§7. Fast RF Spectrometer System on LHD

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RF radiations with a frequency range up to several GHz are often accompanied by MHD events. The RF bursts which coincide with edge localized mode or sawtooth crashes are observed on KSTAR [1,2]. Since the measurement system is quite simple, it is a useful diagnostic tool for studies of MHD instabilities.

RF radiation measurements in the range of the ion cyclotron harmonics have been conducted on KSTAR [1,2] and a similar system is installed on the Large Helical Device (LHD). The measurement system consists of a dipole antenna inside the vacuum vessel, a fast digitizer with a sampling frequency of 1.25 GS/s and a bandpass filter to prevent low-frequency noise pickup and aliasing. In addition, a spectrometer based on filter banks was used to measure the temporal change of the RF emission intensity with moderate spectral resolution for the entire discharge duration as shown in Fig. 1. The received RF signal is divided into the fast digitizer and the filter bank spectrometer.

As shown in Fig. 2, the measured RF spectrum on LHD clearly shows multiple high harmonics up to ~ 20th with a difference of 25 MHz when the NBI#5, which is close to the antenna, is injected. The frequency spacing approximately corresponds to the ion cyclotron frequency of the outboard edge region (B ~ 1.7 T). This observation suggests that the prompt loss of the NBI-produced energetic ions is causing the ion cyclotron harmonic waves (ICHW). Note that the strong horizontal lines during the NBI off time are due to the pickup from unknown noise sources. Furthermore, the fast RF measurement shows the ICHW emission decays on the time scale of ~50 μs. This may imply that the confinement time of the NBI-produced energetic ions.

In addition, responses to the interchange mode driven by the ripple-trapped energetic particles, named "EIC mode" [3], are also observed. Figure 3 shows the response of RF radiations with several frequencies. At the onset of the crash of the EIC mode, identified with the magnetics (dB/dt), the RF radiations lower than 300 MHz increase, while those higher than300 MHz decrease. These behaviors might refract redistribution of energetic particles due to the bursts.

[1] J. Leem, G.S. Yun, H.K. Park, JINST **7**, C01042 (2012)

[2] S. Thatipamula, G.S. Yun *et. al.*, submitted to Plasma Phys. Control. Fusion.

[3] X. D. Du *et. al.*, Phys. Rev. Lett. 114, 155003

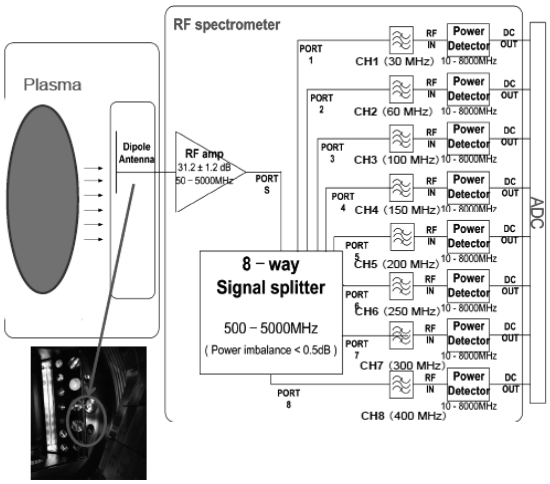

Fig. 1: Block diagram of RF radiation measurement on LHD.

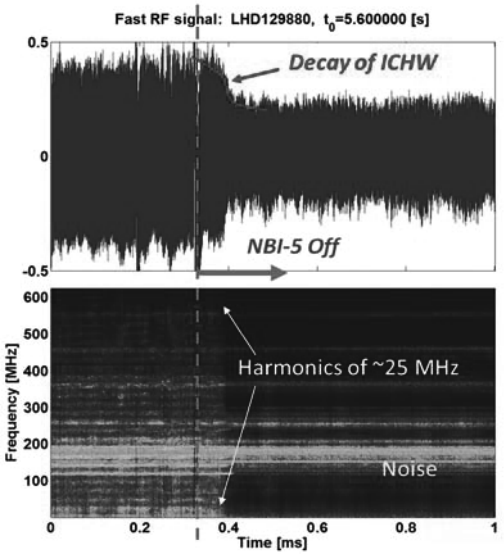

Fig. 2 : RF radiation during NBI #5 injection

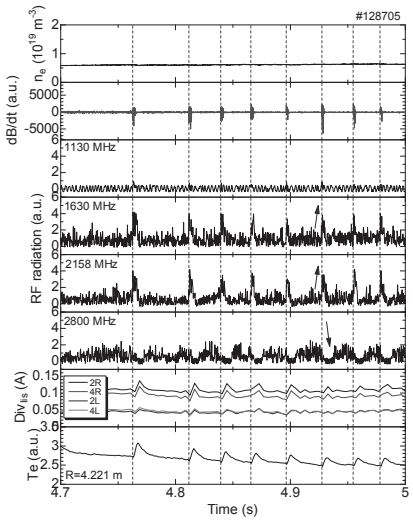

Fig. 3: RF radiations which correlate to EIC modes