§44. Experimental Study of Compact Plasma Wall Interaction Experimental Device (CPD)

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1. Introduction

Spherical tokamak (ST) is a candidate for cost-effective fusion reactor and the improvement of the plasma performance of ST has been tried in many institutes. University of Tokyo has been executed the RF heating experiments on TST-2. The plasma start up without ohmic heating coil by RF current drive has been developed on LATE constructed by the experimental group of Kyoto University. One of the effective ways to provide fuel into plasma is compact toroid (CT) injection, which has been proceeded in University of Hyogo. Some fast CCD cameras are installed on several toroidal devices by the collaborated study organized by Hiroshima University. Steady state operation is also a key issue to realize a fusion reactor. In the research of tokamaks, steady state operation will become crucial point and the trials to do long pulse operations in a large tokamak, JT-60U started. The experimental group of Kyushu University has many experiences to sustain the plasma current by use of RF current drive. They proposed that particle control including in the plasma wall interaction (PWI) was crucial. In NIFS, rotating limiter to control the recycling of Hydrogen was proposed.

A compact ST called compact plasma wall interaction experimental device (CPD) was constructed to resolve the complicated issues concerning steady-state operation of magnetic fusion devices under the framework in by-directional collaboration program organized by NIFS and the collaborated program in the experiments are started in 2005.

2. Plasma start-up by use of RF

Plasma start-up experiments without the assistance of ohmic heating (OH) were carried out. RF system of 8.2 GHz in frequency and 200KW in power was used as a heating source in the experiments. Typical waveforms are shown in Fig. 1. The injected power of RF is gradually increasing with time from 0.12s to 0.16s and current jump phenomena was observed around 0.15s, where the value of plasma current jumps up from 1kA to 2kA for 3ms under the constant vertical magnetic field, Bv. The enlarged waveform of plasma current around current jump is shown in Fig. 1. The signals of Hα and OII measured with spectroscopy do not change so much during the current jump. The phenomena are also observed on LATE in Kyoto University, which show that the current jump is not atypical.

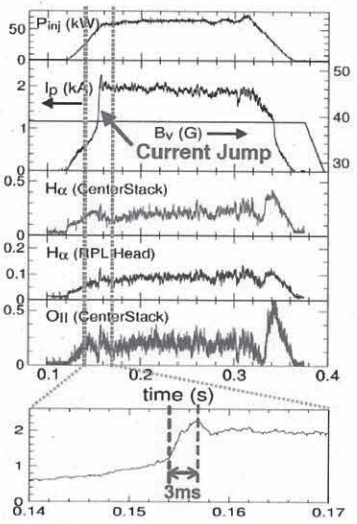

Fig. 1 Typical waveforms in plasma start-up by use of RF. Injected RF power, plasma current and vertical magnetic field, Hα near the center stack, Hα at the head of rotating limiter, OII near the center stack are shown. The bottom figure is the enlarged waveform of plasma current around current jump.

3. Injection of CTs to CPD by use of the CT injection system

The CT injection system was installed on 2005 and the CT injection experiments were started on 2006. To make sure the effect of magnetic field to the CT production, the CT injection to CPD was carried out without plasma. The temperature increment due to the impact of CT to a target plate, which made of SUS and installed in front of CT injection port, was measured with IR camera. The distance of the target plate is about 10cm from the injection port of CT. The center position of the temperature increment was up-shift with the increasing of magnetic field as shown in Fig. 2. This means that the orbit of CT in the vacuum vessel is strongly affected by toroidal magnetic field.

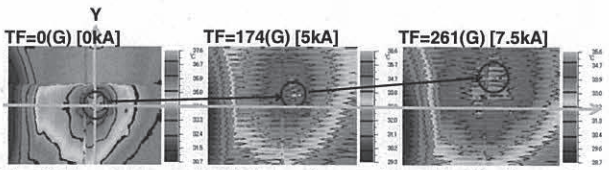

Fig. 2 The magnetic field dependence of the distributions of temperature increment due to the impact of CT on the target plate measured with IR camera is shown. The magnetic fields corresponds to 0 G(left), 174G(middle), 261G(right) at the target plate.

4. Summary

Many researchers were collaborated to execute the CPD experiments and the knowledge derived form CPD experiments will be utilized in the forthcoming QUEST experiments.