§42-21 Study on Utilization of Heavy-metal-ion-beam for LHD-HIBP System

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The heavy ion beam probe (HIBP) is one of a method of plasma diagnostics, which can measure the potential profiles in plasma. An HIBP system has been installed at the Large Helical Device (LHD-HIBP) [1)]. In recent HIBP diagnostics, the current of the heavy ion beam is sufficient for the electron density of 10^{19} m^{-3}. Since the attenuation of the probe beam is severe in higher density plasma, larger Au^{+} current is necessary. Some studies investigating how to increase the current have been done [2, 3)]. These objectives are to increase the negative ion beam current and to improve the charge exchange efficiency in the gas cell of the tandem accelerator, the beam transport efficiency, and the detection efficiency of ejected ions and so on. Especially, the experimental study to optimize the gas cell for high charge exchange efficiency is not easy using LHD-HIBP because it takes much time to change gas species in the gas cell. We have studied on the subject using a tandem accelerator at Kobe University [3)]. The accelerator has a gas cell, and the terminal voltage is up to 1.7 MV.

The charge fractions of Au beam generated by the tandem accelerator have been measured, and some ionization cross sections for Au ions or neutral atom were obtained. To obtain the charge fraction, the current can be measured with a Faraday cup (FC) for ions and a micro channel plate (MCP) for neutrals and ions. The current detected by MCP have been calibrated with an error up to several tens percent [4)]. The MCP (Hamamatsu photonics Inc.) was set on *x-y* movable stage, and the beam profile can be measured by this set up.

The MCP gain becomes small with progress of the use time. It is desired to calibrate the gain before an experiment. In recently, the gain became small and a current could not be measured with enough accuracy. We changed the MCP to a new one into a chamber on straight beam line, and checked the characteristics. The result of a time evolution of the current of MCP is shown in Fig. 1. The current measured with HE FC installed at an exit of a tandem accelerator is also shown. The current of MCP consists of ions and neutrals. The decrease of the current after 45 minutes are caused by an incident current decrease as seen in HE FC current. It is shown that the MCP current, or the gain, was stable in a typical duration on a charge fraction measurement.

The gas pressure dependence of the MCP current was measured. An example of the result are shown in Fig. 2. The current included ions and neutral particles, and was not calibrated. The horizontal axis is a pressure at high energy beam line measured by ionization gas controller. The value corresponds to the gas thickness in a gas cell. The result shows a typical gas thickness dependence of charged particle. It shows that the new MCP worked well.

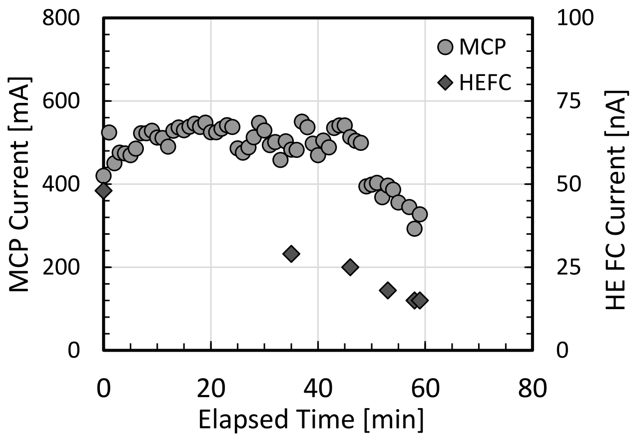

Fig. 1. Time evolution of MCP current and the beam current measured with a HE FC.

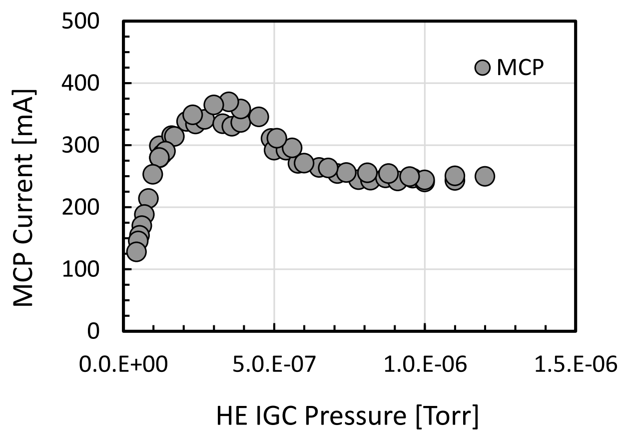

Fig. 2. An example of the gas pressure dependence of the MCP current. The current was not calibrated, and the incident particles to the MCP include ions and neutrals.

We make a plan to focus the charged ions paid attention on the FC and MCP in a few mm in diameter. After the beam spot is observed by a camera, the ions are measured by the FC or the MCP. We have examined a material emitting light for a long time in an irradiation. It is considered that a glass are a candidate for this use.

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4 Taniike, A. *et al*., Plasma Fusion Res. 8, 2401087 (2013).