maXs: Micro-calorimeter Arrays for High Resolution X-Ray Spectroscopy in Atomic Physics

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We recently started the development of 2-dimensional arrays of metallic magnetic calorimeters (MMCs) for x-ray spectroscopy on highly charged heavy ions stored in EBITs and storage rings. MMCs are energy dispersive particle detectors operated at temperatures below 50 mK, which use a paramagnetic temperature sensor to convert the temperature upon the absorption of a single x-ray photon into a change of magnetic flux in a SQUID.

The detector system maXs uses a dry dilution refrigerator with long side arm as common cryogenic platform for 3 detector arrays, each consisting of 8x8 x-ray absorbers with optimized size and thickness for 20/30/200 keV x-rays having an energy resolution below 2/5/50eV. The detector geometry shares many details with the successful one-dimensional predecessors maXs-20/200, where the one for soft x-rays has an instrumental linewidth of 1.6 eV(FWHM) in the investigated energy range up to 6 keV.

We believe to be able to further enhance this energy resolution and push the resolving power of MMCs beyond 10000 by implementing: i) overhanging absorbers on small cross-section stems to reduce the loss of hot phonons and to eliminate position dependencies, ii) paramagnetic sensors made of Ag:Er instead of Au:Er to eliminate the hanging heat capacity carried by Au nuclei in the vicinity of Er ions, iii) a novel fast high resolution susceptibility thermometer to stabilize the operating temperature of the detector platform and allow for unprecedented total gain stability.

We discuss the physics of MMCs and the considerations that went into the design of our 2d-arrays. We present recent results on first maXs-30 arrays, including the linearity, the crosstalk between pixels and the improvement of the signal shapes introduced by the new sensor material Ag:Er. In addition, we show our first measurements done at the experimental storage ring ESR at GSI (Darmstadt, Germany), where we used the linear 1x8 pixel array maXs-200, optimized for hard x-rays, for the high resolution x-ray spectroscopy of H- and He-like xenon. The demonstrated combination of stopping power, energy resolution, linearity and dynamic range will trigger numerous novel approaches in high precision atomic physics experiments with stored ion beams.