§ 6. Initial Results of 106GHz ECH Power Injection Experiments on CHS


This year 106.40GHz gyrotron system has been completed and experiments using the gyrotron was started. After the finish of assembly of whole power transmission line, beam profile in the CHS vacuum vessel was checked. Beam injection mirrors are on CHS outside port (8-O), and a paper target was installed inside the vessel through an opposite inside port (8-I). 1060GHz power pulses with short pulse length were injected on the target so that the beam profile and beam hitting points were confirmed by IR measurement. The injection mirror system was designed so that the beam to be a circular gaussian with beam radius of 15mm at plasma center. The measured data showed a little discrepancy from the designed value but the measured beam radius is about 20mm and circular, that is, about 1/10 of horizontally elongated plasma minor radius looking from 8-O port. It is confirmed the beam is strongly focused to realize localized heating.

The final plane mirror of beam injection mirrors can be tilted so that the injected beam direction is changed within a poloidal cross section including the center of the plane mirror. The beam direction controllability was investigated by variations of plasma stored energy and central electron temperature TeO. Figure 1 shows the result. The horizontal axis is vertical displacement of beam center measured from magnetic axis. It is clearly seen that the highest stored energy and TeO are achieved at the case of magnetic axis heating. This result indicates the precise controllability of beam direction which enables flexible experimental scenario requiring both on- and off-axis heating.

The power transmission line consists of beam matching optics unit (MOU), waveguide transmission line and the beam injection mirrors. The MOU contains three mirrors to make gyrotron output beam match the waveguide mouth in front of the gyrotron. One of the three mirrors is a λ/4-depth grating polarizer which works as a polarization rotator. Rotating the polarizer can change the direction of linear polarization of injected beam. The 106GHz power is used for 2nd-harmonic heating so X-mode heating is required for efficient power absorption. Here, X-mode means that directions of magnetic field and linear polarization are perpendicular and is defined at last closed flux surface. The magnetic field direction at LCFS is about 30 degrees measured from toroidal direction then polarization direction should be 120 or -60 degrees for X-mode heating. The polarization effect is investigated by rotating polarization direction shot by shot as seen in Fig. 2. Plasma stored energy and power monitor output are plotted against the polarizer rotation angle. The power monitor is set so that the output is maximum when the polarization direction is 120 or -60 degrees. It can be concluded polarization control is important technique for effective power absorption.