§63. H/He Ratio in LHD as a Function of Wall Conditioning during Past 9 Years

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Wall conditioning in fusion devices is one of important experimental techniques in order to improve the plasma performance. The edge temperature rise based on the reduction of the particle recycling is the main purpose of the wall conditioning. In LHD the wall conditioning becomes more important because the baking temperature of the plasma facing components is limited to 95° due to a narrow space between the superconducting coils and the vacuum vessel. Therefore, a variety of the wall conditioning techniques has been carried out until now in LHD and the He glow discharge was finally selected as the main method. Although the He glow discharge was very effective to remove the hydrogen from the wall and divertor plates, a large amount of He was unfortunately appeared as the influx during H_2 discharge. It is then important to study the status of the plasma facing components after glow discharge cleaning.

Toroidal distributions of Hα and HeI visible emissions have been measured in LHD to monitor the uniformity of their influxes. In order to analyze the influx absolute emissions are certainly required in addition to edge n_e and T_e profiles. However, it is difficult to obtain such parameters in all discharges. Therefore, a new idea using H/He ratio is adopted to study the status of the wall conditioning. The emission rates of the Hα and HeI lines are generally functions of T_e and n_e, and then the ionization events per photon, which means the conversion rate from the emission to the neutral influx, are also functions of T_e and n_e [1], as shown in Figs.1 (a) and (b). This edge parameter dependence considerably disappears when the ratio of Hα to HeI emissions is taken into account (see Fig.1 (c)). The T_e where the neutrals emit the visible light typically ranges 20-40eV in $n_e \geq 2\times10^{13}cm^{-3}$. When the analysis is done in such the range, the ratio can be treated without consideration of the edge parameters.

The H/He ratio has been calculated in almost all discharges from 2nd cycle (1998) to 10th cycle (2006). Typical results are shown in Fig.3 for 2nd, 4th and 9th cycles. The different wall conditionings were carried out;

2nd: daily He glow and stainless steel divertor
4th: daily He glow and carbon divertor
9th: He glow only when required.

It is clearly seen that recent LHD operation (8th-10th cycles) excellently maintains good H_2 discharges with less He influx. On the contrary the operation with daily He glow (4th-5th cycles) always includes much amount of He in the discharges. In the 2nd cycle most of discharges were dominated by He. The drastic change in the 4th cycle originates in full operation of NBIs with hydrogen beams and hydrogen absorption by the carbon divertor plates newly installed from the 3rd cycle.

The result indicates that the present method can give good information on the status of wall conditioning.

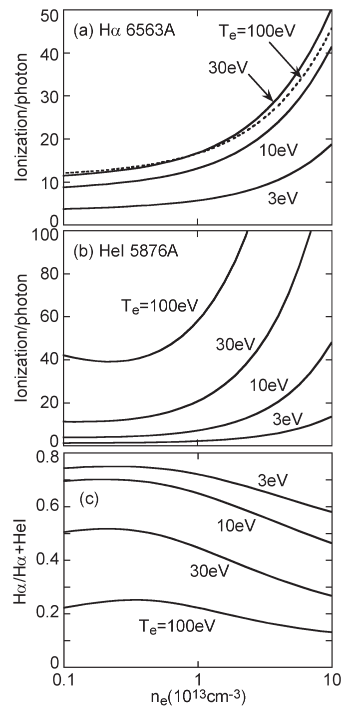

Fig. 1 Ionization events per photon for (a) Hα and (b) HeI emissions and (c) ratio of Hα to Hα+HeI.

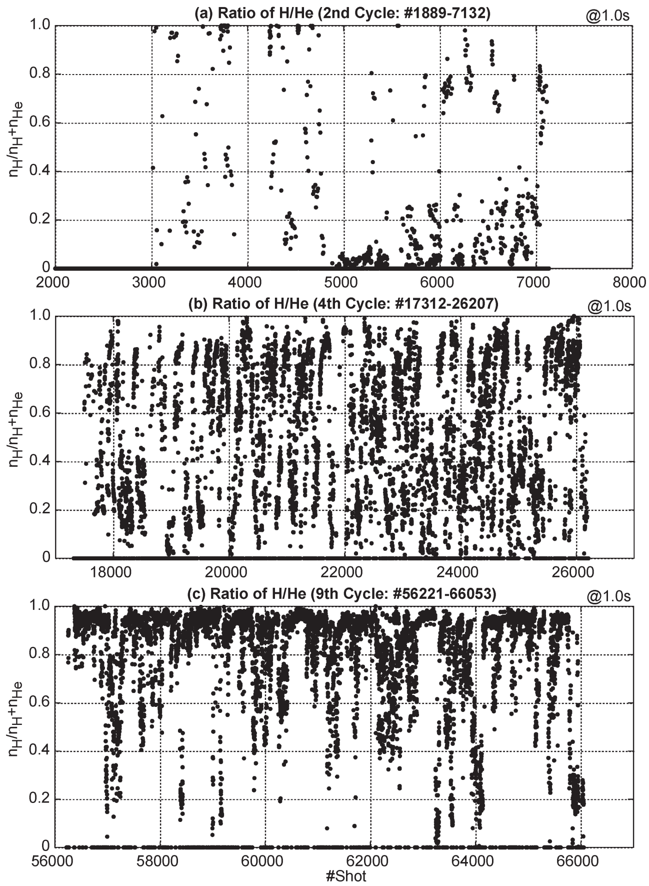

Fig. 2 H/H+He density ratio in (a) 2nd, (b) 4th and (c) 9th experimental cycles.

Reference
1) Goto, M. et al., PoP **9** (2002) 4316.