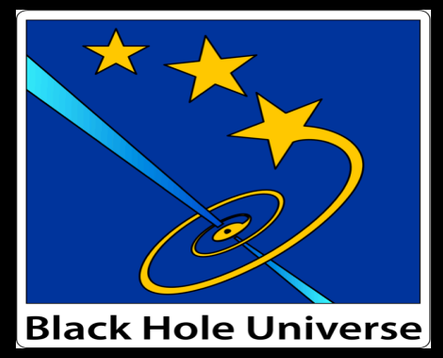
Black Hole Universe 2012
Bamberg, 18-22 June



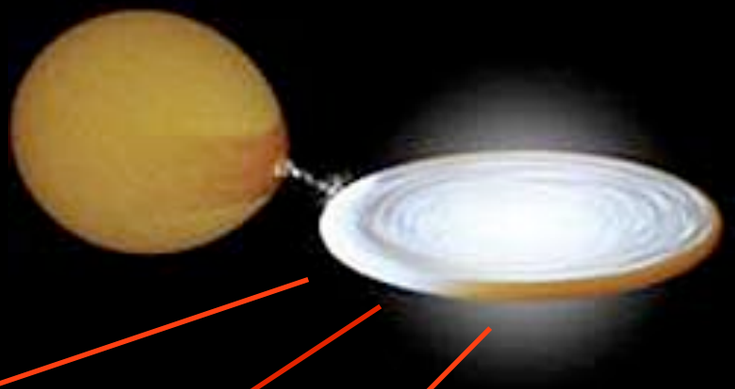
ITN 215212

Self-consistent study of the reflection component in 4U 1705-44 with *XMM-Newton*, *BeppoSAX* and *RXTE* in the Hard and Soft State

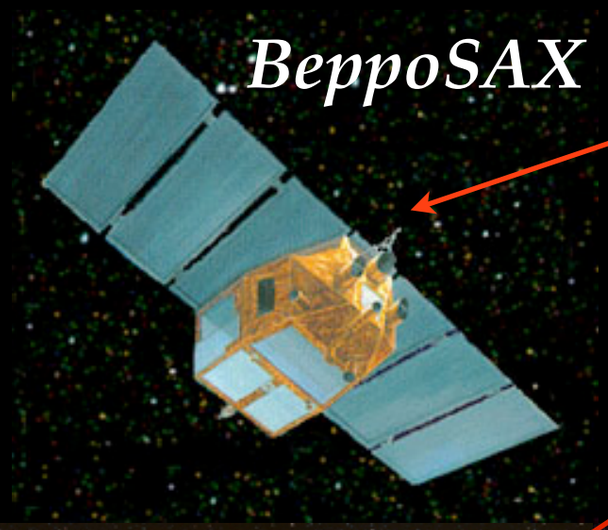
Presented by **Elise Egron**

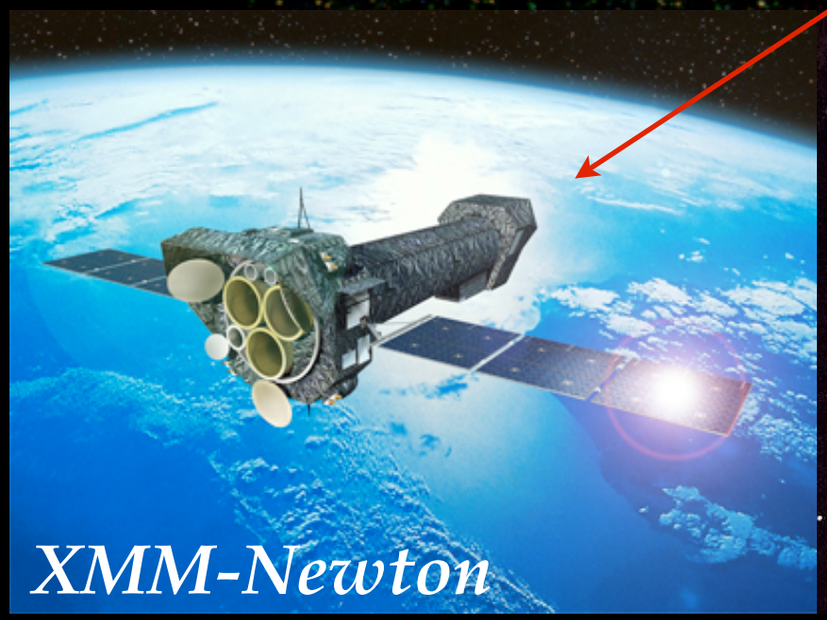
In collaboration with : **Tiziana Di Salvo**
Sara Motta
Luciano Burderi

4U 1705-44

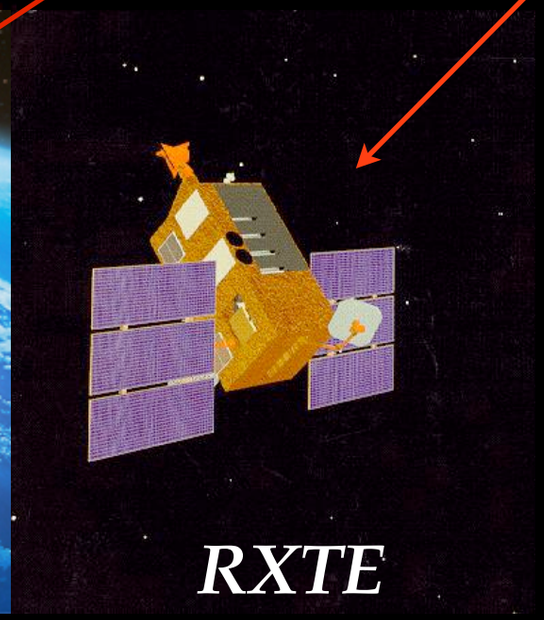


BeppoSAX





XMM-Newton

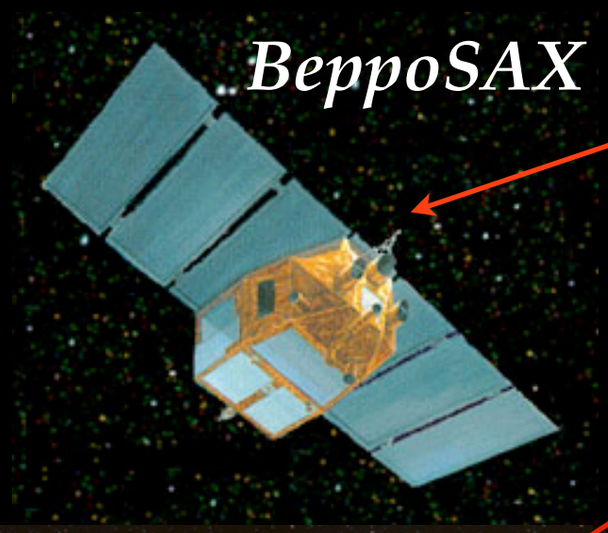


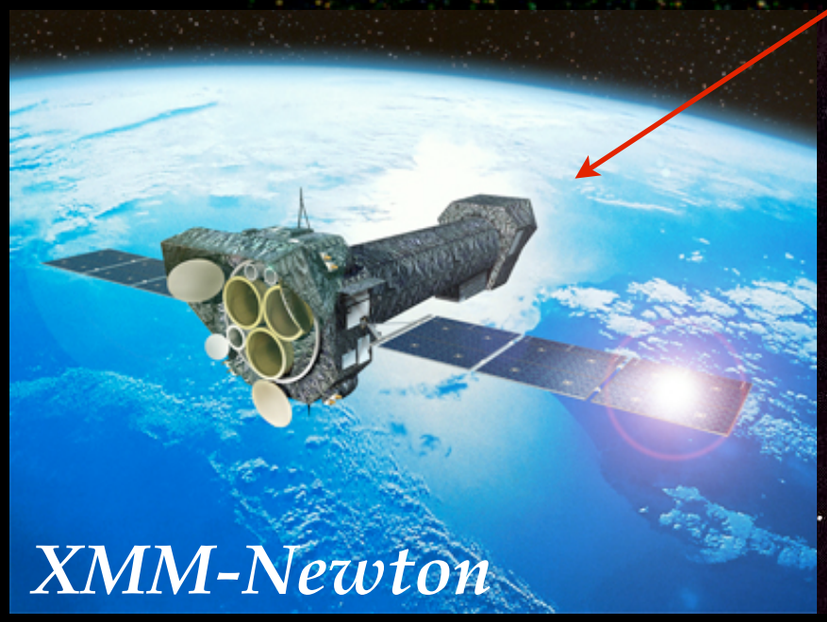
RXTE

1)

To test the validity of the disk-reflection scenario

4U 1705-44



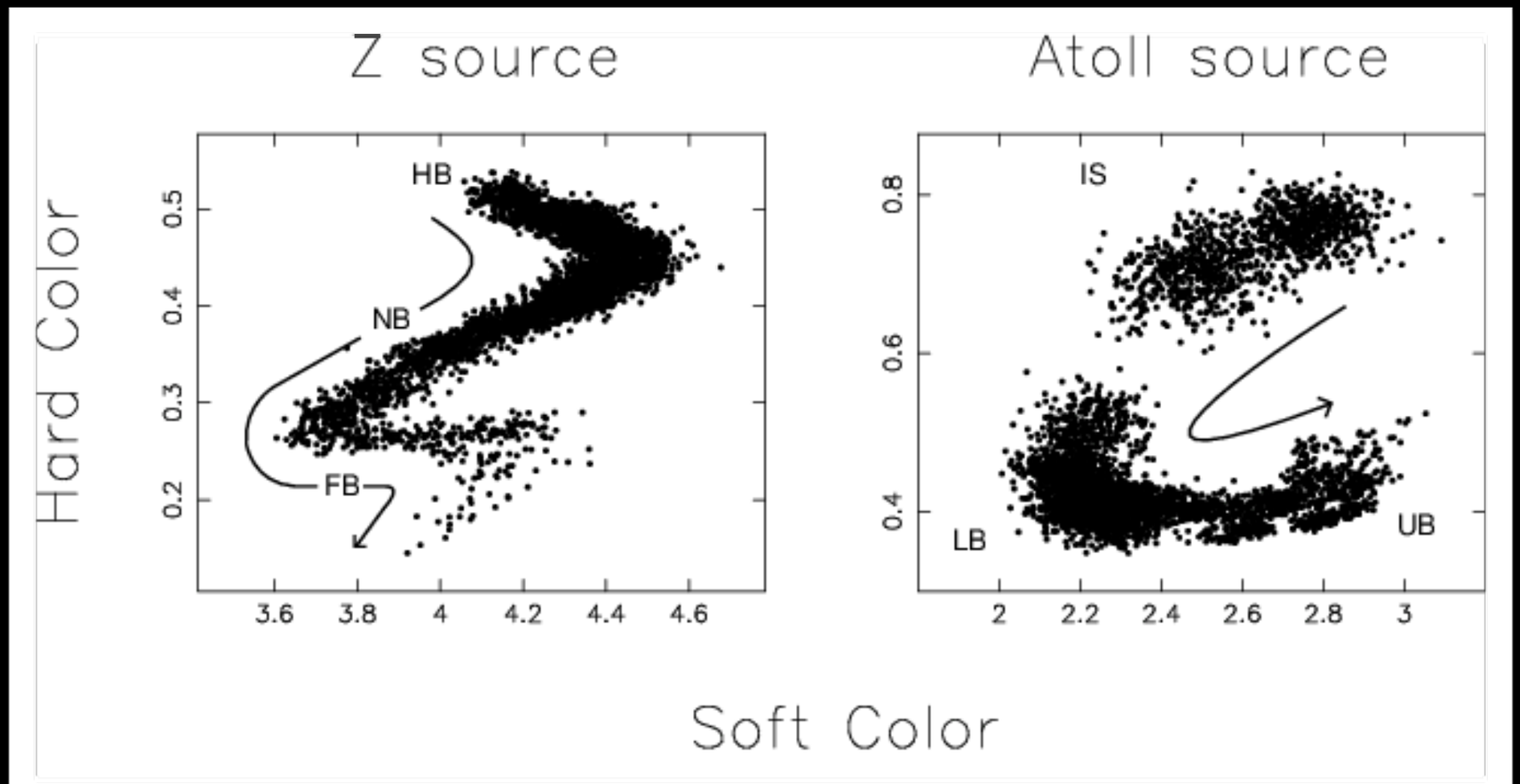


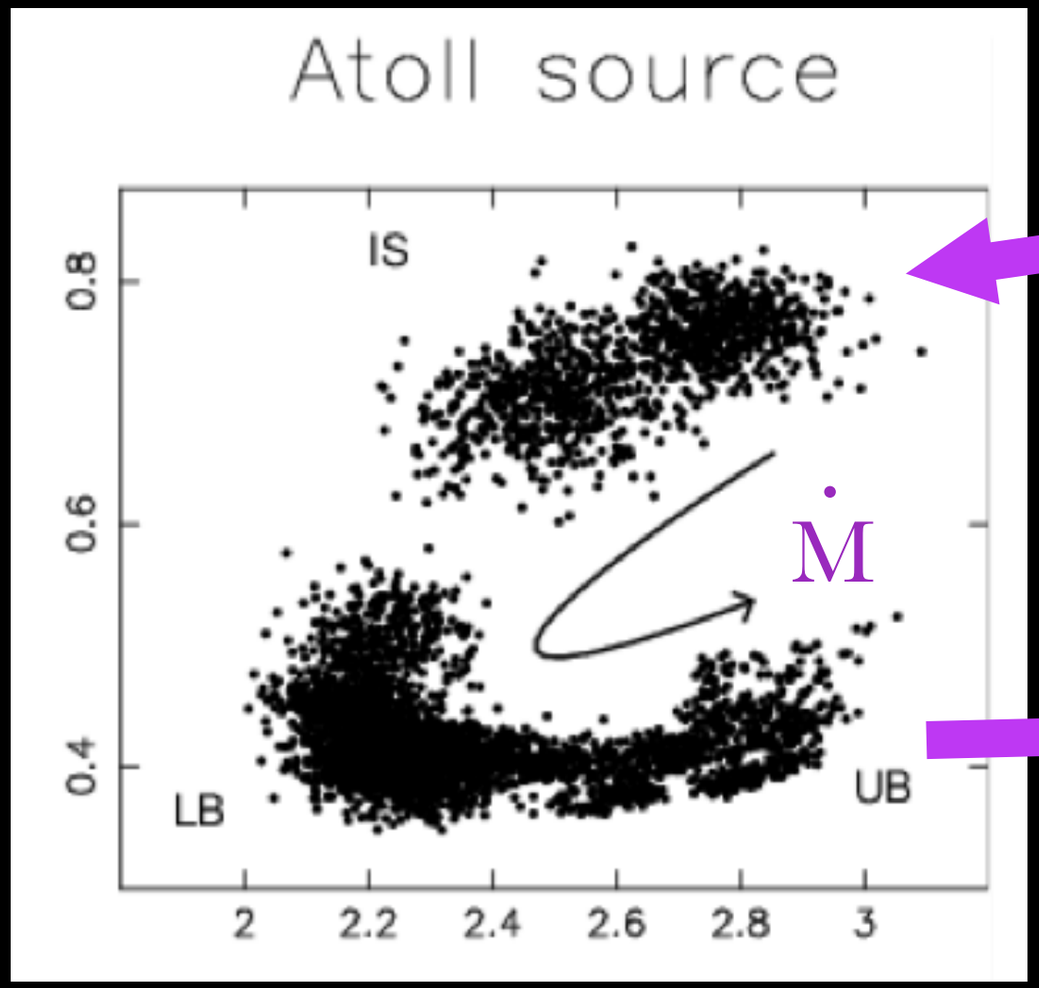
2)

To study the evolution of the spectral shape from the Hard to the Soft state in 0.1-200 keV using reflection models

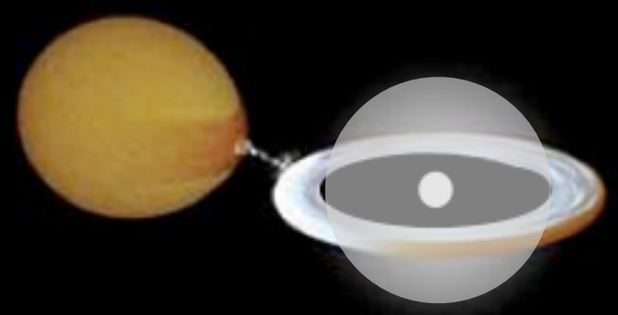
4U 1705-44

- LMXB containing a weakly magnetized neutron star
- Atoll class





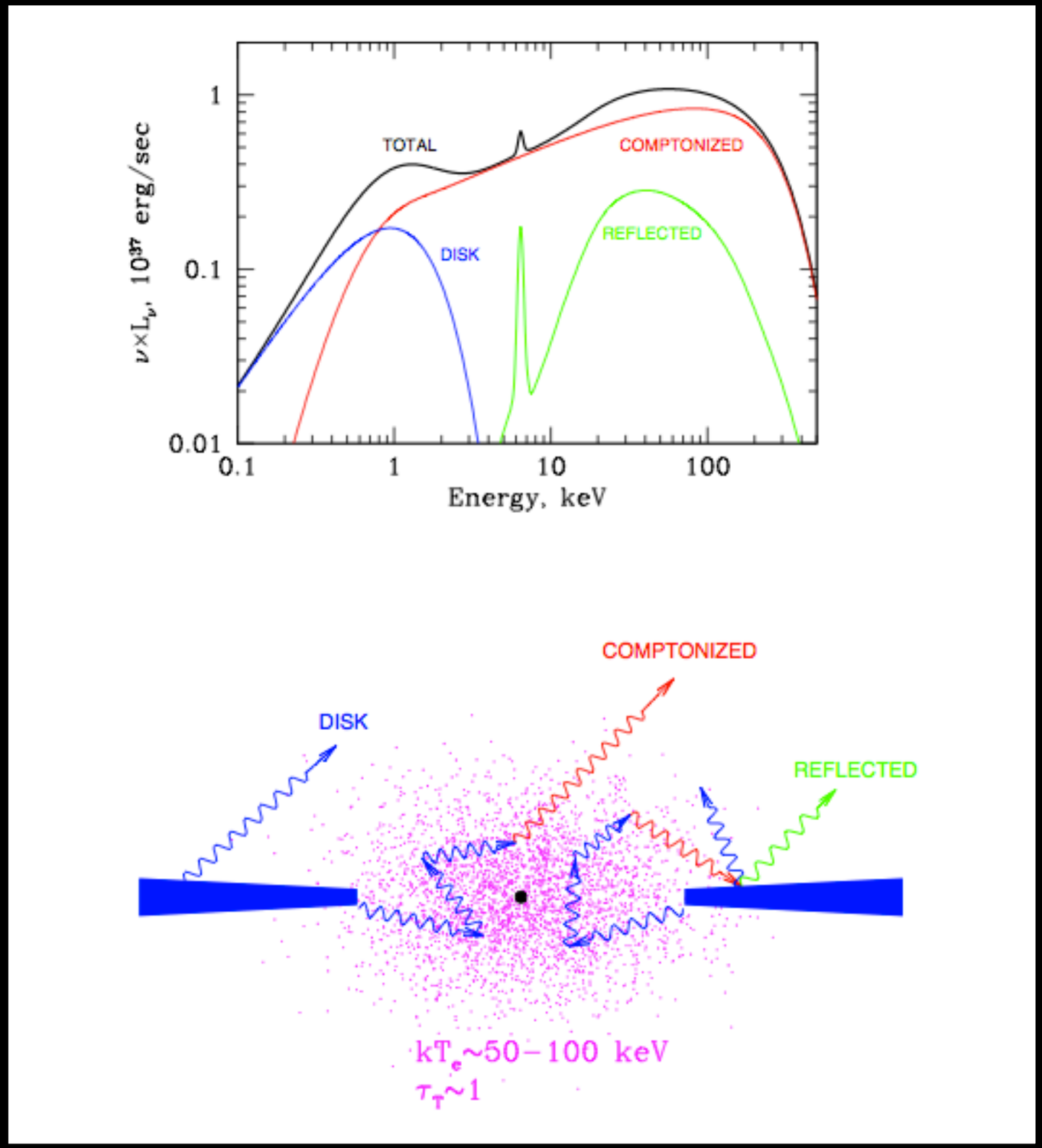
Hard State



Soft State

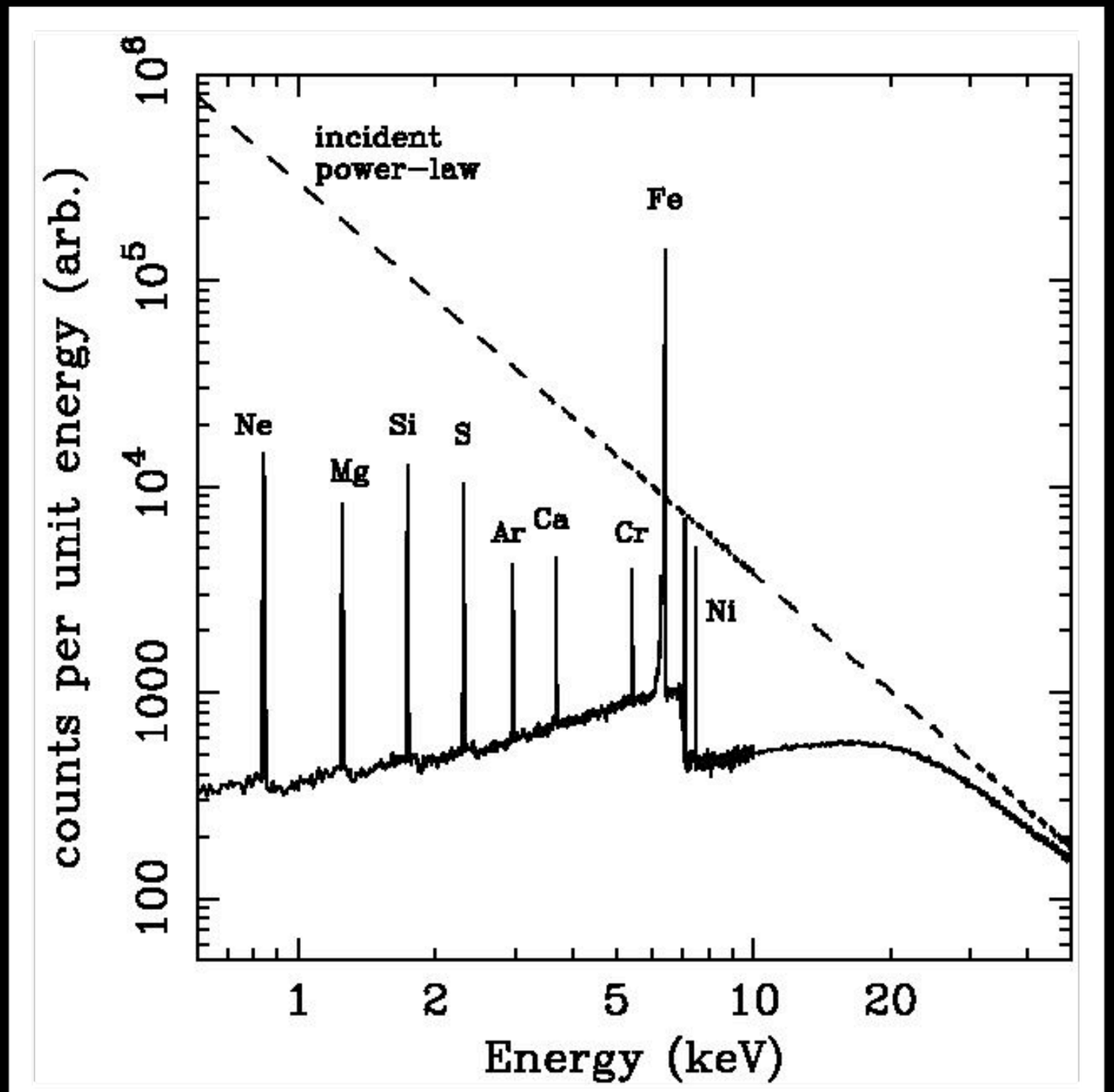
$$L_{\rm acc} = \eta_{\rm acc} \dot{M} c^2$$

Main components of the X-ray emission



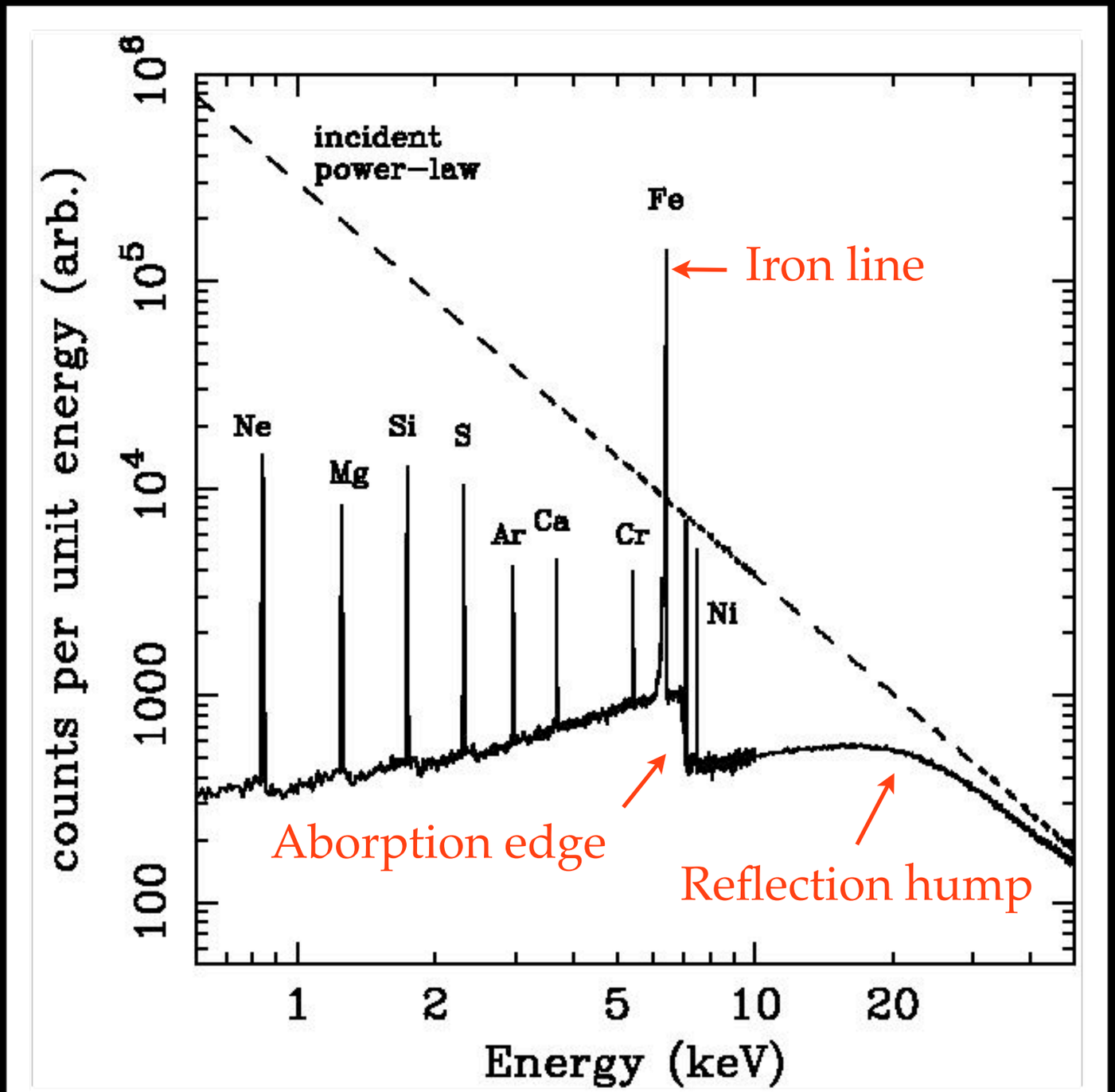
M. Gilfanov (2009)

Reflection spectrum



Monte Carlo simulation
from Reynolds (1996)

Reflection spectrum



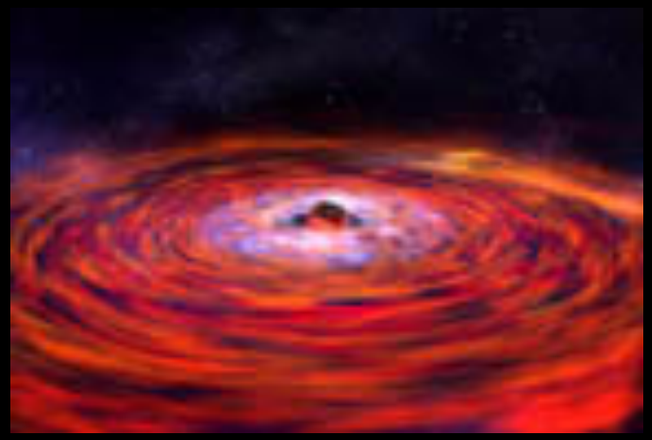
Monte Carlo simulation
from Reynolds (1996)

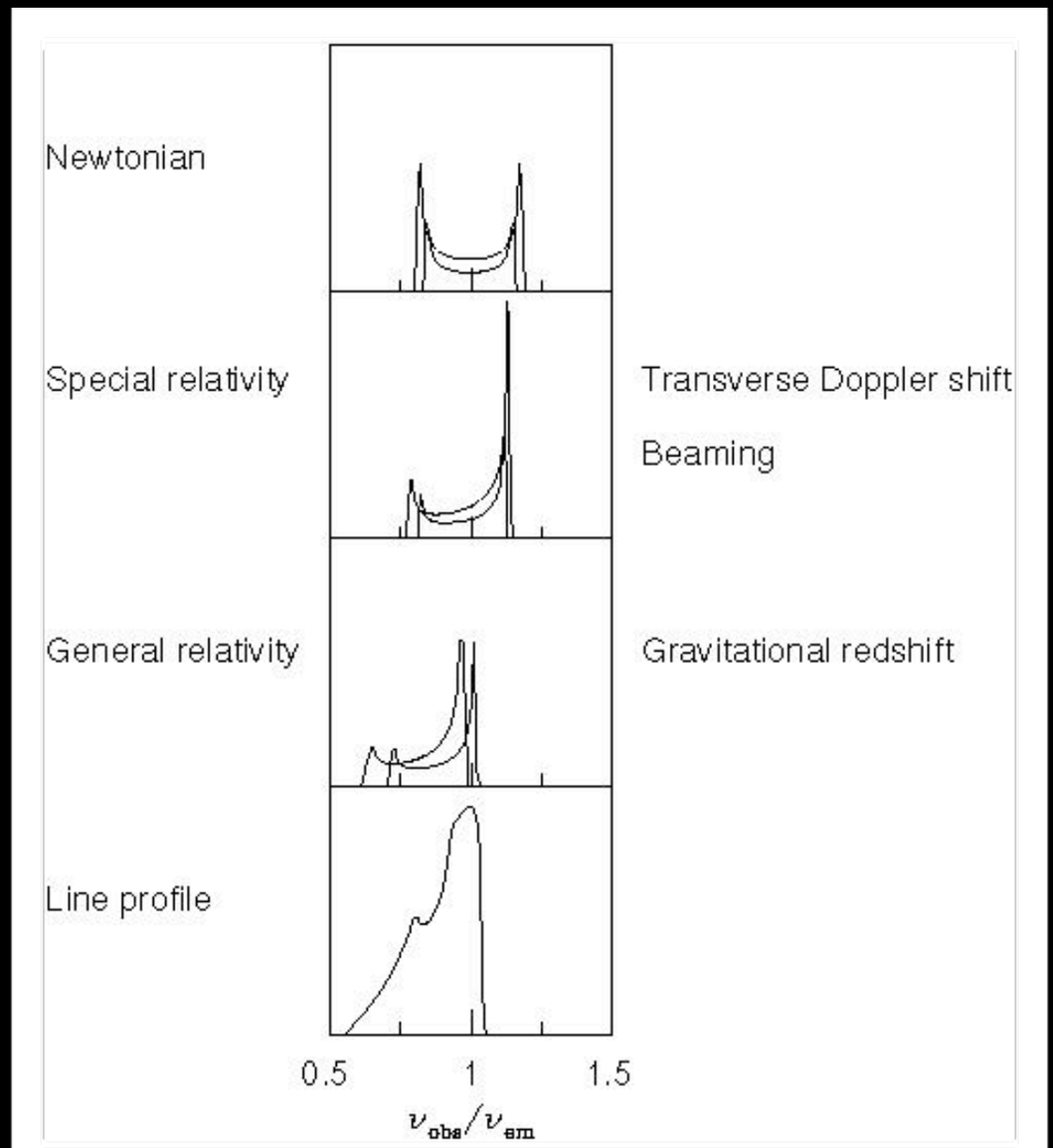
Profile of the iron line

- **Broad and Asymmetric :**

⇩

- Doppler shifts
- Relativistic beaming
- Gravitational redshifting





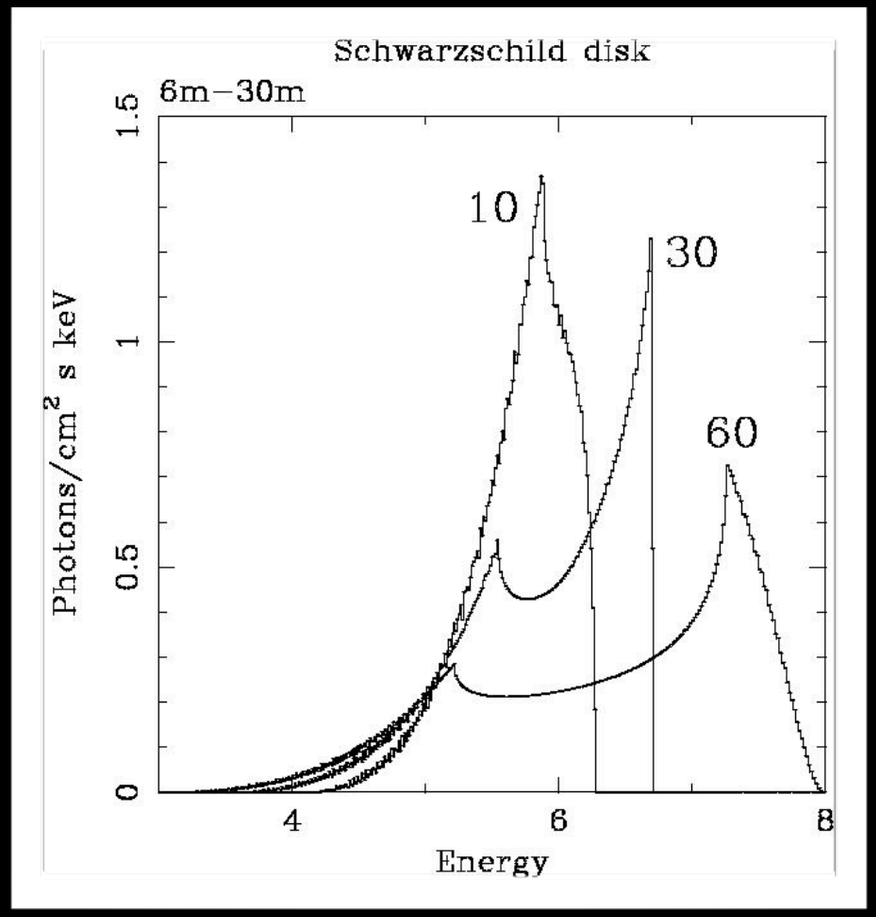
Fabian et al. 2004

Profile of the iron line

- **Determination of parameters of the accretion disk :**

  - Inner radius
  - Outer radius
  - Inclination of the system ⟶
  - Ionization parameter :

$$\xi(r) = 4\pi F_{\mathrm{X}}(r)/n(r)$$



Instruments : broad energy band

RGS

EPIC-PN

PCA

HEXTE

LECS

MECS

HPGSPC

PDS

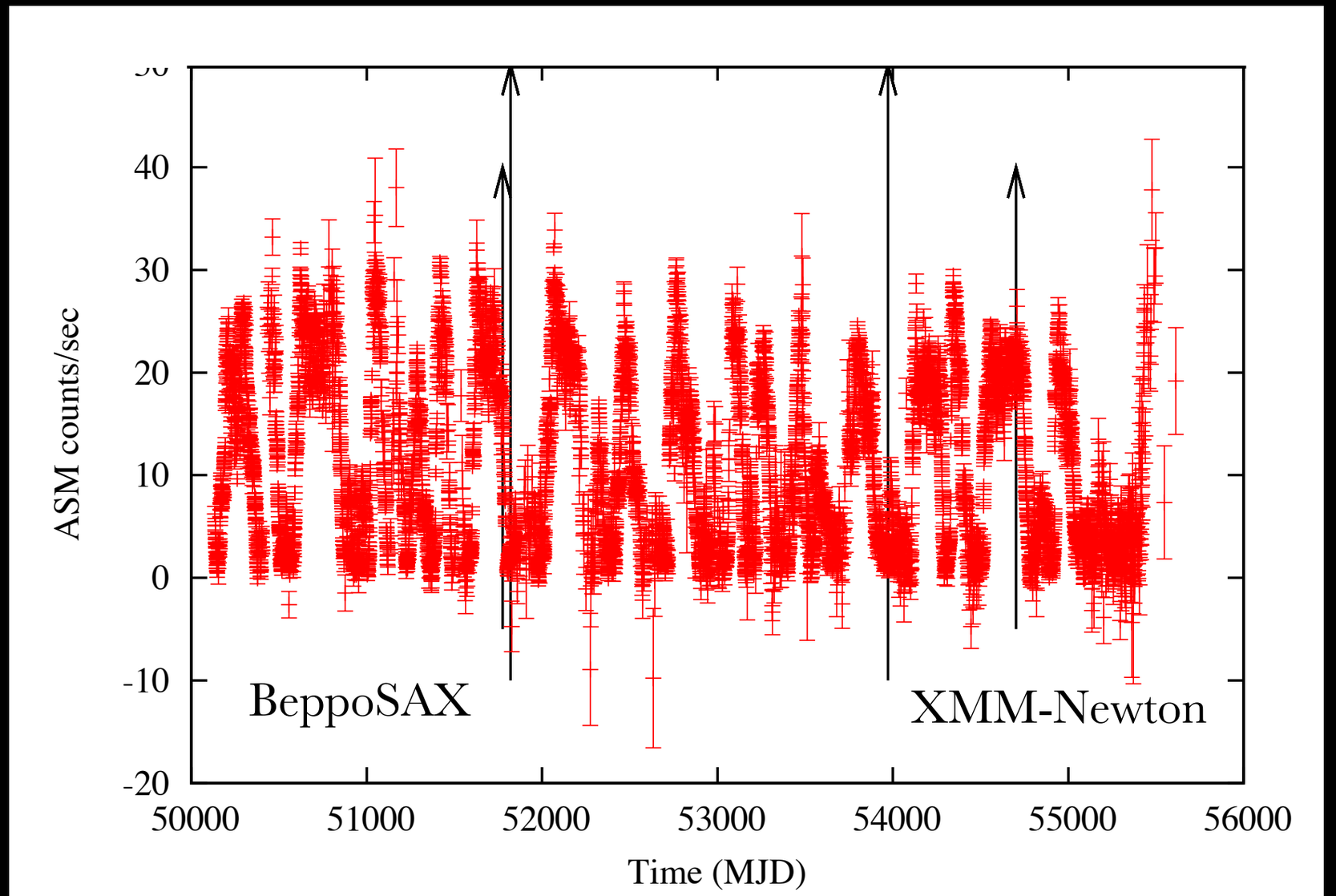
1

10

100

Energy (keV)

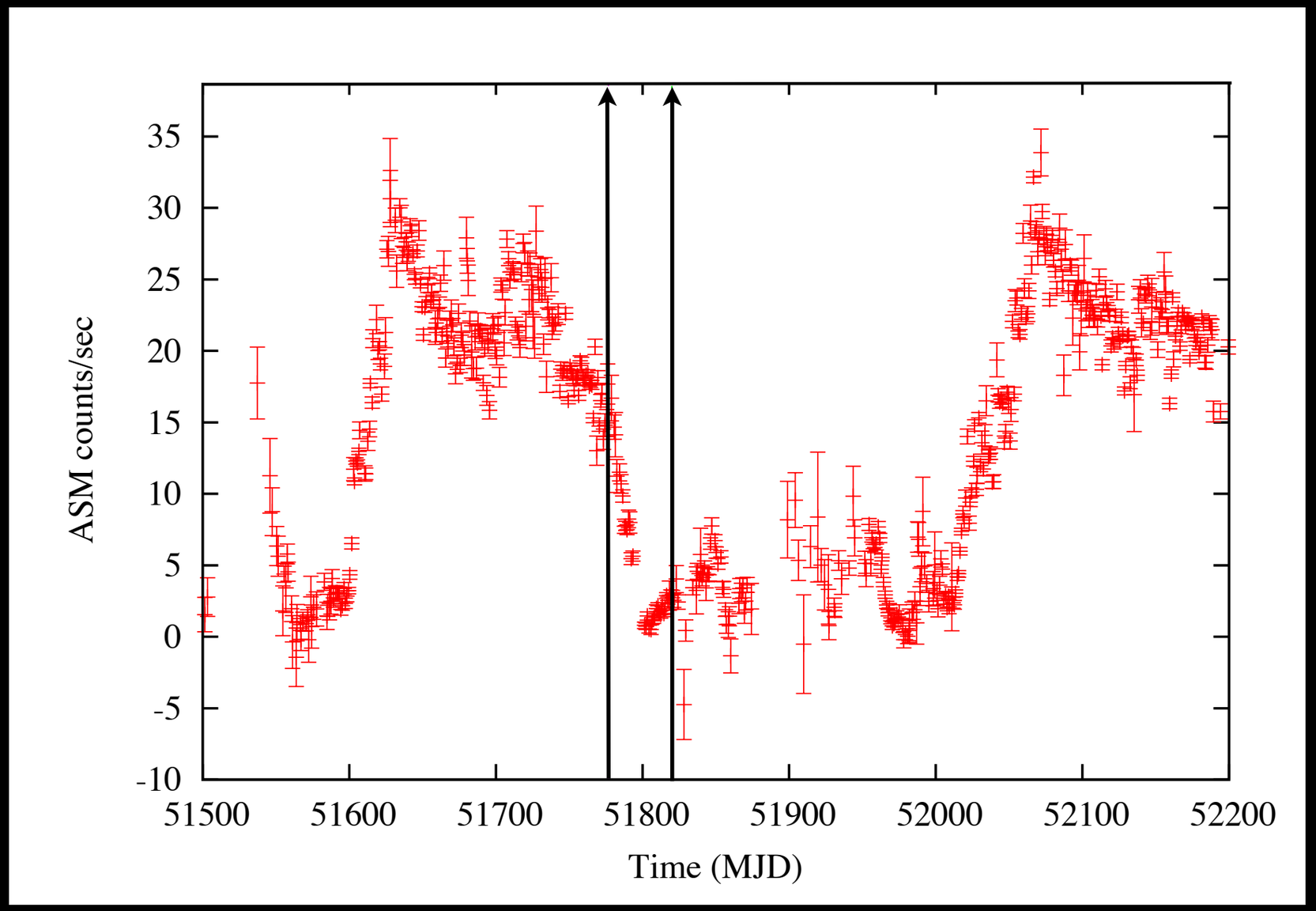
Lightcurve : ASM/RXTE



(1.5-12 keV)

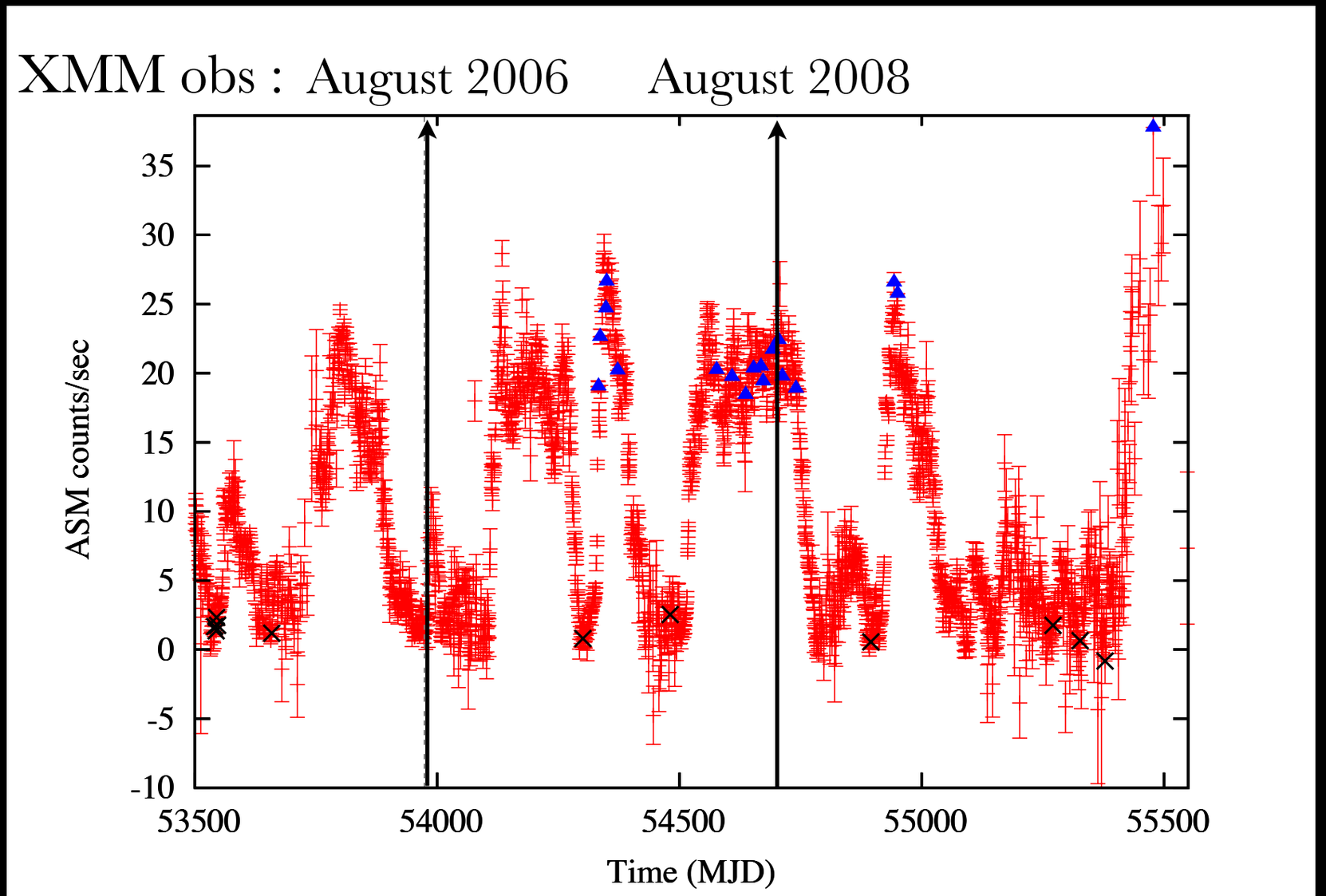
=> Clear spectral state transitions observed on about 16 years

BeppoSAX observations



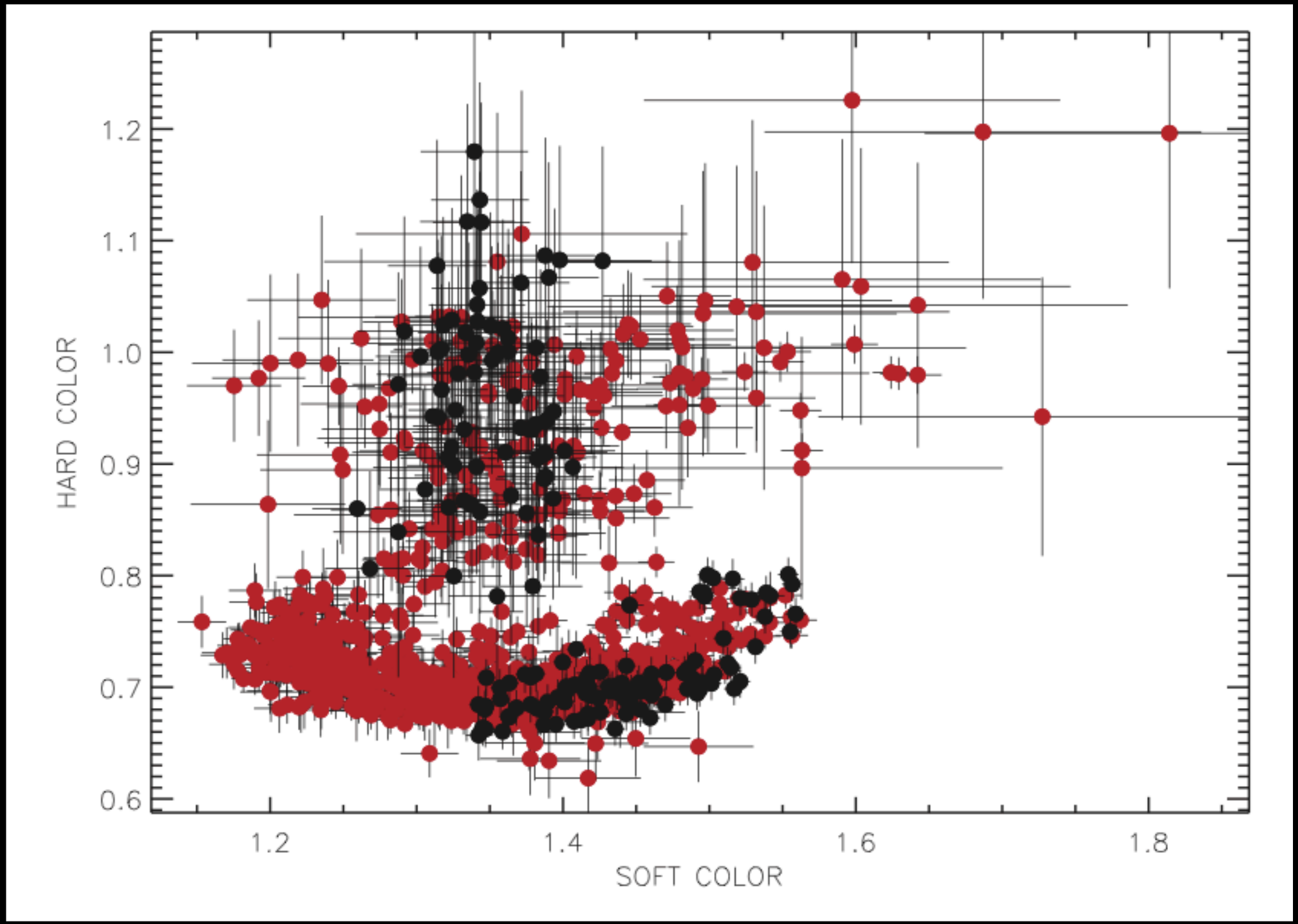
=> Observations performed in August and October 2000

XMM and RXTE observations



▲ × RXTE observations selected for our analysis

Selection RXTE data



Self-consistent reflection models

- **Model :**

constant * photoelectric absorption * (black body + comptonisation + relativistic blurring * reflection)

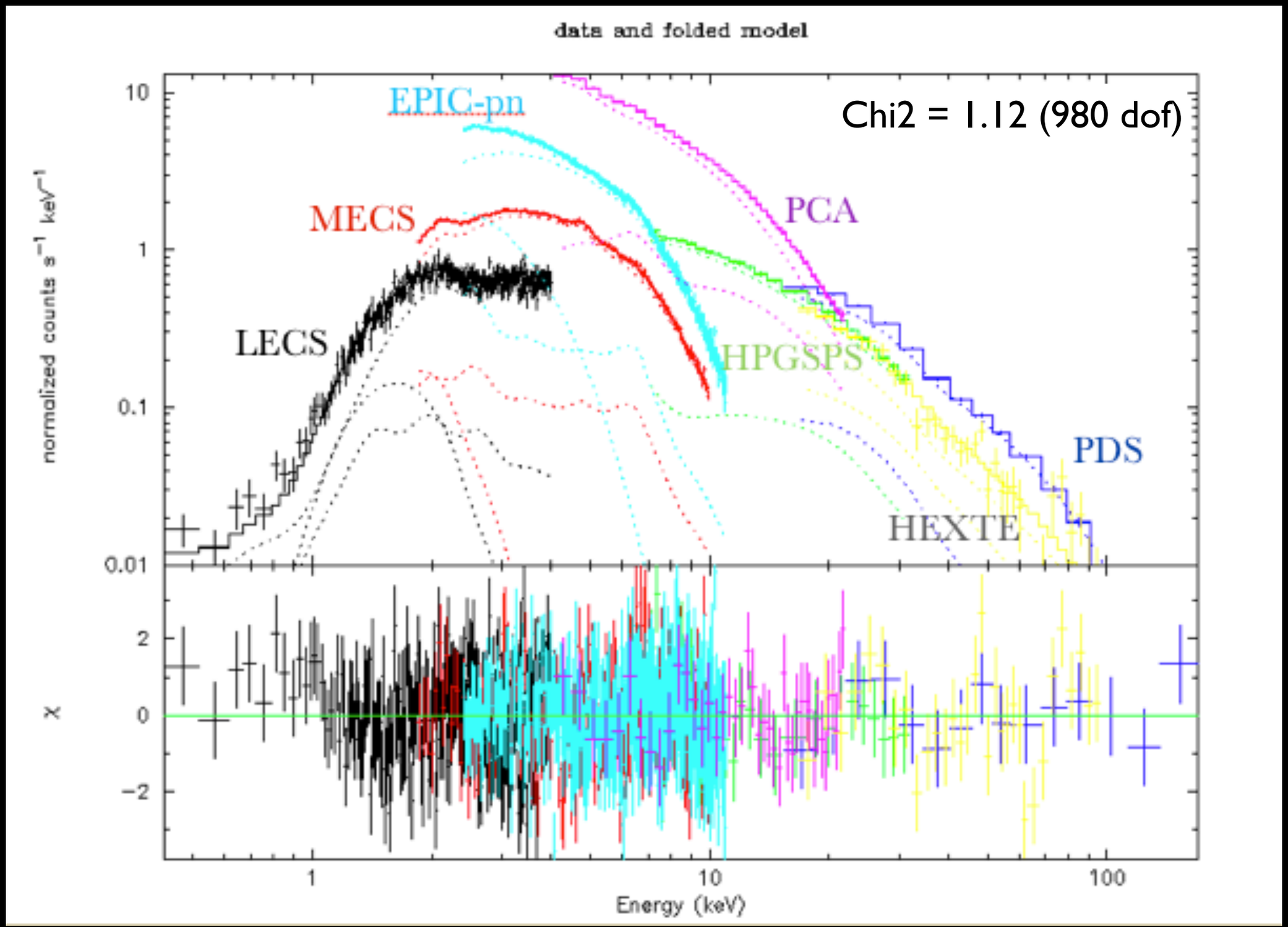
Reflionx : Ross & Fabian (2005)

Xillver : Garcia & Kallman (2010)

Pexriv : Magdziarz & Zdziarski (1995)

=> Comparison of the parameters in the hard and soft state

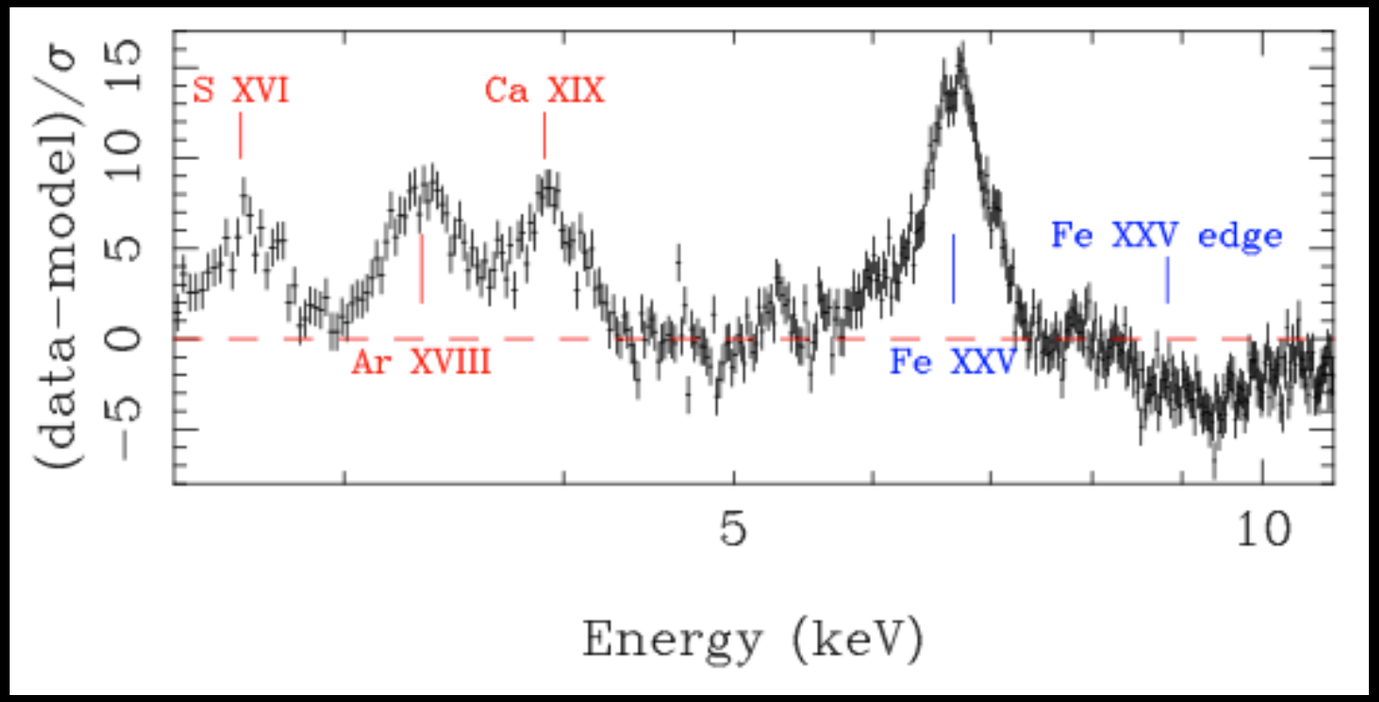
Hard State


data and folded model
EPIC-pn
MECS
LECS
PCA
HPGSPS
PDS
HEXTE
Chi2 = 1.12 (980 dof)
normalized counts s^{-1} keV^{-1}
χ
Energy (keV)
10
1
0.1
0.01
2
0
−2
1
10
100

Soft State

- **Model :**

  const * phabs * rdblur * edge * (bbody + nthcomp + gauss + gauss + highecut * reflection)



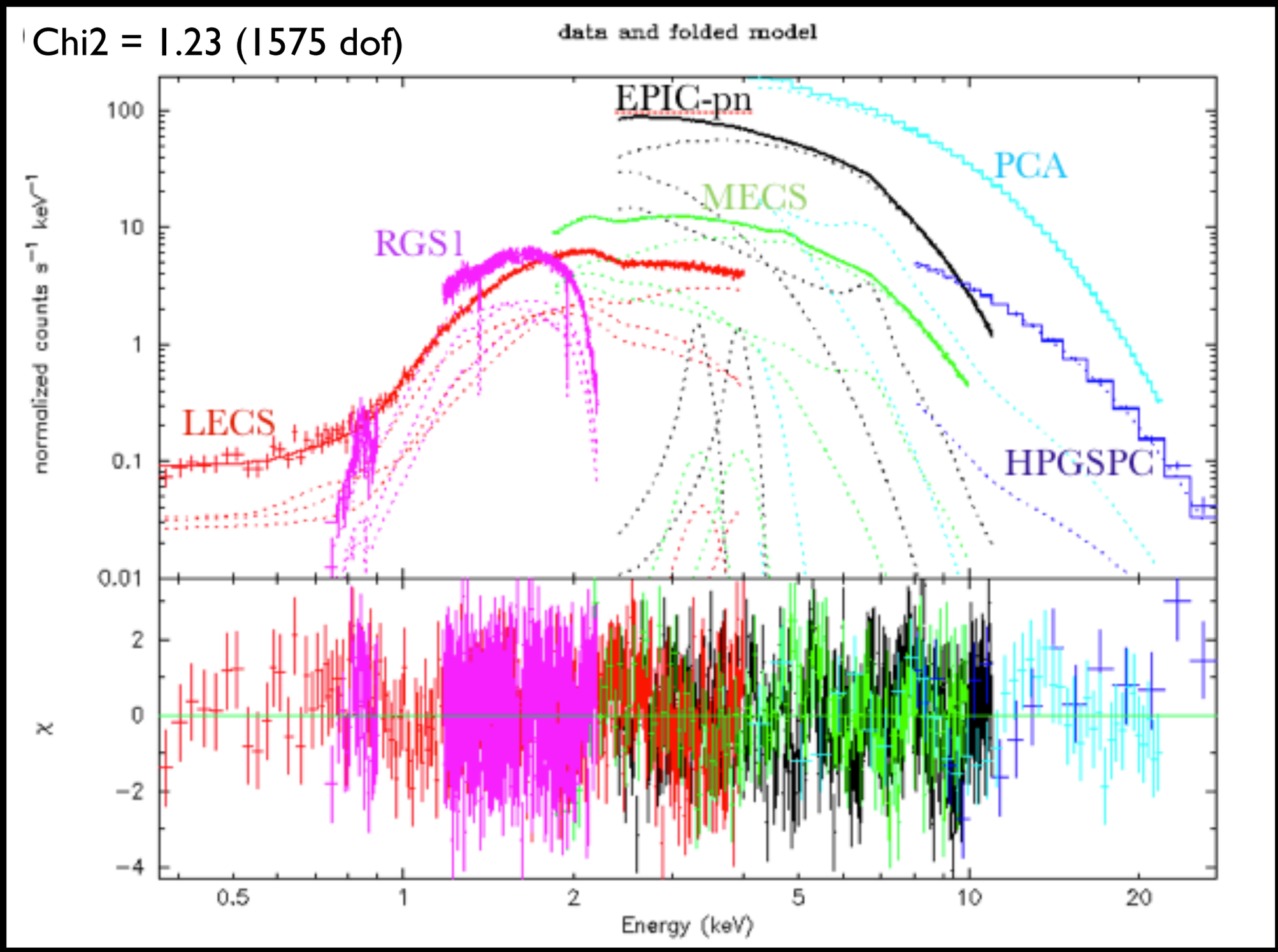
=> Gaussians : 3.31 keV -> Ar
3.90 keV -> Ca

XMM obs : Di Salvo et al. (2009)

- **XMM-Newton observation : pile-up ?**

Soft State

Chi2 = 1.23 (1575 dof)



Comparison of the parameters

	Hard state	Soft state
photon index	1.8 +/- 0.1	2.6 +/- 0.1
T_electrons (keV)	22 +/- 2	3.0 +/- 0.1
ionization (erg/cm2/s)	210 +/- 10	3580 (+1180 -850)
Rin (Rg)	31 (+28 -12)	13 +/- 3
Chi2 (dof)	1.12 (980)	1.17 (1573)

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accretion rate (Msol/yr)	**2*10^-9**	**1.6*10^-8**

Comparison of the parameters

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photon index	1.8 +/- 0.1	2.6 +/- 0.1
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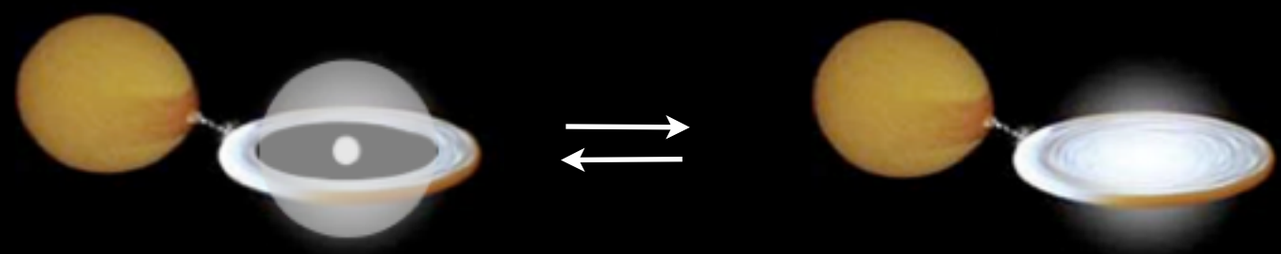


Conclusion

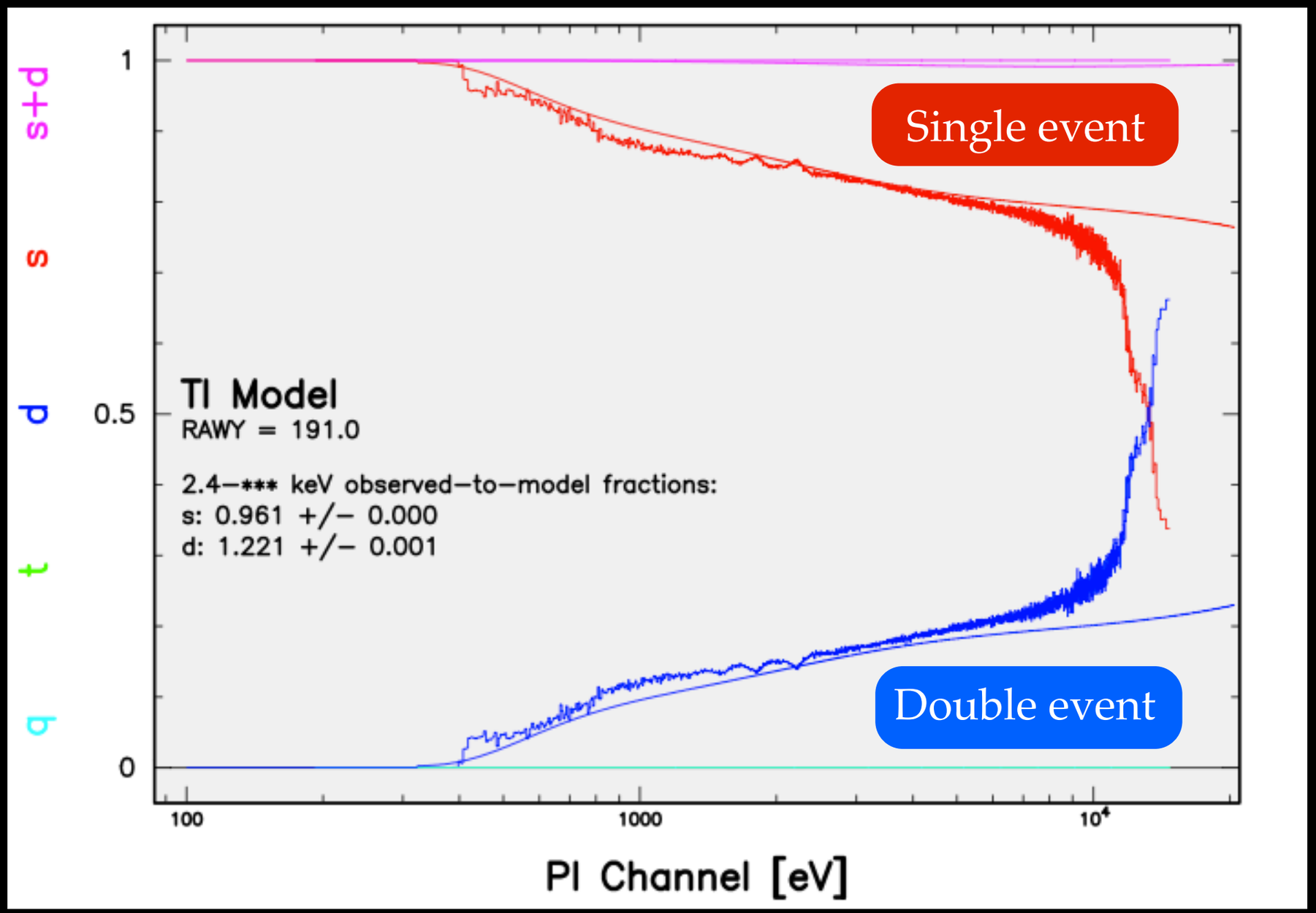
- Fit from non simultaneous data with self-consistent reflection models
- Evolution of the spectral parameters from the soft to the hard state
- Overabundance of some elements (Fe, Ca and Ar) of a factor 2
- Disk truncated further from the neutron star in the hard state

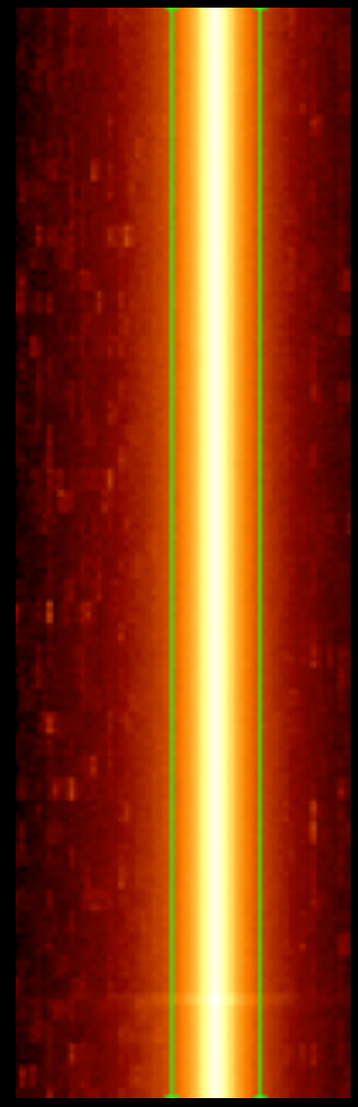
=> Paper submitted to A&A

Thank you !!!

Pile-up (SAS task epatplot)

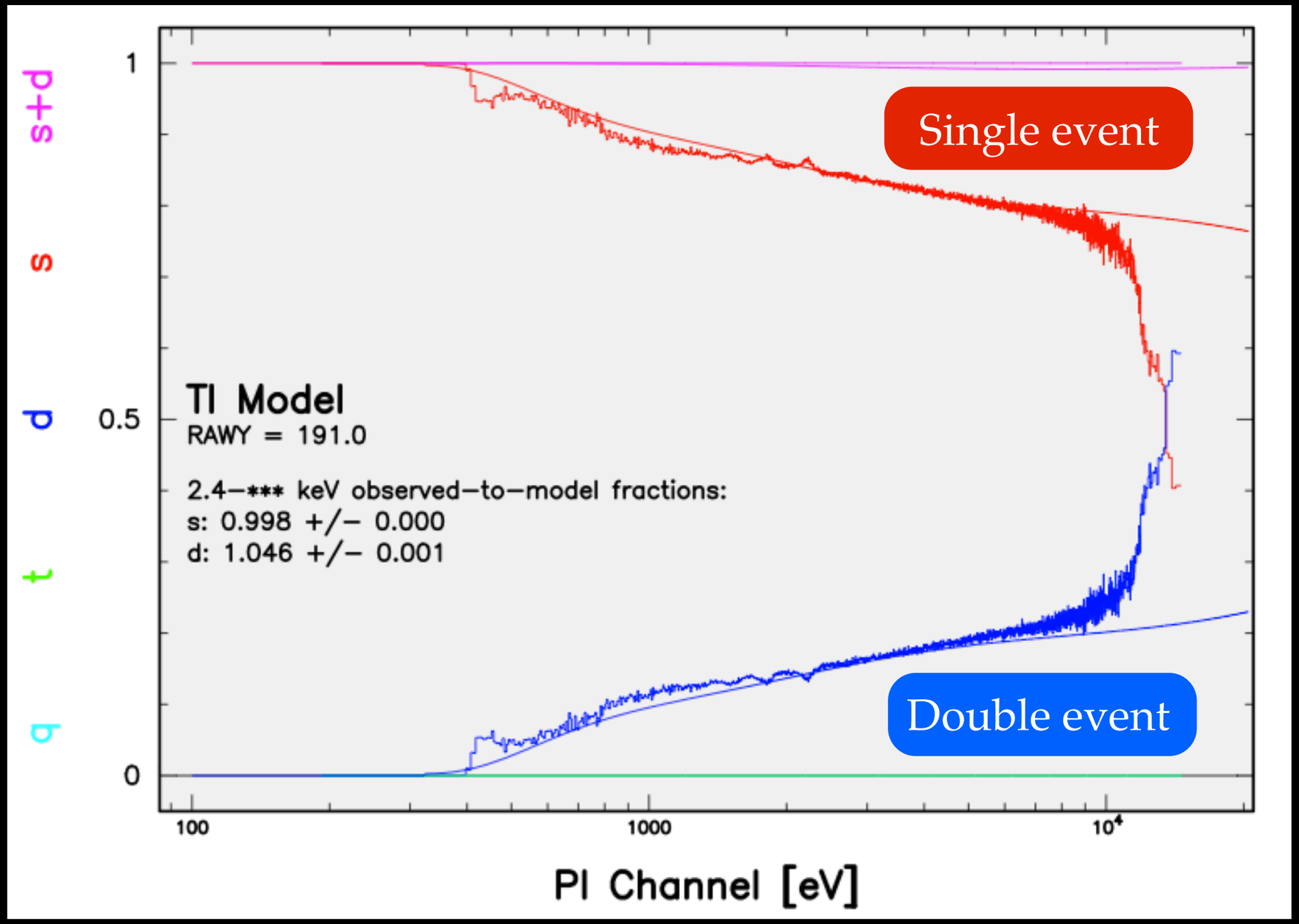
- XMM-Newton / EPIC-pn -- Timing mode : 45 ks -- count rate = 767 c/s

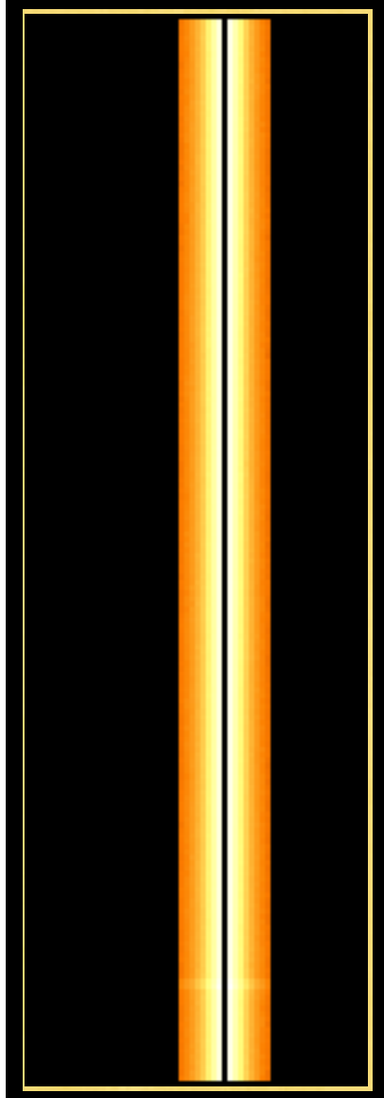




CCD

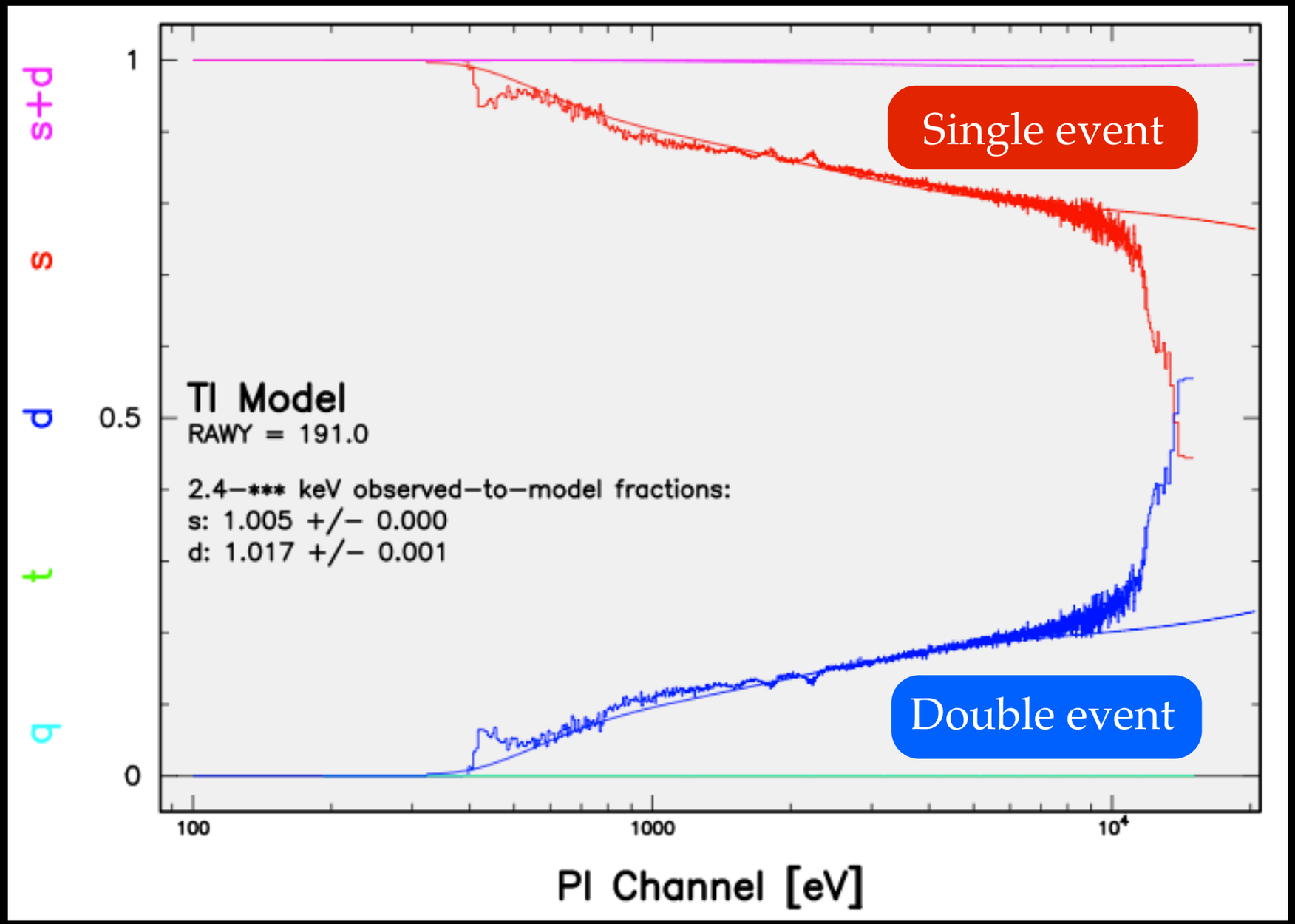
Pile-up without the central raw

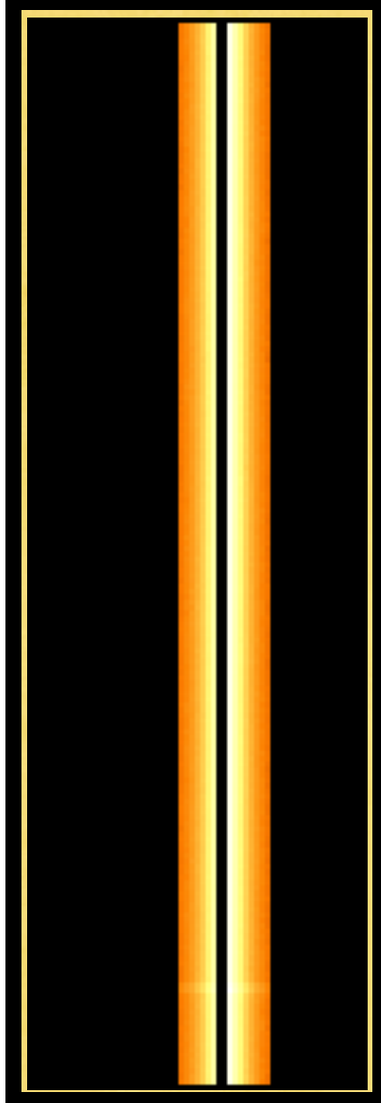




CCD

Pile-up without 2 central raws





CCD

Pile-up fraction in 6-7 keV

	single	**double**
16 raws	0.983 +/- 0.001	1.114 +/- 0.002
16 - (1 central raw)	0.994	1.070
16 - (2 central raws)	1.000	1.041

=> The pile-up fraction decreases but the statistics decreases so we loose information...

Self-consistent reflection models

- **Model :**

const * phabs * (bbody + nthcomp + rdblur * highecut * reflection)

Reflionx : Ross & Fabian (2005)

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