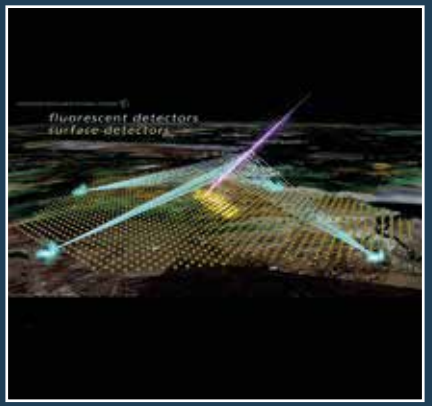
Karlsruhe Institute of Technology

Karlsruhe School of Elementary Particle and Astroparticle Physics: Science and Technology (KSETA)

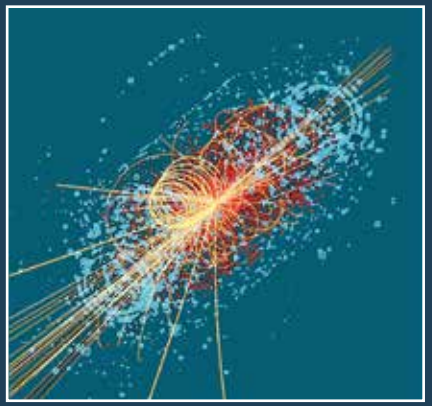
Graduate School of KCETA

Astroparticle physics



High energy cosmic rays at the **Pierre Auger Observatory** in Argentina

Elementary particle physics



Monte Carlo simulation of a Higgs event detected by the Compact Muon Spectrometer **(CMS)** at CERN

Advanced technologies

KATRIN Main Spectrometer – view at one of the pumping ports with getter pump frame (left) and a liquid-nitrogen cooled copper baffle.

The Graduate School

The Karlsruhe School of Elementary Particle and Astroparticle Physics: Science and Technology (KSETA) is the Graduate School of the KIT Center Elementary Particle and Astroparticle Physics (KCETA). The school covers the fields of elementary particle physics, astroparticle physics and related advanced technologies. Its distinguishing feature is the joint doctoral research of young physicists and engineers on thesis topics centered around large-scale projects of particle and astroparticle physics.

The leitmotiv of the school is the optimal training of young researchers for careers in science and industry through research within international interdisciplinary large-scale projects.

KSETA offers an interdisciplinary and stimulating international research environment for doctoral researchers at the intersections of science and technology.

Karlsruher Institut für Technologie

KCETA – KIT Center Elementary Particle and Astroparticle Physics

The KIT Center KCETA bundles experimental and theoretical research and education at the interface between astronomy, astrophysics, elementary particle physics and cosmology.

KSETA

Karlsruhe School of Elementary Particle and Astroparticle Physics: Science and Technology

KSETA is the Graduate School associated with KCETA

The AMS-02 experiment on the International Space Station (ISS)
© NASA

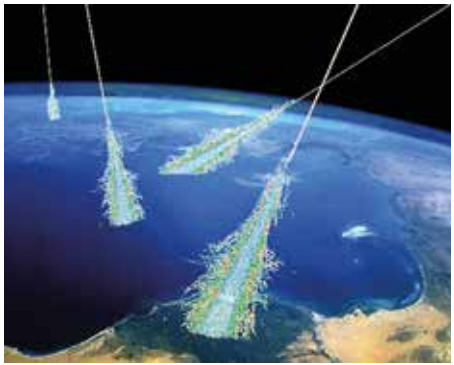
Astroparticle Physics

Our research is focused on high-energy cosmic rays, Dark Matter and neutrino physics.

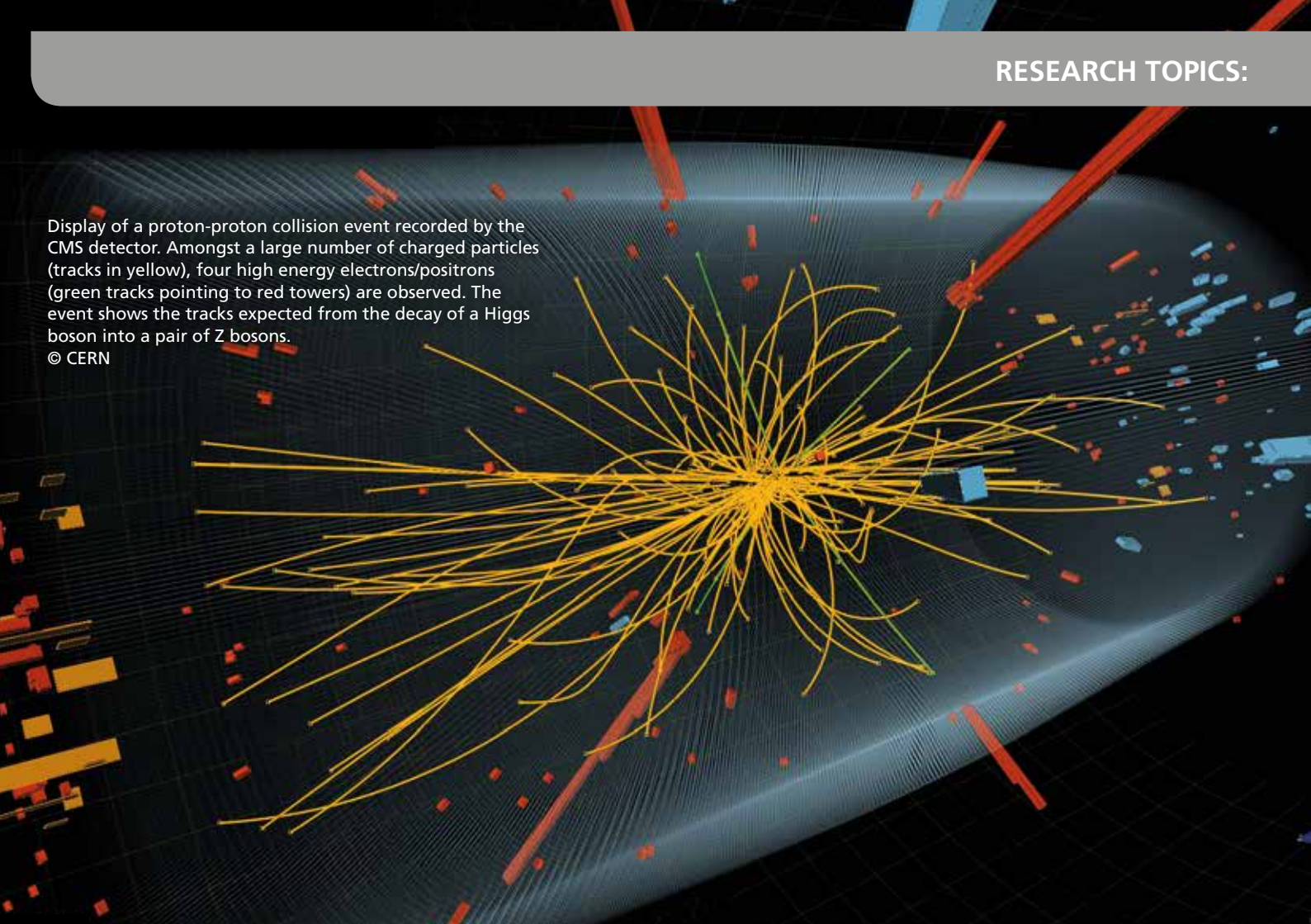
Cosmic rays are messenger particles from the universe that carry important information. Of particular interest are very rare most energetic particles that travel on almost straight lines, pointing back to their origin – they even carry macroscopic energies in a single subatomic object. The Pierre Auger Observatory in Mendoza, Argentina, is the premier international facility to study the most energetic cosmic rays by measuring extensive air showers.

Dark Matter is a fundamental puzzle to both particle physics and cosmology. We search for Dark Matter annihilation signatures in astrophysical observations with the AMS detector onboard the International Space Station ISS and for direct scattering of Dark Matter particles off target nuclei in the Laboratoire Souterrain de Modane with the EDELWEISS and future EURECA cryogenic bolometers.

Neutrinos play an important role in cosmology and elementary particle physics. The most important open question is their mass, which is known to be non-zero. The Karlsruhe Tritium Neutrino (KATRIN) experiment will provide a model-independent measurement of their fundamental mass scale with a sensitivity of 200 meV/c^2. This is achieved by combining a high-intensity molecular tritium ß-decay source with a very large electrostatic spectrometer.



Extensive air showers are generated by the interaction of high-energy cosmic rays with the atmosphere and consist of millions of secondary particles as well as radiate UV light and radio waves.



Display of a proton-proton collision event recorded by the CMS detector. Amongst a large number of charged particles (tracks in yellow), four high energy electrons/positrons (green tracks pointing to red towers) are observed. The event shows the tracks expected from the decay of a Higgs boson into a pair of Z bosons.
© CERN

Elementary Particle Physics

With the start of data taking at the CERN Large Hadron Collider (LHC) and at the upcoming Super B factory at KEK, we are becoming increasingly sensitive to physics phenomena beyond the Standard Model (SM).

KIT has contributed significantly to the construction of the silicon strip detector and related infrastructure of the Compact Muon Solenoid (CMS) detector at the LHC.

Furthermore, KIT hosts one of the 11 large Grid Computing Centers, GridKa, which help process and analyze the huge amount of data from the LHC. Our research focuses on the properties of the recently discovered Higgs boson, on the top quark, on QCD jets and on the search for dark matter particles in the framework of supersymmetry. The construction of a new high-resolution tracking device for the upgraded LHC is in preparation.

Experimental flavor physics at the Belle-II experiment in Japan is focused on precision spectroscopy of hadrons with c and b quarks, measurements of CP violation and oscillations in B-meson decays.

The KIT theory group is one of the world leaders in highest precision (multi-loop) calculations for electroweak observables and for strong interaction physics. Theoretical collider physics includes the development of innovative techniques for a perturbative treatment of quantum field theories, studies for the precision determination of parameters of the SM, the development of new observables and the prediction of cross sections with high precision. Theoretical research in flavor physics addresses the calculation of flavor-changing transitions in the SM and theories of new physics.

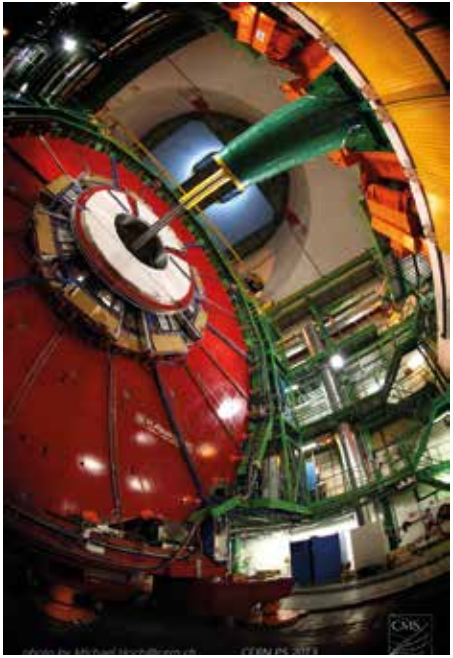
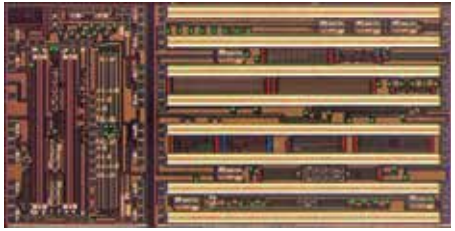


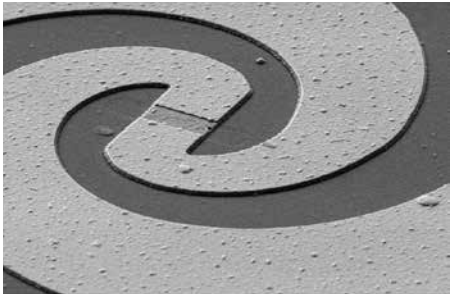
Photo of the 16-m-high CMS detector. Visible above is the access shaft through which all elements of the detector have been lowered. The collision hall is 100 m below the ground.

CMS-Petal – Endcap of the CMS silicon tracker with silicon sensors, custom readout microchips, multi-chip-modules, optical fibers and carbon fiber support structures. © CERN



Custom electro-optical modulator chip for Tb/s data transmission (designed at KIT)

Grid/SCC - A glimpse of the high-performance computing infrastructure of the Grid Steinbuch Centre for Computing Karlsruhe



High-temperature superconducting YBCO film with THz antenna

Advanced Technology

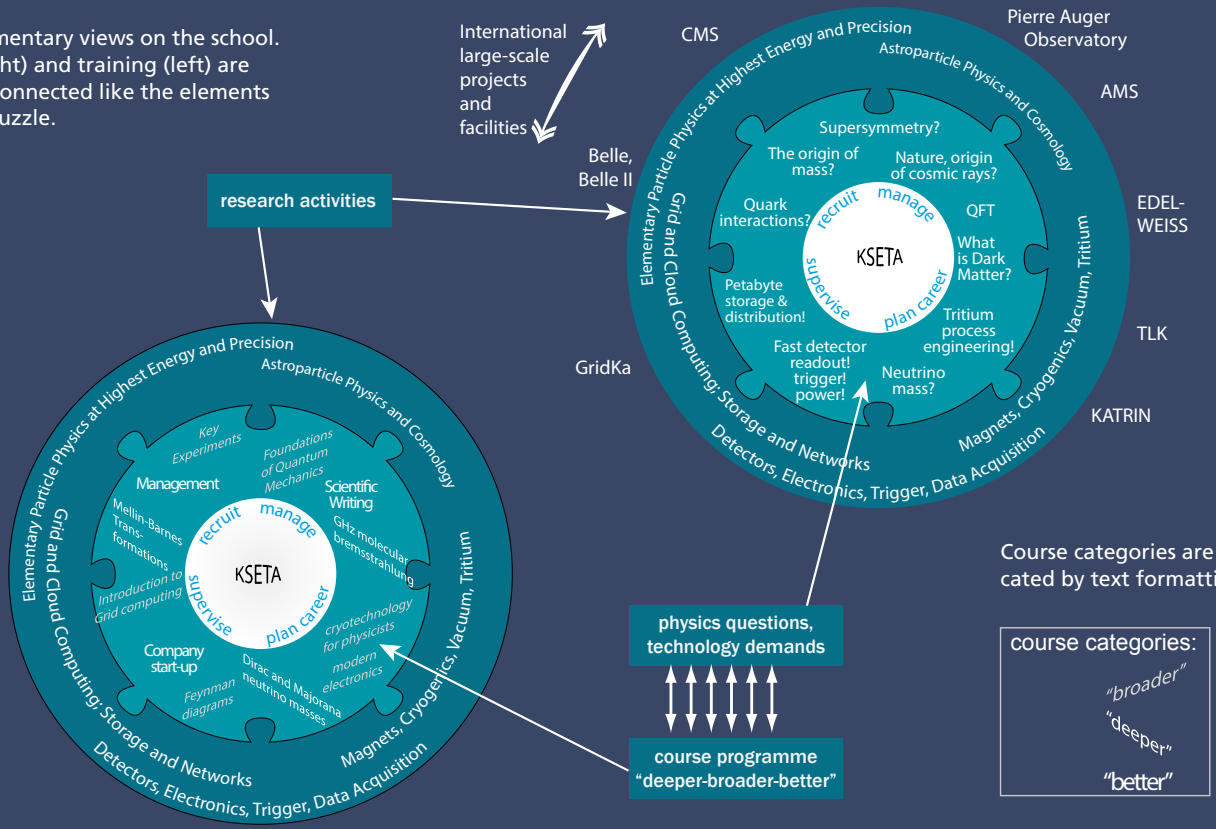
Advanced technologies enable cutting-edge science and are a major asset of KSETA.

For our sophisticated detection systems in particle and astroparticle physics experiments, we fabricate superconducting thin-film sensors for THz radiation, develop radiation-hard silicon sensors for charged particle detection, design custom microchips and construct fast data acquisition and trigger systems. Key competences of KSETA also include high-bandwidth optical data transmission technology, ultra-high vacuum and cryogenics, tritium processing and more.

We host a wealth of unique facilities like the KATRIN neutrino experiment, the Grid Computing Center Karlsruhe (GridKa) with a computing power of more than 10,000 CPU cores and tens of Petabytes of data storage capacity, the Karlsruhe Tritium Laboratory, several superconductor and magnet testing facilities, a 26-MeV proton cyclotron and advanced detector characterization and assembly labs.

Assembly of high-purity germanium crystals for Dark Matter search with EDELWEISS

Two complementary views on the school. Research (right) and training (left) are tightly interconnected like the elements of a jigsaw puzzle.



Course categories are indicated by text formatting:

course categories:

"broader"

"deeper"

"better"

Training program

A rich program of lectures, block courses, workshops and external schools is offered by KSETA. The program serves to provide in-depth training specific to individual research topics and to enable doctoral researchers to work at the cutting edge as soon as possible. It further offers complementary courses on management and "soft skills".

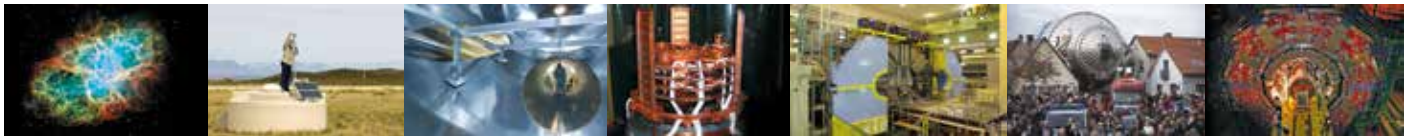
Doctoral researchers are expected to attend on average two individually selected courses per year.

The training concept of KSETA can be summarized by the motto DEEPER – BROADER – BETTER.

DEEPER:
the doctoral researchers will learn the state-of-the-art of their individual fields of research.

BROADER:
the school will bridge the gaps of knowledge between physicists and engineers to build a strong basis for their common research.

BETTER:
the school will improve the individual and social skills of its members.




KSETA

Structure KSETA

Bodies

Advisory Board (AB)

KSETA

Board of Researchers (BR)

All Principal Investigators (PI)
plus two elected Fellows of PDR

Admission Panel (AP)

Elected members of PI

Executive Board (EB)

Coordinator
Deputy Coordinator
Equal Opportunity Officer
Managing Director

Elected members of PI
plus two elected Fellows of PDR

Plenum of Doctoral Researchers (PDR)

Institutes

IPE, IKP, EKP TTP, ITP	Faculty of Physics
IMS, ITEP, ITIV	Faculty of Electrical Engineering and Information Technology
SCC	Faculty of Computer Science
ITTK	Faculty of Chemical Engineering and Technology
IPS (associated)	Faculty of Physics

Admission

The formal requirement to enter the graduate school is a Master or Diploma degree in physics, electrical engineering, informatics or any other discipline of science or engineering related to the research topics.

Openings are announced globally about two times per year. All applicants have to register at the KSETA web page. Subsequently they have to submit their detailed application to the school, with a statement of their tentative field of research. The Admission Panel (AP) screens the applications and selects the admitted doctoral researchers. Doctoral researchers are either employed from the funds of the school or receive salaries or scholarships from other sources, such as institutes or other third party funding projects.

Further information:
Dr. Irmgard Langbein
www.kseta.kit.edu

Karlsruhe Institute of Technology (KIT)

The Karlsruhe Institute of Technology (KIT) is the merger of Forschungszentrum Karlsruhe, member of the Helmholtz Association, and Universität Karlsruhe (TH). KIT has a total of 9000 employees and an annual budget of EUR 730 million. The merger into KIT gave rise to one of the biggest research and teaching institutions worldwide, which has the potential to assume a top position in selected research areas. It is aimed at establishing an institution of internationally excellent research in natural and engineering sciences, outstanding education, promotion of young scientists, and advanced training. KIT closely cooperates with industry as an innovation partner. It is a leading European energy research center and plays a visible role in nanosciences worldwide. KIT focuses on the knowledge triangle of research, teaching, and innovation.

Imprint

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Picture credit:
KIT, CERN, CSNSM Orsay, NASA, American Museum of Natural History, Vipin Gaur**,** Wilfrid Schroeder, Edelweiss Collaboration, Auger Collaboration, Katrin Collaboration, Gabi Zachmann, Marc Schneider

Layout:
Beatrix von Puttkamer

Printed by:
Systemedia GmbH

October 2014