Measurement of the Fission Time Scale by the Blocking Technique

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Fission induced by heavy ion nuclear reactions has time scales of the order of 10^{-19}s typically. However, a recent experiment using emission of K–Xrays as a nuclear clock has indicated a much longer lifetime for fission of highly excited uranium nuclei [1]. The physical reason for this behavior is still unclear. In order to shed more light upon this problem a blocking lifetime experiment [2] has been performed using the ERDA–setup with its position sensitive ionization detector [3].

For this purpose the reaction (^{32}S,f) was measured at 170 and 175 MeV on ^{nat}Ta and ^{nat}W targets . The Coulomb barrier for these systems is at about 155 MeV. The targets were 300 nm thick crystals of natural Ta or W grown epitaxially on a 200 nm thick crystal of Mo which, in turn, was grown on a MgO substrate with its <100> axis normal to the surface. This multilayer crystal was prepared by M. Chevallier from the University of Aarhus. The blocking lifetime measurements were made by orienting the crystal such that a <111> axis was directed at 49.8° towards the ionization chamber which was mounted at a scattering angle of 50.2°. The blocking pattern of another <111> axis at a scattering angle of 159.3° was measured simultaneously, using a second position sensitive solid state detector prepared also at the University of Aarhus. This detector was mounted at a backward angle because it had not the possibility for particle identification as the ionization chamber did.

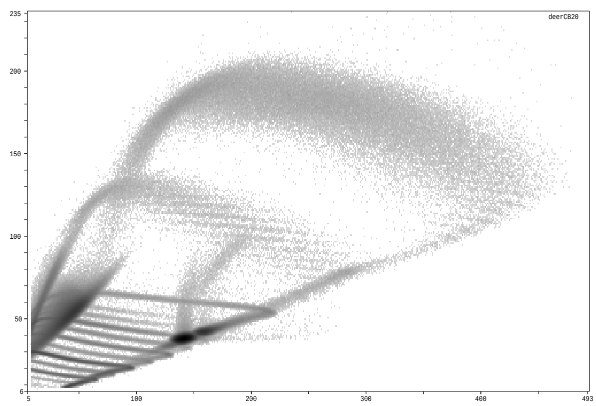

Fig. 1: ΔE–E$_{rest}$–spectrum of the ionization detector

From the measurement at 170 MeV raw spectra are shown in figs. 1-3. In the ΔE–E$_{rest}$–matrix of the ionization chamber (fig. 1) the different reaction products can be identified. Of particular interest are the fission products in the upper part of the spectrum. From the elastically scattered S ions (at ΔE: channel 40, E$_{rest}$: channel 140) the blocking pattern is shown in fig. 2 which covers an angular range of about 5° in both directions. Some artificial effects like electronic distortion or the circular structure can be removed in data replay. The blocking pattern of the fission products seen by the solid state detector with an angular range of about 12° is shown in fig. 3.

The data evaluation process and the extraction of the fission time scale is in progress.

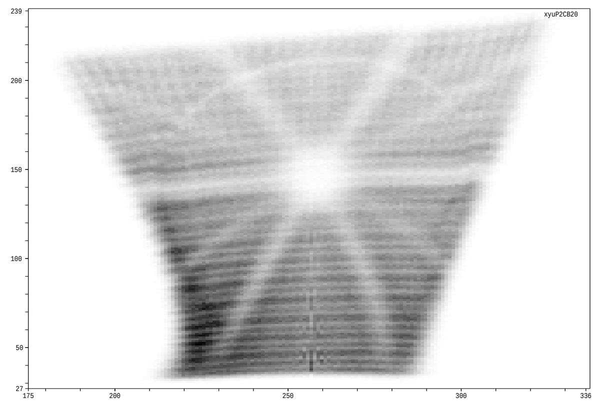

Fig. 2: Blocking pattern of the scattered S projectiles measured with the ionization chamber

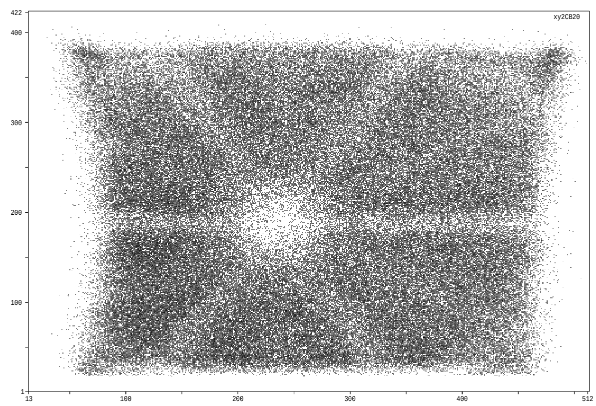

Fig. 3: Blocking pattern of the fission products measured with the solid state detector

References

[1] J.D. Molitoris *et al.*, Phys. Rev. Lett. **70** (1993) 537
[2] J.S. Forster *et al.*, Nucl. Phys. **A464** (1987) 497
[3] W. Assmann *et al.*, Nucl. Instr. Meth. **B89** (1994) 131