Future formation-flight mission FACTORS: Development of plasma particle instruments and evaluation of electric field measurements with short electric field sensors

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FACTORS is a multi-satellite formation flight mission to be proposed. Nominal trajectory of FACTORS is a polar orbit whose perigee and apogee are 400 and 4000km, respectively. Major scientific targets of the mission are to reveal physical mechanisms of (1) energy and particle transportations between the magnetosphere and the ionosphere, including small scales down to auroral fine-scale structures, (2) generation of ion outflow at polar ionosphere through plasma wave - particle interactions, (3) ion - neutral coupling in the thermosphere. Simultaneous multi-point measurements of in-situ plasma wave and particles in small scales provide us discrimination of temporal and spatial variations which are difficult to achieve with measurements by a single satellite. Therefore, each satellite carries plasma wave instruments, and particle instruments as well.

The model instruments onboard FACTORS contains three-axes sensors for electric and magnetic field fluctuations, ion energy-mass spectrometers (supra-thermal to a few tens of keV), and electron energy analyzers (10eV to 2MeV). Among these instruments, the supra-thermal ion energy mass spectrometer (SEP-IMS) is one of the key instruments for exploring the ion outflow phenomena. For measurements of ions in supra-thermal energy range, orbital motion of the satellite affects significantly (RAM effect), and it is important to measure particles coming from RAM direction. Therefore, SEP-IMS must have wide field-of-view with necessary angular resolution. On SEP-IMS design, we have implemented functions of changing the field-of-view by applying specific voltages on sensor electrodes. On the other hand, we have also implemented a sensitivity control mechanism on SEP-IMS, since estimated fluxes of supra-thermal ions in low (~400km) and high (~4000km) altitude are quite different.

For measuring plasma waves, the most challenging part is to observe three components of electric field oscillations using short electric field sensors. Electric field sensors show complicated characteristics in plasmas. In the case that wavelengths of plasma waves are comparable with sensor lengths, their characteristics should be considered carefully. A computer simulation is a useful tool for quantitatively examining the characteristics of sensors in plasmas. Full particle computer simulations targeting electric field measurements in the FACTORS mission show the characteristics of short electric field sensors with the lengths that are in the same order of wavelengths of plasma waves depending on relative angles between electric field sensors and ambient magnetic fields. The quantitative evaluation of electric field sensors is so crucial for meeting the objectives of the FACTORS mission.

We will report on the development status of plasma particle instruments and the evaluation of electric field sensors onboard the FACTORS mission.

Keywords: FACTORS, plasma particle instrument, electric field measurement

