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 studies1) 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, $^{123}$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 known mass $m_0$ requires also a reference particle with known mass $m_0 / q_0$

$$m_1 / q_1 = m_0 / q_0 \sqrt{\frac{1 - \beta_1^2}{1 - (\frac{q_1}{q_0} \beta_1)^2}}.$$  (1)

with $\beta_1$ 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.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Events</th>
<th>Isotope</th>
<th>Events</th>
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<tbody>
<tr>
<td>$^{122}$Sn</td>
<td>104</td>
<td>$^{125}$Sn</td>
<td>178</td>
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<tr>
<td>$^{126}$In</td>
<td>287</td>
<td>$^{127}$In</td>
<td>157</td>
</tr>
<tr>
<td>$^{125}$Cd</td>
<td>140</td>
<td>$^{126}$Cd</td>
<td>4965</td>
</tr>
<tr>
<td>$^{124}$Ag</td>
<td>1261</td>
<td>$^{125}$Ag</td>
<td>406</td>
</tr>
<tr>
<td>$^{123}$Pd</td>
<td>122</td>
<td>$^{124}$Pd</td>
<td>11</td>
</tr>
<tr>
<td>$^{122}$Rh</td>
<td>2</td>
<td></td>
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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.

References
2) H. Li et al., in this report.