§8. Langmuir Probes in the LHD 3rd Experimental Campaign

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1. INTRODUCTION

Edge plasma control using the divertor is one of the main experimental goals of LHD. Therefore, understanding of the physics in the edge and the divertor plasma is a crucial issue in early phase in the LHD experimental program. In the first and the second experimental campaigns, a 21 ch Langmuir probe array embedded in a carbon plate was installed in the inboard side in the holizontally elongated cross-section [1, 2]. During the initial two campaigns, divertor plasma properties were investigated. As the results of these investigation, the magnetic configuration dependences of the divertor particle flux and the relationships between the edge and the divertor plasmas became clear. However, the three dimensional structure of the helical divertor configuration which was predicted by the calculations of magnetic field lines tracing [3,4] has not been investigated. Therefore, in the third campaign, three Langmuir probe arrays embedded in the divertor plates were installed in different position in the helical divertor, that is, the divertor traces in the torus inboard and outboard sides, and near the lower port.

In the first and the second campaigns, the profiles of edge plasma temperature and density were measured by Thomson scattering system and FIR interferometer, respectively. However, these diagnostics were focused on the core plasma measurement, thus they could not satisfy the required quality of data for the investigation of the edge plasma physics. Therefore, a fast scanning Langmuir probe system (FSP) [5] was installed to obtain the profiles of the plasma temperature and the density in periphery region.

In this report, the details of the Langmuir probe arrays embedded in the divertor plates and FSP are described.

2. LANGMUIR PROBE ARRAYS EMBEDDED IN DIVERTOR PLATES

Figure 1 shows the schematic view of the divertor plate with embedded Langmuir probe array. 16 electrodes were arranged along the edge of the divertor plate with the spatial resolution of 6 mm. The electrodes are made of the isotropic graphite that is the same quality as the divertor plates material. The shape of the electrodes tips are hemisphere of the 1 mm radius. To avoid the uncertain interpretation of the I-V characteristics of 'flush' mounted probe [6], 'dome' type shape was chosen. Electrical insulating parts were made of boron nitride, that has relatively good heat conductance [5] to provide the cooling through the heat conduction with actively cooled divertor plate. During the third campaign, thermal damages, such as the dramatical changes of the probe area, thermal electron emission, were not detected.

3. FAST SCANNING LANGMUIR PROBE SYSTEM

FSP was installed from the lower diagnostics port (1.5L-AL01) in LHD. FSP consists of the fast and the slow moving parts. The fast part is driven by a compressed air cylinder, and the moving length and one-way time are 0.6 m and 0.3 sec., respectively. The slow part is driven by two hydraulic cylinders, and the moving length is 1.3 m. Farther detailed mechanical performances were described in ref.[5].

Three electrodes were arranged avoiding the shadow effect, considering the change of magnetic field direction during reciprocation. The material of them was tungsten (ϕ 0.8 mm), and the shape was cylindrical. Figure 2 shows a typical time evolutions of the ion saturation current collected to the electrode and its position, respectively. The stay time at the top of the reciprocation can be changed.

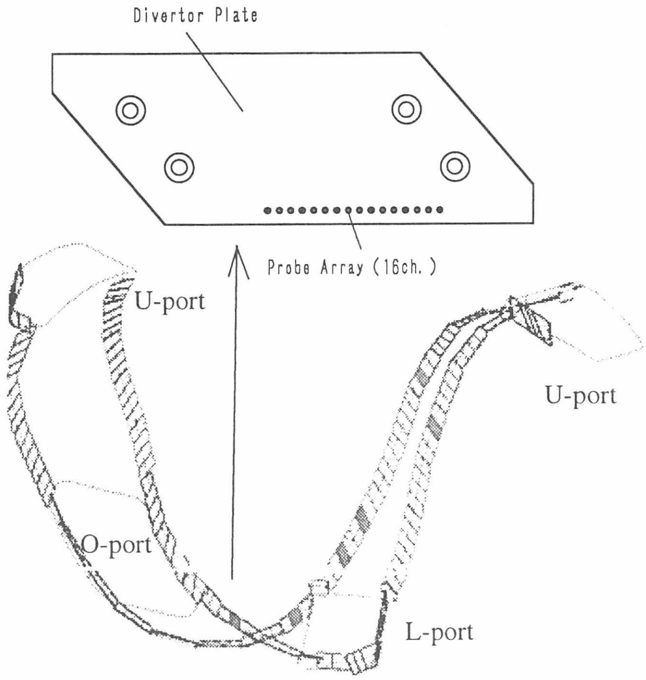

Fig.1: Schematical view of the divertor plate with embedded Langmuir probe array, and the helical divertor configuration (1 toroidal section). The Langmuir probe arrays were embedded in the hatched plates.

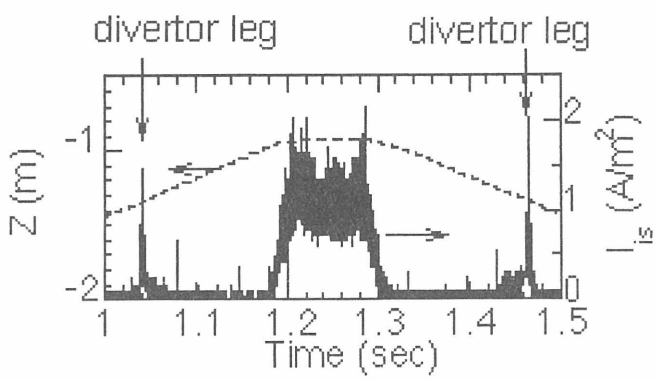

Fig.2: Typical time evolutions of the probe head' s position and ion saturation current to a probe tip of FSP. The position of Z = 0 is the equatorial plane. The velocity of the probe head estimated from this time evolution is about 3 m/s.

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