Effect of high-particle flux produced by pellet fueling in the core plasma to the divertor simulation module plasma in GAMMA 10/PDX

M. Yoshikawa[1], J. Kohagura[1], Y. Nakashima[1], Y. Shima[1], S. Kobayashi[2], R. Minami[1], N. Ezumi[1] and M. Sakamoto[1]

[1] Plasma Research Center, University of Tsukuba, [2] Institute of Advanced Energy, Kyoto University

e-mail: yosikawa@prc.tsukuba.ac.jp

The plasma detachment is one of the key issues in nuclear fusion plasma experiments. The fomation of plasma detachment decreases the impact of both heat flux and particle flux to the divertor plate. In the tandem mirror GAMMA 10/PDX, a divertor simulation experimental module (D-module) was installed for plasma detachment study in high heat flux conditions (> 20 MW/m^2). In the previous studies, we successfully performed the plasma detachment condition in the D-module [1-3]. However, the plasma density of core plasma in GAMMA 10/PDX was low compared to the scrape of layer plasma of normal fusion devises. To study the effect of higher density particle flux during plasma detachment, as in edge localized mode (ELM)-like simulations, we prepared pellet fueling to produce a higher density of core plasma and introduced it to the D-module. In this experiment, we revealed the effect of higher particle flux produced by pellet injection into the detached simulation plasma for the first time.

GAMMA 10/PDX is the largest tandem mirror machine consisting of main confining region of central cell, two axisymmetric minimum-B anchor cells, and two plug and barrier cells. In the west end region, the divertor simulation experimental module (D-module) was set for divertor simulation experiments with the use of the end-loss plasma from the core plasma. The plasma is produced and maintained with the application of the ion cyclotron resonance frequency (ICRF) wave heating after the initial plasma injection by the plasma gun. Typical electron densities and temperatures are about 2×10^{12} cm^{-3} and 25 eV in the central cell and 1×10^{11} cm^{-3} and 25 eV in the end cell without additional gas injection into the D-module, respectively.

The hydrogen plasma is produced and heated by ion cyclotron range of frequency wave from t = 51 to 440 ms and additional hydrogen gas puffing for radiator gas in the D-module from t = 50 to 450 ms with pressure of 1000 mbar for plasma detachment. The sub-millimeter pellet is injected in the central cell plasma at approximately t = 350 ms. Time evolutions of diamagnetism (red dotted line) and line densities in the central cell (blue line) and the D-module (green line) are shown in Fig. 1 with indication of pellet injection time. It is clearly confirmed that the electron line density increase and diamagnetism decrease with pellet injection in the central cell. In the D-module, the electron line density increased a little and decreased with pellet injection. injection. Line density in the D-module shows that the pellet was injected during the plasma detachment condition. The electron temperature and density measured by using electrostatic probes on the target plate of upstream side in the D-module were decreased with pellet injection, respectively. The probes of downstream side in the D-module showed no clear difference with and without pellet injection. Ion fluxes with pellet injection showed only a little decrease. One of the reasons of decrease of line density and ion flux in D-module with pellet injection is the decrease of electron temperature which made the plasma ionization rate degrade in D-module. The higher electron density plasma condition by pellet injection in core plasma affects to improve plasma detachment. This is the first result of the effect of higher particle flux produced by pellet fueling introduced to the divertor simulation plasma experiments.

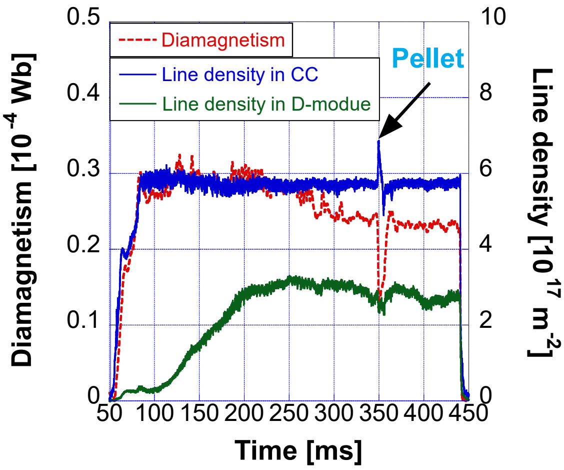

FIG. 1. Time evolutions of diamagnetisms (red dotted line) and line densities of central cell (blue line) and of west end cell (green line).

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