Karlsruhe Institute of Technology

Institute for Data Processing and Electronics (IPE)

Welcome to IPE!

We pursue a broad technology-oriented research portfolio in particle and astroparticle physics, quantum technology, energy research, information and health technologies.

The institute specializes in cutting-edge technologies along the complete signal processing chain, from particle detection and detector systems to signal transmission, online and offline data processing and analysis, persistent storage and data management, and large-scale electronic systems. Our research teams are embedded in and take leading roles in large international collaborations in fundamental research, and work on technology transfer and joint projects with industry.

We offer rich spectrum of topics for Master and Bachelor theses, HiWi jobs and internships in all our research fields. You will become part of our international team dedicated to technology and instrumentation in large-scale research.

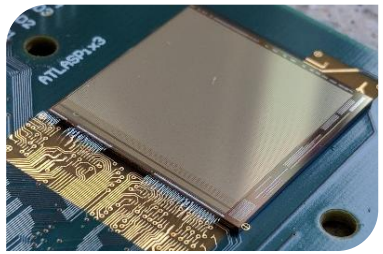
ASIC & Detector Laboratory

Sensors on a chip will allow construction of large-area, high-resolution, low-cost detectors for the next generation of physics experiments.

Example Topics:

- Development and characterization of sensors in high energy physics (e.g. LHCb, Mu3e) or medical applications

Particle detectors for high energy physics: *integrated electronics and intelligent sensors*



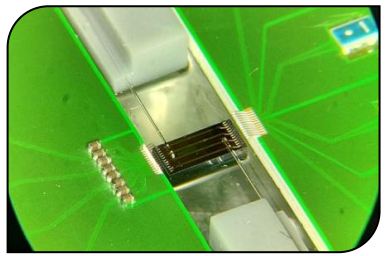
Silicon Photonics and Detector Integration Technologies

Photonic chips offer the potential to greatly increase data transfer rates for detector readout. The 2.5D and 3D integration of sensors, readout ASICs and data transmission is crucial for compact detector systems.

Example Topics:

- Photonic chip design and characterization
- R&D of packaging methods for physics experiments, quantum computing & sensing

Particle physics and photon science: *Optical high-speed data transmission for large detectors*



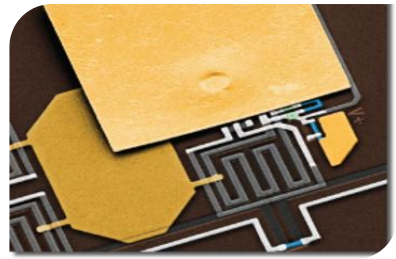
High-resolution Superconducting Quantum Sensors

Superconducting magnetic micro-calorimeters (MMC) and other quantum sensors enable new measurement strategies in many fields of fundamental science.

Example Topics:

- Sensor, SQUID and cryogenic readout development and production technologies

Precision physics with quantum sensors: *Exploring sensors and electronics at lowest temperatures*



Quantum Sensor Readout and Qubit Control

Complex, programmable and intelligent room temperature electronics are required for large-scale experiments using quantum sensors and for the development of qubits for quantum computing.

Example Topics:

- Design and characterization of multi-channel readout electronics, including software tools for neutrino and dark matter physics and quantum computing

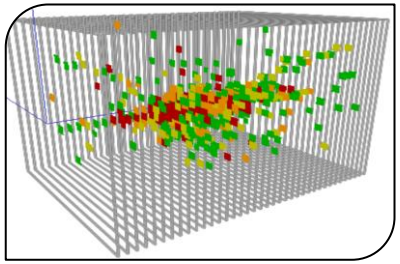
Quantum computing and astroparticle physics: *Development and test of readout systems connected to cryogenic environments*

Detector Concepts and Calorimetry

Future calorimeter systems will improve greatly in granularity and time resolution, increasing the demands on data readout and computing.

Example Topics:

- Trigger design, system integration and tests for the CMS High Granularity Calorimeter
- Reconstruction software
- R&D for FCC detector concepts



Highly granular calorimeters:
5D imaging of particle interactions in the detector

High-performance Data Acquisition

Data acquisition systems for extreme data rates in particle and astroparticle physics experiments, exploiting programmable electronics, heterogeneous systems and powerful compute nodes (like GPUs).

Example Topics:

- Development of data acquisition systems for experiments in particle and astroparticle physics: CMS, Belle II, KATRIN
- Exploration of novel DAQ concepts and algorithms

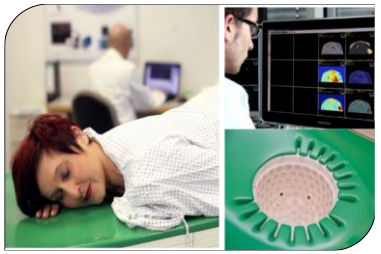
***CMS DAQ**:*
High throughput and powerful online processing with FPGAs

Medical Imaging

The 3D Ultrasound Computer Tomography (USCT) project is developing a new imaging method for early detection of breast cancer that promises three-dimensional images in high resolution.

Example Topics:

- Data acquisition electronics and calibration
- Physical simulation of ultrasound wave propagation
- Multimodal ultrasound reconstruction



Health:
Ultrasound computer tomography

Power Electronics

CO_2 reduction requires new storage concepts for electrical energy from wind and solar sources, safe and secure smart grid integration concepts, combining power and data systems, and new mobility concepts.

Example Topics:

- Battery management for complex battery systems for storage and electric vehicles
- Power electronics for automotive and research applications

Energy:
Storage solutions and power electronic systems

Contact

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