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Discovery of transient iron fluorescence in the bare Seyfert Ark 120



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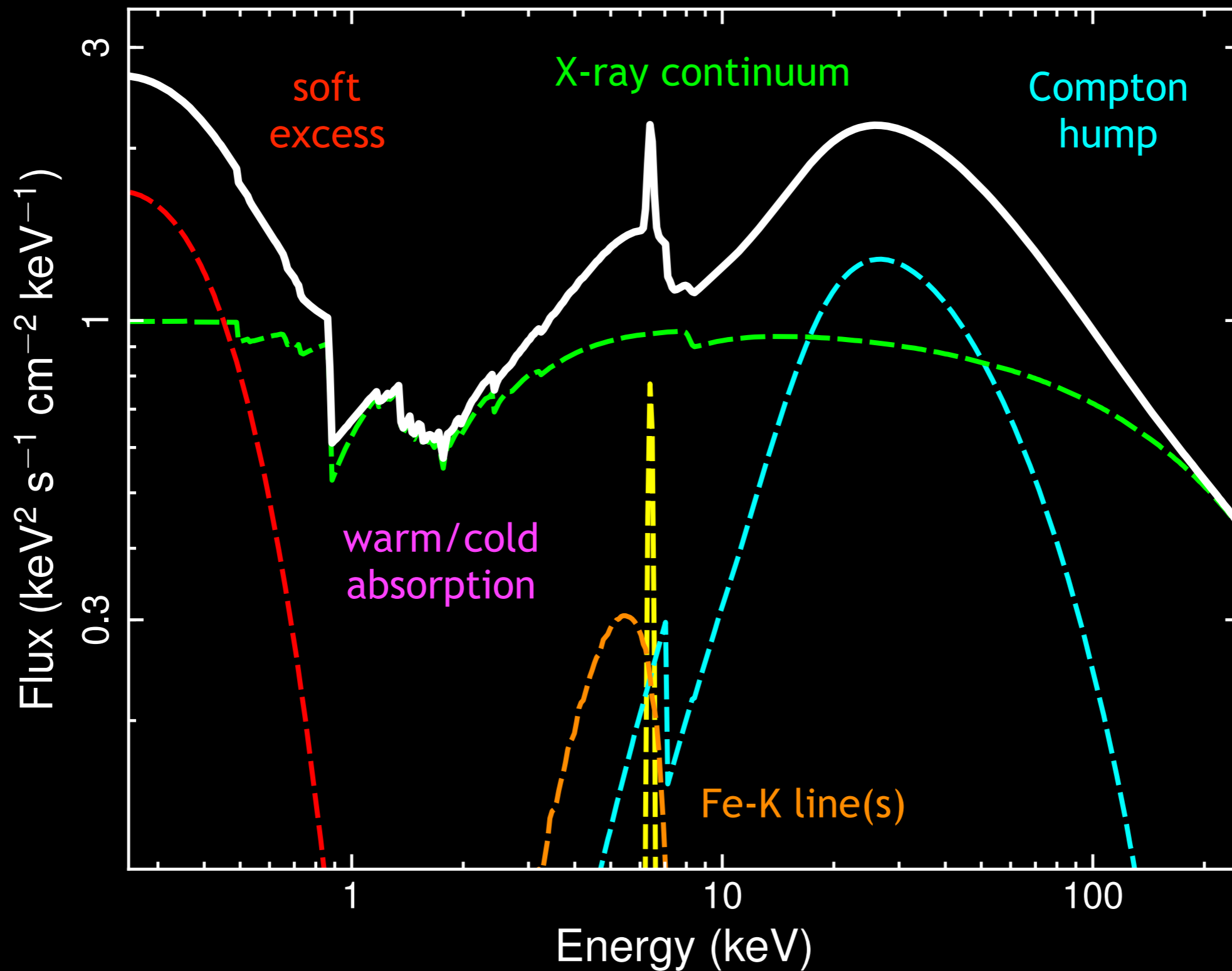
in collaboration with:

D. Porquet, J. Reeves, V. Braito, A. Lobban, G. Matt

Active Galactic Nuclei 12
Napoli, 26-29 Settembre 2016

 **AGN12**
XII Congresso Nazionale sui Nuclei Galattici Attivi

AGN X-ray spectral energy distribution



Ark 120: the 'bare Seyfert' prototype

- ★ Nearest and brightest

$$D = 144 \text{ Mpc}$$

$$F_X = 7 \times 10^{-11} \text{ erg/s/cm}^2$$

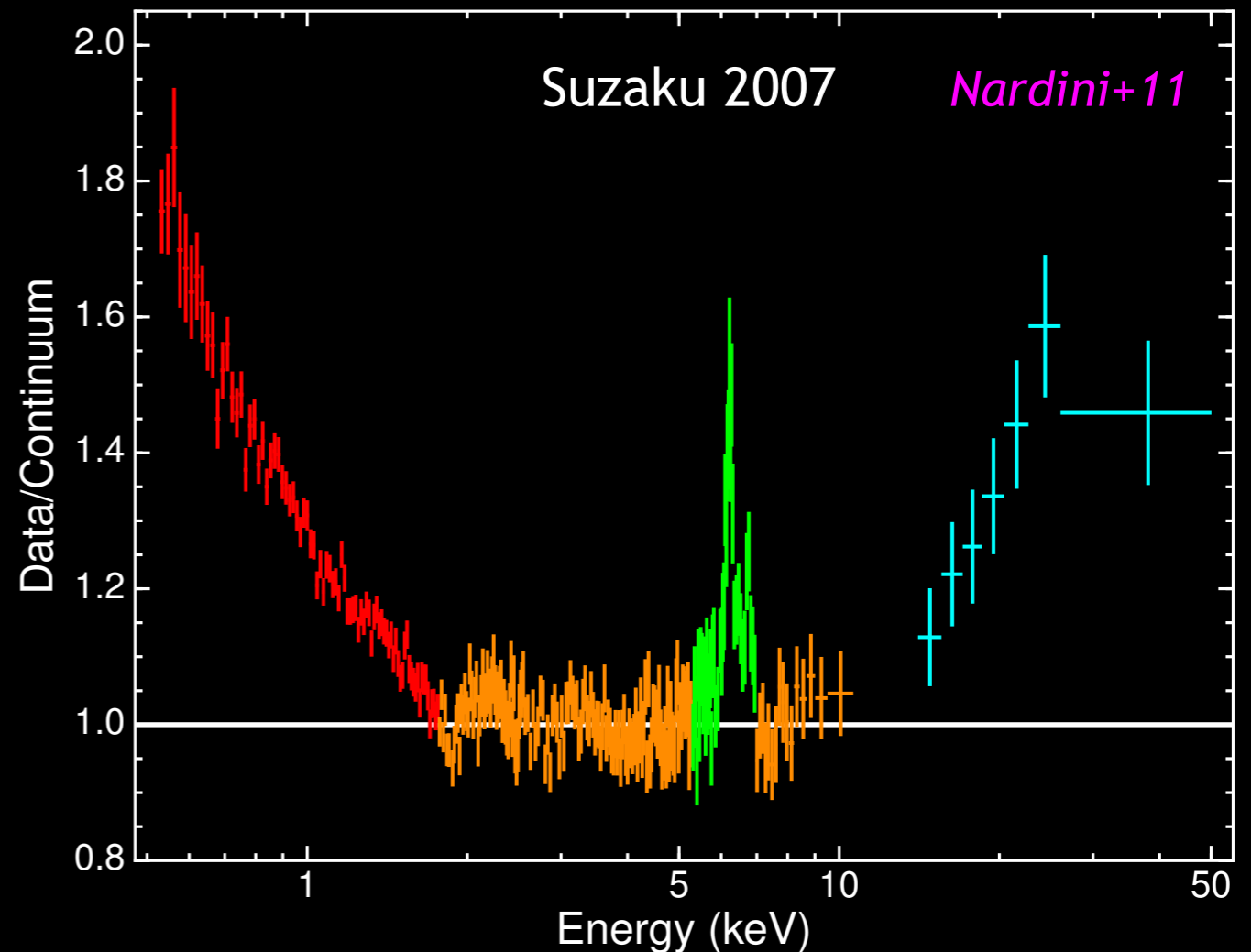
- ★ Bare line of sight (Reeves+16b)

$$N_H < \text{a few} \times 10^{19} \text{ cm}^{-2}$$

- ★ BH mass known from reverberation mapping

$$M_{\text{BH}} = 1.5 \times 10^8 M_{\text{SUN}}$$

- ★ All X-ray spectral traits of a radiatively efficient SMBH



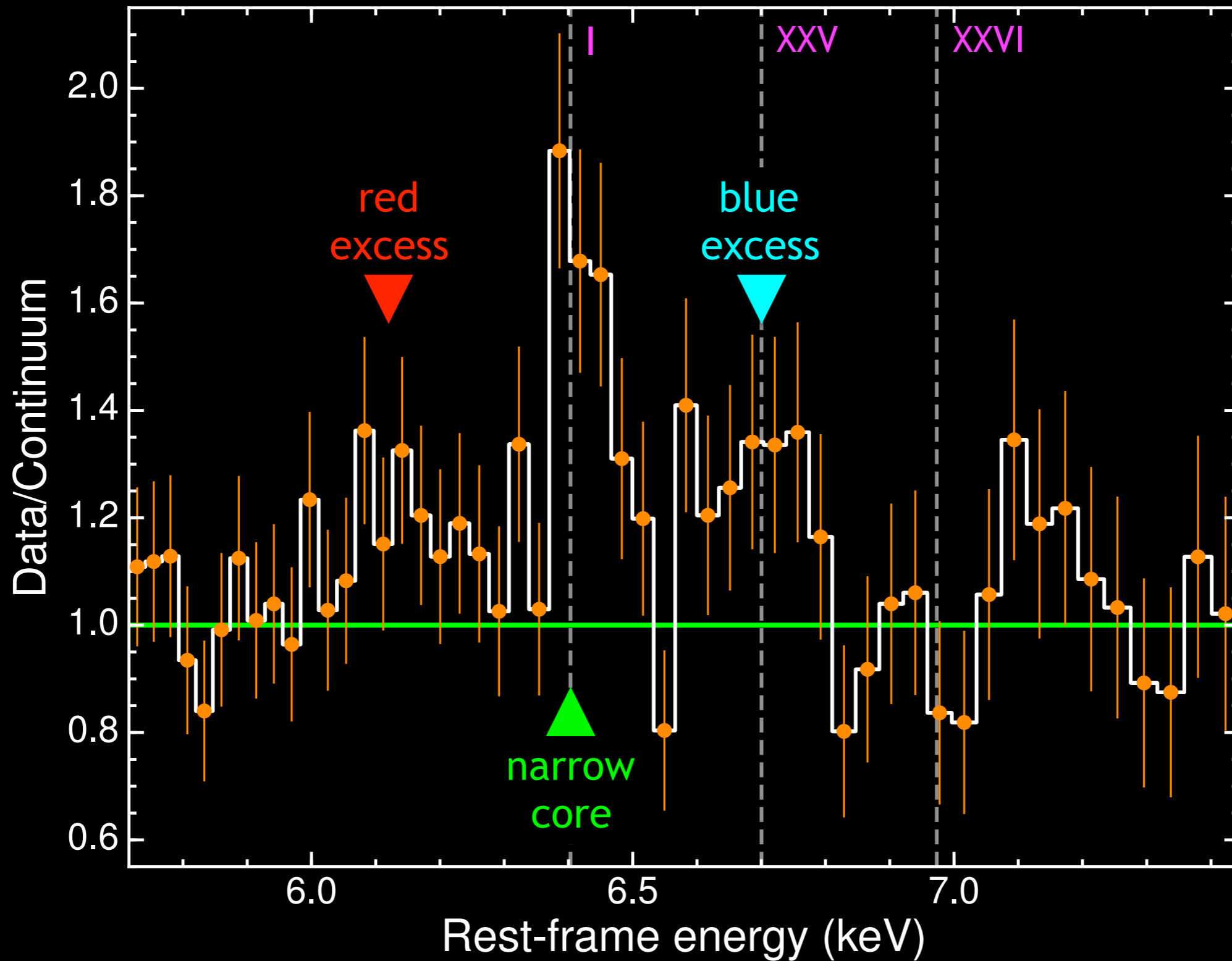
2014 X-ray campaign (PI: D. Porquet)

- ★ Four consecutive *XMM-Newton* orbits (7.5 days, net exposure 330 ks)

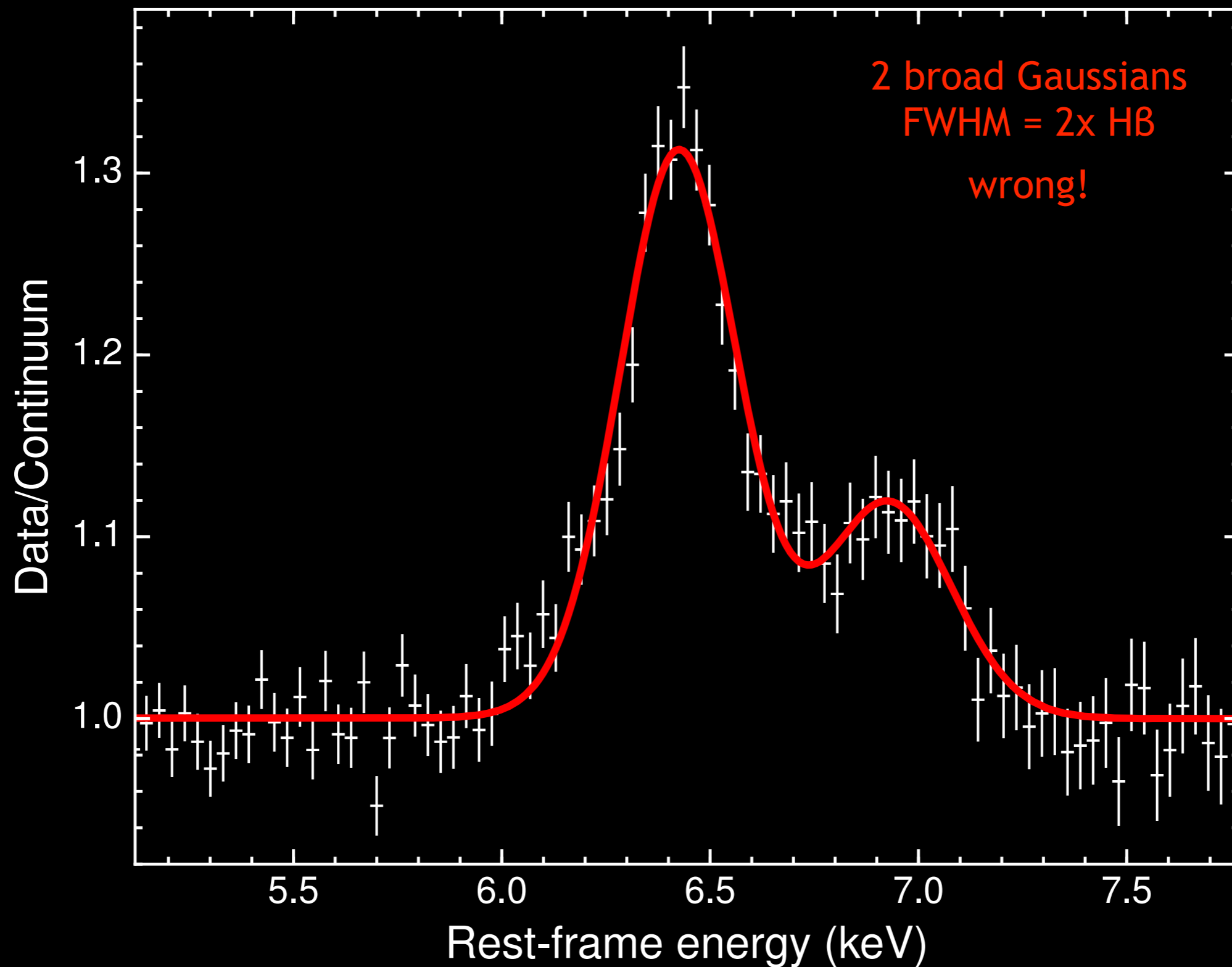
- ★ *Chandra* HETG spectrum overlapping with *XMM*#2 + *XMM*#3 (120 ks)

- ★ *NuSTAR* observation simultaneous with *XMM*#3 (65 ks)

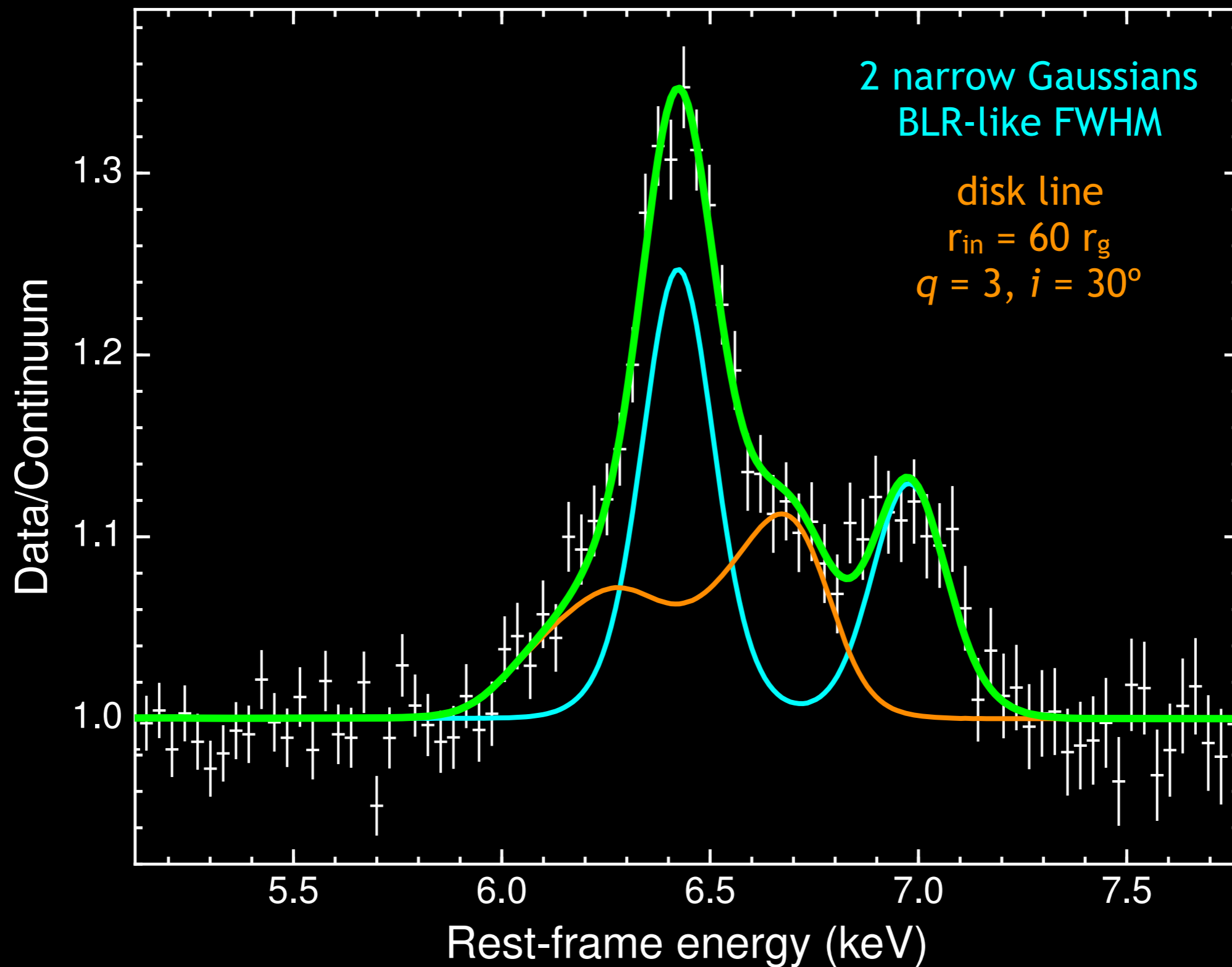
Chandra HETG spectrum



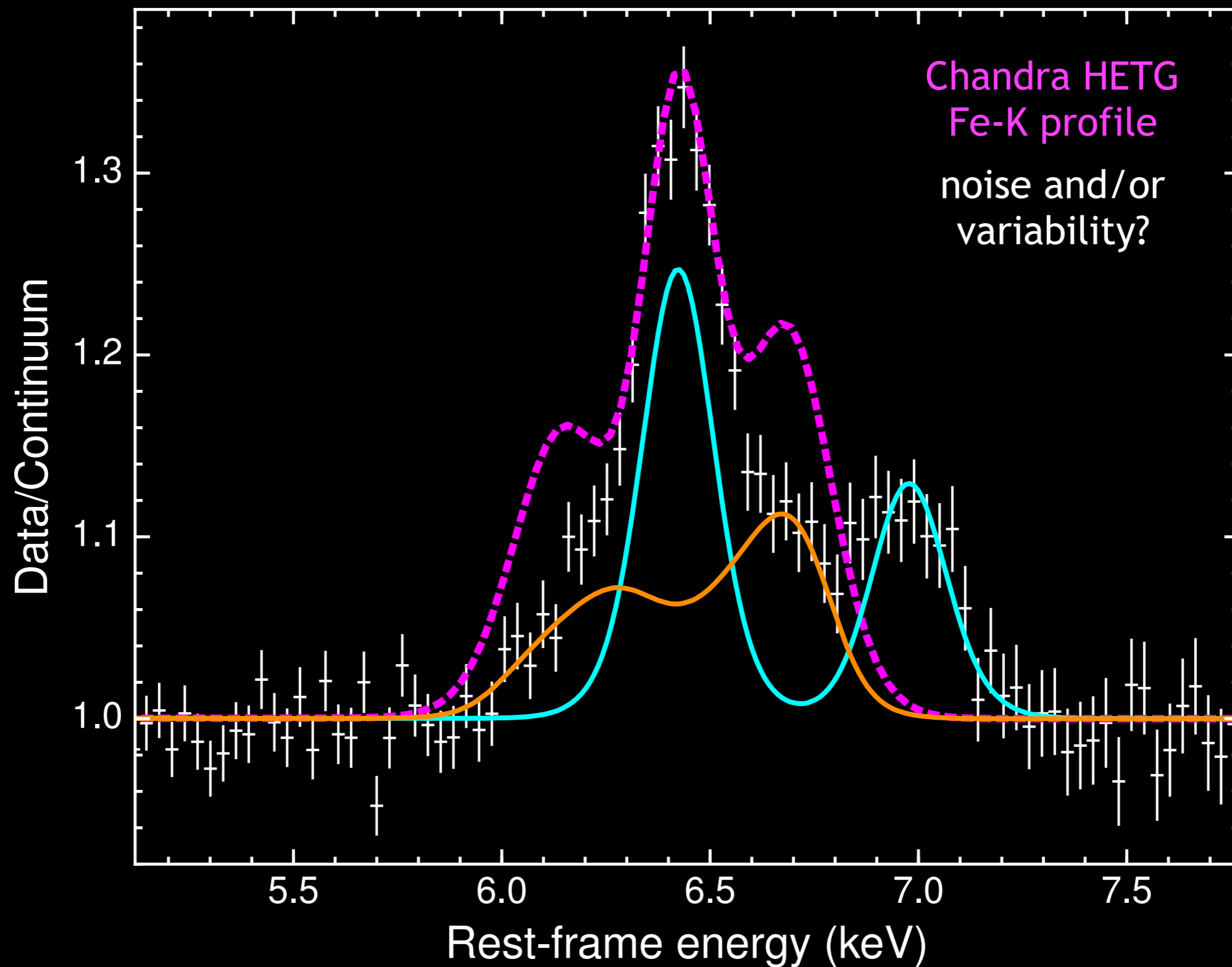
XMM time-averaged spectrum



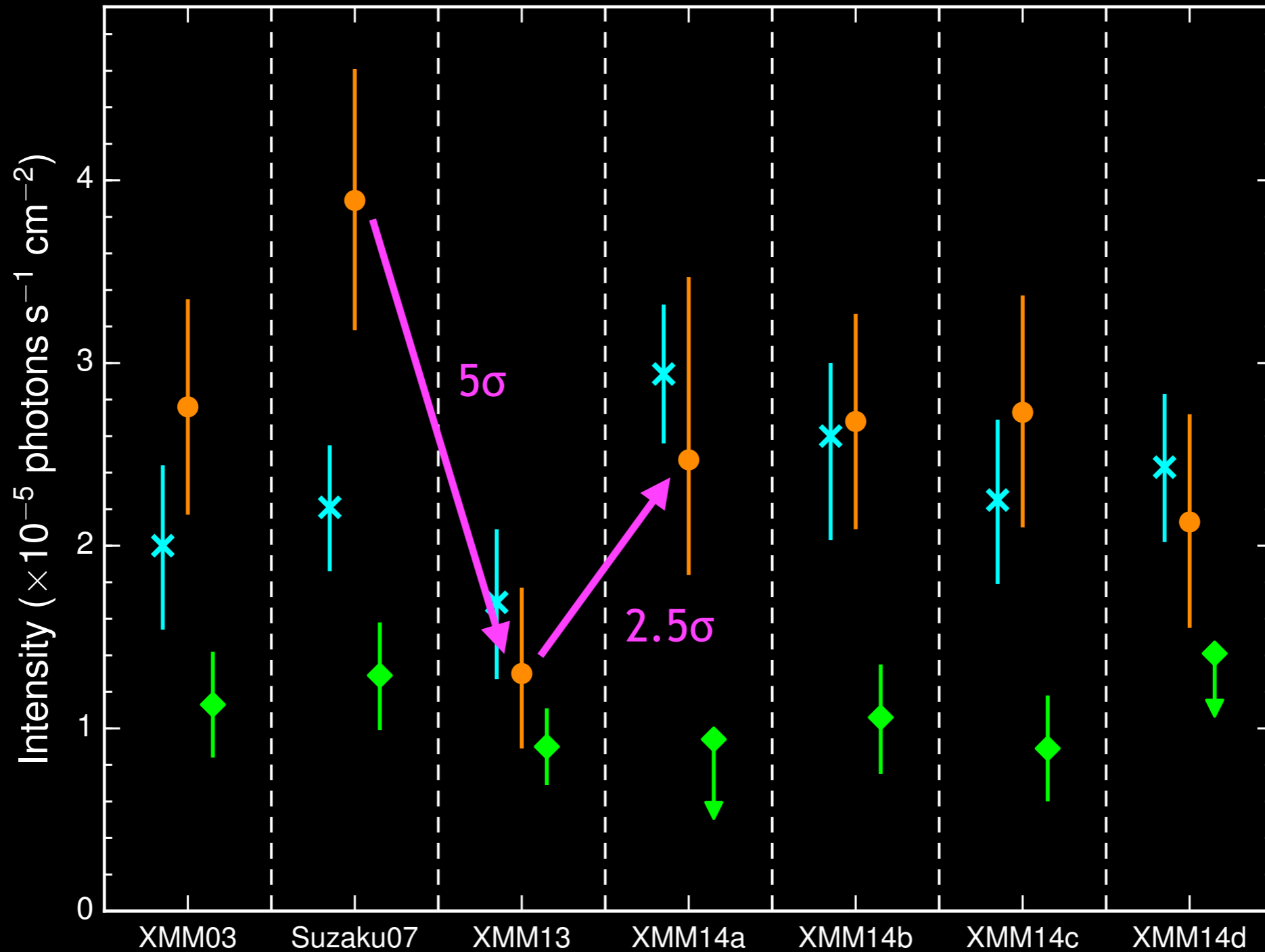
XMM time-averaged spectrum



XMM time-averaged spectrum



Fe-K variability, long timescales

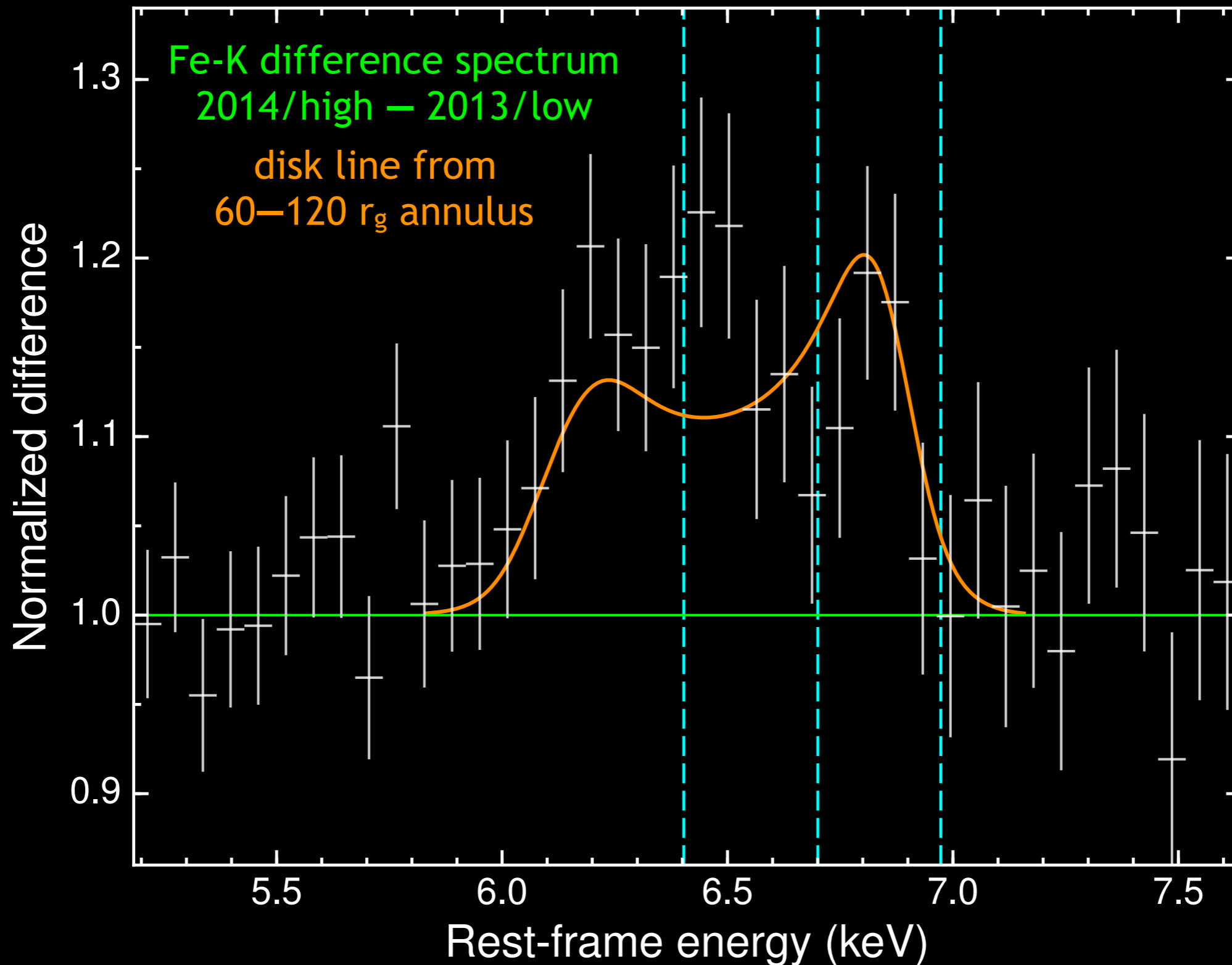


narrow Fe I, 6.40 keV

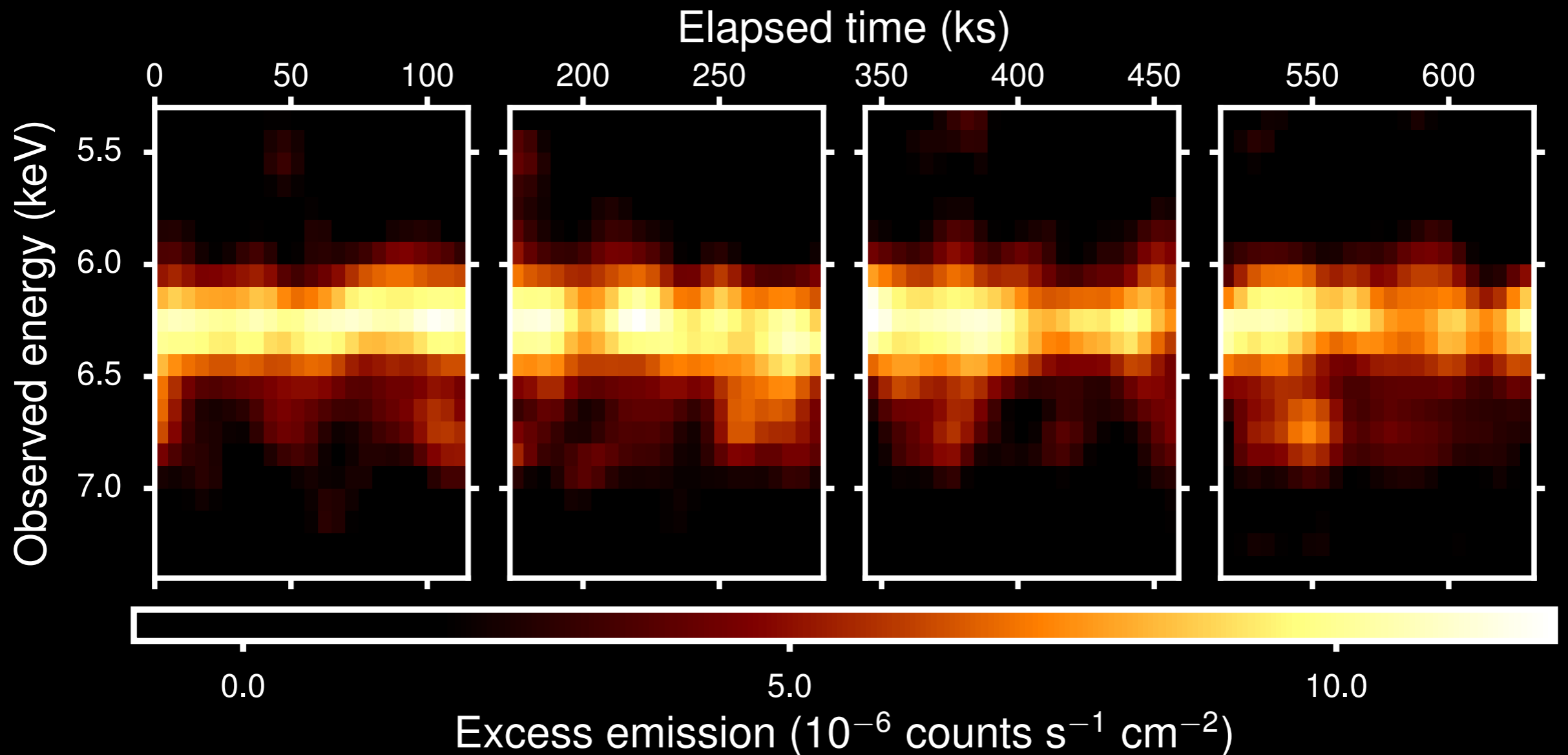
disk line, 6.45–6.55 keV

narrow Fe XXVI (?), 6.98 keV

Fe-K variability, long timescales



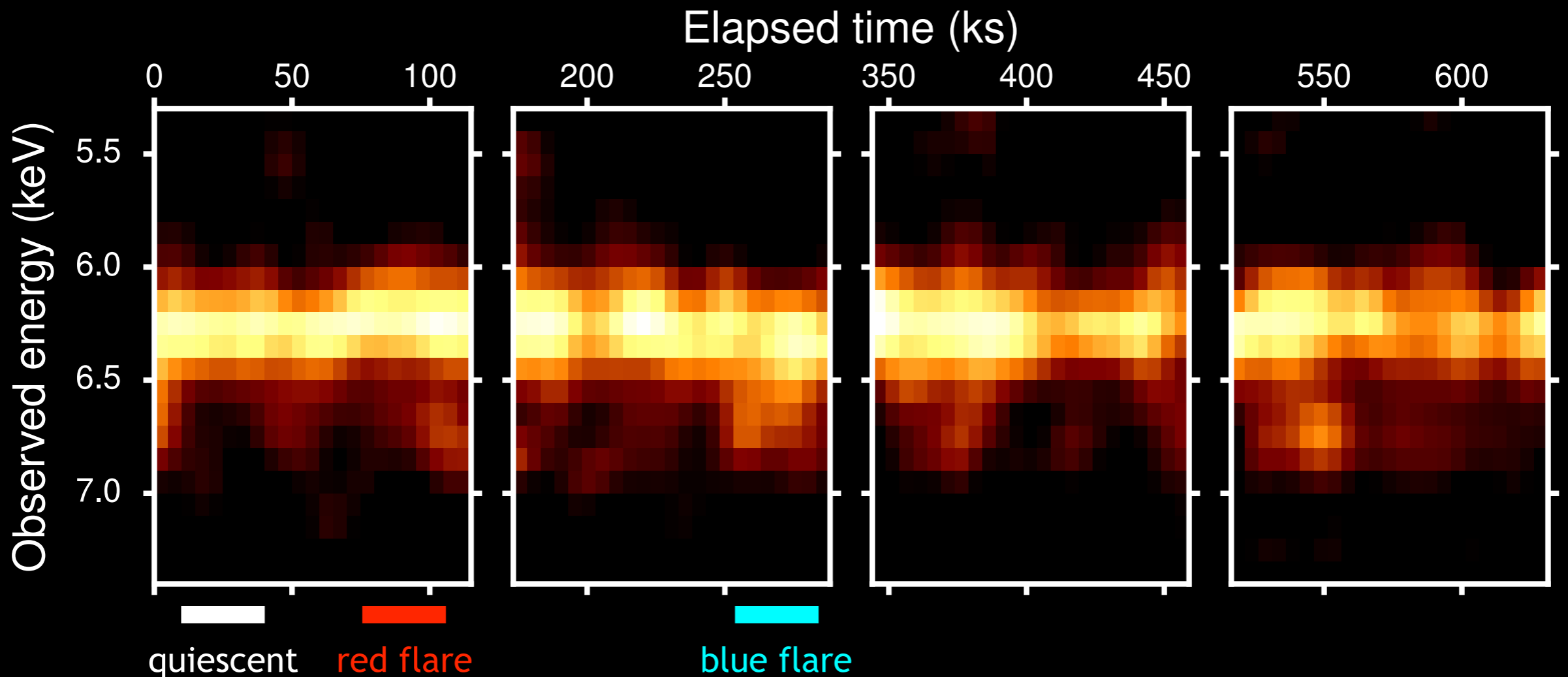
Fe-K variability, short timescales



Excess map technique, used to reveal energy/intensity modulation of Fe-K lines within long exposure observations, but at smaller BH mass (*Iwasawa+04, Turner+06*)

Energy vs. time resolution: 100 eV x 5 ks (orbital time at Kerr ISCO)
Image smoothing: elliptical Gaussian kernel with 250 eV x 15 ks FWHM

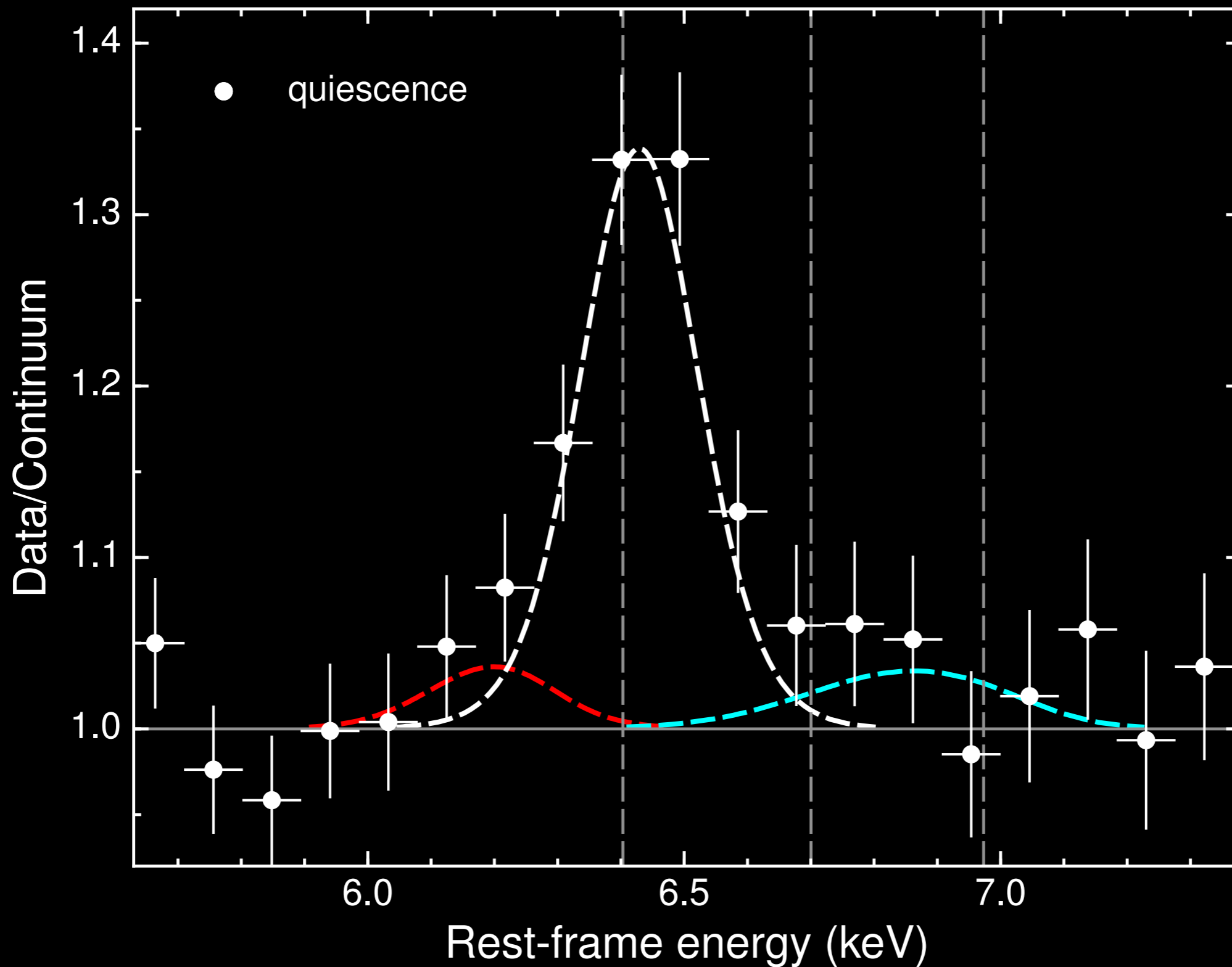
Fe-K variability, short timescales



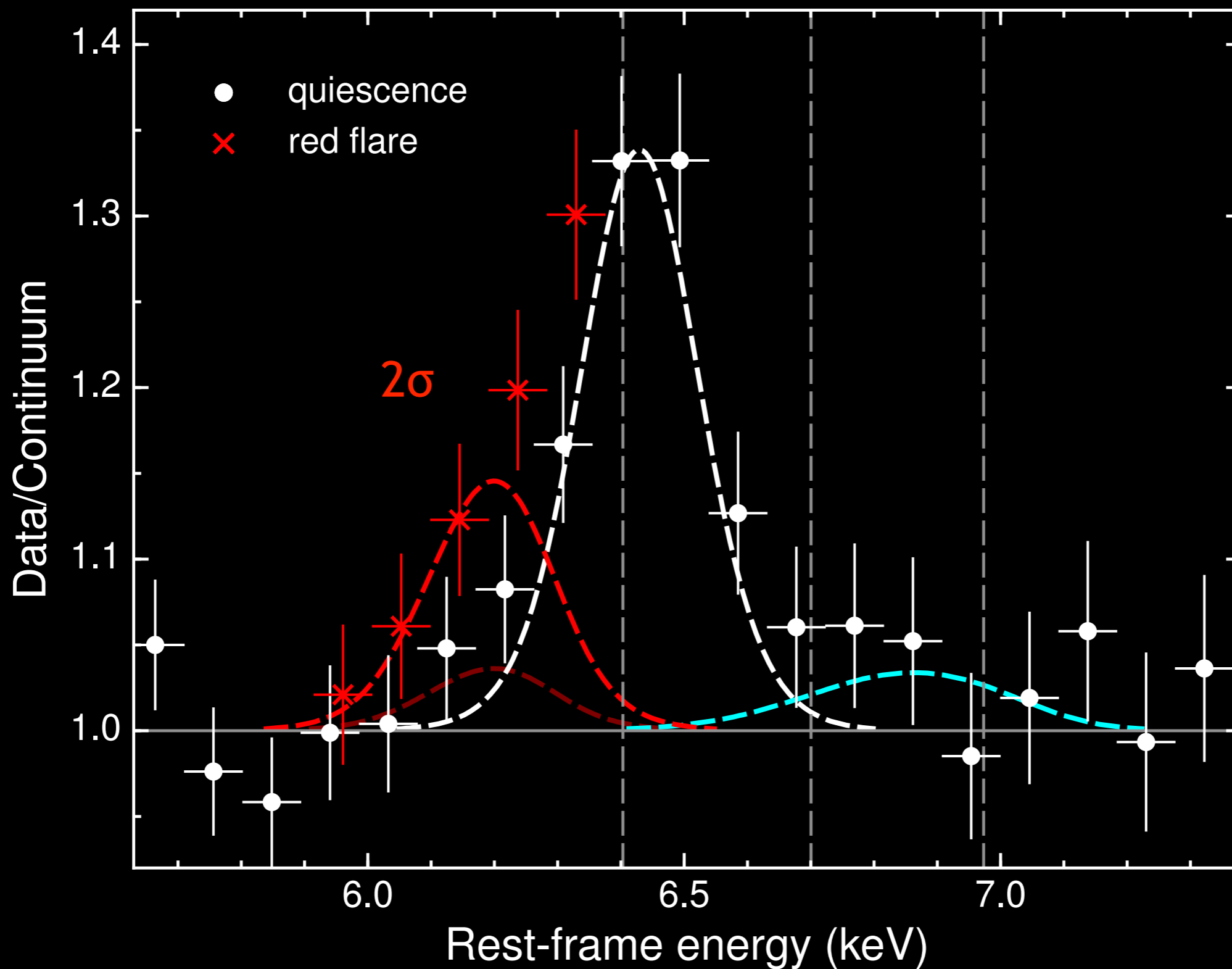
Transient red/blue structures with no obvious periodicity nor correlation with each other: short-lived, individual hotspots at several tens of gravitational radii?

Any alternative explanation that involves some kind of inhomogeneity is viable, e.g. *disk instability* (photon bubbles on suborbital timescales) or *hybrid corona* (no Fe-K feature from around the ISCO). Theoretical effort might be worthwhile.

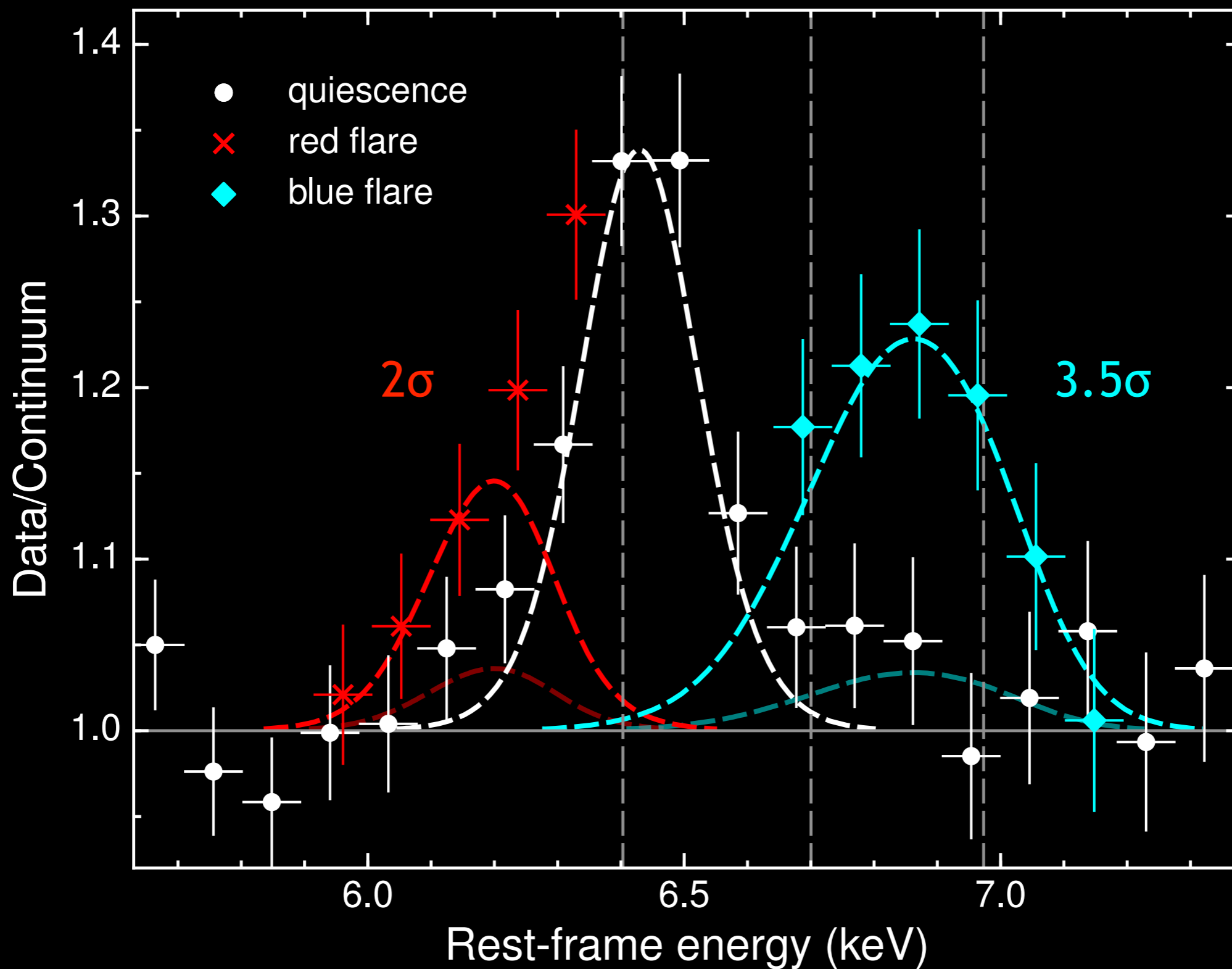
The orbiting hotspots picture



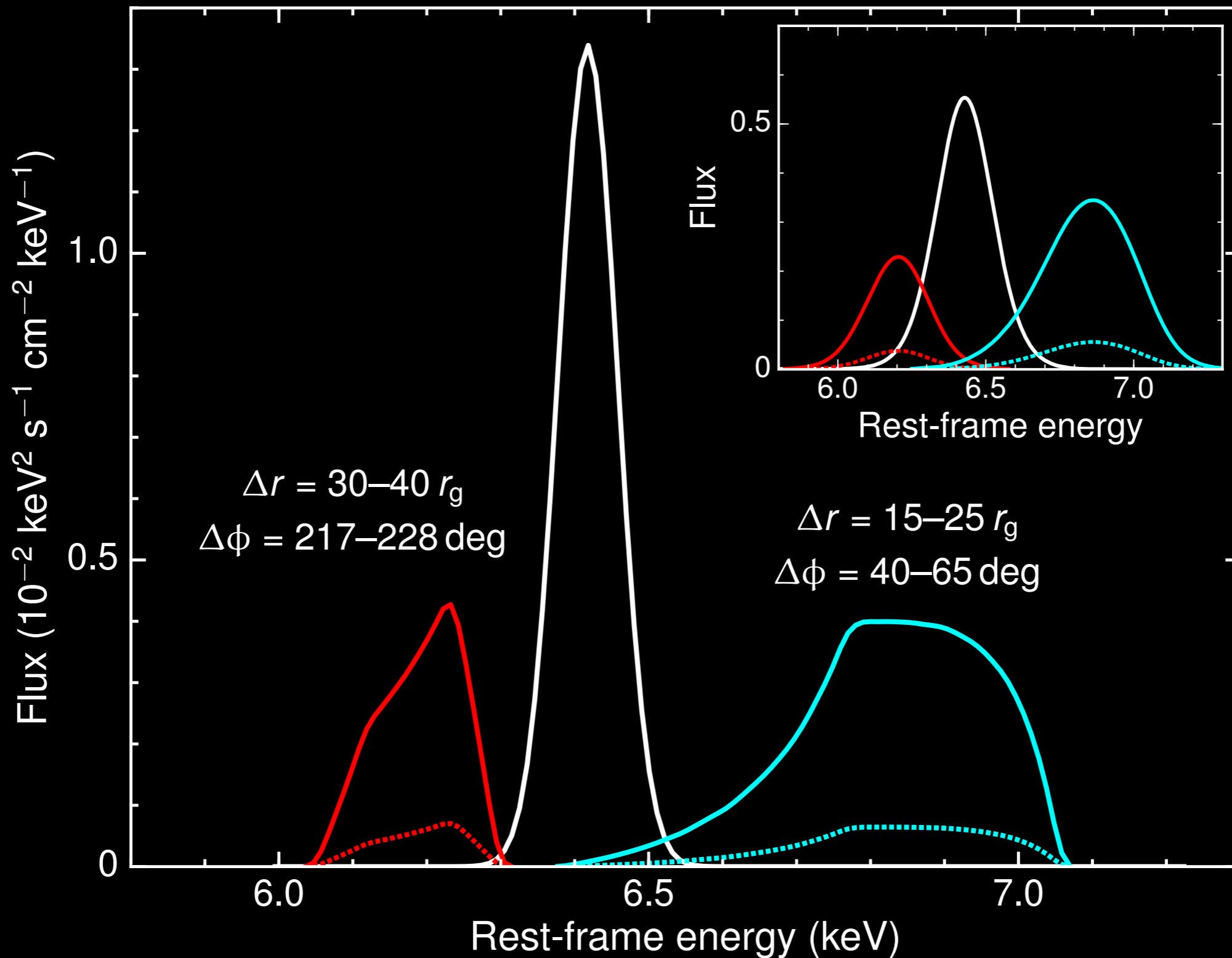
The orbiting hotspots picture



The orbiting hotspots picture



The orbiting hotspots picture



Summary

- ★ Evidence for rapid (several tens of ks) variability of Fe-K fluorescence in the bare Seyfert Ark 120, compatible with flares/hotspots, inhomogeneity and/or instability
- ★ Are these physical conditions and the underlying processes common among AGN? Should we expect any implications on broad Fe-K features and SMBH spin measurements?
- ★ To reveal any fine structure in the Fe-K profile and perform a proper time-resolved spectral analysis, large effective area AND high energy resolution (*read: Athena*) are needed.
- ★ Ark 120 is possibly the most promising source to study the properties of the accretion disk/X-ray corona system in a nearby AGN, and of its flaring, transient component(s).

Nardini et al. 2016, ApJ in press (arXiv:1609.05210)