26aD22P

高密度ヘリコンプラズマの高分解能分光計測
High-resolution Optical Measurement of High-density Helicon Plasma

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It is important for a long-term space mission to extend lifetime of a plasma rocket engine. However, it has a problem of an erosion and a contamination of electrodes due to direct contact with plasmas. To overcome this problem, we have been developing a completely electrodeless plasma thruster [1]. Our proposed scheme is based on a high-density (~10^{13} cm^{-3}) helicon plasma source with an electrodeless electromagnetic acceleration.

However, characterization of helicon plasma parameters and a demonstration of this scheme are not enough. To diagnosing plasmas, we have developed an optical measurement system [2], which has no perturbation to plasma and has a flexible positioning with a high-time resolution.

This study aims to measure an ion flow velocity and its temperature by using a high-resolution spectrometer (Ritu Oyo Kougaku Co., ltd., Czerny-Turner type MC-150: focal length of 1.5 m, 2400 lines/mm grating, 0.006 nm resolution). Since a Czerny-Turner type monochromator can take only single line emission from whole spectrum of plasma, rotating a diffraction grating is required to obtain the spectral distribution. However there are some problems that the diffraction grating motor causes backlash error and one spectral distribution needs some shots of plasma discharge. In order to solve these problems, a multi-channel photomultiplier tube (PMT) array (Hamamatsu H7260-20: 32 channels) system has been developed.

Figure 1 shows the new optical system using this PMT. Emissions from plasma generated in the Large Mirror Device (LMD) [3] pass through an optical fiber into the spectrometer. The light from the exit slit of the spectrometer is magnified approximately 200 times in the wavelength direction with two cylindrical lenses and focused on the surface of the multi-channel PMT, as shown in Fig. 2. We have developed a 32 channels photon counting unit and will collect dates with PC.

In the presentation, we will show more details of the optical system and preliminary experimental results.

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[2] S. Waseda, H. Fujitsuka, S. Shinohara, D. Kuwahara, M. Sakata, H. Akatsuka, Plasma Fusion Res. **9** (2014) 3406125.
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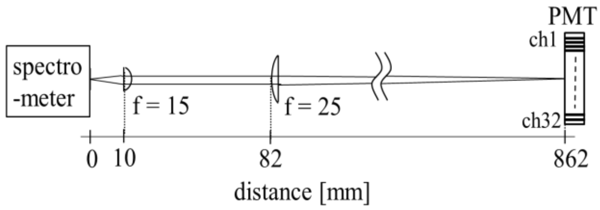

Fig. 2 Magnifying optics.

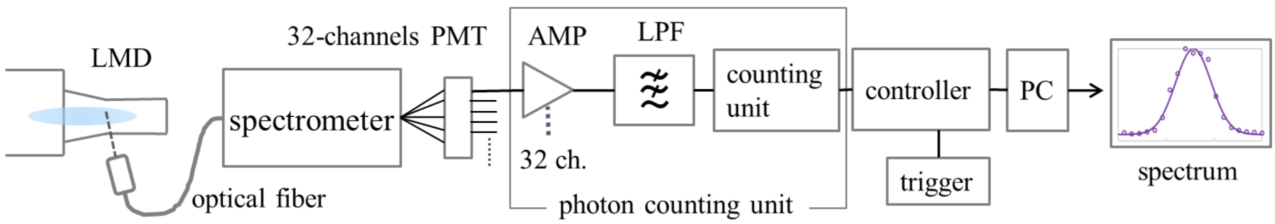

Fig. 1 New optical system using the 32-channels PMT.