5. Network-Type Collaboration Research

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 facility in different universities and institutes to achieve their objectives. In the network-type collaboration, this type of 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. Three projects of the different fields were accepted in FY 2011 for the first time. Challenges in these collaborations spread over various fields. Before starting the collaborations, a collaboration plan for the year should be submitted. The plans include the items how the collaborations between research institutes are planned, that is, who goes when and where by what purpose.

In this fiscal year, seven proposals were submitted and six were accepted. One proposal was joined to another similar proposal. Two proposals are continuing subjects, and five proposals are new subjects in FY2017. The titles of the research items are listed below.

(1) “Estimation of regional and seasonal variations for environmental tritium and radon concentrations in Japan” M. Furukawa (University of the Ryukyus).

(2) “Self-organization via fast electrons in spherical tokamaks” Y. Takase (The University of Tokyo).

(3) “Effect of the resonant magnetic perturbation on MHD phenomena of toroidally magnetized plasmas” M. Okamoto (National Institute of Technology, Ishikawa College)

(4) “Self-organization in high-beta torus plasmas under active control”
N. Fukumoto (University of Hyogo)

(5) “Hydrogen isotope retention of plasma facing materials damaged by neutron irradiation” N. Ohno (Nagoya University).

(6) “Interdisciplinary study of plasma heating at O-point and X-point using laboratory experiments, numerical simulations and solar observations” M. Ono (The University of Tokyo).

The item (1) requires the movement of researchers and students over wide areas to collect samples in different places. The items (2), (3), (4) and (6) are related to the intercommunication of researchers and students, and are the comparative researches of the results obtained in the different devices in universities, institutes, and NIFS. Item (5) is related to the inspection of neutron-irradiated materials by utilizing the compact divertor plasma simulator (CDPS) installed at the Oarai Center of Tohoku Univ. And all proposals take advantage of the merit of the network-type collaboration.

The major achievements of two representative projects are briefly outlined below.

“Hydrogen isotope retention of plasma facing materials damaged by neutron irradiation”

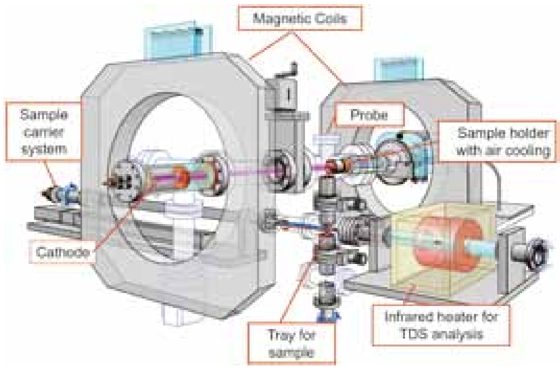
N. Ohno (Nagoya University)

The purpose of this study is to establish the researchers’ network of plasma-wall interaction study focusing on neutron-irradiated materials by utilizing the compact divertor plasma simulator (CDPS shown in the figures below) installed at the Oarai Center of Tohoku Univ. The collaboration is also intended to hold seminars where graduate students learn the principles and usage of instruments of other research institutes.

At the collaborative researchers’ meeting, we discussed the research topics and plans to be carried out at each institution to clarify the hydrogen retention characteristics of neutron irradiated tungsten (W); (a) the effects of defect distribution (Shizuoka Univ.), (b) hydrogen retention characteristics in neutron irradiated W-Re and W-K

(Osaka Univ., Kyushu Univ.), (c) Effects of adding other impurities (Toyama Univ.) , (d) Evaluation of effective diffusion coefficient of neutron irradiated W and verification of effect of annealing (NIFS), (e) helium plasma irradiation effect (Hokkaido Univ.).

The seminar for graduate students was held in NIFS. 14 students from universities participated in the tour and the briefing of surface analysis equipment.



Schematics of compact divertor plasma simulator (CDPS)

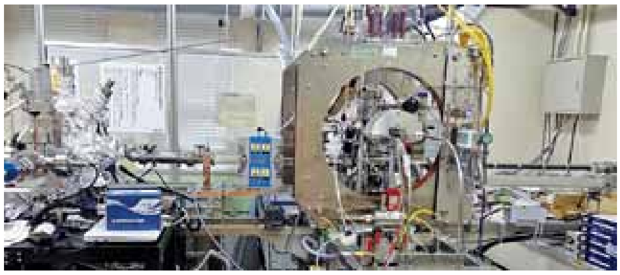


Photo of CDPS

"Self-organization via fast electrons in spherical tokamaks"

Y. Takase (Graduate School of Frontier Sciences, The University of Tokyo)

Experiments on self-formation of the spherical tokamak (ST) configuration and plasma current (I_p) ramp-up by various RF waves (LHW/ECW/EBW) were performed. The purpose of this research is to clarify the physical mechanism of self-organization via fast electrons created by RF waves, and is carried out collaboratively among the University of Tokyo (TST-2), Kyoto University (LATE), Kyushu University (QUEST), and NIFS. The ST plasma is formed and maintained by LHW (TST-2), EBW (LATE), or ECW (QUEST), respectively. Characteristics of these plasmas are determined by RF-accelerated energetic electrons through their pressure and current.

Ion Doppler measurements were performed on LATE with the Univ. of Tokyo visible spectrometer using a total of 33 sightlines. Emission of carbon, CV, and oxygen, OV, lines imply much higher T_e (> 100 eV) than TST-2 and QUEST. T_i had negative, positive, positive correlations with n_e, B_t, and I_p, respectively. Large excursions in T_i (up to 200 eV) were observed under some conditions. The mechanism of this unusual ion heating is under investigation. The particle-fluid hybrid code, MEGA, was modified to treat energetic electrons, and was used to obtain a self-consistent equilibrium with wave/Fokker-Planck codes successfully for the first time.

(T. Shimozuma)