High-precision mass measurements of ground and isomeric states of ^{97}Cd and ^{99}In using ZD MRTOF-MS

W. Xian,[*1,*2,*3] M. Rosenbusch,[*4] C. Fu,[*1] M. Wada,[*2,*5] H. Ishiyama,[*4] D. Hou,[*1,*2,*5] J. M. Yap,[*1,*4] S. Zha,[*1,*2] A. Takamine,[*4,*6] V. H. Phong,[*4] S. Nishimura,[*4] T. T. Yeung,[*4,*7] S. Iimura,[*4,*8] P. Schury,[*2] N. Fukuda,[*4] Y. Hirayama,[*2] Y. Ito,[*9] S. Kimura,[*2] K. Kusaka,[*4] T. M. Kojima,[*4] J. Lee,[*1] H. Miyatake,[*2] S. Michimasa,[*4] T. Niwase,[*6] M. Ohtake,[*4] T. Sonoda,[*4] H. Suzuki,[*4] Y. Shimizu,[*4] H. Takeda,[*4] Y. Togano,[*4] Y. X. Watanabe,[*2] H. Wollnik,[*10] Y. Yanagisawa,[*4] and M. Yoshimoto[*4]

The doubly magic nucleus, ^{100}Sn, is pivoltal for understanding shell evolution and exotic nuclei magicity. The magicity of ^{100}Sn and the nature of single-particle states of nuclei in the vicinity serve as a benchmark for nuclear shell models to constrain their configuration space. With identical proton and neutron numbers, ^{100}Sn is an ideal system to investigate the impact of proton-neutron interaction on the nuclear structure of lighter nuclei, especially of those with $N = Z$.[1)] Moreover, the rapid proton capture process (rp-process) is predicted to end around nuclei with $A \approx 100$ and $N \approx Z$.[2)] Structure information of ^{100}Sn provides key information for understanding the nucleosynthesis in astrophysics. In 2024, in-beam γ-ray spectroscopy and joint mass spectrometry experiments (NP2112-RIBF211) were initiated to probe ^{100}Sn and its neighboring nuclei. Here, we present the identifications and mass measurements of ^{97}Cd, ^{99}In and their isomers by multi-reflection time-of-flight mass spectrograph at ZeroDegree spectrometer (ZD MRTOF-MS).

To produce radioactive ions (RIs) of interest, primary beams of ^{124}Xe, accelerated to 345 MeV/nucleon, bombarded a Be target at the entrance of BigRIPS. The secondary beams generated by the in-flight fragmentation were then accepted, identified, and transported to the focal plane F8, where they interacted with a liquid hydrogen target, producing excited ^{100}Sn through n, $2n$ knock-out reaction from ^{101,102}Sn, respectively, for γ-ray spectroscopic measurements. Following the reaction, the products and unreacted secondary beams were collected and transported to the end of the ZeroDegree spectrometer, where RIs were captured by an RF-carpet-type helium gas catcher (RFGC) and analyzed by ZD MRTOF-MS. By introducing an in-MRTOF deflector (IMD),[3)] target ions of multiple mass numbers can be measured simultaneously, while excluding other mass numbers. Additionally, the implementation of a

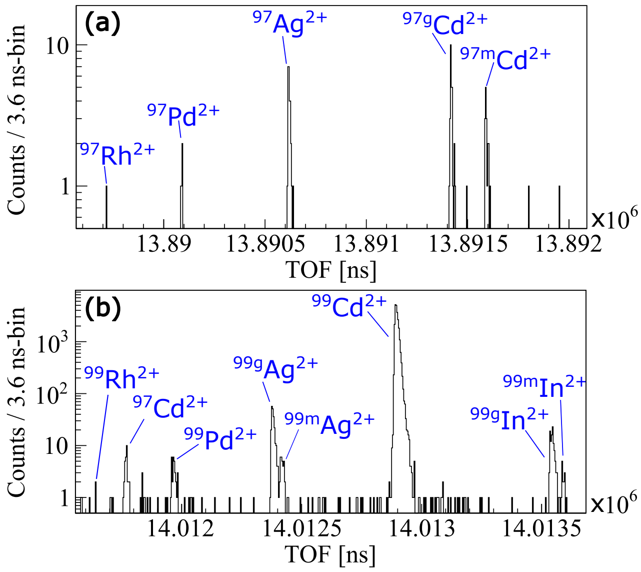

Fig. 1. (a) TOF spectrum of ions with $m/q = 48.5$. (b) TOF spectrum of ions with $m/q = 48.5$, and 49.5.

β-TOF detector[4)] at the end of the ion flight path allows for the determination of time-of-flight (TOF) while simultaneously capturing subsequent β decay events. This facilitates the identification of RIs through coincident measurement of TOF and β decay.

During beam time, ZD MRTOF-MS operated at a high mass resolving power $m/\Delta m \approx 700$ k, achieved through sophisticated ion optics tuning.[5)] The isomers of ^{97}Cd and ^{99}In were clearly separated from their ground states, with measurement uncertainties of approximately 20 keV, as shown in Fig. 1, along with ions from neighboring mass numbers. The observation of coincident β events from ^{97g,m}Cd and ^{99}In further verifies the peak assignments for the corresponding RIs, while the β decay time spectrum helps to estimate the half-lives of the ground and isomeric states of ions of interest.

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*1 Department of Physics, The University of Hong Kong
*2 Wako Nuclear Science Center (WNSC), IPNS, KEK
*3 Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University
*4 RIKEN Nishina Center
*5 Institute of Modern Physics, Chinese Academy of Sciences
*6 Department of Physics, Kyushu University
*7 Department of Physics, University of Tokyo
*8 Department of Physics, Rikkyo University
*9 Advanced Science Research Center, Japan Atomic Energy Agency
*10 Department of Chemistry and Biochemistry, New Mexico State University

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