

JX-ISAS-SUZAKU-MEMO-2008-05

Title: Recent update of the XRT response. II. Vignetting

Category: XRT

Author: MAEDA Yoshitomo

Date: 2008-06-04

Recent update of the XRT response: II. Vignetting

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 04

1 Introduction

In this memo, we report reproducibility on the vignetting function for the combination of the recent software and the CALDB (JX-ISAS-SUZAKU-MEMO-2008-02). Calibration reports on the image and the effective area of the XRTs will be presented in the other companion memos (Image:JX-ISAS-SUZAKU-MEMO-2008-04, Effective area:06).

2 Summary

Table 1: Reproducibility of the vignetting function using the new XRT response simulator.

(arcmin)	Weighted average (Standard Deviation)			
	Ratio XRT-I0	Ratio XRT-I1	Ratio XRT-I2	Ratio XRT-I3
2-10keV	0.978±0.021	0.933±0.043	0.952±0.027	0.979±0.032
3-6keV	0.973±0.022	0.943±0.033	0.942±0.025	0.961±0.024
8-10keV	1.075±0.101	1.055±0.127	1.054±0.084	1.059±0.082
(arcmin)	Average (Standard Deviation)			
	Ratio XRT-I0	Ratio XRT-I1	Ratio XRT-I2	Ratio XRT-I3
2-10keV	0.979±0.021	0.931±0.042	0.951±0.029	0.980±0.032
3-6keV	0.972±0.022	0.940±0.033	0.941±0.027	0.960±0.024
8-10keV	1.070±0.109	1.033±0.133	1.040±0.094	1.067±0.090

Only the data taken in 2006 are used for the calculation above.

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 energy band of 2–10 keV which is almost free from the contamination onto the optical blocking filter (OBF) of the XIS (for details, see the Suzaku technical description document). In this energy band, the detector efficiency can be assumed as flat over the detector. This report is thus valid for the XRT response in all the energy band of the XIS. The contamination gave additional (and maybe larger) systematic error on the angular response in the low-energy band (<1-2 keV) of the XRT-XIS system.

4 Vignetting Function

In Figures, we have drawn the vignetting curves in the three energy bands 2–10 keV, 3–6 keV and 8–10 keV. We took the Crab offset data during 2005 August 25-27, September 15 and during 2006 September 5-19 separately. As shown in Serlemitsos et al. (2007), the vignetting curves calculated by the ray-tracing simulator is compared with the observed intensities of the Crab nebula at various off-axis angles.

To obtain this, we first assume the spectral parameters of the Crab nebula to be a power law with $N_{\text{H}} = 0.30 \times 10^{22} \text{ cm}^{-2}$, photon index = 2.08, and the normalization = 9.55 photons $\text{cm}^{-2} \text{ s}^{-1} \text{ keV}^{-1}$ at 1 keV. These values are the averages of the four detectors at the XIS-nominal position (see our companion memo on the effective area). We then calculate the counting rate of the Crab nebula on the entire CCD field of view in every $0'.5$ step both in the DETX and DETY directions using the ray-tracing simulator “xissim”. Note that the abrupt drop of the model curves at $\sim 8'$ is due to the source approaching the detector edge. On the other hand, the data points provide the real counting rates in the corresponding energy bands within an aperture of $13'.3$ by $17'.8$. They consist of the observations at the nine different off-axis angles $0'$, $\pm 1'.75$, $\pm 3'.5$, $\pm 5'.25$, and $\pm 7'.0$ both in DETX and DETY directions, where the origin is the XIS-nominal position. Finally, we overlaid the count rate of the data onto the simulation curve.

These figures roughly show that the effective area is calibrated in average within $\sim 2\text{--}7\%$ $\sim 2\text{--}6\%$ and $\sim 5\text{--}7\%$ over the XIS field of view, for the 2–10, 3–6, 8–10 keV band, respectively. Detail numbers are given in Table 1. In general, XRT-I1/XIS1 shows larger scatter in the ratio between the data and simulator’s count rate.

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/

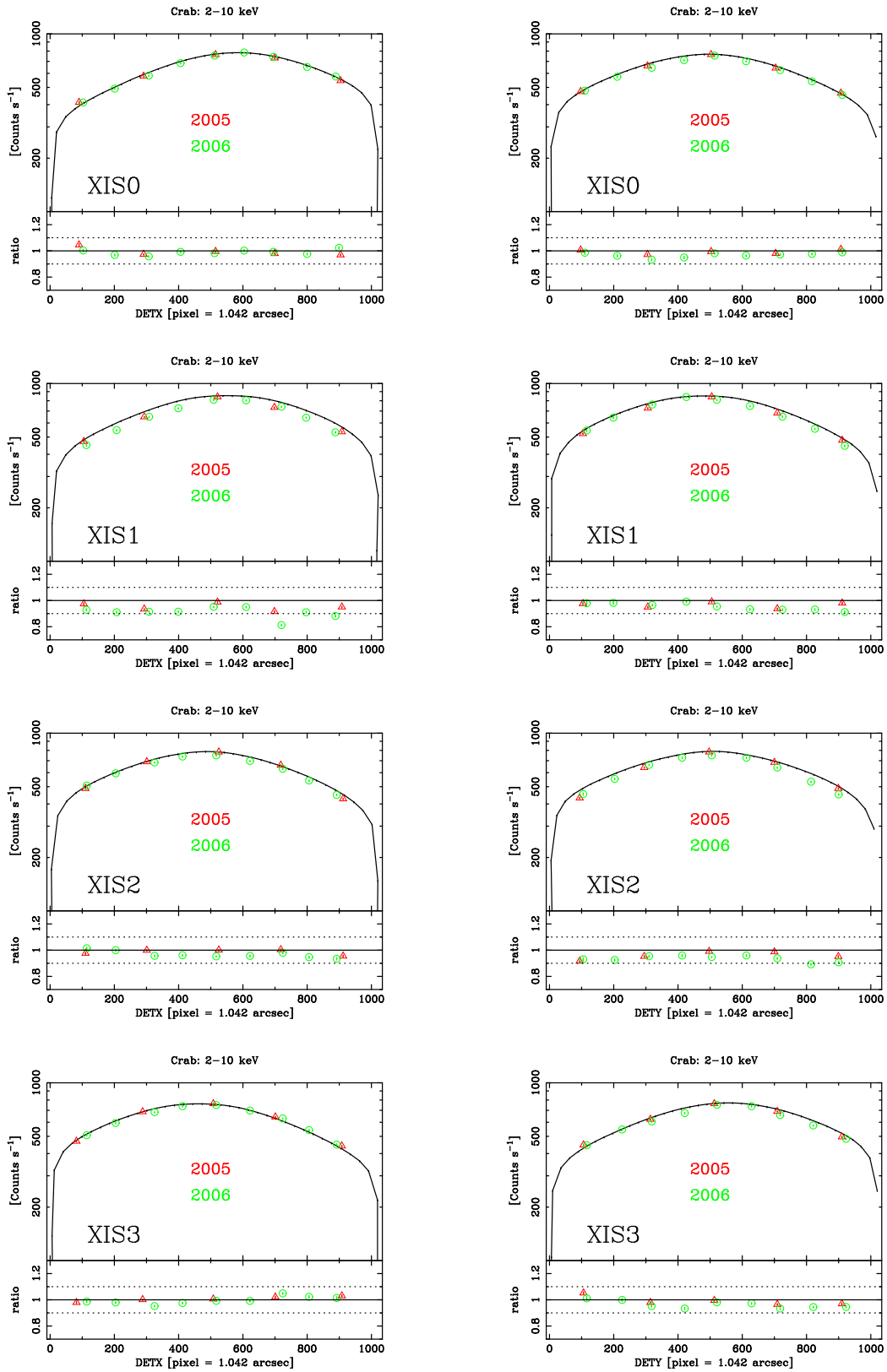


Figure 1: Count rates of the Crab offset pointings to the DETX(left) and DETY(right) directions in the 2–10 keV band. The red and green marks correspond to the data during 2005 and 2006, respectively. The solid line corresponds to the outputs of the ray-tracing simulator xissim. The bottom panels show the ratios of the data to the simulator outputs.

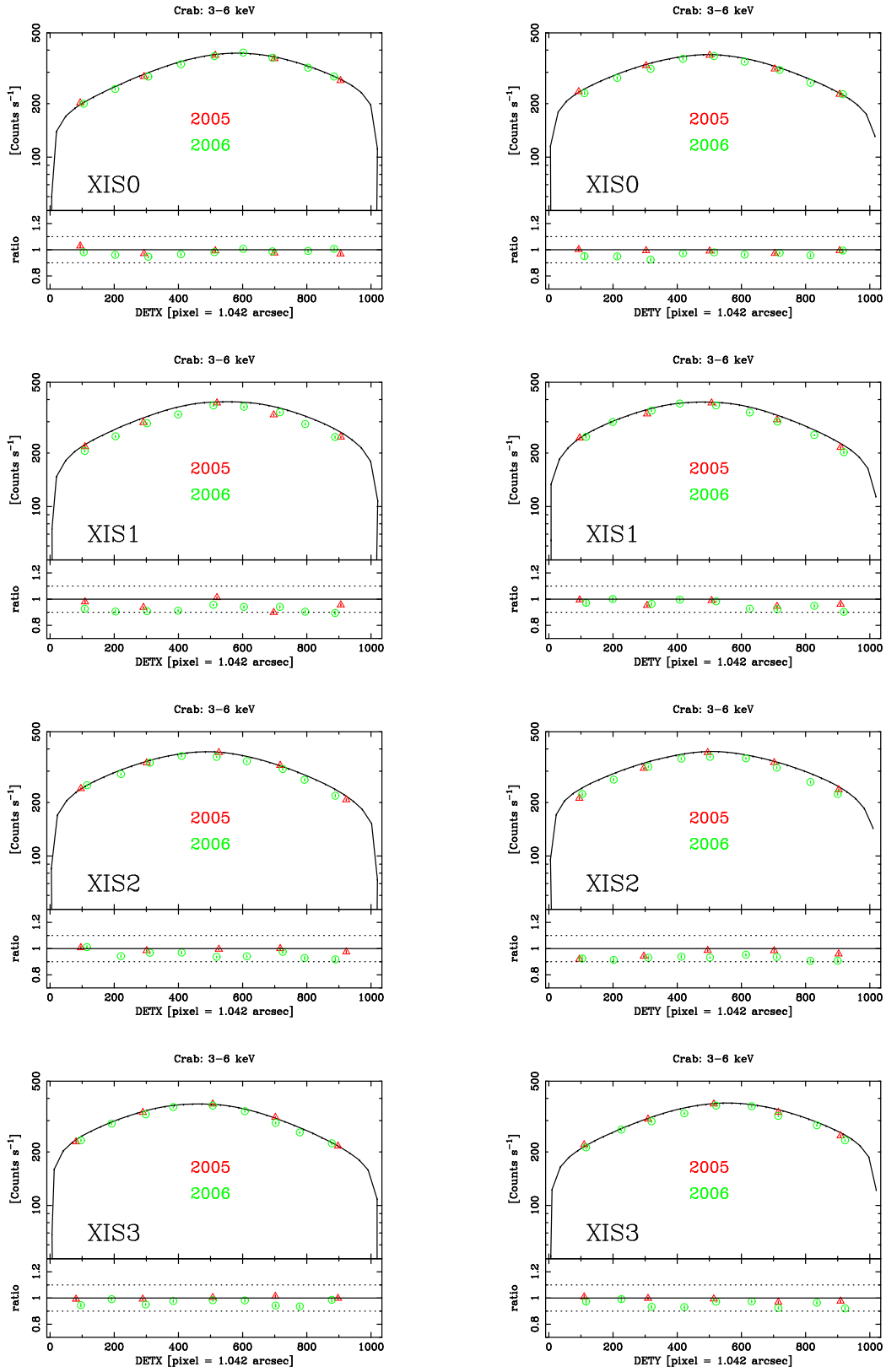


Figure 2: Same as Fig.1 but in the 3-6 keV band.

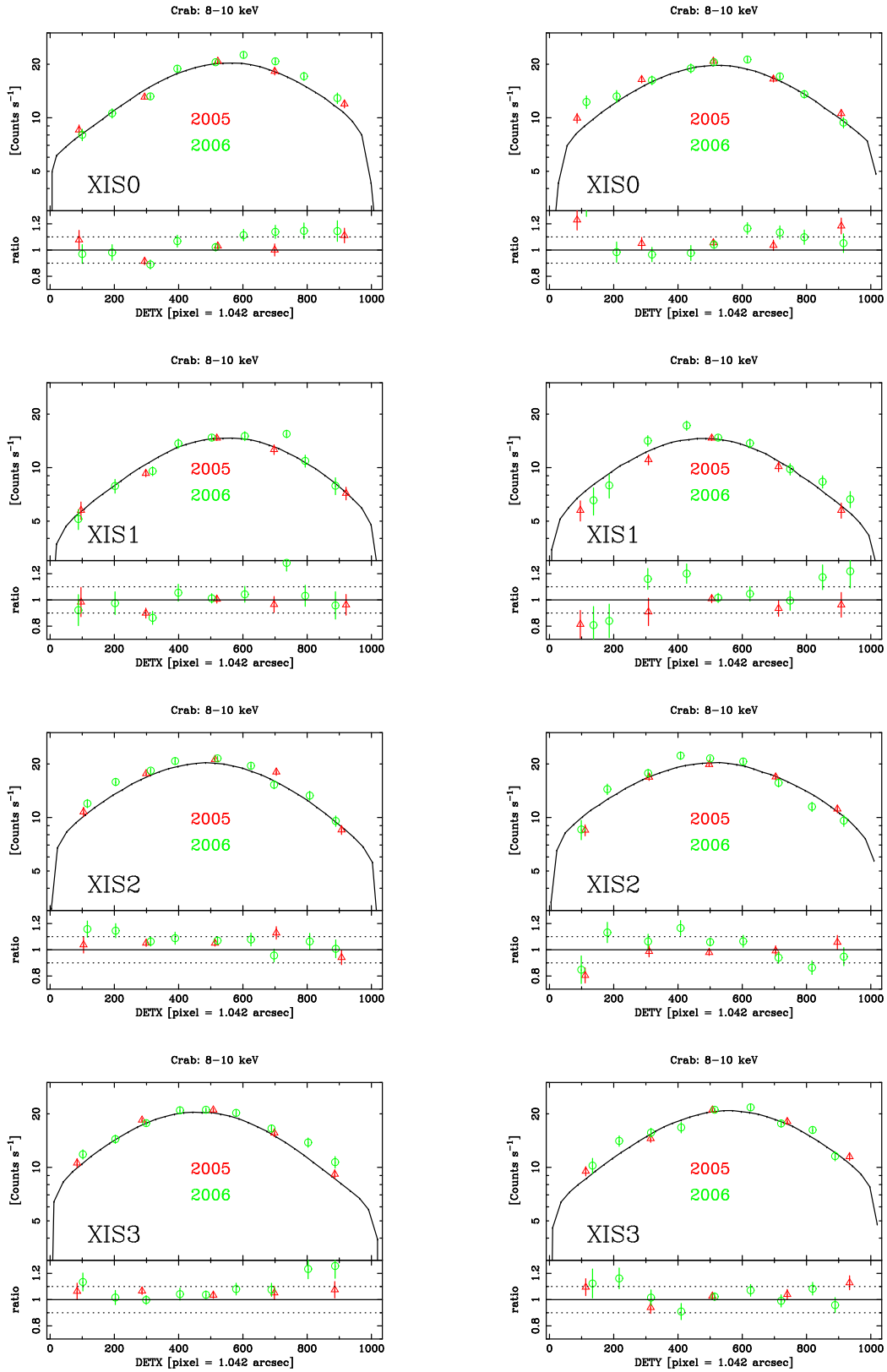


Figure 3: Sane as Fig.1 but in the 8–10 keV band.