



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

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The Extremes of Black Hole Accretion
Madrid, June 8 2015

NGC 5548

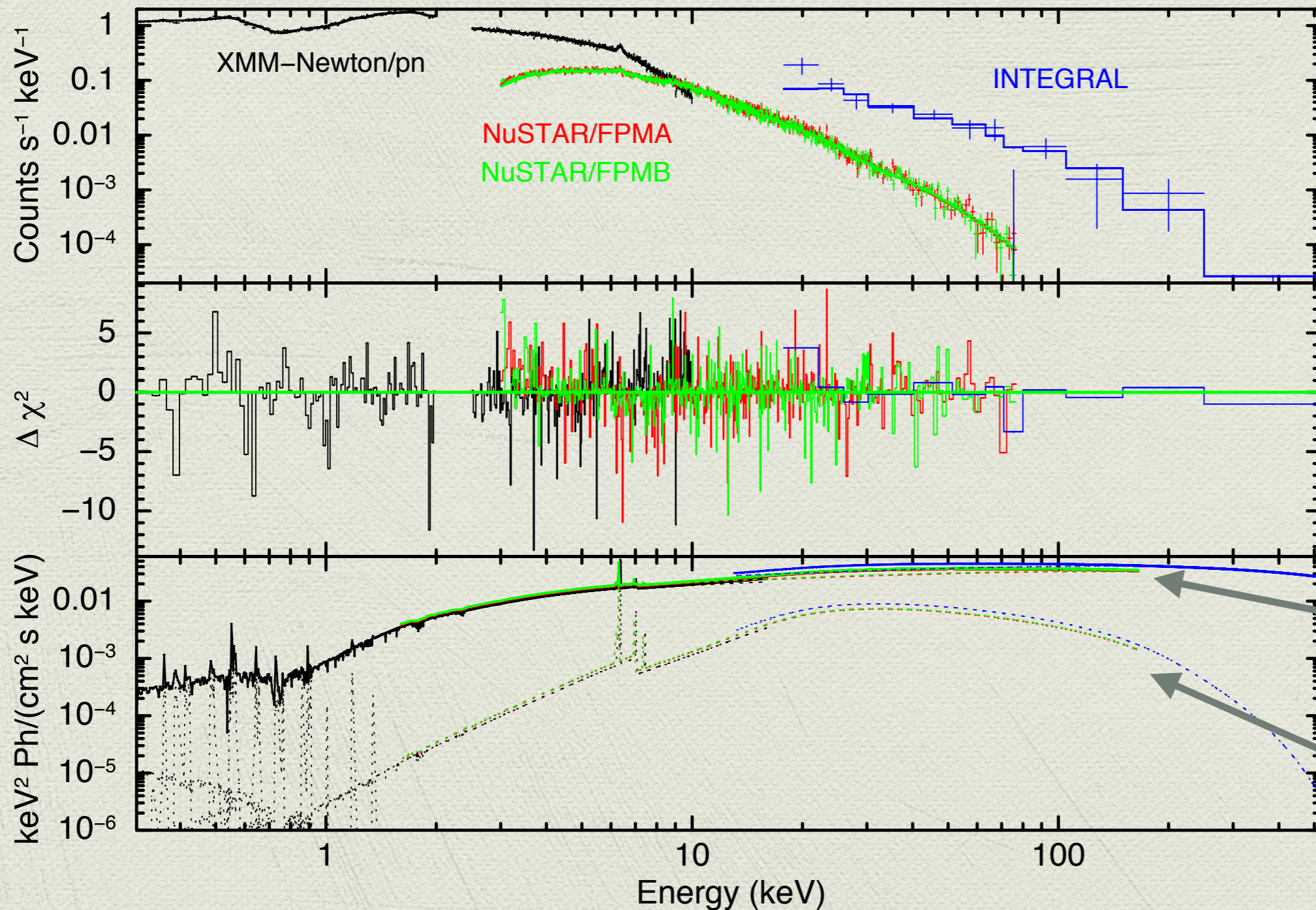
- ◆ Object of a multiwavelength campaign in 2013
- ◆ The nucleus appeared obscured by a clumpy stream of ionized gas - a disc wind? (Kaastra+15; see talk by M. Cappi)
- ◆ 7 high-energy observations with XMM, NuSTAR and INTEGRAL (Ursini+15)

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

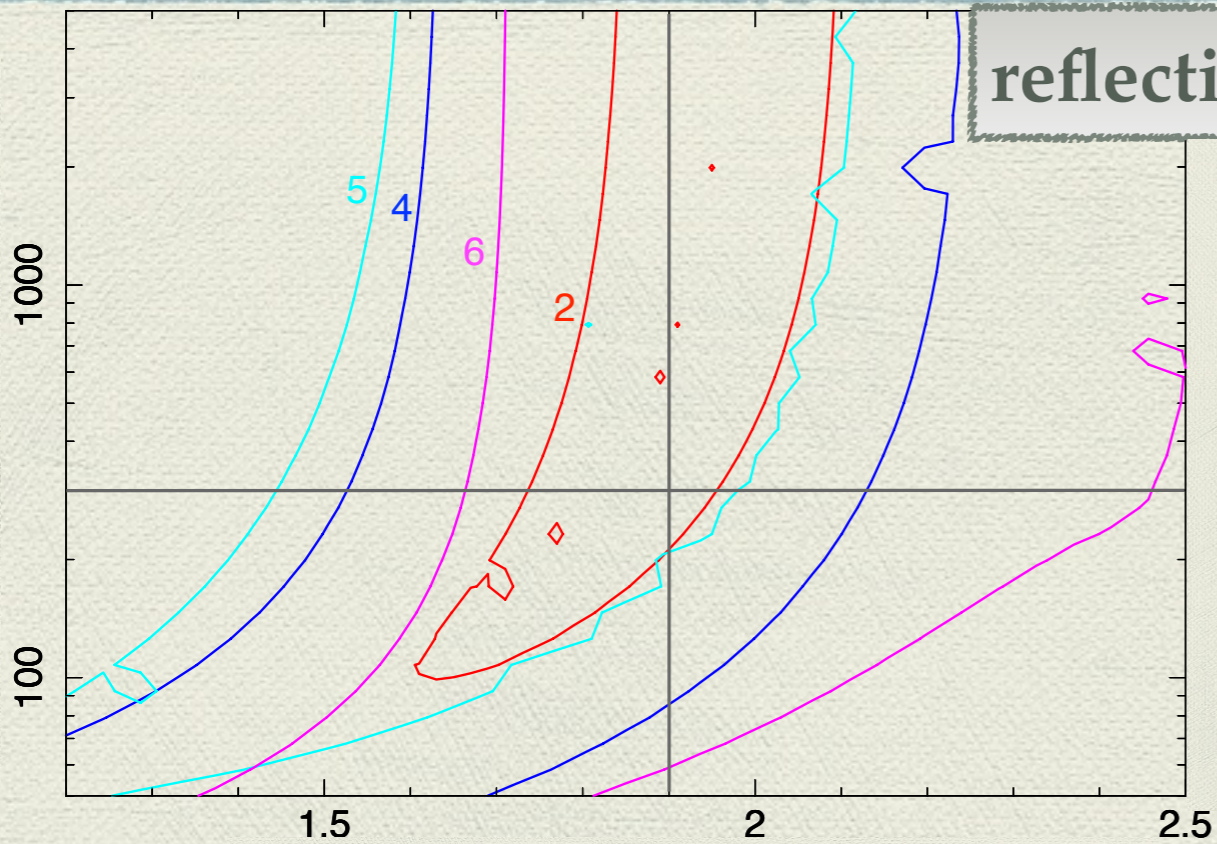
NGC 5548: high-energy view

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



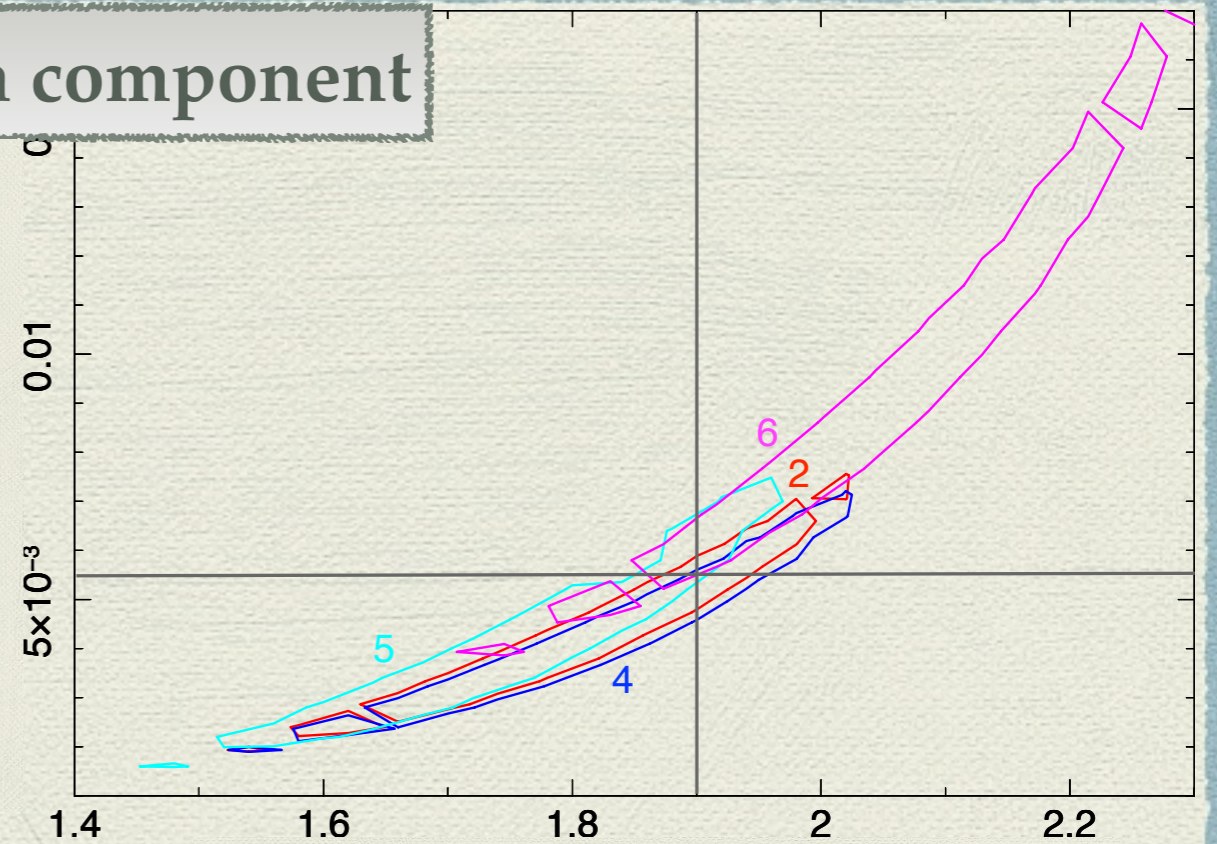
good
constraints
on both
the **primary**
power law
and the
reflection
component

PEXMON Ec (keV)



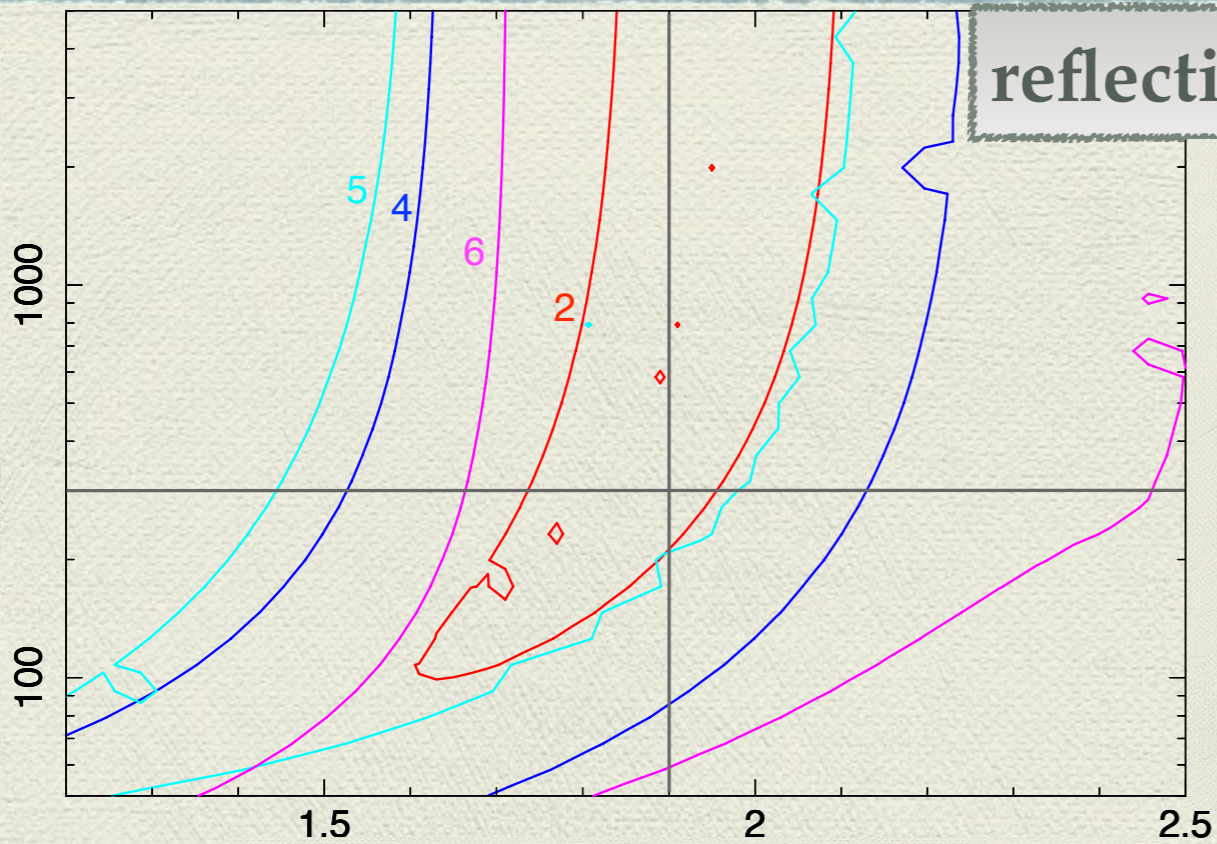
PEXMON Photon index

PEXMON Norm.



PEXMON Photon index

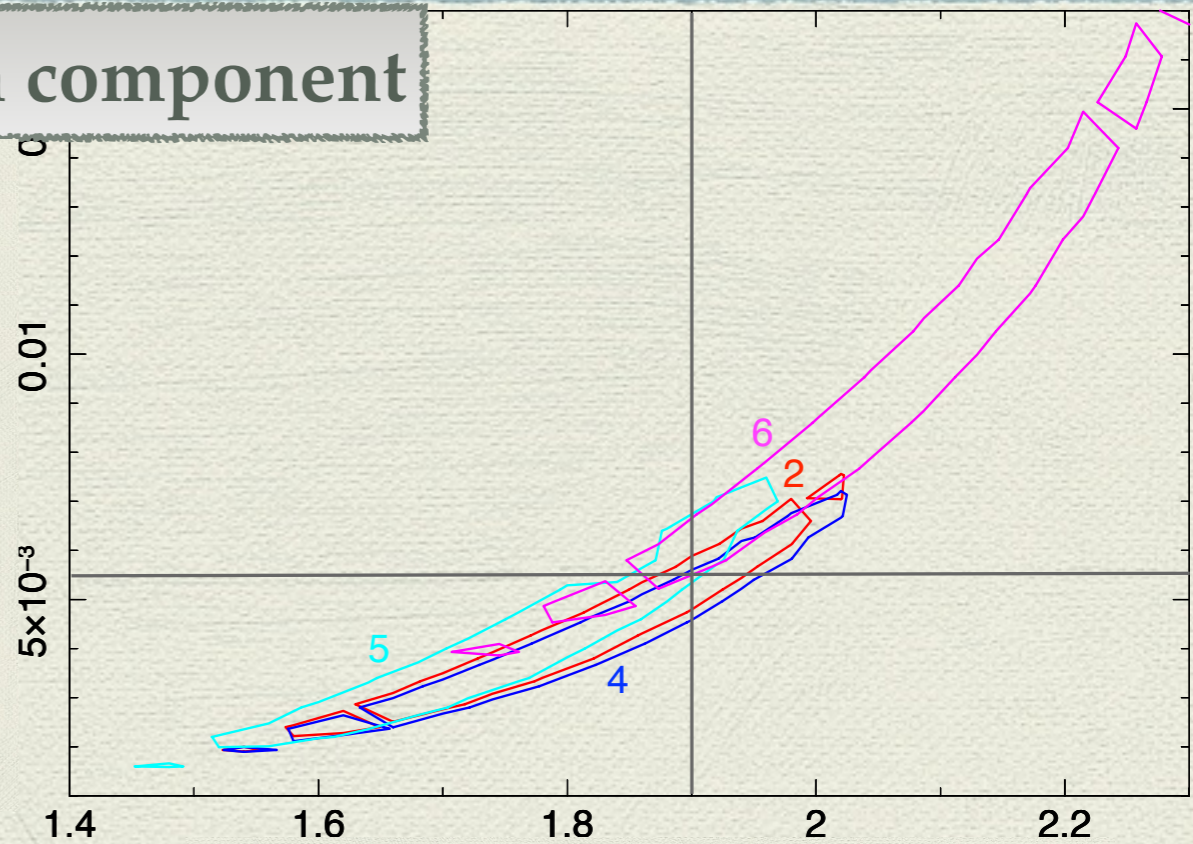
PEXMON Ec (keV)



PEXMON Photon index

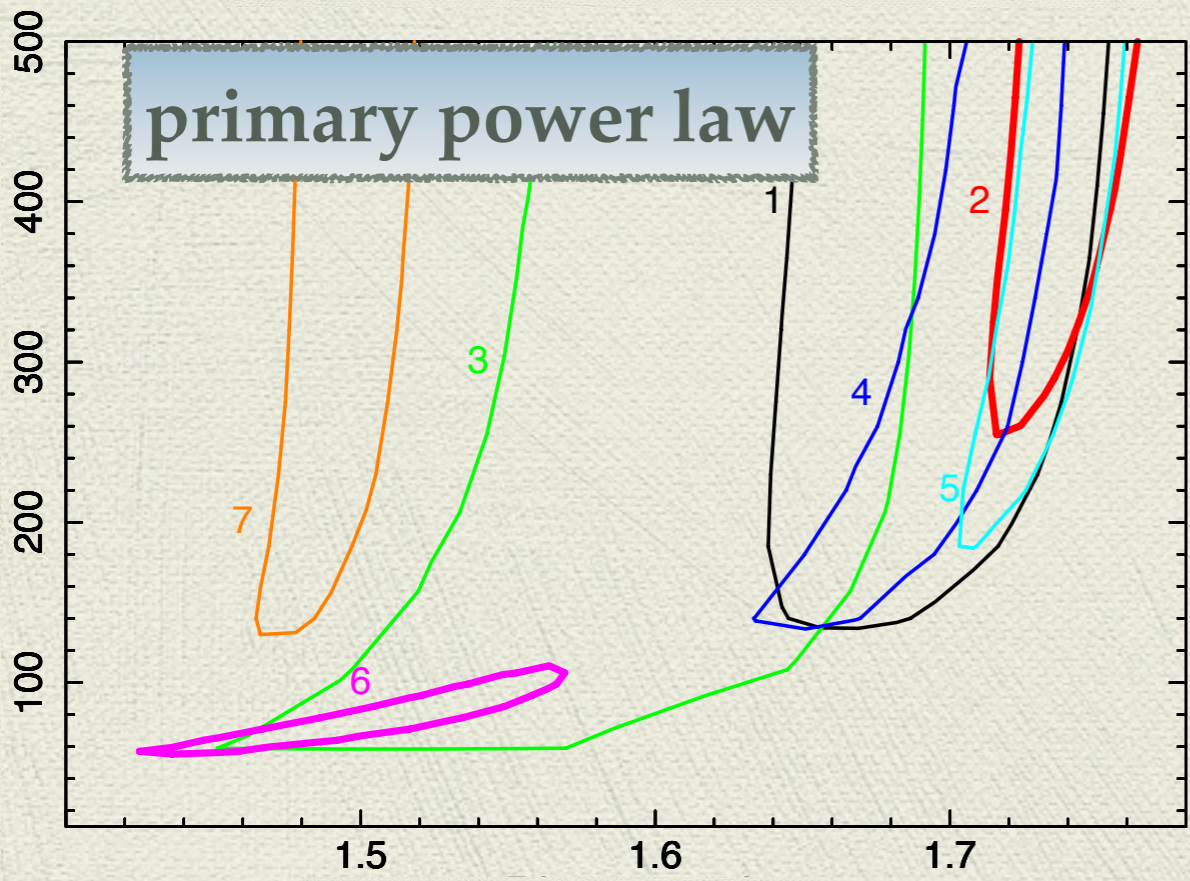
reflection component

PEXMON Norm.



PEXMON Photon index

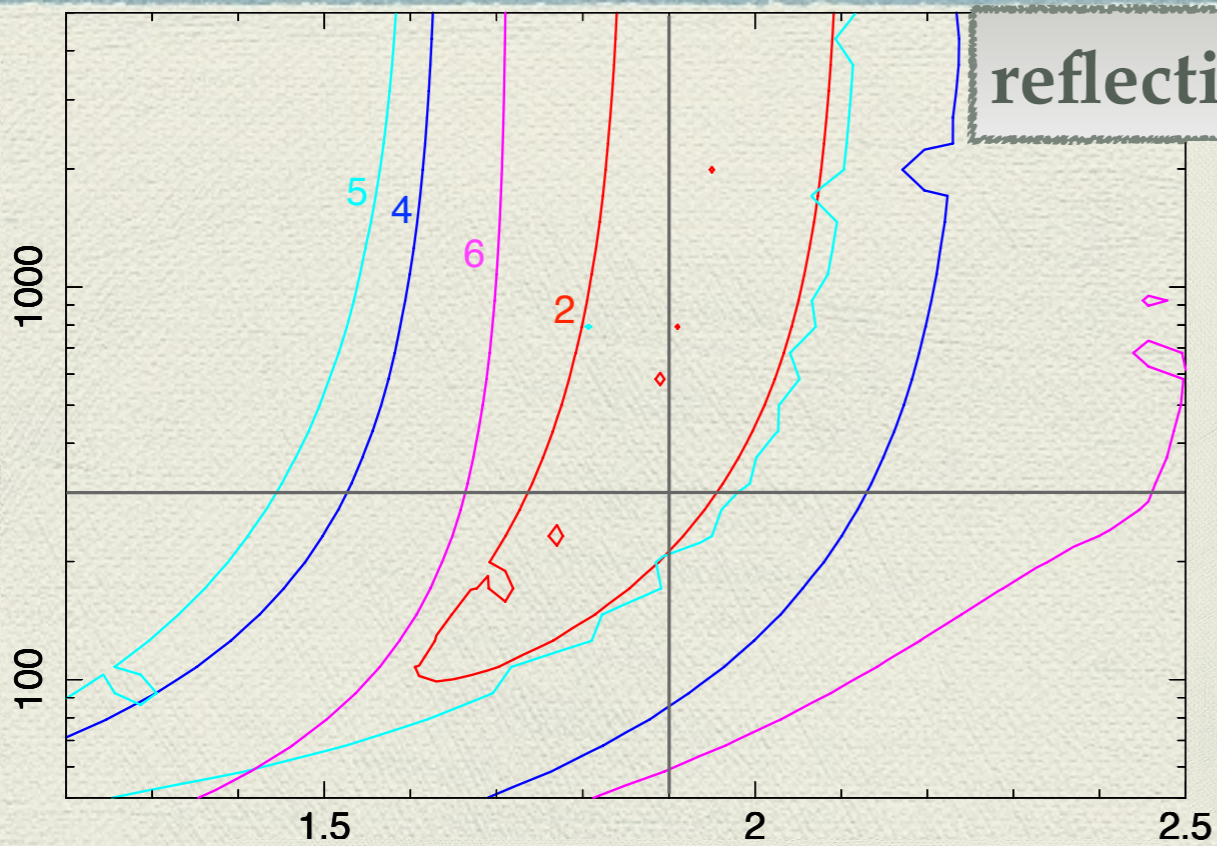
Cut-off energy (keV)



Photon index

primary power law

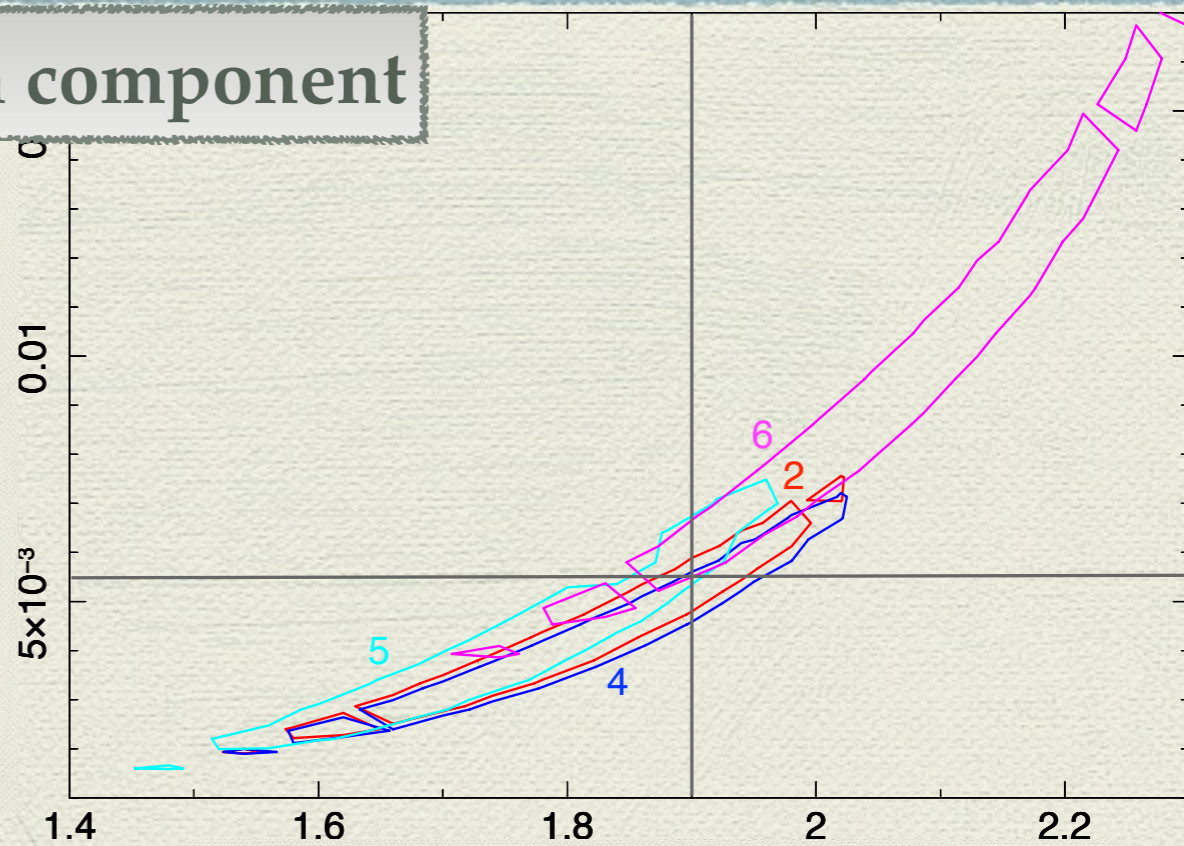
PEXMON Ec (keV)



PEXMON Photon index

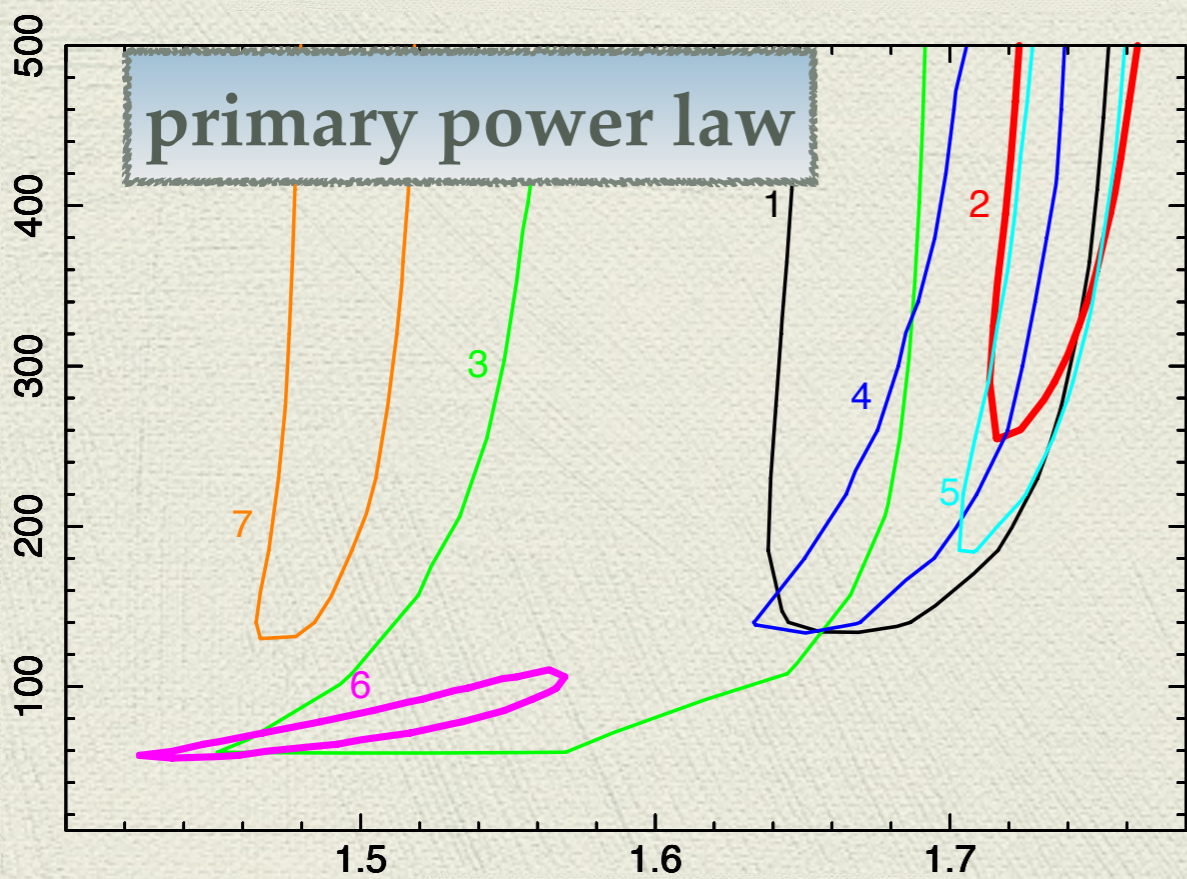
reflection component

PEXMON Norm.



PEXMON Photon index

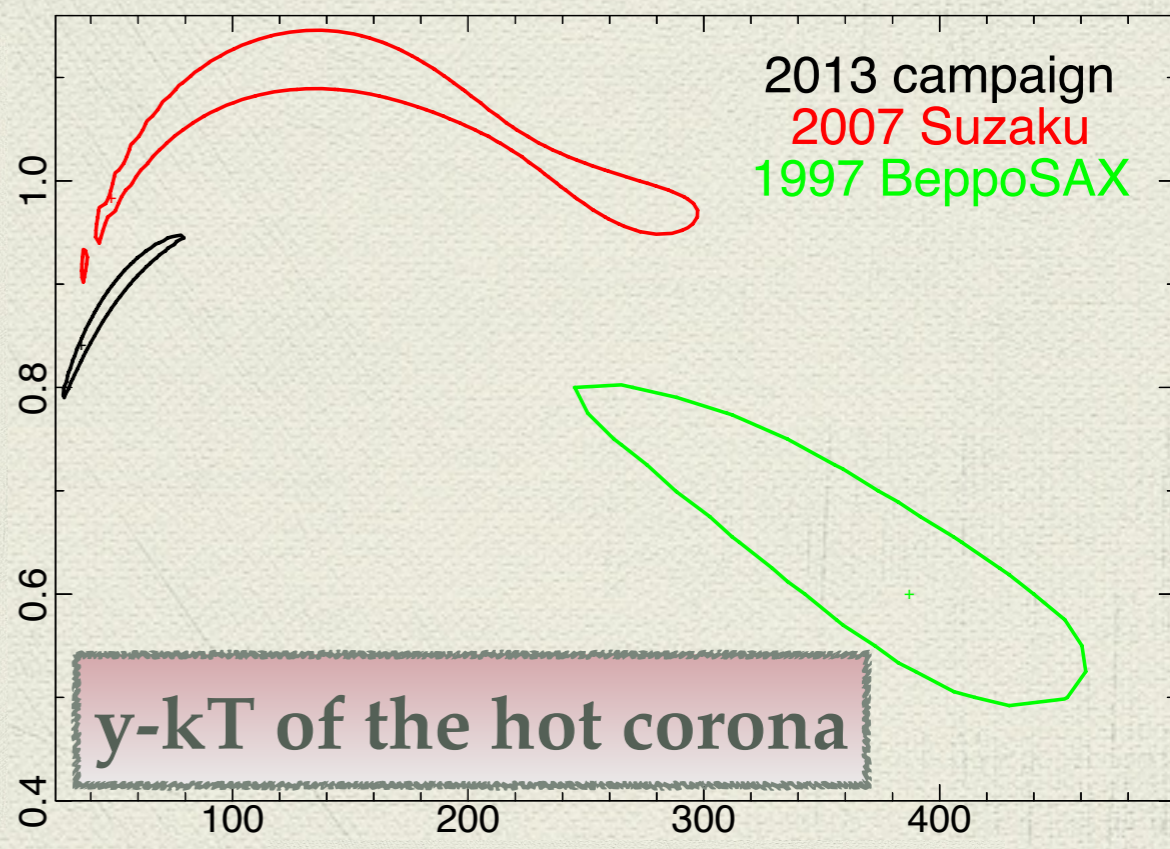
Cut-off energy (keV)



Photon index

primary power law

Compton parameter



Temperature (keV)

y-kT of the hot corona

2013 campaign
2007 Suzaku
1997 BeppoSAX

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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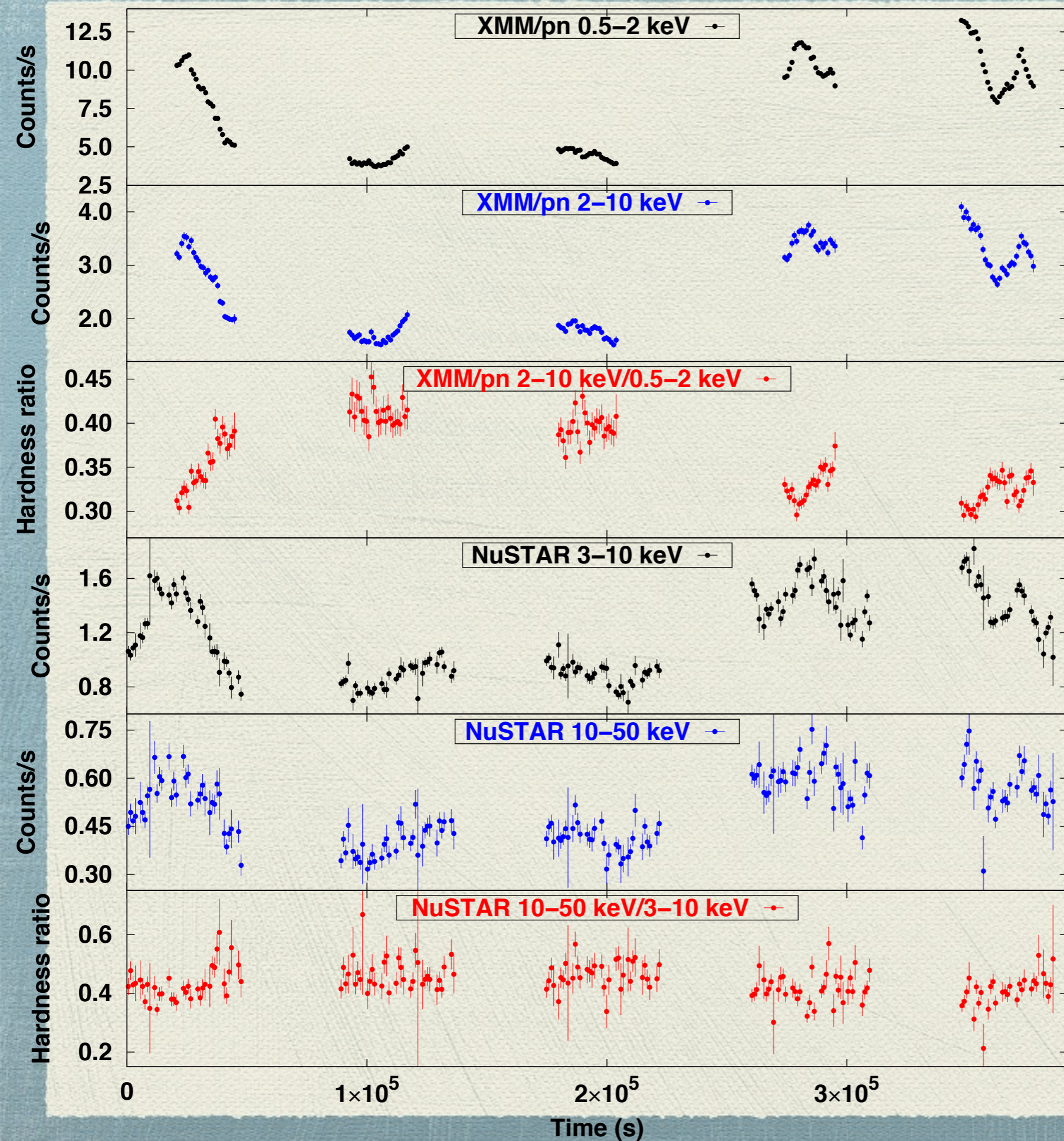
- ◆ a lower limit for the high-energy cut-off of 150 keV

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

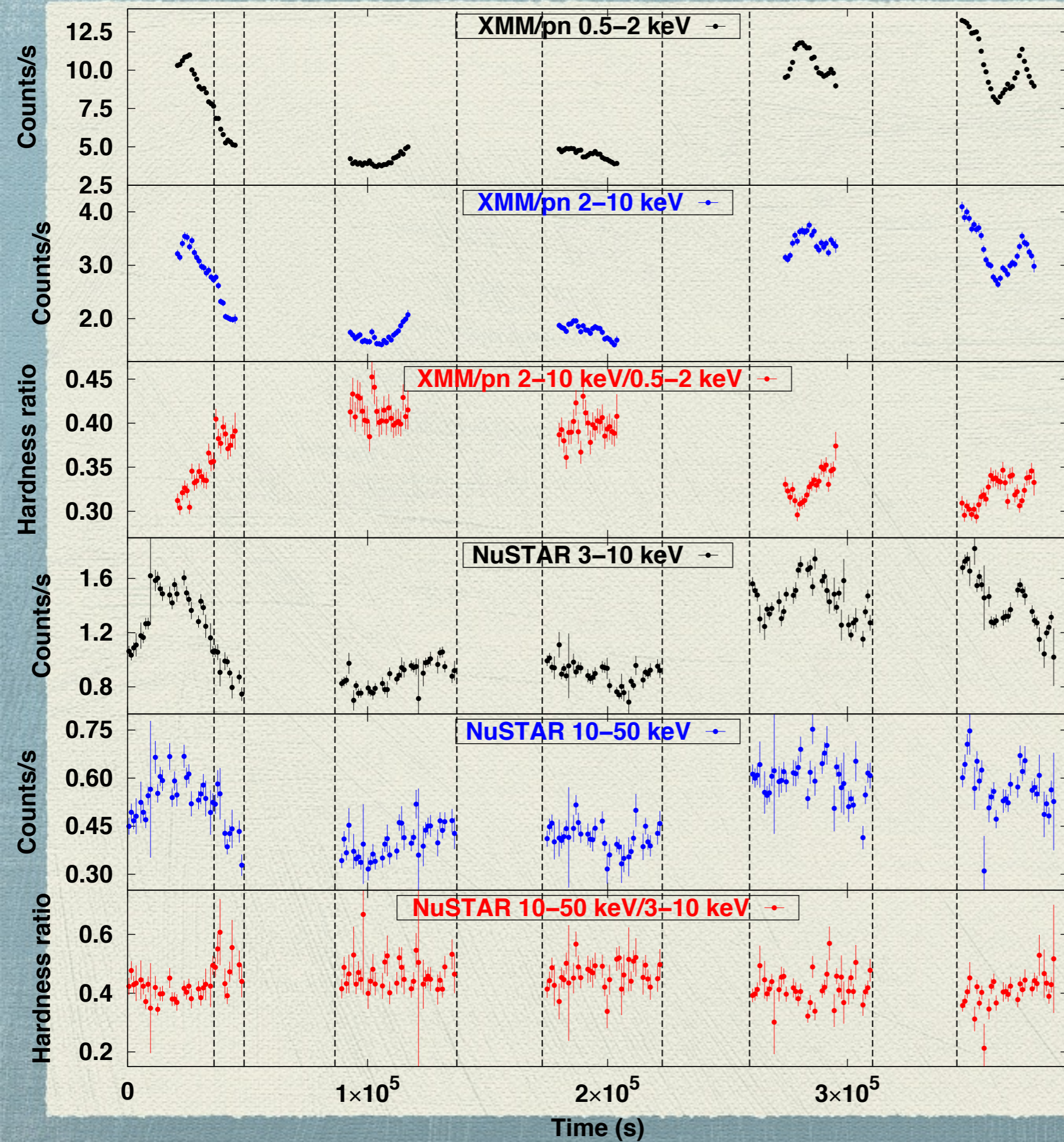


Significant flux
variability

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

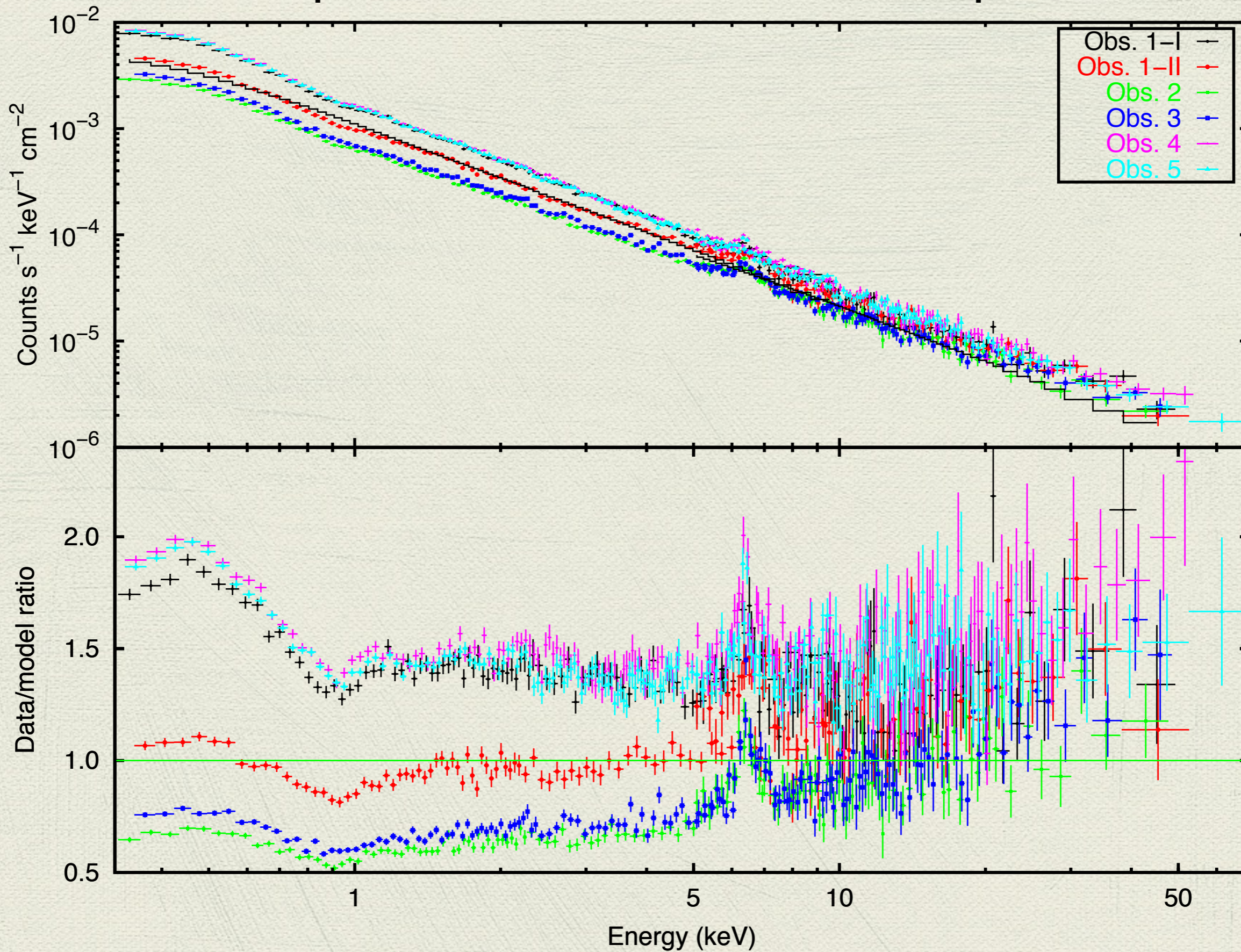
... not much in the
hard band (3-50 keV)

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



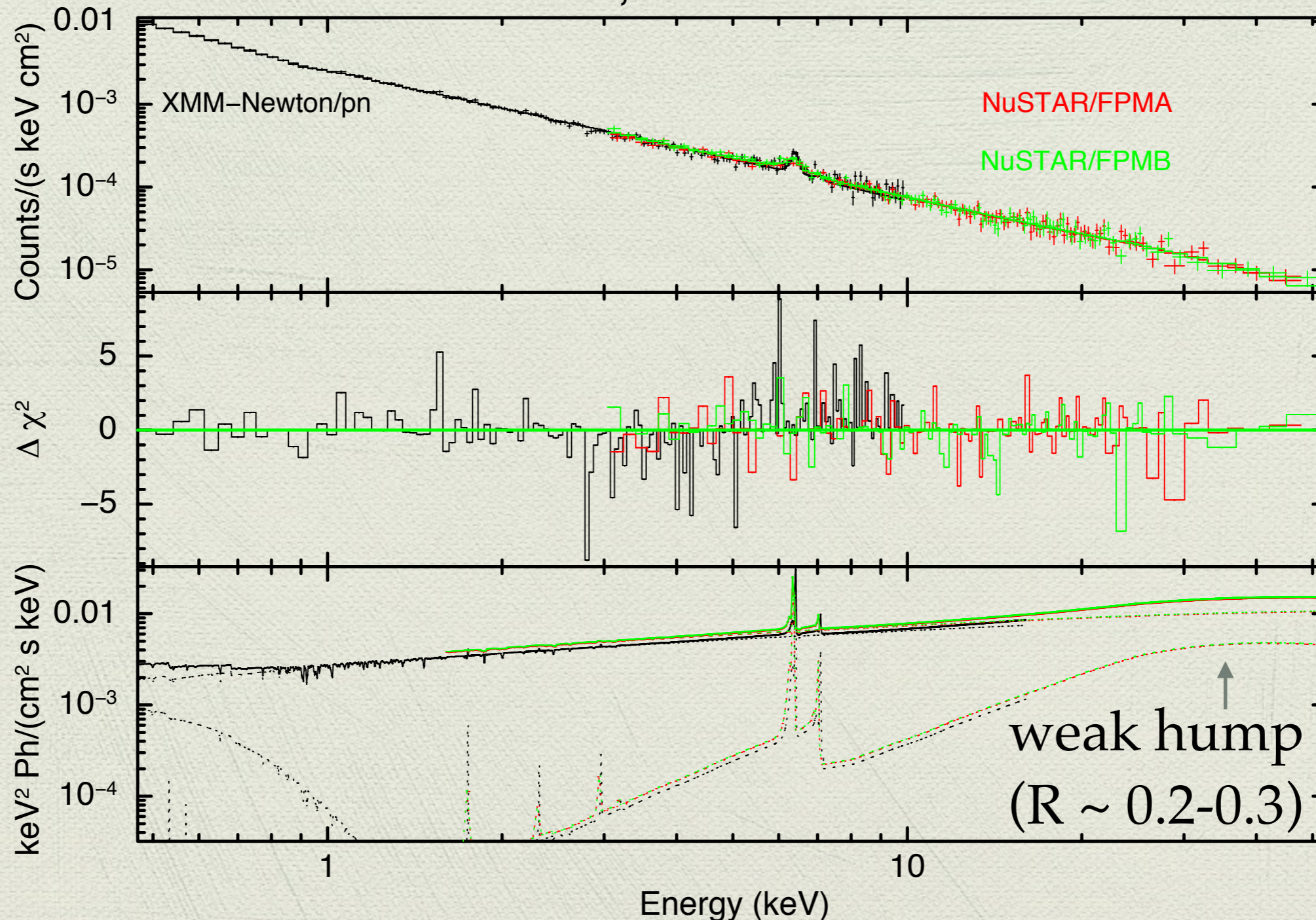
Baseline model:

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

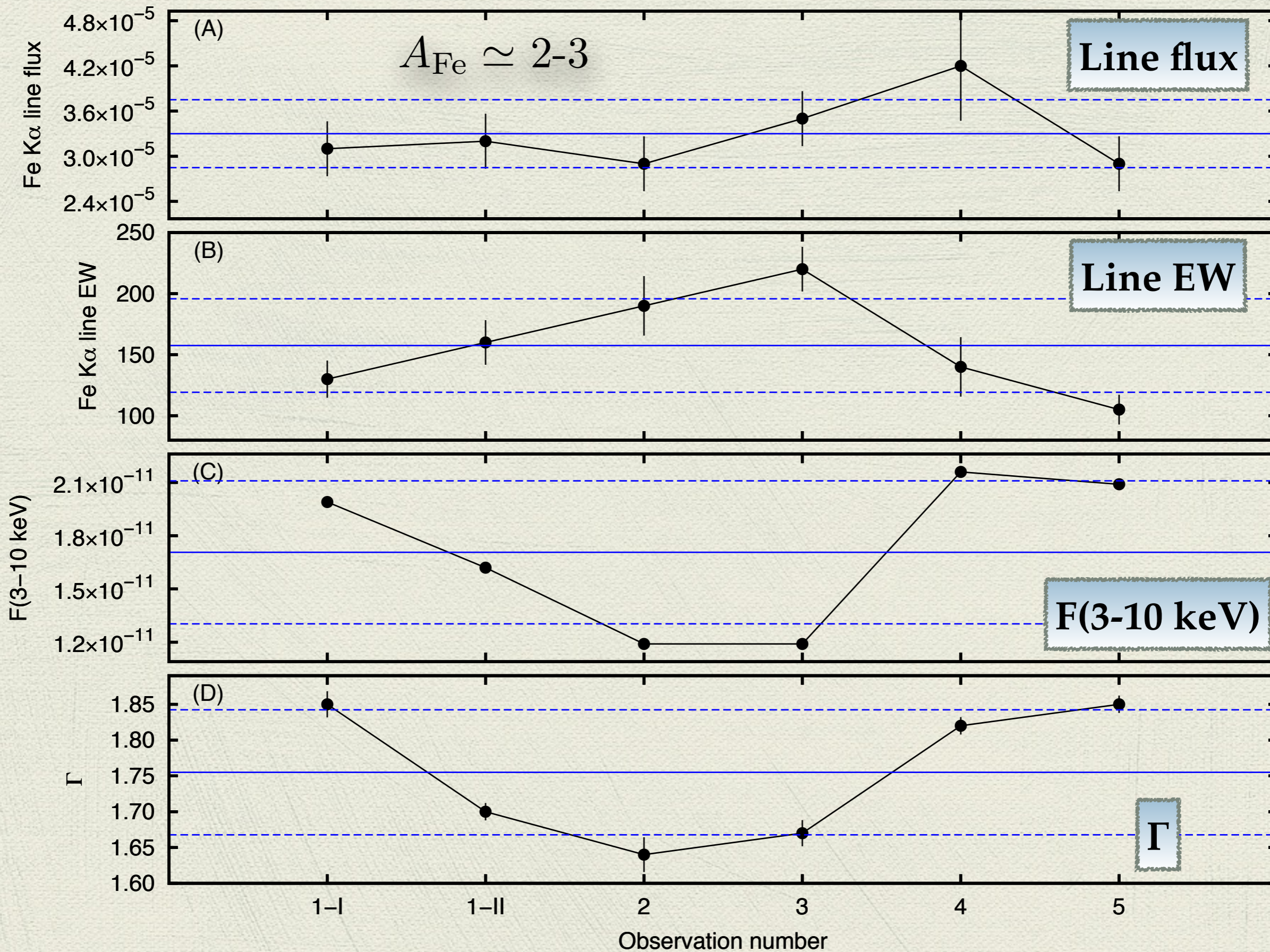
↓
bbody

↓
xillver
 A_{Fe} free

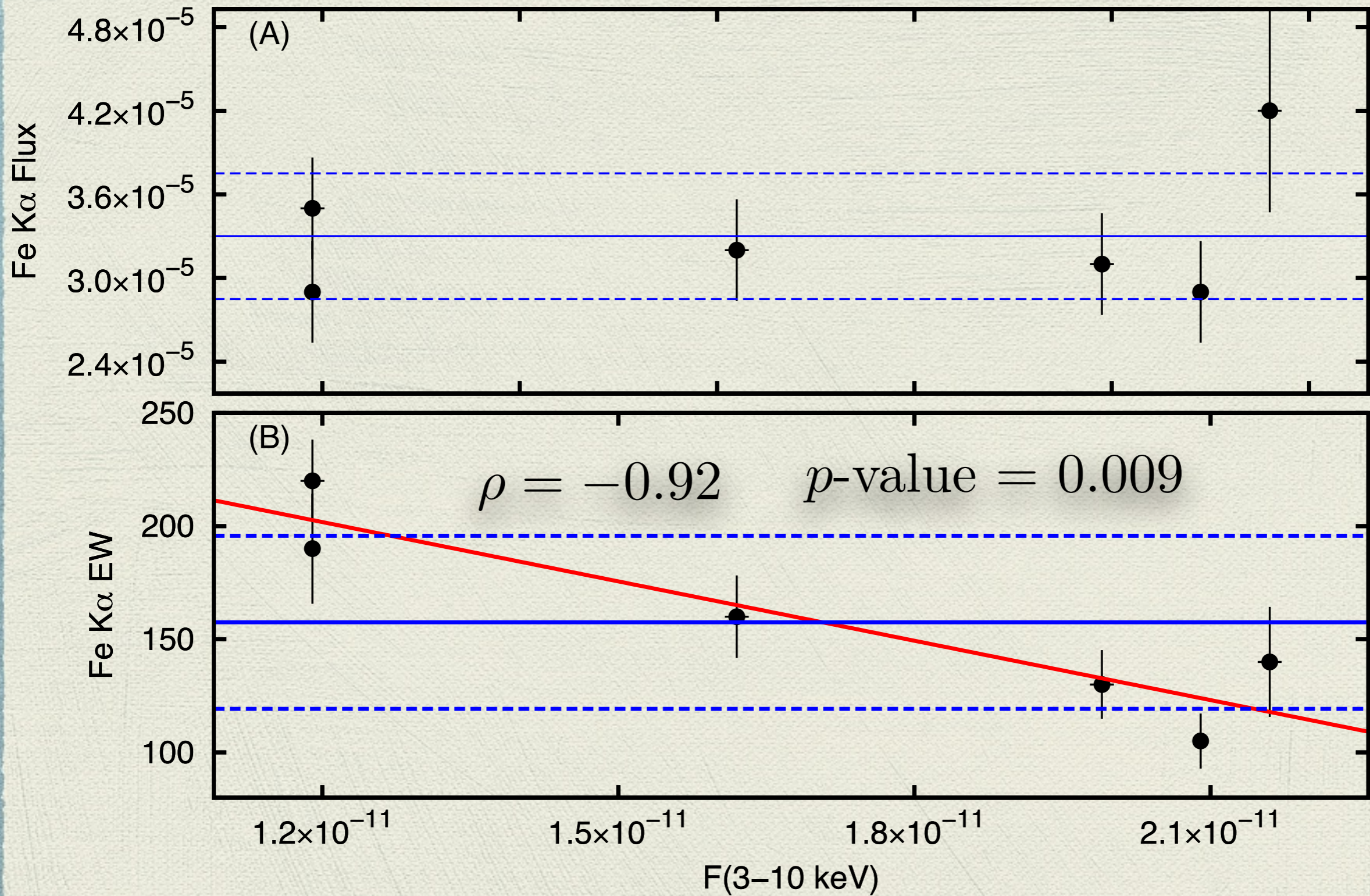
Obs. 2: Broad-band fit, residuals and best-fit model



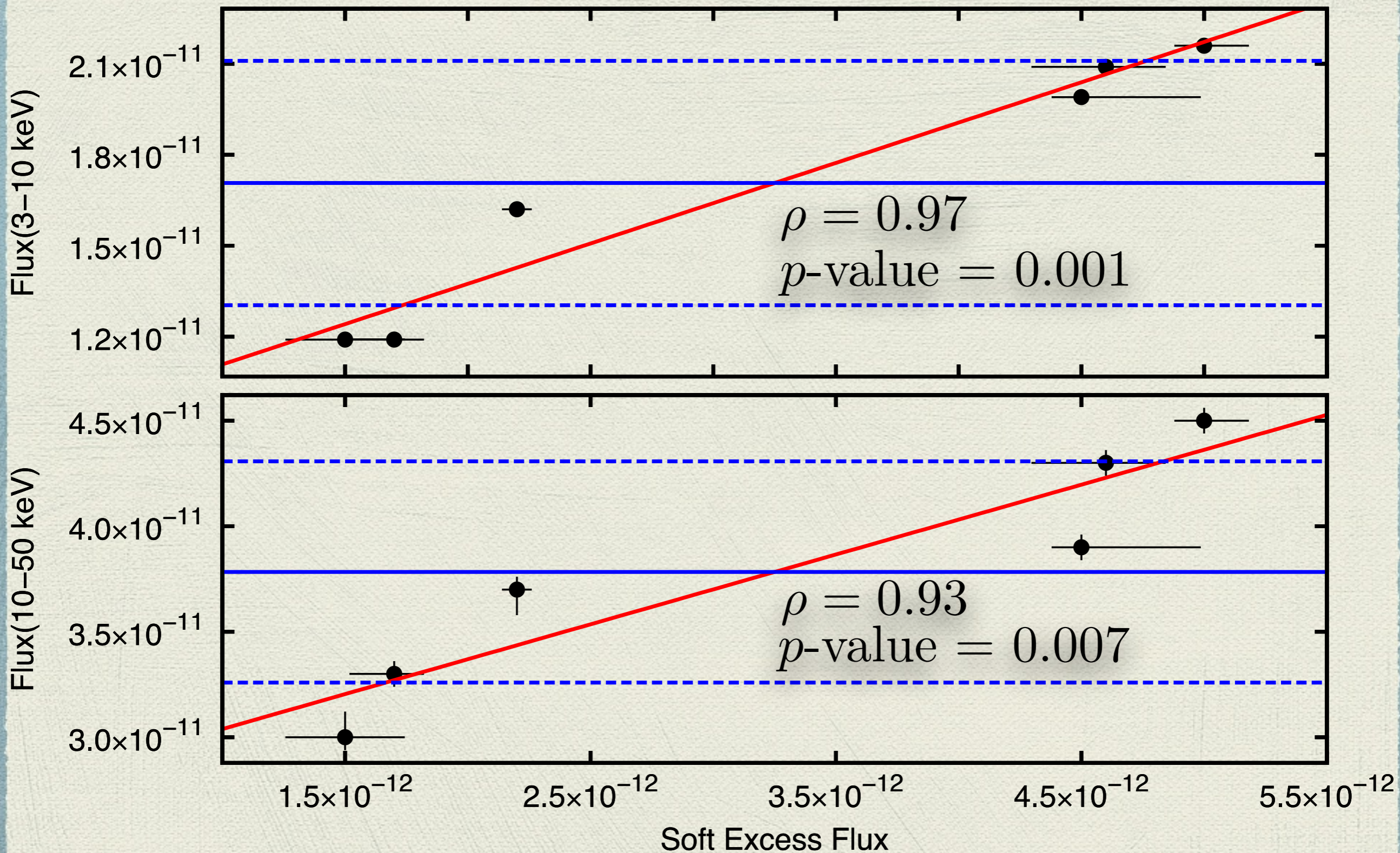
Fe K α line flux and EW, primary flux (3–10 keV), photon index



Anticorrelation between EW of the Fe K α 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 (~ light months)
- ◆ Evidence of variable photon index and high-energy cut-off
- ◆ Temperature and optical depth of the hot corona show long-term (~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 ~ 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!