# Initial Results of He Beam Experiments in LHD

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Helium (He, Z = 2) produced as a by-product of the deuterium-tritium (DT) fusion reaction could be a principal impurity in possible magnetically confined fusion reactors. Therefore, it is crucially important to control the amount of He as efficiently and effectively as possible in the magnetically confined high-temperature plasmas. Otherwise, a fusion burning condition cannot be maintained due to the fuel dilution and the temperature drop by a radiation loss. Therefore, to study the He transport and exhaust as close as possible to the situation of future fusion reactors, He fueling into the core region of magnetically confined high-temperature plasmas is highly necessary. To achieve such purposes, He beam experiments by utilizing a heating neutral beam injector (NBI) have been performed in some tokamaks. For example, in JT-60U tokamak, a fusion ignition condition, which is defined by the ratio of $\tau_{He}^*/\tau_E$ (here, $\tau_{He}^*$ and $\tau_E$ are the global helium confinement time and the global energy confinement time in the core plasmas, respectively), was evaluated as four (4) by utilizing the He beam [1]. However, given the actual situation (in fact, other impurities such as tungsten should be contaminated in the core plasmas) in future fusion reactors, $\tau_{He}^*/\tau_E$ should be as low as possible.

We have upgraded one (NBI#5) of the perpendicular LHD NBIs to inject the He beam for the first He beam experiment in stellarators. The radial profile of thermalized He particles was successfully measured with a charge exchange spectroscopy (CXS) diagnostic utilizing another perpendicular hydrogen isotope neutral beam [2]. As the initial results of the He beam experiments in LHD, it has been found that the observed He radial profile is generally no longer dominated by the central source, but by the recycling from the plasma-facing components, like the results from the JET He beam experiment with sawtoothing H-mode discharges [3]. And the increment of He density seems to be correlated with a divertor temperature. Analysis of thermalized He profile before and after He-NBI, with and without He beam extraction at NBI#5 might help separate the recycling- and beam-derived components. In fusion research, it is also essential to study the transport of high-energy He particles (alpha particles) in the core plasmas. The He beam can also be utilized for simulating such high-energy He particles. In LHD, Fast-Ion D Alpha (FIDA) diagnostic techniques [4] were successfully applied to measure the radial profile of high-energy He particles.

In this contribution, we will present an overview of such initial results of He beam experiments in LHD. And we will discuss the prospects of such an experiment in stellarators.

**References:**

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*This work is supported by a JSPS KAKENHI JP19H01881 and a budgetary Grant-in-Aid (ULHH007, ULHH012) of the National Institute for Fusion Science.