§22. Lithium Beam Probe for Edge Plasma Diagnostic in CHS

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Plasma structures near and out side of the last closed flux surfaces (LCFS) have been measured by the use of the lithium beam probe (LiBP) in CHS. There are two typical magnetic configurations, namely, the inboard limiter configuration and the magnetic limiter configuration. Each configuration is realized by inward-shifted or outward-shifted magnetic axis, respectively. In the inboard limiter configuration, the inboard wall plays a role of material limiter, making the connection length outside of the LCFS very short. The ergodic layer disappears, which is in contrast to the magnetic limiter configuration.

A lithium neutral beam with the energy up to 15 keV and with the equivalent beam current of a hundred microamperes is injected from the M-port (located upside of the torus). Light emission from the beam due to plasma particles impact excitation (670.8 nm) is collected through a window mounted on the O-port (located outside of the torus).

Experiments have been carried out for the inboard limiter configuration for magnetic axis of \( R_{\infty} = 0.921 \) m and the magnetic limiter configuration for magnetic axis of \( R_{\infty} = 1.016 \) m. At the inboard limiter configuration, hydrogen plasmas are produced by electron cyclotron resonance (ECR) heating with a gyrotron of 53 GHz. Neutral beam injection (NBI) heating is additionally applied using the two beam lines (both in co-direction) with 40 keV. Plasma density is controlled by preprogrammed gas puff system. In the present experiments, the average electron density in the ECH phase is about \( 1 \times 10^{19} \text{ m}^{-3} \). The average electron density in the NBI phase depends on the heating schemes and is \( 4 \times 10^{19} \text{ m}^{-3} \) in the present experiment.

On the other hand, the average electron density in the ECH phase is about \( 0.8 \times 10^{19} \text{ m}^{-3} \) and in the NBI phase is \( 2 \times 10^{19} \text{ m}^{-3} \).

The electron density profiles at the inboard limiter configuration are shown in Fig. 1. The LCFS is in the vicinity of position 35 mm. Triangle dots show the profile of ECH phase and cross dots show NBI phase. It is shown that the NBI plasma density is always higher than the ECH plasma density. The core electron density profile is measured with YAG laser Thomson scattering, showing flat and parabolic profiles in ECH and NBI plasmas, respectively.

As for the magnetic limiter configuration, the electron density profiles are shown in Fig. 2. The LCFS is in the vicinity of position 30 mm. It is shown that the ECH plasma density is higher than the NBI plasma density in the edge region. The ECH plasma is showing hollow profile.

The difference of such distributions is considered to be due to the presence of the ergodic layer. By comparing the electron density profiles of the inboard limiter configuration and the magnetic limiter configuration in detail, it is expected to be clarified how ergodic layer contributes to the plasma confinement in helical device.