

9. Bidirectional Collaborative Research Program

The bidirectional collaborative research program started in FY2004 as the third collaboration framework of NIFS. The purpose of this program is to enforce the activities of nuclear fusion research in universities by using their middle-size experimental facilities. The current program involves six university research centers;

- Plasma Research Center, University of Tsukuba
- Laboratory of Complex Energy Process, Institute of Advanced Energy, Kyoto University
- Institute of Laser Engineering, Osaka University
- Advanced Fusion Research Center, Research Institute for Applied Mechanics, Kyushu University
- Hydrogen Isotope Research Center (HIRC) of University of Toyama
- International Research Center for Nuclear Material Science (IRCNMS), Institute for Material Research, Tohoku University.

The latter two institutes were incorporated in the framework of bidirectional collaborative research program in FY2010 to extend the research field towards the fusion engineering because they both institutes have special facility to promote fusion engineering research, that is, neutron irradiation in IRCNMS and tritium handling in HIRC. The facilities in other four institutes are for fusion plasma experiments.

In this collaborative program, each research center can have its own collaboration programs using its major facility so that the researchers of other universities can come and join as if the facility belongs to NIFS. It is unique and important that all these activities are supported financially as research subjects of the NIFS bidirectional collaborative research program. The subjects of the bidirectional research program are subscribed from all over Japan every year as one of the three frameworks of NIFS Collaboration Program. The collaboration committee, which is organized under the administrative board of NIFS, examines and selects the subjects.

From FY2010, the second mid-term period started in NINS as well as in all national universities in Japan. In the new mid-term plan, NIFS enounces to promote (1) the pursuit of high performance plasma in LHD, (2) developing of simulation study to build numerical test reactor, and (3) fusion engineering research for the helical DEMO. These objectives are to be attained by enhancing collaborative research. The extension of the Bidirectional Collaboration towards fusion engineering studies is one of the important actions of the mid-term plan. It is also recommended that the cooperating program among six research institutes is endorsed.

The University of Tsukuba and the Tohoku University were suffered from the Great East Japan Earthquake on 11th March 2011, and some facilities were damaged. (Fortunately, no one was injured) The research programs then delayed to

start at Tsukuba and Tohoku.

The topics of this year are;

- (1) A new divertor module was installed on the west end of GAMMA 10 for divertor plasma simulation, which is a new activity (PDX) in the University of Tsukuba. The advantage of using the large linear machine is its capability of high heat flux plasma irradiation over larger material samples and the easiness of diagnosing. The maximum flux of 10 MW/m² is available with the HWHM of 4 cm. Other activity is to develop high power gyrotron of 28GHz, 1MW, 1s. This gyrotron is capable of 0.4MW CW output, and the collaboration program was started to share this gyrotron for the Electron Bernstein Wave (EBW) heating experiment in QUEST, Kyushu University.
- (2) The QUEST has demonstrated that a diverted spherical plasma with $I_p \sim 15$ kA at $B_t = 0.13$ T, could be sustained for 40 s non-inductively driven by 8.2 GHz 60 kW wave injection. Several probe metallic specimens (W, Mo and 316L SS) were installed inside plasma chamber and were exposed by plasma during experiments. They were analyzed by several diagnostics after experiment. The EBW heating / current drive experiment is planned by borrowing a newly developed 28 GHz gyrotron from the University of Tsukuba. The power supply for the gyrotron was prepared.
- (3) The behavior of tritium on and in the plasma facing materials is a current issue. Basic studies were carried out on the behavior of hydrogen isotope in the surface layer irradiated by hydrogen or helium. The effects of mixed surface layer (mostly carbon) of the metallic surface (w or SUS) on the hydrogen isotope behavior were clearly observed.
- (4) A TDS (Thermal Deposition Spectrometer) was installed in a radiation controlled laboratory at IRCNMS, Tohoku University in FY2010. The apparatus started in operation in FY2011, and an ion gun (3 keV, 3 μ A) was equipped.

In this year, 105 subjects were adopted in this category, among which were 22 at Tsukuba University, 20 at Kyoto University, 17 at Osaka University, 24 at Kyushu University, 12 at Univ. Toyama, 9 at Tohoku Univ. and 1 at NIFS (Activity on all-Japan ST research program). All of these collaborations have been carried out successfully.

Among these subjects, 18 topics from University of Tsukuba, 13 from Kyoto University, 15 from Osaka University, 19 from Kyushu university, 9 from Univ. Toyama, 8 from Tohoku university and 1 from NIFS are reported here.

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