Research Facility Development Division
Instrumentation Development Group

1. Abstract

This group develops the core-experimental instruments at the RI Beam Factory. Four projects are currently going on. SLOWRI is an experimental instrument to provide low and cold ion beam. The high energy RI beam is stopped by a gas catcher system and re-accelerated to several tens of keV to deliver a high-quality cold RI beam to the user. SCRIT is the world's first experimental facility for electron scattering of unstable nuclei and was constructed off the main beamline of RIBF. The first physic result was demonstrated in 2017, and the electron scattering experiment for radioactive isotopes has been started in this year. An upgrade of the electron beam power that drives RI beam production is currently underway. The Rare-RI Ring is an event-by-event-operated heavy ion storage ring for precise mass measurement of extremely rare exotic nuclei. It is currently accepting applications for experimental proposals and has already conducted PAC-approved experiments and published its first physics results. Improvements are currently underway to achieve more precise mass measurements. The compact heavy-ion storage ring RUNBA is an R&D machine for the development of beam recycling techniques for nuclear reaction research on rare elements. This is currently under construction and some of the critical components of the ring are currently undergoing technical development. All instrumentations is designed to maximize the research potential of the world's most intense RI beams, and dedicated RI Beam Factory equipment makes the experimental challenge possible. The experimental technique and experience accumulated in this group provide opportunities for new experimental challenges and form the basis for the future development of the 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 techniques to carry out the above projects. These are high-quality slow RI beam generation technology (SCRIT, SLOWRI), beam cooling and stopping technology (SCRIT, SLOWRI) and beam accumulation technology in a storage ring (Rare RI Ring, RUNBA). The technical know-how accumulated in the project will play a major role in the next generation of RIBF. The current status and future plans for each project are described in the respective sections. We have successfully measured electron elastic scattering from ^{132}Xe isotopes and obtained nuclear charge density distributions in SCRIT. Recently, we have started electron scattering experiment for unstable nuclei. That will be the world's first electron-RI collision experiment. We are in the process of power upgrading of the electron beam from the RTM, which is the driving for RI production, and expanding the nuclei that can be accessed. The Rare RI Ring is an event-by-event based mass measurement system, designed specifically for extremely low-producing isotopes. We carried out PAC-approved experiments and successfully measured the masses of ^{74,76}Ni, ^{122}Rh, ^{123,124}Pd and ^{125}Ag for the first time. To improve mass resolution and efficiency, the first-response kicker system and optical tuning system are being improved. Test experiments are currently underway at SLOWRI to establish slow RI beam generation using two different type of gas cells. PALIS has been commissioned from 2015, and basic functions such as, the RI-beam stopping in Ar gas cell, the extraction from the gas cell and laser ionization have beam evaluated. Movable mass spectrometer combining RF carpet gas cells (RPGC) and multiple reflection time-of-flight (MRTOF) are in operation at facilities such as Zero Degree and GARIS. The combination of RFGC and MRTOF has been used successfully to measure the mass of ^{74,75}Ni isotopes.

According to the future plans of Nishina center, a beam re-cycling technique is under development. Beam recycling technology allows the circulation of RI beams to be maintained in a storage ring with a thin internal target until a nuclear reaction occurs. In order to establish beam recirculation, the increase in energy width and emittance needs to be compensated for using a fast feedback system. We have demonstrated the possibility of compensation in an analytical way and found the properties of EDC and ADC devices necessary for compensation. To develop these new technologies, a compact heavy ion storage ring (RUNBA) connected to ISOL (ERIS) is under construction at the SCRIT facility. Under a research cooperation agreement with ICR in Kyoto University, technical development of the main components required for RUNBA *i.e.* the charge breeder, energy dispersion corrector, angular diffusion corrector and internal target system are underway.

Members

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List of Publications & Presentations

Publications and presentations for each project team are listed in subsections.