RECENT RESEARCH ACTIVITIES

Wave-Particle Interaction Analyzer onboard ERG satellite

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One of the key targets in the ERG mission is to investigate wave-particle interactions leading to the generation of high energy electrons in the terrestrial radiation belt [1]. The study of wave-particle interactions has been conducted by examining the correlation of wave spectra/waveforms and plasma energy spectra/velocity distributions which are observed by plasma wave receivers and particle detectors, independently. The disadvantage of this method is the difference of the time resolutions of plasma wave data and plasma data. Furthermore, the quantitative data analysis is difficult in this method, because the phase relation between electric field and particle velocity vectors is missing. In order to overcome these disadvantages, we proposed the new method for the direct measurement of wave-particle interactions. It is addressed by Wave-Particle Interaction Analyzer (WPIA) [2]. The WPIA makes use of each pulse which shows the detection of particles in plasma detectors. The WPIA calculates $\boldsymbol{E} \bullet \boldsymbol{V}$ at each timing of particle detection by multiplying instantaneous electric field wave vector (see Figure 1). Since $\boldsymbol{E} \bullet \boldsymbol{V}$ is equivalent to time differential of plasma kinetic energy, the quantitative energy flow among waves and plasmas can be obtained using the WPIA.

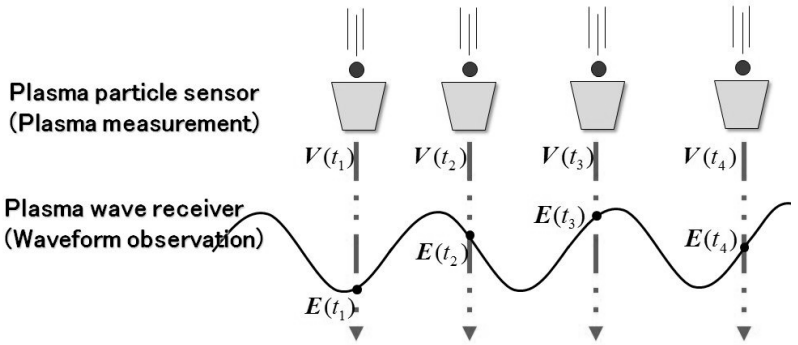

Figure 1. Schematic drawing of the WPIA algorithm.

The WPIA onboard the ERG satellite is realized by the onboard software. The software of the WPIA runs on the digital processing unit addressed MDP (Mission Data Processor). The WPIA needs the information of velocity vectors of sampled particles, instantaneous plasma wave vectors, and the ambient magnetic field vector. These data are stored onto the onboard data recorder through the high speed digital interface called SpaceWire.

The MDP reads out the above data from the data recorder and the WPIA calculates the physical quantity $\boldsymbol{E}_w \bullet \boldsymbol{V}$. The important point in this system is the time accuracy. In order to identify the wave-particle interaction on the chorus emission, we need the time synchronization accuracy is $10\,\mu\mathrm{sec}$ at least. This accuracy will be guaranteed by the synchronization pulse from the system and the high frequency counter installed inside the plasma wave receiver.

The current status of developing the WPIA for the ERG mission is under considering the appropriate algorithm using computer simulations. The computer simulation reproduces the generation process of the chorus emission and the acceleration of electrons by the chorus emission. The algorithm based on the computer simulation will be examined using the breadboard of the MDP designed for the ERG emission.

References

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[2] Fukuhara, H., H. Kojima, Y. Ueda, Y. Omura, Y. Katoh, and H. Yamakawa, "A new instrument for the study of wave-particle interactions in space: One-chip wave-particle interaction analyzer," *Earth Planets Space*, vol. 61, pp. 756-778, 2009.