A study of the fluctuations observed in the PANTA device using imaging diagnostics

イメージング技法を使ったPANTAプラズマの揺動の研究

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Two dimensional turbulent structures are studied using high speed camera system. When the fourie mode are decomposed, coupled mode having a mode number of m = 1, 2 3 can be seen from the image data. Constant rotation rotation of these petterns are disturbed occasionaly when the mode structure expands toword the core of the plasma.

1. Introduction

Mesoscale structure, such as the zonal flow and the streamer plays important role in the drift-wave turbulence. The interaction of the mesoscale structure and the turbulence is a key to understand the turbulence driven transport in the magnetically confined plasmas.

In the cylindrical magnetized device PANTA, the interaction of the streamer and the drift wave has been found [1]. The spatial pattern of the streamer-like structures having azimuthal mode number m = 1, 2, 3 mode number were clearly measured by the bi-spectrum analysis of the static probe system and a movable probe system. Statistical nature of the turbulence can be studied by this unique technique. However, if the dynamical wave-wave interaction process can be observed directly, our understanding about the turbulence will be improved further. For that purpose, direct visualization of the turbulence using a high-speed camera system was made. In this article, initial results and the comparison with the measured signal of the Langmuir probe system will be made.

2. Camera arrangement

A fast camera system observes plasma from the one end of the device as shown in Fig. 1. If the perturbation is aligned on magnetic field lines, two dimensional turbulent structure can be observed from this setting. The parameters of the plasma is the following; Te~3eV, n ~ $1x10^{19}$ m^{-3}, Ti~0.3eV, B=900G, Neutral pressure Pn=0.8 mTorr, a~ 6 cm, L=4m, Helicon source (7MHz, 3kW). No filter was used for the camera. Since the electron temperature is several eV, line emission of Ar I is the dominant component of the visible image. The observing area is schematically shown in Fig. 1(B). In the viewing area shadow of the 64pin Langmuir probe array can be seen. In the fluctuation analysis, data from the bright region (r ~< 30mm) as appeared as a white circle are used.

3. Initial results of using Fourier expansion

Fluctuating component of the visible image is decomposed to orthogonal components by the Fourier-Bessel expansion method [2]. Fourier modes up to m=4 was used for reconstruction.
From the images, m = 1 and m = 2 pattern which rotate in the opposite direction can be easily distinguished. After the fluctuating component at the inner region increases (e.g., 2000.08-2000.10ms, 2000.26-2000.28ms), m = 1 pattern disappear. Then new rotation is started with different phase of the initial rotation until the next event happens. The typical time interval of the event is 0.5 to 1.0 times of the one rotation of the m = 1 component. The wave-wave interaction might be interrupted occasionally. These results will be compared with the density fluctuations measured by Langmuir probe system.

Acknowledgments

One of the authors (S. O.) is grateful to the suggestion by Prof. K. Itoh. This work was supported by the collaboration programs of the RIAM of Kyushu University. and is also partially supported by the Ministry of Education, Science,

Sports and Culture, Grant-in-Aid for Scientific Research 26249144, by the JSPS-NRF-NSFC A3 Foresight Program (NSFC: No.11261140328), and by NIFS/NINS under the project of Formation of International Scientific Base and Network.

References

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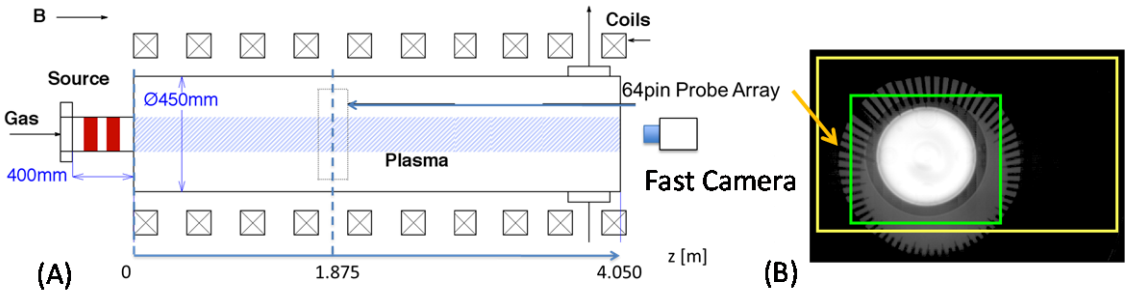

Fig. 1: Arrangement of the camera (A) and the observing area is shown by green box (B).

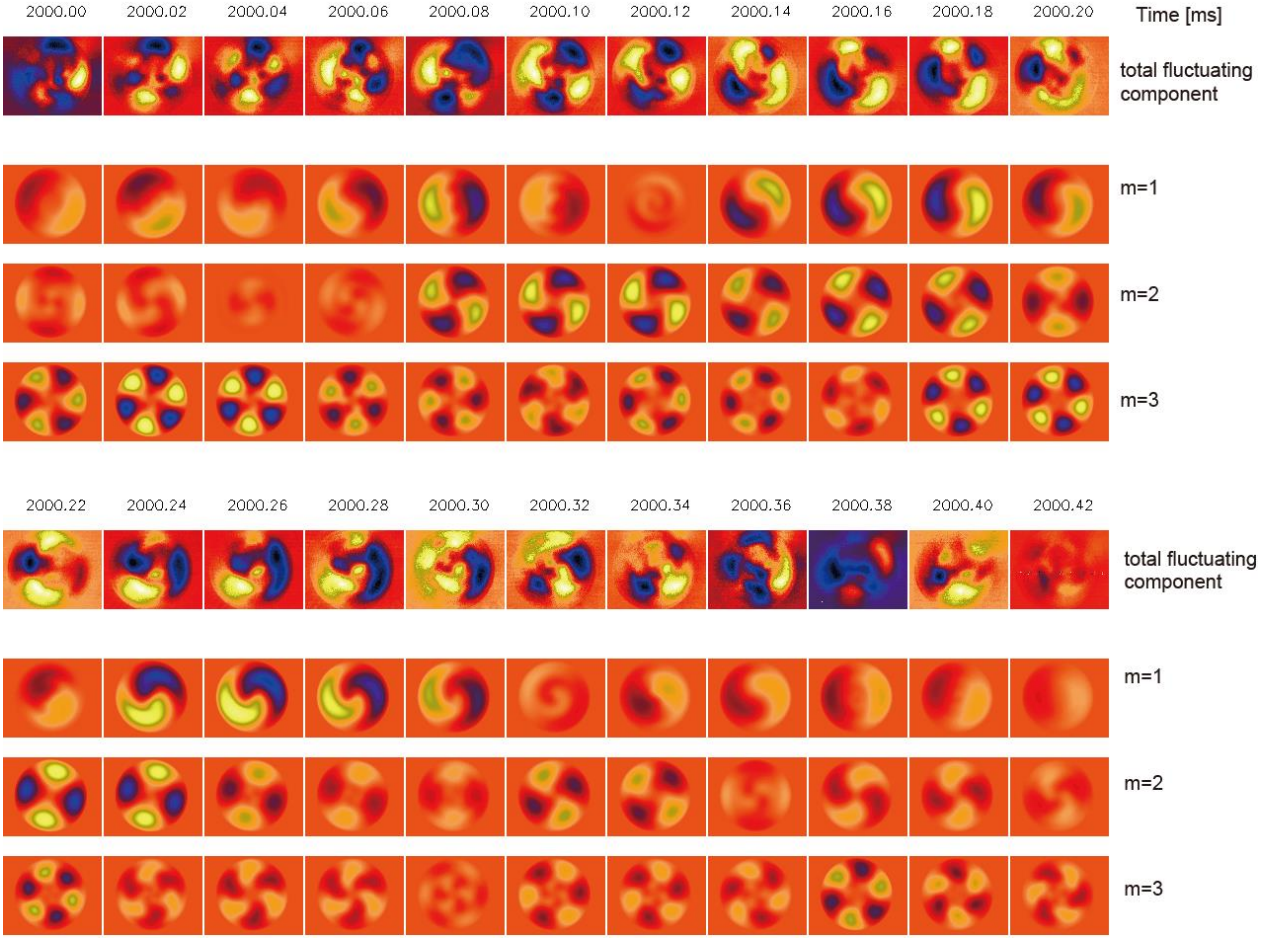

Fig.2. Time evolution of the fluctuating image and Fourier decomposed image of m = 1, 2, 3 are shown together.