Contribution ID: **83**   Type: **Poster (by default)**

Beam Emittance Growth of Highly Charged Ion Beams from the RIKEN SC-ECRIS

The beam emittance of extracted ions from ion sources is an important parameter relating to the beam quality of high energy accelerators such as the Radioactive Isotope beam Factory (RIBF) in RIKEN. In order to improve the output beam intensity and transmission efficiency to be well within the acceptance range of low-energy beam transport systems, it is important to maintain a low beam emittance and understand the different factors that can affect its growth. From ion production, extraction, beam focusing, and mass separation, the analysis of the beam emittance is complex as it is affected by the ion source operation and various beam optical components. Therefore, the first step is to consider the ion source parameters such as extraction voltage, extraction beam current, microwave power, and other parameters to systematically study the effect on the beam emittance size.

The RIKEN 28-GHz superconducting electron cyclotron resonance ion source (SC-ECRIS) was operated to produce multiply charged ions and then separated through a magnetic ion analyzer. Using a slit-type emittance monitor, the beam emittance sizes of the produced highly charged ion beams of Ar, Xe, V and U were measured. To minimize the influence of space charge effects for downstream of the analyzing magnet, the measured beam intensities of highly charged heavy ions (Ar and Xe ions) were kept constant and the observed emittance sizes showed a difference in growth with the increasing extraction current for both x and y beam emittances.

In this contribution, the experimental results of the beam emittance measurements and the influence of the ion source parameters including the effects of space charge are presented in detail.

Funding Agency

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Session Classification: Monday

Track Classification: Beam Formation, Extraction, Transport, and Diagnostics