5. Japan-China Collaboration for Fusion Research (Post-CUP Collaboration)

I. Post-CUP collaboration

The post-CUP collaboration is motivated by collaboration with Southwestern Institute of Physics (SWIP), other institutes and universities in China for fusion research. The SWIP is now operating HL-2A tokamak and starts to construct HL-2M tokamak for further fusion studies. Collaboration with Institute of Plasma Physics Chinese Academy of Science (ASIPP), University of Science and Technology of China (USTC) and Huazhong University of Science and Technology (HUST) are basically included in the A3 Foresight Program financed by the Japan Society for the Promotion of Science (JSPS), of which the institutions are operating EAST tokamak, J-TEXT tokamak and KTX reversed Field pinch devices. The Post-CUP collaboration is basically carried out for studies on steady state sustainment of high-performance plasmas

II. Workshop between NIFS and SWIP

Workshop on ongoing and future collaboration between NIFS and SWIP was held at Gansu province in China during 5^{th} – 8^{th} August, 2013 followed by the conclusion of agreement on academic and scientific cooperation between NIFS and SWIP at April 2012. The workshop is then motivated further development of the scientific collaboration between the two institutes including collaborative studies with existing devices of LHD and HL-2A and future device of HL-2M. Sixteen Japanese and Chinese scientists (eight Japanese and eight Chinese) joined the workshop and discussed on the ongoing and future collaboration by presenting many fruitful results. Studies of fast ions using fast ion loss probes, impurity transport at edge and core plasmas using EUV spectroscopy, edge MHD instability using static and magnetic probes and soft x-ray array, development of Thomson scattering diagnostic and optimization of ECH heating system were mainly presented from both institutes. Discussions were also made on the future collaboration in the fields mentioned above for both the devices of HL-2A and HL-2M. In particular, it was pointed out that development of Thomson diagnostic to measure electron temperature and density profiles in HL-2M device is really important not only for the general confinement study but also for the confinement improvement and divertor study.

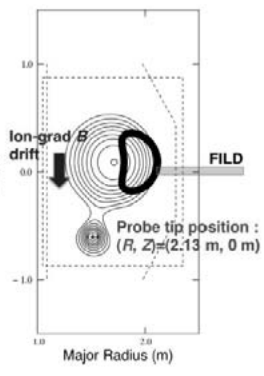

Fig.1 Fast ion drift orbit and FILD probe in HL-2A tokamak.

III. Activities of collaboration in FY 2013

The fast-ion-driven MHD instability has been studied in HL-2A tokamak using scintillator-based fast-ion loss detectors (FILDs). The FILD detector can simultaneously measure a gyro radius centroid and pitch angle of escaping fast ions as a function of time. The detector fabricated at Sichuan University is installed on HL-2A. The fast-ion loss signal was successfully observed from discharges (n_e=1.2x10^{13}cm^{-3}, I_p=160kA and B_t=1.3T) with co-injected tangential NBI. The data are analyzed by considering the scintillator size and aperture structure. The result was consistent with the NBI beam injection energy (E_b=40keV), which indicates reliability of the diagnostic system. A LORBIT code has been used to calculate and understand an orbit of the escaping beam ions. Figure 1 shows the escaping fast-ion orbit reaching the FILD probe. It shows a fairly fat banana orbit because the magnetic field and plasma current are relatively low. The fast-ion driven fishbone and high-frequency modes will be observed in next experimental campaign, since the diagnostic system is soon upgraded by newly installing 8x8 PMT array.

The edge impurity transport was studied [1] at ECH phase of ohmic discharges based on space-resolved vacuum ultraviolet spectroscopy [2] with which radial profiles of impurity line emissions are measured from the core region inside the LCFS and the edge region in the SOL, simultaneously. The ratio of CV to CIV measured from ohmic discharges showed a gradual decrease with electron density, while the ratio suddenly decreases by a factor of 3 when the ECRH focused in the plasma center is switched on suggesting a strong enhancement of the impurity transport. The analysis with the transport code indicates a change in the convective term. The convective velocity of C^{4+} ions changes from inward to outward direction during the ECRH phase, while an inward velocity usually existed in the Ohmic phase. The edge impurity transport was also investigated in the stochastic layer of lHD and SOL layer of HL-2A as a comparative study. The carbon emission measured in the stochastic layer of LHD clearly indicates the screening effect in high density region, while the carbon emission profile from HL-2A is not straightforwardly explained. It is found that the impurity distribution in the HL-2A SOL is very sensitive to the impurity source location.

References

[1] Cui Z.Y., Morita S., Zhou H.Y., et al., Nucl. Fusion **53** (2013) 093001.
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[3] Kobayashi M., Morita S., Dong C.F., Cui Z.Y., et al., Nucl. Fusion **53** (2013) 033011.

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