§15. Development of an H^- Beam Probe System for a High Intensity Positive Ion Beam Profile Measurement

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Under a severe radiation environment such as IFMIF (International Fusion Materials Irradiation Facility) accelerator system, the beam diagnostics in the beam transport line with an extremely high beam intensity seems quite a difficult issue by using conventional techniques because of scattering of the accelerated ions and activation of the accelerator components by collision with the scattered ions. In order to solve this issue, we have proposed a negative ion beam probe system as a new scheme to diagnose beam profiles of high intensity positive ion beams[1].

We started an experimental study with a low energy intense beam system being tested at NIFS to validate the capability of the negative ion beam probe system. We have designed, assembled and tested an H^- ion source for the probe beam source. This ion source was installed on the diagnostic chamber of a strongly focusing He^+ ion source developed at NIFS NBI test stand for measurement of α particles produced by D-T nuclear reaction in thermonuclear reactors[2].

The amount of attenuation of negative ions by electron detachment tends to be inversely proportional to a square of barycentric energy of the positive and negative ions. In case of high energy positive ion beams, it seems to be difficult to measure the negative ion beam attenuation. Therefore, we started another approach to measure the negative ion beam profile by using deflection of the beam orbit due to scattering with the positive ions.

In a system of the positive and negative beams crossing with a right angle, the Rutherford scattering formula is applied to express the deflection angle to the negative ion beam orbit. When some negative ions are neutralized by the crossing of the positive-negative ion beams, the neutralized particles are not affected by the Coulomb's field produced by the positive ions, and flow tangential to the hyperbolic orbit of the negative ion beam at the electron detached points.

We start to design a new probe beam diagnostic system in consideration with this approach.

1) Shinto, K. et al.: Proc. IPAC'10 (2010) 999.
2) Shinto, K. et al.: Annual Report of NIFS (Nov. 2012) 182.