β-decay properties of nuclei in the region around ^{132}Sn

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About half of the elements heavier than iron have their origin in the rapid neutron capture process (r-process). To date, both the astrophysical scenarios as well as the precise r-process "boulevard" are not known for certain. The required conditions for the creation of the r-process isotopes depend – among other parameters – also on nuclear-physics properties of many extremely neutron-rich nuclei, from which so far about 50 have been investigated experimentally, mainly by the Mainz group.

In order to further improve the understanding of the r-process, it is necessary to know, for example, the β-decay half-lives and neutron emission probabilities (P_n) of additional nuclei in the r-process path. Since the abundance pattern is strongly depending on the properties of the "waiting-point" nuclei, there is a special interest in the region around ^{132}Sn with respect to the formation of the A=130 r-abundance peak.

Furthermore, experimental data in this region yield information about nuclear-structure effects far off stability such as the possible erosion of the classical N=82 neutron shell gap.

For this purpose, an experiment has been performed at GSI six years ago to measure $T_{1/2}$ and P_n values of nuclei in the region "north east" of ^{132}Sn.

The experiment used a ^{238}U primary beam of 750 MeV/u impinging on a Pb target. Several so far unknown nuclei were produced via projectile fission.

After subsequent separation and identification, the fragments were implanted into four double-sided Silicon strip detectors allowing a correlation of the implantation and β-decay events.

The whole β-detector array was surrounded by the Mainz 4π neutron long counter in order to measure the β-delayed neutron emission

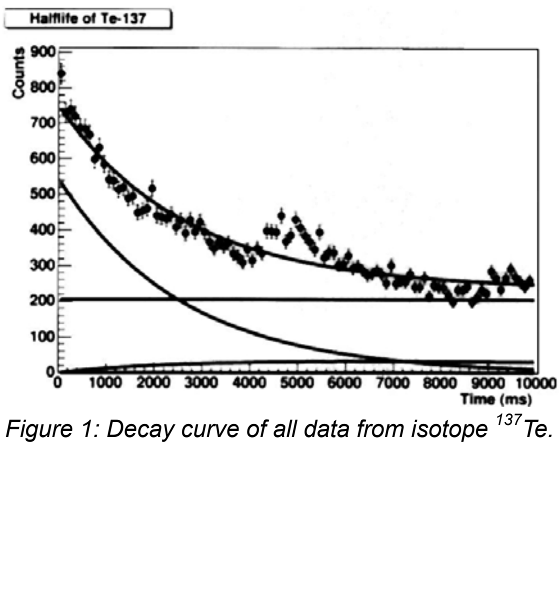

Figure 1: Decay curve of all data from isotope ^{137}Te.

Initially, the data have been analyzed by fitting the decay curves of all events from one isotope. Assuming that the fit function consists of the contributions from the mother, the daughter, the granddaughter and a background component, the half-life of the mother nuclide was derived by minimizing the χ^2.

Figure 1 shows a typical example of such a fit for the case of ^{137}Te, triggered on the corresponding implantation event. The bumps within the decay curve arise from the subsequent spill, i.e. the next package of ^{238}U ions from the primary beam produces an additional background component different positions. The result is an obviously wrong half-life of the respective isotope.

As an alternative way to analyze the data, the Maximum-Likelihood method was chosen. It is the mathematically correct method even in those cases, where the isotope of interest has been produced only with low statistics [1].

First results for the half-lives of some isotopes are presented in Table 1. These values are still preliminary.

Additional work has to be done to determine the half-lives of all measured isotopes, as well as the P_n values.

Table 1: Comparison of β-decay half-lives determined in experiment E040 with literature values [2].

Isotope	**Known half-lives [ms]**	**Preliminary results of this work [ms]**
^{133}Sn	1450 (30)	1568 (135)
^{135}Sn	450 (50)	485 (37)
^{137}Sb	>150 ns	390 (18)
^{138}Sb	>300 ns	296 (35)
^{138}Te	1400 (400)	1151 (28)
^{139}Te	>150 ns	598 (20)
^{140}Te	>150 ns	334 (14)
^{142}In	~200	222 (12)
^{143}In	>150 ns	130 (45)

References

[1] R. Schneider, Dissertation, Uni München, 1996.
[2] G. Audi et al., Nucl. Phys. A729 (2003), 3.