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Development of the Q-band ECE Imaging system in Large Helical Device

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An Electron Cyclotron Emission (ECE) measurement is one of the key tools for obtaining the electron temperature profile because ECE's frequency and intensity are proportional to the magnetic field strength and electron temperature, respectively. Therefore, by arranging the ECE measurement system in an array, it is possible to observe the two-dimensional temperature distribution with high temporal resolution in plasma. This is called ECE Imaging (ECEI) measurement. ECEI can be a powerful tool for measuring the spatial-temporal structure of the temperature fluctuations caused by magnetohydrodynamics (MHD) instabilities in high-β plasma.

In the Large Helical Device (LHD), ECEI measurement has been performed on a high-β plasma with a central magnetic field strength of 1 T. The frequency band was selected on Q-Band (35 to 42 GHz) for focusing on measuring the second harmonic X-mode on the edge plasma of LHD [1]. As the ECEI system, a heterodyne radiometer was adopted, and it is possible to separate the ECE signal into 8 frequency bands (channels) per antenna by a filter bank. This makes it possible to measure the electron temperature distribution at 8 points in the radial direction per line of sight. In this research, we finally manufactured a radiometer array with 8 antennas, resulting in 64 channels in total. In the 22nd LHD experimental campaign, we have successfully obtained two-dimensional temperature fluctuations in LHD for the first time. This was enabled by the breakthrough regarding millimeter-wave components. By replacing the method of local signal supply from the conventional Horn antenna Mixer Array (HMA) by the Local Oscillator Integrated Antenna Array (LIA), we could solve the issues such as an insertion loss of RF and LO power caused by a beam splitter, inhomogeneity of the LO power distribution and expensive high-power LO source. Then, the system could be simplified and the performance could be improved [2,3]. The details of the ECEI system and the initial results of the two-dimensional temperature fluctuations measurement in LHD will be presented.

References

[1] H. Tsuchiya *et al.*, Plasma Fusion Res. **13**, 3402063 (2018)
[2] D. Kuwahara *et al.*, Rev. Sci. Instrum. **81**, 10D919 (2010)
[3] D. Kuwahara *et al.*, J. Instrum. **10**, C12031 (2015)