10. International Collaboration

US – Japan (Universities) Fusion Cooperation Program

In 1977, President Carter and Prime Minister Fukuda discussed a new US-Japan cooperation on fusion. Based on this, the governmental agreement on Japan/US Joint Activity in the field of high energy physics was established, and, under this agreement, CCFE (Coordinating Committee for Fusion Energy) was started in August 1979. Since then, the Joint Activity has been continued for long years steadily. The 37th CCFE meeting was held on March 10, 2017 via televideo conference system. The representatives from the MEXT, the DOE, Universities and Research Institutes both from Japan and U.S. participated in the meeting. At the meeting, current research status of the both countries were reported together with presenting bilateral technical highlights on collaborations. The 2016 cooperative activities were reviewed, and the FY 2017-2018 proposal was approved. It was noted that both sides have developed significant and mutually valuable collaborations involving all technical elements of the fusion energy sciences program, and also discussed the bilateral programs and multi-lateral activities. Thus, the both sides agreed the usefulness and necessity of the continuation of the Joint Activity.

Fusion Physics Planning Committee (FPPC)

In the area of fusion physics, 6 workshops (4 from JA to US, 2 from US to JA) and 18 personal exchanges (13 from JA to US, 5 from US to JA) were carried out. Due to the funding limitation and the schedule conflict, 11 personal exchanges (8 from JA to US, 3 from US to JA) were cancelled or postponed.

Each personal exchange was performed successfully in the research fields of the steady-state operation, high-beta physics, confinement and transport, diagnostics and the high density physics related to the inertial fusion and its application. Fruitful discussions were made in the workshops with many participants from both sides. These programs were productive and beneficial for the progress of the fusion physics, and were recommended to continue.

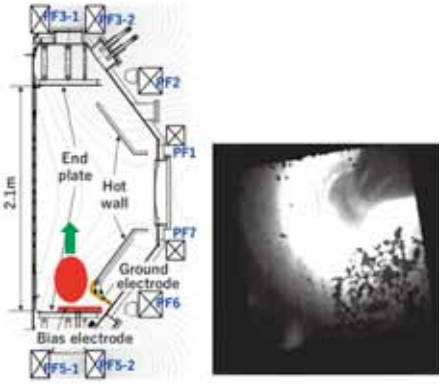

Fig. 1 Poloidal cross-section of QUEST (left). Compact toroid is produced with divertor plates for bias electrode. Compact toroid on vacuum vessel floor, observed through top window port (right). (Collaboration by University of Hyogo, Kyushu University, University of Washington and Princeton Plasma Physics Laboratory.

In experimental collaboration between University of Hyogo, Kyushu University, University of Washington and Princeton Plasma Physics Laboratory, the transient coaxial helicity injection (CHI) for the plasma current start-up was carried out in the QUEST device in Kyushu University (Fig. 1). Plasma current of 30 kA was successfully obtained by transient CHI. It was the first breakdown experiment for CHI with divertor plates in Spherical Torus. A power supply system for the experiment was provided by the US side.

Joint Institute for Fusion Theory (JIFT)

Most of the activities in the two categories, workshops and personal exchanges, that had been scheduled for the 2016-2017 JIFT program were carried out in FY 2016. Four workshops were successfully held, in addition to the JIFT Steering Committee meeting. In the workshops, 3D physics in toroidal plasmas, high energy density physics in the inertial confinement fusion plasmas, extended MHD, and exascale computing are discussed as main topics. (See Fig. 2 of the workshop on "Extended MHD and MHD simulations for magnetized Plasmas" which was held in Kyoto University during October 24-25, 2016.) In the category of personal exchanges, two Visiting Professor and four

Fig. 2 Workshop on "Extended MHD and MHD simulations for magnetized Plasmas" which was held in Kyoto University during October 24-25, 2016.

Visiting Scientists made exchange visits for the purpose of collaborations on theoretical modeling and simulation of magnetic and inertial confinement fusion plasmas. At the JIFT Steering Committee meeting that was held at San Jose Convention Center on November 4, 2016, the status of JIFT activities for 2016-2017 was reviewed and the recommendation plans for 2017-2018 were discussed. The JIFT discussion meeting was held at Toki on September 8, 2016, in the Plasma Simulator Symposium. The information of the JIFT program is released at both of the US and Japanese JIFT web sites.

Fusion Technology Planning Committee (FTPC)

In this category of the US-Japan Collaboration, personal exchange programs were continued in six research fields, i.e., superconducting magnets, low-activation structural materials, plasma heating technology, blanket engineering, high heat flux components, reactor design and others. Of the 10 originally planned items, 9 were completed including 2 workshops/ technical meetings and 7 personnel exchanges.

Fig. 3 An LHD divertor tile analyzed by ex-situ LIBS (by Dr. D. Nishijima of UCSD).

One of the highlights was the ex-situ analysis of the LHD divertor tile using the Laser Induced Breakdown Spectroscopy (LIBS) technology developed and performed by Dr. Daisuke Nishijima of University of California San Diego (UCSD). The divertor areas subjected to erosion and deposition were successfully distinguished by this method.

US-Japan Joint Project : PHENIX

FY2016 was the fourth year of the six-year project of PHENIX. A number of experiments were successfully carried out in the year.

For Task 1, heat transfer studies with the He-cooled divertor with multi-jets (HEMJ) with heat fluxed up to 4.5 MW/m^2 with the temperatures of 300-400°C were performed in the Georgia Institute of Technology (GIT). The new results suggest that there is serious degradation of these W-alloy thimbles over successive heating and cooling cycles. The achievements of HLT (High Load Test) studies include design of a new reflector to increase the heat flux of the Plasma Arc Lamp (PAL) facility to 12 MW/m^2 at Oak Ridge National Laboratory (ORNL).

Fig. 4 Irradiation capsule for HFIR-RB19J

For Task 2, in May 2016, the construction of the RB19J capsule for neutron irradiation at large removable beryllium (RB*) irradiation facility of the High Flux Isotope Reactor (HFIR) was completed (Fig. 4). The first irradiation cycle started in June 2016 (cycle 466) and finished its last cycle in December 2016 (cycle 469). Aimed milestones are the shipping and disassembly of the two rabbits as well as the shipping of the RB19J to the respective hot cell facilities by May 2017. It is envisioned for the post irradiation examination on the rabbit specimens to start in August 2017, while the RB19J specimen examination will start in January 2018.

For Task 3, in 2016, deuterium retention was measured for W specimens irradiated with neutrons at 360 ºC, 690 ºC and 800 ºC at HFIR at Idaho National Laboratory (INL). The deuterium plasma exposures using TPE were performed. Thermal desorption measurements showed that deuterium desorption from the irradiated specimens continued up to high temperatures in comparison with unirradiated specimens. Deuterium and tritium permeation studies were performed at Sandia National Laboratory, California (SNL-CA) and INL, respectively.

(T. Muroga)