Discovery of transient iron fluorescence in the bare Seyfert Ark 120

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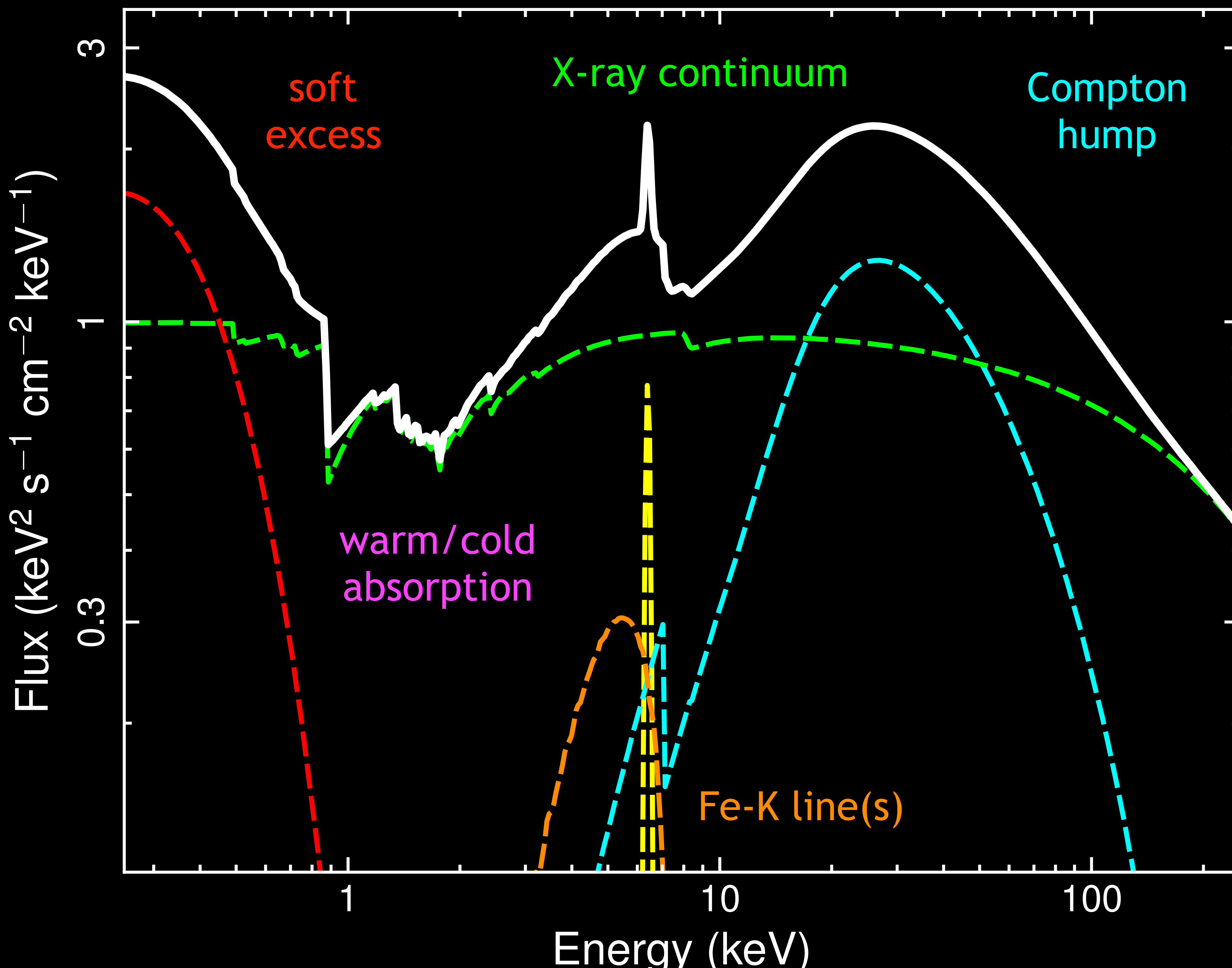
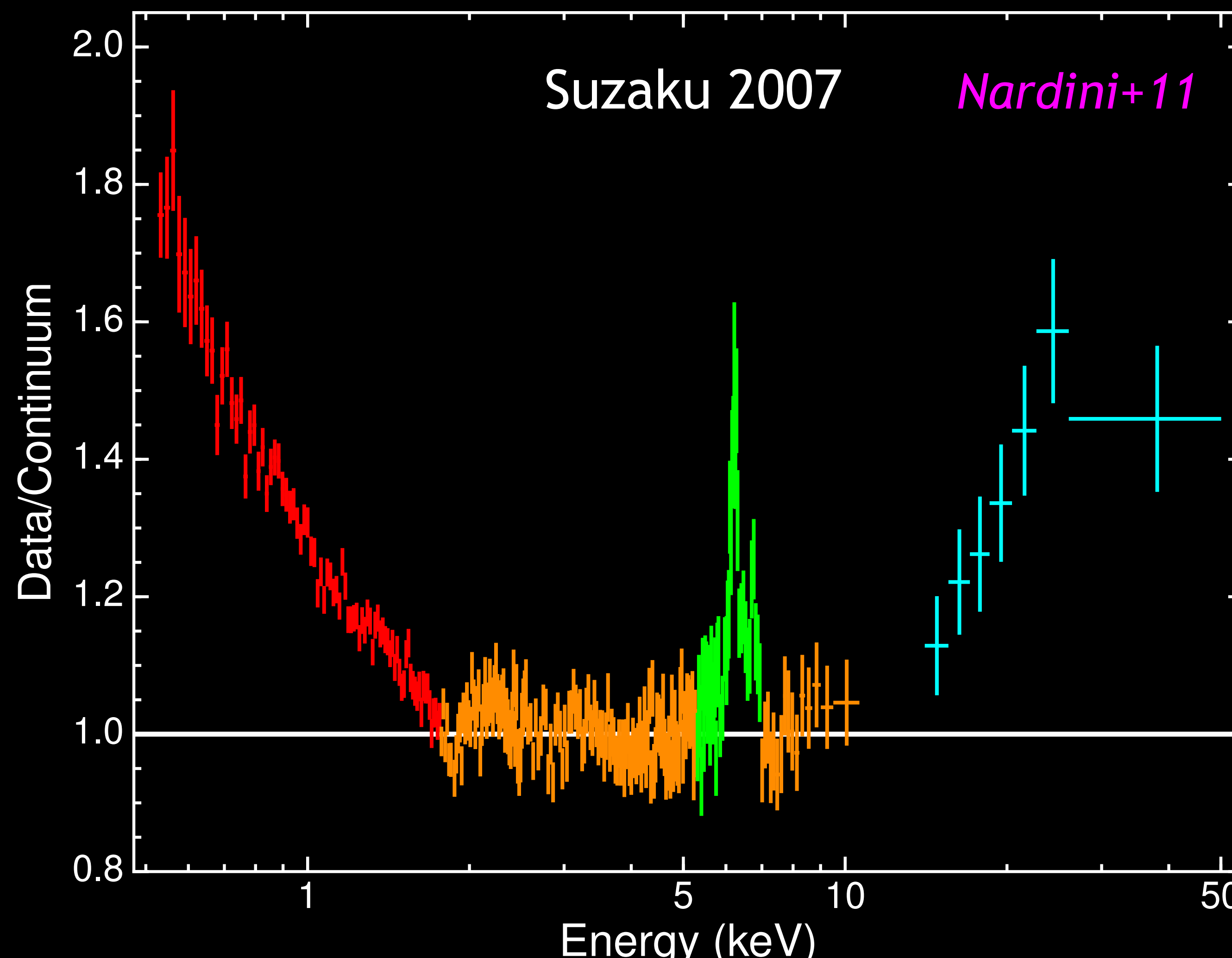
Breaking the Limits
Super-Eddington accretion onto compact objects
Arbatax, 19-23 September 2016

AGN X-ray spectral energy distribution



Ark 120: the 'bare Seyfert' prototype

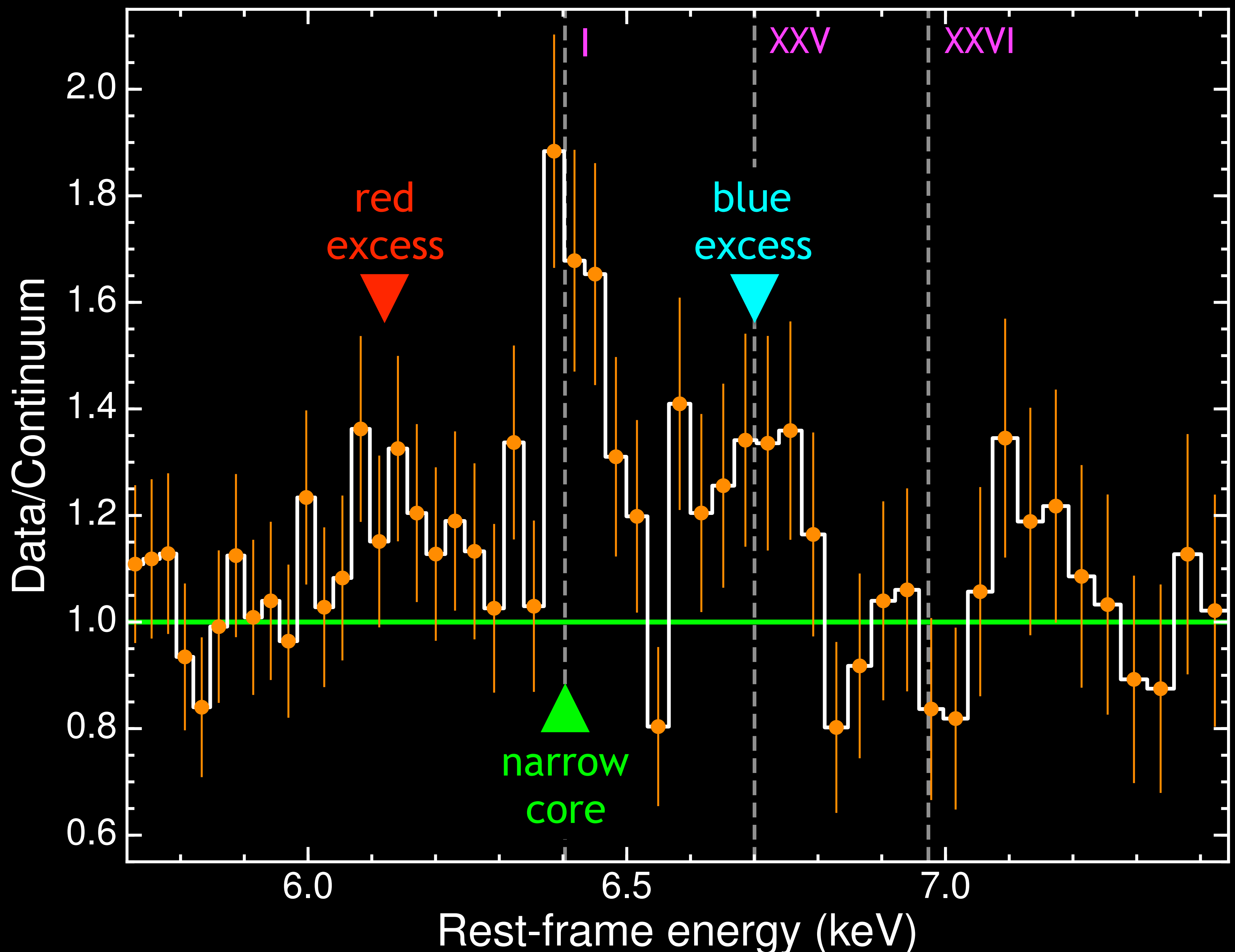
- ★ Nearest and brightest
  D = 144 Mpc
  $F_X = 7 \times 10^{-11}$ erg/s/cm^2
- ★ Bare line of sight *(Reeves+16b)*
  $N_H <$ a few $\times 10^{19}$ cm^{-2}
- ★ BH mass known from reverberation mapping
  $M_{BH} = 1.5 \times 10^8 M_{SUN}$
- ★ All X-ray spectral traits of a radiatively efficient SMBH



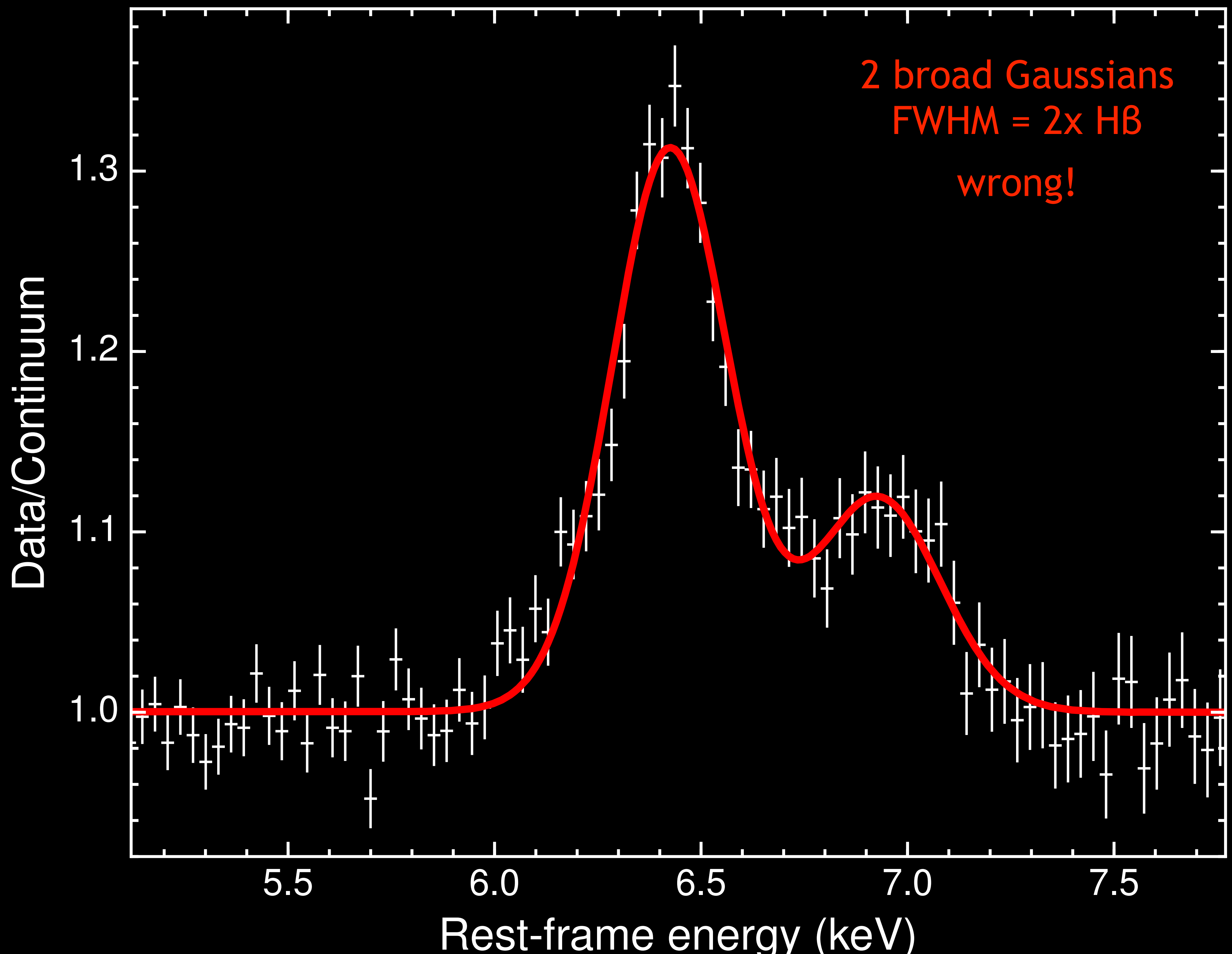
2014 X-ray campaign (PI: D. Porquet)

- ★ 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)

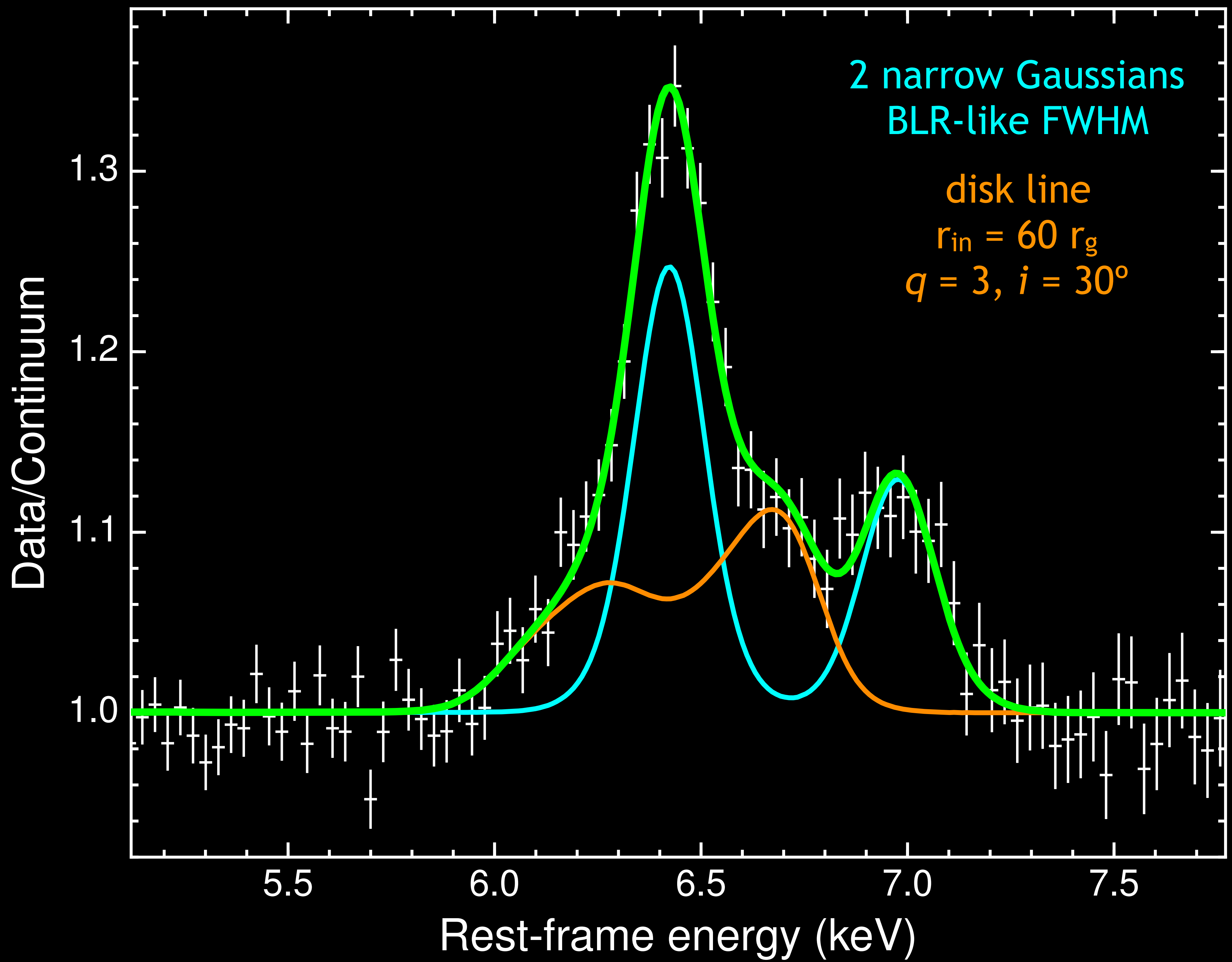
Chandra HETG spectrum



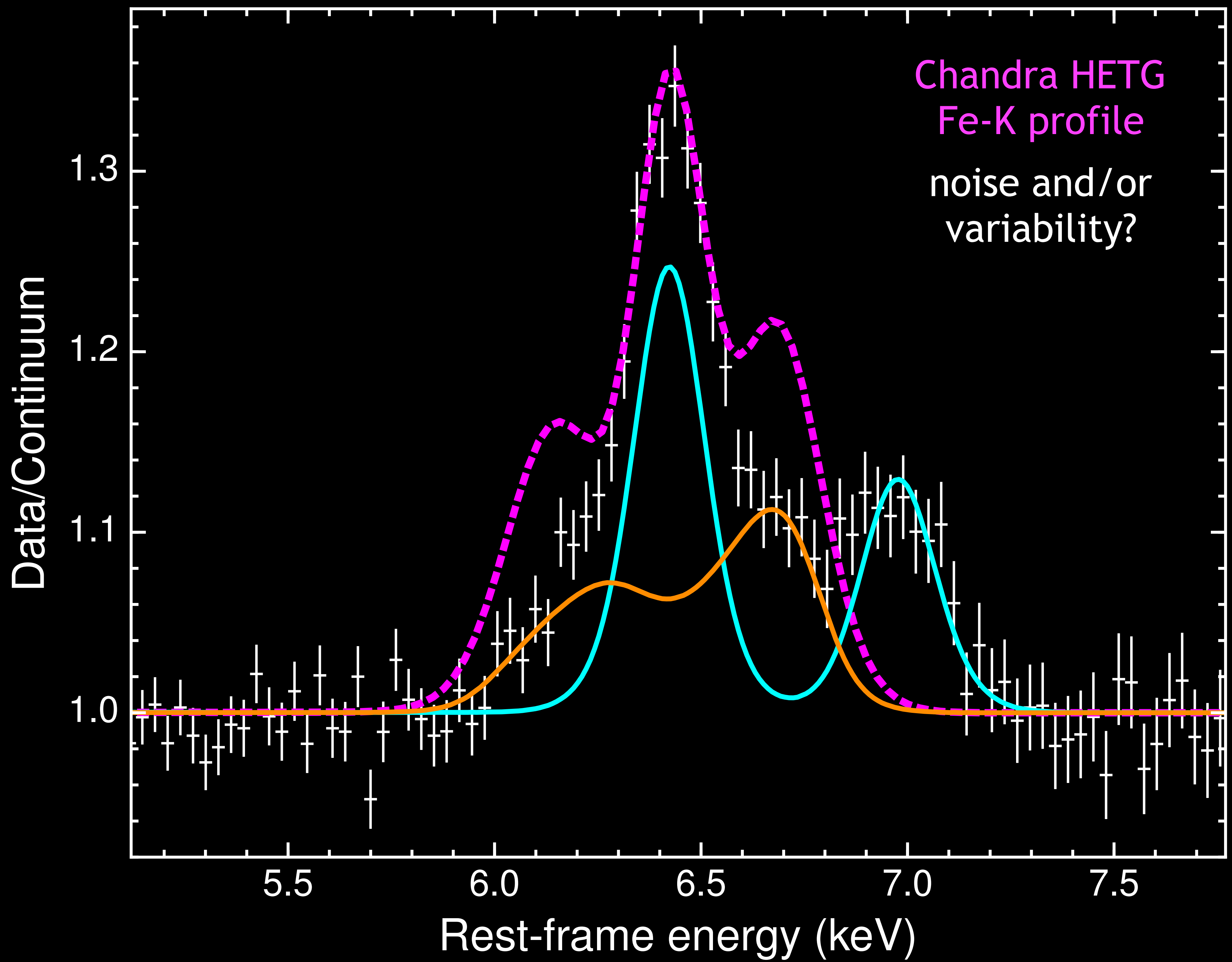
XMM time-averaged spectrum



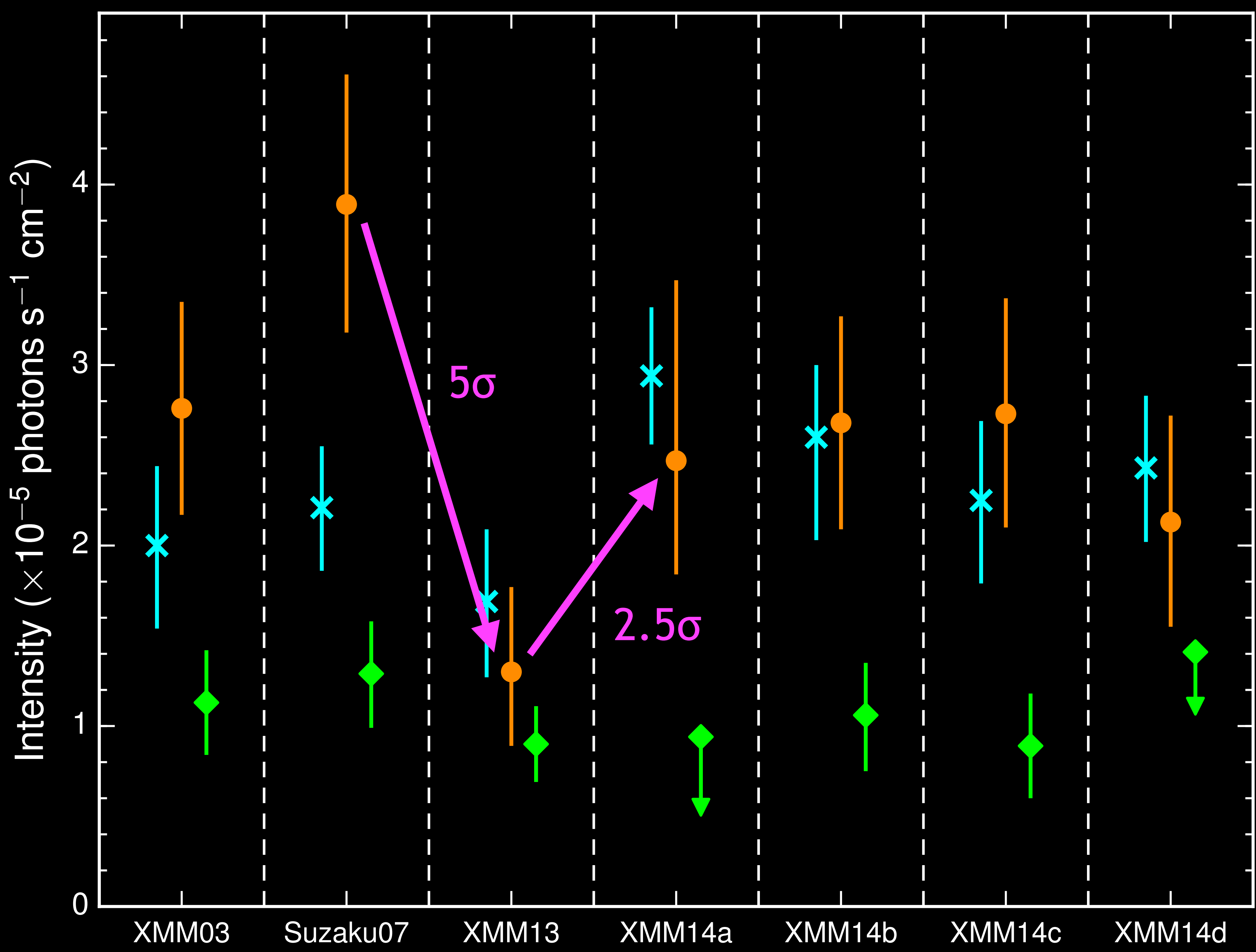
XMM time-averaged spectrum



XMM time-averaged spectrum

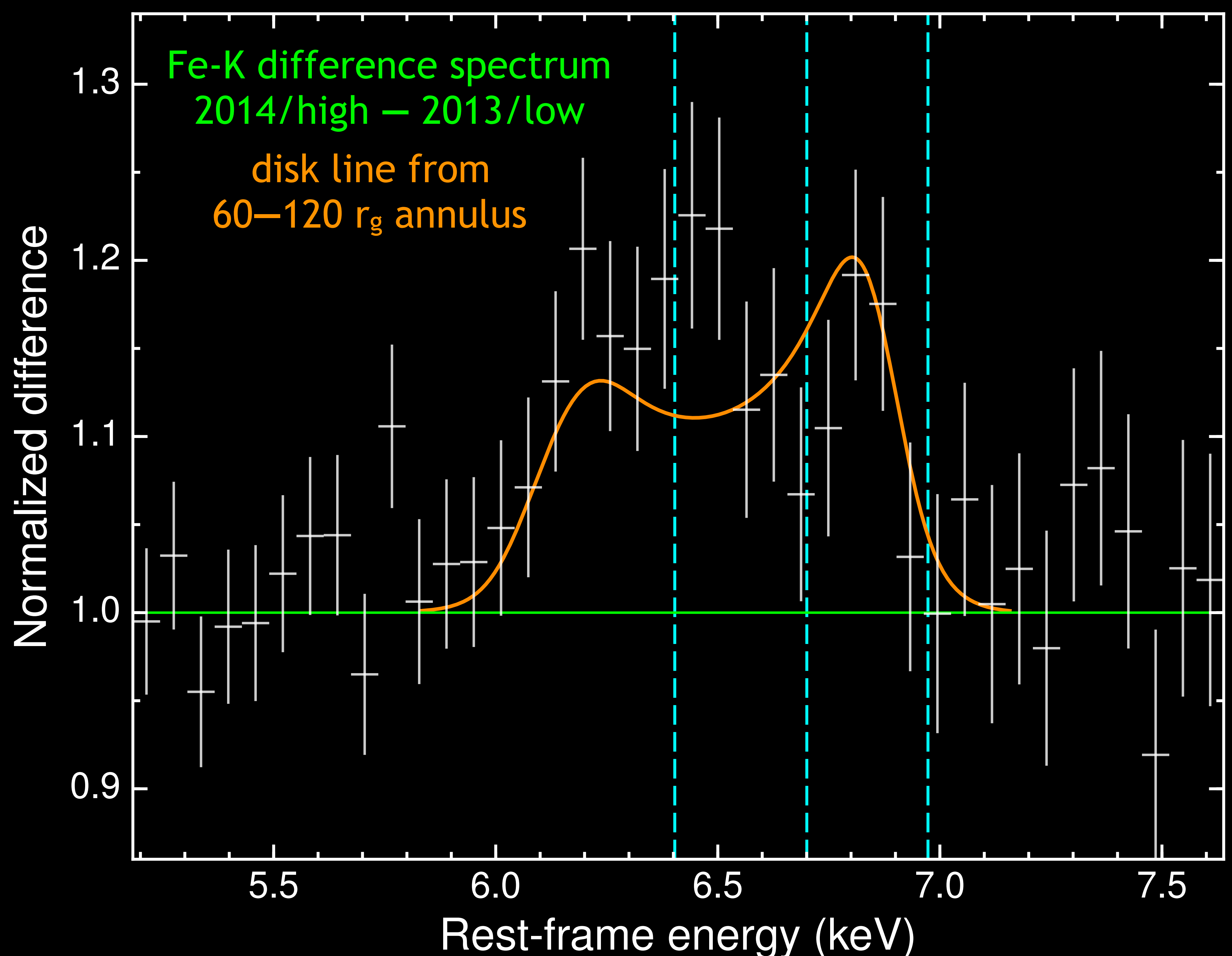


Fe-K variability, long timescales

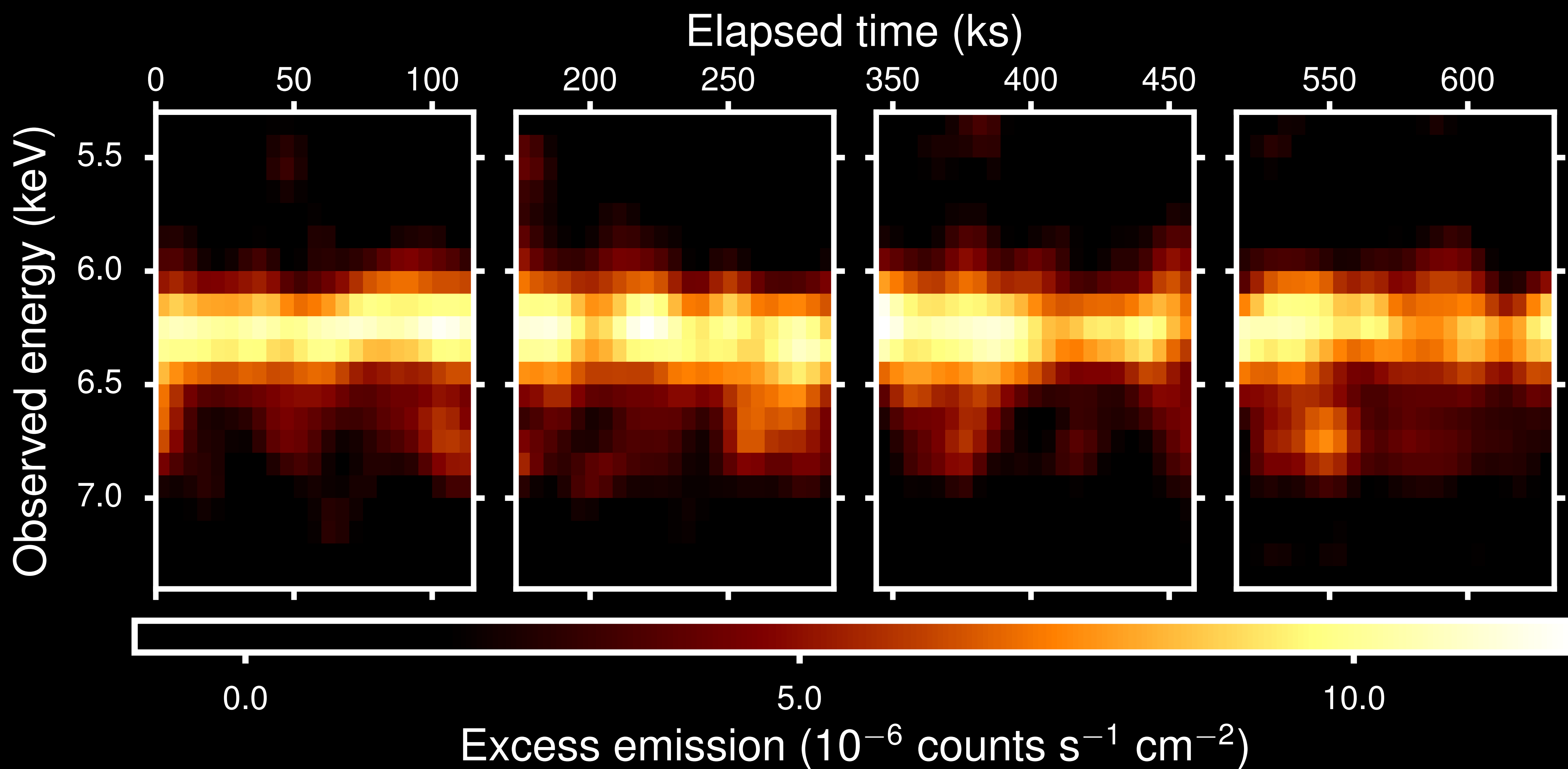


narrow Fe I, 6.40 keV disk line, 6.45—6.55 keV narrow Fe XXVI (?), 6.98 keV

Fe-K variability, long timescales



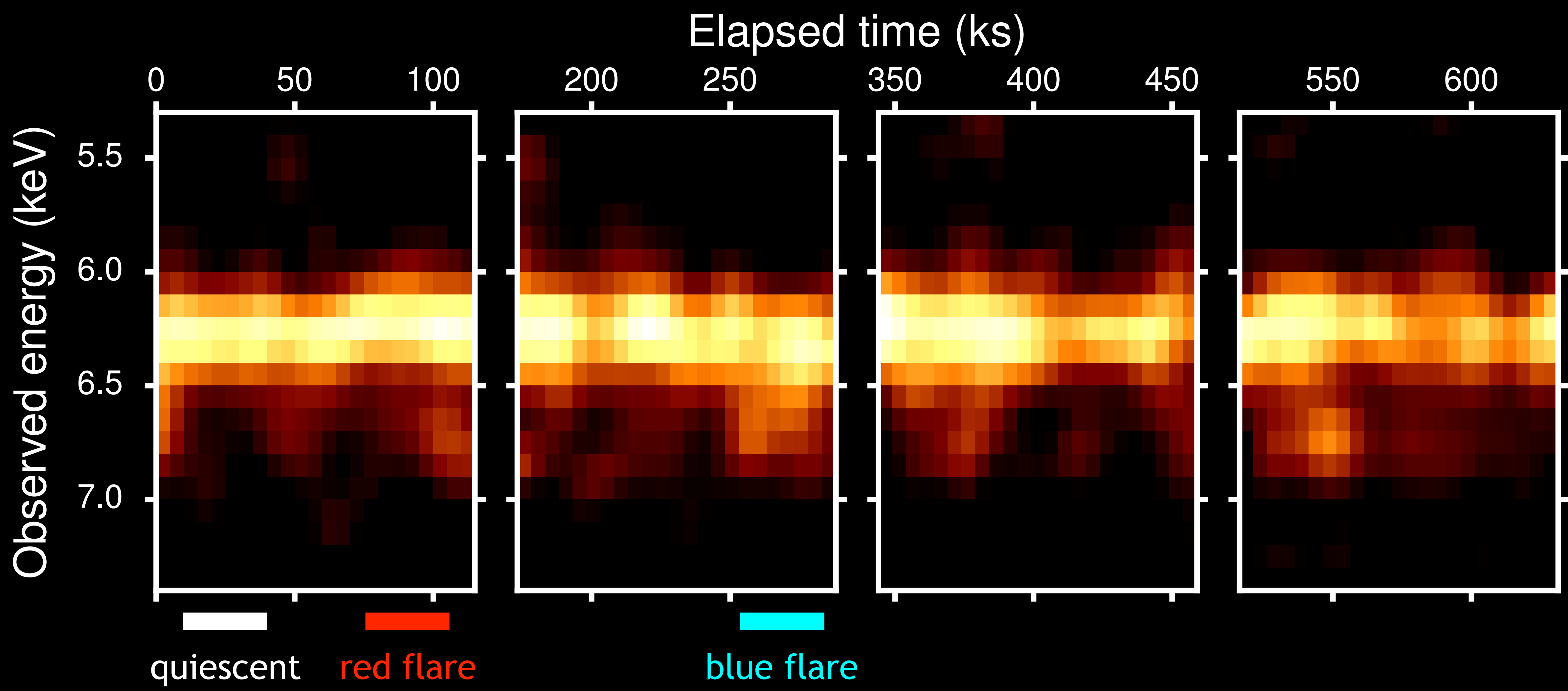
Fe-K variability, short timescales



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

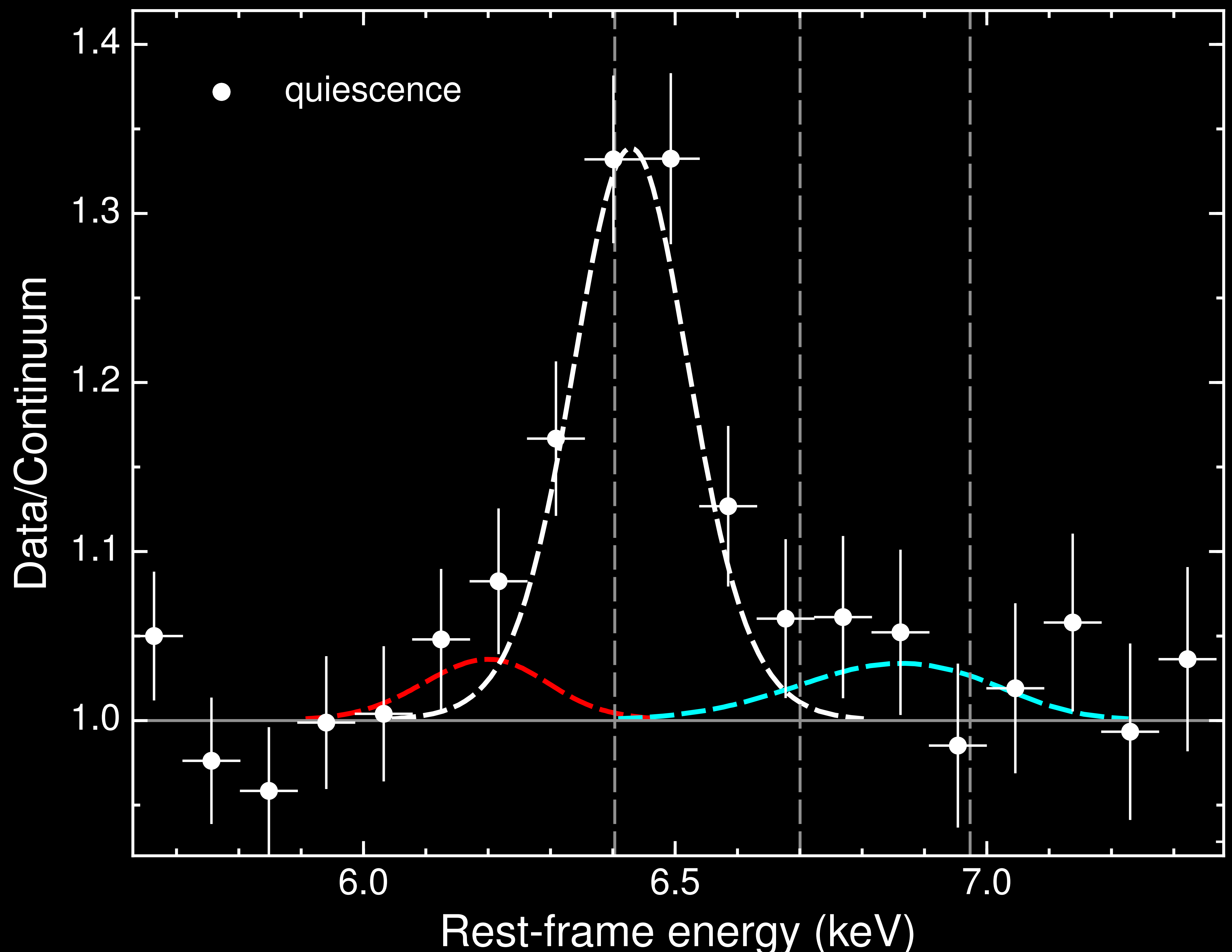
Fe-K variability, short timescales



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



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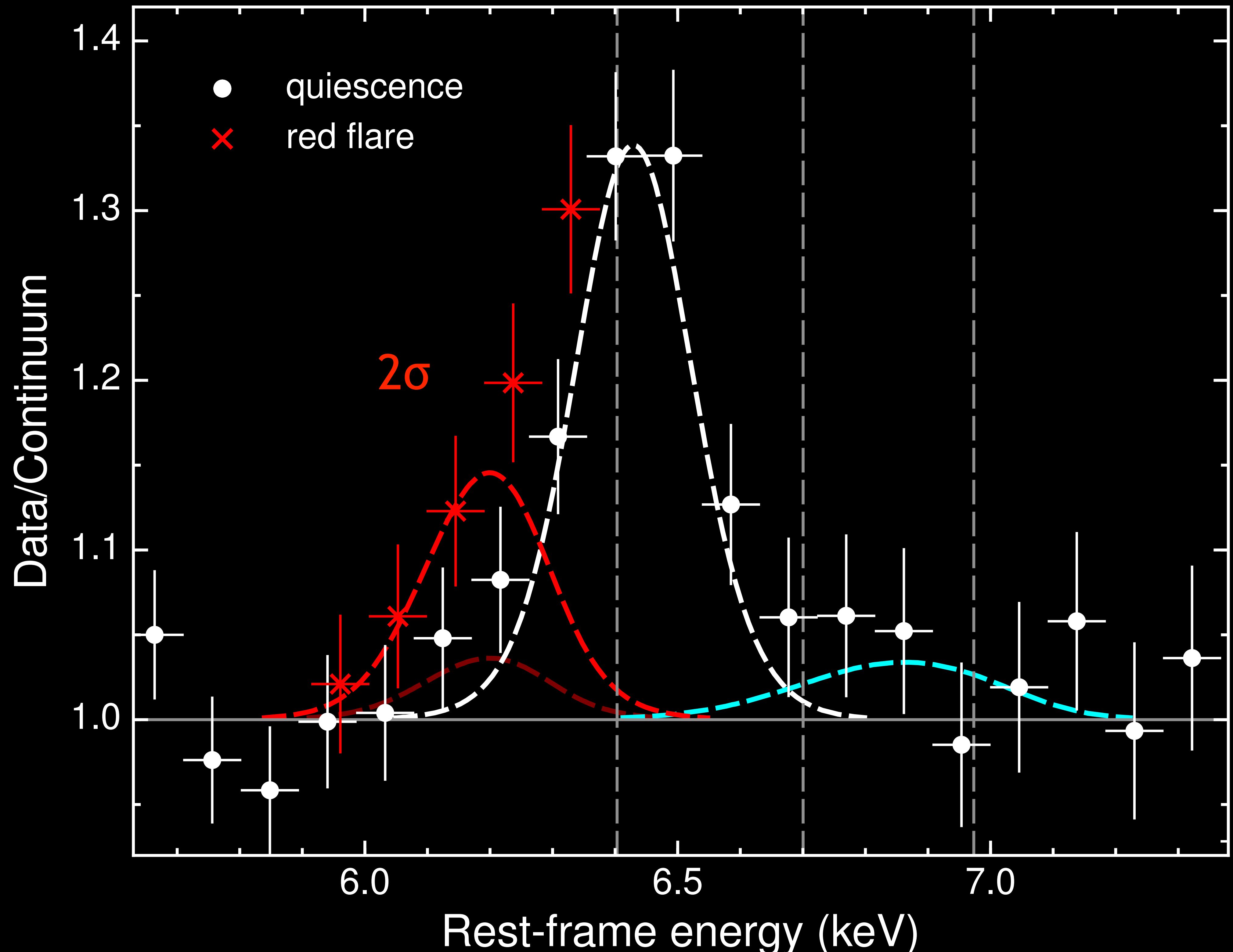

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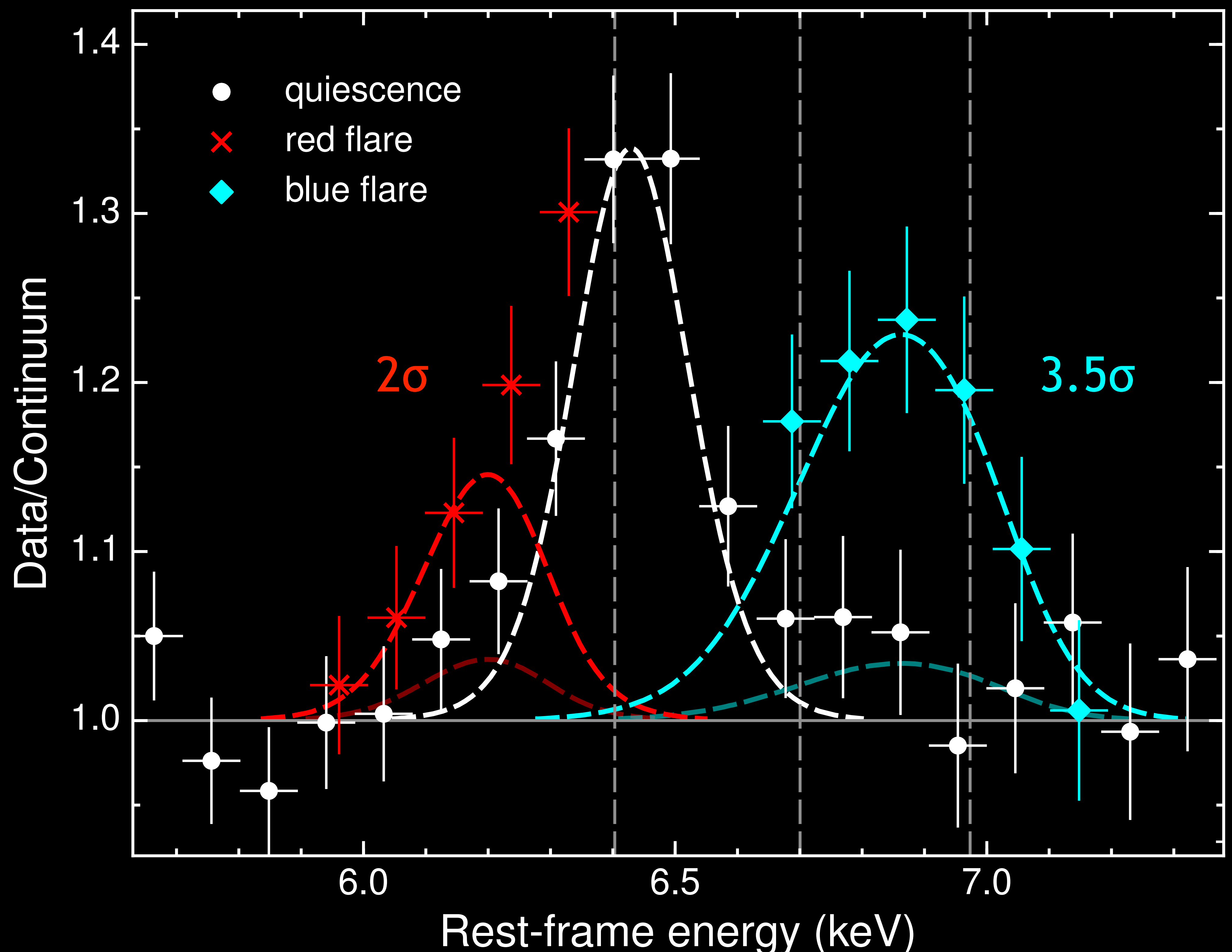

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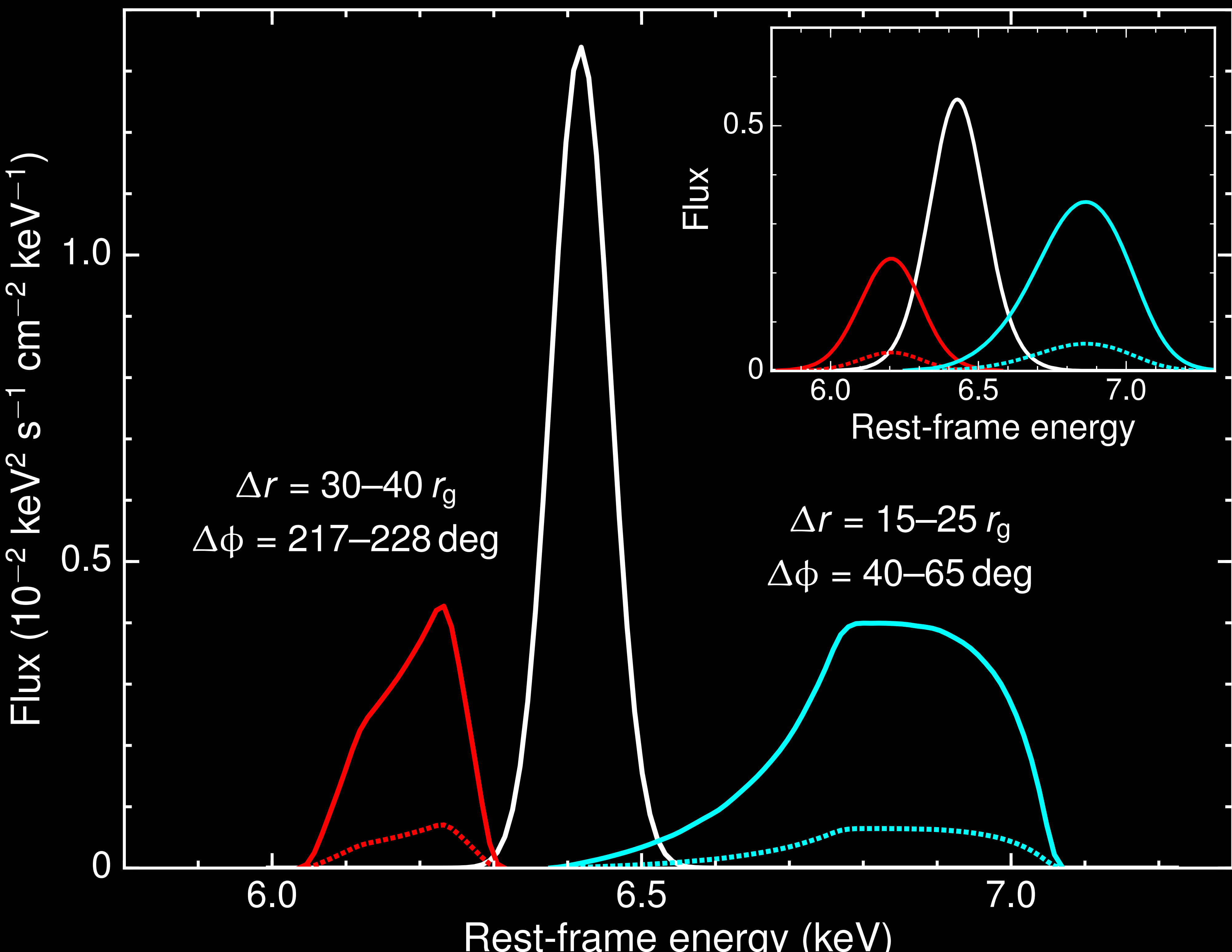

Summary

- ★ 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 <u>AND</u> 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)