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Metallic Magnetic Calorimeter Arrays for High-Resolution X-ray Spectroscopy and Polarimetry

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With their ability to provide a high energy resolution and stopping power over a wide energy range paired with their excellent and predictable linearity, metallic magnetic calorimeters (MMCs) are ideal tools for the investigation of x-ray photons emitted from highly charged ions. We are presently commissioning maXs, an 8x8 detector array for

high resolution X-ray spectroscopy. The detector is operated at T = 20 mK and is attached to the tip of a 400 mm long and 80 mm wide cold finger of a cryogen-free 3He/4He-dilution refrigerator. Three different arrays, maXs-20, maXs-30 and maXs-200, optimized for x-rays with energies up to 20, 30 and 200 keV respectively, will be available. The cryogenic platform will also allow to operate polar-maXs, a novel high resolution x-ray polarimeter based on MMCs. In the ongoing commissioning phase single channel maXs-20 detectors achieved an energy resolution of 1.6 eV (FWHM) for 6 keV photons. A linear detector array of maXs-20 detectors consisting of 8 pixels with an active detection area of 250 µm x 250 µm each has been successfully operated at an Electron Beam Ion Trap (EBIT) at the Max-Plank-Institute for Nuclear Physics in Heidelberg. There it was used to investigate the 4f-3d and 5f-3d transitions in charged tungsten ions and resolved the different charge states from W46+ to W36+ between 2 and 3.5 keV. A linear detector array consisting of maXs-200 detectors with a detection area of 1 mm2 per pixel and an intrinsic energy resolution of 25 eV has been successfully operated at the internal gas target of the Experimental Storage Ring (ESR) at GSI in two different experimental setups. A projectile beam of bare Xe ions interacted with a Xe gas target and the resulting x-ray photon emission of H- and He-like Xe atoms was investigated. We were able to detect the Lyman series up to Ly-eta and could resolve the K-alpha- and K-beta-doublets of He-like Xe52+ ions.

We discuss the results of these experiments including energy resolution, linearity and cross-talk measurements. We show latest results of our first high-resolution two-dimensional MMC-array maXs-30 that will provide a total detection area of 4x4 mm2 and an energy resolution below 5 eV. We present different design studies and simulations for MMC - based polarimeters including Compton and Rayleigh polarimeters.