22P127-P

Measurement of Electric Field using Neutral Beam Probe with Simultaneous two Measurement Points in GAMMA 10

金中性粒子ビームプローブの空間同時二点測定による GAMMA10プラズマの電場計測

Masato Aoyama, Mizuki Sakamoto, Masayuki Yoshikawa, Yoshiaki Miyata[1], Masanori Mizuguchi, Yoshihiro Akabane, Kenichi Furutachi, Katsuhiko Jitsukawa, Shuhei Matsuyama and Tsuyoshi Imai

青山真士, 坂本瑞樹，吉川正志，宮田良明[1]，水口正紀，赤羽泰央，古館謙一，実川克彦，松山周平，今井剛

Plasma Research Center, University of Tsukuba
1-1-1, Tennoudai, Tsukuba, Ibaraki 305-8577, Japan
筑波大学プラズマ研究センター　〒305-8577　茨城県つくば市天王台1-1-1

[1]*Fusion Research and Development, Japan Atomic Energy Agency*
801-1, Mukoyama, Naka, Ibaraki 311-0193, Japan
日本原子力研究開発機構核融合研究開発部門　〒311-0193　茨城県那珂市向山801-1

Precise measurement of a spatial profile of an electric field is important for plasma confinement study. In GAMMA 10 tandem mirror, a gold neutral beam probe is used to measure the plasma potential. The simultaneous two points measurement of plasma potential was developed to measure the local electric field. A new fitting function for the beam profile is suggested to reduce the estimation error. The preliminary result of time evolution of electric field is shown.

1. Introduction

Precise measurement of a spatial profile of an electric field is important for plasma confinement study. In GAMMA 10, the spatial profiles of electrostatic potential and electric field have been measured by using a gold neutral beam probe (GNBP), and the plasma confinement properties were studied [1,2].

So far, the number of measurement points of the GNBP system was one. Namely, an analyzer entrance had only one slit. So, the electric field was deduced from potentials at two close positions in the plasma assuming that the plasma were reproducible. To measure the plasma potentials at two positions simultaneously, the analyzer entrance was improved to have two slits [3].

In this presentation, the method for estimation of the local electric field and the experimental results are reported.

2. Experimental set up

Figure 1 shows a schematic view of the GNBP system. The gold neutral beam, which is accelerated by the acceleration voltage of 11.8kV to 14.2kV, is injected to the plasma. The neutral beam ionized in collision with the plasma electrons is detected by a micro-channel plate (MCP) of the energy analyzer. The MCP has 32 anodes. The width and length of each anode are 2.4 and 31mm, respectively. Figure 2 shows a schematic view of the energy analyzer. The beams through the novel slit and the original one are detected in the range from 3ch to 17ch and from 18ch to 32ch of the MCP detector, respectively. The beam with higher energy reaches at an anode of the larger channel number.

3. Calibration and experimental results

Figure 3 shows the detailed beam profile, which was measured by changing the electric field in the analyzer shot by shot at the calibration experiments. The neutral beam was ionized by collisions with the neutral gas, since calibration experiments were carried out without plasma.

To estimate the plasma potential, it is necessary to estimate a peak position of the beam profile. The peak position is estimated by applying a fitting function to the beam profile. So far, a quadratic curve fitting function was used and then the error was about ±25V. Here, we suggest the following fitting function to reduce the estimation error.

$$f(x) = \frac{A}{2.23} \times \exp\left(\frac{1}{2} \times \left(\frac{2.94}{2.23} \right)^2 + \frac{(x - B)}{2.23} \right) \times erf\,(B + 1 - x) \qquad (1)$$

where x is the anode position. The parameters of A

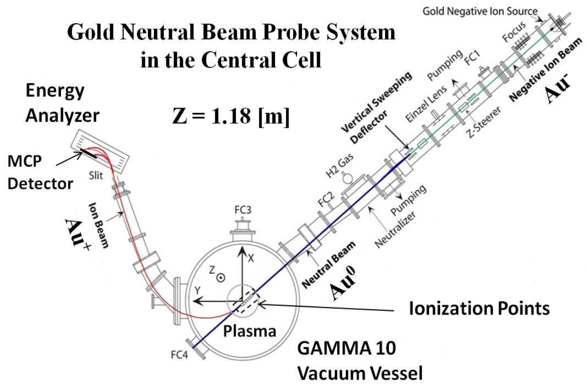

Fig.1. Schematic view of the GNBP system

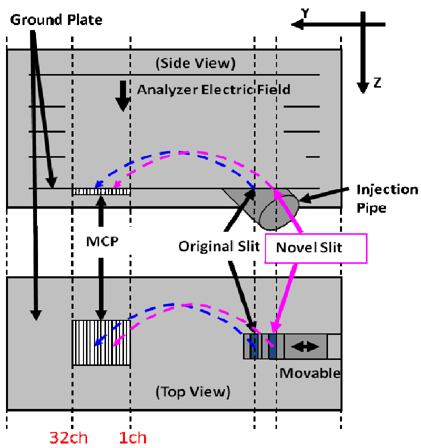

Fig.2. Schematic view of the energy analyzer

and B are fitting parameters and the parameter B corresponds to the anode position of the peak point, respectively. The red line is drawn by using the equation (1) in Fig.3. The estimation error can be reduced to be about ±15V.

The peak position of Fig.3 corresponds to 0V of plasma potential because of no plasma. If there is plasma, the peak position shifts according to the plasma potential. The difference between peak positions without the plasma (i.e. the peak position of Fig.3) and that with the plasma corresponds to the plasma potential. In order to determine the plasma potential, the relation between the anode position and the beam energy was obtained by changing the acceleration voltage (i.e. the beam energy) without the plasma.

Figure 4 shows time evolution of the local electric field deduced from potentials at two simultaneous measurement points. Electron cyclotron heating at the central cell (C-ECH) and ion cyclotron heating (RF3) are applied between 150ms to 170ms and between 180ms to 230ms,

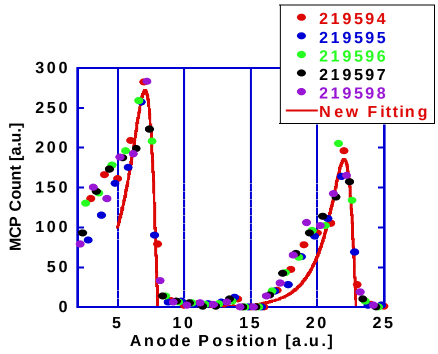

Fig.3. Detailed beam profile and new fitting function

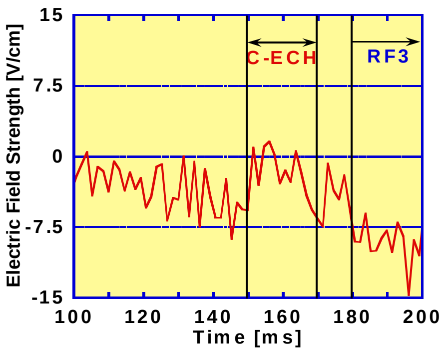

Fig.4. Experimental result of the local electric field

respectively.

We will conduct the detailed study about effects of plug-ECH and barrier-ECH on the formation of electrostatic field and potential fluctuation.

4. Summary

Simultaneous potential measurement at two measurement points in the plasma has been developed. In order to estimate more precise plasma potential, the detailed beam profiles were obtained and then a new fitting function was applied. The estimation error was reduced to be ±15V. From the calibration results, it is able to estimate local electric field deduced from potentials at two measurement points.

As future works, the radial electric field profile and the time evolution of local electric field during various heating period will be measured.

References

[1] M. Yoshikawa et al., Fusion Sci. Technol. **57**, 312 (2010).

[2] M. Yoshikawa et al., Plasma Fusion Res. **5**, S2010 (2010).

[3] Y. Miyata et al., Plasma Fusion Res. **6**, 1202090 (2011).