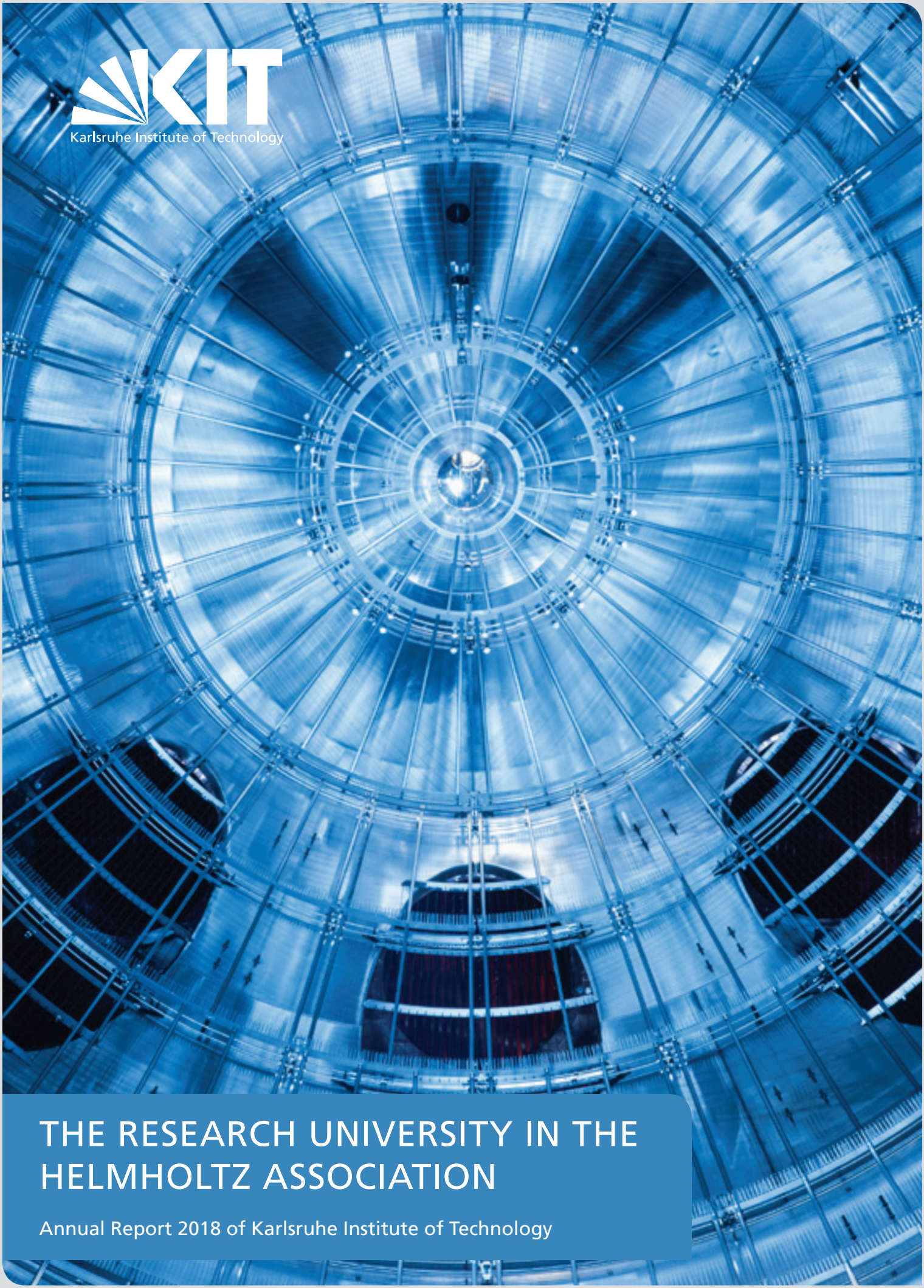


THE RESEARCH UNIVERSITY IN THE HELMHOLTZ ASSOCIATION

Annual Report 2018 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 respect, cooperation, confidence, and subsidiarity. An inspiring work environment as well as cultural diversity characterize and enrich the life and work at KIT.

Employees 2018	
Total	9,277
Teaching and research	5,046
Professors	366
Foreign scientists and researchers	1,074
Infrastructure and services	4,231
Trainees	396

Students	
Winter semester 2018/19	25,100

Budget 2018 in Million Euros	
Total	880.9
Federal funds	279.9
State funds	263.0
Third-party funds	338.0

Karlsruhe Institute of Technology – The Research University in the Helmholtz Association – stands for excellent research and outstanding academic education. It also drives innovation by making best possible use of the synergies resulting from the merger of a state university with a large, national research center nine years ago.

In our annual report, we look back on a very active year, and present to you some highlights of our work. You will read about exciting results and course-setting developments in the areas of research, teaching, and innovation. For example, Federal Minister Anja Karliczek and State Minister Theresia Bauer jointly visited the KIT to prepare concrete steps that will raise the 2009 merger to the next level. In the Excellence Strategy of the Federal Government and the Federal States, KIT was successful with two Clusters of Excellence proposals and submitted a proposal for the Universities of Excellence funding line.

We report on our newly founded KIT Center MathSEE, new standards in energy storage through the research platform CELEST, the Test Area Autonomous Driving Baden-Württemberg (TAF BW), the development of a robot helper for home care, and many other exciting projects of the researchers working at KIT. Of course, we also inform you about life at KIT. For example, we look back on the KIT Summer Festival for employees and students which took place on July 18 at Campus South. At this event, numerous organizational units and networks of KIT presented their activities and services, and young and young-at-heart guests alike enjoyed a colorful program of music, games, and entertainment.

Numerous awards and honors show that, with the help of its outstanding students, professors, and staff in research and administration, KIT is optimally prepared for a successful future.

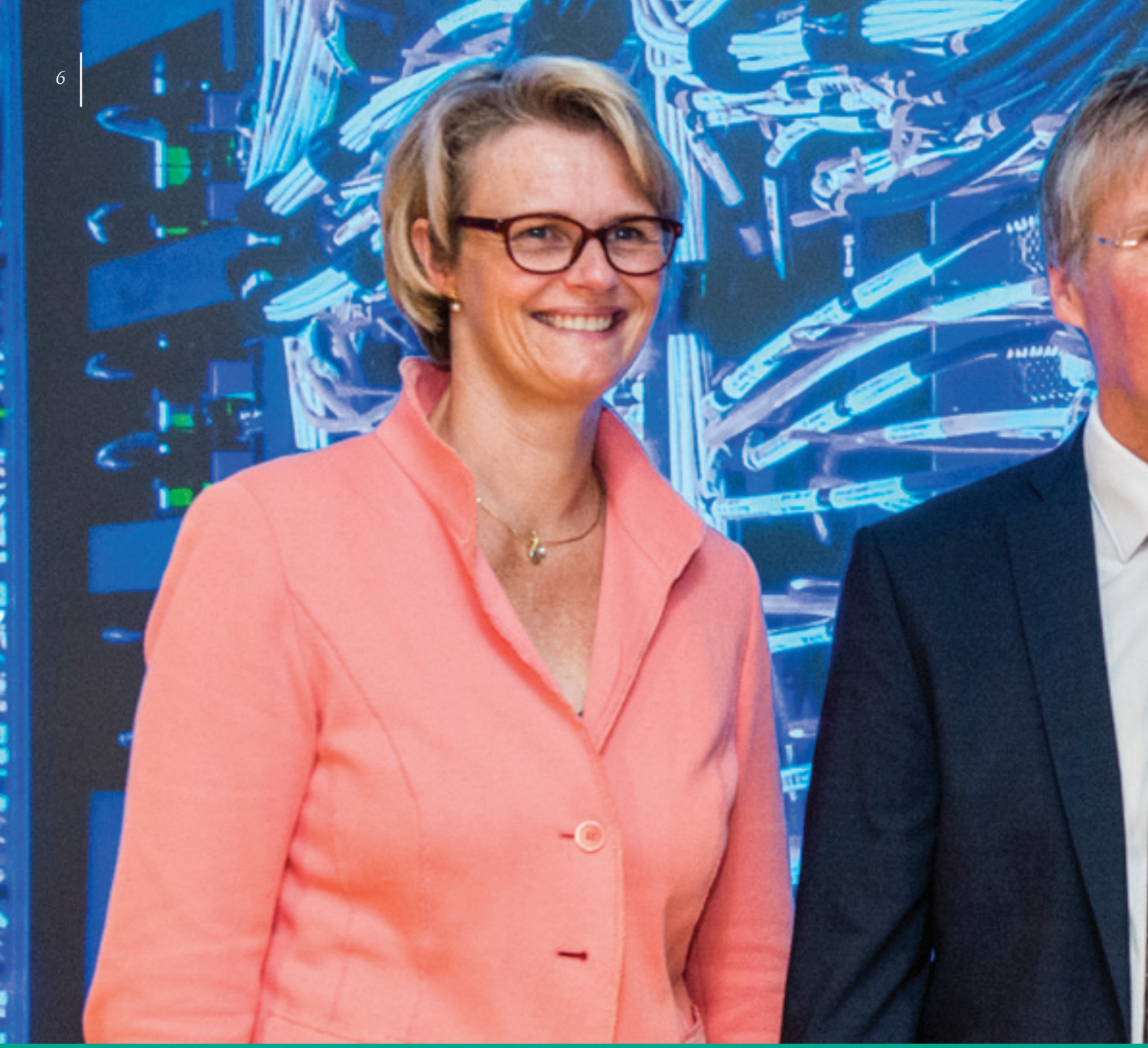
On behalf of the Executive Board of KIT, I express my sincere thanks to our political partners, our partners in research and industry, the KIT Supervisory Board, and the members of KIT for their trusting, intense, and successful cooperation last year.

I cordially invite you to take your time to read and leaf through this annual report and I hope you will enjoy looking back on KIT – The Research University in the Helmholtz Association – in 2018. May 2019 prove to be as thrilling as last year!

Enjoy reading.

Yours,

Professor Dr.-Ing. Holger Hanselka
President of KIT



A RETROSPECTIVE VIEW OF KIT

Among the many events that took place in 2018, two stood out in particular for Karlsruhe Institute of Technology - The Research University in the Helmholtz Association: the success in the first round of the Excellence Strategy of the Federal Government and the Federal States and the joint visit of the Federal Minister of Education and Research, Anja Karliczek, and the Baden-Württemberg Minister for Science, Research, and the Arts, Theresia Bauer, in the summer of 2018.

The two ministers announced additional steps to further support KIT in its operations and advance it consistently, thus raising the courageous 2009 merger to the next level.

The aim is to exploit the full potential of research, teaching, and innovation by, among other things, allowing more flexibility in the use of funds. The ministers intend to create a uniform budget for KIT in the future.

The consistent implementation of the merger strengthens the KIT in all its core tasks and enables it to contribute to the Helmholtz Association the best competencies for solving grand challenges facing society. Both ministers and President of KIT, Holger Hanselka, are convinced: "The joint and forward-looking action of the Federal and State Governments will free up resources for science that are currently tied up in the management and control of two budgets. This will benefit Karlsruhe as a science location, the innovative strength of Baden-Württemberg as a state, and top German research in an international context."

For the consistent further development of KIT, the Federal Government, the State, and KIT particularly want to address the following points: giving KIT greater flexibility in using the funds available to it, consistently involving all researchers in the program-oriented funding scheme of the Helmholtz Association, and enabling all researchers to participate in teaching on equal terms.

Excellence Strategy

KIT has successfully acquired two Clusters of Excellence in the Excellence Strategy of the Federal Government and the Federal States. The Excellence Commission selected the proposals in the fields of energy research and materials science for seven years of funding. The cluster decisions were announced in Bonn on September 27, 2018 by Anja Karliczek, Federal Minister of Education and Research and Chairwoman of the Joint Science Conference (Gemeinsame Wissenschaftskonferenz - GWK), and Professor Eva Quante-Brandt, Science Senator of the State of Bremen and Deputy Chairwoman of GWK.

The Cluster of Excellence "3D Matter Made to Order", jointly supported by KIT and the University of Heidelberg, pursues a strongly interdisciplinary approach in combining the natural and engineering sciences. The cluster focuses on three-dimensional additive manufacturing techniques - from the molecular level to macroscopic dimensions. The goal is the complete digitization of 3D manufacturing and material processing. Components and systems are to be produced, for example, by nanoprinting at the highest possible speeds and resolutions to make possible novel applications in materials and life sciences. The cluster also receives funding from the Carl Zeiss Foundation. Speakers of the cluster are Professor Martin Wegener (KIT) and Professor Uwe H. F. Bunz (Heidelberg University).

The successful implementation of the energy transition requires new materials and technologies for the storage of electricity. In the "Energy Storage Beyond Lithium" excellence cluster jointly applied for by KIT and Ulm

3D designer materials: for the further development of three-dimensional manufacturing techniques, the cluster pools know-how from the natural and engineering sciences.

Energy storage beyond lithium: innovative storage materials and technologies are essential prerequisites for the success of the energy transition.

University, scientists from the fields of electrochemistry, materials science, theoretical modeling, and engineering are working together in a multidisciplinary approach. The central goal of the cluster is to develop a fundamental understanding of electrochemical energy storage in novel systems, to combine basic material properties with critical performance parameters, and thus to create the basis for the practical use of post-lithium technologies. The Center for Solar Energy and Hydrogen Research Baden-Württemberg (Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg - ZSW) and Gießen Justus-Liebig University are further partners. Speakers of the cluster are Professor Maximilian Fichtner (KIT and Ulm University), Professor Helmut Ehrenberg (KIT), and Professor Axel Groß (Ulm University).

KIT was represented in this selection round with four full proposals. The preparation of these proposals was supported by State Minister for Research Theresia Bauer and her ministry.

The decision on the Clusters of Excellence is also fundamental for the competition in the Universities of Excellence second funding line carried out by the German Council of Science and Humanities (Wissenschaftsrat): having acquired two Clusters of Excellence, KIT was allowed to submit a proposal in the second funding line on December 10, 2018; the decision on funding of the Universities of Excellence will be made on July 19, 2019.

KIT 2025 Umbrella Strategy

On March 12, 2018, the KIT Supervisory Board approved the newly formulated area of action International Affairs. This area of action has been added as the eighth chapter of the KIT 2025 Umbrella Strategy. The previous seven fields of action – Mission, Research, Teaching, Innovation, Young Researchers, Governance, and Central Administration and Technical Infrastructure – were retained without changes.

A total of 24 objectives, 67 sub-objectives, and 126 measures are derived from the eight areas of action of the KIT 2025 Umbrella Strategy. These are being addressed in seven lead projects and eleven implementation projects. The lead projects are interdepartmental projects which are supervised by the Executive Board. The implementation projects are followed up in the relevant departments by the respective members of the Executive Board. To date, two of the lead projects – "Design of the Innovation Strategy" and "Career Phases and Paths for Early-career Researchers" – have been completed. One of the implementation projects – "Development of a Marketing and Communication Strategy" - has now also been accomplished.

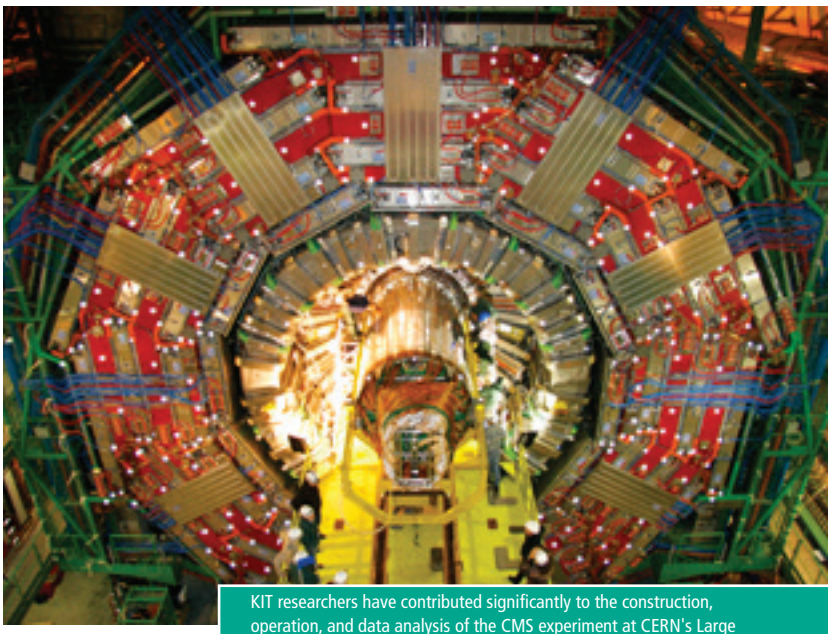
Ten follow-up projects have so far been derived from the finalized lead and implementation projects. The results of these ten follow-up projects will be translated into the day-to-day work of the employees.

Grants and Funding

KIT was also successful with its proposals for Collaborative Research Centers: KIT is the lead university for the Transregio project TRR 257 "Particle Physics Phenomenology after the Higgs Discovery," which was newly approved by the German Research Foundation DFG. The University of Siegen and RWTH Aachen University are partners in the project. The aim of the Transregio is to obtain a comprehensive picture of a possible physics beyond the so-called standard model, which describes all known elementary particles and the important interactions between them. With the discovery of the Higgs particle at CERN in 2012, the last of the fundamental elementary particles predicted by the standard model was identified.

In 2018, the DFG extended two more Collaborative Research Centers, in which KIT researchers are involved, for a further funding period: TRR 88 "Cooperative Effects in Homo- and Heterometallic Complexes (3MET)," which TU Kaiserslautern applied for jointly with the KIT, and TRR 150 "Turbulent, Chemically Reactive Multi-phase Flows Near Walls," for which TU Darmstadt and the KIT applied.

According to a commitment by the Federal Ministry of Education and Research (BMBF) of November 2018, experimental research at KIT on the fundamental building blocks of nature and the necessary technologies will receive additional funding totaling 7.6 million euros between 2019 and 2021. This will enable researchers to further advance research within international large-scale experiments at e.g., CERN in Geneva, Switzerland, or KEK in Tsukuba, Japan.



KIT researchers have contributed significantly to the construction, operation, and data analysis of the CMS experiment at CERN's Large Hadron Collider.

Integration of the electricity, heat, and mobility sectors into a comprehensive network fed by renewable energy sources with central and decentralized structural elements, referred to as the "energy transition," is, indeed, an enormous social challenge. In June 2018, KIT launched the "Energy Transformation in Dialog" project with the aim of making the transformation of the German energy system accessible to the public in a new way while at the same time opening up new ways to participate. The project, which will run for four years and is funded by the

Helmholtz Association's Initiative and Networking Fund, is to be continued from 2020 under the umbrella of the upcoming "Karlsruhe Transformation Center for Sustainable Futures."

The Office of Technology Assessment with the German Bundestag (Büro für Technikfolgenabschätzung beim Deutschen Bundestag - TAB) is an independent scientific institution that advises the German Bundestag and its committees on questions regarding scientific and technological change. Since 1990, TAB has been operated by the Institute for Technology Assessment and Systems Analysis (ITAS) of the KIT. The Committee on Education, Research, and Technology Assessment at the German Bundestag has unanimously decided to entrust ITAS with the operation of TAB for another five years, from September 1, 2018 to August 31, 2023.

Top research produces increasing amounts of data. The KIT supercomputer is not only fast and extremely economical, it is also used very intensively. Between 2019 and 2021, the current ForHLR II supercomputer will therefore be gradually replaced by an even more powerful successor. A total of 15 million euros are available for this purpose. Half of the new supercomputer at KIT will be financed by the Federal Government and half by the state. The funding provided by the State of Baden-Württemberg follows the state strategy on High Performance Computing and Data-intensive Computing to ensure an internationally competitive standard for the research and business hub of Baden-Württemberg.

The President of Tongji University, Professor Chen Jie, visited KIT on December 4, 2018.

Collaborations

KIT and the University of Heidelberg are intensifying their successful collaboration in research and plan to supplement the jointly funded scientific institution "Heidelberg Karlsruhe Research Partnership" (HEiKA) in the areas of "support of early-career researchers," "teaching," and "innovation." The research partnership will thus become a strategic partnership. Longer-term goals include the establishment of joint research institutes and cross-institutional courses of study and graduate schools. In addition, the areas of innovation and technology transfer increasingly will be tackled together. The scientific contacts between Karlsruhe and Heidelberg already have a decades-long tradition and were institutionalized in 2011 by the founding of HEiKA. The "3D Matter Made to Order" Cluster of Excellence has emerged from a HEiKA cluster initiative.

There is a long-standing strategic partnership between the KIT and Tongji University in Shanghai that encompasses many areas, such as cooperation in teaching. Germany and China now also want to cooperate more closely in the development of climate-friendly vehicle technologies. The KIT and Tongji University are therefore researching standardized methods for joint technology development at different locations. In the MorEH2 research project funded by the German Federal Ministry of Education and Research (BMBF) and the Chinese government, engineers will work to simultaneously validate electrified drive systems for fuel cell vehicles in Germany and China.

Ranking Performance

In 2018, KIT again performed excellently in the various rankings and is thus very well positioned in national and international comparisons. Three of the many results are mentioned below.

KIT graduates continue to be very popular with HR managers in medium-sized and large German companies: in the current university ranking of the WirtschaftsWoche magazine, KIT once again ranks among the leaders in all engineering subjects. In informatics, KIT improved to first place since the previous ranking in 2016. In mechanical engineering, KIT improved by one place to share second place with TU Munich. In industrial engineering and electrical engineering, KIT maintained its second place ranking. A seventh place in natural sciences completed the very good results from the survey of 500 personnel managers. The results of the survey reflect their assess-

KIT as a whole	QS World University Rankings: Place 116 (4) QS Graduate Employability Rankings: Place 31 (1)	THE World University Rankings: Place 135 (14)*
	NTU Ranking: Place 216 (19)*	U.S.News: Place 183 (12)*
Subject groups	**NATURAL SCIENCES** QS Ranking: 37 (4) NTU "Taiwan" Ranking: 62 (1) THE Ranking: 69 (5)	**ENGINEERING SCIENCES** QS Ranking: 51 (4) THE Ranking: 54 (3) NTU "Taiwan" Ranking: 95 (1)
Subjects	**Physics** QS Ranking: 35 (4) US News: 50 (4) NTU: 71 (3) ARWU: 51-75 (2-6)	**Chemistry** NTU: 64 (1) US News: 72 (3) ARWU: 51-75 (1-4) QS: 51-100 (3-8)
	Material Sciences US News: 67 (2) NTU: 75 (2) ARWU: 51-75 (2) QS: 51-100 (2-6)	**Informatics** THE: 42 (2) ARWU: 51-75 (2) QS: 51-100 (2-5) CHE: (place 3)
	Geosciences NTU: 40 (1) US News: 62 (1)	**Atmospheric Sciences** ARWU: 16 (1) **Energy Sciences** ARWU: 28 (1)
	Chemical Engineering NTU: 66 (1) QS: 51-100 (2-4)	**Sports Sciences** CHE: (place 2)

Summary of the current ranking results of the KIT. The numbers in brackets indicate the national rank, the numbers without brackets indicate the international rank.
Rankings marked with an asterisk (*) strongly favor universities with medical departments.

ment as to which universities and technical colleges best train their graduates to begin their careers and meet the requirements of the respective employers.

The CHE university ranking, which is the most comprehensive ranking of German universities and universities of applied sciences, found that the KIT is also very popular with students. In the evaluation, informatics, sports/sports science, and chemistry performed particularly well. The students were asked about their general student satisfaction as well as about central aspects of their studies, such as the range of courses offered, pedagogical support, infrastructure on campus, and practical relevance. The KIT proved to be particularly strong in terms of "support at the beginning of studies:" five out of eight courses were among the relevant top groups. In this category, which is particularly important for beginning students, the initial offerings of the universities for orientation, counseling, and competence building are evaluated.

In nine subjects, KIT ranks among the 100 best universities in the world - among the top 50 in physics. This is the result of the "QS World University Ranking by Subject 2018." The ranking is based on criteria such as reputation with researchers and employers, the frequency with which scientific work is cited, and the Hirsch index, which is an indicator of the research performance of researchers.

Special Events

The 10th Carl Benz Memorial Lecture at KIT focused on the further development of the car and the overall mobility system. Speakers on November 22, 2018 were Winfried Hermann, Baden-Württemberg's Minister of Transport, Dr. Dieter Zetsche, Chairman of the Board of Management of Daimler AG, and Professor Holger Hanselka, President of KIT. In their presentations, they addressed the major challenges facing mobility technology and industry: protecting the environment, the growing volume of traffic, and ongoing digitization. The Carl Benz Memorial Lecture is a KIT event in honor of the inventor of the automobile who was born in Karlsruhe and was trained as an engineer at Karlsruhe Polytechnic, a predecessor institution of the KIT.

On October 2, 2018, the Gründerallianz Karlsruhe (Karlsruhe Startup Alliance) and KIT brought the well-known entrepreneur and investor Frank Thelen to the Karlsruhe deep-tech and IT startup scene. Under the heading of "Von Löwen, Einhörnern und Freigeistern" (of lions, unicorns, and free spirits), Frank Thelen, known as member of the jury of the TV show "Die Höhle der Löwen" (lions' den), gave insights into his personal career and explored many crucial questions, such as: what are the challenges for founders, and for investors? What is the future of the startup culture in Germany? How are

In front of a full lecture hall, entrepreneur and investor Frank Thelen talked about lions, unicorns, and free spirits.

technologies changing our work life? In the framework of this event, five Karlsruhe startups pitched for a surprise prize in front of a selected jury led by Thelen.

On June 24, 2018, the Germany-wide multimedia project "Back to the Working Life of the Future - Visions of Tomorrow's Work in the Past and Present" kicked off with an event in Karlsruhe. With a series of discussion events across Germany, the project aims to give historical perspective to the debate about the future of gainful employment. The methodological approach is an intergenerational dialog with citizens in the style of oral history. The project is a cooperation of the Science Communication Department at KIT's Institute for German Studies, the University of Halle-Wittenberg, and science2public - Gesellschaft für Wissenschaftskommunikation (science2public - society for science communication). The project took place within the framework of the "Science Year 2018 - Working Life of the Future" and was funded by the Federal Ministry of Education and Research (BMBF).

After having passed through the cities of Stuttgart and Kehl, a group of runners led by Baden-Württemberg's Digitization Minister Thomas Strobl and former vice world cup winner over 100 kilometers Jürgen Mennel reached FZI Forschungszentrum Informatik (FZI Research Center for Information Technology), an innovation partner of KIT, on November 16, 2018. The third stage of the digitization run "Digitalisierung: Läuft!" took the participants to the city that stands for IT and digitization like no other place in Baden-Württemberg: Karlsruhe. Scientists of KIT and FZI presented their research on artificial intelligence.

On November 10, 2018, the canteen and the Studierendenhaus on KIT's Campus South were transformed again into an elegant ballroom. Under the motto "The Golden 20s," the Executive Board invited to the third ball of the KIT. The event has become a permanent fixture in social life in Karlsruhe and was again a complete success in 2018 enjoyed by 600 dance enthusiasts.

Guests were received festively at the ball of the KIT 2018 under the motto "The Golden 20s."

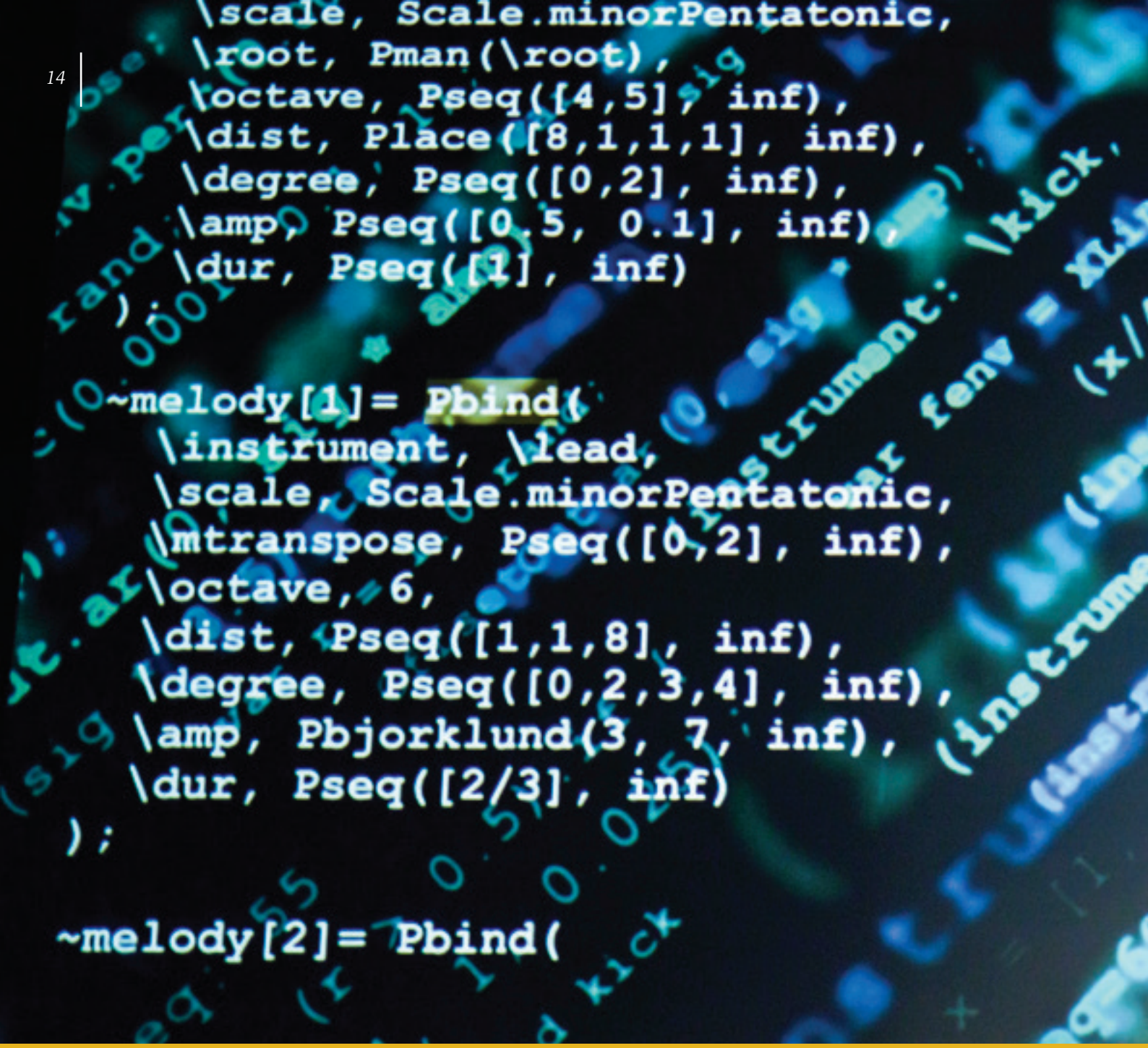
The Executive Board in 2018: Professor Dr. Alexander Wanner, Vice-President for Higher Education and Academic Affairs, Michael Ganß, Vice-President for Finance and Business Affairs, Professor Dr. Thomas Hirth, Vice-President for Innovation and International Affairs, Professor Dr.-Ing. Holger Hanselka, President, Christine von Vangerow, Vice-President for Human Resources and Law, Professor Dr. Oliver Kraft, Vice-President for Research (from the left).

Appointments and Reappointments to the Executive Board

Michael Ganß has been KIT Vice-President for Finance and Business Affairs since August 1, 2018. He is a proven expert in science management with a focus on finance, controlling, and infrastructure. Before that, since 2003, he was Commercial Director of Helmholtz Center Geesthacht. On April 23, 2018, the KIT Senate confirmed the unanimous vote of the Supervisory Board for Michael Ganß with a very large majority.

Professor Holger Hanselka has been heading the KIT since 2013. He will remain President for another six years. At its meeting on September 17, 2018, the KIT Senate confirmed the unanimous vote of the Supervisory Board for Professor Holger Hanselka with a very large majority.

At the same meeting, the reappointment of Professor Alexander Wanner, Vice-President for Higher Education and Academic Affairs, was unanimously confirmed for another six years. Alexander Wanner has also been in office since 2013.



RESEARCH

KIT Centers are organizational units pooling program-oriented and coordinated research at KIT. They represent the strategic research areas of KIT to the public and act as internal and external dialog and strategy partners. The KIT Centers are one of the major research structures of KIT and contribute to thematic profiling and strategic research planning. Another task is to support early-stage researchers.

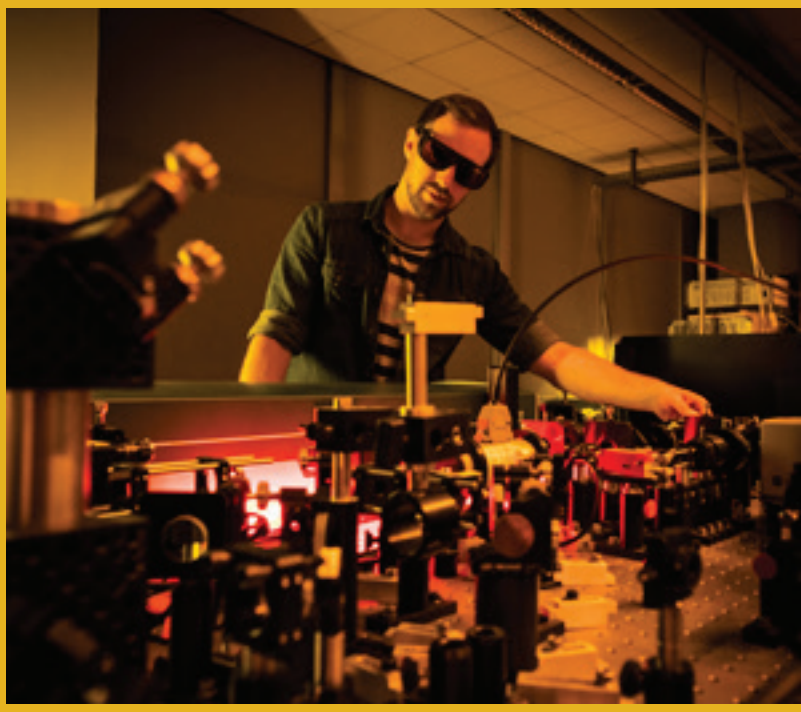
In the course of KIT's further thematic development, new KIT Centers can be established and existing ones can be closed. As of now, eight KIT Centers exist.

The eighth and youngest KIT Center was established in October 2018. The "Mathematics in Sciences, Engineering, and Economics" (MathSEE) Center bundles interdisciplinary mathematical research of KIT and makes it visible both inside and outside of KIT.

Mathematics is a fundamental discipline in science. Applications and methods, including simulations, data evaluations, or computer-based systems, would not be feasible without arithmetic, algebra, or statistics. KIT scientists from mathematics, natural sciences, engineering, and economics cooperate in MathSEE to extend existing collaborations and establish new ones. To this end, the KIT Center organizes specific scientific events and offers initial funding of research projects. The Center began operating with 60 scientists from 22 institutes and all five Divisions of KIT.

The MathSEED graduate school is being established for structured advanced qualification of doctoral researchers. MathSEED offers and pools existing study courses and additionally develops courses that address interdisciplinary issues. These training courses are also open to master's students.


D Smart Load



NEW BENCHMARKS IN ENERGY STORAGE RESEARCH

CELEST: START OF THE BIGGEST RESEARCH PLATFORM FOR ELECTROCHEMICAL STORAGE SYSTEMS IN GERMANY

X-ray photoelectron spectroscopy is used to determine chemical composition of surfaces of storage materials.

Electrochemical energy storage is a key technology of the 21st century. Climate change and declining natural resources urgently require adaptation of our mobility and energy systems to a future without fossil fuels. Technologies suited for storing regenerative energy are needed to ensure stable and secure power supply as well as zero-emission mobility.

With CELEST, the Center for Electrochemical Energy Storage Ulm & Karlsruhe, one of the most ambitious research platforms in this area worldwide has begun operation. It combines finding-oriented research with close-to-practice development and innovative production technologies. CELEST pools the know-how of 29 institutes at KIT, Ulm University, and the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) to accelerate research, academic education and development, as well as technology transfer, in electrochemical energy storage.

CELEST is aimed at enhancing communication and collaboration among the scientists involved and at pushing new interdisciplinary collaboration projects. Joint activities with other universities and research institutions as well as with industry in Germany and abroad will be coordinated and intensified.

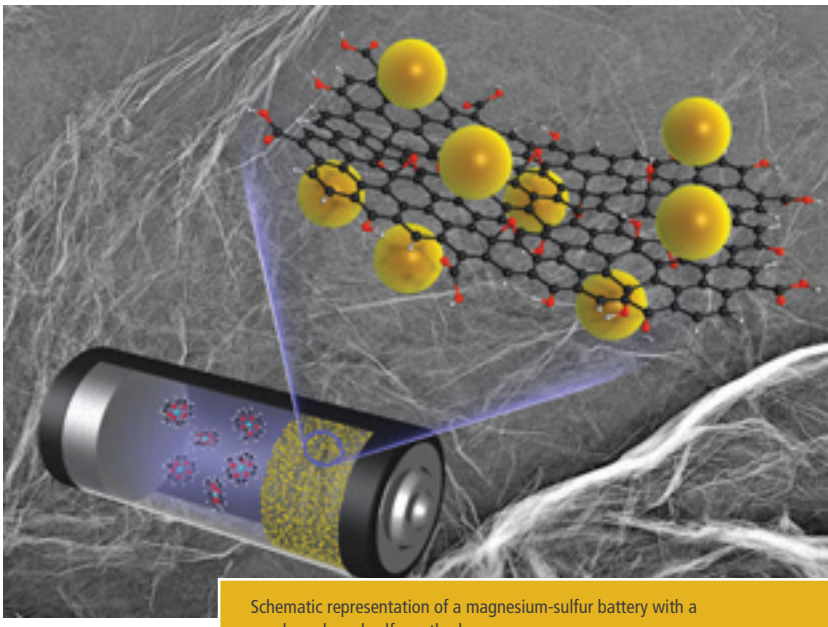
Essential Contributions to Climate Protection and the Energy Transition

With its three research areas "Lithium-ion Technology," "Energy Storage beyond Lithium," and "Alternative Technologies for Electrochemical Energy Storage," CELEST will

cover all highly relevant topics in the area of electrochemical energy storage. This will foster not only finding-oriented research, but also development and production of batteries and fuel cells. "As scientists, we want to make essential contributions to climate protection and the energy transition," says Professor Oliver Kraft, KIT Vice-President for Research. "With CELEST, we have established the biggest research platform in the area of electrochemical energy storage in Germany."

"Scientists in Ulm and Karlsruhe have complementary expertise ranging from experimental basic research into elementary processes on the atomic scale to multi-scale modeling of relevant processes and development of new storage materials and laboratory cells to battery cell manufacture at the biggest pilot plant of the ZSW in Europe," says Professor Maximilian Fichtner, Scientific Spokesperson of CELEST and Director of the Helmholtz Institute Ulm that was established by KIT in cooperation with Ulm University and the associated partners, namely, the German Aerospace Center (DLR) and the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW). Another focus of CELEST will be on collaboration with industry partners for technology transfer, innovation, and commercialization of new technologies. Education of young scientists will be a high priority. A graduate school on electrochemical energy storage therefore will be established.

In the battery tester, cells are exposed to thousands of charge and discharge cycles at defined temperatures.



Schematic representation of a magnesium-sulfur battery with a graphene-based sulfur cathode.

Strong Partners with Excellent Expertise

"The CELEST research platform will raise our cooperation to the next level," says Professor Joachim Ankerhold, Vice President for Research of Ulm University. "Since 2011, the strong partners KIT, Ulm University, and ZSW have successfully pooled their expertise in battery research at the Helmholtz Institute Ulm." The ZSW in Ulm is to transfer battery, fuel cell, and hydrogen technologies to industry.

New battery technologies also are the focus of the Cluster of Excellence "Post Lithium Energy Storage (POLiS)" jointly acquired by KIT and Ulm University. This cluster will push the development of battery technologies based on abundant, low-cost, and non-toxic elements, such as sodium and magnesium, thus reducing pressure on scarce resources. ZSW and Gießen University are partners of this cluster.

REAL-WORLD LAB FOR RESEARCH AND INNOVATION

BADEN-WÜRTTEMBERG TEST AREA FOR AUTONOMOUS DRIVING OPENED

Automatic driving no longer is a vision for the future. In coming years, use of highly automated vehicles in urban transport will increase and their passengers will reach their destinations or be picked up without any active intervention.

In May 2018, State Deputy Minister-President Thomas Strobl and State Minister of Transport Winfried Hermann opened the Baden-Württemberg Test Area for Autonomous Driving (TAF BW) in Karlsruhe. The test area is a real-world lab for mobility concepts and is intended to support the development of sustainable traffic and public transit solutions. After five months of test operation, the joint project of research institutions, municipalities, and the government of Baden-Württemberg officially started work.

"Mobility is being reinvented and Baden-Württemberg is among the leaders of this process," said Deputy Minister-President and Minister of the Interior, Digitization and Migration, Thomas Strobl. "We were pioneers in engine development, the heart of the automobile. We also want to be and will be pioneers in the digital age. The automated automobile will be the future of Baden-Württemberg."

"I am interested in the impacts on traffic and ecology. This includes potential change of the future passenger and goods transport volumes and the choice of transport means as well as potential autonomous public transit with small buses operating from door to door, transport legislation, vehicle registration, data protection, user acceptance, ethical aspects, economic efficiency, and urban development changes," added Minister of Transport Winfried Hermann.

In the test area, companies and research institutions can test their technologies and services relating to connected and automated driving in daily road traffic. Among the vehicles tested will be automated cars, buses, and commercial vehicles, including road cleaning and delivery service vehicles. In contrast to other projects in Germany, the test area covers all types of public roads, such as motorways, state and federal roads, inner-city routes with bicycle, pedestrian, and tram traffic as well as zones with a 30 km/h speed limit, residential areas, and car parks. An important aspect of the test area is local public transit. The roads of the test area are located in the regions of Karlsruhe, Bruchsal, and Heilbronn.

Start of TAF BW: Alexander Pischon, Karlsruhe Transport Authority, Frank Mentrup, Lord Mayor of the City of Karlsruhe, Thomas Strobl, Deputy Minister-President, Marius Zöllner, FZI Executive Director and KIT Professor, Winfried Hermann, Baden-Württemberg Minister of Transport, and Holger Hanselka, President of KIT (from the left).

Scientists at KIT are involved in planning and setting up of the test field. They develop basic traffic flow models and make test facilities available. KIT and its Mobility Systems Center also are responsible for the mobile control station and the supply of office areas and workshops for users of the test area.

The consortium is coordinated by the FZI Research Center for Information Technology, an innovation partner of KIT. It also contributes data storage and data security know-how. Moreover, FZI develops a system for the smart measurement of vehicle movements at crossings. Interested test area users are free to use the FZI research cars for their studies or for sensor measurements.

The vision: smart collective street lighting without dangerous blind spots. For this purpose, stationary street lights will be coordinated with the cars' headlights.

"At the research institutions, future-oriented technologies for autonomous driving are being developed that now will be established in new applications. However, this will be possible only, if tests can be carried out under real-life conditions," says Marius Zöllner, professor at KIT's Institute of Applied Informatics and Formal Description Methods and Executive Director of FZI. "I am happy that the Baden-Württemberg Test Area for Autonomous Driving provides the framework conditions required for safe testing. Now, we have ideal prerequisites to technically, economically, and socially optimize mobility.

The Baden-Württemberg Test Area for Autonomous Driving was designed, planned, and developed by a consortium of FZI, the city of Karlsruhe, KIT, Karlsruhe University of Applied Sciences, the Fraunhofer Institute of Optronics, System Technologies, and Image Exploitation (IOSB), Heilbronn University of Applied Sciences, and the city of Bruchsal, as well as several associated partners. The test area is operated by the Karlsruher Verkehrsverbund (KVV, Karlsruhe Transport Authority).

The Baden-Württemberg Ministry of Transport granted EUR 2.5 million for the setup of the test area. The consortium as well as the associated and industry partners additionally contribute own funds to create a test area for interconnected and automated driving that is open to all technologies and independent of individual companies. The State Ministry for Science, Research, and the Arts granted another EUR 2.5 million for research on the test area under the Smart Mobility Funding Program, which is to produce data on the impacts of autonomous driving on transport.

TESTFELD AUTONOMES FAHREN
BADEN-WÜRTTEMBERG

FUTURE HUMAN-MACHINE INTERFACES

USER-FRIENDLY AND ADAPTIVE ROBOT HELPER FOR CARE AT HOME

Human-machine interfaces must recognize the needs of humans and respond to them. Researchers of KIT are working on them to enable development of robots that can assist humans who need help in managing daily life. Mobile robots might assist persons with physical disabilities and enable them to live at home for a longer time. However, special challenges have to be mastered.

What to Do Next?

"Whenever other persons have to concentrate intensely, are stressed, or have a problem, we humans notice this and react by remaining quiet or offering help," says Professor Barbara Deml, Head of KIT's Institute for Human and Industrial Engineering. "Future robot helpers are supposed to do the same." The psychologist and engineer teaches machines to capture the physical conditions and emotional states of people and to behave accordingly. It does not matter whether the assistance systems are used in a machine control room, the cockpit of an airplane, the operating theater, or in domestic care. "The principles of interaction between human beings and the machine always are the same," Deml says. "In every case, secure and practical solutions are needed."

Assistance Robots Are to Recognize Contacts and Approaches

The SINA project on a type of movable gripper focuses on hand-over processes between the human being and the robot. In case a patient wants a glass of water, for example, novel sensors are used to recognize contacts and approaches and to prevent accidents. Another important aspect is acceptance of robot helpers. If a robot is be used in households, its compatibility with people's pets is considered highly important by users.

One possibility to make machines recognize what we wish or what we will do next is eye tracking. "From where we look, how long our gaze remains locked on a certain

Machines must learn to recognize the physical conditions and emotional states of people. For this, physiological parameters, such as cardiac rhythm, muscle activity, or conductivity of the skin of test subjects are measured.

point, or whether our pupils are dilated, conclusions can be drawn with respect to what we feel," Deml explains. In addition, she measures physiological parameters, such as cardiac rhythm, muscle activity, or conductivity of the skin. These data are then compared statistically by the machine. In the case of deviations from standard values, the machine is activated. In this way, driver assistance systems will anticipate critical traffic situations by observing the driver or industry robots will protect workers from excessive strain by reducing their working speed.

What to do next? To train robots to figure out what people want, researchers of KIT use eye tracking.

Derivation of psychological states from physiological information is based on empirical studies and their statistical data evaluation. "We consider it important to carry out not only data-driven analysis, but to work in a model-based manner against the trend," Barbara Deml points out. This is where her approach differs from the many deep learning approaches in the area of artificial intelligence.

Using a data glove, movements of test subjects doing manual work are recorded.

TRACKING DOWN THE SPURIOUS PARTICLES

NEUTRINOS WEIGHED BY THE WORLD'S MOST PRECISE BALANCE

It finally happened on June 11, 2018: starters pushed many red buttons simultaneously at KIT to start the tritium measurements of KATRIN (Karlsruhe Tritium Neutrino Experiment). All 16 starters were closely related to KATRIN, either as national and international funding partners or as managers of the collaboration with nearly 200 members, partly since its foundation in 2001.

After all red buttons had been pushed, a light signal switched from red to green, thus indicating that the first electrons originating from beta decays of tritium gas in the KATRIN source were passing through magnetic fields over the huge main spectrometer to the so-called focal plane detector. Accompanied by great applause from more than 400 guests from many countries, the electronic signals generated by the electrons made the detector image light up.

"KATRIN is an experiment of superlatives and will complement the knowledge about our universe with a decisive piece of the puzzle," says Federal Minister of Research, Anja Karliczek. "I congratulate the KIT and the research collaboration on the successful assembly of this complex experiment. Such an important experiment on German territory will strengthen Germany as a location of research." With a share of around 75 percent, the Federal Ministry of Research is the biggest funding partner and invested about 50 million euros in the building of KATRIN.

The smooth start of KATRIN marks the beginning of many years of measurements in the experiment to determine the mass of the lightest known particle of matter, the neutrino. Neutrinos play an important role in shaping the visible structures in our cosmos and in our understanding of how elementary particles receive their masses. The mass of neutrinos is smaller by many orders of magnitude than the mass of electrons or quarks.

"KATRIN is an absolute high-tech experiment that will open up so far unknown territory in the coming years and supply major findings on key aspects of particle physics and cosmology," says Guido Drexlin, Professor of KIT's Institute of Experimental Particle Physics and Scientific Co-spokesperson of the international KATRIN collaboration.

Sixteen starters closely related to KATRIN pressed the red buttons to start the experiment.

View into the main spectrometer tank, in which the electrons are sorted depending on their energy.

The KATRIN experiment uses a high-intensity tritium source, in which beta decay of tritium produces helium-3. The resulting electron and neutrino share among them the decay energy of 18,600 electron-volts. The neutrinos leave the experiment unhindered and carry energy that the electrons lack. This fact is of particular interest when electrons carry nearly the entire energy of decay, as then the neutrino carries away the energy corresponding to its rest mass only, according to Einstein's famous formula $E = mc^2$.

Compared to the theoretical energy spectrum of mass-free neutrinos, the energy spectrum of the electrons from tritium decay is shifted by a very small amount, namely, the rest mass of the neutrino. As these decays with an extremely unbalanced energy distribution between electron and neutrino are very rare, a measurement duration of five years is required to reach a sufficient count rate at the highest energies. Energy measurement of highest-energy electrons takes place in the huge main spectrometer of KATRIN by applying of a very precise high voltage that can only be overcome by electrons having quasi maximum energy. Only these will then be counted in the detector. Low-energy electrons will be reflected by the counter voltage of the spectrometer and return to the source, behind which they will be absorbed. To ensure that only electrons and no neutral tritium molecules enter the main spectrometer from the windowless source, all gas molecules fed into the tritium source have to be removed in a multi-stage pumping section.

During complex commissioning measurements in previous years, the KATRIN team successfully tested many technological novelties and achieved several "world records." "An incredible success story is our ultra-precise high-voltage system and the 700 m^2 wire-based electrode system for the large spectrometer. Without these developments, KATRIN would not reach the desired sensitivity to the neutrino mass," explains Professor Christian Weinheimer, Professor of the University of Münster, who is Scientific Co-spokesperson of KATRIN together with Guido Drexlin. He and his team have developed and built key components and, thus, contributed significantly to the success of the project. Several technologies developed for KATRIN now are used in other experiments and disciplines as well.

KATRIN has started. "Our path has been full of challenges. Now, we are at the start of data taking and look forward to spectacular and surprising KATRIN results, as was a good tradition in neutrino physics over the past decades," Guido Drexlin and Christian Weinheimer say. They and the entire KATRIN team expect the future measurements which will last well into the next decade to produce high-impact results.

THINK TANK TO HOLISTICALLY ANALYZE RESOURCE CYCLES

THINK TANK "INDUSTRIAL RESOURCE STRATEGIES" STARTS OPERATION

Baden-Württemberg is a state lacking substantial quantities of raw materials except for some sand, gravel, and stones. With its high production of industrial value added, it depends on the efficient use of raw materials and recycling of resources from waste.

Industry is highly dependent on imports of raw materials and the need for materials like lithium, platinum, magnesium, cobalt or rare-earth metals continues to increase, as new technologies for electric mobility and the energy transition are based on them. Meeting this demand in a sustainable, reliable, and economically efficient manner is one of the big challenges of high-tech centers such as Germany.

To cope with the challenges in resource economy and to support companies in Baden-Württemberg, the state government decided to establish the Think Tank "Industrial Resource Strategies" together with industry and KIT. Here, interdisciplinary concepts for the efficient use of raw materials will be developed. For an initial duration of four years, the Think Tank at KIT will be funded with up to EUR 2 million per year by the State of Baden-Württemberg and industry. A project council will discuss the strategic topics and subjects to be analyzed by the Think Tank.

The Think Tank "Industrial Resource Strategies" is the first institution of its kind in Germany. It will be the expert authority in the raw materials and resource efficiency sector and will make essential contributions to the development of innovative solutions in this area. By supporting resource-efficient technologies, the state will prepare for the future. At the same time, consumption of non-renewable resources and energy will be reduced.

KIT's Think Tank will study the raw materials cycles in a holistic way, from extraction to use to recycling. Studies will also cover technological, economic, ecological, and social impacts. The benefit for society and preservation of our natural basis of life will be of equal importance when transferring findings to application.

Initial activities of the Think Tank "Industrial Resource Strategies" will cover the transparency of resource flows, holistic analysis of circular economy considering both ecological and economic aspects, and the impacts of industrial change on the supply, availability, and security of resources.

Our industrial society's need for resources, such as the selection of rare earths shown here, is growing constantly. That is why new strategies for efficient use of the limited resources have to be developed.

MODERN TECHNOLOGY TO STUDY OLD ARTIFACTS

PARASITES DISCOVERED IN FOSSIL WASP PUPAE

Parasitic wasps already existed as early as several million years ago. Within a project coordinated by KIT, scientists from various disciplines for the first time detected fossil parasites inside their hosts. The researchers studied fly pupae from old collections of the natural history museums in Basel and Stockholm with the help of ultra-fast X-ray imaging. They found 55 cases of parasitization and described four so far unknown extinct wasp species from the Paleogene, a geological era that spanned the period from about 66 million to about 23 million years ago.

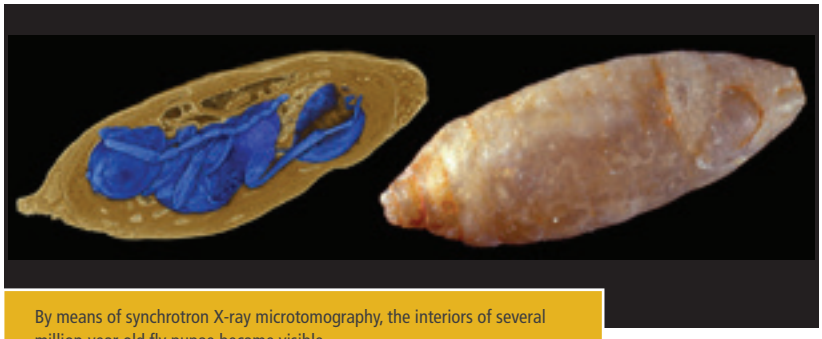
The results of the project provide important information on the evolution of parasitism that is widespread and significantly influences ecosystems. Today, about 50% of all animal species are deemed to be parasites. The relationship between the diversity of species and parasitism is particularly obvious in the insect order of hymenoptera, to which wasps belong.

Each of the four newly discovered parasitic wasp species had its own strategy for adapting to the host. The most frequently observed species of the four was named 'xenomorphia resurrecta' by the scientists. The genus 'xenomorphia' is named after the creature from the 'Alien' science fiction series, which is known as xenomorph. The species name 'resurrecta' refers to the "digital resurrection" of the species.

Ultra-fast X-ray imaging, largely developed and refined by KIT, enabled new examination of the fossils. Researchers studied the samples with synchrotron X-ray microtomography. Inner structures of optically dense samples can be observed non-invasively and in three dimensions with X-rays only. Synchrotron radiation sources, a type of particle accelerator, produce electromagnetic radiation with a much broader spectrum and much higher intensities than conventional sources.

Digitally resurrected: the parasitic wasp xenomorphia resurrecta deposits an egg in a fly pupa.

Measurements for the project were made at the UFO high-speed tomography station of the KIT synchrotron. It is designed for a high sample throughput. Imaging and data evaluation are partly automated. UFO is also suited for other projects in which a large number of samples have to be imaged. Hence, its use is of interest to several disciplines, including materials science.



By means of synchrotron X-ray microtomography, the interiors of several million-year-old fly pupae became visible.

THE MORE EXOTIC, THE LESS TRANSPARENT

GENETIC BARCODES TO PREVENT MIX-UP OF SUPERFOODS

Exotic plants as energy and health boosters are highly popular among consumers. Chia seeds, moringa powder, açai or goji berries, the list of foods with alleged health benefits is increasing constantly. Health-conscious consumers love superfoods that are supposed to have stress-reducing and detoxifying properties and to strengthen the immune system.

But the more exotic the foods are, the less consumers can be sure to have the original product. Thanks to globalization, special medicinal plants grown in a single region find a worldwide market. And if the rapidly changing superfood trends lead to a sudden increase in demand, the latter can hardly be met by existing capacities. Hence, the trade in counterfeits is booming. And as such mix-ups or counterfeit products are increasing, researchers of KIT's Botanical Institute have developed genetic barcodes for superfoods.

Indian basil may be helpful in the case of breathing difficulties or bronchitis. Related species, however, may cause allergic reactions.

Counterfeit medicinal plants and superfoods are difficult to identify even by experts. Often, these are exotic plants and few know what they look like. For example, 1400 species of bamboo exist, but the leaves of only three can be used to prepare tea. It is similar with Indian basil. The right species may be helpful in case of breathing difficulties or bronchitis, whereas other species may cause allergic reactions. Due to such risks, the lists of ingredients of plant products are checked for correctness via import controls. These checks are mostly carried out microscopically with the help of botanical descriptions. In the case of chia powder, however, this method is of no use. Alternative methods, e.g. reading out of gene sequences, which is also done in paternity tests, are very time-consuming and expensive.

KIT researchers have developed a method based on small differences in the gene sequence. Gene scissors are applied to certain points of the DNA strands that make up the genetic material.

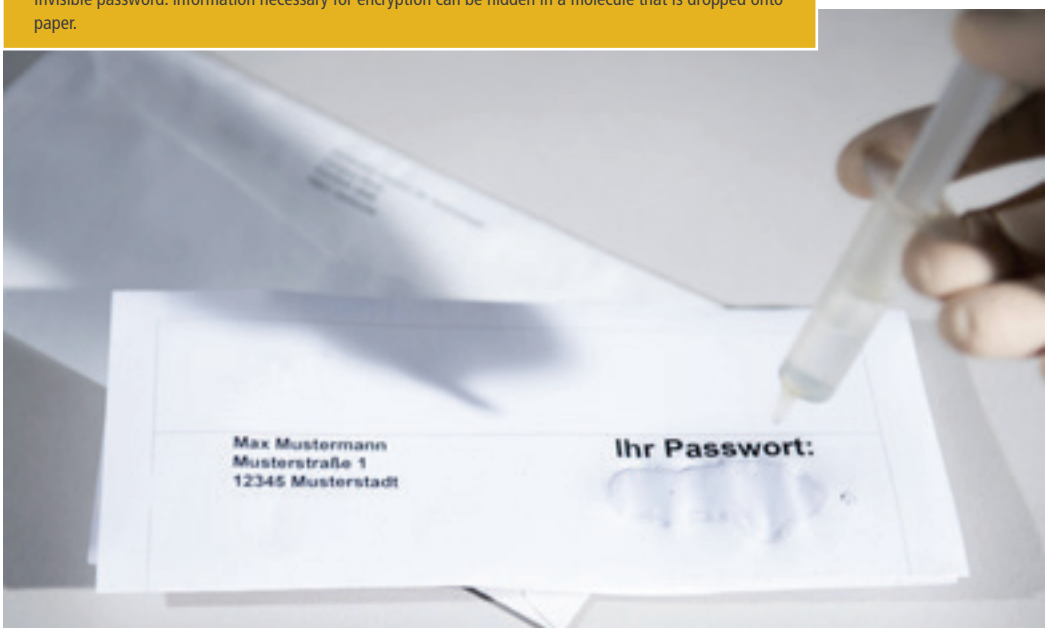
Similar to a key that fits a lock, the scissors only fit to a certain pattern of gene fragments that may serve as a genetic fingerprint for the species searched. If the scissors snap shut, scientists know that this is the right plant. This resembles a barcode that can be read out with the corresponding scanner. 7000 of such barcodes have already been collected in a database.

CHEMICAL COMPOUNDS REPLACE PASSWORD

AGENT 007: ORGANIC MOLECULES AS BEARERS OF SECRETS

In the digital age, security of sensitive information is of utmost importance. Many data are encrypted before transmission. A password usually is used for decryption, and in most cases, exactly this password provides an opening for hackers when it fails to meet the necessary security requirements. Scientists of KIT created a new and highly secure approach by combining computer science with chemistry, melding a conventional encryption method with a chemical password.

Invisible password: information necessary for encryption can be hidden in a molecule that is dropped onto paper.



They conceal the information for the password in a small organic molecule. While the encrypted digital information can travel publicly on the data highway, the key to read this information is transported invisibly and discretely in the form of a small volume of a chemical compound that is dropped onto a piece of paper, for instance.

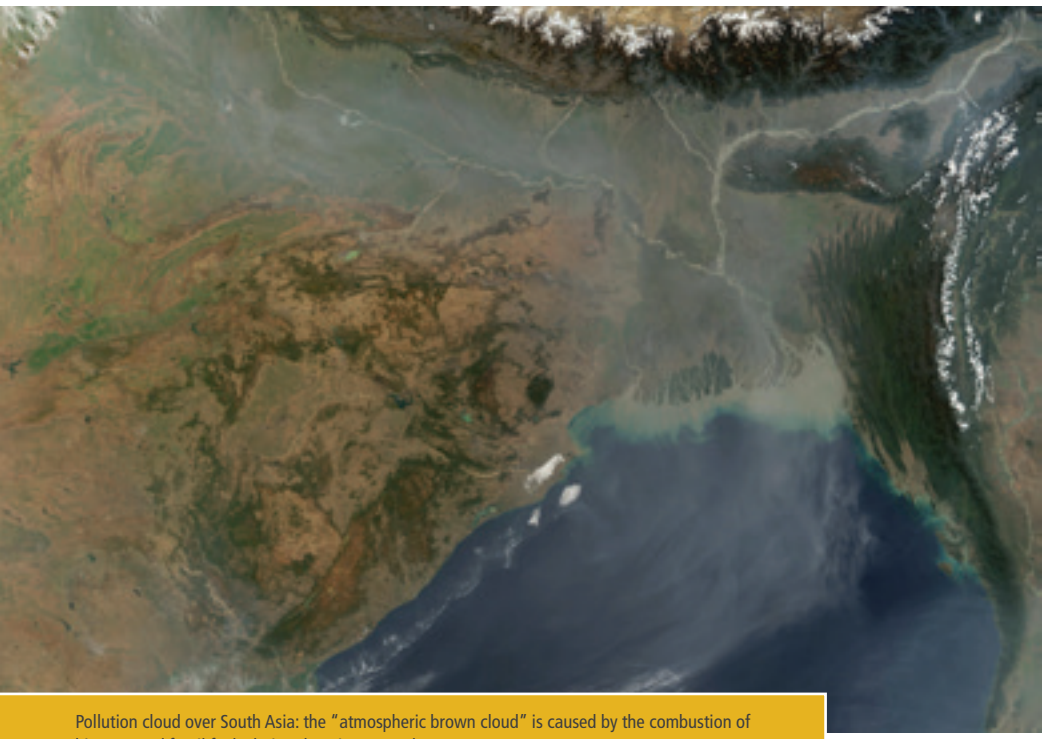
The information of the chemical key is hidden in the sequence of building blocks and attached side chains. Each of these chemical components is assigned a letter and a number. Depending on which components are synthesized in which sequence and with which side chains, an individual alphanumerical code results for the password molecule. It is read out with a specially developed computer program and converted into a binary code.

For synthesis, the scientists use a conventional so-called multi-component reaction. This makes it possible to synthesize a previously defined molecule in one step with a comparably small expenditure. As the compounds selected are highly robust, they are suited for a variety of carrier materials. Tiny amounts of the chemical key are sufficient. It may be isolated from several carrier materials, such as paper, perfume, instant coffee, green tea, sugar, and even pork blood.

The complex method is suited for applications on high security levels that justify a high expenditure, such as the transmission of intelligence or communication from embassies. The method can also be used to distinguish counterfeits from originals or to attach anti-counterfeit tags to products containing information on the batch or date of production.

CLEANING AIR AND PUMPING POLLUTANTS

HALO RESEARCH AIRCRAFT WITH KIT'S MEASURING INSTRUMENTS FLIES THROUGH THE MONSOON



Pollution cloud over South Asia: the "atmospheric brown cloud" is caused by the combustion of biomass and fossil fuels during the winter months.

Every year, atmospheric impacts of anthropogenic air pollution due to the combustion of fossil fuels and biomass are visible on satellite images recorded during the dry season in South Asia. Between December and March, polluted air, referred to as "atmospheric brown cloud" in scientific literature, moves from India across the Indian Ocean. This situation is not expected to improve. Actually, nitrogen oxide and sulfur dioxide emissions in South Asia increased by 50% in the last decade.

But what happens with the pollutants during the South Asian monsoon in summer? Monsoon develops when air masses heat up over the Indian subcontinent, warm air ascends, and moist ocean air is drawn in at the same time. This results in heavy rain and thunderstorms. When the monsoon spreads from the Mediterranean to the Pacific from June to October, the brown cloud disappears in the monsoon's updrafts and thunderstorm systems.

To study the interaction between air pollution and monsoon, scientists used the HALO research aircraft of the German Aerospace Center to cover a distance of 100,000 km within the OMO international project coordinated by the Max Planck Institute for Chemistry, Mainz. HALO was equipped with two measurement instruments of KIT, among others. The results reveal that part of the pollution is converted into water-soluble substances by chemical reactions and washed out with the rain.

The high humidity level and the many lightning strikes create a particularly large number of hydroxyl radicals. These are especially responsive molecules of hydrogen and oxygen that act like a powerful detergent in the atmosphere. The radicals first oxidize the air pollutants which then dissolve in water in the form of less harmful compounds and rain down onto Earth. Another fraction of the air pollutants remains in the air and enters the stratosphere above an altitude of 20 km, where it will spread all around the world.

The KIT-developed instruments measured the concentration of ozone that serves as an indicator of the reactivity of air and a marker for reaching the ozone-rich stratosphere. In addition, a mass spectrometer recorded volatile organic compounds, such as acetone, which an important source of hydroxyl radicals. With this, the origin and whereabouts of the "brown cloud" were studied. India was found to be a major source of organic pollutants.

BEYOND THE STANDARD MODEL

NEW TRANSREGIONAL COLLABORATIVE RESEARCH CENTER APPROVED, TWO OTHERS EXTENDED

With the discovery of the Higgs boson at CERN, a major breakthrough in elementary particle physics was achieved in 2012, providing proof of all the particles predicted by the so-called standard model. The standard model of particle physics is mathematically complete and can describe nature in great detail. It contains all elementary particles and the most important interactions among them: strong, weak, and electromagnetic interactions. However, cosmological and astrophysical observations suggest that there must be an even more fundamental theory beyond this model.

Researchers of the "Particle Physics Phenomenology after the Higgs Discovery" TRR 257 transregional collaborative research center approved by the German Research Foundation in November 2018 want to better understand the underlying fundamental theory. Karlsruhe Institute of Technology (KIT) is the applicant institution, the universities of Siegen and RWTH Aachen are partners in TRR 257.

A number of fundamental questions, such as the nature of dark matter or the surplus of matter observed in the universe cannot be answered by the standard model. While initial results obtained at CERN's Large Hadron Collider (LHC) provided no indication of physics beyond the standard model, some precise experiments (low energy, flavor) revealed a few anomalies that point to a deviation from the standard model – and could develop to heralds of a "new physics."

Using latest theoretical methods and newly developed search strategies, researchers want to establish the theoretical basis for future data analyses at LHC, flavor factories, and in other low-energy experiments. This will make it possible to identify even the smallest deviations from the standard model and find references to this "new physics." Interpreting the results will be the major task in identifying a more fundamental theory underlying the standard model.

Two Collaborative Research Centers with Participation of KIT Were Extended

In 2018, DFG extended funding of two collaborative research centers in which KIT scientists are involved: TRR 88 – Cooperative Effects in Homo- and Heterometallic Complexes (3MET), applied for by TU Kaiserslautern together with KIT, and TRR 150 – Turbulent, Chemically Reactive Multi-phase Flows near Walls, which was applied for by TU Darmstadt together with KIT.

Previous results from the CMS experiment at the Large Hadron Collider of CERN, Geneva, showed no indication of deviations from the standard model of particle physics.

URBAN MINING – LIVING IN A WAREHOUSE OF RAW MATERIALS AND RECYCLABLES

INNOVATIVE RESIDENTIAL UNIT AS AN EXPERIMENTAL FIELD FOR SUSTAINABLE CONSTRUCTION

The residential unit is made of primary resources, such as untreated silver fir wood, newly developed construction materials, and recycled resources.

Global population is growing – and so is the need for living space. But conventional construction materials are running short. To counteract this development, KIT researchers, together with colleagues from the University of Stuttgart, developed the "Urban Mining & Recycling" research unit. The combined laboratory and home near Zurich is to push change towards circular economy in the construction sector. It is made of compostable, recyclable, and reusable construction materials exclusively.

The residential unit demonstrates that buildings today can be constructed such that all materials used can be disassembled and separated again afterwards. For the three-room apartment of 125 square meters, primary resources, such as untreated silver fir wood, were used, but also elements applied at other places before, recycled waste, and newly developed construction materials.

The copper plates framing the facade formerly covered the roof of a hotel in Austria, the door handles come from a bank in Belgium. The building rubble was turned into new bricks, beverage carton packages were converted into wall coverings. The residential unit, hence, is an example of urban mining, as the construction materials come from other buildings and everyday objects.

While natural resources, such as sand or copper, become scarcer, the man-made environment may serve as a big source of materials. Using this urban warehouse of materials enhances sustainability and increases our independence of worldwide raw materials markets.

Instead of bonding or foaming joints, screwing, clamping, or plugging were preferred to ensure later recycling and reuse of the materials. In addition, entirely new construction materials were applied, such as compostable insulation boards made of mycelium, a material consisting of fungal tissue and saw dust.

The pilot project for sustainable construction was created in close cooperation with industry and the crafts sector. It opened in spring 2018. To test various construction materials, construction elements can be exchanged easily. For five years now, researchers will study whether the methods used will stand the test and how the construction materials will behave. The experience gained by two students who moved into the three-room apartment will also be considered.

3D INKS THAT CAN BE ERASED SELECTIVELY

METHOD FOR THE SPECIFIC DEGRADATION OF LASER-WRITTEN MICROSTRUCTURES

3D printing is gaining importance, as it allows for the efficient manufacture of complex geometries. A very promising method is direct laser writing. A computer-controlled focused laser beam acts as a pen and produces the desired structure in a photoresist. In this way, three-dimensional structures with details in the sub-micrometer range can be produced. The high resolution is very attractive for applications requiring very precise filigree structures, e.g. in biomedicine, microfluidics, microelectronics or for optical meta materials.

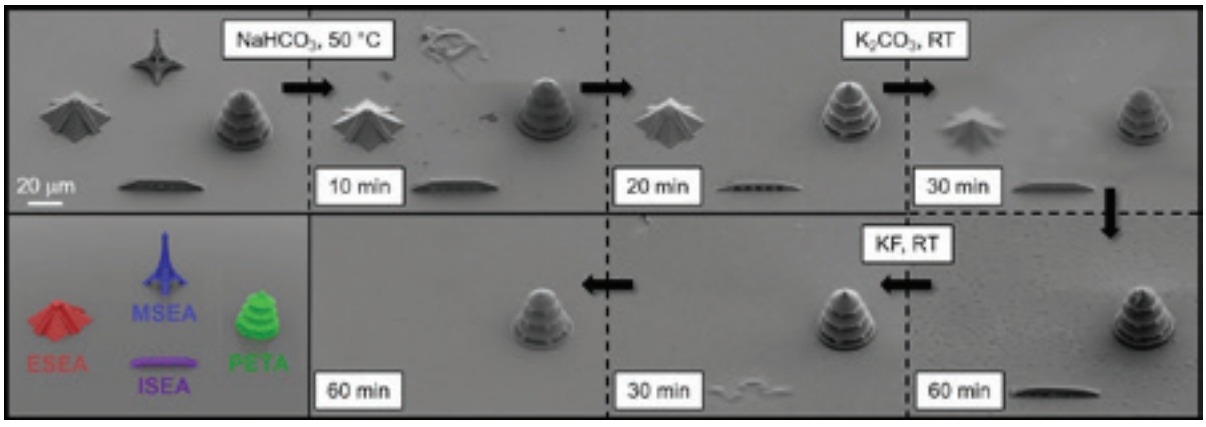
Initially, KIT researchers succeeded in expanding the possibilities of direct laser writing. They developed an erasable ink for 3D printing. Thanks to reversible binding, the building blocks of the ink can be separated again.

Now, working groups of KIT and Queensland University of Technology in Brisbane, Australia, have greatly refined their innovation. They developed several inks, different colors so to speak, that can be erased independently of each other. This enables selective and sequential assembly and degradation of laser-written microstructures. In the case of highly complex constructions, for instance, temporary supports can be produced and removed later. When using three-dimensional scaffolds for cell growth, it is possible to add or remove parts in order to observe how the cells react to such changes. Moreover, the specifically erasable 3D inks allow for the exchange of damaged or worn parts in complex structures.

Production of cleavable photoresists was inspired by degradable biomaterials. The photoresists are based on silane compounds that can be cleaved easily. Silanes are silicon-hydrogen compounds that are processed for the photoresists by specific atom substitution. In this way, microstructures can be degraded specifically without damaging structures with other properties. This is a major advantage over formerly used erasable 3D inks. The new photoresists also contain the monomer pentaerythritol triacrylate, which significantly improves writing without affecting cleavability.

Work is embedded in the newly initiated Cluster of Excellence "3D Matter Made to Order" of KIT and Heidelberg University that focuses on three-dimensionally printed designer structures.

Three-dimensional microstructures made using various cleavable photoresists. Scanning electron microscopies show the selective degradation of the structures.



TEACHING

In the 2018/19 winter semester, the number of KIT students totaled 25,100 and was about 1.5% lower than in the previous year. The proportion of foreign students increased slightly to 23.6%, as did the share of female students, which has grown to a historic high of 29.3%.

State examinations for teaching degree programs were replaced by bachelor's and master's examinations. Within the framework of this process, programs for conferral of the "Master of Education" degree started in the 2018/19 winter semester. In addition, a master's program for teaching a supplementary subject at secondary schools was established. Upon

completion of a bachelor's program, it is now possible to study a third subject with 120 credits. Moreover, the master's program in English "Remote Sensing and Geoinformatics" was established at the KIT Department of Civil Engineering, Geo- and Environmental Sciences in the 2018/19 winter semester. The advanced master's program of "Electronic Systems Engineering and Management" was developed further to the "Mobility Systems Engineering and Management" program that will be offered in future.

At the beginning of the 2018/19 winter semester, 43 bachelor's programs (including ten degree programs for teaching at secondary schools and one program for teaching at vocational schools) and 55 master's programs (including 17 teaching degree programs for secondary schools with supplementary subjects, one program for teaching at vocational schools, and eight advanced programs) were offered by KIT.

Since 2014, KIT has been granted the right to accredit study programs on its own. At the end of the 2018 summer semester, all 98 degree programs of KIT had successfully passed the KIT procedure for "Evaluation of Academic Education and Study Programs," KIT-PLUS for short. Re-accreditation of some programs started in the 2018/19 winter semester.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KIT

ORIENTATION, QUALIFICATION, AND SUPPORT

MINT-KOLLEG BADEN-WÜRTTEMBERG ANALYZES CONDITIONS NEEDED FOR SUCCESSFUL STUDIES

Students transition from schools to universities and their first semesters are highly important for their subsequent studies. When starting their studies, students face a number of challenges. Studies of mathematics, informatics, natural and engineering sciences (summarized by the German acronym MINT) are considered to be particularly difficult. Representatives of German universities were invited by the MINT-Kolleg Baden-Württemberg, an institution established by Karlsruhe Institute of Technology and Stuttgart University, to discuss how success can be enhanced in the early phases of study. The MINT-Kolleg Baden-Württemberg is one of the largest institutions offering courses prior to the start of study in Germany.

In the course of the conference, more than 50 presentations and workshops focused on orientation, qualification, and support. Around 400 representatives of universities, colleges, and institutions and initiatives in the education sector participated and discussed factors of success and best practices, the objective being to further develop concepts and programs for the initial phase of study.

Many factors determine whether students become successful graduates or not. Among these factors are a smooth transition from school to university, a good start of studies, qualified support, and good teaching. Beginning students have increasingly heterogeneous education levels when they start university studies. Support from various services and courses during the first two semesters therefore can enhance their chances for success.

With the Federal and States Program for Better Study Conditions and More Quality in Teaching, universities in Germany are helped in improving their support of students and their teaching quality. The MINT-Kolleg is funded under this program and is additionally embedded in funding programs of the State of Baden-Württemberg. With its comprehensive training courses for prospective students and beginning students, it contributes significantly to increasing their chances for success in initial studies.

How can teaching in the initial phase of studies be improved? This question was covered by the conference organized by the MINT-Kolleg in March 2018.

ONLINE TESTS OF ROUTINES AND ALGORITHMS

WORLDWIDE ACCESS TO ROBOT LABORATORY IN KARLSRUHE

Gaining practical experience online – this sounds contradictory, but is possible at KIT. Here, an innovative robotics learning laboratory, the KUKA Robot Learning Lab (RLL), is now being established for students and researchers of KIT as well as for thousands of online users from all over the world. Via a web interface, they can control sensitive lightweight robots made by high-tech manufacturer KUKA and, in this way, test the routines and algorithms developed in courses. With this lab, KIT enables robotics students to work on real industrial and scientific problems.

At the KUKA Robot Learning Lab of KIT, students and researchers can control real industrial robots via the Internet and test their routines.

At KIT's Institute for Anthropomatics and Robotics, students in Karlsruhe, and soon other students, can log in on the Internet and be given access to KUKA's lightweight robot arms and grippers for testing. The robot arms can be activated online. In a livestream, students can then observe via cameras how well the industrial robots follow their commands. A laboratory course for students is now being developed in addition to a lecture.

The joints of the lightweight robots are equipped with sensors that detect forces acting from outside, such as collisions. The robots are suited for delicate assembly applications on small spaces together with humans. No safety fence is needed.

The robots are used for both basic education of students and real applications, such as autonomous gripping, placing of objects, or execution of assembly tasks. In the area of research, the robots are to independently execute certain tasks with the help of artificial intelligence and without each step having to be programmed.

KIT's Robot Learning Lab will extend education in the area of robotics by a direct practice-related application. Up to 7500 future software developers and roboticists will be able to test their self-developed technical solutions and routines every year. The resulting large volume of data can be used by KIT's scientists for other research projects.

Considering the large number of skilled and motivated talents that will use the RLL, the most complex scientific and technical issues likely will be studied there. Most probably, some users will find very smart solutions of high scientific, innovative, or technical added value. The KUKA Robot Learning Lab at KIT, hence, will be of great benefit both to the education of students and science.

YES, IT'S #HUMBOLDT

PANEL DISCUSSION ABOUT SUCCESSFUL STUDIES WITH THE STATE MINISTER FOR SCIENCE

Under the heading "Yes, It's #Humboldt," the Baden-Württemberg Minister for Science, Theresia Bauer, and representatives of Karlsruhe Institute of Technology and Karlsruhe University of Applied Sciences (HsKA) discussed "Good Academic Education" and "Successful Starts of Studies." This event on KIT's Campus South fostered exchange among students, professors, and representatives of industry about personal experiences as well as measures and projects to support successful studies.

The panel discussion with Minister Bauer among others covered the question of what good academic education means, framework conditions needed for good academic education, and the impact of technical and social developments on academic education. Teaching quality is of crucial importance to successful studies. The students are to be given freedom to use their creativity and curiosity and to work on problems together with their professors without any pre-conceived solutions. Students must think outside of the box, develop knowledge on their own, ask critical questions, and pursue their ideas independently.

In the course of the event, KIT and HsKA presented projects funded by the State Ministry for Science under the "Successful Studies in Baden-Württemberg" program. Within the project "Motiviert für die Wissenschaft – MoWi-KIT" (motivated for science), research-based education through cooperative teaching and learning methods and systematic development of research competence are integrated into bachelor's programs. The project "Studienlotsen, Mentoren und entschleunigte Studienpläne" (study pilots, mentors, and decelerated study plans) is aimed at supporting students in getting used to university studies by individual advice and assistance. In addition, services are offered to decelerate studies.

With the help of the HsKA project "Erfolgreich starten plus" (successful start plus), students with extremely different qualification levels can start their studies with different adapted learning and teaching speeds. The project "H.ErT.Z – Hochschuloffenes Elektro Technik Zentrum" (open electrical engineering center) is to support all HsKA students in acquiring basic knowledge in the area of electrical engineering and in self-controlled learning. E-learning courses are provided for this purpose.

KIT and HsKA conduct projects to support the success of studies.

CHOOSING THE RIGHT SUBJECT

SYMPOSIUM ON APTITUDE TESTS AND SELECTION PROCEDURES IN NATURAL AND ENGINEERING SCIENCES

On November 8, 2018, Karlsruhe Institute of Technology (KIT), together with the universities of Stuttgart and Ulm, organized a symposium on aptitude tests and selection procedures for bachelor's and master's programs in natural sciences and engineering.

Successful studies: how can the best candidates be identified among all applicants?

The symposium covered all aspects, ranging from obtaining first information on study programs available to qualifications required to aptitude tests and selection procedures in natural sciences and engineering.

The judgment of the Federal Constitutional Court on admission restrictions (numerus clausus) in December 2017 drew public attention to the design of aptitude tests and selection procedures for study programs. It is important to optimize rules for the distribution of scarce study places depending on certain selection criteria. But admission to available bachelor's programs should also be linked with an assessment of individual aptitude.

The symposium revealed that challenges and problems in engineering and natural sciences programs are more or less the same in spite of different legal framework conditions in the federal states. How can promising students be identified among the many German and international applicants without the application and admission procedure being a discouraging and demotivating obstacle? This is like squaring a circle: technical and natural scientific study programs require a certain minimum knowledge of mathematics and natural sciences as well as linguistic skills and abstraction capability. Aptitude tests, application and selection interviews, study days or preparatory courses may provide reliable criteria and information for assessing the potential for student success.

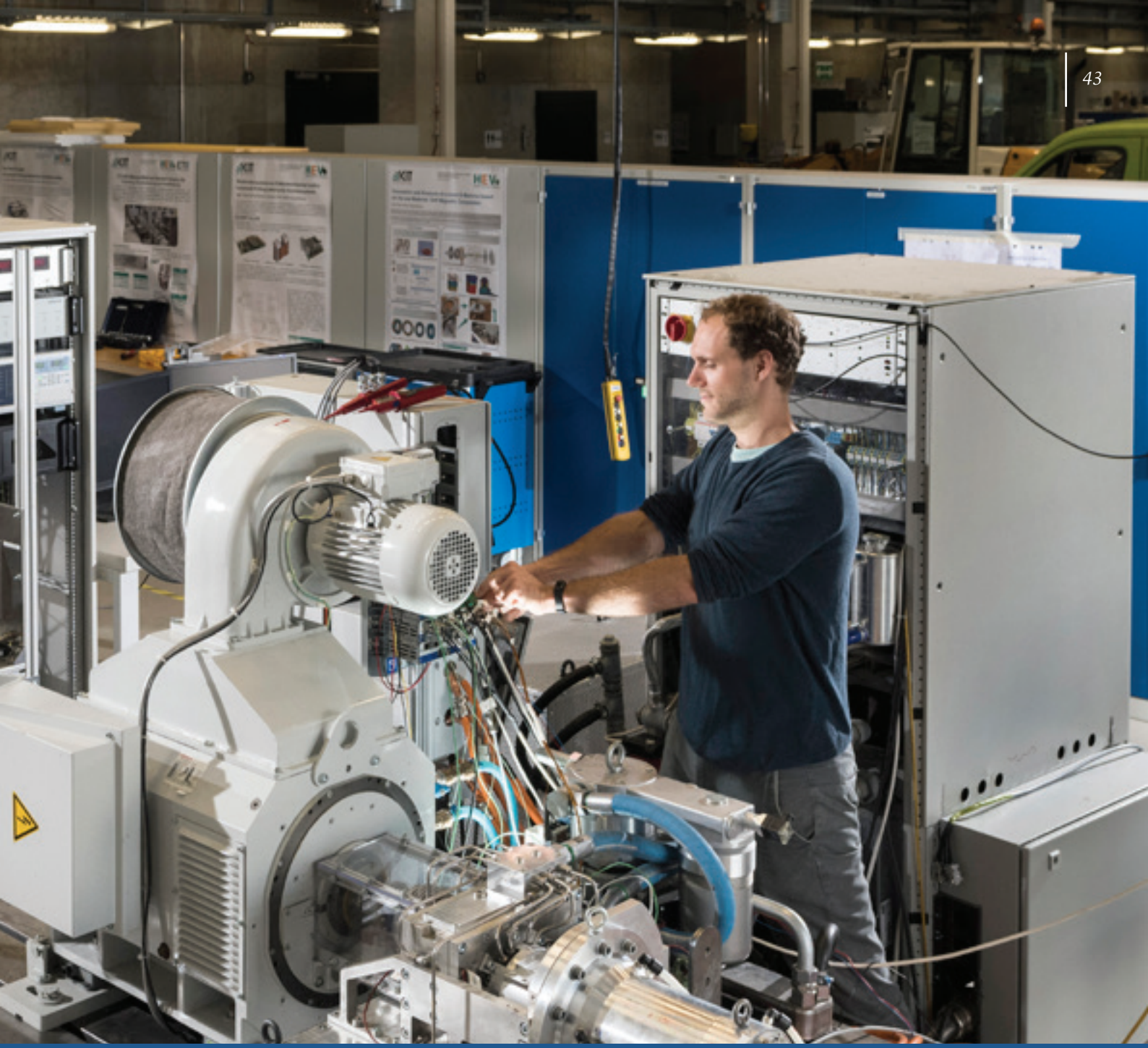
First results obtained after the implementation of such procedures in 2005 confirm that smart use of such tools significantly reduces the number of dropouts. Certain groups, in particular non-EU citizens or female students in natural sciences and engineering subjects, benefitted from such schemes. It is important to give the applicants highly detailed feedback on their capabilities prior to the start of studies and to help them eliminate deficiencies and knowledge gaps.

To establish the infrastructure required for appropriate aptitude tests and admission procedures, the universities of Stuttgart and Ulm, together with KIT, applied for funding that was approved by the State of Baden-Württemberg in January 2019. Within the "Fonds Erfolgreich Studieren in Baden-Württemberg" (FESt-BW, program for successful studies in Baden-Württemberg), the three partners have been granted funding in the total amount of EUR 940,000 to implement aptitude tests and selection procedures for studies of natural sciences and engineering in Baden-Württemberg within the next two years.

INNOVATION

The Karlsruhe Institute of Technology (KIT) stands for the triad of research, teaching, and innovation as represented by excellent science, research-oriented teaching, and transfer of the findings to industry and society.

KIT's innovation strategy adopted in 2017 and orientated towards business and industry is to enable the institution to secure a leading position in the German science system by 2025. KIT is a pioneer in the field of spinoffs and startups. In the current "German Startup Monitor," it holds second place, in the "Startup Radar of the Stifterverband," third place among the large universities. KIT and the Karlsruhe

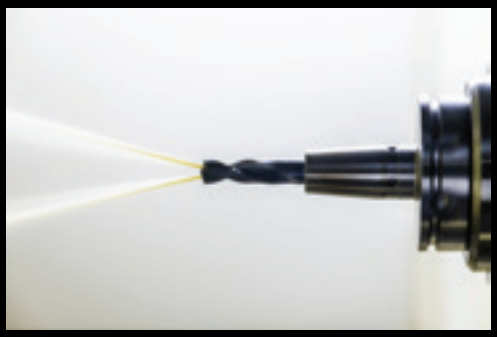


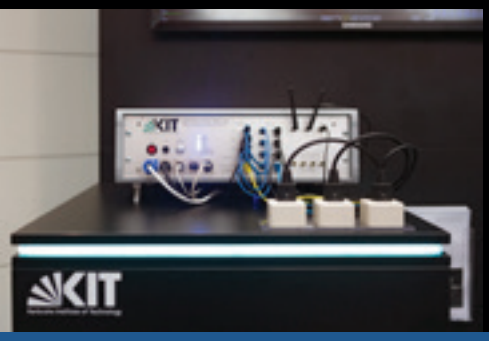
Technology Region are developing into centers of innovation and startups.

NEULAND is an innovation brand, created by KIT in the past few years, in which a number of tools of KIT are concentrated – a competition, a funding source, an innovation day, and a magazine.

The NEULAND competition of ideas is conducted by KIT to market the best technologies and processes as products or components of products. The NEULAND Innovation Day is a platform for all those who are interested in technology transfer and startups at KIT. Seminars, workshops, pitches, awards, and networking ensure an entertaining Innovation Day. The annual NEULAND magazine presents selected innovation stories of KIT.

The Innovation Fund is an internal KIT program for funding technology transfer projects of institutes. In this way, the product-oriented further development of research findings will be achieved jointly with an industrial partner.






OTEGO


Spatenstich ZEISS Innovation Hub @ KIT
06. April 2018


KIT
KIT


Technologieangebote

INDUSTRY 4.0, INFORMATION, MOBILITY, AND ENERGIEWENDE

INNOVATIVE TECHNOLOGIES AT CEBIT AND HANOVER FAIRS

Helper willing to learn: the ARMAR 6 assistance robot can acquire new skills through mere observation, can support people, for instance, by handing them tools.

At the 2018 Hanover Fair organized under the central theme of "Integrated Industry – Connect & Collaborate," KIT presented intelligent sensors for cooperation of humans and robots, a flexible test platform for the power grid of the future, and innovative energy stores and electric motors. KIT was represented at two major lead fairs. "Research & Technology" showed innovative processes for industrial manufacturing while "Energy" presented forward-looking solutions in power supply.

Exhibits included multimodal sensors for industrial robots which enable them to respond simultaneously to movement and touch; production technologies for lightweight motors; a virtual atomizer test rig for all-digital flow experiments; an automated test station for power tools and power-scaled prototype tests up to novel component bonding techniques.

In addition, a flexible test station was presented for power electronics of the future; redox flow batteries were exhibited as stores of renewable energies; there was a monitoring and analyzing tool for power grids; and there were the startups otego, with thermoelectric generators the size of sugar cubes, and SciMo, with electric high-performance drives.

The joint presentations at CEBIT of KIT and the FZI Research Center for Information Technology, an innovation partner of KIT, included research and startup projects. The ARMAR-6 assistance robot acquires new skills by mere observation and is able to support users. The Baden-Württemberg Test Area for Autonomous Driving was experienced virtually in a demonstrator. PriPay is a payment system protecting the private sphere which allows transactions to be handled safely and anonymously, and AUDITOR is designed to achieve Europe-wide data protection certification of cloud services.

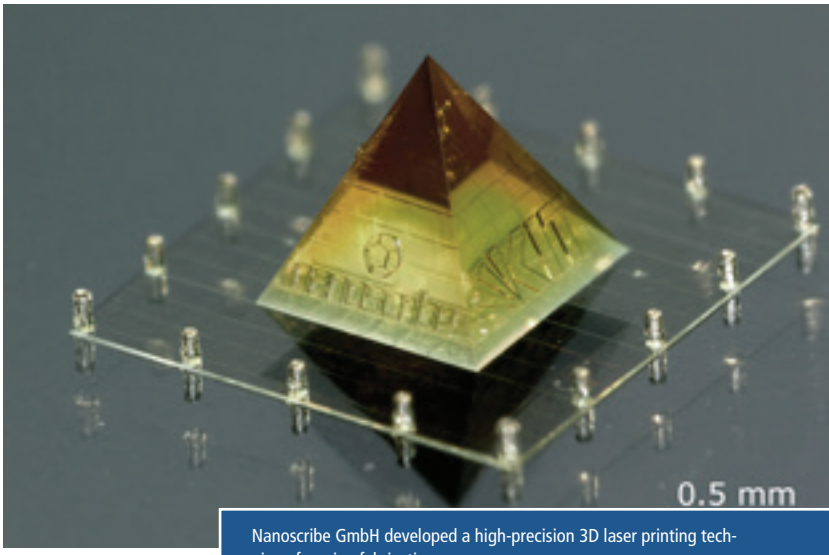
A new KIT startup project was presented every day of the Fair: the Zana startup produces an interactive, intelligent health assistant; the newly founded HQS Quantum Simulations company develops quantum algorithms to predict molecular properties for the chemical and pharmaceutical industries; Usertimes automates established methods of user research; and the Coral Innovation platform of ideas distributes thousands of innovative technologies.

Robot arm with tactile proximity sensors. Multimodal sensors improve cooperation between humans and robots and make it safer.

AWARD-WINNING AND SUCCESSFUL

STRONG STARTUPS: INERATEC AND NANOSCRIBE

Nanoscribe GmbH is one of the most innovative and successful KIT spinoffs. Its founders developed a revolutionary, high-precision 3D laser printing technique at KIT for microfabrication, which made them the world market leader with millions of sales within a short period of time. From a scientific niche, the company founded in 2007 became a technology leader with now more than 60 staff members. The new technology – two-photon polymerization – is being used especially in areas like photonics, micro-optics, medical technology, and communication technology.

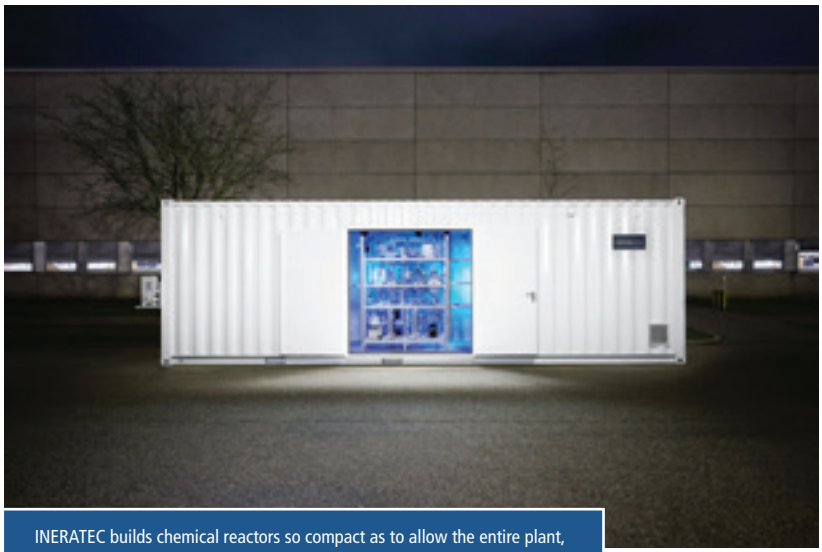


Nanoscribe GmbH developed a high-precision 3D laser printing technique for microfabrication.

Proof of the innovative power of Nanoscribe GmbH is the first prize won in the Baden-Württemberg state competition of young companies organized by the state of Baden-Württemberg and the L-Bank. 375 candidates from all over Baden-Württemberg had competed for that state award. The German Physical Society (DPG) awarded to Nanoscribe and KIT the Technology Transfer Prize, honoring the innovation process which translated scientific findings into economically successful and useful products.

The INERATEC company, another KIT spinoff, founded in 2014, builds chemical reactors of dimensions so compact that the complete assembly fits into a shipping container and can be used anywhere. The plants are operated, for instance, in the economical production of synthetic fuels from renewable energy sources, an important building block for the "Energiewende." Producing synthetic fuels, such as gasoline, kerosene or diesel fuel, so far has required huge facilities. The Karlsruhe founders not only shrunk these large plants to miniature sizes; the energy required for the process may come from renewable sources.

For this innovative technology, INERATEC won the German Entrepreneur Award (Deutscher Gründerpreis) as Germany's best startup. The prize is awarded to particularly innovative founders proposed by a network of experts. At the 2018 Innovation Awards ceremony of the German Gas Industry, the young company won the Special Award for Innovative Start-ups. Moreover, INERATEC received the Lothar Späth Award given for the first time to distinguish outstanding cooperative ventures of business and science in Baden-Württemberg and Thuringia.



INERATEC builds chemical reactors so compact as to allow the entire plant, completely assembled, to fit into a shipping container.

GET FORWARD-LOOKING IDEAS ON THE MARKET

NEULAND – INNOVATIVE IN BUSINESS AND SOCIETY

Early identification of innovation potential is the duty of the Innovation Management Business Unit at KIT. This step is followed by the development, together with the institutes and with partners in industry, of strategies for the use and marketing of technologies. To achieve these aims and strengthen innovation culture at KIT, an innovation brand was created over the past few years, NEULAND, combining various KIT tools, including an Innovation Day and innovation competition at KIT.

On the 2018 Innovation Day, more than 750 participants used the opportunity to learn about recent technologies and spinoffs of KIT. This was the third time that the manifold innovation activities at KIT could be discovered. More than twenty seminars and workshops were offered, ranging from financing possibilities and patent law to the presentation of successful cooperative ventures. On a tour, visitors were able to meet all teams of the technology and startup exhibition. The impulse lecture by Christian Klein, Chief Operating Officer and Executive Board Member of SAP SE, was about "Innovate to Win – Shape Digital Change."

Another event on the NEULAND Innovation Day was the KIT startup pitch. Five promising startup teams of KIT each had four minutes to present their business ideas to the public, show their technologies, and capture the attention of potential collaborative research and industrial partners. Teams presenting included axxelera, HQS Quantum Simulations, µprint, Nesto, and Usertimes. First prize in the startup pitch was shared by Nesto and HQS Quantum Simulations. Those two teams also won the audience award.

The NEULAND innovation prize was awarded on this Innovation Day. Winners of the NEULAND competition of ideas were Professor Jürgen Fleischer and Marius Dackweiler of the wbk Institute of Production Science for their "Flexible Automatic Joining of Lightweight Construction Sections by Means of Innovative Fiber Winding Technology" idea. First prize in the special-award category went to Professor Marc Weber and Dr. Nicole Ruiter of the Institute for Data Processing and Electronics for the "3D USCT for Multi-center Study in China."

Innovation Day on July 10, 2018 gave some 750 guests the opportunity to see the most recent developments of KIT.

OF LIONS, UNICORNS, AND FREE SPIRITS

STARTUP ALLIANCE AND KIT GET FRANK THELEN TO KARLSRUHE

Frank Thelen gave hints about founding startup companies and recounted his professional career.

The event featuring the well-known entrepreneur and investor Frank Thelen was one of the year's highlights for the startup scene at KIT and in Karlsruhe. Under the title "Of Lions, Unicorns, and Free Spirits" Frank Thelen, famous for his participation as a jury member in a TV program titled "The Lion's Den," talked to some 750 listeners in a packed Audimax about his professional experience.

What are the challenges to startups, including investors? What is the future of startup culture in Germany, and how are technologies changing our world of labor? These and similar questions were addressed in his keynote speech; he also offered unique impressions of his personal career and reported exciting experience as a founder and investor. His advice to all future startups: Hang on even if many people first will be shaking their heads although your idea is basically sound.

As in the TV founders' show "The Lion's Den," five startups from Karlsruhe – BRC Solar, Nexol, INERATEC, thingsTHINKING, and Usertimes (the latter three teams coming from KIT) were given the chance after his talk to present their products to Frank Thelen and a select jury of local and regional personalities. In the end, the INERATEC startup from KIT won by the skin of their teeth, receiving an award. Loose networking rounded off the successful evening at KIT. The event had been organized jointly by KIT and the Startup Alliance. The Karlsruhe Startup Alliance is a group of all relevant players promoting startups and business in general as well as research and teaching, making this a strong regional network. Anybody interested will find a broad range of consulting offices and founder initiatives with qualified contacts.

The common objective of all partners in the network is to work with and support startup initiatives. Partners include the Chambers of Industry and Commerce, local business promoters, the Technology Factory, the CyberForum, KIT, universities, and a number of startup initiatives.

Loose networking at the fringes of the event rounded off the successful evening at KIT.

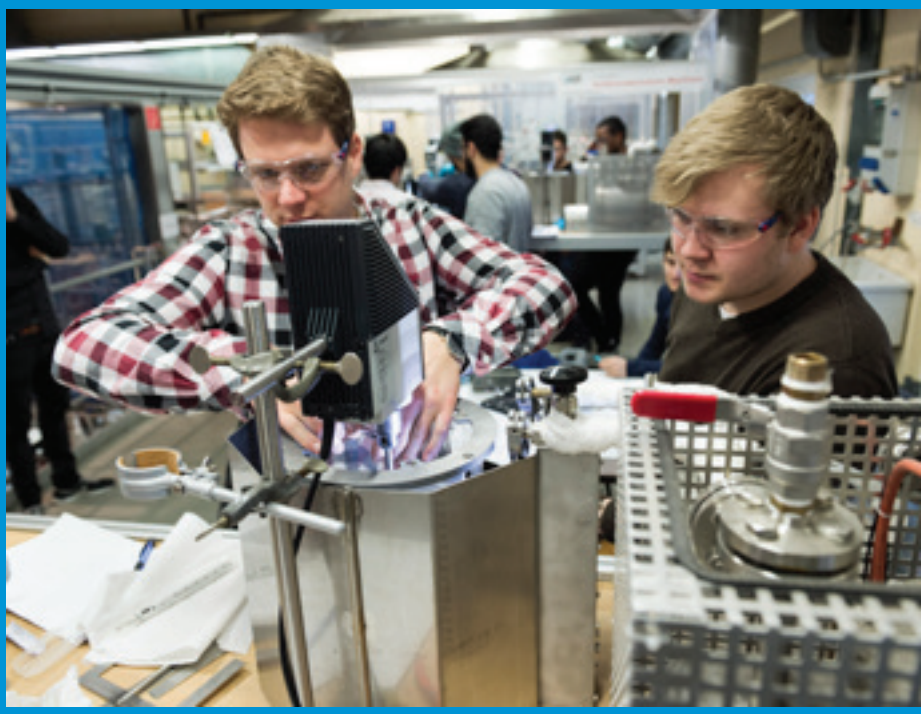
PROMOTING YOUNG TALENT

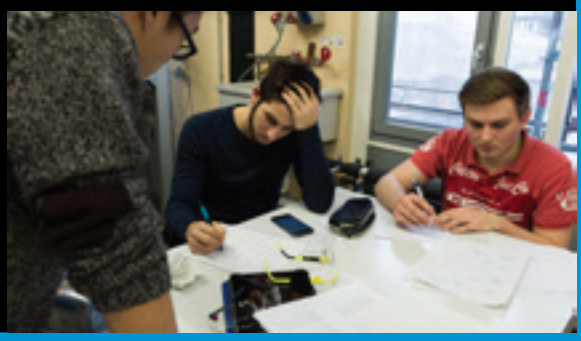
An important objective of the KIT 2025 Umbrella Strategy are plannable career paths and transparency in the professional options of young scientists. In this way, the visibility, (international) competitiveness, and attractiveness of KIT will be enhanced. This implies an expansion of the spectrum of career paths and the establishment of reliable frameworks to help scientists pursue these paths.

These very aspects are addressed in a program launched by the federal and state governments to promote young scientists, the so-called Young-talent Pact, which included a tenure-track program.
For this program, KIT elaborated a personnel develop-

ment concept focusing on young scientists, a description of projects under the program, and a quality assurance concept for tenure-track professorships. KIT received funds out of the Young-talent Pact to finance nine tenure-track positions. Two more are financed out of KIT funds, thus allowing one position to be established at each KIT department.

The objectives derived from the eight areas of action of the KIT 2025 Umbrella Strategy are continued in seven interdepartmental lead projects and eleven intradepartmental implementation projects. The lead project, "Career Phases and Paths for Young Scientists," was completed successfully in the program launched by the federal and state governments. At the present time, the milestones addressed in the application for the pact are being elaborated, such as the expansion of the personnel development concept to more target groups. The complete lead project was transferred into the new "Personnel Strategy" lead project seeking to develop a personnel strategy for KIT with a high level of participation. The personnel strategy is to organize the KIT HR management in a strategic and customer-oriented way and improve transparency of the culture and values of KIT.





INTERNATIONAL TOP-LEVEL RESEARCH

GRADUATE SCHOOL FOR ASTROPARTICLE PHYSICS OPENS

Close cooperation has existed for many years between KIT and Argentinian universities and research institutions in the field of astroparticle physics. Since 2011, a cooperative venture has been in place between the Universidad Nacional de San Martin at Buenos Aires and KIT. In 2015, a dual doctoral program in astroparticle physics was agreed upon. Since 1999, Argentina has been the host country of the Pierre Auger Observatory, whose 3,000-square-kilometer large detector field makes it the world's leading tool for investigating high-energy cosmic radiation.

The close cooperation over many years of Argentinian and German astroparticle physicists has now been further enhanced by a Helmholtz graduate school. With its international research schools, the Helmholtz Association has created a special tool promoting young scientists. In this way, postgraduates are to be taken straight to international top level research in fundamental areas. The dual doctoral program has now been advanced and intensified by the establishment of the international Helmholtz graduate school.

All doctoral researchers have one Argentinian and one German mentor plus the possibility to spend one year working in the partner country. Travel grants and exchanges of teachers are promoted and supported by the Helmholtz Association. Guest stays and close cooperation ensure optimum combination of the expert knowledge of partners in each location to the benefit of doctoral researchers and to enhance research results.

Becoming familiar with a different culture and language in addition to conducting independent international research at an early stage in their careers imposes stringent requirements on young scientists. In the end, they receive a document of graduation bearing testimony, in Spanish on one page and in German on the other page, to their abilities to successfully engage in top-level research in a different language and different culture.

The scientific community of elementary and astroparticle physicists is inconceivable without international cooperation. The Pierre Auger Observatory is nearly unique in the world; its huge detector field as large as Luxembourg, with more than 16,000 detector stations in the West of the Argentinian Mendoza province, can be operated across national frontiers and over many years only on the basis of broad cooperation in a spirit of trust.

The Pierre Auger Observatory in the Argentinian Pampa measures the highest-energy component of cosmic radiation.

ANTENNAS FOR COSMIC RADIATION

ERC STARTING GRANT FOR FRANK SCHRÖDER

Dr. Frank Schröder, junior group leader at the KIT Institute for Nuclear Physics and Assistant Professor at the University of Delaware, USA, receives an ERC Starting Grant for his work in search of sources of highest-energy particles of cosmic radiation from the Milky Way.

Dr. Frank Schröder received one of the coveted Starting Grants of the European Research Council, ERC.

Thanks to major progress in radio measurement technology achieved by Frank Schröder and his junior scientist group at the KIT Institute for Nuclear Physics, also high-energy photons that are associated with the particles of cosmic radiation bearing massive charges can be detected.

The highest-energy particles from our galaxy, the Milky Way, contain many secrets. The sources and mechanisms accelerating them to these high energies are still unknown. These energies are far above those attainable by huge manmade accelerators, such as the Large Hadron Collider, LHC, of the European Nuclear Research Center, CERN, in Geneva. High-energy cosmic radiation is measured by the particle showers it initiates in the Earth's atmosphere, which penetrate to the surface of the Earth. So far, this has been done mainly by particle detectors and optical telescopes. Experiments over many years with antenna stations in the environment of these particle detectors have shown that radio waves also can be used to investigate cosmic radiation.

Radio waves can be observed around the clock, while optical telescopes can be used only for measuring particle showers on clear nights. Moreover, using antennas to make measurements is less expensive. This is how KIT starts searching for photons originating in our galaxy. An ideal observation point for this purpose is the South Pole, from which the galactic center can be observed around the clock. Near the IceCube experiment, an international high-energy neutrino observatory that is part of the U.S. Amundsen-Scott South Pole Station, a measurement area of roughly one square kilometer will be equipped with antennas designed to track the highest-energy photons ever measured.

The European Research Council, ERC, supports Frank Schröder's project with a Starting Grant of EUR 1.6 million for a period of five years. ERC Starting Grants are made available to outstanding early-career researchers with pioneering research projects, whose doctorate was completed between two and seven years earlier. The funding rate of this round of tenders, for which a total of 3170 project proposals were filed, is 12.7 percent.

SCIENTIFIC TALENT FORGE

10TH ANNIVERSARY OF KIT'S YOUNG INVESTIGATOR NETWORK FOR YOUNG TOP-LEVEL RESEARCHERS

For the past ten years, the Young Investigator Network (YIN) of KIT, which is unique nationwide, has served to promote the independence of junior research group leaders and junior professors at KIT, giving them space for intergroup and interdisciplinary networking. This helps recognize common interests and promotes personal development to provide targeted support to researchers displaying responsible leadership qualities.

YIN was founded in 2008. The concept has been unique throughout Germany to this day. More than EUR 150 million of third-party funds acquired, 2000 publications, and 4000 hours of lecturing per term in a decade: the productivity of the approximately 155 active and former members of YIN is something to see. The members manage independent junior groups funded with third-party funds in a variety of research areas, which they acquired themselves and for which they are responsible in regards to HR and budgets. In addition, they make major contributions to teaching at KIT.

YIN offers its members important help and support in successfully implementing these activities. The background of practical experience at YIN that has accumulated over many years turns out to be a valuable resource, and a targeted program of courses allows capabilities to be acquired and competencies essential to junior leaders to be intensified. One successful tool in developing individual potential is the tailored advanced education program, "Academic Leadership – Leadership in Science." This is where members can systematically acquire know-how in management and HR.

Last year, 40 YIN members acquired some EUR 7.3 million of third-party funds in addition to group funds, taught courses for 334 hours per week in a term, and supervised 206 final theses, among them 24 doctoral, 102 master's, and 80 bachelor's theses. Moreover, they published 202 contributions in major scientific journals, attended 186 international science congresses, and filed eleven patents. On average, each YIN member has an annual budget of EUR 360,000, heads a research group of ten members, and teaches seven hours a week during the term. Of the 95 YIN alumni, nearly half now hold professorships, and well over one third conduct research as senior scientists or group leaders at universities in Germany and abroad. The others switched to industry where they hold important posts in research and application.

One success story of KIT is the Young Investigator Network, YIN, which serves for networking of young leading scientists of KIT.

INTERDISCIPLINARY ENVIRONMENT FOR DOCTORAL RESEARCHERS

DATA MINING FOR MEDICINE

Research, diagnosis and treatment of diseases creates immense volumes of data. Mining these systematically can create new knowledge for diagnosing and treating diseases, such as cancer. The Karlsruhe Institute of Technology (KIT), the German Cancer Research Center (DKFZ), and the University of Heidelberg want to jointly train young scientists working at the interface of health research, life sciences and data sciences. This effort is to be funded to the tune of EUR 12 million.

The newly founded Helmholtz Information & Data Science School for Health (HIDSS4Health) will train young scientists in a joint postgraduate program of the three institutions to work on data volumes arising in the health system. This is to teach them how to develop new methods of diagnosis and treatment based on evaluating huge amounts of data.

There are many examples of digital transformation in health: machine learning and other data-driven methods can help interpret images produced in computerized or nuclear magnetic resonance tomography. Physicians need a rich background of experience and much time to evaluate such images. This is where the right kind of algorithms can help, for instance, by directing a physician's attention to specific regions. Also, personalized radiotherapy can employ methods and technologies developed for data sciences.

Positions will be created for 35 to 40 doctoral researchers, who will work in various groups at the three locations in Heidelberg and Karlsruhe. The program is designed for applicants with a background in data science and an interest in medical subjects. KIT is investing more than EUR 3 million, while DKFZ and the University of Heidelberg together are contributing approximately the same amount again. Nearly EUR 6 million comes from the Helmholtz Association of German Research Centers.

The Helmholtz Association will henceforth invest EUR 35 million annually into digitization of research, and is establishing four novel platforms for this purpose, one of which was created with the participation of KIT and DKFZ: the Helmholtz Information & Data Science Academy (HIDA). Five Helmholtz Information & Data Science Schools (HIDSS) will join forces under the HIDA umbrella.

The complete system of the ForHLR II supercomputer available to HIDSS at the Steinbuch Centre for Computing.

INTERNATIONAL AFFAIRS

The KIT is international. People from more than 120 countries conduct research, teach, work, and study on its different campuses. In 2018, the Supervisory Board approved the newly formulated area of action "International Affairs," which now complements the KIT 2025 Umbrella Strategy as the eighth chapter. The area of action defines the framework for shaping internationalization at the KIT.

Each and every individual can help shape internationality, in international learning groups and communities or in European projects, for example. Many members of the KIT are involved in international activities, often beyond their studies and professions.

A new organization, a foreign place – all beginnings are difficult, also for people with an international background. The KIT invites international newcomers to a variety of welcome events and intercultural encounters.

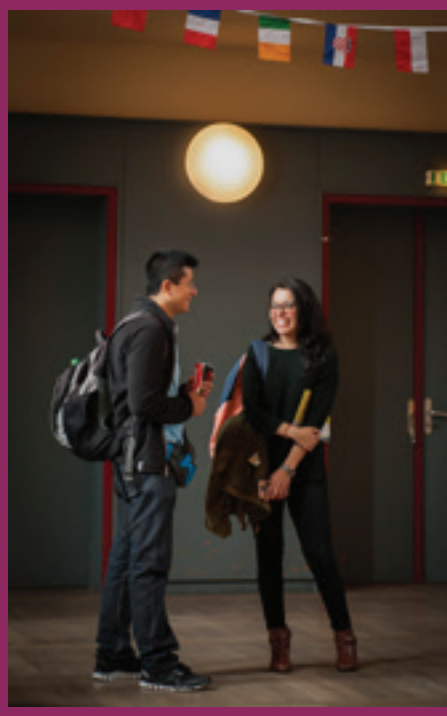
KIT encourages students as well as employees in science and administration to gain experience abroad. As an international campus, KIT also offers opportunities for intercultural dialog and exchange. International teams shape teaching and research at KIT. Collaboration with partners abroad is essential for KIT and indispensable for globally visible excellence.

Scientific progress thrives on exchange and competition with the best. The targeted recruitment of top international scientists and invitations extended to internationally renowned researchers promote scientific exchange and international networking in KIT's three core tasks.

Internationalization at KIT is a continuous process. Data, key figures, and indicators of quality assurance in research, teaching, and innovation at KIT form the basis for continuously monitoring this ongoing effort.


INSA


KIT

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INTERNATIONAL KNOWLEDGE TRANSFER

A NEW PLATFORM TO EXPAND GOOD RELATIONS WITH SILICON VALLEY

KIT Link is a new platform that KIT will use to expand its good relations with universities, companies, and alumni in Silicon Valley. The platform is intended to cultivate existing relationships, activate new ones, and strengthen the visibility of KIT in Silicon Valley. Students, researchers, startups, and established companies will be addressed equally.

The aim of KIT Link is to facilitate knowledge transfer in both directions through intensive exchange. The platform is intended to be a valuable source of inspiration both for society and for business in Baden-Württemberg and Silicon Valley. This could lead to partnerships to solve global issues of the future.

KIT Link stands for knowledge exchange and communication via minds. The alumni of KIT in Silicon Valley can make an important contribution with their CVs and experience. The aim of networking is to give partners on both sides direct access to current knowledge, innovative processes, and working methods. Concrete cooperation between business and science will be initiated, and KIT students will be given more opportunities for internships. The platform is virtually located at SAP, a strategic partner of KIT that has a strong foothold in Silicon Valley.

The first of KIT's Zeitgeist events marked the start of a lively exchange with decision-makers and partners in civil society, politics, business, culture, and science in Silicon Valley. Cyriac Roeding and Guido Appenzeller talked about "Enterprising for a Better Globe: Silicon Valley Insights – Trends and Developments Ranging from AI to Health." The two speakers are alumni of KIT and successful entrepreneurs in Silicon Valley.

Further Zeitgeist events in the San Francisco Bay Area and in Baden-Württemberg are planned. They will focus on topics such as digitization, artificial intelligence, robotics, and autonomous driving.

Host Doug Garland, Vice-President Thomas Hirth, alumnus Guido Appenzeller, Minister-President Winfried Kretschmann, Minister Theresia Bauer, and alumnus Cyriac Roeding (from left to right) at the KIT Link launch event in the San Francisco Bay Area.

CHILE, A STRATEGIC PARTNER OF THE KIT

CONFERENCE OF THE RESEARCH ALUMNI, AND NEW NETWORK – EXCHANGE ON RENEWABLE ENERGIES

KIT is linked to Chile through a strategic partnership, which forms the basis for a large number of activities supported by the Chile Cluster of KIT. The Chile Cluster brings together 45 KIT researchers from 17 institutes. The activities include the establishment of the German-Chilean "Institute for Eco-Industrial Development (IEDE)." The virtual institute has been funded by the Federal Ministry of Education and Research (BMBF) since 2017.

The participants in the KIT Research Alumni Conference, which was held in Santiago de Chile on November 23 and 24, 2018 and was dedicated to the topic of renewable energies.

In 2018, the focus was on strengthening KIT's relations with its research alumni in Chile. KIT organized an event in Santiago de Chile with funds from the Alexander von Humboldt Foundation from a call for proposals for "Research Alumni Meetings Abroad." The research alumni conference focused on the topic of renewable energies and took place at the Heidelberg Center Latin America of the University of Heidelberg in Santiago de Chile.

KIT research alumni who were working at a research institution in Chile or another Latin American country at the time of the conference were invited, as were the Alumni Club presidents in Central and South America. At the conference, participants were able to exchange information on the latest research results on renewable energies, gain insights into current research both at KIT and at their respective institutions, or find out about funding opportunities for new research stays at KIT. In addition, the former visiting researchers gained insights into ongoing KIT collaborative projects in Chile.

26 research alumni and Alumni Club presidents of KIT took part. The conference was opened by KIT Vice-President for Innovation and International Affairs Professor Thomas Hirth. The German Ambassador invited the participants to a reception at the German Embassy in order to show special appreciation for the research alumni and the KIT initiative. During a visit to the Fraunhofer Center for Systems Biotechnology, the participants gained insights into the Center's research.

Also in 2018, the new Eco Mining Concepts network that deals with the challenges of and opportunities for more sustainable mining in Chile was inaugurated in Santiago de Chile. In addition to Vice-President Professor Thomas Hirth, Professor Thomas Kohl from the Institute of Applied Geosciences and Professor Andreas Braun from the Institute of Regional Science, who is also the scientific spokesman of the Chile Cluster, participated in the opening ceremony.

INTERNATIONAL COOPERATION WITH CHINA

INNOVATION FACTORY FOR ARTIFICIAL INTELLIGENCE AND HYDROGEN PROPULSION RESEARCH PROJECT

More than 130 cooperation projects with more than 40 Chinese partners demonstrate the versatile cooperation between KIT and the People's Republic of China. The Global Advanced Manufacturing Institute (GAMI) in Suzhou, which was founded in 2008, laid the foundation for the exchange of knowledge and scientists. GAMI is a branch of wbk Institute of Production Science. In China, it conducts research into global production structures in order to prepare companies that produce locally for country-specific requirements, for example, with regards to Industry 4.0.

Current topics include the integration of Artificial Intelligence (AI) into industrial production and the increasing digitization in the course of Industry 4.0, as well as its consequences for manufacturing processes and employees. The Artificial Intelligence Innovation Factory (AIIF) that was opened recently at GAMI is a German-Chinese platform that serves as a research and training environment providing students, researchers, and industry partners with the necessary skills for AI technologies in production. At AIIF, GAMI, together with German and Chinese companies and startups, explores AI-based applications in the fields of augmented and virtual reality, cloud and big data computing, and human-robot collaboration.

A joint research project on hydrogen propulsion was launched by KIT and Tongji University in Shanghai. New methods for joint technology development are to be tested at separate locations. In the MovE2China research project funded by the German Federal Ministry of Education and Research (BMBF) and the Chinese government, engineers in Germany and China are to work simultaneously on the validation of electrified drive systems in fuel cell vehicles. The spatial separation of the developers makes it necessary to use latest technologies and fast data connections.

In cooperation with the Clean Energy Automotive Engineering Center (CEAEC) at Tongji University, KIT's Institute of Product Engineering IPEK will now develop validation methods and environments, which, contrary to traditional methods, also work at a distance. This means, e.g., that a fuel cell physically located in a laboratory at KIT can be virtually integrated into a test drive in Shanghai for measurement purposes.

German and Chinese representatives from research, politics, and industry celebrated the tenth anniversary of GAMI and, on that occasion, opened the Artificial Intelligence Innovation Factory.

COOPERATION WITH CANADA

SAVING ENERGY THROUGH CONSTRUCTION THAT IS APPROPRIATE TO THE REQUIRED USE

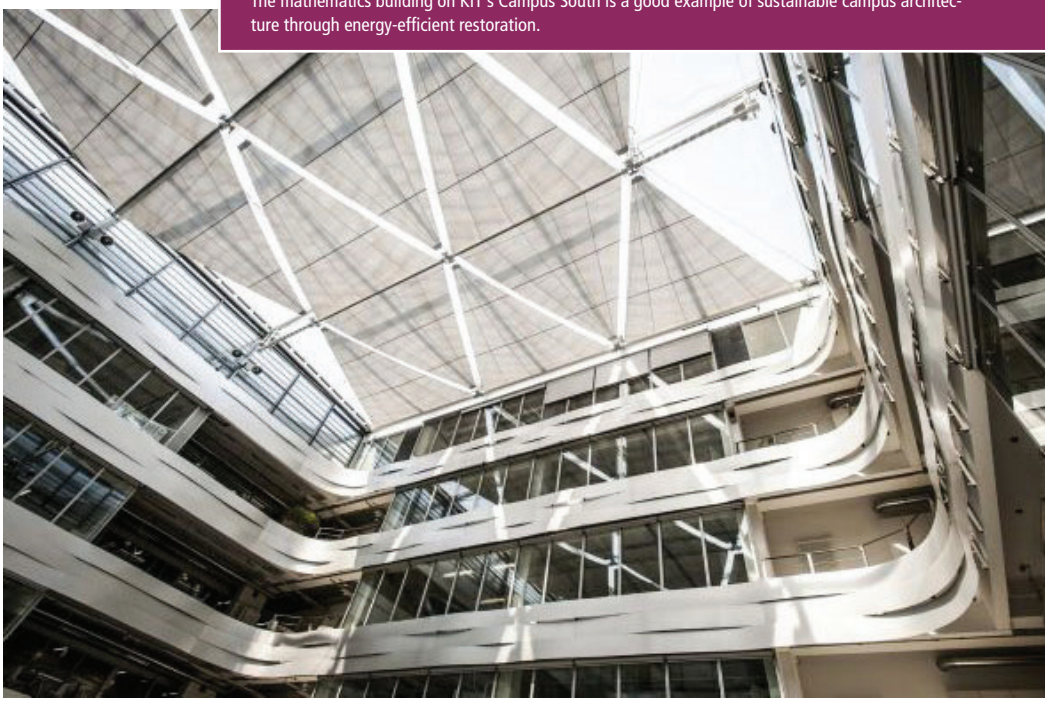
Improving the energy efficiency of buildings is one of the most important factors in climate protection. The focus is usually on energy-efficient construction and renovation, but user behavior is also very important. In a global project of the International Energy Agency (IEA), coordinated by KIT and Carleton University in Ottawa, researchers are investigating how precisely this behavior contributes to the energy balance of a building and how it can possibly be intelligently influenced.

Today, about one third of the world's primary energy is used to power buildings. As the surface area of these buildings is constantly increasing, the energy demand continues to rise despite improvements in energy efficiency. This is the conclusion reached by the IEA, which points to so far untapped potential savings of up to 80 percent. Energy-efficient construction and renovation are not the only ways to reduce the energy requirements of buildings. If customers use energy sensibly and economically, consumption can even be halved, depending on the type of building and how it is used. Wasteful behavior may nearly double consumption.

Often, user behavior is affected adversely by thoughtless automation, such as an automatic heating system that lacks an efficient user interface. If users have no other way to control room temperature, they tear open the windows or use inefficient radiant heaters in addition. To actually save energy, automation has to be designed such that users can sensibly influence building technology at any time.

To systematically study the relationship between user behavior and the energy performance of buildings, KIT and Carleton University in Ottawa are coordinating an interdisciplinary and international research project under the auspices of the IEA. Researchers from fourteen nations are involved in the project. The project first of all deals with fundamental questions, e.g., how comfort parameters in buildings, including thermal, visual, olfactory, or acoustic conditions, interact with each other and influence energy-relevant behavior. In addition, the role of user interfaces will be investigated and light will be shed on how thermostats, light switches, and blinds can be designed as intelligently as possible. To model user behavior with regard to energy consumption, the researchers plan to use big data methods based on different data sets, such as data from building technology or the Internet of Things (IoT).

The mathematics building on KIT's Campus South is a good example of sustainable campus architecture through energy-efficient restoration.



KIT AS AN EMPLOYER

With 9,277 employees, KIT is one of the largest employers in the Technology Region Karlsruhe. The staff is composed of 5,046 scientific and 4,231 non-scientific members. The share of women is 37.23 percent. KIT hosts 1,286 foreign employees, the majority of whom are scientific personnel.

In addition, there are 366 professors and senior researchers, 15 of whom were appointed in 2018.

Important topics in 2018 were the completion of the project "Conflict Management System at KIT" and data protection. A special focus was on the topic of

equal opportunities. Vocational training was also very successful.

KIT is one of the top locations for vocational training among young people in the area of Karlsruhe and throughout Germany. Every year, KIT systematically prepares around 400 trainees and students in more than 30 professions and 12 degree programs at the Baden-Württemberg Cooperative State University for their future tasks.

In order to keep vocational training at KIT at a high level, a training management tool was introduced.

Another focus was on the preparation of a service agreement on telework and mobile work. In addition to dealing with working hours, the service agreement covers topics such as occupational safety, liability issues, and data security. The service agreement came into force in spring 2019.

COORDINATED BY A STAFF UNIT

CONCEPT FOR A KIT CONFLICT MANAGEMENT SYSTEM

For one year, the project "Integrated Conflict Management System (KMS) for the KIT" initiated by the Vice-President for Human Resources and Law worked on a new basis for dealing with conflicts at KIT. At the end of the project, a concept for future conflict prevention and resolution was produced.

From the Medical Services to the Staff Council and ombudspersons of KIT, from KIT's Internal Consulting to the Mediation Staff Unit: numerous units and persons at KIT are entrusted with the resolution of conflicts. All these conflict contact points have been integrated into the project and have successfully contributed their skills and experience.

The basis for further steps was a common understanding of the topic and clarification of terminology. This resulted in a glossary which is made available to the employees and the managers of KIT. In addition, the legal basis was examined and an inventory of existing offers was drawn up. Experiences gained with conflict management systems at other universities, research institutions, and in public administrations were systematically evaluated for their applicability at KIT. An ideal process for handling conflict emerged.

These results led to a proposal for future conflict management at KIT: the interaction of the conflict contact points and the strategic further development of the conflict management system will be part of a network structure that will be coordinated by a staff unit. To this end the Executive Board decided to integrate the Internal Consulting Office of the Human Resources Development and Vocational Training Business Unit into the Mediation Staff Unit and rename it Conflict Management and Psychosocial Counseling Staff Unit (KMB).

In addition to dealing with optimized conflict management, the project focused on conflict prevention: how can conflicts at KIT be avoided in the future? Central starting points for this will be to give information to all employees as well as to offer target group-specific training courses to executives and employees. KIT's internal public relations work will increase the visibility of consulting and training offerings and reduce fears of the topic of conflicts.

In 2019, the implementation of the conflict management system and the establishment of an active network for conflict management will take place with the aim of maintaining or restoring the well-being and working capacity of all employees. On the way to a conflict-proof organization, appreciation, tolerance, transparency, and openness are the basic values of the KIT community.

Vice-President Christine von Vangerow at the kick-off of the Conflict Management System project.

DATA PROTECTION AT THE KIT

A PILOT PROJECT FOR IMPLEMENTATION OF THE GDPR

Data protection is intended to prevent the misuse and criminal use of personal data in particular.

The KIT implements, primarily in a process-oriented manner, the requirements of the EU General Data Protection Regulation (GDPR), which has been applicable throughout the EU since May 25, 2018. A pilot implementation project was established in 2018 by the Vice-President for Human Resources and Law, which initially will deal with teaching. The transferable processes and structures to be developed will be rolled out subsequently throughout the entire KIT. In addition to the Data Protection Staff Unit, representatives from various organizational units and KIT departments as well as a member of the Staff Council are also involved in the project. Among other things, model procedures to fulfill the rights of data subjects, in particular the right to information pursuant to Section 15 GDPR, are being developed. One focus of the project is the creation and establishment of a concept for introduction of the so-called scheme of "decentralized contact persons for data protection."

Obligation to Notify According to Sections 33, 34 GDPR

Pursuant to Sections 33, 34 GDPR, the KIT must report any violation of the protection of personal data to the competent data protection supervisory authority immediately and, if possible, within 72 hours of the violation becoming known if there is a risk to the rights and freedoms of natural persons. If there is a high risk, the data subjects must be informed of the violation. To implement these reporting and information obligations, an internal procedure, the so-called reporting plan, was established at KIT in 2018, which ensures that the relevant requirements are known at KIT and that the necessary reports and information can be submitted on time. Actions included the establishment of an internal reporting office, which is responsible for receiving the reports, assessing the respective risk, coordinating with the Executive Board, and making any necessary reports.

Data Protection E-learning Course

In 2015, e-learning courses on the fundamentals of data protection at KIT were introduced by the Data Protection Commissioner. All employees who have worked at KIT for more than four months have to complete this training every three years. Against the background of the GDPR, a new e-learning training course concept was drawn up in 2018 and developed in cooperation with the Center for Technology-enhanced Learning (Zentrum für Mediales Lernen - ZML).

EVALUATION, KIT SENATE COMMISSION, AND UNCONSCIOUS BIAS

EQUAL OPPORTUNITY – MORE THAN JUST A BUZZWORD

In 2018, KIT continued to focus on the implementation of equal opportunity. Below are some highlights:

In 2018, an external evaluation of KIT's entire equal opportunity policy was conducted by the Center of Excellence Women and Science (CEWS). The aim of this evaluation was to shed light on the status quo of equal opportunity at KIT and to identify potentials and fields of development for a strategic orientation of equal opportunity policy. The good news is that there is a high level of awareness regarding "equal opportunity" at KIT as a whole and that good approaches exist for gender sensitization. In addition, a differentiated portfolio of measures promoting equal opportunity and compliance with the defined objectives was confirmed. The main recommendations of the experts include the development and deepening of gender competence at all levels, the creation of a uniform understanding of equal opportunity, and the sharpening of existing interfaces and processes. In 2019, the recommendations from the evaluation will be systematically elaborated and implemented in a project.

The KIT Senate Commission on Equal Opportunities and Diversity, whose establishment was decided in the Equal Opportunities Plan 2014 to 2018, was set up in 2017: the KIT Senate Commission serves an advisory role to the Executive Board and to the KIT Senate and acts as a multiplier that reaches into the divisions, the administration, and the infrastructure of KIT. It hence is an important element of KIT's equal opportunities structures. In the inaugural meeting on February 7, 2018, the two guidelines on gender-correct language and visual language (concerning students), which were developed by the working groups of the "Recruitment of Women Students" forum, were presented and adopted by the KIT Senate Commission. Another topic was an application filed by the student body regarding the free choice of the first name on the KIT Card for persons without clear gender affiliation. This proposal was taken up again in the second session of the KIT Senate Commission and received the vote to derive recommendations for the Executive Board and the KIT Senate.

The topic "Unconscious Bias," which deals with cognitive distortions of perception and associated unconscious assumptions, was pushed forward at KIT in 2018. The Diversity Management team implemented the concept developed last year for "Unconscious Bias" through several workshops and addressed about 200 KIT employees. "Unconscious Bias" now is part of the repertoire of training programs for greater gender and diversity sensitivity and is continuously being further developed and expanded.

The fourth women's plenary meeting at KIT took place on February 20, 2018 at the auditorium of the Center for Advanced Technological and Environmental Training on Campus North.

SUCCESSFUL VOCATIONAL TRAINING AT KIT

CHRISTIAN WEGMANN IS GERMANY'S BEST APPRENTICE IN HIS PROFESSION

The KIT is one of the largest providers of apprentice positions in the Karlsruhe Technology Region and enjoys an excellent reputation across state borders. This is reflected in the various prizes and awards that KIT's Vocational Training Business Unit received in 2018.

For example, Focus Money awarded KIT the seal for "Germany's Best Apprenticing Companies 2018." KIT also received a special award in 2018 in the form of the nationwide company award "Berufsbildung ohne Grenzen" (vocational training without borders). The KIT was the only institution from Baden-Württemberg to receive the first prize awarded by the network of the same name in cooperation with the Federal Ministry for Economic Affairs and Energy, the German Confederation of Skilled Crafts (Zentralverband des Deutschen Handwerks - ZDH), and the Association of German Chambers of Commerce and Industry (Deutscher Industrie- und Handelskammertag – DIHK). For the inaugural competition, training companies that promote internships for their trainees abroad were invited. The winners of the competition were honored by Dr. Achim Dercks, Deputy Managing Director of the Association of German Chambers of Commerce and Industry (DIHK), and Hans Peter Wollseifer, President of the German Confederation of Skilled Crafts (ZDH). Federal Minister for Economic Affairs Peter Altmaier and the wife of the Federal President, Elke Büdenbender, also took part in the festive event at the Federal Ministry for Economic Affairs in Berlin.

One indicator of the high quality of vocational training at KIT is a success rate of almost 100 percent of final examinations. In 2018, this rate was again significantly higher than the state or national average. At the 2018 Best-of-the-Year event of the Karlsruhe Regional Chamber of Commerce and Industry, ten prize winners came from KIT. One chemical laboratory assistant and one biology laboratory assistant were honored in the scientific professions, three industrial mechanics in the industrial and technical professions, two industrial clerks for foreign trade in the commercial professions, two IT specialists for system integration, and one mathematical-technical software developer in the IT professions. This means that almost ten percent of the 2018 graduates at KIT completed their vocational training as the best in their respective professions.

Dr. Eric Schweitzer, President of the DIHK, honored Christian Wegmann as the national winner in his apprenticed profession "Mathematical-technical Software Developer."

Mathematical-technical software developer Christian Wegmann was honored as one of the best trainees in Germany by the Association of German Chambers of Commerce and Industry (DIHK) in Berlin. During the Best-of-the-Year event, Germany's 200 best apprentices were handed over prizes. Keynote speaker at the event presented by Barbara Schöneberger was Federal President Frank-Walter Steinmeier.

In early November mathematical-technical software developer Christian Wegmann received the award for the best apprentice in Baden-Württemberg. He passed his vocational training at KIT's Institute for Neutron Physics and Reactor Technology. From the very beginning, he was involved in the group's scientific activities and developed visualization programs for simulating particle motions in a reactor. Meanwhile, Christian Wegmann has begun to study mathematics at KIT.

LIFE AT KIT

Bikers' campus, real-world laboratory, climatology and environmental research, spring days of sustainability: KIT has no lack of sustainable concepts, activities, and ideas. Its size and technical orientation allow KIT, as a training center of future players and decisionmakers, to contribute significantly to a more sustainable future. It is for this role that the German Commission for UNESCO awarded to KIT the distinction of "Learning Place for Sustainable Development."

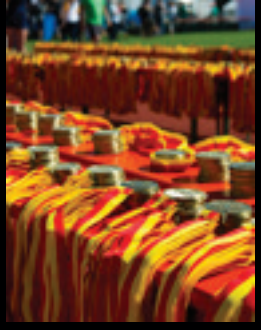
The application for this award was initiated by ZAK I Centre for Cultural and General Studies at KIT together with the ZUKUNFTSCAMPUS Staff Unit and

the Karlsruhe School of Sustainability (KSN). ZAK Director Professor Caroline Y. Robertson-von Trotha accepted the award from the hands of Christian Luft, Undersecretary of State with the Federal Ministry of Education and Research, and the President of the German Commission for UNESCO, Professor Maria Böhmer.

Teaching modules, projects, and accompanying courses on sustainable development have been used by ZAK for many years to work on the theoretical and conceptual perspectives of sustainability, disseminating to all KIT students application-oriented knowledge and competencies.

To anchor sustainability in teaching and research, KSN and the Sustainability Network at KIT (NeNa) interconnect interested players. Through innovative active teaching formats, KSN establishes exchanges among researchers, students, and civil society. The intention is to ensure that, henceforth, all KIT graduates develop the skills necessary to help design sustainability transformations.

Besides teaching and participatory approaches, the jury praised the sustainability management of KIT. For this purpose KIT, among other things, set up ZUKUNFTSCAMPUS, a staff unit for sustainability.




GEMEINSAM
AN DIE SPITZE


KIT
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KIT SC
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FUTURE INFRASTRUCTURE FOR RESEARCH AND TEACHING

NEW BUILDINGS FOR THE ENGLER-BUNTE INSTITUTE AND THE MINT-KOLLEG

Up-to-date building technology, innovative space concepts, and modern architecture are features of two new buildings on Campus South of KIT, marking an important step towards improved research and teaching infrastructure. The new buildings are used by the Fuel Chemistry and Technology Division (EBI ceb) of the Engler-Bunte Institute and the MINT-Kolleg Baden-Württemberg.

The Chair of Fuel Process Engineering and the Professorship of Chemical Conversion of Renewable Energies make EBI ceb a key research institution of KIT in the field of energy and environmental technologies. EBI ceb scientists conduct research and offer courses associated with the generation and use of chemical energy resources and fuels for future energy supply. The new building offers to EBI ceb outstanding conditions for optimally discharging its responsibilities in research, teaching, and innovation in the future.

The MINT-Kolleg is a joint institution of KIT and the University of Stuttgart supporting persons, including students of the MINT disciplines, who are interested in studying the MINT disciplines of mathematics, informatics, and sciences by offering additional courses in the initial phase of study. The new building offers optimum conditions for the MINT-Kolleg by allowing young persons to prepare, at a central location, for the requirements of studying a scientific or engineering discipline.

The builder and owner is the State of Baden-Württemberg as represented by the Karlsruhe Office for Assets and Construction in Baden-Württemberg. Total construction cost amounted to roughly EUR 26 million. The new building is the first block composed of two sections in a new structure designed for a total of four sections. The new building for EBI ceb has a useful area of 1936 m^2 for laboratories for fuel technology, offices, and a large experimental hall. The second new building has a useful area of 1715 m^2 for one lecture hall, several large seminar rooms, the offices of the MINT-Kolleg, and experimental rooms of EBI. Some of the seminar rooms and the auditorium are used by the MINT-Kolleg together with the EBI institute sections.

The new buildings 40.50 and 40.51 designed for the Engler-Bunte Institute and the MINT-Kolleg are located on KIT Campus South on the fringes of the Hardtwald forest.

OUTDOOR SPORTS FACILITIES OF KIT MOVED AND UPGRADED

ATTRACTIVE FACILITIES FOR SPORTS STUDIES AND POPULAR SPORTS

Five new tennis courts, a shot-putting facility, a multi-function open-air sports hall, and an artificial turf have been built on the KIT premises of the Institute of Sports and Sports Science (IfSS) with support from the city of Karlsruhe. The new facility replaces tennis courts, which are being given up, and the "old turf" sports area of KIT, which will henceforth be used by the Karlsruhe SC football club.

The new facilities include a multi-function space of approximately 800 m^2 of artificial turf bearing an open-air hall. Moreover, five tennis courts with sprinkler and fence systems were built. An existing artificial turf acting as a large playground with a floodlight and a sprinkler system and multi-colored lining for soccer football, American football and Lacrosse, was moved to a new location. Extensive ball catching facilities and walls protecting against noise separate the functional areas. Also included is a practice area for shot-putting, a place for discus throwing, and preparatory work for a boulder wall. Surfaces designed to store sports equipment were solidified. Routing within the sports area and surface drainage have been adapted to the new sports grounds.

The new sports facility of the Institute of Sports and Sports Science was built with the support of the city of Karlsruhe.

Moving some of these facilities became necessary because the space occupied by KIT's former tennis courts will be needed for the new football stadium under construction in the Wildpark. The city of Karlsruhe contributed EUR 3 million to finance this transformation. In this way, an innovative and modern sports campus was built in the sports city of Karlsruhe within a very short period of time.

The outdoor sports facilities of KIT are used daily by sports students and participants in university sports. University sports is offered to students and employees of KIT and a variety of cooperating institutions. University sports is also an integral part of the Health Network planning and organizing measures to promote health at KIT. The KIT Health Network won the "Corporate Health Award" in 2018. The auditors saluted KIT for establishing an outstanding health management system which is among the best to be found at German universities.

A discipline which can be trained and played in the new sports facility: Lacrosse, the fastest type of sports on two legs.

CONCISE INFORMATION

COFFEE LECTURES PRESENTED BY THE KIT LIBRARY ON CAMPUS NORTH

The "Coffee Lectures" serve to present the services of the KIT Library on Campus North over a free cup of coffee in several concise lectures of 30 minutes each. This low-level dissemination of information was to show to interested persons how the library can support and advance their work. The range of topics ranged from library services and special information technology around libraries to methods of learning and working.

Approximately 30 participants in the pavilion of the KIT Library on Campus North received information, as well as plenty of caffeine, about the Citavi tool for literature and full-paper searches, the Zotero open-source literature administration program, worldwide literature searches using the Web of Science or Scopus, research data management, and the RDM@KIT service team. The audience learned about research services regarding publishing, such as Open Access and KITopen, or about the way bibliometric analyses support the evaluation of research fields. The 4 1/2-hour program was rounded off by papers about the promotion of open-access publishing by the KIT Publication Fund, and the most important changes in copyright law with respect to teaching and research.

This format, which has been offered at the KIT libraries for a couple of years, picked up on the trend of presenting information in small units in a concise format, providing insights into the manifold services, and preparing topics so as to interest the audience. All staff members in science and administration as well as young scientists are invited to attend the "Coffee Lectures." The staff of the library also can attend internal "Coffee Lectures" on topical subjects.

The KIT Library was the first German library to introduce the "Coffee Lecture" format in 2015. Since then, a Coffee-Lecture family has been created. There are ten-minute low-level lectures on library services three times a week designed for KIT students, which also involve the House of Competence. There are many imitators in Germany now; the first Coffee Lectures User Meeting with guests from Switzerland and Austria has already been organized at KIT.

The KIT Library on Campus North presented its services and consulting efforts in "Coffee Lectures."

STAFF SUMMER PARTY

FUN, GAMES, MUSIC, COMPETITIONS

On July 18, 2018, the KIT summer party for staff and students was organized on the forum premises near the Audimax.

The main program on stage offered a number of highlights: the KAmpus band played traditional Bohemian brass tunes, marches, polkas, and waltzes. Choreographies by students of the Institute of Sports and Sports Science were shown by the SpiRit group of dancers, while the Aikido university sports group presented techniques of the Japanese art of self-defense, and the Jazz Dance university sports group performed a choreography of "Right Now," a song by the Pussycat Dolls band.

After a colorful program of swing to pop played by the KIT Big Band, singer Viviane de Farias introduced Brazilian flair with groovy Bossa Nova. In the evening hours, DJ Tom Röhrer energized dancers with rhythmic beats.

As in previous years, the human-kickers tournament was one of the most popular attractions of the event. 21 teams from various KIT units played for the cup. The finals featured "The Buccaneers of the Gold Cannonball," a team from the Institute for Applied Materials, and "Victoria's Secret," the team of event management. In the end, the materials scientists won 7:1.

21 mixed teams battled for victory in the human-kickers tournament.

KIT celebrated its summer party in bright sunshine on the forum area of Campus South.

The large stage also was the scene for the awards ceremony of the design competition for the 2018 KIT shirt of the year. Each year, students can submit their design proposals for a KIT shirt. The 2018 competition was won by Bo Hu, a mechanical engineering student from China.

Around the stage, magician and KIT alumnus Felix Gauger performed magical tricks, comedian Rosemie Warth presented news from the sciences and other strange things in Swabian regional dialect, while Jeanette Silhouette, true to her name, made portrait silhouettes.

Fun and games were in the focus, but a number of administrative units and networks of KIT also presented their activities and services.

SUSTAINABLE DEVELOPMENT

TOWARDS A MOBILITY CAMPUS

Living, learning, and working at KIT - to some 9,300 members of staff in research, teaching, and administration and more than 25,000 students, this means to be mobile at and between four locations. In the city and the district of Karlsruhe, KIT operates some 430,000 square meters of useful spaces on closed campus sites with all features of a scientific and technical research university. This sophisticated "small city" not only requires top-level logistics with respect to utilities, but also demands mobility for its "inhabitants" and visitors. Only in this way is it possible to achieve a "marketplace of knowledge" as an objective of campus development at KIT, with extensive planned and unplanned interdisciplinary communication.

Avoiding traffic is one of the main rules: farsighted campus development allows supplementary uses of buildings to be concentrated on locations, which avoids traffic and reduces distances. This makes the locations of KIT attractive to pedestrians and bikers. An inter-campus traffic census in 2015 indicated the great potential for sustainable mobility at KIT. Today, these locations have bicycle repair stations and an internet-based mobility portal, which makes information about mobility available to anybody who is interested.

Mobility between locations is ensured by KIT in a highly developed public transit system. Since 2008, a KIT shuttle created specifically to ensure fast connections between the locations operates at short intervals; today, shuttles are fueled by hydrogen and have become most popular. Moreover, Karlsruhe is a city of biking; also KIT members supplement public transit by emission-free mobility. Communications between the city and KIT ensure continuous expansion of the necessary cycling paths.

KIT intends to make mobility on and between locations even more sustainable and, therefore, participated successfully in 2018 in a statewide competition about the development of an emission-free campus that was run by the Baden-Württemberg Ministry for Science, Research, and the Arts. How can buildings be used in a combination so skillfully that traffic to and from these buildings can be made sustainable? Since that time, an interdisciplinary project has engaged scientists of KIT and responsible officers in administration to work on the 2030 master plan for the mobility campus of the future, which is a contribution by KIT to climate protection.

Walking, cycling, using the KIT shuttle or some other means of transport: mobility on location and between locations is a characteristic combination.

DISTRICT FUTURE – URBAN LAB

URBAN TRANSITION LABORATORY TRIES SUSTAINABILITY CULTURE

Climate change, scarcity of resources, demographic change, public budget deficits, and social inequality require comprehensive sustainable development both on a local and a global level. By 2050, some two thirds of the world's population will be living in cities. This makes it meaningful to attempt to achieve sustainability in an urban space. However, how can cities be changed into sustainable spaces? How does sustainable life function in an urban quarter? What are our cities of tomorrow going to look like? To find out, a KIT research team is testing new ideas in the Eastern section of the city of Karlsruhe. The "District Future - Urban Lab" urban transition laboratory is to help make urban life more participatory and sustainable.

The focus of the impulse: the project office of the "District Future – Urban Lab" urban transition laboratory in the Karlsruhe Oststadt is "a future space for sustainability and science."

The research scientists of the District Future coordinate and moderate the sustainability efforts going on within the quarter and accompany them in scientific terms. They look at all facets of urban life encountered by the inhabitants of the quarter every day: areas like business and consumption, labor, education or nutrition are investigated as interwoven phenomena and handled in an integrated fashion.

Everything is connected with everything else, everything is important. Thinking along specific lines of business is broken up and replaced by transdisciplinary methods. Factors playing a role, among others, are environmental sciences, urban construction, migration research, sociology and mobility. In this way, new and potentially sustainable ideas are brought into contact for various ways of life in one place. While sustainability in the district gradually is becoming more reliable, there may be lines which can be transferred, conflicting targets which can be recognized, and solutions found. This includes the "Urban Transition Lab 131: KIT findet Stadt" project supported by the Baden-Württemberg Ministry for Science, Research, and the Arts.

The Karlsruhe "Oststadt," as a typically European quarter that has grown organically, can be a model to other urban spaces in Europe. The variety and variability of living together in the quarter is the real asset: the structures found in urban construction and space differ widely; people with a variety of backgrounds and histories meet and together establish a society. The Karlsruhe "Oststadt" turns into a closely knit microcosmos allowing complex interconnections and major issues to be handled on a small scale.

In 2018, the "District Future – Urban Lab" project won the "Transformative Science" research award in the amount of EUR 25,000. The award is given jointly by the Wuppertal Institute and the Zempelin Foundation in the Stifterverband.

PRIZES, HONORS, AWARDS, AND APPOINTMENTS

In 2018, KIT conferred several high honors. Awarding of honorary titles is decided by the Executive Board and the KIT Senate in accordance with the pertinent regulations of KIT.

Dr. Dieter Köhnlein, founder and long-time conductor of KIT's chamber and symphony orchestras, was appointed Honorary Citizen of KIT. For his strong commitment to the KIT Department of Architecture and the Archive for Architecture and Engineering in Southwest Germany, Philip Kurz, Managing Director of the Wüstenrot Foundation and Adjunct Professor of KIT, was presented the KIT Medal of Merit. A KIT Medal of Merit was also awarded to Achim Quitz,

Board Member of S&G Automobil AG and CEO of the Ernst Schoemperlen Foundation, in recognition of the Foundation's support of KIT.

At the President's Honorary Evening on February 21, 2019, the eleventh Doctoral Prize of KIT for 2018 was presented by Vice-President Professor Oliver Kraft to Dr. Alena Kalyakina, Dr. Tobias Ried, and Dr. Frederik Kotz for their outstanding research achievements. The Doctoral Prize of KIT honors excellent doctoral researchers and reflects the great importance KIT attaches to early-stage researchers.

Every year, the KIT Elementary Particle and Astroparticle Physics Center (KCETA) grants the Julius Wess Award to scientists for their outstanding experimental or theoretical scientific achievements. On March 20, 2018, the 2017 Julius Wess Award was handed over to Professor Francis Halzen for his work in the area of cosmic rays and neutrino physics and in particular for his initiative to construct the AMANDA neutrino detector and use it for the much larger follow-up project IceCube. The physicist was born in Belgium and teaches at the University of Wisconsin-Madison, USA.


KIT


KIT

KIT SCIENTIST IS GRANTED HIGHEST RESEARCH PRIZE IN GERMANY

LEIBNIZ PRIZE FOR WOLFGANG WERNSDORFER

Professor Dr. Wolfgang Wernsdorfer of Karlsruhe Institute of Technology (KIT) receives the Gottfried Wilhelm Leibniz Prize 2019 of the German Research Foundation (DFG).

Professor Wolfgang Wernsdorfer of KIT's Physikalisches Institut received the Gottfried Wilhelm Leibniz Prize 2019 of the German Research Foundation (DFG) for his contribution to quantum computing. The prize is endowed with EUR 2.5 million. The DFG announced its decision in December 2018.

Wolfgang Wernsdorfer is one of the leading experts worldwide on nanomagnetism and single-molecule magnets and their use in quantum computer systems. His research focuses on molecular quantum spintronics, an area at the interface of experimental solid-state physics, chemistry, and materials science. With his research group, Wolfgang Wernsdorfer develops rapid and reliable methods to read out spin states of single magnetic molecules for quantum information processing. This is an essential prerequisite for future quantum technologies. Wernsdorfer conducted pioneering experiments to find out how molecular magnets behave under the laws of quantum mechanics. Wernsdorfer's group was the first to measure and control quantum spin states in a molecule.

Quantum physics effects enable numerous novel applications in various areas, with major increases in capacity, sensitivity, and speed. A good example is information processing: contrary to classical computers working with bits that always assume the value of zero or one, quantum computers use quantum bits, qubits for short, that also assume values in between. Entanglement of qubits results in mixed quantum states that allow for the parallel execution of several computing steps.

Wolfgang Wernsdorfer, born in 1966, has been Humboldt Professor at KIT since 2016. The Humboldt Professorship is awarded by the Alexander von Humboldt Foundation to leading scientists worldwide who are working abroad. Prior to that, in 2008, he was appointed Directeur de recherche première classe at the Institut NÉEL of the Centre National de la Recherche Scientifique (CNRS) in Grenoble, France. Wernsdorfer was granted a number of high-ranking honors and awards, including the Agilent Europhysics Prize, the Olivier Kahn International Award, the Prix Spécial of the Société Française de Physique, and two renowned Advanced Grants of the European Research Council (ERC).

Since 1986, the Leibniz Prize has been awarded annually by DFG. The Leibniz Prize 2019 was granted to ten outstanding scientists for their research in all areas of science.

ACADÉMIE DES SCIENCES IN PARIS HONORS KIT CLIMATE RESEARCHER

GAY-LUSSAC-HUMBOLDT PRIZE 2017 FOR JOHANNES ORPHAL

Climate researcher Professor Johannes Orphal has been awarded the renowned Gay-Lussac-Humboldt Prize of the Paris Académie des Sciences. With this, the Academy honors Orphal's outstanding contributions to remote sensing of the Earth's atmosphere.

The Gay-Lussac-Humboldt Prize is granted annually to up to five exceptional German and French researchers who have rendered outstanding services to German-French collaborations. The Prize was created in 1981 by the then French President Valéry Giscard d'Estaing and the then German Chancellor Helmut Schmidt. It includes a monetary prize of 60,000 euros.

Professor Dr. Johannes Orphal, Head of the Atmospheric Trace Gases and Remote Sensing Division of KIT's Institute of Meteorology and Climate Research (IMK-ASF), received the Gay-Lussac-Humboldt Prize of the Académie des Sciences, Paris.

Johannes Orphal heads the Atmospheric Trace Gases and Remote Sensing Division of KIT's Institute of Meteorology and Climate Research (IMK-ASF) and is scientific spokesperson of the "Atmosphere and Climate" Programme in the research field "Earth and Environment" of the Helmholtz Association.

Orphal has contributed to a number of national and international research projects. He is consultant to the European space agencies ESA and EUMETSAT and advises various scientific organizations worldwide.

Among his areas of expertise are high-precision measurements of atmospheric trace gases, both in the laboratory and with innovative optical instruments from ground stations, aircraft, high-altitude balloons, and satellites. The methods he developed have manifold applications in climate research and weather forecasting, air quality and ozone layer monitoring, and monitoring of worldwide greenhouse gas emissions. Since 2013, Professor Orphal has been heavily involved in the establishment of EUCOR – The European Campus, the association of the universities of Basel, Colmar-Mulhouse, Freiburg, Karlsruhe, and Strasbourg.

Orphal studied physics at the Humboldt-Universität zu Berlin. He then earned his doctorate in high-resolution infrared spectroscopy of atmospheric trace gases at Université Paris-Sud in Orsay. After working on European satellite projects at the University of Bremen for several years, he was appointed "Chargé de Recherche" by the French Centre National de la Recherche Scientifique (CNRS) in 1999. In 2002, he habilitated in Orsay and became Professor of Physics at Université Paris-Est in Créteil in 2006. Since 2009, Professor Orphal has been performing research and teaching at the KIT in Karlsruhe.

The Gay-Lussac-Humboldt Prize of the Paris Académie des Sciences is named after French physicist and chemist Joseph-Louis Gay-Lussac (1778-1850) and the German naturalist Alexander von Humboldt (1769 – 1859), who began joint studies in 1804, including studies of the composition of air at high altitudes.

OUTSTANDING CONTRIBUTIONS TO PHOTOVOLTAIC ENERGY CONVERSION THEORY

PETER WÜRFEL RECEIVES BECQUEREL PRIZE OF THE EUROPEAN COMMISSION

Dr. Peter Würfel, Professor emeritus of KIT's Institute of Applied Physics (APH), was awarded the Becquerel Prize of the European Commission.

Dr. Peter Würfel, Professor emeritus of KIT's Institute of Applied Physics, received the 2018 Becquerel Prize. With this Prize, the European Commission honors the physicist's fundamental contributions to the theory of photovoltaic energy conversion. Peter Würfel developed basic findings relating to the conversion of light energy into electric energy and is considered one of the pioneers of photovoltaic research.

The Becquerel Prize was presented at the "European Photovoltaic Solar Energy Conference" in Brussels on September 24, 2018. It is named after Alexandre Edmond Becquerel (1820 – 1891) who was the first to observe photovoltaic processes in 1839. The European Commission has awarded the Becquerel Prize for outstanding contributions to the development of photovoltaics since 1989, the year of the 150th anniversary of Becquerel's classical experiments in which he discovered the photovoltaic effect.

Peter Würfel has contributed significantly to the understanding of photovoltaic energy conversion. While working at Universität Karlsruhe (TH), one of the precursory institutions of KIT, he developed a consistent thermodynamic concept to explain conversion of radiation energy into electric energy, determine physical limits to efficiency achievable by solar cells, and assess concepts for efficiency increase. His book "Physik der Solarzellen" (physics of solar cells) presents the thermodynamics and optoelectronics of solar cells in great detail.

The findings of Peter Würfel paved the way for new photovoltaic technologies, such as selective contacts to reduce loss of charge carriers and, hence, increase current flow in solar cells. Würfel's work also influenced the development of new methods to characterize solar cells, such as luminescence analysis. During several research stays at the University of New South Wales in Sydney, he issued important publications on the efficiency of novel solar cell concepts.

Current photovoltaics research at KIT focuses on various approaches to low-cost, environmentally compatible, and efficient solar cells. Researchers in many KIT institutes, as well as in collaborations with other universities, research institutions, and industrial companies, study innovative materials and concepts. Work covers the complete range from physical fundamentals to application.

The interaction of solar modules, inverters, and batteries is studied at the Solar Power Storage Park on Campus North of KIT. With more than 100 modules of 1 megawatt total output and a battery storage system of several tens of kilowatt hours in capacity, the Solar Power Storage Park of KIT is the biggest park of its kind in Germany.

OTHER PRIZES, HONORS, AWARDS, AND APPOINTMENTS

■ The 2018 Climate Prize of the Reinhard Süring Foundation went to Dr. **Hendrik Andersen**, Institute of Photogrammetry and Remote Sensing and Institute of Meteorology and Climate Research, for studying the role of clouds in the global climate system with satellite data.

■ Professor Dr. **Almut Arneth**, Professor Dr. **Klaus Butterbach-Bahl**, both from the Institute of Meteorology and Climate Research, Professor Dr. **Annie K. Powell**, Institute for Inorganic Chemistry, Professor Dr. **Tilmann Gneiting**, Institute of Stochastics, Professor Dr. **Stefano Passerini**, Helmholtz Institute Ulm, Professor Dr. **Alexandros Stamatakis**, Institute of Theoretical Informatics, Professor Dr. **Martin Wegener**, Institute of Applied Physics and Institute of Nanotechnology, and Professor Dr. **Wolfgang Wernsdorfer**, Physikalisches Institut and Institute of Nanotechnology, are among "Highly Cited Researchers," a ranking published by the Thomson Reuters Media Group.

■ Dr. **Anastasia August**, Institute for Applied Materials, reached first place in the Green Science Slam of the Energy Agency, Berlin, and became vice champion in the German science slam.

■ Dr.-Ing. **Sebastian Bauer**, Institute of Industrial Information Technology, received the Measurement Technology Prize of the Association of University Teachers of Measurement Technology for his doctoral thesis.

■ Professor Dr. **Henning Bockhorn**, Engler-Bunte Institute, was appointed Fellow of The Combustion Institute.

■ **Christian Borger**, Institute of Meteorology and Climate Research, **Marlène Dorbach**, KIT Department of Architecture, **Jasmin Gärtner**, Building Science Group, Dr. **Johannes Gärttner**, Institute of Information Systems and Marketing, and Dr. **Julian Xanke**, Institute of Applied Geosciences, were handed over the Sparkasse Environmental Award for outstanding work in the area of environmental research.

■ Professor Dr.-Ing. **Petra von Both**, Institute for Building Design and Technology, and Professor Dr.-Ing. **Shervin Haghsheno**, Institute for Technology and Management in Construction, were granted the BIM Award 2018 by the Baden-Württemberg BIM Cluster for their interdisciplinary "Building Information Modeling (BIM)" teaching concept.

■ Dr. **Martin Brandauer**, Institute for Technology and Management in Construction, received the Karl Wirtz Prize of the Kerntechnische Gesellschaft (Nuclear Engineering Society) for his doctorate on the decommissioning of nuclear facilities.

■ Dr. **Sebastian Bretthauer**, Center for Applied Legal Studies and KASTEL, was granted the Dieter Meurer Prize for Legal Informatics for his doctorate at the interface of law and engineering.

■ **Norbert Burkardt**, Institute of Product Engineering, was appointed Honorary Professor of the Technical University of Sofia.

■ **Valerio Calavetta**, student at the KIT Department of Architecture, was granted the 1st Prize of the Sponsorship Award of the German Steel Construction Association 2018 for his master's thesis "Wohnen im Wildparkstadion" (living at the Wildpark soccer stadium).

■ Dr. **Tobias Dehling**, Institute of Applied Informatics and Formal Description Methods, was presented the Science Award by the Faculty of Economics and Management of the University of Kassel for his doctorate on consumer-oriented information systems.

■ Professor Dr. **Olaf Deutschmann**, Engler-Bunte Institute, was appointed Fellow of The Combustion Institute.

■ **Marlène Dorbach**, graduate of KIT, received the Excellence Award of the German-French University 2018. She successfully completed a double-master's program in "Architecture, Construction, and Planning in European Regions" of KIT and École Nationale Supérieure d'Architecture de Strasbourg.

■ Professor Dr. **Olaf Dössel**, Spokesperson of the Collegial Board of the Institute of Biomedical Engineering, was appointed Fellow of the European Alliance for Medical and Biological Engineering & Science.

■ Professor Dr. **Olaf Dössel** and Dr. **Axel Loewe**, both from the Institute of Biomedical Engineering, were granted a Prize for Patient Safety in Medical Engineering by the German Society for Biomedical Technology in the VDE.

■ **Philipp Eisenhardt**, **Michael Lämmle**, **Lars Kiefer**, **Dragos Ana**, **Thea Kannenberg**, **Julian Reichard**, **and Carola Schmidt**, (all from the KIT Department of Mechanical Engineering) as well as **Xenia Augustin**, **Wolfgang Böttcher**, **Olaf Dünkel**, and **Leonhard Döring** (from the KIT Department of Electrical Engineering and Information Technology) were granted a scholarship for highly gifted students by the Gunther Schroff Foundation.

■ Dr.-Ing. **Jens Fahrenberg**, Innovation and Relations Management, was elected Chairman of TechnologieAllianz, the German Association for Knowledge and Technology Transfer.

■ Professor Dr. **Maximilian Fichtner**, Helmholtz Institute Ulm, was appointed member of the Joint Committee on the Handling of Security-relevant Research of Leopoldina and the German Research Foundation.

■ Professor Dr. **Herbert Gleiter**, Institute of Nanotechnology, received the Jan Czochralski Award of the European Materials Research Society for his lifetime achievements.

■ Dr. **Hartmut Gliemann** and **Peter Krolla**, Institute of Functional Interfaces, together with their co-authors from Stuttgart University, were granted the Kajal Mallick Memorial Prize for their publication on protein nanorings by the Institution of Civil Engineers Publishing, London.

■ Dr. **Guillaume Gomard**, Institute of Microstructure Technology and Light Technology Institute, and an interdisciplinary international team of three early-stage researchers received the International Bionic Award of the Schauenburg Foundation for excellent research into photovoltaics.

■ Dr. **Ellen Gottschämmer**, Geophysical Institute, was granted the Award for Excellent Teaching at German Universities in the Subject of Geophysics by the German Geophysical Society.

■ Professor Dr. **Peter Gumbsch**, Institute for Applied Materials of KIT and Director of the Fraunhofer Institute for Mechanics of Materials (IWM, Freiburg), was confirmed as Chairman of the Scientific Commission of the Council of Science and Humanities.

■ Dr.-Ing. **Benjamin Häfner**, wbk Institute of Production Science, was granted the Walter Masing Prize by the German Association for Quality for his work on function-oriented quality control in cyber-physical production systems of highly precise components.

■ Professor Dr.-Ing. **Holger Hanselka**, President of KIT, was elected one of the Vice Presidents of the Otto von Guericke German Federation of Industrial Research Associations (AiF) for Science.

■ Dr. **Frank Hartmann**, Institute of Experimental Particle Physics, was appointed Upgrade Co-Coordinator of the CMS Experiment of CERN, Geneva, for three years. He is now responsible for the planning and upgrade of the entire CMS detector.

■ The Toxicology Award of the German Toxicology Society went to Professor Dr. **Andrea Hartwig**, Institute for Applied Biosciences.

■ Professor Dr. **Andrea Hartwig** also was appointed Member of the Central Committee on Biological Safety (ZKBS) of the Federal Ministry of Food and Agriculture.

■ Professor Dr. **Ulrich Husemann**, Institute of Experimental Particle Physics, was elected Member of the Council of the German Physical Society.

■ Dr. **Alik Ismail-Zadeh**, Institute of Applied Geosciences, was elected Secretary of the International Science Council.

■ Dr. **Stefan Jaiser**, Institute of Thermal Process Engineering, was granted the Peter and Luise Hager Prize 2018 for his outstanding doctorate in the area of energy and environmental technologies.

■ Dr. **Frederik Kotz**, Institute of Microstructure Technology, was honored for his doctorate on quartz glass from a 3D printer in the competition "Innovators under 35" of the journal "Technology Review."

■ Professor Dr. **Torsten Kröger**, Institute for Anthropomatics and Robotics, received the IEEE RAS Distinguished Services Award of the IEEE Robotics and Automation Society.

■ **Monika Landgraf**, Corporate Communications and Chief Press Officer of KIT, was elected Member of the Board of the Federal Association for University Communication.

■ Professor Dr. **Uli Lemmer,** Light Technology Institute, was granted the Esther Hoffman Beller Medal by The Optical Society, Washington, USA, for his outstanding commitment to academic education.

■ Dr. **Axel Loewe**, Institute of Biomedical Engineering, reached third place in the Gips-Schüle Young Scientist Award 2018 competition with his doctoral thesis on computer models of cardiac atrial fibrillation.

■ Professor Dr. **Ulrich Maas**, Institute of Technical Thermodynamics, was appointed Fellow of The Combustion Institute.

■ **Paolo Manzano**, KIT Department of Economics and Management, was granted a Studies Award of the SEW-EURODRIVE Foundation for his master's thesis.

■ Professor Dr. **Nikolaus Marsch**, Institute for Information and Economic Law, received the Werner von Simson Prize of Freiburg University for his habilitation on European law.

■ Professor em. Dr.-Ing. **Harald S. Müller**, Institute of Concrete Structures and Building Materials, was admitted as foreign member to the Russian Engineering Academy.

■ **Carla Neuhaus**, Materials Testing and Research Institute, received the Young Talent Award of the Association of Materials Testing Institutions for her master's thesis.

■ **Maurice Fabien Nitsche**, student at the KIT Department of Architecture, was honored for his master's thesis by the German Steel Construction Association in 2018.

■ **Christophe Pfeifer**, informatics student of KIT, was granted the SaarLB-DFH Scholarship within a collaboration with the Institut polytechnique de Grenoble that is funded by the German-French University (DFH).

■ Dr.-Ing. **Bastian Rapp**, Head of a Working Group of the Institute of Microstructure Technology until mid-2018 and, since December 01, Professor of the University of Freiburg, received a Consolidator Grant of the European Research Council (ERC) for the development of novel tactile displays for visually impaired people.

■ Dr.-Ing. **Jens Reiser**, Institute for Applied Materials, won the SOFT Prize for innovations in the area of fusion energy technology of the European Commission for his work to significantly improve the mechanical properties of tungsten.

■ Professor Dr. **Caroline Robertson-von Trotha**, ZAK I Center for Cultural and General Studies, was appointed Member of the Council of Karlsruhe University of Music.

■ Dr. **Steffen Scherr**, Institute of Radio Frequency Engineering and Electronics, received the Südwestmetall Sponsorship Award for his doctoral thesis "FMCW-Radarsignalverarbeitung zur Entfernungsmessung mit hoher Genauigkeit" (FMCW radar signal processing for distance measurement with high accuracy).

■ **Tim Schmidt**, KIT Department of Informatics, and the ten-strong Team Deutschland won the Cyber Security Challenge Europe 2018, the European championship of hackers.

■ Dr. **Frank Schröder**, Institute for Nuclear Physics, received an ERC Starting Grant (see also page 55).

■ Professor Dr.-Ing. **Thomas Schulenberg**, Institute for Nuclear and Energy Technologies, and Professor Dr.-Ing. Albert Moser (RWTH Aachen University) were granted the Heinrich Hertz Prize by the EnBW Foundation for outstanding achievements in the area of electric power generation, distribution, and application.

■ **Lukas Schwarz**, student of the KIT Department of Economics and Management, received the CDQ Young Talent Award for his master's thesis entitled "Data and Analytics – The Next Frontier of Servitization?"

■ **Pascal Stichler**, who was conferred the Master of Science degree in Business Engineering by KIT in 2016, was included in the Forbes list "Forbes 30 Under 30 Europe" of 2018 and ranked among the most influential young Europeans by the US magazine.

■ Professor Dr. **Nora Szech**, Institute for Economic Policy Research, was listed in the "Top 40 under 40" in the category of "Society and Science" by Capital magazine.

■ **Alexander Tanzer**, student of mechanical engineering, was granted a Studies Award by the SEW-EURODRIVE Foundation for his graduation thesis.

■ Professor Dr. **Manfred Thumm**, Institute for Pulsed Power and Microwave Technology and Institute of Radio Frequency Engineering and Electronics, received the IEEE Nuclear and Plasma Sciences Society (NPSS) 2018 Merit Award.

■ Professor Dr. **Alexey V. Ustinov**, Physikalisches Institut, received a Google Faculty Research Award.

■ Professor Dr. **Dorothea Wagner**, Institute of Theoretical Informatics, was re-appointed Member of the Council of Science and Humanities for another three years. In addition, she was elected Vice-Chairperson of the Scientific Commission of the Council of Science and Humanities.

■ In recognition of her long-standing membership and her support of international collaboration, Professor Dr. **Dorothea Wagner** also received the Heisenberg Medal of the Alexander von Humboldt Foundation.

■ Professor Dr. **Martin Wegener**, Institute of Applied Physics and Institute of Nanotechnology, was appointed Member of acatech – National Academy of Science and Engineering.

■ **Christian Wegmann**, mathematical-technical software developer, was honored as one of the best apprentices in Germany by the German Chamber of Industry and Commerce, Berlin. Previously, he had been selected as the best apprentice in Baden-Württemberg and on the regional level. Meanwhile, he has started to study mathematics at KIT (see also page 73).

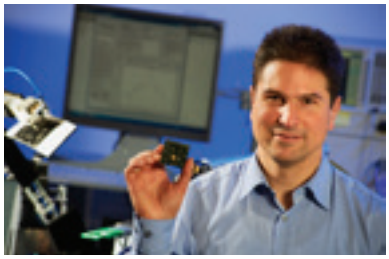
■ Professor Dr. **Thomas Wetzel**, Institute of Thermal Process Engineering, and his team, with researchers from Karlsruhe and Potsdam, won the Innovation Prize of the German Gas Industry.

■ Professor Dr.-Ing. **Jens Wittenburg**, Institute of Engineering Mechanics, received the D'Alembert Award of the American Society of Mechanical Engineers for his contributions to multi-body dynamics.

■ Dr. **Frederik Zanger**, wbk Institute of Production Science, was granted the Otto Kienzle Commemorative Medal of the German Academic Association for Production Technology for his work on the optimization of components with combined fabrication processes.

■ Dr. **Karl-Friedrich Ziegahn**, Division IV, was re-elected Member of the Council of the German Physical Society.

■ For his pioneer work relating to miniaturized sensors for Industry 4.0 and the Internet of Things, the IEEE (Institute of Electrical and Electronics Engineers) Association awarded Professor Dr. **Thomas Zwick**, Institute of Radio Frequency Engineering and Electronics, its highest membership status of Fellow.



■ The second prize of the Berthold Leibinger Innovation Award 2018 competition was granted to the project "**3D Laser Lithography for Integrated Photonics – DELPHI**" led by Professor Dr. Christian Koos, Institute of Photonics and Quantum Electronics and Institute of Microsystem Technology. The project goal is industrial application of femtosecond laser lithography methods for three-dimensional additive nanomanufacture in integrated optics.

■ **INERATEC**, a spinoff of KIT, was granted the German Entrepreneur Award as the best German startup in Berlin (see also page 47).

■ The **INERATEC** company also received the first Lothar Späth Award for their compact chemical reactors. This Award is to support outstanding innovative collaborations of industry and science in Baden-Württemberg and Thuringia (see also page 47).

■ In addition, **INERATEC** was granted the Special Award for Innovative Startups within the German Gas Industry Innovation Prize Competition 2018 (see also page 47).

■ For the transfer of scientific findings to economically successful and useful products, the **Institute of Nanotechnology** and the **Innovation and Relations Management Business Unit** of KIT as well as the **Nanoscribe company** received the Technology Transfer Prize of the German Physical Society (see also page 47).

■ In the Gründungsradar (startup ranking) of the Stifterverband (association for promoting science and education) and the Heinz Nixdorf Foundation, **KIT** was ranked third place in Germany.

■ The student team **kof.co**, supported by the Institute of Process Engineering in Life Sciences, won the Bronze Medal in the ECOTROPHELIA Europe idea competition.

■ The **Landau Microgrid Project** (LAMP) reached the final of the "NEO2018" innovation award competition of the Karlsruhe Technology Region.

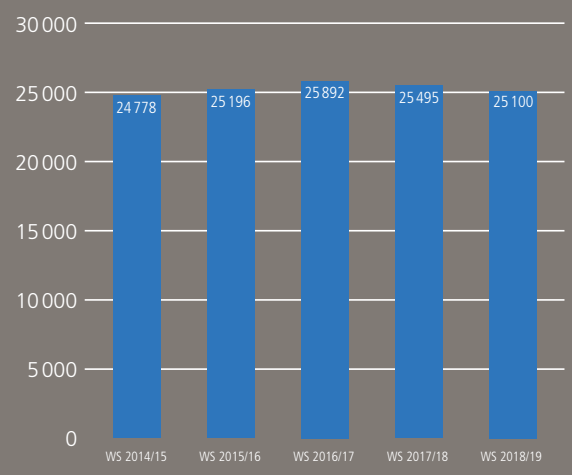
■ **Nanoscribe GmbH**, a spinoff of KIT, won the State Award for Young Companies that is granted every two years by the State of Baden-Württemberg and L-Bank (see also page 47).

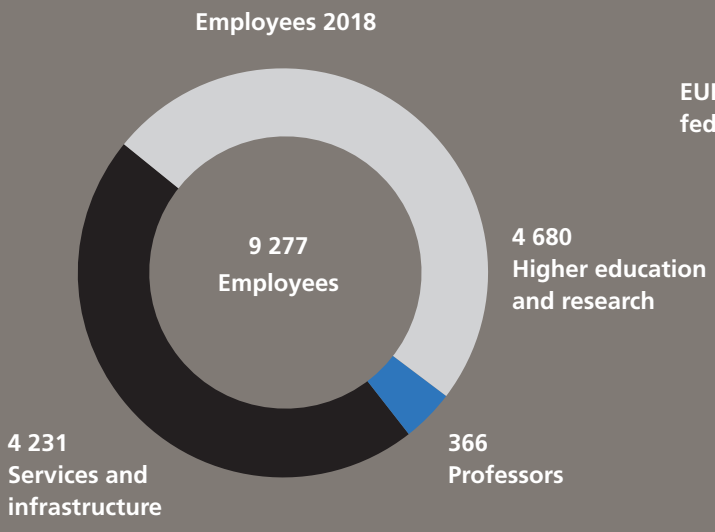
■ The KIT **Health Network** was granted the Corporate Health Award. The jury agreed that KIT has established an outstanding health management scheme that is one of the best of German universities.

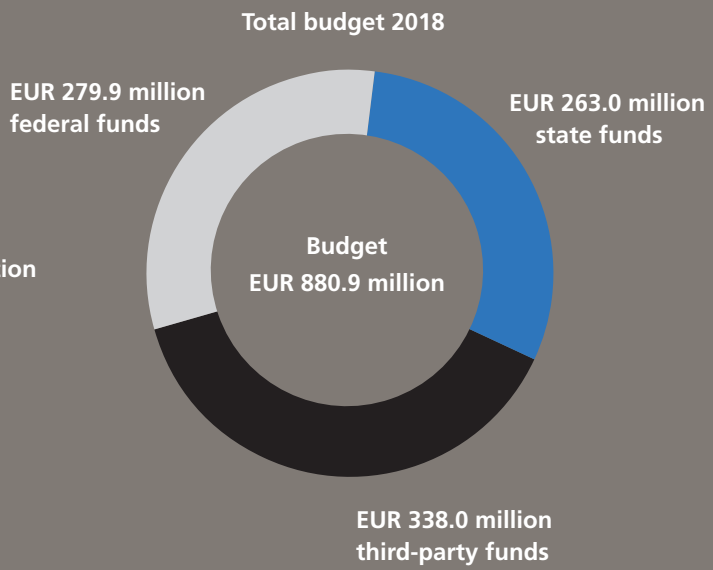
■ The "**District Future – Urban Lab**" project headed by Dr. Oliver Parodi won the Transformative Science Prize in 2018. The Prize is granted by the Wuppertal Institute and the Zempelin Foundation in the Stifterverband (see also page 83).

FACTS AND FIGURES

Number of students



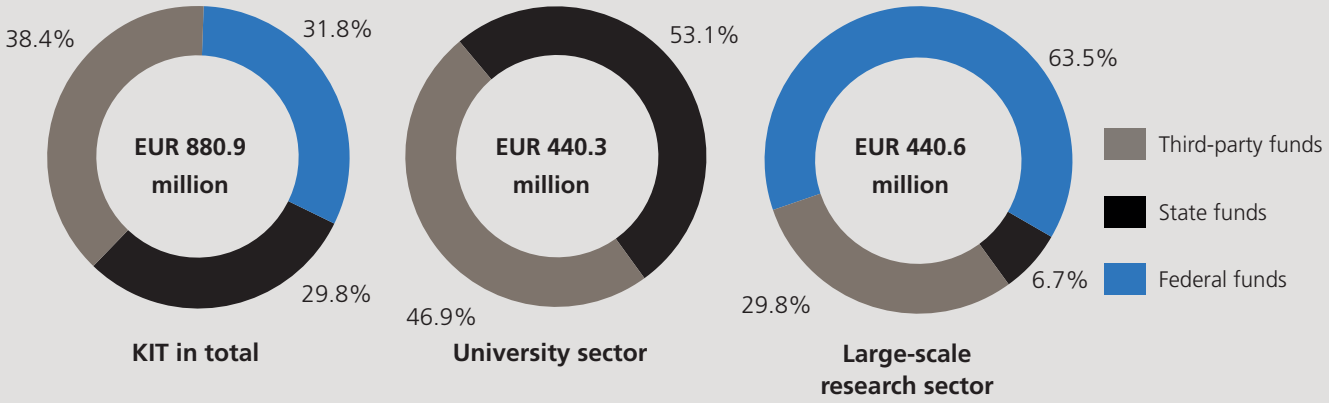

Employees 2018
9 277
Employees
4 680
Higher education
and research
366
Professors
4 231
Services and
infrastructure


Total budget 2018
EUR 279.9 million
federal funds
EUR 263.0 million
state funds
Budget
EUR 880.9 million
EUR 338.0 million
third-party funds

CONTENT

FUNDING

Federal, State, and Third-party Funds



Sources of Funding

KIT in Total

In million euros	2014	2015	2016	2017	2018
Income in total	847.4	860.8	851.1	901.7	880.9
Third-party funds	369.2	358.0	336.4	358.7	338.0
State funds	221.3	248.1	251.5	255.4	263.0
Federal funds	256.9	254.7	263.2	287.6	279.9

University Sector

In million euros	2014	2015	2016	2017	2018
Income in total	420.0	428.4	429.6	445.9	440.3
Third-party funds**	230.5	208.7	208.1	218.7	206.5
State funds**	189.5	219.7	221.5	227.2	233.8
Federal funds*	0.0	0.0	0.0	0.0	0.0

* In the University Sector. federal funds are included in the third-party funds. as they are granted for special projects rather than for basic funding.
** Quality assurance funds (about EUR 12.5 million) are included in third-party funds until 2014 and in state funds from 2015.

Large-scale Research Sector

In million euros	2014	2015	2016	2017	2018
Income in total	427.4	432.4	421.5	455.8	440.6
Third-party funds	138.7	149.3	128.3	140.0	131.5
State funds	31.8	28.4	30.0	28.2	29.2
Federal funds	256.9	254.7	263.2	287.6	279.9

Sources of Third-party Funding

KIT in Total

In million euros	2014	2015	2016	2017	2018
Third-party funding in total	369.2	358.0	336.4	358.7	338.0
Third-party funding by DFG, incl. CRC	47.0	44.1	50.3	52.9	51.4
Third-party funding by ExIn I	3.5	0.0	0.0	0.0	0.0
Third-party funding by EU	31.6	32.3	29.4	30.0	25.2
Third-party funding by Fed. and State	133.8	133.8	124.0	140.9	129.2
Other income	153.3	147.8	132.7	134.9	132.2

University Sector*

In million euros	2014	2015	2016	2017	2018
Third-party funding in total	230.5	208.7	208.1	218.7	206.5
Third-party funding by DFG, incl. CRC	39.4	38.8	41.1	41.4	42.9
Third-party funding by ExIn I	3.5	0.0	0.0	0.0	0.0
Third-party funding by EU	11.9	13.3	11.0	11.9	9.6
Third-party funding by Fed. and State	101.7	92.1	90.6	93.6	83.0
Other income	74.0	64.5	65.4	71.8	71.0

* Third-party funds shall be all income of and grants awarded to the University Sector under the Solidarity Pact in addition to basic funding.

Large-scale Research Sector

In million euros	2014	2015	2016	2017	2018
Third-party funding in total	138.7	149.3	128.3	140.0	131.5
Third-party funding by DFG, incl. CRC	7.6	5.3	9.2	11.5	8.5
Third-party funding by ExIn I	0.0	0.0	0.0	0.0	0.0
Third-party funding by EU	19.7	19.0	18.4	18.1	15.6
Third-party funding by Fed. and State	32.1	41.7	33.4	47.3	46.2
Other income	79.3	83.3	67.3	63.1	61.2

Use of Funds in 2018

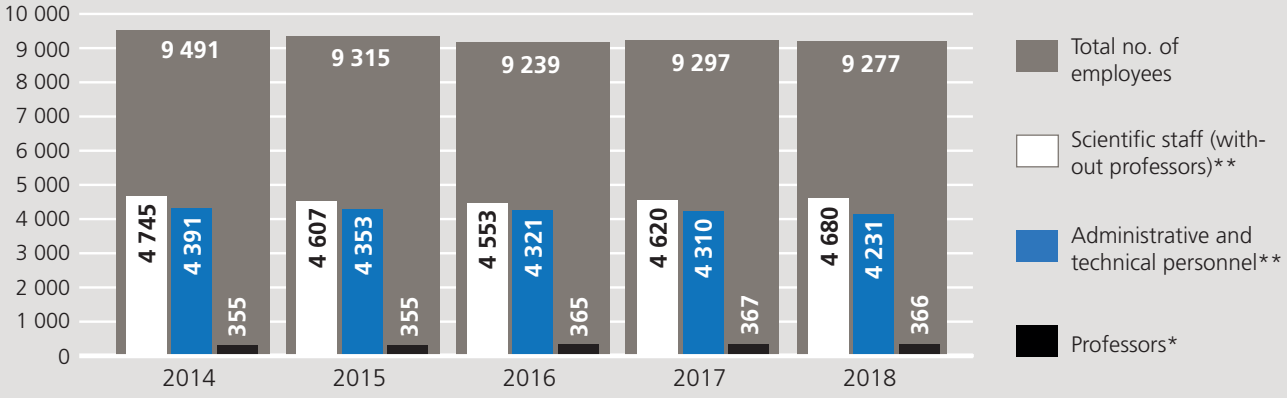
In million euros	KIT in Total	University Sector*	Large-scale Research Sector
Expenses in total	880,9	440,3	440,6
Investments in total	88.9	31.3	57.6
of these, major investments	31.0	0.0	31.0
of these, ongoing investments	57.9	31.3	26.6
Personnel expenses	574.5	323.0	251.5
Material expenses	220.6	89.1	131.5

* 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)	2014	2015	2016	2017	2018
Total number of employees	9 491	9 315	9 239	9 297	9 277
of these, female employees	3 380	3 363	3 373	3 447	3 454
Professors*	355	355	365	367	366
of these, female professors	47	47	49	49	51
of these, junior professors	13	8	8	7	9
of these, female junior professors	7	3	3	2	3
of these, international professors	29	32	34	36	39
of these, endowed professors	7	8	9	9	7
Scientific staff (without professors)**	4 745	4 607	4 553	4 620	4 680
of these, female scientists	1 245	1 193	1 190	1 244	1 255
of these, staff financed from third-party funds	2 536	2 365	2 341	2 408	2 421
of these, international employees	942	933	950	990	1 035
of these, employment contracts of limited duration	3 909	3 677	3 561	3 585	3 612
of these, part-time employees	1 439	1 436	1 529	1 530	1 587
Administrative and technical personnel**	4 391	4 353	4 321	4 310	4 231
of these, female staff	2 088	2 123	2 134	2 154	2 148
of these, staff financed from third-party funds	812	746	736	753	785
of these, international employees	189	191	194	205	212
of these, employment contracts of limited duration	1 251	1 158	1 056	965	894
of these, part-time employees	1 052	1 058	1 112	1 110	1 101
of these, trainees and students of Baden-Württemberg Cooperative State University	474	471	464	432	396
of these, female trainees and students	146	139	162	152	154
Trainees' share in the total number of employees [%]	5	5	5	5	4



* Professors, junior professors, and executive scientists receiving W-type salary according to Article 14 KIT Act.
** Deviations from the 2017 Annual Report due to revision of the category.

Habilitations

	2014	2015	2016	2017	2018
Total	8	22	19	20	7
Men	7	17	16	19	7
Women	1	5	3	1	0

Appointments to W-3 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Frank Dehn, Division IV	Baustofftechnologie	MFPA Leipzig GmbH
Prof. Dr. Marc Eichhorn, Division III	Optronik	German-French Research Institute Saint-Louis
Prof. Dr. Ralph Engel, Division V	Experimentelle Astroteilchenphysik	KIT
Prof. Dr. Roland Griesmaier, Division V	Angewandte Mathematik	Julius-Maximilians-Universität Würzburg
Prof. Dr. Inge Hinterwaldner, Division IV	Kunstgeschichte	Humboldt-Universität zu Berlin
Prof. Dr. Darko Jekauc, Division II	Sportwissenschaft mit Schwerpunkt Gesundheits-bildung/Gesundheitsförderung	Goethe University Frankfurt am Main
Prof. Dr. Hansjörg Kutterer, Division IV	Geodätische Erdsystemwissenschaft	Federal Agency for Cartography and Geodesy
Prof. Dr. Astrid Pundt, Division III	Werkstoffcharakterisierung	University of Göttingen
Prof. Dr. Christian Seidel-Saul, Division II	Philosophische Anthropologie	University of Münster
Prof. Dr. Ali Sunyaev, Division II	Angewandte Informatik	University of Kassel
Prof. Dr. Melanie Volkamer, Division II	Angewandte Informatik III	Technische Universität Darmstadt

Appointments to W-2 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Carsten Sinz, Division II	Zuverlässige Softwaresysteme in der Automobilindustrie	University of Tübingen

PERSONNEL INFORMATION

Appointment to W-1 University Professor at KIT

Name, division	Professorship	Previous employer institution
Prof. Dr. Lennart Hilbert, Division I	Systembiologie/Bioinformatik	Max Planck Institute of Molecular Cell Biology and Genetics, Dresden
Prof. Dr. Xian Liao, Division V	Analysis partieller Differentialgleichungen	Institute of Mathematics, University of Bonn
Prof. Dr. Ingo Wagner, Division II	MINT-Fachdidaktik im Division der Fächer Sport und Mathematik oder Physik	German Sport University Cologne

Appointments to Apl. Professor and Honorarprofessor

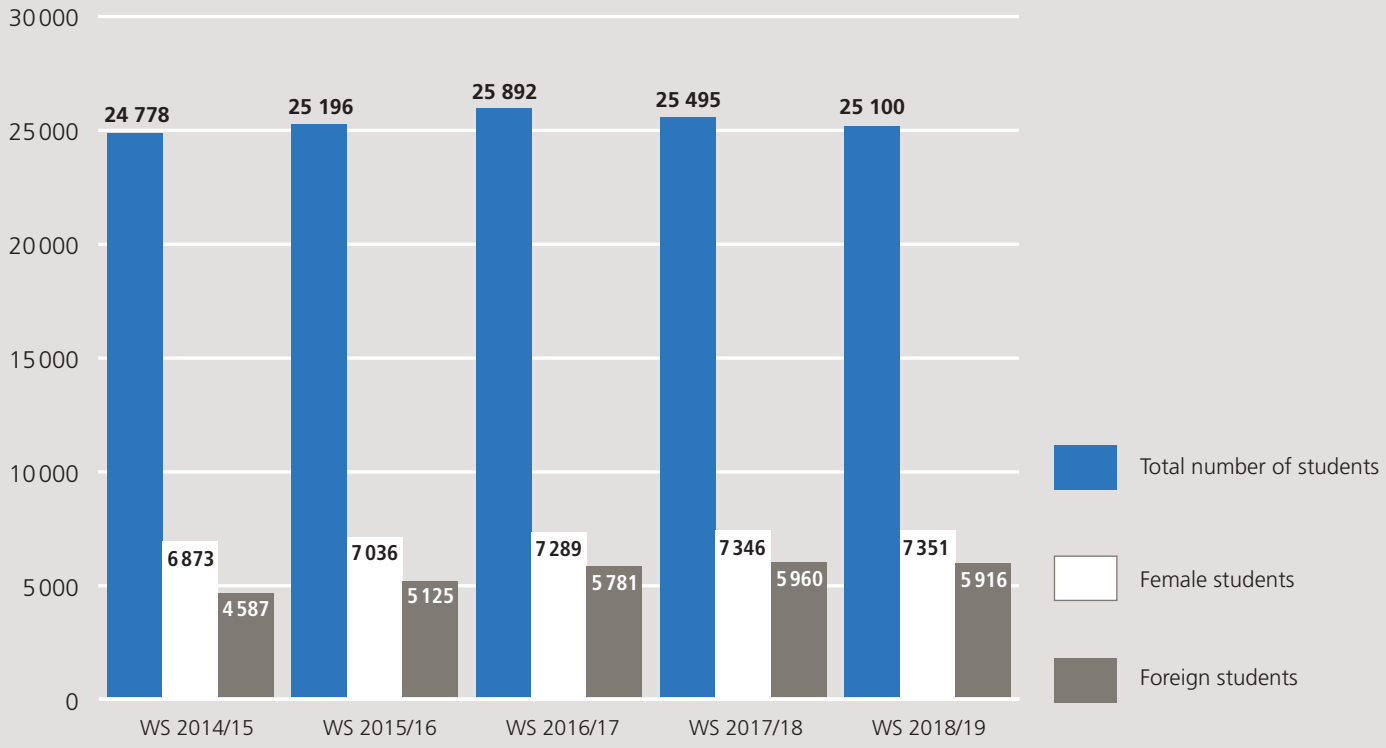
Name	Type	KIT department
Prof. Dr. Thomas Clarmann von Clarenau	Apl. Professor	Civil Engineering, Geo- and Environmental Sciences
Dr. Rolf Frech	Honorarprofessor	Mechanical Engineering
Dr. Thomas Kuballa	Honorarprofessor	Chemistry and Biosciences
Prof. Dr. Heinz-Ulrich Nennen	Apl. Professor	Humanities and Social Sciences
Dr. Andrzej Niemunis	Apl. Professor	Civil Engineering, Geo- and Environmental Sciences
Prof. Dr. Stefan Schmerler	Honorarprofessor	Electrical Eng. and Information Techn.
Prof. Dr. Reinhard Schneider	Apl. Professor	Mechanical Engineering
Prof. Dr. Sven Ulrich	Apl. Professor	Mechanical Engineering

Emeriti/Retirements

Name	Institute	Division
Prof. Dr. Hans Josef Böker	Institute for History of Art and Architecture	Division IV
Prof. Dr. Martin Gabi	Institute of Fluid Machinery	Division III
Prof. Dr. Rolf-Jürgen Gleitsmann-Topp	Institute of Technology Futures	Division II
Prof. Dr. Bernhard Heck	Geodetic Institute	Division IV
Prof. Dr. Hartmut Schmeck	Institute of Applied Informatics and Formal Description Methods	Division II
Prof. Dr. Claus-Günther Schmidt	Institute for Algebra and Geometry	Division V
Prof. Dr. Horst Taraschewski	Zoological Institute	Division I
Prof. Dr. Gert Franz Trommer	Inst. of Theory and Systems Optimization in Electrical Eng.	Division III
Prof. Dr. Ute Werner	Institute for Finance, Banking, and Insurance	Division II

STUDENTS

Students in Total



Students and Desired Degrees

Desired degree	WS 2014/15	WS 2015/16	WS 2016/17	WS 2017/18	WS 2018/19
Bachelor	14 086	14 136	14 245	14 129	13 810
Master	6 819	8 181	9 193	9 424	9 313
Teacher (secondary and vocational schools)	750	780	823	872	918
Doctorate	809	664	555	475	457
State examination	70	50	23	14	6
Diploma	1 579	796	462	57	50
Studienkolleg	220	218	230	207	214
No degree*	445	371	361	317	332
Total	**24 778**	**25 196**	**25 892**	**25 495**	**25 100**

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

STUDENTS

Allocation of Students to Subject Groups

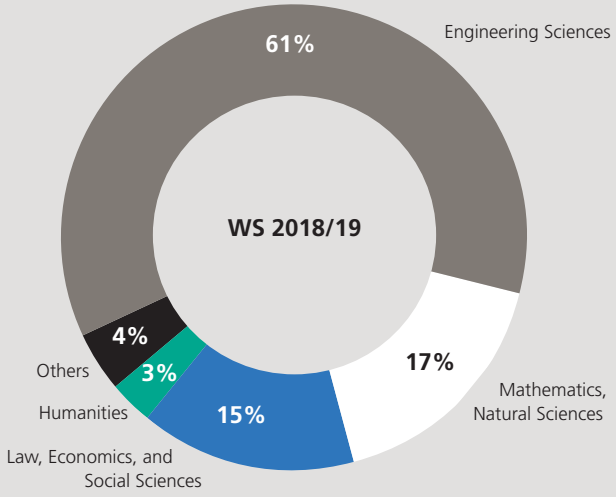
Subject group	WS 2014/15	WS 2015/16	WS 2016/17	WS 2017/18	WS 2018/19
Engineering Sciences	14 481	15 204	15 785	15 671	15 303
Mathematics, Natural Sciences	4 716	4 536	4 504	4 225	4 156
Law, Economics, and Social Sciences	3 896	3 831	3 889	3 854	3 835
Humanities	885	832	840	872	889
Others	800	793	874	873	917
Total	**24 778**	**25 196**	**25 892**	**25 495**	**25 100**

Allocation of Foreign Students to Subject Groups

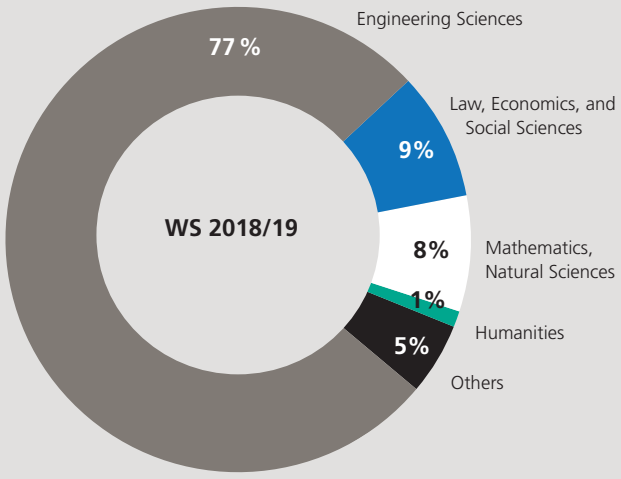
Subject group	WS 2014/15	WS 2015/16	WS 2016/17	WS 2017/18	WS 2018/19
Engineering Sciences	3 429	3 951	4 483	4 674	4 565
Mathematics, Natural Sciences	397	391	457	447	473
Law, Economics, and Social Sciences	453	473	508	527	515
Humanities	73	71	83	81	79
Others	235	234	250	231	284
Total	**4 587**	**5 120**	**5 781**	**5 960**	**5 916**

Foreign students: not of German nationality

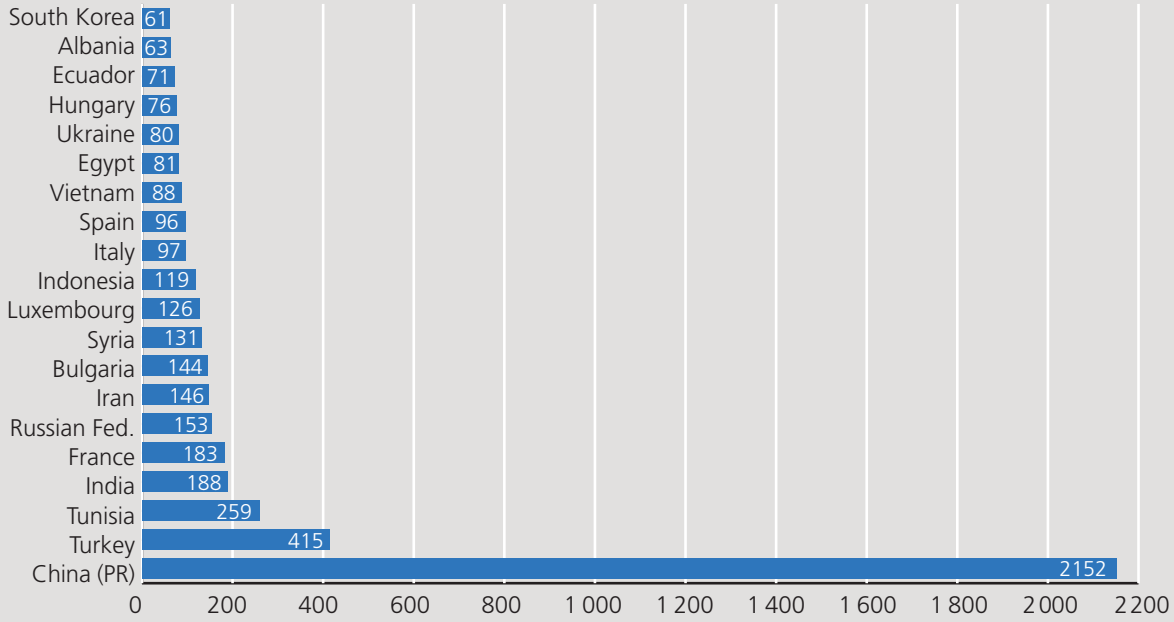
Allocation of Students to Subject Groups



Allocation of Foreign Students to Subject Groups



Home Countries of Foreign Students (Top 20 of 130)



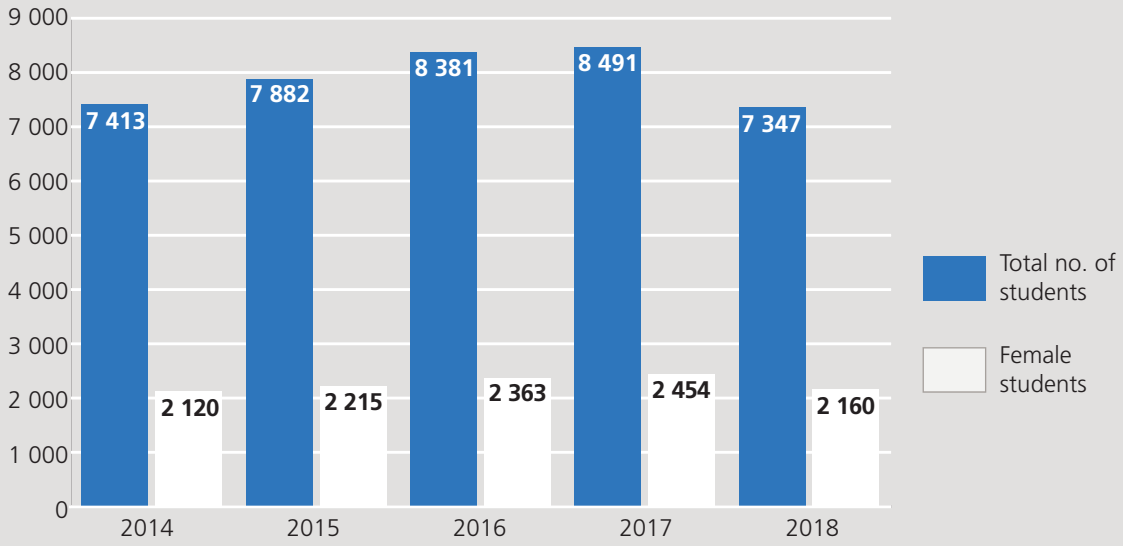
Student Beginners and Degrees Targeted in the 1st Semester*

Desired degree	2014	2015	2016	2017	2018
Bachelor	4 350	4 214	4 439	4 551	4 076
Master	2 607	3 196	3 433	3 390	2 765
Bachelor's degree in teaching at secondary schools	171	136	168	180	223
Bachelor's degree in teaching at vocational schools	28	32	39	37	28
Master's degree in teaching at vocational schools	6	19	17	8	15
Studienkolleg	251	285	285	325	240
Total	**7 413**	**7 882**	**8 381**	**8 491**	**7 347**

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

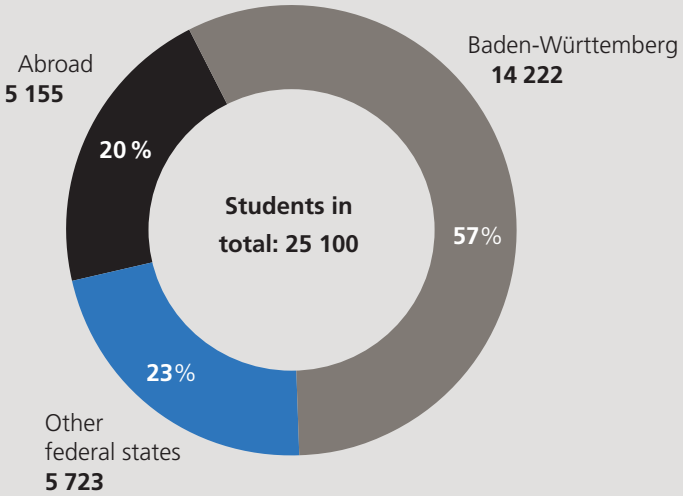
STUDENTS

Number of Student Beginners in the 1st Semester*



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

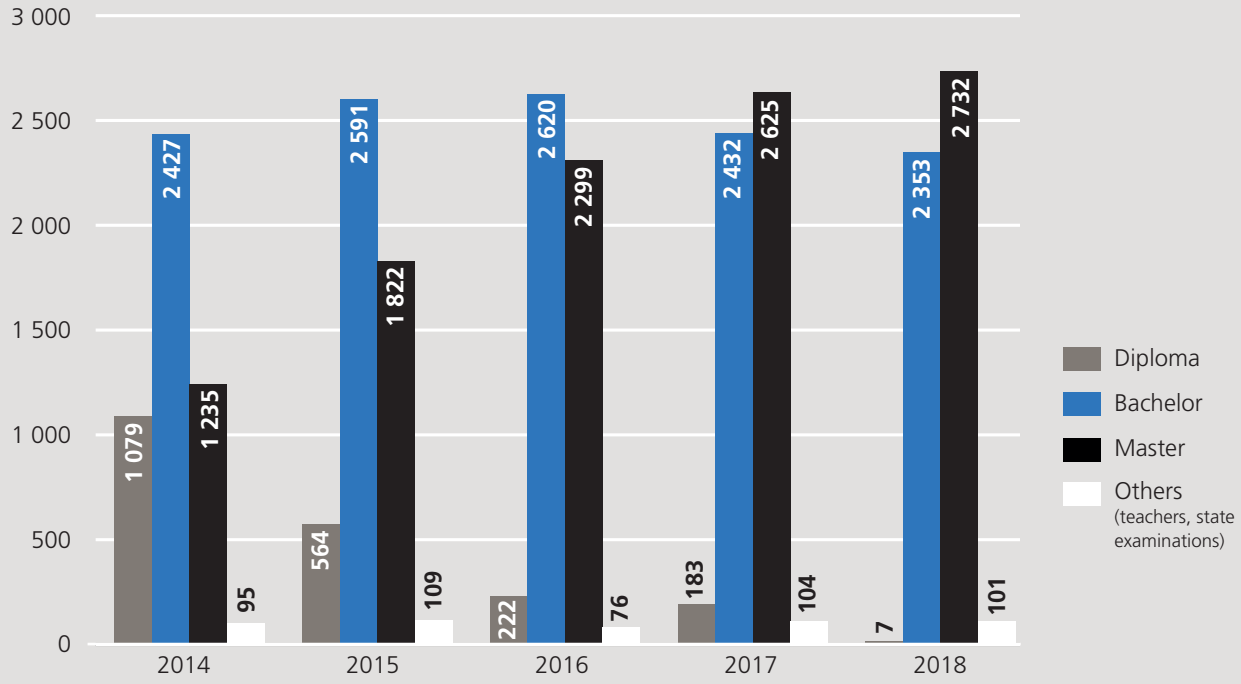
Origin of Students in the 2018/19 Winter Semester*



*Place of acquisition of university entrance qualification.

Region	Students
Karlsruhe city and district	4 194
Karlsruhe Regional Council District	3 814
Rest of Baden-Württemberg	6 214
Baden-Württemberg in total	14 222
Rhineland-Palatinate	1 728
Bavaria	1 002
North Rhine-Westphalia	888
Hesse	856
Lower Saxony	397
Other federal states	852
Germany without Baden-Württemberg	5 723
Asia	3 017
Europe	1 308
Africa	445
America	374
Australia and Oceania	11
Abroad	5 155
KIT in total	**25 100**

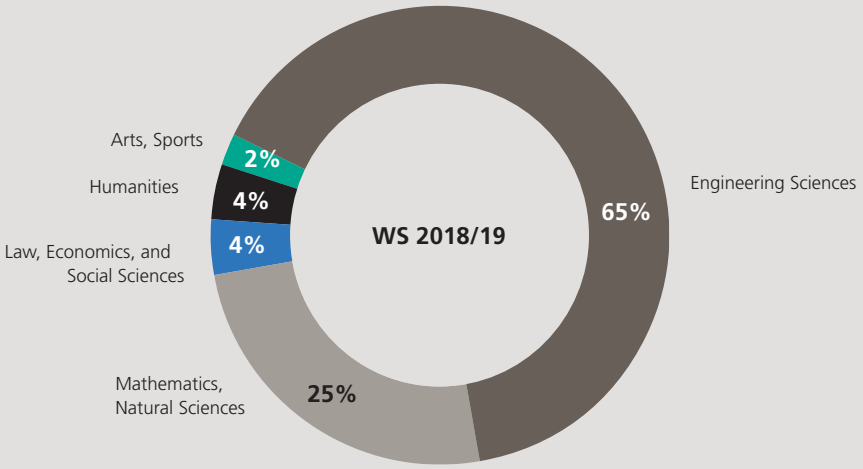
Number of Graduates*



* The number of graduates in 2018 is not yet final.

Doctoral Candidates in the Different Subject Groups in 2018

Subject group	Male	Female	Total
Engineering Sciences	1 645	415	2 060
Mathematics, Natural Sciences	485	295	780
Law, Economics, and Social Sciences	92	52	144
Humanities	61	79	140
Arts, Sports	23	32	55
Total	**2 306**	**873**	**3 179**



STUDENTS

Study Programs in the Area of Engineering Sciences

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Altbauinstandsetzung				●	
Architektur	●	●			*German-French Double Master (École Nationale Supérieure d'Architecture de Strasbourg, France)*
Bauingenieurwesen	●	●			
Bioingenieurwesen	●	●			
Chemieingenieurwesen/Verfahrens-technik	●	●			*ENTECH Master's Program (IST Lisboa, Portugal; Uppsala Universitet, Sweden; INP Grenoble, France)*
Electronic Systems Engineering and Management	●	●			*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 Degree B.Sc. (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 Degrees B.Sc. and M.Sc. (Institut National des Sciences Appliquées Strasbourg, France)*
Informatik	●	●	●		*Double Master Informatics (Institut National Polytechnique Grenoble, France)* *Double Master Cryptography (Université de Rennes, France)*
Informationswirtschaft	●	●			
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 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, France) *Dual Master's Program (Korea Advanced Institute of Science and Technology, Korea)* *Double Master Vehicle or Production Technology (CDHK, Tongji University, China)* *Dual Master's Program (Instituto Tecnológico de Buenos Aires, Argentina)* *Master's Program ENTECH (IST Lisboa, Portugal; Uppsala Universitet, Sweden; INP Grenoble, France)*
Mechanical Engineering (International)	●				
Materialwissenschaft und Werkstofftechnik	●	●			
Mechatronik und Informationstechnik	●	●			
Mobilität und Infrastruktur		●			
Mobility Systems Engineering and Management				●	
Naturwissenschaft und Technik			●		
Optics and Photonics		●			*Double Master's Program (Aix Marseille Université, France; École Centrale de Marseille, France; Barcelona Universities, Spain)*
Production and Operations Management				●	
Regionalwissenschaft		●			*Dual Master's Degree Program (Universidad de Concepción, Chile)* *Double Master's Degree Program (Universidad Tecnológica National, Buenos Aires, Argentina)*
Remote Sensing and Geoinformatics		●			
Service Management and Engineering				●	
Water Science and Engineering		●			

STUDENTS

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	●	●			
Lebensmittelchemie	●	●			
Mathematik	●	●	●		*German-French Bachelor's and Master's Program (École Polytechnique Paris, France)*
Meteorologie	●	●			
Physik	●	●	●		*German-French Double Master (UFR de Physique of Université Joseph Fourier Grenoble, France) German-French Double Master (École Polytechnique Paris, France)*
Technomathematik	●	●			
Wirtschaftsmathematik	●	●			

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

Subject (program)	Bachelor	Master (consecutive)	Teacher	Master (cont. education)	Double degree
Ingenieurpädagogik			●		
Pädagogik	●	●			
Personalentwicklung – Berufs- und Betriebspädagogik*				●	
Technische Volkswirtschaftslehre	●	●			
Wirtschaftsingenieurwesen	●	●			*German-French Double Degree M.Sc. (Institut National Polytechnique Grenoble, France)* *Double Master (Linköpings universitet, Sweden)*

* Will be terminated from the 2019 summer semester

Study Program 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 1173/1	Wave Phenomena: Analysis and Numerics	Prof. Dr. Marlis Hochbruck, Institute for Applied and Numerical Mathematics	2015 – 2019
SFB 1176/1	Molekulare Strukturierung weicher Materie	Prof. Dr. Michael Meyer, Institute of Organic Chemistry	2016 – 2019

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

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

Number	Title	Spokesperson	Duration
FOR 1546	Rechnergestützte kooperative Trassenplanung in mehrskaligen 3-D-Stadt- und Bauwerksmodellen	Prof. Dr. Martin Breunig, Geodetic Institute	2011 – 2018
FOR 1548	Geometry and Physics of Spatial Random Systems	Prof. Dr. Günter Last, Institute of Stochastics	2011 – 2018
FOR 1598	From Catchments as Organised Systems to Models based on Dynamic Functional Units – CAOS	Prof. Dr. Erwin Zehe, Institute for Water and River Basin Management	2011 – 2018
FOR 1650	Dislocation based Plasticity	Prof. Dr. Peter Gumbsch, Institute for Applied Materials	2011 – 2018
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 – 2019

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
SFB TRR 165/1	Waves to Weather: Wellen, Wolken, Wetter	Prof. George C. Craig, Meteorologisches Institut, LMU München Prof. Volkmar Wirth, Institut für Physik der Atmosphäre, JGU Mainz Prof. Peter Knippertz, Institute of Meteorology and Climate Research, KIT	2015 – 2019

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 1246	Kilimanjaro ecosystems under global change	Prof. Dr. Ingolf Steffan-Dewenter, Universität Würzburg (Spokesperson) Dr. Ralf Kiese, Institute of Meteorology and Climate Research, KIT	2010 – 2018
FOR 1451	Exploring mechanisms underlying the relationship between biodiversity and ecosystem functioning	Prof. Dr. Nico Eisenhauer, Universität Leipzig, (Spokesperson) Prof. Dr. Wolfgang Wilcke, Institute of Geography and Geoecology, KIT	2010 – 2018

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RESEARCH

➔ DFG-funded Research Units with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
FOR 1498	Alkali-Kieselsäure-Reaktionen in Betonbauteilen bei gleichzeitiger zyklischer Beanspruchung und externer Alkalizufuhr	Prof. Dr. Rolf Breitenbücher, Ruhr-Universität Bochum (Spokesperson) Prof. Dr. Harald S. Müller, Institute of Concrete Structures and Building Materials, KIT	2011 – 2018
FOR 1525	INUIT – Ice Nuclei research UnIT	Prof. Dr. Joachim Curtius, Universität Frankfurt am Main (Spokesperson) Prof. Dr. Corinna Hoose, Dr. Alexei Kiselev, Prof. Dr. Thomas Leisner, Dr. Ottmar Möhler, Institute of Meteorology and Climate Research, KIT	2011 – 2018
FOR 1701	Introducing Non-Flooded Crops in Rice-Dominated Landscapes: Impact on Carbon, Nitrogen and Water Cycles (ICON)	Prof. Dr. Volkmar Wolters, Universität Gießen (Spokesperson) Dr. Ralf Kiese, Prof. Dr. Klaus Butterbach-Bahl, Institute of Meteorology and Climate Research, KIT	2011 – 2018
FOR 1993	Multifunktionale Stoff- und Energiewandlung	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 – 2019
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 – 2019
FOR 2083	Integrierte Planung im öffentlichen Verkehr	Prof. Dr. Anita Schöbel, Georg-August-Universität Göttingen (Spokesperson) Prof. Dr. Dorothea Wagner, Institute of Theoretical Informatics, KIT	2015 – 2018
FOR 2093	Memristive Bauelemente für neuronale Systeme	Prof. Dr. Hermann Kohlstedt, Christian-Albrechts-Universität zu Kiel (Spokesperson) Dr. Kiran Chakravadhanula, Institute of Nanotechnology, KIT	2014 – 2018

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➔ DFG-funded Research Units with KIT Participation

Number	Title	Spokesperson / KIT participation	Duration
FOR 2290	Understanding Intramembrane Proteolysis	Prof. Dr. Dieter Langosch, Technische Universität München (Spokesperson) Prof. Dr. Burkhard Luy, Institute of Organic Chemistry, KIT	2015 – 2018
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 – 2019
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	2015 – 2018

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 project	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 – 08/2023
Prof. Dr. Dennis Hofheinz, Institute of Computer Engineering, Division II	ERC Consolidator Grant PREP-CRYPTO – Preparing Cryptography for Modern Applications	07/2017 – 06/2022
Prof. Dr. Corinna Hoose, Institute of Meteorology and Climate Research, Division IV	ERC Starting Grant C2Phase – Closure of the Cloud Phase	04/2017 – 03/2022
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 – 04/2023
Dr. Cornelia Lee-Thedieck, Institute of Functional Interfaces, Division I	ERC Starting Grant Blood and bone – conjoined twins in health and disease: bone marrow analogs for hematological and musculoskeletal diseases	02/2018 – 01/2023
Dr. Pavel Levkin, Institute of Toxicology and Genetics, Division I	ERC Starting Grant DropCellArray – DropletMicroarrays: Ultra High-Throughput Screening of Cells in 3D Microenvironments	02/2014 – 01/2019
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. 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
Prof. Dr. Florian Bernlochner, Institute of Experimental Particle Physics, Division V	Suche nach neuer Physik und Präzisionsmessung des CKM Matrixelements |Vub| mit dem Belle II Experiment	02/2018 – 02/2022

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➔ 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. Benjamin Flavel, Institute of Nanotechnology, Division V	Kohlenstoffnanoröhren, Solarzellen und Sensoren	06/2013 – 05/2019
Dr. Christian Greiner, Institute for Applied Materials, Division III	Size effects and microstructure evolution in textured metal surfaces during reciprocating sliding	10/2012 – 03/2019
Dr. Manuel Hinterstein, Institute for Applied Materials, Division III	BNT-BT als zukünftige bleifreie Funktionswerkstoffe für PTCR-, Aktor- und Sensoranwendungen	04/2016 – 03/2021
Dr. Nadine Rühr, Institute of Meteorology and Climate Research, Division IV	Die Auswirkungen von Extremereignissen auf den Kohlenstoff- und Wasserkreislauf	10/2016 – 09/2019
Dr. Karsten Woll, Institute for Applied Materials, Division III	Pulsed Metallurgy on Metallic Thin Films	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.

Helmholtz Young Investigators Groups

Name, institute, division	Title of group	Duration
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 of Solid State Physics, 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 – 03/2024
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

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RESEARCH

➔ Helmholtz Young Investigators Groups

Name, institute, division	Title of group	Duration
Dr. Matthias Mauder, Institute of Meteorology and Climate Research, Division IV	Capturing All Relevant Scales of Biosphere-Atmosphere Exchange – The Enigmatic Energy Balance Closure Problem	02/2012 – 01/2018
Dr. Ulrich Paetzold, Institute of Microstructure Technology, Division III	Nanophotonics for Perovskite/Silicon Multijunction Solar Cells	05/2016 – 04/2021
Dr. Alexander Schug, Steinbuch Centre for Computing, Division II	Multi-scale Simulations of Regulatory RNAs and Two-Component signal Transduction	04/2011 – 06/2019
Dr. Svetoslav Stankov, Institute for Photon Science and Synchrotron Radiation, Division V	Interplay between structure and lattice dynamics in epitaxial rare earth nanostructures	05/2010 – 12/2018
Dr. Manuel Tsotsalas, Institute of Functional Interfaces, Division I	Hierarchically Structured Biomaterials	01/2016 – 12/2020
Dr. Kathrin Valerius, Institute for Nuclear Physics, Division V	Analysis of KATRIN data to measure the neutrino mass and search for new physics	07/2014 – 06/2019
Dr. Tonya Vitova, Institute for Nuclear Waste Disposal, Division III	Advanced synchrotron-based systematic investigations of actinide (An) and lanthanide (Ln) systems to understand and predict their reactivity	07/2011 – 10/2019
Dr. Frank Weber, Institute for Solid State Physics, Division V	Competing Phases in Superconducting Materials	01/2012 – 12/2018
Dr. Roswitha Zeis, Helmholtz Institute Ulm Division I	Investigation of Overpotentials in High Temperature Proton Exchange Membrane Fuel Cells	05/2010 – 02/2020

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 maßgeschneiderte Hochleistungsfaserverbunde (gefördert durch die Vector Stiftung)	07/2014 – 12/2021

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

BMBF Junior Research Groups

Name, institute, division	Title of group	Duration
Dr. Gerardo Hernandez-Sosa, Light Technology Institute, InnovationLab Group, Division III	BIOLicht – Gedruckte biologisch abbaubare organische lichtemittierende Bauteile	11/2014 – 10/2022
Dr. Samiro Khodayar, Institute of Meteorology and Climate Research, Division IV	Vorhersagemodelle für Extremwetterereignisse unter einem geänderten Klima – Abschätzung des mehrskaligen Einflusses aufgrund der Rückkopplung zwischen Boden und Atmosphäre	08/2014 – 07/2018
Dr. Julia Maibach, Institute for Applied Materials, Division III	InSEIde: Grenzflächen in Lithium-Ionen-Batterien verstehen und manipulieren	09/2017 – 09/2022
Dr. Bastian E. Rapp, Institute of Microstructure Technology, Division III	Fluoropor – chemisch inertes, mikro- bis nanoporöses "Teflon" mit einstellbarem Benetzungsverhalten	10/2014 – 09/2018
Dr. Cornelia Lee-Thedieck, Institute of Functional Interfaces, Division I	BioInterfaces Stammzellen-Material-Wechselwirkung	10/2013 – 10/2018
Dr. Aiko Voigt, Institute of Meteorology and Climate Research, Division IV	Wolken-Strahlungs-Wechselwirkungen mit der nordatlantischen Sturmzugbahn (CONSTRAin)	09/2016 – 08/2021

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

Other Junior Research Groups and Funding Measures

Name, institute, division	Title of group	Duration	Funding
Dr. Stefanie Betz, Institute of Applied Informatics and Formal Description Methods, Division II	Nachhaltigkeit in der Softwareentwicklung	02/2015 – 03/2018	Margarete von Wrangell Habilitation Grant of MWK and others
Dr. Christian Brandl, Institute for Applied Materials, Division III	Computergestützte Nanomechanik von Materialien	05/2015 – 12/2020	DFG and others
Dr. Dominic Bresser, Helmholtz Institute Ulm, Division I	Neuartige Elektrodenmaterialien für Wiederaufladbare Elektrochemische Energiespeicher (NEW E^2)	05/2017 – 06/2020	Vector Foundation

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RESEARCH

➔ Other Junior Research Groups and Funding Measures

Name, institute, division	Title of group	Duration	Funding
Dr. Guillaume Delaittre Institute of Toxicology and Genetics, Division I	Polymeric (Nano)Materials for Biotechnology and Biology	03/2013 – 12/2018	BMBF
Dr. Azad M. Emin, Institute of Process Engineering in Life Sciences, Division I	Extrusion of Biopolymeric Systems	08/2016 – 07/2019	DFG and others
Dr. Dietmar Gallistl, Institute for Applied and Numerical Mathematics, Division V	Numerische Mehrskalen-methoden	05/2017 – 03/2018	Junior Research Group within a CRC
Dr. Christian Greiner, Institute for Applied Materials, Division III	TriboKey – Deformation Mech-anisms are the Key to Under-standing and Tayloring Tribological Behaviour	09/2018 – 08/2023	ERC Consolidator Grant
Dr. Andreas Haupt, Institute for Sociology, Media, and Cultural Sciences, Division II	Economic Inequality and Labor Markets	01/2015 – 01/2019	Elite program for postdocs of the Baden-Württemberg Foundation, DFG
Dr. Robert Heinrich, Institute for Program Structures and Data Organization, Division II	Quality-driven System Evolution	03/2018 – 12/2019	MWK and BMBF
Dr. Michael Hirtz, Institute of Nanotechnology, Division V	Dip-Pen Nanolithography and Related Techniques	03/2011 – 12/2020	DFG and others
Dr. rer. pol. Daniel Hoang, Institute for Finance, Banking, and Insurance, Division II	Unternehmensfinanzierung	10/2016 – 09/2019	DFG, Funk Foundation
Dr. Sebastian Höfener, Institute of Physical Chemistry, Theoretical Chemistry Group, Division I	Molecular electronic structure methods in complex environ-ments	02/2017 – 12/2019	DFG and others
Dr. Patrick Jochem, Institute for Industrial Production, Division II	Transport und Energie	10/2009 – 07/2020	BMWi and others
Dr. Mathias Krause, Institute for Applied and Numerical Mathematics 2/ Institute for Mechanical Process Engineering and Mechanics, Divisions V und III	Lattice Boltzmann Research Group	05/2018 – 04/2024	DFG and others

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➔ Other Junior Research Groups and Funding Measures

Name, institute, division	Title of group	Duration	Funding
Dr. Cornelia Lee-Thedieck, Institute of Functional Interfaces, Division I	Blood and bone – conjoined twins in health and disease: bone marrow analogs for hematological and musculoskeletal diseases	02/2018 – 01/2023	ERC Starting Grant
Dr. Pavel Levkin, Institute of Toxicology and Genetics, Division I	DropCellArray – DropletMicroarrays: Ultra High-Throughput Screening of Cells in 3D Microenvironments	02/2014 – 01/2019	ERC Starting Grant
Dr. 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 – 06/2019	Junior Research Group within a CRC
Dr. Ingo Münch, Institute for Structural Analysis, Division IV	Ferroelectric nanostructures for energy harvesting	02/2017 – 02/2018	DFG and others
Dr. Philipp Niemann, Institute for German Studies: Literature, Language, Media, Division II	Science in Presentations	12/2015 – 11/2018	Klaus Tschira Foundation
Dr. Zbigniew Pianowski, Institute of Organic Chemistry, Division I	Chemical Biology, Supramolecular Systems and Prebiotic Chemistry	10/2016 – 09/2019	DFG
Dr. Ioan M. Pop, Physikalisches Institut, Division V	Supraleitende Quantenelektronik	10/2015 – 09/2020	Alexander von Humboldt Foundation
Dr. Achim Rettinger, Institute of Applied Informatics and Formal Description Methods, Division II	Adaptive Data Analytics	06/2014 – 06/2020	BMBF and EU
Dr. Andy Rupp, Institute of Theoretical Informatics, Division II	CyPhyCrypt	07/2017 – 09/2019	DFG, KASTEL
Dr. Frank Schröder, Institute for Nuclear Physics, Division V	Tunka-Rex-Experiment	02/2017 – 12/2018	DFG
Dr. Katrin Schulz, Institute for Applied Materials, Division III	Dislocation based Continuum Theory of Plasticity	01/2016 – 12/2020	Margarete von Wrangell Habilitation Grant of MWK and others

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RESEARCH

➔ Other Junior Research Groups and Funding Measures

Name, institute, division	Title of group	Duration	Funding
Dr. Philipp Schuster, Institute for Finance, Banking, and Insurance, Division II	Liquiditätseffekte auf Finanzmärkten	05/2017 – 09/2019	DFG and others
Dr. Nicole Stricker, wbk Institute of Production Science, Division III	Robuste Produktionstechnik	06/2018 –12/2019	Elite program for postdocs of the Baden- Württemberg Foundation

Junior Professorships

Name, institute, division	Area	Duration
Jun.-Prof. Dr. Andreas Chr. Braun, Institute of Regional Science, Division IV	Risikoorientierte Regionalentwicklung	05/2015 – 05/2019
Jun.-Prof. Dr. Lennart Hilbert, Zoological Institute, Division I	Systembiologie/Bioinformatik	10/2018 – 09/2022
Jun.-Prof. Dr. Anne Koziolek, Institute for Program Structures and Data Organization, Division II	Softwaretechnik	02/2013 – 11/2020
Jun.-Prof. Dr. Xian Liao, Institute for Analysis, Division V	Analysis Partieller Differentialgleichungen	11/2018 – 11/2022
Jun.-Prof. Dr. Boris Neubert, Institute for Visualization and Data Analysis, Division II	Visual Computing	04/2015 – 03/2019
Jun.-Prof. Dr. Matti Schneider, Institute of Engineering Mechanics, Division III	Computational Micromechanics	09/2017 – 08/2021
Jun.-Prof. Dr. Katharina Schratz, Institute for Applied and Numerical Mathematics, Division V	Zeitabhängige partielle Differentialgleichungen	09/2013 – 08/2019
Jun.-Prof. Dr. Petra Schwer, Institute for Algebra and Geometry, Division V	Metrische Geometrie	10/2014 – 11/2018
Jun.-Prof. Dr. Thorsten Stein, Institute of Sports and Sports Science, Division II	Sportwissenschaft mit dem Schwerpunkt Bewegungswissenschaft und Biomechanik	04/2013 – 04/2019

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➔ Other Junior Professorships

Name, institute, division	Area	Duration
Jun.-Prof. Dr. Ingo Wagner, Institute of Sports and Sports Science, Division II	MINT-Fachdidaktik im Division der Fächer Sport und Mathematik oder Physik	10/2018 – 09/2022

Graduate Schools Funded by the DFG or Helmholtz Association

Graduate School	Funded by	Spokesperson / participant	Duration
Karlsruhe School of Optics & Photonics (KSOP)	DFG	Prof. Dr. Ulrich Lemmer, Light Technology Institute	2006 – 2019
Karlsruher Schule für Elementarteilchen- und Astroteilchenphysik: Wissenschaft und Technologie (KSETA)	DFG	Prof. Dr. Ulrich Nierste, Institute for Theoretical Particle Physics	2012 – 2019
Graduiertenschule für Klima und Umwelt (GRACE)	HGF	Prof. Dr. Stefan Hinz, Institute of Photogrammetry and Remote Sensing	2011 – 2022

Research Training Groups Funded by the DFG or Helmholtz Association

Research Training Group	Funded by	Spokesperson / participant	Duration
Prozessketten in der Fertigung: Wechselwirkung, Modellbildung und Bewertung von Prozesszonen	DFG	Prof. Dr. Volker Schulze, Institute of Production Science	2008 – 2018
Elementarteilchenphysik bei höchster Energie und höchster Präzision	DFG	Prof. Dr. Dieter Zeppenfeld, Institute for Theoretical Physics	2011 – 2020
Molekulare Architekturen für die fluoreszente Bildgebung von Zellen	DFG	Prof. Dr. Hans-Achim Wagenknecht, Institute of Organic Chemistry	2015 – 2019
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 – 2019
Energiezustandsdaten – Informatikmethoden zur Erfassung, Analyse und Nutzung	DFG	Prof. Dr. Klemens Böhm, Institute for Program Structures and Data Organization	2016 – 2020

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RESEARCH

➔ **Research Training Groups Funded by the DFG or Helmholtz Association**

Research Training Group	Funded by	Spokesperson / participant	Duration
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 – 2021
Simulation mechanisch-elektrisch-thermischer Vorgänge in Lithium-Ionen-Batterien	DFG	Prof. Dr. Thomas Wetzel, Institute of Thermal Process Engineering	2017 – 2021
Helmholtz International Research School for Teratronics – HIRST	HGF	Prof. Dr. Christian Koos, Institute of Microstructure Technology	2012 – 2018
Mechanisms and Interactions of Climate Change in Mountain Regions MICMoR	HGF	Prof. Dr. Hans Peter Schmid, Institute of Meteorology and Climate Research	2012 – 2019
Energy Scenarios – Construction, Assessment and Impact	HGF	Prof. Dr. Armin Grunwald, Institute for Technology Assessment and Systems Analysis	2011 – 2019
IMD – Helmholtz Research School on "Integrated Materials Development for Novel High-temperature Alloys"	HGF	Prof. Dr. Martin Heilmaier, Institute for Applied Materials	2013 – 2018
Helmholtz International Research School for Astroparticle Physics and Enabling Technologies (HIRSAP)	HGF	Prof. Dr. Ralph Engel, Institute for Nuclear Physics	2018 – 2024

INNOVATION

Innovation Characteristics

Year	Invention disclosures	Priority-establishing patent applications	Property rights (existing)	Royalties [million euros]	New companies (spinoffs)	Participation in spinoffs
2014	133	77	1 884	2.16	33 (7)	6
2015	119	59	1 902	2.04	18 (8)	6
2016	127	55	2 000	1.70	21 (10)	7
2017	124	55	1 965	1.44	29 (10)	7
2018	115	63	1 949	1.57	21 (7)	9

Establishments of New Companies

Spinoffs
Aquarray GmbH
GFX GmbH
Kamedi GmbH
Prenode GmbH
thingsthinking GmbH
Usertimes GmbH
Zana GmbH

Startups
Apic.ai GmbH
auvisus GbR
Bavest GbR
Circle GbR
First Momentum Ventures GmbH
HeliosPasAI GbR
KBOX GbR
Mangolearn GbR
Nestyu GbR
Read! GbR
REVEOX GbR
Secureradiationlab GbR
Studentenfutter GbR
Tortenglück GbR

AWARDS

External Awards
(see separate chapter of this Annual Report from page 84)

KIT Department Teaching Awards

KIT Department	Award winners
Architecture	Prof. Markus Neppl
Civil Engineering, Geo- and Environmental Sciences	Prof. Dr. Frank Schilling
Chemistry and Biosciences	Prof. Dr. Hans-Achim Wagenknecht
Chemical and Process Engineering	Dr. Barbara Freudig
Electrical Engineering and Information Technology	Dr. Holger Jäkel
Humanities and Social Sciences	Marian Hoffman, Johannes Nagl
Informatics	Prof. Dr. Tamim Asfour
Mechanical Engineering	Dr. Anastasia August
Mathematics	Prof. Dr. Marlis Hochbruck
Physics	Prof. Dr. Ulrich Husemann
Economics and Management	Prof. Dr. Petra Nieken

Awards for Doctoral Researchers

KIT Doctoral Awards

Name	Institute
Dr. Alena Kalyakina	Institute for Organic Chemistry
Dr. Frederik Kotz	Institute of Microstructure Technology
Dr. Tobias Ried	Institute for Analysis

Other Doctoral Awards

Name	Institute	Institution
Dr. Susanne Benz	Institute of Applied Geosciences	Sponsorship Award of the Friedrich and Elisabeth Boysen Foundation
Dr. Steffen Scherr	Institute of Radio Frequency Engineering and Electronics	Südwestmetall Sponsorship Award

MEDIA/PUBLICATIONS

Development of Visibility in the Media

	2014	2015	2016	2017	2018
Printed articles	12 968	14 609	16 913	20 372	20 118
Online articles*	19 608	16 578	20 537	23 943	23 544

*Deviations of the number of online articles in 2014-2017 from the 2017 Annual Report are due to updated data.

Publications

Publications in the year	2014	2015	2016	2017	2018
Publications of researchers of KIT	8 576	8 882	9 089	8 469	7 891
of these, books and proceedings	945	885	903	826	844
of these, articles in proceedings	1 538	1 354	1 535	1 305	1 208
of these, articles in journals	3 025	3 578	4 024	3 969	3 540
of these, in WoS- or Scopus-referenced journals	2 620	3 232	3 748	3 658	3 315
of these, open access articles	1 294	1 566	1 861	1 902	1 748

RANKINGS

National Rankings

		2014	2015	2016	2017*	2018
Wirtschaftswoche	Electrical Engineering	2	4	2	–	2
	Informatics	1	5	2	–	1
	Mechanical Engineering	1	4	3	–	2
	Natural Sciences	8	–	7	–	7
	Business Engineering	1	3	2	–	2

* In 2017, no ranking was published by Wirtschaftswoche.

International Rankings

		2014	2015	2016	2017	2018
National Taiwan University Ranking	International – Overall	190	192	198	211	216
	International – Natural Sciences	52	49	53	55	62
	International – Engineering Sciences	79	58	80	81	95
	National – Overall	18	18	18	19	19
	National – Natural Sciences	1	1	1	1	1
	National – Engineering Sciences	1	1	1	1	1
QS World University Rankings	International – Overall	127	93	98	107	116
	International – Natural Sciences	34	34	–	29	37
	International – Engineering Sciences & IT	47	62	–	38	51
	National – Overall	5	4	4	4	4
	National – Natural Sciences	3	3	–	3	4
	National – Engineering Sciences	4	4	–	4	4
Times Higher Education	International – Overall	165	138	144	133	135
	International – Natural Sciences	–	46	68	61	69
	International – Engineering Sciences	56	48	60	55	54
	National – Overall	11	14	14	14	14
	National – Natural Sciences	–	4	9	7	5
	National – Engineering Sciences	3	3	4	4	3
Academic Ranking of World Universities	International – Overall	201–300	201–300	201–300	201–300	201–300
	International – Natural Sciences	76–100	76–100	51–75	–	–
	International – Engineering Sciences	101–150	101–150	151–200	–	–
	National – Overall	14–22	14–21	15–21	16–22	15–20

SUSTAINABILITY

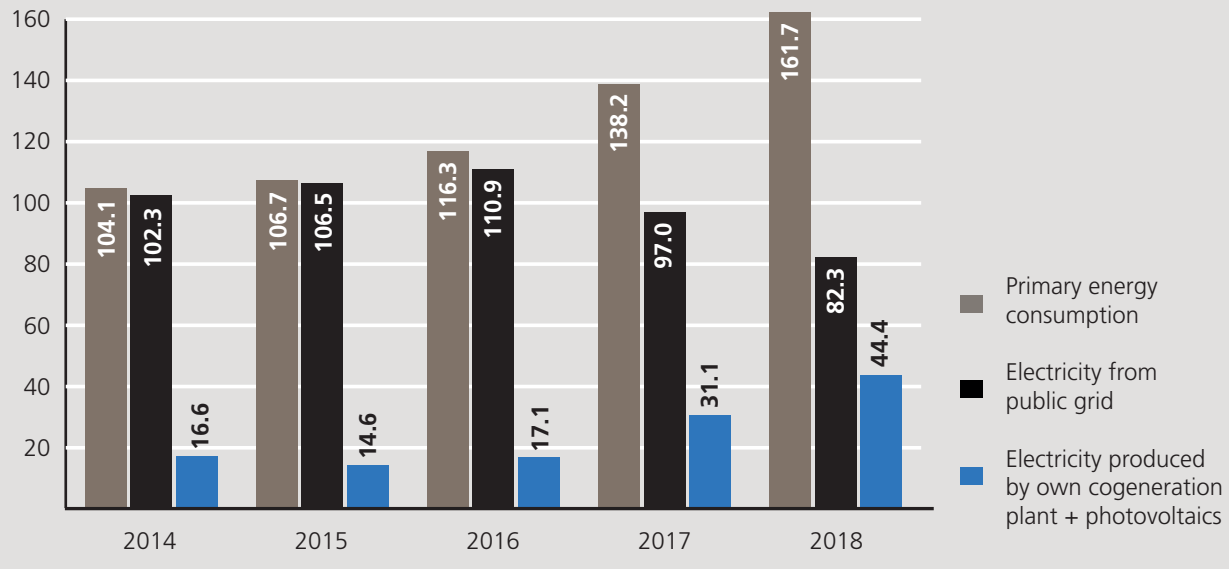
CO_2 Emissions of Heating Power Plants on Campus North

	2014	2015	2016	2017	2018
Heating plant CO_2 [t/a]	11 091	12 580	16 361	10 671	8 511
Cogeneration plant CO_2 [t/a]	7 604	6 281	4 205	6 496	4 754
Total CO_2 [t/a]	18 695	18 861	20 566	17 167	13 265
Allocated CO_2 certificates [t/a]	12 501*	11 073*	9 688*	8 346*	7 047*

* Due to excessive, not needed CO_2 certificates, no further CO_2 certificates had to be purchased.

Energy Consumption and Energy Production on Campus North

Type of energy	2014	2015	2016	2017	2018
Primary energy consumption [GWh]	104.1	106.7	116.3	138.2	161.7
Electricity from the public grid [GWh]	102.3	106.5	110.9	97.0	82.3
Electricity produced by own cogeneration plant [GWh]	16.6	13.6	16.1	30.1	43.2
Electricity produced by own photovoltaics facilities [GWh]	–	1.0	1.0	1.0	1.2
Heat produced (district heating power plant + cogeneration plant) [GWh]	65.9	71.4	77.3	78.9	73.1
Heat. weather-adjusted [GWh]	80.3	74.4	77.3	78.1	81.3



SUSTAINABILITY

Supply and Waste Management Services

Type of service	2016		2017		2018	
	CN	CS*	CN	CS*	CN	CS*
Electricity supply [GWh]	84	55	80	54	79	55
Heat supply [GWh]	51	44	41	44	38	45
Weather-adjusted [GWh]	51	44	40	44	42	50
Water supply [m³]	116 512	224 257	107 543	222 970	99 759	229 100
Waste disposal [t]	9 549**	1 021	16 455**	955	19 978**	899

* The data for Campus East and Campus West are included in Campus South.
**The data refer to Campus North in total, including external institutions.

Areas

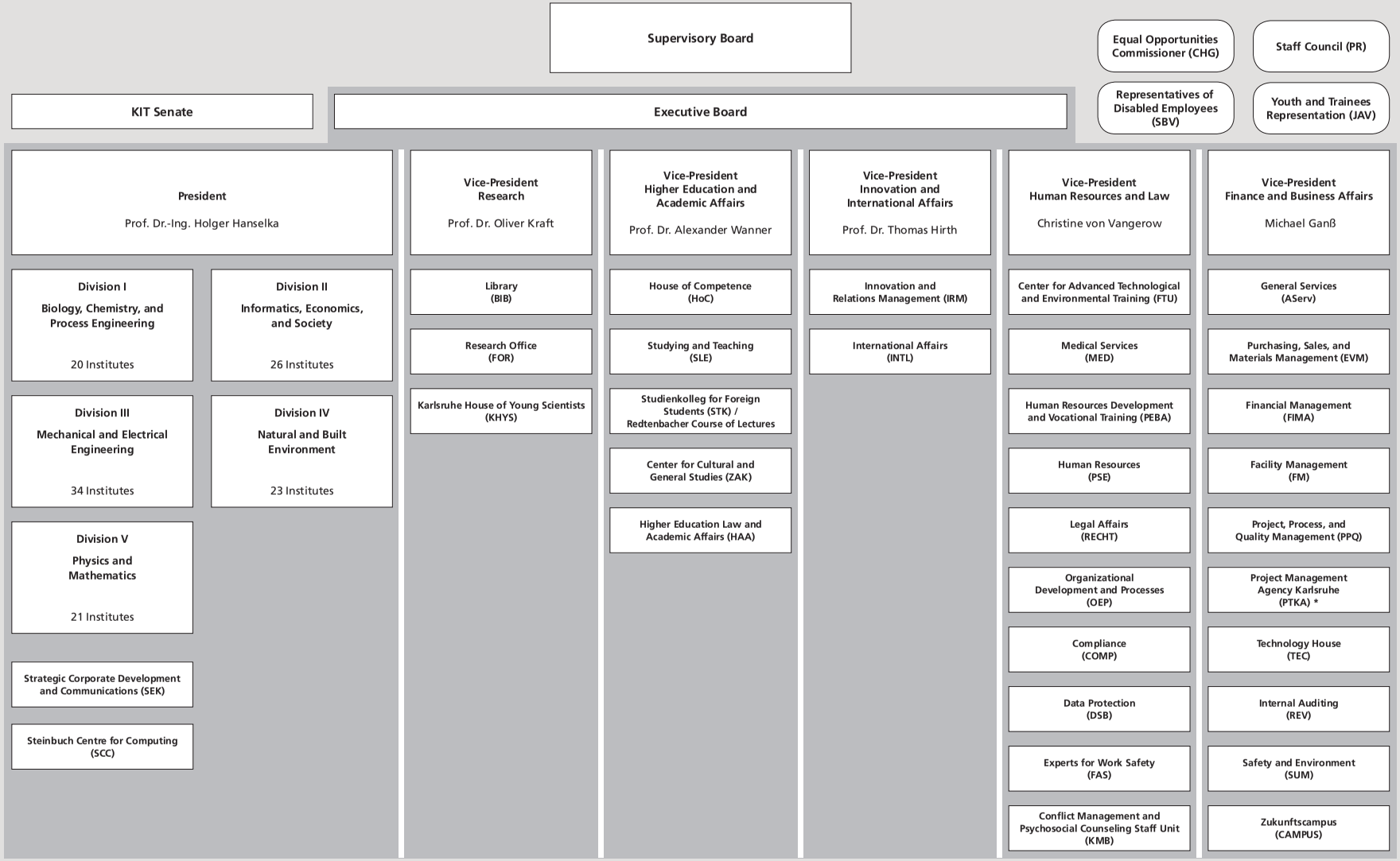
Type of area [m²]	KIT in total		Campus South*		Campus East**		Campus North**	
	[m²]	%	[m²]	%	[m²]	%	[m²]	%
Office areas (including conference rooms. rooms for copiers and servers)	168 498	34.1%	94 415	32%	6 311	2.1%	67 772	37%
Laboratories. workshops. experiment halls	185 798	37.6%	101 338	34.3%	4 075	1.4%	80 385	43.9%
Storage and similar facilities	64 469	13%	33 569	11.4%	4 882	1.7%	26 018	14.2%
Teaching and studies (lecture halls. seminar rooms. practice rooms)	57 092	11.6%	49 633	16.8%	366	0.1%	7 093	3.9%
Library areas (central + decentralized libraries)	13 734	2.8%	11 927	4%	75	0.0%	1 732	0.9%
Sports areas	4 564	0.9%	4 295	1.5%	52	0.0%	217	0.1%
Total usable area	494 155	100%	295 177	100%	15 761	5.3%	183 217	100%
of this. rented areas			18 833m²				2 517m²	

* incl. Campus East and Campus West

** incl. Campus Alpine

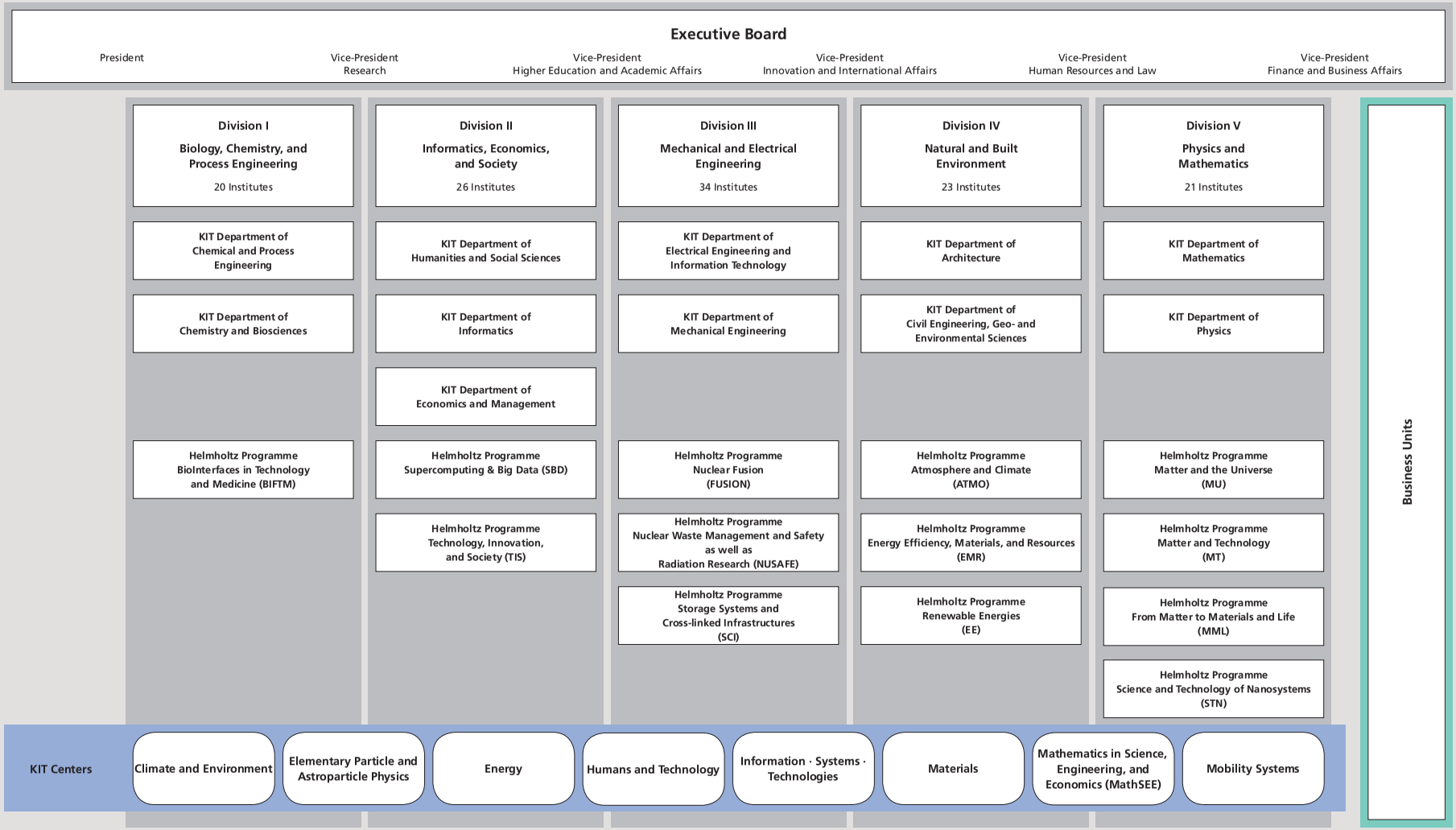
ORGANIZATIONAL CHARTS

Organizational Structure



** no professional instructions by KIT Executive Board*

Science Organization



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President Professor Dr.-Ing. Holger Hanselka
Kaiserstraße 12 · 76131 Karlsruhe, Germany

www.kit.edu

KIT – The Research University in the Helmholtz Association

Contact

Strategic Corporate Development and Communications
Head: Alexandra-Gwyn Paetz
Phone: +49 (0) 721 608-21100
Email: info@kit.edu

Edited by
Dr. Sabine Fodi, Dr. Joachim Hoffmann (responsible editors), SEK

Data and figures: Beata Boos, SEK

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