5. Network-Type Collaboration

The NIFS General Collaboration has been basically based on a one-to-one (especially, NIFS-to-University) collaborative system. Some collaborations, however, require the use of more than one experimental facilities in different universities and institutes to achieve their objectives. For example, a special sample that was prepared in a university is exposed to plasmas produced in LHD, then it should be analyzed using a diagnostic instrument in another university. In the network-type collaboration, this type collaboration becomes practicable by admitting travel expenses for moving between universities, which have not been admitted as a rule in the general collaboration projects.

Since FY 2011, NIFS has employed this network-type collaboration on trial as one of nine categories of the General Collaboration. Three projects of the different fields were accepted in FY 2011 for the first time and were continued in FY2012. Two more proposals were newly accepted in FY2012. The researches of those five proposals were continued in FY2013. Four projects were finished in FY2013, and three new projects were proposed and accepted in FY2014. Challenges of these collaborations spread over various fields.

Before starting the collaborations, a collaboration plan for the year should be submitted. They were including the items how the collaborations between research institutes were planned, i.e., who goes when and where by what kind of purpose.

The major achievements of these projects are outlined below. First proposals (#1 below) is the continuing subject since FY2012, and three proposals (#2 - #4) are new proposals in FY2014.

1. "RF Plasma Generation and Current Ramp-up Experiments on Spherical Tokamaks", Takase, Y.(Univ. of Tokyo), et al.

The purpose of this research is to investigate experimentally the physics of spherical tokamak plasma formation and plasma current ramp-up using radiofrequency (RF) waves as network collaboration among Univ. Tokyo, Kyoto Univ., Kyushu Univ. and NIFS. Compared to advancing research independently on each device, it becomes possible to make more efficient progress towards developing understanding of universal physics by unifying the results obtained on both devices using complementary methods, utilizing the network-type collaboration framework. In FY2014, the plasma flow and ion temperature were measured and compared each other using the CIII line emission (464.7 nm, C2+) in LATE (Kyoto Univ.) and TST-2 (Univ. Tokyo) plasmas, which are sustained by the electron cyclotron wave (ECW) and the lower hybrid wave (LHW), respectively. The same Czerny-Turner spectrometer with 1 m focal length and an instrumental width of 0.03–0.04 nm were used under the collaboration.

2. "MHD Equilibrium Dynamics due to the Rapid Change of Plasma Parameter and the Interaction with the Confinement", Nakamura, Y.(Kyoto Univ.)

A purpose of this activity is to establish an algorithm of the analysis and the prediction of the 3-dimensional MHD equilibrium dynamics taking the rapid change of the plasma parameters (the change of the plasma current and the pressure) into account. Another purpose is to encourage the experimental MHD research activities in the small laboratory of the universities through the collaboration on this research with the experimental devices belong to the laboratory.

The collaboration methods and results in the fiscal year are summarized as follows.

(1) Development of the 3D MHD equilibrium code taking the time evolution into account: A MHD equilibrium calculation method used by a typical 3D MHD equilibrium calculation code (VMEC) for a typical ITER operation with the axisymmetric configuration has been proposed.

(2) Modeling of the 3D effect and the eddy current, and proposal of the experimental methods for the validation: The experiments for the validation will be done in the RFP device in Kyoto Inst. Tech. (RELAX) and the tokamak device in Tokyo Inst. Tech.

(3) Education of the graduated students by the all researchers in this activity: The courses of the education related with this activity is as the follows; (a) Usage of the time evolution of the 2D MHD equilibrium calculation code (b) Knowhow to operate the small tokamaks, to make the diagnostics and the experimental analyzing procedure (c) Usage of the direct identification method of the eddy current.

3. "Observation and Control of Self-governing Events in Compact Torus Plasmas", Inomoto, M. (Univ. of Tokyo), et al.

This network-type collaboration program promotes collaborative research among small-scale and high-beta plasma studies performed in university research groups to enhance their research efficiency and to develop young human resources.

Seven collaborative research subjects regarding high beta compact torus plasmas such as spheromak (SPH), field-reversed configuration (FRC), reversed field pinch (RFP) and spherical tokamak (ST) have been promoted among four groups performing experimental studies (Univ. Tokyo, Univ. Hyogo, Kyoto Inst. Tech., Nihon Univ.) and three groups performing theoretical/numerical studies (Gunma Univ., JCGA, NIFS).

Individual achievements are described below.

(1) CT injection for helicity injection and fuelling (Nihon U., U. Tokyo)

(2) Translation and spontaneous rotation of FRC (Nihon U. and Gunma U.)

(3) Soft X-ray emission in magnetic reconnection events (Kyoto Inst. Tech., U. Tokyo)

(4) Theoretical and experimental approach for two-fluids effects (Kyoto Inst. Tech., JCGA, Hyogo U.)

(5) Novel D-^{3}He reactor concept (Gunma U., Kyushu U.)

(6) Coaxial helicity injection for spherical tokamak start-up (Hyogo U., Kyushu U.)

(7) Numerical research of FRC merging formation (NIFS, U. Tokyo)

4. "Study on Hydrogen Retention/Desorption Behavior Using Long-Term Samples Mounted on the Plasma-Facing Surface in LHD", Nobuta, Y. (Hokkaido Univ.), at al.

The surface of plasma-facing wall is modified by plasma-wall interaction (PWI) phenomena, such as erosion, redeposition and irradiation damage. Long-term samples mounted on plasma-facing surface in fusion devices are useful to investigate the modification of plasma-facing surface. The modification of the wall surface significantly influence the retention/desorption behavior of discharge gases. The purpose of this study is to understand the gas recycling behavior of the modified wall surface using long-term samples. Samples (stainless steel and silicon substrate) were mounted on the top of the helical coil and close to the outer divertor tiles during the 17th experimental campaign in LHD. The depth profiles of atomic composition were investigated by the Auger electron spectroscopy (AES, Hokkaido U.) and a technique of glow discharge optical emission spectroscopy (GDOES, NIFS). These results indicated that the situation of deposition and erosion in LHD is significantly different on each location.

(Shimozuma, T.)