Physics, micro-fabrication and applications of metallic magnetic calorimeters

A. Fleischmann, L. Gastaldo, S. Heuser, A. Kampkötter, S. Kempf, C. Pies, J.-P. Porst, P. Ranitzsch, S. Schäfer, S. Vick, T. Wolf, and C. Enss

Kirchhoff Institute for Physics, Heidelberg University, INF 227, 69120 Heidelberg, Germany

Metallic magnetic calorimeters (MMC) are calorimetric particle detectors, typically operated at temperatures below 100mK, that make use of a paramagnetic temperature sensor to transform the temperature rise upon the absorption of a particle in the detector into a measurable magnetic flux change in a dc-SQUID. During the last years a growing number of groups has started to develop MMC for a wide variety of applications, ranging from alpha-, beta- and gamma-spectrometry over the spatially resolved detection of accelerated molecule fragments to arrays of high resolution x-ray detectors. For soft x-rays an energy resolution of 2.7eV (FWHM) has been demonstrated and we expect that this can be pushed below 1eV with the next generation of devices.
We give an introduction to the physics of MMCs and summarize the presently used readout schemes as well as the typically observed noise contributions and their impact on the energy resolution. We discuss general design considerations, the microfabrication of MMCs and the performance of micro-fabricated devices. In this field large progress has been achieved in the last years and the thermodynamic properties of most materials approach bulk values allowing for optimal and predictable performance.