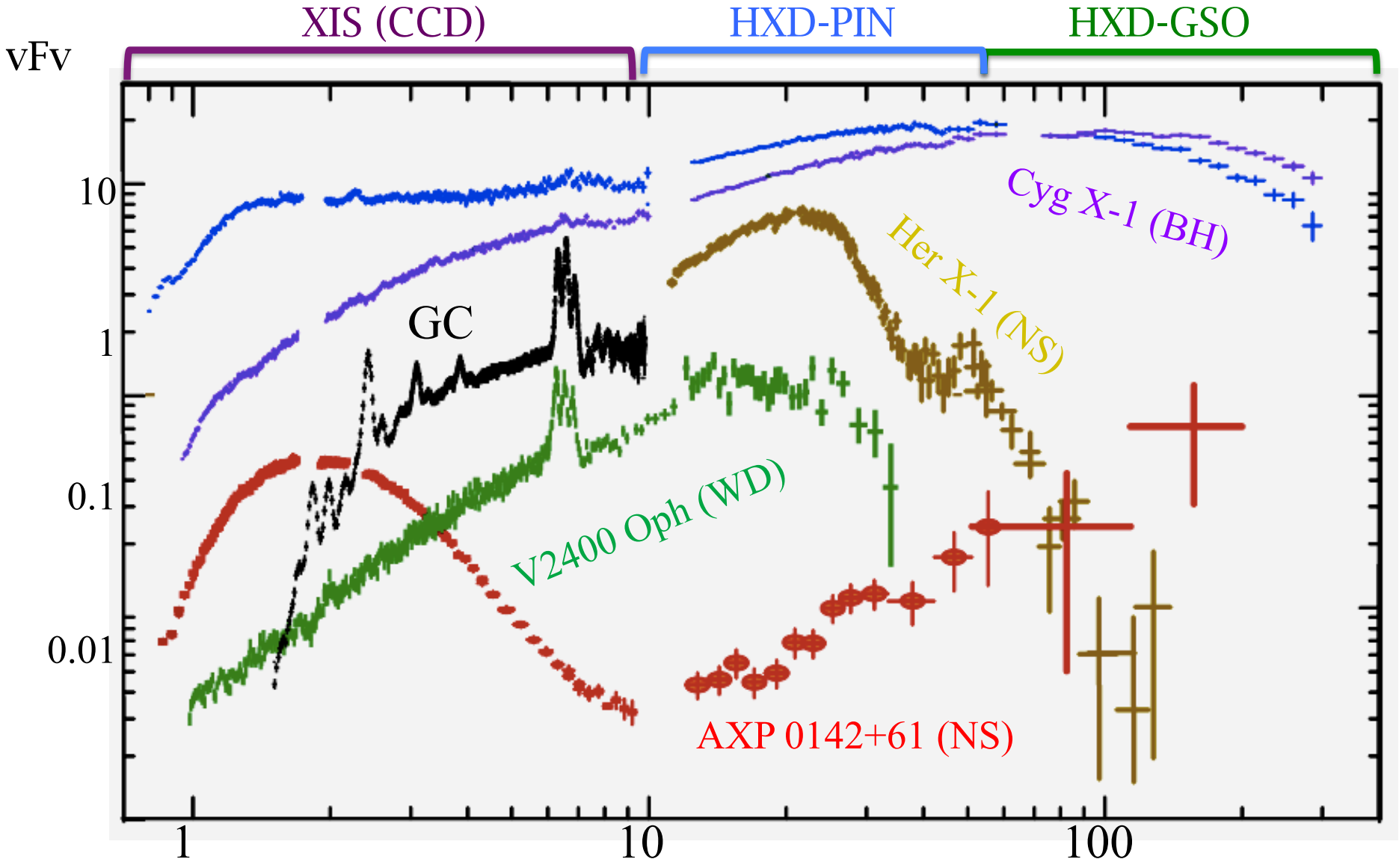
Status report of the Hard X-ray Detector

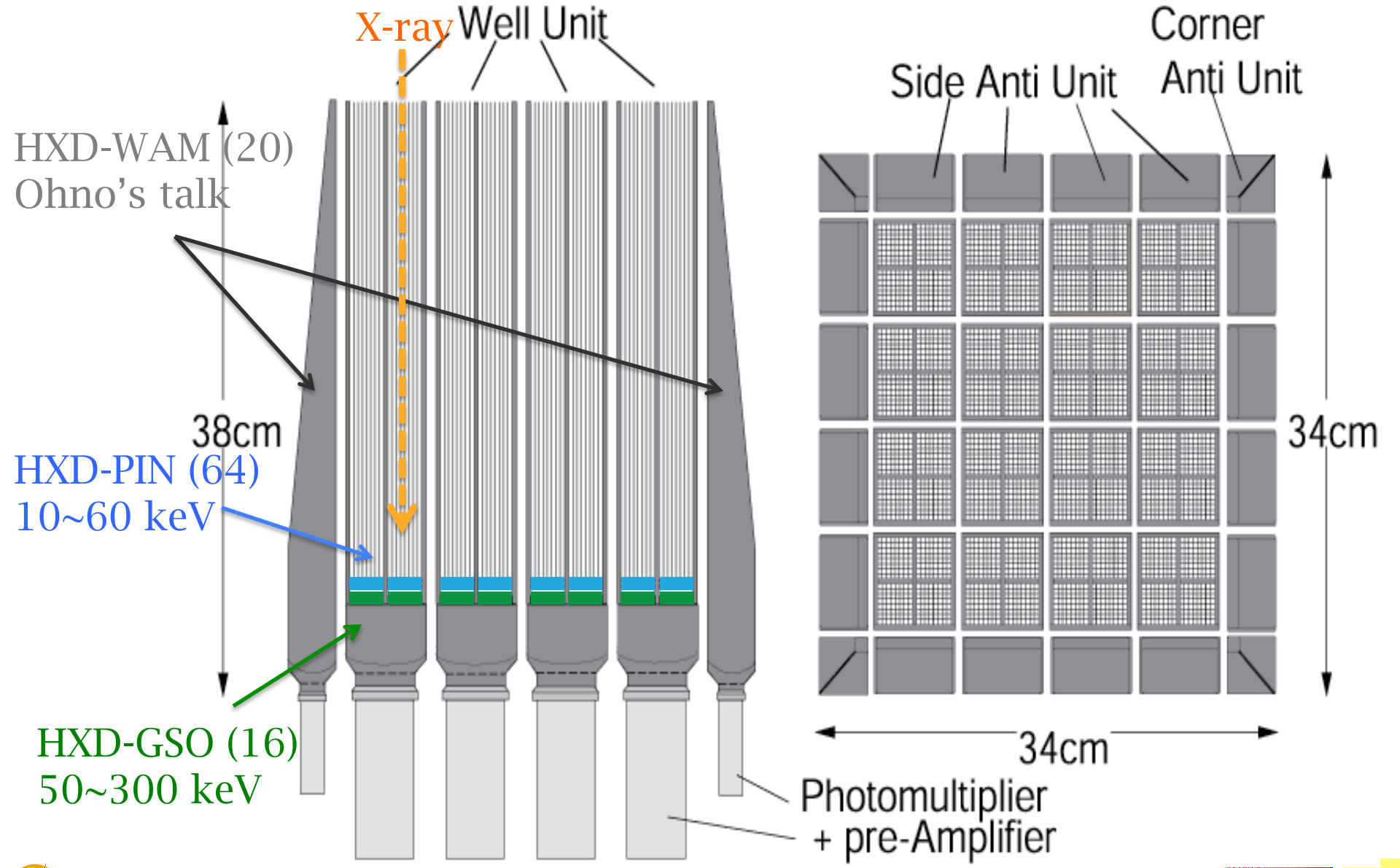
Shinya Yamada, RIKEN
on behalf of the HXD team

Wide-band Spectra of *Suzaku*

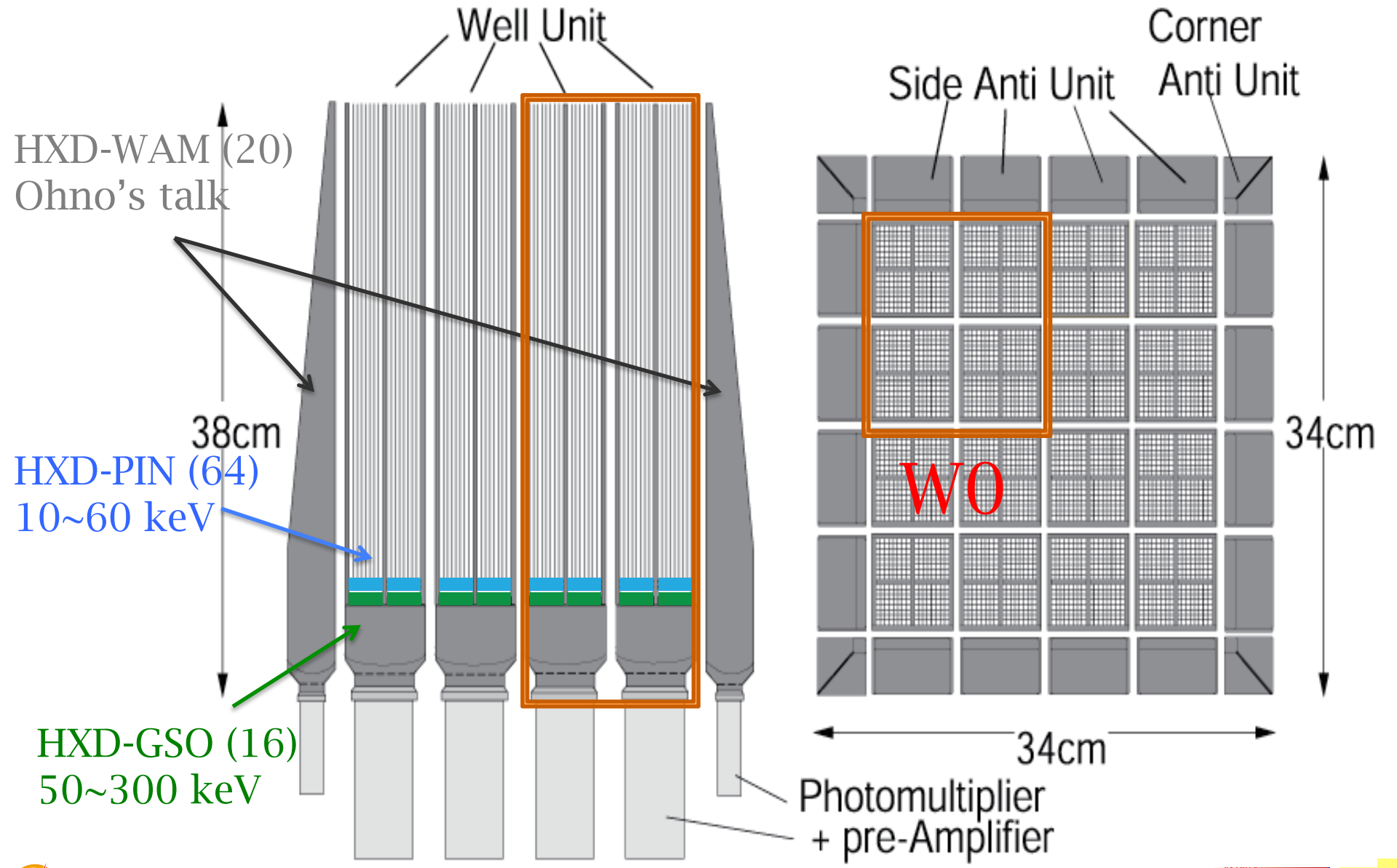


(from Max's presen)

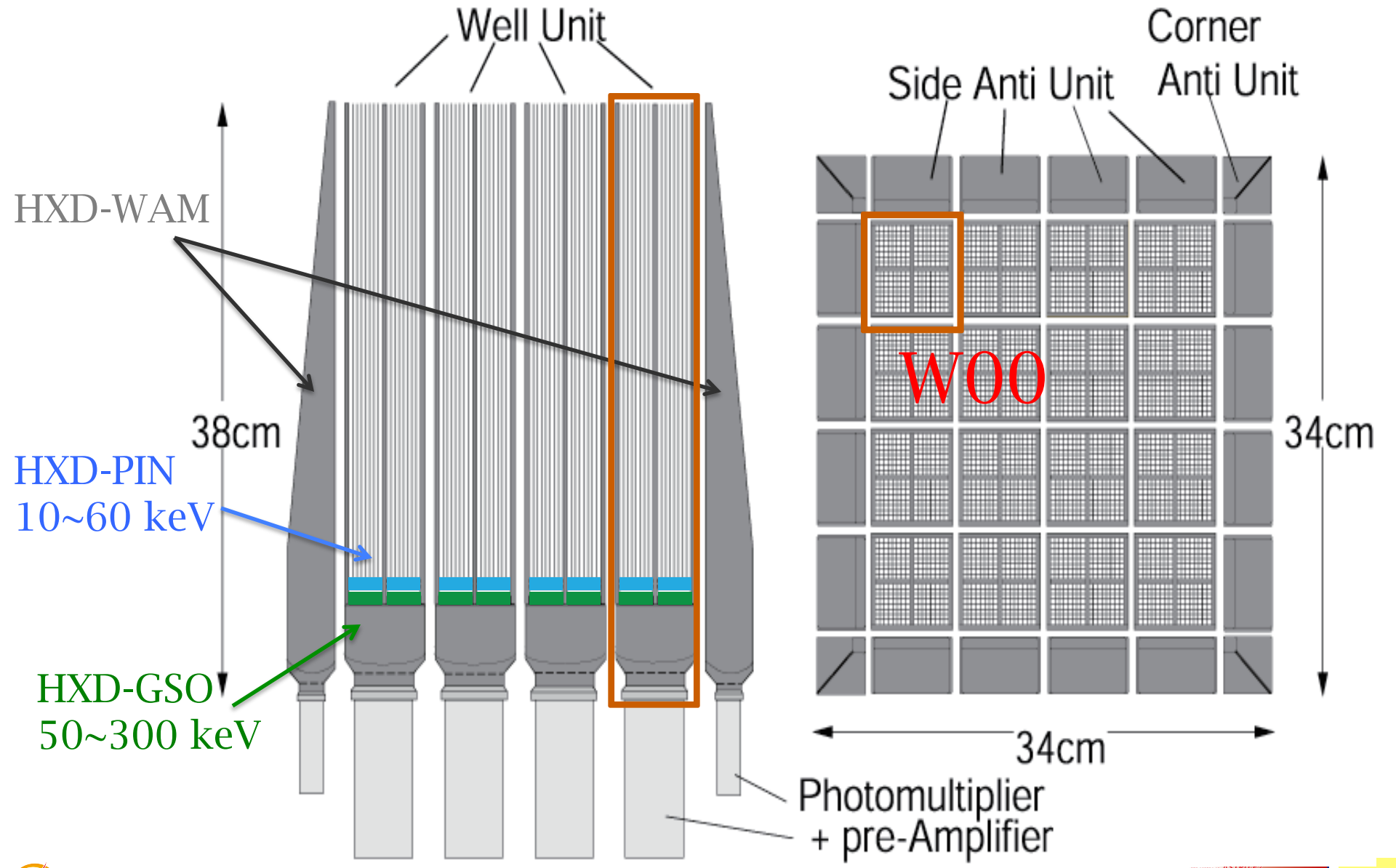
Overview of Hard X-ray Detector (HXD)



Overview of Hard X-ray Detector (HXD)



Overview of Hard X-ray Detector (HXD)



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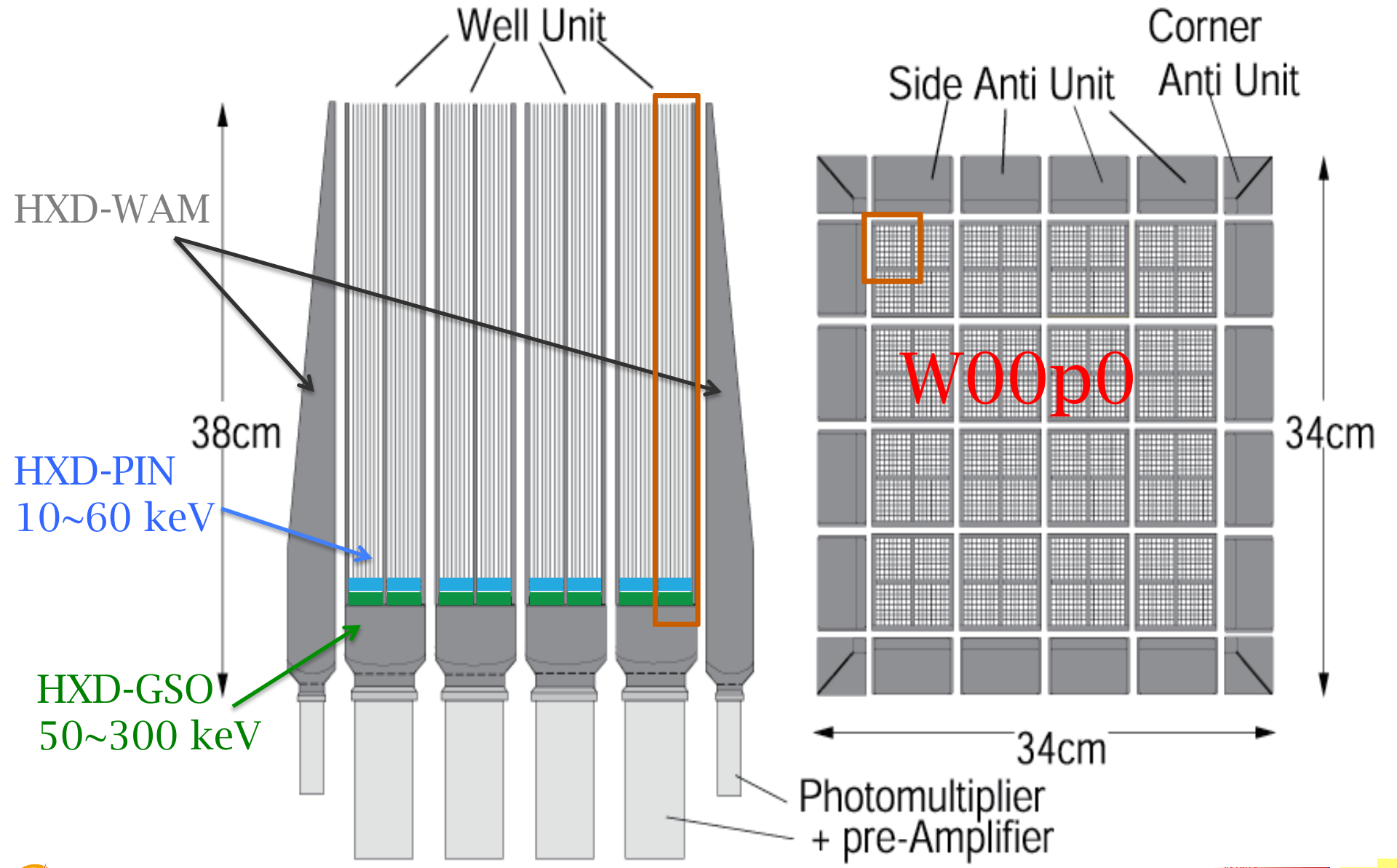


Status of the HXD

- Overview ~ all 116 sensors working well ~
  - PIN (64 units)
    - taking measures for increase in thermal noise.
  - GSO (16 units)
    - energy scale improved
    - gain history updated
    - responses updated
    - detailed analysis of Crab spectra (Kozu's poster)
  - BGO (16 units)
    - working properly.
  - WAM(20)
    - working properly (Ohno's talk)

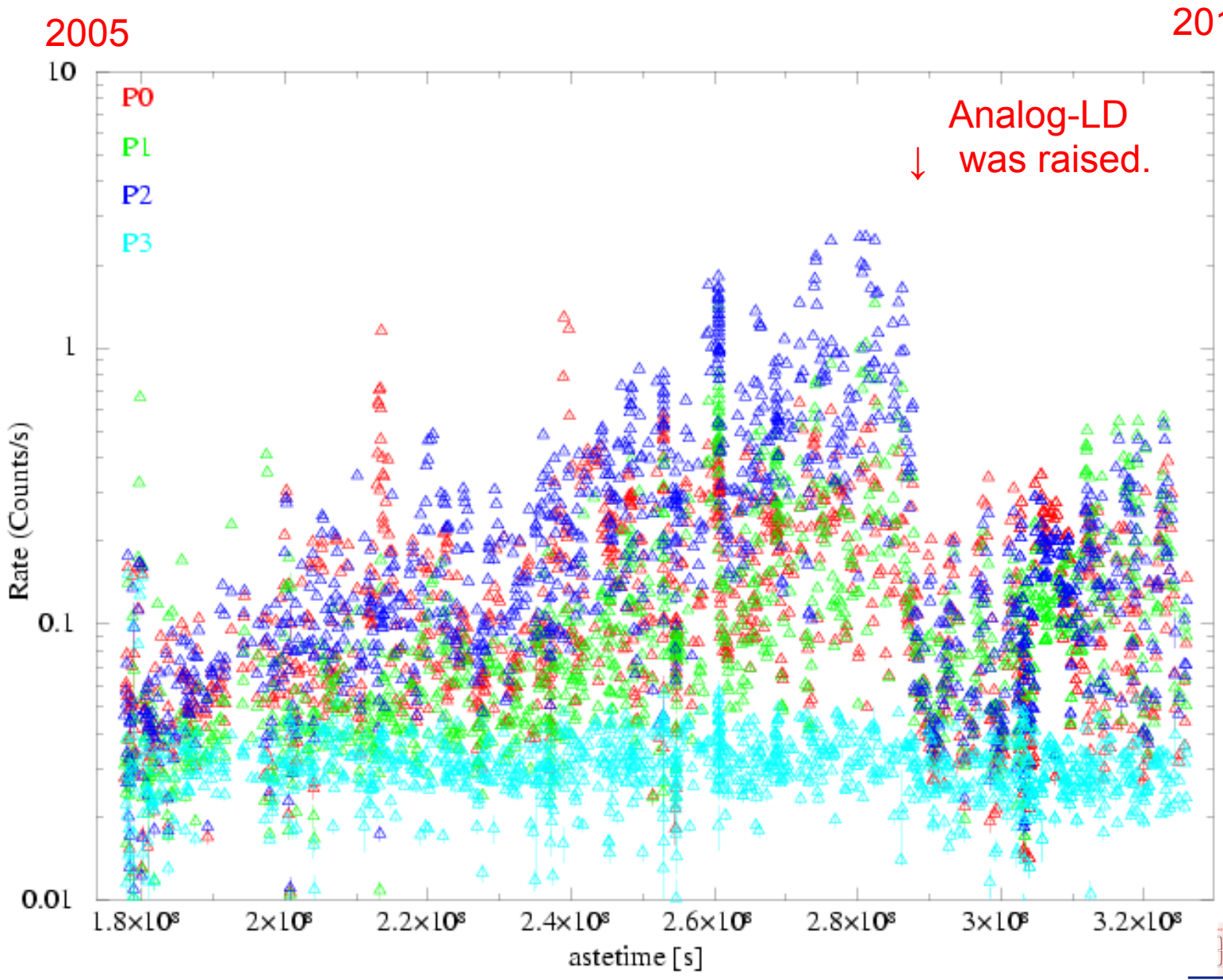
Operations for HXD since June of 2009

- 2009, Sep. 13
  - Count rate of HXD W01p3 suddenly flares up.
    - calmed down spontaneously.
- 2010, Jan. 16
  - need to reduce FIFO-full and buffer flush in W3
    - W3 PIN analog LD was increased.
    - PIN response epoch 7
  - need to reduce buffer flush in W21p1
    - in-orbit software LD was increased.
- 2010, Feb. 2
  - need to reduce FIFO-full and buffer flush in W2
    - W2 PIN analog LD was increased.
    - PIN response epoch 8
- 2010, Apr. 3
  - need to reduce FIFO-full and buffer flush in W0
    - W0 PIN analog LD was increased.
    - PIN response epoch 9
- 2010, Dec. 16
  - LD cut in on-board DE (CPU) were increased for most of PIN.
    - no effects for analysis
- 2011, May 25
  - Need to reduce FIFO-full and buffer flush in W1 and W3
    - W1 and W3 PIN analog LD was increased.
    - PIN response epoch 11

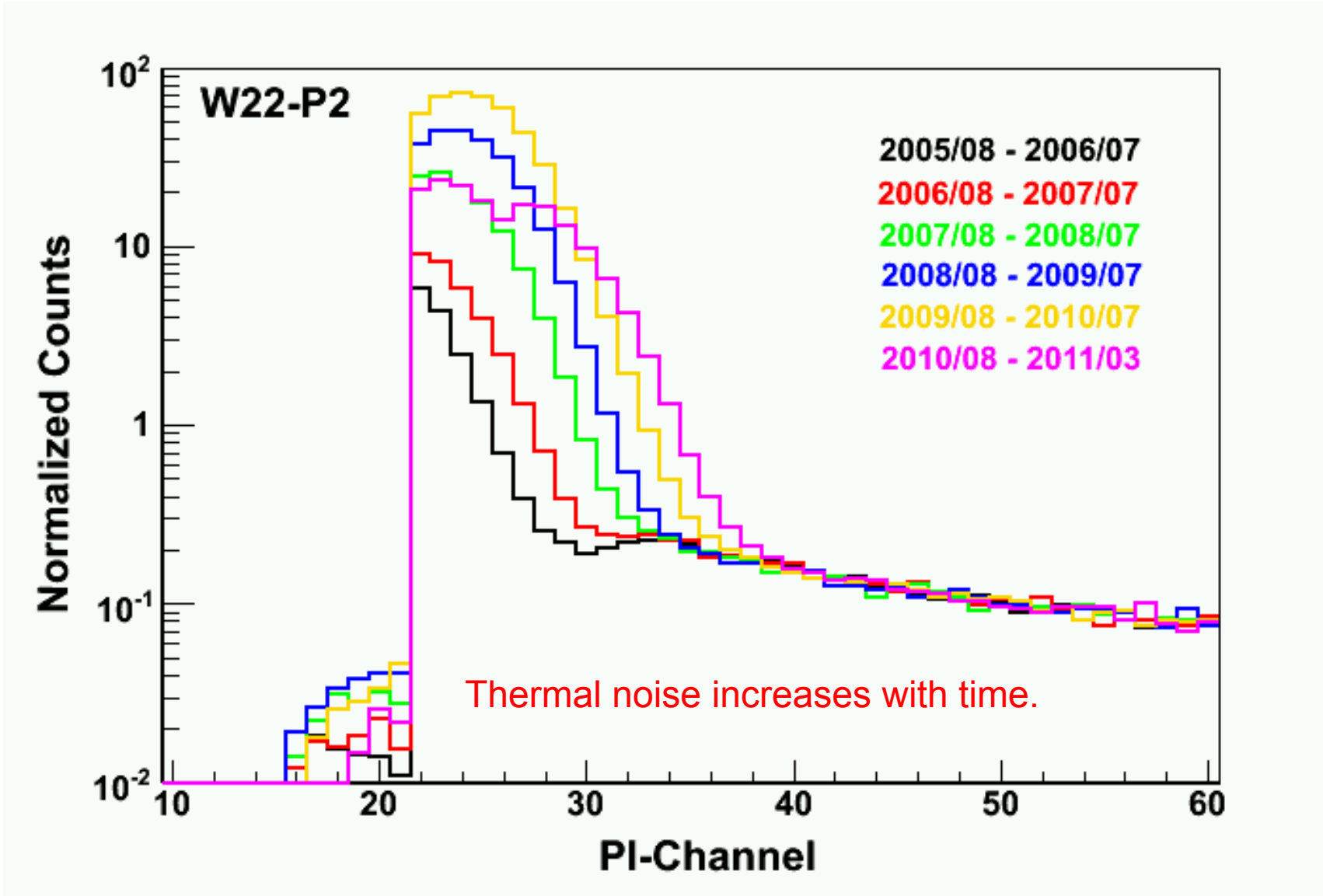
Calibration of HXD-PIN

Sho Nishino (Hiroshima U.)+, 2010, SPIE

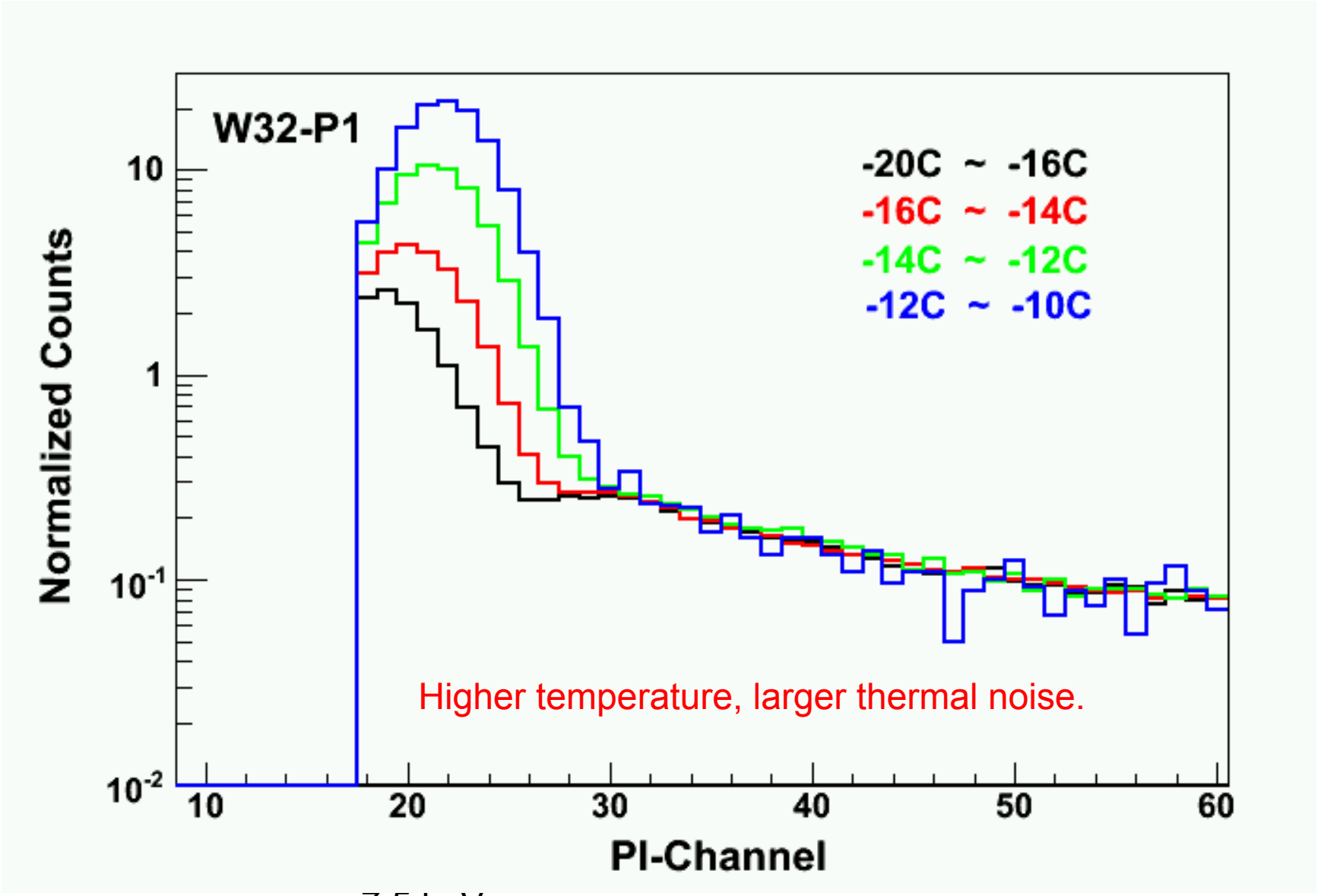
Long-term count rates trend of 4 PINs in W32



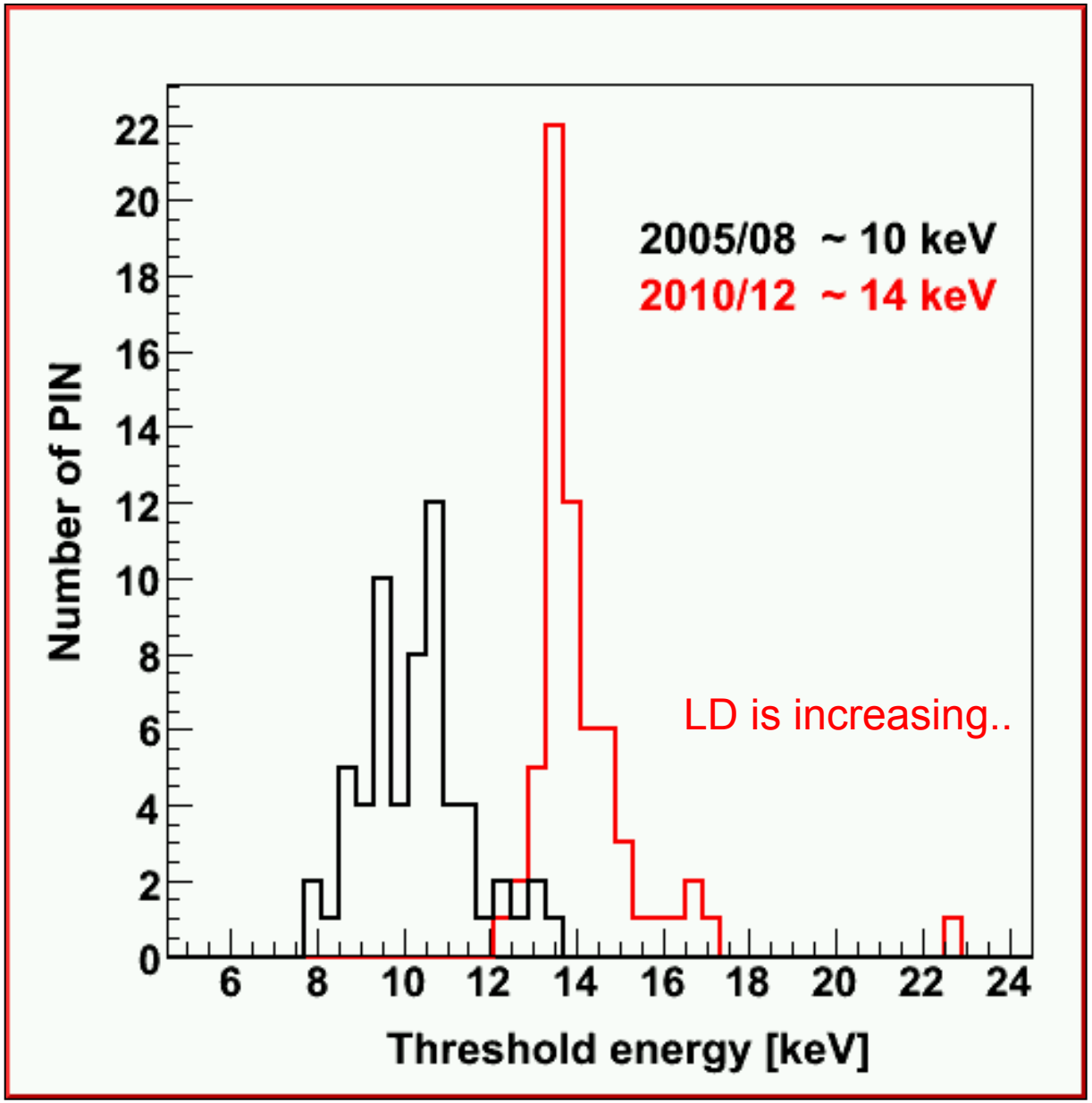
Long-term spectral variation of W22P2



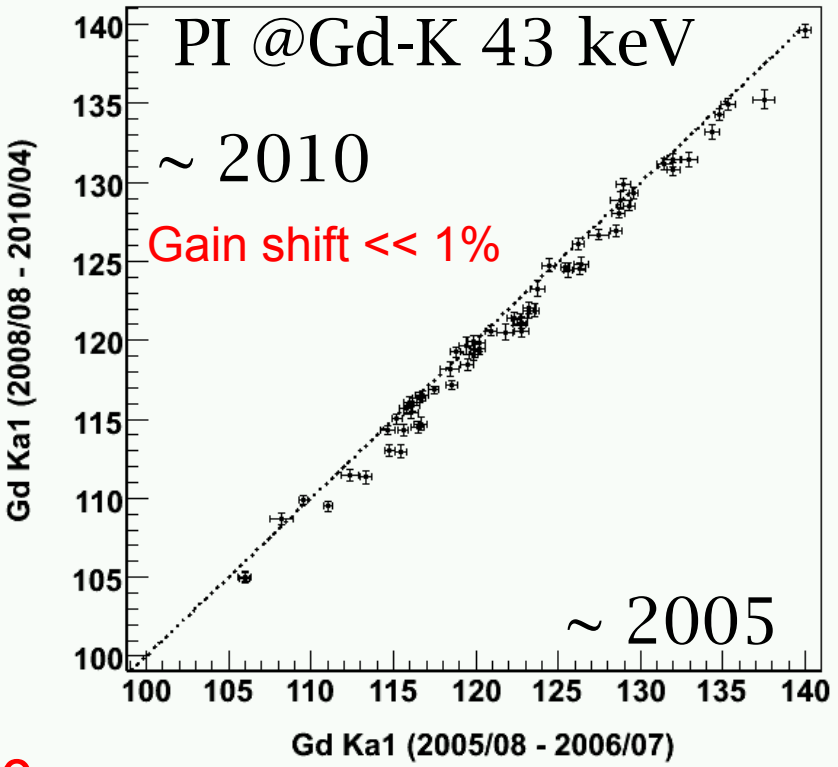
Temperature-sorted spectra of W32P1



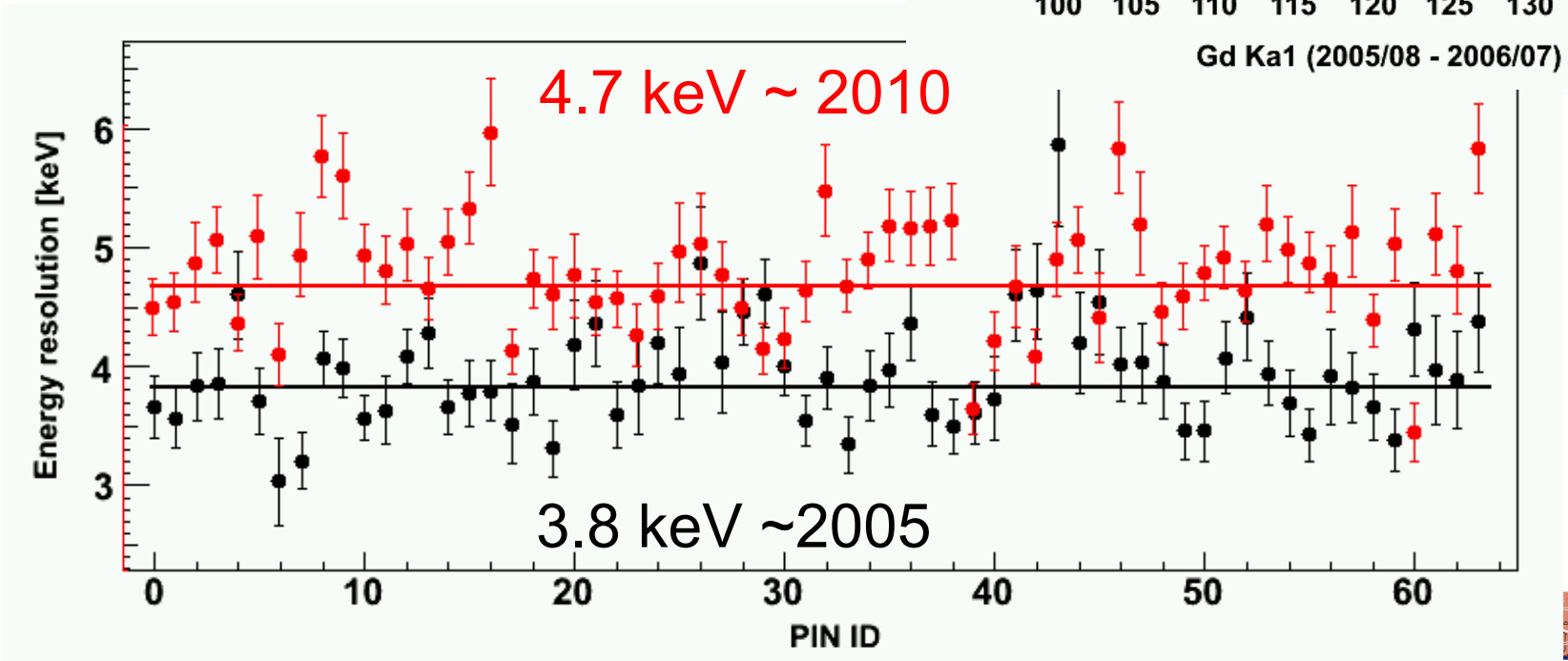
LD distribution for 64 PINs



Gain & Energy resolution of 64 PINs



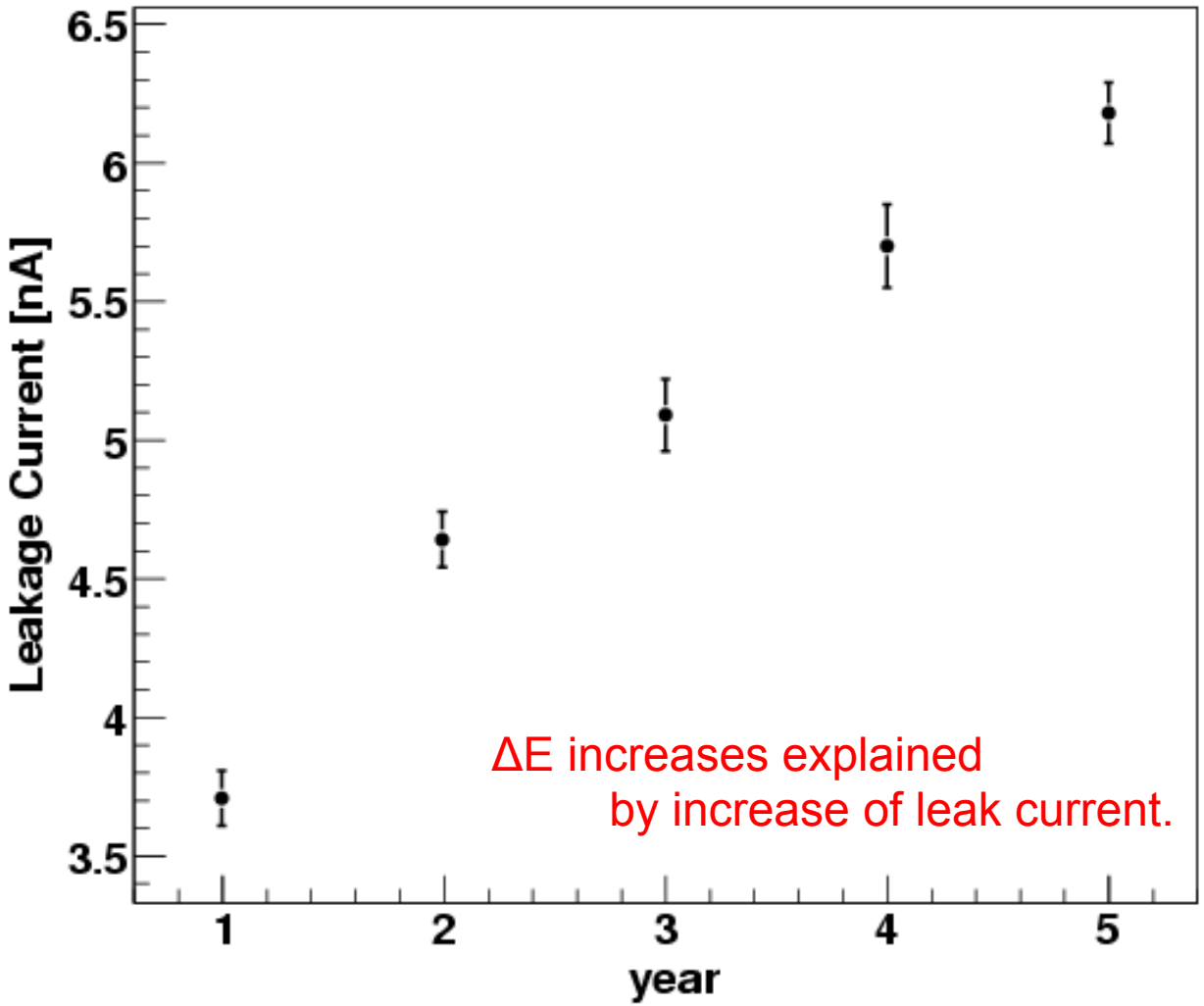
ΔE @Gd-K 43 keV



The Leakage Currents of PIN

Leak current

$$\Delta E = \sqrt{\left(2qI_L + \frac{4k_BT}{R_p}\right)\alpha\tau_s + \left(A\frac{4k_BT}{g_m}C_{in}^2\right)\beta\frac{1}{\tau_s} + \left(2\pi\alpha_f C_{in}^2 + \frac{b_f}{2\pi}\right)\gamma}$$



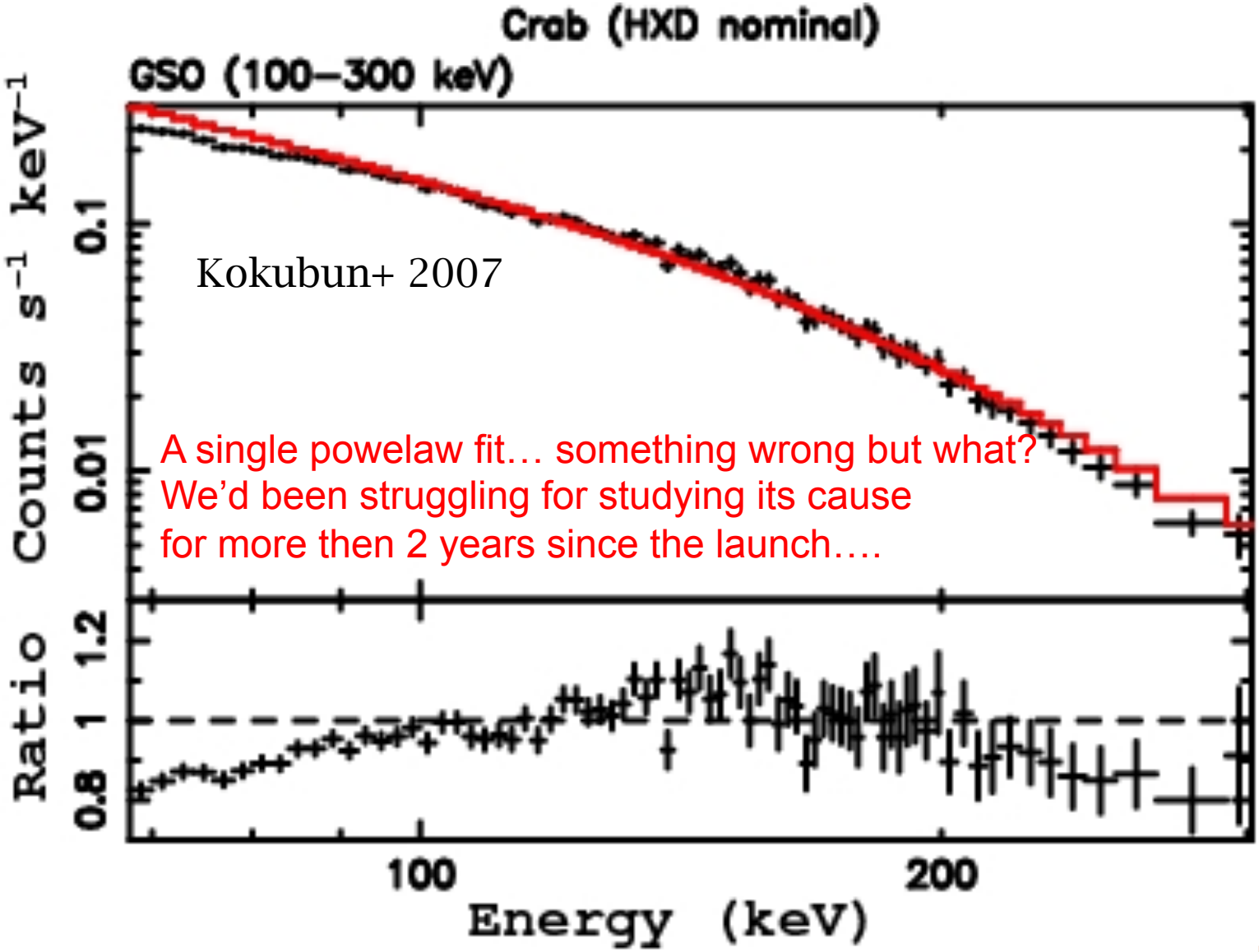
Mostly electronics unchanged

Sugizaki+97'
Sugiho Master thesis

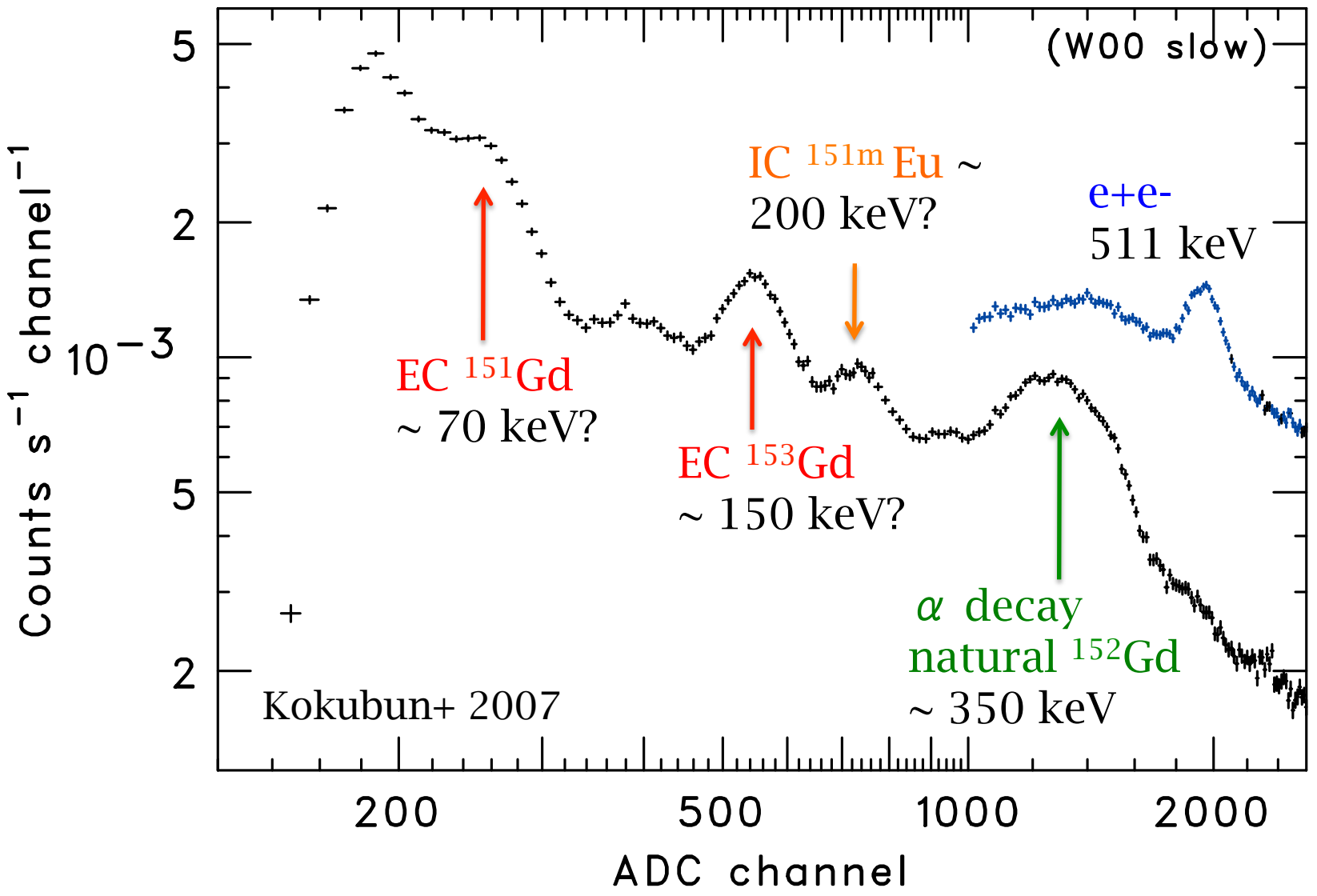
Calibration of HXD-GSO

Yamada, Makishima+, 2011, PASJ

Before calibration…



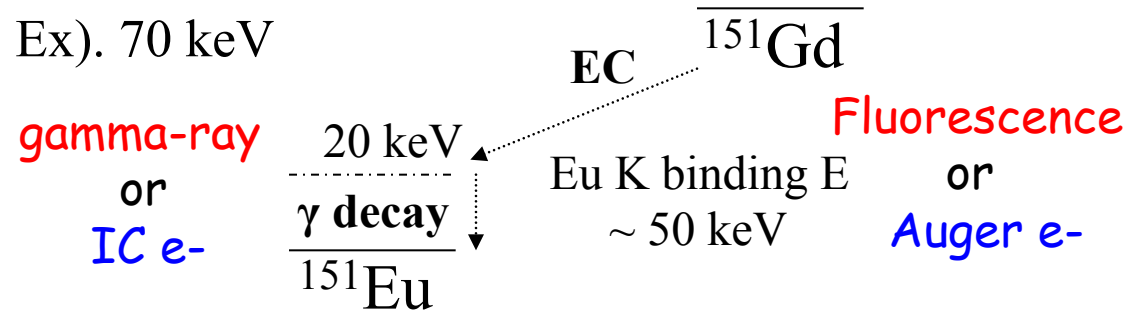
The Background Spectrum of HXD-GSO

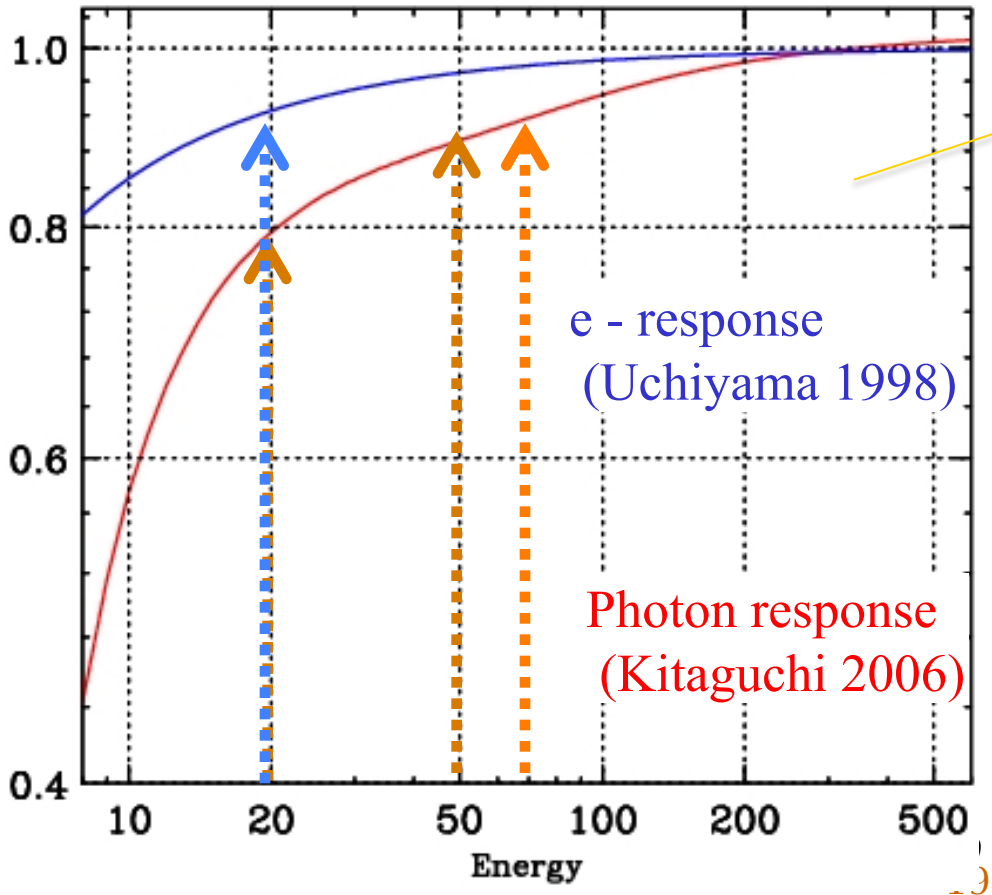


(1) The non-linear effect of light yields in GSO

Annihilation line
→ Single γ 511 keV
Activation lines
→ Multiple γ , e -

Ex). 70 keV

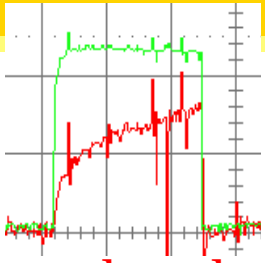




E vs. light yeilds relation in GSO

Several e- or γ reduces light yeilds, considering all decay probability, The correct energy are,

"70 keV" lowered by ~6 %,
"150 keV" by ~ 5%,
"196 keV" by ~ 3 %



(2) The Analog Offset (so-called pedestal) Shift

Satellite Power, Aug. 2004

Laboratory Power June, 2004

Satellite Power Aug. 2006 (In orbit)

Number of Well units

0 2 4 6 8

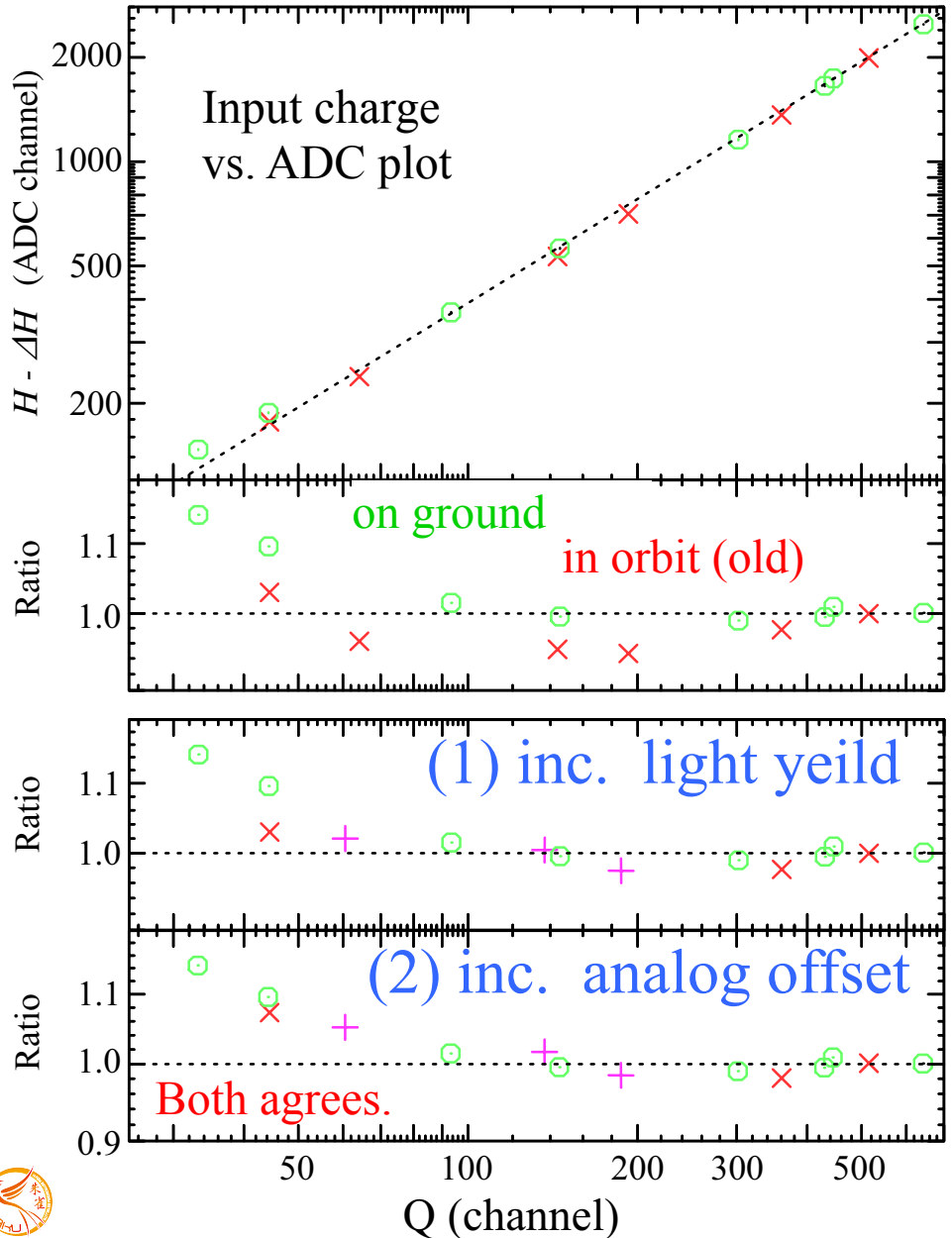
70 80 90

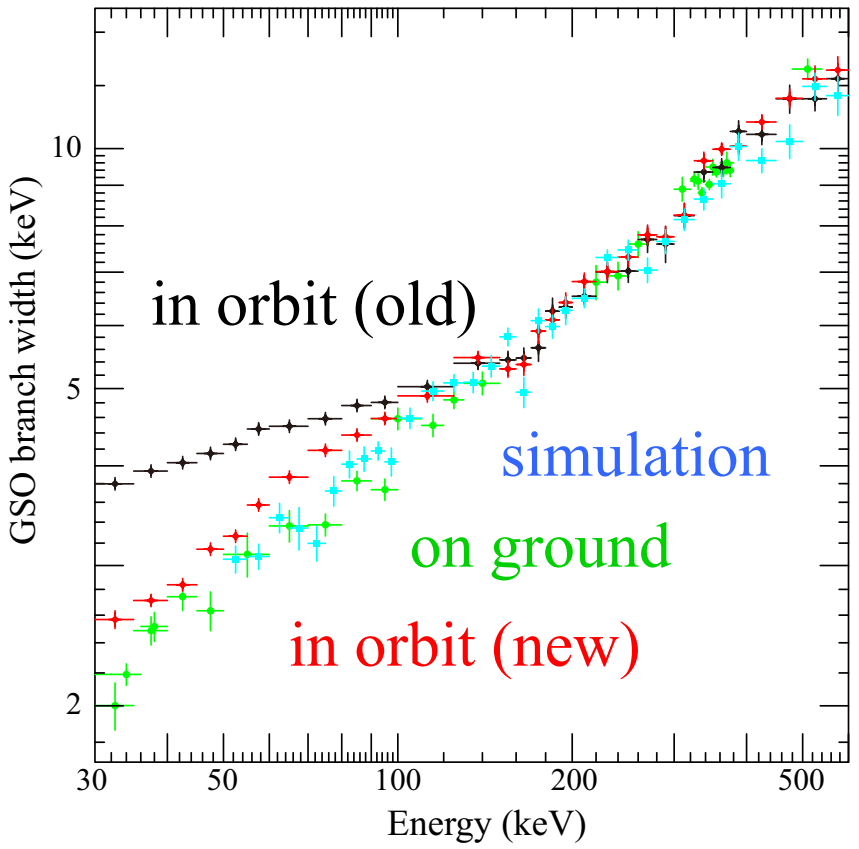
ADC channel

After using the satellite power, the analog offset changed by ~ 8 ch lower

cf. 8 ch << 4096 ch (the maximum ADC channels of GSO)

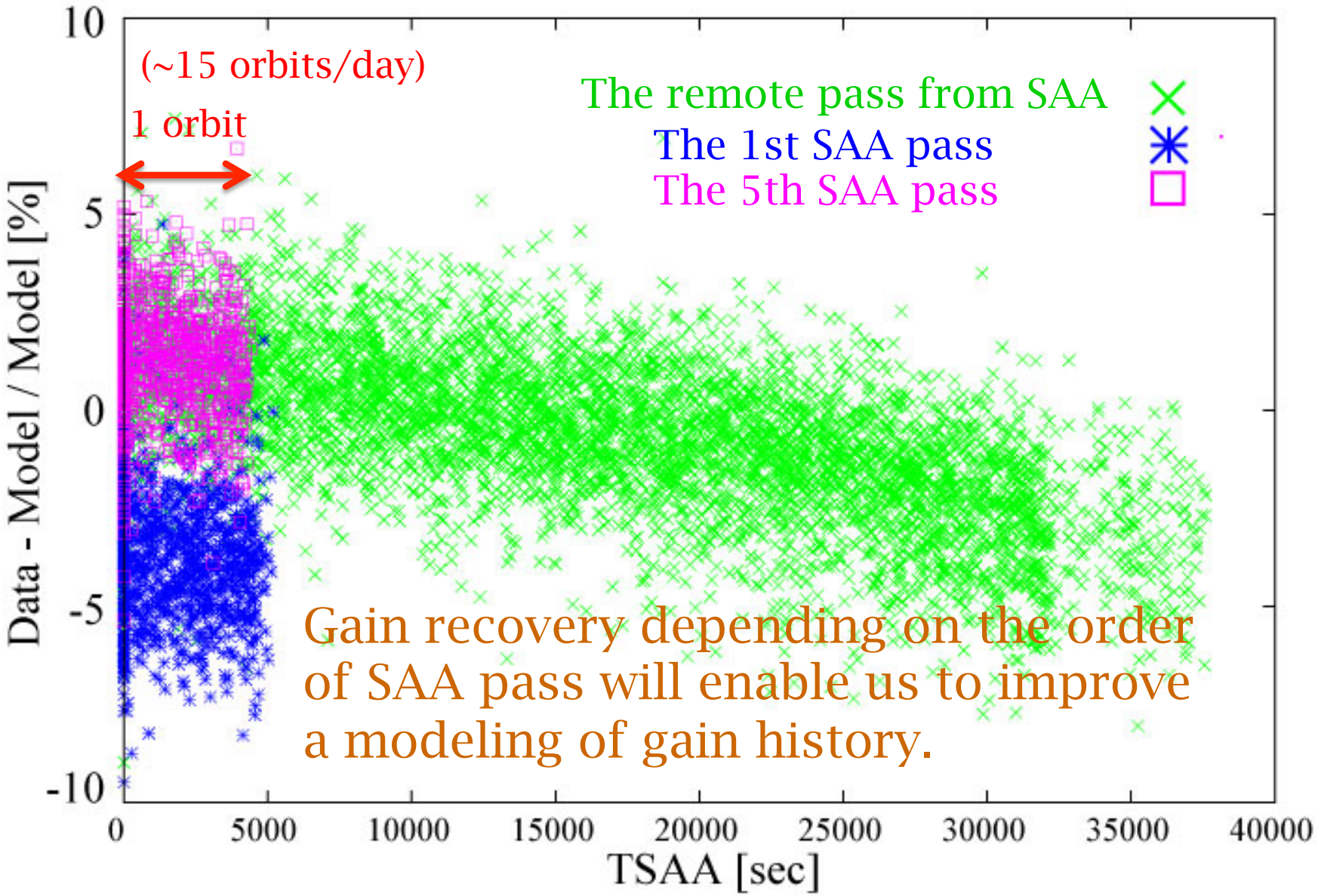
Agreement with On-Ground measurements





In-orbit data agrees with both simulation and on-ground data. (Yamada, Makishima+11, PASJ)

Improvement on reproducing gain history

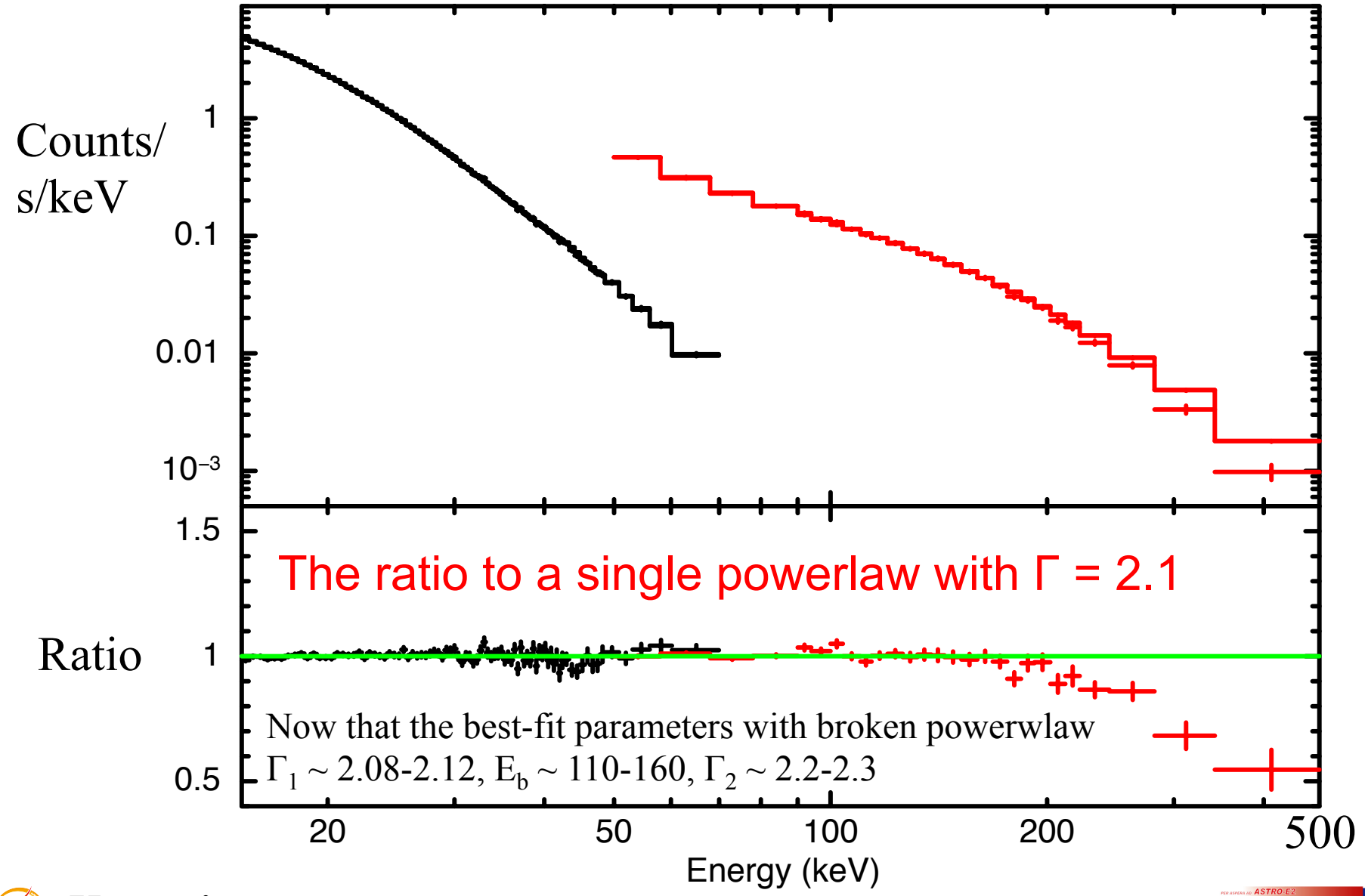


Gain recovery depending on the order of SAA pass will enable us to improve a modeling of gain history.

Crab Nebula

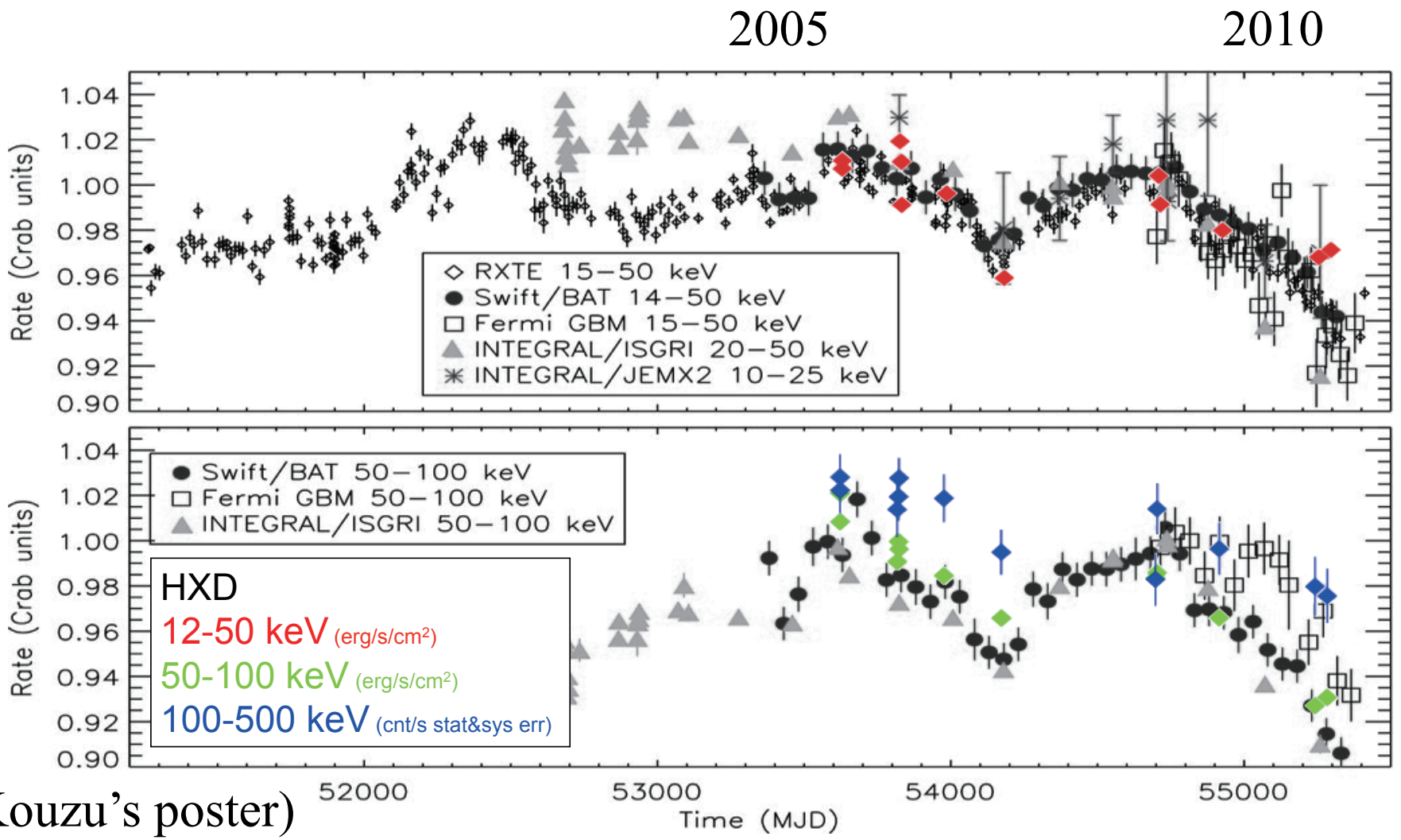
Kozu's poster, and her paper is in progress.

HXD Spectra of the Crab Nebula



Kouzu's poster

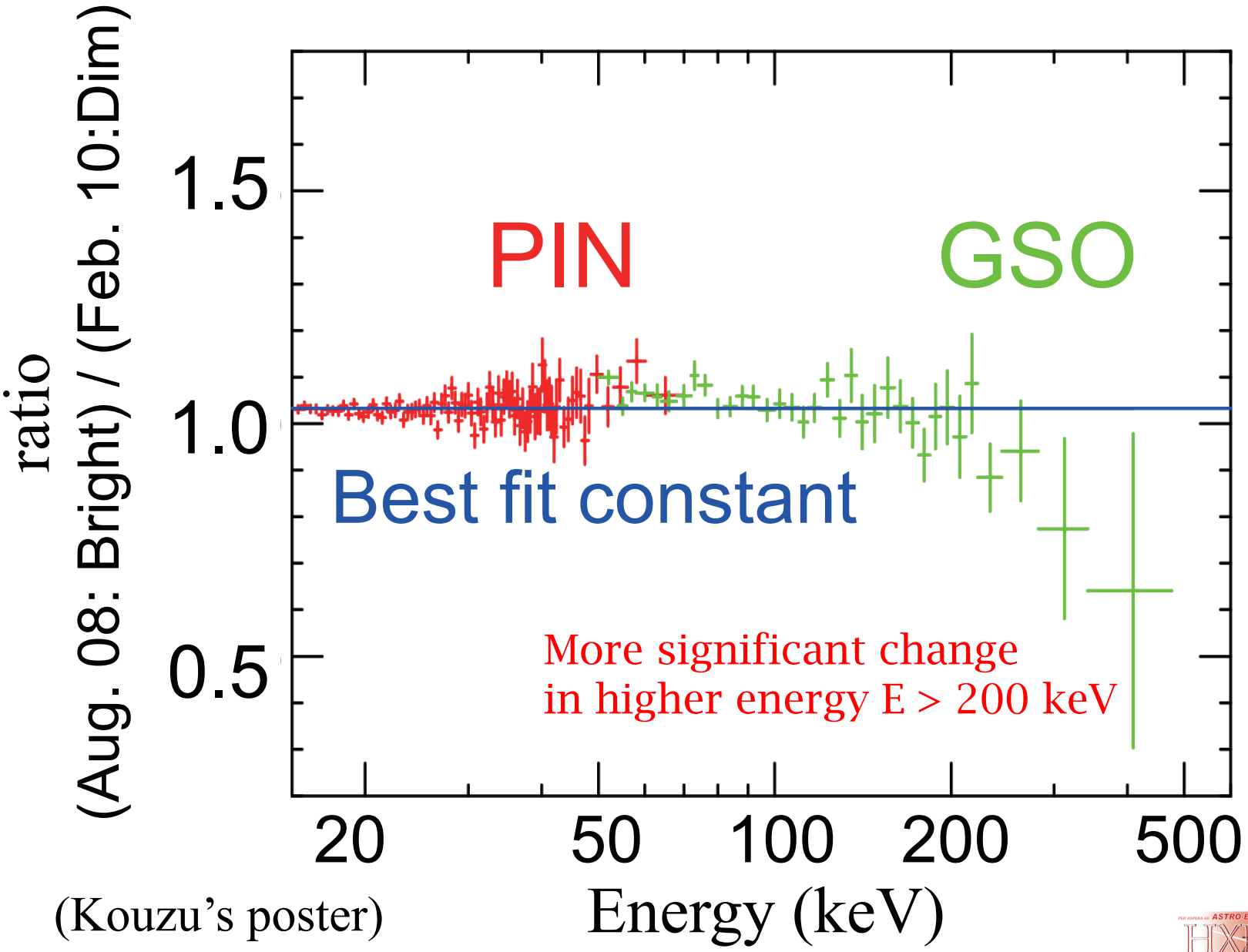
Long-term HXD flux trend of the Crab Nebula



(Kouzu's poster)

The HXD fluxes follows with those of other missions.

Long-term spectral change of Crab Nelula



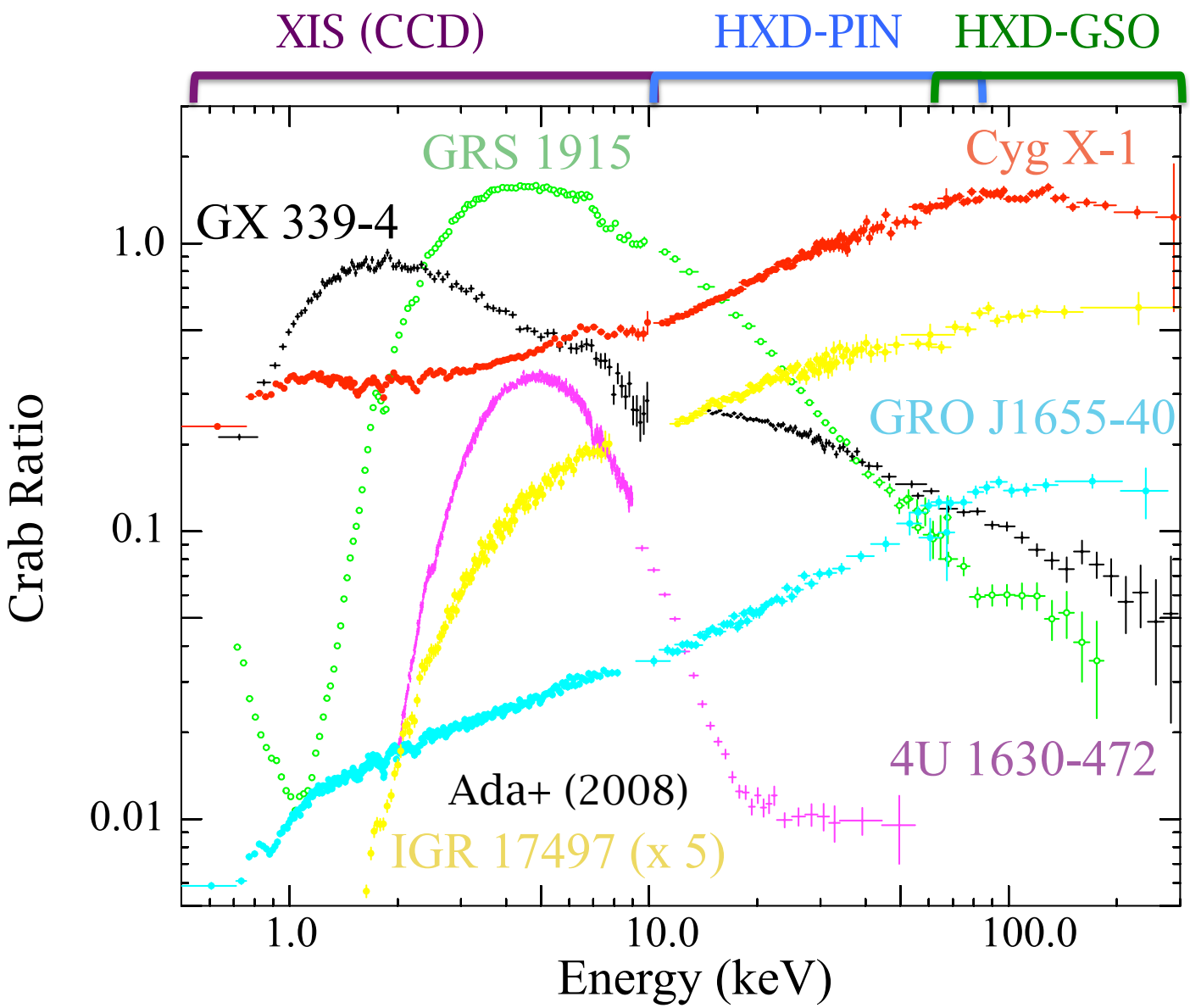
(Kouzu's poster)

Summary

- HXD on board *Suzaku* has realized the wide-band and high-quality observation without any problems.
- Adequate operation for LD of HXD-PIN have been performed, so that all units can be properly analyzed.
- The new HXD-GSO energy scale are obtained by utilizing the calculation of light yield and the shift of an analog offset. Corresponding responses and software have been released.
- Now that we can quantify not only the detailed shape of the Crab Nebula, but also its variation with time.

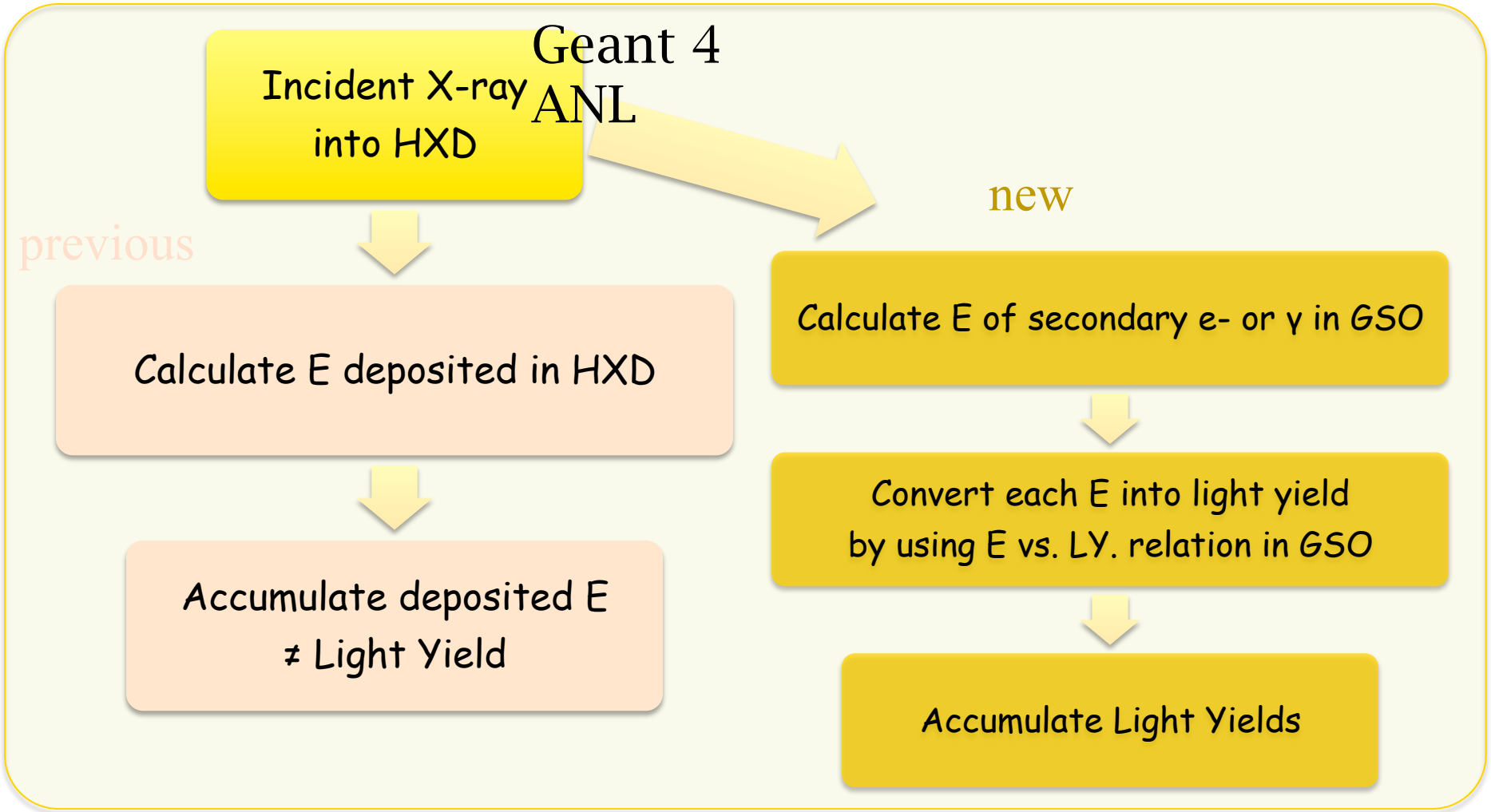
Thank you
(photo; 2004/04/30 HXD completed)

Wide-Band Spectra of Suzaku



Response Simulator includes Light yields

SimHXD : Framework of Response Generator (Terada et al. 2005)



New GSO response have been released since April of 2010