§4. Installation of 1 MW-Gyrotron in the Large Helical Device

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In the Large Helical Device (LHD), the enhancement of the output power per gyrotron was planed to enlarge the plasma operational regime and the replacement of the existing gyrotrons to high-power ones is progressed. Eight sets of gyrotron are operated and the total injection power of ECRH to plasma is less than 2 MW.[1] We will replace all these gyrotrons to 1 MW-ones and set goal as the total injection power of 5 MW. The oscillation frequencies of these 1 MW-gyrotrons were selected as 77 or 154 GHz and are different from those of the gyrotrons already installed in LHD. The frequency of 77 GHz is resonant with the fundamental electron cyclotron resonance layer on axis of the standard configuration of LHD, which shows good plasma confinement, so a higher electron temperature on the axis and a higher peaking factor of the temperature profile than that obtained previously are expected. Moreover, these gyrotrons have the capability of 300 kW-continuous oscillation, thus the gyrotron will contribute to the expansion of the parameter regime of long-time-sustained plasma.

The gyrotron type is CPD and the gun is a triode configuration cathode for controllability. Six sweep coils are set around the collector and a triangular current of 0.45 Hz is applied to the coils to diverse the heat road. $TE_{18,6}$ was selected as the cavity mode taking the cathode configuration, the radio frequency (RF) power loss on the inner wall, matching with the mode converter into consideration. RF beam is extracted from output window of CVD diamond disc after the shaping by 4 copper mirrors in the gyrotron.

The gyrotron configuration with the MOU and the short-pulse dummy load is illustrated in Fig. 1. The MOU mirror system consists of two copper mirrors. A phase distribution of an RF beam is corrected by these mirrors. The mirror surface was designed by the convergence calculation for the height of the bumpy on the mirror corresponding to the phase difference between the initial phase distribution and the goal one, which was calculated from the inverse diffraction for HE_{11} mode at MOU output port. The design value of transmission efficiency of the MOU is 98.8 %. The alignment of the RF beam was done by the adjustment of these two mirrors and the gyrotron final mirror.

Figure 2 shows the dependence of the gyrotron output power P on the electron beam current I_b with and without the MOU in the short pulse test. It was confirmed that the power loss due to the MOU was negligible and the 1 MW output was attained even with the MOU.

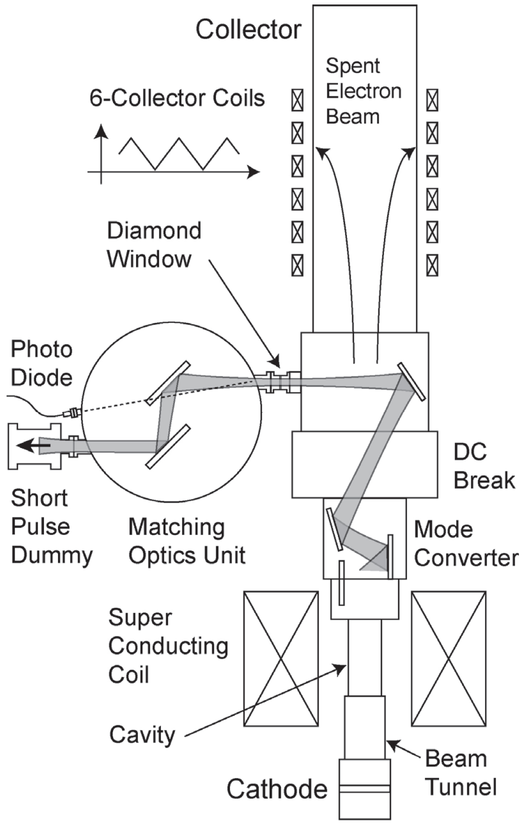

Fig. 1. The gyrotron configuration with the MOU and the short-pulse dummy load.

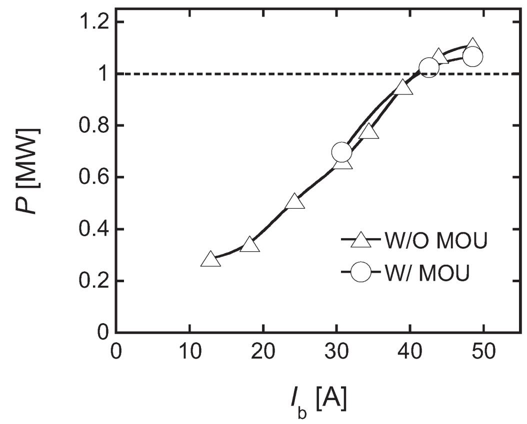

Fig. 2. The gyrotron output power P on the electron beam current I_b with and without the MOU.

1) T. Shimozuma *et al.*, Fusion Sci. Thecnol. **50**, (2006) 403