

# Cross calibration among Suzaku/XMM/CXO with PKS2155-304

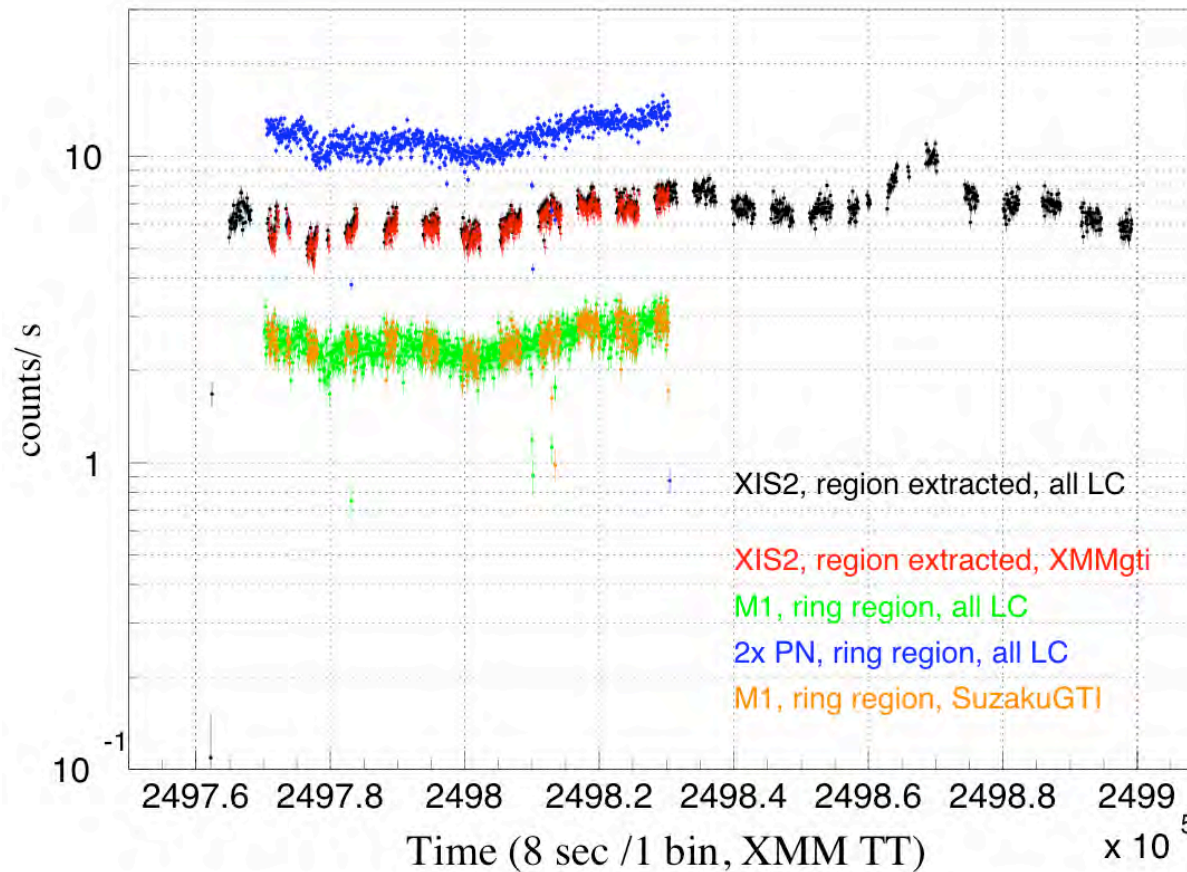
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# Simultaneous observations of PKS2155-304

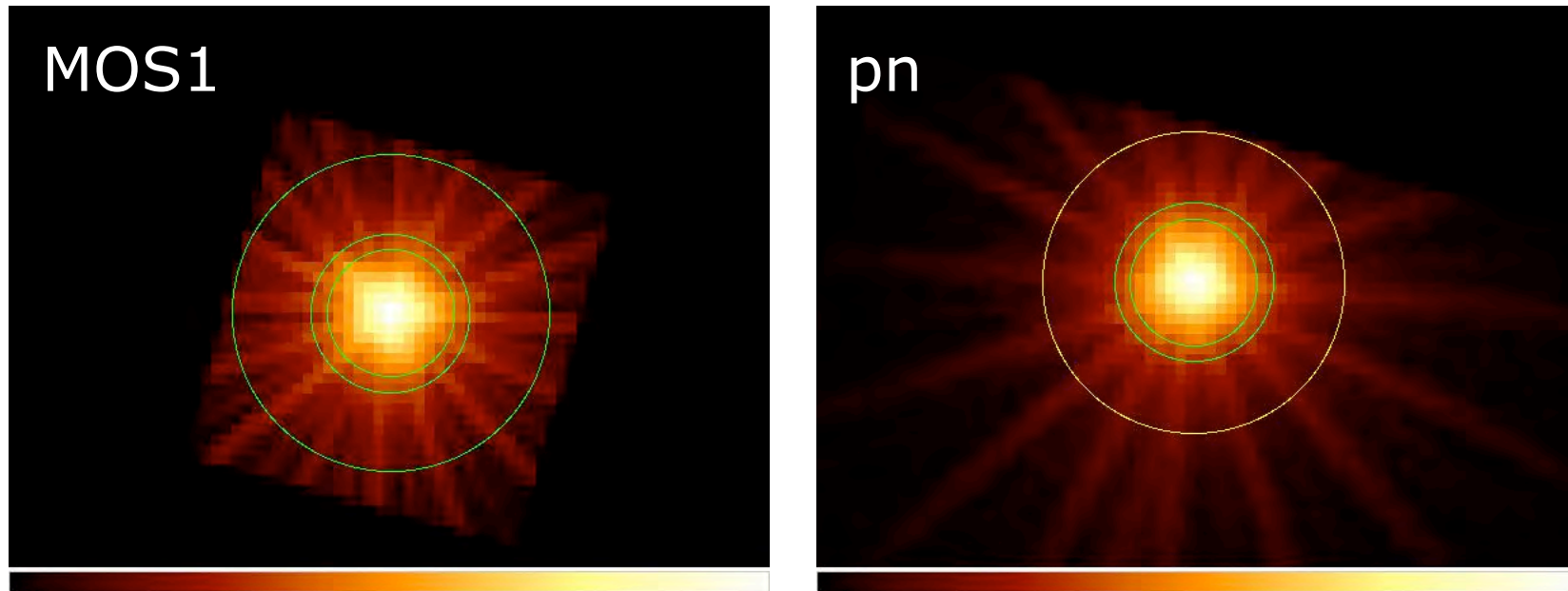
- Two campaigns
  - ★ 2005 Nov. 30-Dec. 2: **Suzaku/XMM**
  - ★ 2006 May. 1-2: **Suzaku/XMM/CXO**
- Collaborators
  - ★ M. Stuhlinger, M. G. Breittellner (XMM),
  - ★ N. Laslo, H. Marshall (CXO),
  - ★ N. Yamasaki (Suzaku)
- Analysis is made by:
  - Y. Takei (CXO data), K. Shinozaki (XMM data),
  - H. Mori (Attitude correction for Suzaku)
- Software/caldb version
  - ★ Suzaku: heasoft 6.0.4 (NASA/GSFC), rev0.6 (data/cal)
  - ★ XMM:SAS v.6.5.0, 2005 September
  - ★ CXO:CIAO 3.3.0.1, 2006-01-04  
CALDB 3.2.1, 2005-12-15

# 2005 Nov-Dec: Light curves



- XMM: pn, MOS1, MOS2, RGS1, RGS2
- Suzaku: XIS0, XIS1, XIS2, XIS3
- ★ Need to apply common GTI, because the source is variable.

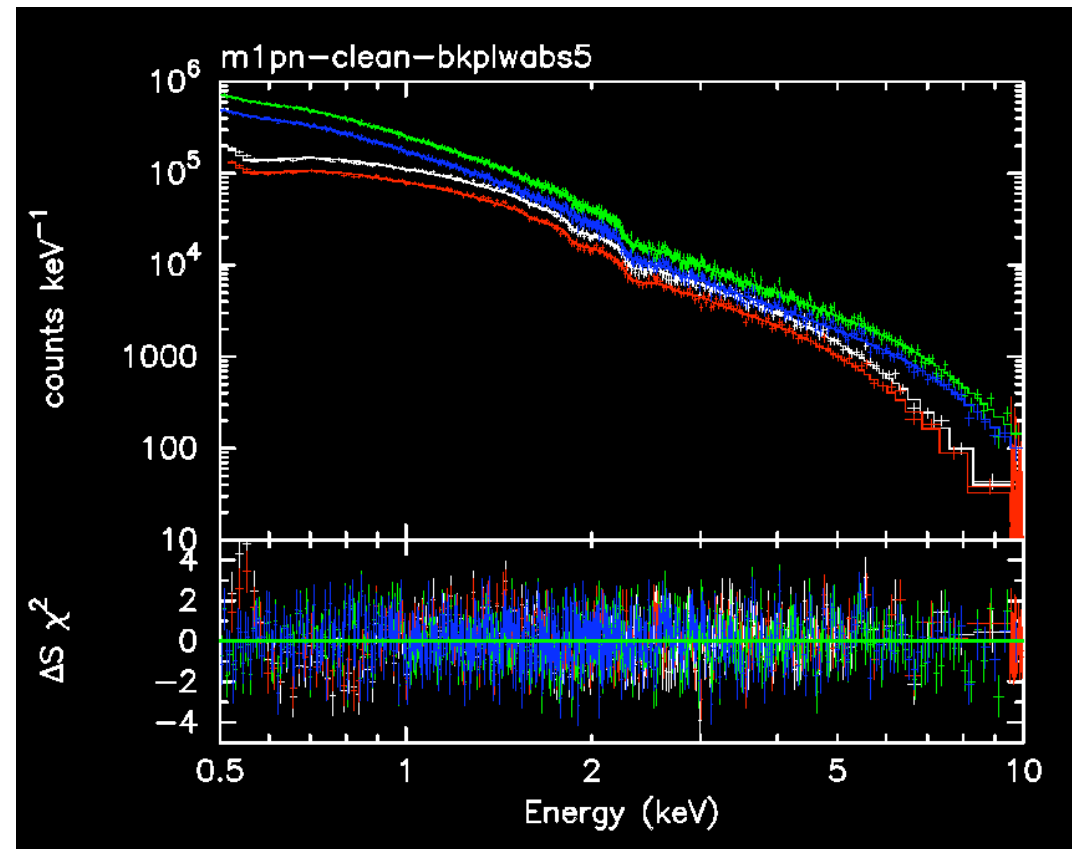
## 2005 Nov-Dec: XMM integration regions



- Intensity: several tens of c/s
  - ★ We should be careful about pile-up.
- MOS1:  $r_{\text{out}} = 50''$ ,  $r_{\text{in}} = 20''$  or  $25''$
- pn:  $r_{\text{out}} = 47.5''$ ,  $r_{\text{in}} = 20''$  or  $25''$
- Background is taken from outside of the SIR.

## 2005 Nov-Dec: MOS1 and pn Spectra

- Individual fit to M1/pn with broken power law
  - ⇒  $E_{\text{break}} \sim 0.3\text{-}0.6\text{keV}$
  - ⇒ Simple power law hereafter
- Parameter difference with different  $r_{\text{in}}$  is negligible.
- For larger  $r_{\text{in}}$ , MOS1 and pn are consistent except for  $N_{\text{H}}$ .



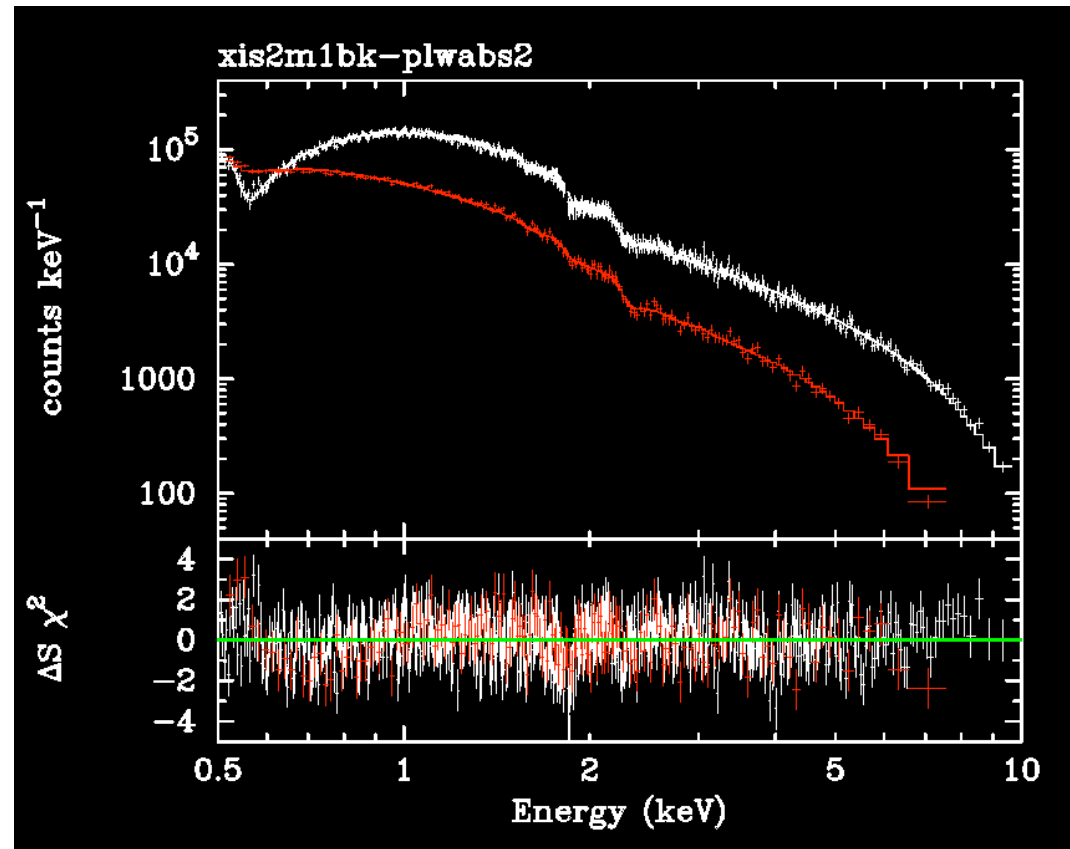
	Const.	$N_{\text{H}}(10^{20}\text{cm}^{-2})$	$\Gamma$	$\chi^2_{\nu}/\text{dof}$
MOS1	1.0 (fix)	4.0 (0.7)	2.679(0.021)	1.21/218
pn	0.985 (0.019)	< 1.2	2.708(0.014)	1.02/510

# 2005 Nov-Dec: MOS1 and Suzaku XIS2

- Individual fit to M1/XIS2 with a simple power law
  - ⇒ Photon index: consistent
  - ⇒ Normalization: 4% difference
  - ⇒  $N_{\text{H}}$ : XIS2 larger, but part of it should be due to **the contamination.**

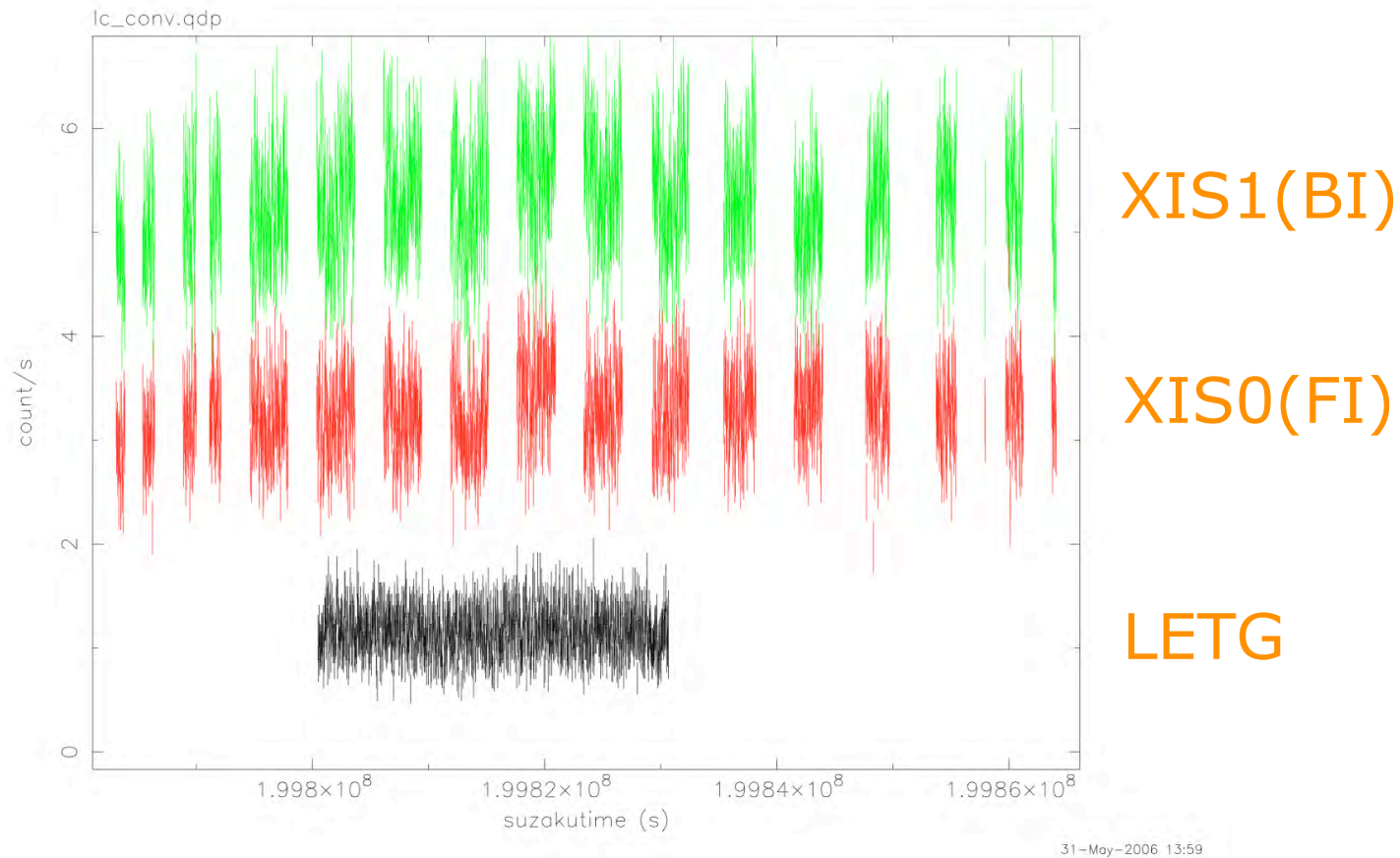
See the table below.

- Simultaneous fit
  - $\Gamma = 2.679 \pm 0.011$
  - const (XIS2) =  $1.043 \pm 0.012$



	Const.	$N_{\text{H}}(10^{20}\text{cm}^{-2})$	$\Gamma$	$\chi^2_{\nu}/\text{dof}$
MOS1	1.0 (fix)	4.0 (0.7)	2.679(0.021)	1.21/218
XIS2	1.043 (0.012)	11.4 (0.4)	2.679(0.012)	1.02/510

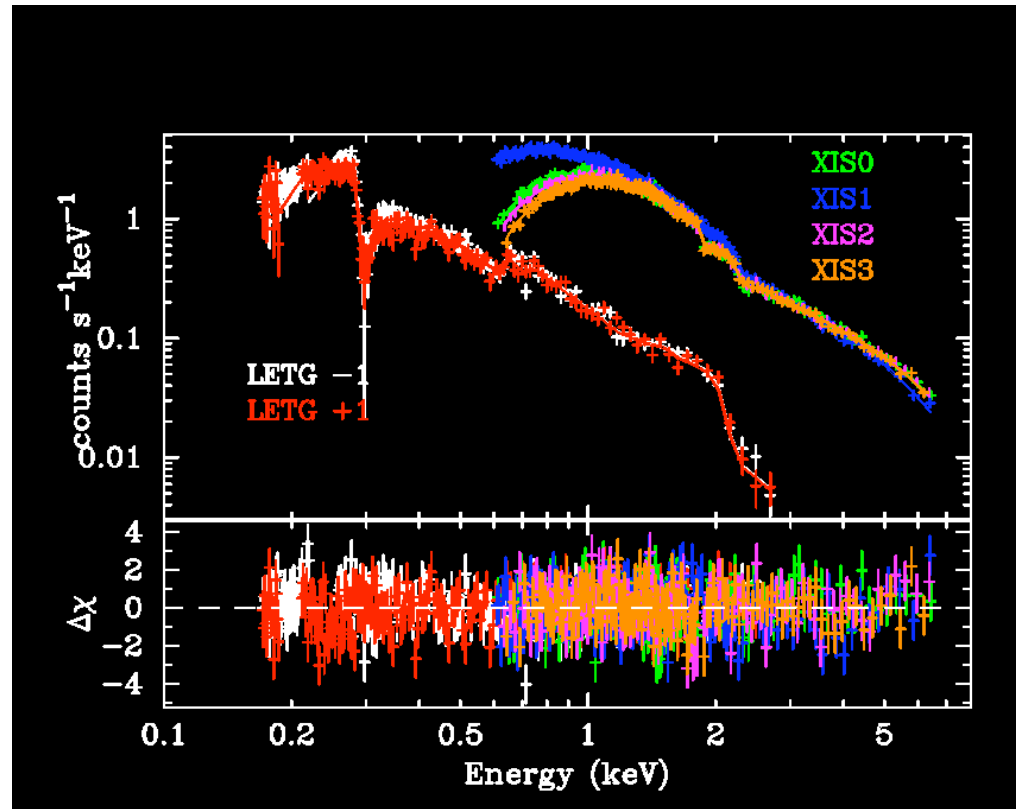
# 2006 May: Light curves



- Chandra: LETG, 30ksec
- Apply common GTI

# 2006 May: Spectral Fit

- Independent Fit
  - ★  $\Gamma$ : 2.49-2.53 (XIS0,2,3:FI)  
2.49 (LETG)
  - ★ Const: 0.97-1.0 (FI)  
1.0 (LETG:fix)
- Constrained Fit (but  $N_H$ )
  - ★  $\Gamma = 2.523 \pm 0.011$
  - ★ Normalization =  
1.006/0.950/1.003/1.001 for  
XIS0/1/2/3 with respect to LETG



	Normalization	$N_H (10^{20} cm^{-2})$	$\Gamma$
XIS0	0.967(0.025)	< 7.8	2.487(0.022)
XIS1	0.961(0.024)	< 3.4	2.557(0.022)
XIS2	0.976(0.026)	< 8.1	2.504(0.023)
XIS3	0.996(0.027)	< 8.8	2.533(0.024)
LETG	1.000	1.314(0.089)	2.485(0.035)

# Summary

- Suzaku XIS2 and XMM MOS1 ('05 Nov-Dec)
  - ★  $\Gamma=2.68$ : consistent within 0.02 (statistical error)
  - ★ Flux: XIS2 is larger by 4%
- Suzaku FI(XIS0,2,3) and CXO LETG('06 May)
  - ★  $\Gamma=2.49-2.53$ : Suzaku  
2.49: LETG
  - ★ Flux: consistent within 3% (statistical error)
- Further calibration is necessary for Suzaku below  $\sim 1\text{keV}$ .