§19. Long Distance Transmission System for High Power ECH in JIPP T-IIU

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Electron cyclotron heating (ECH) is planned in JIPPTII-U. The purposes of the ECH are profile control and current drive. The profile control includes the trial of achieving H-mode with edge heating, sawtooth oscillation and MHD activity stabilization, transport analysis combined with high frequency power modulation. The items for the current drive experiments are high power pre-ionization and producing the high electron temperature plasma or feeding the seed high energy electrons for the target of the fast wave current drive and the demonstration of the current drive by ECH only.

A 400 kW gyrotron installed in the CHS hall is used as a power souce, whose frequency is 53.2 GHz and the output mode is Gaussian beam. This microwave beam is transmitted by a quasi-optical transmission system to CHS. The long distance high power transmission from CHS hall to JIPPT-IIU is done with the combination of the corrugated waveguides and miter bends. One of the mirrors in the quasi-optical transmission system is modified to switch the beam and to couple the beam power into corrugated waveguide. The root of this transmission line is shown in Fig. 1. Total length of the corrugated waveguide is 62 meters. The unit waveguides with the length of 1 meter are connected with the precise coupling rings to prevent the offset and the tilt of each axis. The number of miter bends is 9 in total. In order to absorb the heat expansion of the waveguide, each miter bend has slide mechanisms at both input and output interface to the corrugated waveguides.

This corrugated waveguide is made of aluminum pipe whose inside wall is corrugated so as to transmit low loss HE11 mode as a fundamental mode. The other reason for the adoption of the corrugated waveguide is that theoretically expected matching of the HE11 mode to the Gaussian beam is more than 94% and the connection to the quasi-optical transmission line is relatively easy. In Fig. 2 are shown the attenuation characteristics of typical modes inside the corrugated waveguide as a function of the corrugation depth normalized by the quarter wavelength in the free space. Actually specified depth of the corrugation is 1.1 mm with the pitch of 1.7 mm. The depth of corrugation is determined so that the transmission characteristics is good for both 53.2 and 84GHz, since these waveguides might be used as a part of the transmission line for the ECH in LHD. The result of the cold test indicates that this corrugated waveguide system is efficient.

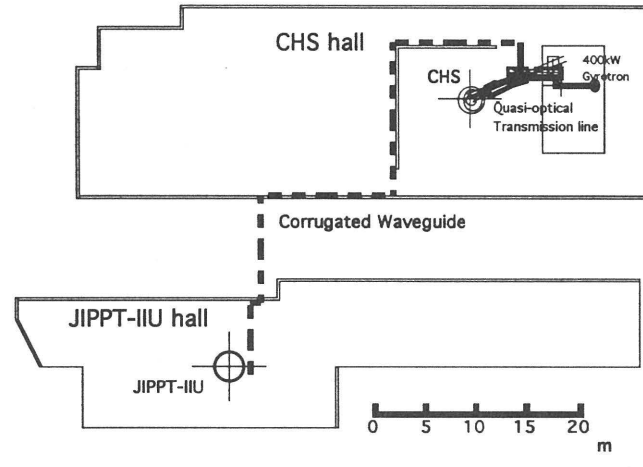

Fig.1 Schematic view of the long corrugated waveguide transmission system (thick dotted line) between CHS and JIPPT-IIU.

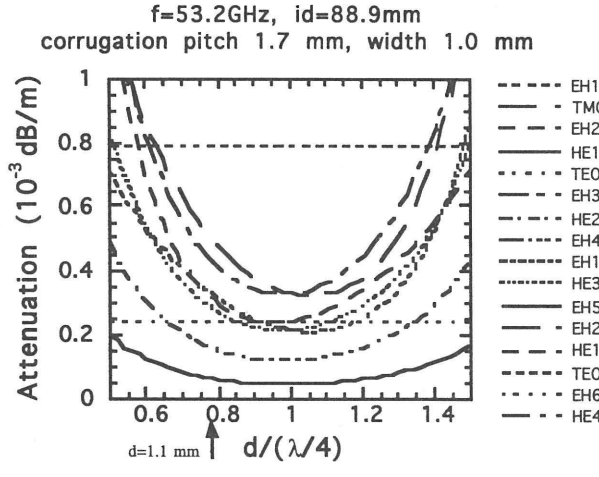

Fig.2 Attenuation characteristics of the designed corrugated waveguide for several typical modes as a function of normalized corrugation depth. Actual depth is set at 1.1 mm as indicated by an arrow.