Effect of pumped closed helical divertor on edge plasma behavior in LHD

T. Morisaki[1,2], G. Motojima1[1,2], T. Murase[1], H. Tanaka[3], S. Masuzaki[1,2], M. Shoji[1],
S. Oliver[4], and LHD Experiment Group

[1] *National Institute for Fusion Science, Toki 509-5292, Japan*

[2] *SOKENDAI, The Graduate University for Advanced Studies, Toki 509-5292, Japan*

[3] *Nagoya University, Nagoya 464-8603, Japan*

[3] *University of Wisconsin, Madison, WI, USA*

The closed helical divertor (CHD) with cryogenic pump was installed in LHD, aiming for the confinement improvement through the effective edge plasma control [1]. Due to the strong nonuniformity of helical divertor flux distribution, quite large pumping capability is available only with partial installation of CHD modules along the divertor striking trails. The measured pumping speed was 67±5 m^3/s which is identical to ~ 20 % of the LHD main evacuation system, and the pumping capacity was 58,000 Pa m^3, which is equivalent to 20,000 deuterium pellets or 20 days of gas amounts of high density experiments [2].

The CHD experiment has started since the last experimental campaign which was the first deuterium experiment in LHD, and initial results to demonstrate the CHD performance were obtained. In the experiment, the plasma was produced and maintained by NBI with moderate power of 10 – 20 MW. Fuelling was performed with pellet injection and/or gas puffing. It was found that about half of the fuelled gas was efficiently evacuated with pumped CHD, thus quite low recycling state was obtained, where effective particle confinement time is one order smaller than that without CHD pumping. This strong controllability for neutral particles also affects the formation of electron density and temperature profiles. In the repetitive pellet fuelled plasma, a peaked temperature profile was realized, and higher central temperature was obtained, compared to the reference discharge without pumping in the same fuelling condition. However, a hollow profile of electron density was formed, although continuous pellet fuelling was performed. This result was brought about by the combination of some physical processes, e.g., heat and particle transport, particle recycling, energy balance, pellet ablation, etc. At the conference, effects of the pumped CHD on profile formation are discussed, taking those process into consideration.

[1] T. Murase *et al*., Plasma. Fusion Research **11**, (2016) 1205030.

[2] G. Motojima *et al*., 2018 Nucl. Fusion **58** 014005.