

§24. Plasma Blob Transport in Detached Plasmas of the LHD Device

Ohno, N., Kajita, S., Tsuji, Y. (Nagoya Univ.),
Tanaka, H., Masuzaki, S., Morisaki, T., Kobayashi, M.,
Komori, A.

Detached divertor operation is expected as an efficient solution to reduce strong loads on the divertor plates. Recently, high-temporal electrostatic measurements suggest that blob-like cross-field transport would be enhanced under the detached divertor condition in the Large Helical Device (LHD) and a linear plasma device.

In this study, we have investigated characteristics of ion saturation current (I_{sat}) fluctuations measured using Langmuir probes during the attached and detached divertor operations in the LHD. Figure 1 shows time traces of plasma parameters in two discharges (110819 and 110821), which are in the same magnetic condition. Magnetic axis (R_{ax}) was 3.9 m, and $n/m = 1/1$ resonant magnetic perturbation (RMP) field was applied in order to easily sustain the plasma detachment. Divertor particle flux into an inboard plate was calculated by summing I_{sat} that were measured using a divertor probe array. After the line averaged electron density exceeded $6 \times 10^{19} \text{m}^{-3}$ at 110821, divertor flux decreased, despite of monotonic increase of the line averaged density. The flux drop was attributed to the plasma detachment phenomenon.

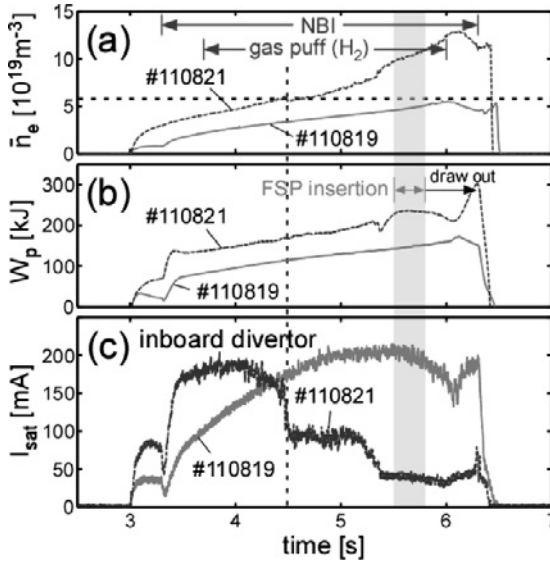


Fig. 1: (a) Time traces of line averaged density, (b) stored energy, and (c) sum of I_{sat} at an inboard divertor plate in two discharges (110819, 110821). The FSP was being inserted during $5.5 \text{ s} < t < 5.8 \text{ s}$ marked with a thick vertical line.

Firstly, we analyzed particle flux distribution on the divertor plate. As shown in Fig. 2(a), the probe array

cuts across a sharp strike point where the connection length (L_c) is over a hundred meters. In the attached state at 110819, divertor flux was localized near the strike point, probe 9 and 10, as shown in Fig. 2(b). In the detached state at 110821, I_{sat} around the strike point were smaller than those in the attached state; in contrast, I_{sat} at private region were relatively high. Similar results were also reported in the LHD without the RMP. Figures 2(c)(d) show time series of I_{sat} signals at private-side probes in the attached and detached states, respectively. Highly positive spikes were observed in both the states at the private-side edge of the strike point (skewness have peaks at probe 8); however, typical duration time was completely different. In addition, correlated positive spikes were widely seen at the private region in the detached state. Connection length in the private region is only a few meters; therefore, cross-field transport would be occurred near the divertor plate and would distribute the divertor flux to the private region, particularly in the detached state. The private side corresponds to the low-field side which is a theoretical propagation direction of plasma blobs. Difference of the duration time may be attributable to differences of size and/or velocity of the blobs.

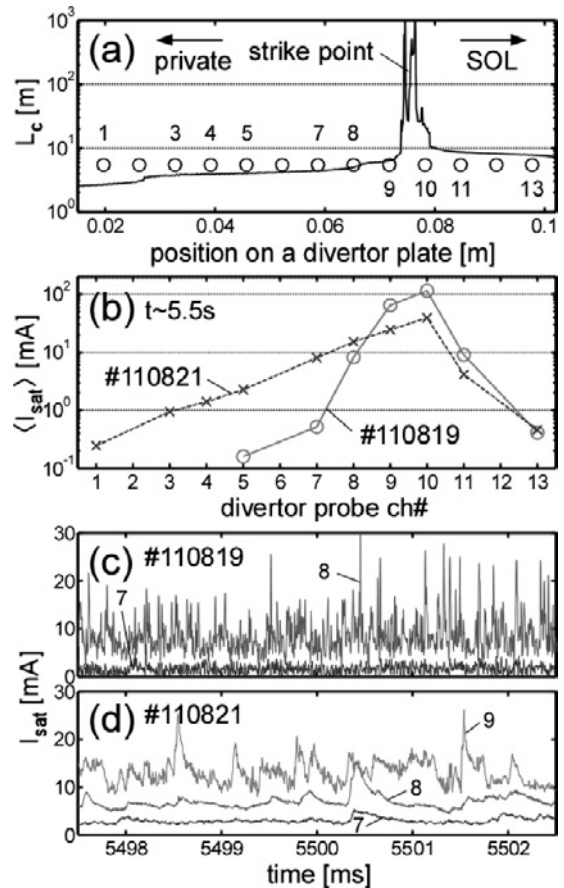


Fig. 2: (a) (L_c) distribution on divertor plate, (b) averaged I_{sat} at $t = 4, 5,$ and 5.5 s and (c) raw time series measured by divertor probe array.