§5. ECE Diagnostics in the First Cycle Experiment on LHD


The electron cyclotron emission (ECE) from LHD plasmas has been successfully measured by the use of the heterodyne radiometer and the fast scanning Michelson interferometer.

The ECE radiation is collected by a pair of mirrors on a side port (the 10-0 port) and directed into a 63.5 mm corrugated waveguide through a double wedged crystal quartz window. The ECE is divided between the radiometer and the Michelson spectrometer by the use of the wire grid beam splitters. A transducer, which is made of a concave mirror in a miter-bend and a short horn antenna, transduces the microwave from a 63.5 mm circular corrugated waveguide to a WR-12 rectangular waveguide.

In the radiometer, the ECE is filtered by a 70 GHz high-pass filter, and is mixed with the output of the 70 GHz Gunn oscillator. The ECE from 70 to 86 GHz is divided by a 16 channels band-pass filter bank with the band-width of 1 GHz. The data of the radiometer are sampled every 2 μsec by the use of Aurora 14 digitizers in the CAMAC crate, which is controlled by the personal computer with the Pentium-pro (200 MHz) processor and the Windows NT system. The Camac handling software was written with the C-language for the PV-wave by M. Kojima at NIFS. The trigger timing is generated from the 10 MHz clock signal common in the LHD system with the VME system, which was developed by H. Nakanishi at NIFS.

Much interference is caused by electron cyclotron heating (ECH) power. Gyrotrons at 82.6 GHz, 84 GHz and 168 GHz are used for plasma production and heating. Quasi-optical notch filters at 84 GHz and 82.6 GHz, which are developed by H. Ikeji and J. Doane at General Atomics, are mounted in the waveguide and each of them reduces the ECH signal by more than 30 dB. These notch filters are effective at their higher harmonics so that the 168 GHz can be also eliminated by the 84 GHz filter. Figure 1 shows the transmission of the combination of these notch filters. The power of each ECH gyrotron is 200 kW and the antenna of the 82.6 GHz ECH is next to the ECE antenna. The leaked ECH power at 82.6 GHz is a few mW at the inlet of the radiometer. This is too big to be measured by the radiometer. Two notch filters at 82.6 GHz and 84 GHz in the rectangular waveguide in front of the radiometer reduce the ECH leak by 40dB to enable the measurement of the ECE signals by the radiometer. Typical radiometer signals are shown in Fig. 2.

![Fig. 1. Transmission of notch filters.](image1)

![Fig. 2. Raw signal of the radiometer (71GHz and 73 GHz).](image2)