§13. W-band ECE Radiometer for Edge Magnetic Structure Study

Tsuchiya, H., Nagayama, Y.

Electron Cyclotron Emission (ECE) Diagnostic is one of the useful measurements for electron temperature, and has been used in many magnetized plasma devices. In LHD, the ECE antenna has been installed at horizontal port of out of torus[1]. The sight line is on the mid plane.

The ECE is divided to the heterodyne radiometers and Michelson Interferometer by 10 micrometer wire grid. On 2013 fiscal year, the new W-band radiometer system was installed, in addition to the F-band radiometer and E-band radiometer. The F-band (90-140GHz) radiometer named "RADH" has 32ch. The RADH is used for the fluctuation measurement in core region at high magnetic field (B_{ax} ~ 2.75T) experiment. The E-band (60-90GHz) radiometer named "RADL" is suitable for the middle magnetic field (B_{ax} ~ 1.5T) experiment. The frequency band of the new radiometer system, which is named "RADM" is W-band (75-110GHz). The frequency band is corresponding to the ECE frequency of Edge area (ρ >0.8) at high magnetic field experiment. The electron cyclotron frequency and the view points of RADH, RADM, and RADL radiometers at typical high magnetic field experimental condition are shown in fig1. The view range of RADM connects to the view range of RADH.

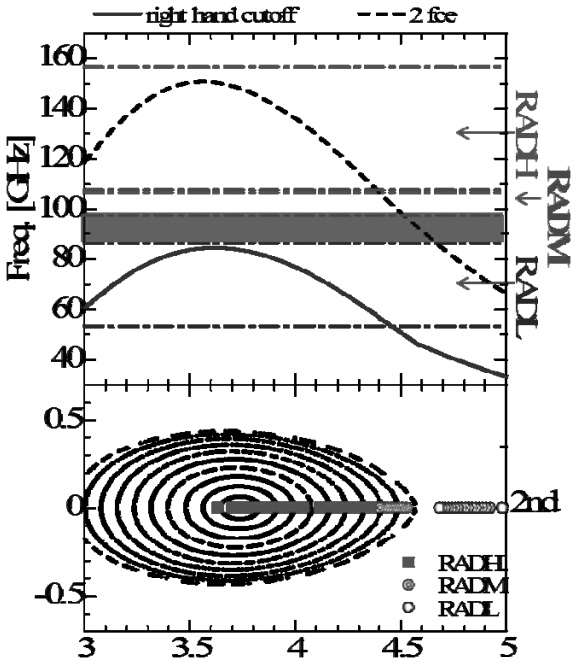

Fig.1 2nd harmonics of electron cyclotron frequency ($2f_{ce}$) and summary of the view points of RADH, RADM,RADL. The magnetic configuration is typical high magnetic field condition in LHD. R_{ax}=3.75m, B_{ax}=2.64T. The cutoff frequency at $n_{e,bar}$ ~ 1*10^{19}m^3 is also overwritten. The each points of lower figure shows the view points of each channels of radiometers.

First, the ECE is filterd by notch filter of 77 GHz to protect from the loss of Electron Cyclotron Heating (ECH). Then it is filtered by a 95 GHz high-pass filter, and is mixed with the output of the 95 GHz Gunn oscillator in RADM. The down-converted ECE is divided by a 12-channel band pass-filter bank with a channel bandwidth of 1 GHz. The frequency resolution is corresponding to the 1cm radial spatial resolution. The radiometer data are sampled every 5 μs and the data length is 10 second. In RADM, only the upper side band (USB) is used, but lower side band (LSB) will be also used for the measurement of electron temperature fluctuation at out of the closed surfaces.

Because the density and electron temperature in the edge or surrounding plasma are not often enough to measure the temperature exactly, it is considered that the heat pulse propagation method [2] is more useful than the spontaneous temperature fluctuation analysis. The heat pulses can be generated by the power modulated electron cyclotron heating (MECH). Because the heat pulse is artificial fluctuation, the amplitude and fluctuation frequency can be selected, and the conditional average technique is easily applied. Fig. 2 shows the preliminary result of heat pulse propagation in the edge region. The aspect that the heat pulse propagates outward from core region is shown. At r_{eff}~0.445 where the rotation transform ι is 1, the heat pulse propagates rapidly. This would indicate the existence of a natural island.

1) Tsuchiya, H. *et al,.* Plasma Fusion Res. 6 (2011) 2402114.

2) Inagaki, S. *et al.*, Phys. Rev. Lett. **92** (2004) 055002.

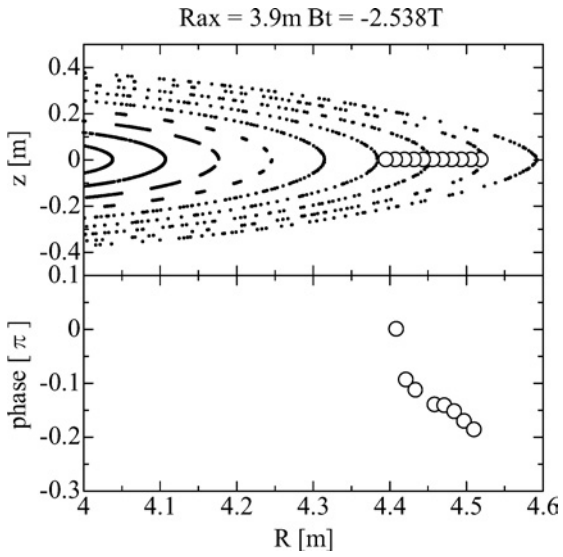

Fig.2 The view points on Poincare map of magnetic field line and the phase of heat pulse fluctuation measured by RADM.