

# High-energy monitoring of Seyfert galaxies: the case of NGC 5548 and NGC 4593

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*The Extremes of Black Hole Accretion*  
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# NGC 5548

- ◆ Object of a multiwavelength campaign in 2013
- ◆ The nucleus appeared obscured by a clumpy stream of ionized gas - a disc wind? (Kaastra+15; see talk by M. Cappi)
- ◆ 7 high-energy observations with XMM, NuSTAR and INTEGRAL (Ursini+15)

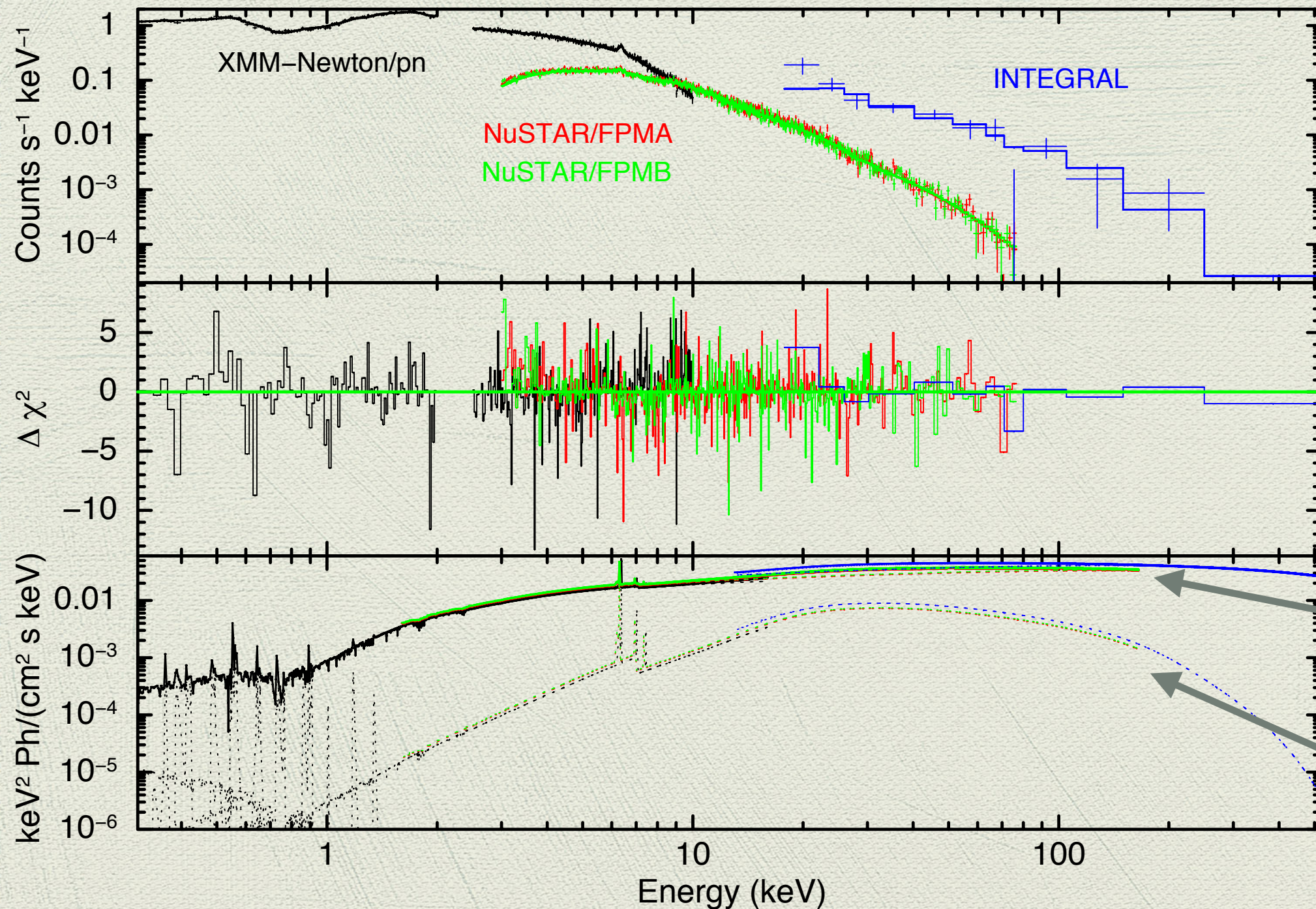
The logs of the simultaneous *XMM-Newton*, *NuSTAR* and/or *INTEGRAL* observations of NGC 5548 during our campaign.

Obs.	Satellites	Obs. Id.	Start time (UTC) yyyy-mm-dd	Net exp. (ks)
1	<i>XMM-Newton</i>	0720110401	2013-06-30	38
	<i>INTEGRAL</i>	10700010001	2013-06-29	62
2	<i>XMM-Newton</i>	0720110601	2013-07-11	37
	<i>NuSTAR</i>	60002044002/3	2013-07-11	50
	<i>INTEGRAL</i>	10700010002	2013-07-11	50
3	<i>XMM-Newton</i>	0720110701	2013-07-15	37
	<i>INTEGRAL</i>	10700010003	2013-07-15	50
4	<i>XMM-Newton</i>	0720111101	2013-07-23	38
	<i>NuSTAR</i>	60002044005	2013-07-23	50
	<i>INTEGRAL</i>	10700010004	2013-07-23	52
5	<i>Chandra</i>	16314	2013-09-10	120
	<i>NuSTAR</i>	60002044006	2013-09-10	50
6	<i>XMM-Newton</i>	0720111501	2013-12-20	38
	<i>NuSTAR</i>	60002044008	2013-12-20	50
7	<i>XMM-Newton</i>	0720111601	2014-02-04	38
	<i>INTEGRAL</i>	11200110001	2014-01-17	94
		11200110002	2014-01-22	40
		11200110003	2014-02-09	30



# NGC 5548: high-energy view

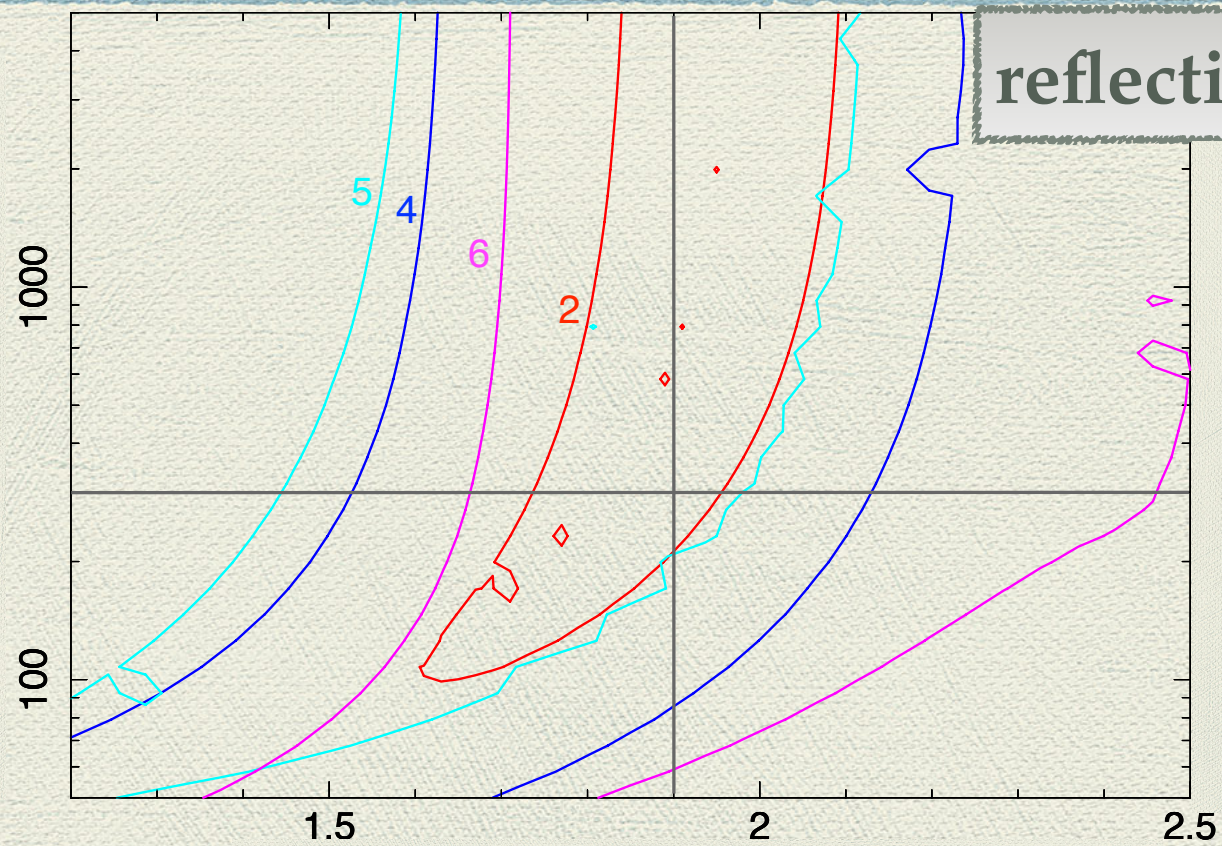
Obs. 2: Broad-band fit, residuals and best-fit model.



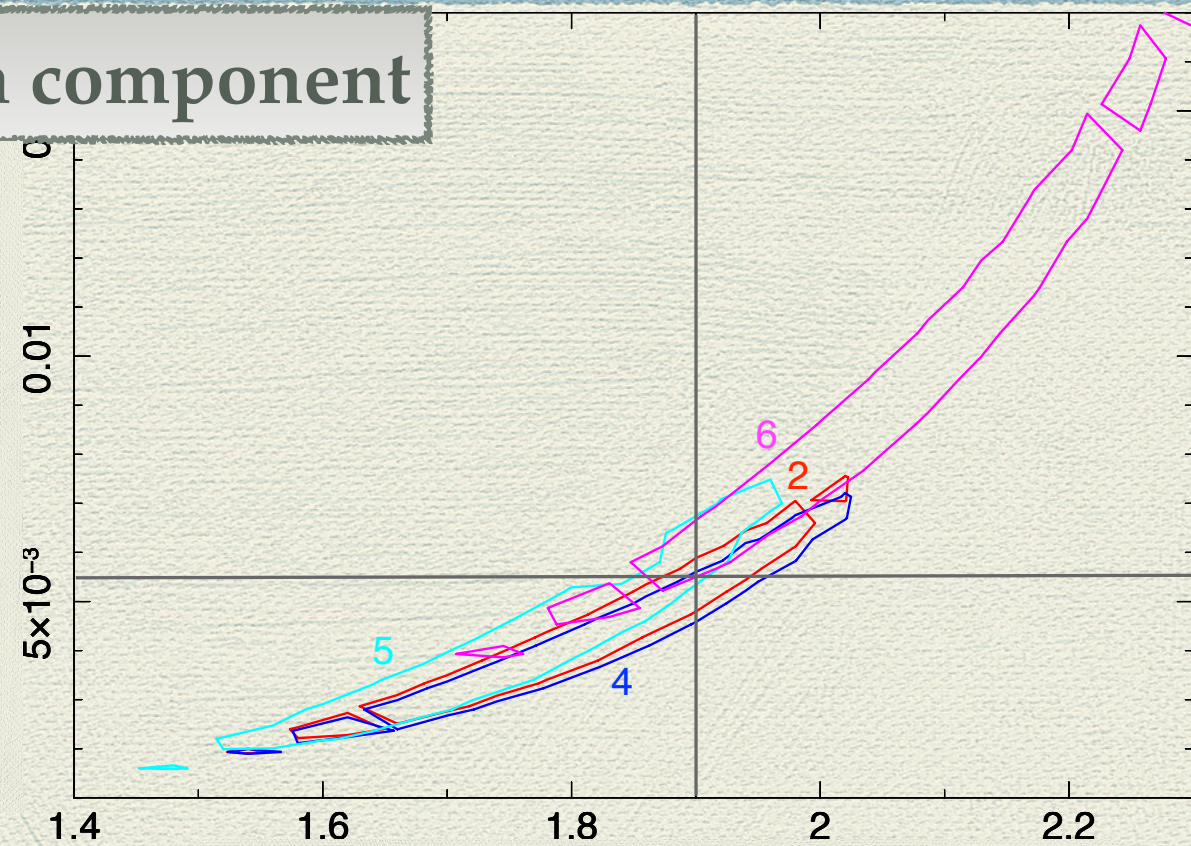
good  
constraints  
on both  
the **primary**  
**power law**  
and the  
**reflection**  
**component**



PEXMON Ec (keV)

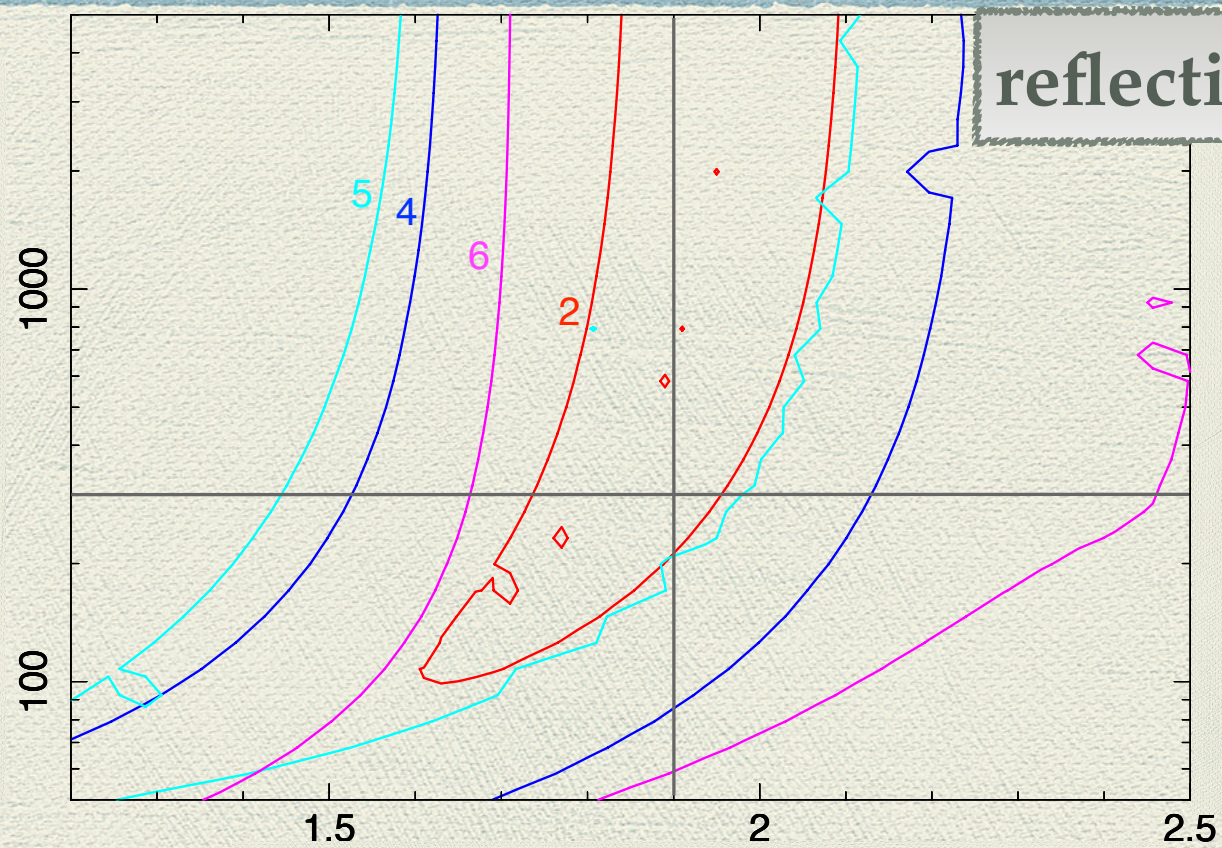


PEXMON Norm.

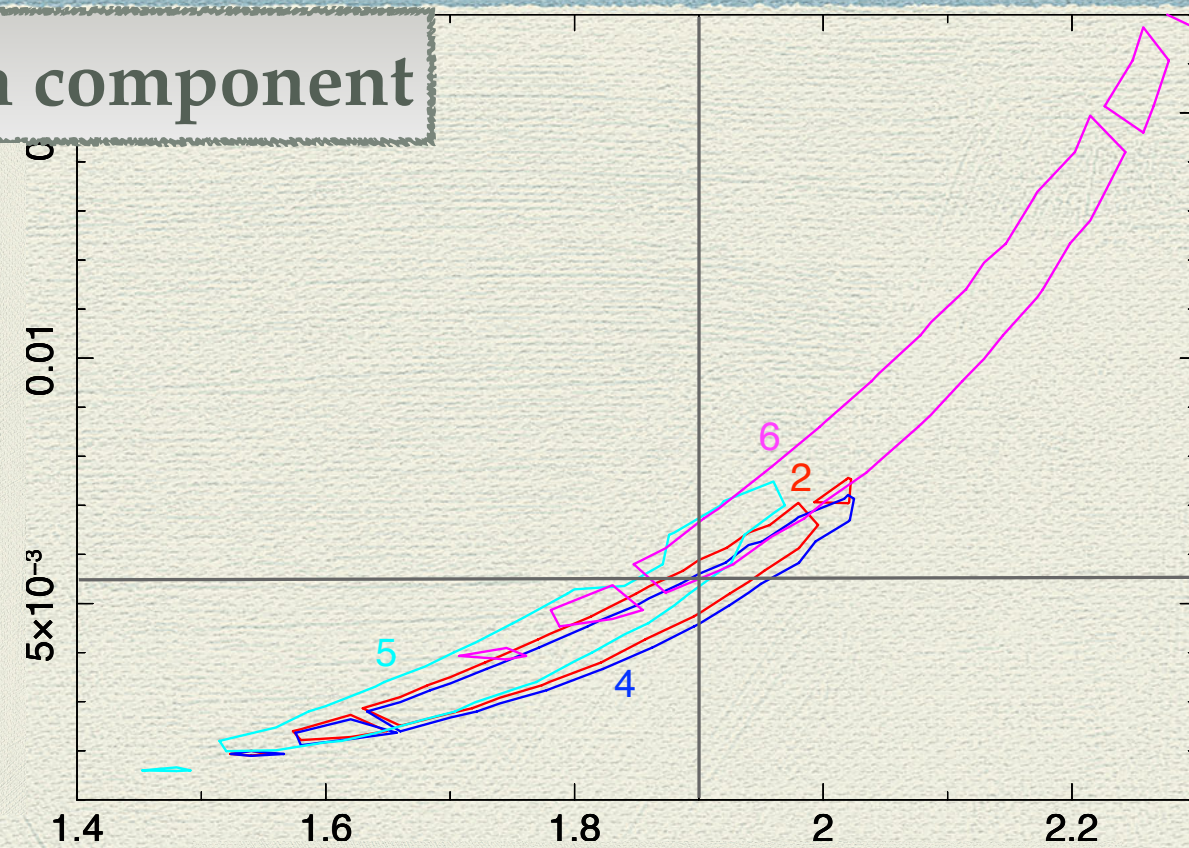




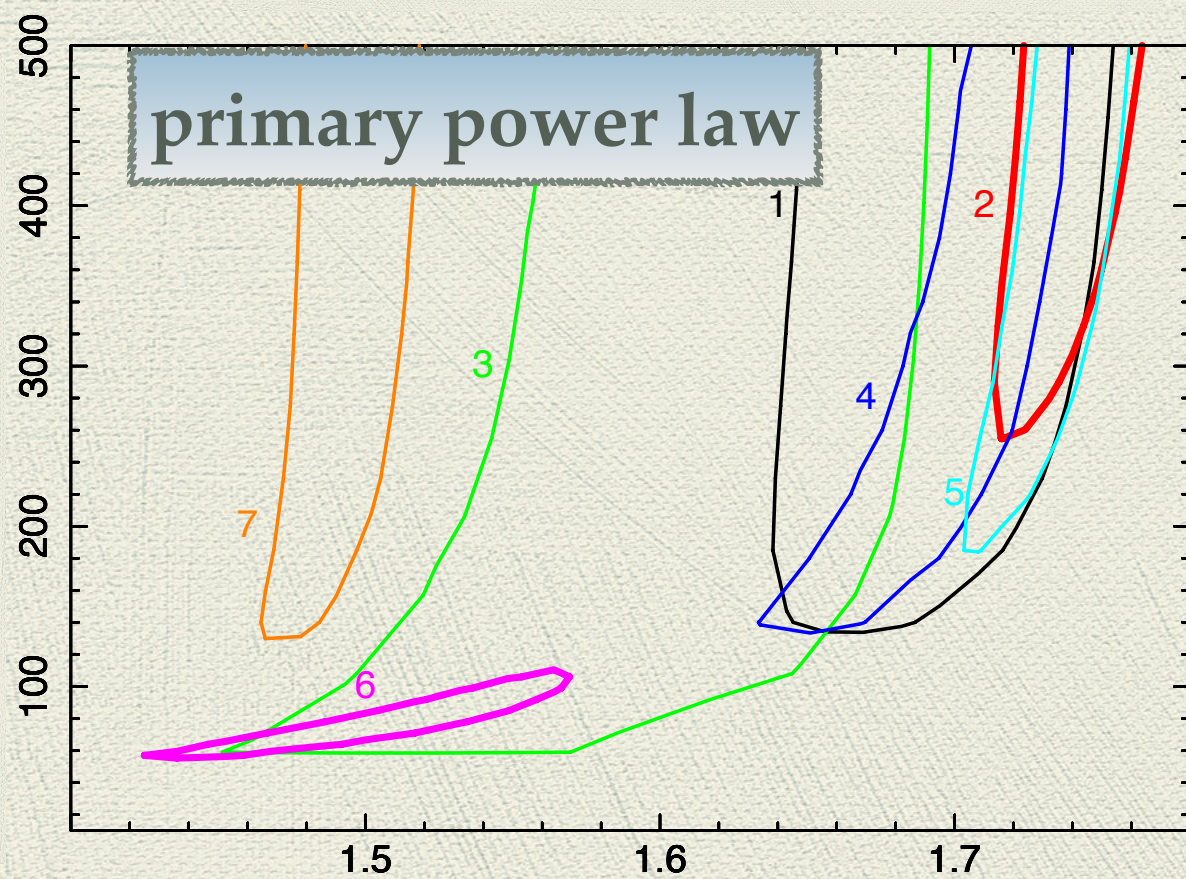
PEXMON Ec (keV)



PEXMON Norm.

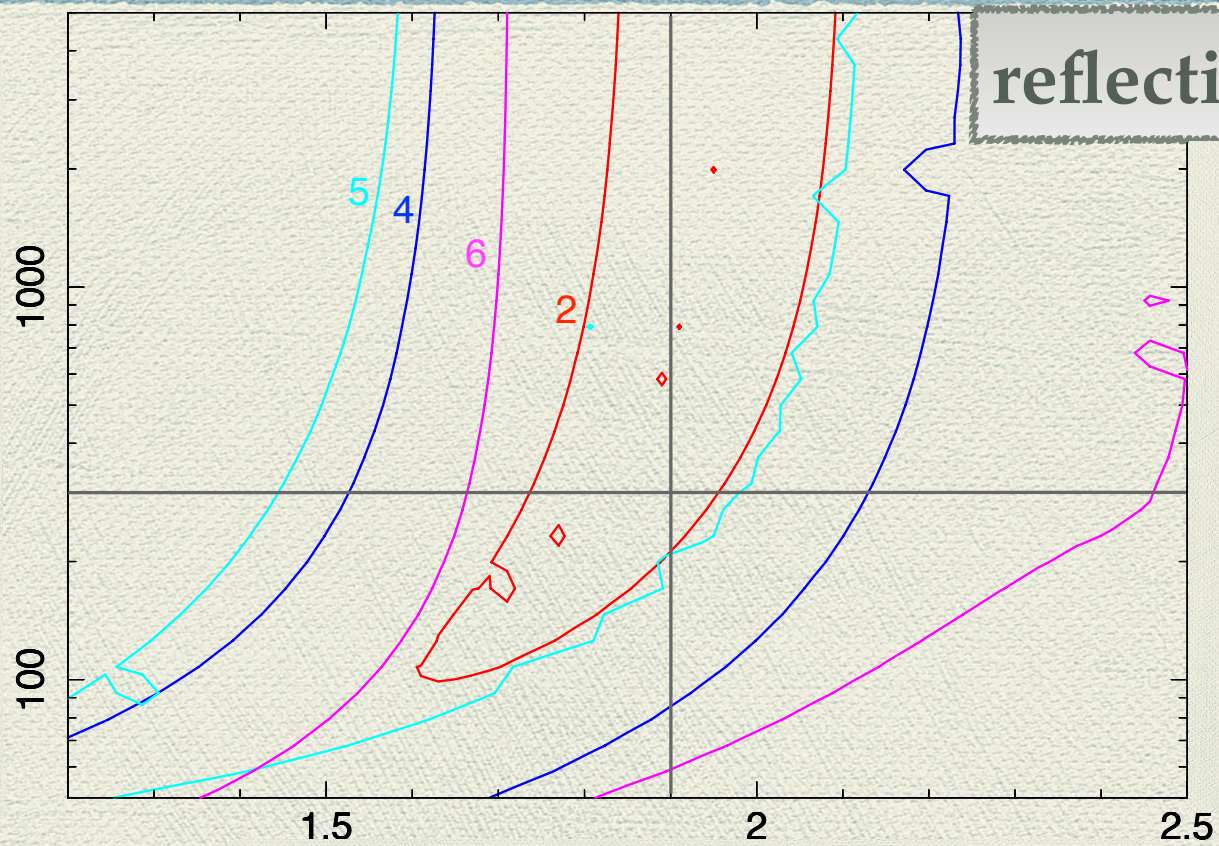


Cut-off energy (keV)

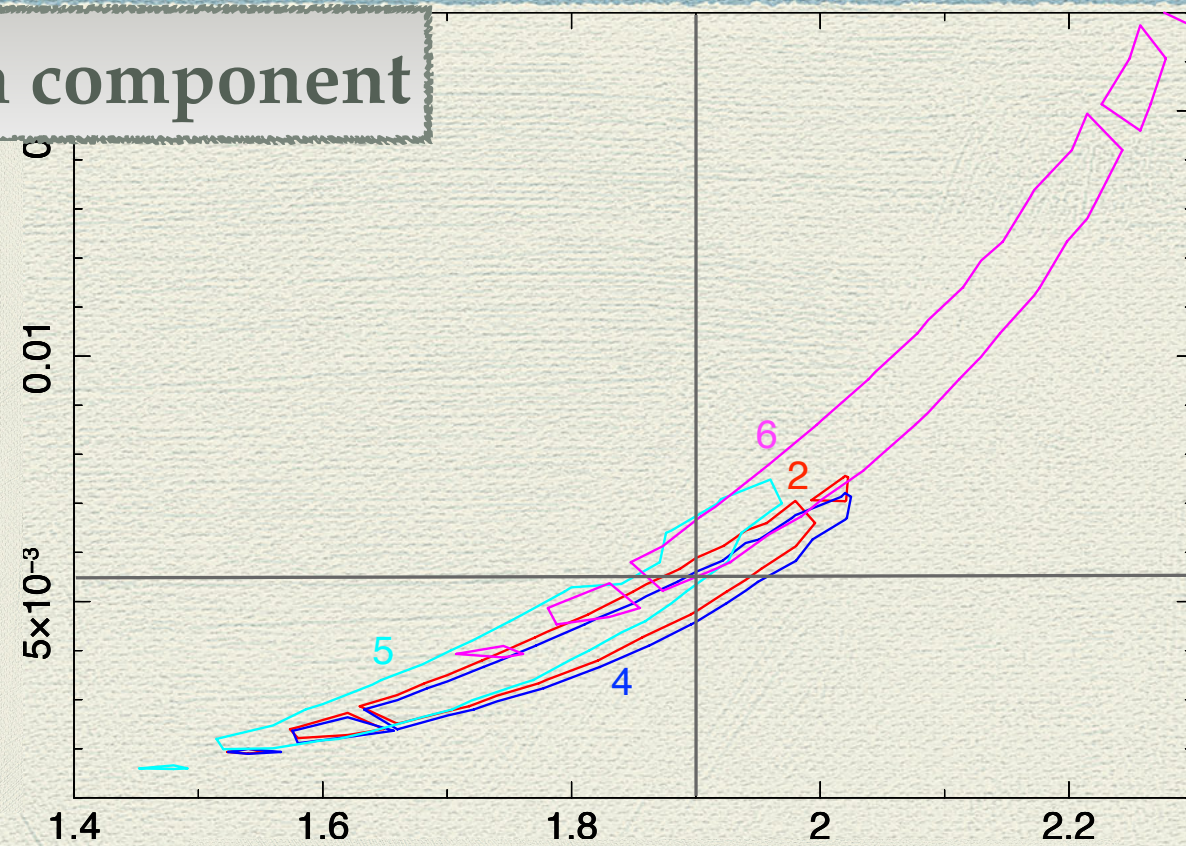




PEXMON Ec (keV)



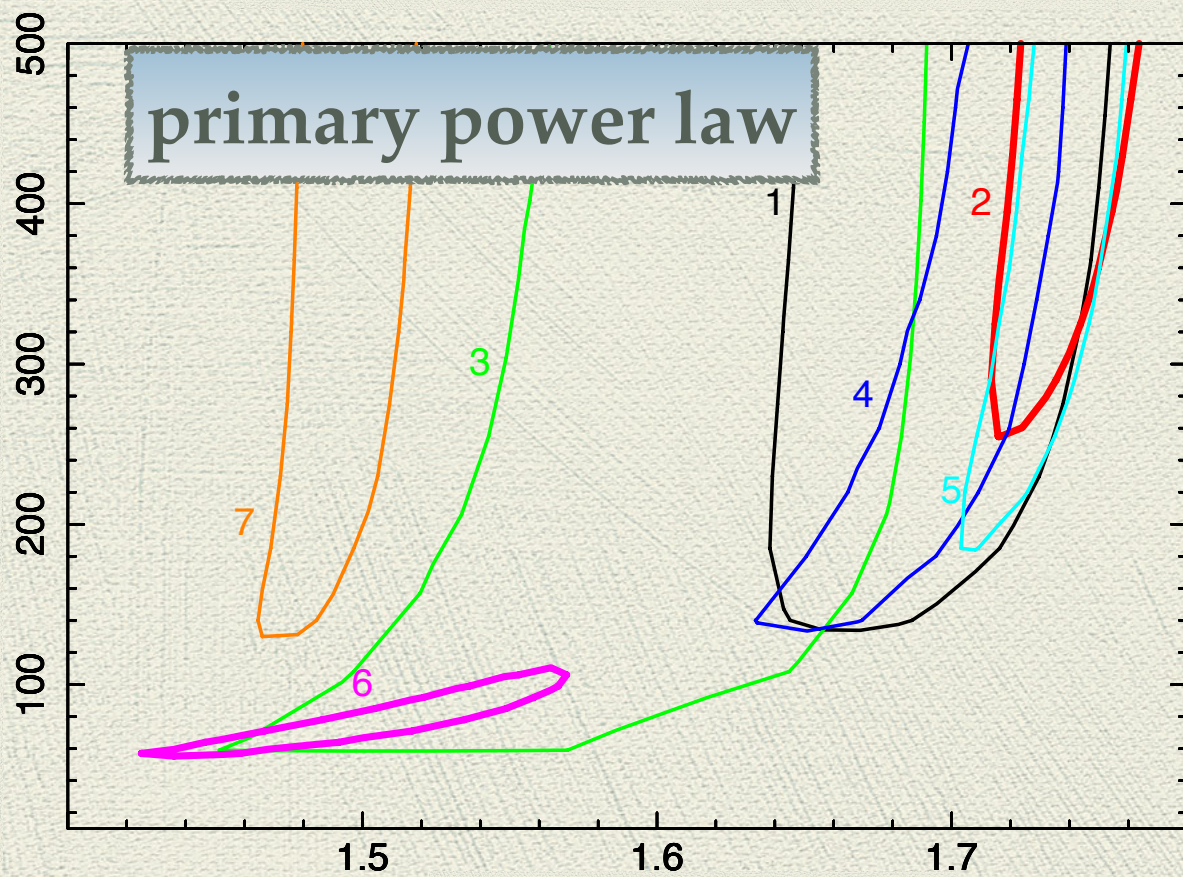
PEXMON Norm.



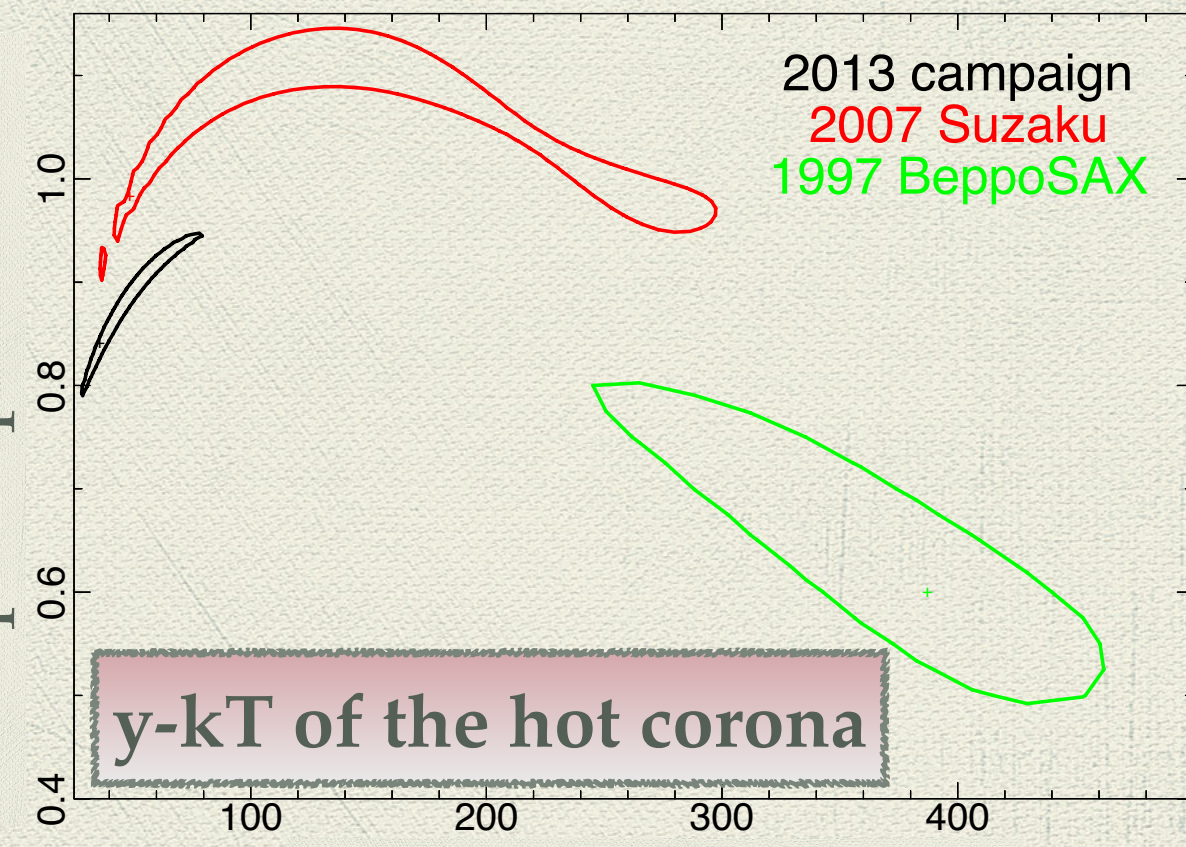
PEXMON Photon index

PEXMON Photon index

Cut-off energy (keV)



Compton parameter



Photon index

Temperature (keV)



# NGC 4593: XMM/NuSTAR monitoring program

Past observations by BeppoSAX (1998: Guainazzi+98), XMM (2002: Reynolds+04, Brenneman+07), Suzaku (2007: Markowitz&Reeves09) show:

- ◆ a strong reflection hump above 10 keV and a prominent, non-relativistic Fe  $K\alpha$  line (truncated disc? distant material?)
- ◆ a significant soft X-ray excess below 1 keV (Comptonization?)
- ◆ a lower limit for the high-energy cut-off of 150 keV



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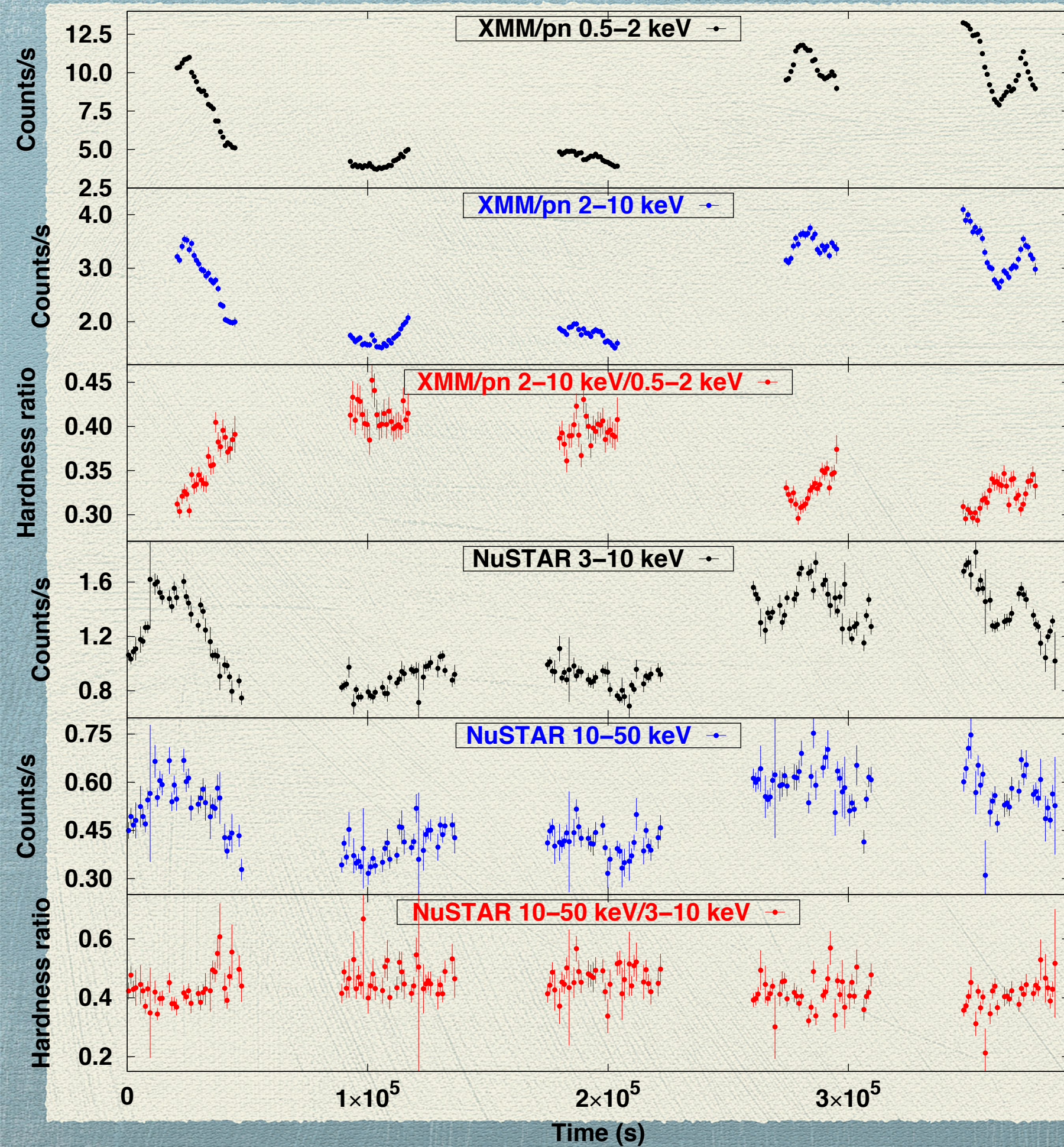
5  $\times$  20 ks joint observations in early 2015

The logs of the joint *XMM-Newton* and *NuSTAR* observations of NGC 4593.

Obs.	Satellites	Obs. Id.	Start time (UTC) yyyy-mm-dd	Net exp. (ks)
1	<i>XMM-Newton</i>	0740920201	2014-12-29	16
	<i>NuSTAR</i>	60001149002		22
2	<i>XMM-Newton</i>	0740920301	2014-12-31	17
	<i>NuSTAR</i>	60001149004		22
3	<i>XMM-Newton</i>	0740920401	2015-01-02	17
	<i>NuSTAR</i>	60001149006		21
4	<i>XMM-Newton</i>	0740920501	2015-01-04	15
	<i>NuSTAR</i>	60001149008		23
5	<i>XMM-Newton</i>	0740920601	2015-01-06	21
	<i>NuSTAR</i>	60001149010		21



# XMM/pn and NuSTAR/FPMA+FPMB light curves and hardness ratios



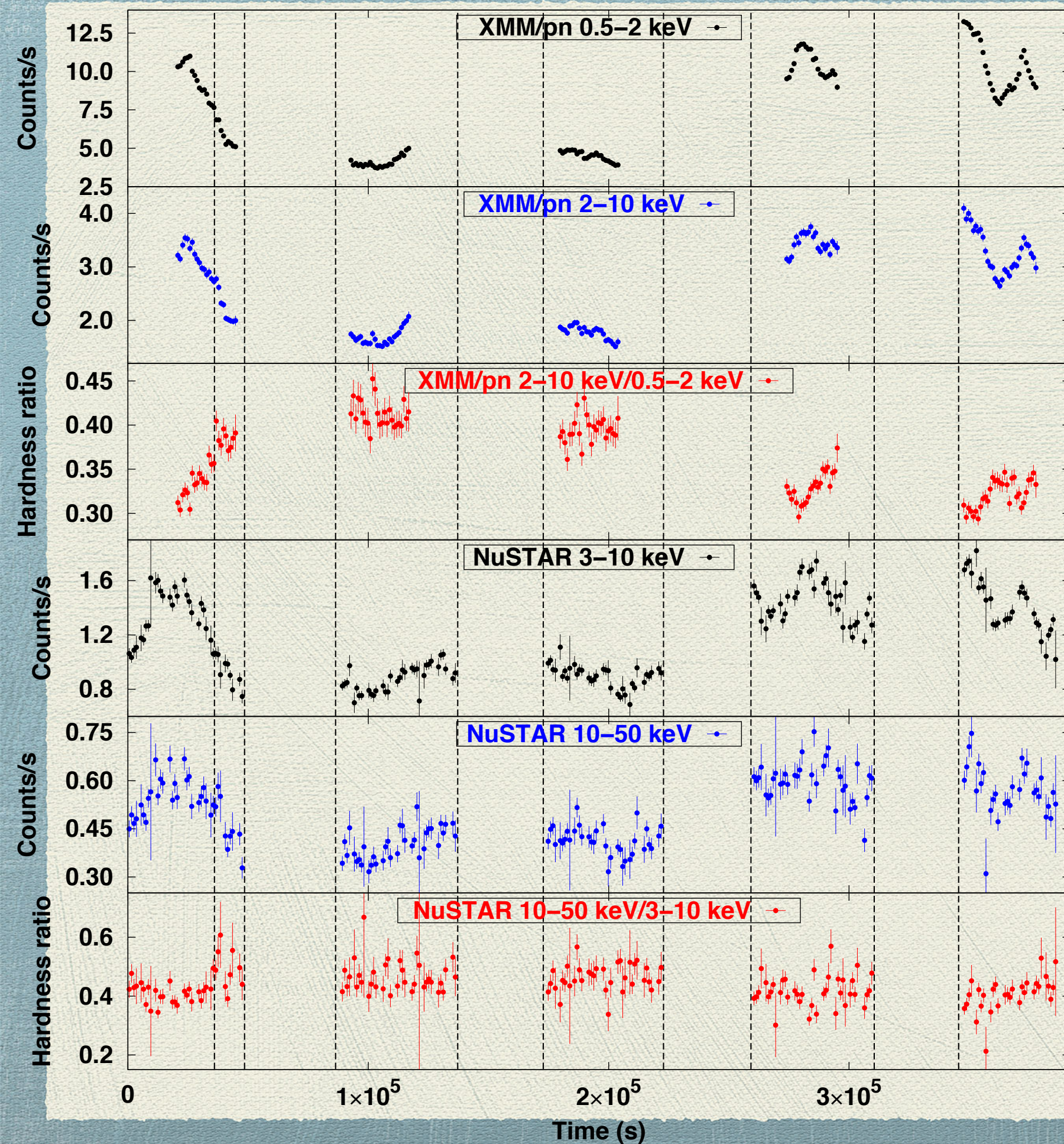
Significant flux  
variability

Significant spectral  
variability in the  
soft band (0.5–10 keV)

... not much in the  
hard band (3–50 keV)



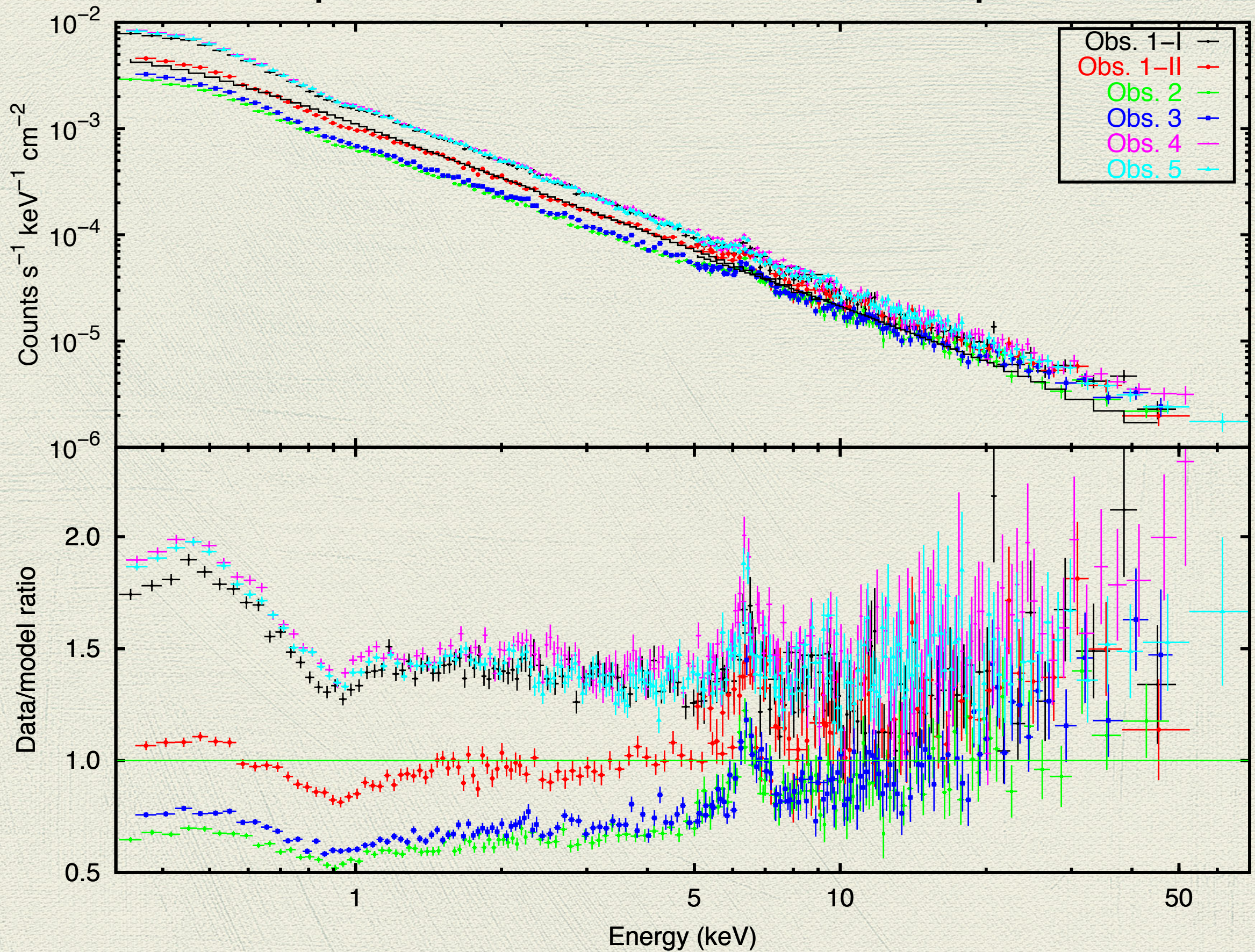
# XMM/pn and NuSTAR/FPMA+FPMB light curves and hardness ratios



Each spectrum is fitted separately; we divide the first observation into two intervals



# XMM/pn and NuSTAR/FPMA data fitted with a power law





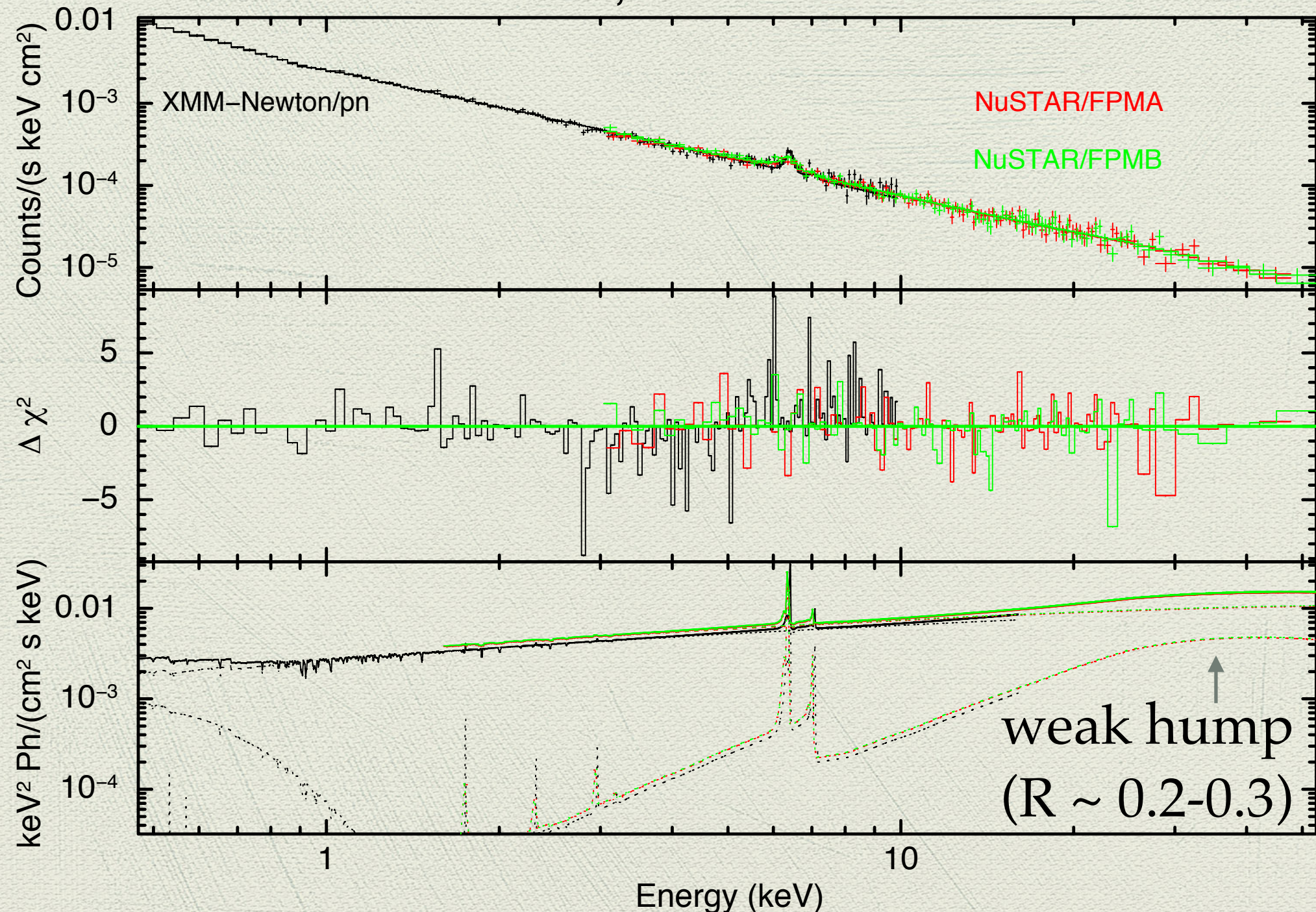
Baseline model:

warm abs.\*(soft excess + cut-off power law + reflection)

↓  
bbody

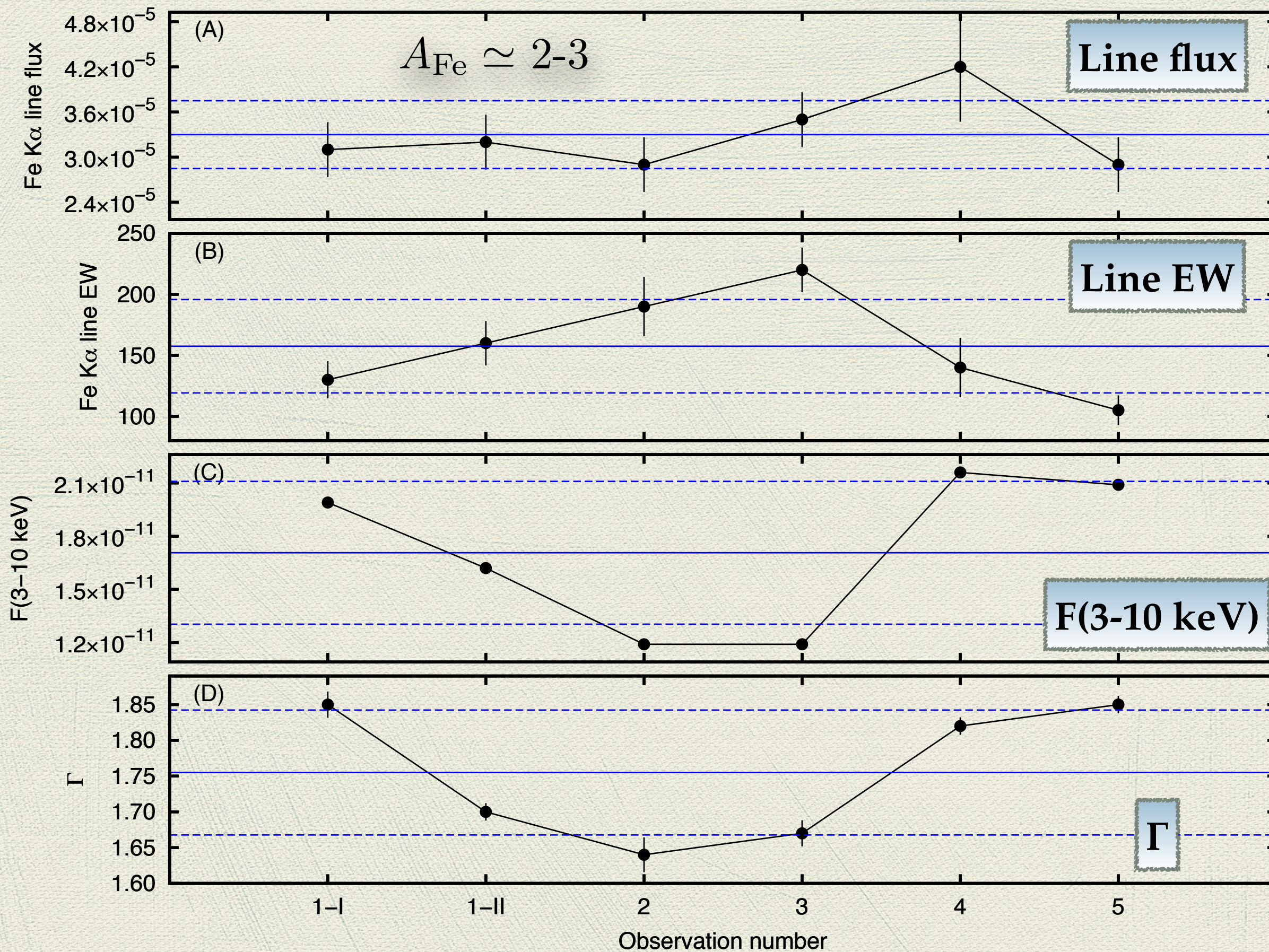
↓  
xillver  
 $A_{\text{Fe}}$  free

## Obs. 2: Broad-band fit, residuals and best-fit model



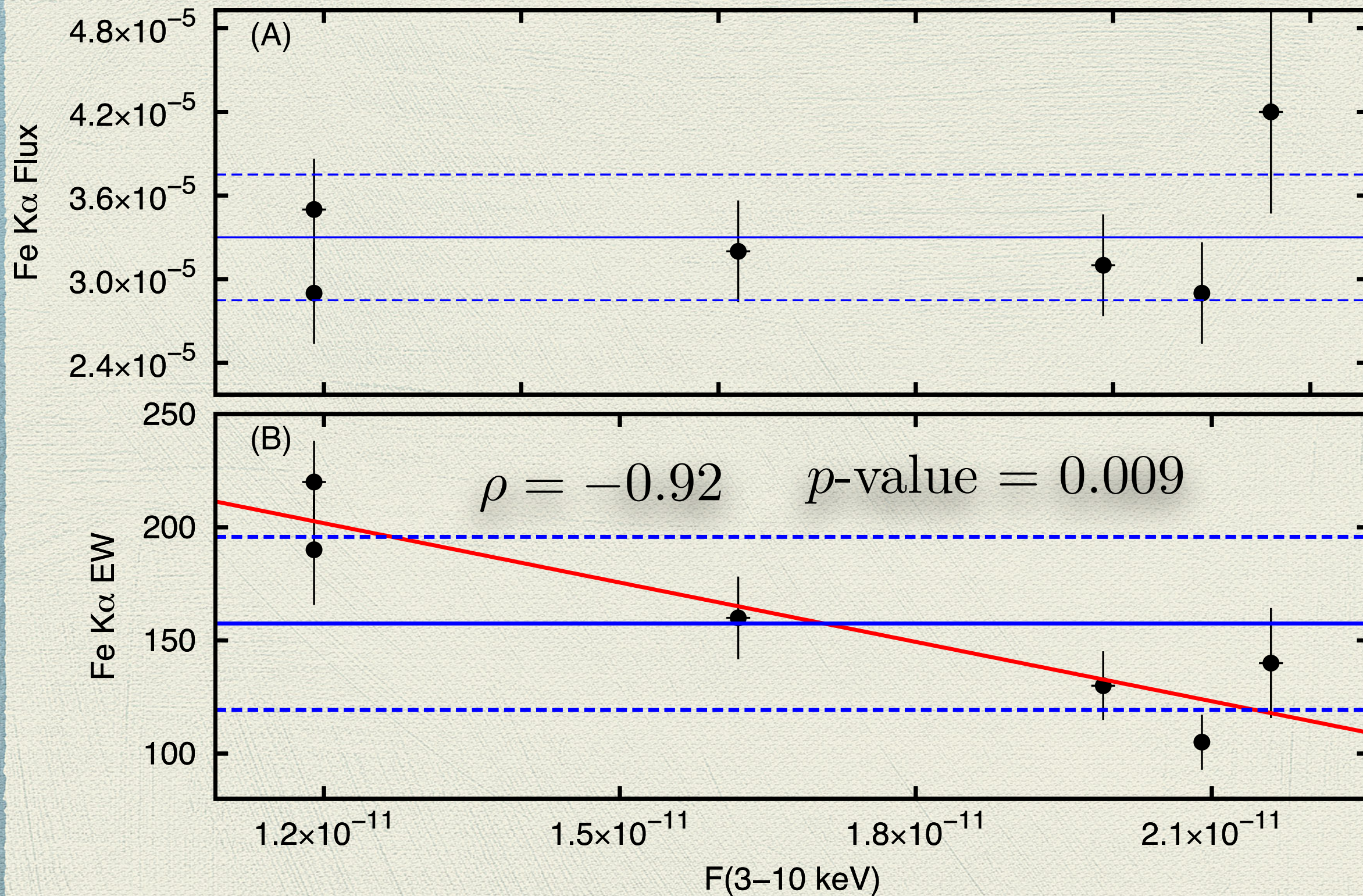


# Fe K $\alpha$ line flux and EW, primary flux (3–10 keV), photon index



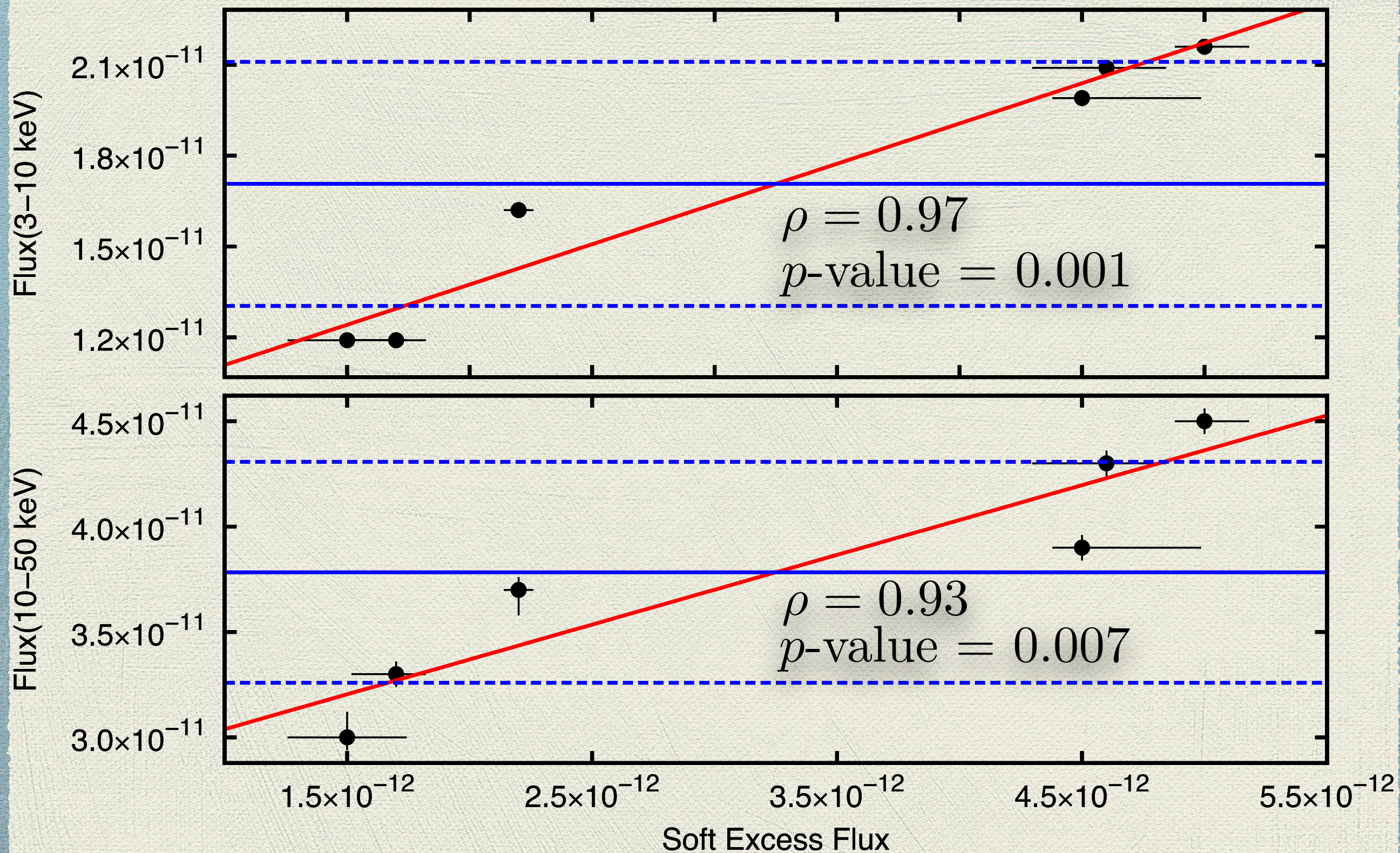


# Anticorrelation between EW of the Fe $K\alpha$ line and primary flux





# Correlation between soft excess and primary flux





# Conclusions

NGC 5548 (see Kaastra+15; Mehdipour+15; Arav+15; Ursini+15; di Gesu+15)

- ◆ Distant reflector ( $\sim$  light months)
- ◆ Evidence of variable photon index and high-energy cut-off
- ◆ Temperature and optical depth of the hot corona show long-term ( $\sim 15$  yrs) variability
- ◆ Next step: detailed test of Comptonization models

NGC 4593

- ◆ Strong spectral variability in the soft band on a time-scale of days
- ◆ Neutral Fe  $K\alpha$  line:
  - ◆ flux  $\sim$  constant; equivalent width anticorrelated with primary flux
  - ◆ accompanied by a weak reflection hump  $\Rightarrow$  two line components?
- ◆ Soft excess below 1 keV correlated with the primary emission
- ◆ Work in progress!