§11. Workshop on "Development and Reactor Application of ICRF Heating Device"

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Ion cyclotron range of frequencies (ICRF) heating will be an important tool to heat core plasma in reactor. To exchange the knowledge on the ICRF heating, we held the fifth workshop on December 3rd in 2015 at NIFS. Nineteen researchers, students and technical staff joined the workshop. The information on the ICRF heating technology, simulation and experiments including LHCD was exchanged. The following topics were presented and discussed.

1. "Progress of ICRF heating of helical devices" presented by T. Mutoh.
ICRF heating study from Heliotron D to LHD was summarized. In LHD confinement of high-energy ions exceeds 2 MeV was confirmed and the world record of the injected energy of 3.4 GJ was achieved.

2. "Investigation of toroidal flow generated by ICRF heating" presented by S. Murakami.
The toroidal flow generation during the ICRF minority heating was investigated in the Alcator C-Mod plasma. It was found that the toroidal precession motion of energetic tail ions generate the averaged toroidal flow, and that the generated minority ion flow could drive the toroidal flow of background plasma. The possibility of the ICRF-driven flow in the LHD plasma was also discussed. The D-D fusion reaction between the energetic deuterium was evaluated in the deuterium experiment plasma.

3. "Measurement of RF electric field in high-β plasma using a Pockels detector in magnetosphere plasma confinement device RT-1" presented by M. Nishiura.
The Electro-Optical sensor system was developed and relevant wave physics in plasmas for efficient ICRF heating was studied. The measured electric field agrees well with that calculated by the TASK/WF code in the vacuum vessel of RT-1. The double loop antenna is optimized and characterized by the TASK code for efficient heating. As the result, first successful ion heating has been accomplished.

4. "Progress of LHCD upper antenna scheme in TST-2" presented by S. Yajima.
Upper Capacitively Coupled Combline Antenna in TST-2 as shown in Fig. 1 was developed. With this antenna, increase of LHCD efficiency at core region is expected.

5. "Development of TASK3D/WM module for evaluation of the ICRF wave propagation and absorption in LHD" presented by R. Seki.
Development of TASK3D/WM applied on LHD is ongoing for the realistic absorption profile.

6. "Non-inductive plasma startup using lower-hybrid waves on TST-2" presented by N. Tsujii.
Non-inductive plasma start-up up to 25 kA has been achieved on TST-2 using lower-hybrid waves. Quantitative comparison of the rf current drive model and the experimental measurements is under way with the improved Thomson scattering and hard X-ray diagnostics.

7. "Fast Ion Generation by Combination Heating of NBI and ICRF in Heliotron J" presented by H. Okada.
Fast ions with energy beyond 50 keV were detected by the CX-NPA in the low-ε_t configuration. This configuration is better for the fast ion production than the high bumpy configuration.

8. "ICRF heating experiment for high-density plasma production in GAMMA 10/PDX" presented by S. Sumida.
Controls of phase difference between central-cell and anchor-cell antennas were conducted in east and west sides simultaneously for effective ICRF heating. This enabled the production of high-density plasmas at the central-cell on GAMMA 10/PDX.

9. "The plan of ICRF experiments in W7-X" presented by H. Kasahara.
Plan of ICRF heating in W7-X was reported. Faraday-shield-less double strap antenna will be used to study the confinement of high-energy ions. ICRF heating of mixed plasma (H, He and ^{3}He) is expected for the effective production of high-energy ions.

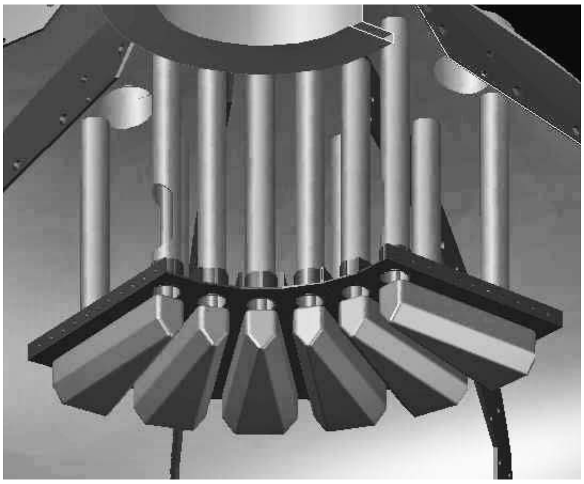

Fig. 1. Upper CCC Antenna in TST-2.