Monitor of All-Sky X-ray Image(MAXI) mission

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Abstract

Monitor of All-sky X-ray Image (MAXI) is the first astrophysical payload which will be mounted on the Japanese Experiment Module (JEM) Exposed Facility of International Space Station (ISS) in 2008. It is designed for monitoring all-sky in the X-ray band by scanning with slat collimators and slit apertures. Its angular resolution and scanning period are 1arc degree and 90 minutes, respectively. MAXI employs two types of X-ray camera. One is Gas slit Camera (GSC), the detectors of which are one-dimensional position sensitive proportional counters. Its position resolution is 1.0 mm along carbon anode wires. GSC covers the 2.0-30keV energy band. The other camera is Solid-state Slit Camera (SSC). We employ a pair of SSCs, each of which consists of sixteen CCD chips. Each CCD has 1024x1024 pixels, and each pixel is 24x24 micrometers. The CCDs are to be operated at -60 degree using Peltier coolers. SSC covers an energy range of 0.5-10.0keV. PDR is finished in September 2001. CDR will be performed in September 2003. The continuous Ethernet down link will enables us to alert the astronomers in all over the world to the appearance of X-ray transients, novae, bursts, flares etc. MAXI cannot only monitor Galactic and extra-galactic variable X-ray sources, but also this mission can produce simultaneous observations for variable sources such as BL Lac objects with various institutes. In this paper we will report on the current status of the MAXI mission.

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1. Introduction

A large majority of the X-ray sources are known to be various time scales. The variations on short term scales (shorter than several days) of persistent sources can be studied with dedicated pointing observations with satellites. The variation on longer time scales (tens of days or longer), or the unpredictable outbursts of transient sources, however, is difficult to study unless a large part of the sky is constantly monitored. The all-sky monitors (ASMs) have been developed and have flown on generations of X-ray astronomy satellites. The Vela 5B satellite operated for ten years and collected a database of long-term variability of bright X-ray sources. Ariel V[1] and Ginga[2] had ASMs, and discovered strong outbursts of binary sources such as black hole candidates and Be transient pulsars. The alerts by the ASMs enabled quick follow-up with higher sensitivity pointed observations. More recently, Watch on Granat[3] , and BASTE on CGRO[4] have also detected outbursts from bright transient sources. The latest experiment is ASM on RXTE[5] which is constantly monitoring about one hundred sources with higher sensitivity. A more sensitive monitor is also planned with MOXE on Spectrum X-gamma. We plan to extend the monitoring of X-ray sky with MAXI on the international Space Station. In addition to the detection of bright or even faint transient sources, we plan to study the long-term variability of a large number of faint X-ray sources including binary sources and bright AGNs. We can also study an uniformity of the cosmic X-ray background(CXB).

2. Monitor of All-Sky X-ray Image (MAXI)

MAXI[6][7][8][9] is a highly sensitive X-ray all-sky monitor. It was selected as the first astrophysical payload on Japanese Experiment Module (JEM) Exposed Facility (EF) on the International Space Station (ISS). The PDR was finished in September 2001 and CDR will be performed in September 2003. The launch is now scheduled in 2008 by the Japanese HII-A rocket. The satellite H-II Transfer Vehicle (HTV) will carry MAXI and other payload to the ISS. MAXI is to be attached to the port # 1 of the JEM-EF. MAXI is box-shaped in 0.8 x 1.0 x 1.85 m with the weight of 500kg (Fig.1). The mission life time will be at least 2 years.

It is equipped with two kind of the X-ray slit cameras. The Gas Slit Camera (GSC) is with the proportional counters and the Solid-State Camera (SSC) is with X-ray CCDs. Those slit cameras scan the whole sky as the ISS rotates around the earth. We made engineering model GSC counters and engineering model SSC chips in 2000. Those have been tested in RIKEN, NASDA and Osaka-university. Their expected performances were confirmed[10][11]. We are making flight model counters and flight model chips at present. MAXI can scan almost all sky with a precision of better than 1 degree and in X-ray energy range of 0.5-30 keV. The simulation showed that the sensitivity of MAXI is 1 mCrab in a day[12]. MAXI

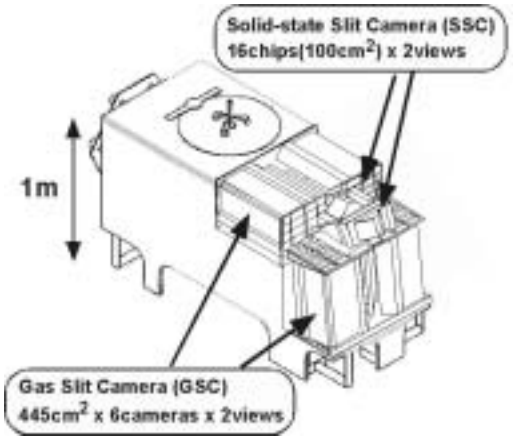

Fig. 1. MAXI has two X-ray instruments: GSC and SSC. Each has two sets of cameras looking at the horizon and the zenith directions. Radiators and thermal shields are removed in this figure to show the cameras.

will be able to detect not only galactic objects but also extra galactic objects. It will achieve a non-biased long-term (day-year) monitoring of AGNs for the first time.

Detected X-ray photons are processed on-board and sent to the ground. There are two lines for the data down-link, 1553B and Ethernet. The 1553B is low-rate and contains HK and essential data. The ethernet is mid-rate and contains all the information on the detected X-ray. We will use the ethernet data for the detail analysis, but only 1553B data can lead to the minimum success. There are two ways in the down-link to the Tsukuba Space Center . One is via the ICS antenna on JEM-EF through Japanese data relay satellites DRTS and other is via NASA antenna on ISS, USA data relay satellites TDRSS, and NASA center to Tsukuba space center. There will be 5 hours of contact at maximum per day in the ICS link when the data can be obtained in real time. The NASA link has 17 hours at maximum. When ISS is out of contact, the data are stored in the ICS data recorder and replayed in the next contact. The real-time contact is essential for making the prompt "alert". The full time coverage is desirable. We are developing the ground analysis softwares for the real-time "alert" system.

3. Conclusion

MAXI is an X-ray all-sky monitor approved for the JEM Exposed Facility of the ISS. It is optimized to monitor the faint X-ray sources with flux levels down to 1 mCrab, and is composed of large-area proportional counters and X-ray CCD arrays. The fan-like field of views will scan the full sky during each orbital revolution of ISS. The PDR was finished in September 2001 and CDR will

be performed in September 2003. We are making the flight model detectors at present. The launch is scheduled in 2008.

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