Preliminary analysis of the mass measurement experiment in the south-western region of ^{132}Sn with Rare RI Ring

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Mass measurement experiments were conducted at Rare RI Ring (R3)[1] in 2018. Neutron-rich ^{122}Rh, ^{123,124}Pd, and ^{125}Ag nuclides were measured in two settings.[2] The principle of the mass masurement in the R3 can be described by the following equation:

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

where T_1 and T_0 are the revolution times of nucleus of interest and reference nucleus, respectively, and β_1 is the velocity of the nucleus of interest.[3] The unknown mass m_1 is determined relative to the mass of reference nucleus m_0. When a particle is injected into R3 using the kicker magnet,[1] it circulates for approximately 0.7 ms. The particle is then extracted to ELC using the same kicker magnet. The detector setup in R3 is shown in Fig. 1 We measured the time-of-flight (TOF) from F3 to S0 to determine the velocities of each particle and from S0 to ELC to determine T_1 and T_0.

To obtain the revelotion time of the particle in R3, we need to know the turn number of each particle before the extraction. For this purpose, we used detectors at R-MD4 of R3, which were composed of the E-MCP detector,[4] a plastic scintillator, and a CsI(Tl) telescope.

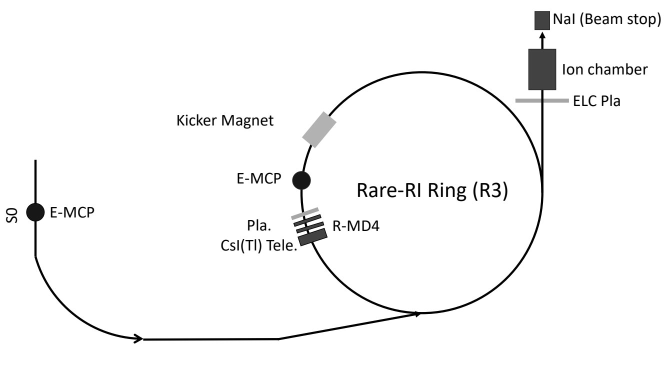

Fig. 1. Schemaic view of the detector setup at R3.

Table 1. TOF, revolution times, and deduced turn numbers of nuclide in the two settings.

Nuclei	^{128}Sn	^{127}In	^{126}Cd	^{125}Ag
Rev. time [ns]	394.00	397.642	405.44	405.44
R3 TOF [ns]	724922.66	724897.19	724904.61	724904.61
Turns	1840	1823	1806	1788

^{127}Sn	^{126}In	^{125}Cd	^{124}Ag	^{123}Pd
391.69	395.28	399.04	402.99	407.09
724293.23	724204.20	724284.13	724561.00	724621.44
1849	1832	1815	1798	1780

First, the telescope detectors and plastic scintillator at R-MD4 were placed on the central orbit and the injection time spectrum was recorded. Second, the detectors were moved to the inner side of the ring, 85 mm away from the central orbit, which corresponds to the extraction orbit. The TOF of the nuclei, circulating in R3, can be determined from these two measurements. Third, we inserted the E-MCP detector with a thin foil into the central orbit of the ring to measure the revolution time of the nuclei. The turn number of each nucleus was determined based on the TOF obtained by the first two steps and the revolution time obtained by the third step. The TOF in the R3, revolution time measured by the E-MCP detector, and the deduced turn number are listed in Table 1. For ^{122}Rh and ^{124}Pd, the turn numbers could not be clearly determined owing to the low statistics of the revolution times. However, the revolution times of ^{122}Rh and ^{124}Pd could be precisely estimated based on the mean $B\rho$ value and central orbit length, which were calibrated by the data of other nuclei.

To determine the mass, besides $T_{0,1}$, we also need to calculate β_1 for each event. β_1 will be determined by the TOF between the F3 achromatic focus of BigRIPS and S0 and the corresponding path length that will be calibrated by the reference nuclei in the future.

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