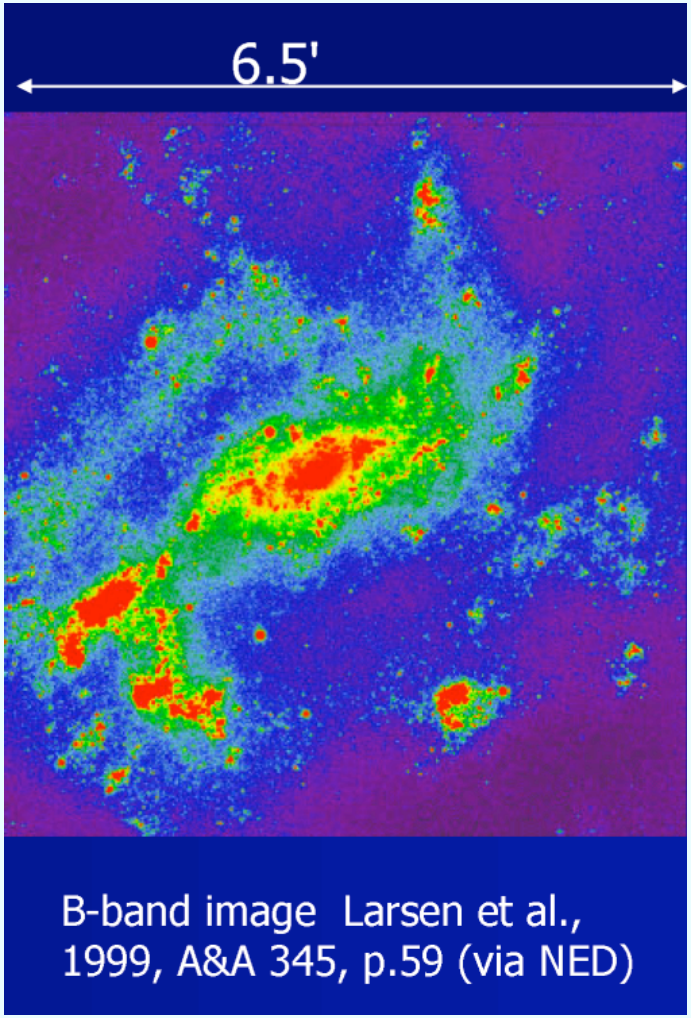
Suzaku Observation of NGC 4395:

Very hard X-ray spectrum and strong variability of the smallest known AGN

K. Iwasawa, L. Gallo and Y. Tanaka

"The Suzaku X-Ray Universe", San Diego CA, December 10-12, 2007

Interests of X-ray observation of NGC 4395



B-band image Larsen et al., 1999, A&A 345, p.59 (via NED)

NGC 4395 (@4.3 Mpc) hosts the smallest and the least luminous AGN so far known.

Yet, Bona-fide Type I AGN with BLR

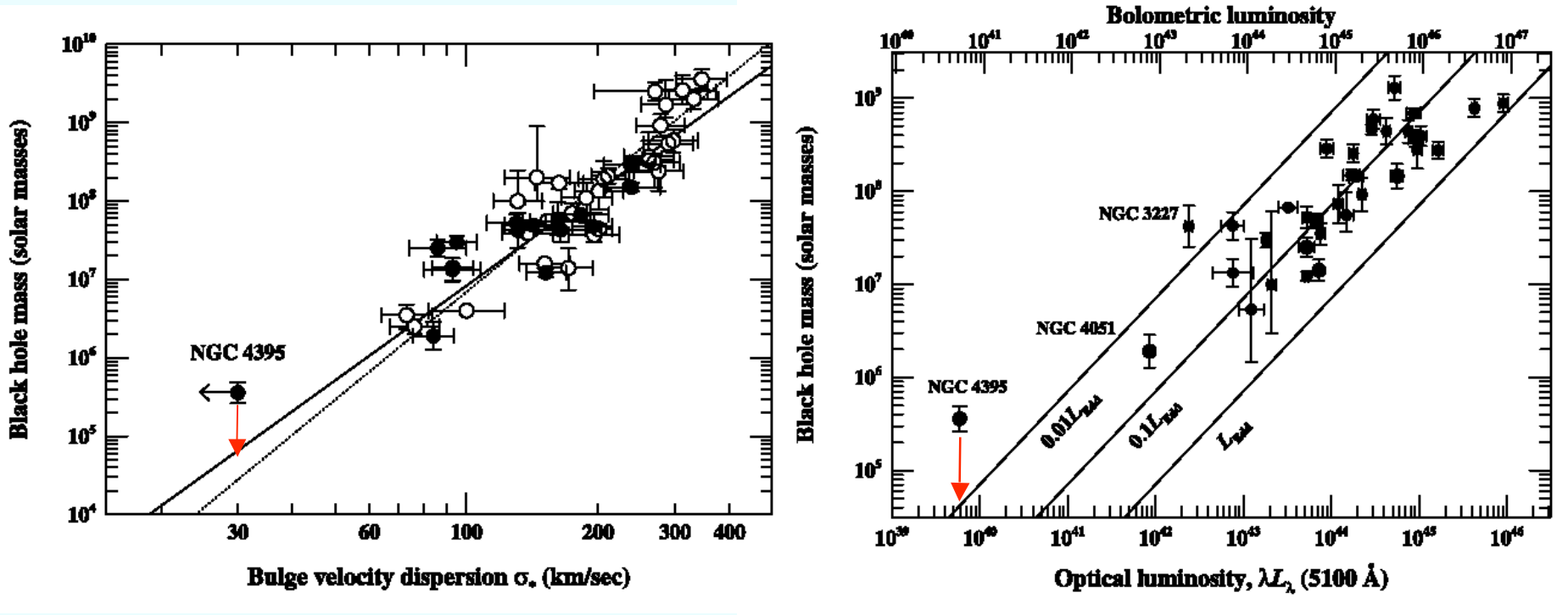
NGC 4395: the smallest mass AGN

$M_{BH} \approx 3 \_10^{5} M_{sun}$ (reverb. Peterson et al.2005)

several $\times 10^{4}$ M_{sun} (other estimates)

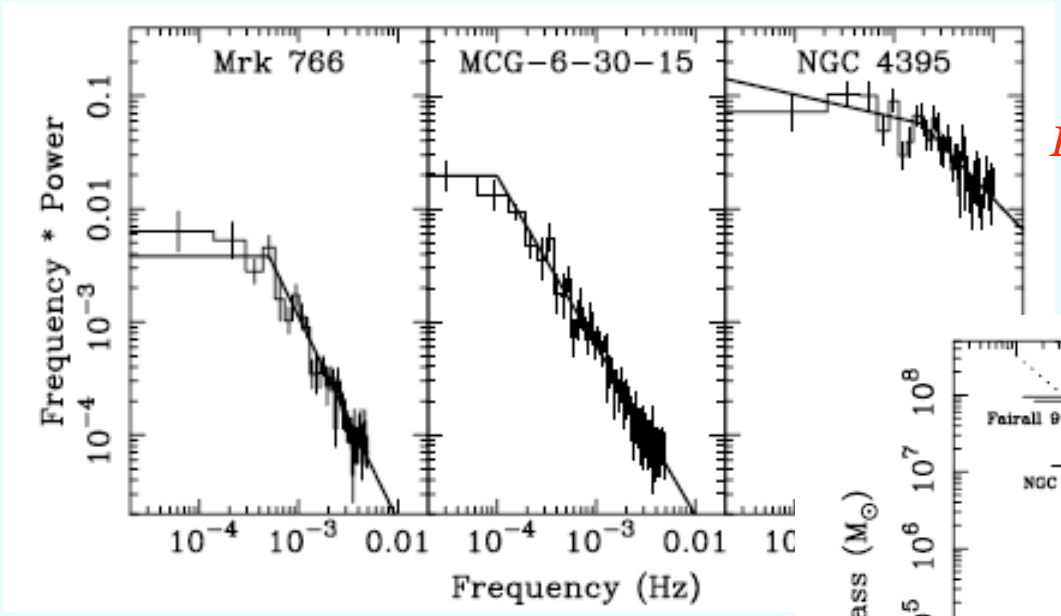
$L_{bol} \sim 5 \_10^{40}$ erg/s (Peterson et al. 2005)

$L_{bol}/L_{Edd} \sim 1\%$, cosistent with typical Sy1 value

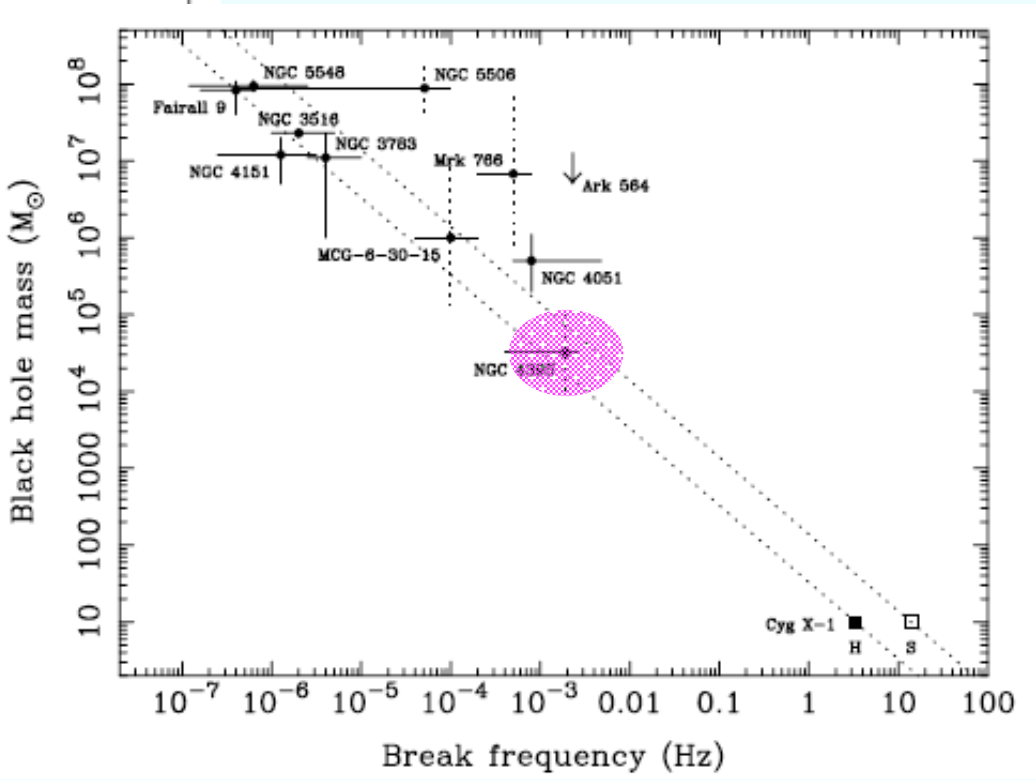


Peterson et al. 2005

X-ray variability power-spectrum of NGC4395



Fast & strong !

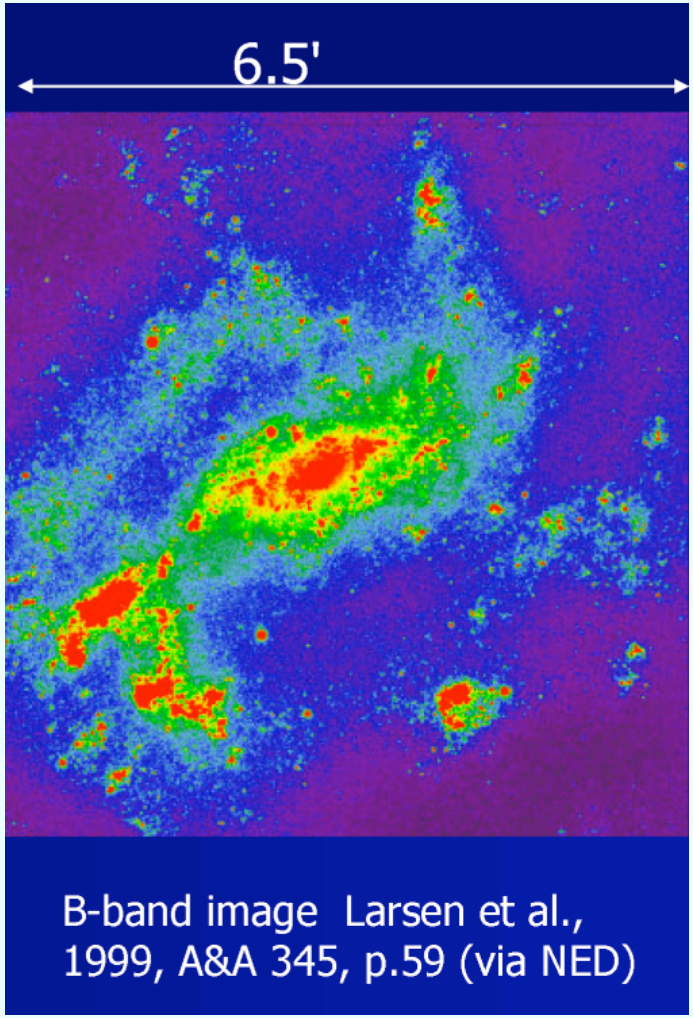


Cosmic black holes come in .....

X-ray binaries

Galactic nuclei

Interests of X-ray observation of NGC 4395



B-band image Larsen et al., 1999, A&A 345, p.59 (via NED)

NGC 4395 (@4.3 Mpc) is the smallest and the least luminous AGN so far known.

Yet, Bona-fide Type I AGN with BLR

Unique characteristics:

extreme time variability

unusually hard spectrum (>10 keV spectr. important)

Lowest-mass key point for the study of mass-scaling of BH properties

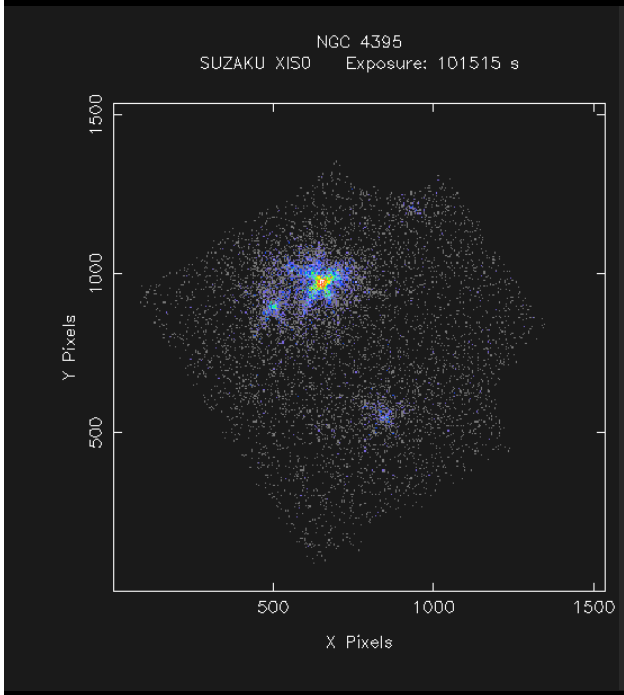
Suzaku observation (2007)

Peroformed on June 2 - 5, 2007

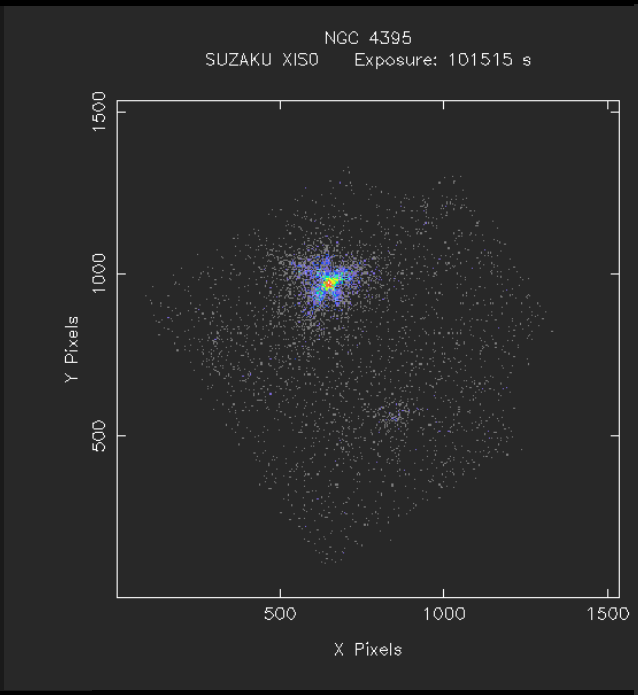
Exposure time ~ 100 ksec

XIS0

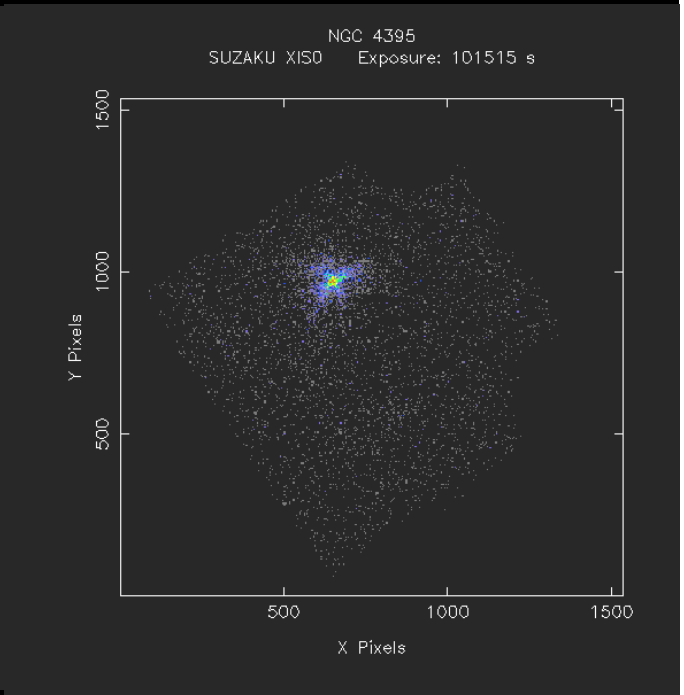
1 – 3 keV



3 – 5 keV

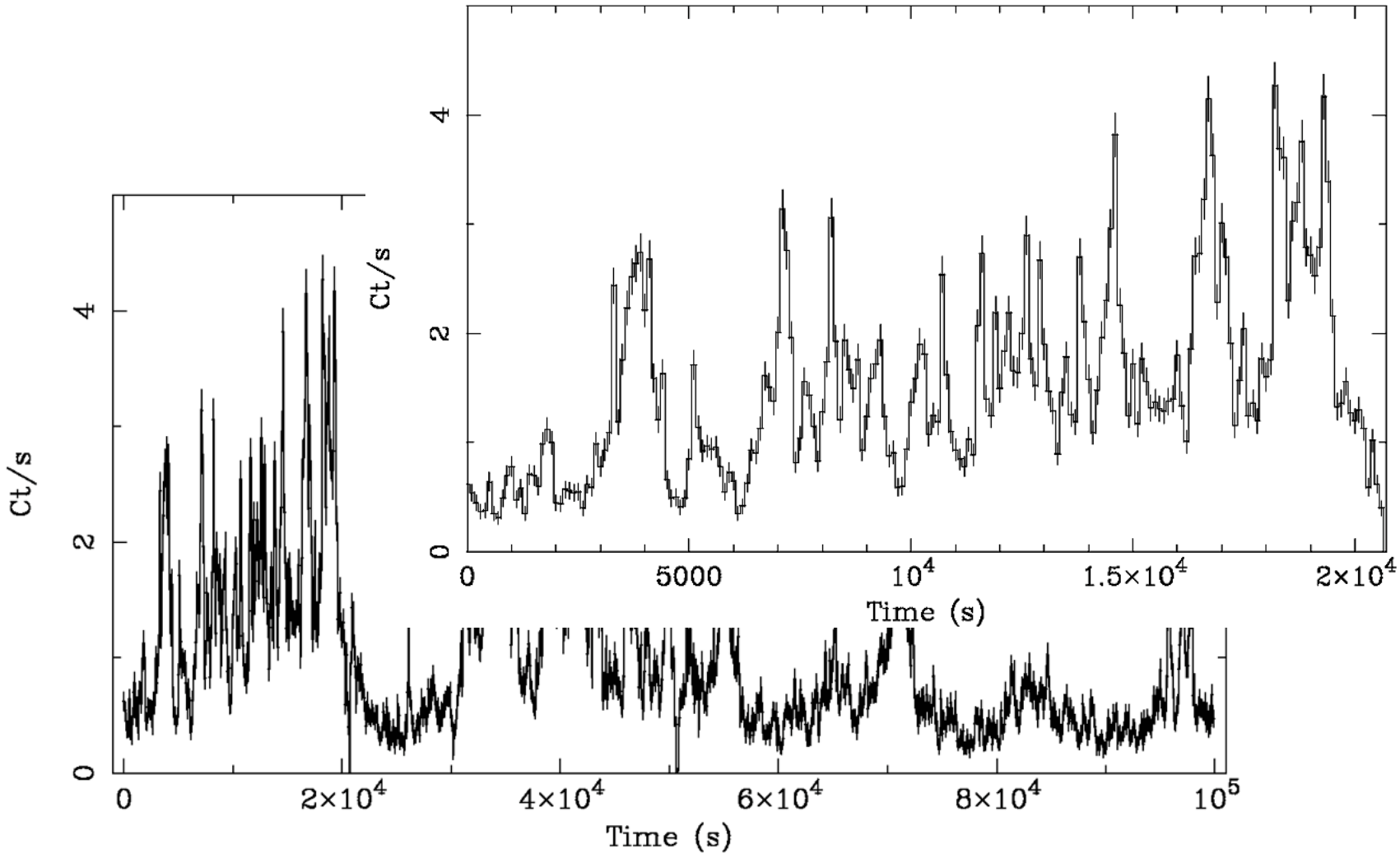


5 – 8 keV



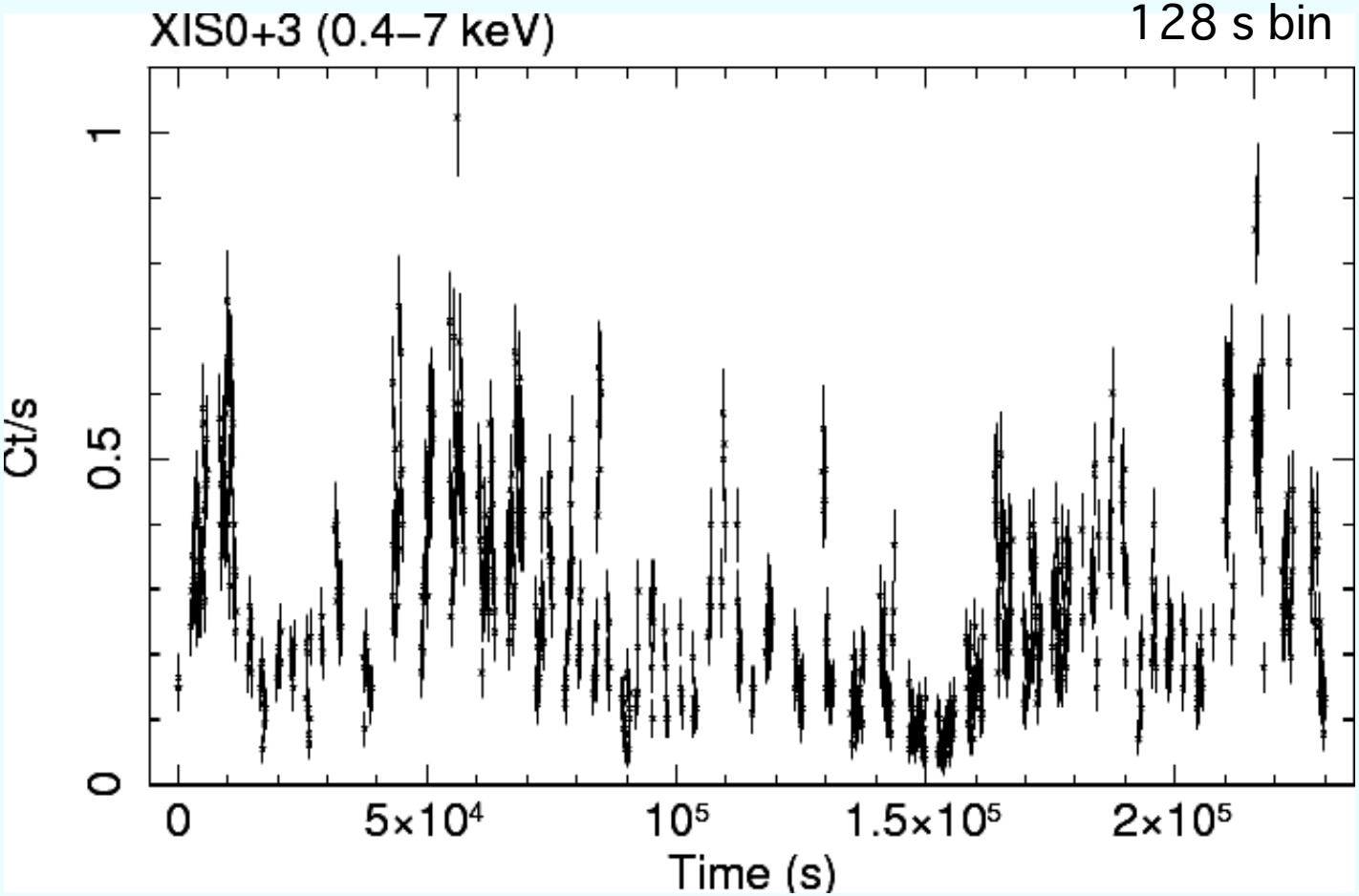
Murakami

X-ray light curve from a long XMM observation (2003)



Vaughan et al 2004

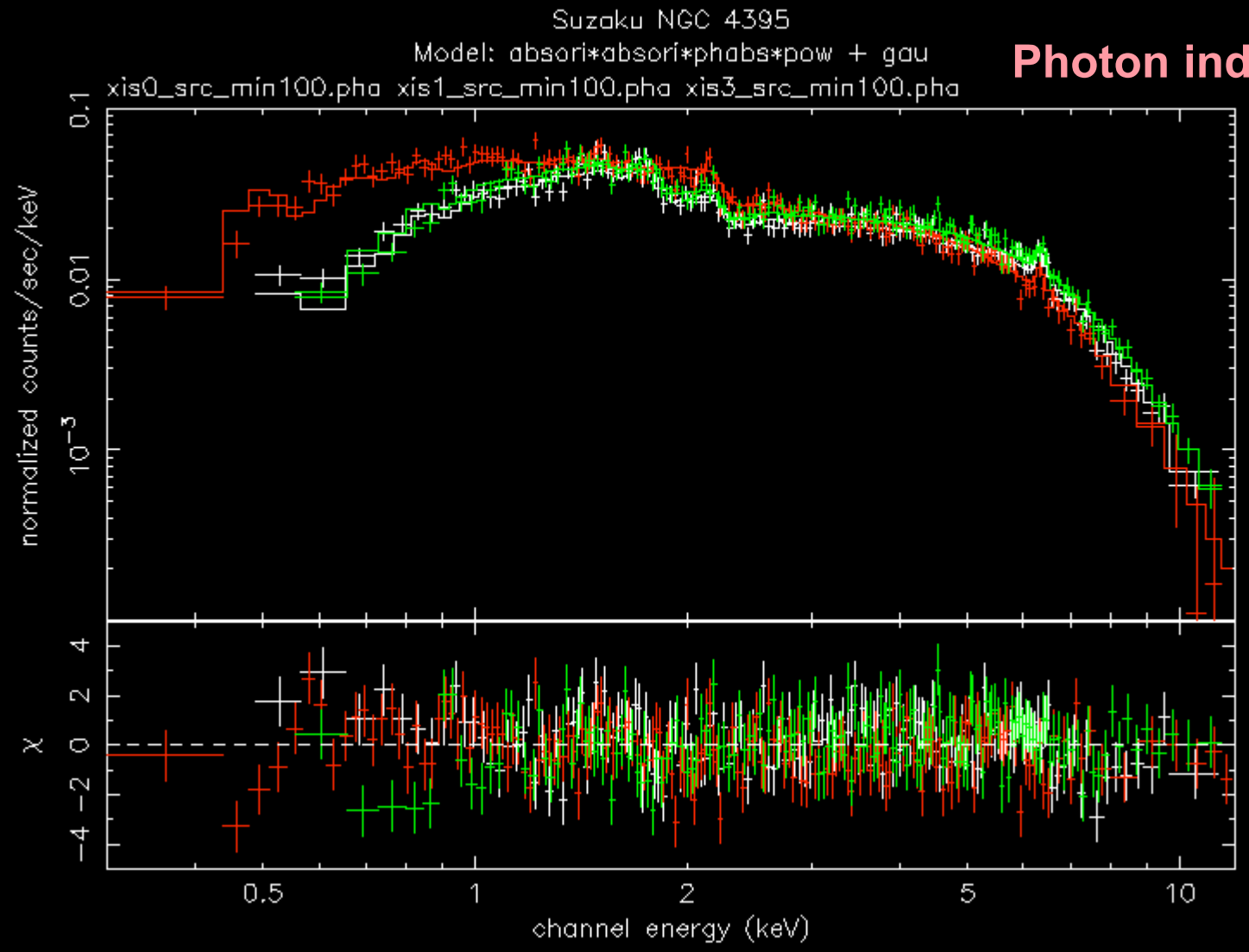
Suzaku observation (2007)



Suzaku observation (2007)

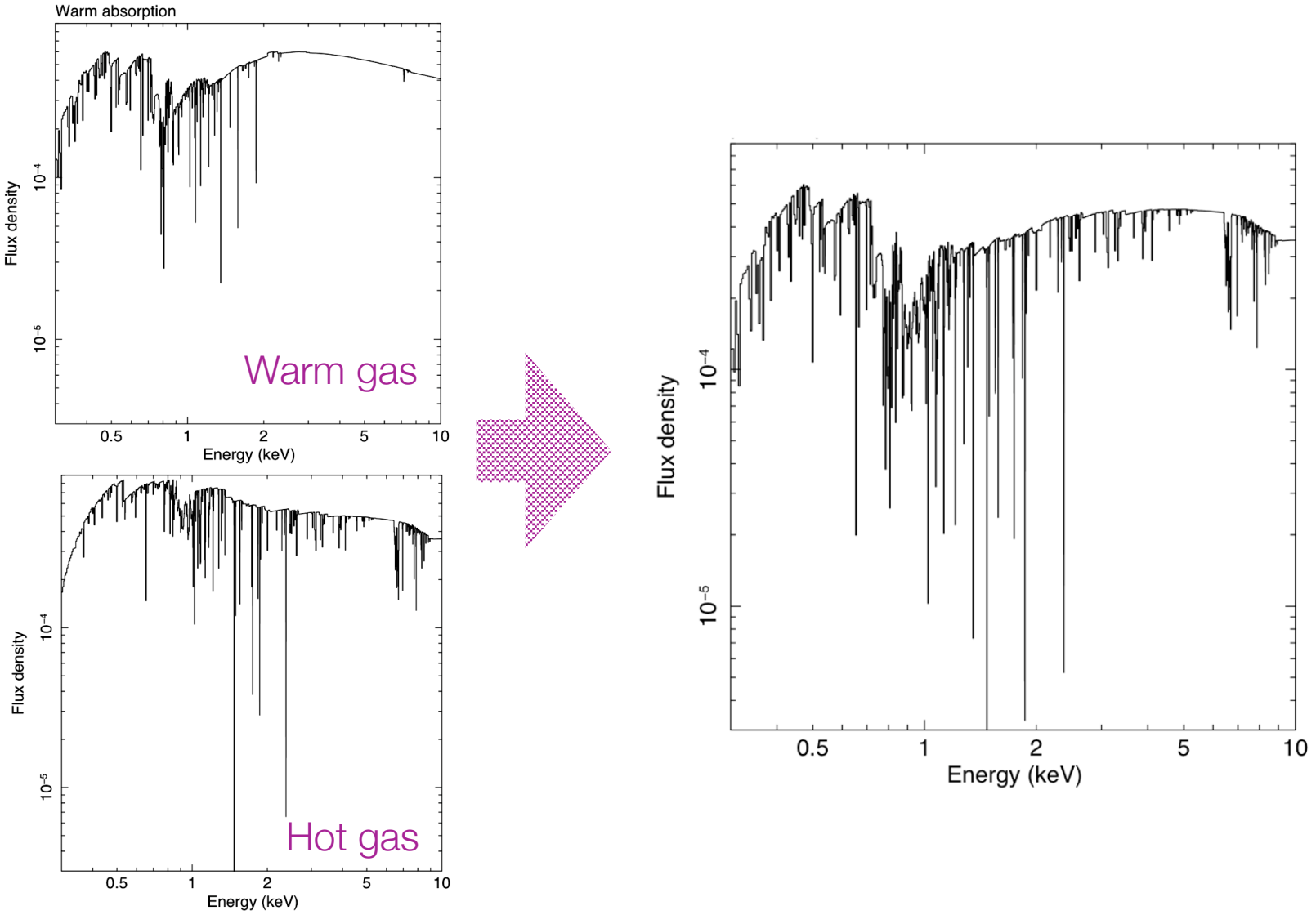
XIS0,1,3 simultaneous fit

Three (neutral, warm, hot) absorbers required



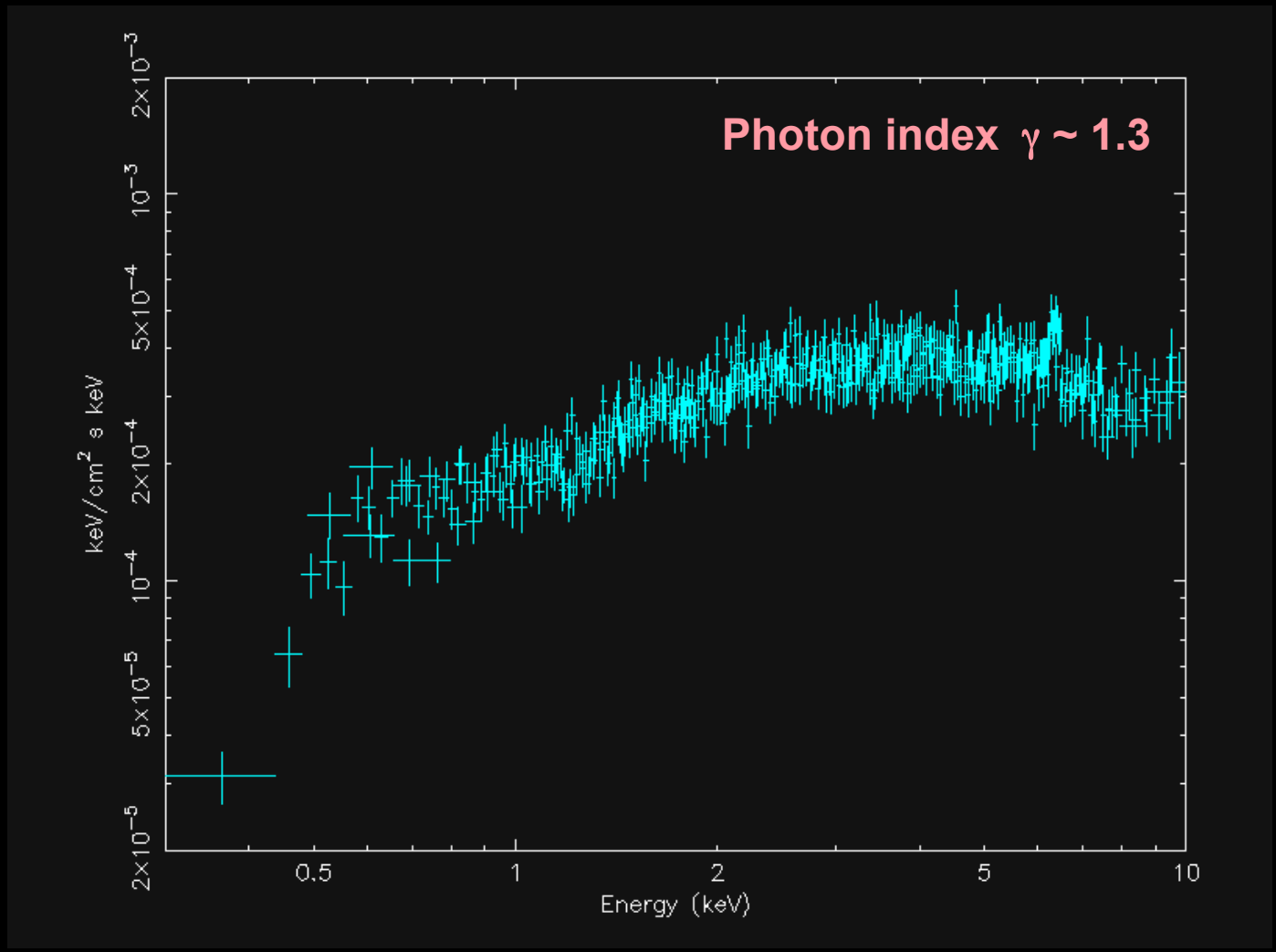
Photon index $\gamma \sim 1.3$!

Multi-zone absorber of ionised gas



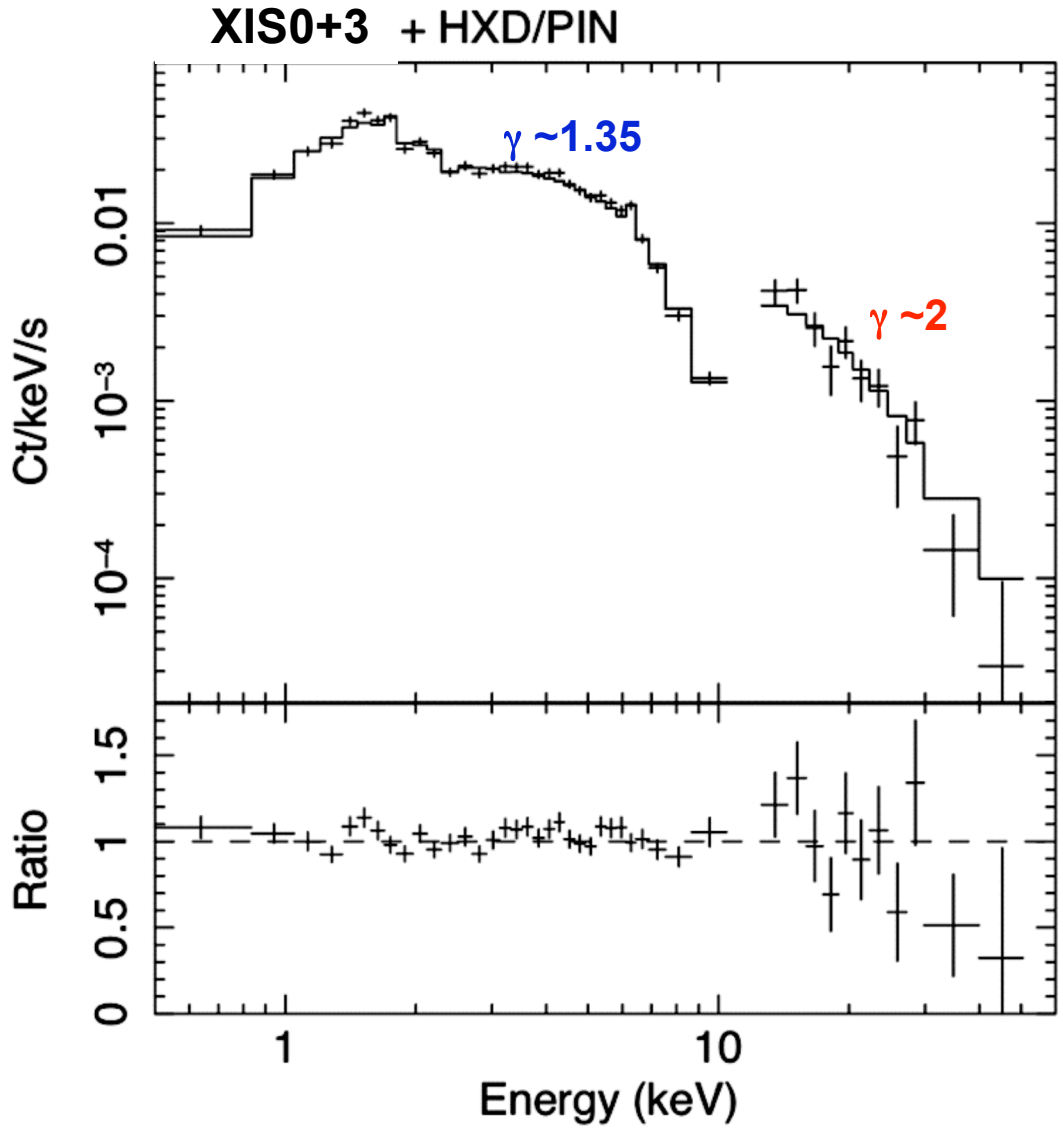
Suzaku observation (2007)

Flux density from XIS0,1,3 simultaneous fit with three (neutral, warm, hot) absorbers



Suzaku observation (2007)

Time-averaged wide-band spectrum



***XSTAR* parameters:**

Log ξ_1 **= 1.5**
$N_{H\text{-}1}$ **= 1.4e22**

Log ξ_2 **= 2.9**
$N_{H\text{-}2}$ **= 9e22**

N_{Hcold} **=1.4e21**

γ **=1.35± 0.1 <10 keV**

γ **=2.0-2.3 >15 keV**

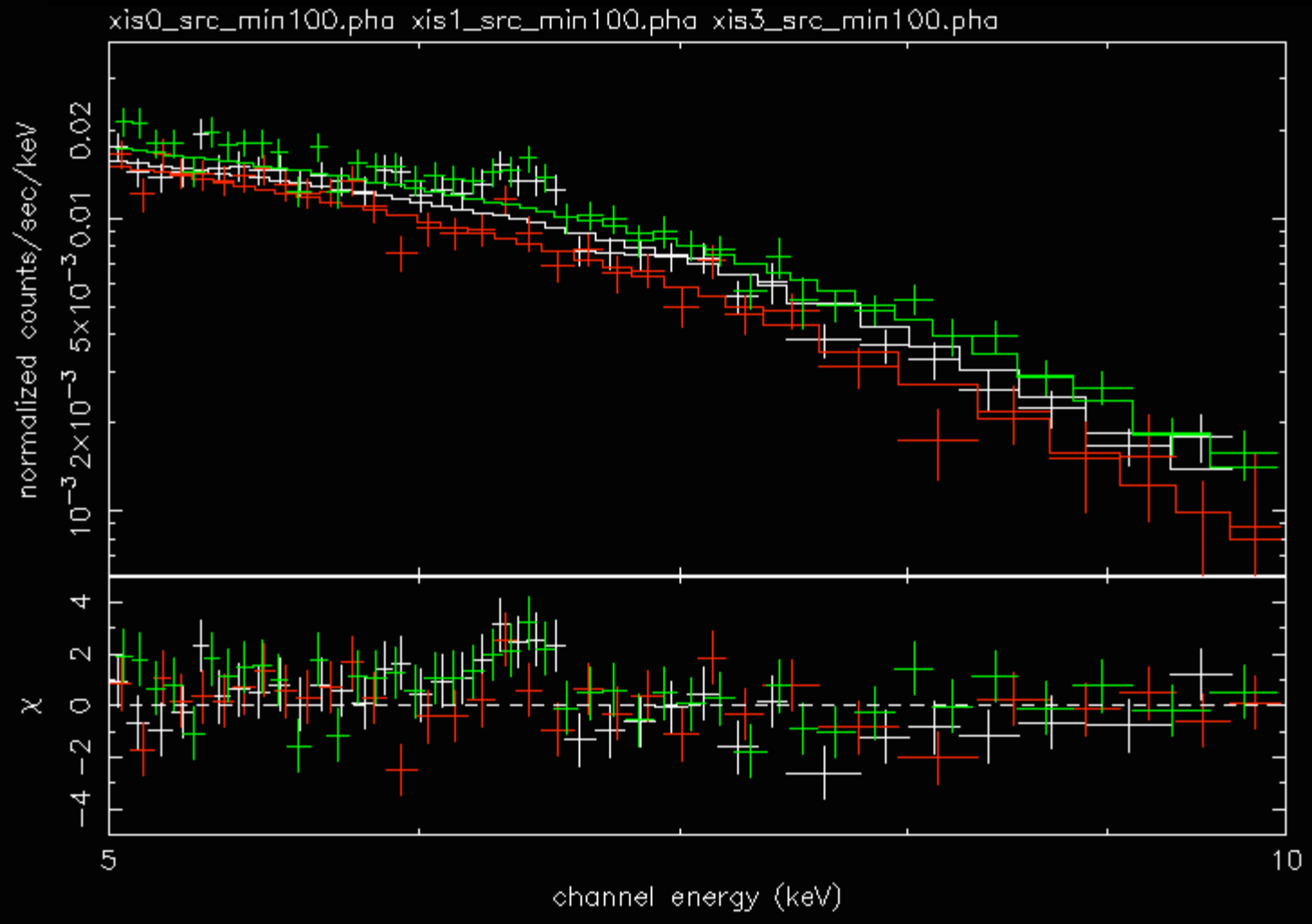
Spectral break around 10 keV likely.

Reflection hump not dominant

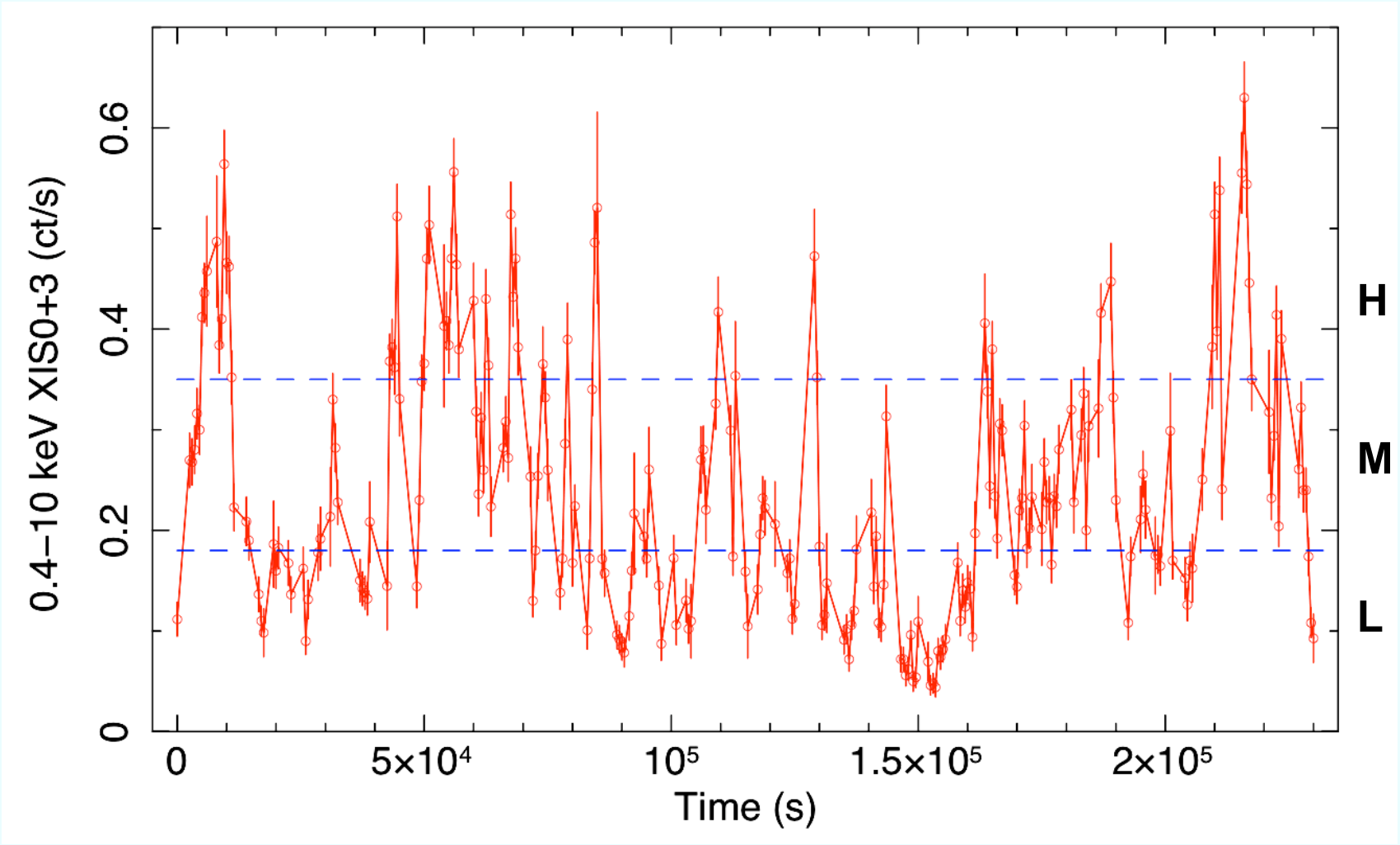
Suzaku observation (2007)

Fe K-line: if a Gaussian, σ~80eV

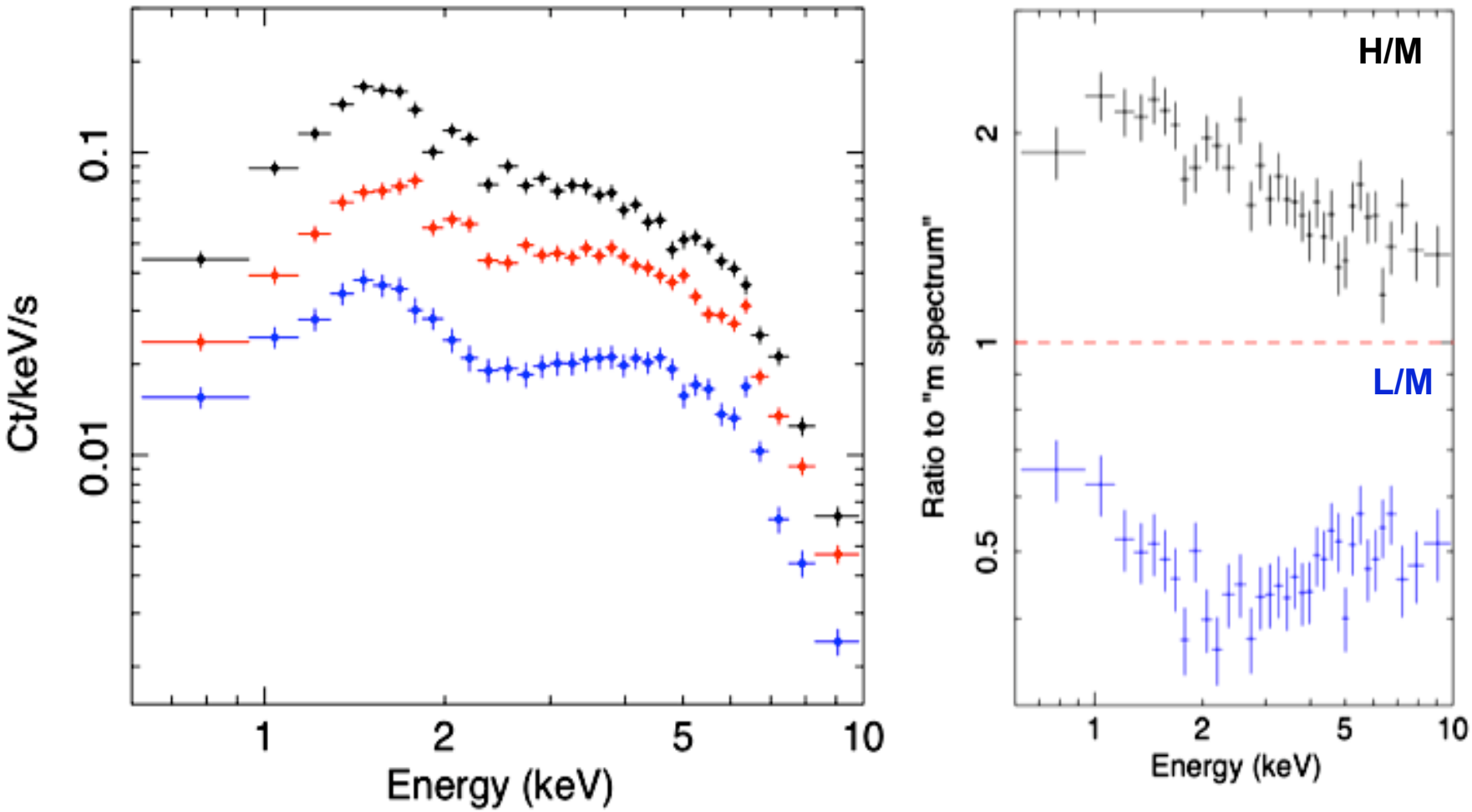
hint of a red wing



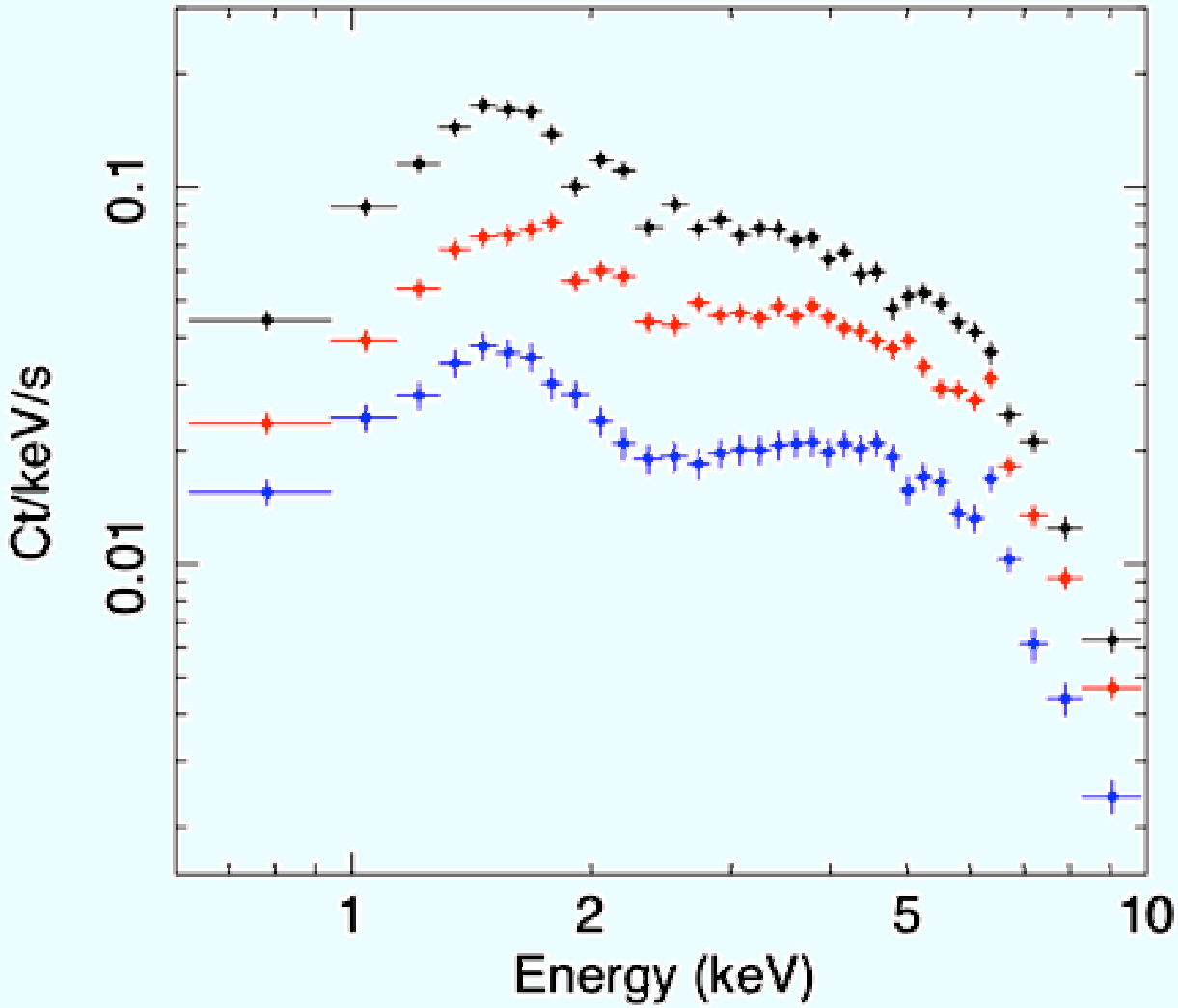
High, Medium, Low Flux Slices



High-, Med-, Low-flux Spectra

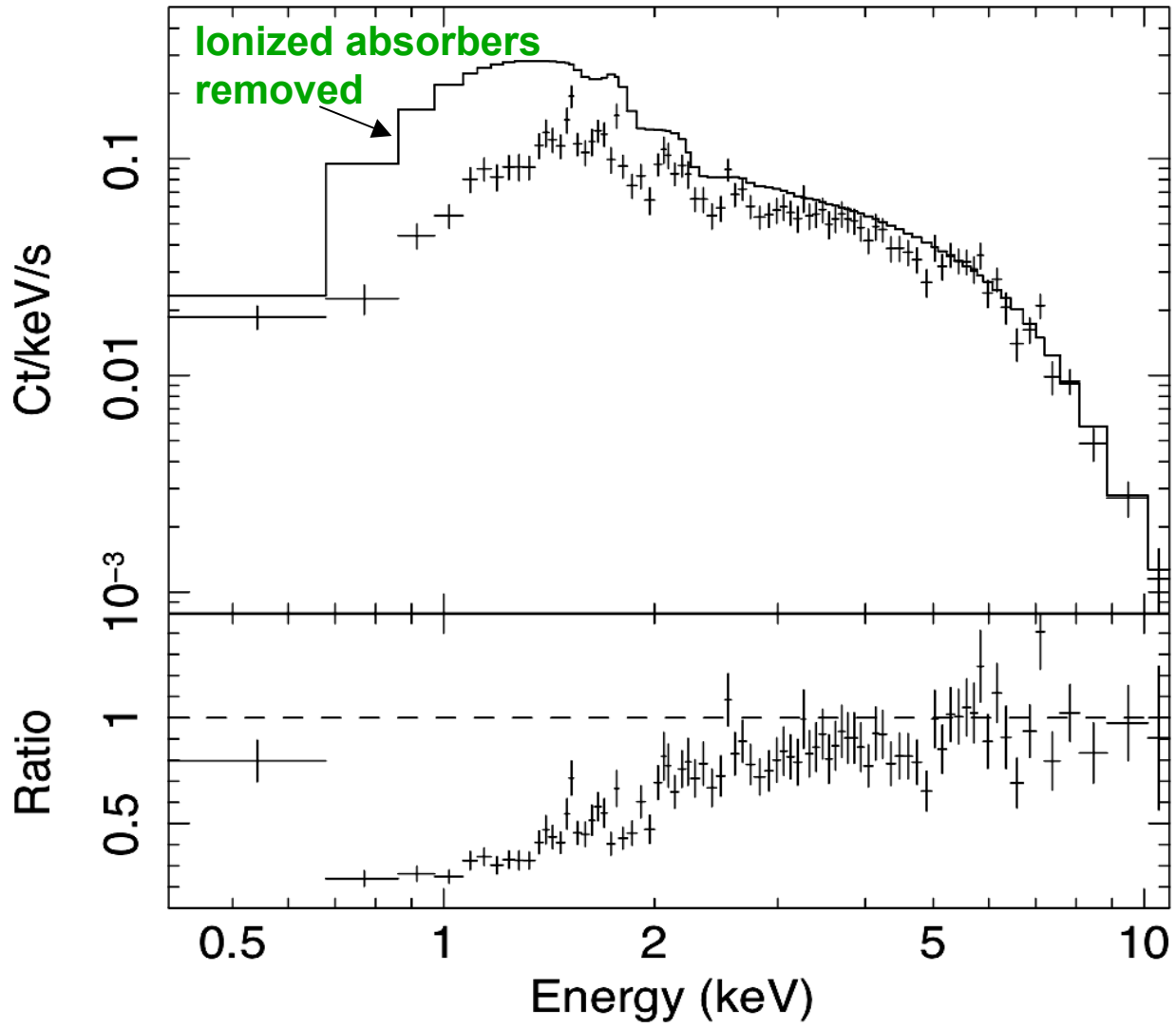


High-, Med-, Low-flux Spectra



Difference Spectrum:

High-flux spectrum – Low-flux spectrum

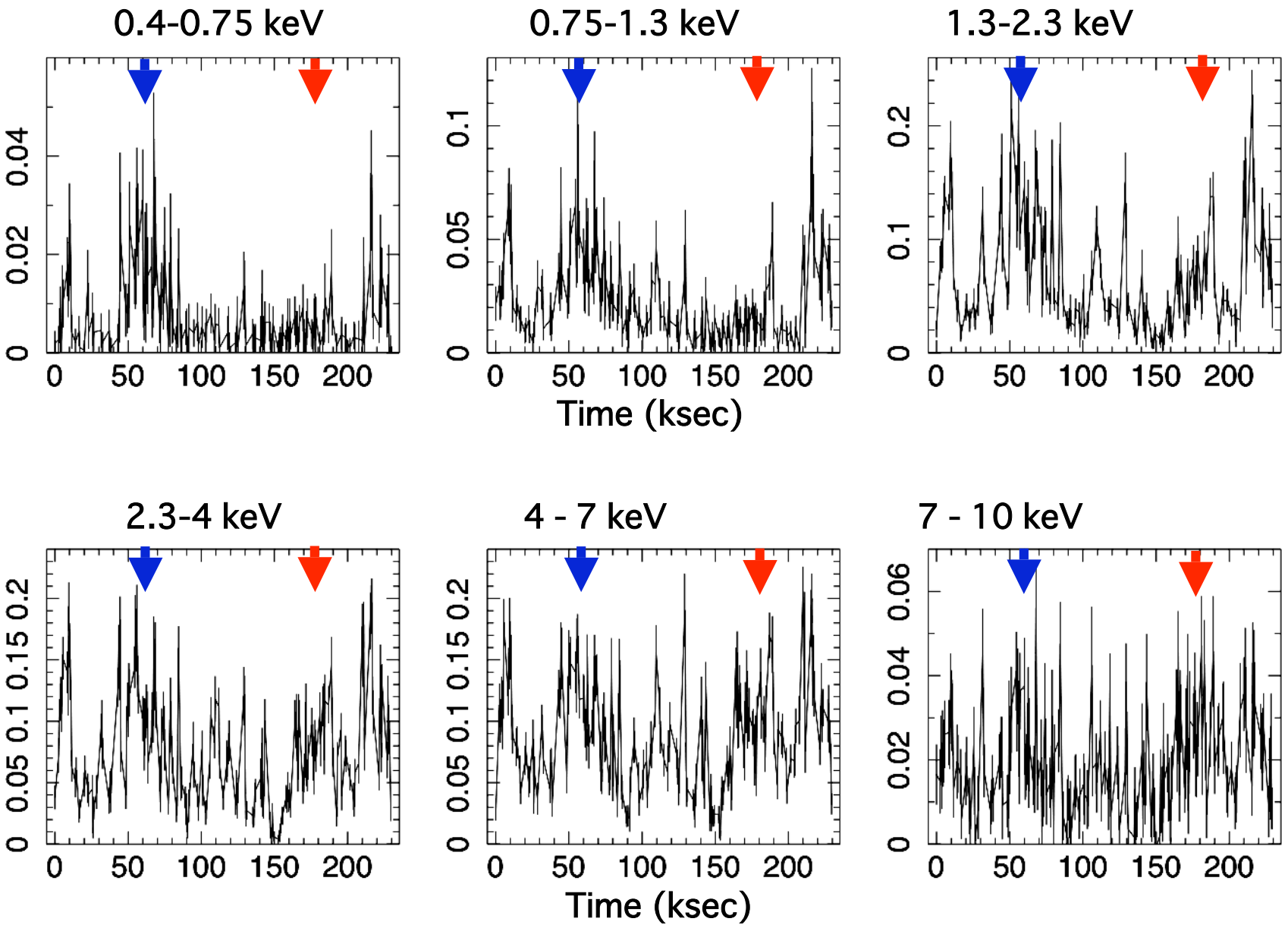


If the parameters of the ionized absorbers are fixed to the values for the time- averaged spectrum, the photon index of the difference is ~1.7.

However, this may not be the unique solution.

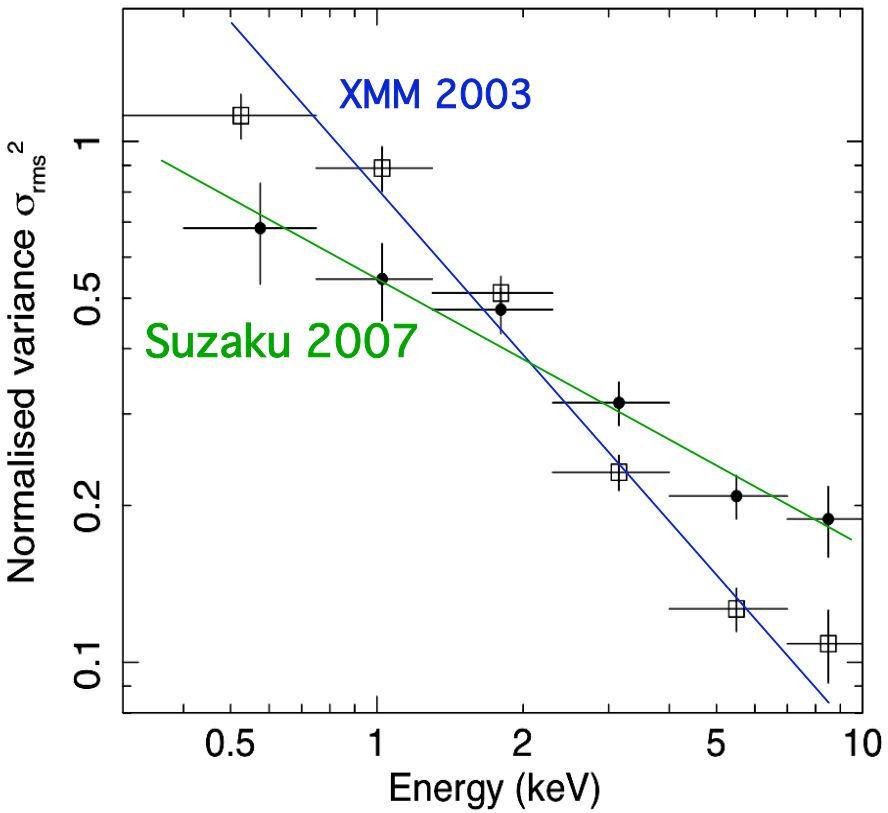
HXD/PIN data statistically insuffi-cient to link.

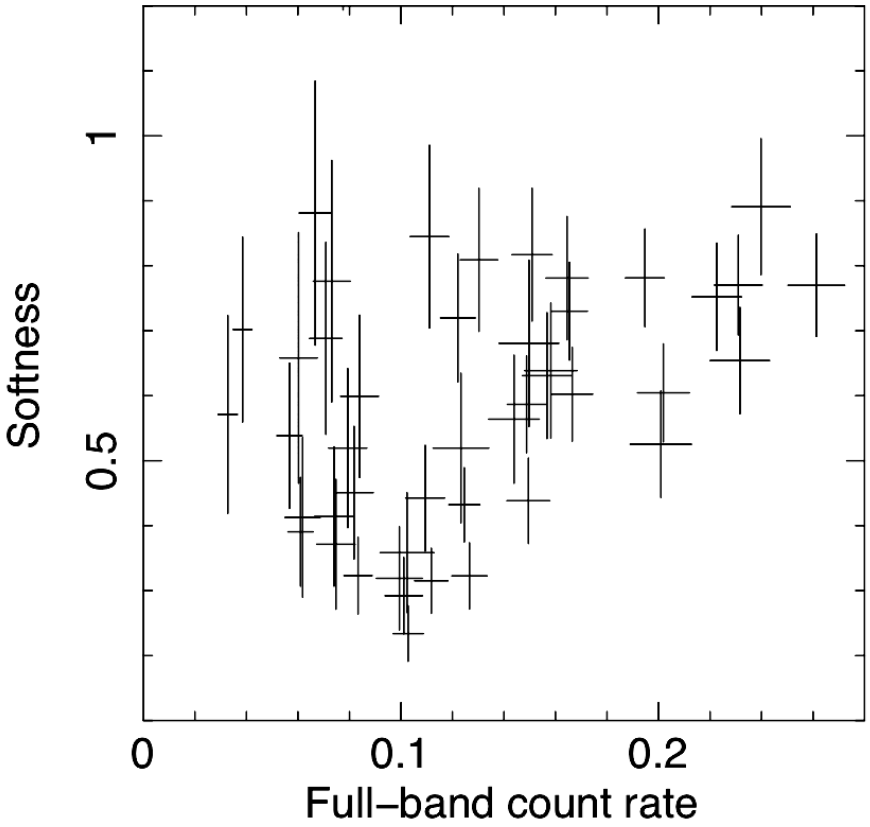
Suzaku observation (2007)



Complex variability

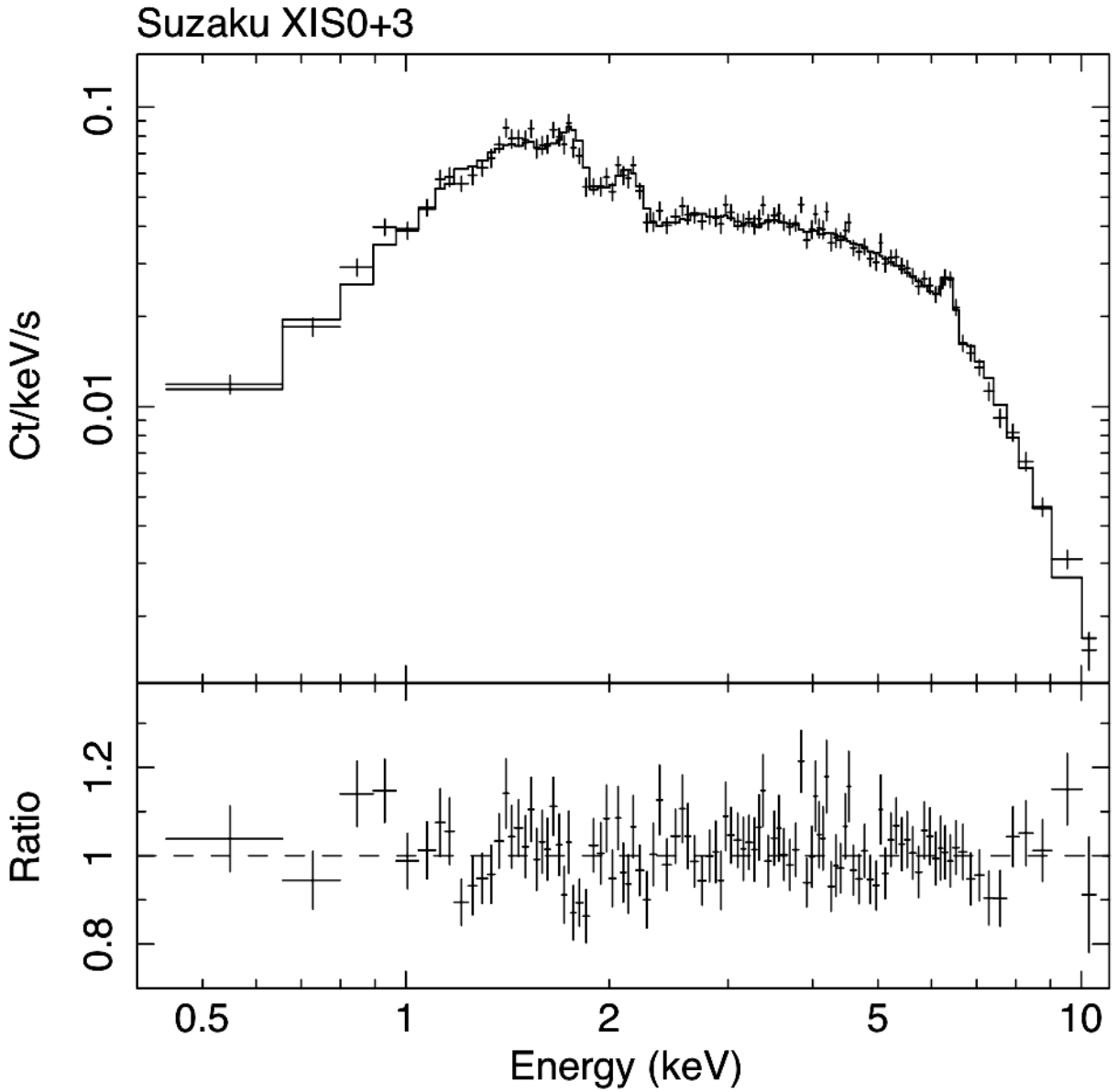
Pivoting? Not enough



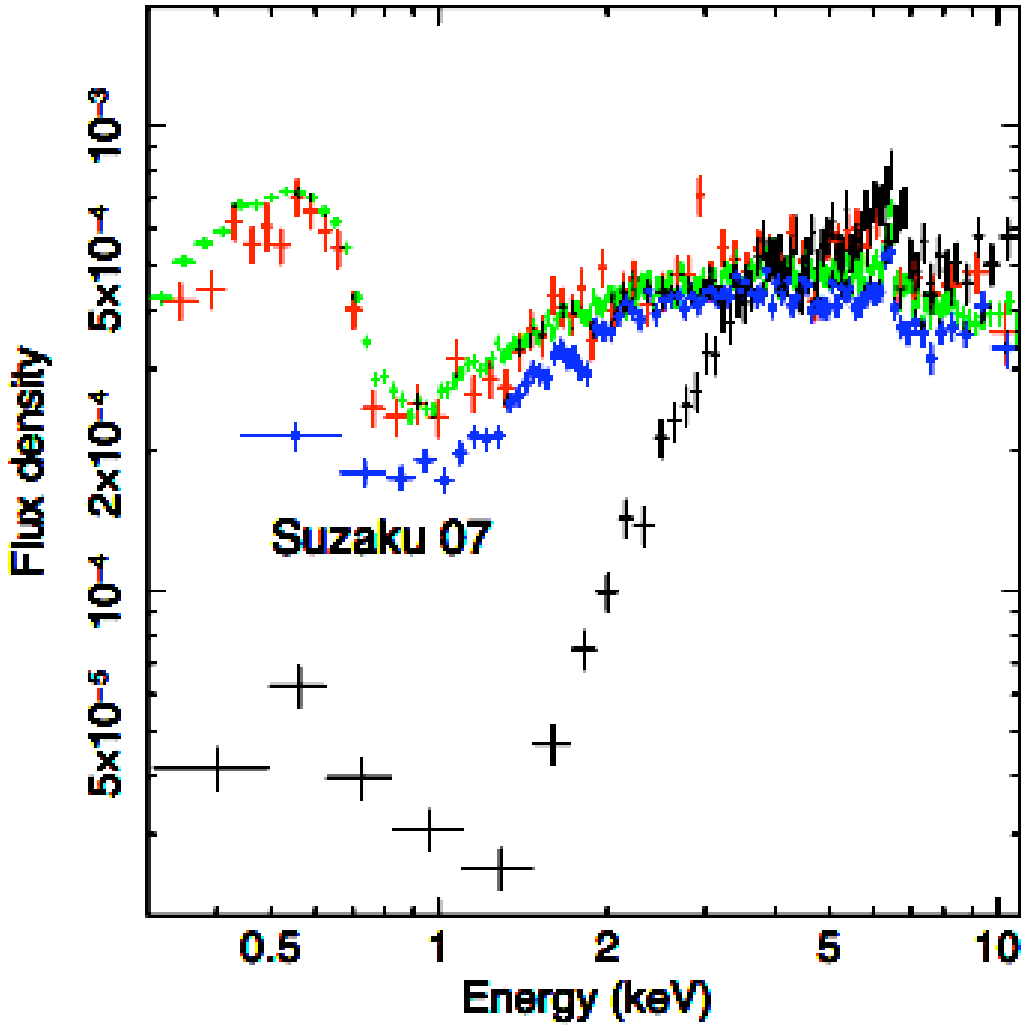


Summary

- **Spectrum > 10 keV measured first time**
- **Hardening above 10 keV (γ: 1.4→ >2)**
- **Reflection component *not* dominant**
- **The hardest AGN (why γ<<1.8?)**
- **Complex (soft vs hard) time variability**
- **Spectral pivoting not confirmed (nor refuted)**
- **Better PIN data essential**


Suzaku XIS0+3
Ct/keV/s
0.1
0.01
Ratio
1.2
1
0.8
0.5
1
2
5
10
Energy (keV)

Long-term variations of absorbers



Long-term variations of absorbers