§26. Estimation of the He Particle Confinement Time 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., Sagara, A.

The ratio of the helium ash confinement time to the energy confinement time ($\tau_\alpha{}^*/\tau_E$) should be lower than 7 in the FFHR helical reactor. However, for maintaining ignition $\tau_\alpha{}^*/\tau_E$=3 is usually assumed. As such data are not yet available in any helical device, it is urgent to measure helium particle confinement time experimentally. In the previous campaign, the density decay rate was monitored to estimate the He particle confinement time assuming the charge neutrality condition. It was found that the small amount of hydrogen gas was injected as observed by H-alpha line during the He gas puffing pulse. This hydrogen injection makes the charge neutrality unclear during the He gas puffing. Therefore, in this fiscal year, the charge exchange recombination spectroscopy (CXRS) with positive NBI (40 keV) has been used to measure He^{++} ions directly. Without assuming the charge neutrality condition, it is possible to estimate the helium particle confinement time.

Experiments have been done in the LID configuration with active pumping and B_o=2.64T and R_o=3.75. To study the pumping effect on a helium confinement time, helium gas was injected in the density regimes of 1.5×10^{19} m^{-3}. However, as the detector of CXRS was saturated by the strong He light, the density was set to the low value of 8×10^{18} m^{-3} range to remove the detector saturation. 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 CXRS are shown. It is clearly seen the signal difference between the NBI modulations. Basically, the signal during the NBI off period comes from the plasma edge. As the ratio of the hydrogen and He neutrals, H/(H+He), is available from this fiscal year as observed in Fig. 1-(b), we can estimate the He source term S_{HE4}. We should estimate the He confinement time using the helium particle balance equation:

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

where $\tau_\alpha{}^*$ is the effective helium particle confinement time. The density decay waveform (Fig. 1-(c)) was also monitored by FIR interferometers. The base line of the density during He gas puffing is monitored in the separate shot without He gas puffing. Analysis is underway at present.

This work is performed with the support and under the auspices of the NIFS Collaborative Research Program NIFS06KLPP013.

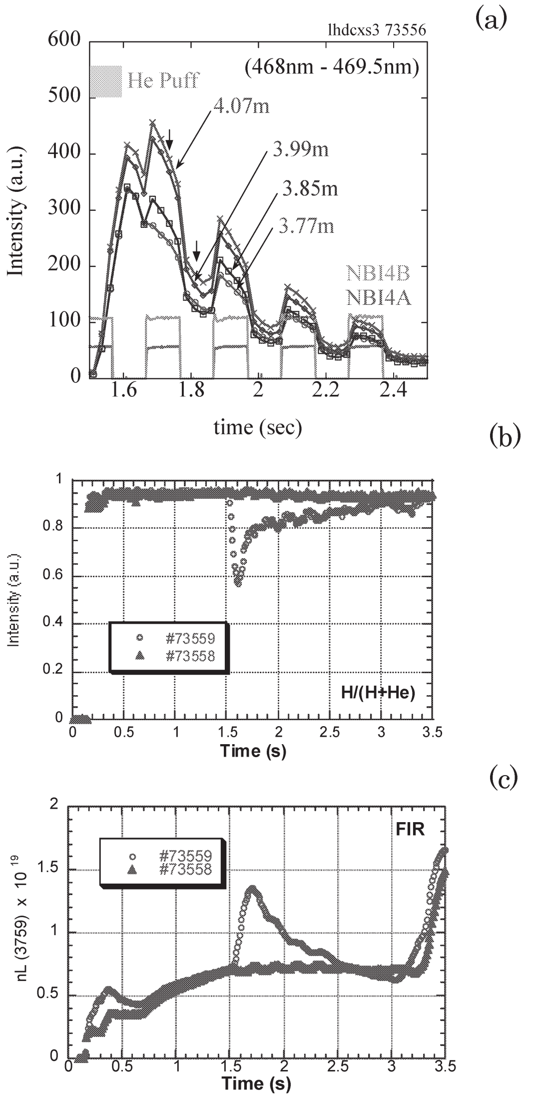

Fig. 1. (a) Modulated signals around 4686 Å on CXRS at various positions. (b) H/(H+He) neutral particle ratio. (c) Line density waveforms by far infrared interferometer with He gas puff (#73559) and without He gas puff (#73558).