# §5. Analysis of Turbulent Structures by the Correlation ECE Radiometer

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It is considered that a turbulence in a plasma transports stored energy from a core region to outer confinement region of a plasma. Therefore, it is important to measure turbulences to study relation between quality of the confinement and turbulences. The purpose of this study is to develop a turbulent measurement system based on an ECE radiometer, and develop an analysis method to clarify the turbulent structure from an acquired data..

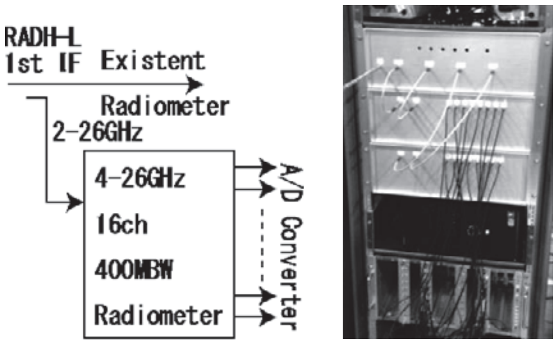


Fig. 1 A block diagram of 16ch cECE radiometer and a picture of the installed cECE radiometer system.

Fig. 1 shows a block diagram of the cECE radiometer, that we have developed. This radiometer utilizes first IF (2-26GHz) of the existent radiometer signal (RADH-L). The developed radiometer divides the IF signal into 16ch signals, and detects the amplitude of the signal with bandwidth of 400MHz at the selected frequency. We have applied the cECE radiometer to the LHD as shown in Fig. 1. Fig. 2 shows an example of a raw data. We analyzed such data with cross-correlation analysis, however, no strongly correlated result was observed. We consider that this reason is due to large amplitude of random noise as shown in Fig. 2. An ECE signal contains random noise in principle. This noise easily masks a turbulent signal. Thus, we began to analyses detectable S/N range with cross-correlation analysis by the following simulation. Two types of signal are considered as ECE signal as follows. We prepare two signals in both signal types for correlation. First type signal is composed from sinusoidally oscillated signal, which is commonly contained in both two signals, and white noise, which is independent from another one. Second type signal is composed from white noise signal, which is commonly contained in both two signals, and white noise, which is independent from each other. We have applied cross correlation (XCORR) analysis and cross power spectrum density (CPSD) analysis to these two type signals. S/N ratio is changed from 0.1 to 1000.

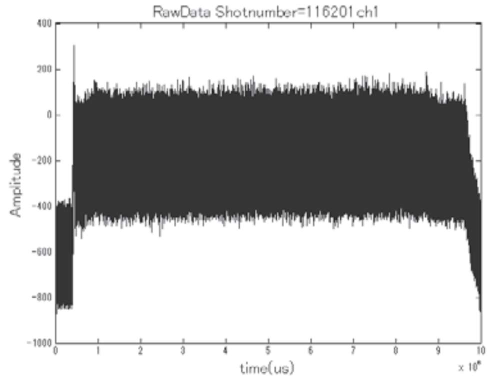


Fig. 2 An example of cECE radiometer signal.

Fig. 3 shows an example of the simulation with the CPSD analysis and signals with sinusoidal wave. The CPSD amplitude is proportional to the point number of the data when the S/N ratio is high. This means that the CPSD analysis can detect the sinusoidal signal from the raw data. The larger amount of data point utilized for the analysis, the weaker signal becomes detectable with this method.

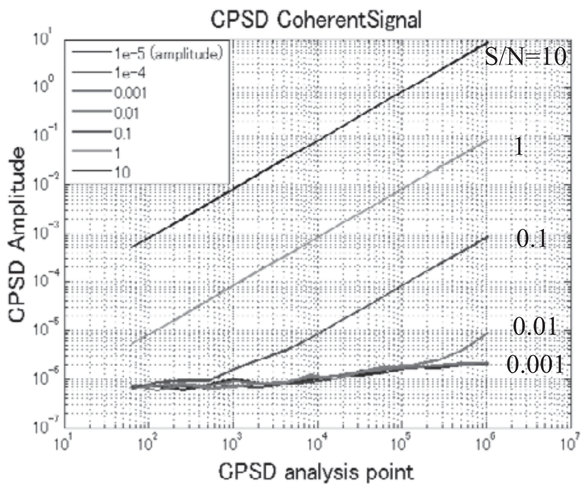


Fig .3 Simulation results with sinusoidal signal type and the CPSD analysis.

The detail characteristics of simulation results are not indicated here, but, the CPSD analysis is only applicable to the sinusoidal type signal. The XCORR analysis is applicable to both type signals; however, it is found that larger point number, compared to the CPSD, of the signal is required to detect the common noise signal component from the noisy white signal.

It is considered that S/N ratio of the real signal is not so high to detect the signal with this method. The measurement system is required to suppress noise level more.