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. In FY2015, one project was finished and three projects were continued. And two new ones were accepted. 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 three proposals (#1 - #3 below) are the continuing subjects since FY2014, and two proposals (#4 - #5) are new proposals in FY2015.

1. "Effects of Modified Surfaces Produced at Plasma-Facing Surface on Hydrogen Isotopes Release Behavior in the LHD", Nobuta, Y. (Hokkaido Univ.), at al.

   Hydrogen release behavior at the modified surface of entire wall area has not been clarified. In this study, a number of long-term samples made of stainless steel, which is the same material as the first wall panels in the LHD, were mounted on the plasma-facing surface at each toroidal sector in the LHD during the 17th experimental campaign. After several months of plasma operation, the samples were extracted from the vacuum vessel, and deposition species and H retention were investigated with Auger electron spectroscopy (AES) and thermal desorption spectroscopy (TDS), respectively. In order to clarify the hydrogen isotopes release behavior at the top surface of the modified layer, a D ion irradiation against the long-term samples of the 17th experimental campaign was performed. The present study revealed that H retained in the modified surface in the erosion dominant area desorbed at much lower temperatures than that in carbon deposition area. This suggests that H release from the erosion dominant area could be more significant in terms of fuel recycling when the wall temperature increases during the start-up of a long time discharge in the LHD.

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 considering the rapid change of the plasma current and the eddy current as the cause of the transient response in the surrounding structure. 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 research activities are categorized in the follows from four aspects. (1) Development of the 3D MHD equilibrium calculation code taking the time evolution into account. (2) Modeling of the 3D effect and the eddy current, and proposal of the experimental methods to validate the model. (3) Education on the usage of the calculation program and the way to make an experimental methods beyond the local organization. (4) Identification of the new topics related with MHD research fields by the small experimental devices and the trial.

   The methods and the main results of each activity are summarized. The education program by the all collaborators in the activity is the very effective way to educate the students in the MHD research field in the universities, and would lead to the increase of the community related with the MHD researches

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.

Collaborative subjects in three categories such as (a) application of CTs, (b) development of CT diagnostics, and (c) theoretical/numerical studies on CTs, have been carried out among five groups performing experimental studies (U. Tokyo, U. Hyogo, Kyoto Inst. Tech., Nihon U., Kyushu U.) and four groups performing theoretical/numerical studies (Gunma U., Hokkaido U., JCGA, NIFS).

These collaborations has greatly promoted joint research projects conducted mainly by young researchers and students. These collaborative studies provided good opportunities for students to be involved in different research environment.

4. "Estimation of Regional and Seasonal Variations for Environmental Tritium and Radon Concentrations", Furukawa, M. (Ryukyu U.), et al.

The environmental tritium data around NIFS is required to draw a comparison with data obtained in the past and in the wide area. Measurement of tritium concentration has been carried out on precipitation and inland water samples collected in Okinawa and Hokkaido prefectures located in the southwestern- and the northern-most parts of Japan, respectively. Because the environmental tritium concentration varies with latitude and some geographical conditions, the comparison between tritium data obtained at NIFS, the central part of Japan, and other region is very important for safety operation of the nuclear fusion plant.
The result shows that the correlation between tritium concentration and amount of precipitation was not recognized in Okinawa Island. Also the results indicate that the tritium concentration of precipitation in Okinawa Island is clearly lower than those obtained at NIFS in Gifu prefecture (range: 0.15-0.45 Bq/L from June 2014 to July 2015) and at Sapporo city in Hokkaido prefecture.

5. "Interdisciplinary Study of O-point and X-point Dynamics by Plasma Experiment, Solar Observation and Numerical Simulation", Ono, Y. (Univ. of Tokyo), et al.

The UTST tokamak merging experiments and 2D PIC simulation reveal a small and peaked electron heating as well as fast energy conversion from magnetic to ion kinetic / thermal energies in downstream regions.

In the two merging tokamak plasma experiment of UTST, it is noted that the electron heating is localized at the X-point and partly around the downstream. In the PIC simulation result, the high T_e area forms another sheet in sharp contrast with the peaked high T_e area in the UTST experiment. This difference is the important research subject to solve the electron heating mechanism of high guide field magnetic reconnection.

The possible mechanism for this localized electron heating is 1) betatron-type fast acceleration of electrons along the X-line with zero poloidal and high toroidal field and 2) a stable plasma formation at the X-point that can confine the high energy electrons.

(Shimozuma, T.)