§2. 2D Characteristics of Intermittently Generated High-energy Electrons in an ECR Plasma

Terasaka, K., Kato, Y., Yoshida, Y., Tanaka, M.Y. (Kyushu Univ.), Yoshimura, S., Nakano, H., Morisaki, T.

Intermittent phenomena have been frequently observed in magnetized plasmas. For example, a solar flare releases a large amount of plasma particles and energy from sun's surface to interstellar space through the intermittently occurring magnetic reconnection. Another example is a plasma blob. The particle transport across the magnetic field due to the blobs is significant for the plasma confinement in torus plasmas.

Recently, the generation of intermittent high-energy electron flux (IHEF) has been found in a linear electron cyclotron resonance (ECR) plasma.[1)] From our previous experiments using a local Langmuir probe, the duration of the IHEF is typically 10 μs, and the IHEF has finite spatial size perpendicular to the magnetic field. These results show that 2 dimensional measurement on the plasma cross section is required to clarify the generation mechanism and the characteristics of the IHEF. Then, we have studied the 2D characteristics of the IHEF, such as the spatial size and occurrence position, by developing a multi-channel probe.

Experiments have been performed in the HYPER-I device at National Institute for Fusion Science. The HYPER-I device has a cylindrical vacuum chamber (2.0 m in axial length and 0.3 m in inner radius). A helium plasma was generated by ECR heating with a 2.45 GHz microwave, and the typical electron density and temperature are 10^{17} m^{-3} and 10 eV, respectively.

To measure the 2 dimensional profile of the IHEF, we used a modified wire-grid probe (WP) shown in Fig. 1. The WP consists of eight horizontal and eight vertical tungsten wires with 0.7 mm in diameter, and there are 64 lattice points with the grid interval of 10 mm on the lattice plane. Each wire is connected to the independent voltage-follower circuit, which is compensated the floating potential fluctuation with the frequency less than 200 kHz. The spatial distribution of the IHEF is estimated by calculating

$$F_{\mathrm{i,j}} = \sqrt{\tilde{V}_{\mathrm{f,i}} \times \tilde{V}_{\mathrm{f,j}}} \quad (1)$$

at each lattice point, where $\tilde{V}_{\mathrm{f}}$ denotes the perturbed quantity of floating potential, and the subscripts i (= 1-8) and j (= 1-8) show the horizontal and vertical wires, respectively. The quantity $F_{\mathrm{i,j}}$ becomes large only when the IHEF through the lattice point at (x_{j}, y_{i}).

Figure 1(b) shows the spatial size of the IHEF evaluated for 30 events with various magnitude. Since all the data lie on a solid line showing the relation of $X_{\mathrm{w}} = Y_{\mathrm{w}}$, the spatial profile of IHEF on the plasma cross section is circular form with the diameter of 30 ± 10 mm. The quantities X_{w} and Y_{w} show the full width at half maximum of the $F_{\mathrm{i,j}}$ in x and y direction, respectively. We also evaluated the characteristic of the occurrence position of IHEF. Figure 1(c) shows the probability of occurrence as a function of the distance between occurrence positions of consecutive two IHEFs. The probability is almost constant value of 1/6. This shows the IHEF occurs randomly.

We have studied the 2 dimensional characteristics of the IHEF with a WP. It is shown that the WP can easily determine both the spatial size and the occurrence position of IHEF. The IHEF randomly occurs in space, and has the characteristic diameter of 30 mm. These results clearly show that the WP has a capability to study 2D characteristics of IHEF, and then further studies utilizing the conditional averaging method will be performed.

1) S. Yoshimura et al. : Bull. Am. Phys. Soc. **56** (2011) 209.

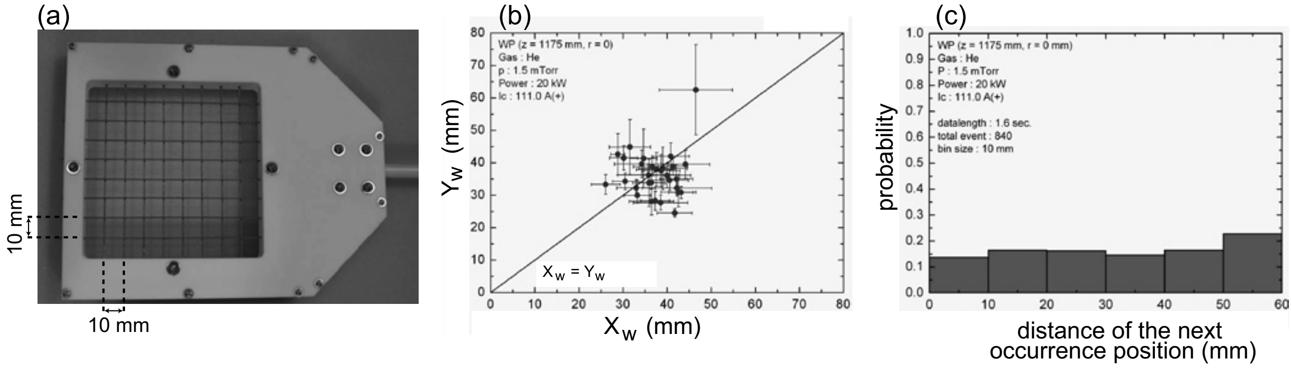

Fig. 1: (a) A picture of wire-grid probe. (b) Spatial size of the IHEF. (c) Probability of occurence position as a function of distance of the next occurrence position of IHEF.