HXD Operation and Calibration status

K. Nakazawa (U. Tokyo)
on behalf of the Suzaku-HXD team

Status Report of HXD

1: Introduction & Operation status

-Introduction and high-lights
-status report
→ all channel is working fine, as of 21 Sep. 2009
-PIN noise cut threshold update

2: Calibration updates

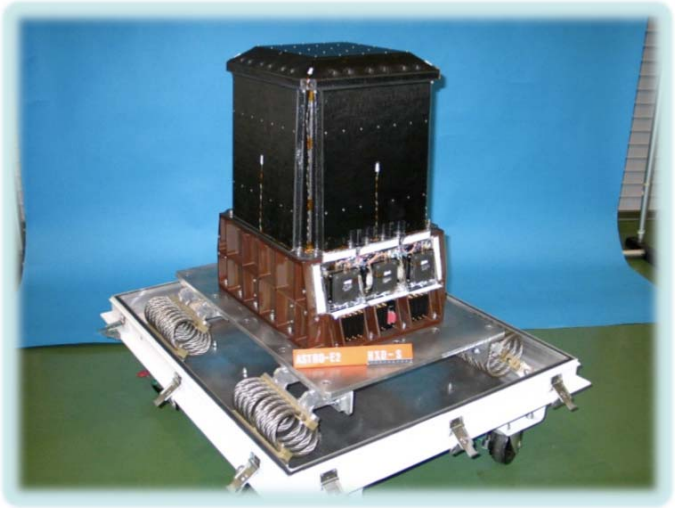
-Recent Crab spectra
-GSO gain correction update status
-NXB reproducibility *revisiting*

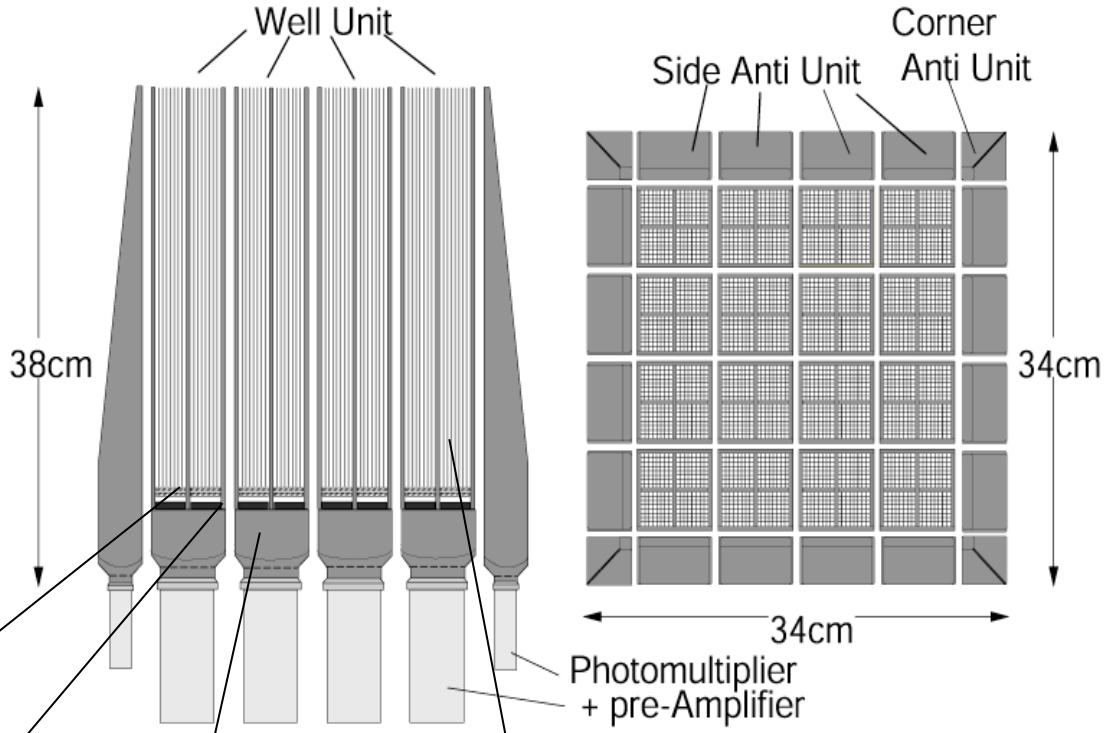
3: Comments on Analysis

-hxdarfgen for off-bore sight sources *revisiting*
-comments on GSO analysis

1: Introduction
&
Operation status

1-1: The Hard X-ray Detector





64 PIN-Si diodes :
13-70 keV, ΔE~4keV(FWHM)

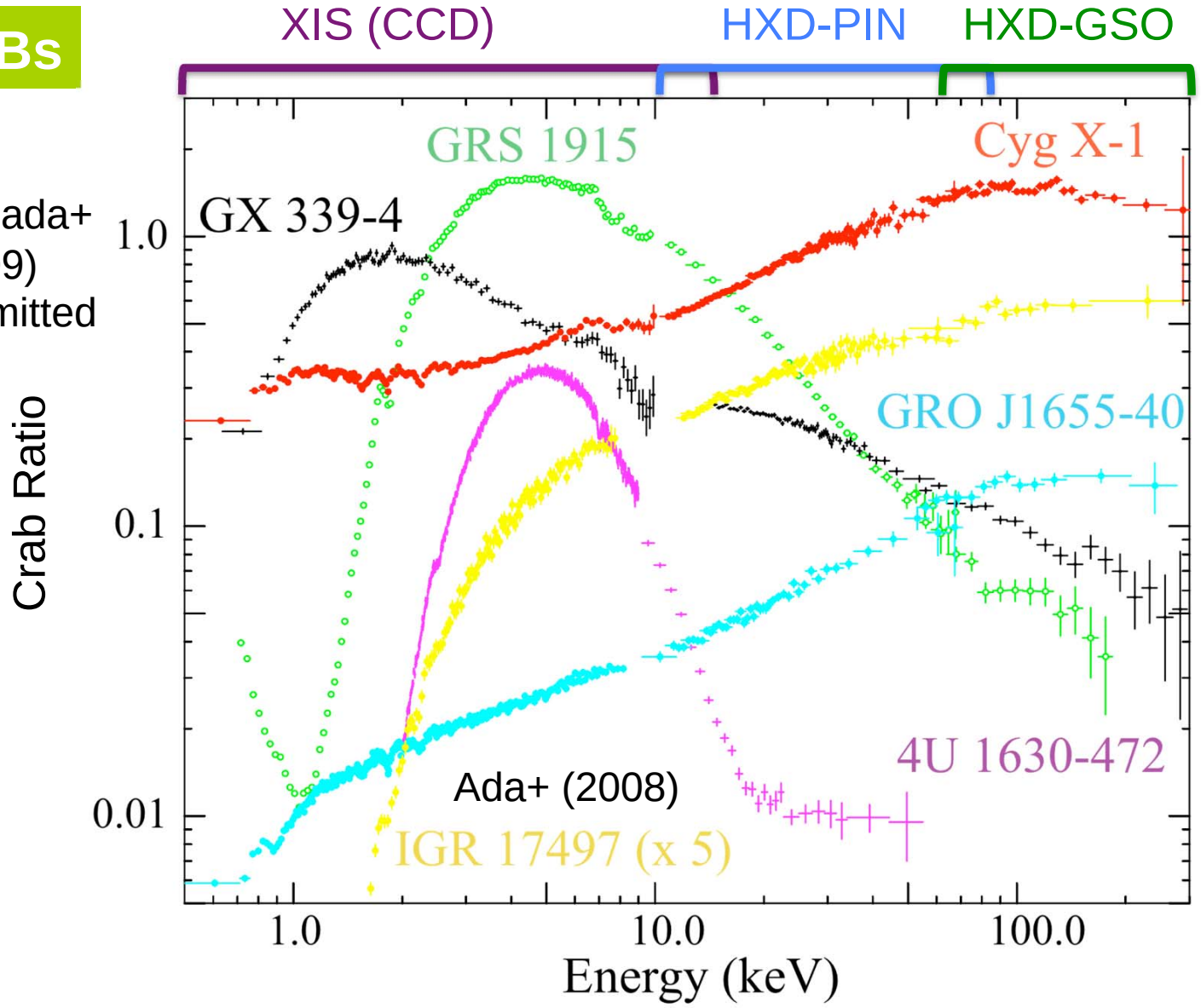
16 well-type phoswich (GSO) :
50-600 keV

Fine-Collimator : low CXB, confusion
FOV 34x34 arcmin (FWHM) < 100 keV

BGO well-type active shield : ***low BGD***
FOV 4.5x4.5 deg (FWHM) > 100 keV
+ Wide-band All-sky Monitor (WAM) as a GRB detector

The power of wide-band spectra

BHBs



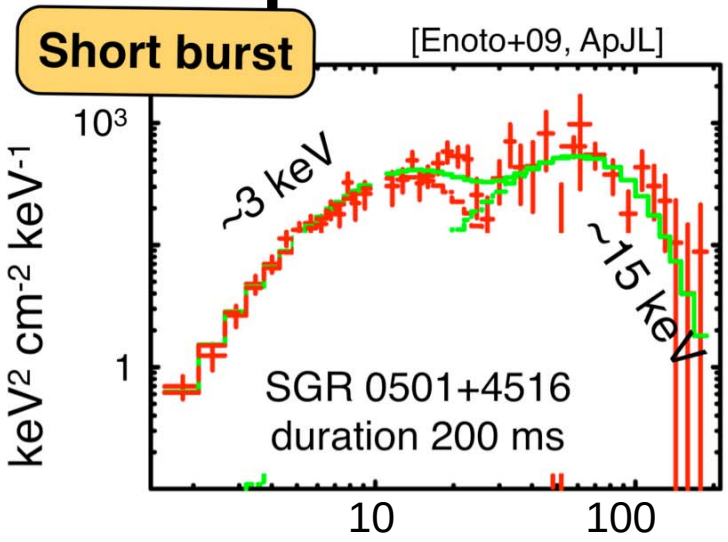
Yamada+ (2009) submitted

17.4 ks, Makishima+ (2008)

20 ks, Takahashi+ (2008)

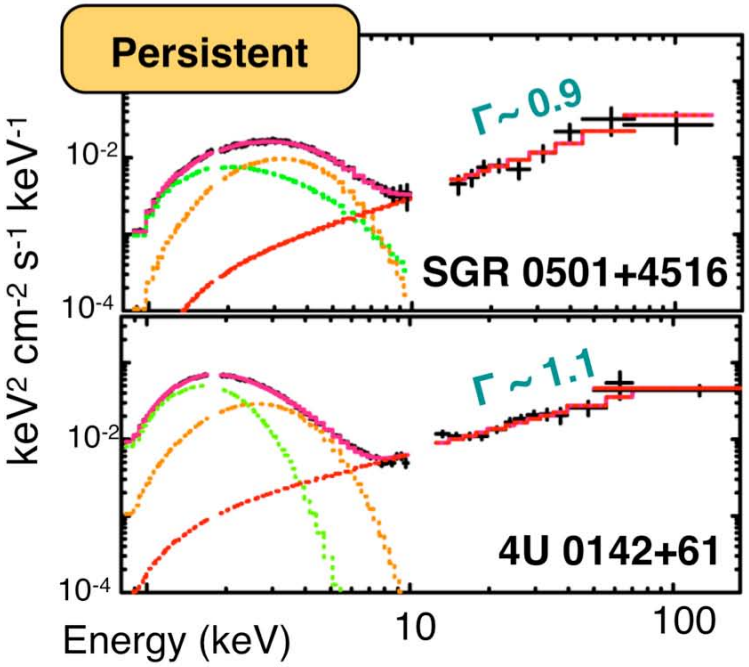
Kubota+ (2007)

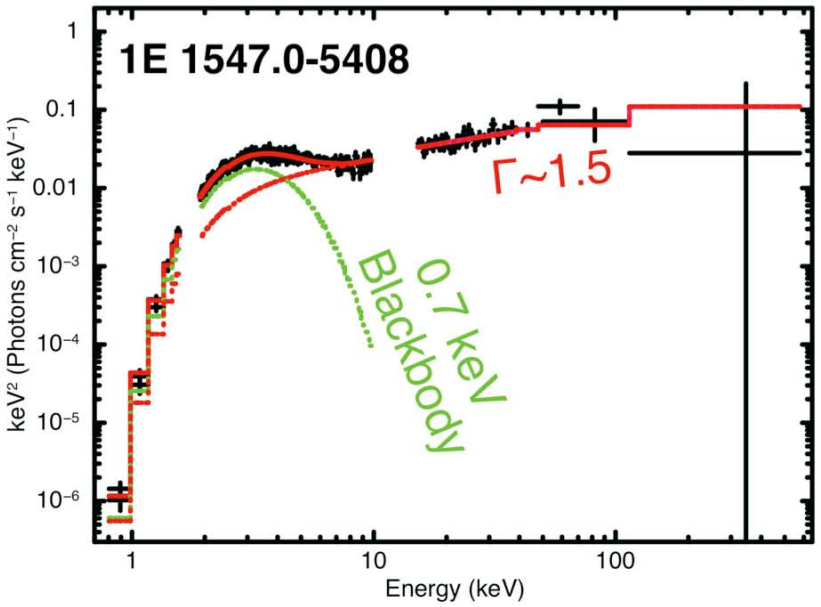
The power of wide-band spectra



SGRs

Enoto+ (2009) submitted





1-2: HXD Status

Normal operation for
ALL 64 PINs and 16 GSOs continues

3 Operational Events taken place within 1 year,
2 impacts on observations, no effect on current observation

A: WPU-1 PIN Analog LD + Anti-unit gain correction

12 Feb 09:30 UT
PIN = No impact on data was observed (because of proper soft-LD).
Anti = No impact (doing almost annually)

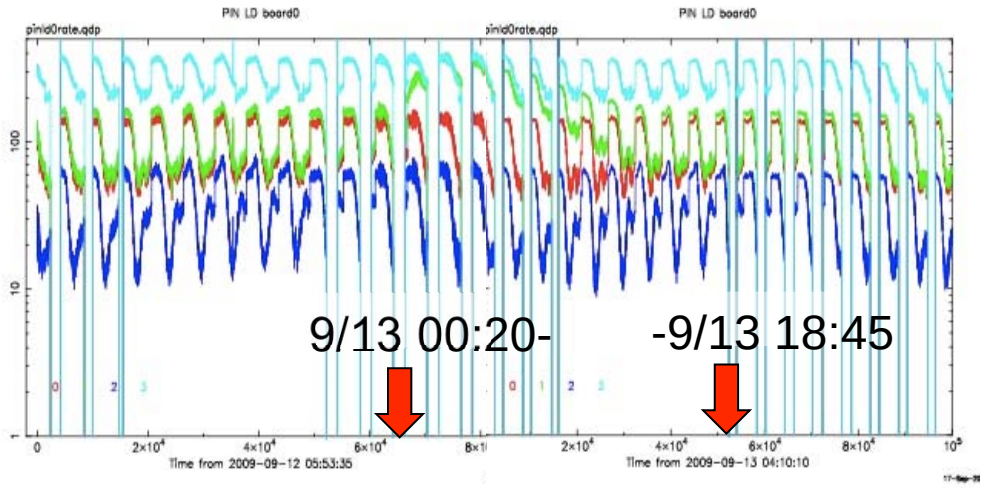
B: DE (CPU) halt at 27 June – 1 July 2009 : "Otaru-event"

Jun.27 (A1795_NEAR_WEST)
17:27- A sudden halt of HXD-DE occurred during a SAA passage.
HXD observation was stopped till 18:09 July 1.
Caused by register SEU. Reason resolved. No permanent impact.

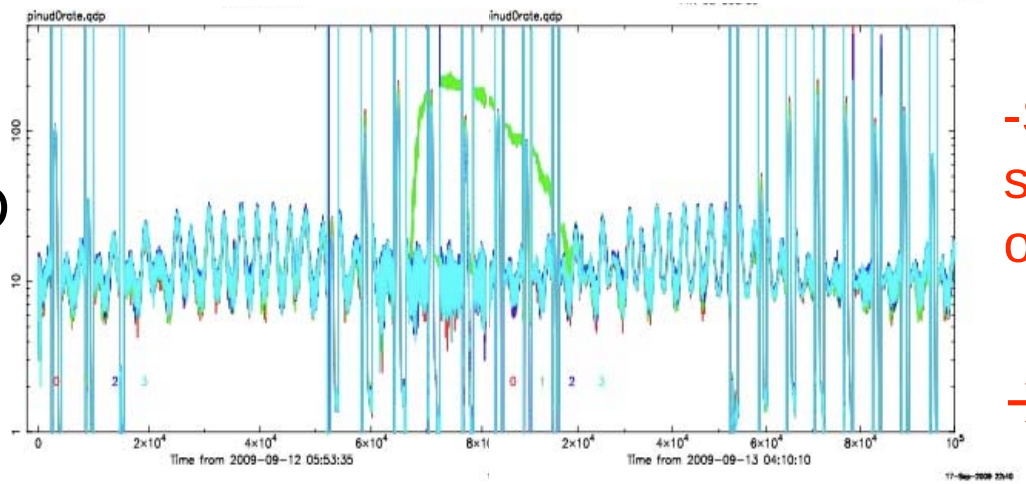
1-2: HXD Status

C: WPU-01 PIN-3 out-burst

LD



UD



- A sudden LD and UD rate rise of W01-PIN3 at 13 Sep. 2009.

-calmed down within 8 hours

-the 3rd case in the whole HXD life.

- the same PIN, which showed similar behavior at May 2006 (the 2nd case).

-Still monitoring, i.e. no need to switch off trigger. No after-effect observed to date

→ Now **at normal observation**

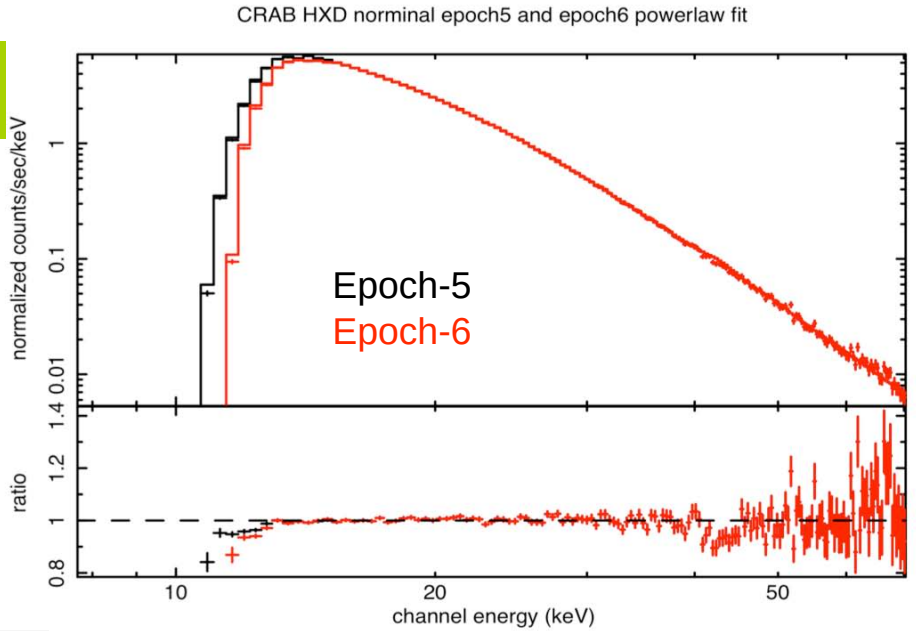
2: Calibration status

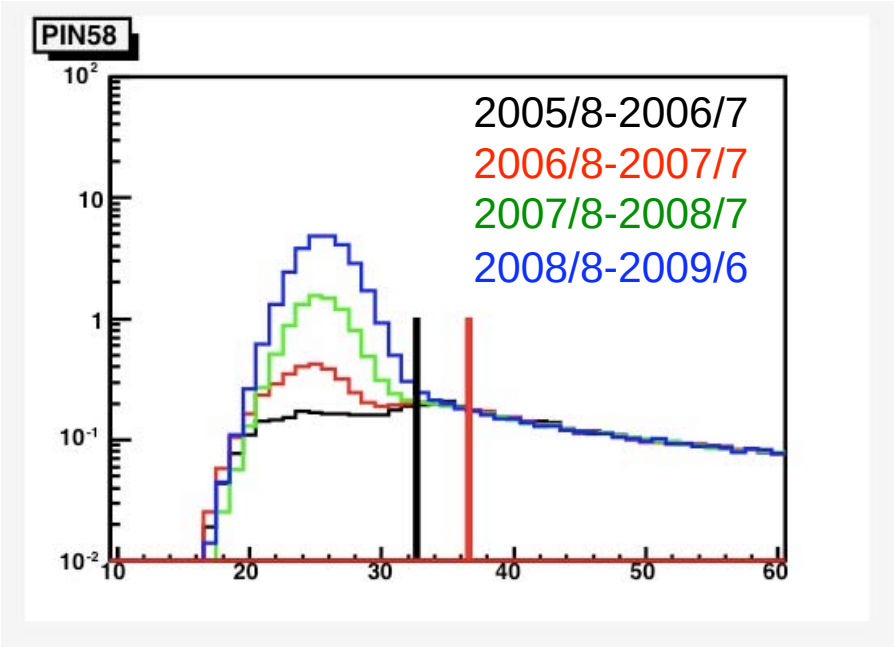
2-1: Annual PIN software-threshold update

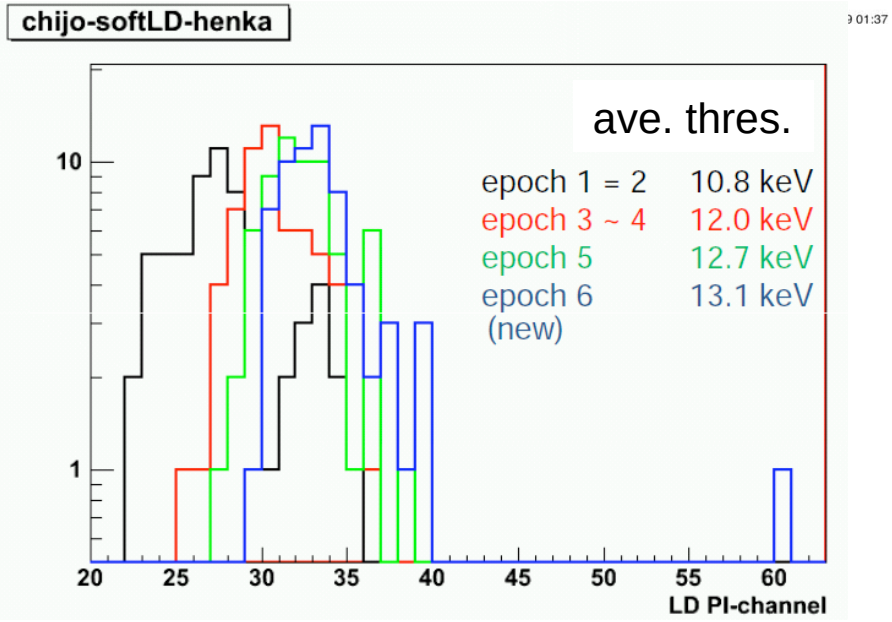
Epoch-6 defined (2009/10-)

-update ”soft-LD” for data screening to handle slow increase of noise (by CR bombarment)
- good spectra without noise hump secured

Sho Nishino(Hiroshima)+







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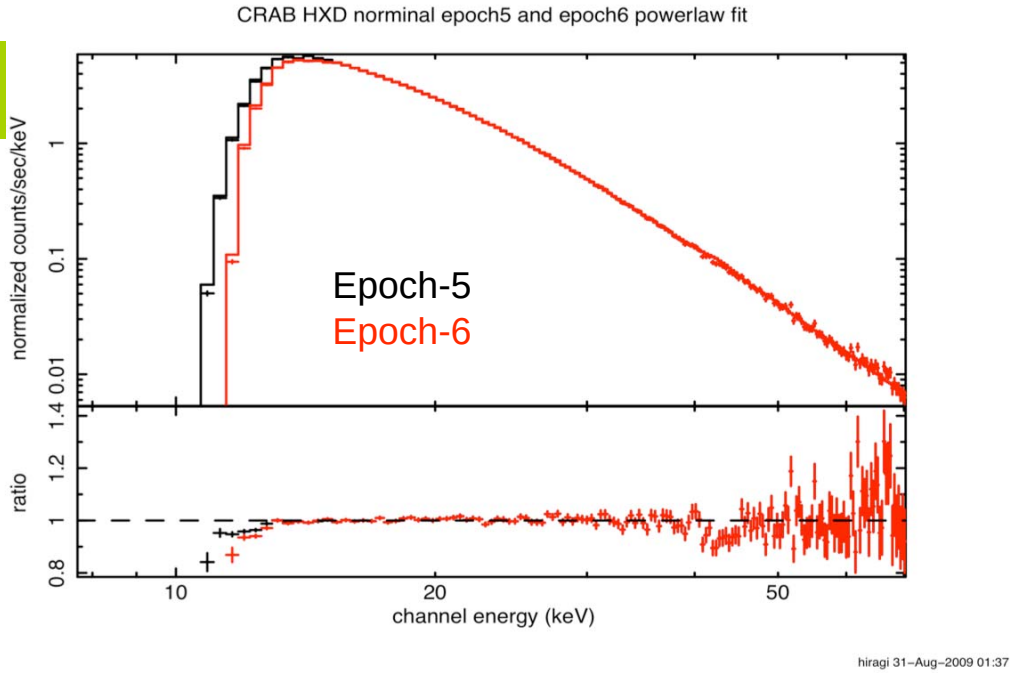
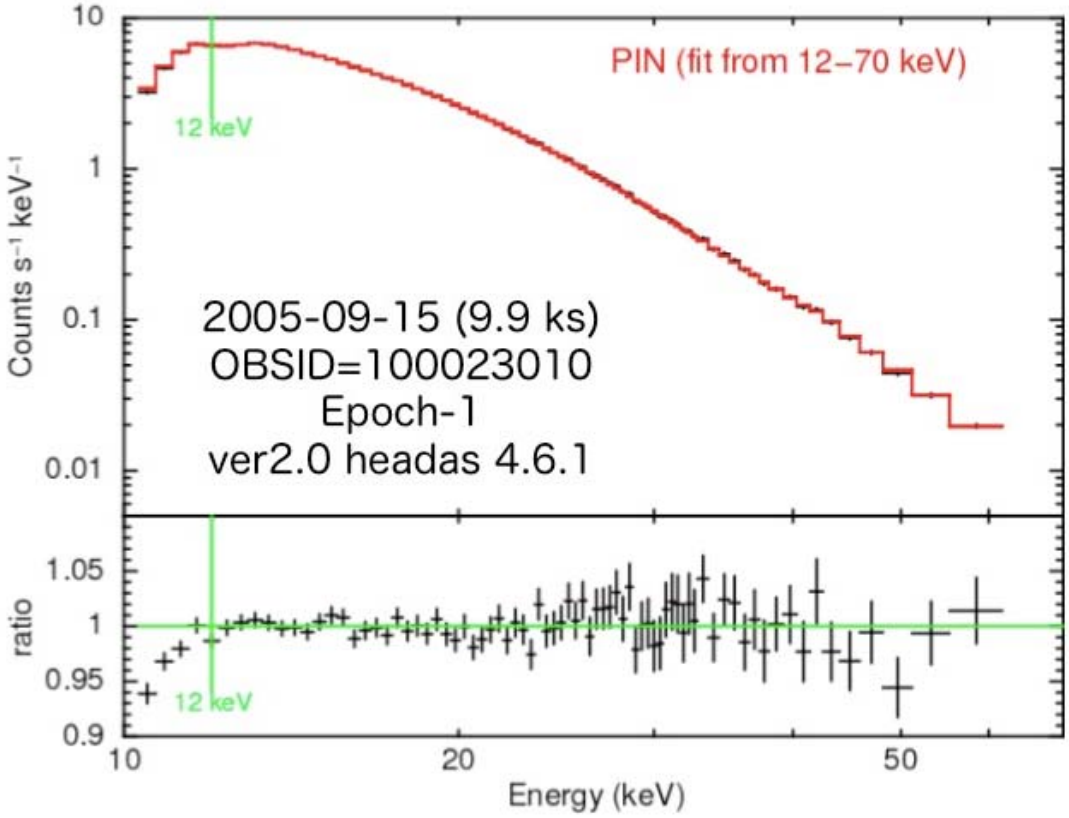


6 sets of ae_hxd_pinthr_YYYYMMDD.fits in CALDB.
epoch 1) 2005-08-17
epoch 2) 2006-05-25
epoch 3) 2006-10-03
eopch 4) 2007-07-28
eopch 5) 2008-08-31
eopch 6) 2009-10-01

←automatically selected by *hxdpi*.

2-2: Crab spectra (PIN)

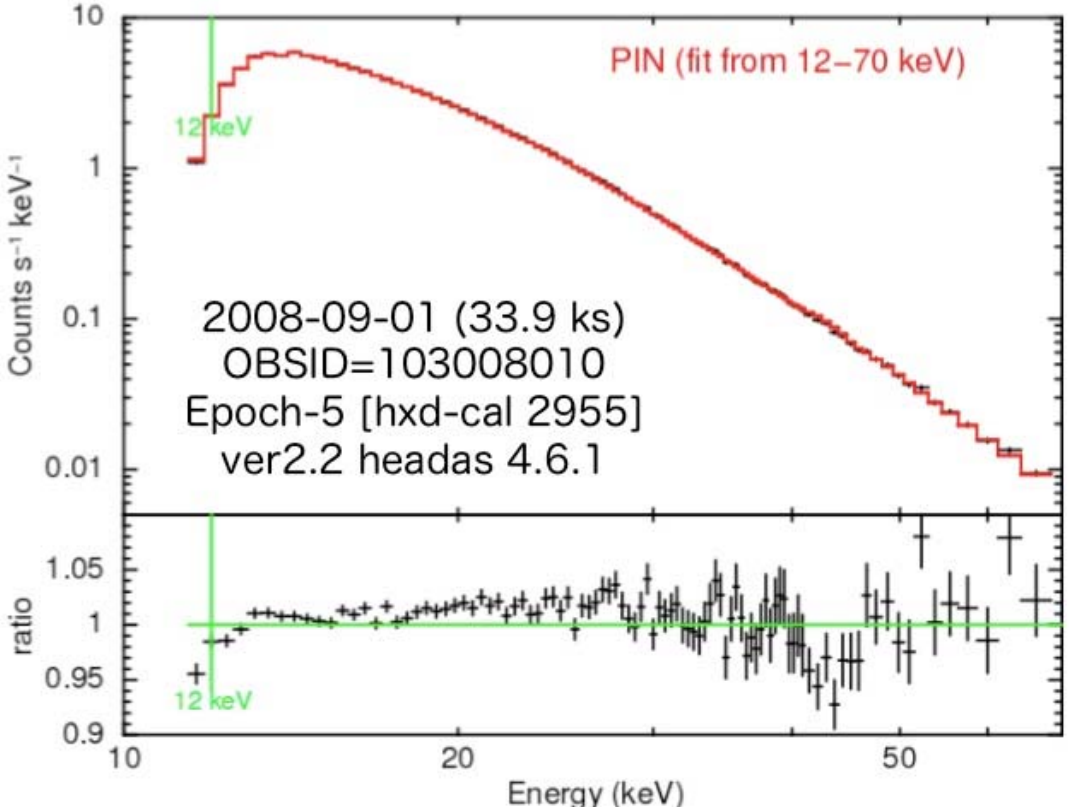
PIN Crab spectra unchanged within 5%



2-2: Crab spectra (PIN)

PIN Crab spectra unchanged within 5%

no attitude correction



HXD-nom

- response stable within $5_{pk\text{-}pk}$%
- A ~5% dip caused by Ge-K line exists at 42 keV

18% difference to XIS remains

2008 Crab observation compared to the 2005+2006 Crab best fit model

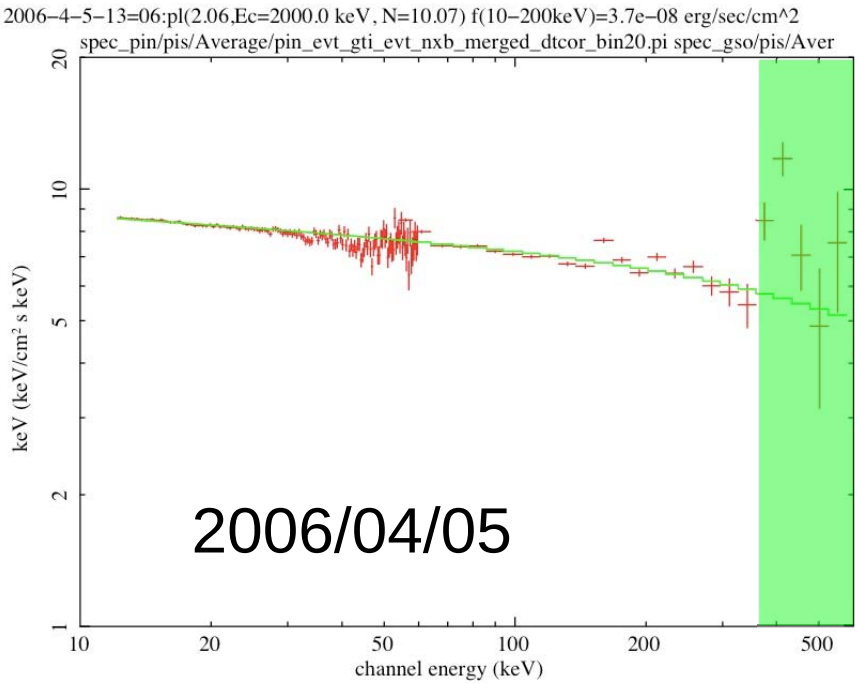
Γ = 2.10 ± 0.004,

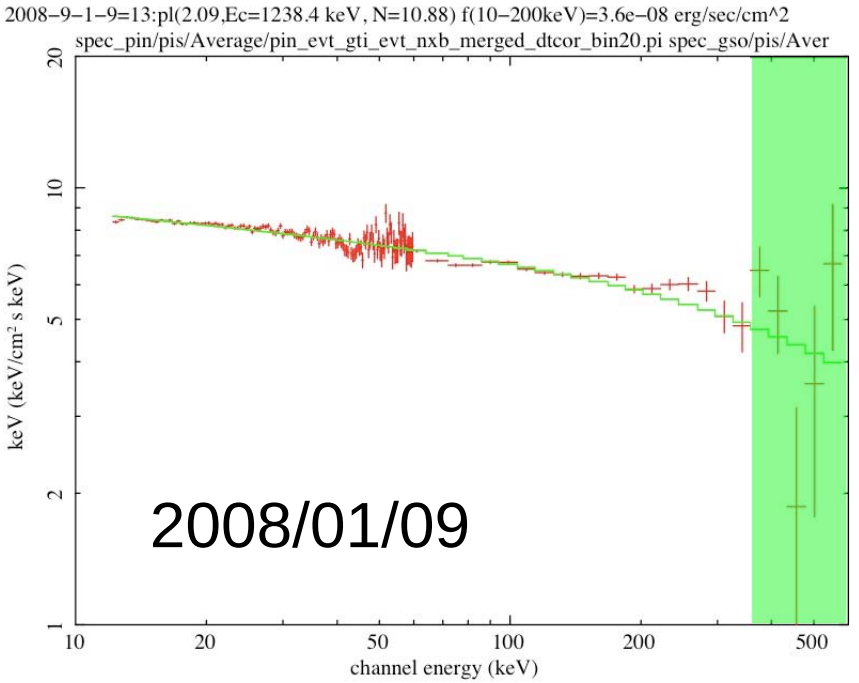
Norm = 11.1 ± 0.12 photons cm^{-2} s^{-1} keV^{-1} at 1 keV

2-2: Crab spectra (GSO)

PIN-GSO Crab spectra (1)

S. Yamada+





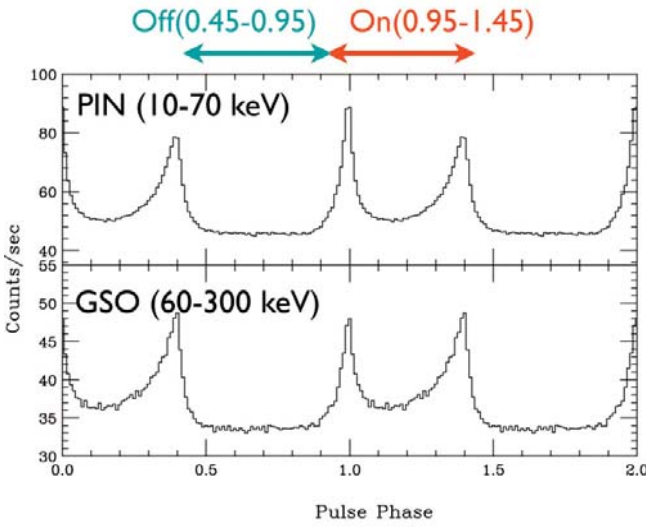
-response stable within 10% below <300 keV
-at > 350 keV, NXB systematic error is non-negligible

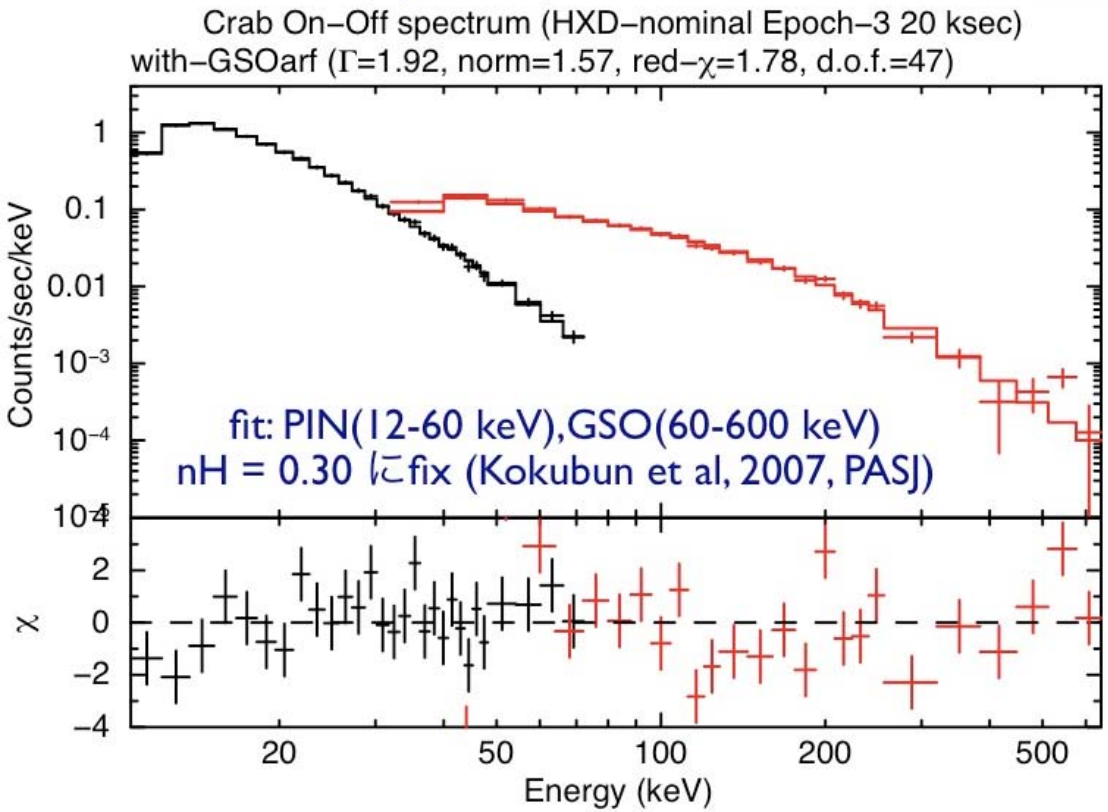
2-2: Crab spectra (GSO)

PIN-GSO Crab spectra (2)

Pulsed

T. Enoto+





PIN-GSO spectra up to 300+ keV, OK

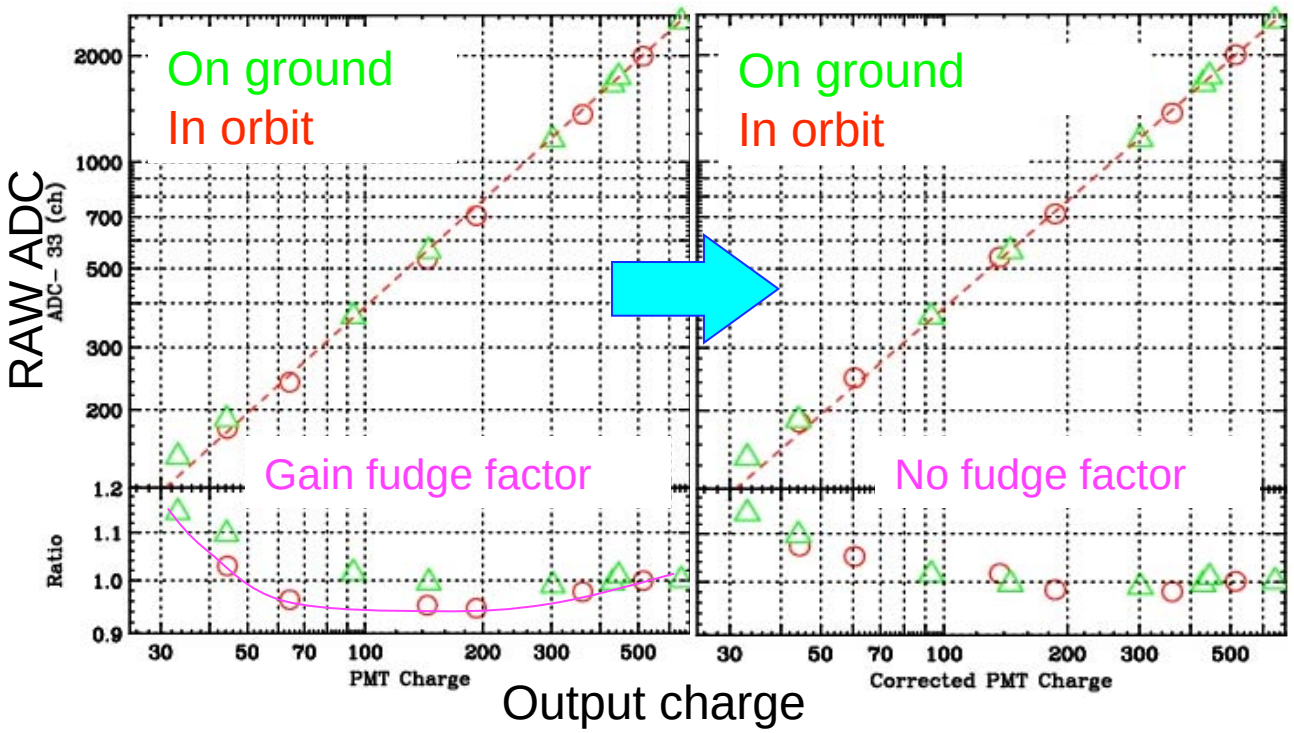
2-3: GSO gain updates

GSO gain correction

Feb. 2010 to be released

Re-calibrating activation lines

Yamada 08



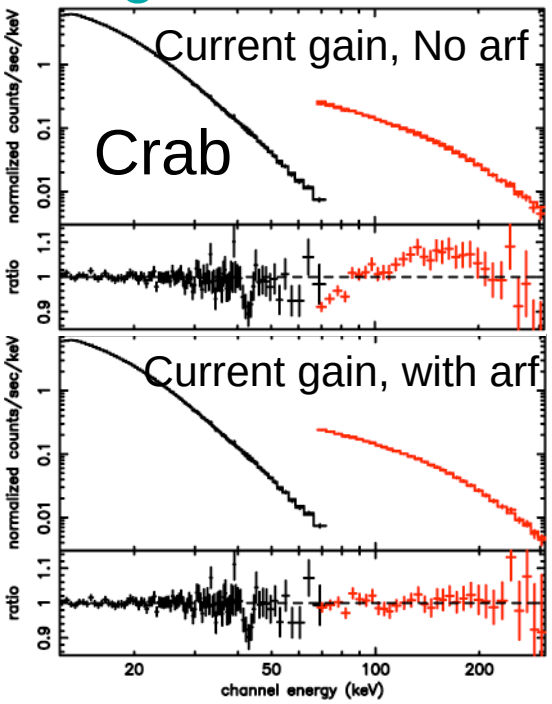
Resolved the origin of the gain fudge in GSO

2-3: GSO gain updates

GSO gain correction

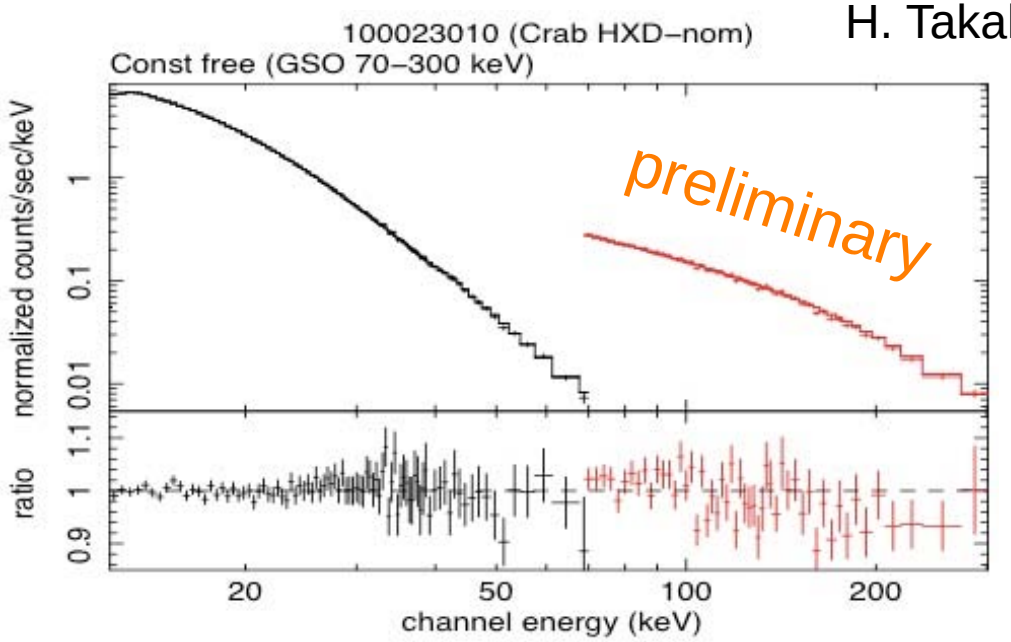
Feb. 2010 to be released

Fudge arf for GSO



new gain / no fudge arf

H. Takahashi+



Resolved the origin of the gain fudge in GSO

→ try eliminating the Eff. Area fudge (arf) from GSO

→ Much confident fitting

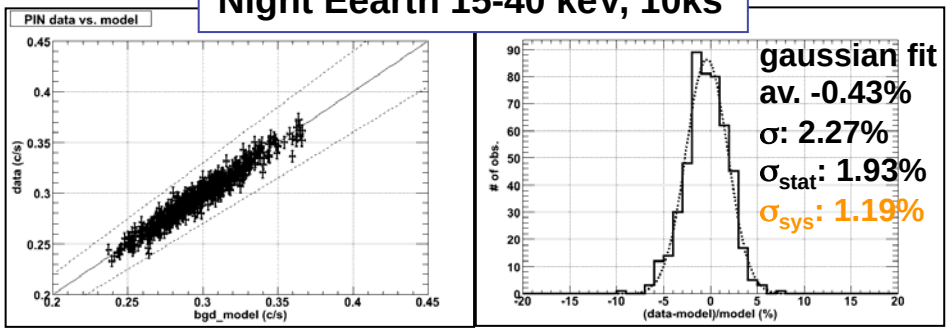
2-4: NXB *revisited* (PIN)

not new
still good

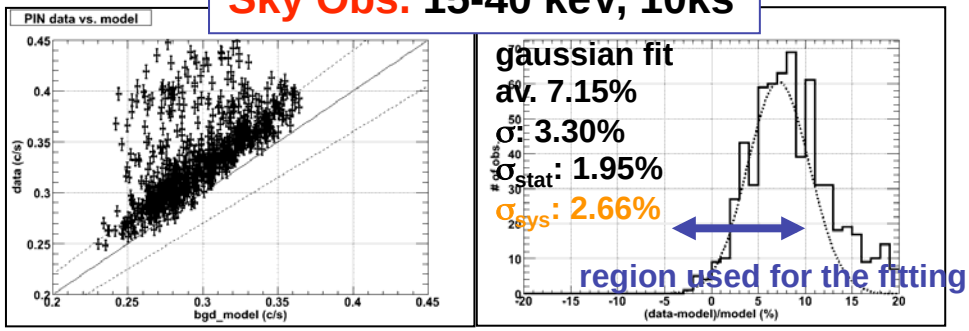
Please use “tuned (LDFITDT)” NXB for analysis of dark objects

Reproducibility distribution

Night Eearth 15-40 keV, 10ks



Sky Obs. 15-40 keV, 10ks



“tuned” NXB needs ~ 2 month to generate. Temporary, quick NXB can be used, but with worse systematic error

“tuned” PIN NXB WILL BE reliable with 2.7% (1σ) sys-error, while 3.3% ***or worse*** in “quick (PINUDLCUNIT)” NXB

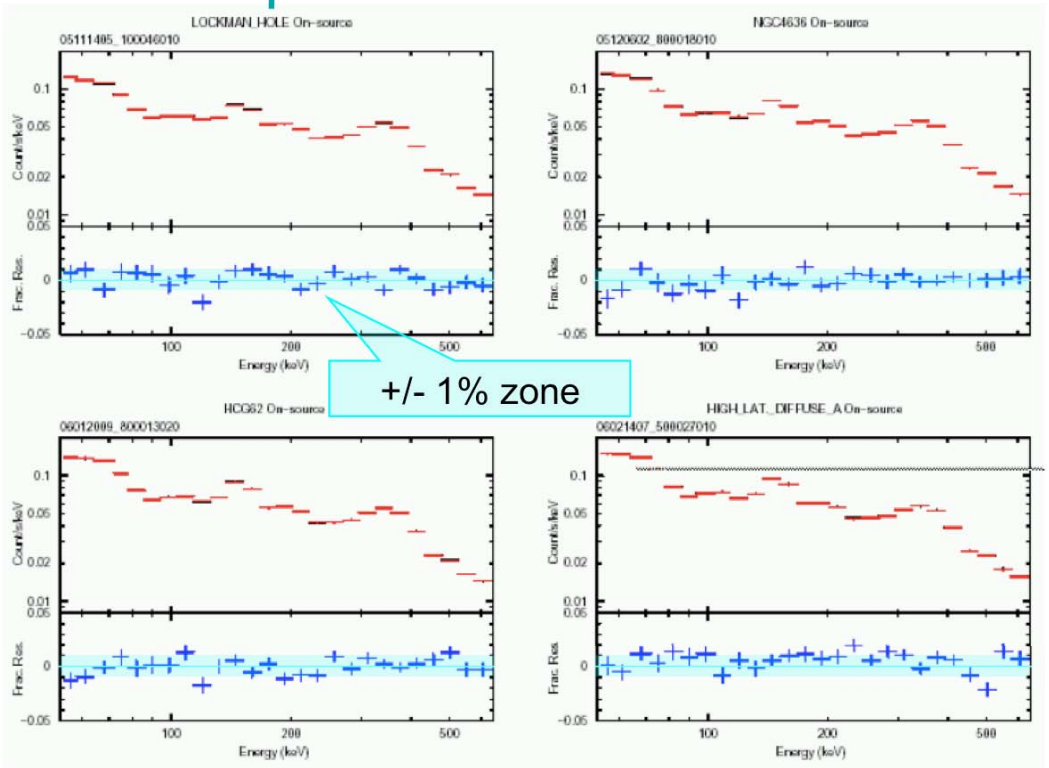
From Fukazawa+09, PASJ 61 , Mizuno et al. Cal document 2008.

2-4: NXB *revisited* (GSO)

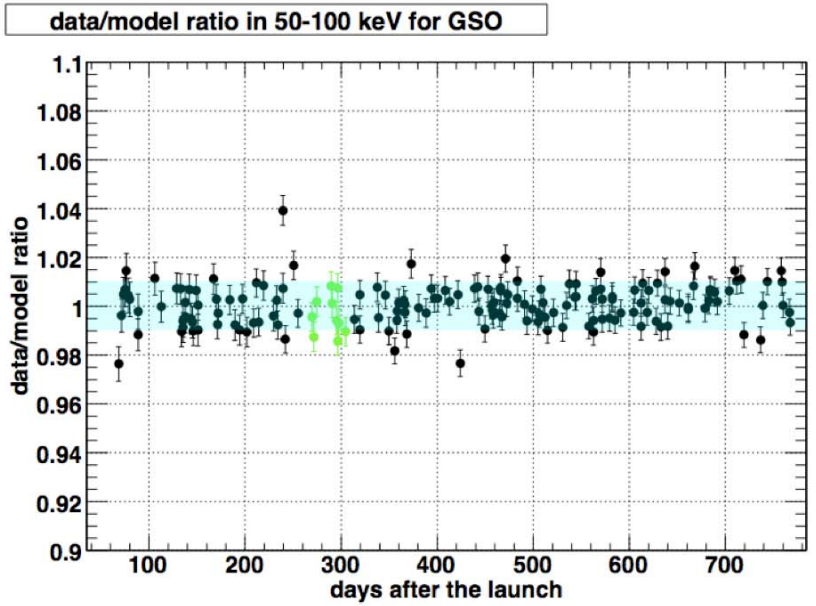
not new
still good

Only “tuned (LDFITDT)” NXB is provided

Example Data/NXB model ratio



Long term stability (50-100 keV)



GSO NXB reliable on 0.8% (1σ) sys-error

From Fukazawa+09, PASJ 61 and Suzaku web GSO bgd page

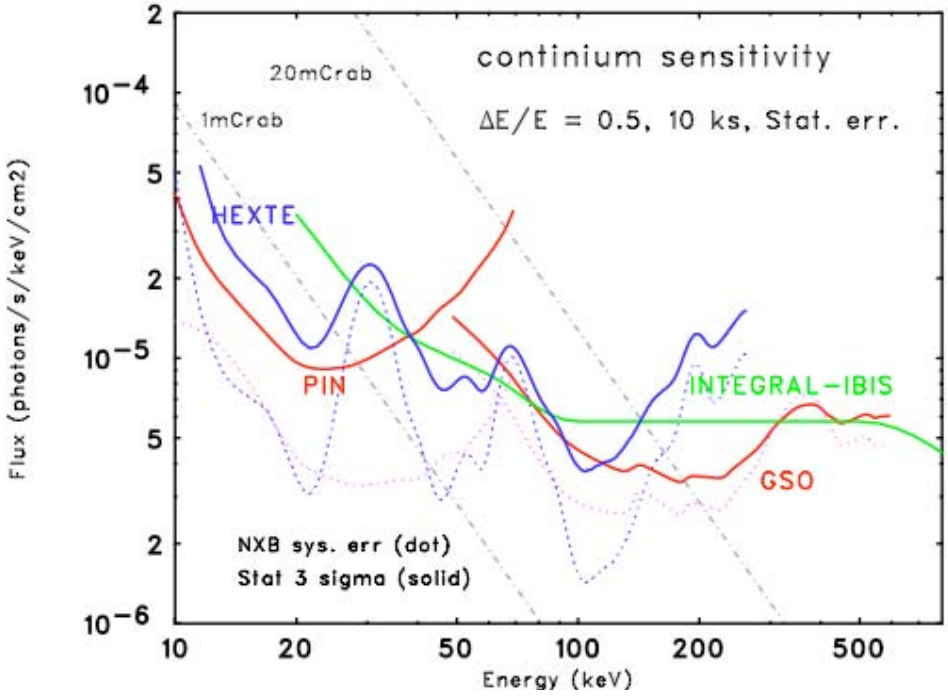
HXD, figure of merits, with these NXBs

What means <1% sys. err?

Calculated Sensitivity for point source (10 ks exp.)

With relatively short (~10 ks) exposure, not only HXD-PIN, but also HXD-GSO provides highest sensitivity

>> a tool for *variability*



The HXD is 4 times faster than Integral at 200 keV for 20 mCrab source, and 4 times faster than the RXTE-HXTE at 30 keV for 1 mCrab source.

From Fukazawa+09, PASJ 61 and Suzaku web GSO bgd page

2-5: Calibration Updates (2009)

Error Budgets of Scientific Instrument Calibrations

	Calibration Item	Oct 2008	Requirement	Goal
HXD	Absolute effective area	20%	20%	5%
	Relative effective area	10%	10%	5%
	Vignetting	5%	10%	5%
	Background modeling (PIN) [g]	$3 \sim 5$%	10%	1%
	Background modeling (GSO) [g]	$1.5 \sim 2$%	10%	3%
	Absolute timing [h]	300 μs	300 μs	100 μs
	Relative timing [h]	1.9×10^{-9}	10^{-8}	10^{-10}
	GRB absolute timing	$\sim$2ms	10ms	1ms

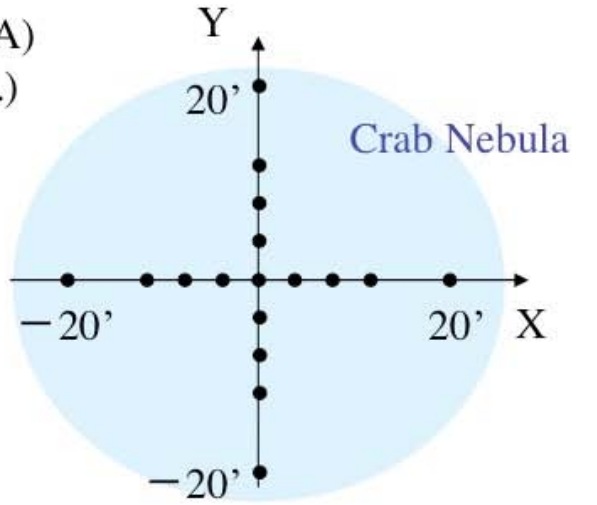
3: Comments on Analysis

3-1: "*hxdarfgen*" ready from 2007

HXD alignment calibration

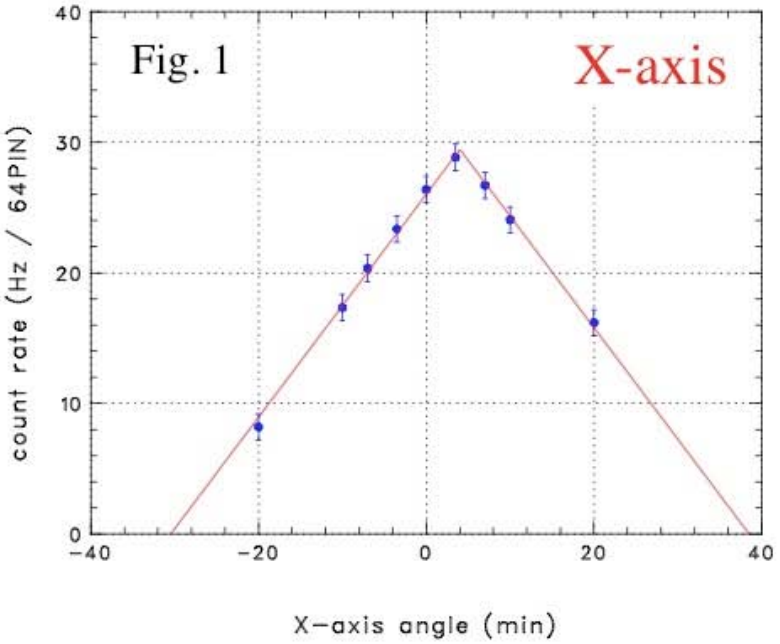
2005/09/03

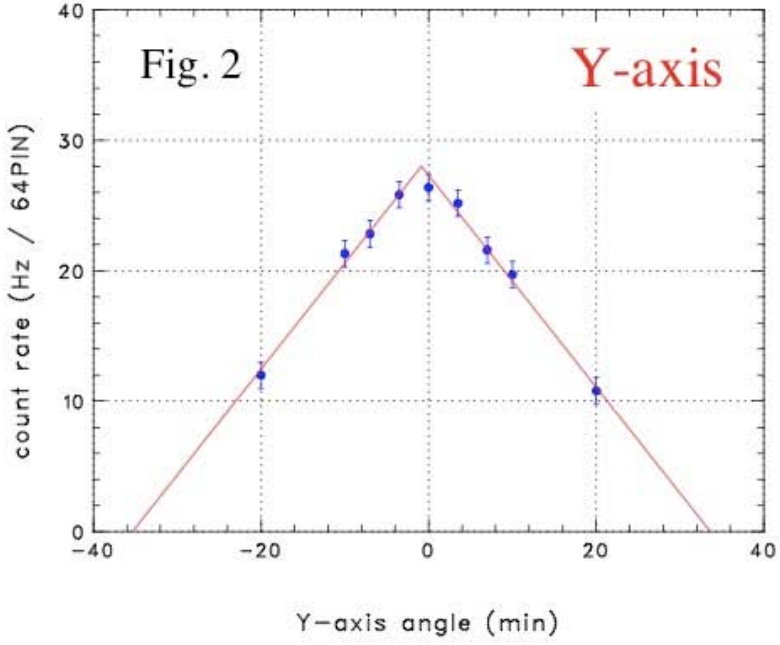
Ken-ichi Tamura, Kazuhiro Nakazawa (ISAS / JAXA)
Naomi Kawano, Ayumi Hirasawa (Hiroshima Univ.)



Note:
combine "hxdnominal response" with arf from *hxdarfgen*

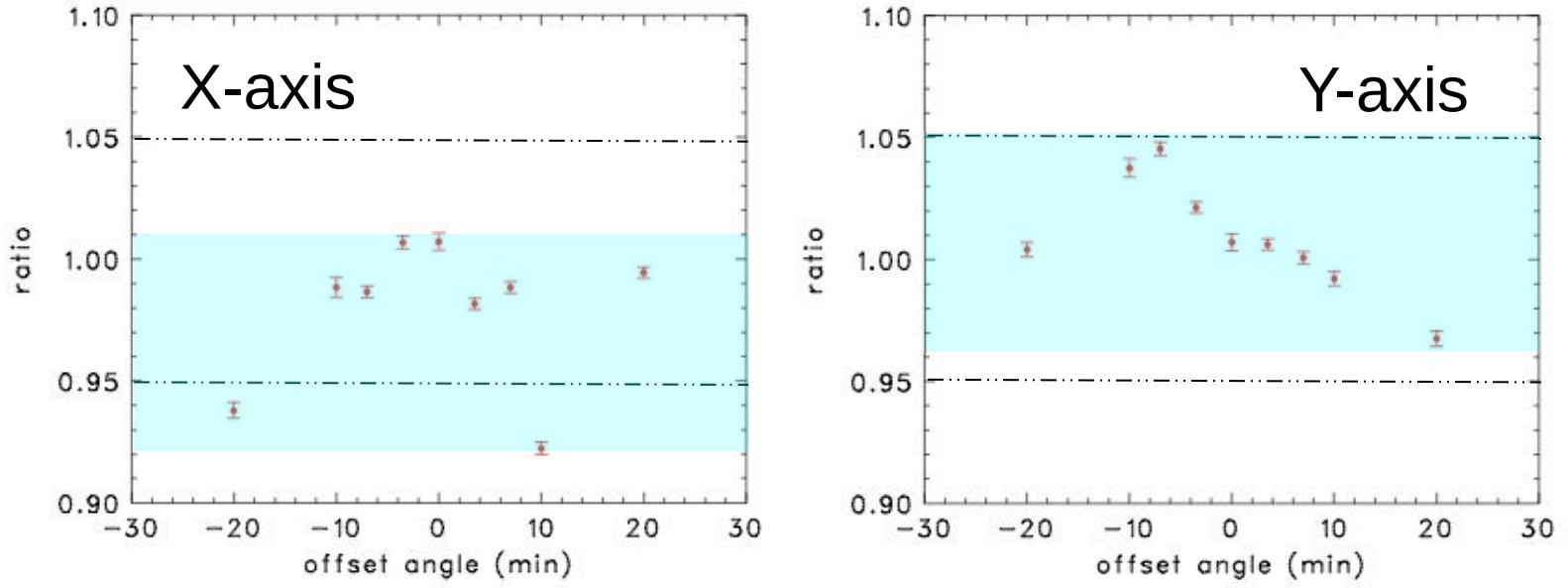
e.g. ae_hxd_pinhxnome?_20YYMMDD.rsp





3-1: "*hxdarfgen*" ready from 2007

Crab scan observation vs "*hxdarfgen*" prediction



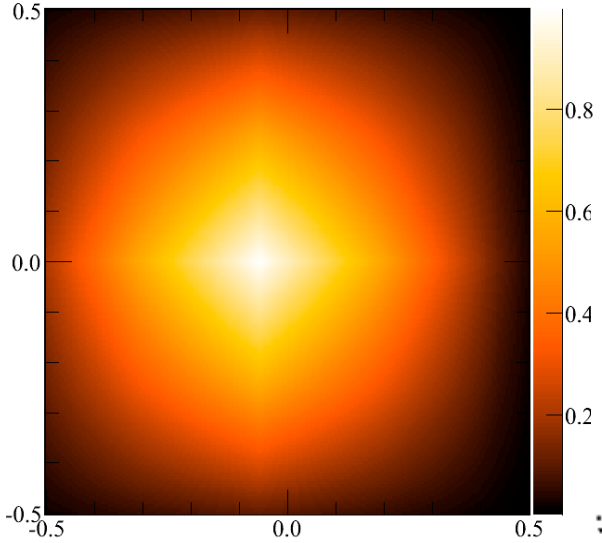
"*hxdarfgen*" is accurate within 9% pk-pk over +/- 20 arcmin

Notes: GSO angular arf from *hxdarfgen* is not well calibrated yet. Since scattering is non-negligible, not easy and not recommended. (Existing "GSO arf" is for response fudge correction at the two aimpoints)

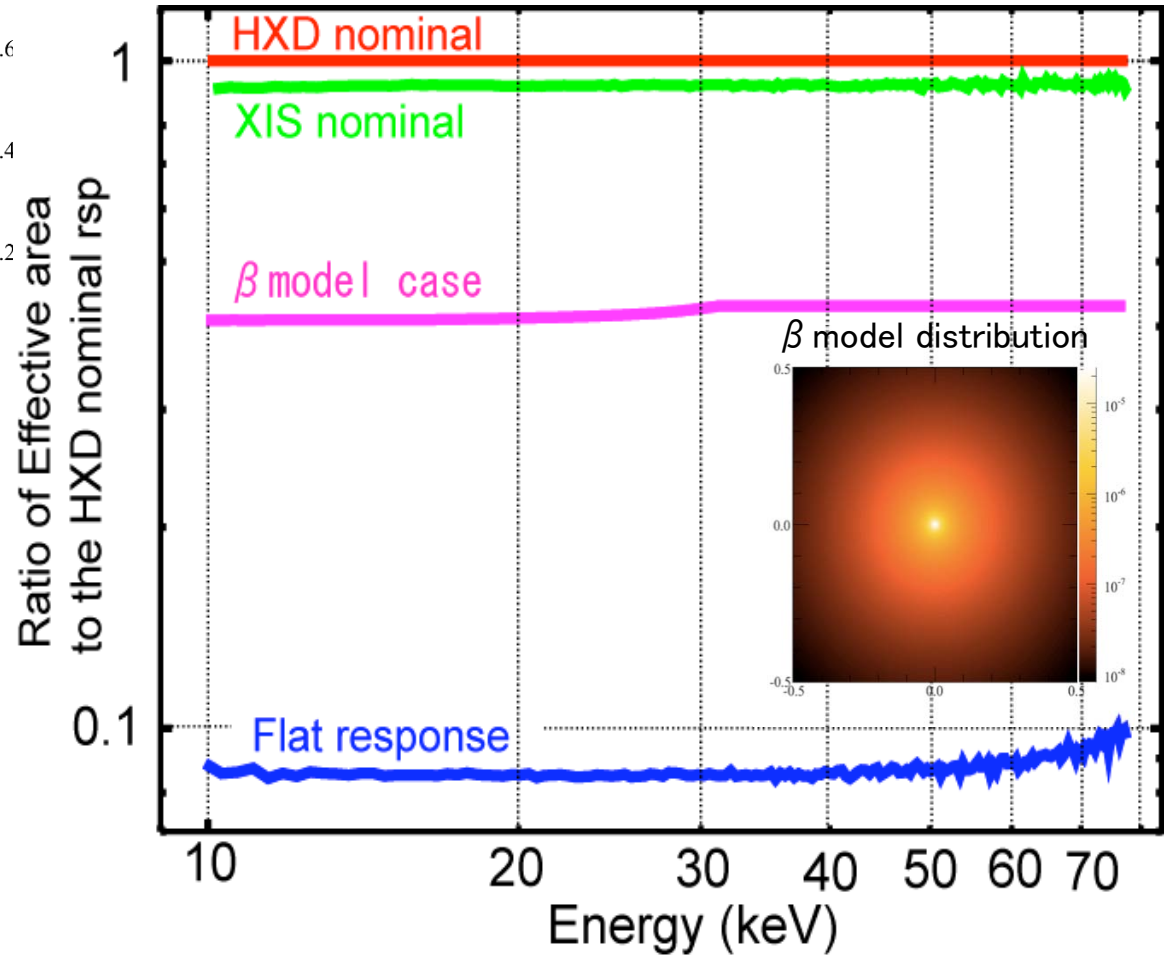
3-2: Diffuse source

HXD arf: correction factor to the HXD nominal rsp
Produced by ***hxdarfgen***
Not support an image input → Please add arfs by yourself

Angular response of PIN



diffuse arf(PI) = Σ (arf(PI) x model) / Σ model



3-3: Simple comments on GSO analysis

Only 4+1 differences to PIN

rule of thumb

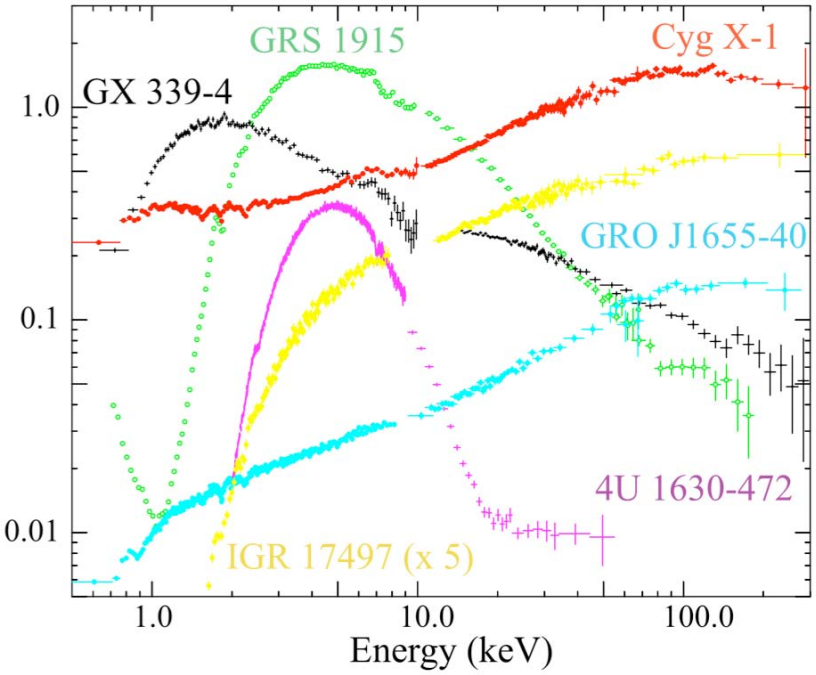
1: reprocess needed (long-term gain correction with good stat.).

2: NXB has the same exposure to the data (in PIN, is x10),

3. data should have the same grouping as the NXB

4: use of “fudge arf” in analysis.

(5: *hxdarfgen gso-arf* not calibrated well. No problem for hxd/xis-nominal point-sources)

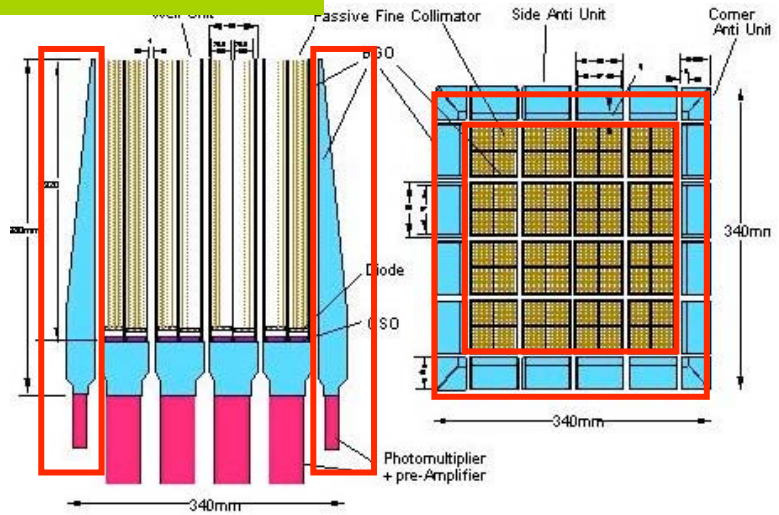


Please enjoy GSO spectra !!

3-4: WAM status

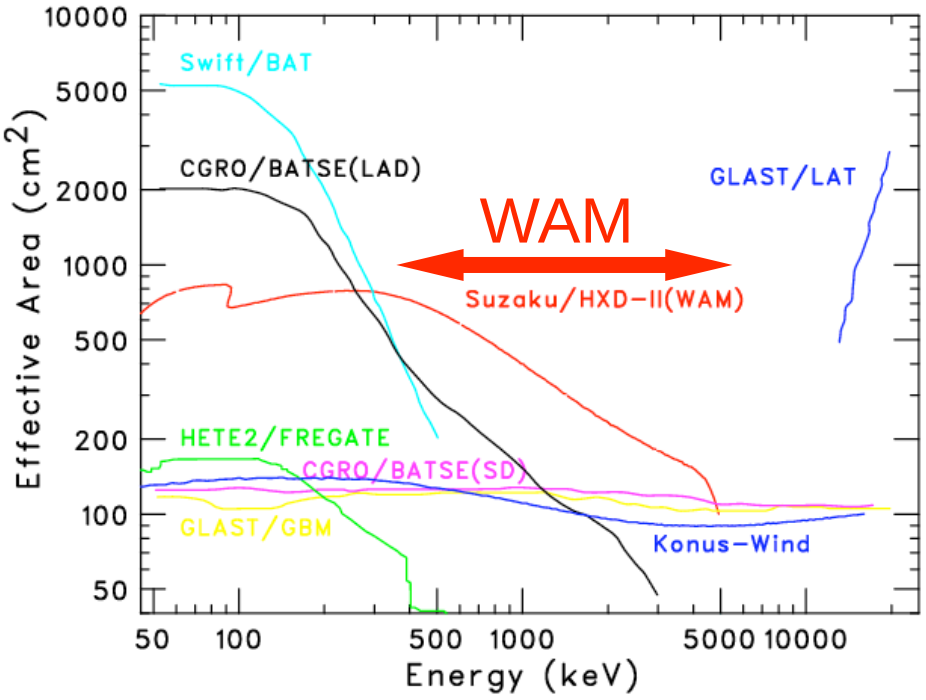
Not for proposal, but can be used via web

- Lateral large BGO shield of the HXD
- Work as not only a shield but also an all-sky monitor
- Scientific objectives: GRBs, SGRs, solar flares & blackhole candidates



The WAM key parameters

Energy range : 50-5000 keV
Field of view : ~2π
Geometrical area : 800 cm^2
Effective Area : 400 cm^2@1 MeV
Energy resolution: ~30%@662 keV
Time resolution : 1 s (TRN)
15.625 msec (BST)

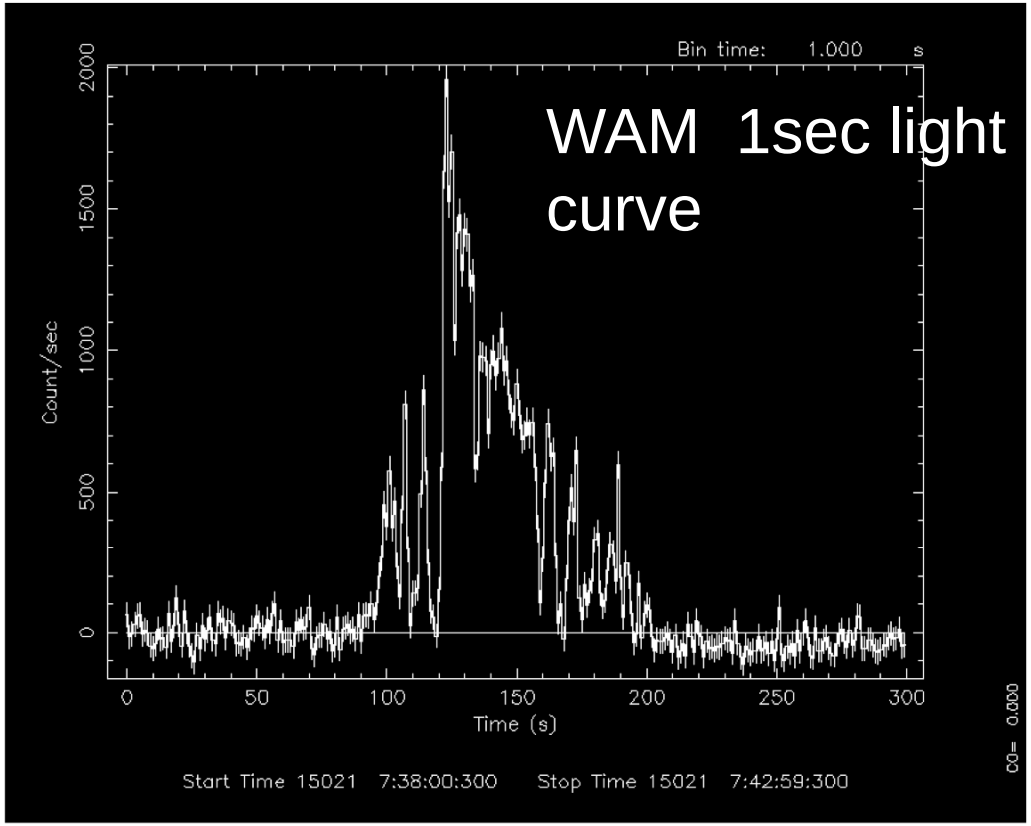


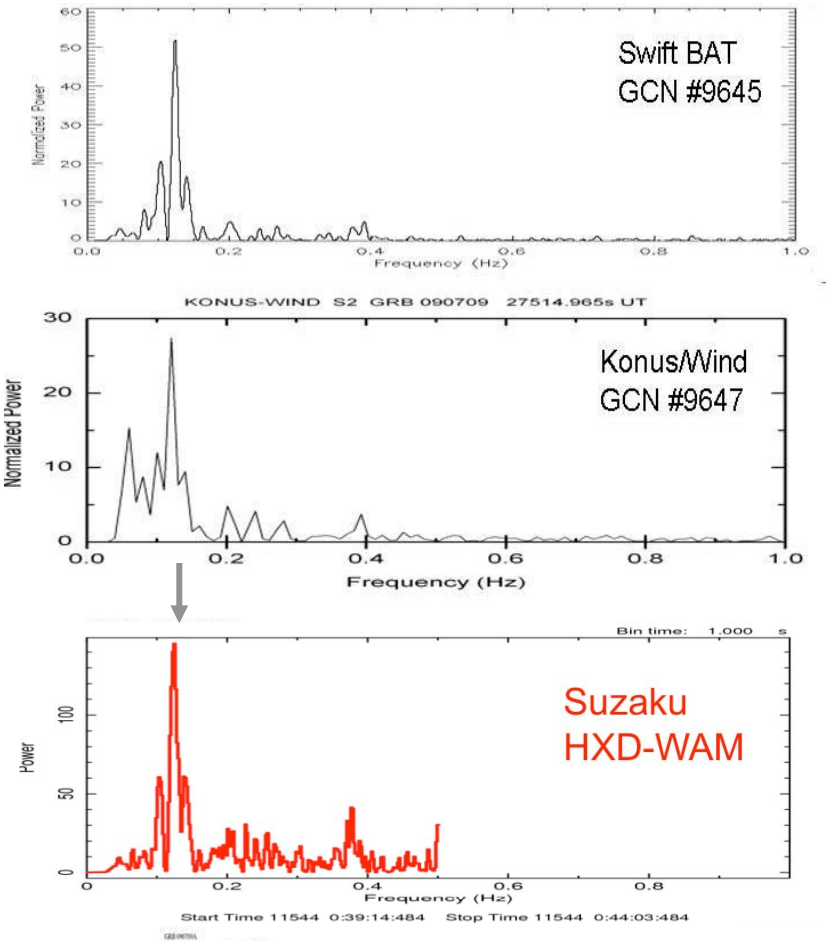
3-4: WAM status

- Suzaku XIS and HXD also observed X-ray afterglows of this burst (Nakagawa et al. GCN 9737)
- A QPO at 0.124 Hz is found in its power spectrum.

→ SGR ? but X-ray afterglow properties are typical as GRBs.

GRB 090709A





3-4: WAM status

Status of prompt emission observations

WAM event list from Aug. 2005
to Aug. 2009 (~ 4.1 years)

confirmed GRBs	600 (367)
possible GRBs	350 (158)
SGR/AXP	378 (15)
Solar flare	172 (28)

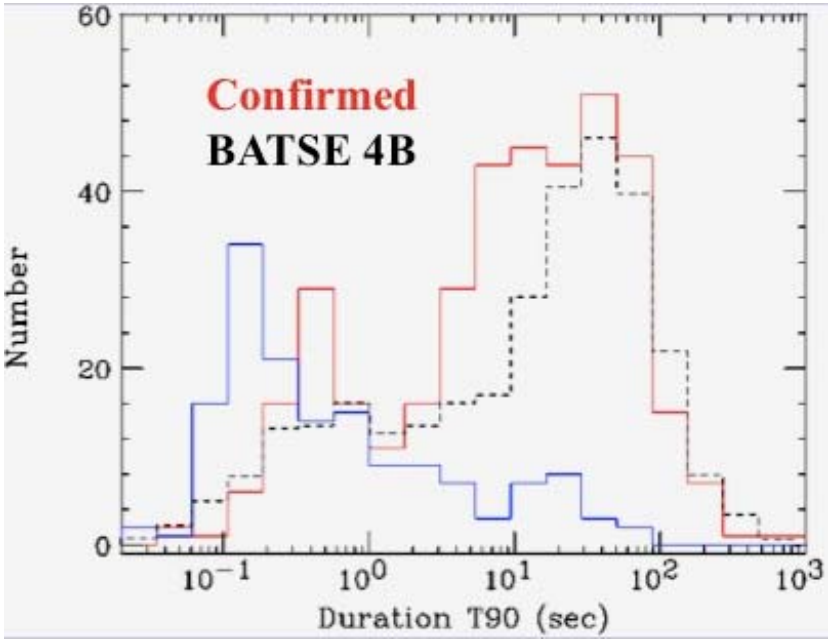
(): triggered event

~150 GRBs per year !

125 GCN circulars

- 91 WAM spectral analysis
- 26 IPN localizations

T90 distribution



3-4: WAM status

- WAM Web site:

  http://www.astro.isas.jaxa.jp/suzaku/HXD-WAM/WAM-GRB
- Light curve data are already publicly available, and response matrices and spectra for some GRBs will be available within this year.
- The software package related with WAM data analysis are already included in current version of FTOOLS.
- Contact: suzaku-wam@astro.isas.jaxa.jp