§14. Divertor Plasma Behavior during IDB-SDC Discharges

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Particle and heat loads to the divertor have three dimensional structures in LHD, and their profiles on the divertor plates are strongly related to the edge magnetic field lines structure [1]. In the IDB-SDC discharges, central beta (β_0) is enough large to modify the equilibrium drastically, and it affects edge magnetic field lines structure. Figure 1(a) shows the time evolutions of the ion saturation current (I_{sat}) profiles on a top divertor plate measured by the Langmuir probe array during IDB-SDC discharge (R_{ax} = 3.75 m, γ = 1.254, B_Q = 100%, B_t = 2.64T), and Fig. 1(b) shows the time evolution of central plasma pressure. Fueling pellets were injected every 50 ms from t = 0.65 s to 1.05 s. The I_{sat} profile is similar to that in the low beta discharge before pellet injections. After the termination of the pellet injection, IDB began to be formed and the central pressure increased. I_{sat} profile was largely changed from t=1.1 s to 1.6 s with increase and decrease of central plasma pressure. At t = 1.4s, two peaks appear at the positions of 60 and 84 mm. The profiles of the connection length of field lines (L_c) terminated at the divertor plate were calculated by the field lines tracing code for vacuum and IDB conditions, respectively. In the case of IDB condition, HINT2 code [2] was utilized for three-dimensional equilibrium calculation assuming β_0 = 4.1 %. L_c profile for IDB condition has peaks at the positions of 60 mm and 86 mm, and these positions agree with the Isat peaks positions in Fig. 1(a). Only the long field lines over several hundred meters approach the LCFS, and thus they are main channels for parallel transport. Therefore the peaks of particle and heat fluxes usually appear at the positions of L_c peaks. Therefore, it is suggested that the modification of the edge magnetic structure causes the change of the divertor particle flux profile on the divertor plates. On the other hand, to understand the mechanism of the movement of I_{sat} peak in Fig. 1(a) during the central pressure increasing and decreasing phase, L_c calculations in same manner are necessary for time step by step. Despite of the apparent modification of I_{sat} profile on the divertor plate, toroidal/poloidal particle deposition profile is prediced to be not largely modified with increase β_0 as shown in Figs. 3. It should be noted that in spite of the much higher line averaged density in the IDB-SDC discharge than that in the low beta discharge (factor 10 - 50), the sum of I_{sat} to the Langmuir probe array are similar. It suggests that the particle flux to the divertor is determined by the edge density and temperature those are similar values in both discharges.

[1] S. Masuzaki *et al.*, Nucl. Fusion **42**, (2002) 750.
[2] Y. Suzuki *et al.*, Nucl. Fusion **46**, (2006) L19.

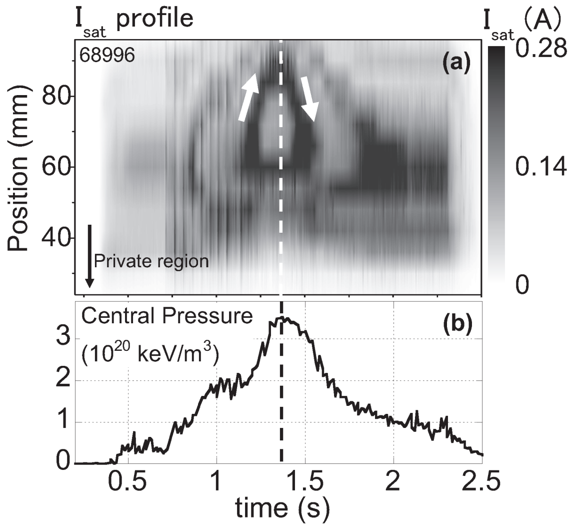

Fig. 1. Time evolutions of (a) the ion saturation current profile on a divertor plate and (b) central plasma pressure during an IDB-SDC discharge, respectively. The vertical axis of (a) is the position along the divertor plate edge, and the origin is the private side edge. Fueling pellets were injected every 50 ms from t = 0.65 s – 1.05 s.

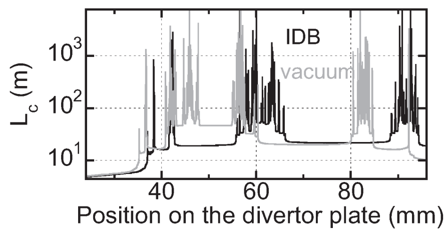

Fig. 2. Profiles of the connection length of the magnetic field lines on the divertor plate for vacuum (gray) and IDB (black) conditions, respectively.

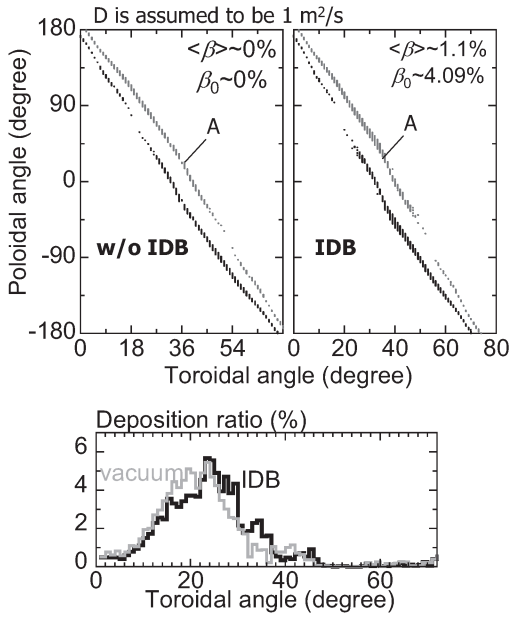

Fig. 3. (top) Simulated particle deposition profiles calculated by using field line tracing with the effect of diffusion. Poloidal angles of 0 and ±180 are outboard and inboard, respectively. (bottom) Toroidal angle distribution of particle deposition for the divertor trace “A” in top figures.