Determination of nuclear charge distributions of fission fragments from 235U (nth, f) with Calorimetric Low Temperature Detectors

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Calorimetric low temperature detectors (CLTDs) for heavy-ion detection have been frequently demonstrated to achieve an excellent relative energy resolution of 1-5x10-3

in a wide range of ions and energies from 20 to 700 MeV. Such detectors were already successfully applied in accelerator mass spectrometry and stopping power measurements [1, 2]. A new potential application of such detectors is the determination of nuclear charge distributions of fission fragments produced by thermal neutron induced fission. Such an experimental study has been undertaken at the LOHENGRIN parabola spectrometer (ILL, Grenoble) by using the absorber method [3].The spectrometer separates fission fragments according to their mass-to-ionic-charge ratio and their kinetic energy, but has no selectivity with respect to nuclear charges. For the separation of the nuclear charges one can exploit the nuclear charge dependent energy loss of the fragments passing through a degrader foil. This separation requires detector systems with high energy resolution and negligible pulse height defect, as well as degrader foils which are optimized with respect to thickness, homogeneity and energy loss straggling.

The present CLTD array with an active area of 15x15mm2 consists of 25 independent detector pixels with transition-edge-sensors (TES) operated at Top≈1.5K. During a test measurement at the Maier Leibnitz tandem accelerator facility in Munich with 109Ag and 127I beams and different degrader materials, silicon nitride (Si3N4) was identified to be a very suitable degrader material concerning thickness and homogeneity. In the present experiment, CLTDs as well as Si3N4 degrader foils were used for the first time for these types of measurements at the LOHENGRIN mass separator. The quality of nuclear charge separation for selected masses in the region 82≤A≤132 was measured as a function of the degrader thickness (4µm-8µm of Si3N4) for various fission fragment kinetic energies between 55 and 110 MeV. For mass 92, a systematic measurement of the cumulative fission yield was performed. These data are needed to improve the uncertainties of the analysis of the reactor neutrino anomaly [4].Furthermore, this new technique opens the path towards Z-selective fission yield measurements in the symmetry region. A study of the odd-even effect in that region may lead to a better understanding of the nuclear fission process. First data in the mass region above A=107 have been taken for these purpose. In this presentation the experimental technique will be described, and the the status of the data analysis including preliminary results as well as perspectives for future measurements will be discussed.

[1] S. Kraft-Bermuth et al., Rev. Sc. Inst. 80, 103304 (2009)
[2] A. Echler et al., J. Low Temp. Phys. 176, 1033 (2014)
[3] U. Quade et al., Nucl. Instr. Meth. 164, 435 (1979)
[4] A. A. Sonzogni et al., Phys. Rev. C 91, 011301(R) (2015)