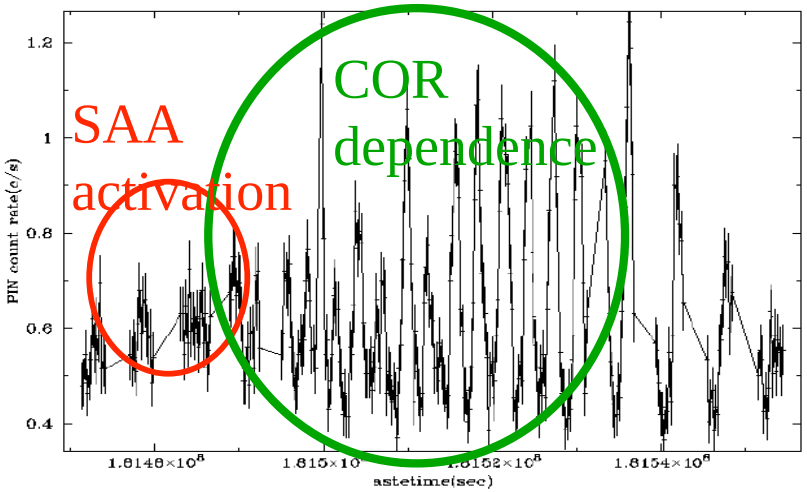
The issues on the HXD background

Y. Fukazawa, and HXD team

1. General properties of HXD background (BGD)
2. Brief introduction on the background modeling
3. Model reproducibility
4. General notes on the analysis

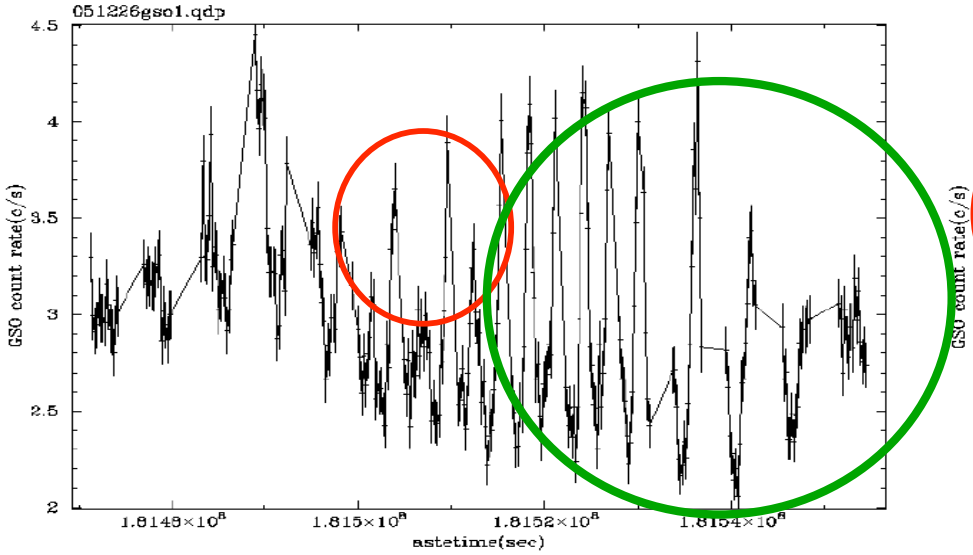
(1,2) One-day BGD Variation (due to COR, SAA)

PIN (12-90keV)

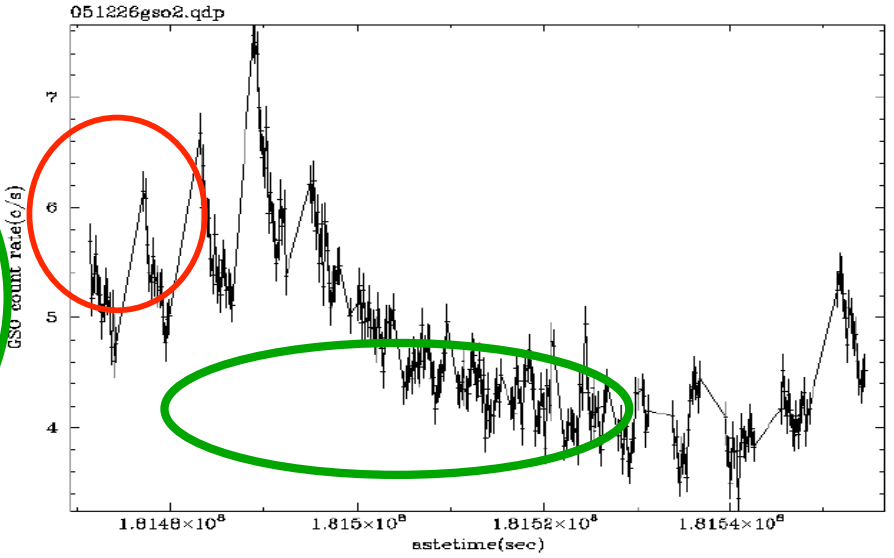


Highly variable
Energy dependent

GSO(40-60keV)

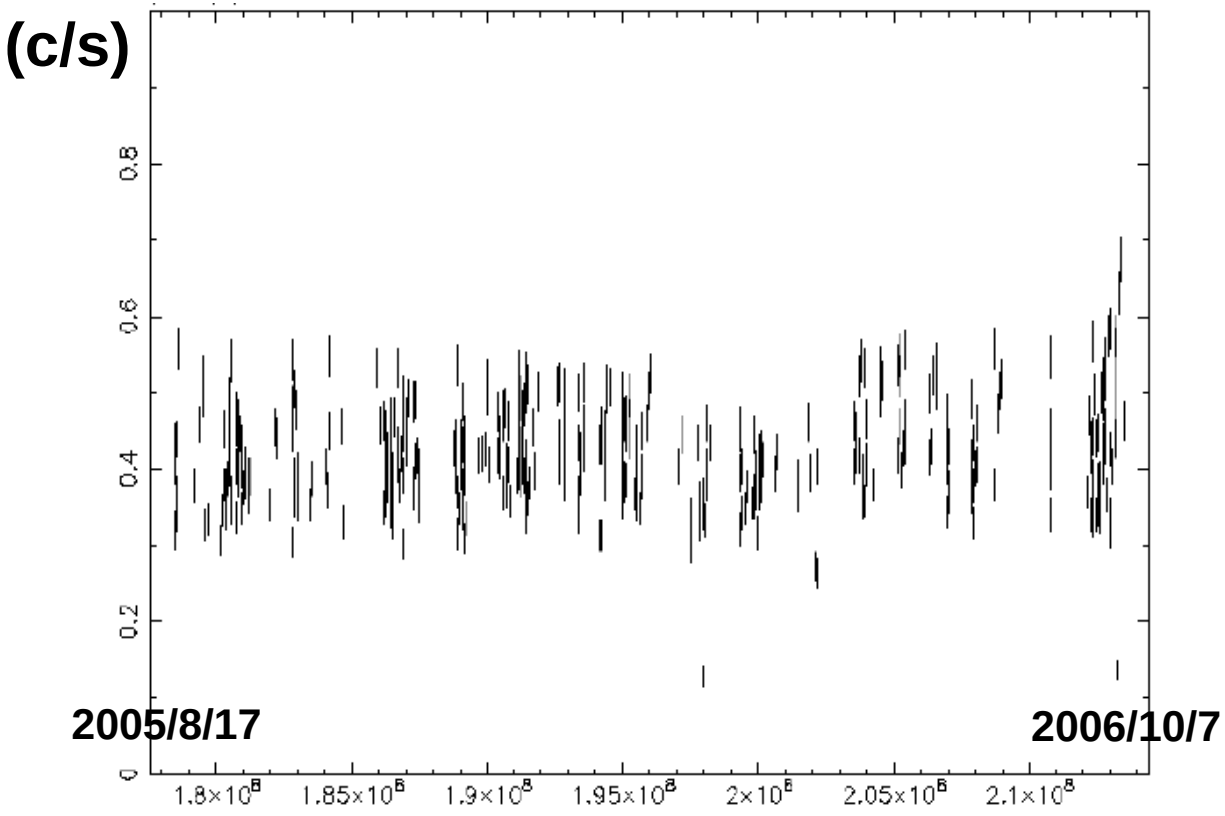


GSO(466-700keV)



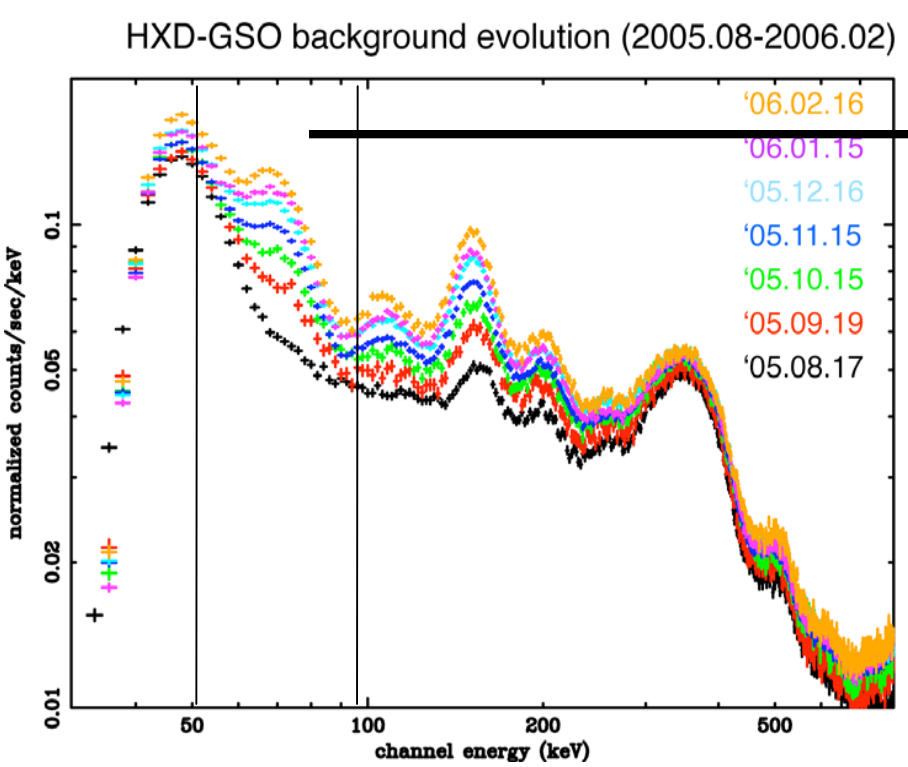
(3) Long-term BGD variation (Radio-Isotope with long-decay, mode change)

History of count rate of PIN background
12-70keV, COR>13GV, HXD_SAA>10000s

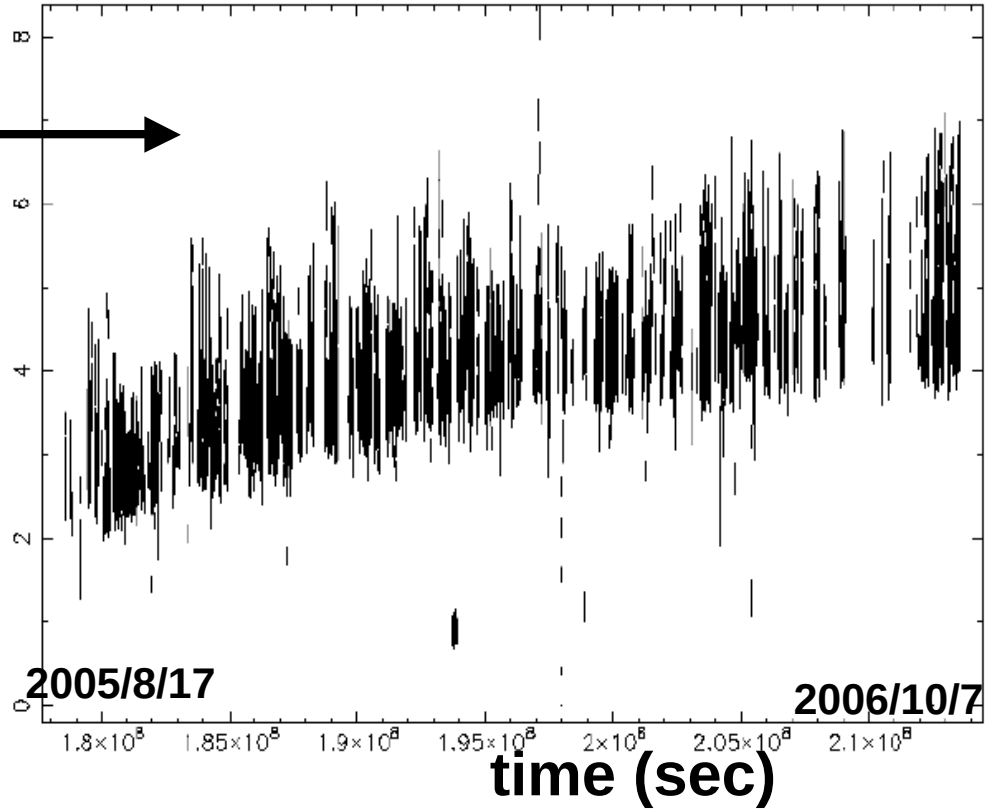


The most significant effect by the obs mode change is that GSO LD was lowered in 2006/3/23-5/13, when the PIN BGD becomes low and GSO BGD becomes high.

History of count rate of GSO background
50-90keV, COR>10GV, HXD_SAA>20000s



(c/s)



time (sec)

Model of the PIN background by S.Watanabe(ISAS/JAXA)

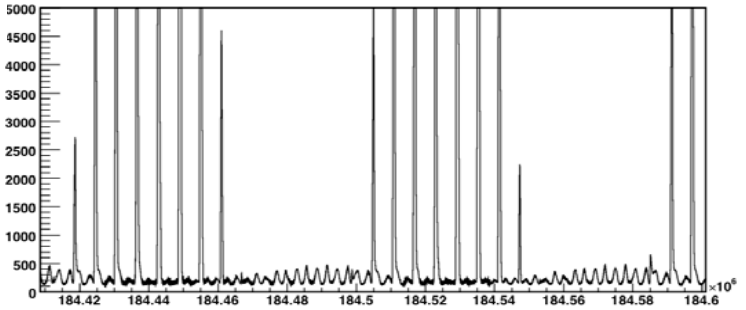
Data-Base type

Parameters used in the PIN NXB modeling

Modeling the COR-dep. component

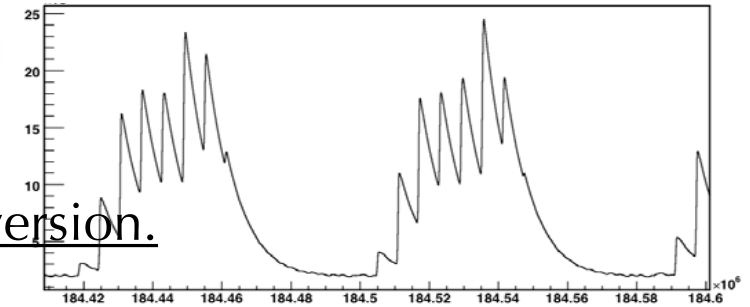
- PIN UD Count Rate

(including HXD HK files (HK, SCL packets))
a real-time flux monitor of high energy particles, even during the SAA passages



- PIN UD Build up

(extracted from PIN UD data)



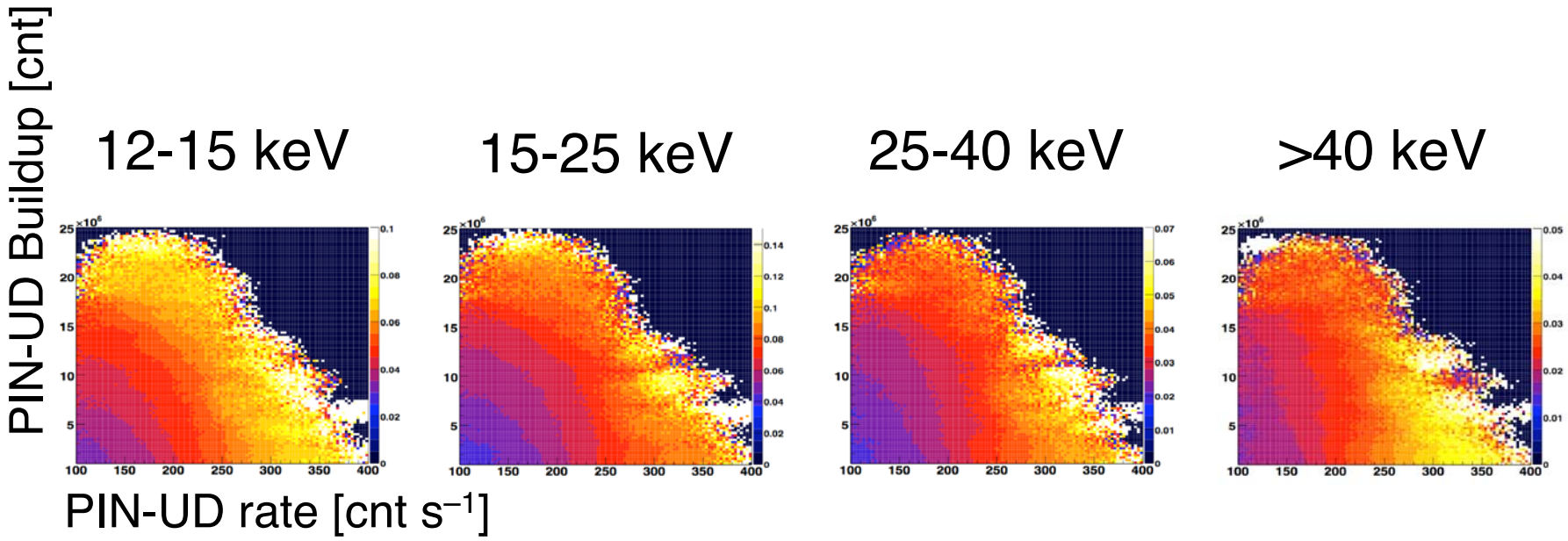
τ=8000 sec is selected in this version.

Modeling the activation-induced BGD

$$PINUDbuildup(t) = \int_{-\infty}^{t} PINUDRate(t_0)\exp((t_0 - t)/\tau)dt_0$$

PIN NXB Database

PIN NXB database was constructed by using earth occultation data during the SWG phase (13 Sep. 2005—16 April 2006) -> Sorted by the PIN-UD Count Rate and the PIN-UD Build up(τ=8000 sec)



Refering to PINUD and PINUD-buildup, the count rate and spectrum of the BGD is modeled, based on the data base.

GSO Background　Y.Fukazawa (Hiroshima Univ)

The model is obtained by fitting the light curve of BGD, by an appropriate formula indicated by the properties of the BGD variability.

This technique is also available for the PIN background, and a part of Released PIN BGD is prepared by this model.

The model formula is as follows for each 32 energy band,
So, 32ch pulse height spectrum of BGD is prepared.

COR-dep

$$a + b \cdot PINUD(t) + c \cdot PINUD^2(t)$$

activation

$$+ \sum_{i=0..3} d_i \int PINUD(t') \left[1 + e_i \left| \frac{90 - \theta}{90} \right| \right] * \exp\left(-(t - t') / \tau_i \right) dt'$$

$$+ f_i \cdot GSO_{450-700keV}(t) \exp\left(-(t - t_{SAA}) / T \right)$$

Inputs data: **PINUD(t), GSO$_{450\text{-}700keV}$(t),** θ

Monitor count of particles

Almost BGD

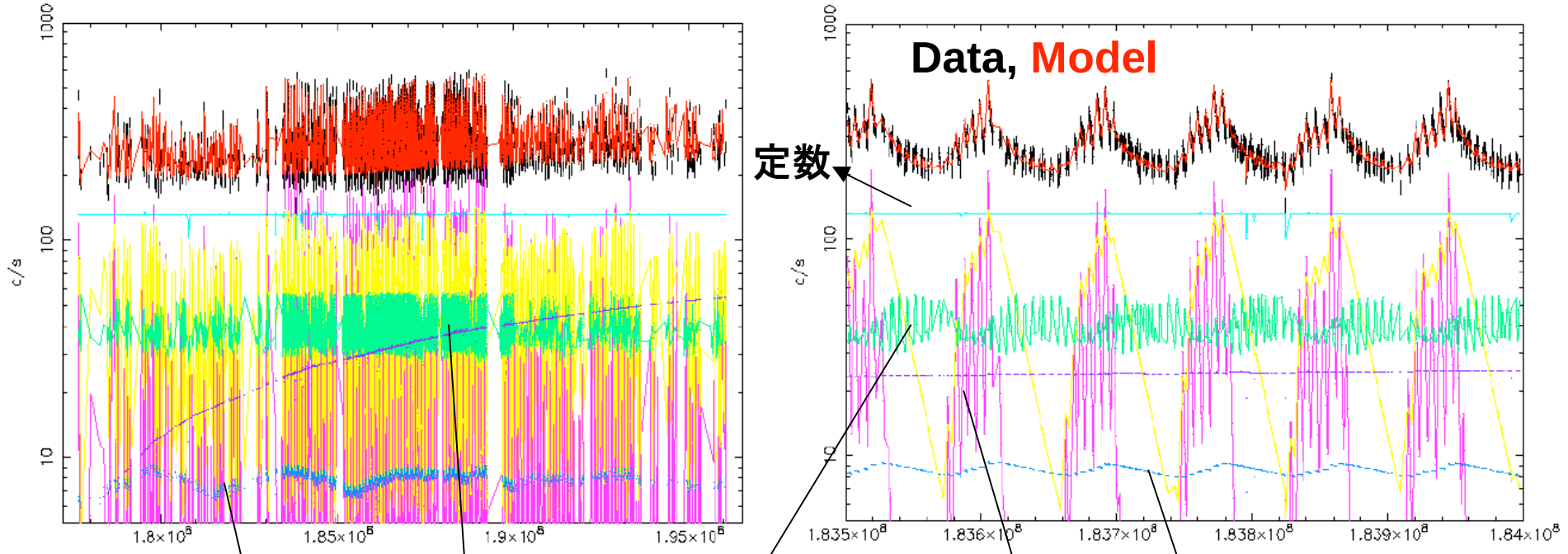
Angle between B-direction and FOV

Coefficients of a,b,c,… are determined every one month.

Decomposition of the components with each time constant (around 511 keV)

2005/8/17 – 2006/3/31

Enlargement (10/24-10/30)



PINUD 350000sec build-up

PINUD 30000000sec build-up

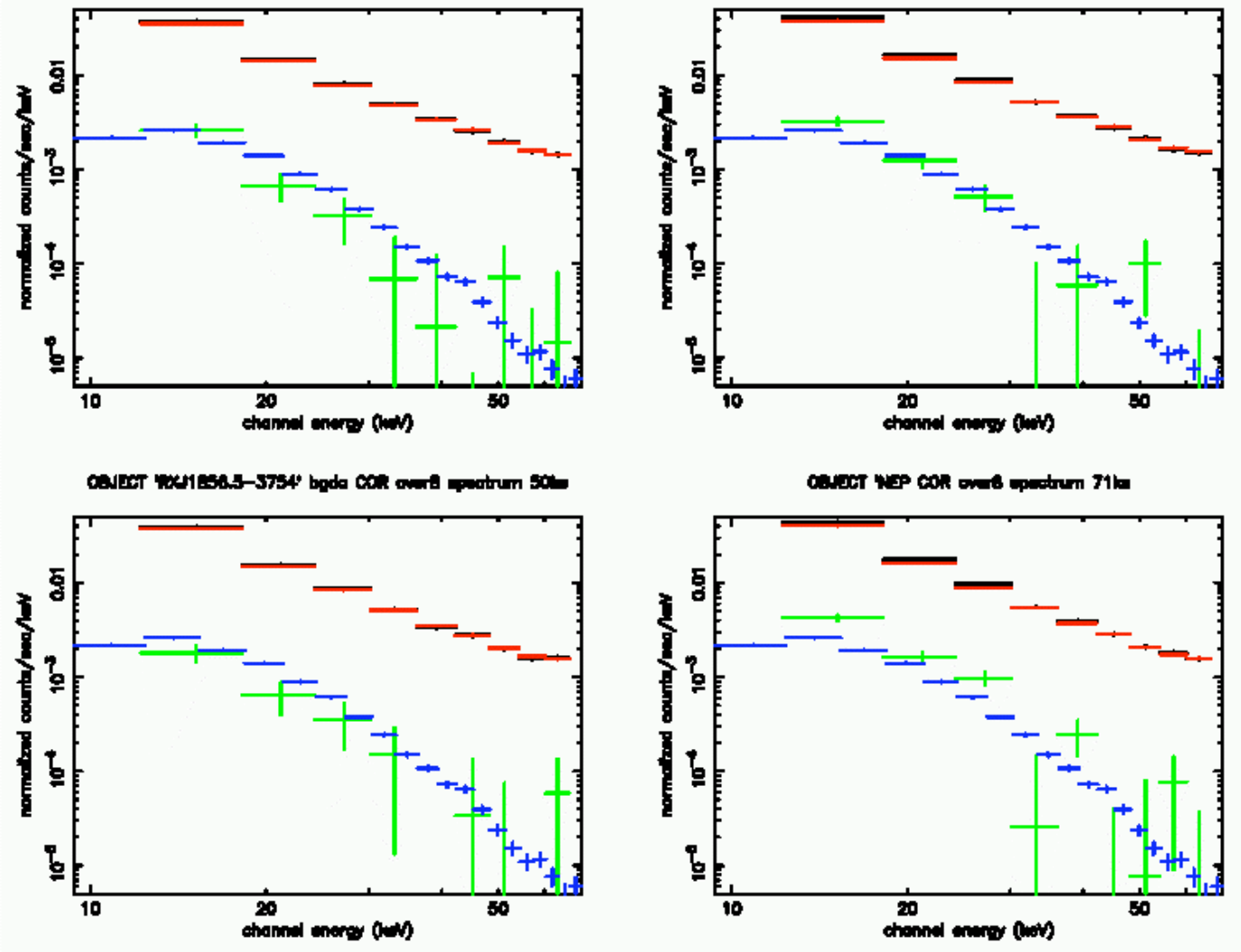
PINUD (COR)

PINUD 1500sec build-up

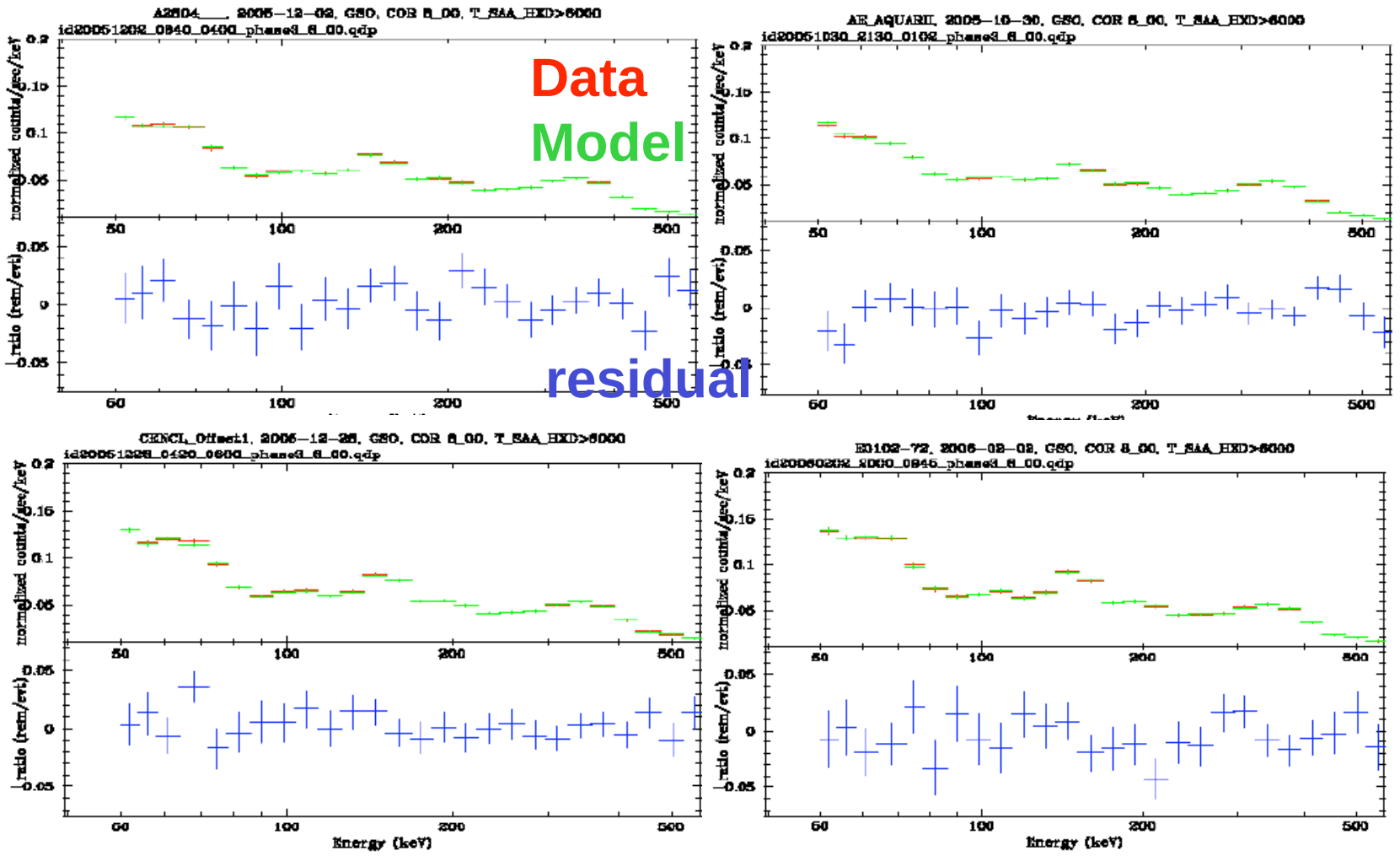
PINUD 15000sec build-up

Background model reproducibility

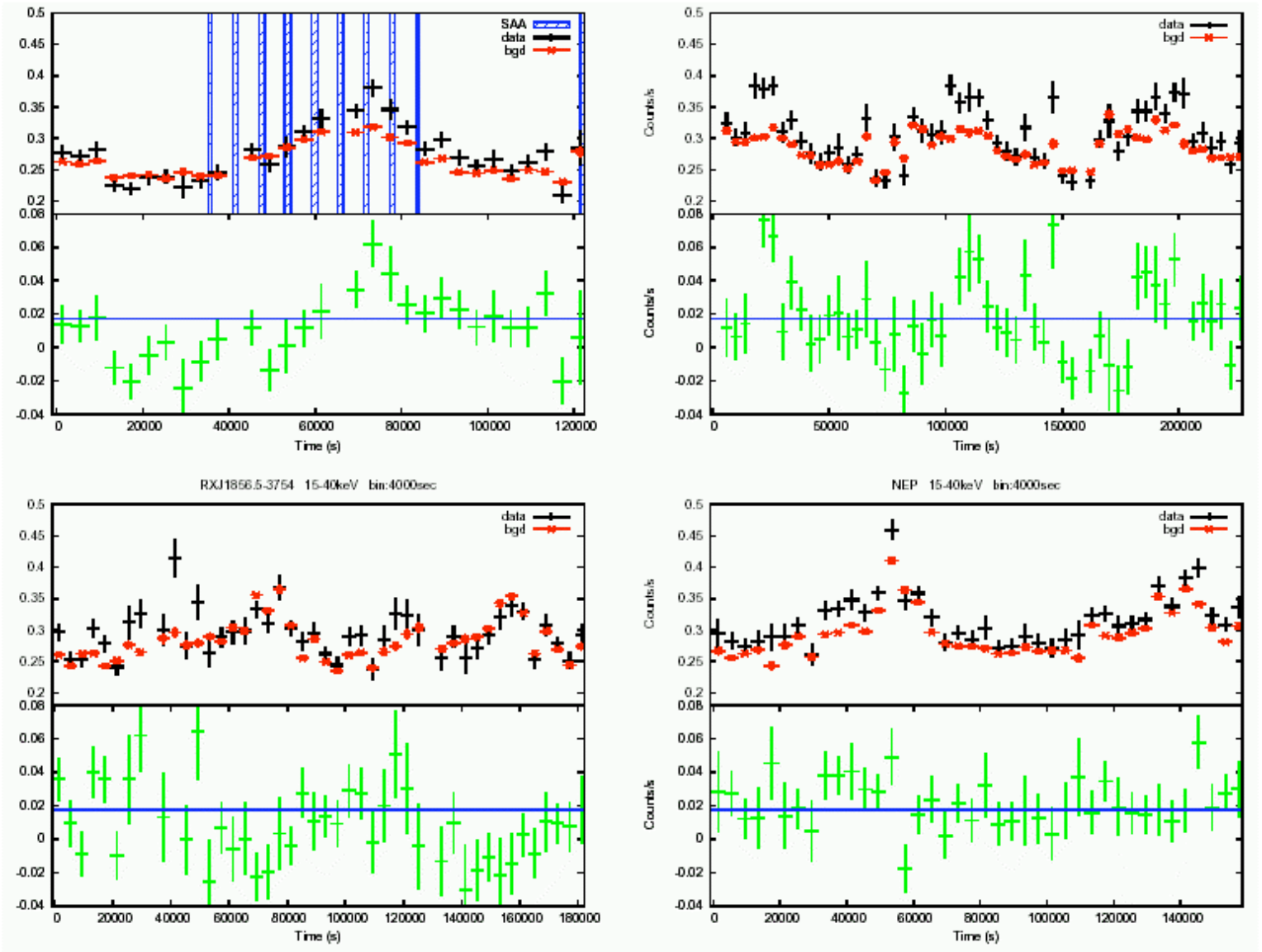
Example of BGD-subtracted PIN spectra for objects whose hard X-ray Is faint, where the CXB (approx. 5% of the total background level) is detected with PIN.



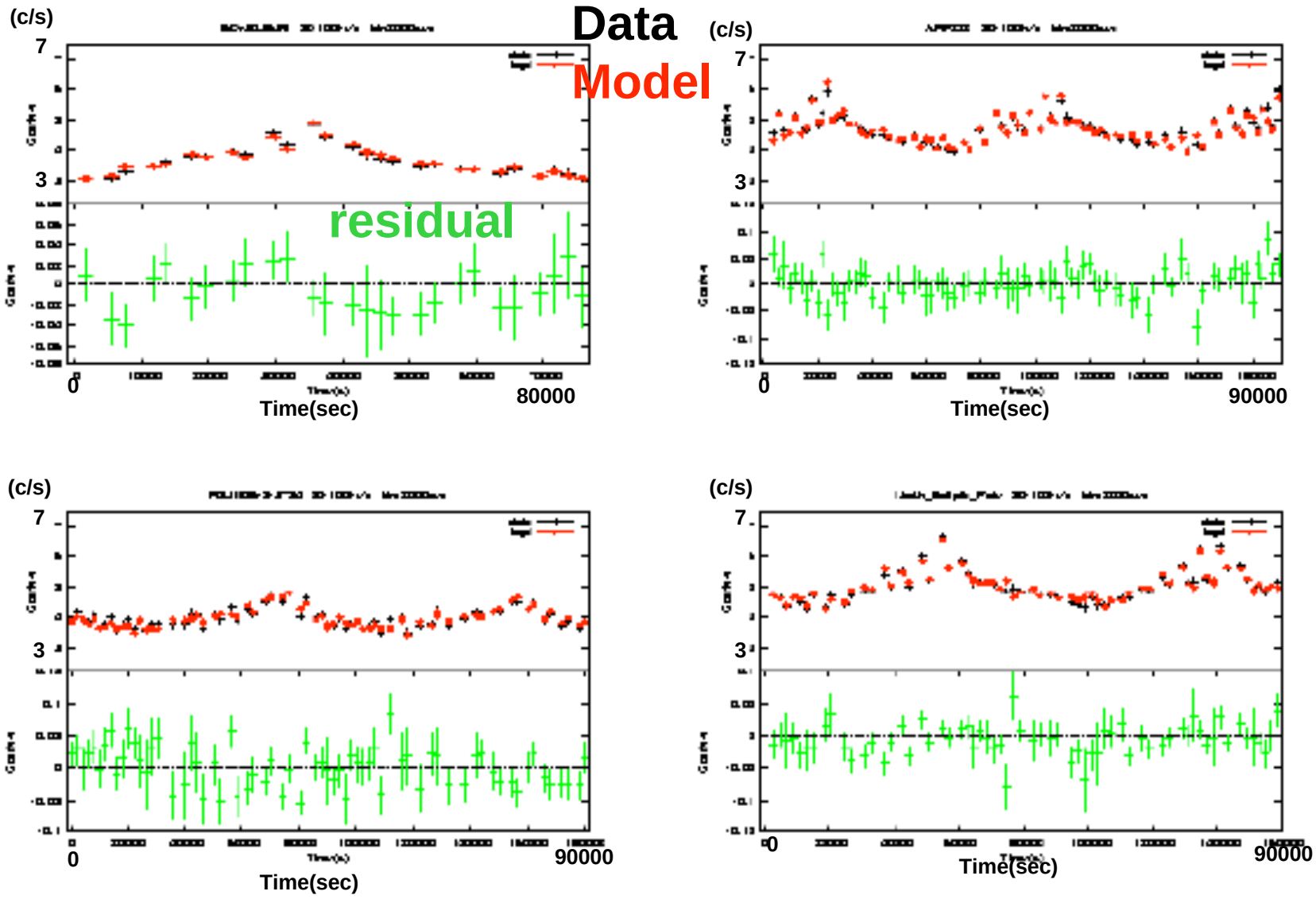
BGD-subtracted GSO light curves for blank sky data



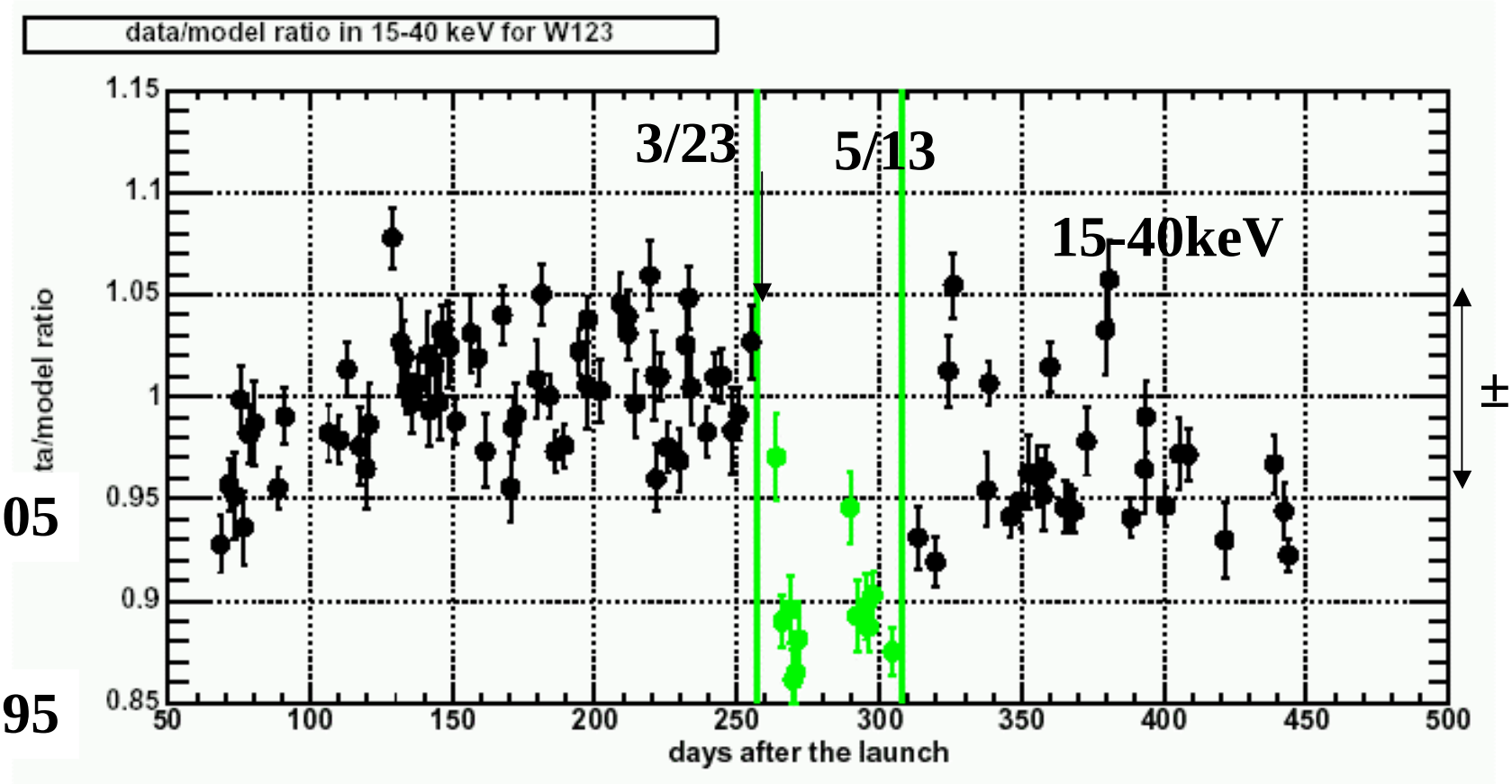
Example of comparison of PIN light curves (15-40keV, time bin = 4000sec) between data and model (top) and residual (bottom) <u>in one pointing observation of faint objects</u>.



Example of comparison of light curves (50-100keV, time bin = 2000sec) between data and model (top) and residual (bottom) in one pointing observation of faint objects.



The time history of ratios of PIN count rate between earth data and model. The green indicates the period where the GSO=LD is changed.

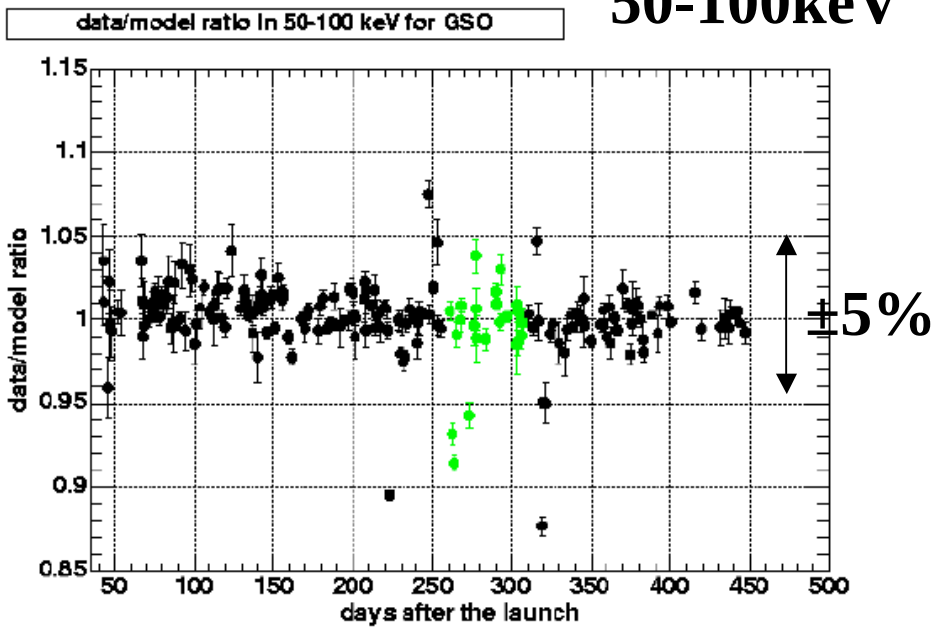


The most significant effect by the obs mode change is that GSO LD was lowered in 2006/3/23-5/13, when the PIN BGD becomes low.

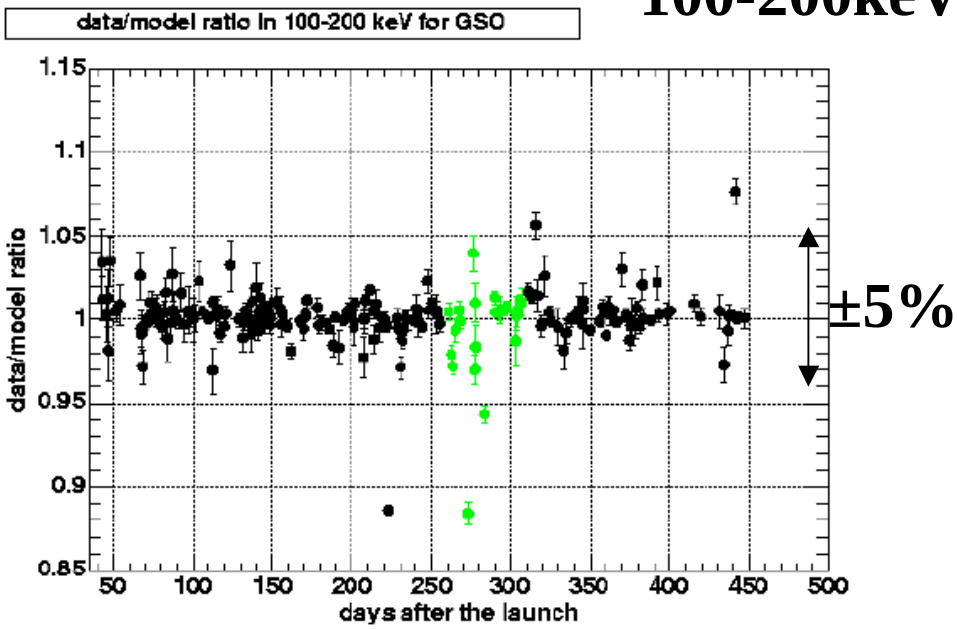
HXD team is now preparing the updated BGD model for this period.

>1ks earth

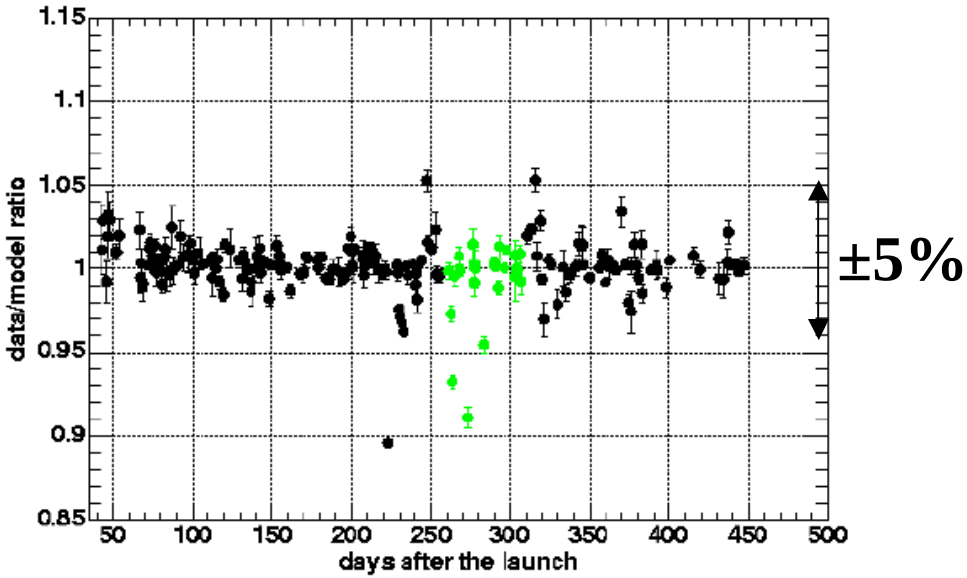
50-100keV



100-200keV



200-400keV



For the GSO

General notes on the analysis

Before using the background model, please read the release Notes carefully to subtract the BGD correctly.

Dead time correction, exposure correction,
pha binning, data selection,
effects by obs mode change…

Also, the following 4 documents (Suzaku-memo) are useful.

Description on the PIN BGD model	**S.Watanabe**
Description on the GSO BGD model	**Y.Fukazawa**
BGD model reproducibility for PIN	**T.Mizuno**
BGD model reproducibility for GSO	**H.Takahashi**

Already available

BGD model is available on the Suzaku web page,
within 1.5 months after the observation

Of course, HXD team is now continuing to improve the BGD model. Your feed-back is welcome.

Special Notes for the PIN BGD.

Due to the change of operating HV to PIN, we should Take care in the choice of sensors from 64 PINs.

----2006/5/24 all PIN 500V all PIN can be used.

2006/5/27-10/3 16PIN(W0) 400V
48PIN(W123) 500V
Please use BGD for W123
Do not use W0 PINs momentarily

2006/10/4-- 32PIN(W01) 400V
32PIN(W23) 500V
Please use BGD for W23
Do not use W01 PINs momentarily

In the near future, HXD are going to prepare the updated BGD available for all PINs.

Release of the background model for ver 1.2 (SWG and GO)

HXD team

PIN … bgd_a

Currently, no significant difference of accuracy between bgd_a and bgd_b.

GSO … bgd_d

PIN bgd_a has been already available for the SWG targets, and GSO bgd_d will be available soon. The BGD model for the GO targets will be prepared after the ver1.2 obs data become available.

Technical description will be distributed, together with the model .
This document will include the explanation of models, some technical notes for usage, and information of studies of the BGD model accuracy, performed by the HXD Team. User can refer to it, for considering and investigating the background accuracy by him(her)self.

Build-up of activation

$$\int PINUD(t') * \exp\left(-(t-t')/\tau\right) dt'$$

We search for the time constant, and determined four constants.

2dim-scan around the followings, use 10/22-11/10 earth occultation

500,800,1000,1500,2000,2500,3000,4000,5000,7000,
10000,13000,15000,18000,22000,30000,45000,60000,80000,100000 sec

In each energy band, we determined the pair by making the confidence contour.

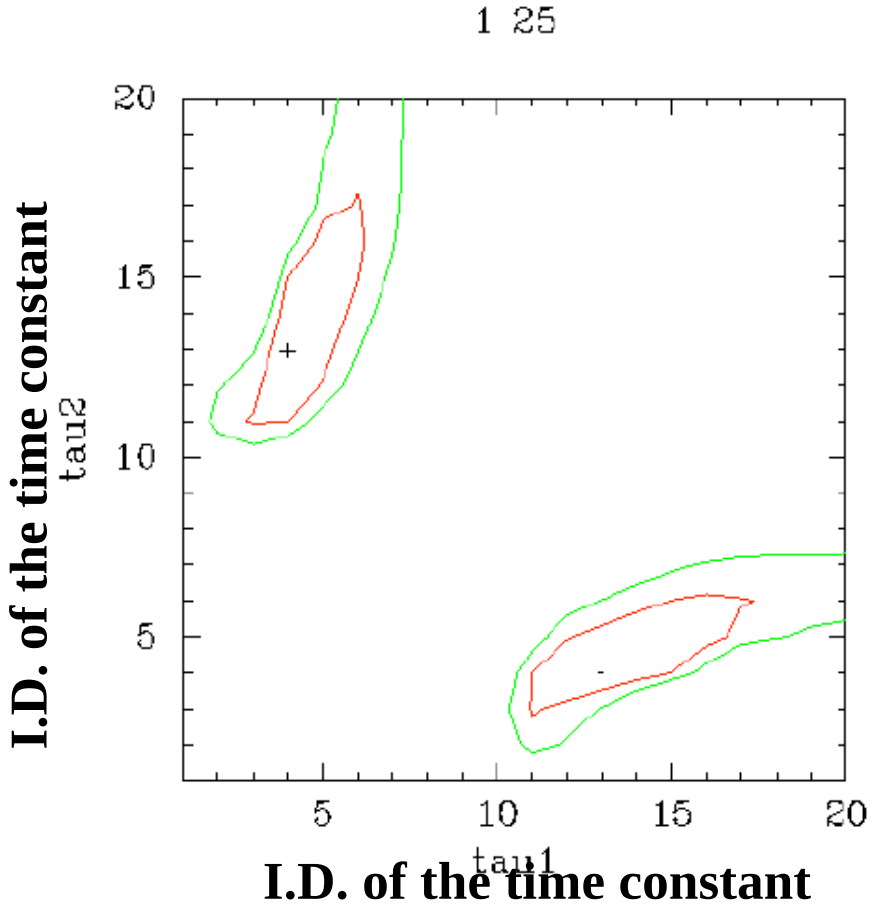
Furthermore longer two time-constants in the same way as the above.
Use all the earth occultation data in the SWG data

150000,250000,350000,450000,550000,800000,1000000,
2000000,3000000,5000000,6500000,8000000,10000000,
20000000,30000000 sec

Examples of the contours

GSO (490-510 keV)

Short time-constants



Long time-constants