§22. Study on the Exhaust Characteristics of the He Gas by LID in LHD

Mitarai, O. (Kyushu Tokai Univ.),
Sakamoto, M. (Kyushu Univ.),
Yoshinuma, M., Ida, K., Tanaka, K., Goto, M.,
Morisaki, T., Masuzaki, S., Ashikawa, N.

The ratio of the helium ash confinement time to the energy confinement time (τ_α*/τ_E) should be lower than 7 in the high temperature and low density operation of FFHR helical reactor. As this parameter is unknown in a helical system, it is quite important to measure helium particle confinement time experimentally. In the previous campaign, the charge exchange recombination spectroscopy (CXS) with positive NBI (40 keV) was used to measure He^{++} ions directly in the lower density regime than 1×10^{19} m^{-3}. The helium particle confinement time to the energy confinement time ratio was estimated as τ_α*/τ_E=5~6 by He gas puffing and decay measurements. However in the higher density regime, measurement was not possible due to the detector saturation by the strong light in the plasma edge by He gas puffing.

In this fiscal year, CXS has been used up to 1.5×10^{19} m^{-3} range. Frame just placed at the front of the detector was adjusted and its opening time was narrowed to reduce the total light. He gas puffing experiments have been done in the LID configuration with active pumping and B_o=2.64T and R_o=3.75. During NBI injection, modulation was applied to the beam to distinguish the H^+ line originated He^{++} ions by charge recombination in the core from the H^+ line in the plasma edge excited by electrons. In Fig. 1-(a) the modulated NBI and signals from the CXS are shown. It is clearly seen the signal difference between the NBI modulations in the higher density regimes of 1.5×10^{19} m^{-3}. We also examined what caused the signal during the NBI off period. We confirmed from Fig.1-(b) that the signal during NBI off period is due to from the plasma edge, not from the plum effect.

After subtracting the NBI off phase signal, He decay was obtained as shown in Fig. 1-(c). We estimate the He confinement time using the exponential decay waveform as using the relationship without the source term and without the plum effect:

$$\tau_\alpha^* = -\frac{n_{HE4}}{\left(\dfrac{dn_{HE4}}{dt}\right)} \qquad (1)$$

The decay time is obtained as τ_α^* = 456 ms at 4.05 m from Fig. 2. As the energy confinement time is estimated as τ_E~ 50 ms in the same discharge, the largest bound of confinement time ratio may be τ_α^*/τ_E~9. We note that 3D geometrical effect on the signal should be further taken into account.

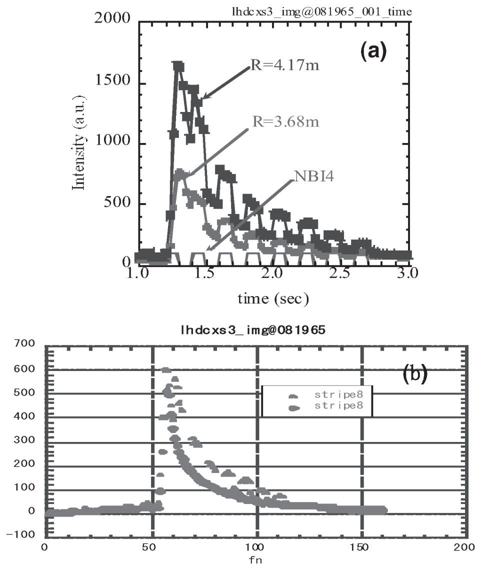

Fig. 1. (a) Modulated signals around 4686 Å on CXS (#81965). (b) Comparison of the detected signal during He gas puff with NBI (Red, #81965) and without NBI (Blue,#81966).

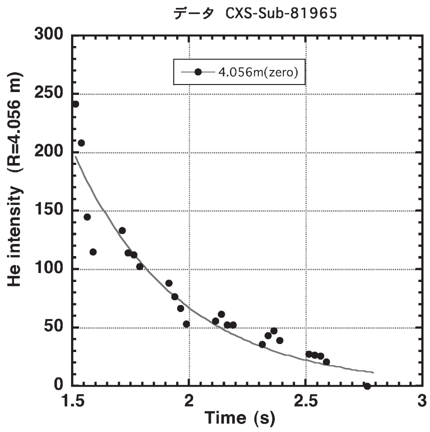

Fig. 2. He^{++} decay for various positions after He gas puff at R=4.05m when the plume effect is neglected for n=$1.5\times10^{19}$$m^{-3}$.

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