Development of an on-line high-temperature surface ion source for fission products at TRIGA-SPEC*

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Precise knowledge of nuclear properties like binding energies, nuclear spins and moments or charge radii is essential to obtain a detailed understanding of nuclear structure. The TRIGA-SPEC facility [1] allows to determine these properties by investigating stable nuclides, long-lived actinide isotopes and neutron-rich fission products. An on-line ion source, based on the ion source of the HELIOS mass seperator setup [2], was recently installed and tested.

Short-lived neutron-rich isotopes are produced in the neutron-induced fission of, e.g., ^{235}U at the TRIGA Mainz research reactor. The fission products are thermalized in a gas-filled recoil chamber, which is flushed with the gas seeded with KCl aerosol particles, on which non-volatile fission products adsorb. They are rapidly transported with the gas flow through a capillary (1 mm ID) to the on-line ion source [3].

The first part of the source is a cone-shaped skimmer to remove the carrier gas while the aerosol particles enter the source. The main part of the source consists of a tungsten tube, which is heated up by electron bombardment to temperatures above 2000°C. Aerosol particles inside the source break up and fission products are released and ionizied by surface ionization. This method works well for alkaline, alkaline earth and rare earth elements. The ions are subsequently extracted and accelerated by high voltage (30 kV) towards a 90°-dipole-magnet which is used for mass separation. Behind the magnet, several detection systems (Faraday Cup (FC), Si-Detector, Microchannel plate (MCP)) are available for beam monitoring.

In a first run, two mass spectra were recorded with the FC (Figure 1), with and without gasjet. Ions of alkaline elements (Na^+, K^+, Rb^+) were detected as expected. The K^+ signal increases significantly when the gasjet is turned on because of the large number of KCl particles entering the source.

In a second step a Si-Detector was used to detect the β-decay of fission products. The focus was on Rb isotopes, because they are produced with high yield and can be easily ionized. The signal of the Si-Detector had only a weak background signal (about 1ct/s). While scanning through the mass region of Rb, significant increases in the count rate were observed. Around mass 92 and 93 count rates of up to 5-20 cts/s were achieved. This corresponds to the short-lived isotopes ^{92}Rb and ^{93}Rb with half-lifes of 4.5 s and 5.8 s. ^{92}Rb was collected for about 45 min by implantation into an Al foil. Afterwards, the decay products (Sr and Y isotopes) were detected by a γ-measurement (Figure 2). This measurement demonstrates for the first time the ionization of fission products at the TRIGA-SPEC facility. Future work will focus on improving the overall efficiency and stability of the setup.

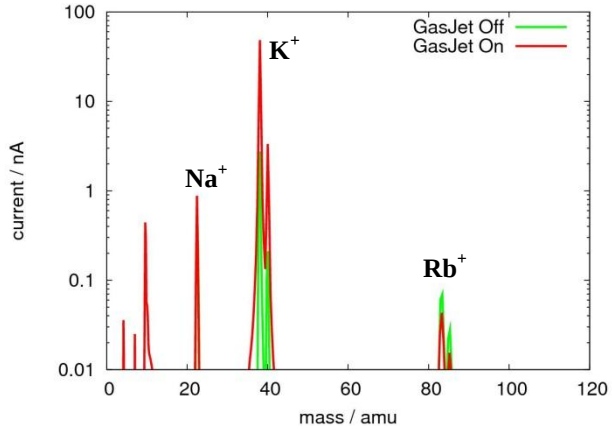

Figure 1. Mass spectrum behind the dipole magnet recorded with a Faraday Cup.

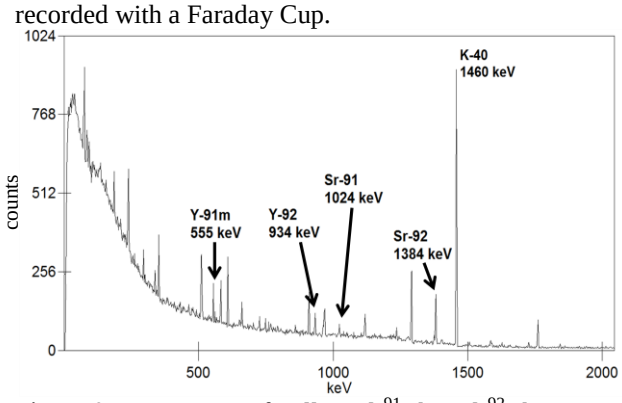

Figure 2. γ-spectrum of collected ^{91}Rb and ^{92}Rb isotopes. Due to the short half-life of the Rb isotopes, the decay products Sr and Y were detected.

References

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* Financial support by the Max-Planck Society, by BMBF (06MZ91721), the Research Center "Elementary Forces and Mathematical Foundations" (EMG), and Stiftung Rheinland-Pfalz für Innovation (961-386261/854) is acknowledged.