§30. Detection of Ion Cyclotron Emissions by Use of ICRF Antennas in LHD

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In the large helical device (LHD), there are six ICRF antennas. They were used not only as heating tools but also as detectors. They have a merit of good sensitivity owing to large loop areas. 4.5U and L antennas are disconnected from impedance matching devices so as to transmit power to an oscilloscope without reflection. The maximum sampling speed of the oscilloscope is 5GHz. One of purpose is a detection of ion cyclotron emissions (ICEs), which was detected in tokamaks [1-3]. ICEs have a potential as a diagnostic tool of fusion products. ICEs can be excited when the distribution function increases with the perpendicular velocity, and the exited frequencies are close to multiples of an ion cyclotron frequency, f_{ci} at the excited point. Perpendicular NBI (40keV, hydrogen) may produce the structure of the distribution function. In LHD a single high frequency fluctuation associated with perpendicular injection of neutral beam around 71MHz had been detected by magnetic probes [4].

During injection of perpendicular NBI, ICEs were clearly detected by using ICRF antennas. Figure 1 shows a power spectrum during the injection of the perpendicular NBI measured with 4.5L ICRF antenna. The magnetic field strength on axis was 2.75T. Peak frequencies were 24.0MHz, 49.3MHz, 74.2MHz, 97.8MHz, ···. They were approximately multiples of the fundamental frequency of 24.0MHz. Figure 2 shows the location where the cyclotron frequency f_{cH} is 24.0MHz. It was found that ICEs are excited at the peripheral region of plasma. Injected hydrogen ions escape before slowing down by collisions due to the large loss of ions at the peripheral region and non-relaxed distribution function may be formed there. The ICE frequencies changed when the magnetic field strength on axis decreased to 1.5T as shown in Fig.3. The frequencies were 12.8MHz, 25.9MHz, 39.5MHz, 53.2MHz, ···. It was found that the frequencies are proportional to the magnetic field strength on axis. This means that the location where ICEs are excited is fixed. The ICEs are synchronized with NBI as shown in Fig.4. The ICEs decay within 1ms after turn off of the NBI. This suggests the small slowing down time or large particle loss at the point of ICE exitation. The ICE signal tends to increase with electron density, and it was detected in SDC plasma, therefore excitation seems to occur at outer side of plasma because NBI is injected from outer port.

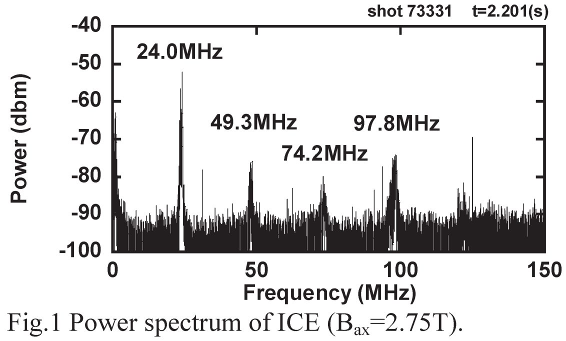

Fig.1 Power spectrum of ICE (B_{ax}=2.75T).

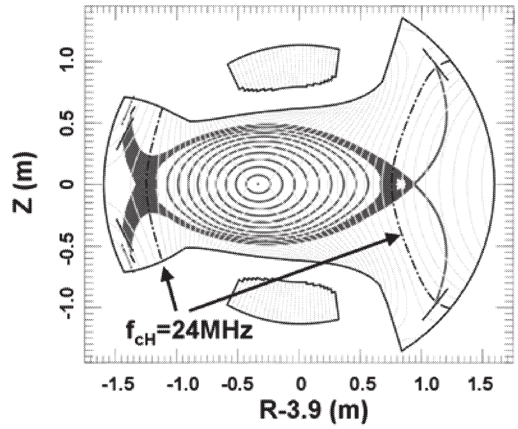

Fig.2 Location of ICE excitation, where f_{cH} is close to fundamental ICE frequency.

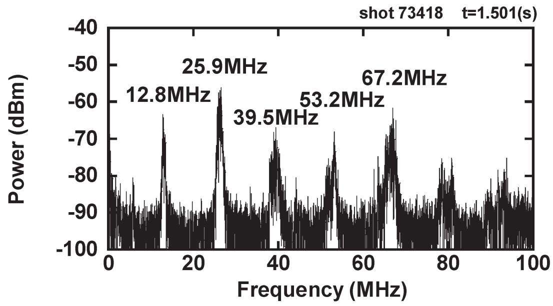

Fig.3 Power spectrum of ICE (B_{ax}=1.5T).

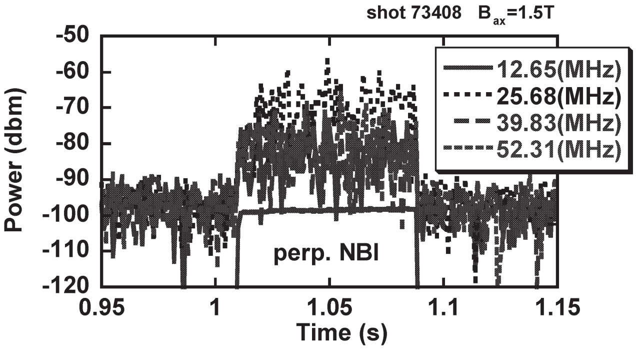

Fig.4 Synchronization of ICE and perpendicular NBI.

References
1) Cotterell, G.A., et al. Nucl. Fusion **33**, (1993) 1365
2) Cauffman, S., et al. Nucl. Fusion **35**, (1995) 1597
3) Ichimura, M., et al. Proceeding of 21st IAEA Fusion Energy Conference, EX/P6-7
4) Higaki, H., et al. Annual report of NIFS 2005-2006, p75