§2. Applying 2D Measurement with ICCD Camera to an Intermittent Phenomenon in an ECR Plasma

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Recently, we have observed the generation of intermittent negative floating potential spikes on a Langmuir probe signal in an electron cyclotron resonance (ECR) plasma.[1)] This intermittency of floating potential signal is induced by a creation-annihilation process of high-energy electron component. It is noted that the phenomenon has a finite spatial size on the plasma cross section, which is typically 40 mm in diameter and is less than the plasma size. To understand the 2-Dimensional (2D) characteristic, we have measure the 2D distribution of emission intensity of ions and neutral particles with an ICCD camera.

The experiment was performed in the HYPER-I device[2)] at the National Institute for Fusion Science. The HYPER-I device consists of a cylindrical vacuum chamber with 2.0 m in axial length and 0.3 m in inner diameter. The eight magnetic coils were set around the chamber, and a weakly diverging magnetic field (< 0.12 T) was produced. A helium gas (1.5 mTorr) was introduced, and the plasma was produced using ECR heating with a 2.45 GHz microwave.

The ICCD camera was set to measure the line-integrated emission intensity along the chamber axis (parallel to the magnetic field line) though a quartz window. The interference filter was set to the camera. A Langmuir probe was also introduced at the axial position $z = 1.175$ m from the microwave launching position ($z = 0$ m), and measured the floating potential. The floating potential signal was used to produce a trigger pulse to control the ICCD gate timing (see Fig. 1). In this experiment, we measured the emission intensities only when the amplitude of floating potential spike satisfies the sampling condition $(12 \pm 1)\sigma$, where σ stands for the standard deviation of time series.

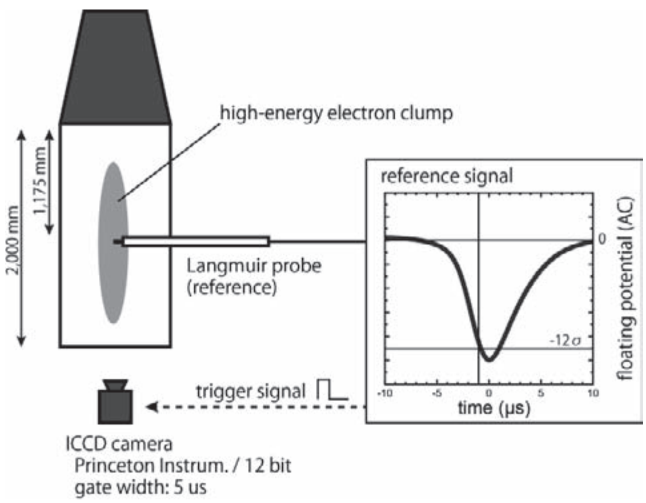

Fig. 1. A schematic diagram of the conditional sampling system with an ICCD camera.

Figure 2(a) shows the 2D distribution of emission intensity of He-II line (468 nm). This figure is made by 120 events satisfying the sampling condition. A blight region with a diameter of 40 mm clearly appears, and the emission enhancement coincidently occurs with the generation of floating potential spike. Since this emission takes place by the high-energy electron (higher than 48 eV), this result indicates that the high-energy electron clump, which has enough energy to ionize the ground state neutral particle, is locally generated.

Figure 2(b) shows the 2D distribution of a ratio of He-I line (706 nm) to square root of He-II line (468 nm), $I_{706}/\sqrt{I_{468}}$: this ratio is positively correlated with the neutral particle density. The hollow profile can be seen, and this means that the neutral particle density decreases in the core.

We measured the emission intensity with the ICCD camera by applying the conditional sampling method. The 2D distributions of the emission intensity of ion and neutral emission lines are obtained during the creation-annihilation process of high-energy electron takes place.

1) Yoshimura, S. et al.: JPS conf. Proc. **1** (2014) 051030.
2) Tanaka, M. Y. et al.: Rev. Sci. Instrum. **69** (1998) 980.

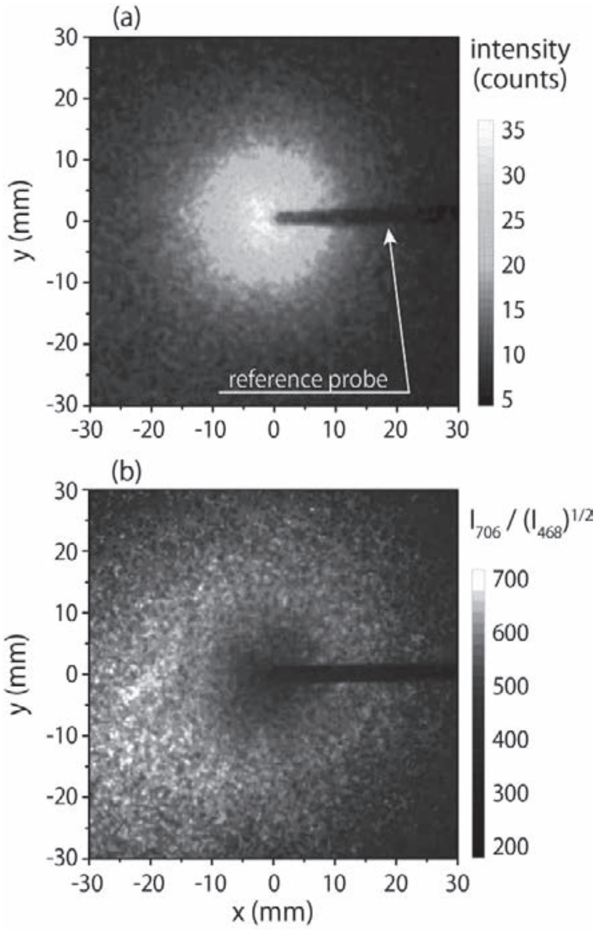

Fig. 2. 2D distributions of (a) He-II emission intensity (468 nm) and (b): a ratio of He-I (706 nm) to sqare root of He-II (468 nm), $I_{706}/\sqrt{I_{468}}$.