§24. Workshop on "Development and Application of ICRF Heating"

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Ion cyclotron range of frequencies (ICRF) heating is suitable for the selective ion heating and the high-density plasma heating. Therefore ICRF heating devices are highly expected to apply for the future fusion devices. However, there are a lot of issues to be solved such as the increase of heating efficiency and power density, the prevention of arcing in the transmission line and antenna.

In Japan, the ICRF heating research has been conducted in University of Tokyo, Kyoto University, University of Tsukuba, and many universities and institutes. However the technology including experiment and simulation has been developed independently in each university or institute. To solve the ICRF heating issues, the information on the ICRF heating technology was exchanged. We held a workshop for the first time on February 18th in 2012 in NIFS. The following topics were presented and discussed.

1. "Review of ICRF heating" presented by Kumazawa.
It was cleared in LHD that the resonance position is important as well as the heating efficiency for the increase of plasma stored energy since the confinement is depending on the power deposition profile.

2. "Measurement of distribution of high-energy ions around resonance layer using pellet charge exchange (PCX) method" presented by Ozaki.
Distribution of high-energy ions during ICRF heating was measured with PCX method. The high-energy ions were localized around the resonance layer.

3. "Simulation of toroidal flow by ICRF heating" presented by Murakami.
Though the direction of particle kick by ICRF electric field is perpendicular to the magnetic line of force, toroidal flow was detected in C-Mod. This phenomenon was successfully simulated by using GNET code.

4. "Behavior of high-energy particles produced by ICRF heating and heating property on Heliotron J" presented by Okada.
It was cleared that the bumpiness of magnetic field has an effect on the confinement of high-energy particle.

5. "ICRF heating in LHD" presented by Saito.
The ICRF heating experiment in LHD was summarized. Recently phase controllable antenna (HAS antenna) was installed as shown in Fig. 1. The heating efficiency was increased with larger wave length parallel to the magnetic line of force ($k_{//}$). This tendency was explained by the Doppler broadening and simulated as shown in Fig. 2.

6. "Progress of ICRF heating experiment in GAMMA 10" presented by Ikezoe.
By the modification of ICRF antenna for anchor heating, the antenna-plasma coupling was much improved.

7. "Measurement of beat-wave by using of high-frequency magnetic probe in TST-2" presented by Shinya.
Two waves with different frequencies were injected into TST-2 plasma. Several spikes in power spectrum were detected around original frequencies. This suggests the production of the beat-wave with the difference frequency of injected waves by the non-linear coupling.

8. "Measurement of RF electric field by microwave reflectometry" presented by Ambo.
Measurement of RF electric field in LHD with reflectometry system was presented.

Through the discussion of the workshop the useful information for the research on ICRF heating was shared by many participants.

Fig. 1 HAS antenna in LHD

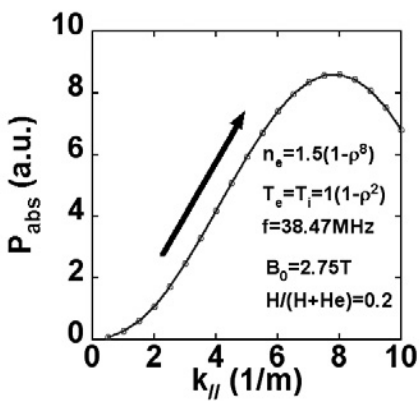

Fig. 2 Power absorption depending on $k_{//}$.