27P-C07

Density and temperature fluctuations measured by correlation radiometry and correlation reflectometry on Heliotron J

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Diagnostics that simultaneously resolve multiple spatial and temporal scales are necessary to study the interaction between turbulence and transport. The development of high bandwidth oscilloscopes [1] (up to 100 GHz) enables the direct measurement of microwaves during plasma experiments, which are used to measure electron temperature and plasma density fluctuations at multiple radial scales. A Teledyne LeCroy oscilloscope with 36 GHz bandwidth (80 GS/s) has been used as part of a heterodyne radiometer, and separately as part of a reflectometer system, to make fluctuation measurements on Heliotron J.

The oscilloscope was used to directly measure the Intermediate Frequency (IF) spectrum from a radiometer with a 56 GHz local oscillator, corresponding to 2nd harmonic Electron Cyclotron Emission (ECE) between 58-74 GHz.

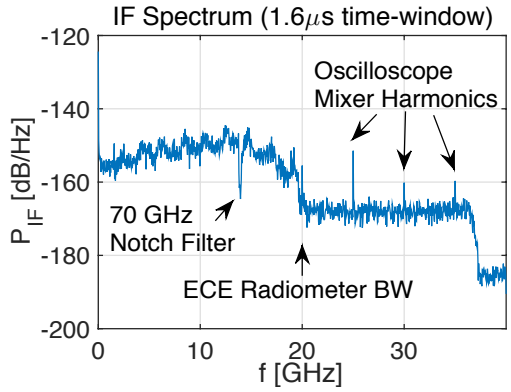

Fig.1. ECE Intermediate Frequency (IF) spectrum measured by a 36 GHz oscilloscope (shot 58666).

Figure (1) shows the IF spectrum measured during shot 58666 in the standard magnetic configuration of Heliotron J. The signal at 14 GHz is reduced due to a 70 GHz waveguide notch-filter that is used to suppress signal at the electron cyclotron resonant heating frequency.

Low frequency fluctuations (10-60 kHz) are measured in magnetic diagnostics, and coherent electron temperature fluctuations are measured across the plasma radius at the same frequencies. Figure (2) shows the coherence between two radially separated ECE channels.

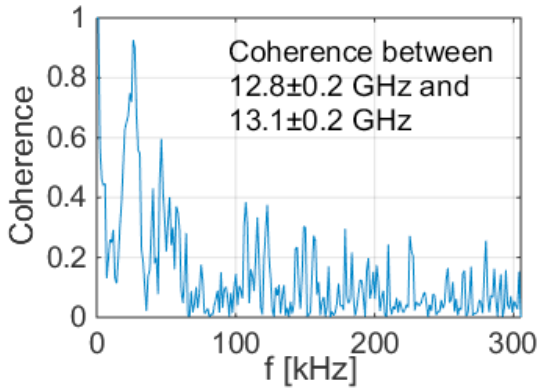

Fig.2. Electron temperature fluctuations are measured between radially separated ECE channels (shot 58666).

A conventional single-sightline correlation ECE (cECE) radiometer has been developed and implemented on Heliotron J, and the first results using the new cECE diagnostic will be presented.

Additionally, the oscilloscope was used to measure the launched and reflected waves between 24-28 GHz, corresponding to the steep plasma density gradient region, during two-source microwave reflectometry experiments. The radial correlation length of the edge plasma density fluctuations was measured to be approximately 5 mm in the high bumpiness magnetic configuration of Heliotron J.

Acknowledgments

The author acknowledges support as an International Research Fellow of the Japanese Society for the Promotion of Science.

References

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