The Current Status of the MAXI/SSC

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Abstract

Solid-state Slit Camera (SSC) is a X-ray CCD camera onboard the MAXI mission. After the installation of MAXI onto the International Space Station, SSC was successfully activated, and has been conducting the scan observation for more than 1.5 years. This proceeding reports the results of the initial checkout and the current status of the SSC.

Key words: MAXI: SSC

1. Introduction

MAXI (Monitor of All-sky X-ray Image) is an X-ray monitor on the International Space Station (ISS). After the activation of MAXI on August 2009, MAXI has discovered many transients objects with GSC (Gas Slit Camera).

SSC (Solid-state Slit Camera) is a X-ray CCD camera onboard the MAXI mission. Compared with the GSC, the SSC has good sensitivity at the low energy band (<2keV) and good energy resolution, while the X-ray collection area is limited. In this paper, we will describe the observation status of the MAXI/SSC. The details of the in-orbit performance can be found in Tsunemi et al (2010). The study of the background is summarized by Daikyuji et al (2011), and the gain calibration is summarized in Kitayama et al (2011). Kimura et al (2011) describes the scientific results of the MAXI/SSC. The detailed description of the SSC hardware is in Tomida et al (2011).

2. Observation with the SSC

MAXI was launched by Space Shuttle Endeavor in Jul 2009. After the successful installation of MAXI, SSC was activated on 2009-08-15. In the initial check-out, we conducted the health check of all of 32 CCDs, peltier coolers, and the SSC electronics, and confirmed that they worked well. The SSC, then, started the observation on 2009-08-17.

The SSC has been conducing the scan observation for more than one year, the SSC has suffered from a problem in the image data. Figure 1 shows the raw image of a MAXI-CCD obtained in the orbit. The image taken at the night is as expected, however, the outer region of the image taken when the Sun is close to the field of view (FOV) of SSC is very bright. The surface of the CCD is coated with aluminum of 2000A thick to block the optical and infrared light. However the side of the CCD wafer is free from the aluminum coating. We think that the infrared light enters from the CCD side, and contaminates the CCD images. We, then, have been operating the SSC when the ISS is at night.

Figure 2 show the ratio of the night time in each day. About 40 % of a day is night, while there is no night period every ∼60 days. In these days, SSC cannot observe the sky with the sufficient quality. In addition to the day/night condition, SSC cannot be activated when the ISS is in the South Atlantic Anomaly (SAA) region. Then Figure 2 shows the maximum observation efficiency of the SSC.

Figure 3 is a SSC image taken at 2010-07-16 and 2010-12-04. The sky coverage of the one-day observation is about 40%. The unobservable region moves according the sun position and the ISS orbit. Then, it takes about a half year for the SSC to cover the entire sky. In the season from spring to autumn, the galactic center region can be observed, but in the other seasons, we cannot monitor the galactic center with the SSC.

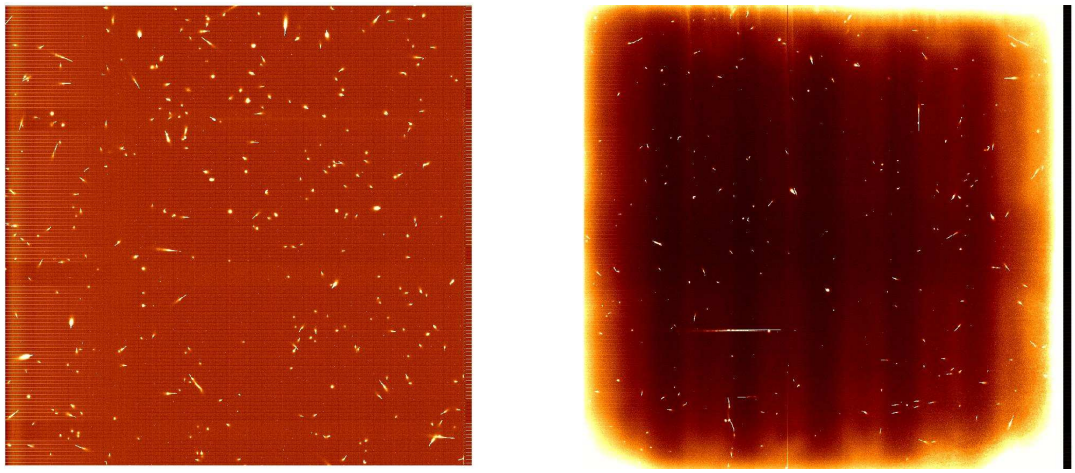

Fig. 1. SSC raw images. The right image was obtained when the ISS is at the night, and the left is obtained when the Sun is close to the SSC field of view. White lines in the left edge of the night image is due to the flip mode operation.

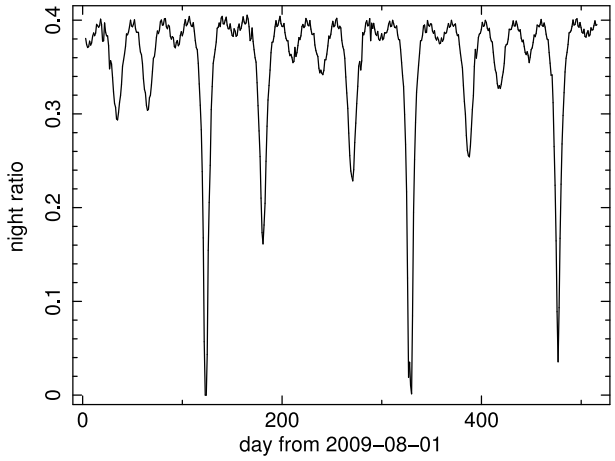

Fig. 2. The night ratio of the ISS. The horizontal axis is day from 2009-08-01, and the vertical axis is the night ratio of each day.

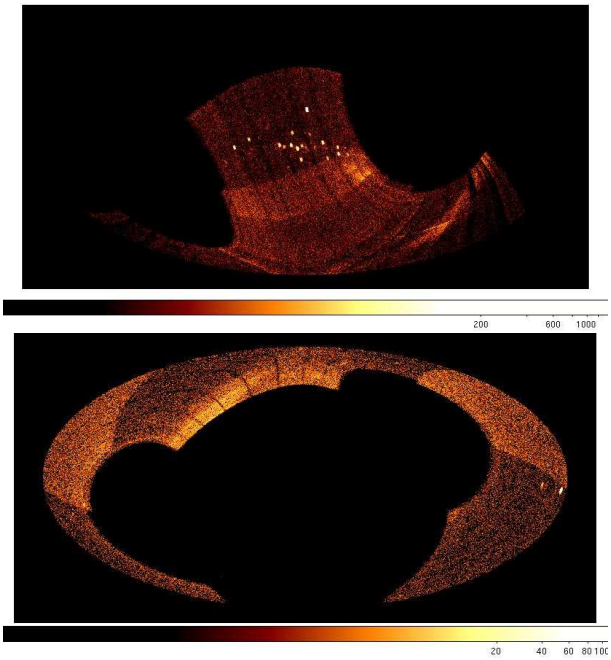

Fig. 3. The one-day image obtained with the SSC in the Galactic coordinate. The right was taken in 2010-07-16, and the right is in 2010-12-04. The background is not subtracted and exposure is not corrected.

3. cooling ability

In order to reduce the thermal noise, it is essential for CCDs to be cooled in the orbit operation. SSC camera bodies are cooled with radiator panels and loop heat pipe, and the CCDs in the camera bodies are cooled with peltier devices.

Figure 4 shows the long-term trend of temperatures of CCDs, camera body, and the radiator panels. Since the peltier devices are operated in constant current mode, the CCD temperatures are not kept constant, but depend on the camera temperature. The camera temperature depends on the that of radiator panels. CCD temperature depend on the MAXI/ISS attitude, but no degradation of the cooling ability. The peltier devices, loop heat pipe, and radiator panels have been working quit well.

4. data reduction

The figure 5 is spectra created from grade 0 and grade 012 events of the SSC-H. The grade definition is described in Tomida et al. (2011). At the lower energy range (<1keV) of grade 012 spectrum, we can see a large hump. This component is generated by the charged particle events. This is a large background component, but this component can not be seen in the grade 0 spectrum. At the lower energy region, more than 90 % of the X-ray

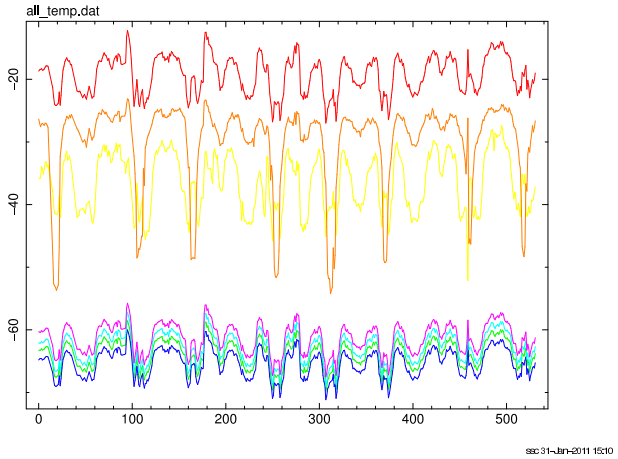

Fig. 4. Long term trend of temperatures of SSC. The red is the temperature of SSC camera body, the orange and yellow are temperatures of radiator panels, and the other four curves are temperatures of four CCDs.

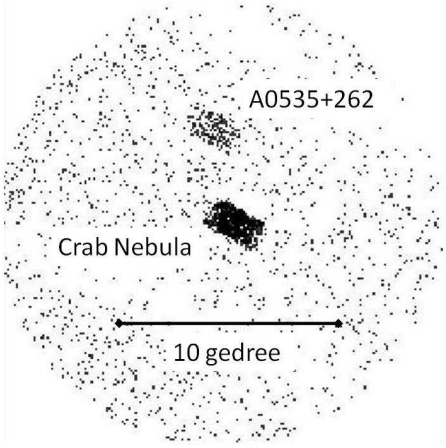

Fig. 6. The one-day image around the Crab nebula. The image was obtained at 2009-12-28 with SSC-Z. Grade 3 events are removed.

events is detected as grade 0 event. We, then, decided that only grade 0 events should be used at the soft band (<1.85keV=Si edge), and grade 012 at the higher energy range (>1.85keV). The SSC has suffered from various types of the background components, e.g. moon light, charged particles at high latitudes. The study of the background is summarized in Daikyuji et al. (2011).

Figure 6 is a SSC image around the Crab nebula. The exposure is 24 hours, and only the SSC-Z detected the Crab nebula. The grade selection way is as described above. The crab nebula was detected in about 100 σ level, so the sensitivity of the SSC in one-day accumulation is estimated to be $\sim$50 mCrab in 5 σ confidence level. The sensitivity of one scan is about 200 mCrab. The accuracy (systematic error) of the position determination is about 0.1$\sim$0.2 degrees.

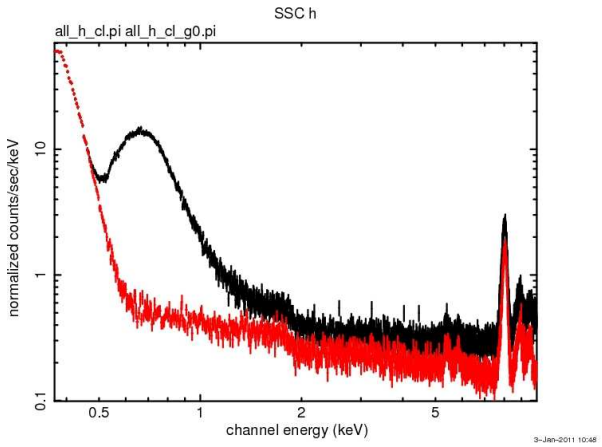

Fig. 5. The spectrum of SSC-H. The red is made of grade 012 events, and the black is grade 0 only. The peak around 8 keV is copper line coming from the collimator sheets in the SSC unit.

5. data distribution

The SSC data will be distributed from RIKEN web site (http://maxi.riken.jp) as the GSC data has already been. At the RIKEN web site, the light curve will be distributed in three energy band (<1.85 keV, 1.85–4 keV, and >4keV).

The SSC light curves will be made from the Ethernet telemetry data. In the data transfer via the Ethernet, there had been a problem, which was fix by an installation of data converter in the pressurized module. Before the installation at March 2010, the availability of the Ethernet data was limited. The SSC light curves suffer data loss. After the installation, the data availability of the Ethernet data is almost 100%, however the SSC cannot observe the entire sky. The distributed light curves will, then, lack more than 60 % data. SSC cannot cover the entire sky in the one-day observation.

References

Matsuoka M. et al. 2009 PASJ., 61, 999
Tomida H. et al. 2011 PASJ., 63, (in press)
Tsunemi H et al. 2010 PASJ., 62, 1371
Kimura M. et al. this proceeding
Kitayama H. et al. this proceeding
Daikyuji A. et al. this proceeding