§19. Two-Dimensional Lithium Beam Probe for Edge Plasma Diagnostic

Nakamura, K., Iguchi, H., Narihiro, Z. (Nagoya Univ.)

Two-dimensional plasma structures near and out side of the last closed flux surfaces (LCFS) have been measured by the use of the two-dimensional lithium beam probe (LiBP). The beam injection angle is variable and observation points covers edge and separatrix region of heliotron type helical magnetic 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, where the magnetic axis is at R_{ax} = 0.921 m and the magnetic field strength is 0.95 T on the axis. Hydrogen plasmas are produced by electron cyclotron resonance (ECR) heating with a gyrotron of 53 GHz and 170 kW. Neutral beam injection (NBI) heating is additionally applied using the two beam lines (both in co-direction) with 40 keV and total power of 1.3 MW. ECH is applied from t = 20 ms to 120 ms and NBI from t = 80 ms to 180 ms, where t = 0 is the start of data acquisition for diagnostic instruments. Plasma density is controlled by preprogrammed gas puff system. In the present experiments, the average electron density in the ECH phase is about $1x10^{19}$ m^{-3}. The average electron density in the NBI phase depends on the heating schemes and is $4x10^{19}$ m^{-3} in the present experiment. The core electron density profile is measured with YAG laser Thomson scattering, showing flat and parabolic profiles in ECH and NBI plasmas, respectively. The measurements are carried out in shot by shot bases with changing the Li beam injection angle in the major radius direction.

Two-dimensional profiles of the electron density are reconstructed from beam emission profiles, which are shown in Fig. 1 for the ECH phase and Fig. 2 for the NBI. The contour lines in the figures are the magnetic surface for ρ = 0.837 ~ 1.171, and the thick line is for ρ = 1.0 (LCFS). In ECH phase, it is noted that the influence of time of flight is taken into account, namely, the whole density distribution is shifted by 1.7 cm in the beam injection direction. Equi-density contours coincide the magnetic surfaces inside of the LCFS. While, in NBI phase, significant amount of plasmas are observed even outside of the LCFS.

The relation between the electron density and the average minor radius ρ is shown in Fig. 3. It is shown that the electron density inside of the LCFS for ECH plasma is a good function of the minor radius ρ. It is consistent with the two dimensional map of the electron density shown in Fig. 1. As for the NBI plasma, the electron density is well described as a function of the minor radius even outside of the LCFS. It suggests that the influence of the magnetic surface still remains outside the LCFS in spite of the inboard limiter configuration. Real plasma boundary appears to exist around ρ = 1.10 for NBI plasma.

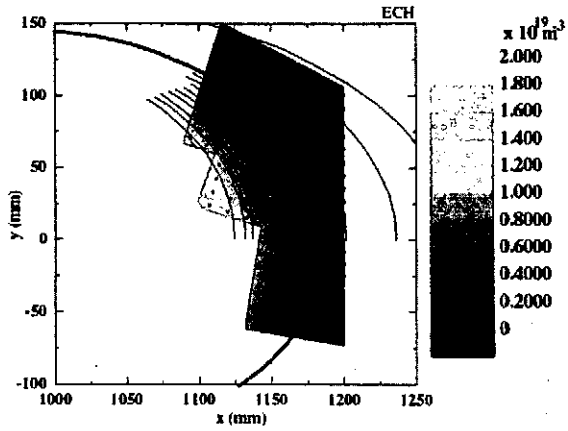

Fig. 1. Two-dimensional profiles of the electron density for ECH plasma

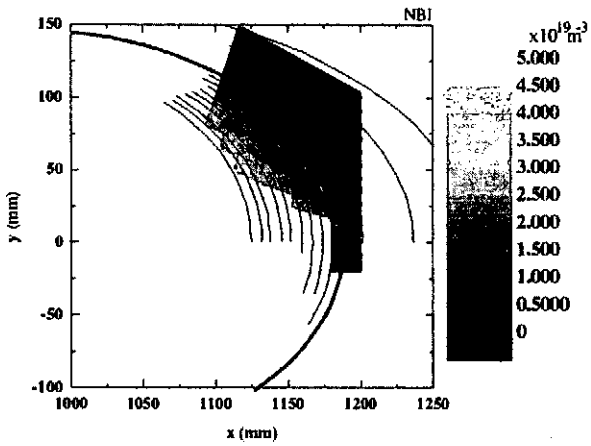

Fig. 2 Two-dimensional profiles of the electron density for NBI plasma

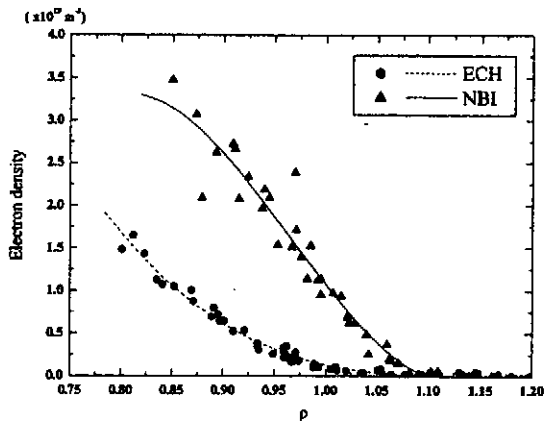

Fig. 3 The relation between ρ and the electron densities for ECH plasma and NBI plasma.