Development of a large-area detector for position and energy resolving detection of molecular fragments

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The recombination of a molecular cation with a low-energy electron, followed by fragmentation, is a fundamental reaction process in cold and dilute plasmas [1]. For polyatomic ions, it can yield molecular fragments in excited states [2].

The construction of a cryogenic storage ring to store molecular ions in their groundstate is in progress to be built at the Max-Planck Institute for Nuclear Physics in Heidelberg [3]. For measurements in the ring, a metallic magnetic calorimeter (MMC) will be implemented.

A MMC consists of a particle absorber and a paramagnetic temperature sensor, placed in a weak magnetic field. According to the calorimetric detection principle, the deposition of energy in the absorber causes a rise in temperature of the detector. The resulting magnetization change of the sensor can be read out as a change in magnetic flux by a low-noise dc-SQUID-magnetometer [4].

We present a detector that encompasses sixteen pie-shaped large-area absorbers to form a circular whole with a diameter of 36mm. The temperature sensor is positioned on the outer edge of each absorber. Due to the diffusive expansion of heat in the absorbers, the rise-time of the detector-signal depends on the impact location of the particle. This fact allows one to associate a position to a detected particle. To characterize the expected signals, numerical simulations were performed by using the program OpenFOAM. These indicated that, dependent on the impact position, expected rise-times are between 20µs and 800µs. Furthermore the energy resolution could be pre-estimated to several hundred eVs by surveying the simulated events with a new developed analysis-algorithm [5].

References

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