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Technical data acquisition equipment for GOSAT

YASUTOMO SASAKI [1], HARUHISA MATSUMOTO [1], TATEO GOKA [1], TOSHIYUKI NAKAMURA [1], KAZUHIRO TERASAWA [1,3], HISASHI KITAMURA [2]
[1] Japan Aerospace Exploration Agency
[2] National Institute of Radiological Sciences
[3] Waseda University
sasaki.yasutomo@jaxa.jp

Abstract: We have been developing the Technical Data Acquisition Equipment (TEDA) for the Greenhouse gases Observing Satellite (GOSAT). The GOSAT satellite will be launched in 2008 into a sun-synchronous sub-recurrent orbit with 666km altitude and 98deg inclination. The nominal mission duration is 5years. The TEDA is a comprehensive orbital radiation environment monitoring system designed to provide measurements of the energy spectra of energetic electrons, protons, and heavy ions of masses ranging those of from helium to iron. The TEDA includes five newly developed sensors that are more compact and lightweight than conventional sensors. The obtained data are expected to contribute to science and technological development by increasing our understanding of the causes of radiation-induced spacecraft degradation and anomalies, updating the space radiation environment model, and so on.

Introduction

In space, highly energetic particles can cause anomalies and degradation of space systems. In recent years, we must meet high levels of system performance using commercial devices and technologies that are not originally intended for rad-hard systems. These trends have made the radiation management complex and difficult in designing space systems, and we must quantify the radiation environment more accurately than ever before.

At JAXA, many on-board space environment measurement systems, named Technical Data Acquisition Equipment (TEDA), were developed for earlier satellites. Their collected data have been used to establish and update the radiation environment model and contribute to the science regarding of particle acceleration and transform (Fig.-1). The data have also helped researchers to diagnose space systems anomalies [1, 2]. They are important for exact radiation management in future satellite programs.

We are now developing the TEDA for the Greenhouse gases Observing Satellite (GOSAT), which will be launched in 2008 into a sun-synchronous sub-recurrent orbit with 666km altitude, 98 deg inclination. Its nominal mission duration is 5years.

In this paper, we present a brief description of the instruments and their ground irradiation testing.

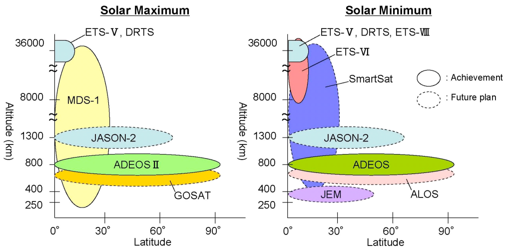

Figure 1: Space environment measurement

Description of Instruments

The GOSAT TEDA comprises Light particle telescope (LPT) and Heavy Ion Telescope (HIT) (Fig.-2, Fig.-3). These are designed to characterize the high energy charged particle radiation environment that is responsible for on-orbit electronics damage and physical material damage in space systems.

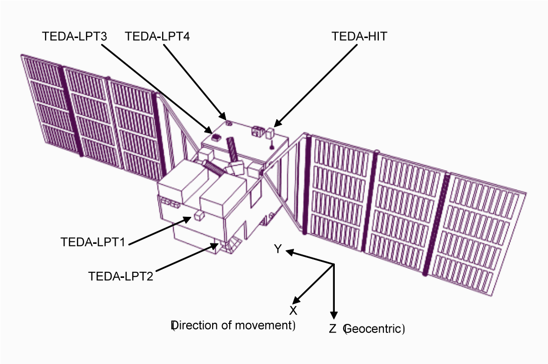

Figure 2: Location of instruments

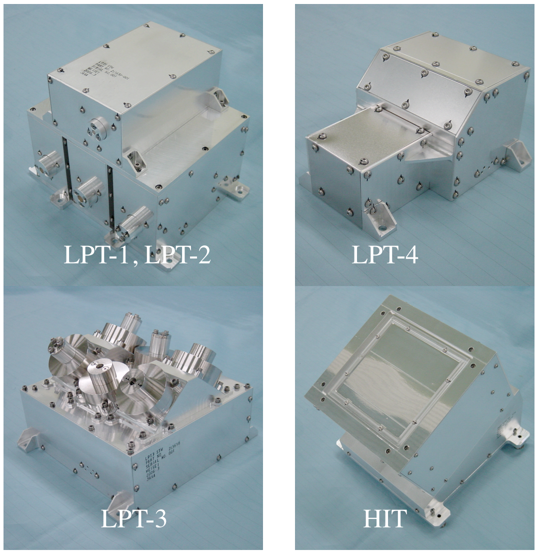

Figure 3: Light Particle Telescope (LPT) and Heavy Ion Telescope (HIT)

Light Particle Telescope (LPT)

The LPT discriminates electrons, protons, and alpha particles and analyzes their energy. The LPT comprises five compact and light weight sensor units, each with different measurement ranges and particle types. Table-1 describes the performance of these sensor units.

These sensor units include silicon solid-state detectors and scintillators. They identify energy and particle types from these detector signals proportional to the energy deposited in them. (Fig.-4, Fig.-5)

These sensor units are integrated into four instruments: LPT-1, LPT-2, LPT-3, and LPT-4. The fields of view of these instruments are designed to examine each effect of trapped particles, aurora particles and solar flare particles.

Table 1: Sensor units of LPT

Sensor Units	Particle types and energy	Weight [Kg]	Size [mm]
ELS-A	Electron: 30 keV ~ 1.3 MeV	0.6	115 x 85 x 65
ELS-B	Electron: 280 keV ~ 20 MeV	1.2	133 x 78 x 65
APS-A	Proton: 400 keV ~ 37 MeV α: 3 MeV ~ 16 MeV	1.1	120 x 90 x 65
APS-B	Proton: 1.5 MeV ~ 250 MeV α: 20.7 MeV ~ 400 MeV	1.1	120 x 90 x 86
APS-C	Proton: 100 MeV ~ 500 MeV α: 25 MeV/n ~ 500 MeV/n	1.3	134 x 120 x 71

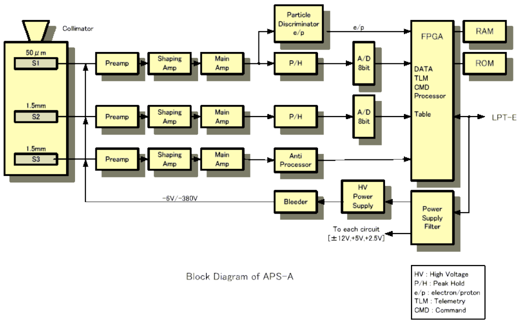

Figure 4: Block diagram of APS-A

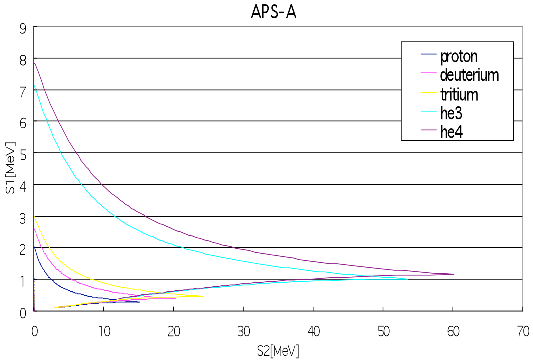

Figure 5: Deposited energy in APS-A

Heavy Ion Telescope (HIT)

The HIT characterizes the fluxes and energy distributions of heavy ions having masses from that of helium to iron, identifying isotopes by methods of dE × E. The HIT is composed of two position-sensitive detectors that detect the incident particle direction, and eight PIN type detectors that detect the incident particle energy. The detection of direction is necessary to compensate the difference in the dE signal depending on the incident direction. To observe heavy ions in cosmic ray with good statistical probability, we designed the geometrical factor to be larger than those of conventional heavy ion telescopes using a newly developed thick silicon detector and reducing the length of the silicon detector stack. (Fig.-6).

The HIT performance is described in Table-2.

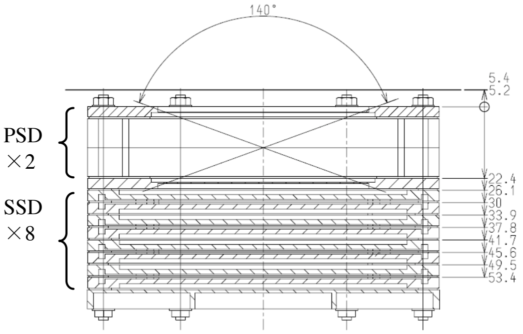

Figure 6: Cross-section view of HIT

Table 2: Performance of HIT

Particle types (*)	Measurement energy range
He	7 - 48MeV/u
Li	8.5 - 56MeV/u
C	13 - 90MeV/u
O	16 - 106MeV/u
Fe	28 - 201MeV/u

Ground irradiation test

We are now performing ground irradiation testing. We have performed many tests using beams from HIMAC and cyclotron facility of the National Institute of Radiological Sciences, RIKEN ring cyclotron, and the facility at Tsukuba University.

Figure-7 shows an example of test results of LPT using the cyclotron facility of the National Institute of Radiological Sciences. We were able to validate the sensor modeling and detectors' performance.

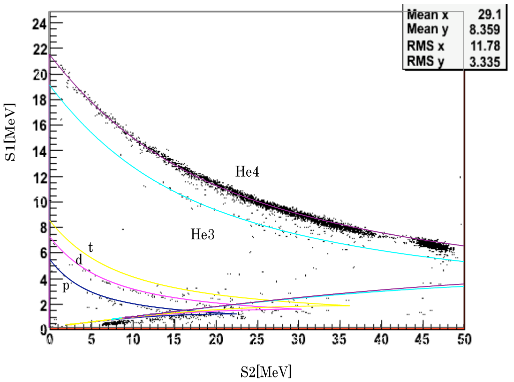

Figure 7: Scatter plot of APS-B

Summary

We have been developing a space radiation monitoring system composed of compact, light weight and high-performance sensor units. We are now performing irradiation testing to validate their performance. We will complete testing in June 2007.

Acknowledgement

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References

[1] T. Goka, H. Matsumoto, MEASUREMENT OF NEAR EARTH RADIATION ENVIRONMENT -OVERVIEW AND PLAN-, IAC-06-D5.2.02, 57th IAC, Valencia, 2006

[2] Y. Sasaki, H. Matsumoto, T. Nakamura, T. Goka, Development of Technical Data Acquisition Equipment on board GOSAT, IEICE general conference, 2006