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Integrated Simulation of Deuterium Experiment Plasma in LHD

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The deuterium experiment project from 2017 is planned in LHD, where the deuterium NBI heating beams with the power more than 30MW are injected into the deuterium plasma. Principal objects of this project are to clarify the isotope effect on the heat and particle transport in the helical plasma and to study energetic particle confinement in a helical magnetic configuration measuring triton burn-up neutrons. In this paper, the deuterium experiment plasma of LHD is investigated by applying the integrated simulation code TASK3D and the 5-D drift kinetic equation solver GNET.

First, we perform the integrated transport simulation of deuterium plasma, n_D/(n_H+n_D)=0.8, by TASK3D code assuming a typical flat density profiles. We evaluate the heat deposition profiles for the multi-ion species plasma (e, H, He, C) by using the multi-ion version of GNET, which can treat the D and H ion heatings precisely. One-dimensional (1-D) diffusive heat transport equation with multi-ion species (H, He, C) is solved using the heat deposition profiles by GNET. It is found that the deuterium ion temperature reaches more than 6 keV with the isotope effect in the deuterium experiment plasma. On the other hand, the ion temperature reaches about 5 keV if we assume a pure hydrogen plasma. This result indicates that we will obtain about 20% higher ion temperature than that of the hydrogen plasma in the deuterium experiment of LHD if we assume an isotope effect on the turbulent transport based on the He/H experiment results.

Next, we perform the triton burn-up simulation of the deuterium experiment of LHD and evaluate the D-T fusion reaction rates to compare with the experimental results of the 14 MeV neutron diagnostic system. It is found that more than 7.0x10ˆ11 mˆ-3/s of 14MeV neutrons are generated by the D-T fusion reaction at the plasma center. We also find that the confinement of the 1MeV tritons is improved by the strongly inward shifted configuration of LHD (R_ax=3.5m). and that the triton burn-up ratio, which is the ratio of 14 MeV to 2.5 MeV neutron production, is increased to about 0.1%, which is still smaller than that of the large tokamak experiment results.

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Primary author: Dr MURAKAMI, Sadayoshi (Departement Nuclear Engineering, Kyoto University)

Co-authors: Mr SAKAI, Akira (Department of Nuclear Engineering, Kyoto Univ); Prof. FUKUYAMA, Atsushi (Kyoto University); Dr NAKANO, Haruhisa (National Institute for Fusion Science); Dr TOMITA, Hideo (Department of Quantum Engineering, Nagoya Univ); Dr TAKAHASHI, Hiromi (National Institute for Fusion Science); Dr YAMAGUCHI, Hiroyuki (Department of Nuclear Engineering, Kyoto Univ); Dr IDA, Katsumi (National

Institute for Fusion Science); Prof. NAGAOKA, Kenichi (National Institute for Fusion Science); Dr TANAKA, Kenji (National Institute for Fusion Science); Dr OGAWA, Kunihiro (National Institute for Fusion Science); Prof. YOKOYAMA, MASAYUKI (National Institute for Fusion Science); Prof. OSAKABE, Masaki (National Institute for Fusion Science); Mr HOMMA, Masayuki (Department of Nuclear Engineering, Kyoto Univ); Dr YOSHINUMA, Mikirou (National Institute for Fusion Science); Dr ISOBE, Mitsutaka (National Institute for Fusion Science); Mr MAETA, Shoo (Department of Nuclear Engineering, Kyoto Univ)

Presenter: Dr MURAKAMI, Sadayoshi (Departement Nuclear Engineering, Kyoto University)

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