

The Hard X-ray Detector (HXD) onboard Suzaku

By the HXD team

- 1: Introduction and PIN etc. Kazuhiro Nakazawa (ISAS/JAXA)
- 2: GSO and background etc. Motohide Kokubun (Univ. Tokyo)



Introduction

- the HXD calibration is in the phase to **establish default parameters**
 - Identify the match and difference with other observatories.
- ground calibration is limited to energy scale cal., shape of response cal., and basic alignment cal.
- **In orbit calibration for EA, Gain and alignment** is held **with Crab** observations and activation lines in (mainly) discarded events.
- Background modeling** is ALSO connected to response, because any hard X-ray measurements are always background dominated

See how the HXD data looks like

The HXD design

FOVs

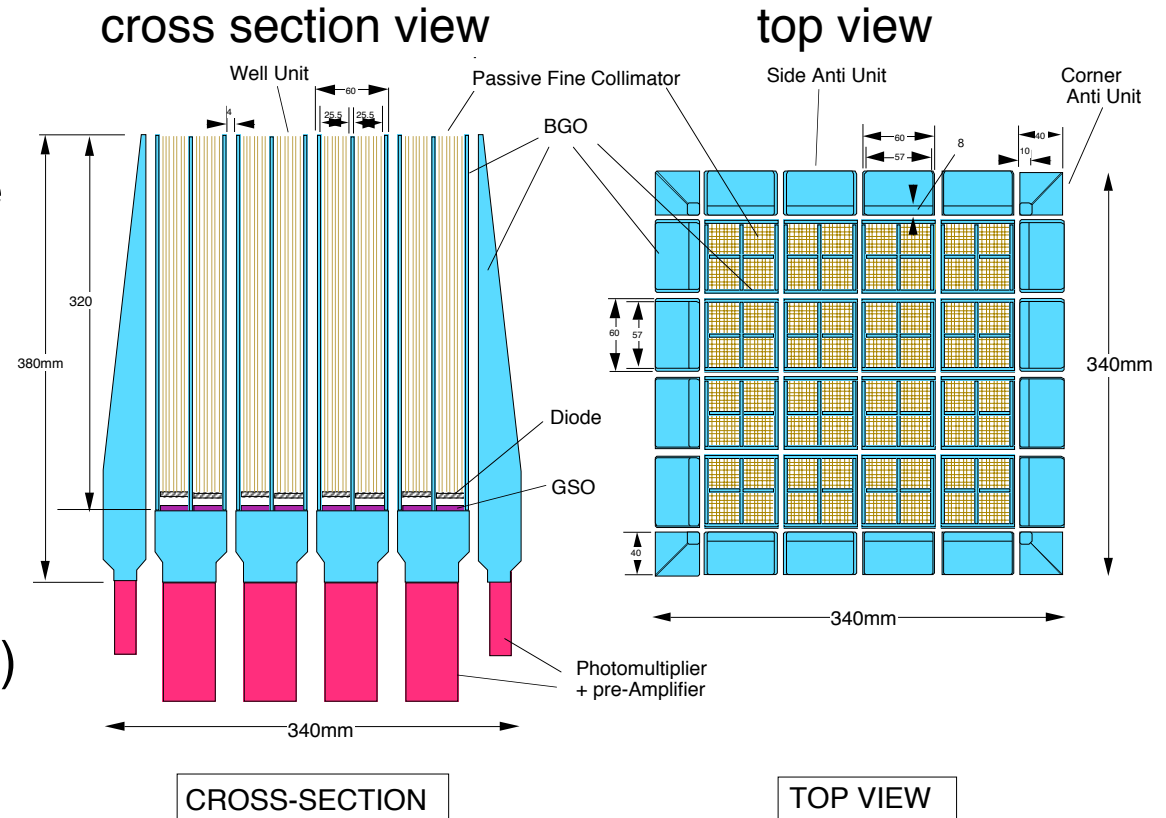
- BGO active shield
4.5° FOV /anti-coincidence
- PSnCu passive collimator
0.55° fine FOV

Energy range

- 2 mm^t Si-PIN diode (64 sig.)
10-60 keV
- 5 mm^t GSO scintillator (16 sig.)
40-600 keV

Event data format

- PINx4, GSO/BGO in **one event data**
- Hit pattern of 36 units
- 61 μ s (opt. 30.5 μ s) time resol.

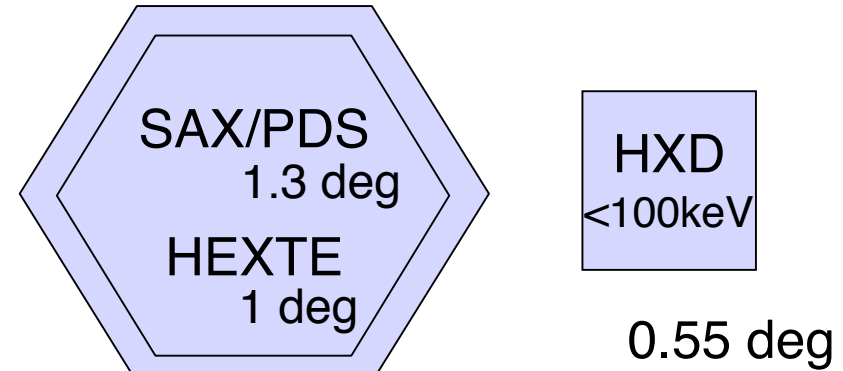
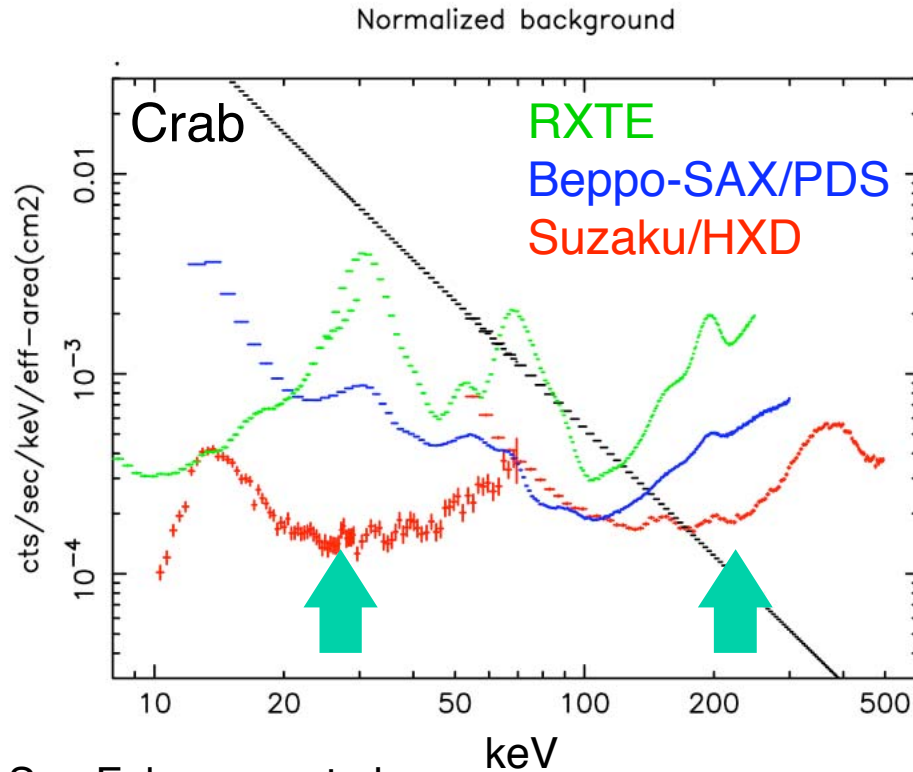


34x34x38 cm³
160 kg

Key points of the HXD

The lowest background

Narrower Field of View

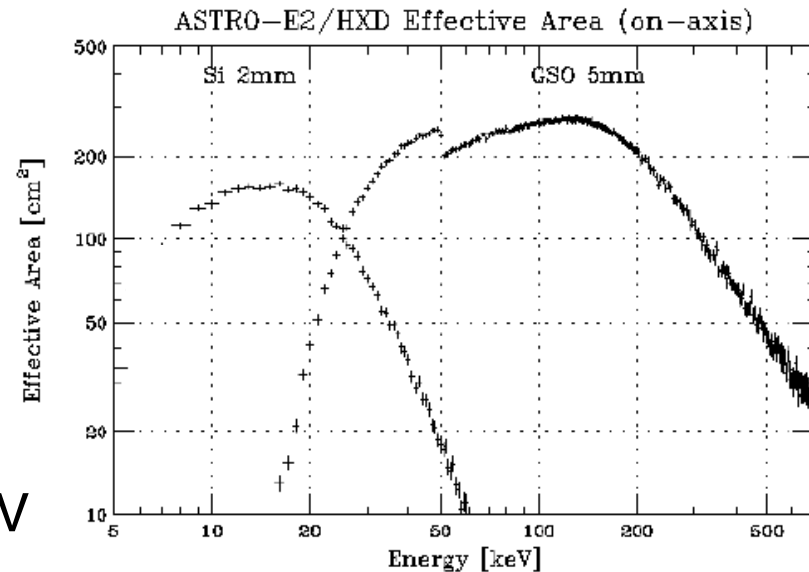


Wide energy band

See Fukazawa et al. proc.
SPIE Orlando 2006

Small Eff. Area

155 cm² @ 15 keV
270 cm² @ 120 keV

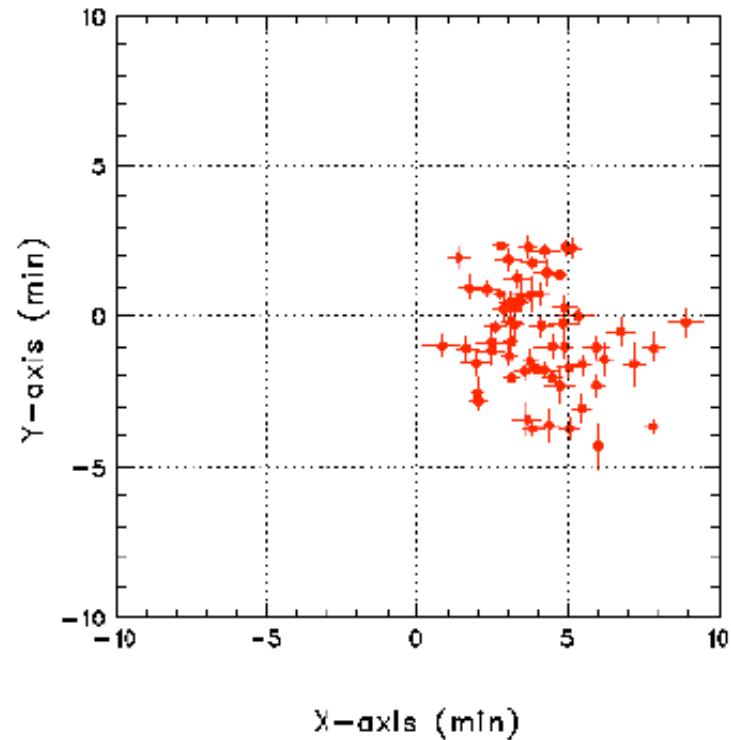
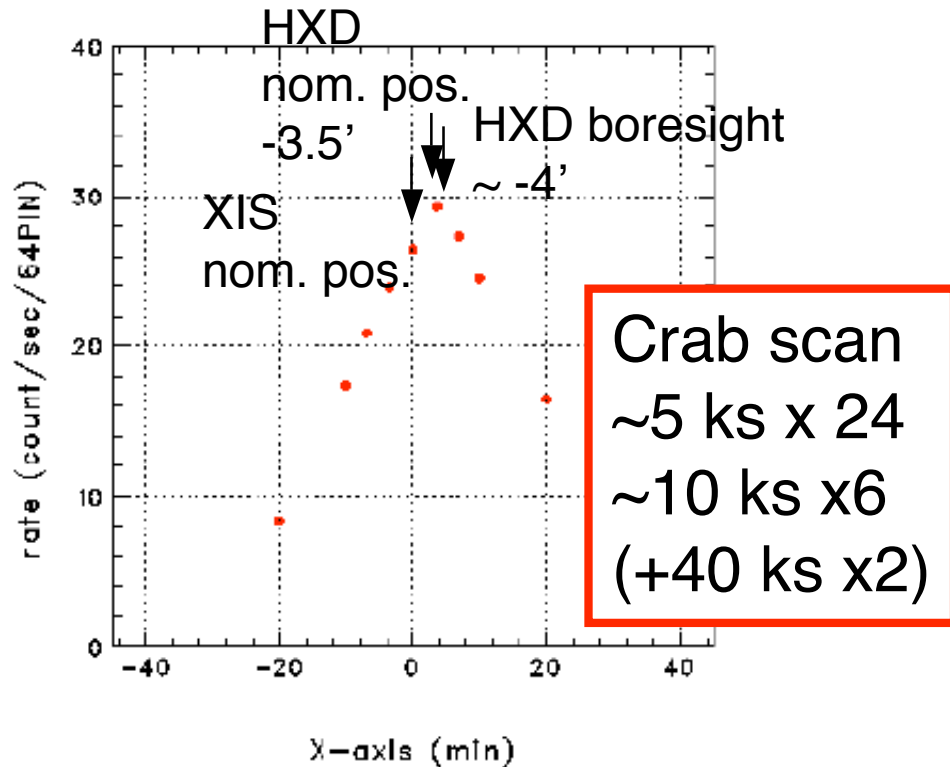


1: FOV, Through-put: Fine collimator alignment In orbit with Crab scans

Defines the through put --> eff. area of the HXD

64 fine collimators
0.1 mm / 30 cm = 1 arcmin

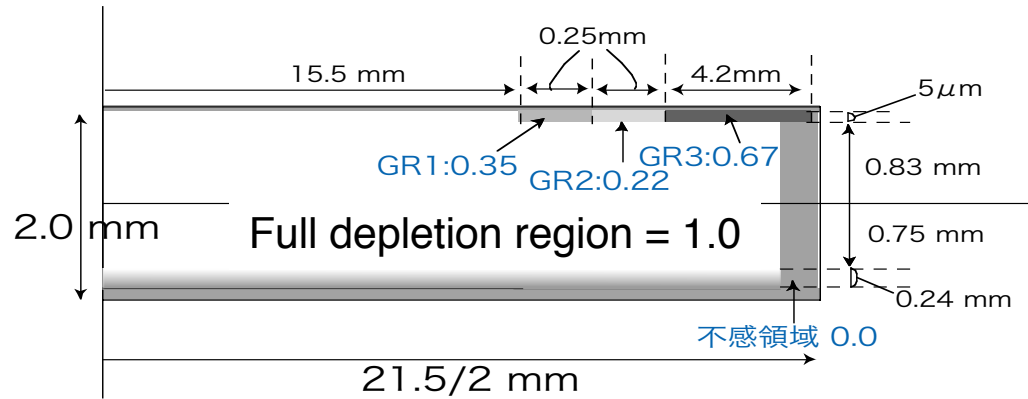
Scatter is 1.7 arcmin (RMS)
against 34arcmin FOV.



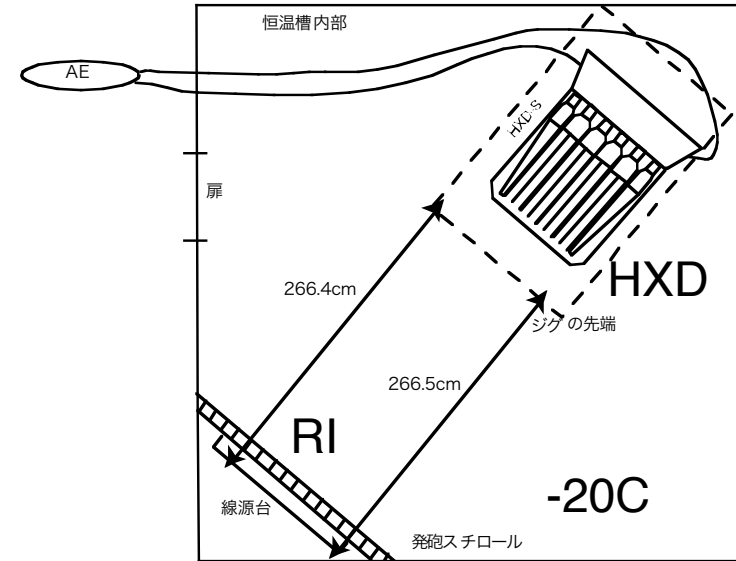
Included as TELDEF file

2: Gain, Rsp : Ground Calibration

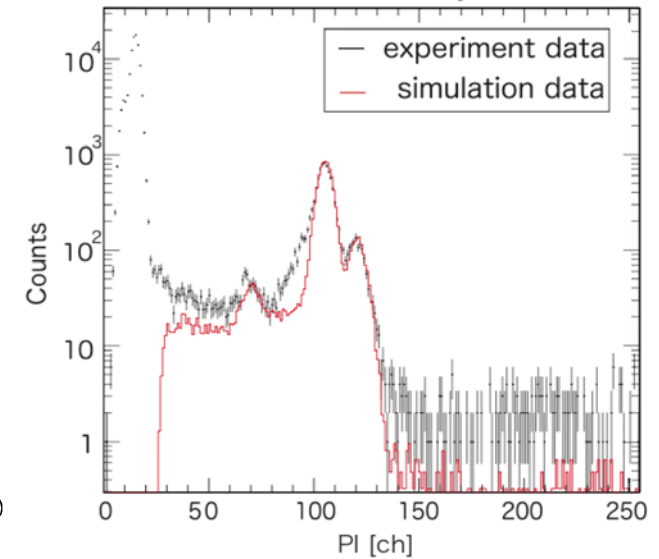
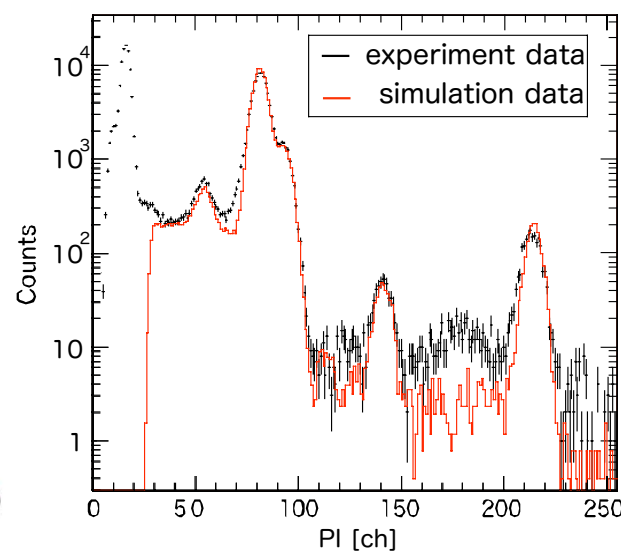
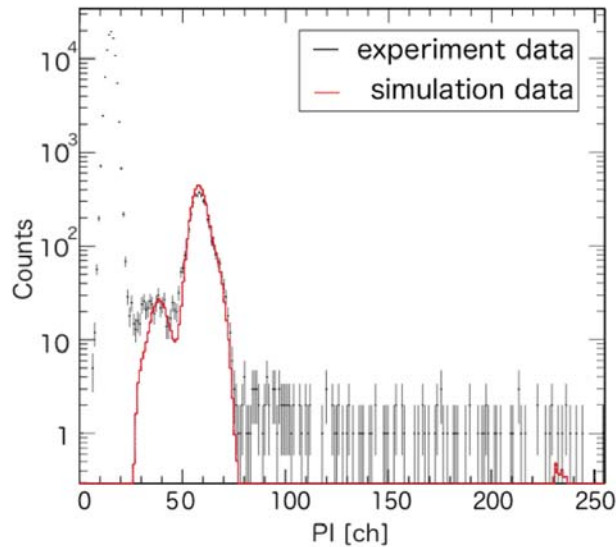
Detector Mass Model
Utilizing Geant4 framework



See Sugihō et al. IEEE TNS.49, 2001



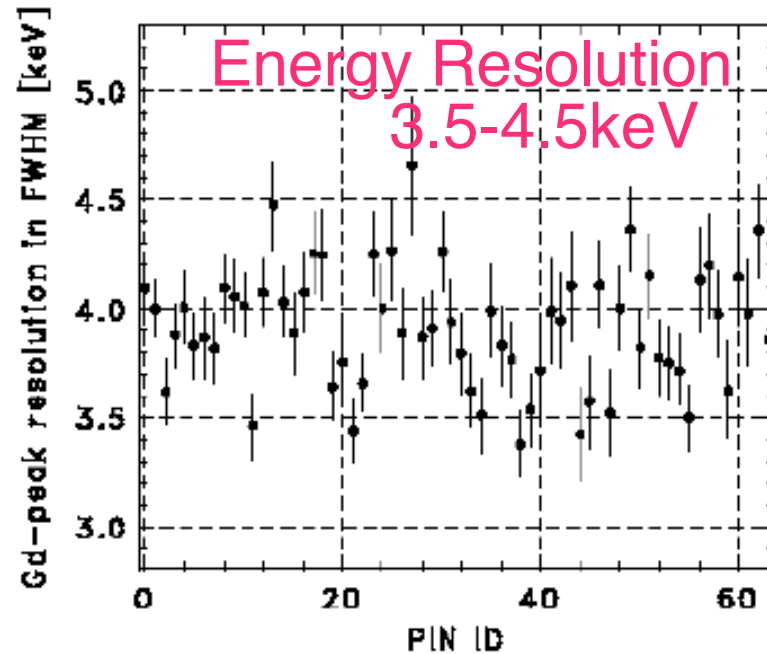
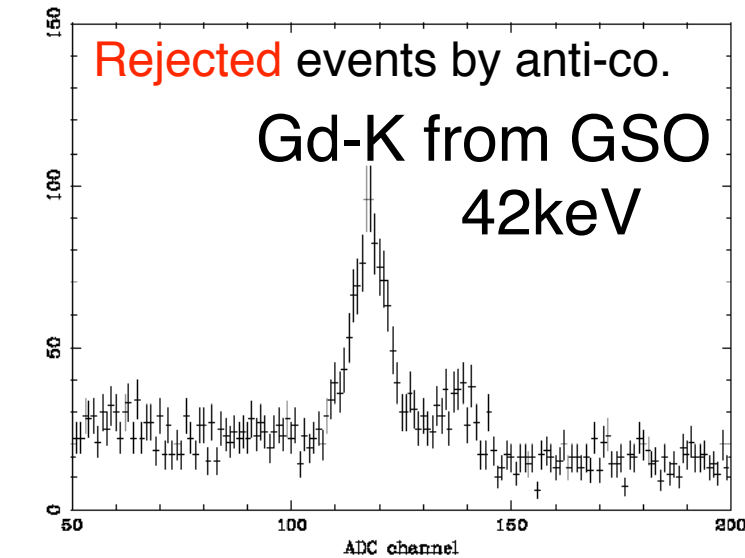
From T.Kisita Master Thesis, the Univ. of Tokyo, 2006



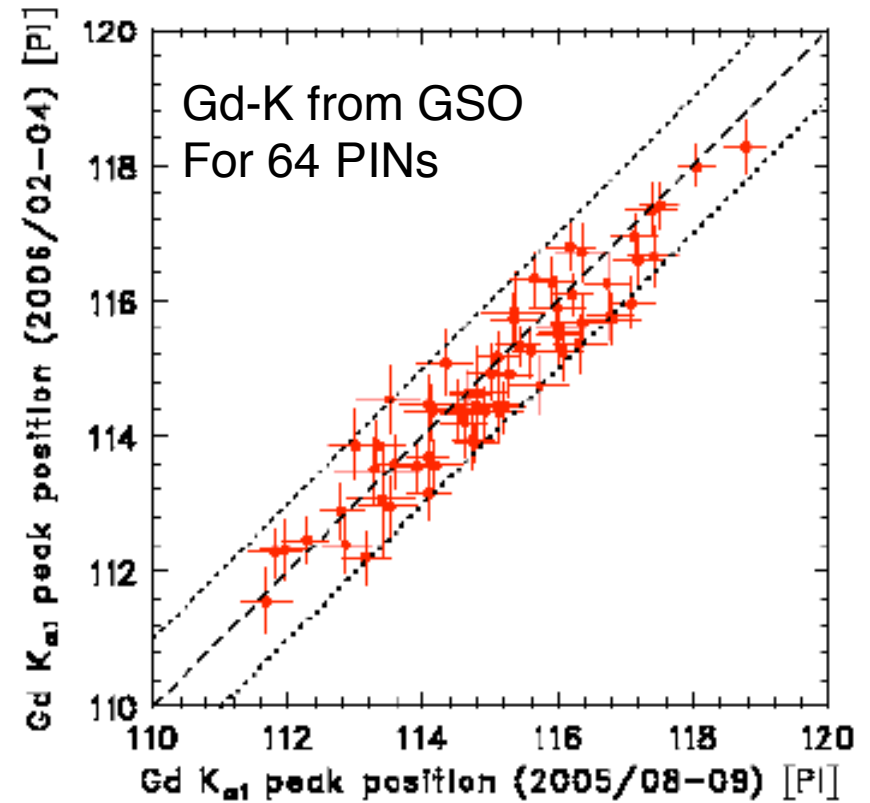
2: Gain, Rsp : In orbit

(traced with <1% accuracy)

Gain is almost constant.



2006/02-04

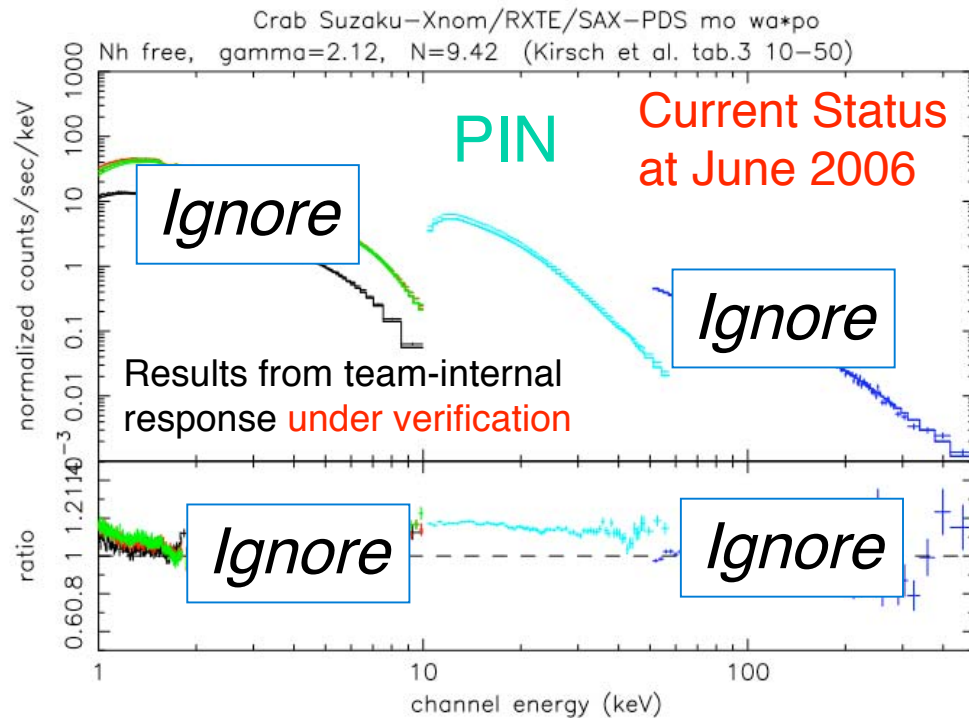


2005/08-09

2: Gain, Rsp : In orbit

Please focus only on PIN

The Crab fitting
XIS nominal



Default response

(as of 2006/06/13

Suzaku-SWG-team-internal)

with Fixed model

$\Gamma=2.12$, $N(1\text{keV})=9.42$

PIN: ~10 % residual in effective area in 10-200 keV

PIN: 15-40 keV sole fit : $\Gamma=2.16$ $N=12.5$ (flux diff. is much less)

Compare with Kirsch et al. 2005

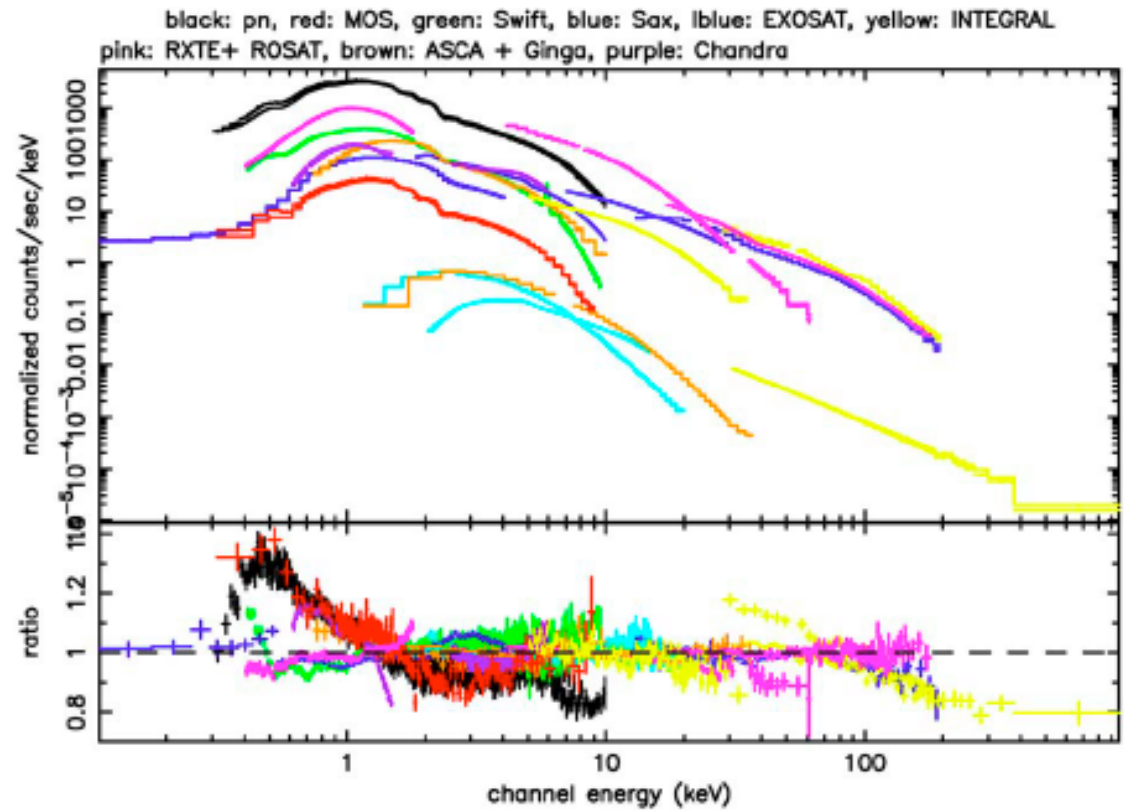


Figure 7: Joint fit to all data in the energy range 0.1-1000 keV

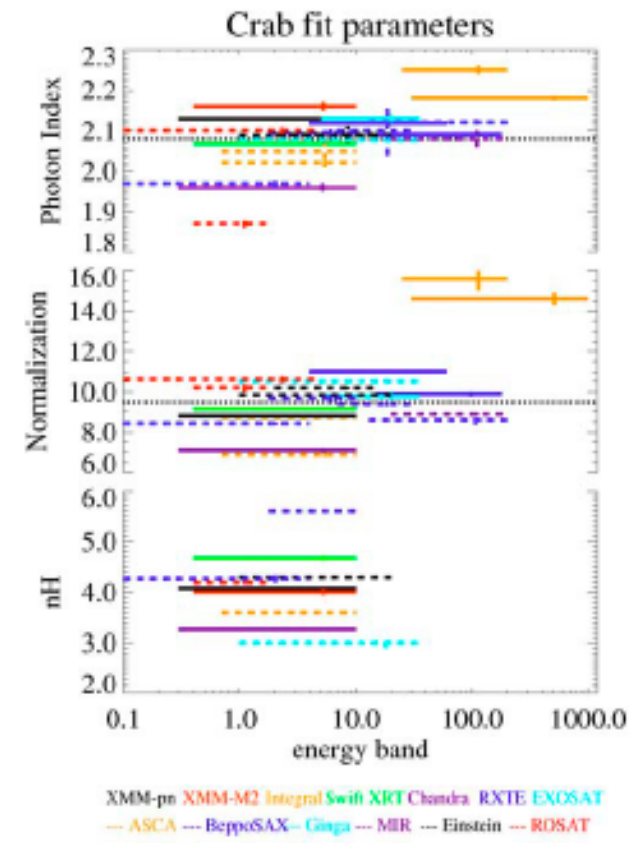


Figure 6: Spectral parameters of the Crab for various X-ray missions. The horizontal bars represent the instrument's operational energy range. N_H is given in 10^{21} cm^{-2} and normalization in photons $\text{keV}^{-1} \text{ cm}^{-2} \text{ s}^{-1}$ at 1 keV.

Compare with Kirsch et al. 2005

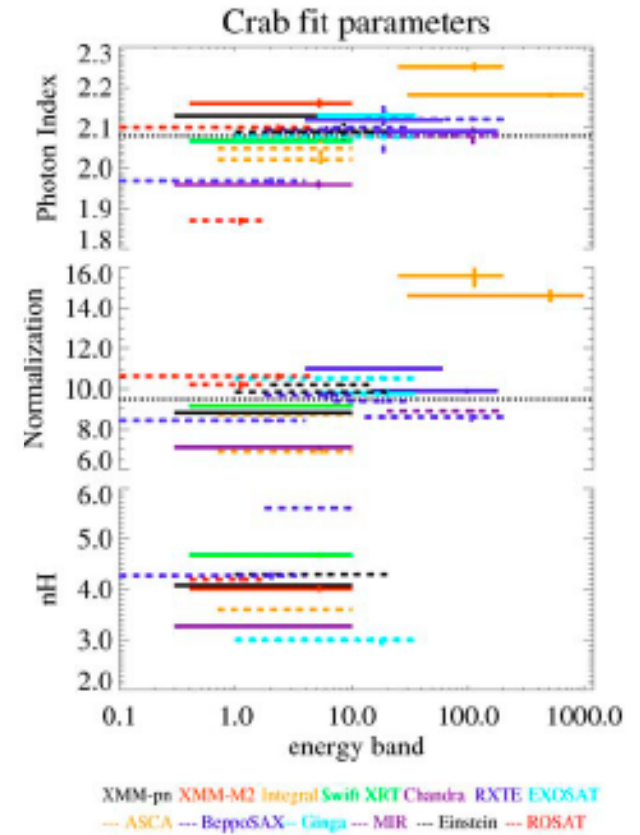
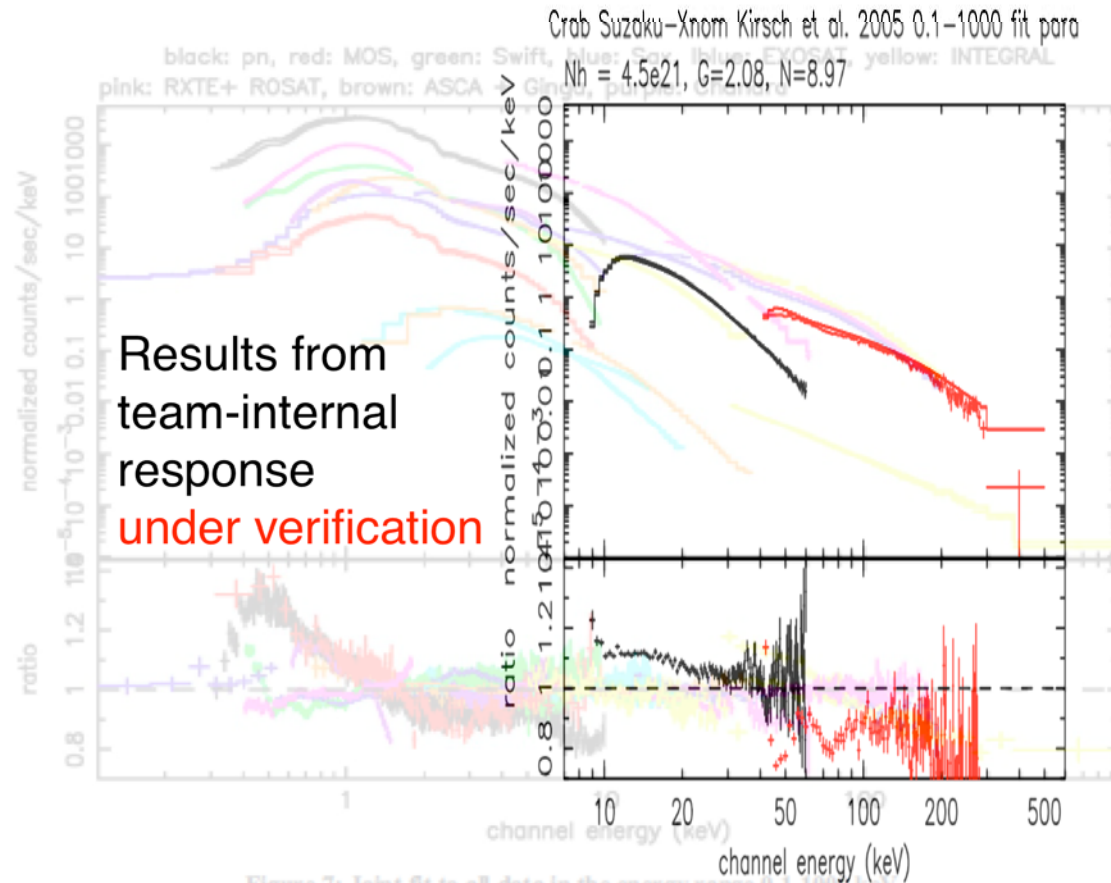
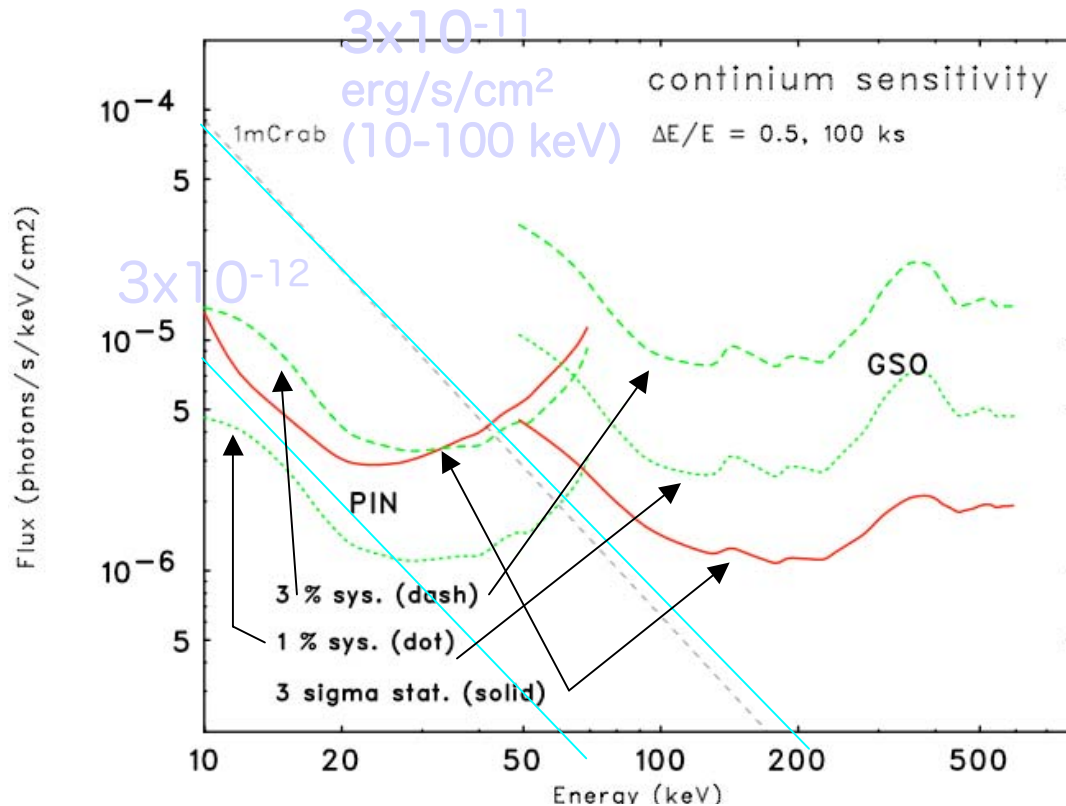


Figure 6: Spectral parameters of the Crab for various X-ray missions. The horizontal bars represent the instrument's operational energy range. N_H is given in 10^{21} cm^{-2} and normalization in photons $\text{keV}^{-1} \text{ cm}^{-2} \text{ s}^{-1}$ at 1 keV.

Apdx. Expected Sensitivity



Continuum Sensitivity

$dE/E = 0.5$

Exp. = 100 ks

3 sigma stat.

1 and 3 % of BGD

- 10-30 keV, 3 sigma photon limit for 100 ks : 0.1 mCrab
- 10-30 keV, 2% of BGD : 0.1 mCrab

The better modeling of background will allow fainter source, 0.1–0.2 mCrab at 10–40 keV.