Observation characteristics of Digital Wave Particle Correlator (DWPC)

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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.

System introduction of DWPC

We have installed several functions for an evaluation in the DWPC system. Three BNC connectors are prepared for the test waveform inputs. A sampling frequency is 62.5 kHz and a 16-bit A/D convertor was chosen to provide a dynamic range of 90dB. 4-kbytes ROM is installed and used as dummy particle data or magnetic field data. 16-Mbytes SRAM is also installed to store the filtered waveform and the information of particle energy and direction. SRAM is also prepared for synchronization between the waveform and particle. We can also emulate background magnetic field with DIP switch. With these test functions, we can evaluate a wave-particle correlation in the DWPC unit only. For a practical examination with particle sensor, we prepared an LVDS (Low Voltage Differential Signaling) connector. It is prepared to connect the particle sensor developed for SELENE mission.

The sequence of unit test for DWPC

Our designed system is assembled in one FPGA (Field Programmable Gate Array) IC. 3-channel of digital filters with variable cut-off frequency (16-24Hz, 950-1.05kHz, 19.5-20.5kHz) are installed in FPGA. We can dynamically change the cut-off frequency of filters depending on the observed phenomena. We can process the particle data with FPGA whose data rate is 10^7 counts per second. We will estimate the specification of DWPC and improve the program sequence. To confirm our algorithm, we do the unit test of the wave-particle correlator and compare the data results with computer simulation. For the unit test, we will prepare the dummy waveform data as analog signal inputs from signal generator. Incoming particle signals are generated by block module in FPGA. From the correlation data, we verify that our algorithm is well programmed and behaves certainly via computer simulation. We will show the detail results of test simulation and discuss it.

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