§11. Correlation between ICRF Waves and Behavior of High Energy Ions on GAMMA 10

Ichimura, M., Yamaguchi, Y., Sato, S., Imai, Y., Murakami, T. (Univ. Tsukuba),
Kumazawa, R.

The ion cyclotron range of frequency (ICRF) waves have been used for the plasma production and heating in the GAMMA 10 tandem mirror. The high ion-temperature plasmas above 10keV have been produced and sustained stably. In a typical discharge, Alfvén-ion-cyclotron (AIC) modes are spontaneously excited due to the strong temperature anisotropy. In 2007, low-frequency (LF) waves which have differential frequencies between these ICRF waves and the AIC-modes have been detected and spatial structures of these modes in the azimuthal direction have been evaluated for discussing the parametric decay of the heating ICRF waves to the AIC-modes and LF waves. In 2008, the spatial structure in the axial direction has been also discussed [1,2]. These LF fluctuations sometimes induce the saturation or reduction of the density and diamagnetism in the central cell. High energy ion detectors in the central cell (ccHED) and at the east end (eeHED) are used for the evaluation of the transport of high energy ions due to these fluctuations in the perpendicular direction to the magnetic field line and along the magnetic field line, respectively. Correlation between ICRF waves and behavior of high energy ions on GAMMA 10 is studied in this research [3,4].

Recently, magnetic probes, which have larger cross section than the conventional pick-up loop of several *mm* in diameter, have been installed for detecting low-frequency magnetic fluctuations in the central cell. Low-frequency magnetic fluctuations around 100 kHz, of which frequencies are differential frequencies between discrete peaks of the AIC-modes, are clearly observed. These frequencies are also detected in the ion-saturation current signal measured with electrostatic probes (ESPs) in the central cell. The density fluctuations will be induced due to the AIC modes. Figure 1 shows the intensity plot of temporal evolution of the frequency spectra; (a) high-energy ions escaped from the central cell perpendicular to the magnetic field line (ccHED), (b) ion-saturation current signal in the central cell (ESP) and (c) high-energy ions reached to the east end (eeHED). There are burst-like signals from 160 ms on ccHED and ESP signals. These bursts are due to the application of electron cyclotron heating (ECH) and are not considered in this study. As seen in Fig.1 (b), two types of fluctuations are detected in ESP signal; one is the drift-type fluctuations with frequencies around 10 kHz and another is the fluctuation with differential frequencies among peaks of the AIC-modes around 100 kHz. It is clearly indicated in the figure that drift-type fluctuations appear only in the signal of ccHED and fluctuations with frequencies around 100 kHz appear only in the signal of eeHED. ccHED is located just outside of the limiter radius at the central cell midplane and can detect high-energy ions which escape from the confined region in the perpendicular direction. Radial transport due to drift-type fluctuation and velocity space diffusion due to spontaneously excited Alfvén wave are clearly detected experimentally. High-energy ions are scattered into the loss region due to the AIC-modes.

[1] Ichimura, M., et al., J. Plasma Fusion Res. SERIES, Vol. 8 (2009), 893-896.
[2] Ichimura, M., et al., Transactions of Fusion Science and Technology, 55 No.2T (2009) 59-62.
[3] Sato, S., 25th Annual Meeting of JSPF, Utsunomiya, Dec.5th, 2008, 5aB17P
[4] Imai, Y., 26th Annual Meeting of JSPF, Kyoto, Dec.4th, 2009, 4pD24P

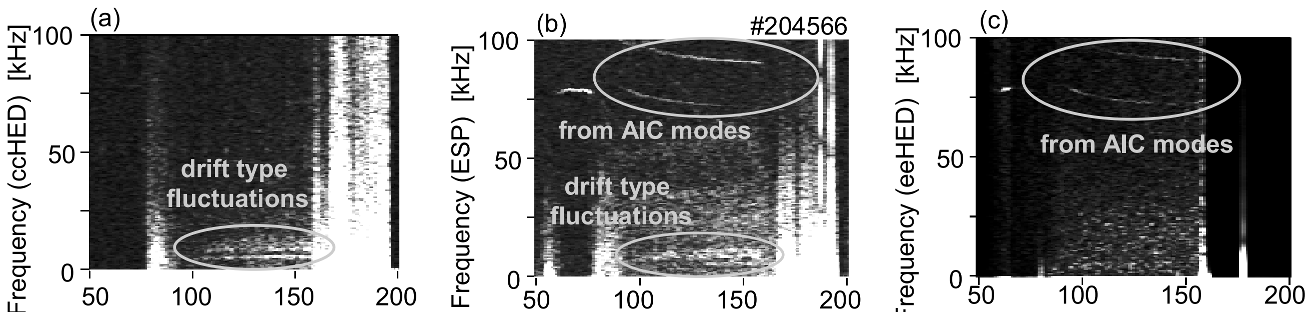

Fig.1 The intensity plots of the temporal evolution of frequency spectra; (a) high-energy ions escaped from the central cell perpendicular to the magnetic field line (ccHED), (b) ion-saturation-current signal in the central cell (ESP) and (c) high-energy ions escaped to the east end (eeHED). Two types of fluctuations are detected and correlation between fluctuations and behavior of high energy ions is clearly indicated.