FIRST MEASUREMENTS WITH THE BETA DELAYED NEUTRON DETECTOR AT THE JYFL PENNING TRAP

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Beta delayed neutron emission takes place when a precursor nucleus beta-decays and the resulting daughter emits a neutron.

The study of beta delayed neutron emission is of interest in different fields, such as technological applications, nuclear astrophysics and nuclear structure.

The first experiment with this detector was performed in JYFL, Finland, in November 2009 to measure the beta delayed neutron precursors ^{88}Br, ^{94,95}Rb and ^{138}I.

The isotopes were produced at IGISOL with a deuteron beam impinging on a Uranium target. Subsequently, the Penning trap, JYFLTRAP, was used to prepare a monoisotopic beam which was implanted on a movable tape placed inside the neutron detector. The radioactivity was accumulated during a period of $3T_{1/2}$, while the measurement period was extended up to $10T_{1/2}$ in order to obtain the growth and decay curves.

The acquisition worked in a triggerless mode [1], where the signals from all detectors above a certain threshold were time-stamped and energy-time pairs were stored. This system allowed full flexibility for the offline modification of the correlation time between the beta decay and the neutron detection. This correlation time is of the order of hundreds of μs due to the long time required for the neutron moderation in the polyethylene. The flexibility to modify the β-n correlation time assures a proper removal of the random coincidences originated by the background.

In the preliminary analysis the growth and decay curves for the betas (Figure 1a)) and the neutrons (Figure 1b)) were fitted to the Bateman equation [2] in order to separate the contribution for each nucleus in the decay chain and for the background.

A further plot was constructed with the coincidences between the neutrons and betas in a 1ms time window forward and backward from the detection of a neutron (Figure 2). The true coincidences $N_{\beta n}$ are the counts on left half of the spectrum on top of the flat background of random coincidences which is defined by the counts on the right half of the spectrum.

The neutron emission rate (P_n) is obtained with the following formula using the number of beta counts due to the decay of the father nucleus (N_β), the number of coincidences beta-neutron ($N_{\beta n}$) and the neutron detector efficiency (ε_n).

$$P_n = \frac{1}{\varepsilon_n}\frac{N_{\beta n}}{N_\beta}$$

The status of the analysis and the preliminary results will be presented.

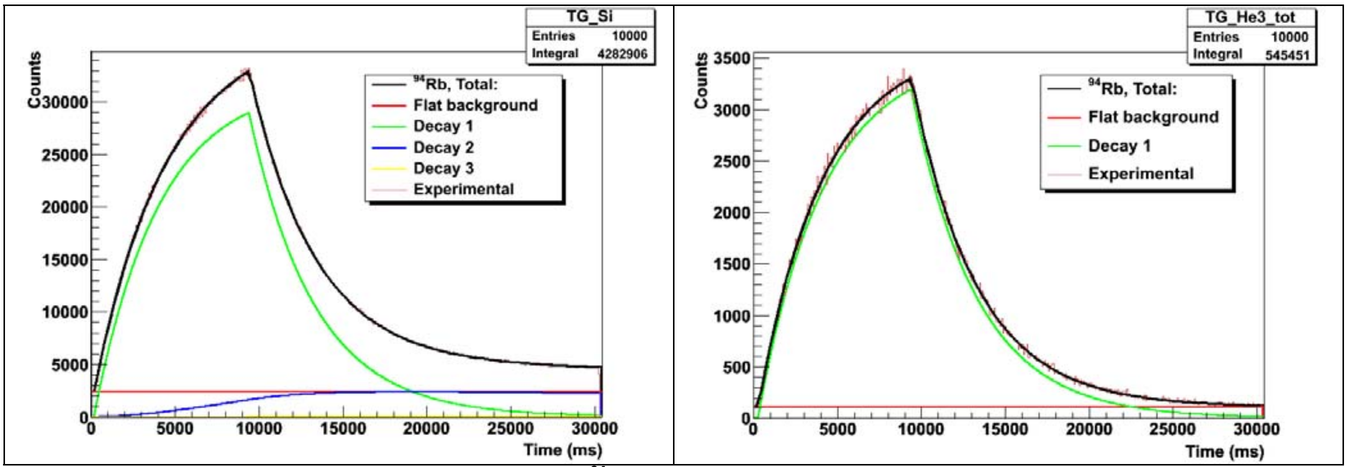

Figure 1: a) Si detector, implantation and decay curve for ^{94}Rb and the fit of the decay chain to Bateman equations. b) Neutron detector, implantation and decay curve for ^{94}Rb and the fit to the Bateman equation.

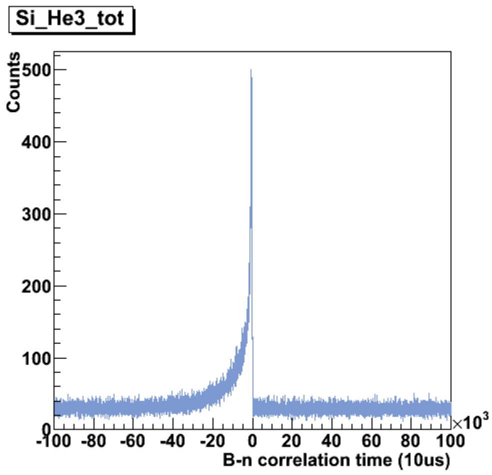

Figure 2: Beta-neutron correlation spectrum.

[1] Agramunt, J. et al, "A triggerless DACQ system for nuclear decay experiments". In preparation, Nuclear Instrumentation and Methods A.

[2] Skrable, K.W. et al "A general equation for the kinetics of Linear First Order Phenomena and Suggested Applications" Health physics. VOL 27, 155 (1974).