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Ion Beam Emittances of Intense Highly Charged Ion Production from the RIKEN 28GHz SC-ECRIS

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The production of high intensity multiple charged heavy ions is one of the main objectives of the 28GHz superconducting electron cyclotron resonance ion source (SC-ECRIS) at RIKEN. As the SC-ECRIS gradually move towards high power operation, it is important to confirm that the extracted ion beam properties are within the acceptable range of the low energy beam transport system. Investigating the beam quality through the beam emittance and the possible growth factors are currently in progress. Beam emittances were measured using a slit-wire-type emittance monitor and the normalized rms emittances were calculated in a systematic study under different beam conditions. From the experimental results, a proportional relation between the beam emittance and extraction current was observed and an approximation for finding an initial value of the beam emittance ε₀ was tested. For the case of uranium ²³⁸U³⁵⁺ ion beam, the approximation of the initial beam emittance was found to be at ~0.09 π mm mrad. However, considering the expected beam conditions of the required output beam current, this initial beam emittance is predicted to increase up to 0.22 π mm mrad based on growth factors from space charge effects in the extraction region. Although conditions with low total beam current result in smaller beam emittance sizes, achieving such conditions will be challenging while optimizing for high beam intensities. As a next step, space charge compensation methods are currently being considered to further lower the emittance sizes. Fundamental studies to understand the beam dynamics in the extraction region are being planned and this will be used to properly formulate strategies for space charge beam compensation.

Primary author: SAQUILAYAN, Glynnis Mae (RIKEN Nishina Center)

Co-authors: HIGURASHI, Yoshihide (RIKEN Nishina Center); NAGATOMO, Takashi (RIKEN Nishina Center); MORITA, Yasuyuki (RIKEN Nishina Center); OHNISHI, Jun-ichi (RIKEN Nishina Center); KAMIGAITO, Osamu (RIKEN Nishina Center for Accelerator-Based Science)

Presenter: SAQUILAYAN, Glynnis Mae (RIKEN Nishina Center)

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