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QUASY- Quantum Sensor Platform for Synchrotron X-ray Spectroscopy

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Magnetic microcalorimeters (MMCs) are energy-dispersive single particle detectors that promise exceptional energy resolution and high quantum efficiency. Their potential has led to growing interest across various disciplines, including basic science, medicine, astrophysics, and materials research. Especially for X-ray spectroscopy at brilliant light sources, precise energy, time, as well as spatial resolution are essential to characterize the chemical and electronic structure of samples and their temporal evolution during chemical reactions.

Within this context, we are developing a modular and transportable detector system based on a microfabricated 64-pixel MMC array optimized for the soft and tender X-ray regime. The prototype array was designed and fabricated in-house and has successfully demonstrated its functionality in first characterization measurements. Building on this, a modular detector system tailored for this existing prototype array is now being developed, enabling X-ray spectroscopy experiments at different beamlines of the KIT Light Source.

A primary focus of our work lies in the mechanical and thermal integration of the detector into the cryogenic environment, aiming for continuous operation at temperatures below 50 mK. To maximize detection efficiency, we strive to position the detector as close as possible to the sample, which requires extending the module toward the beamline. This introduces a steep thermal gradient between the room-temperature sample and the cryogenic detector. To address this, we employ custom-designed thermal filters that block infrared radiation while allowing X-ray transmission across a wide photon energy range (from 100 eV to several tens of keV).

The detector is suspended within the cryostat using custom-designed mechanical supports that ensure thermal stability. Particular care was taken to thermally isolate the ultra-sensitive detector from warmer components such as the readout SQUIDs. While SQUIDs also benefit from low operating temperatures, they can introduce localized heating due to their resistive elements, which may degrade the performance of the MMC array. These efforts pave the way for the next stages of detector optimization and beamline implementation.

We present the current development status of the detector module, discuss recent integration results, and outline which steps will be taken next.

Speed talk:

Normal speed talk selection

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