§51.First Results of Lithium Beam Probe for LHD

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A lithium beam probe system to measure edge density and its fluctuation has been developed for LHD 1) and has started the operation since the end of the 4th experimental campaign. In this report the setup of the system together with results in the R & D activity and preliminary data obtained in the LHD experiment are presented.

The lithium beam system consists of a beam injector and an optical detector. The beam is extracted from a β-Eucryptite solid ion source by Pierce-type electrode with the energy of 10-20keV. Being focused by Einzel lens, it is neutralized in a charge exchange cell filled with lithium vapor. Since the injector is not equipped with the magnetic shield, it has a two-dimensional electric deflector coupled with an in situ beam position monitor.

The beam is injected to the LHD plasma horizontally from the outboard side of the torus, as shown in Fig.1. In spite of a long distance more than 6m from the injector to the plasma, FWHM of the beam at the plasma surface is about 2cm, as shown in Fig.2, which was measured by a movable probe on the test bench with the same configuration as on LHD. Equivalent beam current was also measured to be ~0.1mA. Emission from the beam is detected by a cooled CCD camera with an interference filter for Doppler shifted Li I line (671.9nm). Figure 3 is an image taken by the camera during an ICRF discharge, whose time and spatial resolutions are 0.5sec and 20mm (beam width), respectively. The He I line is so near to Li I line that the back ground light from He, which is for ICRF minority heating, is relatively bright, as shown in Fig.3.

Subtracting the back ground level from the signal, the emission profile was obtained (broken line in Fig.4) and the electron density profile was reconstructed (thick line in Fig.4). From the magnetic field line analyses, it has been found that the last closed flux surface (LCFS) is at R=4.476m and there exists the ergodic region outside LCFS, which is depicted as the hatched area in Fig.4. It can be seen that the reconstructed density profile well reflects the magnetic field structure. Three regions what is called closed, ergodic and laminar, with different magnetic characters can be distinguished by difference in density gradients.

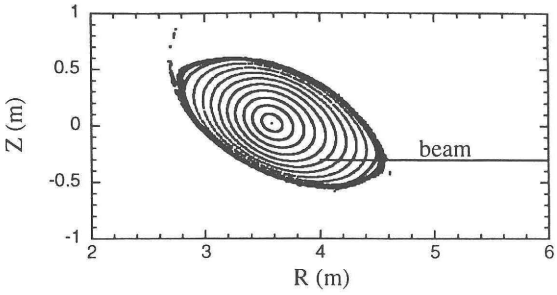

Fig.1. Poloidal cross section at beam chord.

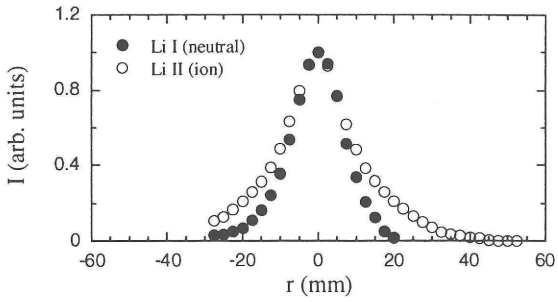

Fig.2. Beam density profiles.

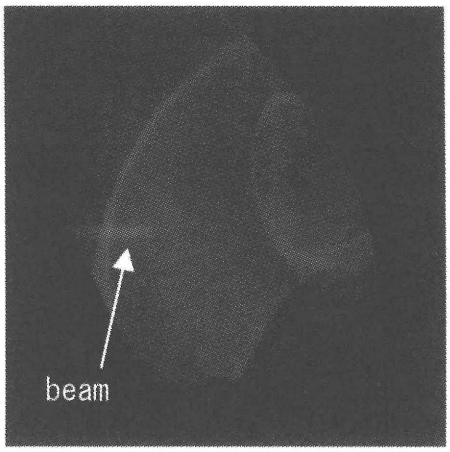

Fig.3. Emission from beam.

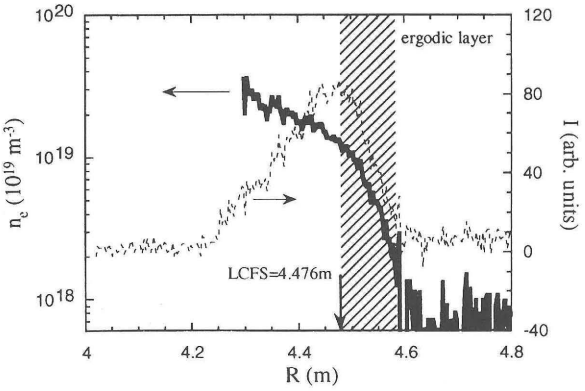

Fig.4. Beam emission I and reconstructed electron density n_e profiles. Hatched region is corresponding to ergodic layer.

Reference

1) Morisaki, T., Annual Report of NIFS (1996-1997) 55.