§1. Studies of the Divertor-Simulating Boundary Plasma and Transport Control in Making Use of Open End Magnetic Field and Effects of Electric Potential and Field

Ichimura, M., GAMMA 10/PDX Group (Univ. Tsukuba)

The GAMMA 10/PDX device has open magnetic field configuration and improvement of the plasma confinement with potential formations in both parallel and perpendicular directions to the magnetic field line has been demonstrated. By using the controllability of plasma parameters, divertor-simulation experiments at the end-cell region have been performed with strong ICRF and ECH systems. The ITER relevant level heat flux of 10 MW/m^2 at the end-cell has been obtained. Recently, the divertor simulation experimental module (D-module) has been installed on the west end of the device. This module has a V-shaped target plate and closed divertor structure. The V-shape plate can be changed its angle and the pumping speed in the D-module is controllable. Two tungsten plates are mounted on the V-shaped plate and these plates can be heated up to 300 degrees centigrade for studying interactions between plasma and wall materials under high temperature. Gasses are injected into the D-module for realizing detached plasma operation and the clarification of radiation cooling mechanism toward the development of future divertor systems. In addition to the divertor simulation experiments, the development of high power gyrotrons is also main subject of the GAMMA 10/PDX device.

At the GAMMA 10/PDX end cell, high plasma temperature of T_i = 100 – 400 eV and T_e = 30 eV has been produced under the high magnetic field around 1 Tesla. In the experiment, target plasmas are produced and heated with ICRF waves in the central cell. The maximum ion temperature becomes more than 10 keV in the perpendicular direction in the central cell. Recently, additional ICRF antennas have been installed in the anchor and plug/barrier cells in order to increase both particle and heat fluxes at the west end. A remarkable increase of the end-loss flux up to 10^{23} m^{-2}sec^{-1} has been observed when ICRF waves are injected in both east and west anchor cells at the same time.

Figure 1 shows the temporal evolution of (a) diamagnetic signal in the central cell, (b) electron temperature and (c) electron density on the target plate in the D-module in cases without additional gas injection and with H_2 and H_2+Ar gas injections. As shown in the figure, remarkable reduction of electron temperature and increase of electron density are observed in the case of H_2+Ar gas injection. The reduction of electron temperature from a few tens eV to a few eV in the linear device with an inherent feature of short connection length of the magnetic field line indicates the possibility of the GAMMA 10/PDX device contributed to boundary plasma research. The electron density more than 10^{18} m^{-3} was obtained by injecting H_2 and Xe gasses in the D-module.

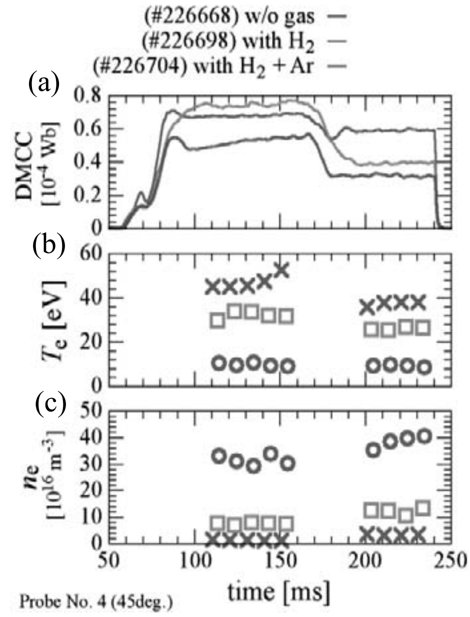

Fig.1 The temporal evolution of (a) diamagnetic signal in the central cell, (b) electron temperature and (c) electron density on the target plate in the D-module in cases without additional gas injection and with H_2 and H_2+Ar gas injections.

In University of Tsukuba, gyrotrons with wide range of frequencies from 14 to 300 GHz are developed in collaboration with JAEA, NIFS and TETD. Heat flux more than 10 MW/m^2 at the end mirror throat has been observed when ECH with gyrotron of 380 kW power has been performed in the plug/barrier cell. The heat flux increases with gyrotron power. Recently, output power of 1.25 MW at 28 GHz and 0.87 MW at 35.45 GHz from the same gyrotron tube have been achieved with design improvement, which is the first demonstration of the dual frequency operation in lower frequency tube. The output power of 600 kW for 2 sec at 28 GHz is also demonstrated. This tube is applied to QUEST on Kyushu University and has given a new operating region of EC non-inductive driven current in higher density plasma. In the joint program with NIFS, The power of 1.9 MW gyrotron at 77GHz and a new frequency of 154 GHz with $TE_{28,8}$ cavity, which delivered 1.16 MW for 1 sec, has been successfully developed. The total power of 4.4 MW to LHD plasma with other three 77 GHz tubwes, which extended the LHD plasma to high T_e region. Figure 2 shows the summary of gyrotron development in Univ. Tsukuba.

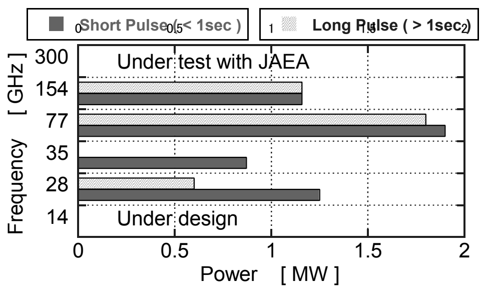

Fig.2 The summary of gyrotron development in Univ. of Tsukuba