§20. Study of Pellet Injection for Efficient Core Plasma Fuelling in Heliotron J

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In Heliotron J device, to investigate the effect of the perturbation by the pellet injection on the background plasma, the penetration analysis using Supersonic Molecular Beam Injection (SMBI) are conducted as a simulation of the pellet injection. The cold pulse propagation is observed using electron cyclotron emission (ECE) measurements when the SMBI is injected. In consequence, the cold pulse is propagated into the plasma core within one millisecond elapsed after SMBI injection, suggesting that the background plasma is cooled to the core. The calibration of the injection particles of SMBI is not conducted yet, and the validation of the assumed pellet size and speed discussed at previous study[1] will be investigated in the future.

In this study, the change of ECE intensity, which is proportional to the background electron temperature, is observed when the SMBI is injected. The ECE measurements are effective as a local measurement. In Heliotron J, the new ECE system (CHS ECE) which was used in CHS device is newly installed in addition to the original ECE system (Heliotron ECE). The Heliotron ECE is installed close to SMBI injection port, and the CHS ECE is installed far from the port. The magnetic configuration is selected as the standard configuration. Figure 1 shows the local position of each ECE frequency of the CHS ECE, which corresponds to the magnetic field. The local measurement from the plasma center to the peripheral region is possible. The plasma is sustained by only NBI after the start-up of ECH. The electron temperature and averaged electron density of the plasma is about 1 keV and $1{\times}10^{19}$ m^{-3}, respectively.

Figure 2 shows the time evolution of ECE intensity obtained by the CHS ECE before and after the SMBI injection. After the SMBI injection, the cold pulse is propagated to the plasma core within one millisecond. It should be noted that the SMBI might be directly injected to the plasma core. The minor radius is about 10 cm and the cold pulse with the speed of at least 100 m/s(=10 cm/1 msec) might be propagated. Moreover, we confirmed that the propagation occurs at the same time scale in the different toroidal angle. So far, the number of injection particles of SMBI is not identified yet, and therefore we can not discuss quantitatively whether the pellet size and speed assumed from the ablation code is appropriate or not. However, if the deeper penetration by the pellet injection is considered to be attained, the serious reduction of the electron temperature in the plasma core by an only single pellet would be predicted. In order to suppress the perturbation of the pellet injection on the background plasma, the higher temperature background plasma is needed and/or the smaller size of pellet with the slower speed is presumably needed.

In future, the calibration of the particles of SMBI will be conducted. Moreover, the change of electron temperature profile of the background plasma before and after the SMBI injection will be measured by thomson scattering system.

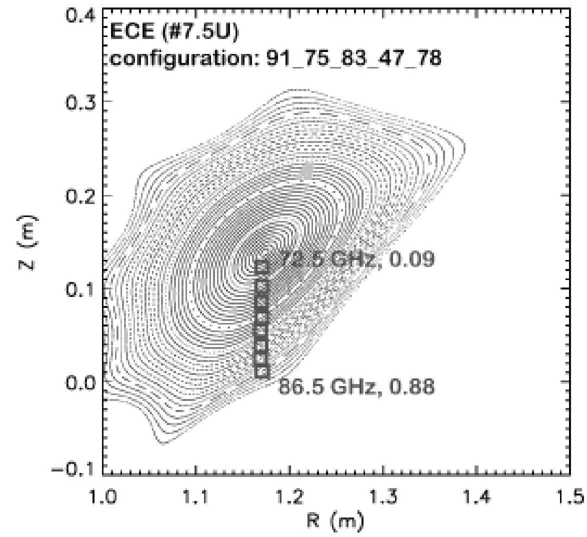

Fig. 1: Measurement position of the CHS ECE system.

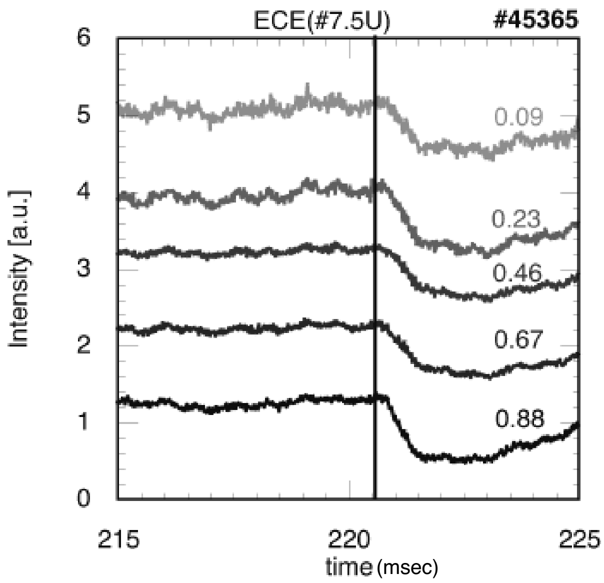

Fig. 2: Time history of ECE intensity before and after the injection of SMBI. The solid line shows the injection timing of SMBI. The values in the figure show the normalized minor radius.

1) G. Motojima, et al., Ann. Rep. NIFS (2011) 499.