§13. Development of 1-D Antenna Array for O-mode Microwave Imaging Reflectometry in LHD

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Microwave Imaging Reflectometry (MIR) has been developed for Large Helical Device to investigate three dimensional structures of electron density fluctuations[1]. Developed MIR system used probe beams at the frequency range of 60 - 65 GHz and X-mode cutoff layers. However, the X-mode cutoff layer is not only the function of an electron density but also a magnetic field. Therefore, it was difficult to observe same magnetic surface by each antenna elements. In order to solve this problem, we have planned to develop an O-mode MIR system.

This study aimed for development of a 1-D antenna array for the O-mode MIR system. The frequency range of the 1-D antenna array is around 40 GHz. The use of this frequency range as the probe beam of reflectometry, the edge region of LHD plasma can be observed. The MIR system requires Local Oscillation (LO) signal to use heterodyne detection. Former MIR system had a LO optics to supply the LO wave to each antenna elements. However, the LO optics causes an enlargement of whole optics and a decrease of the power of LO wave for each antenna elements. To solve this problem, we plan to employ an internal LO module each antenna elements.

Figure 1 indicates a conceptual diagram of the new antenna array. The new antenna is based on a Horn Antenna Mixer Array[2]. The new HMA consists of 6 parts: horn antennas, waveguide-to-microstrip line transmissions, mixers, IF amplifiers, LO frequency multipliers and LO dividers. In this year, we have developed the waveguide to microstrip line transmission and a mounting method of MMIC mixer. Figure 2 shows photograph of printed circuit board of the waveguide to microstrip line transmission. The transmission employs a finline waveguide to microstrip line transmission. The characteristic of transmission loss as the function of frequency is shown in Fig. 3. The transmission loss at the frequency of 35 GHz is around 3 dB. Figure 4 is a photograph of a MMIC mixer bonding on a PCB. The conversion loss of the MMIC mixer is low; however it is necessary to connect using a wire bonding technique.

For the next experimental campaign of LHD, we will develop the eight channel HMA with internal LO module, and try to install it on LHD.

1) Nagayama, Y. et al.: Rev. Sci. Instrum., 83, 10E305 (2012).
2) Kuwahara, D. et al.: Rev. Sci. Instrum, **81**, 10D919 (2010).

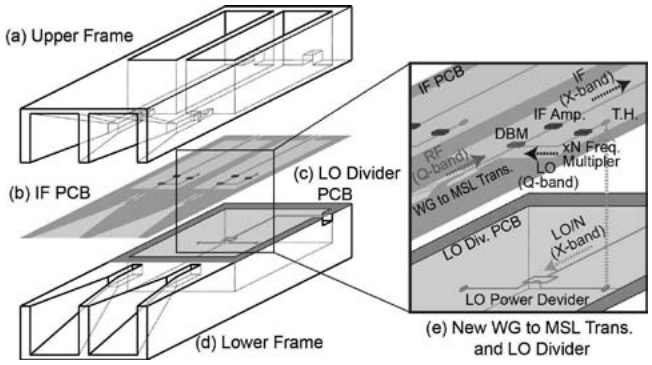

Fig.1 Conceptual diagram of HMA with internal LO.

Fig. 2 PCB of 40 GHz waveguide to microstrip line transmissions.

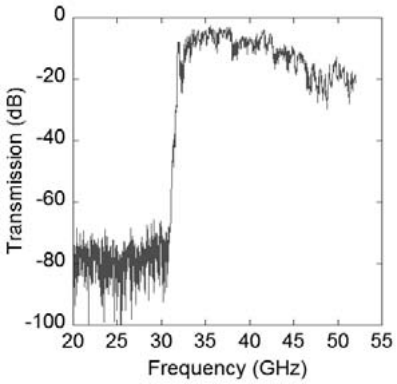

Fig. 3 Transmission characteristic of 40 GHz waveguide to microstrip line transmission.

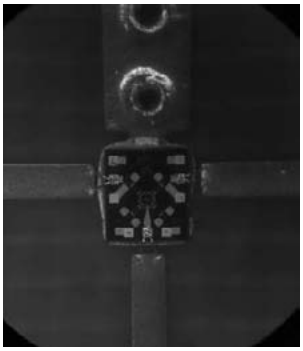

Fig. 4 MMIC mixer bonding on PCB.