**Improving Nuclear Data Input for r-Process Calculations Around A ∼ 80**

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Abstract

We made an experiment to measure half-lives T1/2 and neutron emission

probabilities Pxn of nuclei around mass 80, aiming to improve r-process abundance

calculations around the first abundance peak with a new dedicated experimental setup

at RIKEN. Details of the experiment and a few preliminary results are presented.

Introduction

β-delayed neutron emission (βn) is a form of β-decay, in which one or more neutrons

are emitted. This form of decay plays a key role during the synthesis of heavy elements

through the r-process [1], where highly neutron-rich nuclei are produced. The half-lives

of the nuclei along the r-process path determine the initial abundances. The final

abundance distribution of the synthesized elements is affected by the βn decay mode

in a complex way, shifting the decay path to lower masses on the one hand, while

providing additional neutrons for further late captures with the opposite effect [2].

Experimental Setup and Measurements

The BRIKEN (Beta-delayed neutron measurements at RIKEN) collaboration [3] had

installed a new dedicated setup for T1/2 and Pxn measurements at the Radioactive

Isotope Beam Factory (RIBF) in RIKEN, which currently provides the highest intensities

of the most neutron-rich nuclei produced by in-flight fission. The detection

system is composed of the Advanced Implantation Detector Array (AIDA) [4], and

a 4π neutron counter. It is placed at the F11 focal plane of BigRIPS spectrometer

[5].

AIDA consists of a stack of six Si DSSDs. The setup registers ion implantations

and the subsequently emitted β particles. The highly segmented DSSDs grant a high

detection efficiency and reduce accidental implant-beta correlations.

The neutron counter, which surrounds AIDA, is made of an array of 140 3He tubes

embedded in a hydrogenous matrix (PE). A parametrized Monte Carlo optimization

algorithm was developed in order to determine the best position of the tubes [6].

Neutron energies are moderated by elastic scattering with the matrix and the neutrons

are absorbed by the 3He in an exothermic reaction. The energy deposited in the tube

produces a signal that is recorded by the eventless DAQ system Gasific developed at

IFIC, Valencia [7]. The setup includes also two HPGe detectors for high resolution

γ -ray spectroscopy.

The data from BigRIPS, AIDA and BRIKEN, which run independently and synchronized,

is merged and sorted by time stamp using dedicated software. The output

can be used directly in the analysis procedure where complex correlations can be

applied.

The first radioactive beam was delivered to the setup on November 2016 for

commissioning. Two experimental campaigns were carried out in Spring and Fall of

Analysis and Results

The Pxn value, the half-life and the number of parent decays are obtained from a

simultaneous fit of the implant-decay curves. The example of 86Ge is shown in Fig.

1. Most of the detected neutrons come from the beam-induced background, and

a method for correcting the accidental correlations was implemented.



Fig. 1 Preliminary fits of time correlation histograms for 86Ge decay. Left: implant-β. Right:

implant-β (n-gated). By colours: black, data; red, total activity; green, parent activity; rest of colours,

additional contributions

The energy threshold applied to the β-events causes the β-efficiency to be somewhat

dependent on the energy window of the decay and beta intensity distribution,

and thus on each isotope [7]. This can be taken into account introducing selected

efficiencies as adjustable parameters during the fit. We are currently working on the

minimization of thresholds for β-signals to further reduce the systematic uncertainties.

Impact on r-Process

Previous studies have shown the relatively large sensitivity of the abundance pattern

of the r-process to T1/2 and Pxn of selected isotopes [8, 9], like 86Ge.We are currently

working to evaluate the impact of our new T1/2 and Pxn values in this region on the

result of network calculations of r-process abundances.

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