

X-ray variability of Seyfert galaxies during transient obscuration events: the case of NGC 3783

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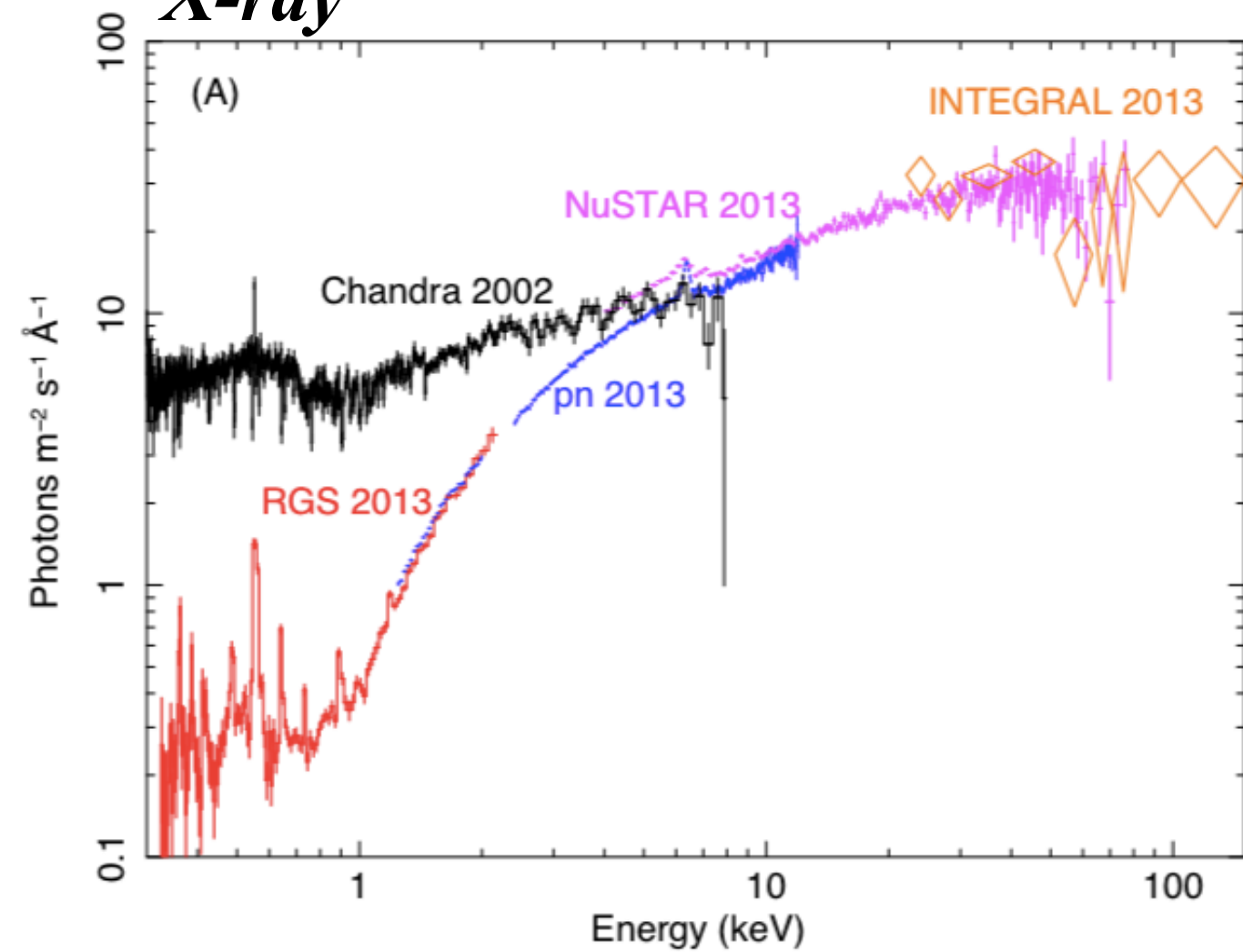
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Transient X-ray obscurers

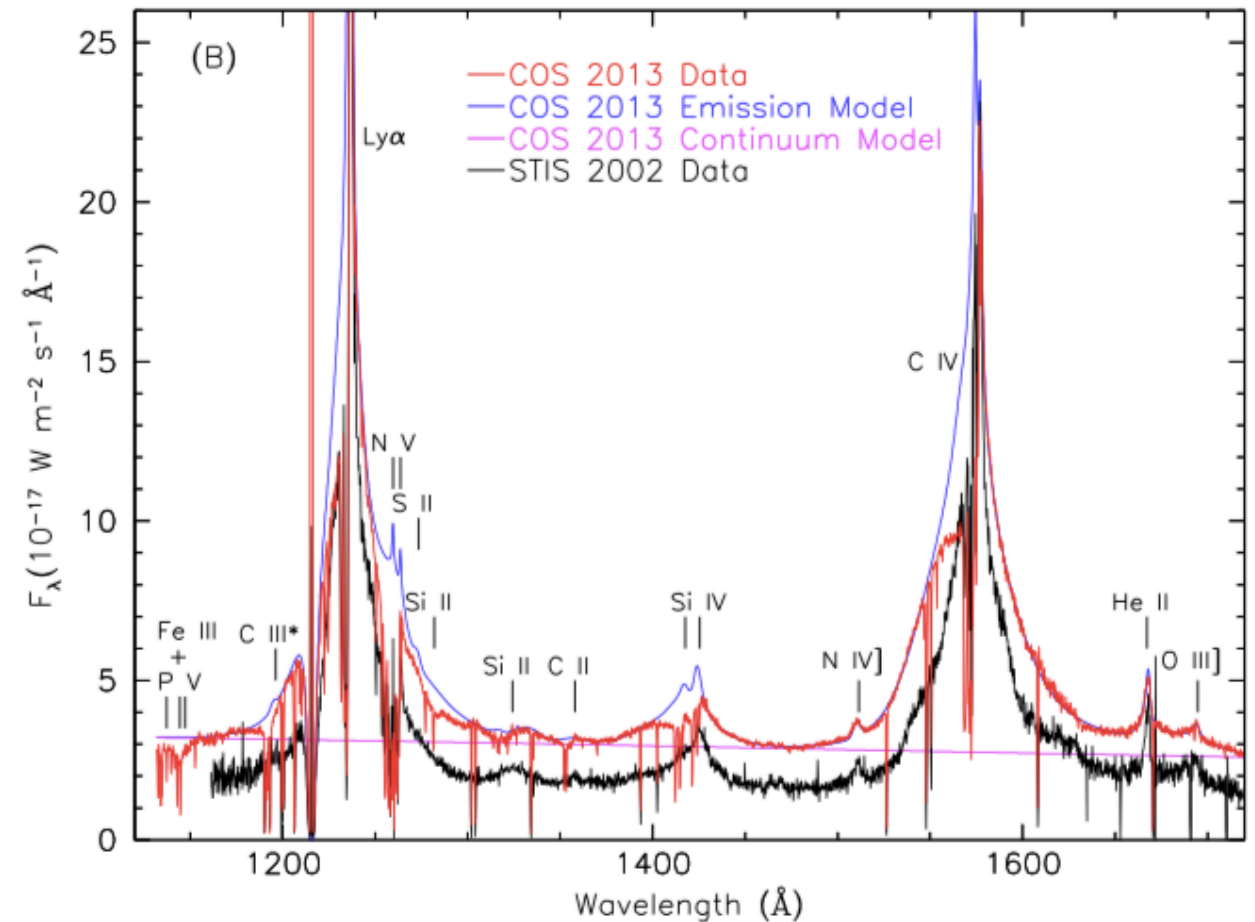
Low ionization outflowing gas significantly obscuring the X-ray source

NGC 5548

X-ray



UV



[Kaastra+'14, Science]

[see also, e.g. Risaliti et al. 2011; Longinotti et al. 2013, 2019; Mehdipour et al. 2017; Ebrero et al. 2016; Turner et al. 2018; Kriss et al. 2019]

Goals

Probe X-ray obscurer variability on the shortest time scales

Obtain constraints on the density, and ultimately on the distance of the obscuring gas

Spectral-timing techniques

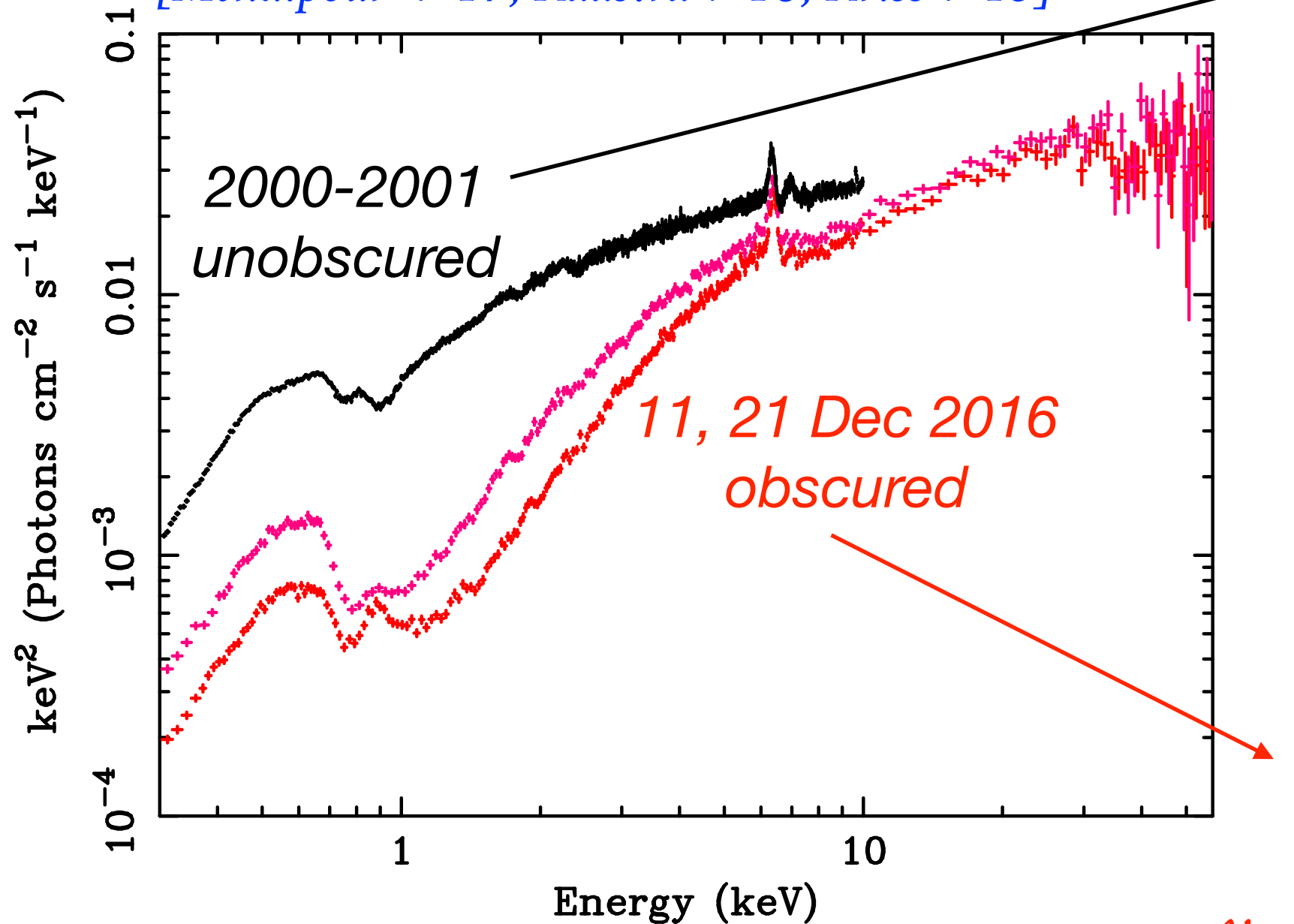
[Uttley + '14, for a review]

Characterize the impact of variable obscuration on the observed X-ray spectral-timing properties of Seyfert 1 galaxies

NGC 3783

Heavy X-ray absorption detected in December 2016

[Mehdipour + '17; Kaastra + '18; Kriss + '19]



Primary X-ray
continuum + reflection
Classical warm absorber
Scattered emission

Obscuring gas:

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

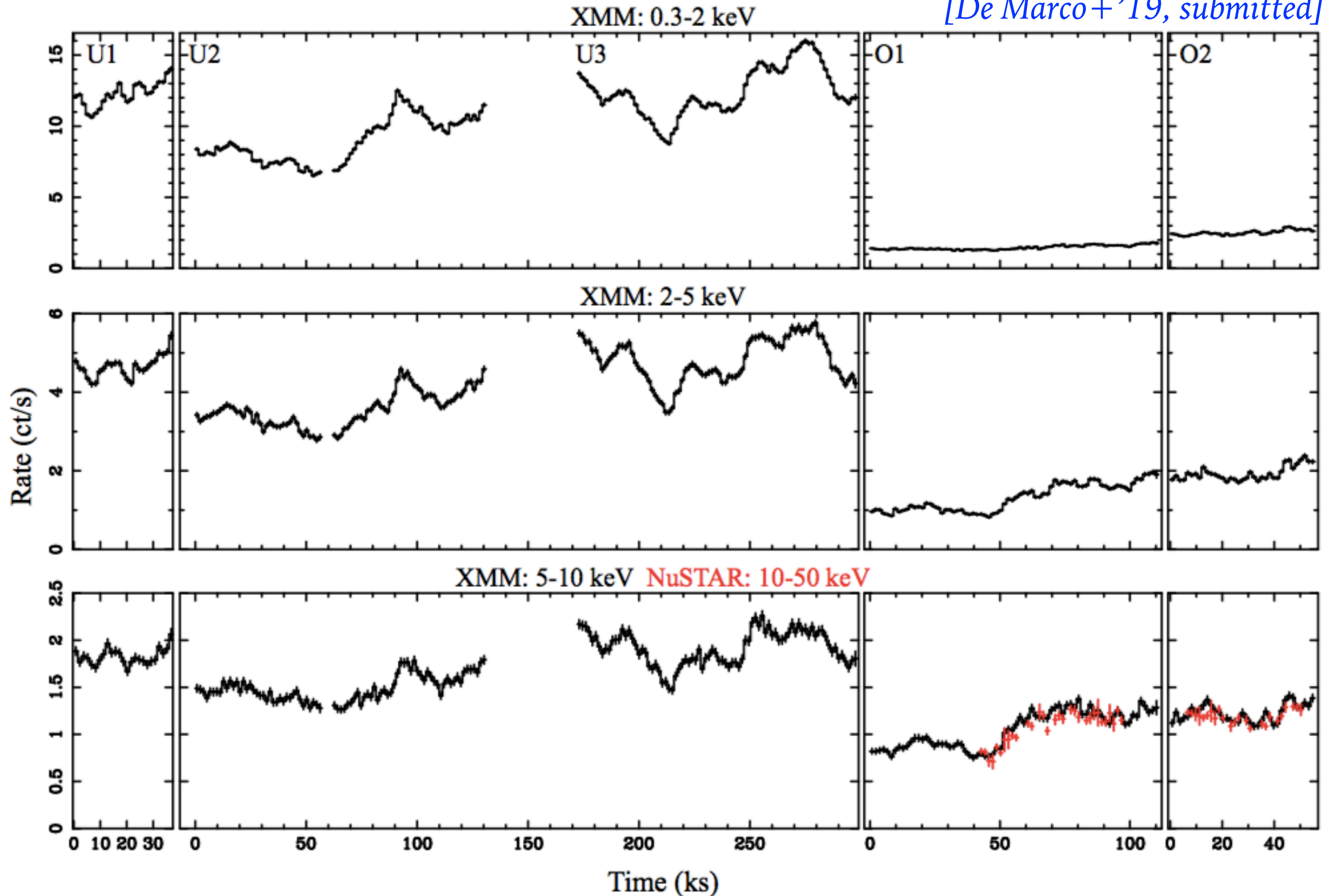
$\log \xi \sim 1.84$

$v_{\text{out}} \sim 3000\text{-}6000 \text{ km/s (UV)}$

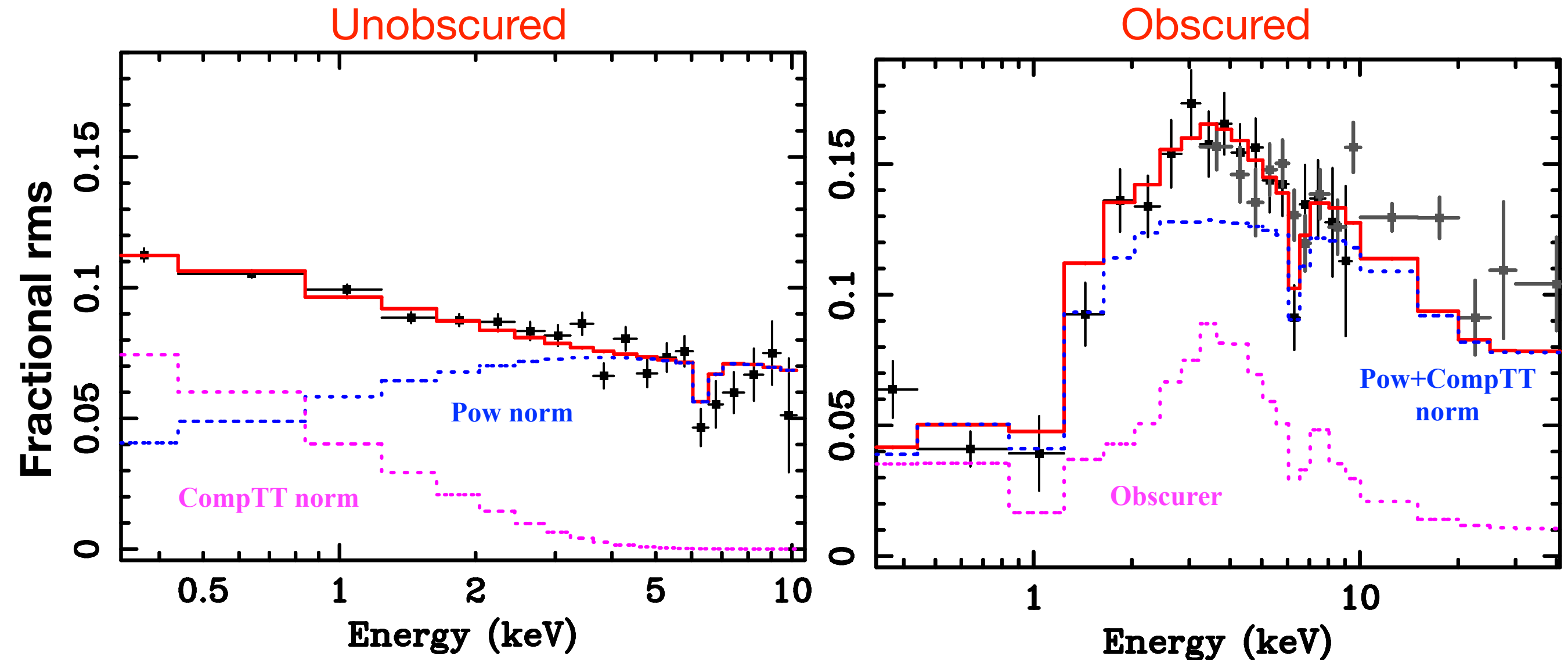
NGC 3783

Does the obscurer respond to the short time scale variability of the continuum?

[De Marco + '19, submitted]



Fast variability of the obscurer



[De Marco + '19, submitted]

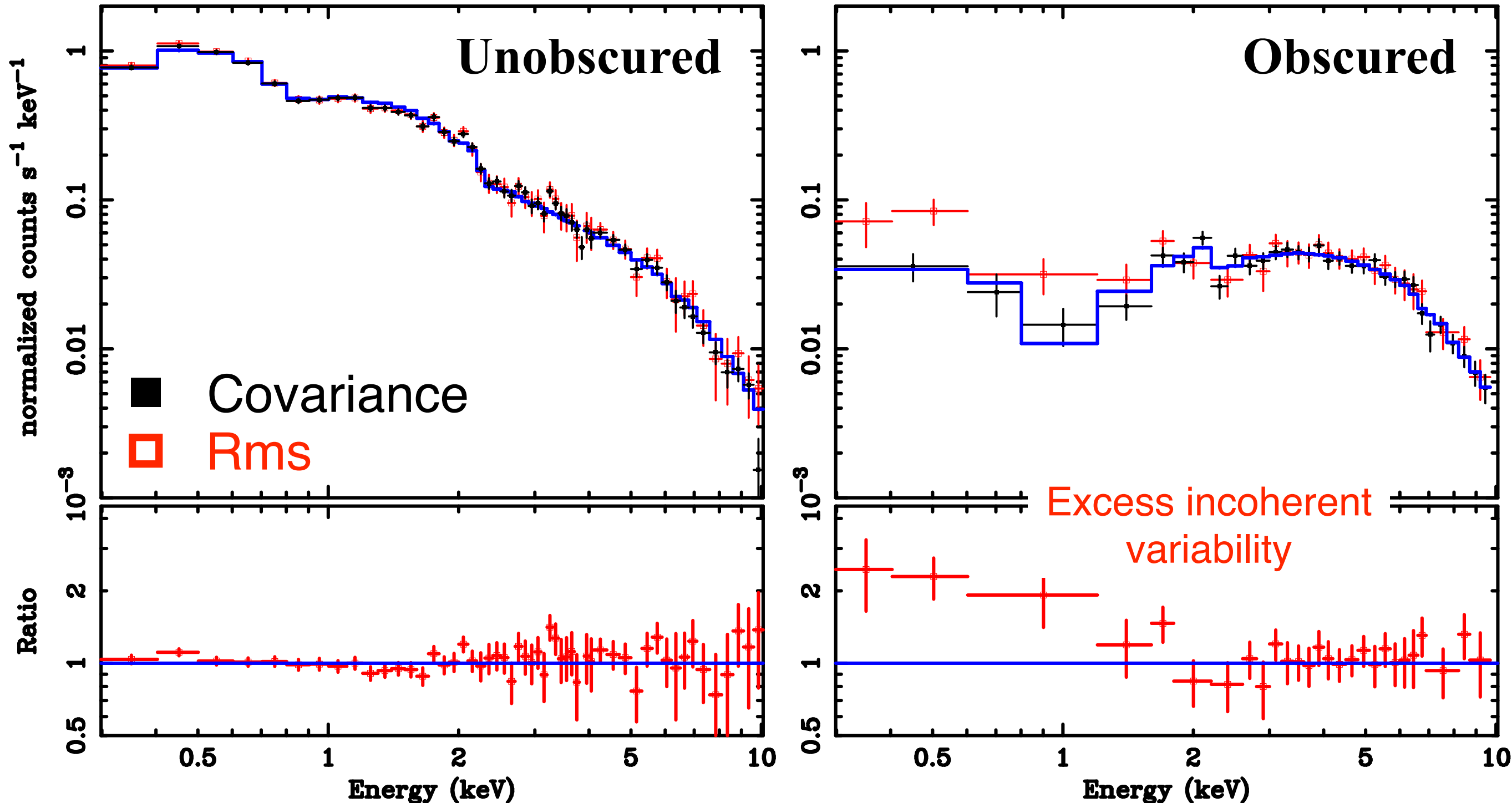
Obscurer's variations detected on time scales between one and ten hours

The obscurer is expected to vary non linearly (incoherently) with the X-ray continuum [e.g. Rybicki & Lightman 1991]

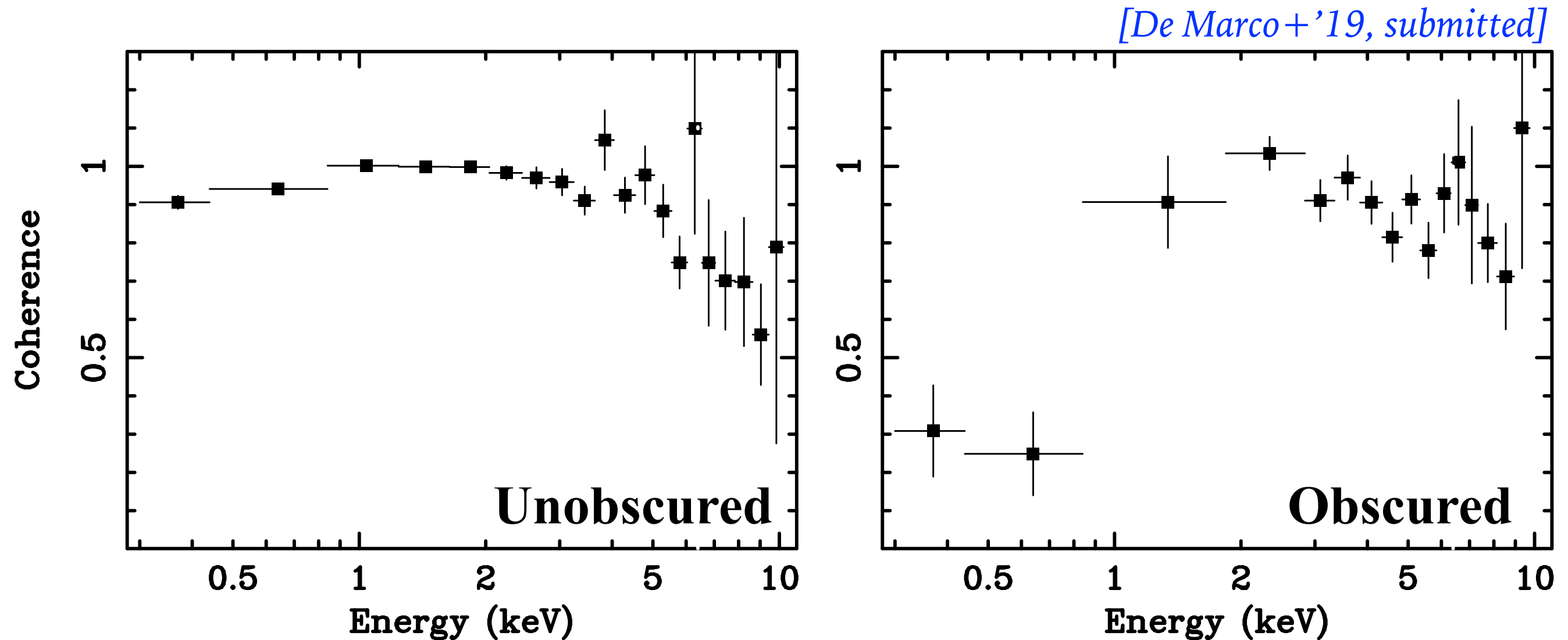
Incoherent variability of the obscurer

Differences between rms and covariance spectra due to components non linearly-correlated with X-ray continuum

[De Marco + '19, submitted]



Variations of the ionization state of the obscurer?

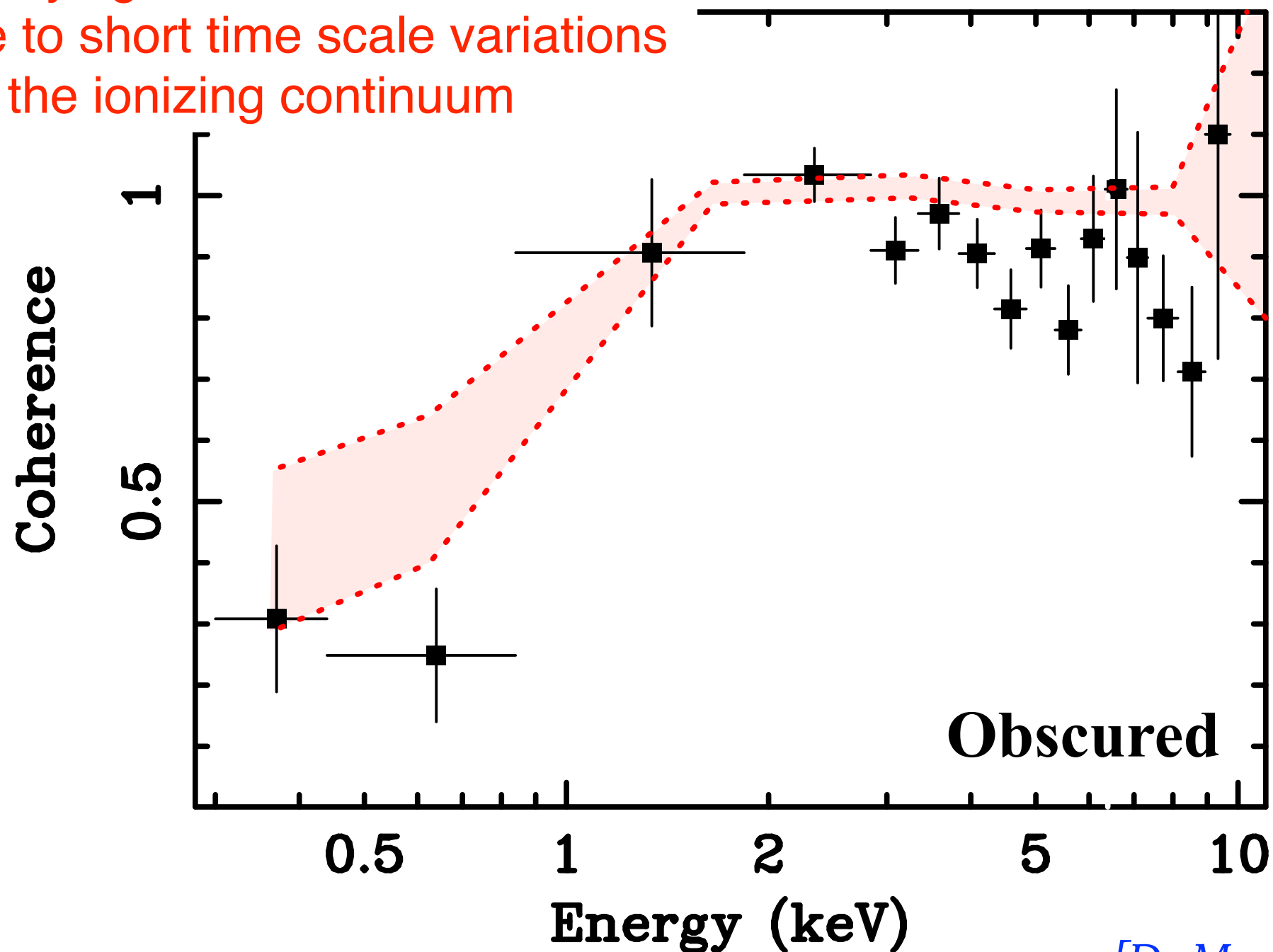


Photoionization model of a variable X-ray obscurer responding to fast X-ray continuum variability

Cloudy simulations of obscuring gas with parameters from Mehdipour + '17 and assuming photoionization equilibrium on time scales < 1.5 ks

Fast variations of the ionization state of the obscurer reproduce the drop of coherence

log ξ varying between 1.5 – 2.1 in
response to short time scale variations
of the ionizing continuum



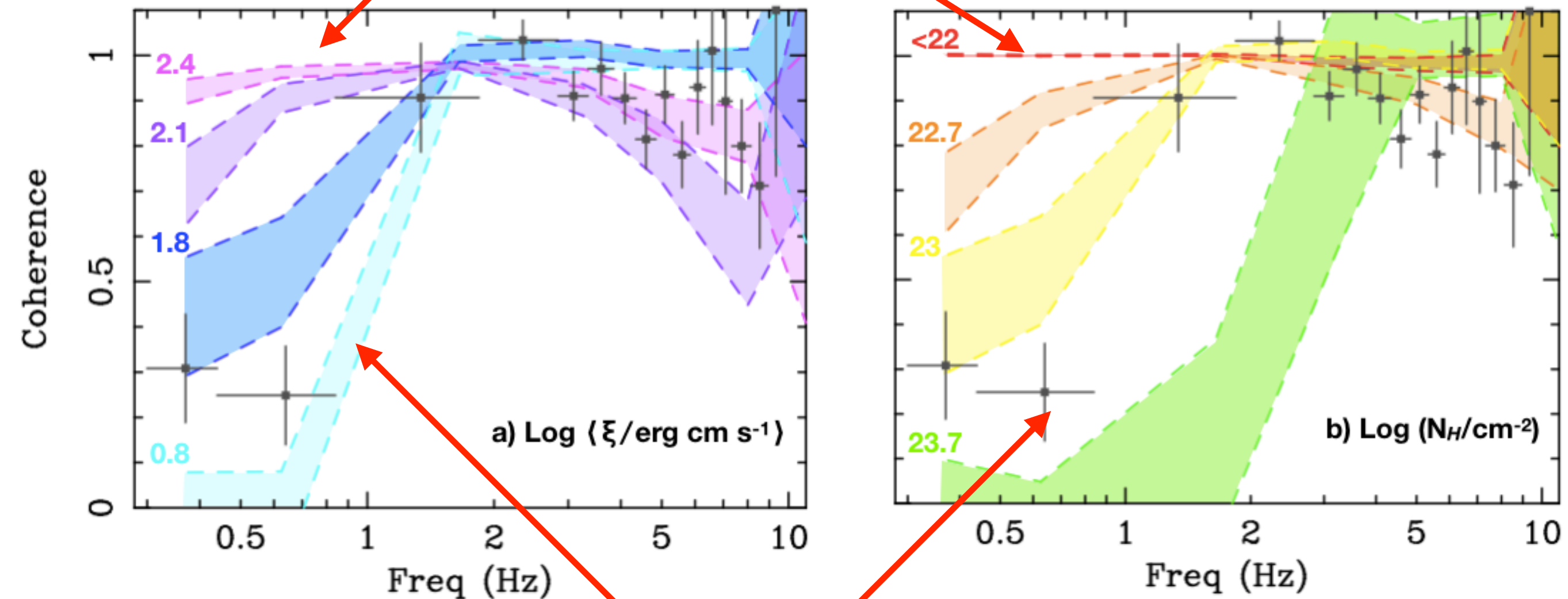
[De Marco + '19, submitted]

Intensity of the drop of coherence

Less ionized, high column density gas producing deeper drops

Warm absorbers

[De Marco + '19, submitted]

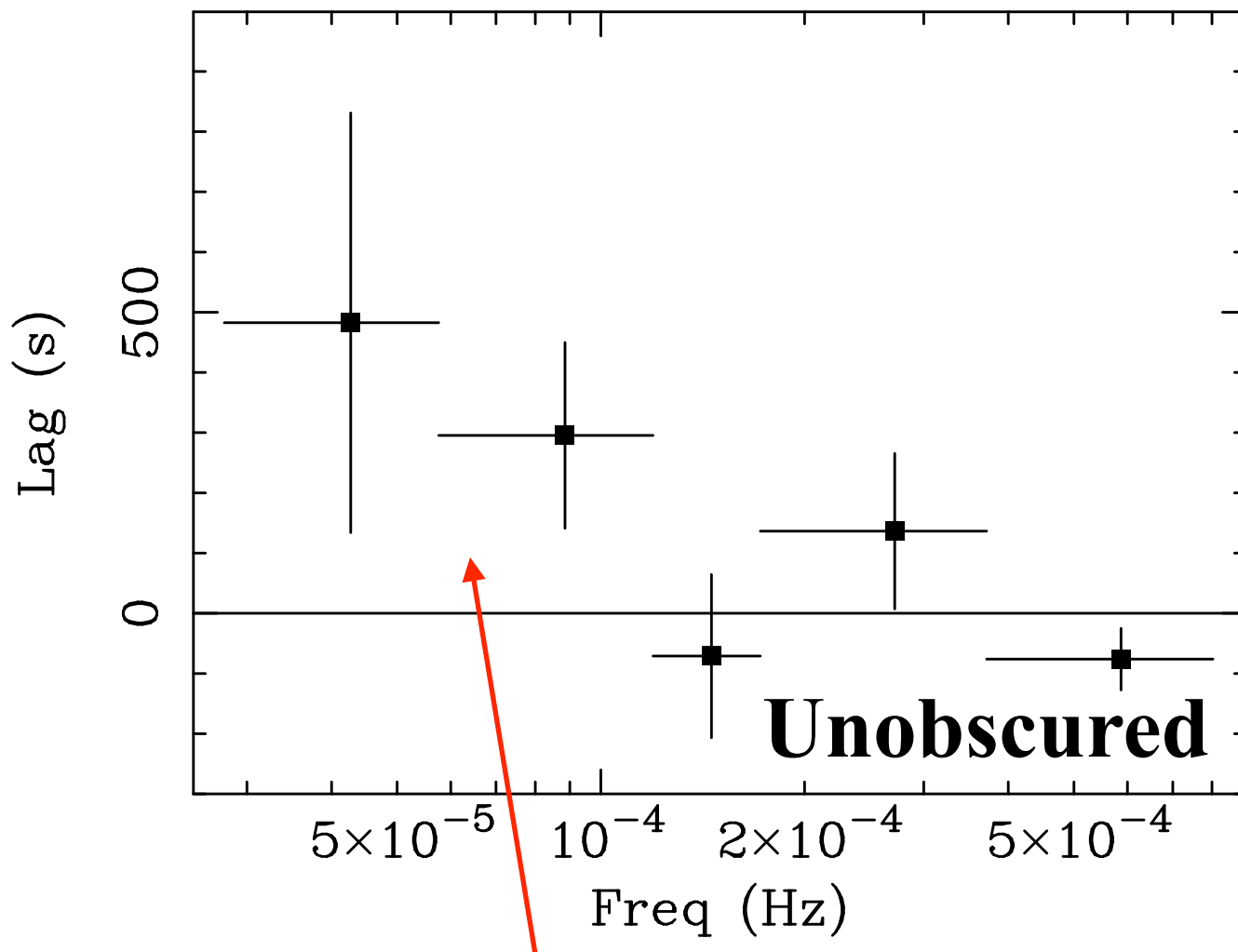


X-ray obscurers

Searching for time delays in the response of the obscurer

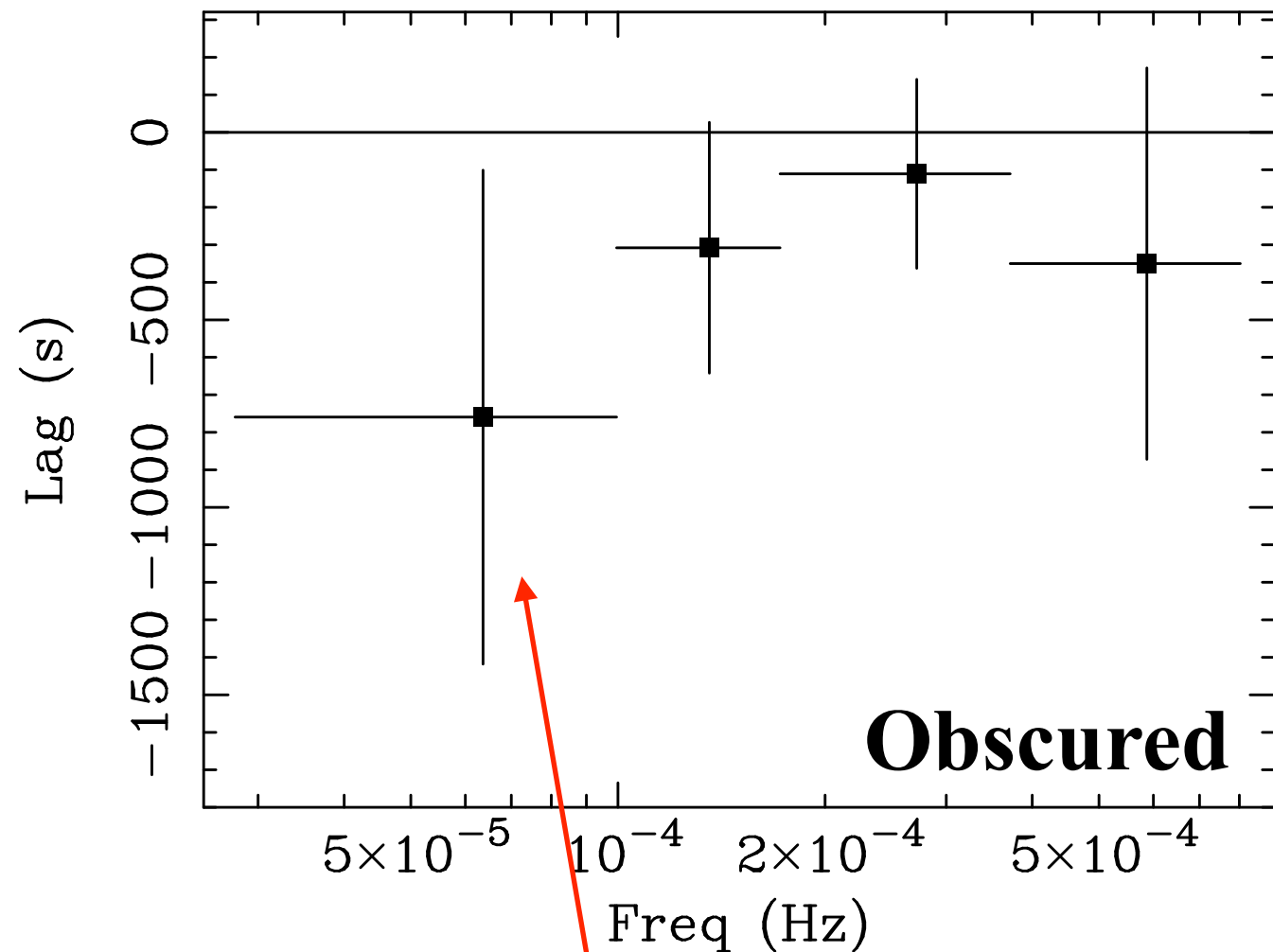
Time lags between 0.5-2 keV and 4-10 keV

[De Marco + '19, submitted]



Hard lags associated with the broad band X-ray continuum

[e.g. Kotov et al. 2001; Arévalo & Uttley 2006]



Tentative indication of a soft band delay of -760 ± 660 s

Conclusions

The X-ray obscurer in NGC 3783 varies on short time scales (a few hours)

The obscurer responds incoherently to variations of the X-ray continuum

Variations of the ionization state of the obscurer can reproduce the observed drop of coherence

and physical inferences

The observed variability time scales imply $n_e > 7.1 \times 10^7 \text{ cm}^{-3}$ in agreement with independent results of Mehdipour+ '17 ($n_e \sim 2.6 \times 10^9 \text{ cm}^{-3}$) and consistent with the gas being part of the BLR

!! see D. Costanzo's poster on FeK variability!!

Thanks!