§58. Statistical Analysis of Density Fluctuation in SOL/Divertor Plasmas of the LHD with Super-SINET

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In low field sides of SOL in tokamaks, positive bursts, associated with radial propagation of plasma blobs, have been often observed in the ion saturation current I_{sat} by the Langmuir probe measurements[1-5]. Theory predicts that plasma blobs propagate toward a low field side due to $\boldsymbol{E}$x$\boldsymbol{B}$ drift, where the electric field $\boldsymbol{E}$ in the plasma blob is generated by the poloidal charge separation due to gradient $\boldsymbol{B}$ drift. In the LHD[6], magnetic field strength is large near the helical coils. Positive bursts were observed at a probe located at a low field side from the divertor leg. On the other hand, at a probe located at high field side, there is no positive burst in the I_{sat}[7]. This tendency is consistent with the theoretical prediction for plasma blobs.

In order to reveal the typical burst's profile, conditional averaging method was employed. In this method, large bursts with a peak above four times as large as the standard deviation of the original signal are selected and averaged in the same time domain. The result of the I_{sat} averaged over 480 events indicates that the positive spikes have the common property of a rapid increase and slow decay shown in Fig. 1. This feature is similar to that of plasma blobs in tokamaks.

To investigate the fluctuation property near divertor legs in an open field line layer, the profile of I_{sat} was measured by the reciprocating Langmuir probe. Fig.2 (a) shows the profile of I_{sat} across a divertor leg, in which two peaks were observed around Z = 1.35 m and Z =1.38 m, where Z is a distance from the equatorial plane of the LHD. The locations of the peaks are corresponding to the regions with large connection length L_c. As shown in Fig. 2(b), between the two I_{sat}'s peaks, the values of skewness is almost zero or slightly negative. On the other hand, at Z more than 1.38 m corresponding to the low field side of the divertor leg, the skewness as well as the fluctuation amplitude increases with Z. This result is consistent with the observation at the divertor probe array mentioned above, which suggests the possibility of the blobby plasma transport in the LHD. The inset of Fig. 2(b) shows the logarithmic plot of the I_{sat} above Z =1.35 m. The I_{sat} decays exponentially. There is no flat profile (so called second SOL), which has been often observed in the far-SOL of tokamaks associated with blobby plasma transport. One of the reasons is that the lifetime of plasma blob could be small in the SOL of the LHD, because the connection length L_c dramatically drops away from the divertor leg. Thus, the bobby plasma transport has small effect on the density profile around the divertor legs in the LHD, compared with tokamaks.

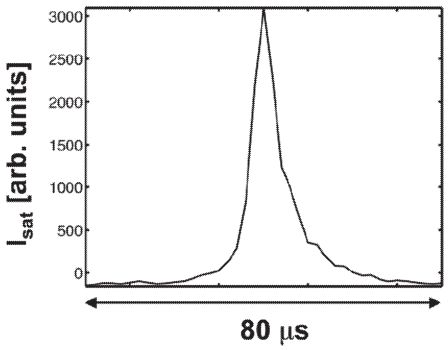

FIG. 1 Conditional averaging result of the I_{sat} measured at a divertor probe.

More quantitative evaluation of plasma blob transport should be required, such as velocity measurement of plasma blobs by using a reciprocating Langmuir probe with multi-electrodes.

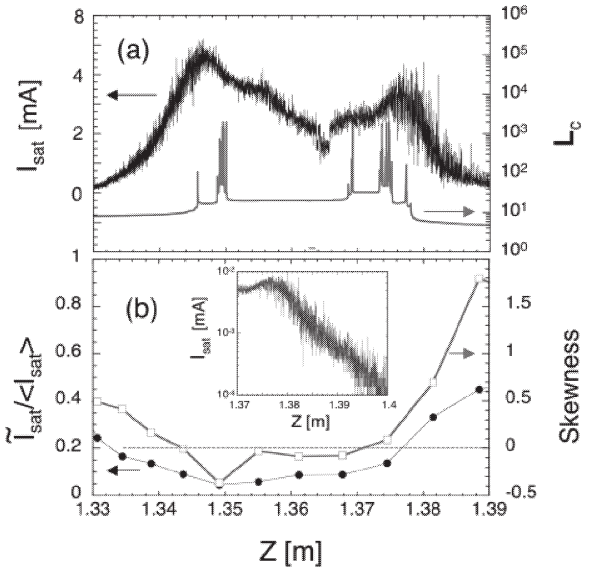

FIG.2 (a) profile of I_{sat} around a plasma leg measured by the reciprocating probe and magnetic connection length L_c, (b) profiles of normalized fluctuation amplitude and skewness of I_{sat} in Fig. 2(a). The inset shows logarithmic plot of I_{sat} at Z > 1.38 m.

References

1) B.A.Carreras e.a , Phys. Plasmas **3** , 2664 (1996).
2) LaBombard e.a. Nucl. Fusion **40** , 2041 (2000).
3) R.A.Moyer e.a., Plasma Phys. Controlled Fusion **38** , 1273(1996).
4) G.Y.Antar e.a , Phys. Rev. Lett. **87** , 065001 (2001).
5) V.Budaev e.a., Plasma Physics and Controlled Fusion **3** , 429 (1993).
6) S. Masuzaki e.a. Nuclear Fusion **42**, 750(2002).
7) N.Ohno *et al.* "Bursty Fluctuation Characteristics in SOL/Divertor Plasmas of Large Helical Device", 21th IAEA Fusion Energy Conference, Chengdu, China, 16-21 October 2006, EX/P4-20