

10. International Collaboration

Japan–Korea Fusion Collaboration Programs

NIFS and the National Fusion Research Institute (NFRI) in Korea have been collaborating in several areas of magnetic fusion research for 12 years. The main objectives are to advance the KSTAR experiment through the collaborative development of diagnostics and heating facilities, and also to collaborate in LHD experiment. The summary report of the collaboration was prepared until JCM in 2016. KSTAR experiment successfully continued from 2008 and has been achieved many excellent results. Another important aspect of this collaboration is human resource development for future fusion research.

I. KSTAR collaboration

1 Plasma Heating Systems

This collaboration consists of development projects for heating systems for the KSTAR experiment and discussion about physics and technology for plasma heating systems.

1.1 Plasma Heating Systems

The Korea-Japan workshop on the physics and Technology of Heating Current Drive was held in Japan in December 2015. Many physics, theoretical and technical issues were discussed by experts of both countries from various universities and institutes.

1.2 Radio Frequency Systems

Both Parties continued collaboration and exchanged personnel and technical knowledge for the development of radio frequency technologies in fusion plasmas. NIFS researchers visited NFRI and discussed ECH and ICRF technologies and the KSTAR experiment. Both Parties continued the collaboration for the development of the in-line polarization monitor for the use of the KSTAR ECRH experiments.

2 Diagnostic Systems

NIFS and KSTAR groups discussed the measurement of KSTAR plasmas, modification of a diagnostics systems for better performance and development of new diagnostics systems.

2.1 Bolometer Systems

A new design of resistive bolometer arrays for reinstalling on KSTAR was begun by KO experts. Damaged resistive bolometer amplifiers were repaired by the manufacturer and returned to KO. The Resistive bolometer detectors were upgraded to platinum detectors. KO and JA experts discussed improving the performance of the imaging bolometer for KSTAR by upgrading the IR camera in 2016. KO and JA experts worked together to integrate optical and foil calibration to produce calibrated images of radiation from the imaging bolometer data. KO experts from KAIST worked with NFRI and JP experts to develop a two dimensional tomography system for the KSTAR imaging bolometer.

2.2 Edge Thomson Scattering System

NIFS continued the collaboration on the YAG Laser¹⁾. As for polychromators, we are now developing new polychromator system, which is based on the NIFS polychromator. To measure more accurate raw signals and increase S/N ratio, feedback controlled temperature-stabilizing units and high-voltage power supply units are installed inside a polychromator box. In addition, new laser image position monitor system will be installed by the next campaign to obtain more accurate electron density data.

2.3 ECE Radiometer System

The ECE radiometer system made by NIFS have been stably operated by the NFRI collaborators, and provides the real time temperature profile data, which is basic information of physics study in KSTAR. Especially the system came into use for the real time control of EC heating devices.

2.4 Charge Exchange Recombination Spectroscopy (CES)

The collaboration of the measurements of ion temperature, toroidal and poloidal rotation velocities with charge Exchange Recombination Spectroscopy has contributed to the acceleration of the international collaborative research on pedestal physics in the H-mode plasmas^{2, 3)}. Precise of measurements of poloidal rotation velocity and radial electric field profiles at the pedestal have been done by optimizing the fiber arrangement at the entrance slit of the spectrometer.

2.5 Neutron and Energetic Ion Diagnostics

Neutron energy and distribution measurement experiments were conducted in 2015 KSTAR plasma campaign using Associated Particle Coincident Counting (APCC) neutron spectrometer and nuclear emulsion,

respectively, in collaboration with Nagoya University, NIFS, and NFRI. Because we have reached an intended goal, collaborative work on neutron diagnostics was finished on mutual agreement in 2015FY. Joint work on scintillator-based fast neutron loss detector has been steadily ongoing. The improvement of NIFS Lorentz orbit code called LORBIT was performed by the experts in NFRI and was applied to data analyses on the effect of 3D perturbed magnetic field produced by RMP. The results have been presented at several international conferences and workshops.

2.6 Soft X-ray CCD Camera (SXCCD)

The transfer of the X-ray imaging system from LHD to KSTAR has been discussed to investigate the flux surface shape of the KSTAR discharges. Port-flange of the SXCCD system was assigned to one of peripheral ports in Bay-B. Redesign of the support structure and the installation process are being conducted.

2.7 VUV Telescope System

The transfer of the VUV telescope system (detecting 2D image of the 13.5nm emission) from LHD to KSTAR has been discussed for the experiments related with edge MHD activities and RMP physics.

2.8 Japan-Korea Seminar on Advanced Diagnostics

The 8th Korea-Japan Seminar on Advanced Diagnostics was scheduled to be held in Busan, Korea August 24-27, 2016 and will be hosted by Prof. W.H. Choe of KAIST in Korea. The purpose of this seminar is as follows: (1) to give young researchers and students of both countries a comprehensive knowledge of diagnostics for steady-state fusion plasmas, (2) to give them the opportunity to present their scientific results and (3) to help them to develop international friendships and collaborations.

II. Human Resource Development

The total number of researchers that were exchanged between Japan and Korea in JFY 2015 were 47 from Japan to Korea and 55 from Korea to Japan. Workshops and Seminar of various fields were held in each country:

- Suitability of Low Activation Material for Fusion Demonstration Reactor, Dong-eui University, Korean Institute of Material Science, Korea, 20-23 December 2015 (T. Hino).
 - Modeling and Simulation of Magnetic Fusion Plasmas, JAEA, Rokkasho, Japan, 13-14 July 2015 (M. Yagi).
 - Blanket Material R & D for DEMO reactor, Seoul National University, Korea, 18-20 October, 2015 (H. Kishimoto).
 - Tritium safety technology for fusion reactor and environment, Kyushu University, Japan, 4-5 June, 2015 (Y. Oya).
 - Fusion Material and Engineering Toward Next Fusion Devices, Toyama University, Japan, 12-13 November 2015 (Y. Yamauchi).
 - Spectroscopy of KSTAR plasmas, NFRI, Korea, 20-23 April, 2015 (M. Yoshikawa).
 - Development of Neutron Spectrometer in KSTAR for Deuterium Plasma Diagnostics, NFRI, Korea, 1-5 September 2015 (H. Tomita).
 - Workshop on Physics and Technology of Heating and Current Drive, Hitachi, Civic Center, Japan, 21-22 December, 2015 (K. Nagasaki).
 - Japan-Korea KSTAR Diagnostics Collaboration Meeting, NFRI, Daejeon, Korea, 12 May 2015 (B.J. Peterson).
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(K. Ida)