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Factors Influencing the Fluctuation Amplitude of the H- Ion Beam Extracted from an RF Wave Excited Ion Source Plasma

An internal antenna type RF driven negative hydrogen (H^-) ion source supplies beams to the J-PARC accelerator facility. The H^- ion beam current exhibits high stability, while it fluctuates with less than 5% amplitude of the DC current when a Faraday cup measures the current extracted from the source mounted on a test stand. Two frequencies are identified as the main oscillation components, 2 MHz and 4 MHz which are the driving RF frequency and the second harmonic, respectively. The amplitude levels of these components appear larger as parts of the beam directing specific angles passing through a slit are detected. A possible reason for observing a small amplitude oscillation in the total beam intensity is the averaged phase-shift of the local beam depending upon the position of the H^- ion production and the succeeding trajectory reaching the Faraday cup. To confirm if the phase-shift is the main reason for diminishing the oscillation amplitude for the total beam, the phase-shift between the 2 MHz and 4 MHz components were measured for beams passing through a 0.1 mm slit detected by a Faraday cup having a 0.1 mm entrance slit. The result indicated the phase-shift changed substantially depending upon the position, but no simple model can explain the measured spatial distribution of the phase-shift. Further attempts will be made to clarify the beam dynamics relevant to the H^- ion beam transport including the measurements of the beam current phase-shift with respect to the RF antenna current, and the time evolution of Balmer-α light emission from the source plasma.

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