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Development of the real-time steady-state noise reduction module for plasma wave waveforms on FPGA

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Measuring plasma wave is indispensable to understand the plasma physics through wave-particle interaction in the magnetosphere. To precisely measure weak plasma waves, it is important to suppress artificial noises originated from spacecraft. We have conventionally installed a wave sensor on the tip of long extension mechanisms to reduce the artificial noises. However, it is technically difficult to install such long extension mechanisms in a small and lightweight nano-satellites. Thus, we need to develop a new technique to suppress the artificial noises contaminated in the observed waveform data. Since real-time signal processing needs a heavy computational cost, we have developed the several FPGA modules to realize real-time onboard processing under the limited computation resources.

In this study, we develop an FPGA module for noise reduction using the spectral subtraction (SS) method. Our proposed method is able to estimate quasi-stationary noise spectra contaminated in waveform data and subtract them from the waveform. We apply a recursive filter method to estimate the quasi-stationary noise spectrum by updating the previously estimated noise spectrum. By changing a parameter called forgetting factor, we can adjust a time constant of noise estimation while keeping a small memory usage on the FPGA.

We develop a noise reduction module for an Intel FPGA to confirm that the noise reduction can be performed well in the simulation. In this presentation, we report the overview of our noise reduction module and the results of the evaluation of noise reduction performance