First Demonstration of Mass Measurements for Exotic Nuclei using Rare-RI Ring

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The Rare-RI Ring is an isochronous storage ring at the RI Beam Factory of RIKEN. Its mission is measuring masses of most neutron-rich nuclei relevant for r-process nucleosynthesis. The Rare-RI Ring is based on the isochronous mass spectrometry technique to achieve mass measurement with a precision of 10^{-6} in less than 1-ms measurement time. A demonstration of mass measurements of ^{79}As, ^{77}Ga, ^{76}Zn, and ^{75}Cu, whose masses are well known is presented. The Rare-RI Ring is now ready to start its mission of measuring masses of rare isotopes.

KEYWORDS: Nuclear mass, Isochronous storage ring, exotic nuclei

1. Introduction

Nuclear mass is one of the basic probes to obtain information about the nuclear structure, stability of the nuclei, shape, and interactions. Nuclear masses are also important for understanding the synthesis of heavy elements via the r-process. However, mass measurements of exotic nuclei far from the β stability line is challenging because of their low production rates and short life-times. For determination of such exotic nuclear masses, a new device, Rare-RI Ring [1], has been in construction at the RIKEN RI Beam Factory [2] from 2012 to 2013. The Rare-RI Ring is based on the Isochronous Mass Spectrometry (IMS) technique that allows reaching a high precision of 10^{-6} within a short measurement time of approximately 1 ms. We conducted two commissioning experiments in 2015. In the first commissioning experiment, we verified the operation of each component by using ^{78}Kr primary beam [3], while in the second commissioning experiment, we made the first attempt of a mass measurement by using stable nuclei of ^{36}Ar and ^{35}Cl [4]. In 2016, a first demonstration of mass measurement using exotic nuclei with well-known masses have been accomplished, thus confirming the feasibility of such experiments.