, Strategic Corporate Development and Communications Business Unit and Press Officer of KIT, was re-elected member of the Board of the Federal University Communication Association.


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■ The Federal Ministry for Economic Affairs and Climate Action appointed **Professor Dr. Gisela Lanza**, wbk Institute of Production Science, member of the advisory board of the National Metrology Institute for a term of five years.


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■ In addition, **Gisela Lanza** was elected deputy scientific spokesperson by the research council of the Industry 4.0 platform.

■ **Dr. Kathrin Menberg**, Institute of Applied Geosciences, was awarded a Margarete von Wrangell Habilitation Grant by the State of Baden-Württemberg.

■ **Matthias Mohs**, Institute of Concrete Structures and Building Materials and Materials Testing and Research Institute Karlsruhe, received the 2021 Young Scientist Award of the Association of Materials Testing Institutes for his master's thesis "Experimentelle Methoden zur Untersuchung der Dauerhaftigkeit von Arbeitsfugen in Betonbauwerken" (experimental methods to study durability of construction joints in concrete structures).

■ Soroptimist Club Karlsruhe granted the 2021 Erna Scheffler Sponsorship Award to **Dr. Gabriela Molinar** for her doctoral thesis "Machine Learning Tool for Transmission Capacity Forecasting of Overhead Lines based on Distributed Weather Data" written at KIT's Institute for Information Processing Technology.


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■ **Professor Dr. Margarete Mühlleitner**, Institute for Theoretical Physics, and Professor Dr. Ulrich Husemann were appointed members of the expert committee for the upcoming funding period starting in July 2021 by the Federal Ministry of Education and Research.


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■ The Baden-Württemberg Ministry of Science, Research, and the Arts appointed **Professor Dr. Jörn Müller-Quade**, Institute of Information Security and Dependability, member of the Council of Karlsruhe University of Education.


271

■ **Professor Dr. Hermann Nirschl**, Institute for Mechanical Process Engineering and Mechanics, received the Hans Rumpf Medal of the DECHEMA Association for Chemical Engineering and Bioengineering for his outstanding research in the area of mechanical process engineering.

■ In February 2021, **Dr. Andreas Nürnberg** and Dr. Ivan Shvetsov, both from the Institute of Experimental Particle Physics, received the CMS Award 2020 of the international Compact Muon Solenoid collaboration at CERN in Geneva for their outstanding contributions to the CMS project.

■ **Dr. Peter Oberle**, Institute for Water and River Basin Management, was appointed member of the Steering Committee for Flood Risk Management of the State of Baden-Württemberg.

■ The Joachim Reutter Prize 2021 of the Gips-Schüle Foundation went to **Dr. Oliver Parodi** and his research group Sustainability and Transformation of the Society at the Institute for Technology Assessment and Systems Analysis for their real-world lab project "District Future – Urban Lab."


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■ In addition, the BNE University Network Baden-Württemberg honored **Oliver Parodi** and three other members of KIT for their course "Frühlingstage der Nachhaltigkeit" (sustainability spring days) with the University Education for Sustainable Development Prize.

■ **Professor Dr. Stefano Passerini**, Director of the Helmholtz Institute Ulm, and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.


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■ The presentation "Ultra-fast line-camera KALYPSO for fs-laser-based electron beam diagnostics" about the development of an innovative and operable radiation diagnostics instrument by doctoral researcher **Meghana M. Patil**, Institute for Beam Physics and Technology, received the IBIC'21 Conference Award.

■ At the virtual conference "Advanced Nanoparticle Generation and Excitation by Lasers in Liquids" in Hefei, China, the Fojtik-Henglein Prize was granted to **Dr. Anton Plech**, Institute for Photon Science and Synchrotron Radiation, and Professor Leonid Zhigilei (University of Virginia) for the experimental investigation and theoretical modeling of ablation and fragmentation.

■ **Professor Dr. Holger Puchta**, Botanical Institute, and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.


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■ **Dr. Gabriel Rau**, Institute of Applied Geosciences, received the Hermann Credner Prize of the German Society for Geosciences.

■ The BNE University Network Baden-Württemberg honored **Anne-Sophie Risse**, ZAK I Centre for Cultural and General Studies, and three other members of KIT for their course "Frühlingstage der Nachhaltigkeit" (sustainability spring days) with the University Education for Sustainable Development Prize.

■ **Dr. Janna Ruhland**, wbk Institute of Production Science, received the sponsorship award from the Arbeitgeberverband Südwestmetall for her doctoral thesis "Prozessmodellierung des Fünf-Achs-Nadelwickelns zur Implementierung einer trajektorienbasierten Drahtzugkraftregelung" (modeling of five-axial needle winding to implement trajectory-based wire pull force control).


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■ The University of Cambridge appointed **Professor Dr. Wilhelm Schabel**, Institute of Thermal Process Engineering, an Edwards Fellow. This honor is associated with regular research stays as a guest professor at the University.


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■ **Leona Schmidt-Speicher** received the Erna Scheffler Sponsorship Award 2021 of the Soroptimist Club Karlsruhe for her master's thesis "Herstellung, Untersuchung und Parametrisierung von bakteriziden Nanostrukturen am Beispiel von Titan und Silizium" (production, investigation, and parameterization of bactericidal nanostructures with titanium and silicon being used as examples) written at the Institute of Microstructure Technology.

■ **Professor Dr. Volker Schulze**, wbk Institute of Production Science, was elected Member of the Board of the Heat Treatment and Materials Technology Association.


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■ In February 2021, Dr. Andreas Nürnberg and **Dr. Ivan Shvetsov**, both from the Institute of Experimental Particle Physics, received the CMS Award 2020 of the International Compact Muon Solenoid collaboration at CERN in Geneva for their outstanding contributions to the CMS project.

■ **Dr. Frank G. Schröder**, Institute for Astroparticle Physics and University of Delaware, was granted a Sloan Research Fellowship, one of the most renowned recognitions of early-career researchers in the USA and Canada.


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■ **Laura Spitzmüller**, Institute of Applied Geosciences, was granted the 2020 Sparkasse Environmental Award for her master's thesis "Entwicklung eines element-spezifischen Fällungsprozesses zur Reduktion der Siliziumdioxidkonzentration im Vorfeld der Rohstoffextraktion aus geothermalen Fluiden" (development of an element-specific precipitation process to reduce silicon dioxide concentration prior to the extraction of resources from geothermal fluids). The award was handed over in summer 2021.

■ **Professor Dr. Alexandros Stamatakis**, Institute of Theoretical Informatics and Head of a research group at the Heidelberg Institute for Theoretical Studies (HITS), and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.


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■ For his continuous work at the Helmholtz Incubator, **Professor Dr. Achim Streit**, Steinbuch Centre for Computing, was granted the Helmholtz Incubator Needle of Honor by the Helmholtz Association.

■ **Dr. Gudrun Thäter**, Institute for Applied and Numerical Mathematics, was elected Member of the Board of the German Mathematical Society for a term of four years.


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■ **Professor Dr. Mehdi Tahoori**, Institute of Computer Engineering, and his team received the Best Paper Award from the IEEEE Circuit and System Society for a method to detect trojans.


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■ **Dr. Sandra Trautwein**, Institute of Sports and Sports Science, was awarded the Karl Feige Prize by the Association for Sports Psychology in Germany for her outstanding dissertation project.

■ In accordance with the articles of association, **Professor Dr. Dorothea Wagner** was reelected Chairperson of the Council of Science and Humanities after one year. She has been one of its members since 2015. She was Deputy Chairperson of the Council's Scientific Commission from 2019 to 2020.


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■ **Professor Dr. Ludwig Wappner,** Institute of Design and Construction Engineering, started to chair the Urban Design Council of the City of Mannheim in January 2021.

■ In addition, **Ludwig Wappner** has chaired the Board of the Schelling Architecture Foundation in Karlsruhe since January 2021.

■ **Professor Dr. Alexander Wanner**, KIT Vice-President for Higher Education and Academic Affairs, was elected Spokesperson of the Steering Group of the University Network for Digitalization in Academic Education in Baden-Württemberg.


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■ **Professor Dr. Martin Wegener**, Institute of Applied Physics, Institute of Nanotechnology, and Spokesperson of the Cluster of Excellence "3D Matter Made to Order," and six other KIT scientists are among "Highly Cited Researchers." This international ranking of researchers, whose publications are cited most frequently worldwide, is published by the Web of Science Group.

■ **Professor Dr. Marion Weissenberger-Eibl**, Institute for Entrepreneurship, Technology Management, and Innovation, was included in the list of the 100 most influential women in German industry in 2020 by the manager magazine and Boston Consulting Group.


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■ **Dr. Jannik Wilhelm**, Institute of Meteorology and Climate Research, was granted the 2021 Sparkasse Environmental Award for his doctoral thesis "Einfluss atmosphärischer Umgebungsbedingungen auf den Lebenszyklus konvektiver Zellen in der Echtzeit-Vorhersage" (influence of atmospheric ambient conditions on the lifecycle of convective cells in real-time forecasting).

■ **Dr. Philip Willke**, Physikalisches Institut, received the 2022 Gaede Prize of the German Physical Society for his outstanding experimental work to study single electron and nuclear spins by means of electron spin resonance of single atoms on surfaces.


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■ In addition, **Philip Willke** was honored as early-stage researcher of the year 2021 by academics. This honor is granted to early-stage researchers, who have advanced their scientific discipline with their research achievements and have additionally shown an exemplary and voluntary commitment to science.

■ **Dr. Thomas Windmann**, Conflict Management and Psychosocial Counseling Staff Unit, was elected Member of the Board of the Federal Mediation Association by the assembly of members in September 2021.


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■ **Dr. Simon Woska**, Institute of Applied Physics, received the Emerging Researcher Best Paper Prize 2020 from the Optical Materials Express Journal.

■ **Dr. Alik Ismail Zadeh**, Institute of Applied Geosciences, was selected as a Distinguished Lecture Series Speaker of the American Geophysical Union's College.

■ **Swenja Zaremba**, ZAK | Centre for Cultural and General Studies, was selected Fellow 2022 of Thomas Mann House in November 2021. This recognition is associated with a 3-month stay at the former home of Thomas Mann in Los Angeles.

■ **Dr. Walter Zürn**, Black Forest Observatory Schiltach, was granted the Paul Melchior Medal on the occasion of the 19th International Symposium on Geodynamics and Earth Tide. The Medal is granted every four years to outstanding researchers having vast expertise and profound influence in tidal research.

Institutions

■ The startup **ARCUS Greencycling Technologies**, licensee of a pyrolysis technology developed at the Institute for Technical Chemistry, won second place at the 2021 Lothar Späth Award Competition for its materials recycling solution.


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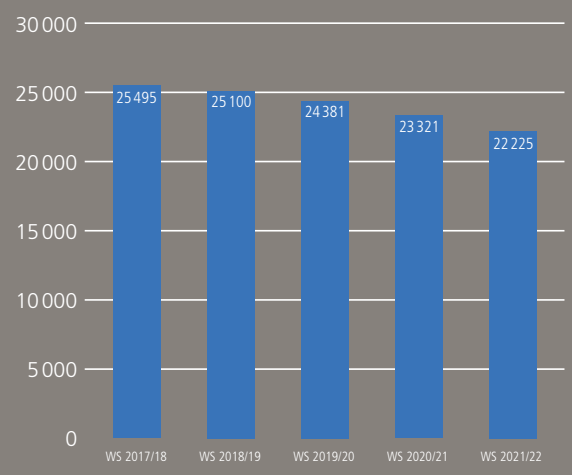
■ The winners of the chemPLANT students competition of creative young process engineers of VDI Society Chemical and Process Engineering come from KIT. The winning team Lukas Richter, Paul Neugebauer, Phillip Beeskow, and Jonas Jaske with their team leader Tom Poppe convinced the jury of the digital Thermodynamics Colloquium with their **chemSACK** concept for recycling a garbage bag typical of a fictitious big city.

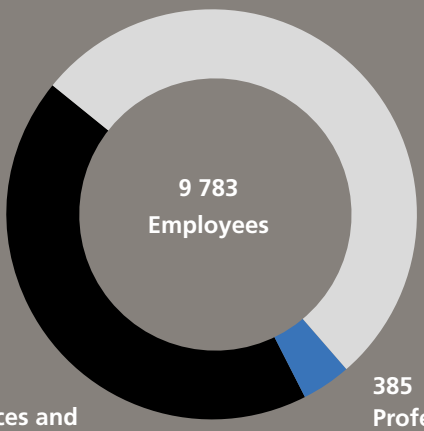
■ **Glassomer GmbH**, Freiburg, won one of two third places at the 2021 Lothar Späth Award Competition, for its granular materials developed in cooperation with KIT and other partners. The materials are used to produce glass components by injection molding.

FACTS AND FIGURES

Number of students



Employees 2021

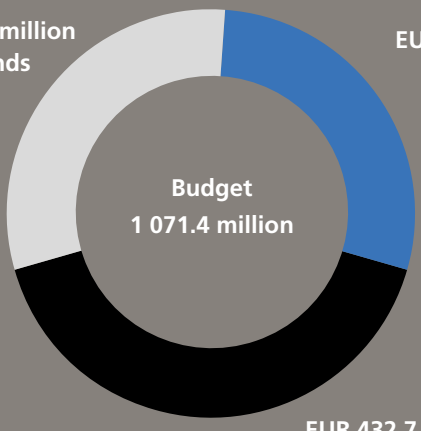


5 171
Higher education and research

385
Professors

4 227
Services and infrastructure

Total budget 2021



EUR 333.7 million
federal funds

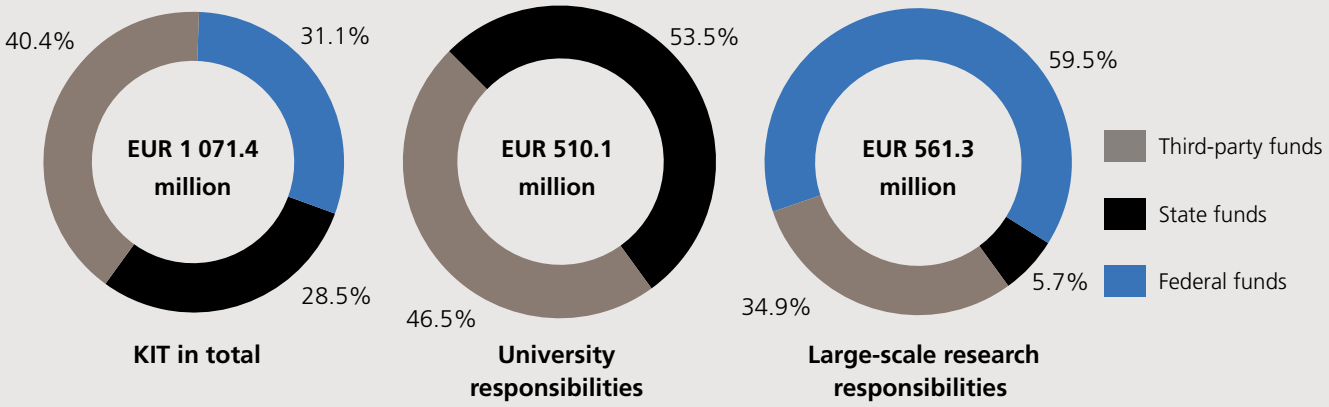
EUR 305.0 million
state funds

EUR 432.7 million
third-party funds

Content

FUNDING

Federal, State, and Third-party Funds Acquired



Sources of Funding

KIT in Total

In million euros	2017	2018	2019	2020	2021
Income in total	901.7	880.9	951.3	955.8	1 071.4
Third-party funds	358.7	338.0	369.7	388.4	432.7
State funds	255.4	263.0	271.4	278.5	305.0
Federal funds	287.6	279.9	310.2	288.9	333.7

University Responsibilities

In million euros	2017	2018	2019	2020	2021
Income in total	445.9	440.3	466.7	480.4	510.1
Third-party funds	218.7	206.5	224.4	230.9	237.0
State funds	227.2	233.8	242.3	249.5	273.1
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	455.8	440.6	484.6	475.4	561.3
Third-party funds	140.0	131.5	145.3	157.5	195.7
State funds	28.2	29.2	29.1	29.0	31.9
Federal funds	287.6	279.9	310.2	288.9	333.7

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	2017	2018	2019	2020	2021
Third-party funding in total	358.7	338.0	369.7	388.4	432.8
Third-party funding by DFG, incl. CRC	52.9	51.4	59.9	53.6	63.9
Third-party funding by EU	30.0	25.2	28.5	30.9	26.5
Third-party funding by Fed. and State	140.9	129.2	142.6	169.1	195.0
Other income	134.9	132.2	138.7	134.8	147.5

University Responsibilities*

In million euros	2017	2018	2019	2020	2021
Third-party funding in total	218.7	206.5	224.4	230.9	237.0
Third-party funding by DFG, incl. CRC	41.4	42.9	45.1	41.3	47.1
Third-party funding by EU	11.9	9.6	11.0	11.9	8.6
Third-party funding by Fed. and State	93.6	83.0	91.2	105.9	108.2
Other income	71.8	71.0	77.1	71.8	73.1

* 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	2017	2018	2019	2020	2021
Third-party funding in total	140.0	131.5	145.3	157.5	195.8
Third-party funding by DFG, incl. CRC	11.5	8.5	14.8	12.3	16.8
Third-party funding by EU	18.1	15.6	17.5	19.0	17.8
Third-party funding by Fed. and State	47.3	46.2	51.4	63.2	86.8
Other income	63.1	61.2	61.6	63.0	74.4

Use of Funds

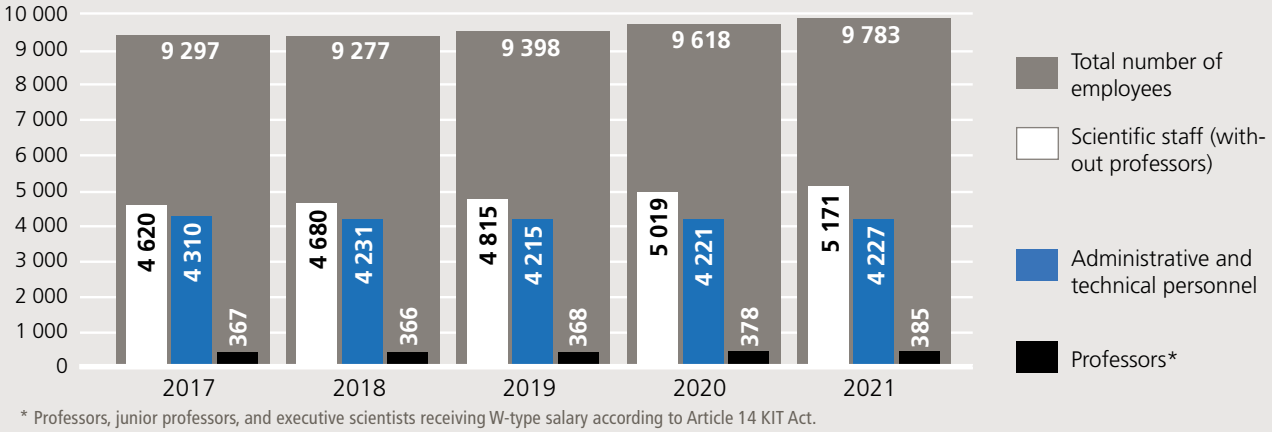
In million euros	KIT in Total	University Responsibilities*	Large-scale Research Responsibilities
Expenses in total	1 071.4	510.1	561.3
Investments in total	131.2	50.6	80.6
of these, major investments	27.1	0.0	27.1
of these, ongoing investments	104.1	50.6	53.5
Personnel expenses	662.8	374.3	288.5
Material expenses	277.4	85.2	192.2

* Figures taken from the financial statement corrected by cost items not relevant to expenses (e.g. provisions).

PERSONNEL INFORMATION

KIT Staff in Total

Staff (headcount)	2017	2018	2019	2020	2021
Total number of employees	9 297	9 277	9 398	9 618	9 783
of these, female employees	3 447	3 454	3 553	3 636	3 754
Professors*	367	366	368	378	385
of these, female professors	49	51	54	59	63
of these, junior professors	7	9	11	17	24
of these, female junior professors	2	3	3	5	8
of these, international professors	36	39	43	44	46
of these, endowed professors	9	7	6	10	9
Scientific staff (without professors)	4 620	4 680	4 815	5 019	5 171
of these, female scientists	1 244	1 255	1 317	1 385	1 478
of these, staff financed from third-party funds	2 408	2 421	2 446	2 543	2 614
of these, international employees	990	1 035	1 135	1 240	1 359
of these, employment contracts of limited duration	3 585	3 612	3 737	3 925	4 049
of these, part-time employees	1 530	1 587	1 605	1 634	1 638
Administrative and technical personnel	4 310	4 231	4 215	4 221	4 227
of these, female staff	2 154	2 148	2 182	2 192	2 213
of these, staff financed from third-party funds	753	785	751	679	713
of these, international employees	205	212	223	237	246
of these, employment contracts of limited duration	965	894	845	859	876
of these, part-time employees	1 110	1 101	1 149	1 172	1 169
of these, trainees and students of Baden-Württemberg Cooperative State University	432	396	371	370	367
of these, female trainees and students	152	154	140	140	136
Trainees' share in the total number of employees [%]	5	4	4	4	4



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

Habilitations

	2017	2018	2019	2020	2021
Total	20	7	12	9	14
Men	19	7	10	7	12
Women	1	0	2	2	2

Appointments to W-3 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Jasmin Aghassi-Hagmann, Division V	Elektronische Bauelemente und Systeme in zukünftigen Technologien	Offenburg University of Applied Sciences
Prof. Dr. Philipp Dietsch, Division IV	Ingenieurholzbau und Baukonstruktion	University of Innsbruck
Prof. Dr. Torben Ferber, Division V	Experimentelle Teilchenphysik	Deutsches Elektronen-Synchrotron DESY
Prof. Dr. Mário Franca, Division IV	Wasserbau und Wasserwirtschaft	TU Delft
Prof. Dr. Steffen Freitag, Division IV	Baustatik	University of Bochum
Prof. Dr. Christian Greiner, Division III	Additiv hergestellte Bauteile und Mikrostrukturdesign	KIT
Prof. Dr. Markus Klute, Division V	Experimentelle Teilchenphysik	Massachusetts Institute of Technology
Prof. Dr. Ann-Kristin Kupfer, Division II	Dienstleistungsmanagement	University of Münster
Prof. Dr. Riccardo La Magna, Division IV	Tragwerksplanung und Konstruktives Entwerfen	str.ucture GmbH
Prof. Dr. Alexander Lytchak, Division V	Algebra/Geometrie	University of Cologne
Prof. Dr. Senja Post, Division II	Wissenschaftskommunikation mit dem Schwerpunkt Wirkung/Transfer	University of Göttingen
Prof. Dr. Alexander Stark, Division IV	Massivbau	H+P Ingenieure GmbH
Prof. Dr. Hans Henning Stutz, Division IV	Bodenmechanik und Grundbau	Aarhus University
Prof. Dr. Mathias Trabs, Division V	Mathematische Stochastik	Universität Hamburg

PERSONNEL INFORMATION

Appointment to W-1 University Professor at KIT

Name, division	Professorship	Previous employer institution
Jun. Prof. Dr. Hartwig Anzt, Division II	Fixed-Point Numerical Algorithms	KIT
Tenure-track Prof. Moritz Dörstelmann, Division IV	Digital Design and Fabrication	FibR GmbH
Tenure-track Prof. Dr. Schirin Hanf, Division I	Fundamentale Anorganische Chemie: Nachhaltige Nutzung von Metallen	hte GmbH
Tenure-track Prof. Dr. Christoph Klahn, Division I	Prozessintensivierung in der Verfahrenstechnik durch Additive Fertigung	inspire AG
Tenure-track Prof. Dr. Julia Maibach, Division III	Grenzflächenprozesse	KIT
Tenure-track Prof. Dr. Ulrich Wilhelm Paetzold, Division III	Next Generation Photovoltaics	KIT
Tenure-track Prof. Dr. Nevena Tomašević, Division IV	Allgemeine Geologie	University of Tübingen

Appointments to Apl. Professor and Honorarprofessor

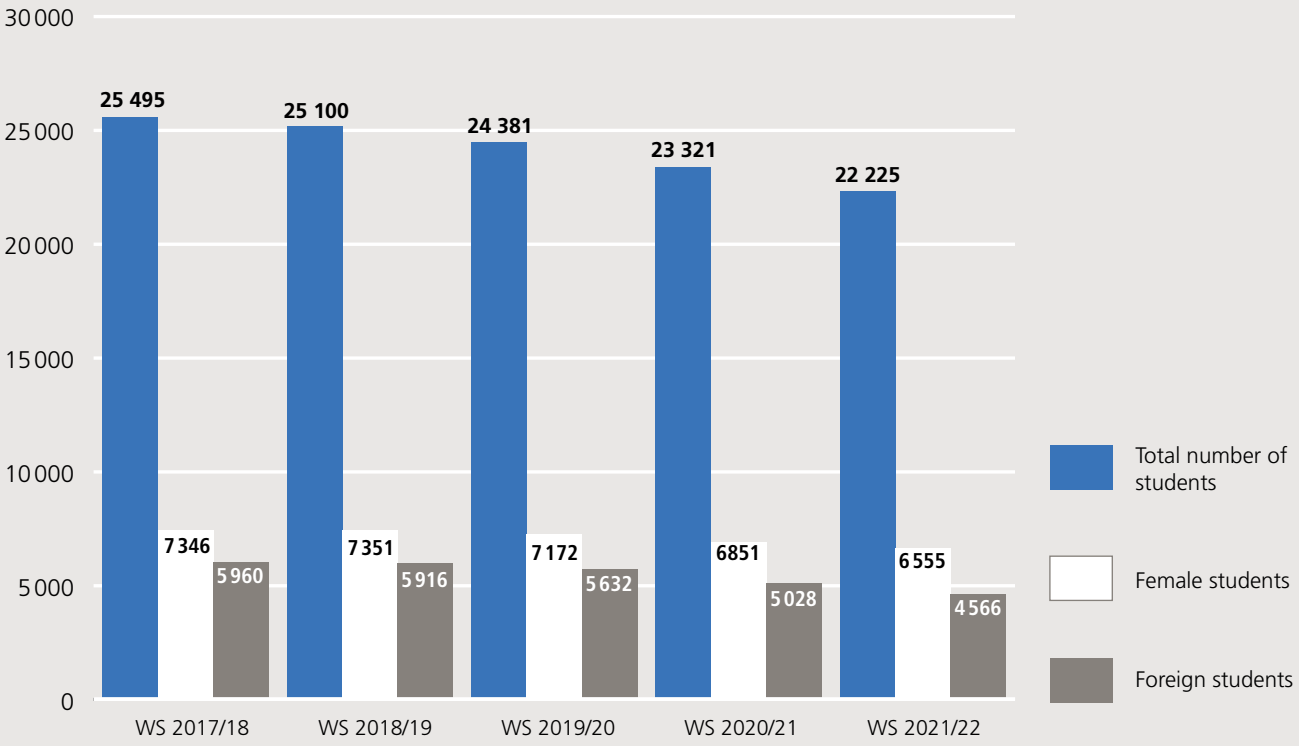
Name	Type	KIT department	Division
Prof. Dr. Katja Emmerich	Apl. Professor	BGU	Division IV
Prof. Dr. Werner Finger	Honorarprofessor	ARCH	Division IV
Prof. Dr. Gerhard Ruben Geerling	Honorarprofessor	MACH	Division III
Prof. Dr. Holger Jacob-Friesen	Honorarprofessor	ARCH	Division IV
Prof. Dr. Alexandre Kostka	Honorarprofessor	ARCH	Division IV
Prof. Dr. Jörg Matthes	Apl. Professor	MACH	Division III
Dr. Sven Spieckermann	Honorarprofessor	WIWI	Division II
Prof. Dr. Andreas-Neil Unterreiner	Apl. Professor	CHEMBIO	Division I
Prof. Dr. Moritz Werling	Apl. Professor	MACH	Division III

Emeriti/Retirements

Name	KIT Institute	Division
Prof. Dr. Hans Joachim Blaß	Research Center for Steel, Timber, and Masonry	Division IV
Prof. Dr. Dagmar Gerthsen	Laboratory of Electron Microscopy	Division V
Prof. Dr. Peter Gratzfeld	Institute of Vehicle System Technology	Division III
Prof. Dr. Frank Herrlich	Institute for Algebra and Geometry	Division V
Prof. Dr. Thomas Müller	Institute of Experimental Particle Physics	Division V
Prof. Dr. Franz Nestmann	Institute for Water and River Basin Management	Division IV
Prof. Matthias Pfeifer	Institute of Design and Construction Engineering	Division IV
Prof. Dr. Clemens Posten	Institute of Process Engineering in Life Sciences	Division I
Prof. Dr. Lothar Stempniewski	Institute of Concrete Structures and Building Materials	Division IV
Prof. Dr. Joachim Vogt	Institute of Regional Science	Division IV
Prof. Dr. Werner Wagner	Institute for Structural Analysis	Division IV
Prof. Dr. Dieter Zeppenfeld	Institute for Theoretical Physics	Division V

STUDENTS

Students in Total



Students and Desired Degrees

Desired degree	WS 2017/18	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22
Bachelor	14 129	13 810	13 495	13 086	12 454
Master	9 424	9 313	8 955	8 548	8 089
Teacher (secondary and vocational schools)	872	918	952	964	960
Doctorate	475	457	441	355	325
State examination	14	6	0	0	0
Diploma	57	50	32	22	4
Studienkolleg	207	214	185	148	114
No degree*	317	332	321	198	279
Total	**25 495**	**25 100**	**24 381**	**23 321**	**22 225**

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

Allocation of Students to Subject Groups

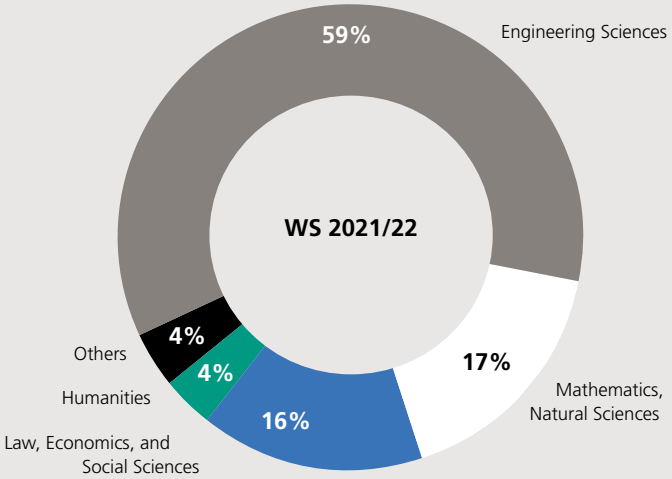
Subject group	WS 2017/18	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22
Engineering Sciences	15 671	15 303	14 729	14 025	13 170
Mathematics, Natural Sciences	4 225	4 156	4 042	3 933	3 851
Law, Economics, and Social Sciences	3 854	3 835	3 833	3 678	3 571
Humanities	872	889	877	830	818
Others	873	917	900	855	825
Total	**25 495**	**25 100**	**24 381**	**23 321**	**22 225**

Allocation of Foreign Students* to Subject Groups

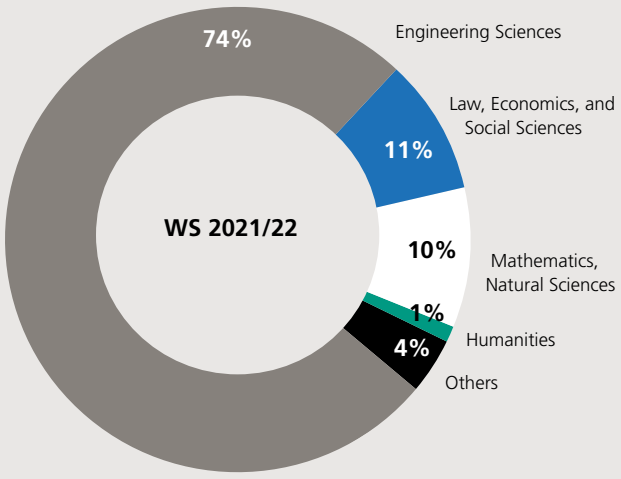
Subject group	WS 2017/18	WS 2018/19	WS 2019/20	WS 2020/21	WS 2021/22
Engineering Sciences	4 674	4 565	4 267	3 819	3 400
Mathematics, Natural Sciences	447	473	507	472	445
Law, Economics, and Social Sciences	527	515	529	487	486
Humanities	81	79	78	61	57
Others	231	284	251	189	178
Total	**5 960**	**5 916**	**5 632**	**5 028**	**4 566**

*Foreign students: Not of German nationality

Allocation of Students to Subject Groups

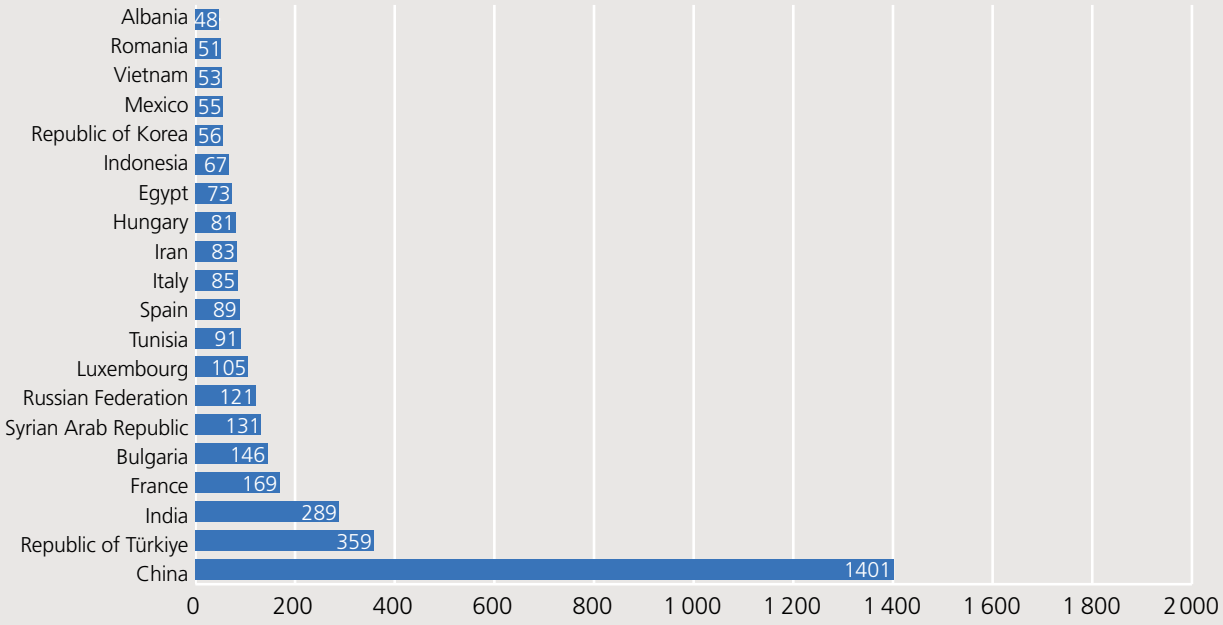


Allocation of Foreign Students to Subject Groups



STUDENTS

Home Countries of Foreign Students (Top 20 of 127)

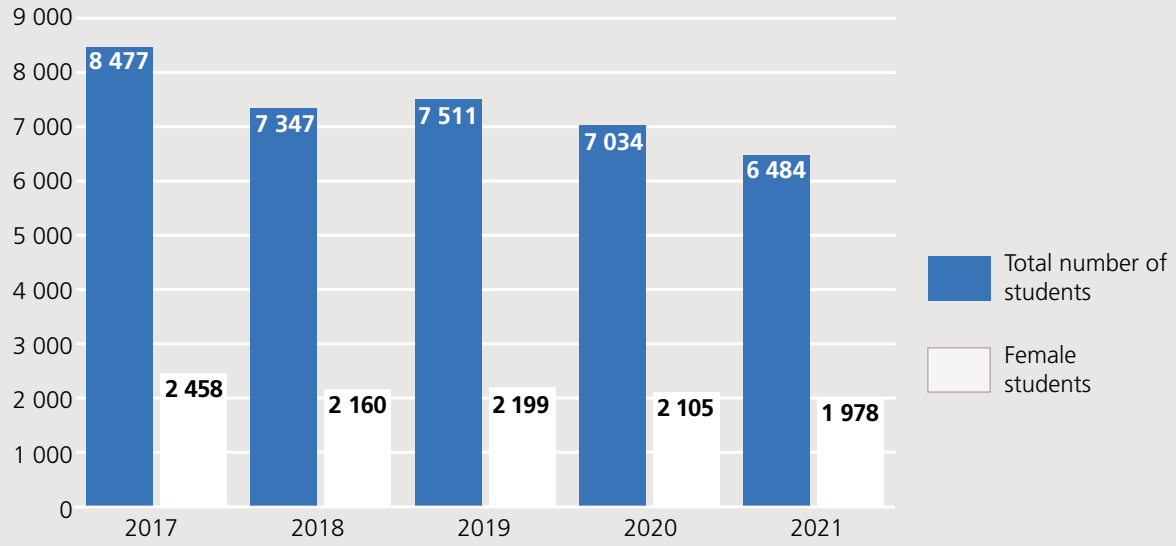


Student Beginners and Degrees Targeted in the 1st Semester*

Desired degree	2017	2018	2019	2020	2021
Bachelor	4 551	4 076	4 038	3 935	3 454
Master	3 390	2 765	2 924	2 602	2 596
Bachelor's degree in teaching at secondary schools	175	223	213	185	173
Bachelor's degree in teaching at vocational schools	37	28	16	17	12
Master's degree in teaching at secondary schools	0	0	33	50	83
Master's degree in teaching at vocational schools	8	15	27	22	22
Studienkolleg	316	240	260	223	144
Total	**8 477**	**7 347**	**7 511**	**7 034**	**6 484**

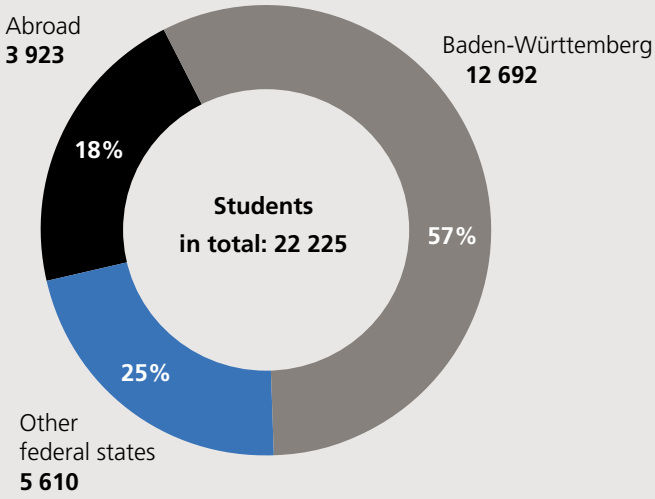
*Without doctoral students and exchange students, who do not aim at a degree at KIT.

Number of Student Beginners in the 1st Semester*



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

Origin of Students in the 2021/22 Winter Semester*

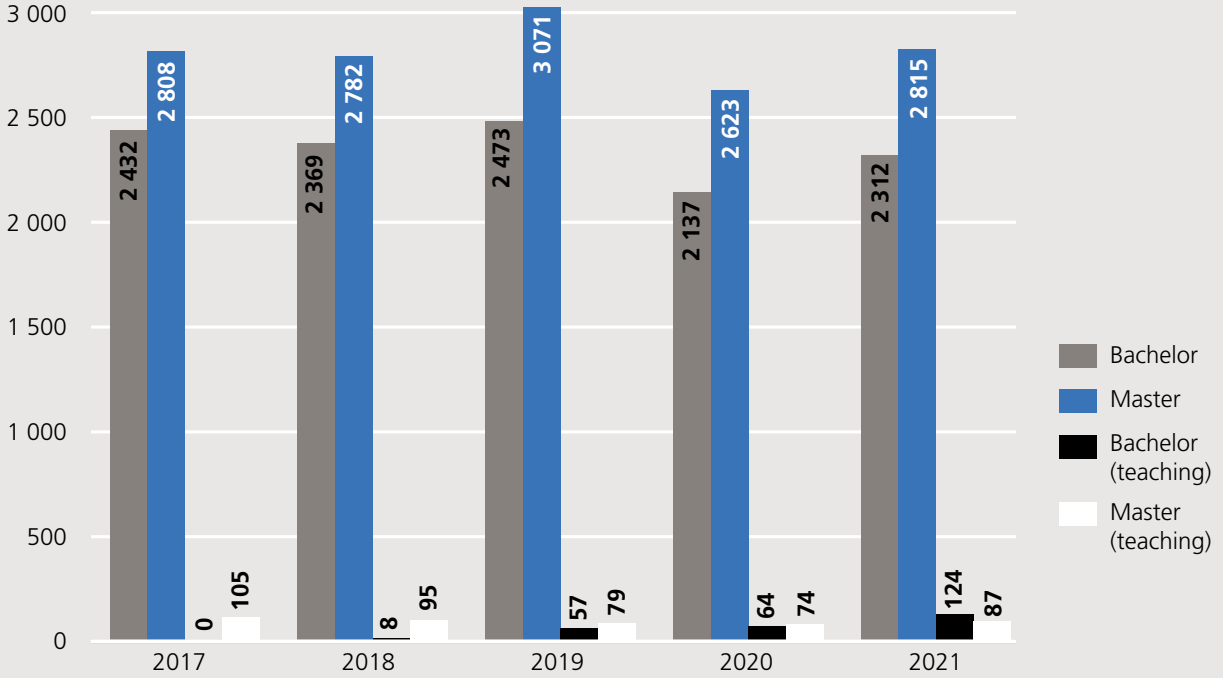


*Place of acquisition of university entrance qualification.

Region	Students
Karlsruhe city and district	3 623
Karlsruhe Regional Council District	3 509
Rest of Baden-Württemberg	5 561
Baden-Württemberg in total	12 692
Rhineland-Palatinate	1 719
Bavaria	965
Hesse	840
North Rhine-Westphalia	836
Lower Saxony	363
Other federal states	887
Germany without Baden-Württemberg	5 610
Asia	2 206
Europe	1 129
Africa	234
America	344
Australia and Oceania	10
Abroad	3 923
KIT in total	22 225

STUDENTS

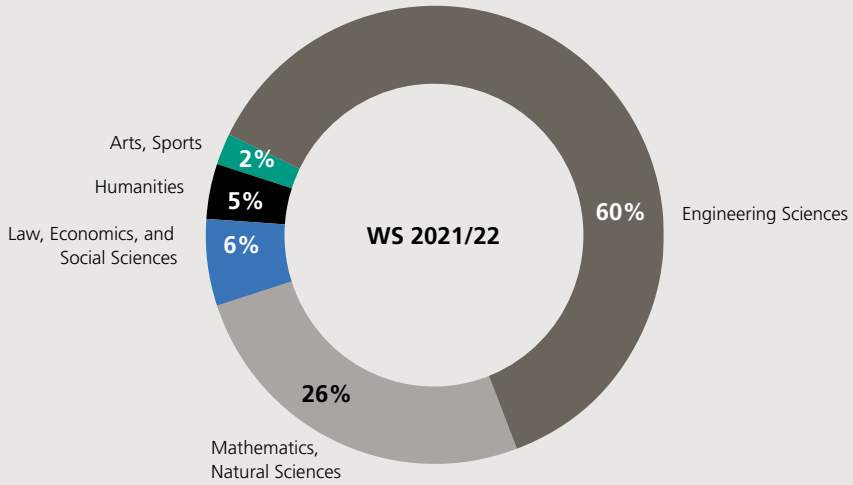
Number of Graduates*



* The number of graduates in 2021 is not yet final.

Doctoral Candidates in the Different Subject Groups

Subject group	Male	Female	Non-binary	Total
Engineering Sciences	1 485	408	1	1 894
Mathematics, Natural Sciences	479	355		834
Law, Economics, and Social Sciences	134	69		203
Humanities	66	86		152
Arts, Sports	33	36		69
Total	**2 197**	**954**	**1**	**3 152**



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)*
Informatik	●	●	●		Doppelmaster Informatik *(Institut National Polytechnique Grenoble, France)*
Information Systems Engineering and Management				●	
Management of Product Development				●	
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)*

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

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
					German-French Bachelor's and Master's Program *(École Polytechnique Paris, Palaiseau, France)* 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
Mechanical Engineering (International)	●				
Materialwissenschaft und Werkstofftechnik	●	●			
Mechatronik und Informationstechnik	●	●			*German-Bulgarian Double Degree B.Sc. (Technical University of Sofia, Bulgaria)*
Mobilität und Infrastruktur		●			
Mobility Systems Engineering and Management				●	
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		●			
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	●	●	●		German-French Bachelor's and Master's Program *(École Polytechnique Paris, Palaiseau, France)*
Meteorologie und Klimaphysik/ Meteorology and Climate Physics	●	●			
Physik	●	●	●		German-French Double Master *(Université Grenoble Alpes, France)* German-French Bachelor's and Master's Program *(École Polytechnique Paris, Palaiseau, 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

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. Kirill Melnikov, Institute for Theoretical Particle Physics	2019 – 2022
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

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 of KIT with KIT Being the Coordinating University

Number	Title	Spokesperson	Duration
FOR 1650	Dislocation-based Plasticity	Prof. Dr. Peter Gumbsch, Institute for Applied Materials	2011 – 2021
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

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 refers to the complete project. Partial projects at KIT may deviate.

Collaborative Research Centers with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
SFB TRR 88/3	Kooperative Effekte in homo- und heterometallischen Komplexen (3MET)	Prof. Dr. Gereon Niedner-Schatteburg, TU Kaiserslautern (Spokesperson) Prof. Dr. Manfred Kappes, Institute of Physical Chemistry and Institute of Nanotechnology, KIT	2011 – 2022
SFB TRR 89/3	Invasives Rechnen (InvasIC)	Prof. Dr. Jürgen Teich, Friedrich-Alexander-Universität, Erlangen-Nürnberg (Spokesperson) Prof. Dr. Jörg Henkel, Institute of Computer Engineering, KIT	2010 – 2022
SFB TRR 150/2	Turbulent chemisch reagierende Mehrphasenströmungen in Wandnähe	Prof. Dr. Andreas Dreizler, TU Darmstadt (Spokesperson) Prof. Dr. Olaf Deutschmann, Institute for Chemical Technology and Polymer Chemistry, KIT	2015 – 2022

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➔ Collaborative Research Centers with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
SFB TRR 165/2	Waves to Weather: Wellen, Wolken, Wetter	Prof. Dr. George C. Craig, LMU München Prof. Dr. Volkmar Wirth, JGU Mainz Prof. Dr. Peter Knippertz, Institute of Meteorology and Climate Research, 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 (Spokesperson) Prof. Dr. Jairo Sinovar, JGU Mainz Prof. Dr. Jörg Schmalian, Institute for Theoretical Condensed Matter Physics, KIT	2020 – 2024

The typical budget approved for a Collaborative Research Center / Transregio Project amounts to about EUR 1 to 3 million per year of duration.
The duration refers to the complete project. Partial projects of 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 (Spokesperson) Prof. Dr. Olaf Deutschmann, Institute for Chemical Technology and Polymer Chemistry, KIT Prof. Dr. Ulrich Maas, Dr. Robert Schießl, Institute of Technical Thermodynamics, KIT	2013 – 2022
FOR 2063	The Epistemology of the Large Hadron Collider	Prof. Dr. Gregor Schiemann, Bergische Universität Wuppertal (Spokesperson) Prof. Dr. Rafaela Hillerbrand, Institute for Technology Assessment and Systems Analysis, KIT	2016 – 2022
FOR 2083	Integrierte Planung im öffentlichen Verkehr	Prof. Dr. Anita Schöbel, Technische Universität Kaiserslautern (Spokesperson) Prof. Dr. Dorothea Wagner, Institute of Theoretical Informatics, KIT	2015 – 2021
FOR 2290	Understanding Intramembrane Proteolysis	Prof. Dr. Dieter Langosch, Technische Universität München (Spokes-person) Dr. Claudia Muhle-Goll Institute for Biological Interfaces, KIT	2015 – 2021

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➔ DFG-funded Research Units with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
FOR 2325	Interactions at the Neurovascular Interface	Prof. Dr. Ralf H. Adams, Max-Planck-Institut für molekulare Biomedizin, Münster (Spokesperson) Prof. Dr. Ferdinand le Noble, Zoological Institute, 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 (Spokesperson) Prof. Dr. Klaus Butterbach-Bahl, Institute of Meteorology and Climate Research, KIT	2016 – 2022
FOR 2397	Multiskalen-Analyse komplexer Dreiphasensysteme	Prof. Dr. Thomas Turek, Technische Universität Clausthal Prof. Dr. Ulrike Krewer Institute for Applied Materials, KIT	2016 – 2023
FOR 2589	Zeitnahe Niederschlagsschätzung und -vorhersage	PD Dr. Silke Trömel, Rheinische Friedrich-Wilhelms-Universität Bonn (Spokesperson) Dr. Christian Chwala, Institute of Meteorology and Climate Research, KIT	2018 – 2025
FOR 2730	Umweltveränderungen in Biodiversitäts-Hotspot-Ökosystemen Süd-Ecuadors: Systemantwort und Rückkopplungseffekte (RESPECT)	Prof. Dr. Nina Farwig Philipps-Universität Marburg (Spokesperson) Prof. Dr. Wolfgang Wilcke, Institute of Geography and Geoecology, 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 (Spokesperson) Prof. Dr. Corinna Hoose, Dr. Gholamali Hoshyaripour, Dr. Bernhard Vogel, Institute of Meteorology and Climate Research, KIT	2019 – 2022
FOR 2936	Klimawandel und Gesundheit in Afrika südlich der Sahara	Prof. Dr. Rainer Sauerborn, Universitätsklinikum Heidelberg (Spokesperson) Prof. Dr. Harald Kunstmann, Institute of Meteorology and Climate Research, KIT	2019 – 2022
FOR 3010	Multifunktionale, grobkörnige, refraktäre Verbundwerkstoffe und Werkstoffverbunde für großvolumige Schlüssel-Bauteile in Hochtemperaturprozessen	Prof. Dr. Christos Aneziris, TU Bergakademie Freiberg (Spokesperson) Dr. Torben Boll, Prof. Dr. Martin Heilmaier, Prof. Dr. Michael Hoffmann, Dr. Peter Franke, Prof. Dr. Hans Jürgen Seifert, Dr. Susanne Wagner Institute for Applied Materials, KIT	2020 – 2023

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.

RESEARCH

ERC Grants

Name, institute, division	Title of group	Duration
Dr. Christian Greiner, Institute for Applied Materials, Division III	ERC Consolidator Grant TriboKey – Deformation Mechanisms are the Key to Understanding and Tayloring Tribological Behaviour	09/2018 – 08/2024
Prof. Dr. Corinna Hoose, Institute of Meteorology and Climate Research, Division IV	ERC Starting Grant C2Phase – Closure of the Cloud Phase	04/2017 – 09/2023
Prof. Dr. Christian Koos, Institute of Photonics and Quantum Electronics, 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 and Dr. Benno Meier, Institute of Microstructure Technology, Division III Institute for Biological Interfaces, Division I	ERC Synergy Grant Highly Informative Drug Screening by Overcoming NMR Restrictions	01/2021 – 12/2026
Prof. Dr. Holger Puchta, Botanical Institute, Division I	ERC Advanced Grant CRISBREED – Multidimensional CRISPR/Cas Mediated Engineering of Plant Breeding	10/2017 – 09/2022
Prof. Dr. Peter Sanders, Institute of Theoretical Informatics, Division II	ERC Advanced Grant ScAlBox – Engineering Scalable Algorithms for the Basic Toolbox	01/2020 – 08/2025
Prof. Dr. Laurent Schmalen, Communications Engineering Lab, Division III	ERC Consolidator Grant Reinventing Energy Efficiency in Communication Networks	06/2021 – 05/2026
Dr. Frank Schröder, Institute for Astroparticle Physics, Division V	ERC Starting Grant PeV-Radio – Digital Radio Detectors for Galactic PeV Particles	02/2019 – 01/2024
Dr. Tonya Vitova, Institute for Nuclear Waste Disposal, 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. Frank Biedermann, Institute of Nanotechnology, Division V	In vitro und in vivo Sensing von (Bio)organischen Analyten mit neuartigen Hoch-Affinitätsrezeptoren	10/2016 – 09/2021
Dr. Manuel Hinterstein, Institute for Applied Materials, Division III	BNT-BT als zukünftige bleifreie Funktionswerkstoffe für PTCR-, Aktor- und Sensoranwendungen	04/2016 – 03/2022
Dr. Alexander Hinz, Institute for Inorganic Chemistry, 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
Prof. Dr. Rudolf Lioutikov, Institute for Anthropomatics and Robotics, Division II	Intuitive Robot Intelligence: Efficiently Learning and Improving of Explainable Skills and Behaviors for Intuitive Human-Robot Interaction	04/2021 – 03/2023
Dr. Nadine Katrin Rühr, Institute of Meteorology and Climate Research, Division IV	Wälder aus der Balance: Die Auswirkungen von Dürre und Baumsterben auf den Kohlenstoff- und Wasserkreislauf (Fortführung 2)	10/2016 – 09/2021
Dr. Belina von Krosigk, Institute for Astroparticle Physics, 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
Dr. Philip Willke, Physikalisches Institut, Division V	Quantenkohärente Kontrolle atomarer und molekularer Spins auf Oberflächen	10/2020 – 09/2026
Dr. Karsten Woll, Institute for Applied Materials, Division III	Gepulste Metallurgie an metallischen Dünnschichten	01/2017 – 12/2022

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

BMBF Junior Research Groups

Name, institute, division	Title of group	Duration
Dr. Simon Fleischmann, Helmholtz Institute Ulm, Division I	InfinBat: Zwischenschicht-funktionalisierte Materialien für neuartige elektrochemische Interkalationsbatterien	11/2021 – 10/2026
Tenure-track Prof. Dr. Julia Maibach, Institute for Applied Materials, Division III	InSEIde – Künstliche SEI: Grenzflächen in Lithium-Ionen Batterien verstehen und manipulieren	09/2017 – 09/2022

The total budget of a group typically ranges from EUR 1.5 to 3.2 million.

RESEARCH

Helmholtz Young Investigators Groups

Name, institute, division	Title of group	Duration
Jun. Prof. Dr. Hartwig Anzt, Steinbuch Centre for Computing Division II	Fixed-Point Methods for Numerics at Exascale (FiNE)	05/2017 – 04/2022
Dr. Anna Böhmer, Institute for Quantum Materials and Technologies, Division V	Strain Tuning of Correlated Electronic Phases	10/2017 – 09/2022
Dr. Tom Brown, Institute for Automation and Applied Informatics, Division III	New Methodologies to Master Complexity in Energy System Optimisations	04/2018 – 04/2021
Dr. Giovanni De Carne, Institute for Technical Physics, Division III	Hybrid Networks: a multi-modal design for the future energy system	07/2021 – 06/2026
Dr. Christian Grams, Institute of Meteorology and Climate Research, Division IV	Sub-seasonal atmospheric predictability:understanding the role of diabatic outflow	10/2017 – 09/2022
Dr. Emma Järvinen, Institute of Meteorology and Climate Research, Division IV	Solving the Cirrus Cloud Puzzle – Do Cirrus Warm or Cool Our Climate?	04/2020 – 03/2026
Dr. Martina Klose, Institute of Meteorology and Climate Research, Division IV	A big unknown in the climate impact of atmospheric aerosol: Mineral soil dust	11/2020 – 10/2026
Dr. Benno Meier, Institut für Institute for Biological Interfaces, Division I	Hyperpolarized Magnetic Resonance	03/2019 – 02/2025
Tenure-track Prof. Dr. Ulrich Wilhelm Paetzold, Institute of Microstructure Technology, Division III	Nanophotonics for Perovskite/Silicon Multijunction Solar Cells	05/2016 – 05/2022
Dr. Manuel Tsotsalas, Institute of Functional Interfaces, Division I	Hierarchically Structured Biomaterials	01/2016 – 12/2021

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

Young Investigators Group

Name, institute, division	Title of group	Duration
Dr. Luise Kärger, Institute of Vehicle System Technology, Division III	Gewichtsoptimierte Fahrzeugstrukturen durch maß-geschneiderte Hochleistungsfaserverbunde (funded by the Vector Foundation)	07/2014 – 12/2021

The annual budget typically amounts to EUR 80,000 plus a non-recurrent investment allowance of EUR 50,000.

Industry Fellowship (IF)

Name, institute, division	Title of group	Duration
Dr. Nicole Stricker, wbk Institute of Production Science, Division III	Robuste Produktionstechnik	07/2019 – 08/2021
Dr. Frederik Zanger, wbk Institute of Production Science, 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-Nachwuchsgruppen (Junior Research Groups) and Funding Measures

Name, institute, division	Title of group	Duration	Funding
Dr. Claudia Bizzarri, Institute of Organic Chemistry, Division I	Künstliche Photosynthese	12/2021 – 08/2023	CRC/TRR and others
Dr. Dominic Bresser, Helmholtz Institute Ulm, Division I	Neuartige Elektrodenmaterialien für Wiederaufladbare Elek-tro-chemische Energiespeicher (NEW E²)	05/2017 – 04/2023	Vector Foundation
Dr. Azad M. Emin, Institute of Process Engineering in Life Sciences, Division I	Extrusion of Biopolymeric Systems	08/2016 – 07/2022	DFG and others
Dr. Benjamin Flavel, Institute of Nanotechnology, Division V	Carbon Nanotube based Solar Cells	11/2018 – 05/2021	DFG
Dr. Robert Heinrich, Institute for Program Structures and Data Organization, Division II	Quality-driven System Evolution	03/2018 – 02/2022	MWK and BMBF

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➔ Other Recognized KIT-Nachwuchsgruppen (Junior Research Groups) and Funding

Name, institute, division	Title of group	Duration	Funding
Dr. Daniel Hoang, Institute for Finance, Banking, and Insurance, Division II	Unternehmensfinanzierung	10/2016 – 12/2021	DFG, Funk Foundation
Dr. Sebastian Käfer, Institute of Applied Informatics and Formal Description Methods, Division II	Knowledge Graph-based Artificial Intelligence Systems	02/2021 – 10/2023	BMBF
Dr. Mathias Krause, Institute for Applied and Numerical Mathematics 2 / Institute for Mechanical Process Engineering and Mechanics, Divisions V and III	Lattice Boltzmann Research Group	05/2018 – 04/2024	DFG and others
Dr. Sebastian Lerch, Institute of Economics – Econometrics, Division II	Artificial Intelligence for Probabilistic Weather Forecasting	05/2021 – 03/2025	Vector Foundation
Dr.-Ing. Axel Loewe, Institute of Biomedical Engineering, Division III	Computational Cardiac Modelling	11/2018 – 06/2021	DFG and MWK
Dr. Rainer Mandel, Institute for Analysis, Division V	Nichtlineare Helmholtzgleichungen	05/2017 – 06/2022	Junior research group within a CRC
Dr. Claudia Niessner, Institute of Sports and Sports Science, Division II	Health Related Fitness and Physical Mobility in Children, Youth and Young Adulthood	12/2021 – 04/2024	MWK and others
Dr. Zbigniew Pianowski, Institute of Organic Chemistry, Division I	Chemical Biology, Supramolecular Systems and Prebiotic Chemistry	11/2021 – 04/2022	DFG own position
Dr. Ioan M. Pop, Physikalisches Institut, Division V	Sofja Kovalevskaja-Preis	10/2015 – 09/2021	Sofja Kovalevskaja Prize of the Humboldt Foundation
Dr. Somidh Saha, Institute for Technology Assessment and Systems Analysis, Division II	Sylvanus	08/2019 – 12/2024	BMBF and others
Dr. Thomas Sheppard, Institute for Chemical Technology and Polymer Chemistry, Division I	X-ray Microscopy in Catalysis	02/2020 – 06/2022	BMBF and others

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➔ Other Recognized KIT-Nachwuchsgruppen (Junior Research Groups) and Funding

Name, institute, division	Title of group	Duration	Funding
Dr. Ulrike van der Schaaf, Institute of Process Engineering in Life Sciences, Division I	Interfacial properties of pectin-based biopolymers	10/2020 – 10/2022	German Federation of Industrial Research Associations
Dr. Barbara Verfürth, Institute for Applied and Numerical Mathematics, Division V	Numerical analysis of multiscale methods	02/2021 – 05/2024	CRC
Dr. Penelope Whitehorn, Institute of Meteorology and Climate Research, Division IV	Climate change and land-use impacts on European bumblebee populations	02/2020 – 03/2021	Baden-Württemberg Foundation and others
Dr. Ruming Zhang, Institute for Applied and Numerical Mathematics, Division V	Waves in Periodic Structures	05/2021 – 01/2023	DFG Individual Research Grant

Junior Professorships

Name, institute, division	Area	Duration
Jun. Prof. Dr. Hartwig Anzt, Steinbuch Centre for Computing, Division II	Fixed Point Numerical Algorithms	11/2021 – 10/2027
Tenure-track Prof. Dr. Thomas Bläsius, Institute of Theoretical Informatics, Division II	Skalierbare Algorithmik und Verfahren für große Datenmengen	10/2020 – 09/2026
Jun. Prof. Dr. Andreas Ch. Braun, Institute of Regional Science, Division IV	Risikoorientierte Regionalentwicklung	11/2021 – 05/2022
Tenure-track Prof. Moritz Dörstelmann, Institute of Design and Construction Engineering, Division IV	Digital Design and Fabrication	04/2021 – 03/2027
Tenure-track Prof. Dr. Yolita Eggeler, Laboratory of Electron Microscopy, Division V	Elektronenmikroskopie	10/2020 – 09/2026
Tenure-track Prof. Dr. Pascal Friederich, Institute of Theoretical Informatics, Division II	KI-Methoden in der Materialwissenschaft	12/2019 – 12/2025
Tenure-track Prof. Dr. Schirin Hanf, Institute for Inorganic Chemistry, Division I	Fundamentale Anorganische Chemie: Nachhaltige Nutzung von Metallen	11/2021 – 10/2027

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➔ Junior Professorships

Name, institute, division	Area	Duration
Tenure-track Prof. Dr. Lennart Hilbert, Zoological Institute, Division I	Systembiologie/Bioinformatik	10/2018 – 09/2022
Tenure-track Prof. Dr. Christoph Klahn, Institute for Mechanical Process Engineering and Mechanics, Division I	Prozessintensivierung in der Verfahrenstechnik durch Additive Fertigung	05/2021 – 05/2027
Tenure-track Prof. Dr. Britta Klopsch, Institute for Vocational Education and General Education, Division II	Schulpädagogik	04/2020 – 03/2026
Tenure-track Prof. Dr. Fabian Krüger, Institute of Economics, Division II	Empirische Wirtschaftsforschung	10/2019 – 10/2022
Tenure-track Prof. Dr. Xian Liao, Institute for Analysis, Division V	Analysis Partieller Differentialgleichungen	11/2018 – 11/2022
Jun. Prof. Dr. Claudio Llosa Isenrich, Institute for Algebra and Geometry, Division V	Geometrie	10/2020 – 09/2026
Jun. Prof. Dr. Reza Maalek, Institute for Technology and Management in Construction, Division IV	Digital Engineering and Construction	11/2020 – 10/2026
Tenure-track Prof. Dr. Julia Maibach, Institute for Applied Materials, Division III	Keramische Werkstoffe	11/2021 – 10/2027
Jun. Prof. Dr. Franziska Mathis-Ullrich, Institute for Anthropomatics and Robotics, Division II	Medizinrobotik	04/2019 – 04/2025
Tenure-track Prof. Dr. Katharina Scherf, Institute for Applied Biosciences, Division I	Bioaktive und funktionelle Lebensmittelinhaltsstoffe	08/2019 – 07/2025
Jun. Prof. Dr. Matti Schneider, Institute of Engineering Mechanics, Division III	Computational Micromechanics	09/2021 – 08/2023
Tenure-track Prof. Dr. Helge Sören Stein, Institute of Physical Chemistry, Division I	Angewandte Elektrochemie	06/2020 – 05/2026
Tenure-track Prof. Dr. Julian Thimme, Institute for Finance, Banking, and Insurance, Division II	Finanzierung	08/2019 – 07/2025

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➔ Junior Professorships

Name, institute, division	Area	Duration
Tenure-track Prof. Dr. Nevena Tomašević Institute of Applied Geosciences, Division IV	Allgemeine Geologie	04/2021 – 03/2027
Tenure-track Prof. Dr. Ulrich Wilhelm Paetzold, Light Technology Institute, Division III	Next Generation Photovoltaics	03/2021 – 02/2027
Jun. Prof. Dr. Ingo Wagner, Institute for School Pedagogy and Didactics, Division II	MINT-Fachdidaktik im Bereich der Fächer Sport und Mathematik oder Physik	10/2018 – 09/2022
Tenure-track Prof. Dr. Christian Wressnegger, Institute of Information Security and Dependability, Division II	KI-Methoden in der IT-Sicherheit	12/2019 – 11/2025

Graduate Schools Funded by the DFG or Helmholtz Association

Graduate School	Funded by	Spokesperson / participant	Duration
Graduate School "Electrochemical Energy Storage"	DFG	Prof. Dr. Jürgen Behm, Universität Ulm (Spokesperson) apl. Prof. Christine Kranz, Universität Ulm (Co-spokesperson) Prof. Dr. Rolf Schuster, Institute of Physical Chemistry, KIT (Co-spokesperson)	2019 – 2025
HEiKA Graduate School "Functional Materials"	DFG	Prof. Dr. Martin Wegener, Institute of Applied Physics / Institute of Nanotechnology, KIT (Spokesperson) Prof. Dr. Uwe Bunz, Universität Heidelberg (Co-spokesperson)	2019 – 2025
Graduiertenschule für Klima und Umwelt (GRACE)	HGF	Prof. Dr. Stefan Hinz, Institute of Photogrammetry and Remote Sensing, KIT	2011 – 2022

RESEARCH

Research Training Groups Funded by the DFG or Helmholtz Association

Research Training Group	Funded by	Spokesperson / participant	Duration
Molekulare Architekturen für die fluoreszente Bildgebung von Zellen	DFG	Prof. Dr. Hans-Achim Wagenknecht, Institute of Organic Chemistry	2015 – 2024
Integrierte Entwicklung kontinuierlich-diskontinuierlich langfaserverstärkter Polymerstrukturen	DFG	Prof. Dr. Thomas Böhlke, Institute of Engineering Mechanics Together with: University of Waterloo, University of Western Ontario, University of Windsor (all Canada)	2015 – 2024
Energiezustandsdaten – Informatik-Methoden zur Erfassung, Analyse und Nutzung	DFG	Prof. Dr. Klemens Böhm, Institute for Program Structures and Data Organization	2016 – 2025
Asymptotische Invarianten und Limiten von Gruppen und Räumen	DFG	Prof. Dr. Roman Sauer, Institute for Algebra and Geometry Together with: Prof. Dr. Anna Wienhard, Mathematisches Institut, Ruprecht-Karls-Universität Heidelberg	2016 – 2025
Simulation mechanisch-elektrisch-thermischer Vorgänge in Lithium-Ionen-Batterien	DFG	Prof. Dr. Thomas Wetzel, Institute of Thermal Process Engineering	2017 – 2021
Tailored Scale-Bridging Approaches to Computational Nanoscience	DFG	Prof. Dr. Marcus Elstner, Institute of Physical Chemistry	2019 – 2023
MatCom-ComMat: Materials Compounds from Composite Materials for Applications in Extreme Conditions	DFG	Prof. Dr. Martin Heilmaier, Institute for Applied Materials	2020 – 2024
KD²School: Gestaltung von adaptiven Systemen für ökonomische Entscheidungen	DFG	Prof. Dr. Christof Weinhardt, Institute of Information Systems and Marketing	2021 – 2026
Helmholtz International Research School for Astroparticle Physics and Enabling Technologies (HIRSAP)	HGF	Prof. Dr. Ralph Engel, Institute for Astroparticle Physics	2018 – 2024
Helmholtz Information and Data Science School for Health (HIDSS4Health)	HGF	Prof. Dr. Ralf Mikut, Institute for Automation and Applied Informatics	2019 – 2025

Innovation

Innovation Characteristics

Year	Invention disclosures	Priority-establishing patent applications	Property rights (existing)	Royalties [million euros]	New companies (spinoffs)	Participation in spinoffs
2017	124	55	1 965	1.44	29 (10)	7
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

Establishments of New Companies

Spinoffs
Aimino Tech GmbH
askui GmbH
Chemogy GmbH
Cloudfluid GmbH
enabl Technologies UG
Mara Solutions GmbH
NeoCargo AG
Phytonics GmbH
Qinu GmbH
revoAI UG
SafeAD GmbH
SilOrix GmbH

Startups
Aam Digital GmbH (i.G.)
Aufklärwerk GbR
Black Forest AI GmbH
bliro.io GbR
Bytefabrik.AI GmbH
CarryBots GmbH

Startups
Chapp! UG
Constreo Systems UG
Daedalus GmbH
hydrop water systems GbR
Innovation Matters GbR
JuniorJob UG
KaLi. Getränkefabrik GbR
Knowunity UG
Leihzeug GbR
Luckiwi GbR
Mooz GbR
MyMUN GmbH
Optimo Gbr
patena.ai GbR
Pembe Algorithm UG
Rayny GbR
spannwerk GbR
Tofano GbR
Vivio Stressmanagement OHG

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AWARDS

External Awards

(see separate chapter of this Annual Report from page 104)

KIT Department Teaching Awards

KIT Department	Award winners
Architecture	Prof. Marc Frohn, Florian Bengert, Tim Panzer, Federico Perugini, Adrianne Wilson Wootton, Marco Zelli
Civil Engineering, Geo- and Environmental Sciences	Dr. Carmen Sandhaas
Chemistry and Biosciences	Dr. Manfred Focke
Chemical and Process Engineering	Prof. Dr. Heike Karbstein
Electrical Engineering and Information Technology	Prof. Dr. Ahmet Cagri Ulusoy
Humanities and Social Sciences	David Lohner
Informatics	Fachschaft Informatik
Mechanical Engineering	Dr. Martin Lauer
Mathematics	Maximilian Gaedtke, Marc Haußmann, Dr. Mathias J. Krause, Stephan Simonis, Dr. Gudrun Thäter
Physics	Dr. Michael Frietsch, Katharina Maurer, Dr. Achim Mildenberger
Economics and Management	Prof. Dr. Orestis Terzidis

Awards for Doctoral Researchers

KIT Doctoral Awards

Name	Institute
Dr. rer. nat. Jakob Asenbauer	Helmholtz Institute Ulm
Dr. rer. nat. Tobias Frenzel	Institute of Applied Physics
Dr.-Ing. Julia Rau	Institute for Applied Materials
Dr.-Ing. Alina Roitberg	Institute for Anthropomatics and Robotics

Other Doctoral Awards

Name	Institute	Institution
Dr.-Ing. Marion Börnhorst	Institute for Chemical Technology and Polymer Chemistry	Sponsorship Award of the Friedrich and Elisabeth Boysen Foundation
Dr.-Ing. Janna Hofmann	Institute of Production Science	Südwestmetall Sponsorship Award

MEDIA/PUBLICATIONS

Development of Visibility in the Media

	2017	2018	2019	2020 *	2021
Printed articles	20 737	20 133	24 739	17 837	20 006
Online articles	19 196	20 721	19 375	15 598	20 226

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

Publications

Publications in the year	2017	2018	2019	2020	2021
Publications of researchers of KIT	9 717	9 894	9 973	8 351	8 839
of these, books and proceedings	836	900	988	960	1 025
of these, articles in proceedings	1 390	1 437	1 336	1 038	1 219
of these, articles in journals	4 077	3 904	4 369	4 327	4 527
of these, in WoS- or Scopus-referenced journals	3 735	3 587	4 076	3 999	4 283
of these, open access articles	2 204	2 382	2 767	3 083	3 645

Rankings

National Rankings

		2017*	2018	2019	2020	2021
Wirtschaftswoche	Electrical Engineering	–	2	3	5	5
	Informatics	–	1	2	4	4
	Mechanical Engineering	–	2	3	3	4
	Natural Sciences	–	7	8	10	9
	Business Engineering	–	2	2	2	2

* In 2017, no ranking was published by Wirtschaftswoche.

International Rankings

		2017	2018	2019	2020	2021
National Taiwan University Ranking	International – Overall	211	216	228	251	249
	International – Natural Sciences	55	62	67	70	80
	International – Engineering Sciences	81	95	106	101	115
	National – Overall	19	19	19	21	20
	National – Natural Sciences	1	1	1	1	1
	National – Engineering Sciences	1	1	1	1	1
QS World University Rankings	International – Overall	107	116	124	131	136
	International – Natural Sciences	29	37	48	58	53
	International – Engineering Sciences & IT	38	51	59	68	70
	National – Overall	4	4	5	6	6
	National – Natural Sciences	3	4	3	4	3
	National – Engineering Sciences	4	4	4	4	4
Times Higher Education	International – Overall	133	135	175	201–250	180
	International – Natural Sciences	61	69	69	70	77
	International – Engineering Sciences	55	54	74	78	56
	National – Overall	14	14	20	19–23	18–20
	National – Natural Sciences	7	5	7	7	8
	National – Engineering Sciences	4	3	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	16–22	15–20	11–21	11–19	11–20

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	2017	2018	2019	2020	2021
Use of natural gas for heat/cold/power	34 234	39 940	40 187	41 644	50 141
Power consumption (according to current supplier – market-specific)	20 246	12 559	10 499	8 905	6 758
Reference power (federal power mix – site-specific)	28 598	20 102	16 316	12 691	11 191

* All CO_2-equivalent emissions, including upstream chains

Campuses South, West, East	2017	2018	2019	2020	2021
Use of natural gas for heat/cold/power	459	373	450	548	635
Power consumption (according to current supplier – market-specific)	3 024	2 970	2 808	2 150	2 021
Reference power (federal power mix – site-specific)	29 214	28 875	24 840	20 450	19 223
District heat consumption	3 520	3 780	3 479	2 911	4 312

Campus Alpine	2017	2018	2019	2020	2021
Use of natural gas for heat/cold/power	344	403	440	384	410
Power consumption (according to current supplier – market-specific)	47	37	31	25	25
Reference power (federal power mix – site-specific)	458	360	272	240	240

Energy Consumption and Energy Production of KIT

Type of energy / Campus North	2017	2018	2019	2020	2021
Primary energy consumption (natural gas)* [GWh]	138.6	161.7	162.7	168.6	203
Electricity from the public grid* [GWh]	97	82.3	78.8	76.3	68
Installed el. capacity, cogeneration/trigeneration plants [MW]	13	13	13	13	13
Electricity produced by own cogeneration/trigeneration plants [GWh]	30.1	43.2	44.1	47	58.9
Installed photovoltaics capacity [MW]	1	1	1	1.2	1.2
Electricity produced by own photovoltaics facilities [GWh]	1	1.1	0.9	0.9	1.2
Heat produced* (excluding heat for thermal refrigeration plants) [GWh]	78.9	73.1	76.6	76	83
District heating from public grid [GWh]	–	–	–	–	–

* For CN, including third institutions on campus

Type of energy / Campuses South, West, East	2017	2018	2019	2020	2021
Primary energy consumption (natural gas) [GWh]	1.86	1.51	1.82	2.22	2.57
Electricity from the public grid [GWh]	54	55	54	50	47
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]	0.61	0.48	0.59	0.72	0.83
Installed photovoltaics capacity [MW]	–	–	–	–	0.03
Electricity produced by own photovoltaics facilities [GWh]	–	–	–	–	–
Heat produced (excluding heat for thermal refrigeration plants) [GWh]	0.81	0.62	0.75	0.82	0.93
District heating from public grid [GWh]	44	45	49	41	49

Type of energy / Campus Alpine	2017	2018	2019	2020	2021
Primary energy consumption (natural gas) [GWh]	1.39	1.63	1.78	1.55	1.66
Electricity from the public grid [GWh]	0.85	0.69	0.59	0.59	0.59
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]	0.29	0.37	0.38	0.41	0.39
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
District heating from public grid [GWh]	–	–	–	–	–

Supply and Waste Management Services

Type of service / Campus North	2017	2018	2019	2020	2021
Electricity consumption KIT (excl. grid losses) [GWh]	80	79	77	74	82
Heat consumption KIT* [GWh]	41	38	40	35	42
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	40	42	42	40	38
Water supply [m³]	107 543	99 759	86 058	74 182	81 407
Compressed air generation [10^6 m³]	6.3	6.29	6.04	5.79	6.03
Wastewater disposal** [m³]	93 994	90 278	84 009	83 702	77 501
Waste disposal KIT**/*** [t]	16 455	19 978	12 370	4 664	4 073

* (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	2017	2018	2019	2020	2021
Electricity consumption KIT (excl. grid losses) [GWh]	54	55	54	50	47
Heat consumption KIT* [GWh]	44	45	49	41	49
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	44	50	51	46	44
Water supply [m³]	222 970	229 100	220 941	198 573	165 027
Waste disposal KIT**/*** [t]	955	899	1 629	1 125	1 115

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

Type of service / Campus Alpine	2017	2018	2019	2020	2021
Electricity consumption KIT (excl. grid losses) [GWh]	1.14	1.06	0.97	0.99	0.98
Heat consumption KIT* [GWh]	–	–	0.73	0.73	0.78
Heat consumption KIT (excl. grid losses, weather-adjusted) [GWh]	–	–	0.70	0.65	0.71
Water supply [m³]	817	873	932	865	605

* (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

	2017	2018	2019	2020	2021
Vehicles (centrally administrated cars, mini-buses/vans, buses, trucks, special vehicles)	n.a.	131	132	134	129
Vehicles with a combustion engine (of these, hybrid)	n.a.	125	123	114 (1)	104 (8)
Battery vehicles	n.a.	4	7	18	23
Fuel cell vehicles (H2 buses for KIT shuttle services)	n.a.	2	2	2	2
Average CO_2 emission factor of the fleet [gCO_2/km]	n.a.	167	166	147	136
Gasoline consumption of the fleet [l]	23 055	24 395	22 306	16 626	17 097
Diesel consumption of the fleet [l]	74 712	71 192	59 732	41 980	36 145
Hydrogen consumption of the fleet [kg]	6 255	4 231	5 039	1 830	6 567
Driven kilometers of the fleet	1 199 620	1 091 128	1 009 567	541 073	618 383
CO_2 emissions resulting from fuel use, including upstream chains [tCO_2 p.a.]	382	349	316	203	245

n.a. = not available

Use of Shared Cars

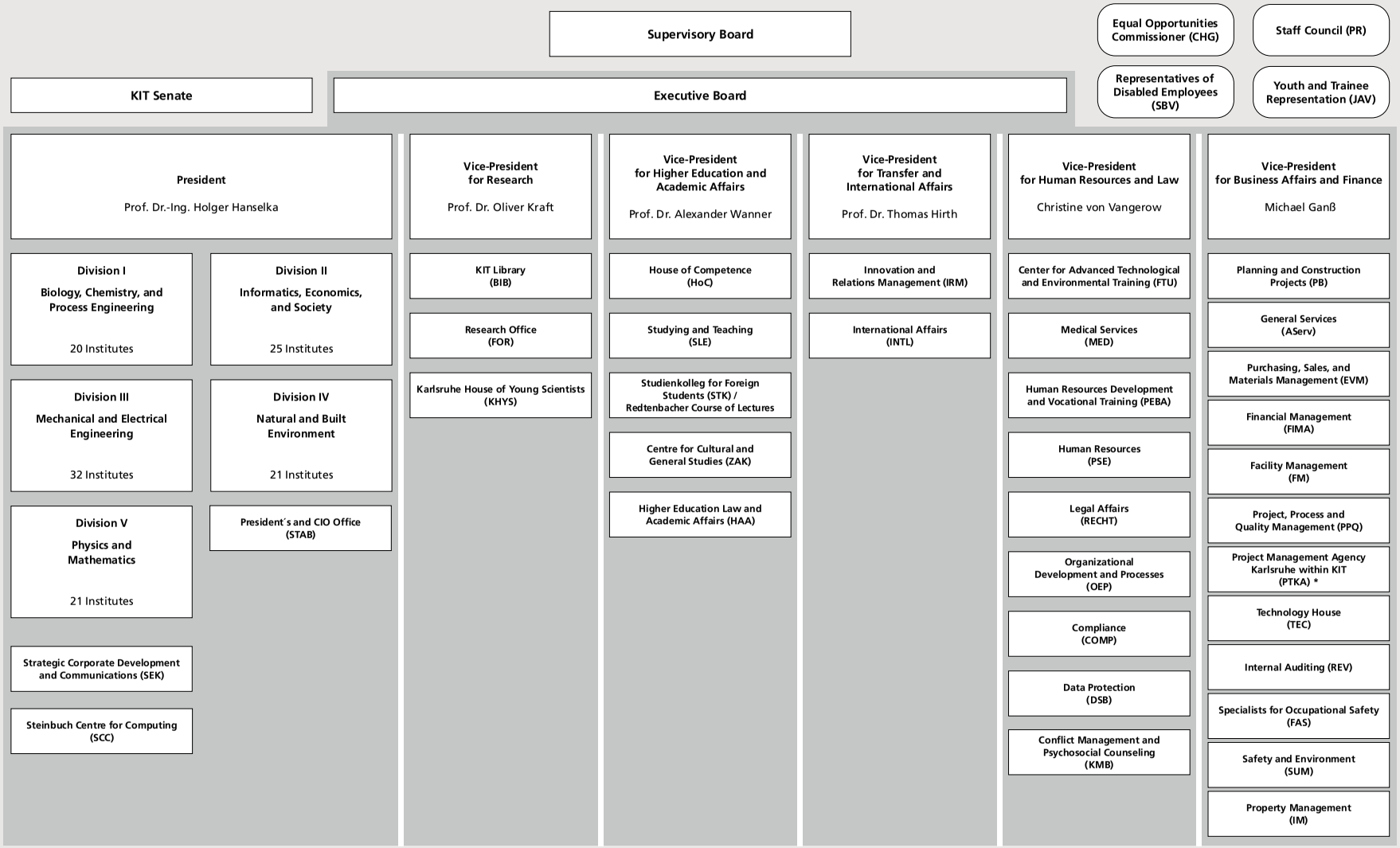
	2017	2018	2019	2020	2021
Trips	944	973	1502	887	1 496
Km	246 294	259 240	457 560	216 533	384 259
CO_2 emissions [tCO_2 p.a.]	31	33	57	27	48
Company ebikes	n.a.	n.a.	6	6	6

Areas

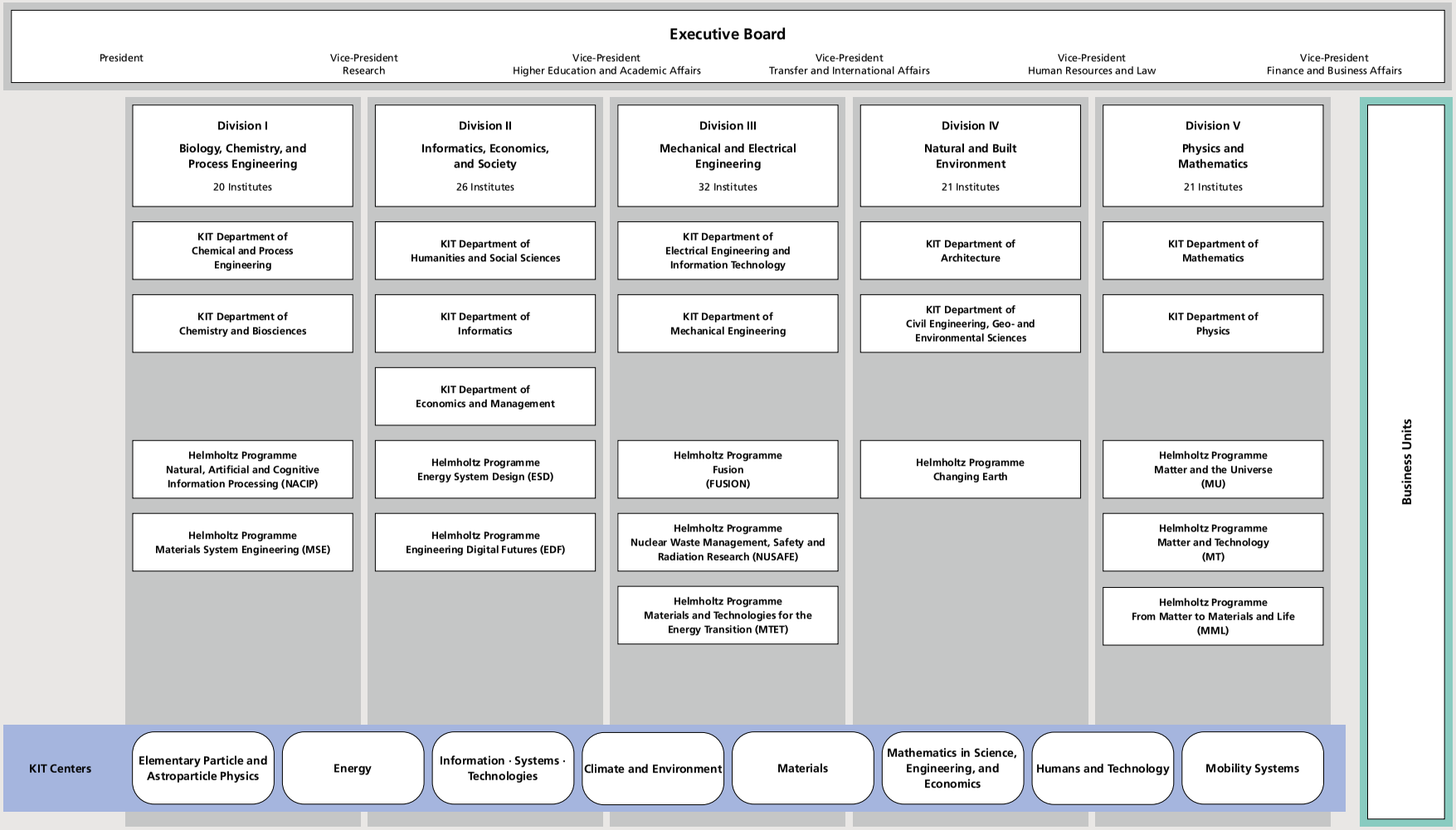
Type of area [m²]	KIT in total		Campus South*		Campus North**	
	[m²]	%	[m²]	%	[m²]	%
Office areas (including conference rooms, rooms for copiers and servers)	176 660	35.9%	102 285	34.8%	74 375	37.6%
Laboratories, workshops, experiment halls	172 374	35.1%	84 883	28.9%	87 491	44.2%
Storage and similar facilities	65 733	13.4%	37 238	12.7%	28 495	14.4%
Teaching and studies (lecture halls, seminar rooms, practice rooms)	58 042	11.8%	51 890	17.7%	6 152	3.1%
Library areas (central + decentralized libraries)	12 978	2.6%	11 641	4.0%	1 337	0.7%
Sports areas	5 922	1.2%	5 705	1.9%	217	0.1%
Total usable area	491 709	100.0%	293 642	100.0%	198 067	100.0%
of this, rented areas			19 444 m²		2 283 m²	

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

Organizational Structure



Science Organization



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