

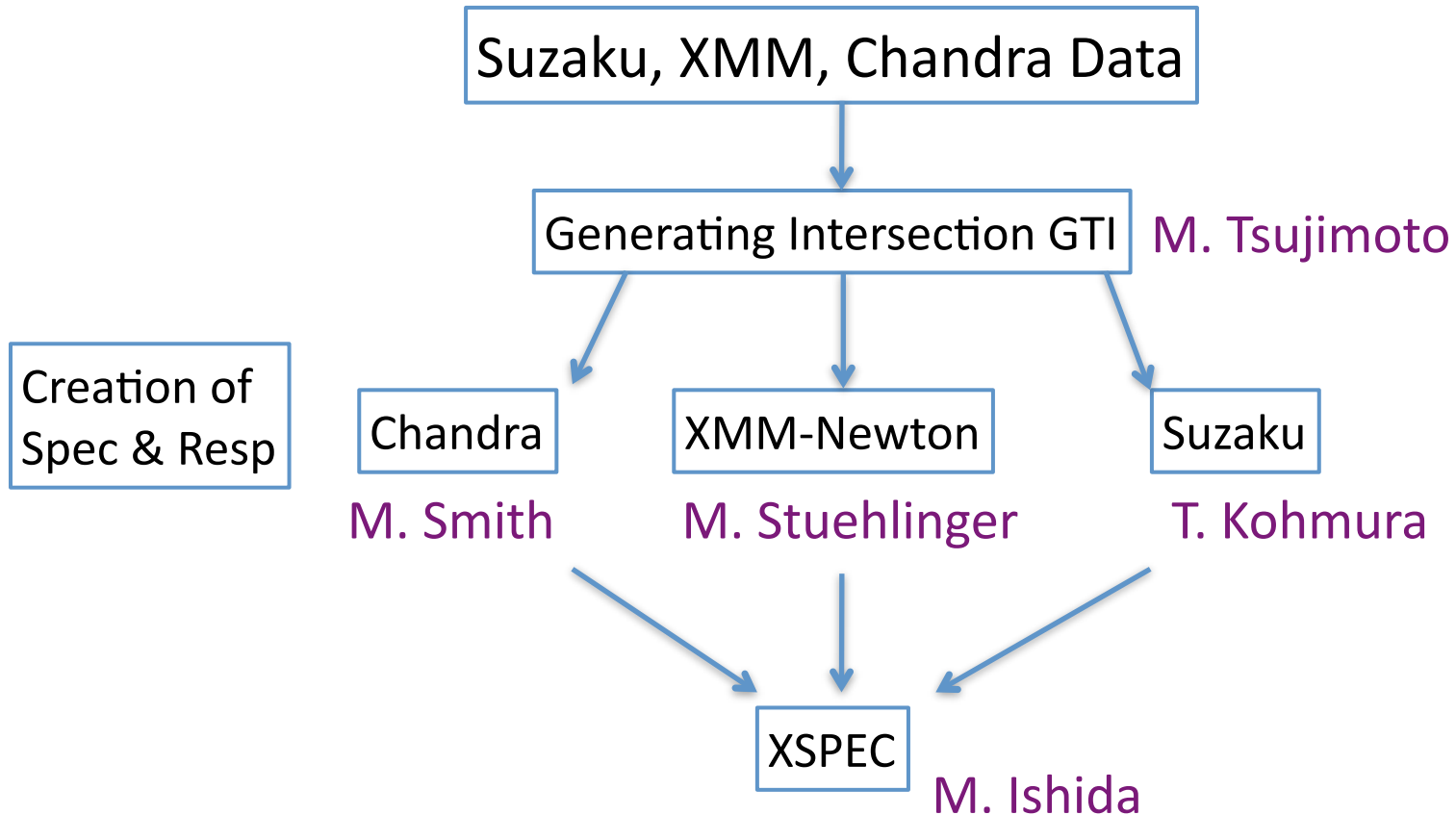
# Cross spectral calibration of Suzaku/ XMM/Chandra with PKS2155-304

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# PKS2155-304

- We have carried out cross spectral calibration with PKS2155-304 among Suzaku, Chandra, and XMM-Newton since 2005.
  - One of the brightest BL Lac objects.
    - Represented by a simple power-law (possibly broken power-law) spectrum at least up to 10 keV.
  - Point source.
    - Needless to care about uncertainty of the telescope vignetting due to source spatial extension.
    - Free from contamination from a thermal component (unlike a rotation-powered pulsar in thermal SNRs).
  - Variable: need simultaneous observation among alive missions.
- ⇒ We have carried out coordinated observation among Suzaku, XMM-Newton and Chandra for calibration purpose since 2005.

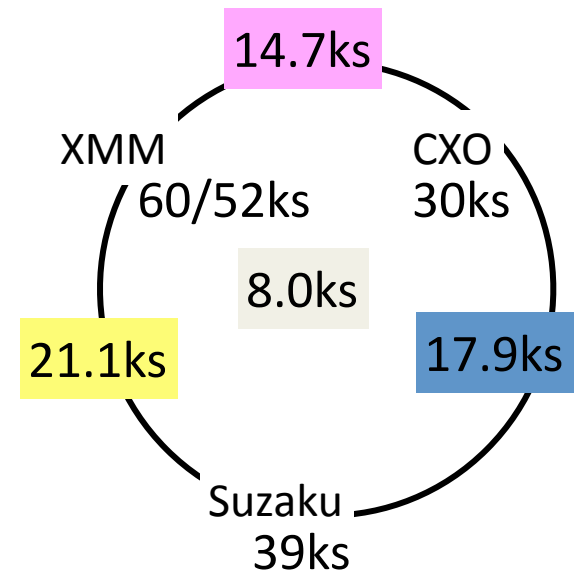
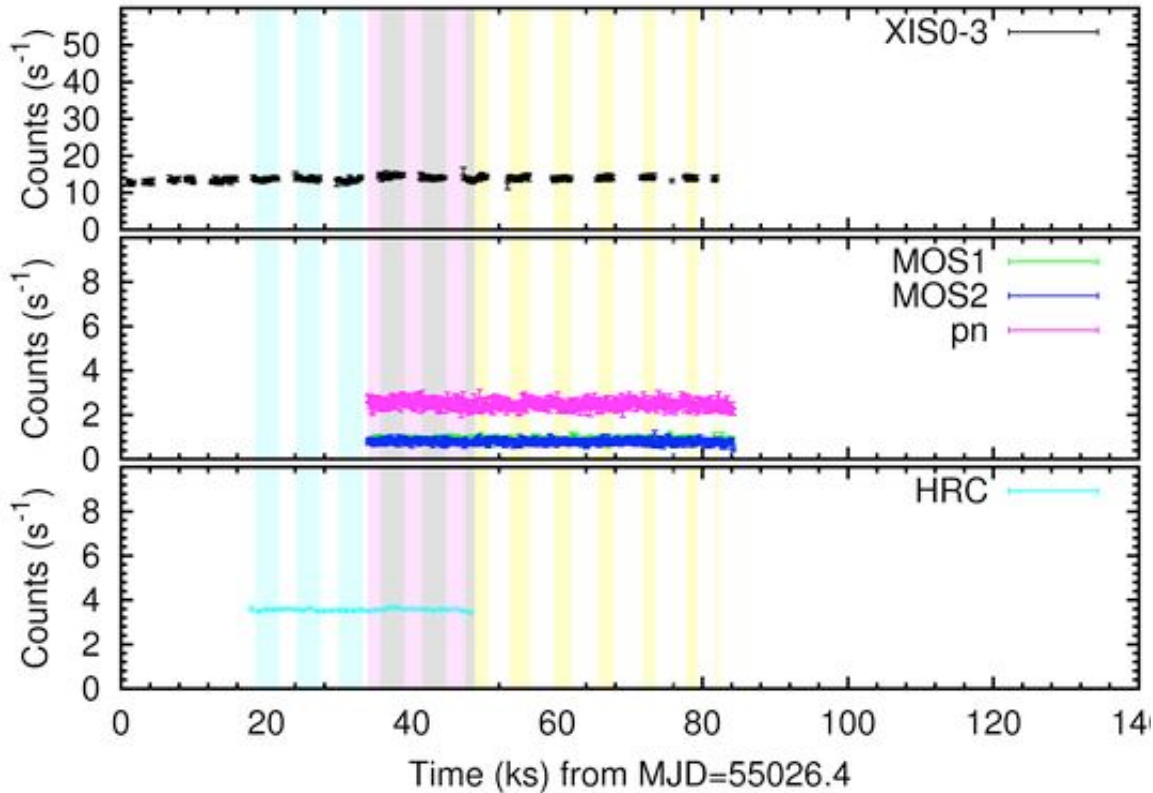
# Data reduction procedure



# Rough observation log

- 2005 Nov 30-Dec 2
  - XIS-FI/BI, EPIC-MOS/pn
- 2006 May 1-2
  - XIS-FI/BI, EPIC-MOS/pn, HRC-LETG
- 2007 Apr 22
  - XIS-FI/BI, EPIC-MOS/pn, HRC-LETG
- 2008 May 12-13
  - XIS-FI/BI, EPIC-MOS/pn, ACIS-LETG
- 2009 May 27-29
  - Not yet analyzed

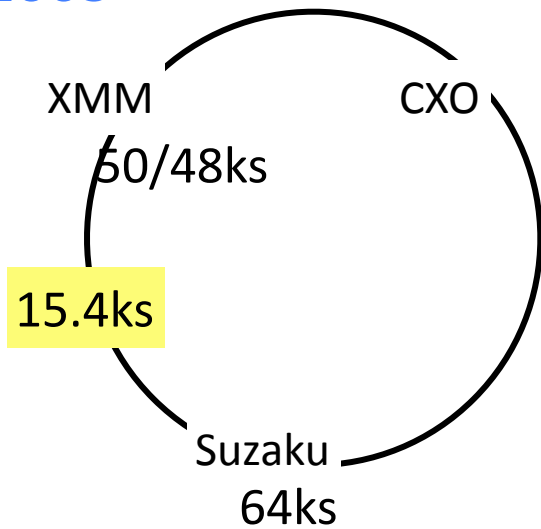
# Intersection GTI (2006, as an example)



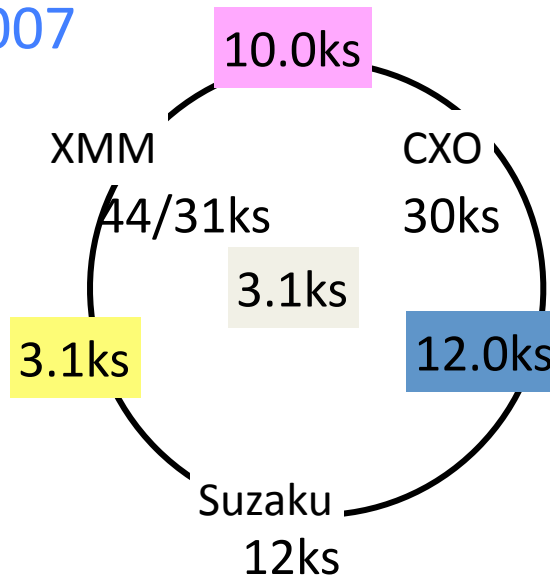
- Check GTIs individually.
- Calculate intersection GTIs between all pairs out of the three, as well as among all three satellites.

# Intersection GTI Summary

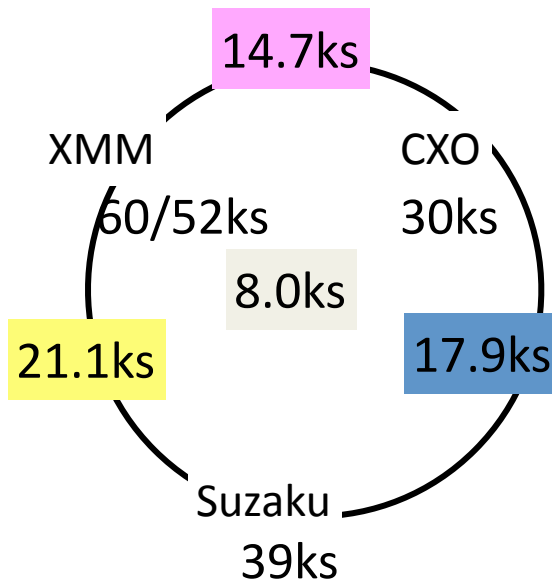
2005



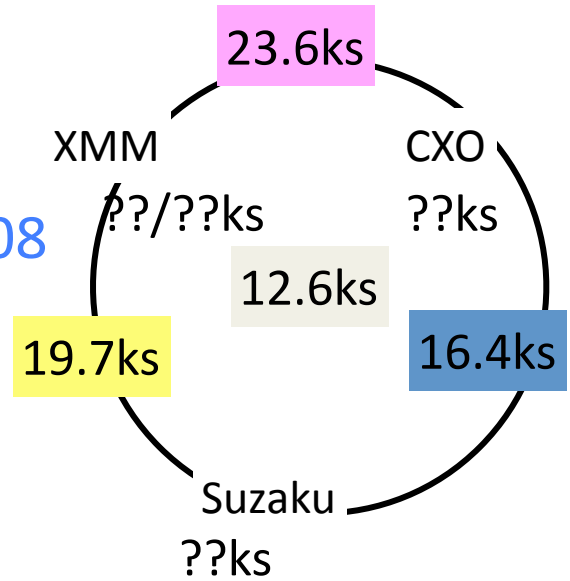
2007



2006

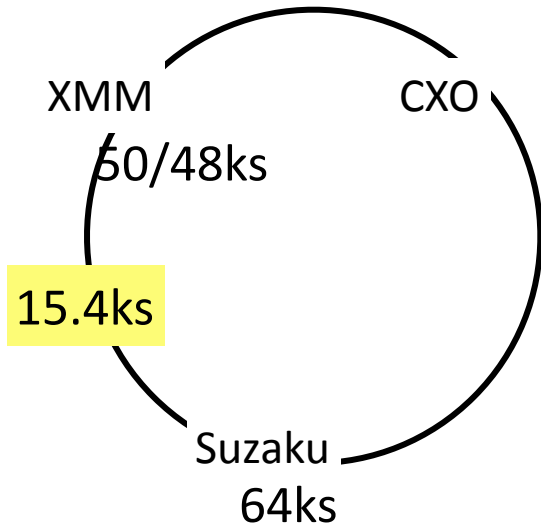


2008

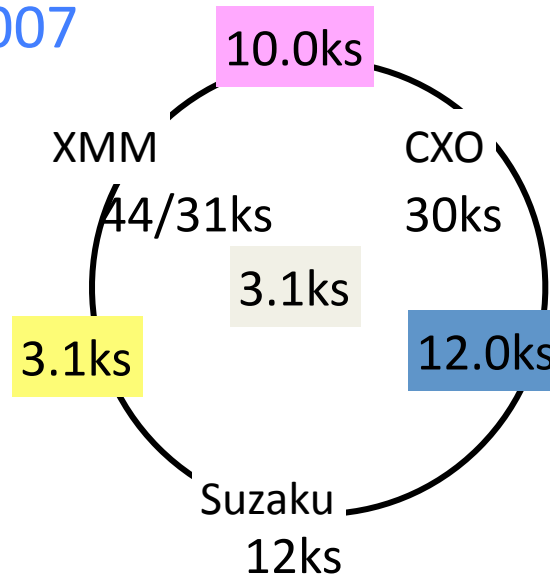


# Intersection GTI Summary

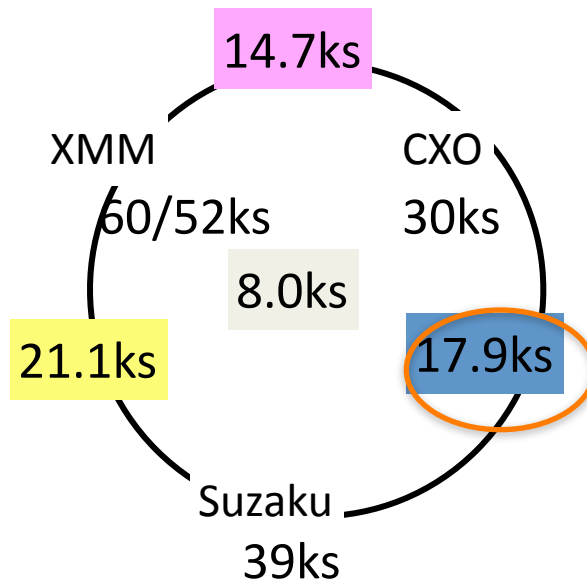
2005



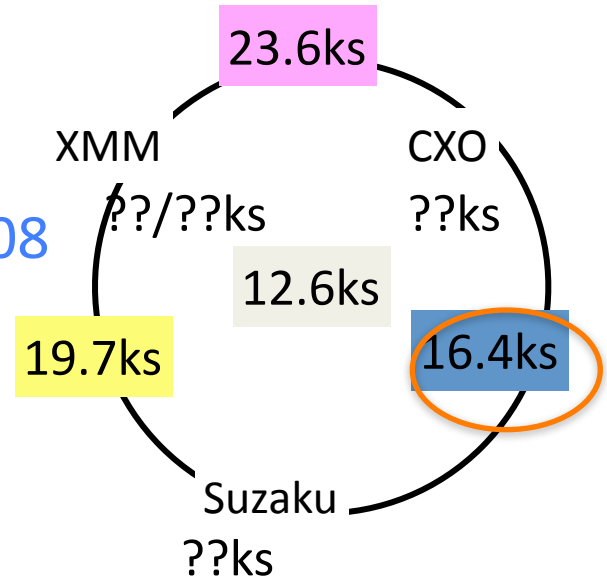
2007



2006



2008



# Data screening: Suzaku

- CALDB XIS20090402, XRT20080709
- Heasoft 6.6.2
- grade ....0+2+3+4+6
- BAD column ....excluded
- SAA .... SAA\_HXD=0 && T\_SAA\_HXD > 436
- ELV .... > 5° / DYE\_ELV .... >20°
- ANG\_DIST ...<1.5'
- Source ....r<4.33' / BGD .... r=4.33'–6'



# Data screening: Chandra

- Data reduced with CIAO 4.1 + CALDB 4.1.1.
- The 2006 observation was performed with the HRC + LETG
  - Spectra with orders  $\pm 1$  to  $\pm 10$  have been generated (only  $\pm 1$  have been used for spectral analysis), together with corresponding response and background files.
- The 2008 observation was performed with ACIS-S + LETG
  - Spectra with orders  $\pm 1$  have been generated, together with corresponding response and background files.

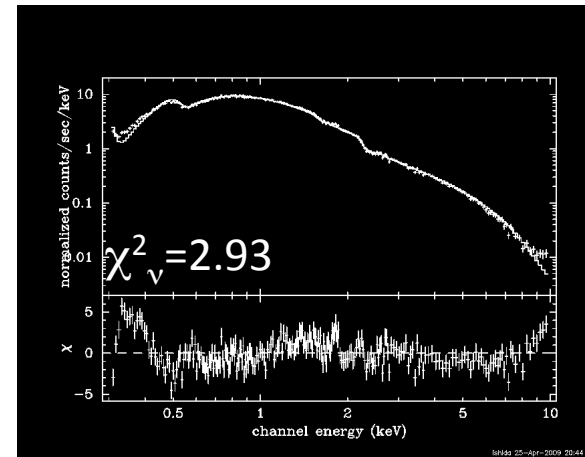
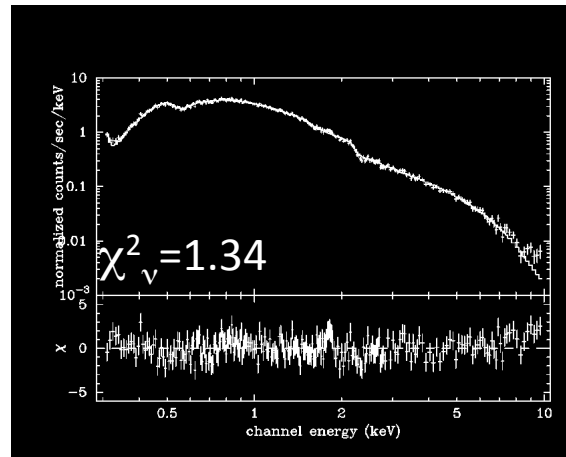
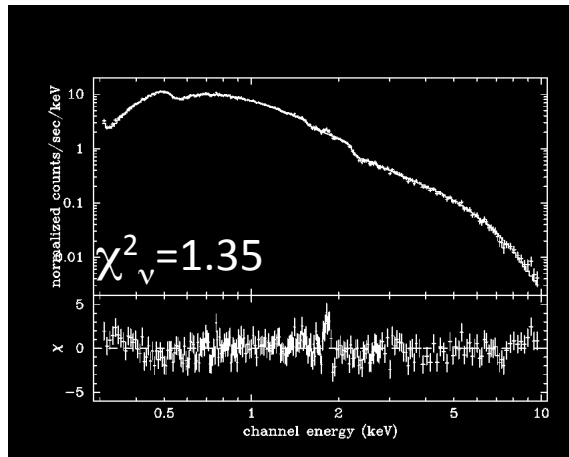
# Suzaku XIS: 2005, 2006, 2008

2005

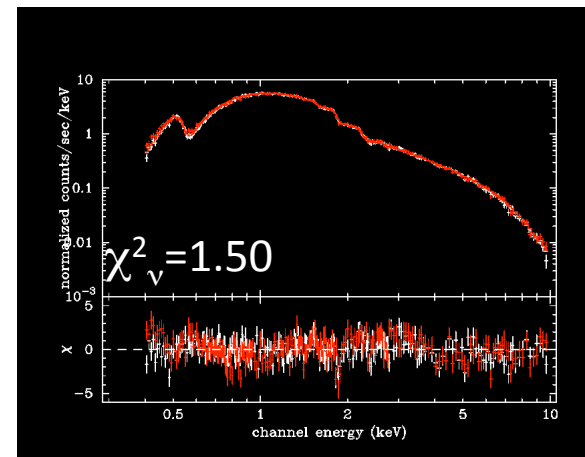
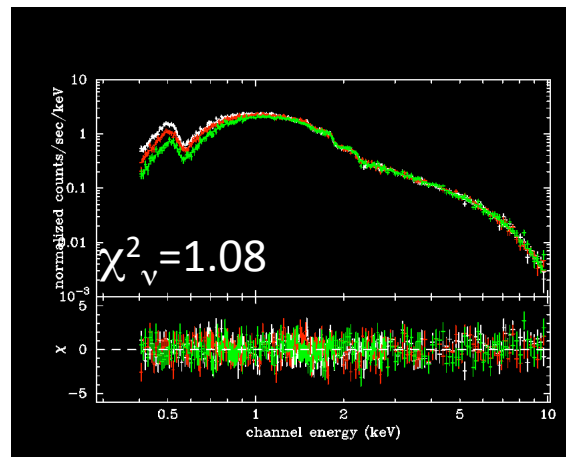
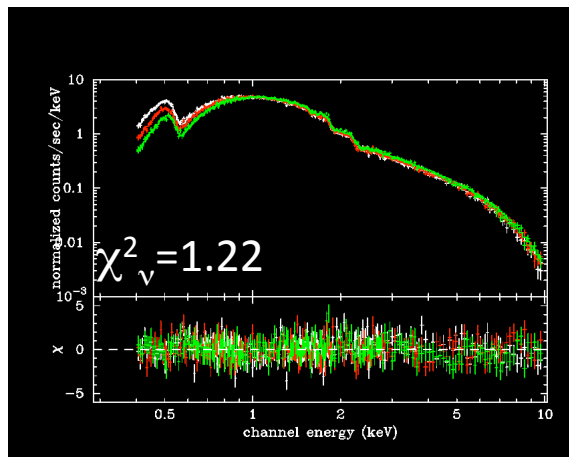
2006

2008

XIS-BI



XIS-FI



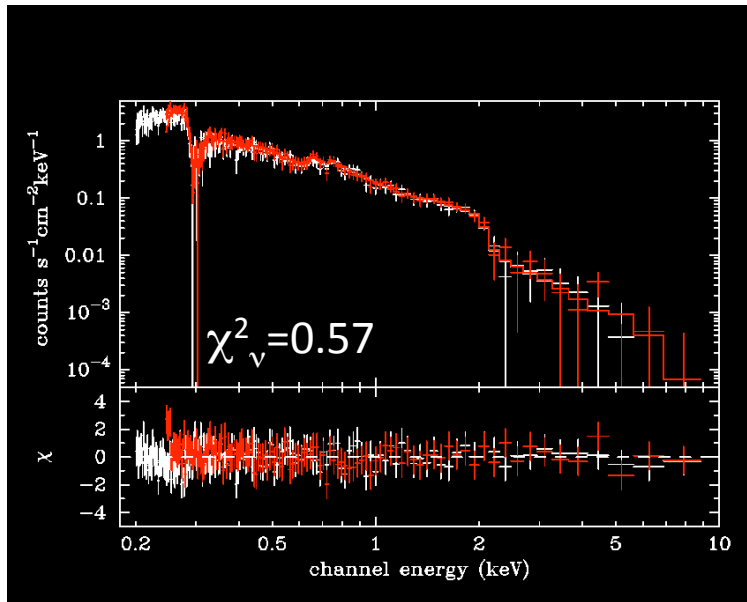
Common GTI with XMM-Newton

2009 September 21

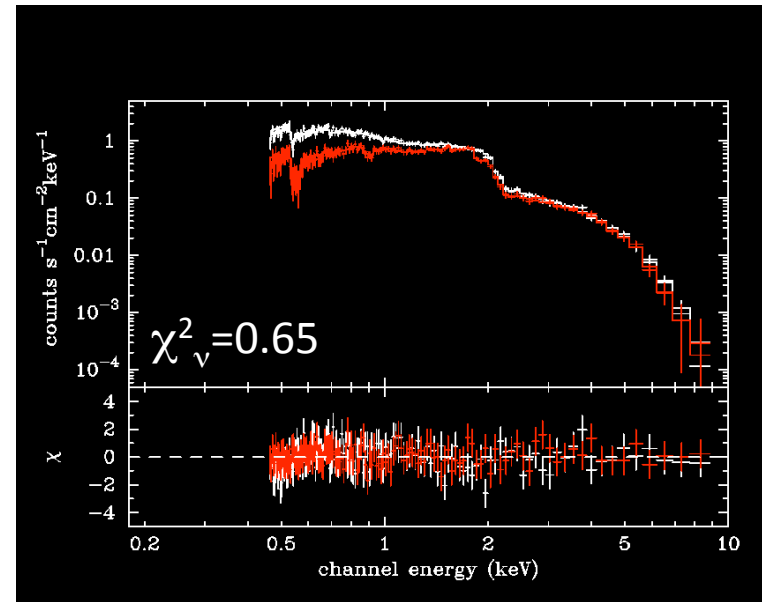
Suzaku & Chandra, Boston, USA

# Chandra Spectra: 2006, 2008

2006, HRC+LETG



2008, ACIS-S+LETG



Common GTI with Suzaku

2009 September 21

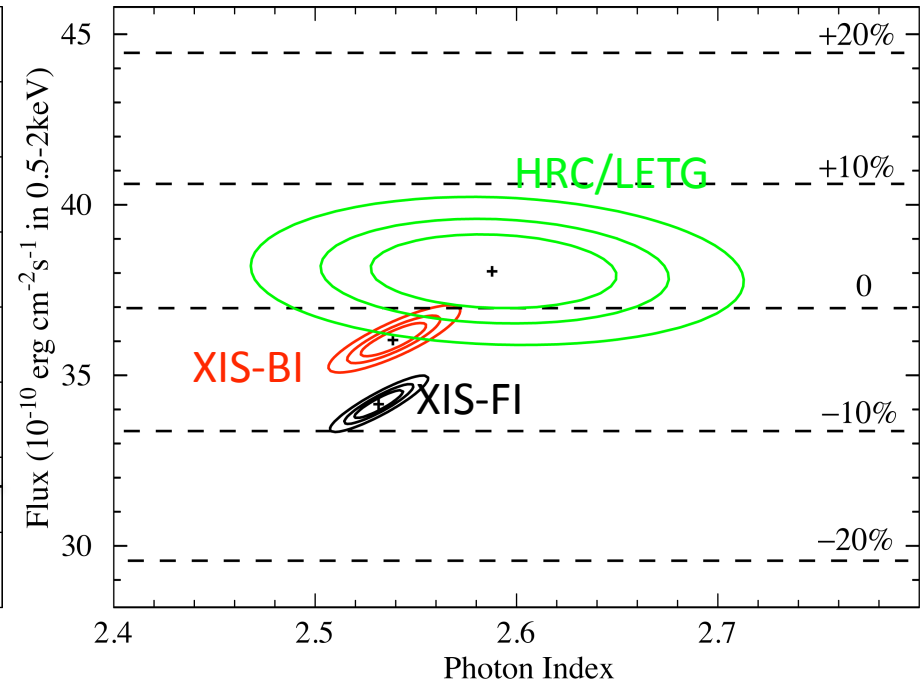
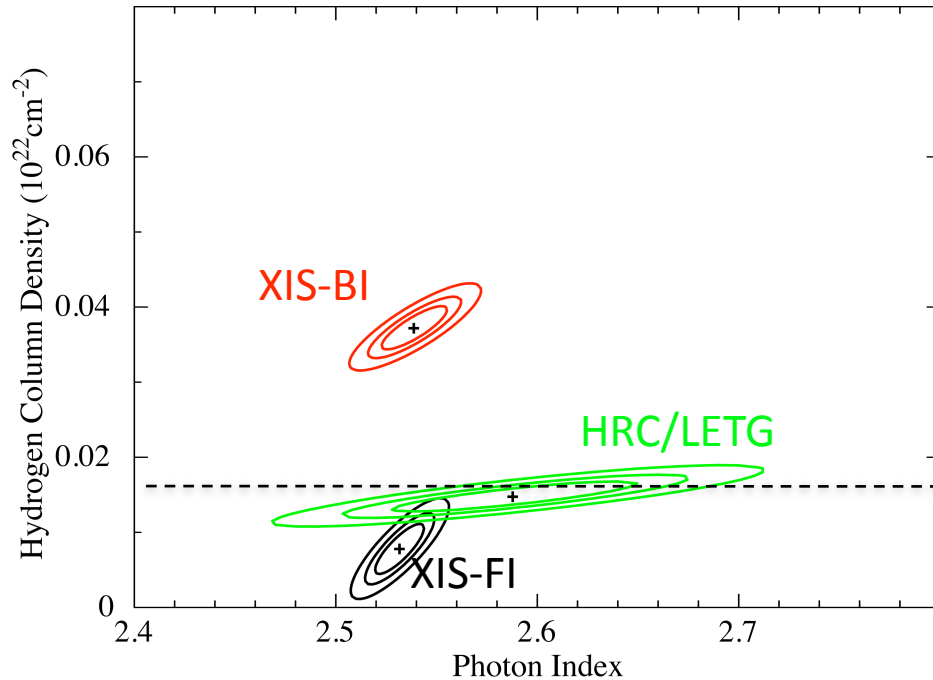
Suzaku & Chandra, Boston, USA

# XIS/HRC-LETG parameters (2006)

XIS-FI: 0.4-10.0 keV, HRC/LETG: 0.2-10 keV (+1)

XIS-BI: 0.3-10.0 keV,

: 0.245-10 keV (-1)

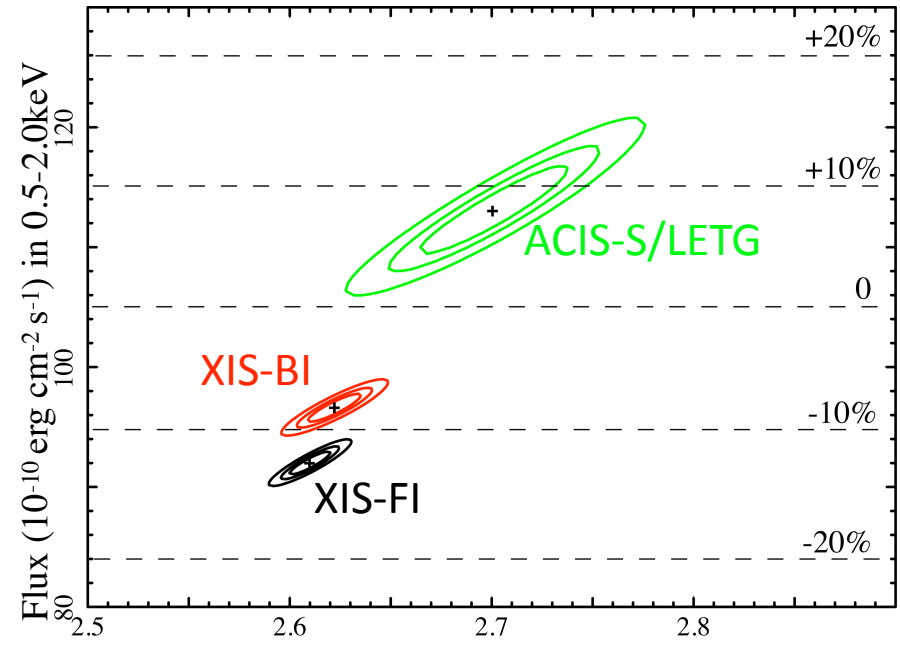
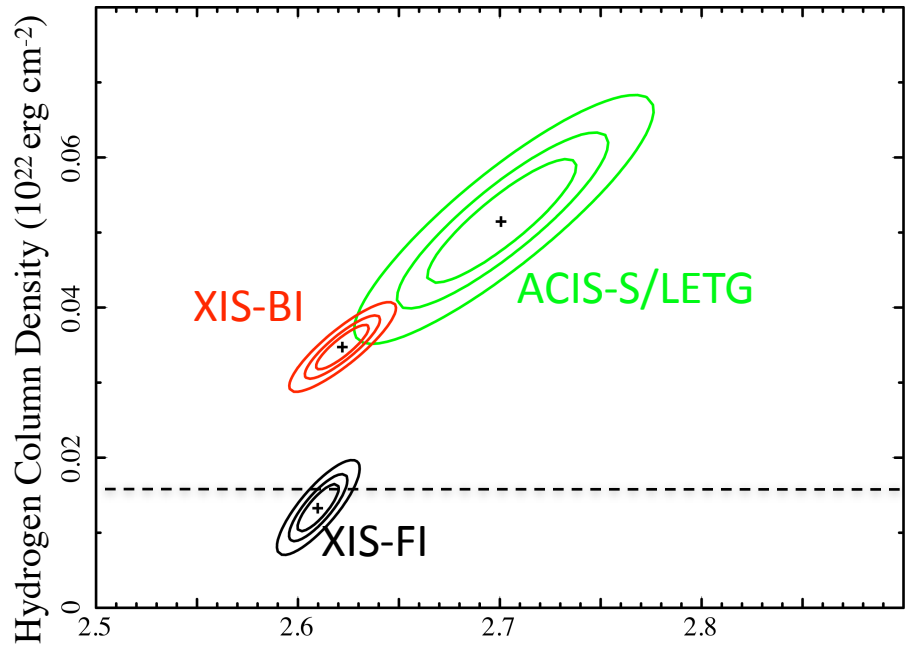


Photon index: 2.53-2.59

HRC/LETG flux in 2006 is larger than those of XIS by 5-10%

# XIS/ACIS-S+LETG parameters (2008)

XIS-FI: 0.4-10.0 keV, ACIS-S/LETG: 0.4-10 keV  
XIS-BI: 0.3-10.0 keV



Photon index: 2.61-2.70

ACIS-S/LETG flux in 2008 is larger than that of XIS by ~20%.

# Summary

- Photon Index is consistent among all within  $\sim 0.1$ .
- Flux
  - HRC/LETG flux is larger than that of XIS by  $\sim 10\%$  in 0.5-2keV in 2006.
  - ACIS-S/LETG flux is larger than that of XIS by  $\sim 20\%$  in 0.5-2keV in 2008.
- Need more calibration for years later than 2008 at least.
  - Suzaku spectral calibration is relatively poor in 2008.
  - NH determined by ACIS-S/LETG is larger than the galactic value in 2008.