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Development of a Beam Profile Monitor Using a Negative Ion Probe Beam for High Intensity Positive Ion Beams
負イオンプローブビームを用いたビームプロファイルモニターの開発

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We have proposed a negative ion beam probe system as a new scheme to diagnose beam profiles of high power positive ion beams. We show the present status of the proof-of-principle experiment for the negative ion beam probe system performed at NIFS NBI test stand. A negative hydrogen ion source which produces a rectangular shape beam was installed and the total current of H^- beam extracted from the ion source was measured. We obtained the total H^- beam current of 10 μA with the beam energy of 3 kV.

1. Introduction

In order to diagnose beam profiles of high intensity positive ion beams in a high radiation field environment such as the International Fusion Materials Irradiation Facility (IFMIF) linear accelerators [1], we have been developing a negative ion beam probe system as a new tool. We designed, assembled and tested a compact KAMABOKO type H^- ion source at Doshisha University for the proof-of-principle experiment of the negative ion beam probe system [2].

After the beam test at Doshisha University, the H^- ion source was moved to National Institute for Fusion Science (NIFS). It has attached on a strongly focusing and high-intensity He^+ beam diagnostic chamber at NIFS Neutral Beam Injection (NBI) test stand in order to validate the system feasibility [3]. In this summer, we performed the H^- beam extraction at NIFS NBI test stand. In this article, we show the experimental results of the beam test and future prospects.

2. Experimental setup and results

Figure 1 is a photograph of the compact KAMABOKO type H^- ion source attached on the diagnostics chamber for the He^+ beam extracted from the strongly focusing and high-intensity He^+

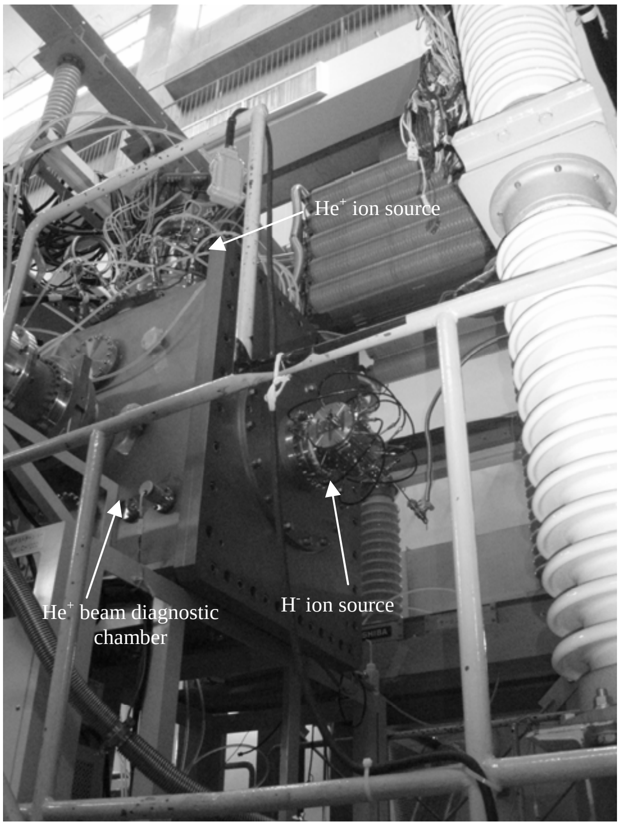

Fig.1. A photograph of the compact KAMABOKO type H^- ion source attached on the diagnostic chamber for the strongly focusing and high-intensity He^+ ion source.

ion source. The H^- ion source is designed to produce the H^- beam with a rectangular shape of 70 mm × 2 mm.

In order to measure the total H^- beam current extracted from the ion source, a Faraday cup with the rectangular aperture of 100 mm × 10 mm was installed in the diagnostic chamber. The distance between the exit of the H^- beam extraction aperture of the H^- ion source and the entrance of the Faraday cup aperture is about 1,000 mm.

Figure 2 shows an experimental result of the H^- beam measurement. The extracted H^- beam current was obtained about 10 μA at the maximum discharge current of 2.5 A which was limited by the power supply and by increasing the hydrogen gas pressure in the ion source and optimizing the lens voltage applied to the intermediate electrode in the extraction system of the H^- ion source.

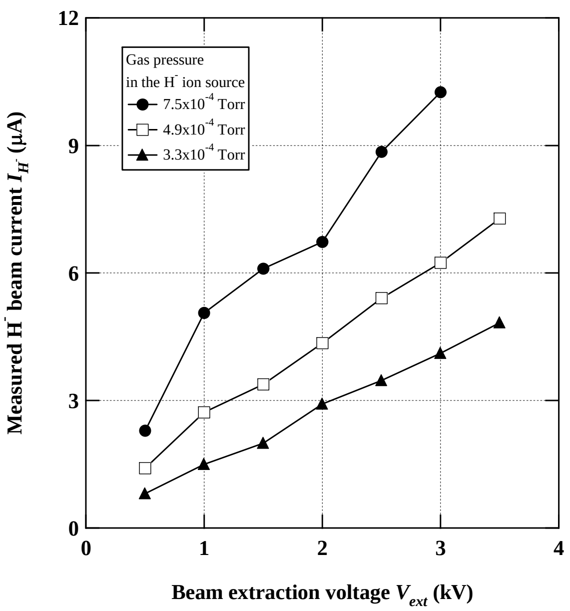

Fig.2. Measured H^- beam current extracted from the compact KAMABOKO type H^- ion source as a function of the extraction voltage. Hydrogen discharge voltage and current in the ion source, V_d = 70 V and I_d =2.5 A, respectively.

3. Summary and future plan

We have installed the compact KAMABOKO type H^- ion source in the beam diagnostic chamber for the strongly focusing and high-intensity He^+ ion source at NIFS NBI test stand in order to validate the active beam probe technique as a new tool for the beam profile diagnostics of high intensity positive ion beams and measured the total H^- beam current extracted from the H^- ion source. We obtained the H^- beam current of 10 μA with the beam energy of 3 kV. In this winter, we will perform an experimental study for the proof-of-principle of the new spatial beam profile monitor tool by crossing this H^- beam to the He^+ beam perpendicularly.

Acknowledgments

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