§5. Study of Current Decay Time during the Discharge Termination of Plasmas in Toroidal Magnetic Field

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Purpose;

Toroidal plasma current would affect the toroidally confined plasmas by magnetic field through the MHD instabilities, the release of the electro-magnetic energy, and so on. The purpose of this study is the adept understandings of the termination mechanism and the behavior of the toroidal plasma current during the discharge termination from the viewpoints of the interaction between the properties of plasma confinement and MHD equilibrium through the comparative analysis on the current behavior during the termination among some magnetic confinement systems which have various MHD equilibrium properties. In addition, another purpose is the promotion of the research activities related with the MHD equilibrium and instability in universities by utilizing their experimental devices.

Approach and Results;

The research subject and the researchers are organized into the following three subjects and groups by topic; improvement of the prediction code, development of the identification methods of MHD equilibrium in experiments and analysis of the current decay behavior. Figure 1 shows the organizational chart.

(1) Improvement of the prediction code

The toroidal current time evolution analysis code based on a 1.5D (dimensional) transport analysis code taking the time evolution of the MHD equilibrium into account, DINA[1], is improved to take the electron temperature profile time evolution during the current quench into account. The code is applied to the analysis of the time evolution of the toroidal current during the current quench phase in a Ne gas-puff induced JT-60U disruption discharge. A MHD equilibrium analysis code taking the time evolution of the direct interaction between the coil currents and the plasma current, TSC[2], is improved to apply it the analysis of the current time evolution during the vertical displacement events (VDE) for the various tokamak plasmas. The first application are being done to the QUEST (Kyushu Univ.) plasmas.

(2) Development of the identification methods of MHD equilibrium in experiments

An identification method of the plasma boundary directly by the magnetic probes located at outside of plasmas, CCS (Chauchy-Condition-Surface) method[3], is improved to reduce the necessary magnetic sensor number to reconstruct the plasma boundary identification with enough accuracy. The next target of the work is to confirm the capability by using the presently installed magnetic sensors in LHD, and to optimize the location and the number of the magnetic probes in the actual LHD configuration. In addition, the CCS method is extended to identify the eddy current profile directly evaluated by the magnetic probe signals in the RELAX plasmas which is a RFP type device, where the eddy current is induced in the quasi-steady to maintain the MHD equilibrium.

(3) Analysis of the current decay behavior

The HYBTOK-II in Nagoya univ., which is a main experimental device in this research activity and stopped the operation last year because the building where the device is located was under a renovation, re-starts the experiment this year. Because the know-how of its operation is not succeeded to the next generated students while the device operation stopped, a collaborator of this research activities give the know-how to the graduated students in Nagoya univ., other collaborators give the lecture on the MHD field. As an instructive subject of the operation of the HYBTOK-II, the study on the effects of the resonant magnetic perturbation (RMP) on the current decay time during the disruption is selected, and the related experiment has been done. The collaborators in Tokyo Institute of Technol. make the experiments related with development to suppress the VDE by a helical field in the HYBTOK-II.

2 subjects are proposed as the NIFS collaborated programs in 2014 Fiscal year from the discussion through the collaboration related with the above mentioned topics, (2) and (3), that is, the experimental study on the penetration of the RMP and the confirmation of the identification method of the eddy current on the experimental device. In addition, the education over a university as mention in the above (1) and (3), that is, the students are taught the usage of the calculation codes and the how-to of the operation of the devices by the researchers belong to the other universities and/or the institutes, is another result, which would lead to the pushing-up the number of the researchers related with the field on the MHD equilibrium and the instability.

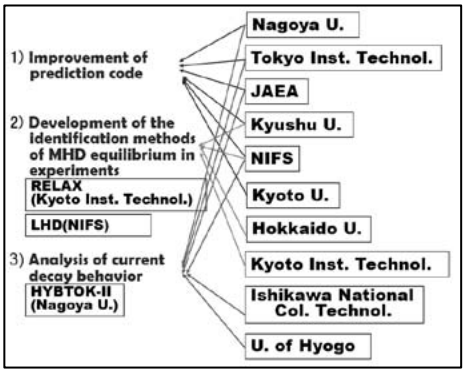

Fig. 1. Organizational chart

1) R.Hayrutdinov and V.Lukash, J. Comput. Phys. 109 (1993) 193.
2) S.C. Jardin et al., J. Comput. Phys. 66 (1986) 181.
3) M. Itagaki et al., Plasma Fusion Res., 8 (2012) 1402134.