Research Facility Development Division
Instrumentation Development Group

1. Abstract

This group develops core experimental installations at the RI Beam factory. Three projects are currently going on. SLOWRI is an experimental installations under testing and a common element enabling multiple-use. This will stop high-energy RI beams in a gas-catcher system and re-accelerates up to several-tenth keV, and the high-quality cold RI beam will be delivered to the users. SCRIT is the world first facility for an electron scattering off unstable nuclei, and has been constructed independently of the RIBF main facility. The first physic result was demonstrated in 2017, and the facility is now under upgrading of the electron beam power driving the RI beam production. Rare-RI Ring is an event-by-event operated heavy-ion storage ring aiming at the precision mass measurement for extremely rare exotic nuclei. This is now open for an experimental proposal application, and has already performed PAC-approved experiments, and an improvement for higher precise mass measurement is now going on. A small size heavy-ion storage ring, RUNBA, is R&D machine for technical development of beam recycling aiming at nuclear reaction study for rarely produced isotopes. This is under preparing for construction and the technical development for some key components in the ring are now going on. All instrumentations were designed to maximize the research potential of the world's most intense RI beams, and the exclusive equipment available at the RI Beam Factory makes experimental challenges possible. Technologies and experiences accumulated in this group will be able to provide opportunities of new experimental challenges and the foundation for future developments of RIBF.

2. Major Research Subjects

(1) SCRIT Project
(2) SLOWRI Project
(3) Rear RI Ring Project
(4) RUNBA project (Beam recycling development)

3. Summary of Research Activity

We are developing beam manipulation technology in carrying out above listed project. They are the high-quality slow RI beam production (SCRIT and SLOWRI), the beam cooling and stopping (SCRIT and SLOWRI), and the beam accumulation technology (Rare RI Ring and RUNBA) in a storage ring. The technological knowhow accumulated in our projects will play a significant role in the next generation RIBF. Status and future plan for each project is described in subsections. The electron scattering from ^{132}Xe isotopes has been successfully measured and the nuclear charge density distribution has been obtained in SCRIT. We are upgrading the power of electron beam from RTM, which is the driver for RI production, for going to world-first electron scattering off unstable nuclei. Performance of Rare RI Ring has already been evaluated and successfully started mass-measurements for unknown-mass nuclei in the experiments approved by PAC. Recently, we succeeded in measurement of masses of ^{74,76}Ni, ^{122}Rh, ^{123,124}Pd, and ^{125}Ag for the first time. Since expected performances on a mass resolution and an efficiency has slightly been unachieved, the fast kicker system and the optics tuning system are under improvement. SLOWRI is now under test experiments to establish a slow RI beam production using two types of gas cells. PALIS has been commissioned from 2015, and basic functions such as, for instance, the RI-beam stopping in Ar gas cell and the extraction from the gas cell have beam evaluated. RF carpet gas cell (RFGC) combined with multi-reflection time-of-flight device is now working as a movable mass spectrograph at some facility such as ZeroDegree and GARIS. Detail status and future plans for these projects are described in subsections.

According to the future plans of the Nishina Center, we have started development of a beam re-cycling technique. A circulation of an RI beam in a storage ring equipped by a thin internal target is maintained until that some nuclear reaction occur at the target. In order to establish a beam re-cycling technique, the energy loss has to be compensated and growth of the energy-spread and the emittance have to be corrected by using a re-acceleration system and a beam-cooling or a fast feedback system, respectively. A beam re-cycling technique is supposed to greatly enhance an RI use efficiency in a nuclear physics study. For the development of these novel technique, we will construct a relatively small size of heavy-ion storage ring (RUNBA) connected to ISOL (ERIS) in the SCRIT facility. This is equipped by acceleration devices and beam-cooling devices necessary in our R&D study. It was originally constructed as a beam cooler ring (sLSR) at the Institute for Chemical Research (ICR), Kyoto University more than ten years ago. This ring is re-cycled at RIBF and it has been already moved to RIBF. Technical development for key devices required in RUNBA such as a charge breeder (CB), an energy-dispersion corrector (EDC), angular diffusion corrector (ADC), and an internal target system have been already started under the research cooperation agreement with ICR Kyoto University.

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List of Publications & Presentations

Publications and presentations are listed in subsections.