§3. Effective Utilizing Wall Conditioning by ICH Main Plasma Discharges for High T_i Mission Experiment

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It was found that the main plasma discharges of ion cyclotron resonance heating (ICH) reduce the wall recycling in the end of the 15th experimental campaign of LHD[1]. In the 16th campaign, by effectively utilizing the wall conditioning by ICH main plasma discharges in high ion temperature (Ti) mission experiments, records of high T_i missions were broken[2]. Additionally we were able to produce frequently plasmas with central T_i of around 7 keV which is the record in the 15th campaign.

The duration and operation sequence time of the ICH main plasma discharge for the wall conditioning is about 10 s and 3 min. In the ICH main plasma discharge, to prevent radiation collapse, additional heat source of electron cyclotron resonance heating (ECH) was superimposed. Figure 1 shows the relation between residual gas pressure which is the partial gas pressure just before discharge sequence and total input ICH energy from a start of the wall conditioning by ICH main plasma discharges. The residual pressure of hydrogen molecular (H_2) decreases with the total input ICH energy. After the residual H_2 gas pressure reduces to a few 10^{-6} Pa by ICH main plasma discharges, we can reproduce plasmas with the central T_i of around 7 keV. Thus the residual H_2 pressure is one of the empirical indicators for the degree of the progress of the wall conditioning. The residual He pressure increases because He gas is puffed for maintaining the ICH main plasma discharge.

Figure 2(a) shows time evolutions of the partial gas pressure of H_2 and He, and total input ICH energy from the start of each set of the wall conditioning in one day. The wall conditionings were performed four times, and the last one was conducted for the high T_i mission experiment in next day. The reduction of residual H_2 gas pressure was also read as mentioned above. During high T_i trial term, although the H_2 gas was not puffed, the residual H_2 gas pressure increased. This might be caused by carried hydrogen to LHD plasma by neutral beam (NB) and/or leaked hydrogen from NB line. With residual H_2 gas pressure, radiation of Balmer-alpha line and line-averaged electron density increase (Fig. 2(b)-(d)). These indicate that the deposition power of NB per ion density at the core region gradually reduces and the achieved central T_i decreases by repeating the high T_i trial discharges.

1) Takahashi, H., et al.: Annual report of National Institute for Fusion Science April 2011-March 2012, p11.
2) Nagaoka, K., et al.: Annual report of National Institute for Fusion Science April 2012-March 2013

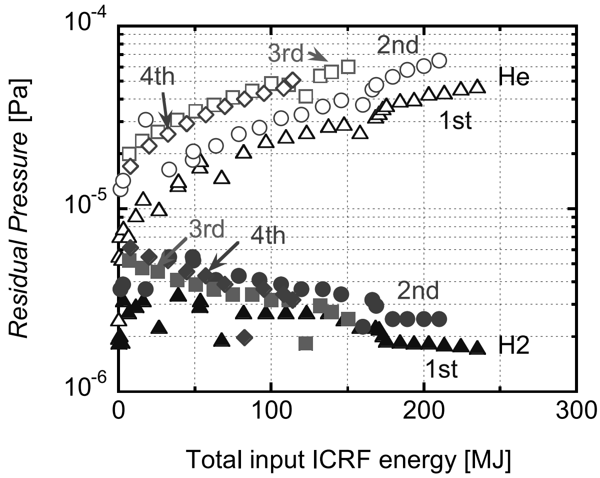

Fig. 1. Relation between residual gas pressure and total input ICH energy. Filled and open plots indicate the pressure of H_2 and He, respectively.

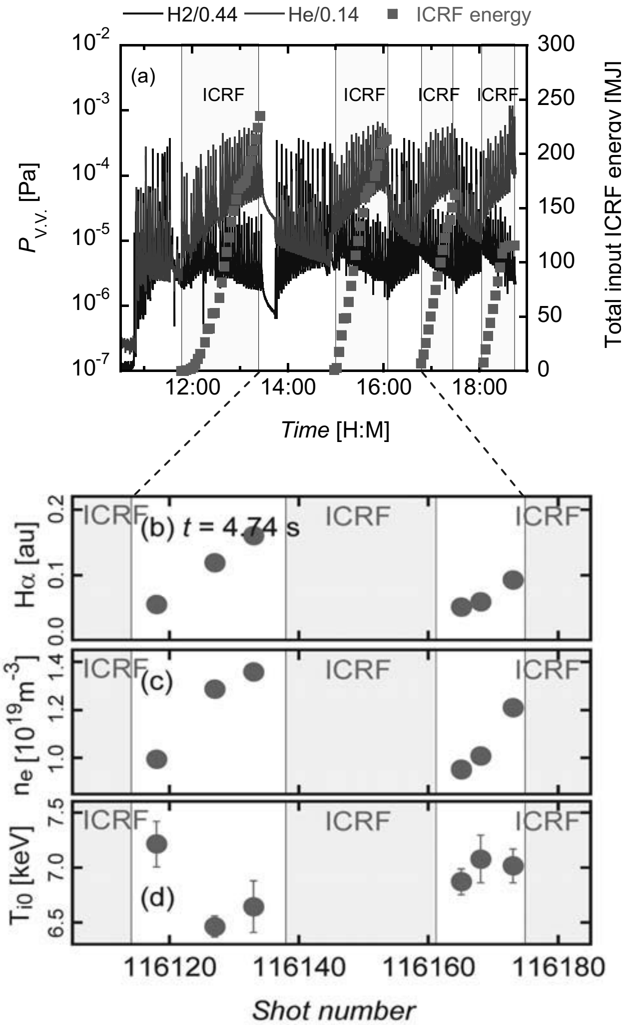

Fig. 2. (a) Time evolution of partial gas pressure (H_2 and He) and total input ICH energy. Shot histories of (b) radiation intensity of Balmer-alpha line, (c) line-averaged n_e and the central T_i.