Production of neutron-rich surface-ionized nuclides at PARRNe

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The most promising approach to produce very intense ISOL beams of fission products seems to be neutron-induced fission. This method is not confronted with the problem of excessive target heating by the driver beam as is the case with charged particles. In the framework of the EURISOL project [1] in which a facility is planned capable of producing radioactive beams with intensities two or three orders of magnitude higher than today, an experiment to measure yields of neutron-rich isotopes produced by fast-neutron-induced fission of ^{238}U took place at the PARRNe ISOL set-up installed at the 15 MV Tandem of IPN Orsay.

A 1 μA beam of 26 MeV deuterons was fully stopped in a 3 mm thick graphite converter to produce a forward peaked flux of fast neutrons. The converter was in direct contact to a thick UC$_x$ ISOLDE-type target. The fission target was connected to a tungsten surface ionizer heated to about 2050°C. This ion source produces most efficiently alkali beams and shows a selectivity in favour of elements with ionisation potential lower than 6 eV [2].

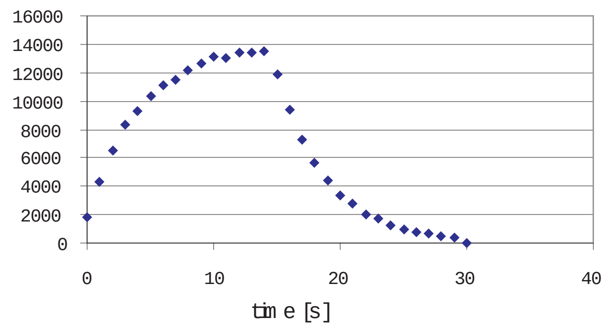

Figure 1: Release curve for Rb ions as measured with the β-delayed neutron activity of ^{94}Rb ($T_{1/2}$=2.7 s).

The ions were implanted in a movable metallized mylar tape. The detection system consisted of the Mainz neutron long-counter, a plastic scintillator for β-particles and a 68% HP-Ge detector. The signals from the detectors were tagged with absolute, high-resolution (400 ps) time information allowing the reconstruction of coincidences and release curves as function of time (e.g., see Fig. 1).

First results on the yields of Rb and Cs activities are displayed in Fig. 2. The most neutron-rich isotopes observed with target and ionizer temperature about 2050°C were ^{99}Rb ($T_{1/2}$=50.3 ms) and ^{147}Cs ($T_{1/2}$=225 ms). Raising the temperature for the ionizer to 2450°C and the target to 2200°C increased the yields for the short-lived isotopes and also ^{148}Cs ($T_{1/2}$=158 ms) could be observed by its

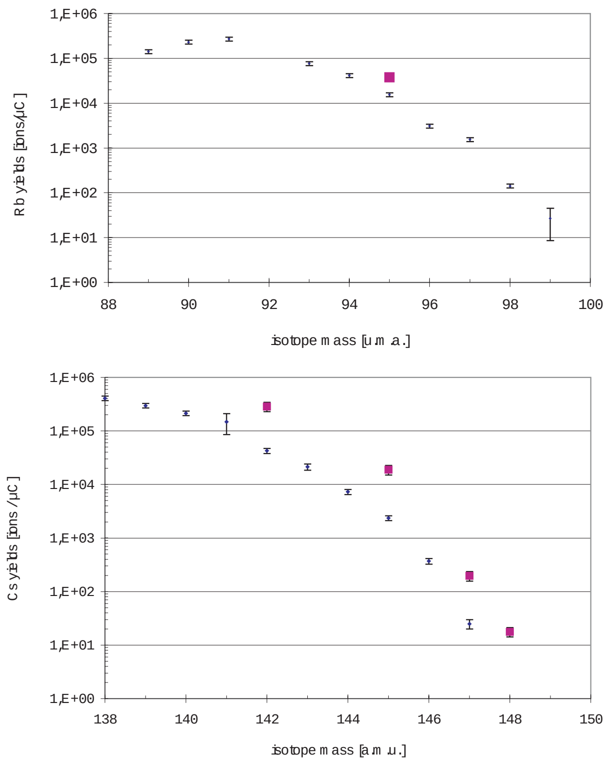

Figure 2: Yields in ions/μC of neutron-rich Rb (upper part) and Cs isotopes (lower part) produced with the PARRNe isotope separator with a ^{238}UC$_x$/graphite target and a W ionizer at about 2050°C. The square spots are yields measured with the target at 2200°C and the ionizer at 2500°C.

β-delayed neutron activity [2]. In addition, less efficiently produced elements as In can be obtained.

Comparing these data with cross sections measured in thermal neutron-induced and high-energy proton-induced fission will allow a study of the long-standing question on the dependence of fission yields of the most neutron-rich isotopes on the excitation energy of the fissioning system. Furthermore, the data will provide reliable estimations for neutron-rich beams with next generation ISOL facilities as EURISOL.

References

[1] http://www.ganil.fr/eurisol/index.html

[2] Ch. Lau et al., Proc. EMIS-14, Nucl. Instr. Meth. B, in print