System Performance and Characteristics of Digital Wave Particle Correlator

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For a practical application of a plasma wave instrument, a direct measurement system of wave-particle interactions is one of the important systems to the space science mission. Electron bunching generates wave interactions and in the previous spacecrafts and rockets, an observation target for conventional wave particle correlator is a packet-like langmuir wave generated in the polar aurora or in the solar wind. This instrument can observe wave-particle interactions by calculation of the cross correlation functions between obtained waveforms and detected particles onboard.

In Japan, we have never developed or flown a direct measuring system for wave particle interaction before. We firstly designed and developed a Digital Wave Particle Correlator (DWPC) system. Our designed system is assembled in one FPGA (Field Programmable Gate Array) IC. For a new electron instrument in the development stage, FPGA is installed in many latest rocket and spacecraft to combine multi-channel, multi-frequency range array of correlators with technical improvements. We realized 3-channel of variable waveform filter and data synchronization with waveform and particle in the DWPC system. In FPGA, our algorithm controls waveform data, particle data, and magnetic field data. We can easily change the many parameters like filter frequency, particle information, parallel/perpendicular component of Electric field. These flexible methods are very important and useful for onboard instrument. Our correlator system can be measured not only an electrostatic wave-particle interaction but also an electromagnetic wave-particle interaction because of the flexibility. We are now testing the specification of DWPC and improve the program sequence. To confirm our algorithm, we do the unit test of the wave-particle correlator. We prepare the dummy waveform data as analog signal inputs from signal generator. Incoming particle signals are generated by block module in FPGA. In our algorithm, we compare a polarity of waveform and particle information. We calculate the correlation between waveform polarity and particle information. From the correlation data, we verify that our algorithm is well programmed and behaves certainly. We will show the detail results of test simulation and discuss it.