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

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Ion cyclotron range of frequencies (ICRF) heating is an important and unique method to heat core ions of large size plasma like ITER. To enhance the ICRF heating technology we held the third workshop on February 21st in 2014 at NIFS. Twenty eight researchers and students joined the workshop. We exchanged the information on the ICRF heating technology. The following topics were presented and discussed.

1. "Fabrication of FAIT antenna and injection experiments" presented by K. Saito.
Field-Aligned-Impedance-Transforming ICRF antennas were installed in LHD. High loading resistance was achieved with the optimized impedance transformer in the transmission line.

2. "Measurement of ICRF waves using a microwave reflectometer in GAMMA 10" presented by R. Ikezoe.
In GAMMA10, ICRF waves are measured simultaneously at two positions using a microwave reflectometer to determine the structure of Alfvén ion-cyclotron (AIC) waves. The spectrum of the AIC waves has several peaks and the waves with low frequencies are produced by mode coupling. This wave is thought to be the cause of loss of high-energy ions.

3. "Production and confinement of high-energy ions by using ICRF heating in Heliotron-J" presented by H. Okada.
Large ion tail was formed using ICRF heating in Heliotron-J for the case of magnetic configuration with the large bumpiness. This experimental result agrees well with a Monte Carlo simulation.

4. "Plasma current start-up experiments using the dielectric-loaded waveguide array antenna in the TST-2 spherical tokamak" presented by T. Wakatsuki.
Plasma startup experiments were performed by using waveguide array antenna in the TST-2. The antenna was filled with ceramic in order to transmit the wave with the frequency of 200 MHz through the compact waveguide. It was found that there is optimum wave number parallel to the magnetic field line. Issues such as reduction of plasma density in front of antenna due to ponderomotive force and the increase of reflection were clarified.

5. "Recent results of ICRF heating experiment in LHD" presented by S. Kamio.
Faraday shield was removed from one of ICRF antennas in LHD as shown in Fig. 1. The properties of antennas with and without Faraday shield were compared. The heating efficiency decreased slightly, but the loading resistance increased. No devastating impurity influx was seen. Faraday-shield-less antenna will be useful for fusion reactors.

6. "ICRF phase control experiments and wave analysis on GAMMA 10" presented by T. Yokoyama.
High density plasma was generated by the phase control of two antennas in GAMMA 10. Simulations with the ICRF wave analyses code (TASK/WM) are now on going to understand this phenomenon.

7. "Simulation study of toroidal flow generation by ICRF heating " presented by S. Murakami.
Toroidal flow generated by ICRF heating in Alcator C-mod was successfully simulated. The flow is driven by the banana motion of high-energy ions accelerated by ICRF wave.

8. "ICRF Wave Measurement by a Microwave Reflectometer on LHD " presented by A. Ejiri.
ICRF waves in LHD was measured by a microwave reflectometer. Comparing the data from six antennas, the damping length of ICRF wave was measured.

9. "Electromagnetic analysis using TASK/WM and COMSOL in LHD " presented by H. Kasahara.
The status of full wave code TASK/WM and COMSOL was presented. ICRF wave in LHD was calculated assuming a cold plasma with a collisional damping model.

A lot of useful information was exchanged for future research on ICRF heating in various devices.

Fig. 1 ICRF antennas with and without Faraday shield in LHD in 2013