The structure of AGNs from X-ray Absorption variability

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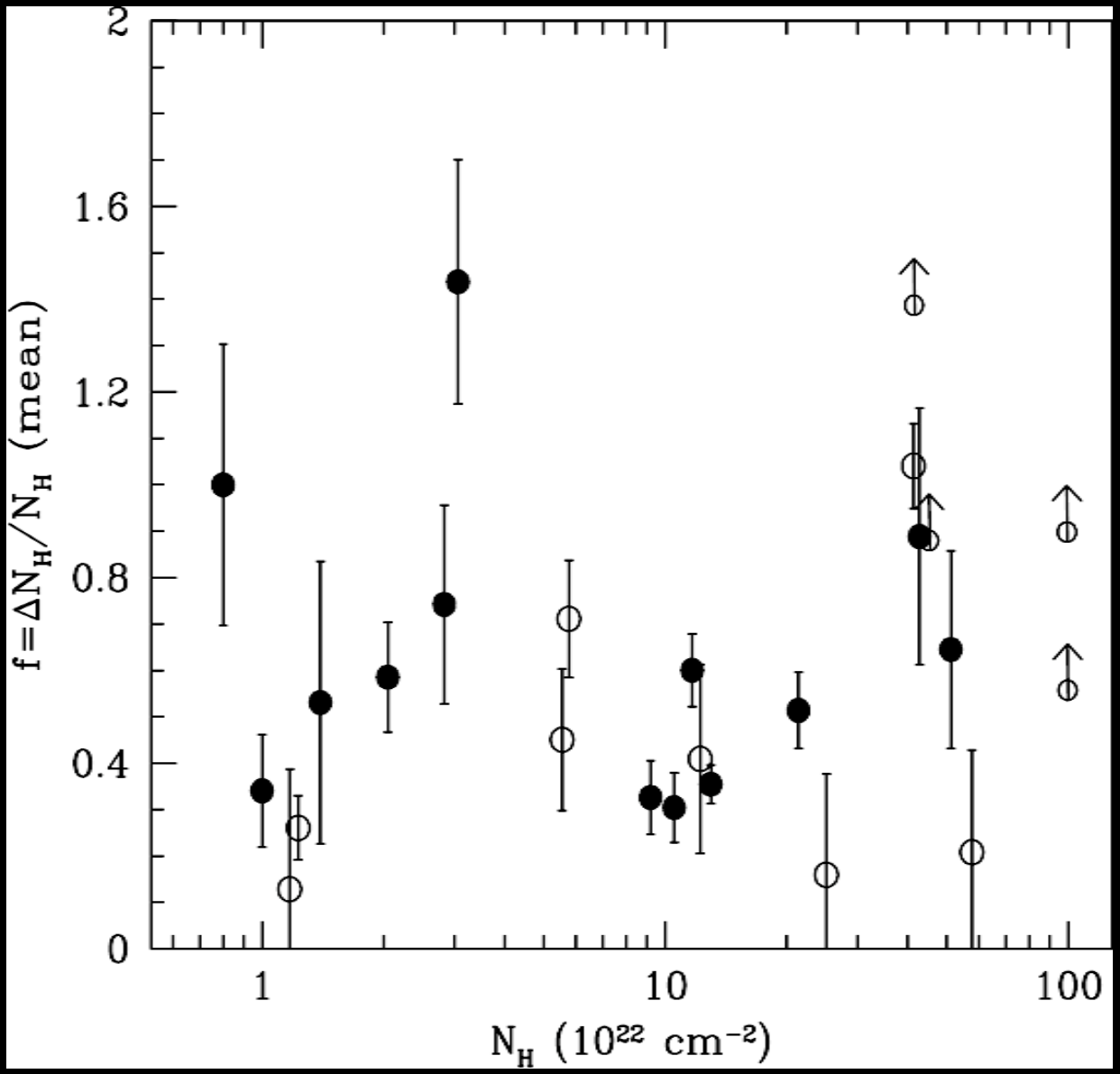
Ubiquitous Variability of N_H in Seyfert Galaxies



N_H variable in 23/25 sources

Timescales from months to years

Clumpy absorber
Sub-parsec distance

Risaliti, Elvis & Nicastro 2002

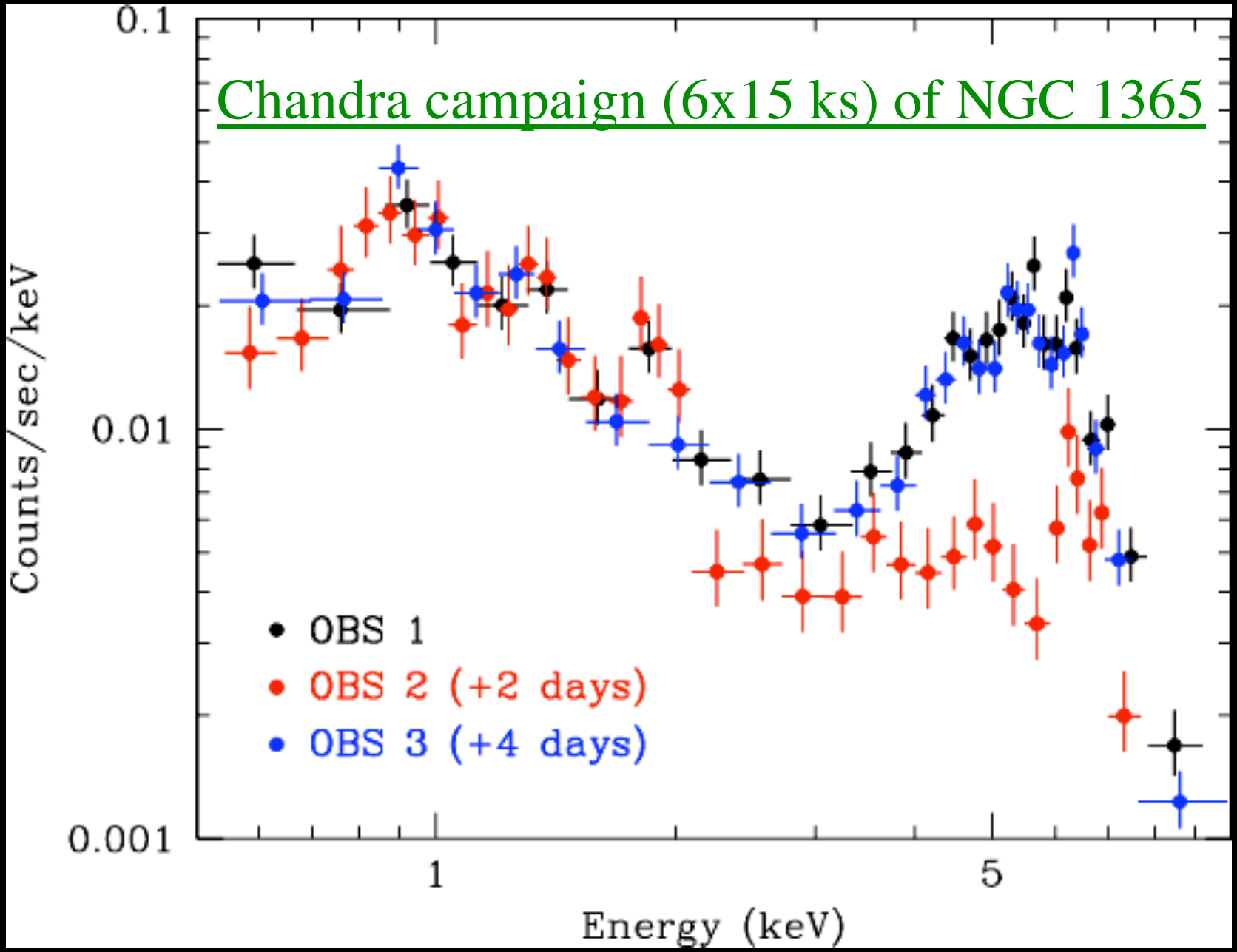
Next step: Search for column density variations in hours -- days

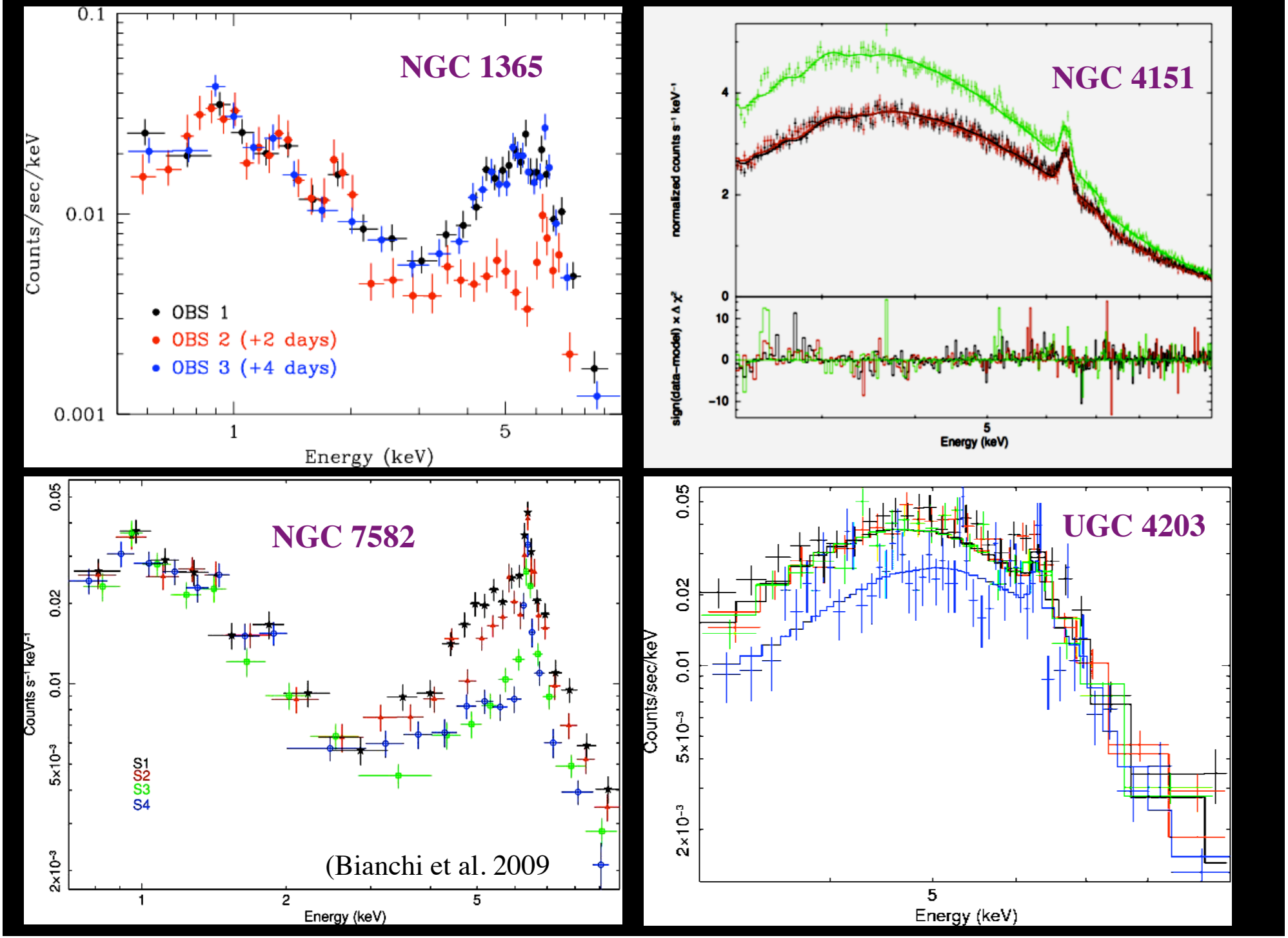
Two methods:

1. **Campaigns of snapshot observations within ~a few days**

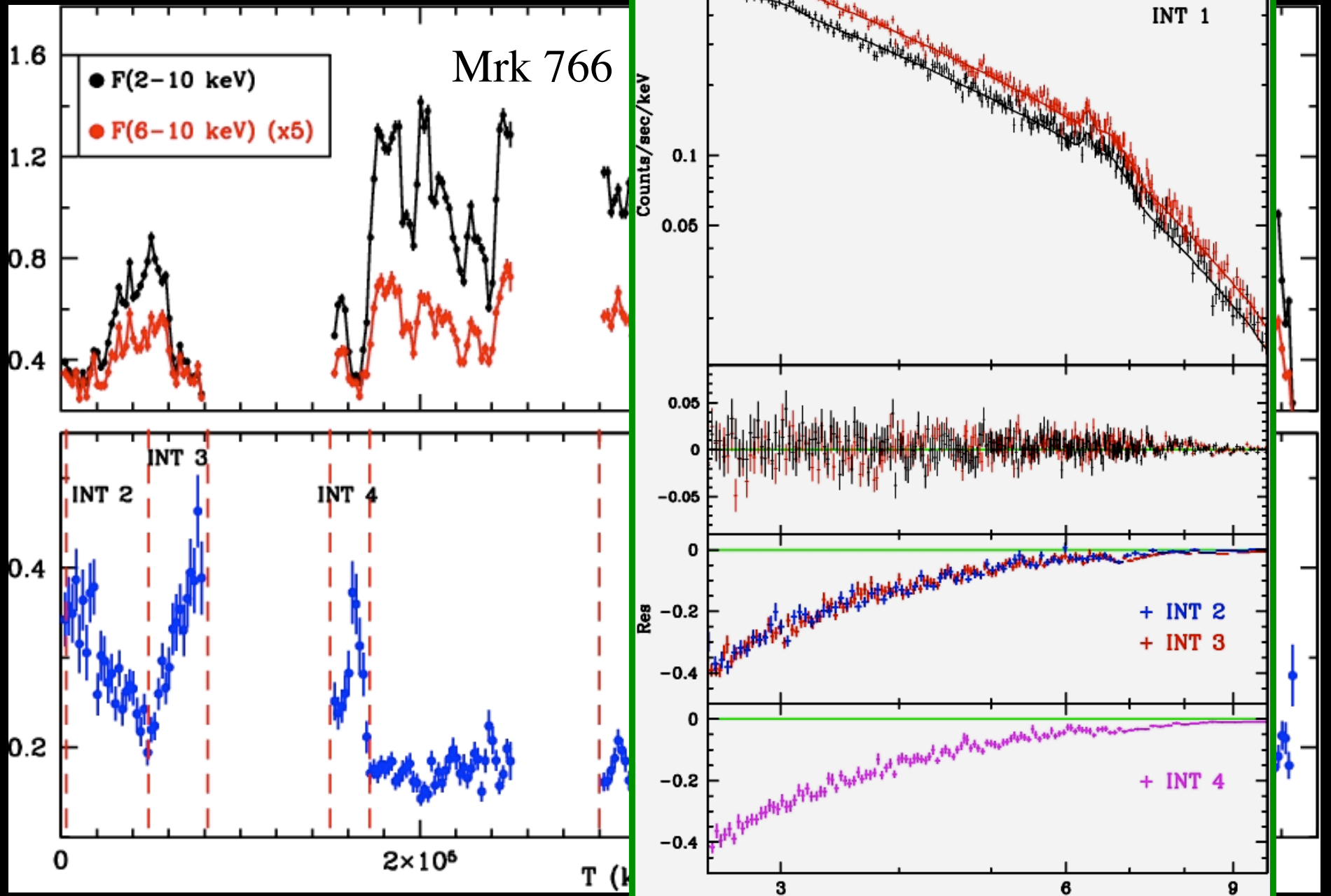
2. **Analysis of HR light curves in long observations**

1) Repeated snapshot observations

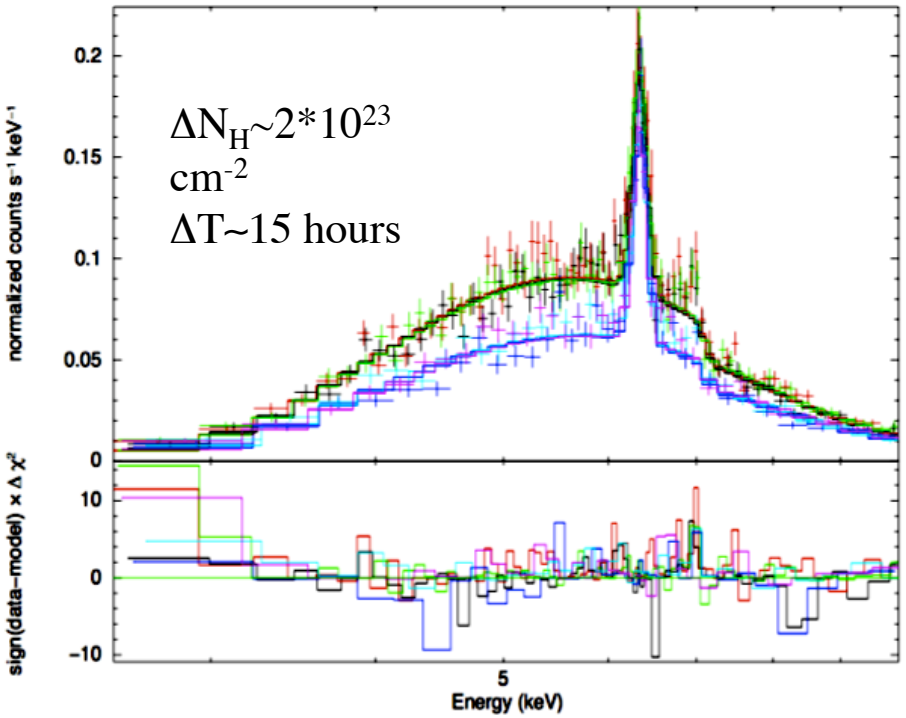



NGC 1365
Counts/sec/keV
Energy (keV)
OBS 1
OBS 2 (+2 days)
OBS 3 (+4 days)
NGC 4151
normalized counts s⁻¹ keV⁻¹
sign(data−model) × Δ χ²
Energy (keV)
NGC 7582
Counts s⁻¹ keV⁻¹
Energy (keV)
S1
S2
S3
S4
(Bianchi et al. 2009
UGC 4203
Counts/sec/keV
Energy (keV)

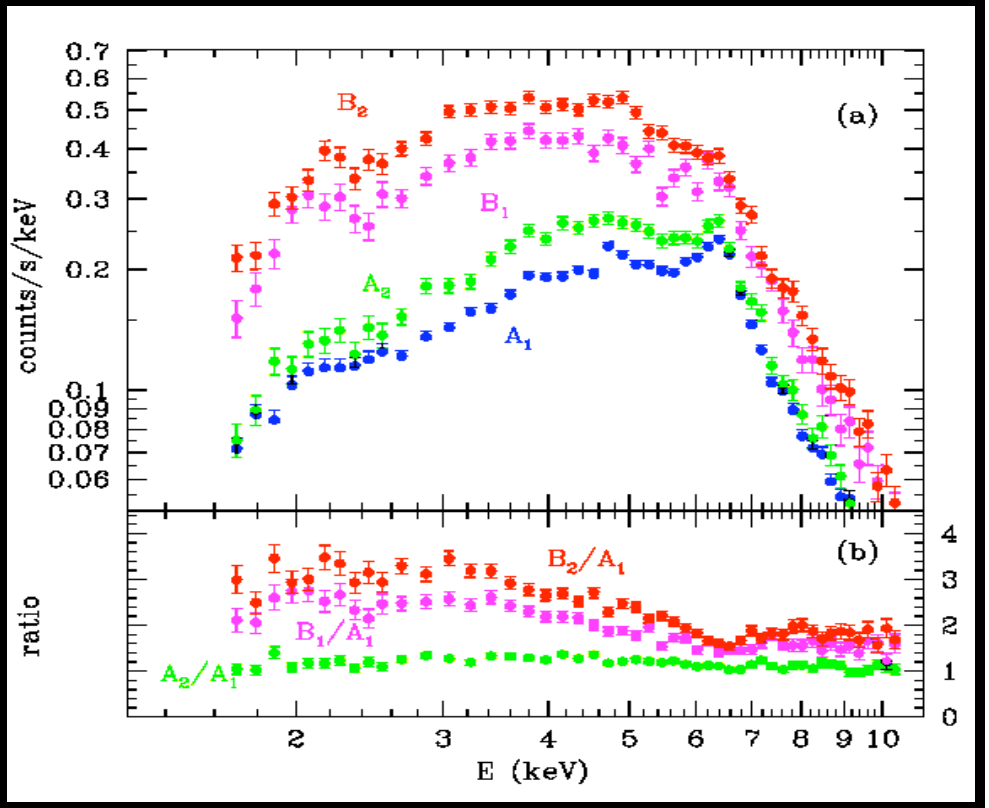
2) Single long observations



NGC 4388



NGC 4151



Puccetti et al. 2007)

General results:

Eclipses of the X-ray source are COMMON in nearby AGN

$\Delta N_H \sim 10^{23}-10^{24}$ cm^{-2}

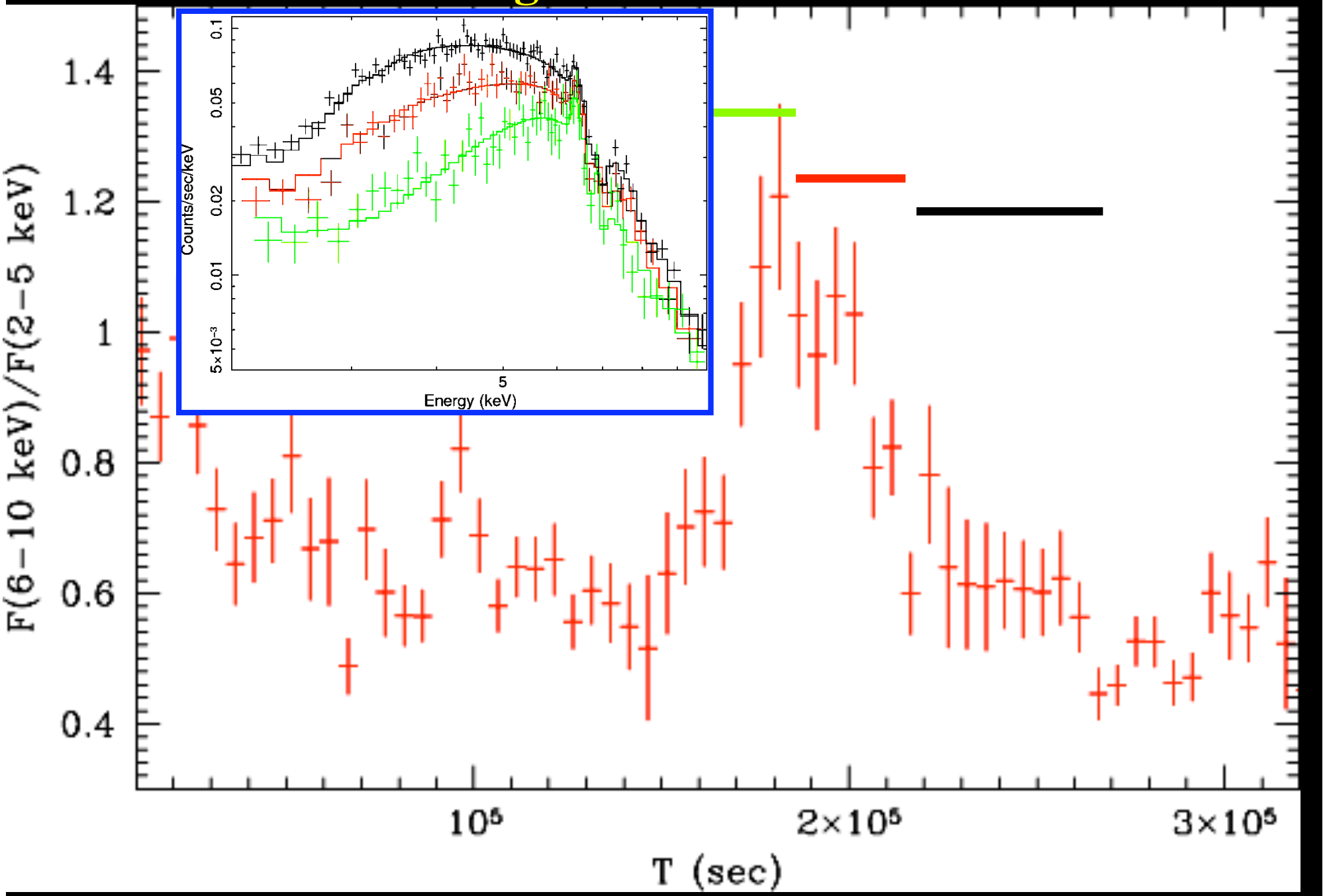
$V > 10^3$ km/s

$D \sim 10^{13}$ cm

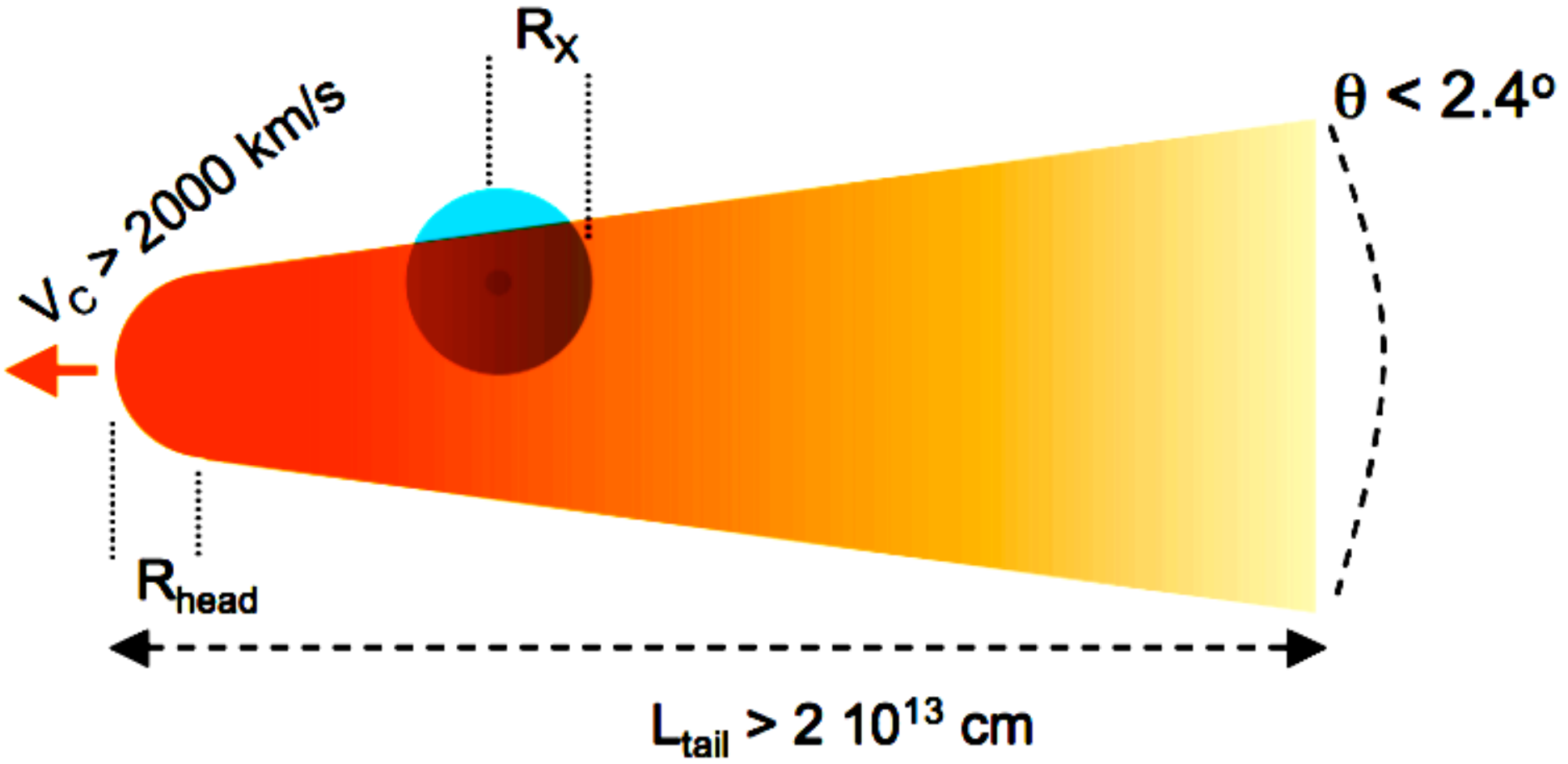
$n \sim 10^{10}$-10^{11} cm^{-2}

X-ray absorber = BLR clouds

NGC 1365 in high state: Suzaku observation



Shape, size and dimensions of BLR clouds



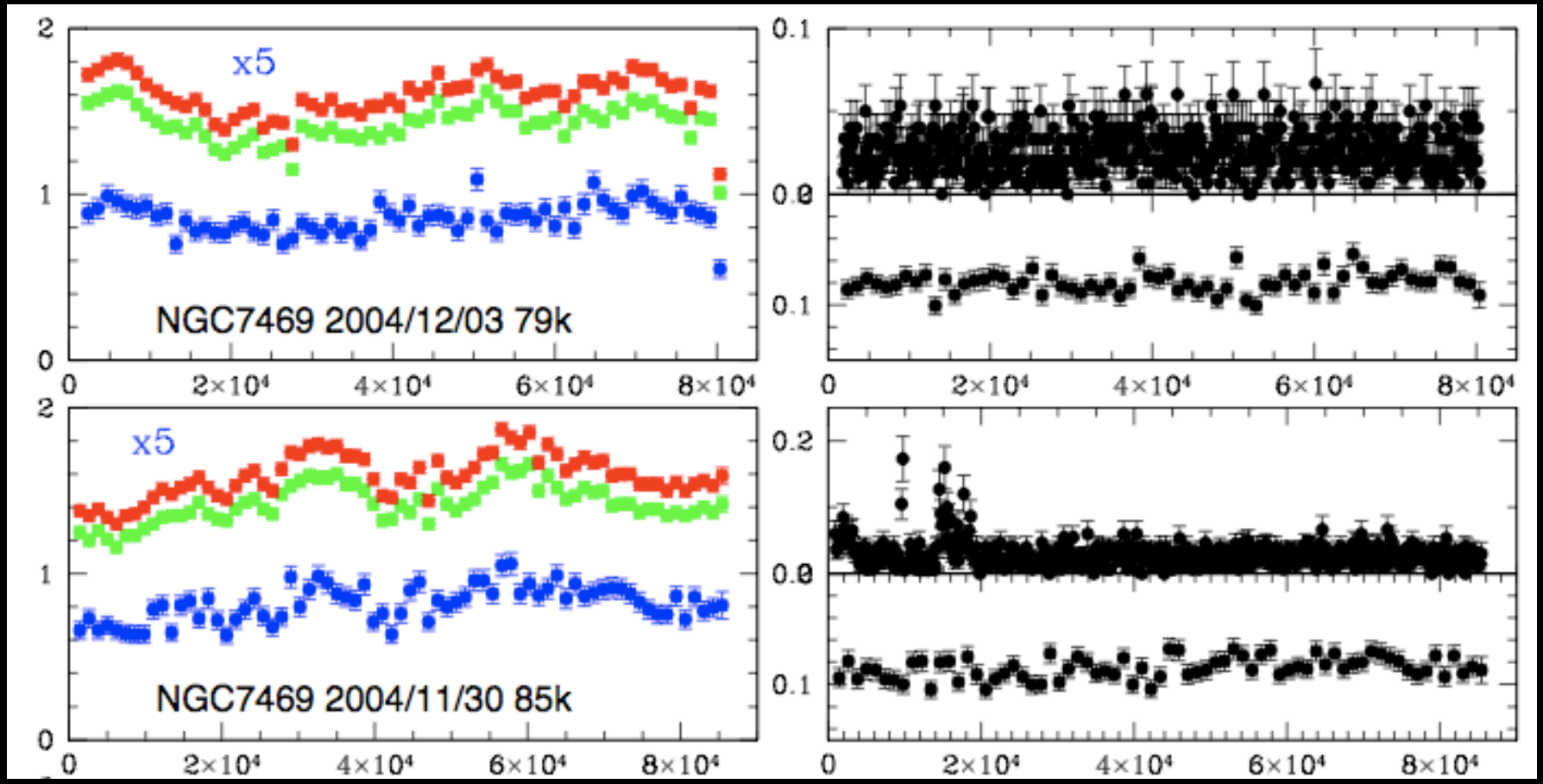
LIMITATIONS:

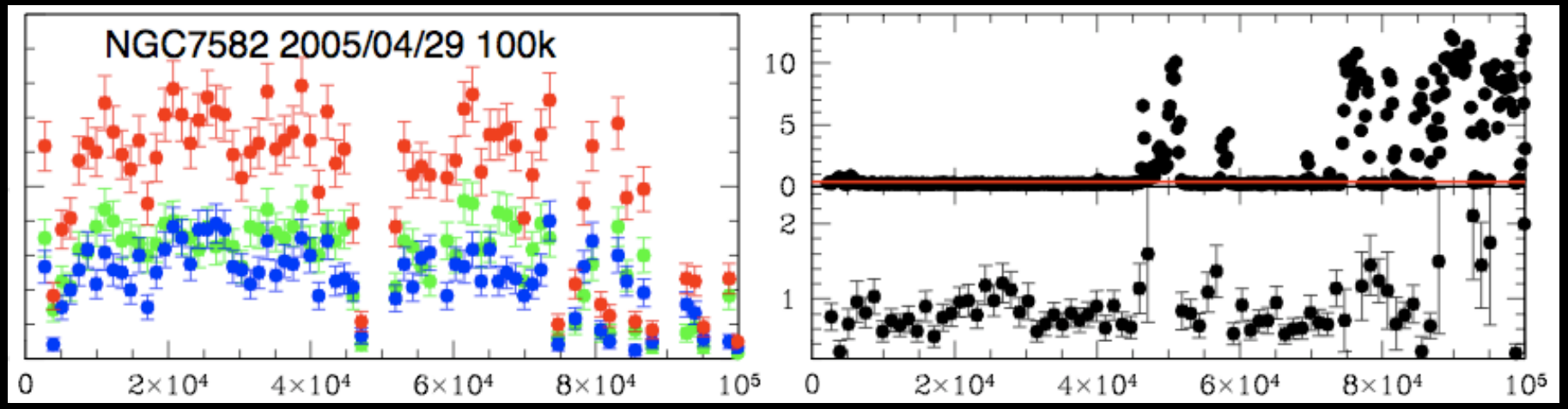
- Fluxes: $F(2\text{-}10)_{INTR} > 10^{-11}$ erg cm^{-2} s^{-1}

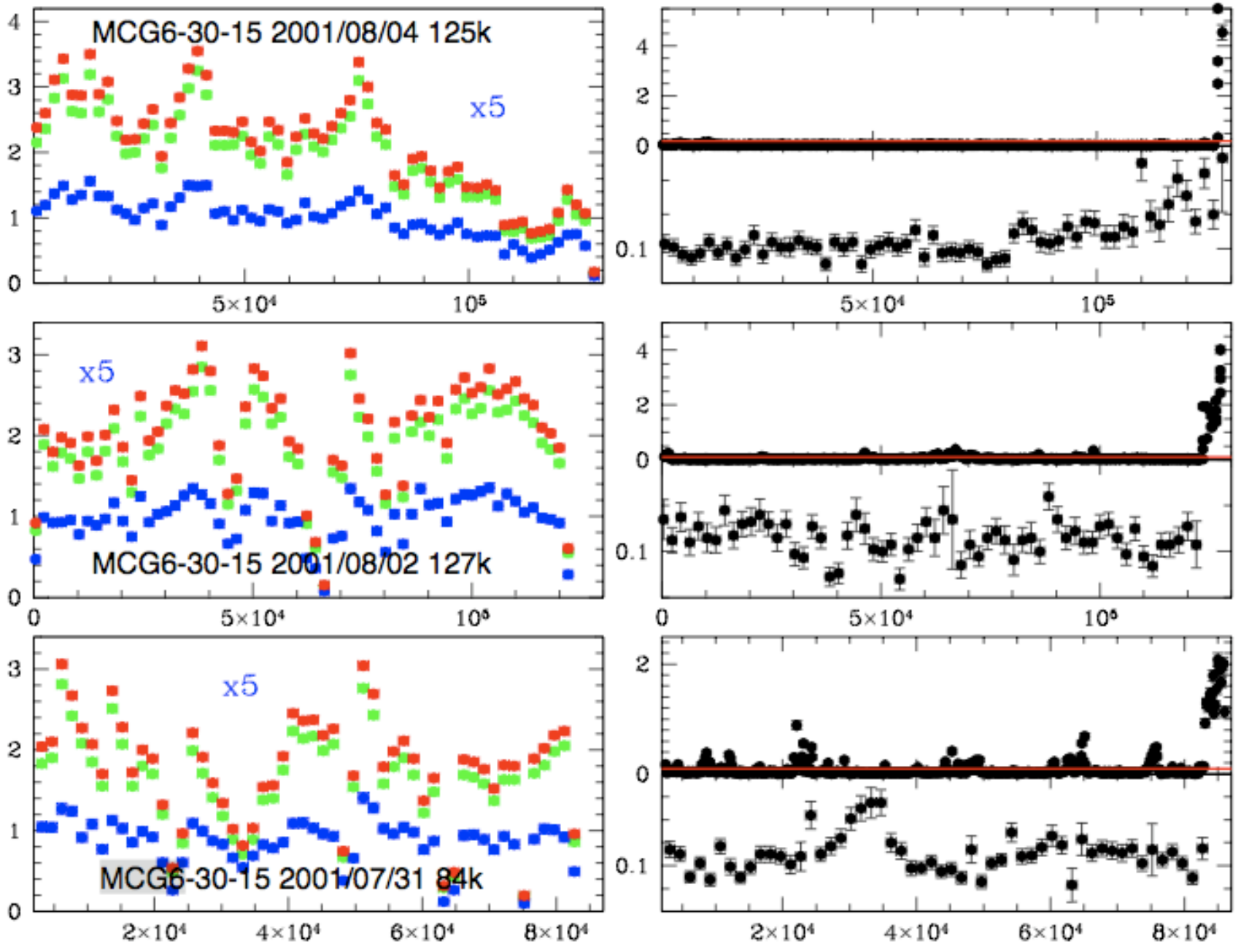
- Time intervals (T>15 ks)

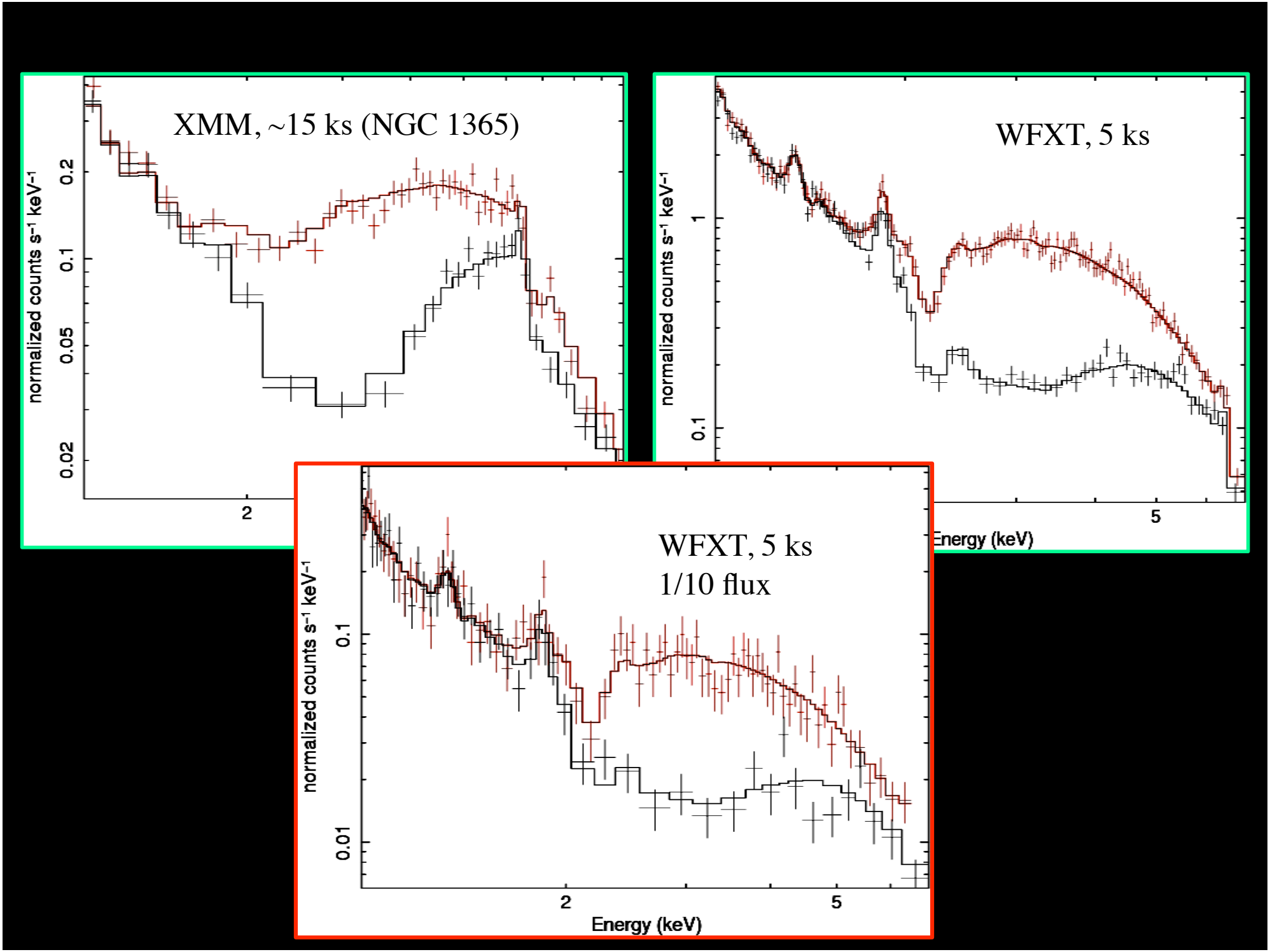
- Non-homogeneous analysis

→ Analysis possible only for the most extreme cases in ~15 sources + ~20 type 1s


x5
NGC7469 2004/12/03 79k
x5
NGC7469 2004/11/30 85k


NGC7582 2005/04/29 100k


MCG6-30-15 2001/08/04 125k
x5
MCG6-30-15 2001/08/02 127k
x5
MCG6-30-15 2001/07/31 84k
x5
5×10⁴
10⁵
2×10⁴
4×10⁴
6×10⁴
8×10⁴


XMM, ~15 ks (NGC 1365)
WFXT, 5 ks
WFXT, 5 ks
1/10 flux
normalized counts s⁻¹ keV⁻¹
Energy (keV)
0.02
0.05
0.1
0.2
0.01
1
2
5

WFXT deep survey:

- Statistical analysis of HR variations for hundreds of sources
  → evaluation of the relevance of variable absorption in different classes of AGN

- Spectral analysis of N_H variations (analogous to that performed on bright sources with XMM/Suzaku) for several tens – a few hundred sources → determination of average physical parameters (size, shape, density, distance) of BLR/X-ray obscuring clouds

- Time-resolved spectroscopy on time scales of a few 100 sec for very bright sources → complete characterization of the BLR/X-ray absorbing clouds