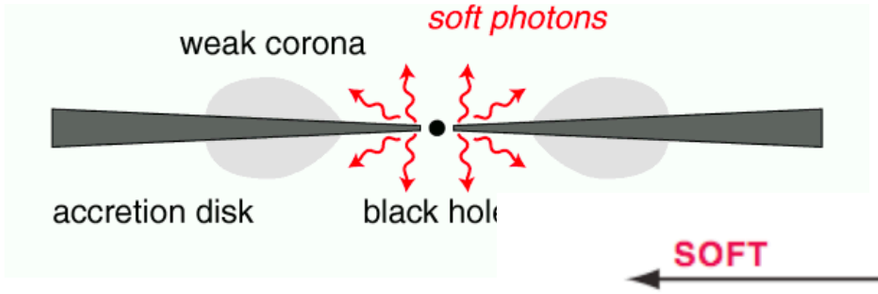
ISSI Bern
January 14, 2020

On the vertical extent of the X-ray corona

Erin Kara
MIT

slides also provided by Jingyi Wang

How does the outburst evolve?



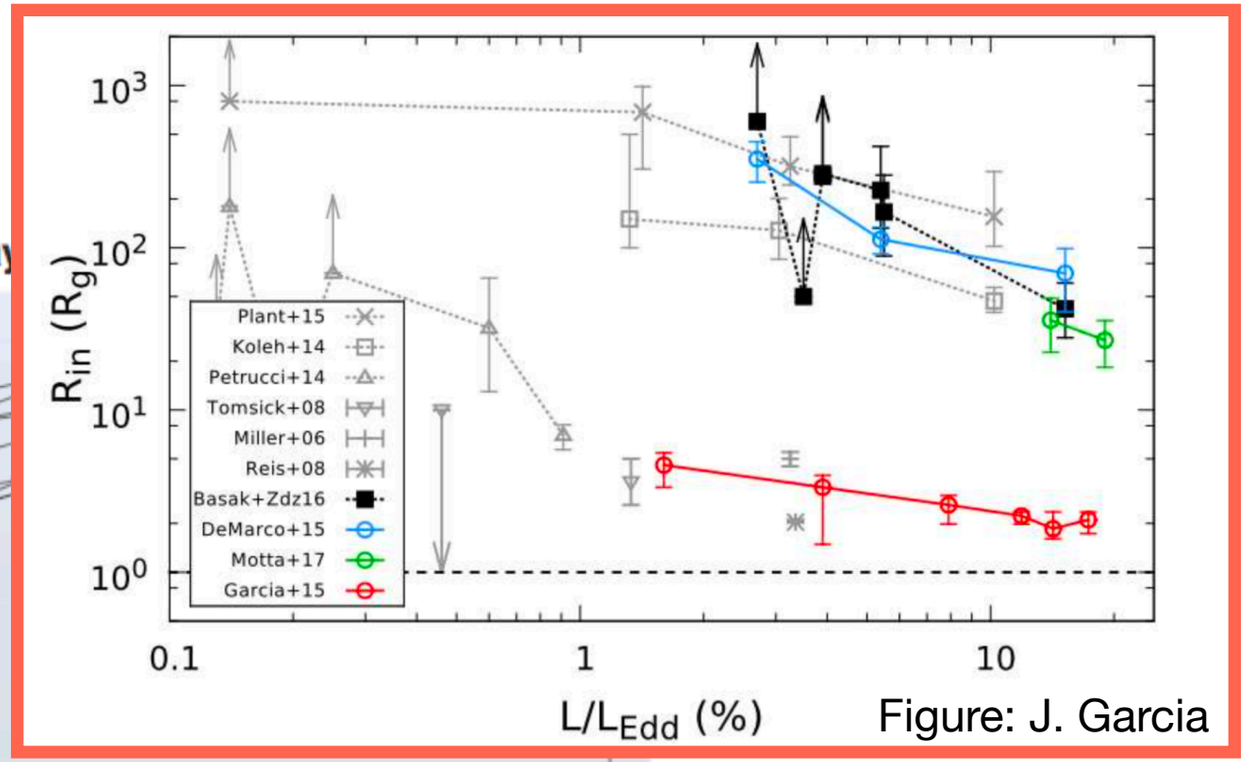
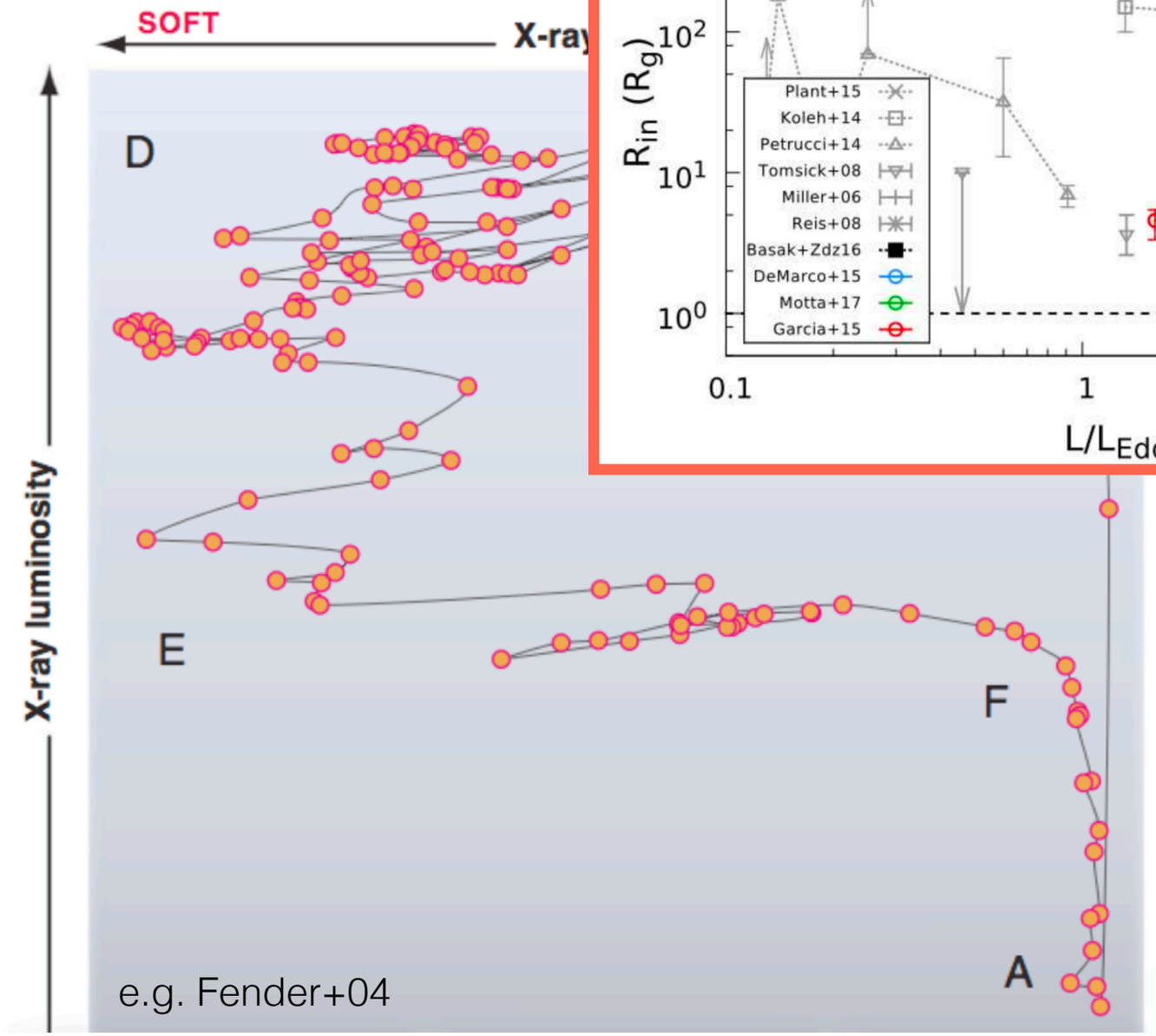
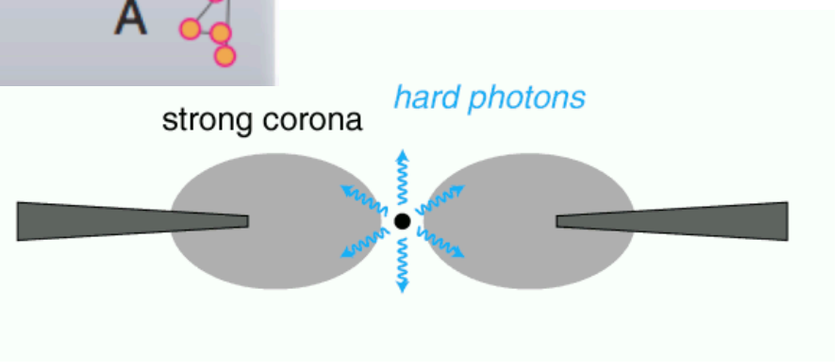
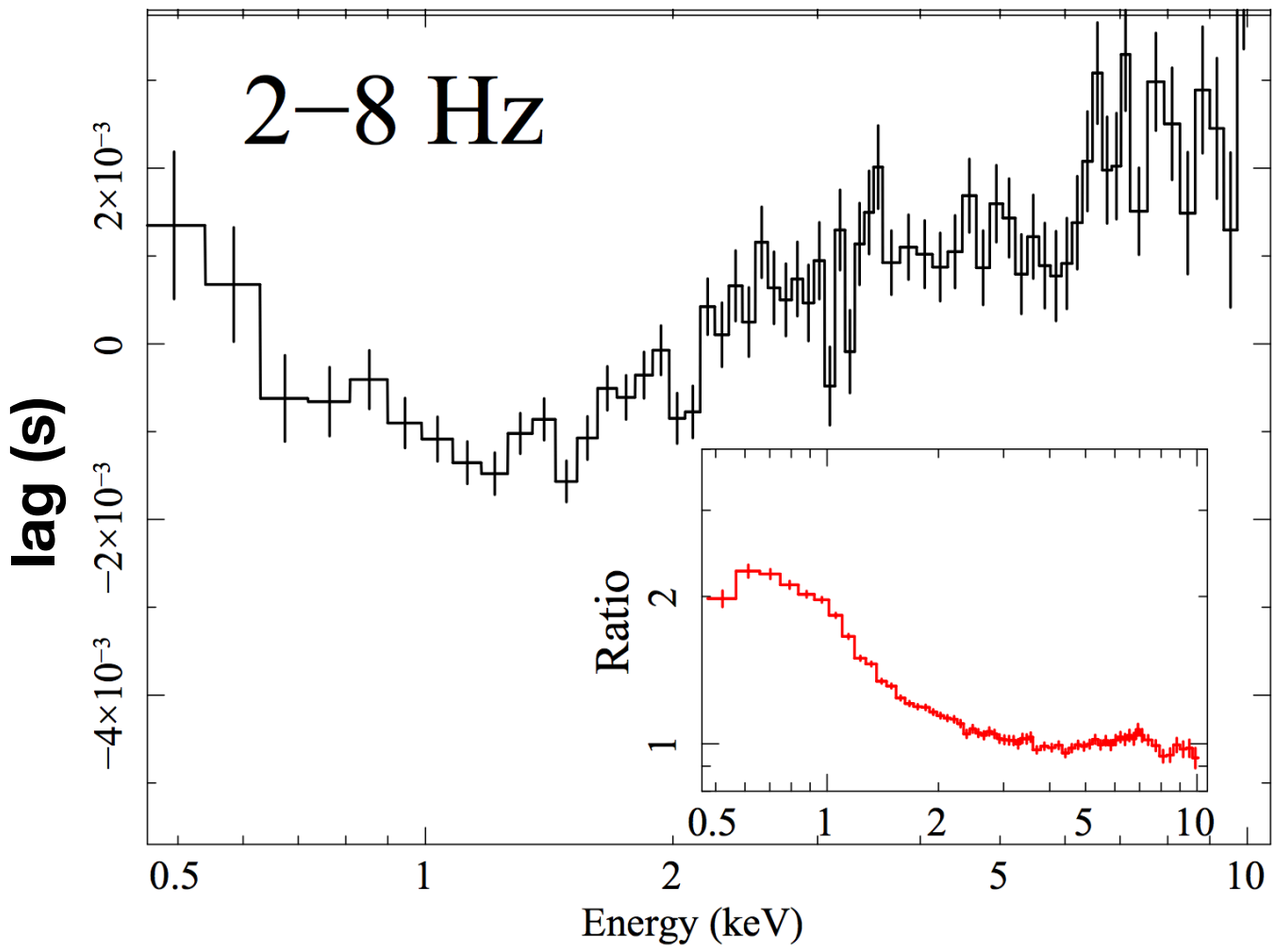


Figure: J. Garcia

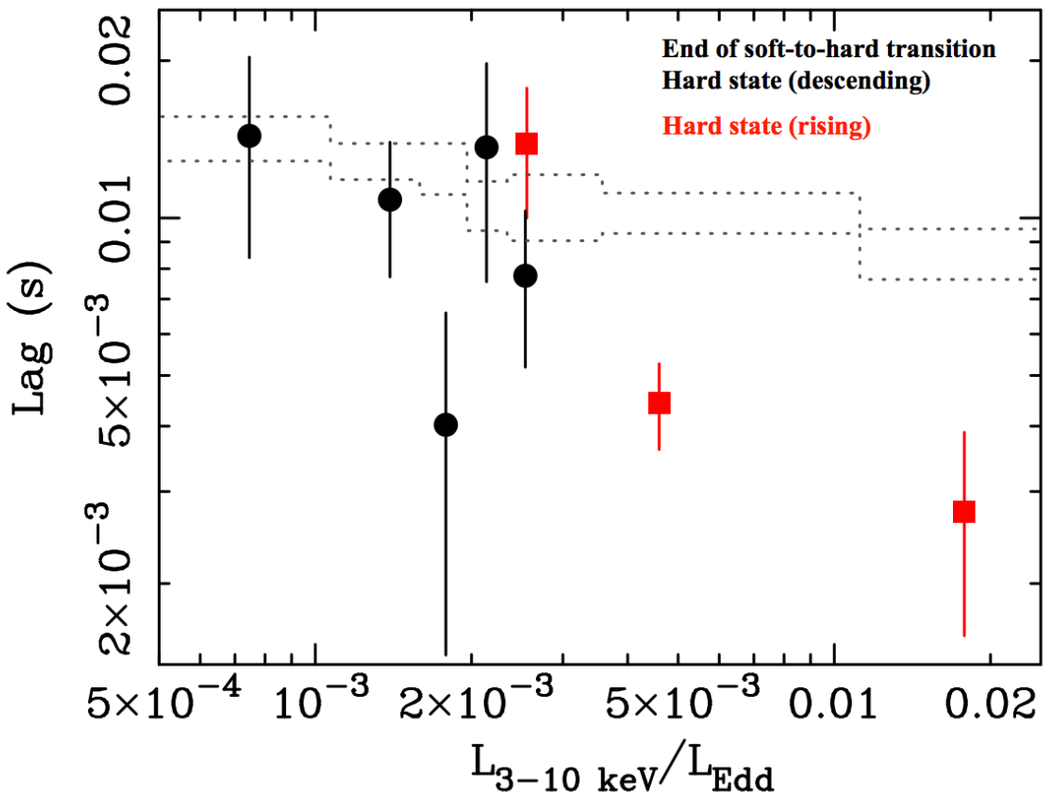




Studying the inner accretion flow in BHBs with XMM-Newton

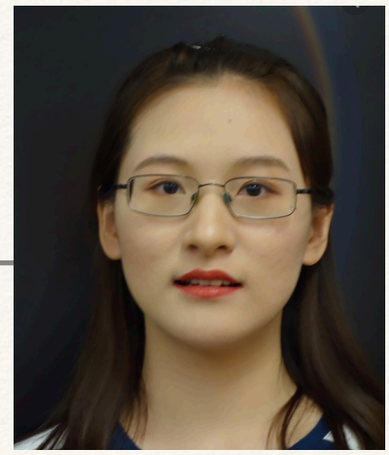


Uttley et al., 2011



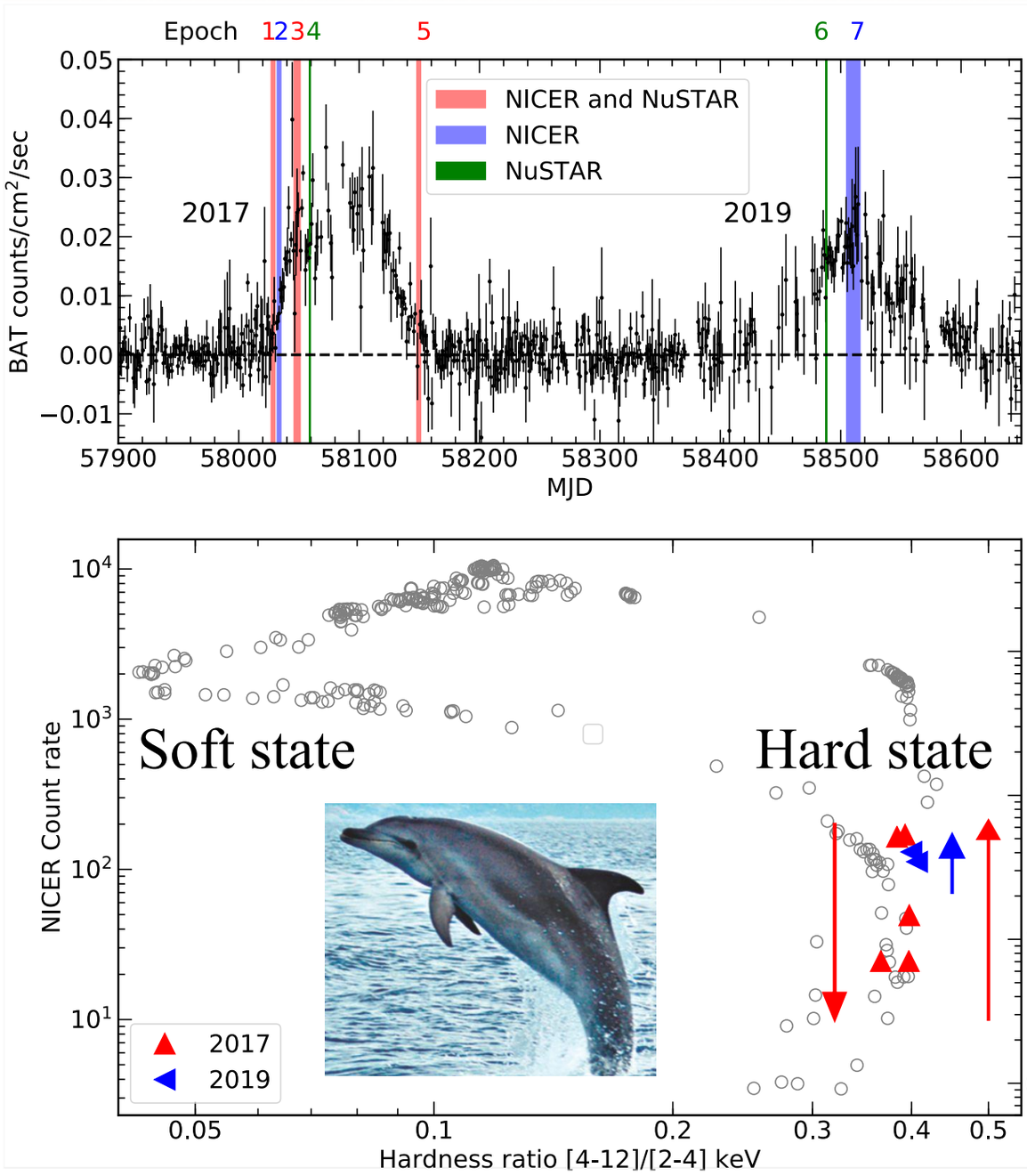
De Marco 2017

Black hole transient GX 339-4



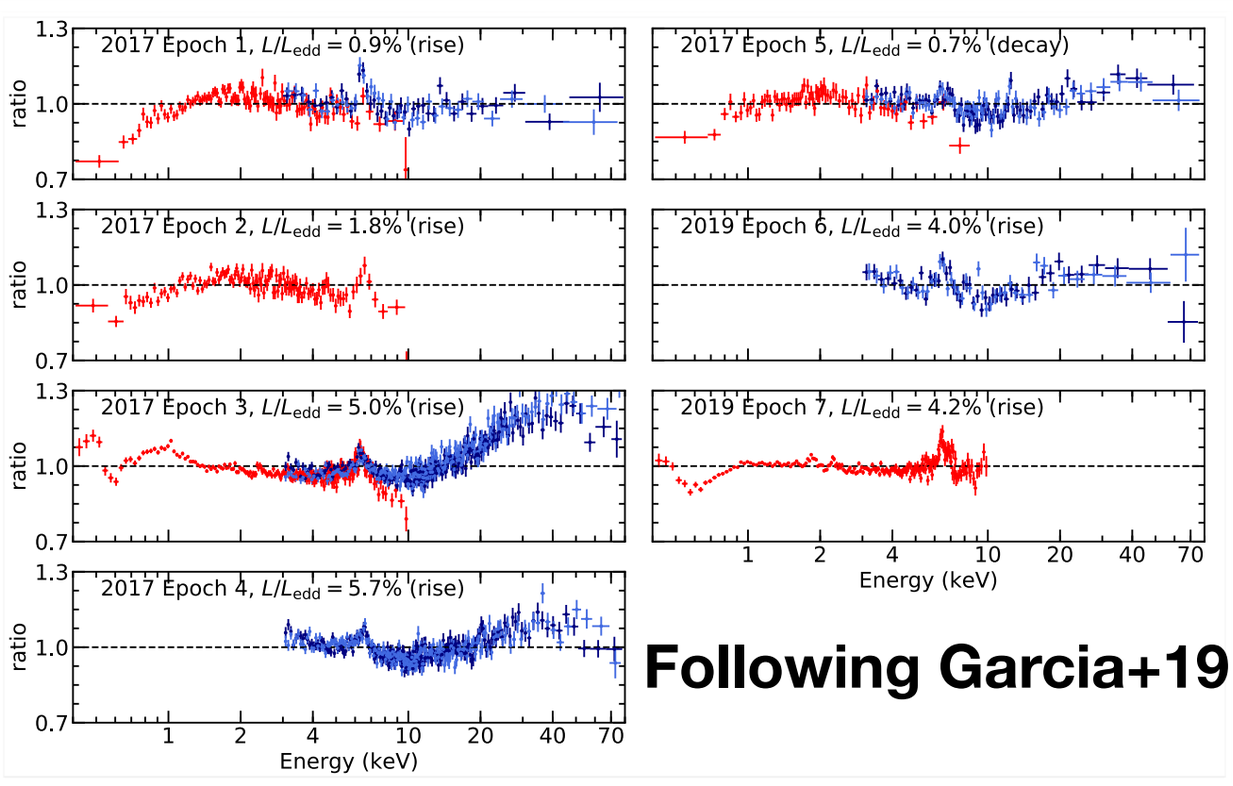
Jingyi Wang

Swift / BAT light curve



2017 & 2019 hard-only outbursts

- 7 epochs to cover the evolution
- Luminosity 0.9% - 5.7% L_{Edd}

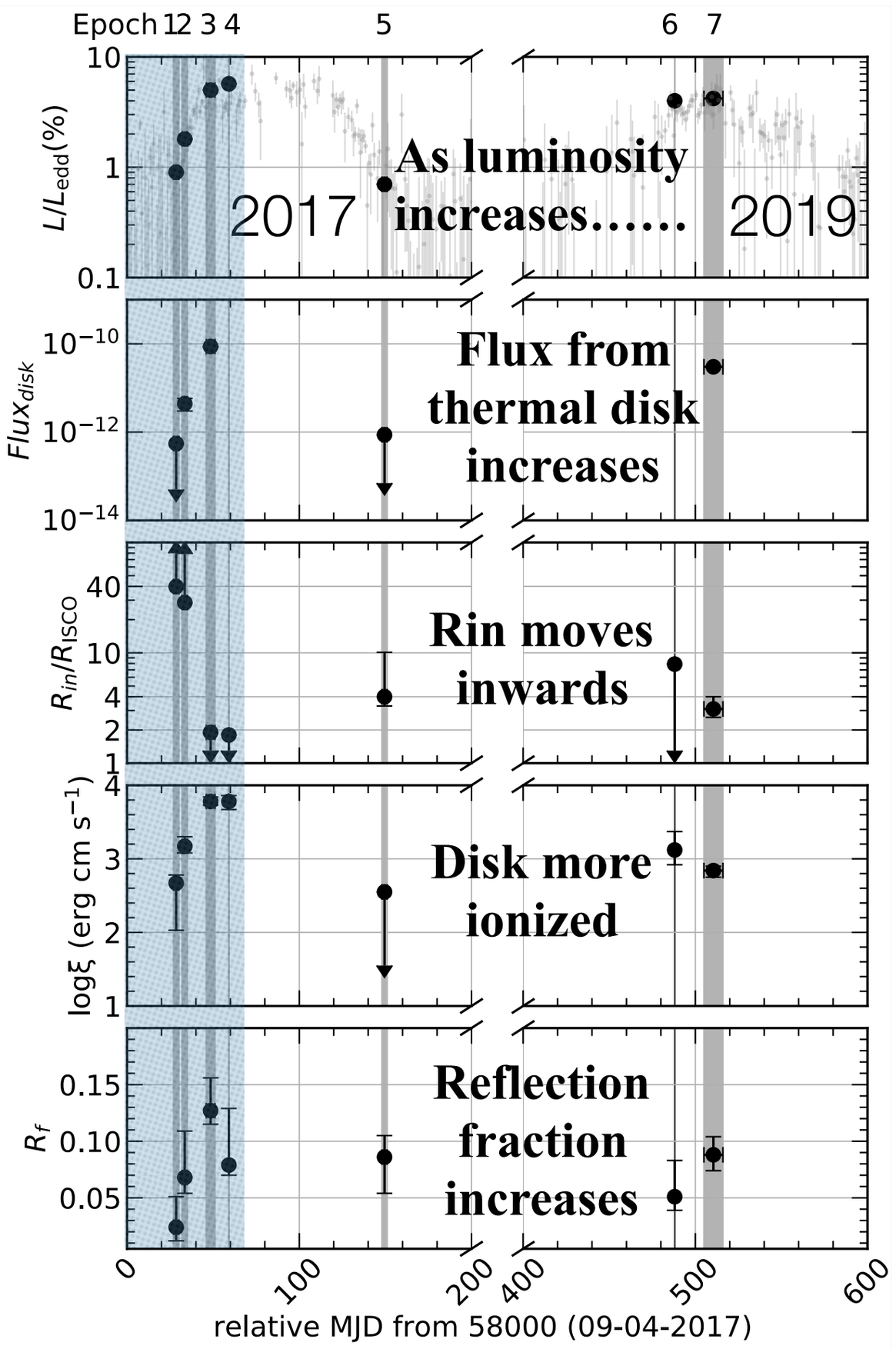


Following Garcia+19

Hardness-intensity diagram

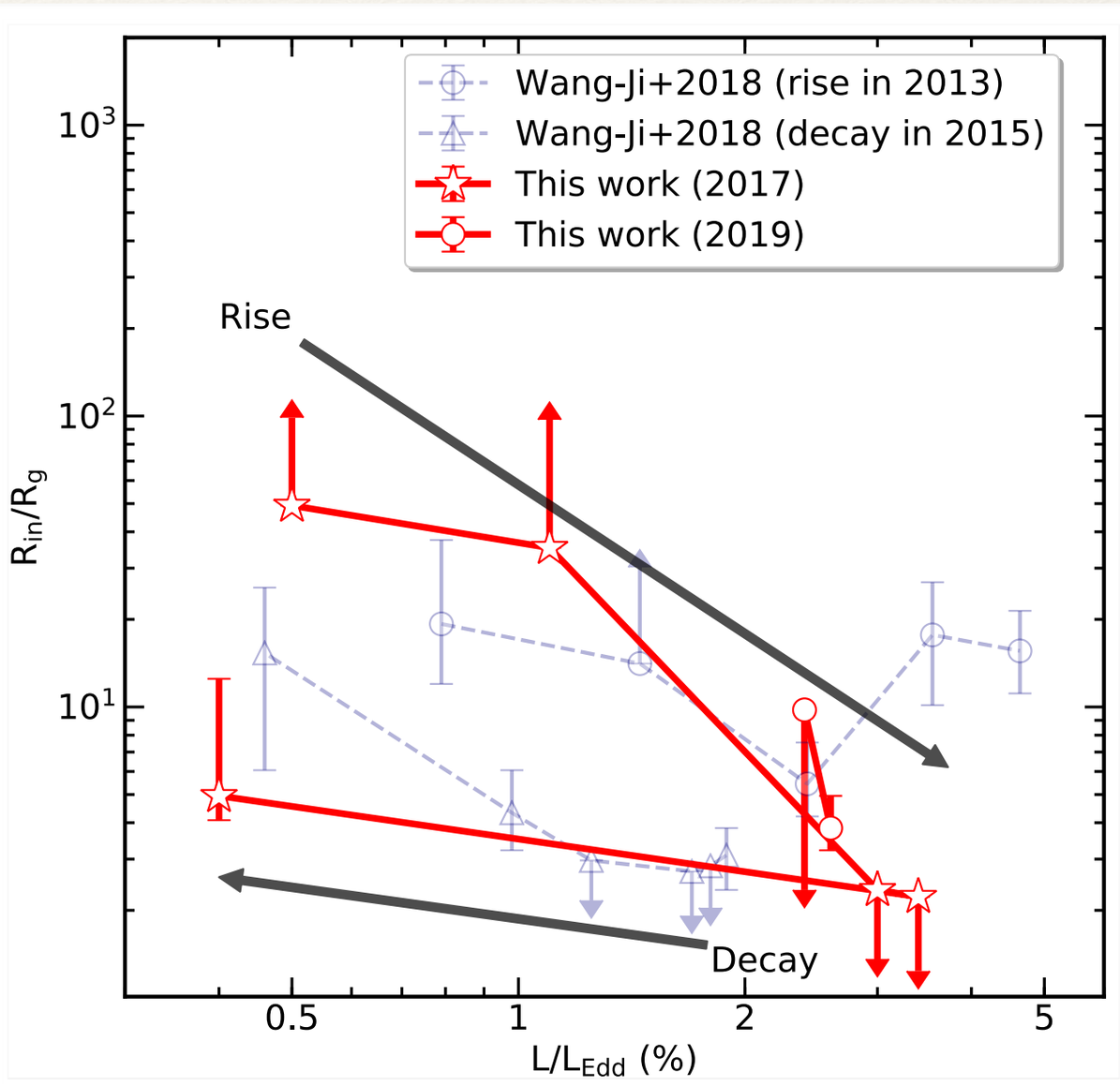
data / model ratio of power-law fit

✤ Parameter evolution

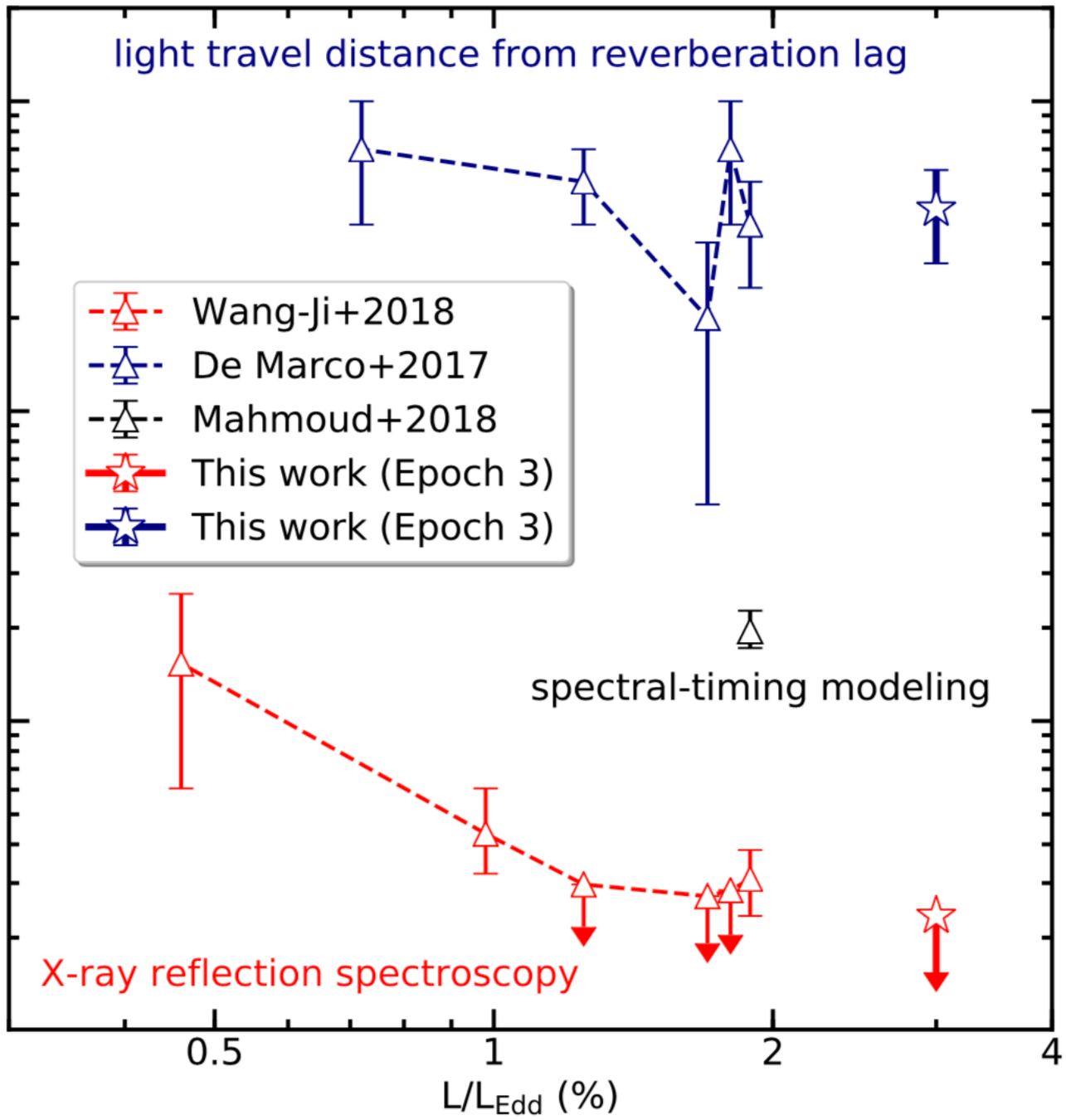


Spectroscopy results

✤ hint of hysteresis



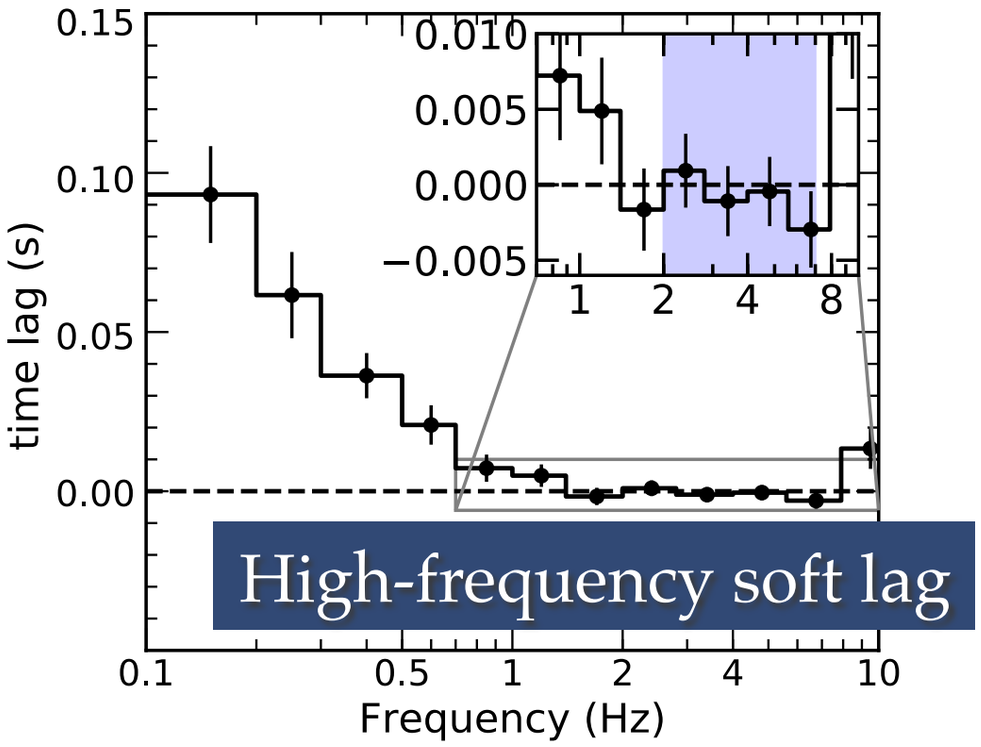
Wang, EK, Garcia + 2020



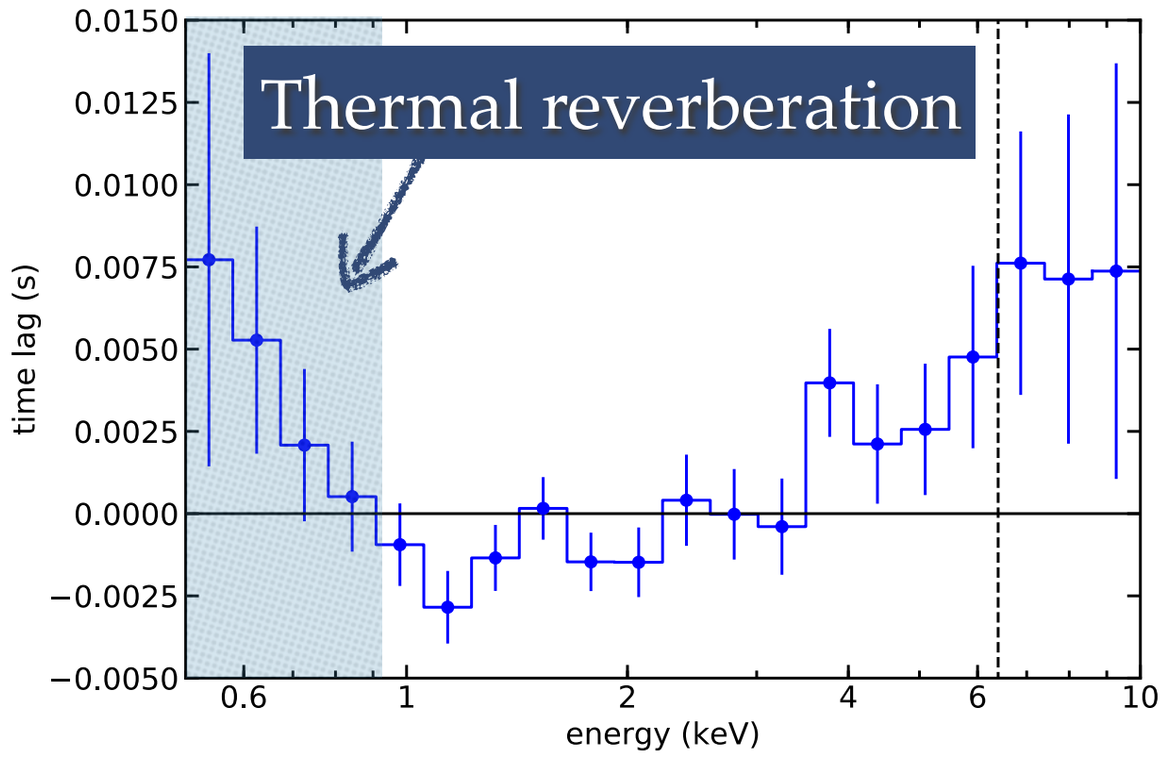
Wang, EK, Garcia + 2020

Lag analysis on 2017 Epoch 3 (L/L_{Edd}=5%)

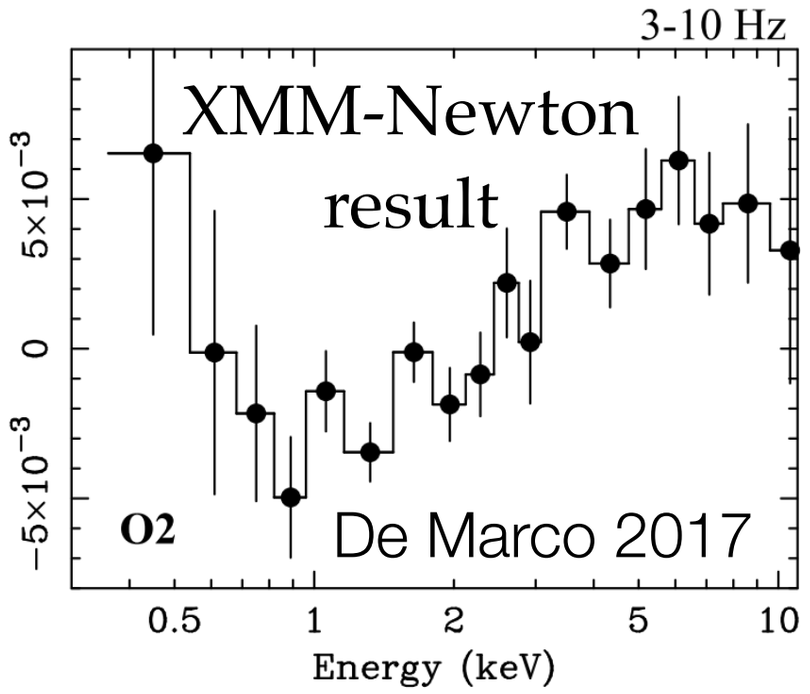
Lag-frequency spectrum
([0.5-1] vs [1-10] keV)



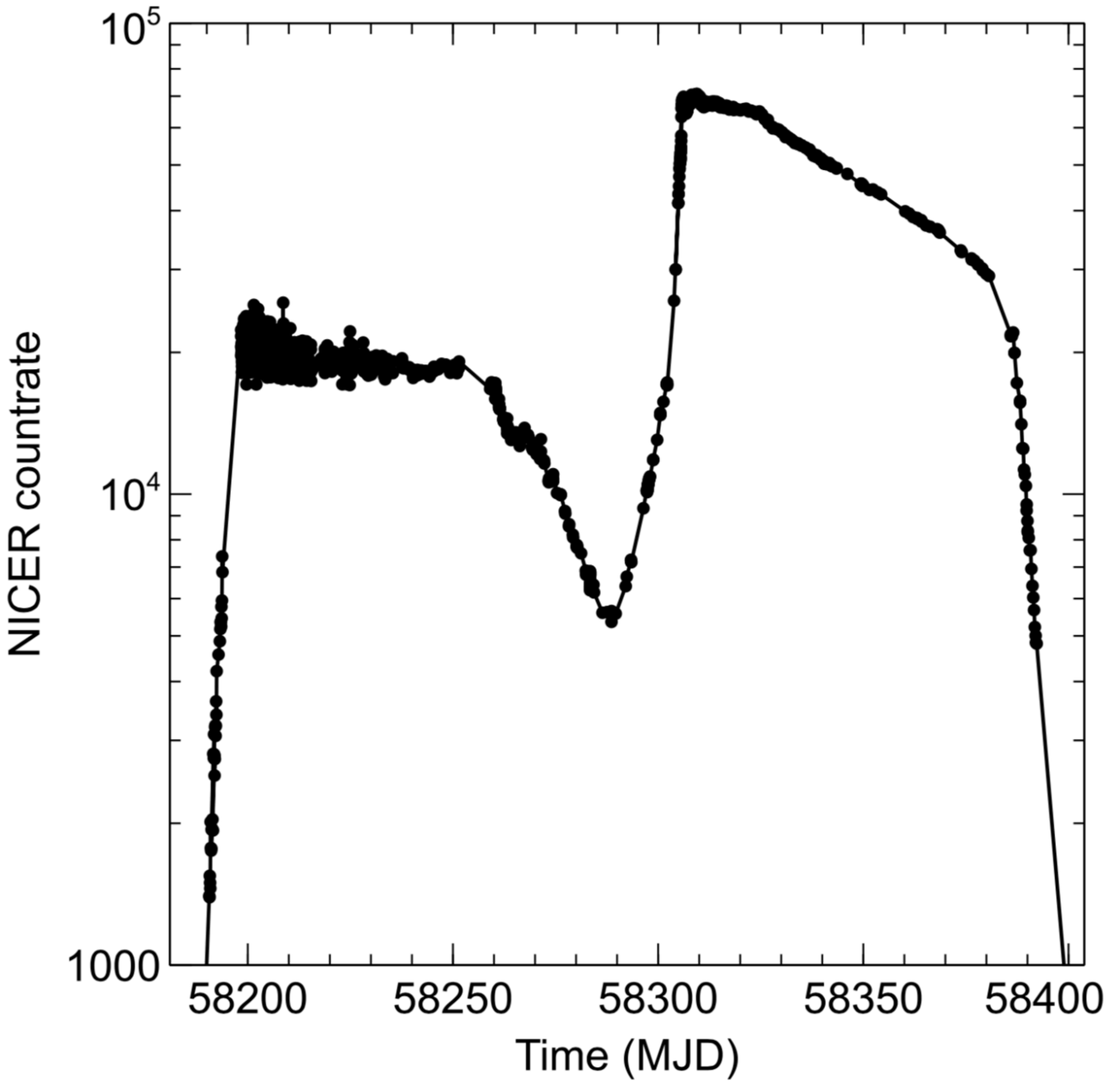
Lag-energy spectrum
(high frequency 2-7 Hz)

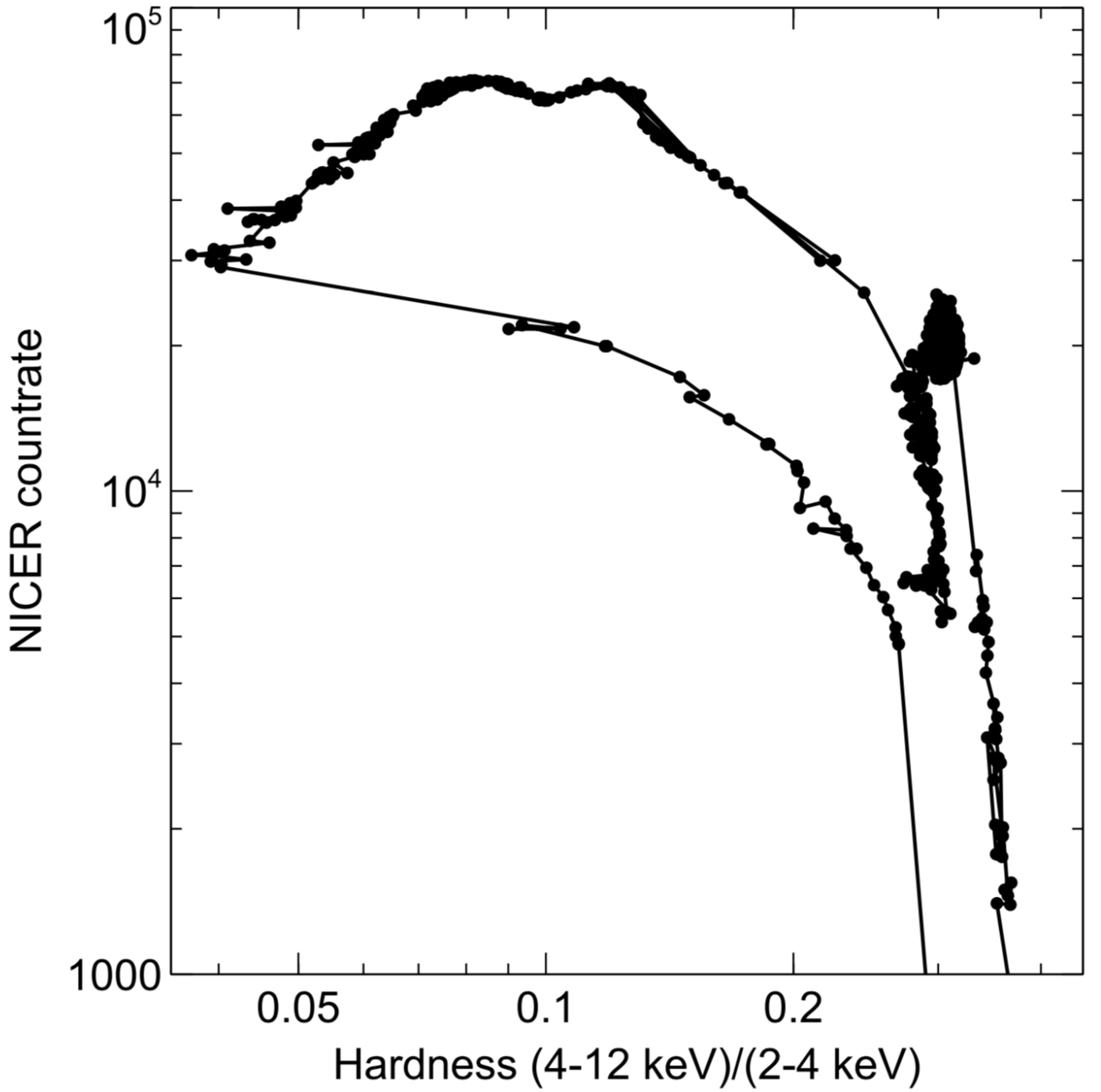


- Thermal reverberation lag amplitude ~ 9+/-3 ms.
- Ongoing work: using reverberation model to determine physical quantities.

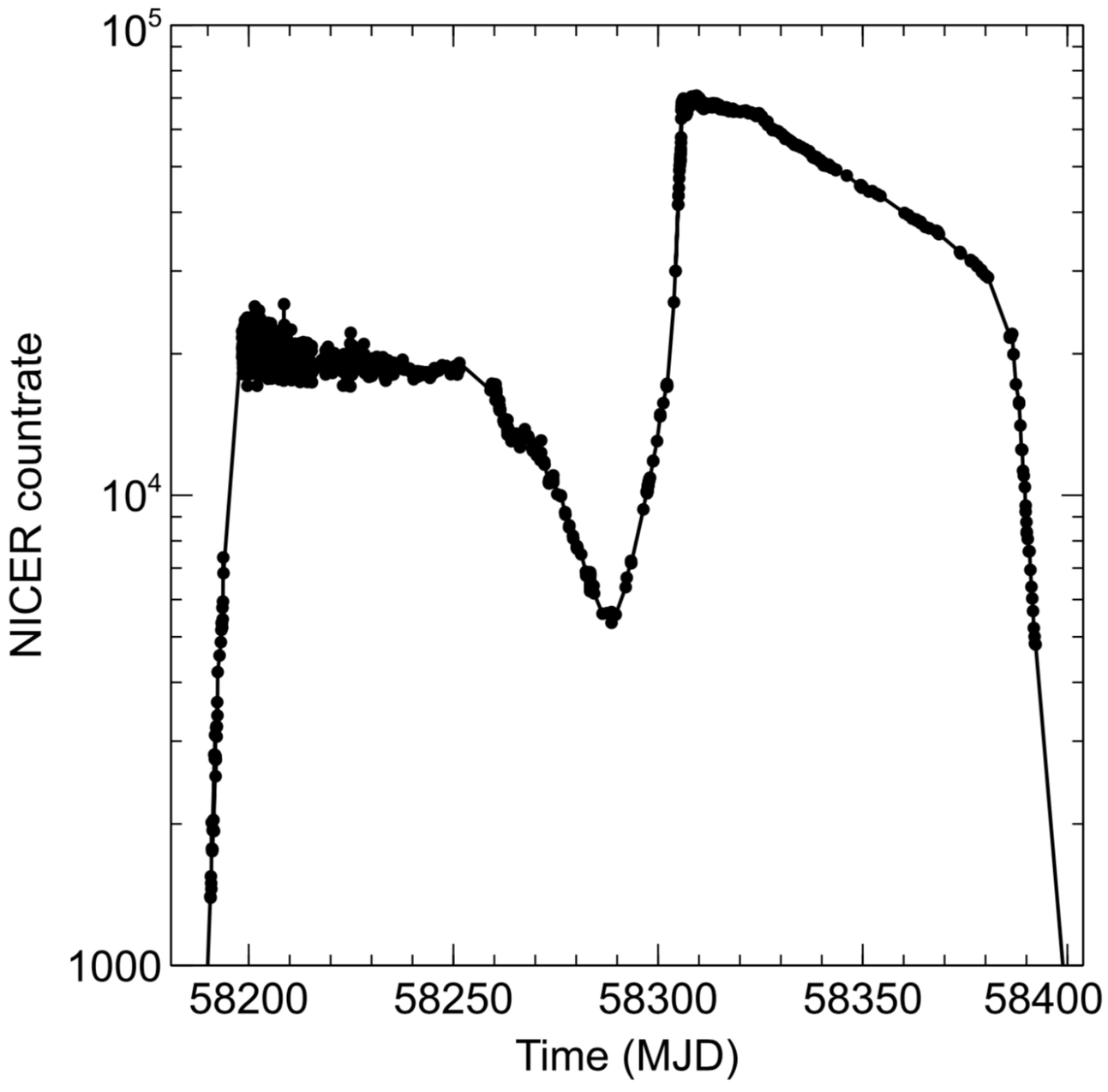


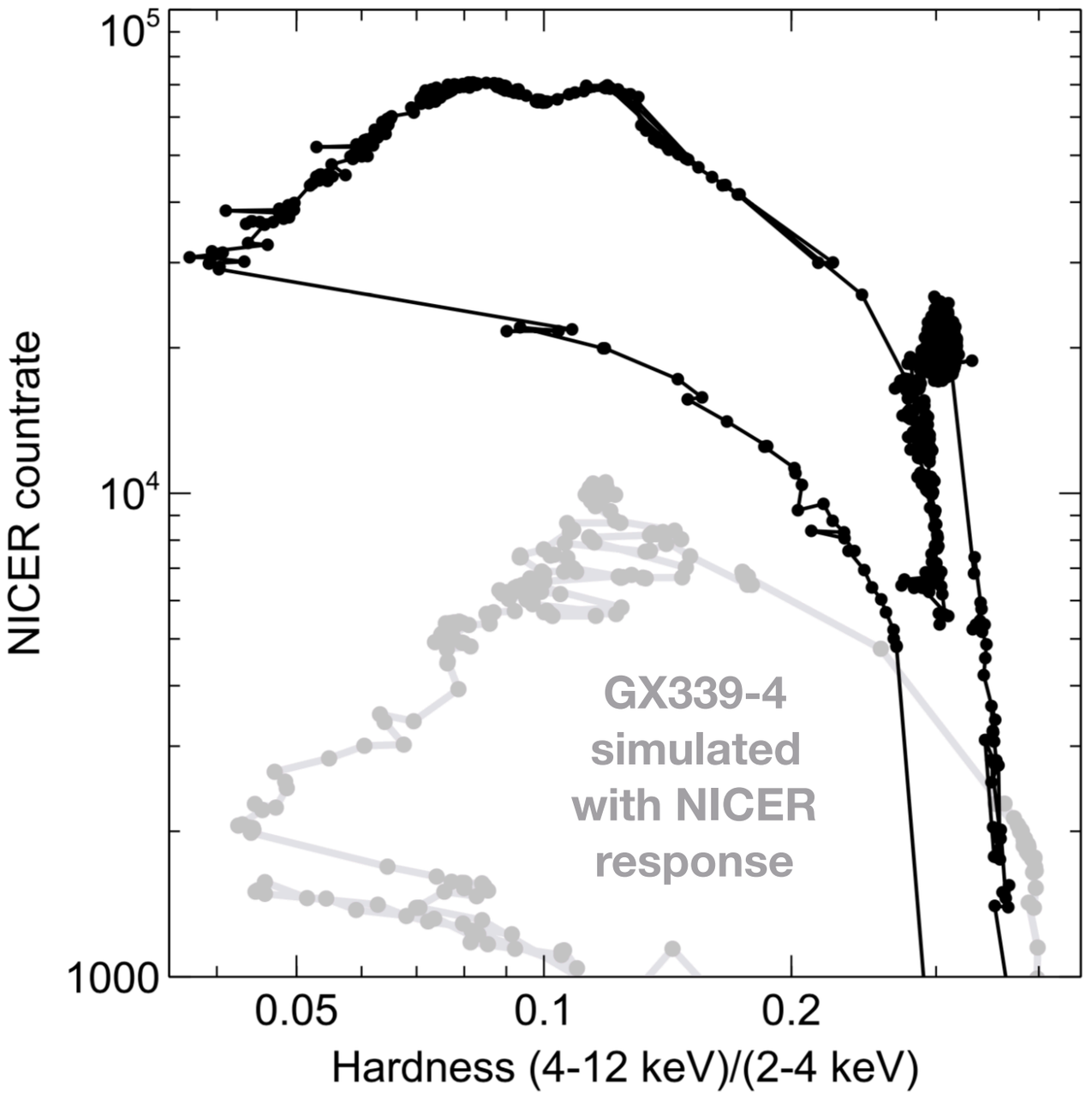
NICER observations of MAXIJ1820+070



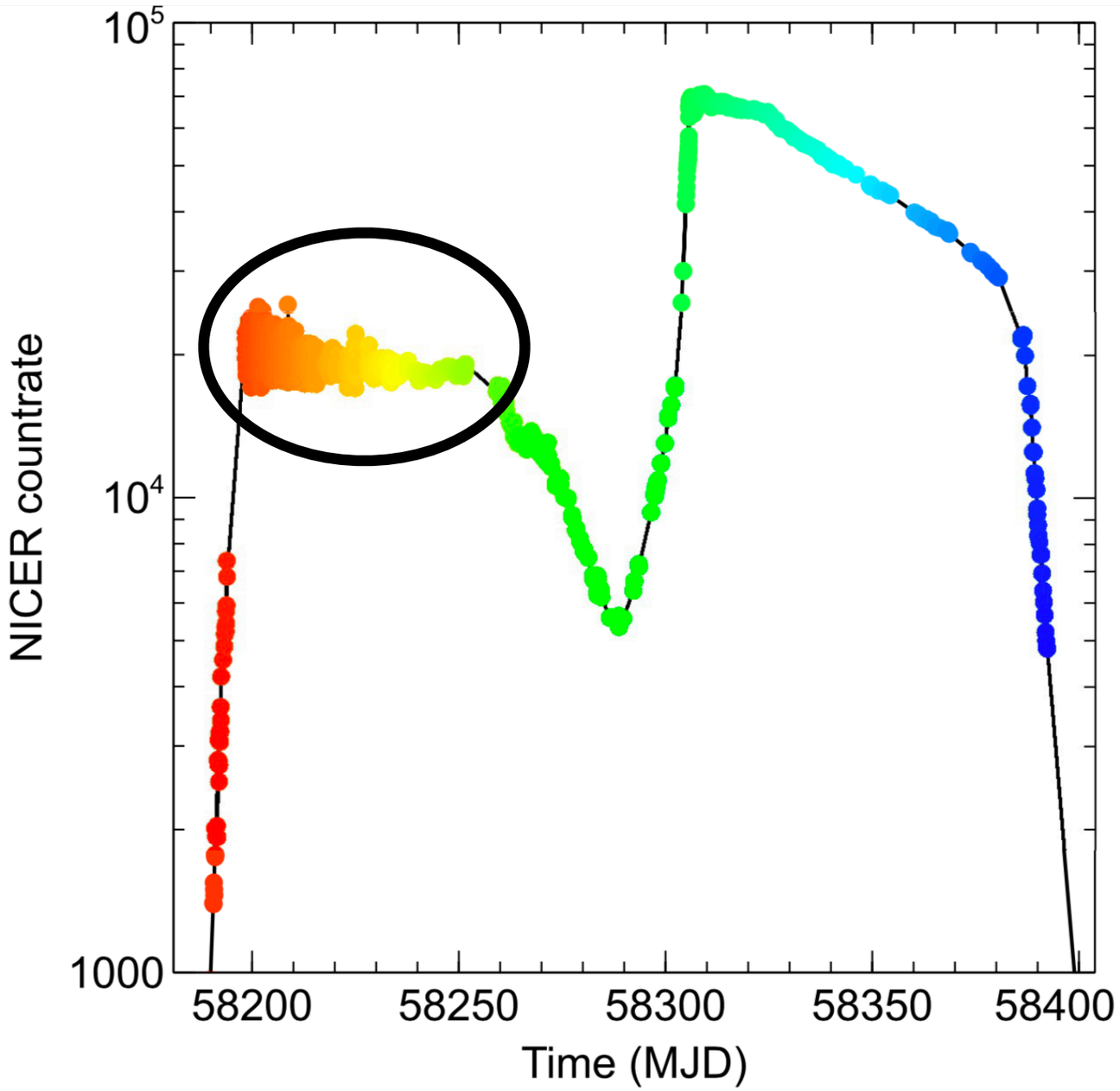


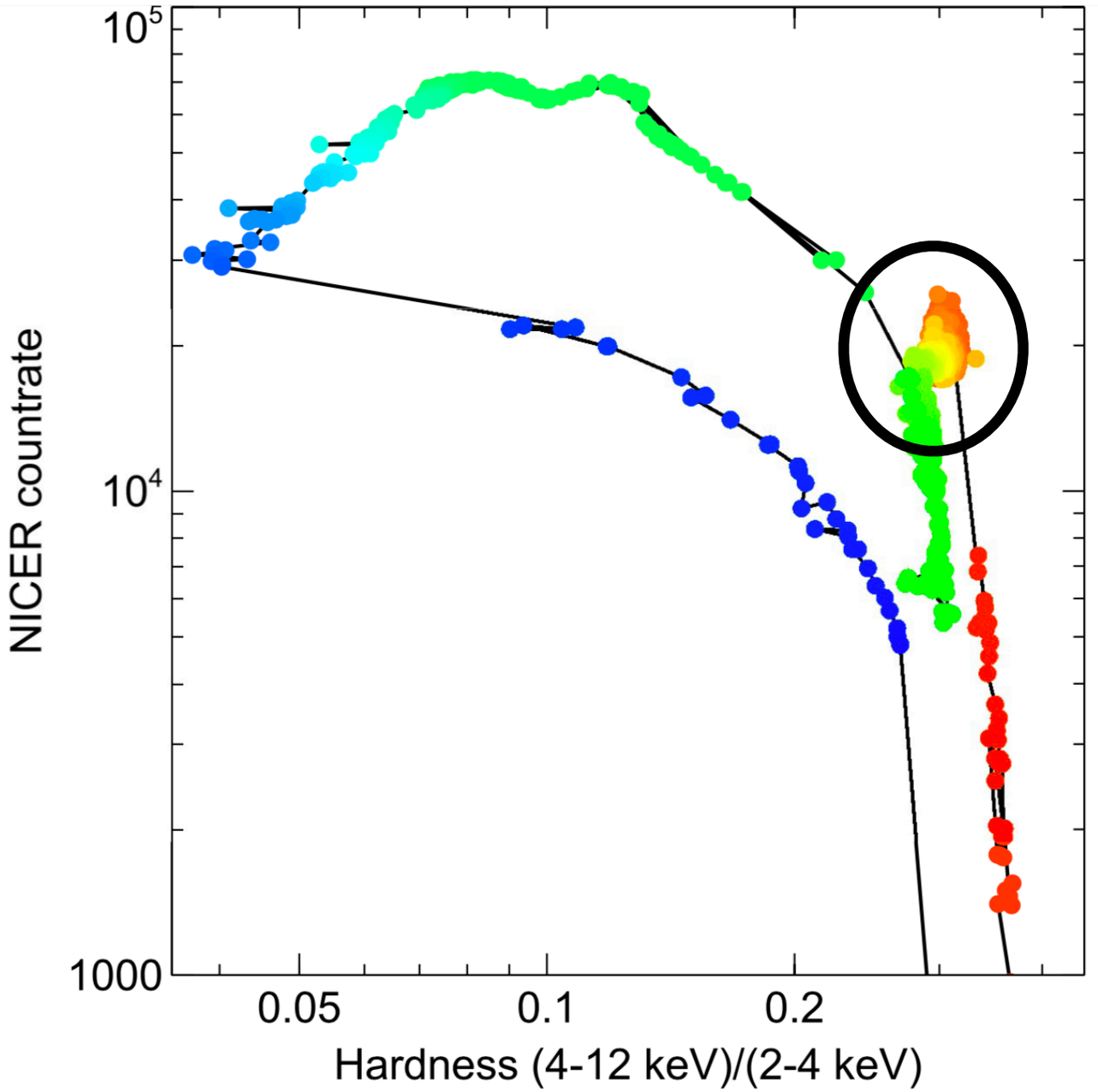
NICER observations of MAXIJ1820+070



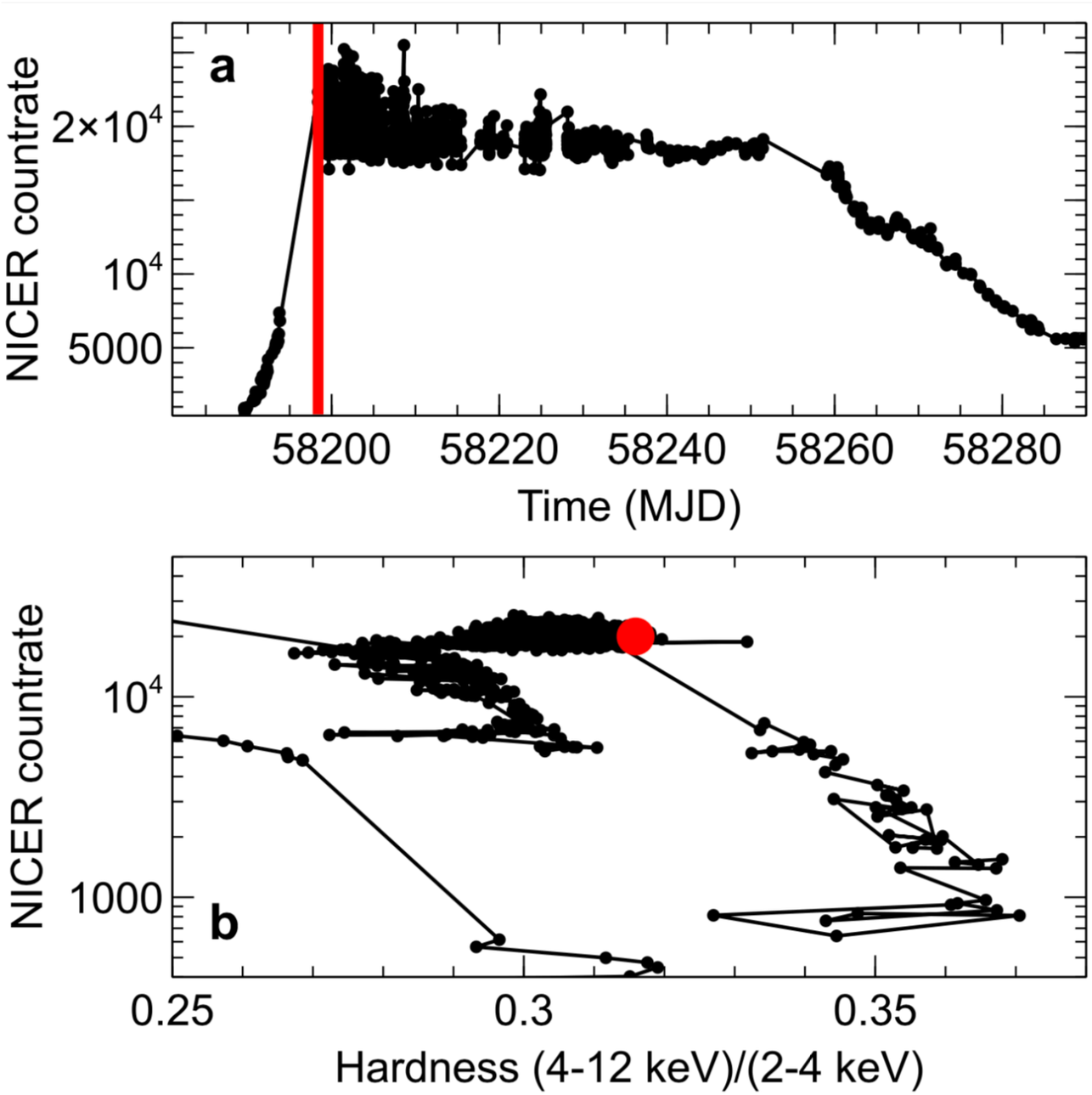


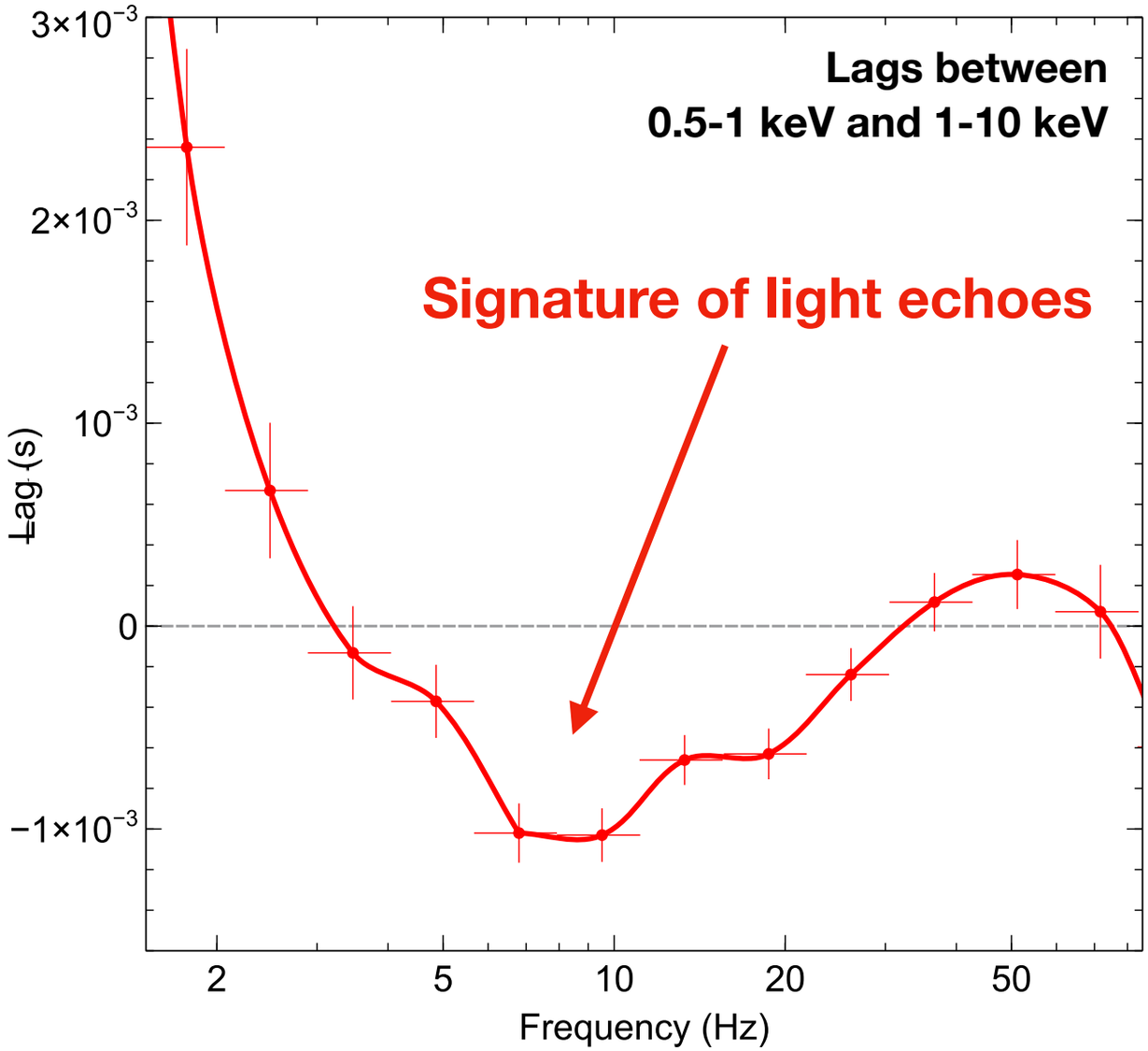
NICER observations of MAXIJ1820+070





NICER measures short reverberation lags

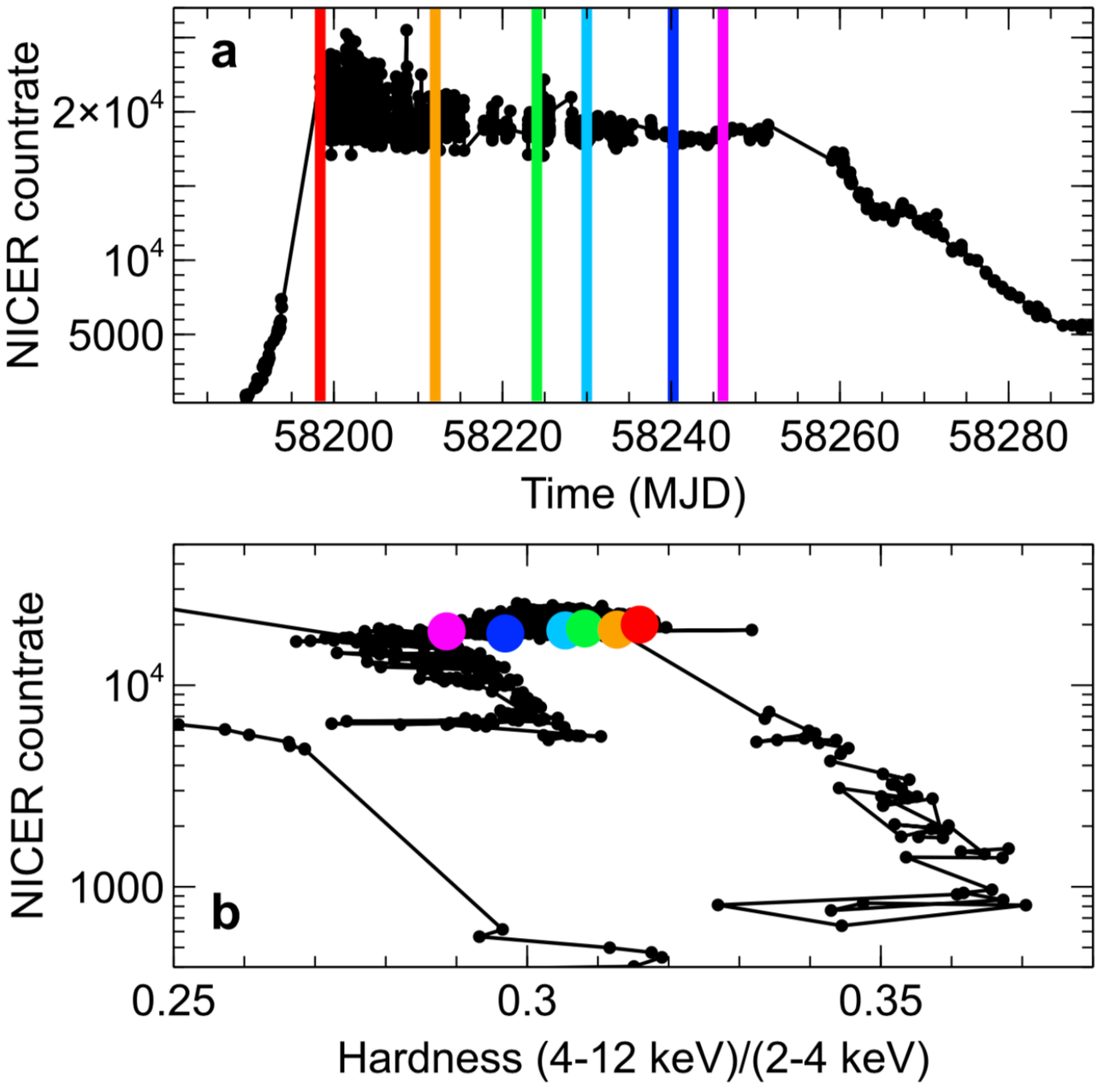


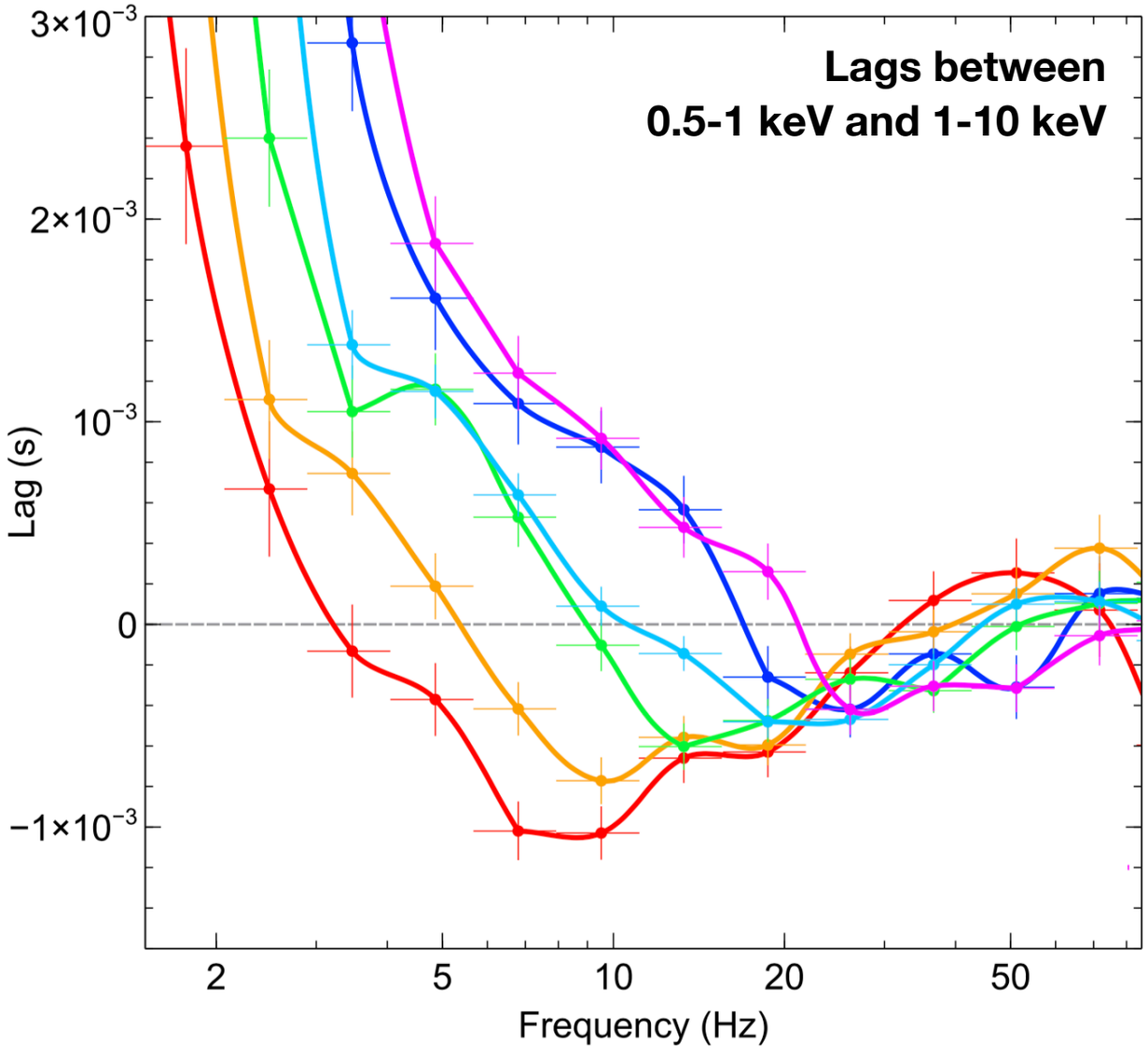


(Temporal Frequency —
how rapidly light curve varies)

Reverberation in XRBs: Uttley et al., 2011, De Marco et al., 2017

NICER measures short reverberation lags

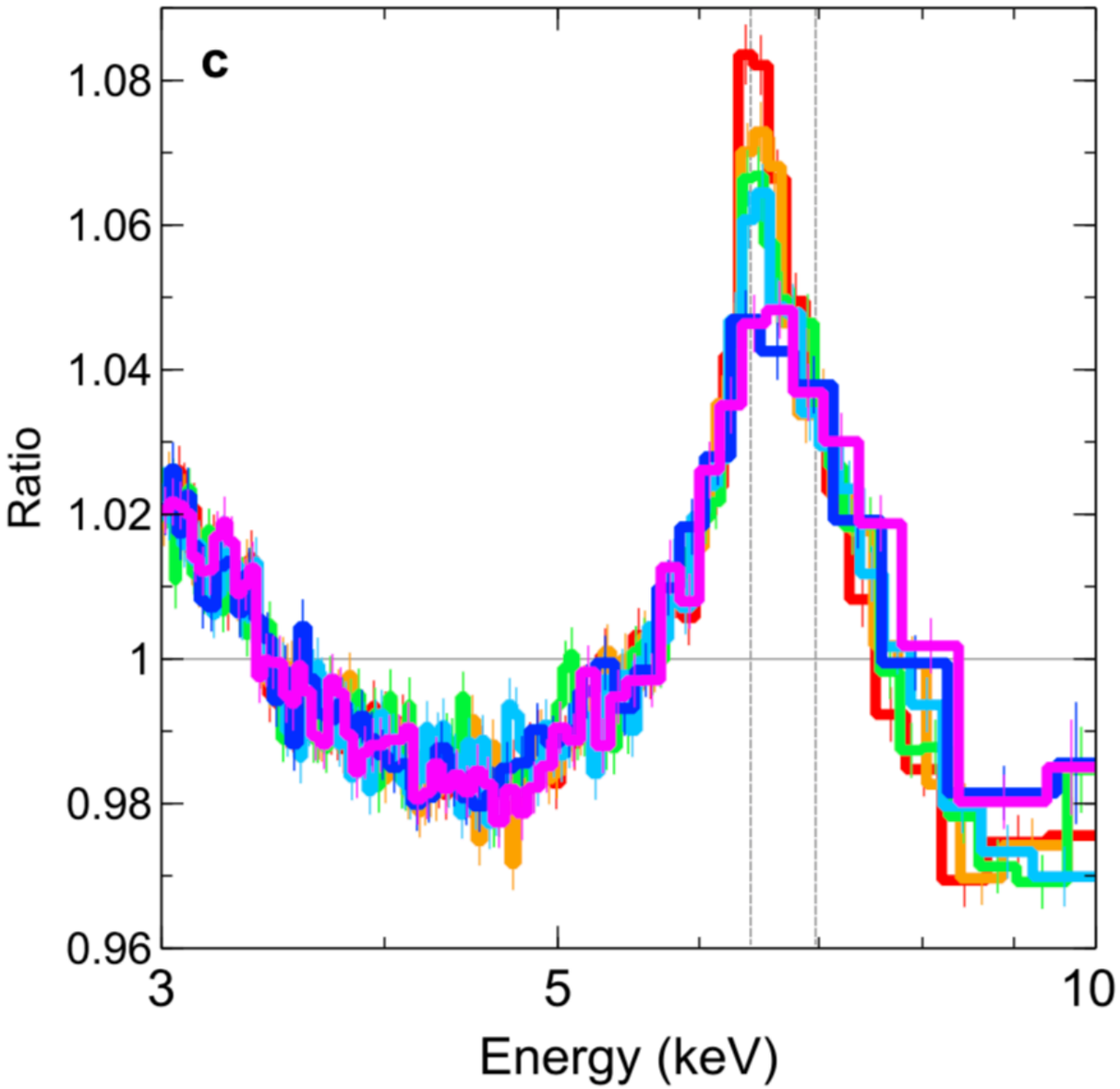




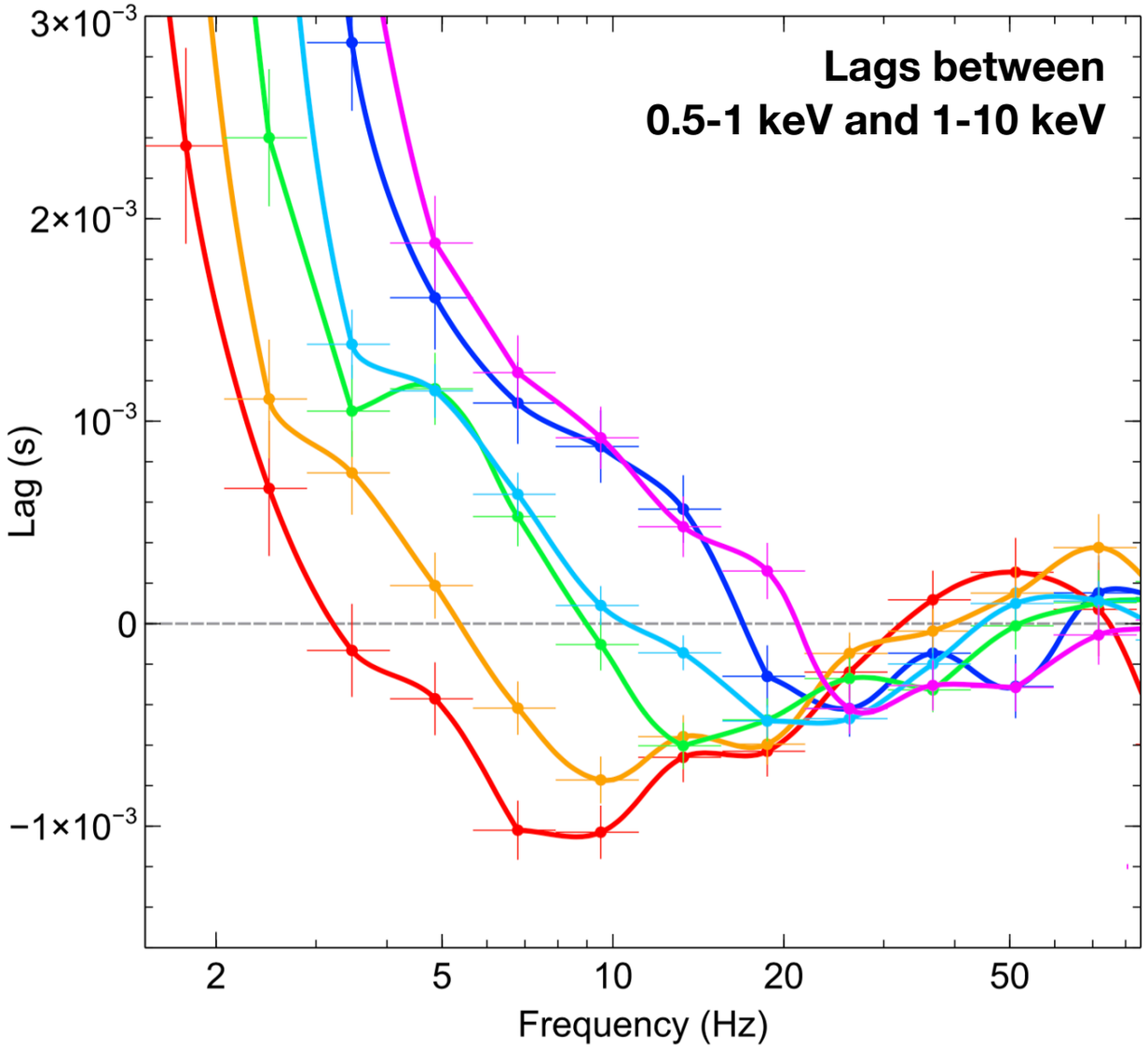
Lags evolve to higher frequencies

Reverberation in XRBs: Uttley et al., 2011, De Marco et al., 2017

relativistic reflection and reverberation

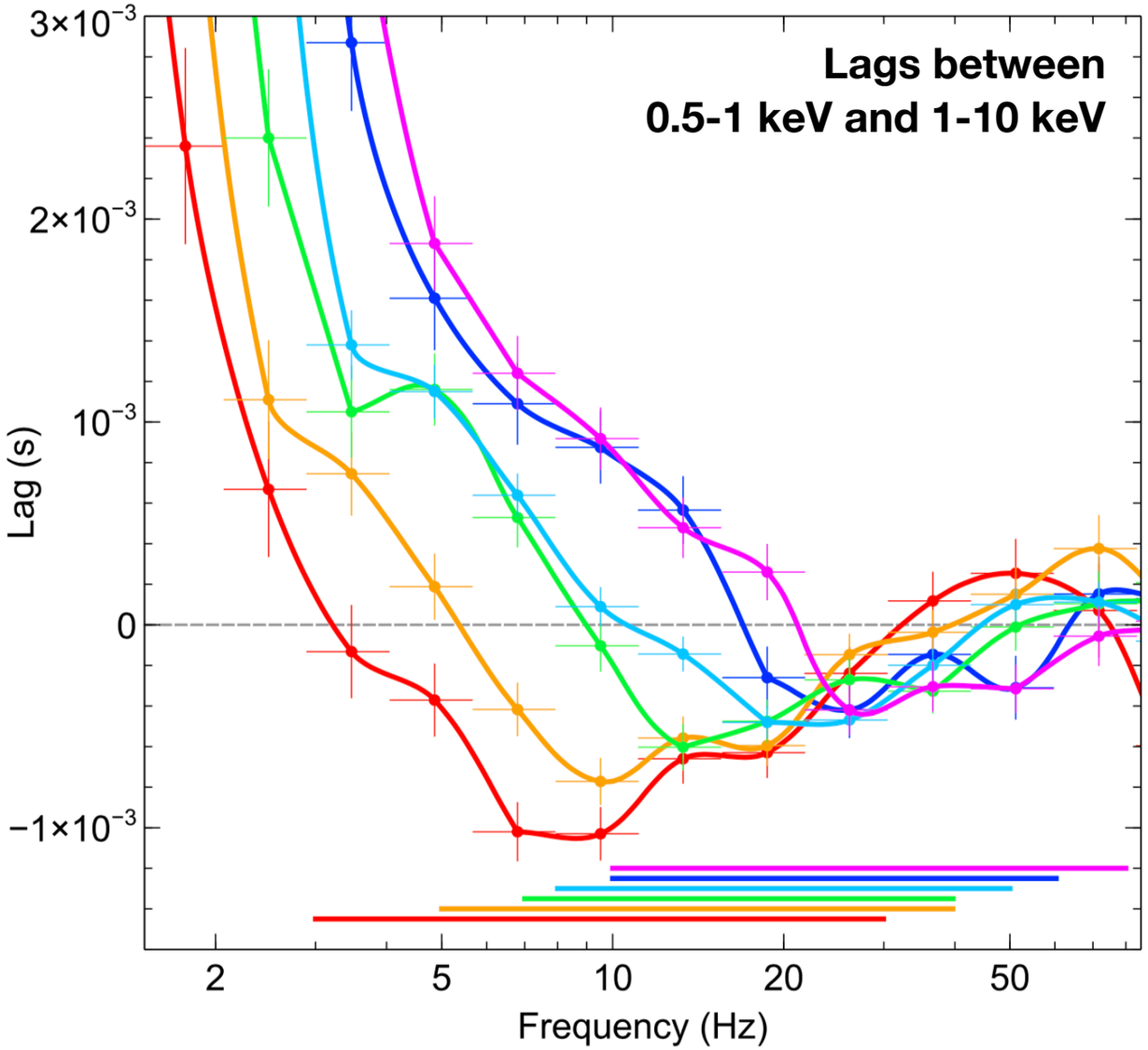


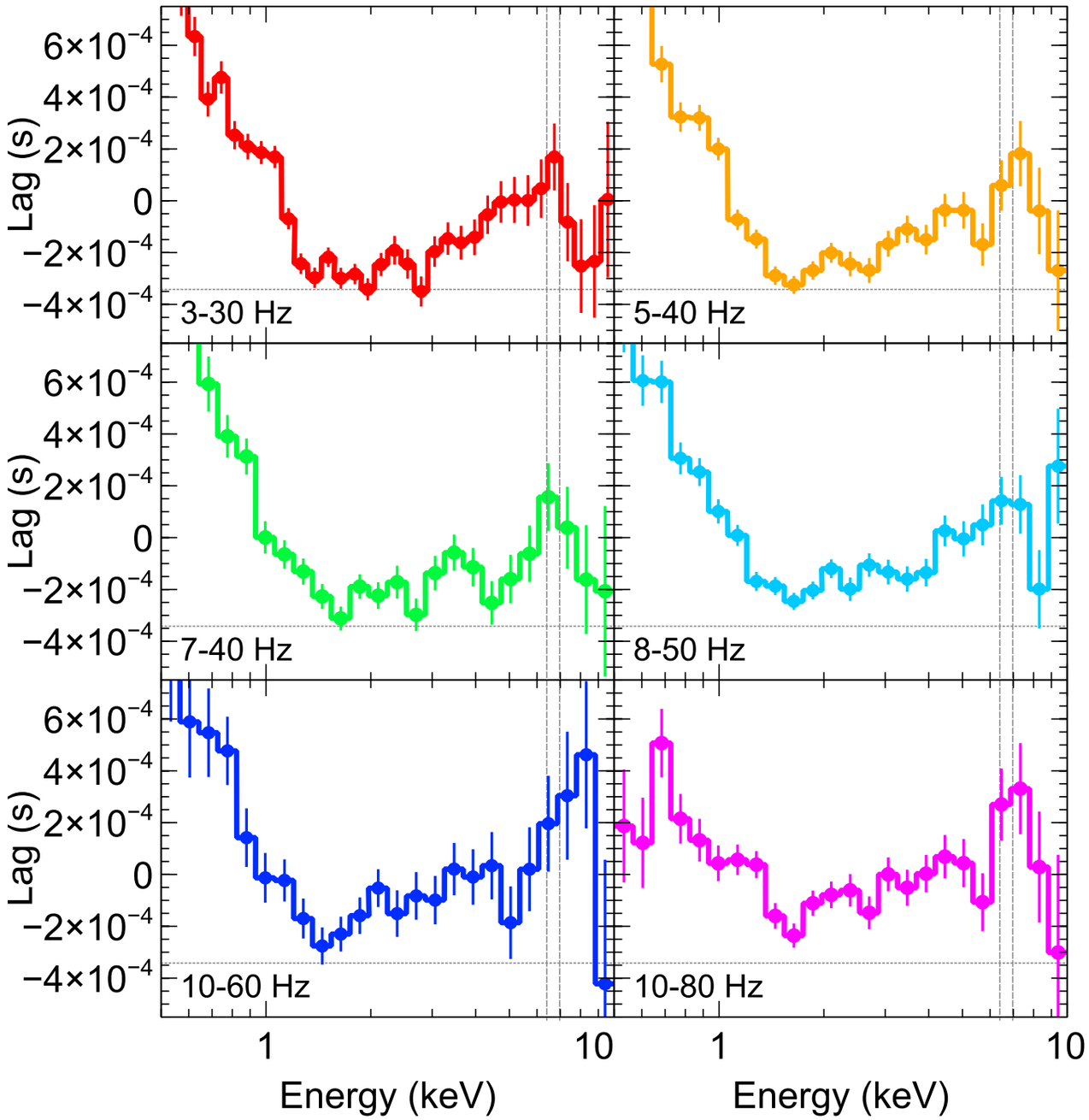
Broad line is constant over time



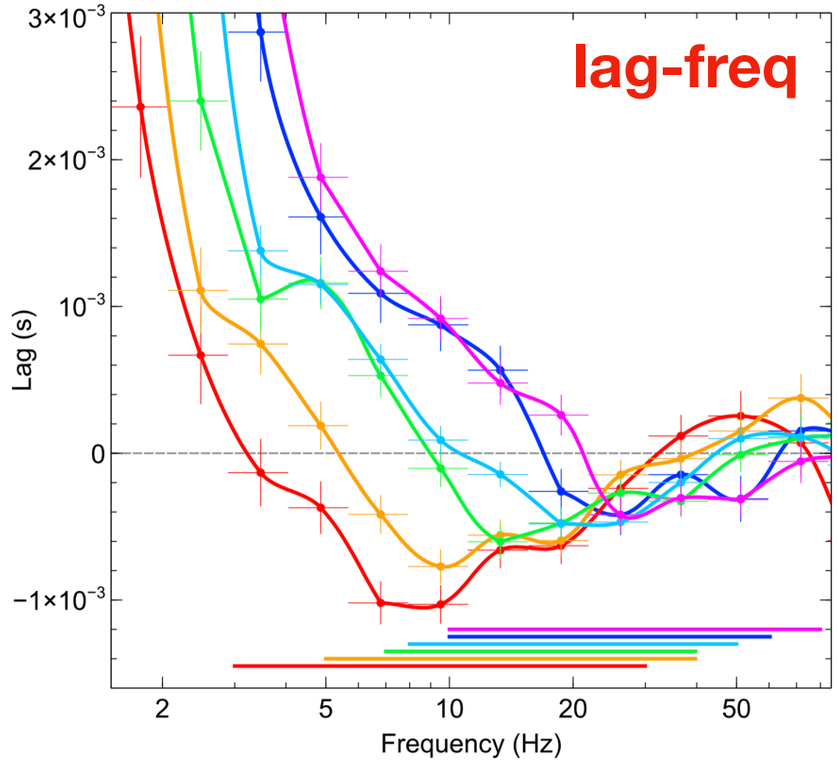
Lags evolve to higher frequencies

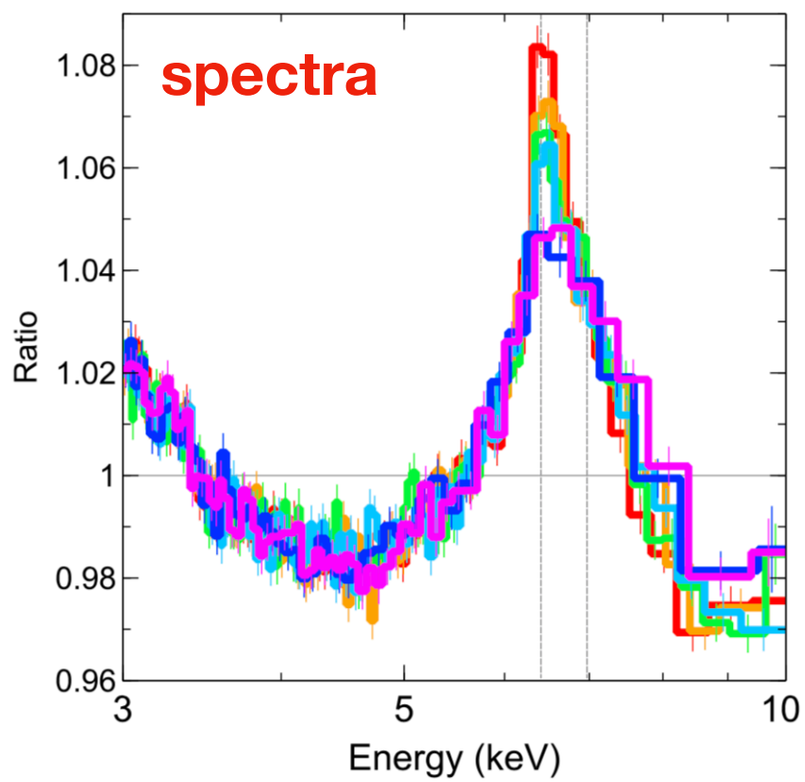
Lag-energy spectra

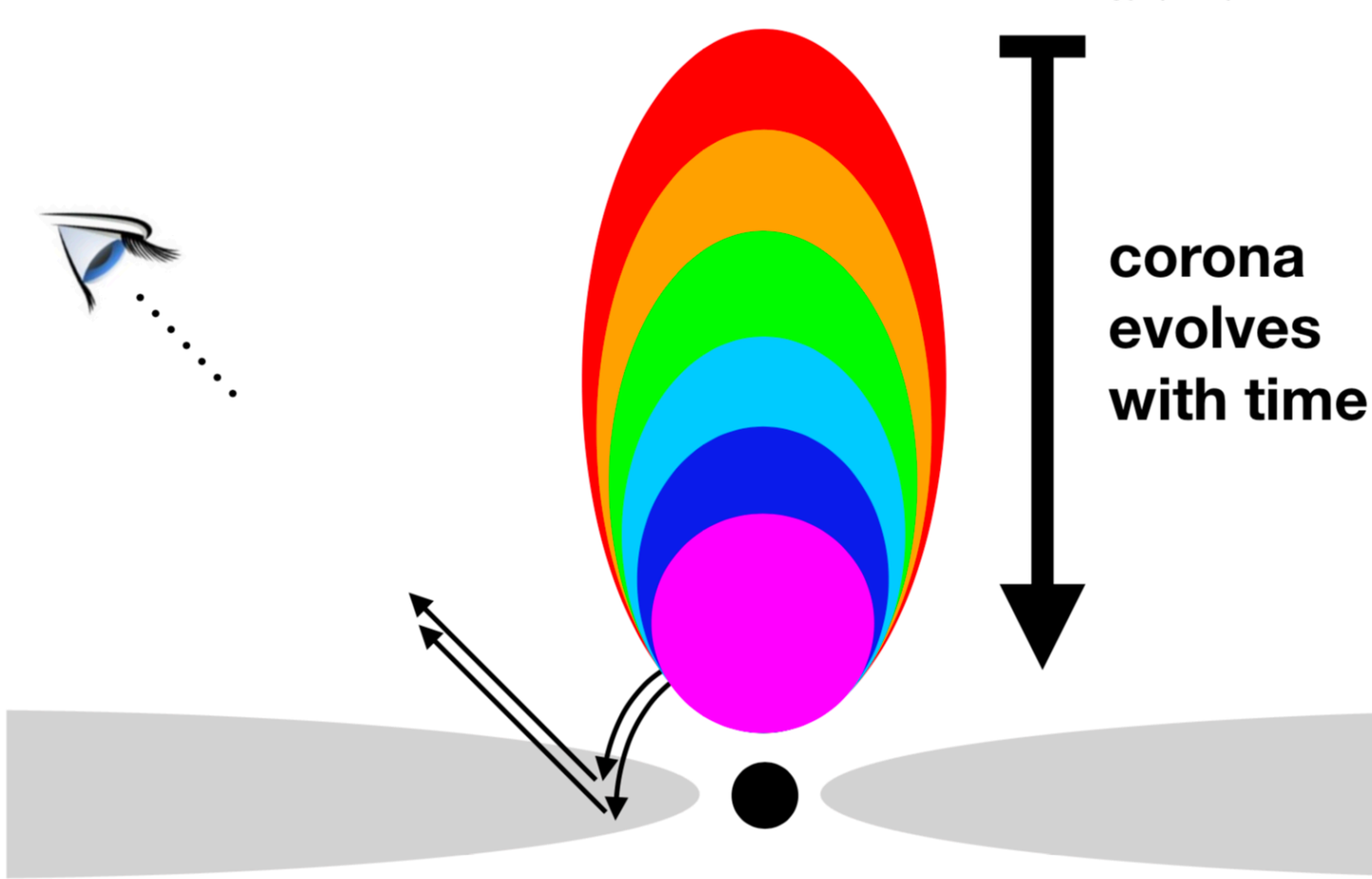




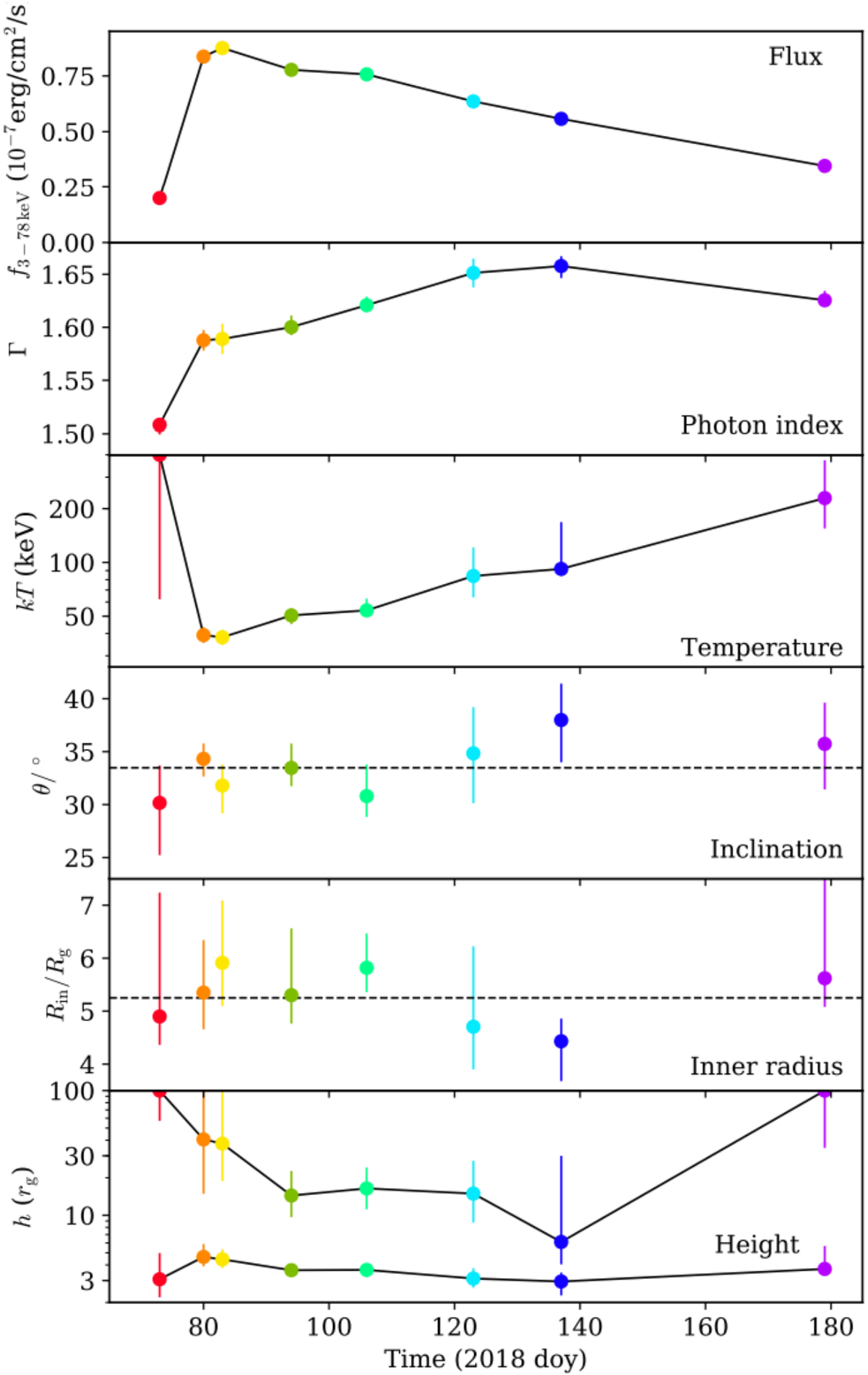
Consistent picture between spectra and timing analyses!







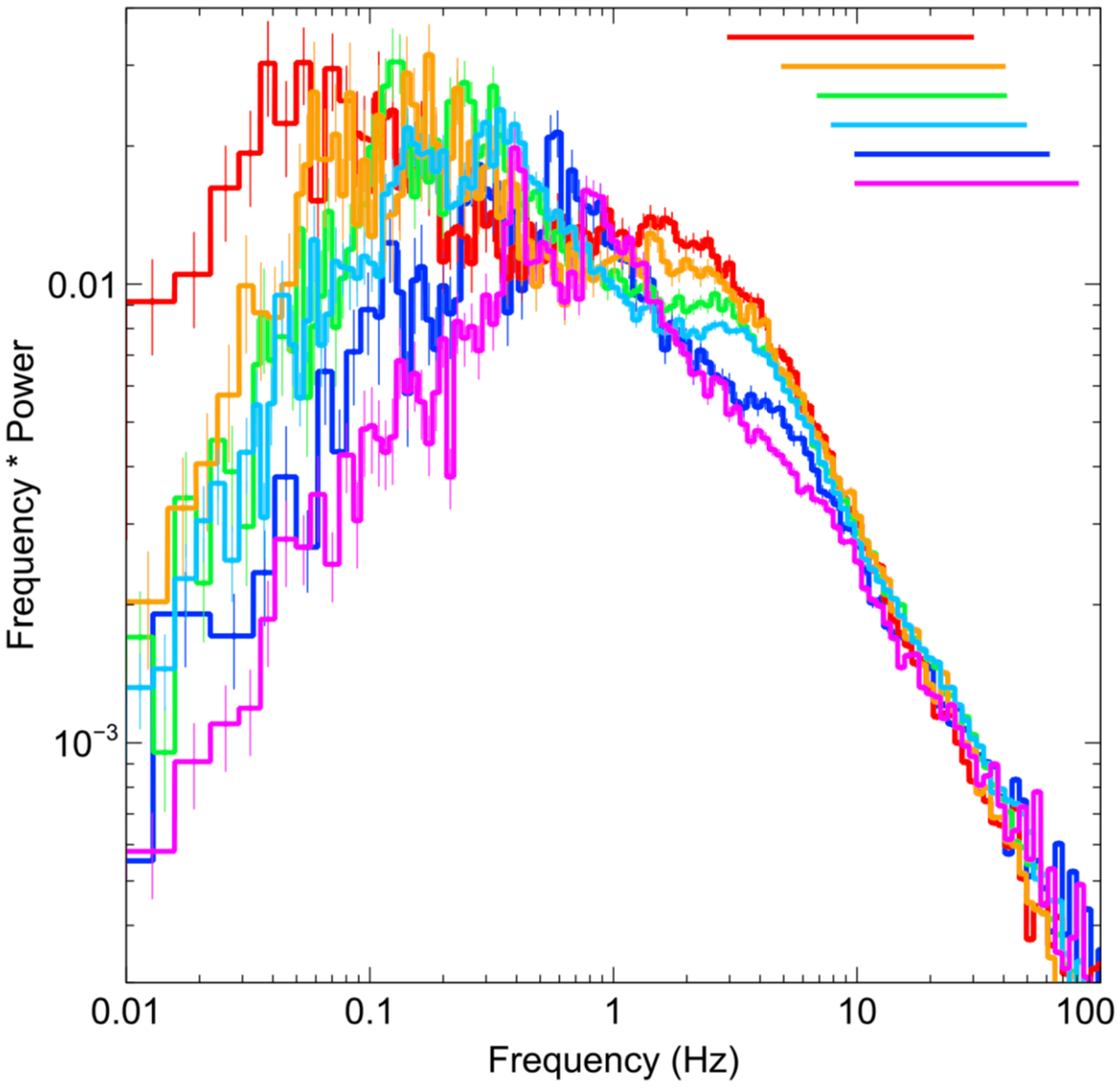
Corona evolves during state changes



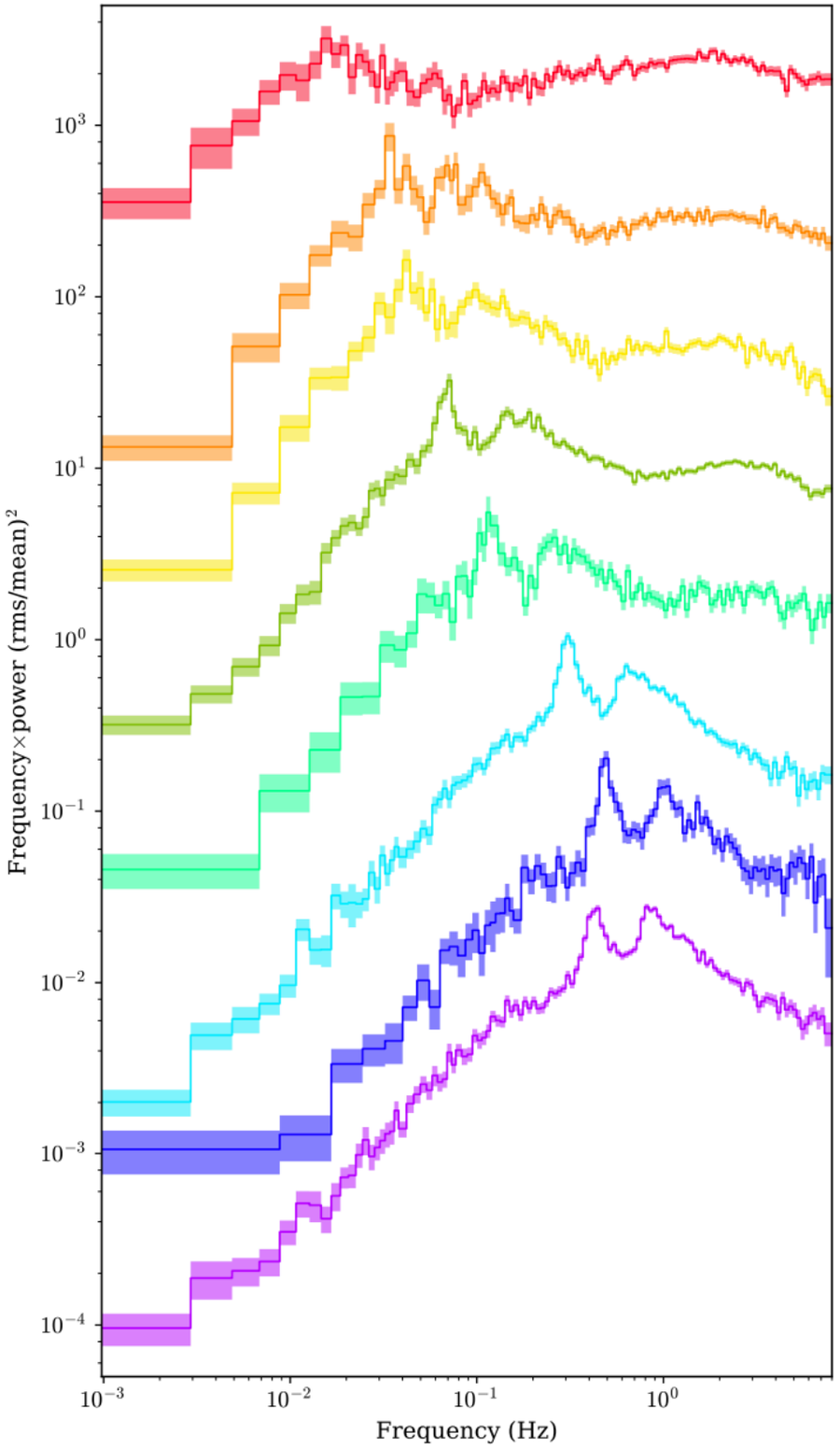
NuSTAR spectroscopy reveals heating corona

Buisson et al., 2019

Other important timing features

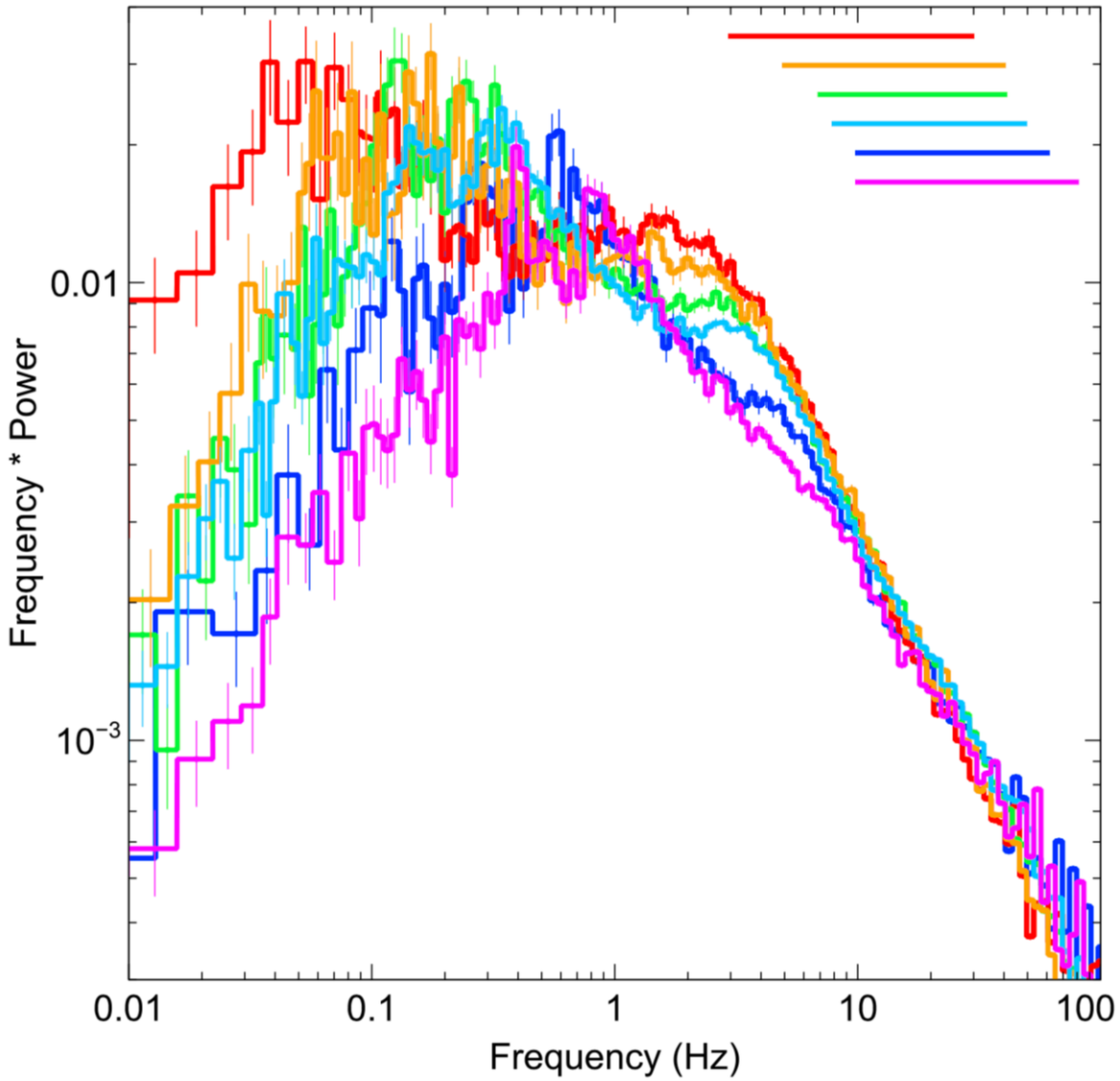


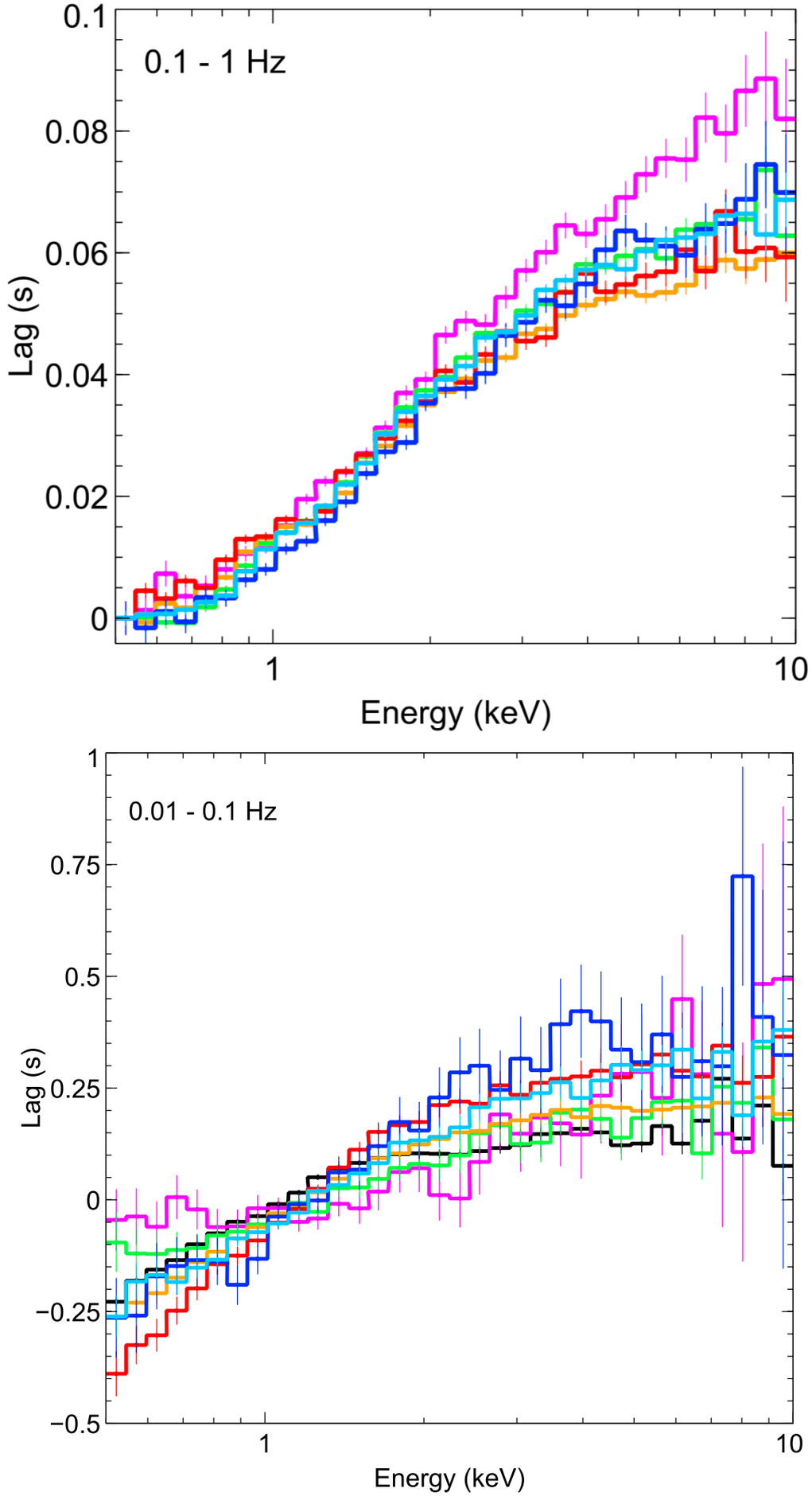
NICER (0.3-10 keV)
Kara+19



NuSTAR (3-79 keV)
Buisson+19

Other important timing features





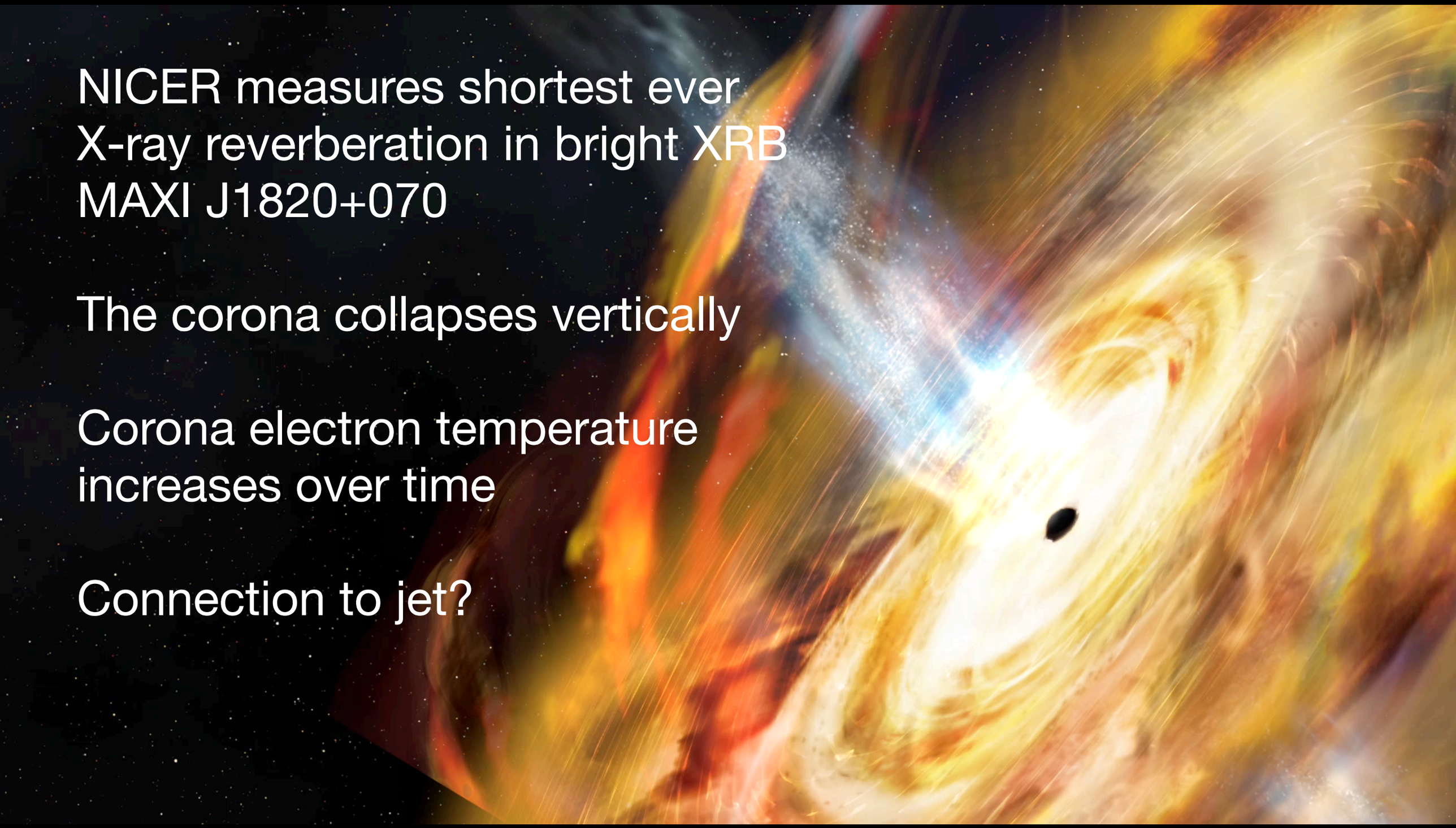
Conclusions

NICER measures shortest ever X-ray reverberation in bright XRB MAXI J1820+070

The corona collapses vertically

Corona electron temperature increases over time

Connection to jet?



NASA/GSFC Press Office. Image Credit: Aurore Simonnet