

## 5. Japan-China Cooperation in Area of Magnetic Fusion Energy Research and Development and Related Fields

The collaboration between Japan and China has been started since 2008. The official title is "Cooperation in the Area of Magnetic Fusion Energy Research and Development and Related Fields". The third Joint Working Group (JWG-3) for Implementation Arrangement between the MEXT of Japan and MOST of China was held at Shangri La, China July 19-20 2010. Then the activities and the collaboration results in 2009 were introduced from two bureaus and four institutes during this meeting as follows:

- 1) Recent activities of MEXT, JAEA and NIFS from Japan
- 2) Recent activities of MOST, SWIP and ASIPP from China

The collaborations in the last year (2009) were reported, i.e., reports from JA to CN and from CN to JA. The proposals of this year were discussed and confirmed as follows:

- 1) Overall Status of Joint Research Program
- 2) Proposal of Joint Research Program from JA to CN, 19 scientists from NIFS visiting SWIP and ASIPP.
- 3) Proposal of Joint Research Program from CN to JA, 12 scientists visiting NIFS.

Both sides recognized collaborations of experiment and theory mainly through personnel exchanges, and the importance to develop the fusion technical cooperation taking into account the avoidance of overlap of programs under bilateral S&T cooperation scheme, for example, ITER Agreement and Core University Program (CUP) etc.

Then the JWG-3 agreed that the next meeting (JWG-4) would be held in Japan with the host of NIFS.

Brief reviews of collaboration results in each personal exchange are described as follows:

### **[Japan to China]**

Ryuhei Kumazawa visited ASIPP hosted by Yanping Zhao Dec. 20-25. He joined the ICRF heating experiment on EAST. The H-mode was achieved with the LHCD (Lower Hybrid Current Drive) and the ICRF heating for several seconds. However it was observed that the reflected RF power fraction was a few % even in the H-L transition. He suggested that the small RF power injection efficiency should cause a small change of the difference in the reflected RF power fraction. Then he suggested to measure the plasma loading resistance using the existing RF probes.

Katsuyoshi Tsumori visited ASIPP hosted by Zhimin Liu and Chungong Hu Dec.26-30. He discussed the design and the construction of the EAST-NBI system, which is projected to work in 2012. He joined the experiment on the NBI test stand, which has been recently started in ASIPP. The ion source was mounted there. A DC power with 18V/5.5kA was supplied to the filament for 120 sec. In addition the arcing power source was tested at 180V/3.1kA for 30 sec. He introduced the numerical calculation code developed in NIFS to optimize the structure of the ion source. The electron trajectories are tracked in the presence of the applied electrostatic and magnetic fields.

Kazunobu Nagasaki visited SWIP hosted by Zhou Jun Jan. 14-19. He discussed the system of 68/140GHz

ECH&ECCD and suggested a new system for that including a polarizer of the groove mirror. TRAVIS codes including a ray trace code was introduced to analyze the power deposition and the ECCD radial profiles.

Motoshi Goto visited SWIP hosted by Hangyu Zhou Mar. 9-12. He setup the EUV spectrometer system on HL-2A and joined to measure the Lyman- $\alpha$  line profile at the H-mode plasma discharge. Then it was found that the neutral penetration depth was changed during the H-mode.

Kazumichi Narihara attended the seminar of "Confinement of High Performance Plasmas" at Guillin, Oct.30-Nov.5. He presented "Asphericalizing the Light Collection Mirror for the 200-Point Thomson Scattering Diagnostic Installed on the Large Helical Device". The SN ratio was improved by twice in the Thomson Laser scattering system on LHD employing asphericalized collecting mirror.

Kazuo Toi attended the seminar of "Confinement of High Performance Plasmas" at Guillin, Oct.30-Nov.5. He presented "MHD Spectroscopy in Toroidal Plasmas using various MHD Instabilities". He presented the characteristics of the AEs (Toroidal Alfvén waves excited with high-energy ion beams) on LHD and suggested the method to measure the q-profile using the MHD spectroscopy of these AEs.

Akihiro Shimizu attended the seminar of "Confinement of High Performance Plasmas" at Guillin, Oct.30-Nov.5. He presented "Measurement of Plasma Potential and GAM Oscillation". He discussed GAM on LHD using Heavy Ion Beam Probe (plasma potential measurement method) and the interaction between GAM and the density fluctuation with the turbulence.

Shuichi Yamada attended the seminar of "Superconducting Key Technology for Advanced Fusion Device" held at Xi'an, Oct.18-22. He presented "Giga watt class hybrid energy transfer line of hydrogen and electricity" and "Summary of the 20D collaboration in CUP during seven years". He discussed ongoing ITER related SC conductor, magnets and feeders, cryogenic systems of EAST and LHD, power supply and power plant for advanced fusion device. In addition he visited TIPC hosted by Laigeng Li and ASIPP hosted by Yuntao Song Feb.24-Mar.3. He discussed cryogenic systems of 900W at 4.5K in the helium refrigerator in ASIPP for testing the ITER superconducting and the SC feeder components in ASIPP.

Tetsuhiro Obana attended the seminar of "Superconducting Key Technology for Advanced Fusion Device" held at Xi'an, Oct.18-22. He presented "Superconducting Key Technology for Advanced Fusion device". The content was the tests of JT-60SA EF conductors in the NIFS superconductor test facility. He discussed the experimental results about the dependence of the critical current on the temperature of the coil under the high magnetic fields. The test results showed that the requirement in JT-60SA was satisfied.

Yoshimitsu Hishinuma attended the seminar of "Superconducting Key Technology for Advanced Fusion

Device” held at Xi’an, Oct.18-22. He presented “Development of Low activation superconducting wire for an advanced fusion reactor”. He discussed the low activation materials of  $V_3Ga$  and  $MgB_2$  as the superconducting wires. Their half-life is much shorter than those of Nbs.

Arata Nishimura visited ASIPP hosted by Song Yuntao, Dec.13-16. He discussed the neutron irradiation effect on the superconducting properties such as  $Nb_3Sn$ ,  $Nb_3Al$  and  $NbTi$ . He proposed the neutron irradiation test of Chinese samples in JRR-3 in JAEA as the collaboration research between Japan and China.

Takuya Nagaska visited SWIP hosted by Jiming Chen and ASIPP hosted by Qunying Huang Dec.6-10. He discussed the low activation materials toward DEMO reactor. His research was as follows: A 500 kg ingot of CLF-1 and a 30 kg ingot of SWIP-30 has been melted in SWIP. A 1200 kg ingot of CLAM has been melted in ASIPP. Li-Pb loop systems, DRAGONS are in operation to investigate Li-Pb flow effects in DFL blanket in ASIPP.

Noriyoshi Nakajima visited Beijing Univ. hosted by by Shaojie Wang, Deng Zhou and Xuantong Ding Aug.29~Sep.3. He discussed the MHD equilibrium with a chaotic magnetic field. Then he discussed the future collaboration research on theory and simulation of fusion plasma research, e.g., MHD related problem (stability etc.), turbulence transport, integrated modeling and plasma heating.

Yukihiro Tomita visited Beijing Univ. hosted by Lowen Yan, Aug.29~Sep.3. He discussed the theoretical model of dust charging and its dynamics on HL-2A plasma. The dust injected from the equatorial plane penetrated to the plasma and then escaped to the scrape-off layer. He discussed the preparation of dust injection experiment on HL-2A in the next experiment campaign.

Gakusi Kawamura visited Beijing Univ. hosted by Qian Xu, Aug.29~Sep.3. He discussed results using Monte Carlo simulation code for LHD modifying ERO code and the possibility to analyze the impurity transport on EAST. Using this code the carbon redeposition distribution on the divertor plate was analyzed and quite agreed with the observation. These results will be compared with those of EDDY code, which would be analyzed by Dr. Xu in ASIPP.

Masahiro Hobayashi visited SWIP hosted by Yudong Pan, Aug.29~Sep.3. He discussed the impurity transport study in SOL/Divertor plasma in HL-2A and LHD. He implemented the edge transport code, EMC3-EIRINE to analyze the SOL/Divertor plasma on HL-2A. The impurity screening effect was better in the high collisionarity at the SOL region. Experiment data were compared with the results of the code.

Shinichiro Toda visited ASIPP hosted by Guosheng Xu and SWIP hosted by Aiping Sun, Dec14~24. He discussed the comparison of the formation of the radial electric field between Tokamak and LHD and its effect to the plasma confinement. He discussed two codes of GFL23 and TGLF, whose results of ECH experiment on GIII-D quite agreed with the experimental measurement.

Atsushi Itoh visited ASIPP hosted by Zhou Deng and SWIP hosted by Peng Xiaodong, Dec14~24. He discussed the stability of toroidal equilibria with the toroidal and

poloidal flows in the toroidal system and the effect of poloidal flow on the GAM and ballooning modes. He suggested a closure model to introduce kinetic effects on equilibria with plasma flow.

Naohiro Kasuya visited ASIPP hosted by Zhou Deng and SWIP hosted by Liu Yi, Dec14~24. He discussed the numerical diagnostics of the turbulence on the toroidal plasmas and experiment data observed with Heavy Ion Beam Probe. The zonal flow and GAM on HL-2A will be the simulation target for this simulation in the future collaboration.

#### [China to Japan]

In the fiscal year of 2010, five scientists of SWIP and seven scientists of ASIPP visited NIFS. But Chinese fiscal year is different from Japanese one, so a few personal exchanges have not executed yet. Details of the personal exchanges are as follows:

- 1) Wei Chen (SWIP, hosted by M.Isobe)  
July 3~9. High energy particle physics and diagnostics.
- 2) Zhou Yan (SWIP, hosted by N.Ashikawa)  
Aug. 29~Sep. 4. The measurement of transparency in first mirror during plasma discharge.
- 3) Long Chang (SWIP, hosted by A.Komori)  
Oct.24~30. Attending the Tritium 2010 meeting.
- 4) Liming Yu (SWIP, hosted by Y.Takeiri)  
Oct.24~30. NBI ion source and particle beam diagnostic technologies
- 5) Huang Zhihui (SWIP, hosted by Y.Tomita)  
Jan.19~28 and Mar.21~31, Cooperation of the PSI of HL-2A plasmas and the simulation studies on the dust of HL-2A tokamak.
- 6) Xinjun Zhang (ASIPP, hosted by R.Kumazawa)  
Jan. 10~16. Development of various ICRF heating schemes.
- 7) Shuai Yuan (ASIPP, hosted by R.Kumazawa)  
Jan. 10~16. R & D on RF transmission insulation.
- 8) Yuaniai Xie (ASIPP, hosted by Y.Takeiri)  
Mar. 1~11. Neutral beam injector development.
- 9) Yongjian Xu (ASIPP, hosted by Y.Takeiri)  
Physics experiment on neutral beam injector.
- 10) Ling Zhang (ASIPP, hosted by S.Morita)  
Dec. 5~15. Measurement on visible spectroscopy.
- 11) Jiafeng Chang (ASIPP, hosted by S.Masuzaki)  
Dec. 5~15. Edge plasma diagnostics and edge plasma study.
- 12) Liang Wang (ASIPP, hosted by S.Masuzaki)  
Dec. 5~15. Diagnostics of divertor and edge plasma study.

(Kumazawa, R., Yamada, S.)