Measurement of $\beta$-delayed neutrons around the third $r$-process peak

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This report summarizes the present status of the data analysis of the S410 experiment, which is about to reach final results. The measurements will give new relevant data such as half-lives and $\beta$-delayed neutron emission branching ratios of neutron rich nuclei beyond $N=126$ for isotopes of mercury, thallium and lead. The measurement used a primary beam of $^{238}$U at 1 GeV/u impinging on a $^{162}$Tb impinging on a 223 mg/cm$^2$ Be target with a 223 mg/cm$^2$ Nb stripper behind it. The FRS was operated using degraders at S1 and at S2 and the separation was done with the $B_{\rho} \Delta E_{-} B_{\rho}$ method. Nuclei identification was determined with standard FRS tracking detectors which allowed to identify about 40 isotopes in the range from Platinium ($Z=78$) to Francium ($Z=87$), all of them identified previously in [1] and [2]. The detection system consisted of SIMBA (Silicon Implantation detector and Beta Absorber) [3], based on a double side silicon detectors array.

In order to determine the half-lives for the implanted nuclei, several correlation methods have been studied. As a first approach the numerical method reported by [4] and [5] was applied as described in [6]. Recently we have been able to successfully apply a more conventional analysis method [7], based exclusively on time correlations for each implant, with all $\beta$-decay events in the neighboring pixels. Furthermore, it has been possible to determine the half-life of $^{210}$Pb via two different approaches: using the information of the alpha line of 6.778 MeV ($^{210}$Po), in a similar way as it is reported in [8] for $^{213}$Pb, and by means of implant-$\beta$ correlations. The good agreement between both values confirms that the implant-$\beta$ method gives consistent half-lives for the measured nuclei.

In summary there are at least eight nuclei with enough statistics to determine their half-lives: $^{209,210}$Hg, $^{211-214}$Tl, $^{215-217}$Pb. Some of them were measured in previous experiments [5] [8]. The obtained half-lives are in reasonable agreement with those reported in these references.

Neutron emission events in correlation with implant-$\beta$ have been observed for several of the measured nuclei using the Beta deLAYEd Neutron (BELEN) detector [9]. First values of $P_{n}$ for nuclei beyond $N=126$ will be given for the first time for several nuclei in the region of interest.

References


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