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

Manabu ISHIDA
Tokyo Metropolitan University

Simultaneous observations of PKS2155-304

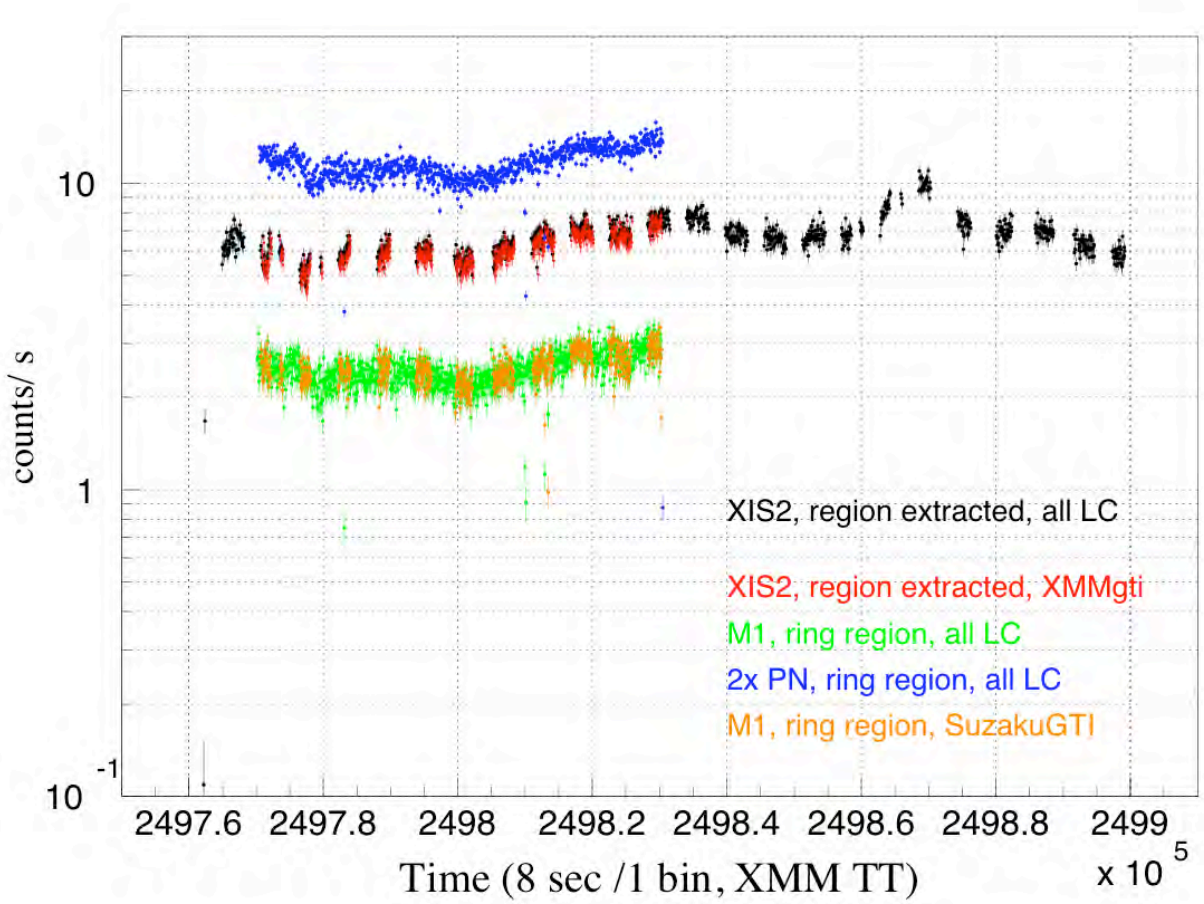
- Two campaigns
  - ★2005 Nov. 30-Dec. 2: Suzaku/XMM
  - ★2006 May. 1-2: Suzaku/XMM/CXO
- Collaborators
  - ★ M. Stuhlinger, M. G. Breitfellner (XMM),
  - ★ N. Laslo, H. Marshall (CXO),
  - ★ N. Yamasaki (Suzaku)
- Analysis is made by:

  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

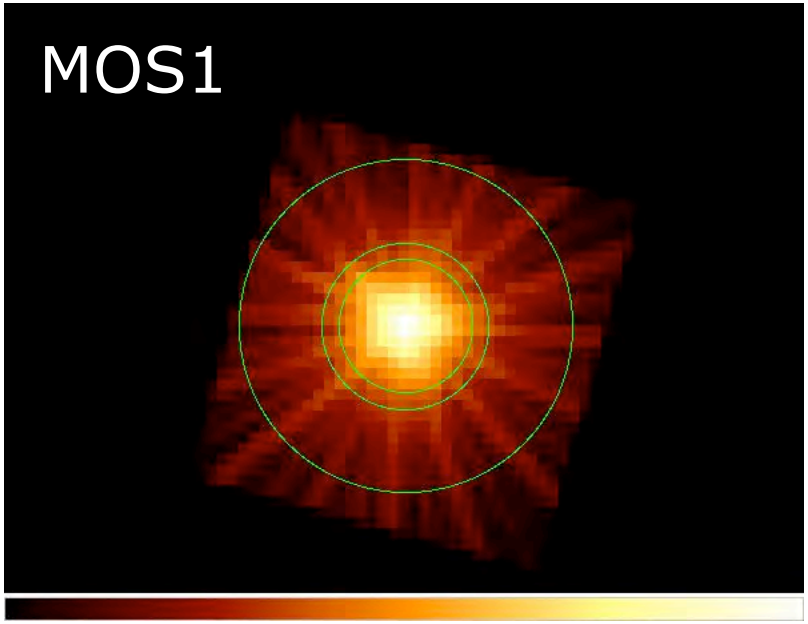
2005 Nov-Dec: Light curves

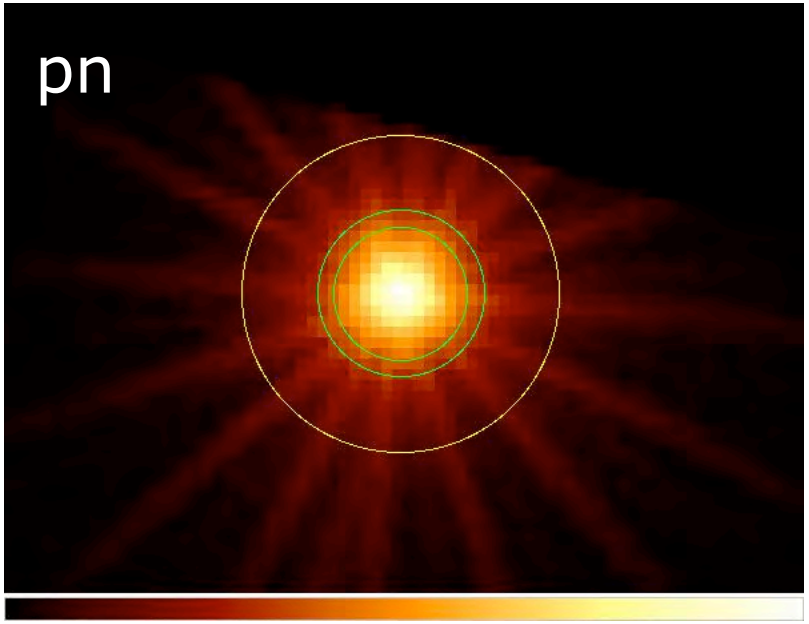


- XMM: pn, MOS1, MOS2, RGS1, RGS2
- Suzaku: XIS0, XIS1, XIS2, XIS3

★ Need to apply common GTI, because the source is variable.

2005 Nov-Dec: XMM integration regions

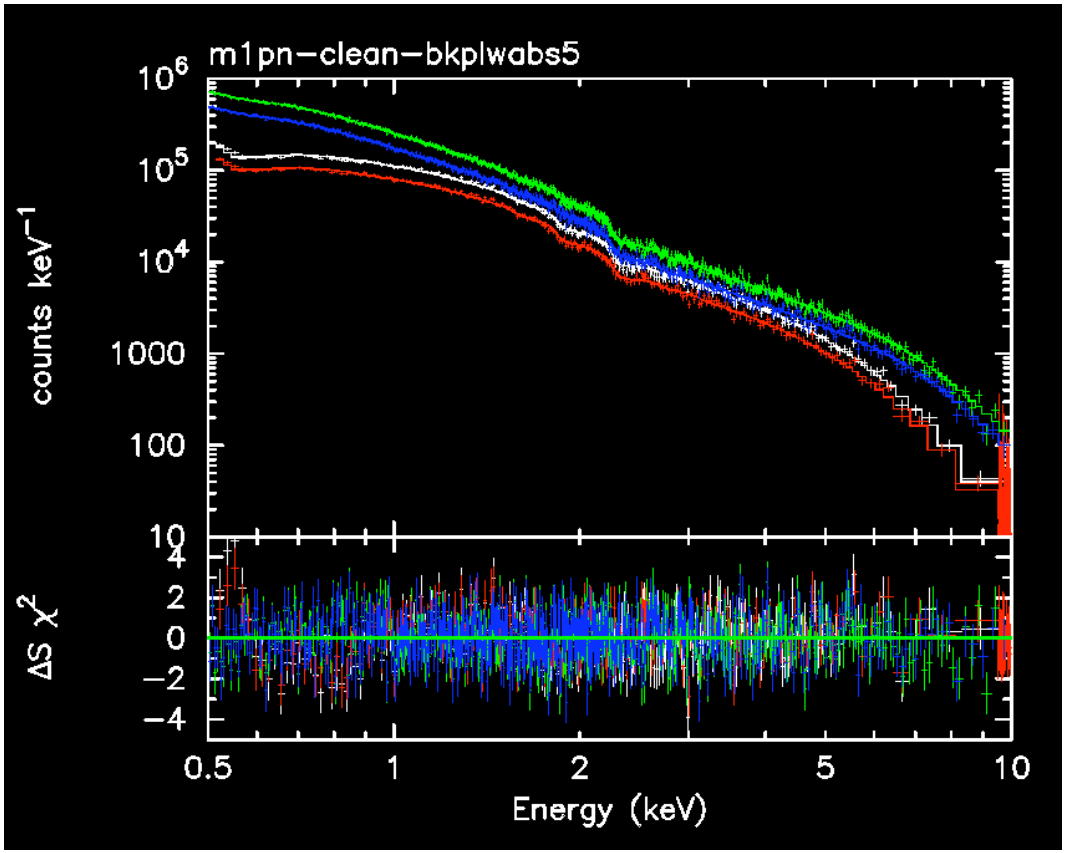




- Intensity: several tens of c/s
  - ★ We should be careful about pile-up.
- MOS1: $r_{\rm out} = 50$”, $r_{\rm in} = 20$” or 25”
- pn: $r_{\rm out} = 47.5$”, $r_{\rm in} = 20$” or 25”
- Background is taken from outside of the SIR.

2005 Nov-Dec:MOS1 and pn Spectra

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



	Const.	$N_{\rm H}(10^{20}{\rm cm}^{-2})$	Γ	χ^2_ν/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

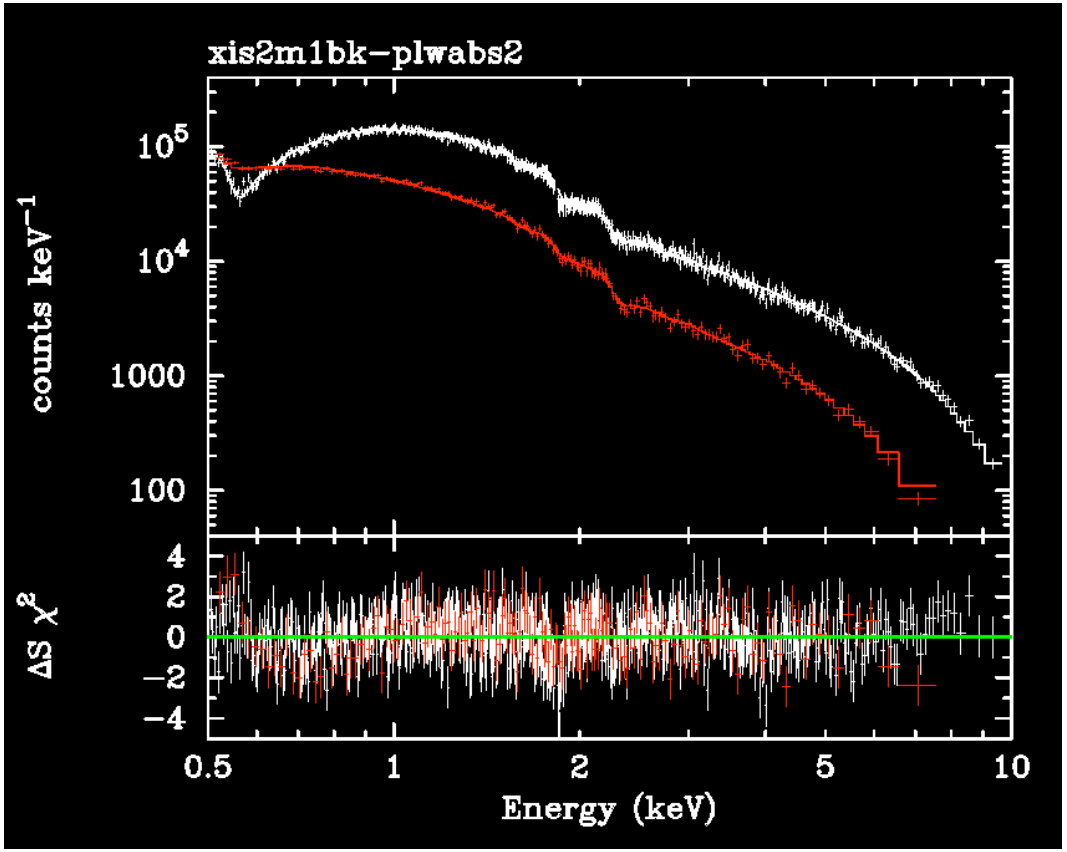
2005 Nov-Dec:MOS1 and Suzaku XIS2

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

  See the table below.
- Simultaneous fit

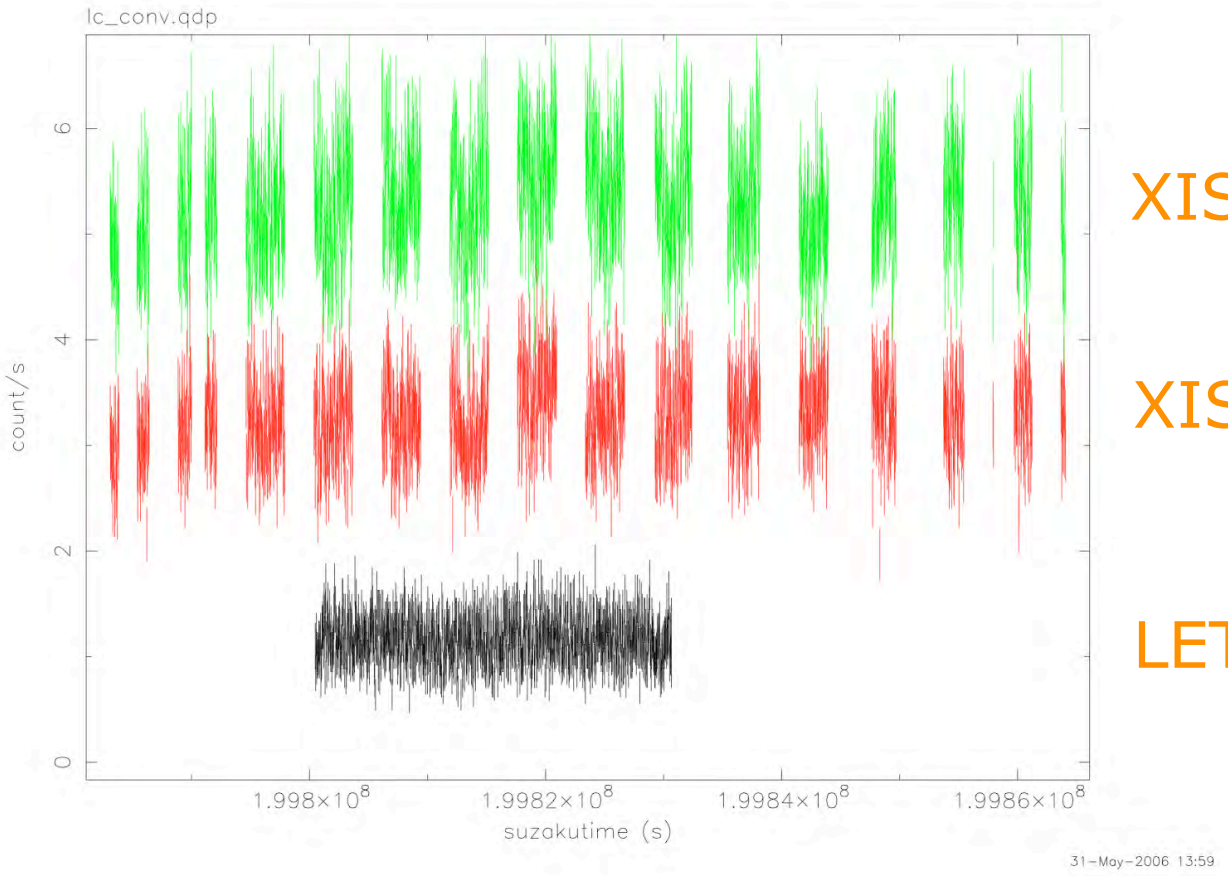
  Γ = 2.679±0.011

  const (XIS2) = 1.043±0.012



	Const.	$N_{\rm H}(10^{20}{\rm cm}^{-2})$	Γ	χ^2_ν/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



XIS1(BI)

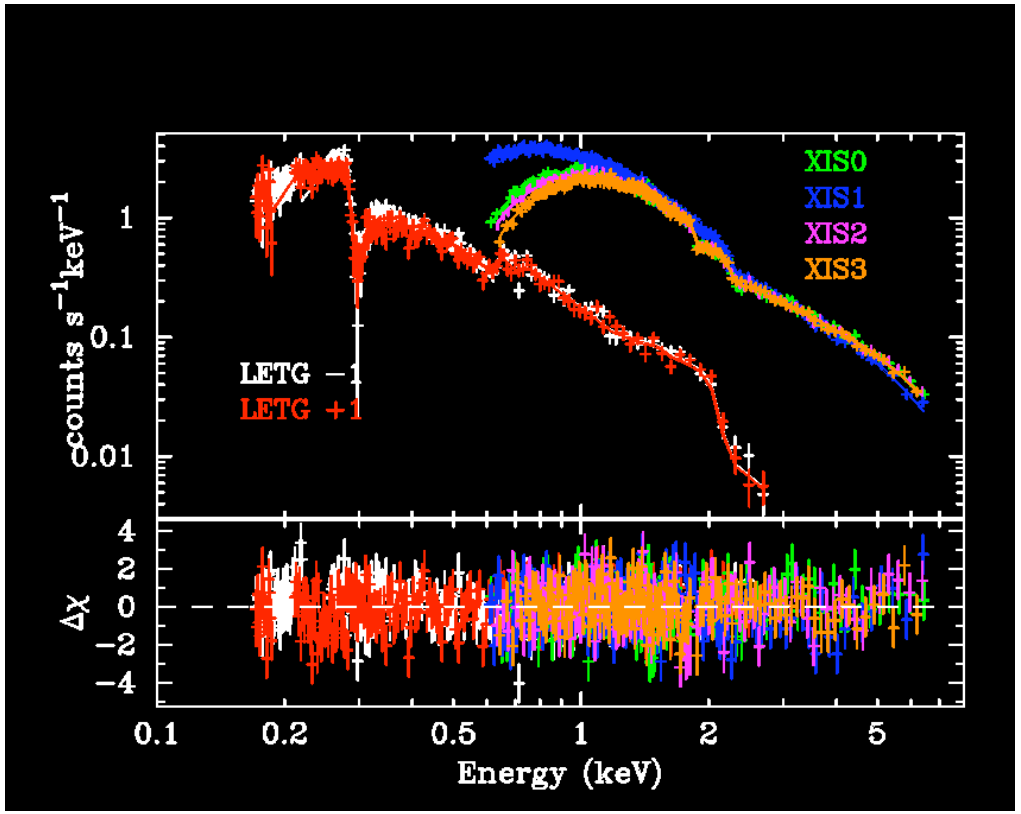
XIS0(FI)

LETG

- Chandra: LETG, 30ksec
- Apply common GTI

2006 May: Spectral Fit

- Independent Fit
- ★ Γ: 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)
- ★ Γ =2.523 +/– 0.011
- ★ Normalization = 1.006/0.950/1.003/1.001 for XIS0/1/2/3 with respect to LETG



	Normalization	$N_H(10^{20}cm^{-2})$	Γ
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)
  - ★ Γ=2.68: consistent within 0.02 (statistical error)
  - ★ Flux: XIS2 is larger by 4%
- Suzaku FI(XIS0,2,3) and CXO LETG(‘06 May)
  - ★ Γ=2.49-2.53: Suzaku
    2.49: LETG
  - ★ Flux: consistent within 3% (statistical error)
- Further calibration is necessary for Suzaku below ~1keV.