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Measurement of End Loss Electron Flux during ECRH in GAMMA 10/PDX
GAMMA 10/PDXにおけるECRH印加時の端損失電子流束計測

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For the purpose of the diverter simulator experiment in GAMMA 10/PDX, the intense axial warm electron flow is produced through the characteristic velocity-space diffusion of electrons by high power plug ECRH. This warm electron flow becomes end loss electron flux and the heat load to a diverter simulator. It is expected to be applies to the experiments of ELM simulation and diverter simulator. Because of these reasons, the experiment to control the end loss electron flux parameter is being carried out. It is found that the higher end loss flux can be produced by higher power density of ECRH because the effective temperature is increased as increasing the plug ECRH power.

1. Introduction

A heat load of diverter and a plasma wall interaction are serious issue for various plasma experimental devices and demonstration fusion reactor. In addition to a steady-state heat load of diverter, an intermittent heat load by Edge Localized Mode (ELM) is one of the very important theme that should be solved for ITER and future DEMO. Many diverter studies are being performed for nuclear fusion reactor at various research institutions. In GAMMA 10/PDX, the experiment of diverter simulator with the movable V-shaped tungsten target (D-module) has been started. The heat load flux to a diverter is the end loss plasmas characteristic of an opened system. The measurement of the end loss electron flux produced by ECRH is being carried out because it is very important to know the characteristics of the irradiation plasma, to expand the heat load and to control then actively.

2. Diffusion of electrons during ECRH

A plasma confinement is improved by an ion confinement potential that generated by fundamental ECRH at plug region in GAMMA 10/PDX. Plug ECRH induces characteristic three diffusions of electrons. Figure 1 is representing a schematic diagram of diffusions of an electron during plug ECRH [1]. The vertical axis is the energy of an electron ε and the horizontal axis is the magnetic moment μ. In Fig. 1, B_{m},B_{p},B_{EP} are magnetic field at the plug region, the end mirror region and the end plate region respectively. Similarly, Φ_{m}, Φ_{p}, Φ_{EP} are potential at the plug region, the end mirror region and the end plate region respectively. Low temperature electrons of region I are loss electrons from the loss corn of the central region. Electrons are diffused from region I to region II (diffusion (1)), then electrons are confined by a magnetic field of the end mirror region and a potential of the end plate region. As a result, an ion confinement potential is generated in the plug region because of the electroneutrality principle. A part of bounced low temperature electrons by the potential of end plate is diffused to end loss region by plug ECRH (diffusion is (2)). Electrons of region III are magnetically confined in the end mirror region. The diffusion (3) is occurred because a part of these high temperature electrons are diffused to end loss region by plug ECRH. The diffusion (2) and (3) generate a low and high temperature end loss electron flux respectively.

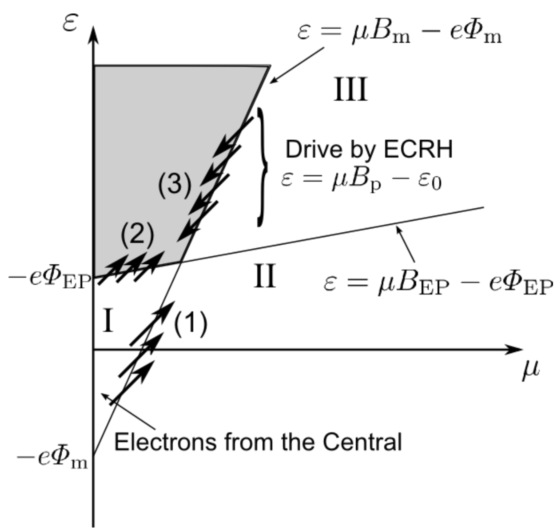

Fig. 1. Velocity space diffusion during ECRH
(Figure is quoted from Ref. [1])

3. End loss electron flux measurement

End loss electrons are measured by LED (Loss Electron Diagnostics), which is an electrostatic energy analyzer of multiplex grid type. One LED is installed at each east and west end region. Because end loss electrons have two temperature components, an electron current density I_e is fitted to two components Maxwell distribution as below,

$$I_e = I_{eL}\exp\left(-\frac{V_{ER}-\Phi_{ER}}{T_{eL}}\right) + I_{eH}\exp\left(-\frac{V_{ER}-\Phi_{ER}}{T_{eH}}\right) \quad (1)$$

Where, T_e is electron temperature, V_{ER} is electron repeller voltage and subscript L and H show the low and high temperature. The effective temperature of end loss electron T_{eff} is defined as Eq. (2).

$$T_{eff} = (1-\beta)T_{eL} + \beta T_{eH} \quad (2)$$

$\beta = I_{eH}/(I_{eL}+I_{eH})$ is defined a ratio of high temperature electron current density to total current density.

4. Experimental results

The end loss flux measured calorimetrically is achieved 10 MW/m^2 at the plug ECRH power of 380 kW with the pulse width of 5ms [2]. The heat flux is increased with increasing the plug ECRH power without saturation. The plug ECRH power P_{P-ECRH} dependence of the electron temperature and electron current density are shown in Fig. 2 and Fig. 3. The effective temperature is increased in proportion to the plug ECRH power without saturation. The total electron current density is constant with ECRH power. However, the electron current density of high temperature is increased with increasing the plug ECRH power. Furthermore, to change the parameters of the end loss electron flux, the localized gas puffing was performed at the plug region. As a result, the effective temperature was decreased and the electron current density was increased by increasing the plenum pressure of the gas puff.

5. Summary and conclusion

We measured the end loss flux by varying ECRH power. As a result of measurement, the effective temperature is increased in proportion to the plug ECRH power without saturation, and the total electron current density is constant with ECRH power. Therefore, the higher heat flux and the electron flow with the higher effective temperature can be expected by higher power density of ECRH. Besides, we can be controlled the end loss electron flux parameter by varying the plenum pressure of the gas puff.

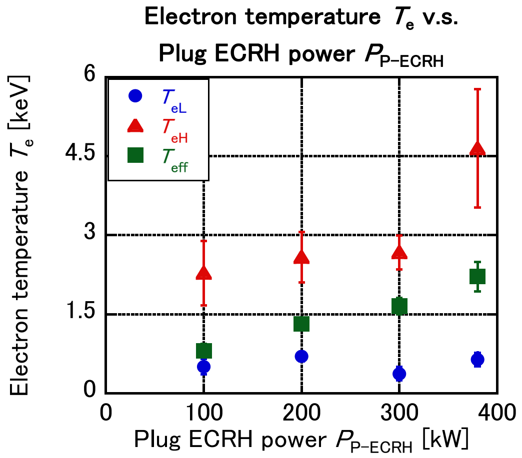

Fig. 2. The dependence of the electron temperature on plug ECRH power in east LED

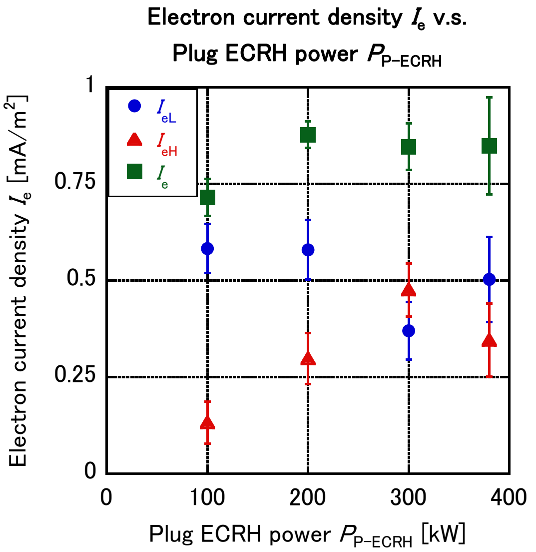

Fig. 3. The dependence of the electron current density on plug ECRH power in east LED

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