Nuclear Physics Division IEP UW
ANNUAL REPORT 2005

Half–life measurements of isomeric states in neutron–rich nuclei using LOHENGRIN separator

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Neutron–rich nuclei were produced by thermal–neutron induced fission of the actinium elements placed inside the high–flux reactor at the ILL (Grenoble, France). Fission fragments, flying freely from the target, were separated using the LOHENGRIN recoil fragment separator [1]. The time of flight through LOHENGRIN spectrometer is about 2 µs and so only states with significantly enhanced lifetimes are observed at the detectors position. To measure the half–life at LOHENGRIN facility we can use either γ–ion correlation or pulsed beam technique.

To measure the half–life of the 830.2 keV isomeric state in ^{97}Sr [2] we have used γ–ion correlation technique. To obtain the half–live of the state we measured time intervals between fragments detected by the ionisation chamber, placed after the LOHENGRIN separator, and isomeric γ rays observed at the end of the chamber where fragments were stopped. In this experiment isomeric γ rays were registered by two Ge detectors. A trigger–less digital electronic and acquisition system equipped with real–time, 40 MHz clock providing time stamps to all measured signals was used. Correlations between fission fragments and γ rays were made in an off–line sort. The half–life of the isomer was obtained by fitting the exponential decay curve to the time delayed spectrum shown in Fig. 1. The value resulting from this fit is $T_{1/2}$=519(19)ns.

The γ–ion correlation technique we can only use to study isomers with half–life from $\sim$1 µs up to $\sim$100 µs. To obtain the half–live of isomeric states with half–life longer then $\sim$100 µs we should use pulsed beam of separated ions rather then γ–ion correlation technique. In the first measurement of this kind performed at LOHENGRIN we used an optical shutter to pulse the beam. The shutter can operate with frequency up to 10 Hz with opening–closing time about 4 ms. With the beam off the exponential decay was observed for the intensity of isomeric γ rays. In this measurement we also used digital electronic with real time clock and two Ge detectors. The result of the measurement is the half–life of known 3523.3 keV isomeric state in ^{97}Y[3] selected as a test case for our new technique. The value $T_{1/2}$=138(14)ms obtained for that state agrees with previously reported value [3]. Due to limitations of the mechanical chopper the electrostatic one was installed. The electrostatic chopper can operate with frequency up to 1kHz. The beam deflection time is neglectible. We used this equipment to measure half–life of several isomeric states. To show the great capabilities of that instrument we would like to present

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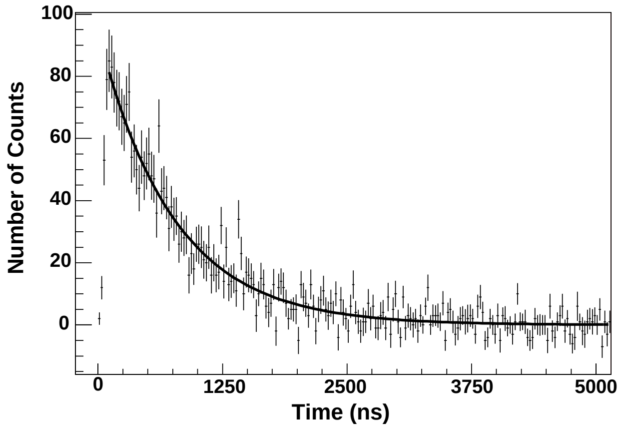

Figure 1: Time–delayed spectrum corresponding to the 522 keV transition in ^{97}Sr. The half–life determined from the fit is $T_{1/2}$=519(19)ns.

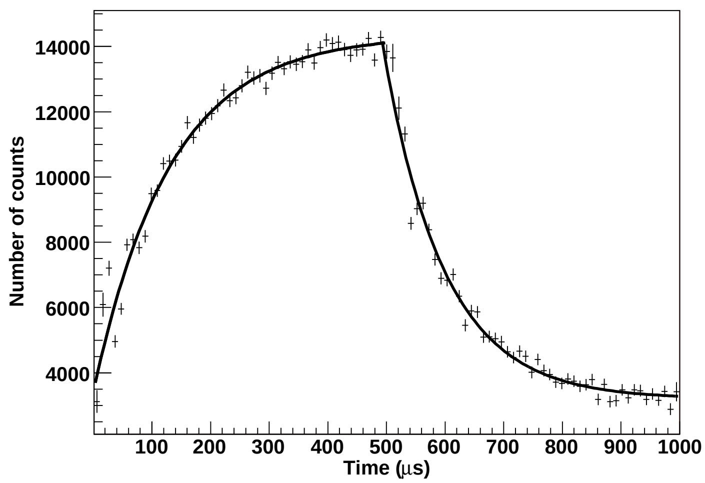

Figure 2: The spectrum of the intensity of the isomeric 450 keV and 1126 keV transitions in ^{131}Sb obtained in the whole time period of the beam pulse. The half–life determined from the fits is $T_{1/2}$=81(3) µs.

the result of the measurement of the 1676.1 keV isomeric state in ^{131}Sb. Isomeric γ rays were registered by three Ge detectors. The electrostatic deflector was working with frequency at the limit and the digital electronic with real time clock was used. In Fig.2. the grow up and the decay of intensity of the isomeric γ ray is shown. The half–life obtained by the fitting the exponential decay and growth is $T_{1/2}$=81(3) µs. The value agrees with previously reported [4]. Data analysis is still in progress.

References

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