§41. Divertor Plasma Behavior in High Density Discharges in R_{ax}=3.75m Configuration

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As a result of the investigation of the relations between the edge and the divertor plasma, a divertor-detachment like phenomenon was observed in relatively high density regime in R_{ax}=3.75m, the 'thick' ergodic layer, configuration. Figure 1 shows the time evolutions of plasma parameters during a discharge with density ramp-up (#29265). T_e at the divertor plate ($T_{e,div}$) is almost proportional to T_e at the edge (ρ=0.94) until t=2.7sec, and at this time, $T_{e,div}$ starts to decrease faster than $T_{e,\rho=0.94}$. Electron density at the divertor plate ($n_{e,div}$) is also proportional to n_e at the LCFS ($n_{e,LCFS}$) and the line averaged density until t=2.7sec, and it starts to rise faster than $n_{e,LCFS}$. At t=3.2sec, $n_{e,div}$ start decreasing, though $\bar{n}_e$ and $n_{e,LCFS}$ still rise. This phase looks like divertor-detachment. Figure 2 shows the line averaged density dependences of plasma parameters in the discharge of #29265. Three density regimes are appeared. The regime-I, II and III look to be sheath limited, conduction limited and divertor-detachment regimes, respectively. Divertor heat flux can roughly estimated by $q_{div}=\gamma\Gamma_{div}T_e$, where γ is the sheath energy transmission factor, Γ_{div} is the particle flux. In Fig.2(c), q_{div} to an electrode of the Langmuir probe array is shown. In this case, γ is assumed to be 7, corresponding to $T_e=T_i$. In the regime-II and III, q_{div} is reduced, and it becomes about one third of maximum at $\bar{n}_e$ $=6\times10^{19}\text{m}^{-3}$. It seems favorable from the point of view of the reduced q_{div} operation. On the other hand, confinement is degraded in the regime-II and III. Figure 2(d) shows the $\bar{n}_e$ dependence of $W_p/P_{abs}^{0.41}$. It is proportional to $\bar{n}_e^{0.51}$ in ISS95 scaling. In the regime-I, the density dependence is conserved, though it degrades in the regime-II and III.

Onset of divertor-detachment needs T_e reduction in front of the divertor plates. In tokamaks, such reduction of T_e is mainly caused by impurity radiation. Figure 1(e) shows the line integrated radiation power measured by bolometer fan array. Relatively large radiation power is observed just in front of the divertor plate (chord #20), and the radiation power in the chord #19 is very small compare with that in #20. That means, localized radiation region exists just in front of the divertor plate. This radiation is decreased with reduction of $T_{e,div}$, and it is considered to be mainly caused by ionization of hydrogen. On the other hand, the radiation power in the chord #8 increases during the discharge. Therefore, $T_{e,div}$ reduction is seems to be not due to the divertor radiation, but the radiation in the ergodic layer.

The process of this phenomenon is not clear now, and is expected to be clear in the next experimental campaign.

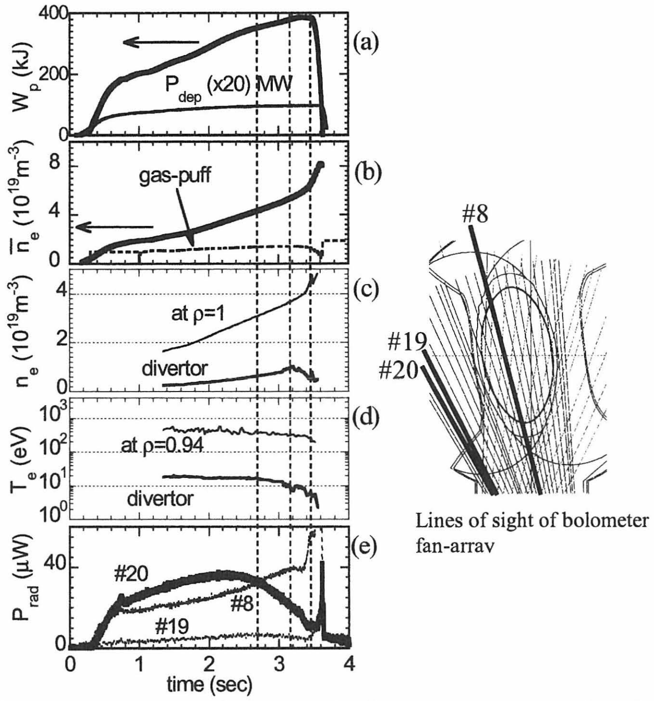

Fig. 1. Time evolutions of plasma parameters in the discharge of #29265. (a) Stored energy and deposited power. (b) line averaged density and gas-puffing. (c) n_e at the LCFS and at the divertor plate. (d) T_e at r=0.94 and at the divertor plate. (e) line integrated radiation power. Lines of sights of bolometer fan-array are shown in the insertion.

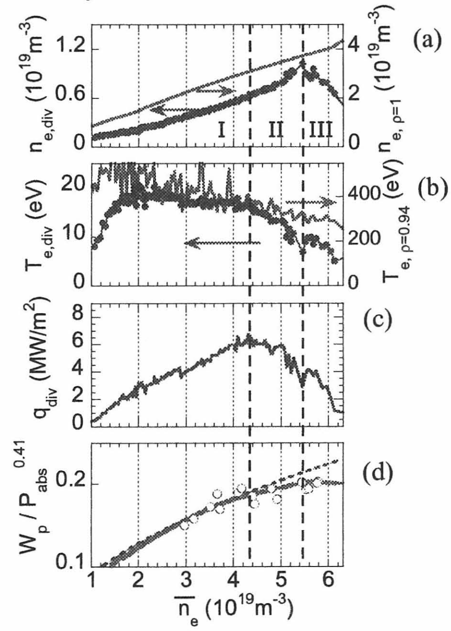

Fig. 2. Line averaged density dependences of plasma parameters. (a) n_e at the LCFS and at the divertor plate (#29265). (b) T_e at ρ=0.94 and at the divertor plate (#29265). (c) Heat flux to an electrode of Langmuir probe array (calculation, #29265). (d) Comparison of confinement property with ISS95 scaling. Dashed line is the reference line that has the same density dependence as ISS95 scaling ($\propto n_e^{0.51}$). Solid line is for the discharge of #29265. Open circles are for various discharges at the time of maximum stored energy.