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Measurement on electron temperature fluctuation in LHD using correlation ECE technique

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Investigation on plasma turbulence and micro-instabilities is believed to be essential for understanding the "anomalous" transport phenomenon and improving confinement techniques on plasma. The correlation-electron cyclotron emission (C-ECE) technique, typically cross-correlates two ECE channels that contain identical temperature fluctuation information and individual thermal noise signal. The C-ECE system resolves turbulent temperature fluctuations embedded in the random thermal noise, which may give information about turbulence and micro-instabilities [1].
A C-ECE system on the large helical device (LHD) at the National Institute for Fusion Science (NIFS) measures emission at 74-79.6 GHz using the spectral decorrelation method. The C-ECE system uses a receiver for a collective Thomson scattering diagnostic in the LHD [2]. The C-ECE receiver system shares the RF stage and is divided into a filter bank system consisting of 32 band-pass filters and a fast digitizer system (NI PXIe-5186) at 12.5 GHz sampling rate in the intermediate frequency (IF) stage. Both systems allow measurement frequencies of 0.5-5.6 GHz in the IF stage. The fast digitizer system is flexible on bandwidth and a time resolution for frequency channels [3]. However, this system encounters a long computational time and allows simultaneous processing on only two channels due to the enormous data volume engaged in the analysis.
In this work, initial experimental results on the temperature fluctuation spectra in LHD are obtained by the C-ECE system with a coherency-based analysis method [4]. The coherence spectra is corrected by removing the bias error presented in coherence calculation process. An MHD mode at 5 kHz is excited from the onset of neutral beam injection in a magnetic probe and a coherence spectrum a from two C-ECE receiver systems. According to Figure 1, the coherence spectra spectrum attained from the fast digitizer system give the˜0.6 coherence of ˜ 0.6 and a small statistical error level (˜7%) for the observed mode at 5 kHz. The result on temperature fluctuation is computed from the bias removed coherence spectrum and gives a ˜3% level in the frequency range (0 - 400 kHz), which is above the sensitivity limit (˜ 0.9%). Further work will be performed to investigate drift wave turbulence activities and to reconstruct the radial profile of the temperature fluctuation in LHD using the C-ECE receiver systems.

References

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