Contribution ID: **117** Type: **Invited Plenary**

Prospect towards steady-state helical fusion reactor based on progress of LHD project entering the deuterium experiment phase

Thursday 8 June 2017 08:40 (40 minutes)

Large Helical Device (LHD) is one of the world-largest superconducting fusion experiment devices, having demonstrated its inherent advantage for steady-state operation since the start of experiments in 1998. LHD has also demonstrated reliable operation of the large-scale superconducting magnet system for more than eighteen years. Development of the challenging heating systems, such as negative-ion-based NBI, high-power and high-frequency ECH and steady-state ICH, have led to achieving high-performance plasmas, individually, with Ti of 8.1 keV, Te above 10 keV, volume-averaged beta of 5.1 %, and steady-state operation with the world-record total injected energy of 3.36 GJ.

LHD has progressed to the next stage, that is, the deuterium experiment starting in March 2017, which should further extend plasma parameters towards reactor-relevant regime. For establishing firm basis for designing steady-state helical fusion reactor, advanced physics research, such as on isotope effect, energetic particle confinement, and plasma-wall interaction, will be intensively performed in the deuterium experiments. In an engineering aspect, the upgrade of NBI system has been executed in preparation to the deuterium experiment, and it should contribute to future NBI development for fusion reactors including ITER. For enhancement of the particle control, the closed divertor system has been installed with pumping capability. Diagnostics for neutron measurements are newly developed and installed for the deuterium experiment.

Aligned with all the progress of LHD project in terms of engineering and physics aspects, the conceptual design activity of the LHD-type helical fusion reactor, FFHR-d1, has been programmatically conducted. In parallel to the design study, engineering R&Ds for the component development have been performed, including those based on employing challenging ideas such as high-temperature superconductor, liquid metal ergodic divertor, and molten salt breeder blanket.

The present status of LHD project entering the deuterium experiment phase is overviewed with an emphasis on the engineering aspects, and then the engineering R&D activities towards steady-state helical fusion reactor are presented.

Eligible for student paper award?

No

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Session Classification: R.PLN: Plenary R

Track Classification: Stellarators