§20. Development of Multi-channel Heterodyne Receiver for ECE Imaging and Application on LHD

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An electron cyclotron emission (ECE) radiometer is an essential tool to investigate radial electron temperature profile in magnetically confined plasmas. In the ECE diagnostics, a receiver antenna detects the ECE from plasma. Since the frequency of the ECE is too high to process such as amplifying etc., it is common to introduce heterodyne detection which utilizes frequency mixers and local oscillators (LOs) to convert the signal frequency. After the frequency conversion, a band-pass filter bank with different pass-band, which corresponds to radial emission point, resolves the heterodyne signals. Then video detectors detect amplitude of these filtered signals which correspond to the electron temperature of the specific area. In the recent study, this diagnostics is progressed to not only one-dimensional resolved measurement but also two or three-dimensional measurement by utilizing a detecting antenna array. This study is performed to construct the IF system for the ECE imaging diagnostics. Fig. 1 shows a photograph of the developed IF system. It consits from a 3 stages of broad band amplifier, a low pass filter, a band pass filter bank, and video detectors. These functional components are realized on a Teflon substrate. In the IF system, signal is processed as follows. 1st of all, The IF system accepts the signal with a frequency component up to 10GHz. The signal is amplified by broad band amplifiers with 30dB gain. The signal is then fed to the bandpass filter bank. In the filter bank, the signal separates into the 8 signals with distinct frequency range. Center frequencies of the filters are from 2 to 9GHz, and all the bandwidht are 500MHz. After the filtering, these signals are detected by the video detectors, which are optimized to each frequency range of the signal.

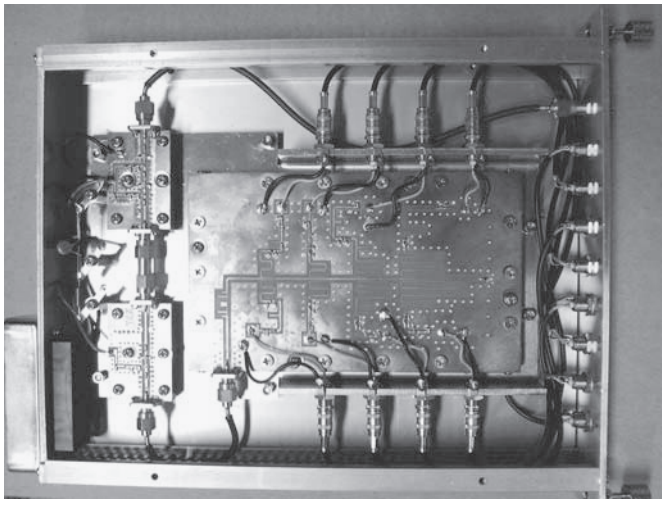

Fig. 1 The photograph of the IF system

The ECE imaging system needs number of the IF systems corresponding to the number of the receiver of the ECE. By the end of year, we prepared 20 IF systems. In order to evaluate the IF systems, we performed following evaluation. We utilize synthesized sweeper as a microwave source instead of ECE signal. 1st evaluation is characteristics between input frequency vs DC output voltage. Frequency is swept from 1 to 10 GHz. DC voltage from the each output is measured by the multimeter. Here, power of the input signal is fixed at -25dBm. The evaluation results are not shown in this report, however, we confirmed fine characteristics reproduction among 20 IF systems. 2nd evalation is characteristics between input power vs DC output voltage. Input frequency is fixed at center frequency of the each bandpass filter. Input power is swept from -55 to -10 dBm. Fig. 2 shows example of the evaluation results of 20th IF system. Each trace corresponds to each detector output. We confirmed that approximately linear region in power-voltage from -50 to -20dBm. We also noticed that each characteristics is shifted up and down relative to other output. This deviation will be calibrated by the absolute temperature-voltage calibration in near future.

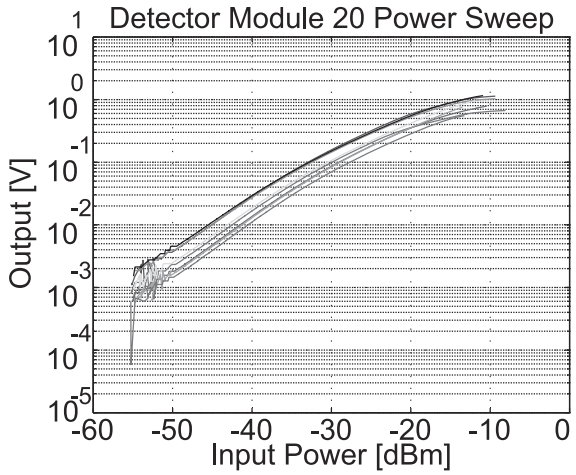

Fig. 2 Power - Voltage characteristics measured at each detector output.

1) Y. Kogi, T. Sakoda, A. Mase, N. Ito, Y. Yokota, S. Yamaguchi, N. Nagayama, S. Jeong, M. Kwon, and K. Kawahata, Rev. Sci. Instrm. **79** 10F115 "Development of multichannel intermediate freuquency system for electron cyclotron emission radiometer on KSTAR Tokamak"