ASTRO-H SXI Development Status

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Abstract

SXI (Soft X-ray Imager) is the X-ray CCD camera system consisting of 4 back-illuminated CCD chips of 1280x1280-pixel format, each of which is read out with 2x2 on-chip binning scheme at every 4 sec, and a couple of single stage Stirling coolers. The incident optical photons are blocked by OBL (optical blocking layer) coated on the chips instead of traditional optical blocking filters. The contamination on OBL from the spacecraft is controlled by a baffle connecting the camera body and the X-ray telescope mirror.

The CCD driver and ADC are placed in the camera body unit, and no analog signal appears among the SXI components. All the analog and digital BBMs have already been built, while some functions in the digital part have not implemented yet and the end-to-end analog performance has not investigated yet.

Key words: ASTRO-H — SXI — X-ray CCD — Analog ASIC — SpaceWire

1. Focal Plane Assembly (FPA)

The FPA uses four backside-illuminated CCDs developed by Hamamatsu Photonics K.K. (HPK). Compared to previous HPK-CCD based FPA, the camera body has much smaller room for SXI FPA. Thus, it is essential to redesign its structure from heritages and the work has almost been finished.

Instead of the traditional optical blocking filters (OBF) used for Suzaku XIS (Koyama et al. 2007), SXI has the optical blocking layer (OBL) that has a layered structure of Al-Polyimide-Al. Figure 1 shows the measured transparency of an OBL sample. The detail of the OBL is described by Watanabe et al. 2010.

2. Electrical Circuits

The electrical components of SXI consist of a SXI-FE, four -PEs and a -DE. Figure 2 shows the SXI components and the electrical connections between them. The SXI-FE is placed beside the camera body and includes all the analog circuits and digital interface to the SXI-PEs. This unit receives the CCD driving patterns, drives CCDs, converts the CCD outputs to digital data and sends back them to the SXI-PEs. All the I/Os are of LVDS interface, and the protocol is under development. The bread-board models of the driving and ADC units have been built, and the latter including custom made ADC ASIC achieves 135 eV energy resolution (FWHM) for Mn-Kα fluorescence line (figure 3) combined with an SXI-baseline CCD chip.

An SXI-PE generates the driving patterns for a CCD, stores an exposure image, estimates the dark-frame image and generates the list of event-candidate pixels for each exposure. All the functions are implemented as FPGA circuits, and the images and the list are sent out to SXI-DE via SpaceWire (ESA 2008) interfaces. The SXI-PE also collects the HK information from SXI-FE and sends them out to SXI-DE; this function has not, however, implemented yet.

SXI-DE receives the commands from the satellite management unit (SMU) and sends out the observation data as CCSDS space packets. SXI-DE also edits the CCD data from SXI-PE and generates the output data. There is no bread-board model of SXI-DE; instead, the SXI-PE outputs are received by a SpaceCube computer and for-

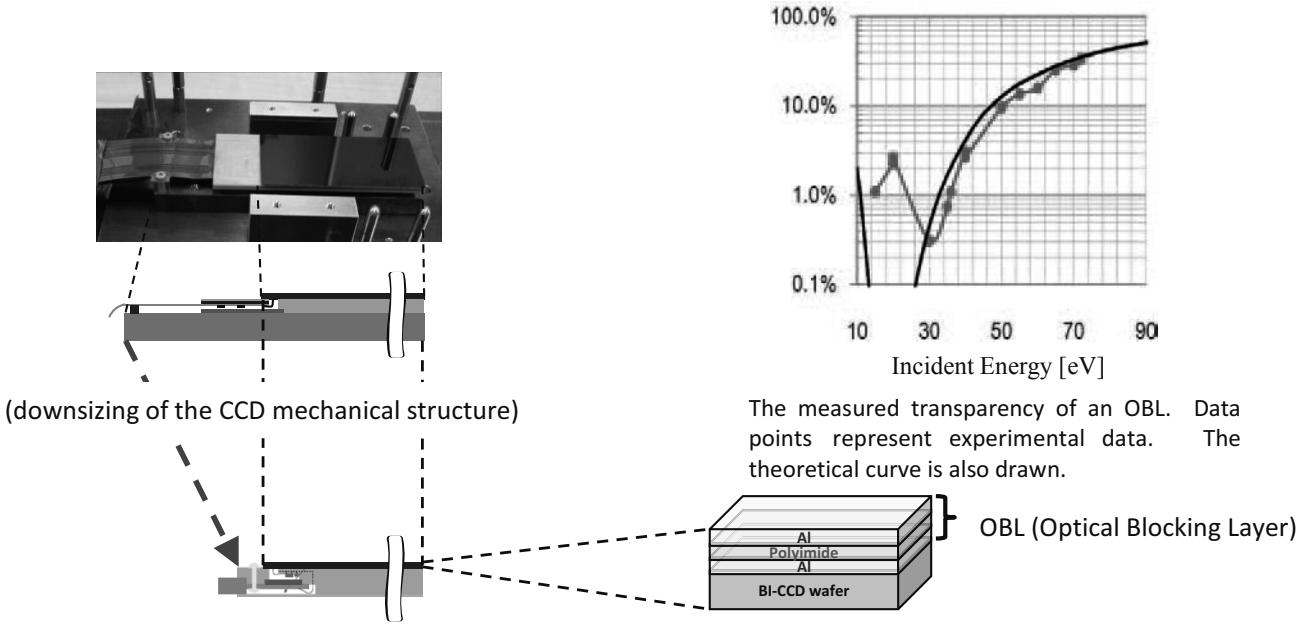

Fig. 1. Baseline (upper-left) and current (lower-left) designs of FPA quadrants and the optical blocking layer design (right).

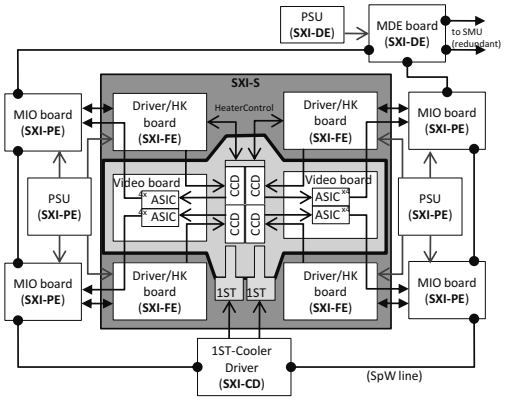

Fig. 2. A schematic drawing of the SXI components and the electrical connections between them.

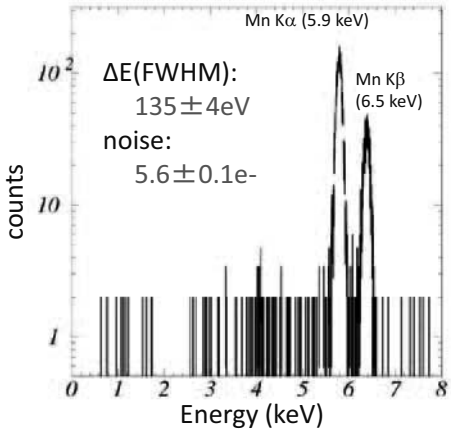

Fig. 3. A ^{55}Fe spectrum taken by an EM ASIC and a baseline CCD chip.

warded to a POSIX computer (such as Linux or MacOS) via Ethernet. The obtained data are thus stored and evaluated by usual PCs.

3. Contamination Control

Based on the lessons learned from Suzaku (Hayashida et al. 2007), Chandra and XMM-Newton, we decided to attach contamination control baffles between each sensor and telescope except for HXI.

4. Thermal and Mechanical Design

As the FPA is cooled by a pair of mechanical coolers, the total mass and the heat dissipation is significantly larger than SXI. As a result, thermal distortion of the camera body can affect the alignment of the optical bench unless some isolation system. The camera body is thus supported by a kinematic mount and the exhaust heat is pulled out by two heat pipes connected to radiators.

References

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