§9. Study of Divertor Simulation Using End-region of a Tandem Mirror – Mechanisms of Radiation Cooling Divertor and Plasma Detachment –

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As a future research plan of Plasma Research Center, University of Tsukuba, making use of the advantage of open magnetic field configuration, we have started a study of divertor simulation under the closely resemble to actual fusion plasma circumstances and we directly contribute the solution for realizing the divertor in toroidal devices.

Figure 1 shows the schematic view of the GAMMA 10/PDX tandem mirror and the divertor simulation experimental module (D-module). The experimental module (D-module) was installed at the exit of west end-mirror and plasma is irradiated onto the V-shaped target in D-module. Experiments for realizing detached plasma state from the high-temperature plasmas have been performed using H_2 and noble gas injection in D-module. Here, the plasma with n_e ~2×10^{18} m^{-3} and $T_{i//}$ ~150 eV was produced at the upstream region (central-cell).

Figure 2 shows the dependence of the electron temperature (T_e) near the V-shaped corner measured with the probe, the heat flux (P_{heat}) and $I_{i\text{-}sat}$ measured with the corner detector in D-module on the plenum pressure of two kinds of injected gases (Xe, Ar). The measured T_e decreases with the increase of the gas throughput and is attained to a few eV at a plenum pressure of 1000 mbar in each case. P_{heat} also decreases with the plenum pressure and reduces to 20 - 30% of the case without gas injection at the same pressure. In the case of Xe injection, $I_{i\text{-}sat}$ is reduced to 20 % at the plenum pressure of 1000 mbar, however the reduction of $I_{i\text{-}sat}$ in the case of Ar remains small in spite of considerable reduction of T_e. This result indicates that Xe has stronger effect on the detached plasma formation than Ar.

In Fig. 3, 2-D image of light emission near the V-shaped target in the case with simultaneous injection of H_2 and Xe gas. In this experiment, a filter corresponds to Hα light (656.3 nm) is used. As seen in the figure, a bright Hα emission is recognized in front of the target. It is found that

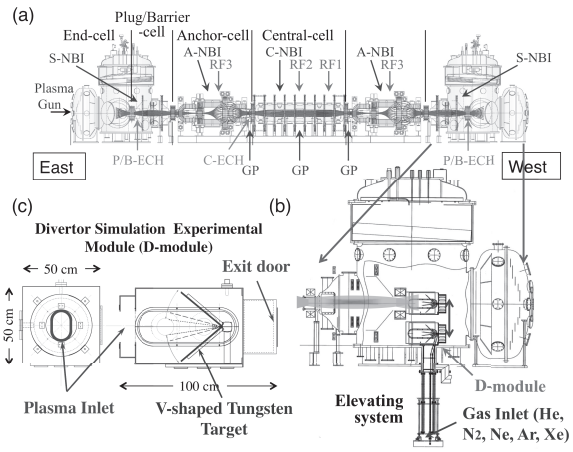

Fig. 1 Schematic view of GAMMA 10/PDX (a), west end-mirror vacuum vessel (b) and the divertor simulation experimental module (D-module) (c).

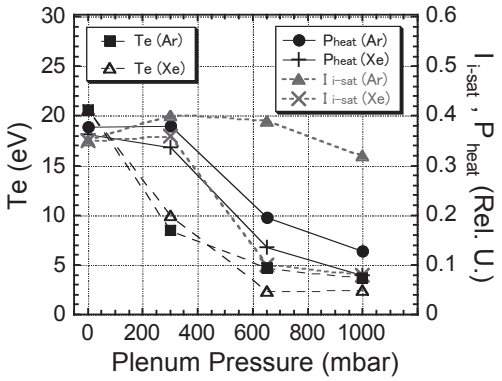

Fig. 2 Dependence of the T_e and ion flux ($I_{i\text{-}sat}$) and heat flux on Ar and Xe plenum pressure measured with calorimeter and probe on the target plate and behind the V-shaped corner.

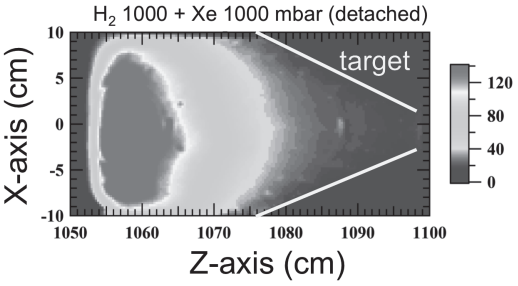

Fig. 3 Two-dimensional image of Hα emission in front of the V-shaped target plates in D-module captured by a fast camera.

a circular boundary of the bright emission is formed and the intensity strongly diminishes toward the V-shaped corner.

The presentations and publications from this collaborative research are listed below:

1. Y. Nakashima, et al., 21st Int. Conf. Plasma Surface Interactions, Kanazawa, Japan (May 2014) P1-091.
2. Y. Nakashima, et. al., 10th Int. Conf. Open Magnetic System for Plasma Confinement, Daejeon, Korea (August 2014) OS3-02.(Invited)
3. Y. Nakashima, et. al., Proc. of IAEA FEC2014, St. Petersburg (October 2014) FIP/P8-10.