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Deuterium experiment on LHD and its contribution on Energetic Particle Physics in Toroidal Plasmas

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Deuterium experiment was started since March, 2017 on the Large Helical Device (LHD). One of the objective of the deuterium experiment is to explore the physics of energetic particles (EPs) in helical plasmas, but the experiment is also beneficial to the comprehensive understanding of EP physics in toroidal devices.
The EP physics study on LHD is characterized by the use of negative-ion based energetic (180keV) and powerful (15MW) Neutral Beams (NBs). The wide operational range in magnetic field strength (0.5T-3T) and operational electron density (1017-1021 m-3) also characterize the LHD as a good platform for EP physics study. These features enable us to explore the EP driven instability study in wide area of EP velocity normalized by the Alfvén velocity and EP beta value [1]. Although LHD has these nice character, the EP studies on LHD during its hydrogen-phase experiment [2,3] was limited because the global EP confinement evaluation was not possible and the validation of EP simulation codes, such as GNET, MORH and etc [5,6], with experimental data were limited. The neutron diagnostic, which becomes possible by starting deuterium experiment, is a powerful tool for evaluating the EP confinement property because the cross section of D(d,n)3He reaction is monotonically increasing with the relative energy between reactant particles up to 1MeV.
In the deuterium experiment on LHD, the maximum neutron emission rate of 1.9x1016 n/s is expected and the most of the neutrons are emitted by the reaction between bulk ions and energetic particles produced by NBs[4]. Using the benefit of neutron diagnostics, the validation of EP simulation codes was started and the database construction using diffusive model of EP transport was also started for the integrated simulation code, TASK3D [7]. These activities are beneficial not only for the community of stellarators but also for that of tokamaks because the LHD is the only machine where the high energy Negative-ion based NBs (N-NBs) are in operation, which will be the main heating device in ITER and/or future DEMOs, and can be used as a platform to evaluate the heating, the current drive and diagnostics using N-NBs if these codes are validated.
In the presentation, the current status of LHD deuterium experiment and the results related to EP physics studies will be shown.

References

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