§60. Characteristics of Heat Pulse Propagation during Staircase ECH in the ECR Plasma

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Characteristics of heat pulse propagation were investigated with modulated electron cyclotron heating (MECH) in discharges where the plasma was sustained only by electron cyclotron heating (ECH). At first the plasma was started up by ECH and counter neutral beam injection (NBI) BL1, BL3. From the starting up to the end of the discharge 0.67MW/77GHz electron cyclotron (EC) wave was launched perpendicularly to the magnetic field from the top port with 40Hz/90Hz power modulation. After NBI was turned off, 0.77MW EC wave was launched obliquely to the magnetic field from the horizontal port into the plasma sustained only by MECH. Electron cyclotron current drive (ECCD) may occur by this oblique injection to some extent. 0.1 second after from the oblique launching, additional 0.88MW EC wave was launched perpendicularly from the top port antenna. The magnetic configuration (R_{ax},Bt,γ,Bq)=(3.53m, 2.705T, 1.2538, 100%) and (R_{ax},Bt,γ,Bq)=(3.60m, 2.705T, 1.2538, 100%) were selected.

Figure 1 and 2 show the results when (R_{ax},Bt,γ,Bq)=(3.53m, 2.705T, 1.2538, 100%) was selected. In figure 1, for each term of MECH only, MECH + oblique ECH and MECH + oblique ECH + additional ECH, profiles of electron temperature, phase delay and modulation amplitude are shown. For oblique ECH, the wave launched with $N_{//} > 0$ where $N_{//}$ is the parallel component of the refractive index to the magnetic field. The MECH frequency was 40Hz. For ECE signals, modulation amplitude and phase delay are estimated by FFT analysis and are plotted. In the terms of MECH only and MECH + oblique ECH, at R=3.78m, 3,83m, 3.86m, 3.92m, 4.03m, 4.1m the gradients of the temperature profile, phase delay, modulation amplitude change all together. However in the term of MECH + oblique ECH + additional ECH, ECE was affected by non-thermal electrons since the gas fueling had not been optimized yet in this discharge therefore the electron density after turning on the additional ECH phase was lower than that before turning on the additional ECH.

Figure 2 shows similar plots as figure 1 however $N_{//} < 0$ for oblique ECH. In the terms of MECH only and MECH + oblique ECH, it is difficult to relate the changes of temperature gradient to the change of the gradient of the phase delay. In the term of MECH + oblique ECH + additional ECH, in the region R<4.0m the gradients of temperature, phase delay and modulation amplitude may be related to each other. While in the region R>4.0m the modulation amplitude is larger than that in the central region although the MECH power is absorbed in the central region. It is required to check the origin of ECE by ray-tracing calculation taking into account the influence of the non-thermal electron.

In this experiment, the obtained ECE signal was noisy and the accuracy of the FFT analysis may not be well. It was difficult to observe modulated signals with 90Hz MECH in ECE. Application of another method of analysis for heat pulse propagation should be required.

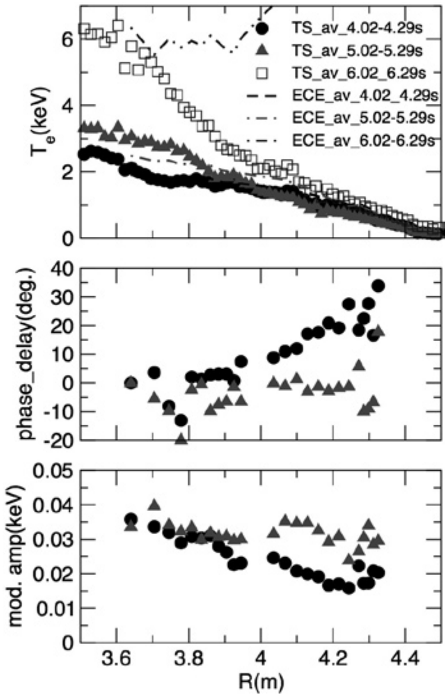

Figure 1 : profiles of electron temperature(top), phase delay of 40Hz modulation (middle) and modulation amplitude (bottom). MECH only (●), MECH+ oblique ECH (▲), MECH+ oblique ECH +ECH(□). $N_{//} > 0$ for oblique ECH

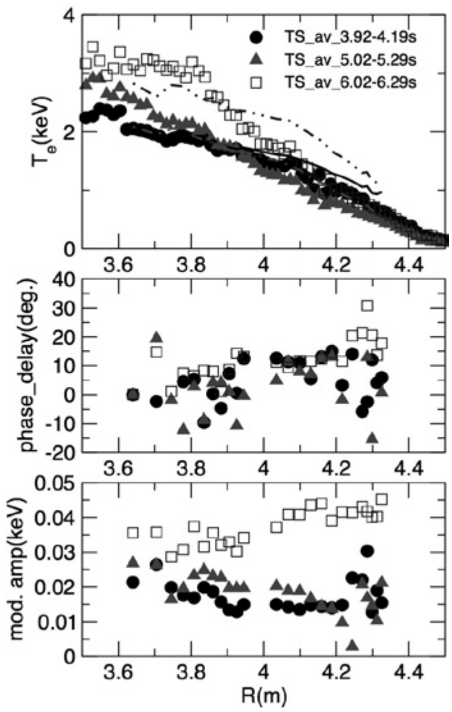

Figure 2: Similar plot as figure 1. $N_{//} < 0$ for ECCD.