Anatomy of the AGN in NGC 5548: Evidence for an unexpected, new, heavy, variable and complex absorber

- EPIC data analysis (work in progress)

Massimo Cappi

INAF/IASF-Bologna

Outline

1. Timing Analysis
   1. *Lightcurves*
   2. *Fvar*
2. Spectral Analysis
   1. *CTI*
   2. *Reflector*
   3. *Obscurer*
3. *Conclusions & Remaining issues?*

See also tomorrow's press release

Special thanks to B. De Marco, G. Ponti, P.O. Petrucci, F. Ursini, S. Bianchi, G. Matt, and the whole NGC5548 collaboration, of course

Data selection and reduction

- Used all available XMM observations, i.e:
  - 3 “old” (archival) observations performed in 2000 and 2001
  - 14 “new” observations from our campaign (12 in July 2013 + 1 in Dec. 2013 + 1 in Feb. 2014)
  - In total 17 observations

- Reduction typically standard (for both pn and MOS), except for the need to use (and test) 3 different CCF-CTI corrections (August, Dec. 2013 and Feb. 2014) to attempt correction of the pn CTI current offset/degradation.

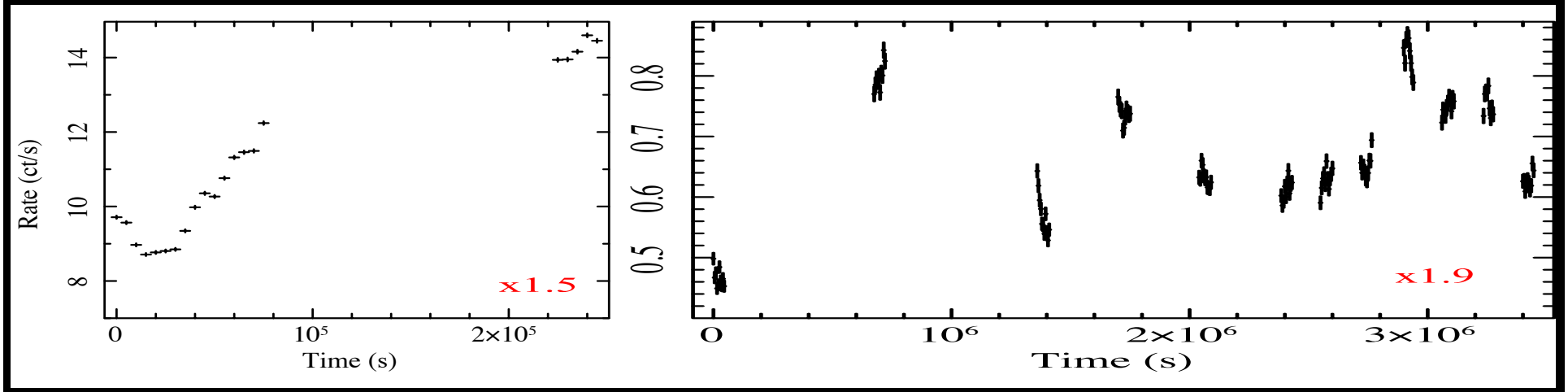
  Unavoidable at the end:

  E(pn)=E(MOS)+40-60 eV @6 keV ; σ(pn)=50 eV (systematics)

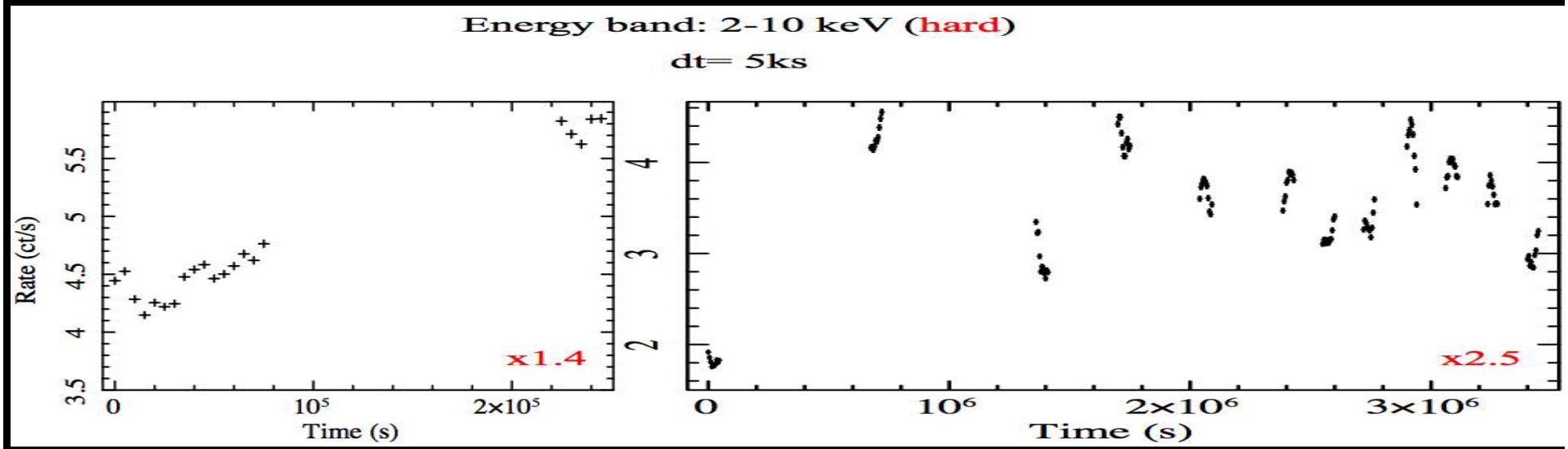
- Special Thanks to Matteo Guainazzi and Michael Smith (ESA/SOC) for promptly facing this issue. Looking forward for the new implementation of correction propt(quiescent background level)
  – see XMM-SOC-CAL-TN-0018 + presentation at User Group on April 10th

Timing Analysis

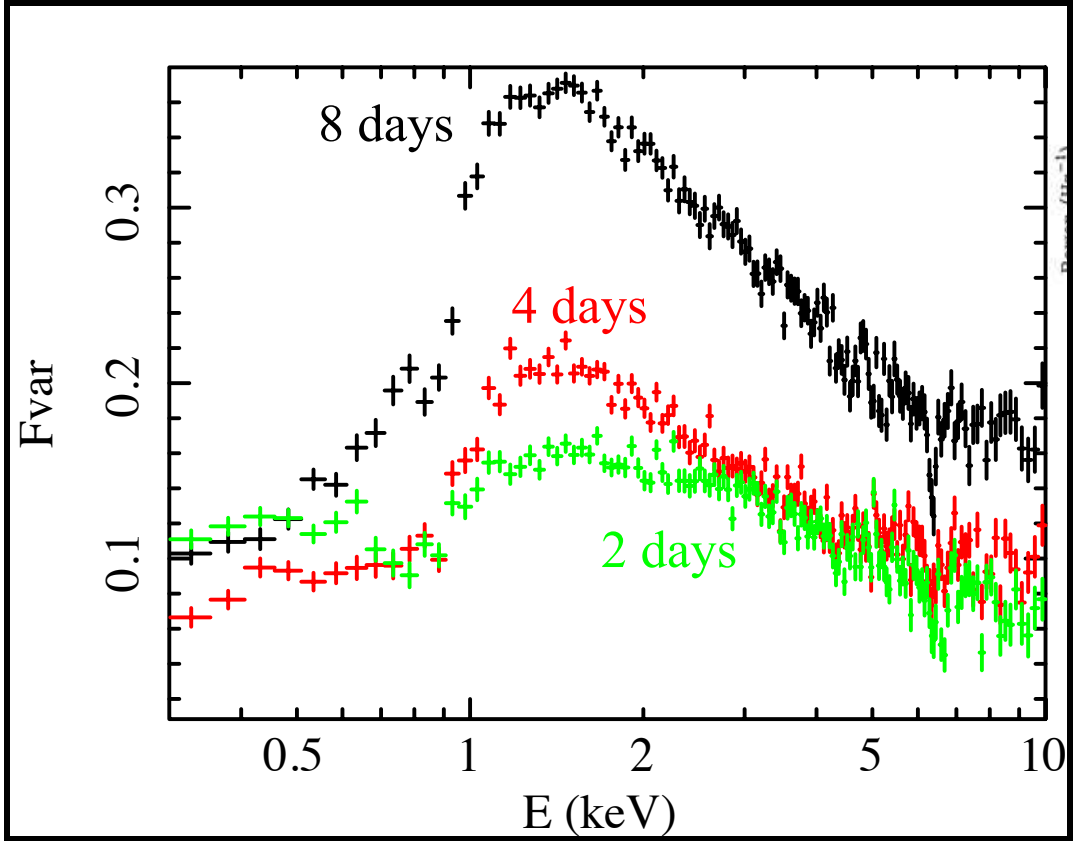
0.3-2 keV lightcurve dt=5ks

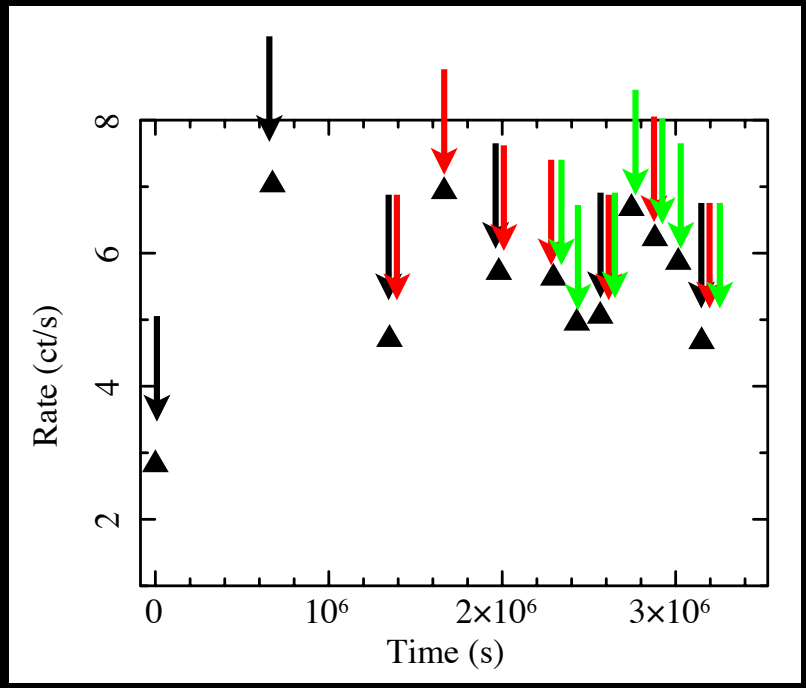


2-10 keV lightcurve dt=5ks



Timing Analysis: Fractional variability during the July campaign





① Most of variability between 1-5 keV (Complex absorption?)
② Constant narrow FeK emission (and therefore reflection)
③ Variability between 0.3-0.8 keV ~ 8-10 keV (Partial covering?)

Timing Analysis: Fractional variability on long and short timescales

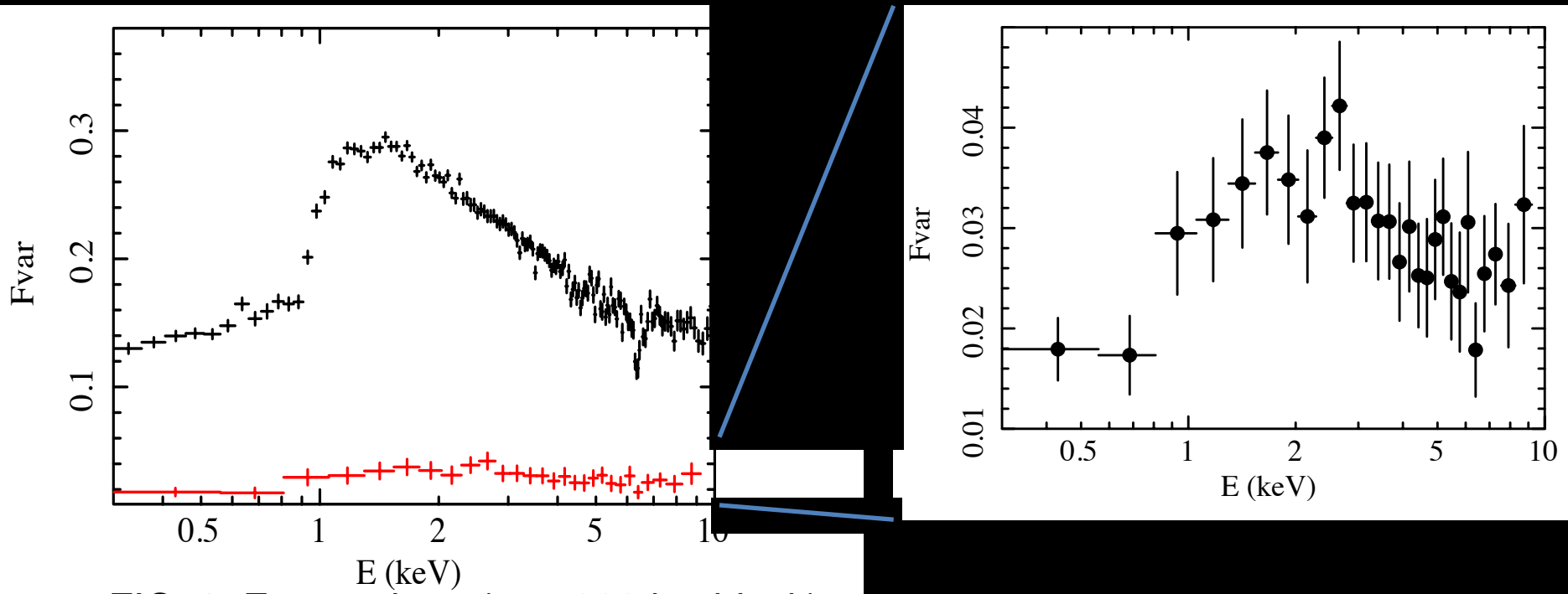
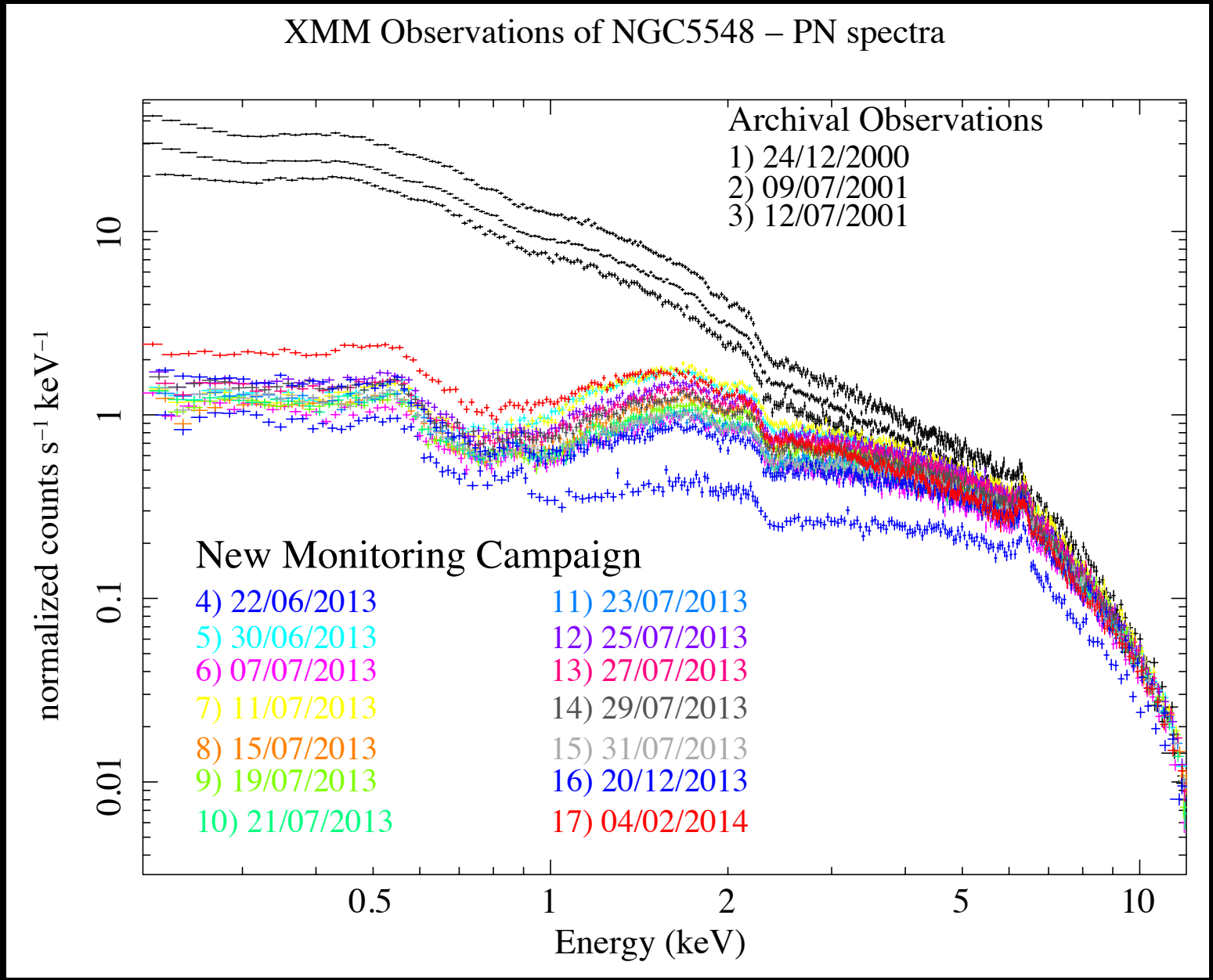


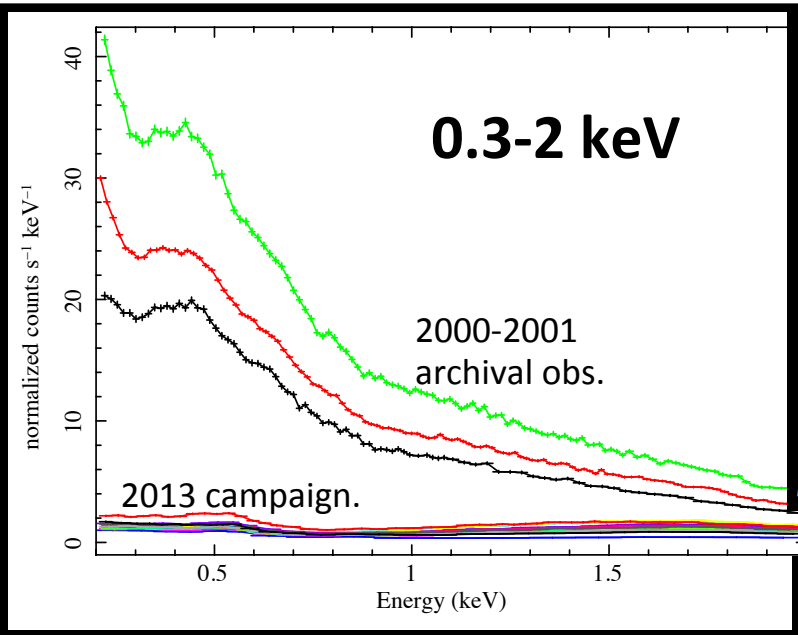
FIG. 2: Fvar on long (45-4000 ks, black) and on short (2-25 ks, red) time scales.

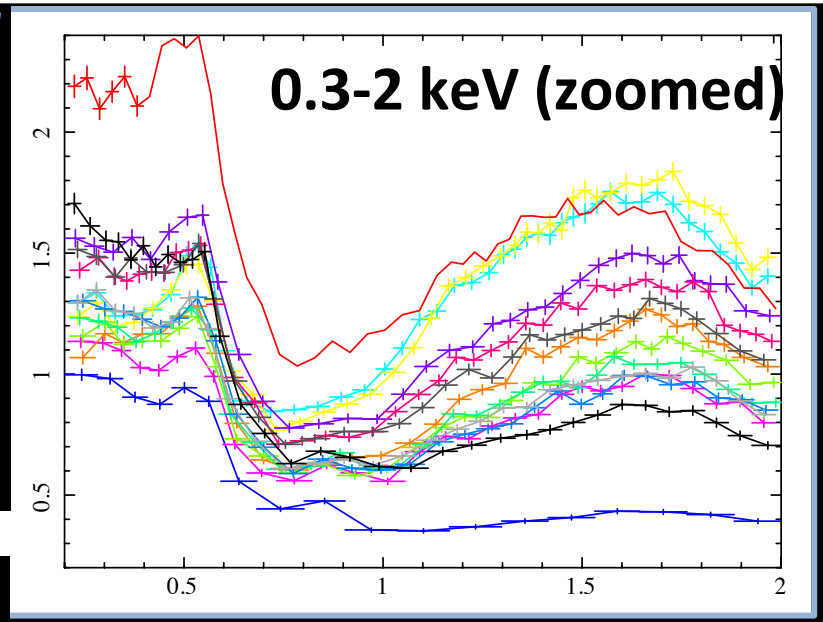
① Variability shape on short time scale similar to longer-term
② Consistent with only/mostly red-noise leak

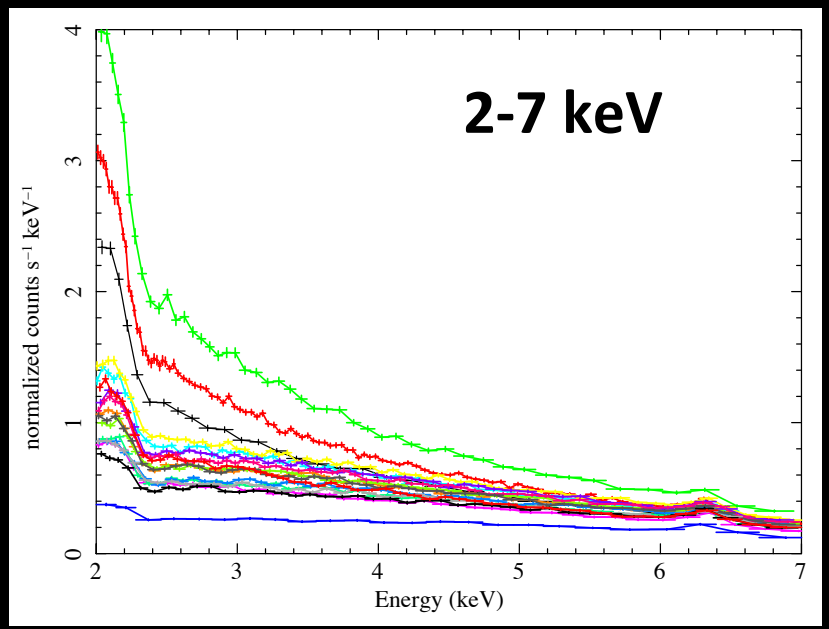
Spectral Analysis: all pn spectra

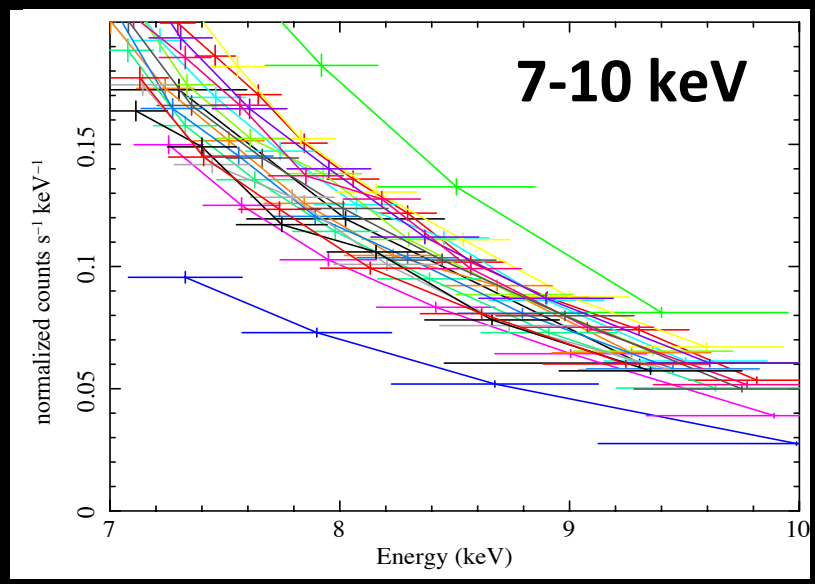


Spectral Analysis: complex spectral variability



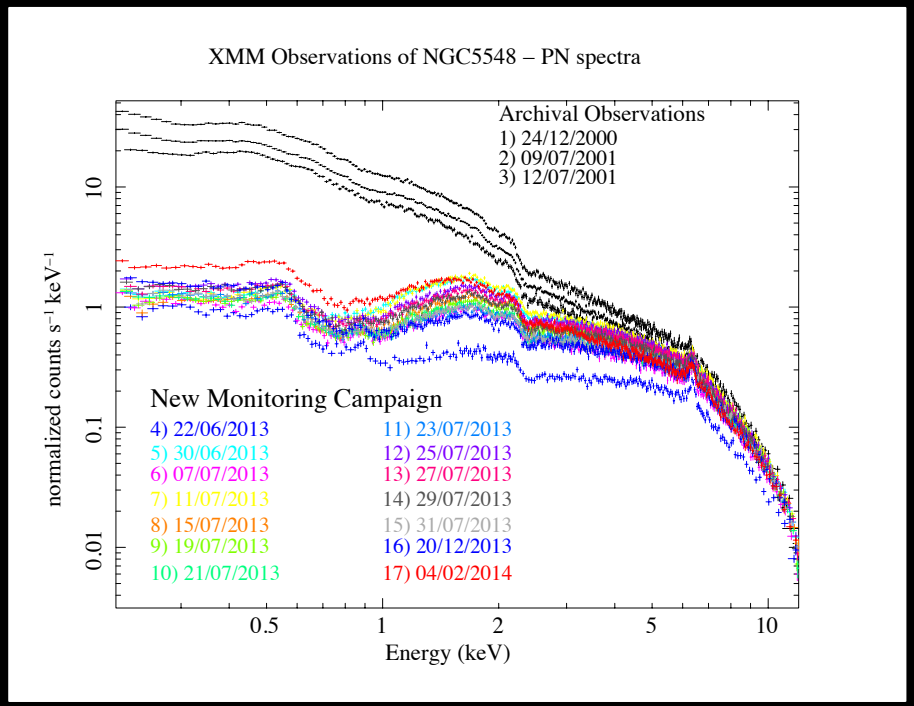






…and Nustar (4 obs.) show 10% variability
in the 10-80 keV band (see Francesco's next talk)

Spectral Analysis: complex spectral variability, and complex analysis



- Given the complexity of the spectra, and their complex variability, several approaches are possible:

- Different approaches followed:
  - ✓ each obs.-by-obs. Independent fitting
  - ✓ simultaneous fitting with1-3 and 4-17 grouped (or 1-3, 4 and 5-17)
  - ✓ Or average 1-3, 4, 5-15, 16, 17

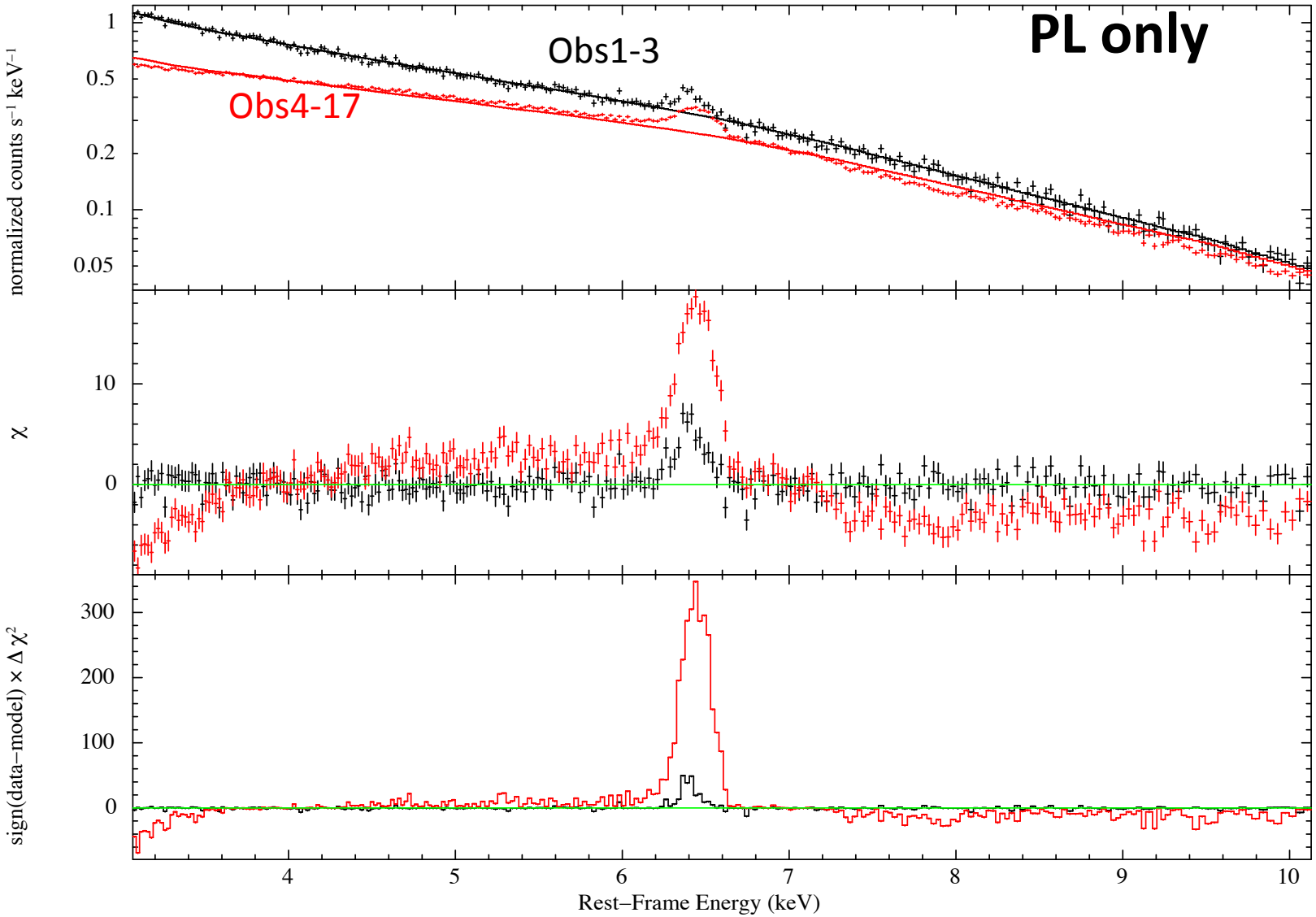
- Different energy bands: analysis first in the 3-10 keV band, then in the 1.5-10 keV band, then in the 0.3-10 keV band, then in the 0.3-80 keV band, etc…

Work in progress, but robust results on:

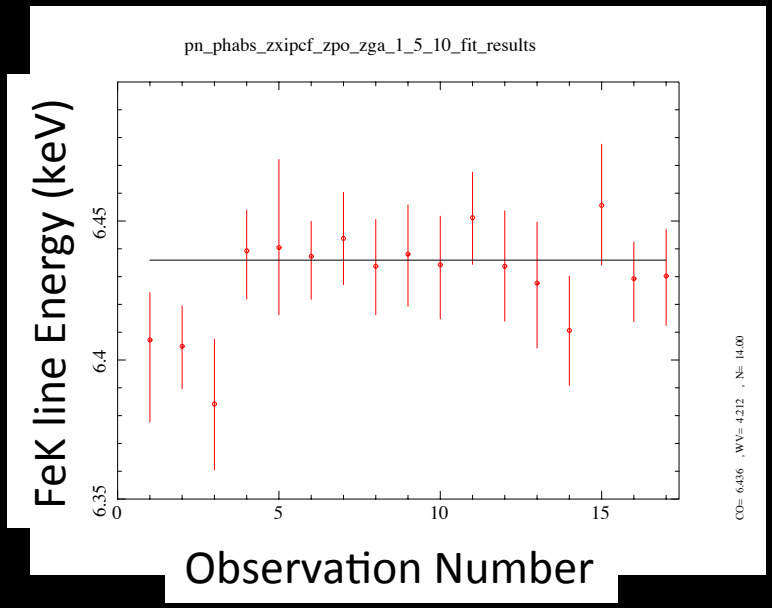
- CTI correction/control (here skipped for lack of time)
- Constant and distant reflector
- (Moderately ionized) Variable and complex absorber

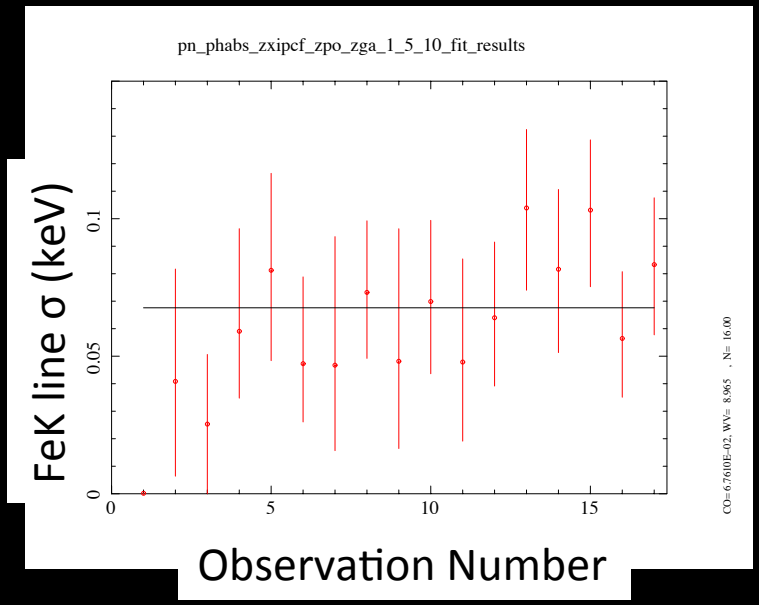
Spectral Analysis: the simultaneous fits

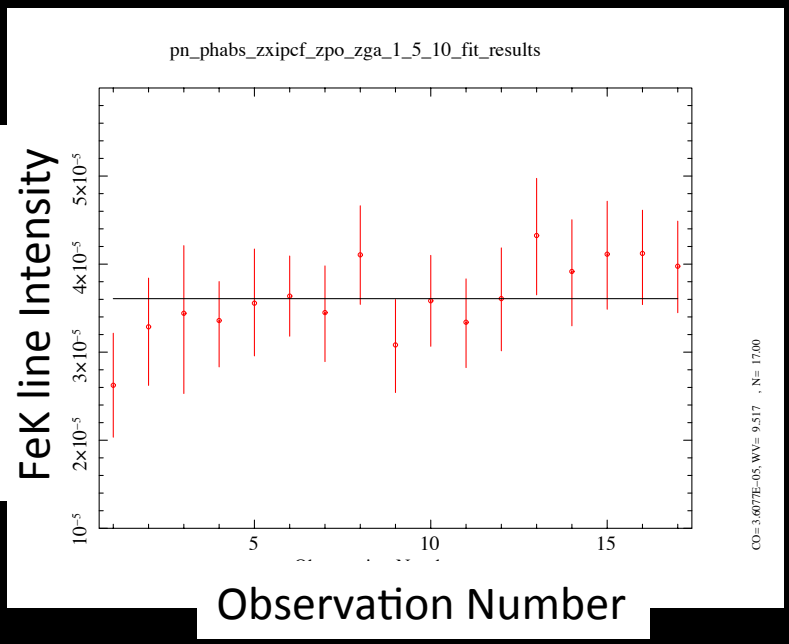
3-10 keV simultaneous fits (not average); black is 3 historical unabsorbed, red is 14 XMM campaign observations



Spectral Analysis: the constant reflector



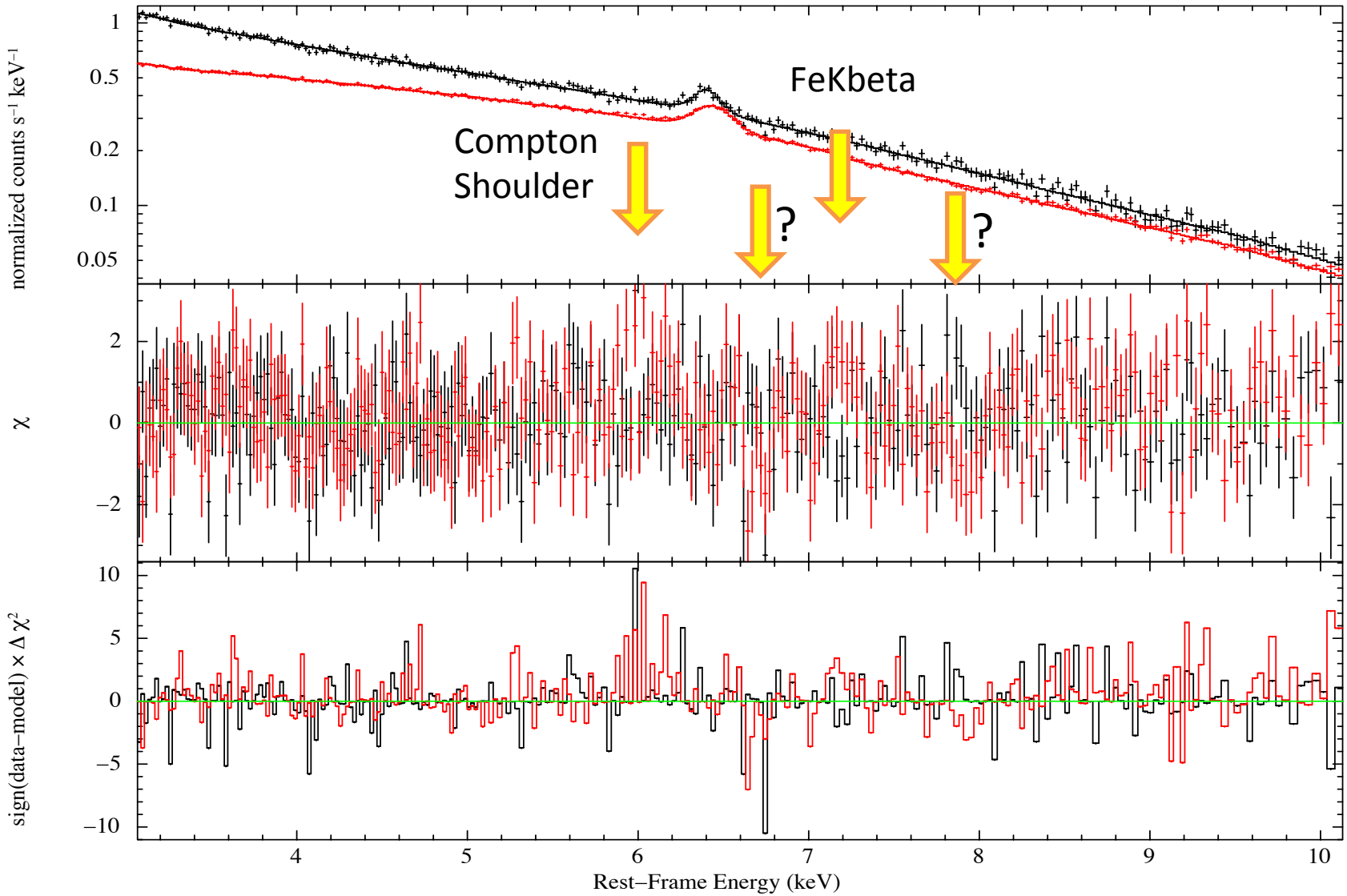




Constant, narrow and cold FeK alfa (~6.4 keV, σ<50 eV, EW~80-100 eV)
→ A constant and distant reflector

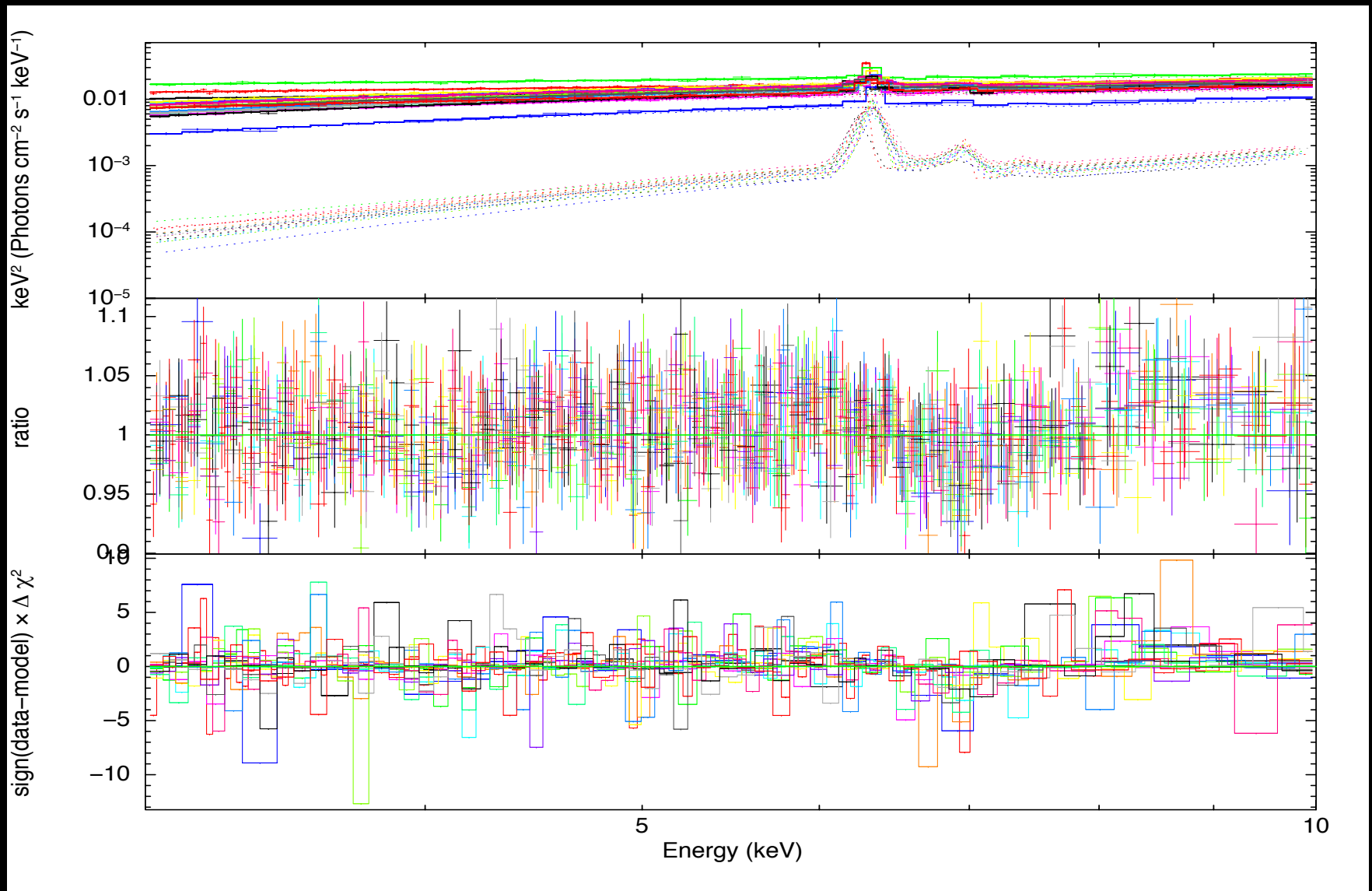
Spectral Analysis: the constant reflector

PCFABS*(PL + Gaussian FeK Emission Line)

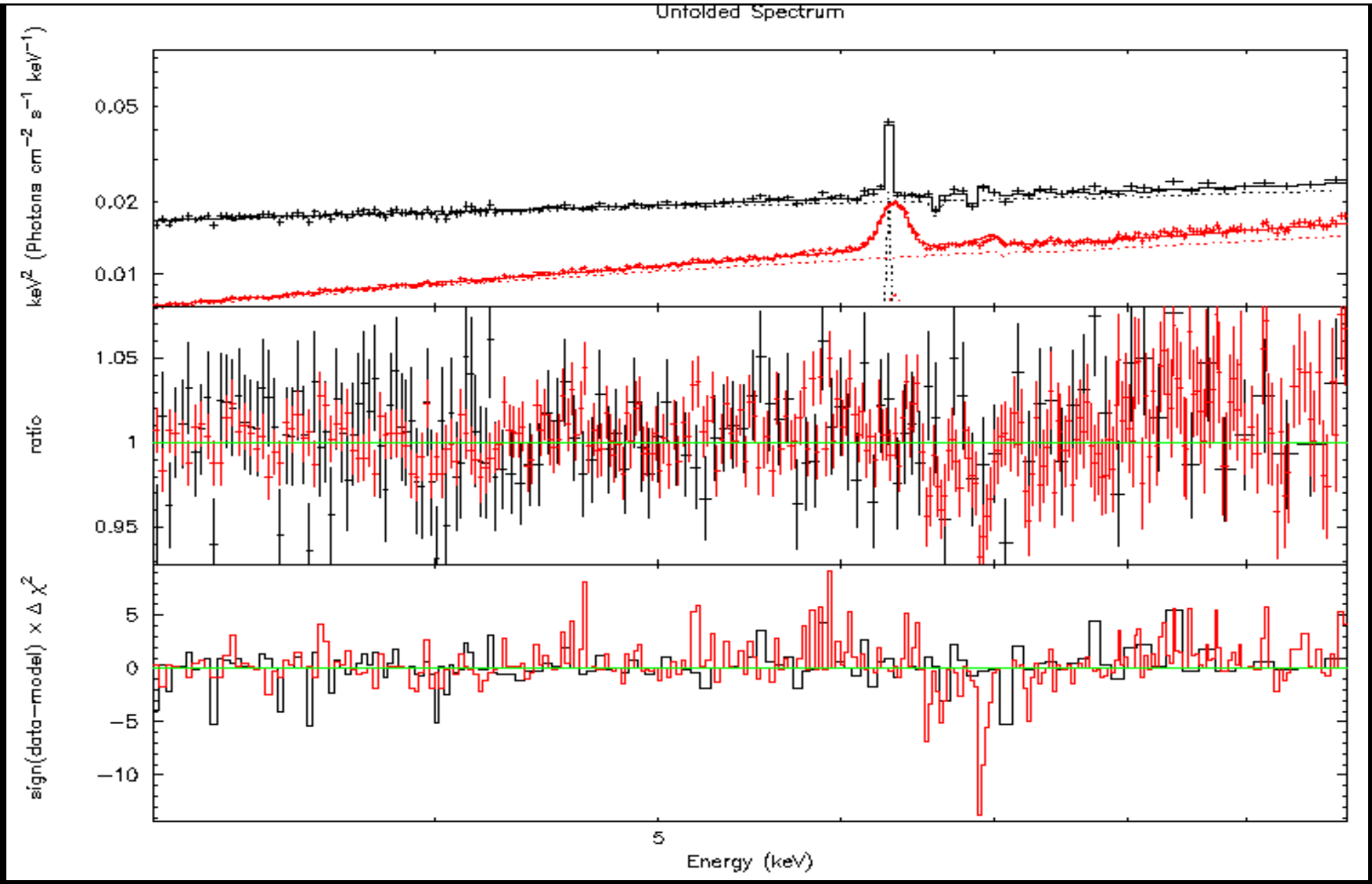


Spectral Analysis: the constant reflector - pexmon

Plot with Pexmon (R=0.4-0.5, i=30 deg.) yields an acceptable, though not perfect fit.

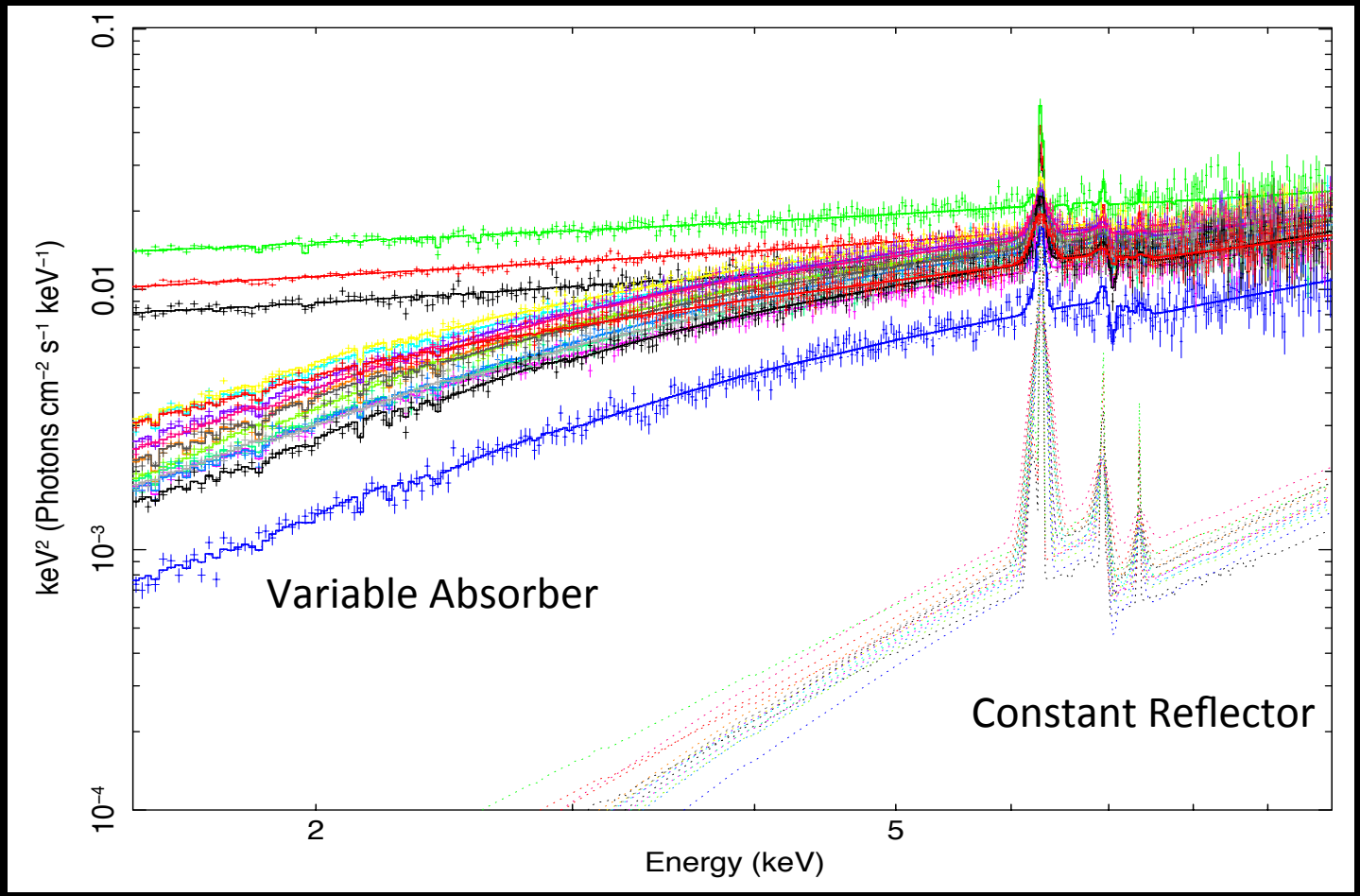


Spectral Analysis: the constant reflector - pexmon



Additional components/remaining features, partly introduced by the use of the Pexmon reflection model are under investigation

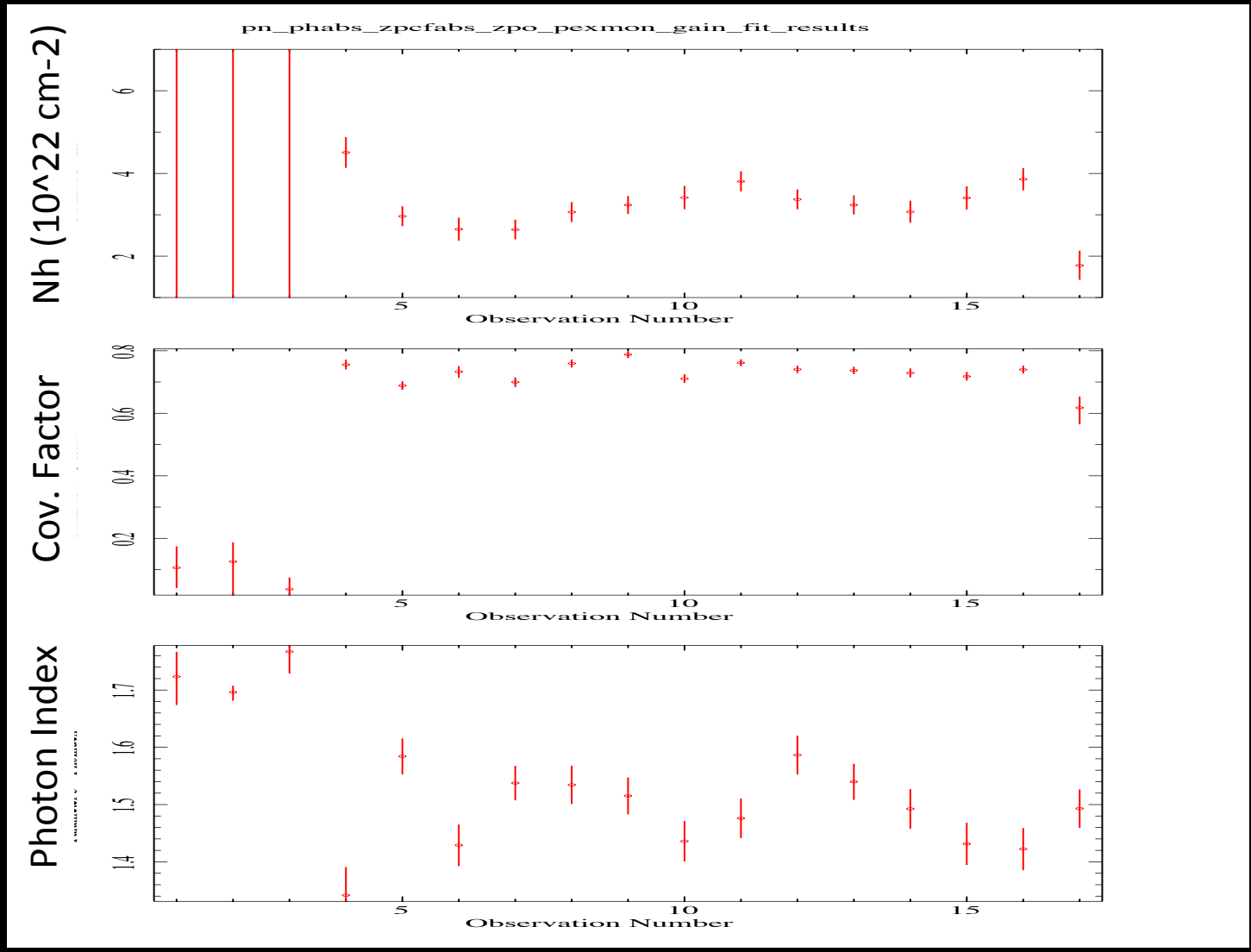
Spectral Analysis: the variable absorber



N.B: The low-energy cut-off is too sharp for a highly ionized absorber (only) but too flat for a single cold absorber too.

→ A combination of one, or more, partial covering and/or mildly ionized absorbers required

Spectral Analysis: the variable absorber (e.g. if neutral PC)



Need to break degeneracies before understanding which parameter(s) drive the variability (e.g. Photon Index should be fixed at E>10 keV constant value…see Ursini's talk)

BUT clearly a new, long lived, heavy obscurer in NGC5548 (similar to H0557-385 in Coffey's talk)

Conclusions

Timing analysis → Absorption variability
Constant FeK (and) reflection component

Spectral Analysis

→ Reflector: Constant, narrow and cold, FeK alfa
Consistent with being produced by a distant reflector

→ Absorber: A new, unexpected (in this source), heavy, variable and complex absorber
Mostly cold absorber, and a long-lasting absorber

Combined to HST/COS BAL (see talk by Kaastra) → consistent with a long-lived accretion disc wind that btw will also act as a shielding gas! ;-)

On-going analysis:

Parameter variations (and degeneracies) and additional complexities/ components under investigation, require use of combined set from all instruments, observations, and energy bands, together with tests/use of alternative theoretical models (e.g. xillver for reflection, swind for a wind, compp for comptonization, etc.)

The end