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Initial result from LHD deuterium experiment

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After the completion of the facilities and the legal procedure for the safety issues, the deuterium experiment was started since March 7th, 2017. The objectives of the deuterium experiment are [1],[2]:

(1) to realize high-performance plasmas in helical systems by confinement improvement and by upgraded facilities;

(2) to study the isotope effects on plasma confinement in toroidal plasma devices [3], [4], [5], [6], [7];

(3) to demonstrate the confinement capability of Energetic Particles (EPs) in helical systems; and

(4) to extend the research on the plasma-material interactions with long time scale using the benefits of the LHD's steady state operation ability.

The first plasma with electron temperature of 6 keV and total neutron number of 6.5 × 10^{10} was produced by ECH. From the next day, two positive-ion based NB was injected with deuterium and the plasma parameters rapidly increased, then the ion temperature T_i of ~ 9.1 keV was obtained only 1 week after the first deuterium shot. In this discharge, some different features from those in the hydrogen plasma, in addition to the achieved T_i, were observed, i.e., the T_i, gradient is steeper at the central region and the sustainment time for the high T_i phase is longer than in hydrogen plasmas. As for the T_i gradient, although strong flattening was observed in the high T_i hydrogen plasma, neither flattening nor hollowness was seen in the deuterium plasma. The duration time for keeping the high T_i state was much longer than that in the hydrogen plasma, which may be closely related to the longer decay time of the central carbon density after the carbon pellet injection, suggesting the different impurity transport property in the deuterium plasma from that in the hydrogen plasma. This high T_i regime is often interrupted by the sudden appearance of the energetic particle driven resistive interchange mode [8], which was known from the correlated signals between magnetic probes and newly installed neutron diagnostics which provide information about density of the high energy particle in the core region.

Better energy confinement was observed in the EC heated deuterium plasma, supporting the isotope effect on the trapped electron mode, which is predicted by a gyrokinetic simulation [9], to be suppressed more in deuterium plasma in the higher collisional regime. Higher T_e was actually obtained with lower ECH power in the deuterium plasma.

In this conference, an overview of the initial results of the deuterium experiment is presented.

References

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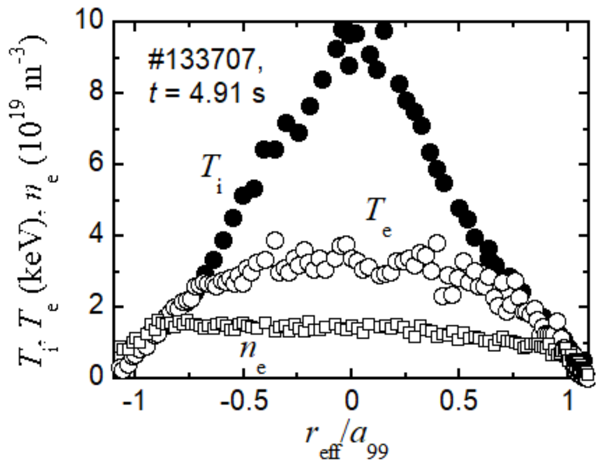

Figure 1. Radial profiles of ion temperature T_i, electron temperature T_e and electron density n_e when the highest T_i was obtained.