Software-type Wave-Particle Interaction Analyzer on board the ARASE satellite

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Wave-Particle Interaction Analyzer (WPIA) is a new type of instrumentation recently proposed by Fukuhara et al. (2009) for direct and quantitative measurements of wave-particle interactions. WPIA computes an inner product $W(t_i) = q\mathbf{E}(t_i)$ dot $\mathbf{v}_i$, where t_i is the detection timing of the i-th particle, $\mathbf{E}(t_i)$ is the wave electric field vector at t_i, and q and $\mathbf{v}_i$ is the charge and the velocity vector of the i-th particle, respectively. Since $W(t_i)$ is the gain or the loss of the kinetic energy of the i-th particle, by accumulating W for detected particles, we obtain the net amount of the energy exchange in the region of interest.

Software-type WPIA (S-WPIA) is installed in the ARASE satellite as a software function running on the mission data processor. S-WPIA on board the ARASE satellite uses electromagnetic field waveform measured by Waveform Capture (WFC) of Plasma Wave Experiment (PWE) and velocity vectors detected by Medium-Energy Particle Experiments - Electron Analyzer (MEP-e), High-Energy Electron Experiments (HEP), and Extremely High-Energy Electron Experiment (XEP). The prime target of S-WPIA is the measurement of the energy exchange between whistler-mode chorus emissions and energetic electrons in the inner magnetosphere. It is essential for S-WPIA to synchronize instruments in the time resolution better than the time scale of wave-particle interactions. Since the typical frequency of chorus emissions is a few kHz in the inner magnetosphere, the time resolution better than 10 micro-sec should be realized so as to measure the relative phase angle between wave and velocity vectors with the accuracy enough to detect the sign of W correctly. In the ARASE satellite, a dedicated system has been developed in order to realize the required time resolution for the inter-instruments communications; for the synchronization of instruments, we use both the time index distributed to all instruments with the time resolution of 15.6 msec and a SWPIA counter, which is a counter accumulating pulses distributed from PWE every 1.9 micro-sec to particle instruments through a direct line. In this presentation, we show the principle of the WPIA and its significance as well as the implementation of S-WPIA on the ARASE satellite.