JX-ISAS-SUZAKU-MEMO-2008-04
Title: Recent update of the XRT response. I. Images (PSF, EEF, etc)
Category: XRT
Author: MAEDA Yoshitomo
Date: 2008-06-05

Recent update of the XRT response: I. Images

Yoshitomo Maeda, Kentaro Someya, Takayuki Hayashi, Kensuke Suzuki, Ryoko Nakamura, Masatoshi Ebara, Hirohiko Inoue, Shunsaku Okada, Ryo Iizuka, Hideyuki Mori, Yoshitaka Ishisaki, Manabu Ishida and the XRT team

2008 June 5

1 Introduction

We recently updated the response simulator xissim/xissimarfgen (ver. 2008-04-05) and the calibration files CALDB (ver. 20080602). In this memo, we report image reproducibility for this combination of the software and the CALDB. Calibration reports on the vignetting and the effective area of the XRTs will be presented in the other companion memos (Vignetting:JX-ISAS-SUZAKU-MEMO-2008-05, Effective area:06). A description of the CALDB update can be also referred to another Suzaku memo (JX-ISAS-SUZAKU-MEMO-2008-02).

2 Summary

Table 1: Reproducibility using the new XRT response simulator.

Radius (arcmin)	Ratio XRT-I0	Ratio XRT-I1	Ratio XRT-I2	Ratio XRT-I3
Encircled Energy Function				
0.5	1.07	1.07	1.07	1.05
1	0.99	0.98	0.98	0.98
2	0.98	0.97	0.97	0.99
3	0.99	0.98	0.98	0.99
4	1.00	0.99	0.99	1.00
5	1.00	0.99	0.99	1.00
6	1.00	1.00	1.00	1.00
Decircled Energy Function				
0.5	0.97	0.98	0.98	0.98
1	1.01	1.00	1.02	1.02
2	1.13	1.00	1.15	1.04
3	1.09	0.97	1.33	1.07
4	1.04	0.87	1.35	1.05
5	1.03	0.77	1.30	1.00
6	1.01	0.72	1.24	0.99

3 Data and Software Versions

The following versions of the data, software or CALDB were adopted in this memo.

- Data: V2.1. The empirical correction of sky coordinates of X-ray photons by Uchiyama et al. 2008 was applied.
- xissim or xissimarfgen ver 2008-04-05
- CALDB 20080602

Caution for the low energy application

In this report, we used the data taken during the early phase of the operation when the contamination onto the optical blocking filter (OBF) of the XIS can be ignored (for details, see the Suzaku technical description document). The point spread function of the XRT has less energy dependence. This report is thus valid for the XRT response in all the energy band of the XIS. HOWEVER, the low-energy contamination has position dependence that makes the detector efficiency positionally dependent and changes the XRT image mildly. This effect gives additional uncertainties to the image reproducibility (PSF/EEF) of the simulator xissim/xissimarfgen. Please refer to another report on the contamination for this issue.

4 Images

As shown in Serlemitsos et al. (2007), verification of the imaging capability of the XRTs has been made with the data of SS Cyg in quiescence taken during 2005 November 2 01:02UT–23:39UT. The total exposure time was 41.3 ks. SS Cyg is selected for this purpose because it is a point source and moderately bright (3.6, 5.9, 3.7, and 3.5 c s^{-1} for XIS0 through XIS3), and hence, it is needless to care about pile-up even at the image core. In Fig. 1, we give the images of all the XRT-I modules thus obtained. The HPD is obtained to be $1'.8$, $2'.3$, $2'.0$, and $2'.0$ for XRT-I0, 1, 2, and 3, respectively.

In Fig. 1, we also show them produced by the updated "new" simulator xissim (ver 2008-04-05). The simulator was tuned with the unit of the quadrant. Therefore, their images look different from quadrant to quadrant. More local or spiky structures seen in the images are not reproduced at all.

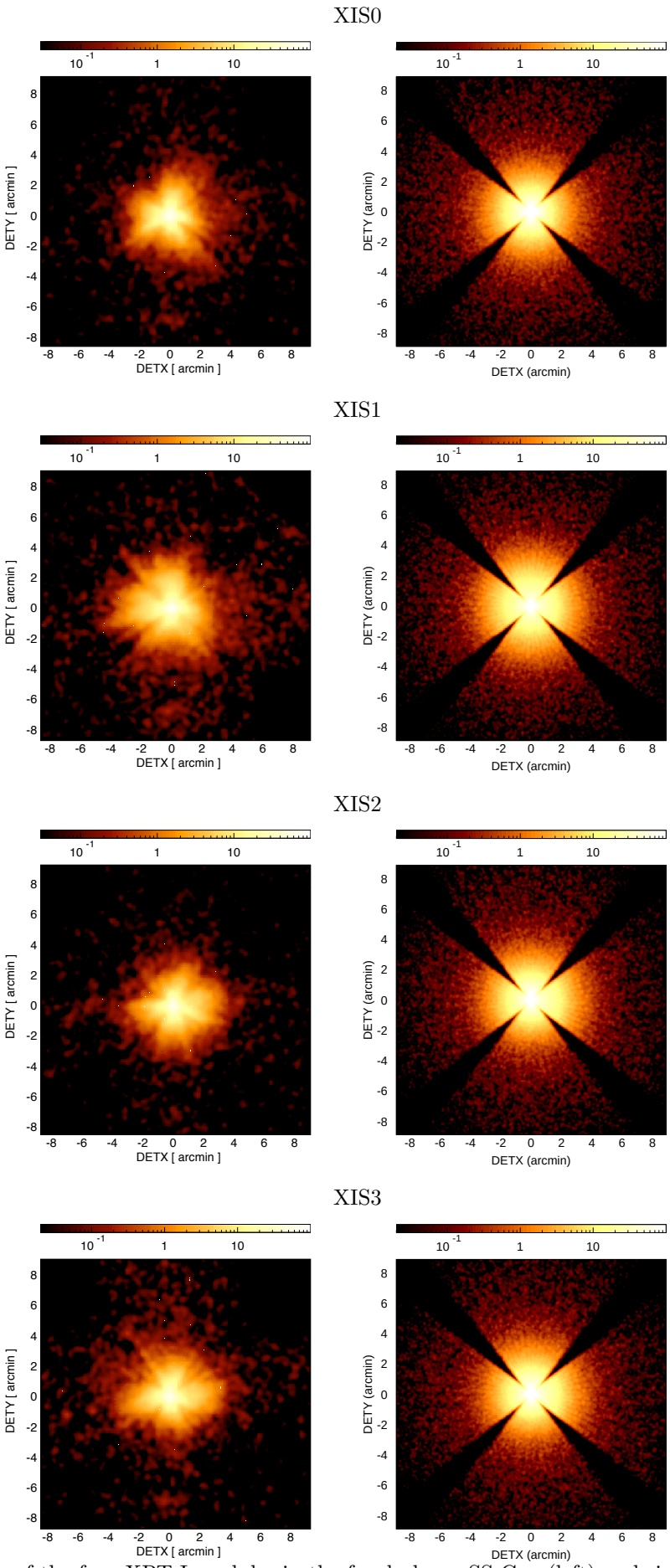

Figure 1: Image of the four XRT-I modules in the focal plane: SS Cyg (left) and simulation (right). All the images are binned with 2×2 pixels followed by being smoothed with a Gaussian with a sigma of 3 pixels, where the pixel size is 24 μm. The Fe55 events were removed from the SS Cyg image.

5 Point Spread Functions

In Fig. 2, we show Point Spread Functions (PSFs) using the data shown in Fig. 1 but before smoothing. In the new simulator, the reproducibilities for the "shoulder" (2–5 arcmin) and for the tail (> 5 arcmin) are improved, largely in XRT-I1/I3 and mildly in XRT-I0/I2. Note that the core shape within 0.2 arcmin is not tuned at all.

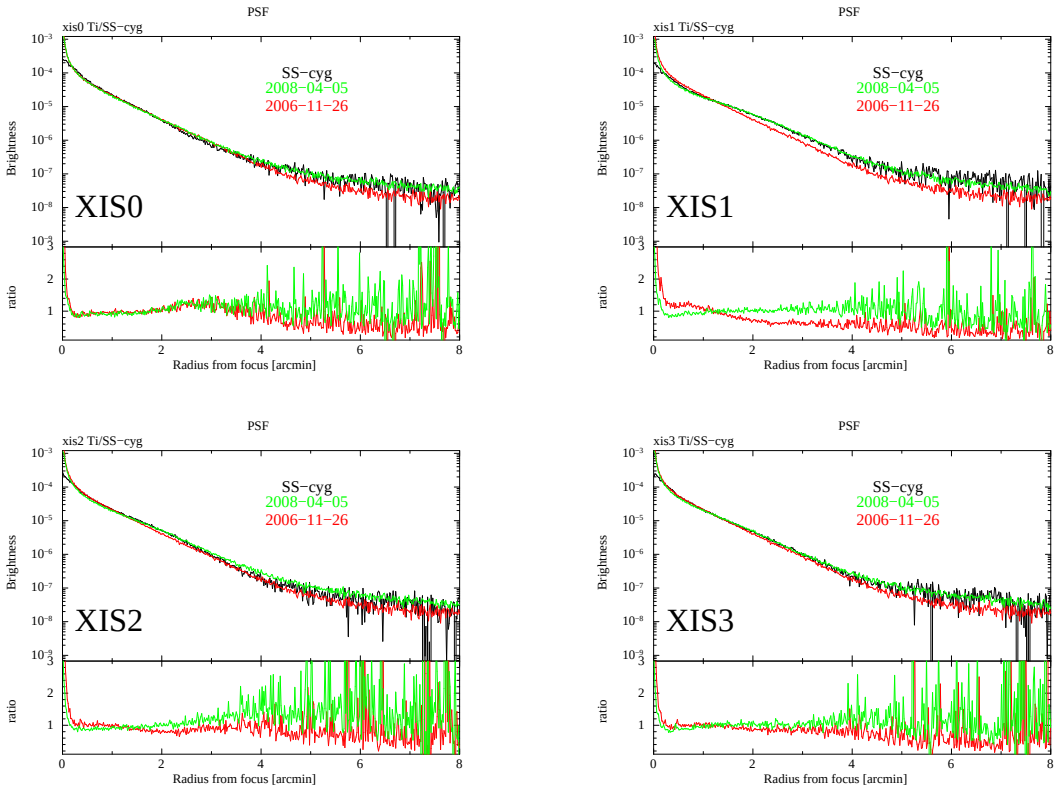

Figure 2: PSF of the four XRT-I images. The lower panels show the ratio between the data and the simulator outputs. Green and red lines correspond to the old and new simulator's outputs.

6 Encircled Energy Functions

In Fig. 3, we show encircled energy functions (EEFs). The reproducibility of the EEF is useful when we make spectra extracted from a circular region with a given radius. In the new simulator, the EEF of the simulator coincide with that of the data within 4% from 1 to 6 arcmin radius.

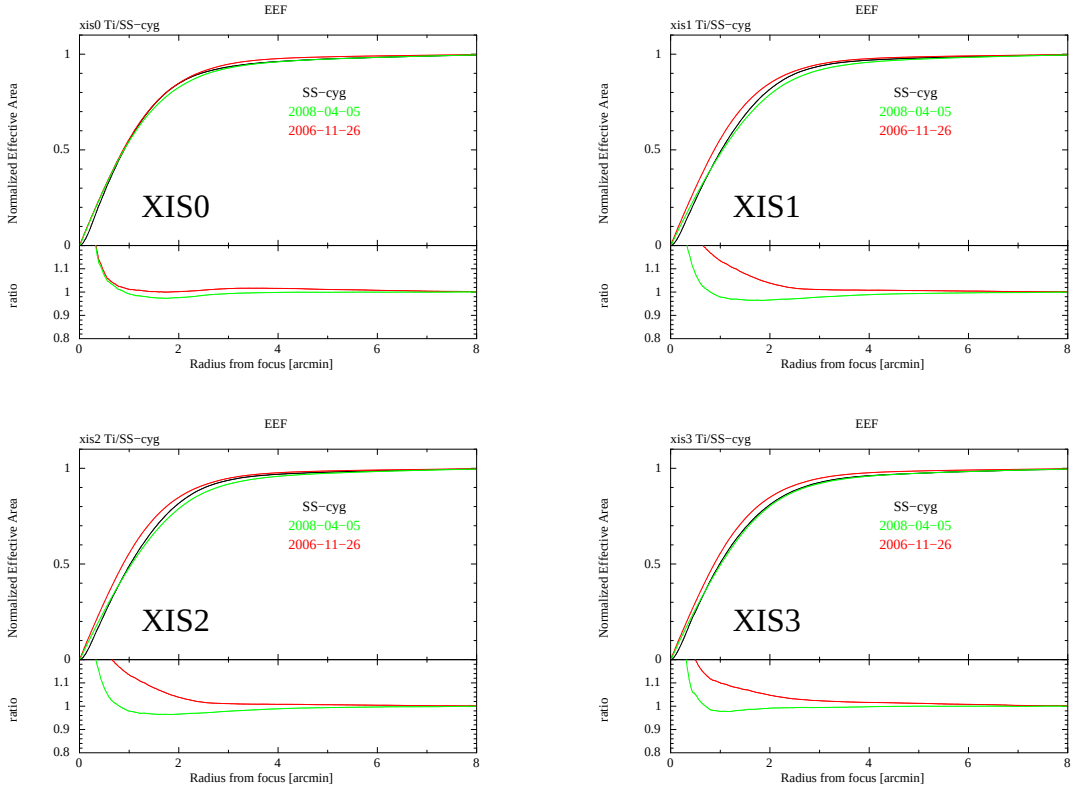

Figure 3: EEF of the four XRT-I images. The EEF is normalized to unity at the edge of the CCD chip (a square of 17′.8 on a side). The lower panels show the ratio between the data and the simulator outputs. Green and red lines correspond to the old and new simulator's outputs.

7 Decircled Energy Function

In Fig. 4, we show the "De"-circled Energy Functions (DEF). The DEF was made simply with an equation 1−EEF. This plot is useful if you make a diffuse spectrum around the point source. The ratio reflects the accuracy of the flux contaminated from the central point source into the surrounding diffuse source. The reproducibility of the DEF is better for XRT-I0 and I3 while worse for the XRT-I1 and I2. When we remove the point source with a 2 arcmin radius circle, the contamination flux outside the region can be reproduced with $\sim$15% and $\lesssim$5% accuracies for XRT-I0/I2 and for XRT-I1/I3, respectively.

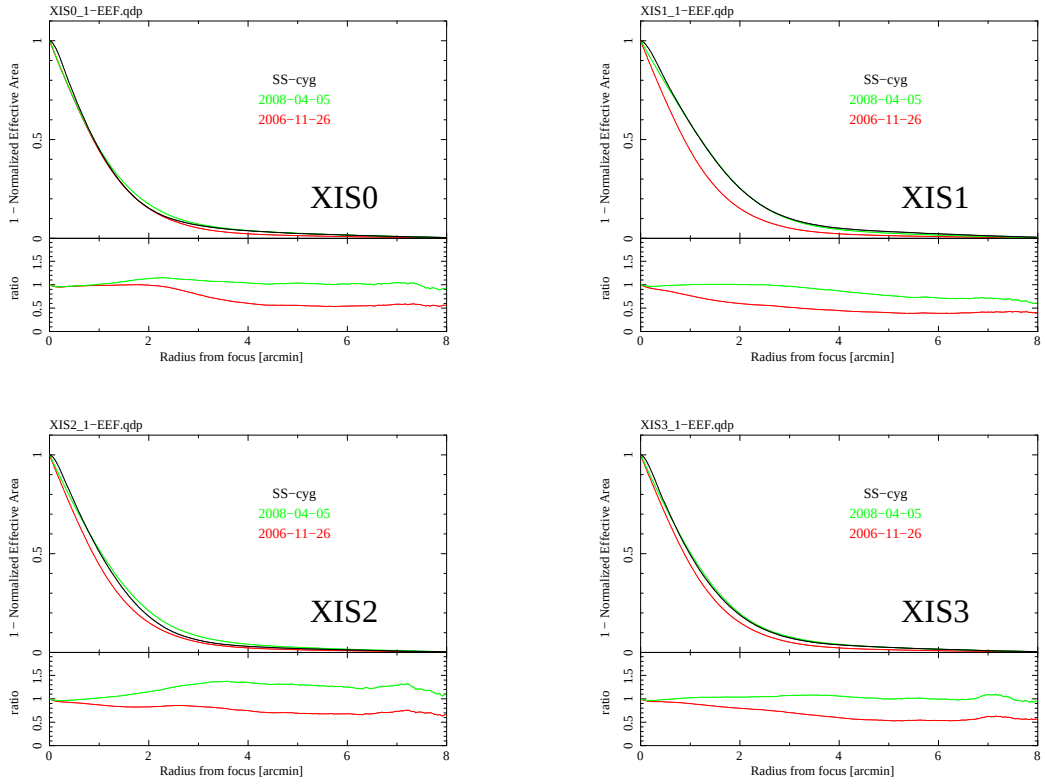

Figure 4: Decircled energy function (1− EEF) of the four XRT-I images.

References

- Serlemitsos et al. 2007, PASJ 59S, 9
- Ishisaki et al. 2007, PASJ 59S, 113
- Uchiyama et al. 2008, PASJ 60S, 35
- Suzaku Technical Description: http://www.astro.isas.jaxa.jp/suzaku/doc/suzaku_td/