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MOCCA - An MMC based 4k-pixels molecule camera for studying electron-ion interactions at the cryogenic storage ring CSR

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Due to its extremely low background pressure and its cryogenic environment, the Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg allows to prepare and store molecular ions with an energy of up to 300keV per unit charge in their rotational and vibrational ground state. This enables studies on electron-ion interactions such as dissociative recombination or electron capture dissociation for which the mass spectrometric identification of fragmentation products is a key requirement. Today, mostly electromagnetic filters are used to determine the mass of ionized particles by measuring their charge-to-mass ratio. However, neutral fragments then either occur as a natural loss or have to be ionized first resulting in a much more ambiguous data analysis. Alternatively, the mass of neutral particles can be deduced from their kinetic energy if the particle velocities are known. For this calorimetric approach, cryogenic microcalorimeters are ideally suited, in particular since they provide a large resolving power even at low keV energies or doesn't suffer from surface dead layers. To actually resolve the full reaction kinematics, a position sensitive coincident detection of multiple reaction products is required.

Within this context, we have developed MOCCA, a metallic magnetic calorimeter based 4k-pixels molecule camera for the position and energy sensitive detection of neutral molecule fragments. MOCCA has a sensitive detection area of 45mm x 45mm and relies on different readout techniques to actually read out all pixels by only 32 SQUID channels. Within this contribution, we first show that metallic magnetic calorimeters are ideally suited for performing studies on electron-ion interactions within CSR and then discuss the detector design of MOCCA, its microfabrication challenges that were successfully addressed as well as the custom-made hardware setup to be used for integrating MOCCA and its $3\text{He}/4\text{He}$ dilution refrigerator into CSR.

Less than 5 years of experience since completion of Ph.D

N

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