§53. Works Preparatory to Long-Pulse/Steady State Experiments

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One of the aims in the LHD project is to demonstrate a long-pulse, steady-state operation of a high temperature plasma. The goal in the early stage of the project is to sustain a steady state discharge for more than 1 hour with 3 MW heating power. All the coils are superconducting, the vacuum vessel and the divertor plates are cooled by water, and long pulse operation in heating devices (ECH, ICRF, NBI) is available.

One of the concerns for this operation is an impact of residual microwave power upon rubber gaskets and windows, because a fraction of the heating power will be provided by 84 GHz microwave in ECH mode, and the gaskets and/or window could be damaged by absorbing the microwave power. In order to avoid an unexpected catastrophe during the experiments due to the power absorption by gaskets and windows, a series of tests has been carried out for several types of gate valves and windows with 84 GHz microwave incidence. The results suggest that (1) a 0.2 mm gap of SS flange in front of the gaskets is sufficient to prevent the power penetrating into the gasket region, (2) a mesh of 100 wires/inch is effective to reduce the power flow to the windows or the gate valves, (3) a fused quartz window absorbs much less power than a covar-seal window does, which is popular as a view window. A simplified detector for the microwave is developed in order to measure the residual power distribution outside a plasma in the vacuum vessel.

Major efforts will be dedicated to realize a high temperature, long sustained plasma in the beginning phase of this project. Scientific and engineering research programs will be important after it will be achieved. There are several issues to be investigated with the long-sustained operation. These programs have been under discussion. Proposals are categorized with the following items:

(1) real time changing the magnetic field configuration,
(2) erosion/deposition and net erosion study on divertor plates,
(3) particle and heat removal and control.

The magnetic configuration could be changed slowly during a single shot, which would give us an opportunity to investigate dependencies of plasma parameters on the configuration more clearly than in short pulse discharges with a fixed configuration. The net erosion study is important for designing fusion devices in future. Long time discharges are effective and essential to get a precise and reliable database in this issue. Time constants relating to the particle and heat control is expected to be long, at least longer than a few hundreds minutes. The divertor is an essential tool for this control. Particle exhaust by widely distributed helical divertor is one of the crucial issues for the long-pulse operation.