§10. Extension of Plasma Duration Time with 1MW Power in LHD

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The maximum plasma duration time by using ICRF heating is 54 minutes and 28 seconds [1]. The injected ICRF power was only 0.4MW, though the goal of injected power in steady-state operation is 3MW. The duration time with the power more than 1MW was 525 seconds before the 11th LHD experimental campaign (2007-2008) [2]. Duration time decreased with the injected ICRF power. Plasma was terminated mainly due to the iron impurity contamination. Sparks from inner side of torus were often observed with the CCD camera monitoring 7I toroidal section close to 7.5U&L ICRF antennas.

Before the 11th LHD experimental campaign, in order to prevent the iron flake from entering into plasma, layer of iron on 500 divertor plates was grinded by 0.4mm. 80 carbon diverter plates located at inner side of torus near ICRF antennas were replaced with improved ones, since the heat load from ICRF antennas was large there. Moreover, flakes on all divertor plates were removed. Figure 1 shows the temporal evolution of temperature in a divertor plate before and after replacement of the divertor plate. The injected ICRF power from 7.5U&L antennas in the two discharges were almost the same. The increase of the temperature was suppressed by a factor of two with the adoption of the improved divertor plates.

Figure 2 shows the longest pulse discharge with the power over 1MW. 3.5U and 7.5L ICRF antennas were used for the minority ion heating. ECH of 0.1MW was also used. Magnetic axis position was swept in order to disperse the heat load on divertor plates. Electron density was kept at $6\times10^{18}m^{-3}$ by the feedback control. In the long pulse discharge of 525 seconds achieved before replacement of divertor plates, the maximum temperature in the divertor plates reached 500°C and it was not saturated, but in the discharge shown in Fig.2 the temperature was less than 300°C and saturated. However, at the end of this shot, the electron density increased abruptly and the plasma could not be sustained with 1MW power. It was thought that the iron impurity entered into plasma.

Figure 3 shows relation between pulse length and RF power. Open squares are data points before 11th LHD experimental campaign and the filled squares are new ones. The duration time was extended up to 1.5 times at the power level of 1MW.

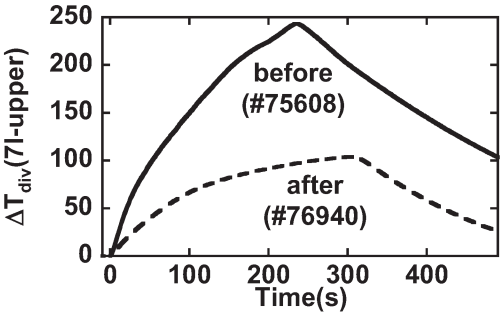

Fig.1 Variation of temperature in a divertor plate.

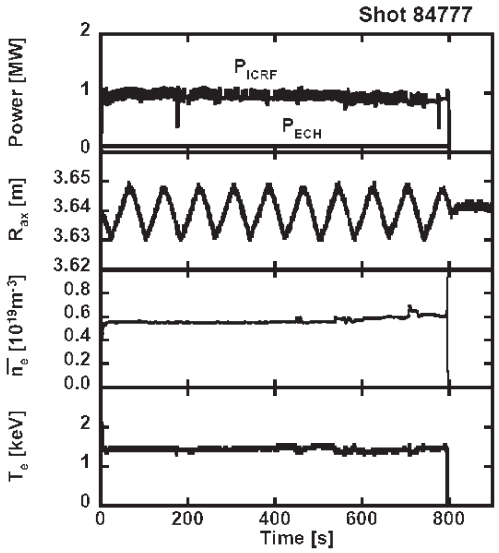

Fig.2 The longest discharge with the power of 1MW.

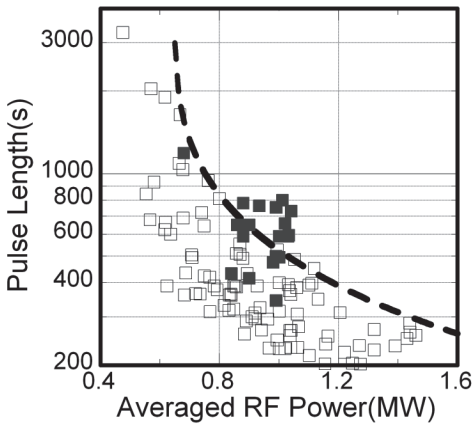

Fig.3 The relation of pulse length and RF power.

1) Saito, K, et al., J. Nucl. Mater. 363-365 (2007) 1323.
2) Saito, K, et al., 17th Topical Conf. on RF Power in Plasmas, AIP Conf. Proc. 933, 71.