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# Energy nonlinearity correction of a high resolution metallic magnetic calorimeter

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Photon spectrometry is commonly used to analyse the elemental composition or radioactive content of a sample. It is also used to study the structure of nuclei or the interactions of electrons with nuclei in fundamental quantum physics. The latter field requires a great precision on the measured photon energies to be able to experimentally confirm theoretical values predicted by quantum electrodynamics. To do so, X-ray energies below 100 keV must be measured with an energy uncertainty below 0.1 eV, like the hydrogenoid lamb shift [1]. Others projects aim to measure gamma-ray energies with the same order of precision for the development of future nuclear clocks based on the low-lying isomeric state of  $^{229m}\text{Th}$  [2]. Wavelength-dispersive spectrometers (WDS) and energy-dispersive spectrometers (EDS) are the two main kinds of X-ray and gamma-ray spectrometers: WDS have high energy resolution but lose their efficiency at high energy while EDS are more suitable for high X- and gamma-ray energy measurement. Semi-conductor detectors are frequently used as EDS but their energy resolution, close to their theoretical limit, e.g. around 300 eV at 60 keV, is not sufficient.

As an alternative, cryogenic detectors are developed as EDS with ultra-high energy resolution, more than one order of magnitude better than that of semi-conductor detectors. The used cryogenic detector is a magnetic metallic calorimeter (MMC). It can measure energetic particles with an energy resolution of 20-50 eV below 100 keV when operated at 15 mK [3]. However, they are intrinsically nonlinear in energy. It is then important to correct for their nonlinearity in order to achieve the required uncertainty for accurate photon energy measurements.

In this work, we report the measurement of photon energies below 100 keV from the decay of  $^{241}\text{Am}$ ,  $^{152}\text{Eu}$ ,  $^{210}\text{Pb}$  and  $^{139}\text{Ce}$  with a MMC to study his nonlinearity. The experimental nonlinearity of the detector is compared with its theoretical nonlinearity calculated from the thermodynamic properties of MMC. The influence of the signal processing on the nonlinearity is also investigated through different methods of pulse energy determination.

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[3] M.Rodrigues, M.Riham, M.Loidl, EPJ Web of Conferences 146, 10012 (2017)

