23P062-P

The radial profile measurement of electron temperature fluctuation in PANTA

PANTAにおける電子温度揺動の径方向分布計測

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Electron temperature fluctuations observed by the triple probe method in PANTA. Five Langmuir probes have been aligned in a straight line and the probe angle has been adjusted along magnetic field line direction by checking that floating potential fluctuations of all pins have same phase. Radial profiles of averaged electron temperature and normalized fluctuation levels were obtained. The electron temperature fluctuation level was found to be low (≤ 10 %) across the plasma radius.

1. Introduction

Fluctuation measurements are widely carried out in many magnetically confined plasma devices to understand the cross-field transport relevant to turbulence. Evaluation of time-averaged flux is dependent on fluctuations of density, poloidal electric field and temperature. High temporal and spatial resolutions are required for fluctuation measurements. Langmuir probes fulfill such high requirement for density and potential. However the electron temperature fluctuation measurement with high temporal resolution is more difficult. The electron temperature fluctuation is often assumed to be small and neglected in the evaluation of fluctuation-driven transport.

Recently, electron temperature fluctuation was obtained by improved triple probe method in high density helicon plasma where triangle-wave-like fluctuations are excited [1].

In this paper, we evaluate the radial profile of electron temperature using an improved triple probe technique in plasma where fluctuations with a broad spectrum are excited.

2. Experimental Setup

Fluctuation measurements were carried out in Plasma Assembly for Nonlinear Turbulence Analysis (PANTA). PANTA is linear magnetic plasma confinement device. Cylindrical plasma (length=4 m, diameter=10 cm) was produced with a helicon wave (7 MHz, 3 kW) using a double-loop antenna around a quartz tube. The quartz tube is filled with argon gas. The magnetic field was 0.09

T. The vacuum vessel was at ground potential. An insulated endplate allowed controlling the potential of the plate by electrical biasing. Fluctuations were measured with movable 5-pins probe. This probe was installed at z = 1.675 m from the quartz tube. The five tungsten pins (diameter=0.7 mm, length=3 mm) were aligned in a straight line with intervals of 3 mm and the probe was allowed to rotate to follow the magnetic field line direction. The phase delay of floating potential between the pins was canceled by adjusting the angle of the probe to match the magnetic field line. The time-averaged values of each pin's floating potential were the same within the error of 6 %. The central two or three pins were used for the double probe and triple probe measurements and the other pins were measuring floating potential.

3. Result

This experiment was carried out at low neutral gas pressure under no biasing condition (endplate is grounded). The fluctuation spectrum has a peak around 7 kHz and FWHM of peck is broad [2].

Figure 1 shows radial profiles of averaged values. The averaged values are also measured by double probe method. Averaged values of electron temperature estimated by two methods were consistent as shown in Fig.1 (b).

Figure 2 shows radial profiles of normalized fluctuation amplitude. The fluctuation amplitude was calculated with all frequency components. Electron temperature fluctuation amplitude is one-third compared to density fluctuation amplitude at r=4 cm, which is relatively larger than that observed in the triangle-wave-like fluctuations in high density plasma [1]. Electron temperature fluctuation levels remain small in the central region, however density fluctuation levels decrease in the central region and thereby the ratio of electron temperature and density fluctuation levels increase $\left(\left(\tilde{T}_e/T_e\right)/\left(\tilde{N}_e/N_e\right)\sim 0.6\right)$.

4. Discussions and Summary

We obtained the radial profile of fluctuation levels using an improved triple probe technique. The electron temperature fluctuation level is lower than fluctuation levels of other quantities, but ratio of amplitude between electron temperature and density fluctuation becomes large in the central region. Thus, electron temperature fluctuation may not be neglected in the estimation of heat and also particle fluxes induced by fluctuations in the core region.

Endplate biasing experiments have been performed in PANTA. The change in fluctuations with respect to biasing will be discussed.

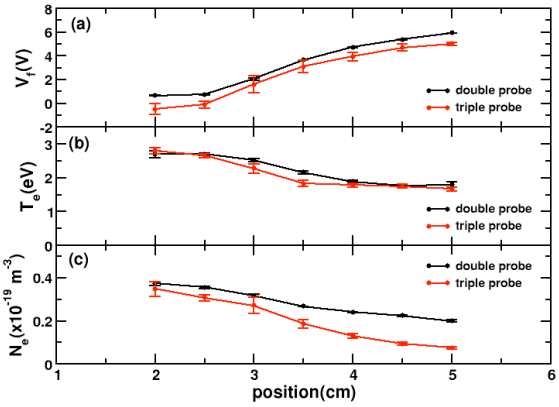

Fig.1. Radial profiles of mean floating potential (a), mean electron temperature (b), mean density (c). The black line shows result from double probe and the red line shows result from triple probe. The error bar corresponds to standard deviation for series of three shots.

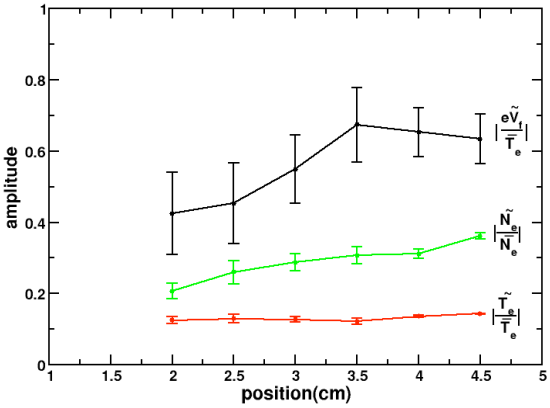

Fig. 2. Radial profiles of normalized fluctuations amplitude. The black line corresponds to normalized potential fluctuation, the red line to normalized electron temperature fluctuation and the green line to normalized density fluctuation. The error bar corresponds to standard deviation for series of three shots.

Acknowledgments

This work is partly supported by a grant-in-aid for scientific research from JSPS (21224014, 23360414) and by the collaboration programs of NIFS (NIFS10KOAP023) and of the RIAM of Kyushu University.

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