Mass Measurements with the Rare-RI Ring for the $A = 130$ r-process Abundance Peak

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In the fall of 2018, we have conducted an experiment at the Rare-RI Ring (R3) to measure masses of nuclei in the south-west region of ^{132}Sn. As it has been shown from sensitivity studies[1)] masses of nuclei in the region around $N = 82$ has the most significant impact on the $A = 130$ r-process abundance peak. We have measured masses of the most exotic nuclei approaching $N = 82$, namely ^{122}Rh, ^{123,124}Pd and ^{125}Ag isotopes.

Particles of interest were produced at RIBF by impinging a 40-pnA Uranium beam on a 5-mm thick Be target. Particles were identified at BigRIPS by energy loss in an Ionization Chamber (IC) placed at F3 and their Time-of-Flight (ToF) from F3 to F5. After injection into the R3 and storage for about 1 ms, equivalent to almost 2000 turns, the particles were extracted. Figure 1 shows the PID at F3 of all events a BigRIPS in yellow and extracted events after R3 shown in pink.

The mass will be determined from the total time-of-flight in the storage ring and a velocity correction. The mass determination of a particle with m_1/q_1 requires also a reference particle with known mass m_0/q_0

$$\frac{m_1}{q_1} = \frac{m_0}{q_0}\frac{T_1}{T_0}\sqrt{\frac{1-\beta_1^2}{1-(\frac{T_1}{T_0}\beta_1)^2}}, \tag{1}$$

with β_1 being the particle of interest velocity that is measured along the beamline before injection. The time-of-flight of the reference particle T_0 and particle of interest T_1 inside the ring are determined by a procedure detailed elsewhere.[2)]

Table 1. Preliminary total events extracted after the ring.

Isotope	Events	Isotope	Events
^{127}Sn	104	^{128}Sn	178
^{126}In	287	^{127}In	157
^{125}Cd	140	^{126}Cd	4965
^{124}Ag	1261	^{125}Ag	406
^{123}Pd	122	^{124}Pd	11
^{122}Rh	2		

In Table 1, we show the number of extracted events preliminarily confirmed with the PID. The overall extraction efficiency was lower than expected and was less than 1% for the reference particle. The data analysis is being carried out.

In the future we aim at studying even more exotic, relevant nuclides in this region.

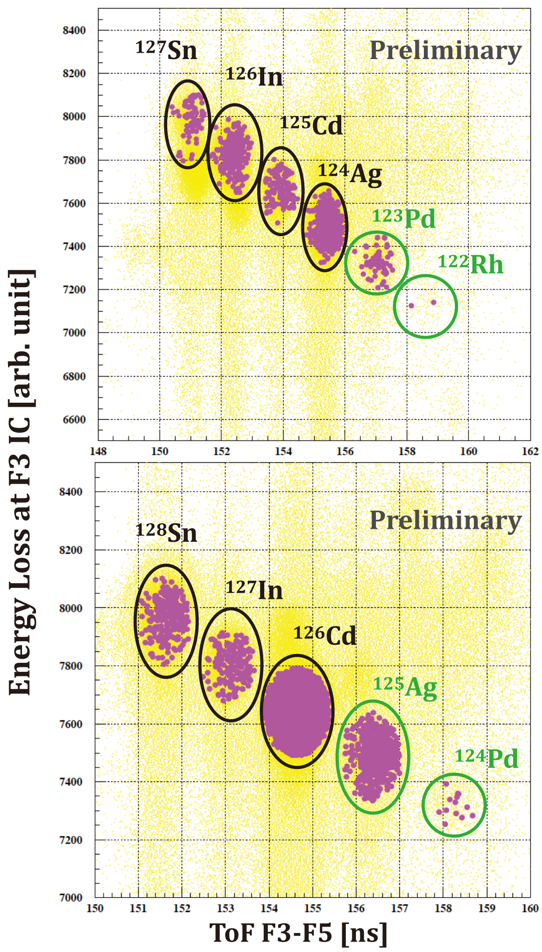

Fig. 1. Particle Identification (PID) showing the energy loss in the Ionizarion Chamber (IC) at F3 and ToF from F3 to F5. In yellow are shown events at BigRIPS and in pink are shown extracted events after R3. Particles of interested are labeled in green, while reference particles are labeled in black.

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References

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