18PB-042

Development of Measurement System Employed to Two-Fluid Plasma Experiments on BXU
2 流体プラズマ生成実験に用いる画像計測器の開発と測定システムの構築

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To measure two-demensional luminosity distributions of both Li^+ and e^- plasmas in the BXU machine, we have depeloped a new imaging system with MCP and a phosphor screen. In this paper, the detail of the system is presented.

1. Introduction

Recently, we proposed a new experiment for testing the two-fluid plasma model. The proposed method uses a lithium ion (Li^+) and an electron (e^-) plasma. These plasmas are called non-neutral plasmas (NNPs) [1]. In the proposed experiment, NNPs are confined in a Penning-Malmburg type trap so that particle flux must be measured by passive methods. For this reason, we had employed a Faraday cup and a phosphor screen [4,5]. With the Faraday cup, both ion n_i and electron n_e densities were obtained. Using the phosphor screen, time evolutions of two demensional (2-D) distributions of the injected e^- beams and the produced e^- plasma were measured successfully.

However, for the case of Li^+ plasmas, no imaging data have been obtained yet, because the phosphor screen does not emit light when ions hit it. This is probably due to the small n_i. In fact, the Faraday cup have shown that n_i is the order of 10^6 cm^{-2} which is much lower than $n_e \sim 10^8$ cm^{-2}. A new imaging system that emits visible light by Li^+ plasmas is thus called for.

For this reason, we have developed a new imaging system using MCP and phosphor screen. In this paper, the detail of it is presented.

2. New Imaging System for BXU

The new imaging system will be placed at the one end of the BXU machine. Also, the phosphor screen must be applied for measuring 2-D luminosity distributions of both Li^+ and e^- plasmas. Thus, several requirements exist for MCP.

2.1 *Employed MCP*

A typical 2-D distribution of Li^+ plasma measured with the Faraday cup is shown in Fig. 1. As seen, the radius of the Li^+ plasma is at most 2.5 cm. Then, we chose the MCP (No. F2225-21P, Hamamatsu Photonics). The radius of it is 2 cm. Regarding the gain of the MCP, $n_i \sim 3 \times 10^4$ cm^{-2} of Ar^+ plasmas was successfully measured in past experiments [6,7]. Their MCP are assembled by the same micro channels ($\phi = 12$ μm) that are used for our MCP. Also, in BXU, n_i of Li+ plasmas has been approximately 10^6 cm^{-3}, which is much larger than those of Refs. 6 and 7. Therefore, our MCP will also output photoelectrons enough to emit a visible light from the phosphor screen.

Since the employed MCP is a two-stage type, the spatial resolution is 80 - 100 μm. On the other hand, the ion gyro radius ρ_i is typically 0.3 cm. Thus, the spatial resolution of the MCP is much smaller than ρ_i.

2.2 *Assembly of MCP with phosphor screen*

In order to place the MCP on the machine axis of BXU, we mount it directly to an ICF203 flange, as shown in Fig. 2. The applied bias voltages are shown in Fig. 3. By switching those voltage sets each other, the MCP can measure 2-D luminosity distributions of both Li^+ and e^- plasmas.

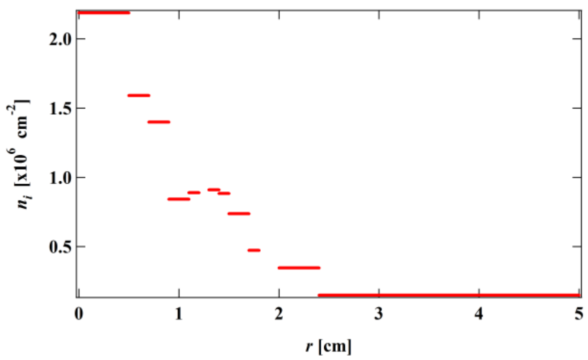

Fig. 1. A typical 2-D distribution of n_i.

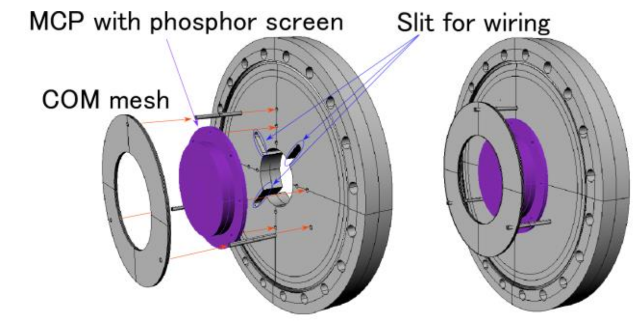

Fig. 1. An exploded view of the ICF 203 flange on which the employed MCP with a phosphor screen are mounted.

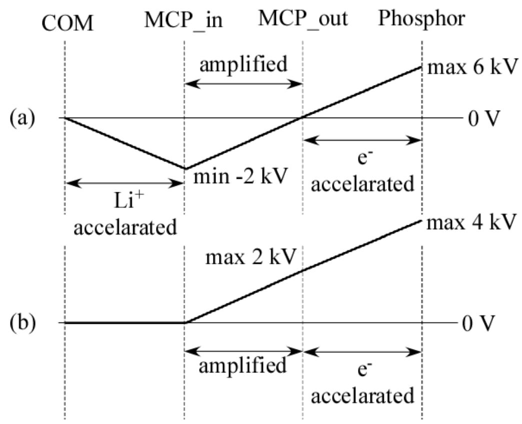

Fig. 2. Bias voltages applied to the MCP and the phosphor screen for cases of (a) a Li^+ plasma and (b) an e^- plasma.

Summary

In this work, we have been developing a new imaging system with an MCP and a phosphor screen. This system will be applied for measuring 2-D luminosity distributions of both Li^+ and e^- plasmas. After finishing all assembly, we will experiment to measure those soon.

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