# The Current Status of Solid-state Slit Camera aboard MAXI

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Abstract

We present the current status of the performance of the Solid-state Slit Camera (X-ray CCD camera of the MAXI mission). The charge transfer efficiency (CTE) of the CCDs have been degrading, and the energy resolution has been also degrading. On the other hand, the cooling capability of the MAXI/SSC has been stable since the beginning of the in-orbit operation. The radiator temperature and camera temperature shows no significant change without those coming from the Sun-orbit plane angle, and the cooling power of the Peltier devices has been unchanged. Then, the CCD temperatures have been stable.

Key words: MAXI: SSC — X-ray Camera: CCD

## 1. CCD performance

Fig.1 represents the spectrum of Cu-k$\alpha$ line obtained with SSC-H/CCDID-0, that are those applied for with the correction of CTE (charge transfer efficiency) and temperature-gain dependency. Fig.2 represents the long term trend of the pulse height of Cu-k$\alpha$ line and the line width of all CCDs. We can see gradual broadening of the line width and the shift of the Cu-line center. The causes of the width broadening are degradation of the charge transfer efficiency, and inaccurate gain-corrections. The performance degradation is more serious for the CCDs whose position is close to the camera slit. The intensity of charged particles is higher at the position closer to the slit, which likely causes the deference of the degradation level. The energy resolution of SSC-Z/CCDID-0 is very bad, which is due to the insufficient cooling power of the Peltier cooler. Then, we should not use the data of SSC-Z/CCDID-0. In the MAXI operation, the data of SSC-Z/CCDID=0 have not been down-linked. Between Mar 2013 and Apr 2014, SSC-Z was not operated due to the on-board-computer trouble. After the non-operation period, SSC-Z has functioned completely. The performance of the SSC-H and Z had been gradually degraded. For the detailed spectrum analysis of SSC, we should be careful when you use the data obtained after 2014.

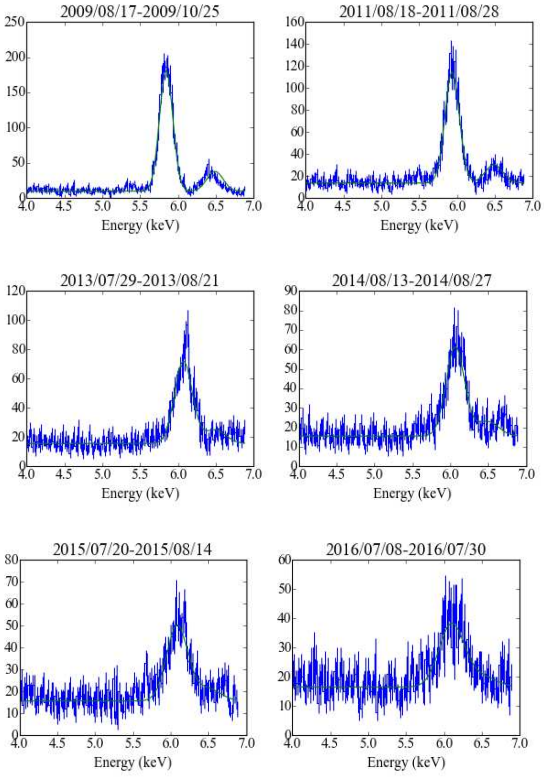


Fig. 1. Cu-K$\alpha$ line profiles of SSC-H/CCDID-0. 6 spectra are extracted from single-pixel event data in 6 different periods, that are shown above each panel.

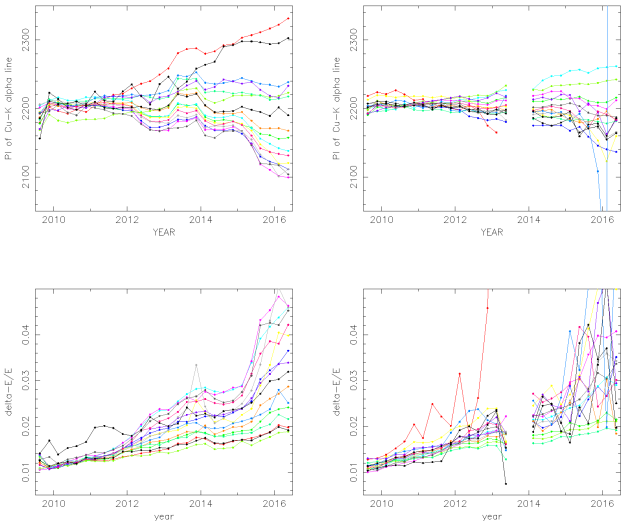


Fig. 2. Trend of characteristics of Cu-k$\alpha$ line. The center and width of the Gaussians are plotted. Each dot (spectrum) is extracted from the 3-months integrated data. In each panel, data of 16 CCDs are plotted.

## 2. Cooling Capability

CCD chips of SSC are cooled with Peltier coolers in the CCD devices, and the heat from the Peltier coolers are transported to radiator panels on the surface of MAXI payload via the loop heat pipe. Fig.3 (left) shows the long term trends of the radiator temperature, and Fig.3 (right) shows that of SSC camera body. The orbital plane of the International Space Station precess every 70 days, then the temperatures show the periodic change according to the precession. However no inclination can be seen. There is no degradation for the cooling capability of the radiator and loop heat pipe system in the 7-years MAXI in-orbit operation. The temperature change of the camera body around 2014 corresponds to the period that SSC-Z was not operated due to the computer trouble. During this period, the heat generation from SSC was small compared with that in other period. Fig.4 shows the temperature difference of CCD chips and camera body, which represents the colling power of Peltier devices. Peltier Current is 1.0 A and 0.82 A for SSC-H and SSC-Z, respectively. No significant degradation can be seen. A small change around 2014 in SSC-H is due to the temperature increase pf camera temperature when SSC-Z was not operated.

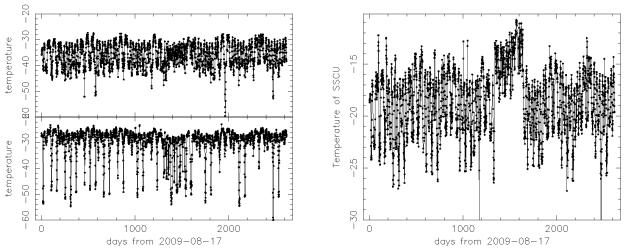


Fig. 3. Temperature trend of the radiator panels (left) and SSC camera body (right). Each dot represents the one-day averaged temperature. MAXI has two radiator panels.

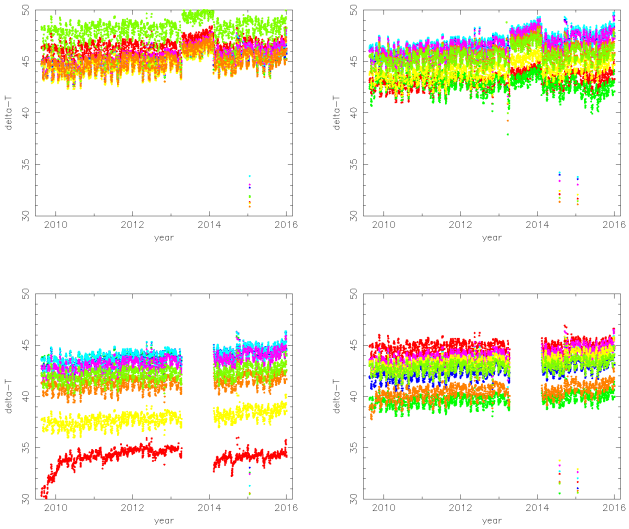


Fig. 4. Cooling power of 32 Peltier devices. The vertical axis shows the temperature difference between CCD ship and camera body. The left upper, right upper, left bottom, and right bottom panel are the data of SSC-H/CCDID0-7, SSC-H/CCD8-F, SSC-Z/CCD0-7, and SSC-Z/CCD8-F, respectively.