§18. Toroidal Asymmetries of the Divertor Flux Induced by the Gas Puffing in LHD

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Gas puff injection is an ordinary fueling tool; in addition, it is also used to achieve large radiation loss in the edge region. In the future reactor, huge power flows into the SOL and divertor regions from the core. Therefore, not only fueling gas (D_2) puffing but also higher Z impurity (N_2, Ne, Ar, Xe, and Kr) seeding is expected as an effectual solution. To reduce peak heat flux effectively, understanding of impurity behavior is quite important.

From 16 cycle experiment in the LHD, we had installed Langmuir probe arrays on inboard divertor tiles at #2, 4, 6, 8, 10 toroidal sections. In each section, two tiles with probes were set at left and right hand sides, viewed from each O-port.

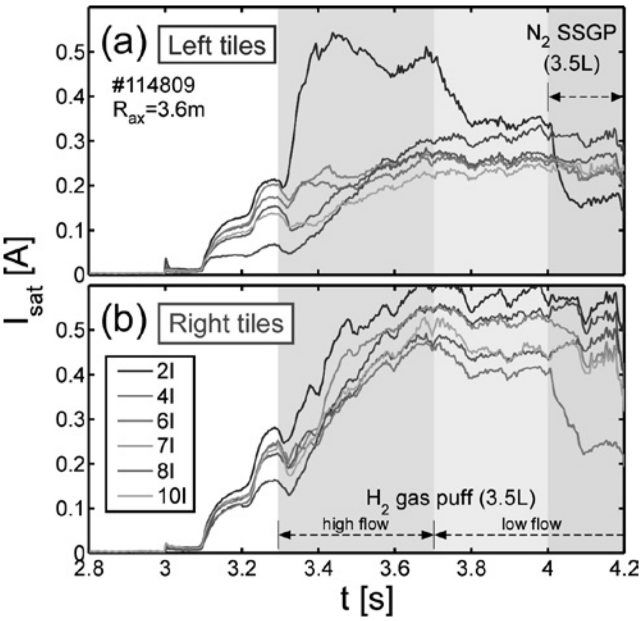

Fig. 1. Time series of I_{sat} measured at (a) left and (b) right divertor tiles viewed from O-port at several sections.

Figure 1 shows time series of ion saturation current (I_{sat}) at the left and right tiles. During a discharge (#114809), high flow rate H_2 gas puff was done from t = 3.3 s; then, the flow rate was decreased at t = 3.7s. In addition, supersonic gas puffing (SSGP)[1] of N_2 was carried out at t = [4, 4.2] s. In Fig. 1(a), I_{sat} at #2 section shows a unique time series among the left tiles. It rapidly increases after high flow rate H_2 gas puffing; then, it decreases and again decreases after the SSGP of N_2. On the other hand, among the right tiles in Fig. 1(b), all I_{sat} show similar change during the H_2 gas puffing. After that, only I_{sat} at #6 decreases at the N_2 injection period. Amplitude of I_{sat} is proportional to electron density (n_e) and square root of electron temperature (T_e). Therefore, observed increase and decrease of I_{sat} would dominantly reflect increase of n_e and decrease of T_e, respectively. In comparison between Figs. 1(a) and (b), I_{sat} at right tiles are basically larger than those at left tiles. This magnitude relationship depends on the toroidal magntic field direction; thus, it would be caused by the **ExB** flow in the edge region. These results imply that divertor flux is asymmetrically affected in toroidal direction according to the gas puffing. Moreover, it is found that the asymmetrical effect depends on the injection position, flow rate, gas species, and so on.

To clarify the positional relationship between the gas deposit location and the divertor probes, magnetic geometry was analyzed with KMAG code. Figure 2 shows magnetic field lines connecting to the left tile at #2 and right tile at #6, which had high sensitivity against the N_2 gas puffing. Divertor channels connecting to the two tiles are lying side-by-side between #2 and #6 sections. The SSGP was approximately intermediately positioned (3.5L) in toroidal direction. Because I_{sat} at #4 was not influenced from the N_2 seeding (see Fig. 1), N_2 deposition was localized in narrow area in toroidal and poroidal directions.

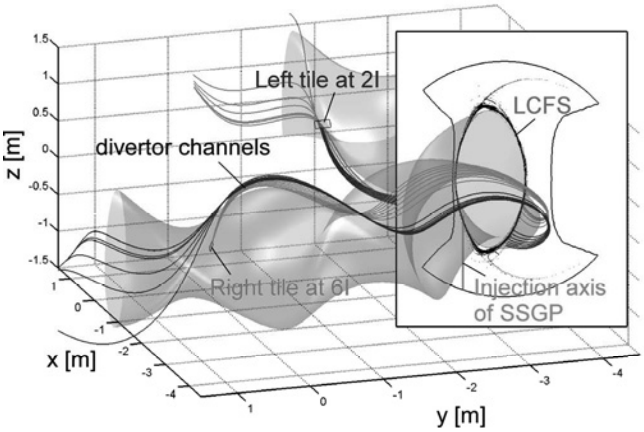

Fig. 2. Divertor channels connecting to the left (blue) and right tiles (red) at #2 and #4 sections, respectively. Poincaré plot for R_{ax} = 3.6 m is also depicted with injection axis of SSGP.

To reduce peak heat flux with radiation, locality is an unwanted effect. Decrease of I_{sat} at all measurement positions were observed with Ne gas puffing during the other discharge (#112897). We must explore globally effective condition of gas puff injection.

1) Murakami. A. et al.: Plasma Phys. Control. Fusion **54** (2012) 055006.