

Kristin Kruse Madsen
For IACHEC 2018

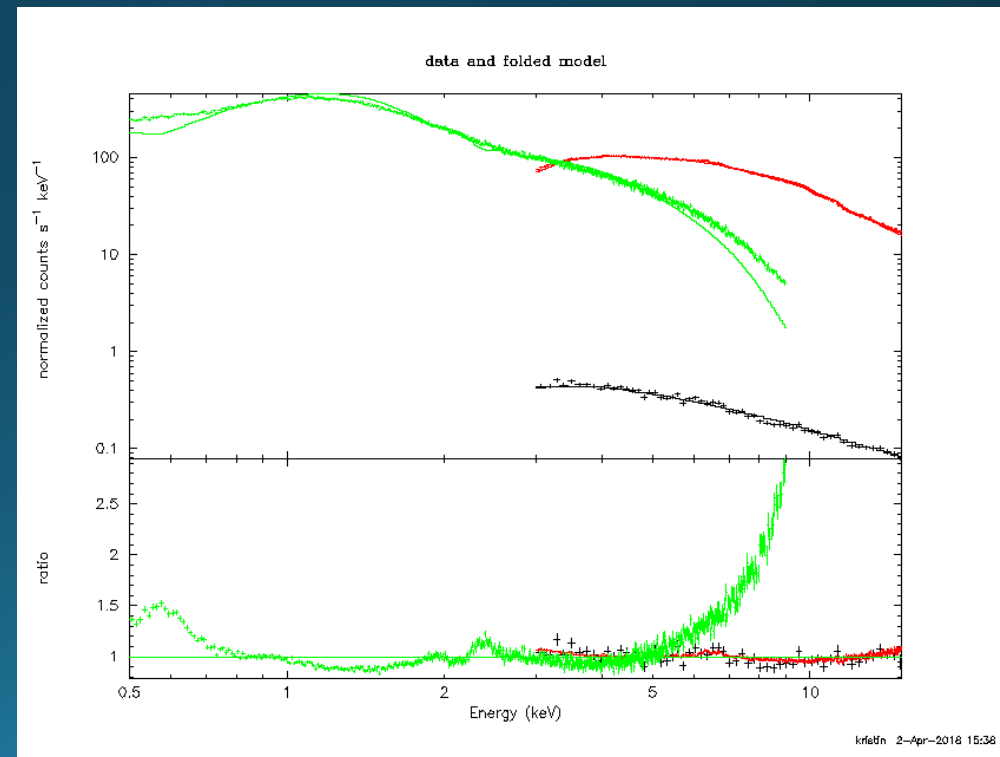
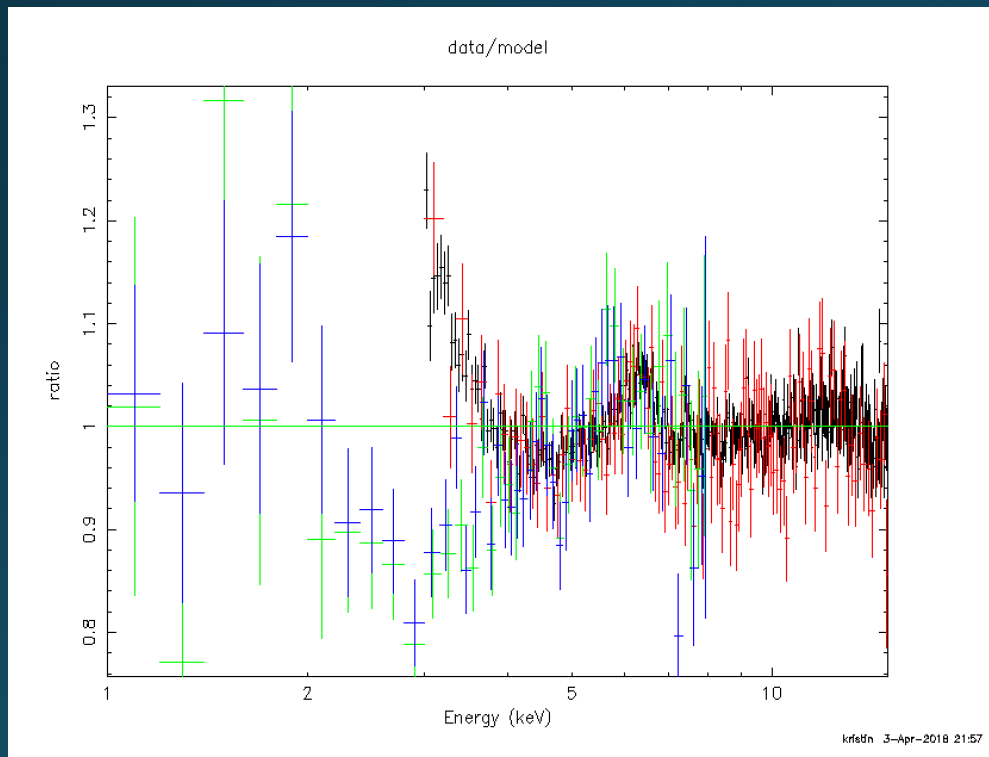
XRT – NuSTAR X-cal report

Introduction

- The Problem
- Bright NuSTAR-XRT observations
- Conclusions/Discussion

The Problem

- Increasing reports from NuSTAR and XRT users about mismatches between XRT-WT and NuSTAR in bright sources.



Comparing NuSTAR to Swift

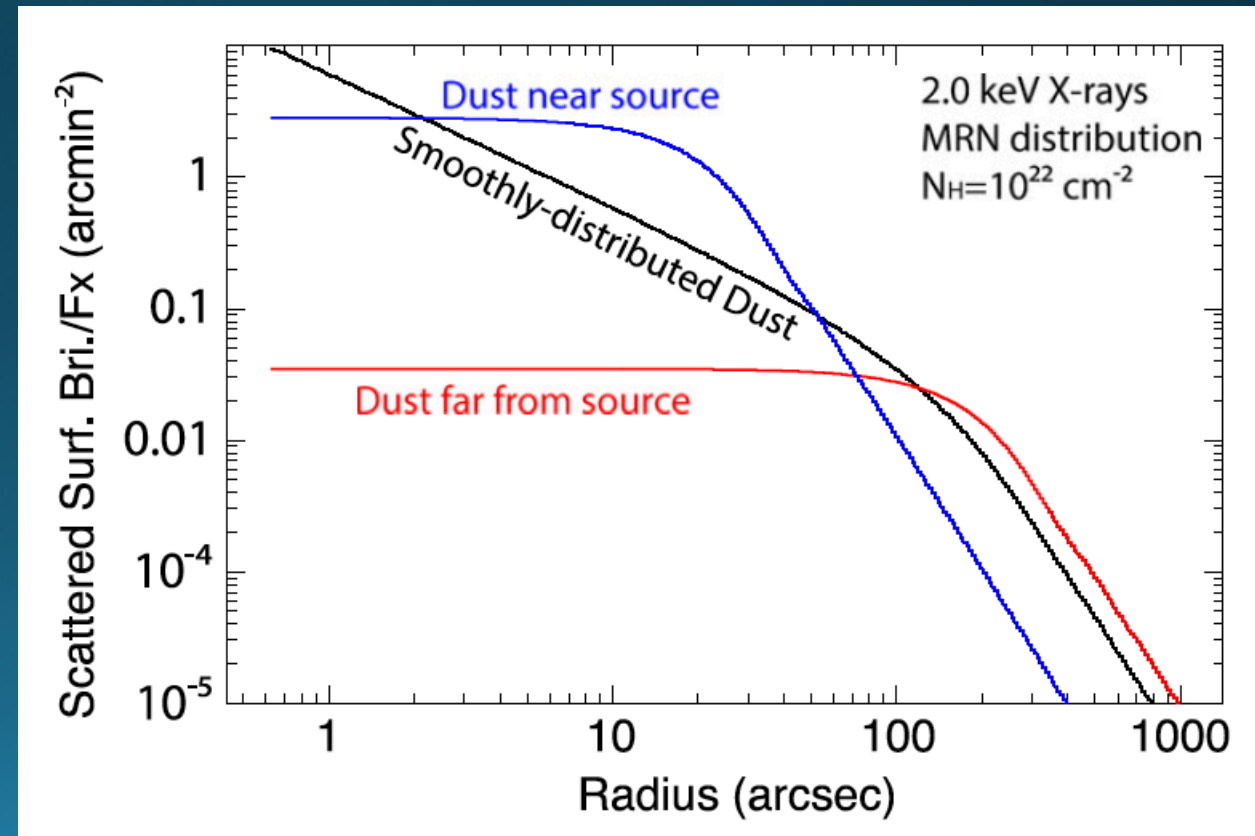
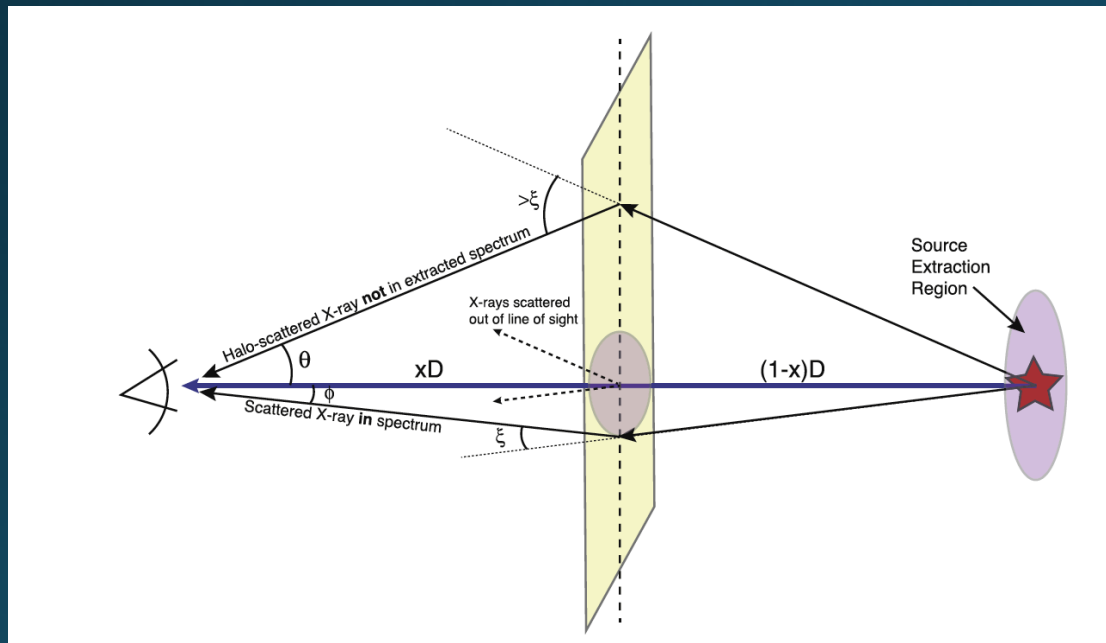
Object Name	N_H (10^{22})	NuSTAR Obsid	Swift Obsid	Swift countrate (counts/s)	NuSTAR countrate (count/s)
Her X-1	1.7e-2	10202002002	00081452005	30	75
MAXI J1820+070	~0.2	90401309006			~940
		90401311004 SL	00010627010	~910	~35
		90401309002	00010627003	~170	~220
			00010627001	~170	
GX13+1	~3	30301003001	0088018001	~110	~200
GRS 1915+105	~4	30202033004	00081904002	~120	~250
GRS 1915+105	~4	30202033002	00081904001	~270	~930
GRO J1744-28	~8	80002017004	00030898021	~60	~330
J1658d2-4242	~15	90401307002	00810300002	~ 10	~40

Phase space



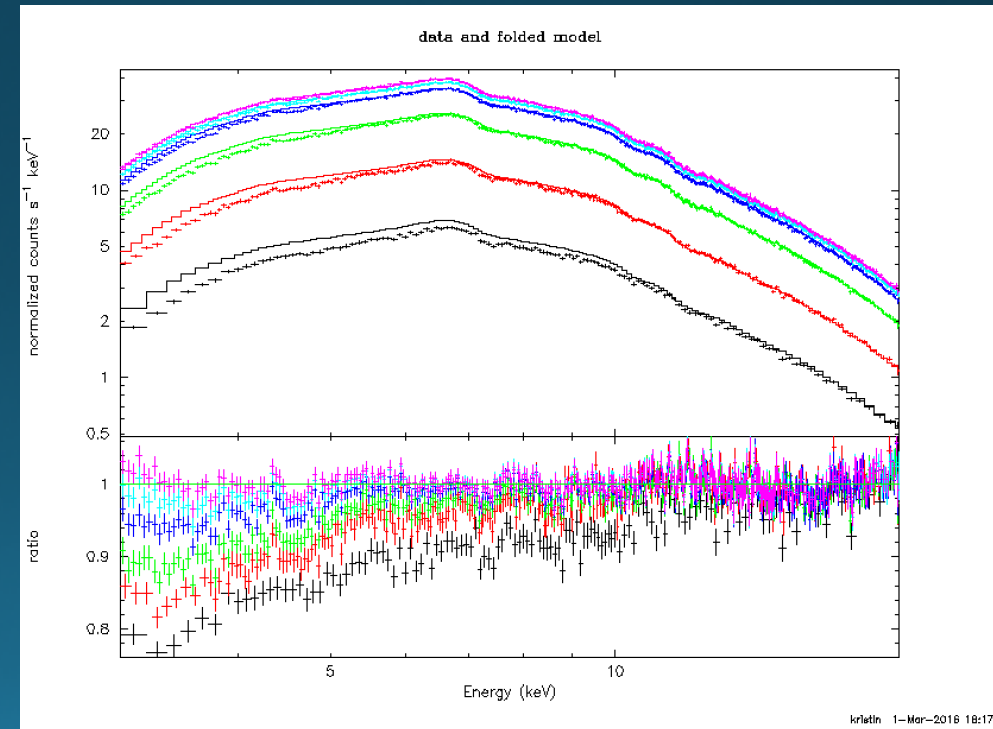
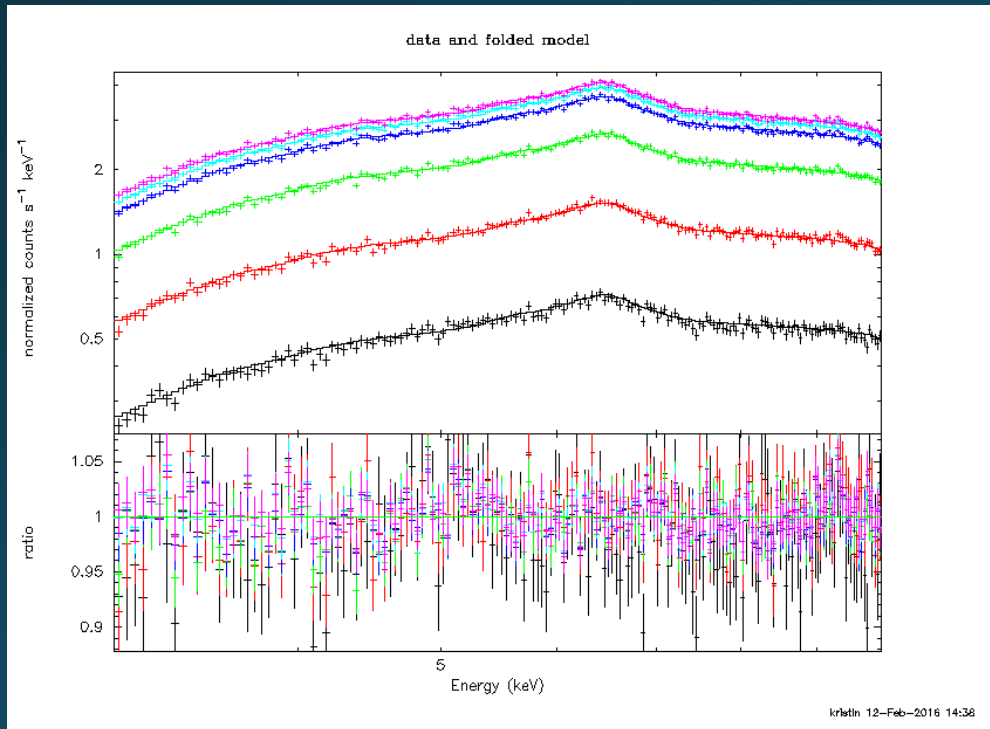
Reductions: NuSTAR

- Standard pipeline
- Different extraction regions to check for dust haloes



Reductions: NuSTAR

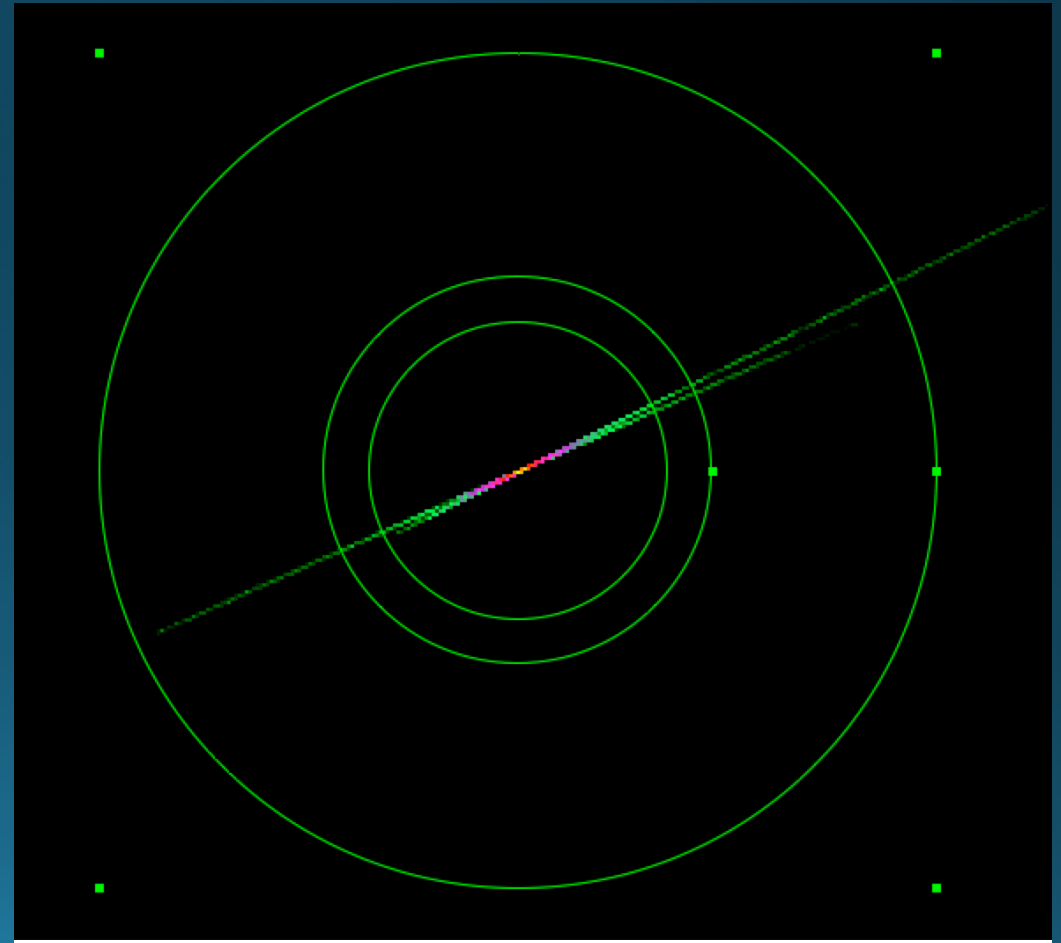
- Standard pipeline
- Different extraction regions to check for dust haloes



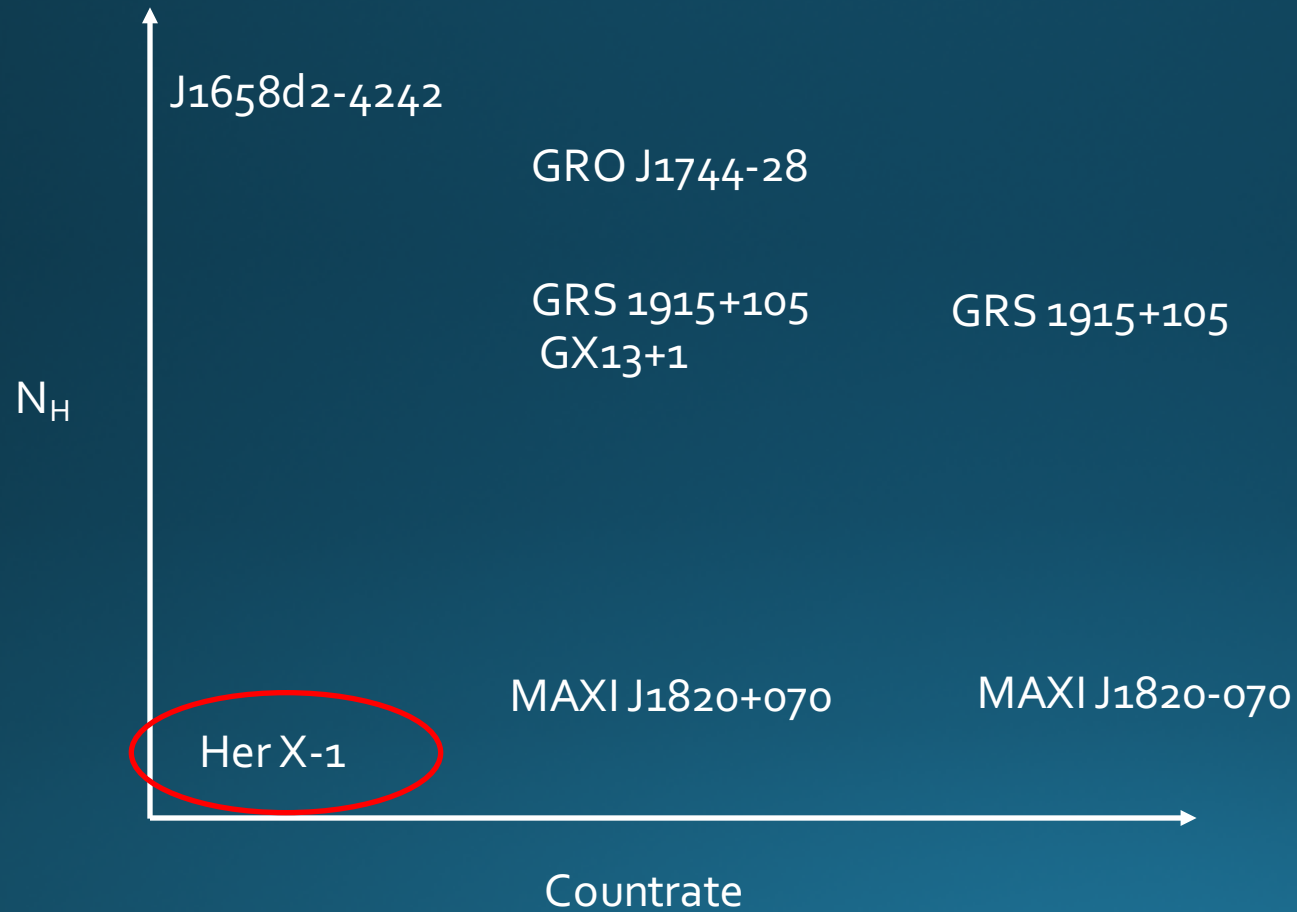
Dust scattering

Reductions: Swift-XRT WT

- xrtpipeline, xselect, xrtrmkarf
- Grade 0 v. grade 0-2
- Extraction region
 - Circle: size
 - Annulus: innerradius



Phase space

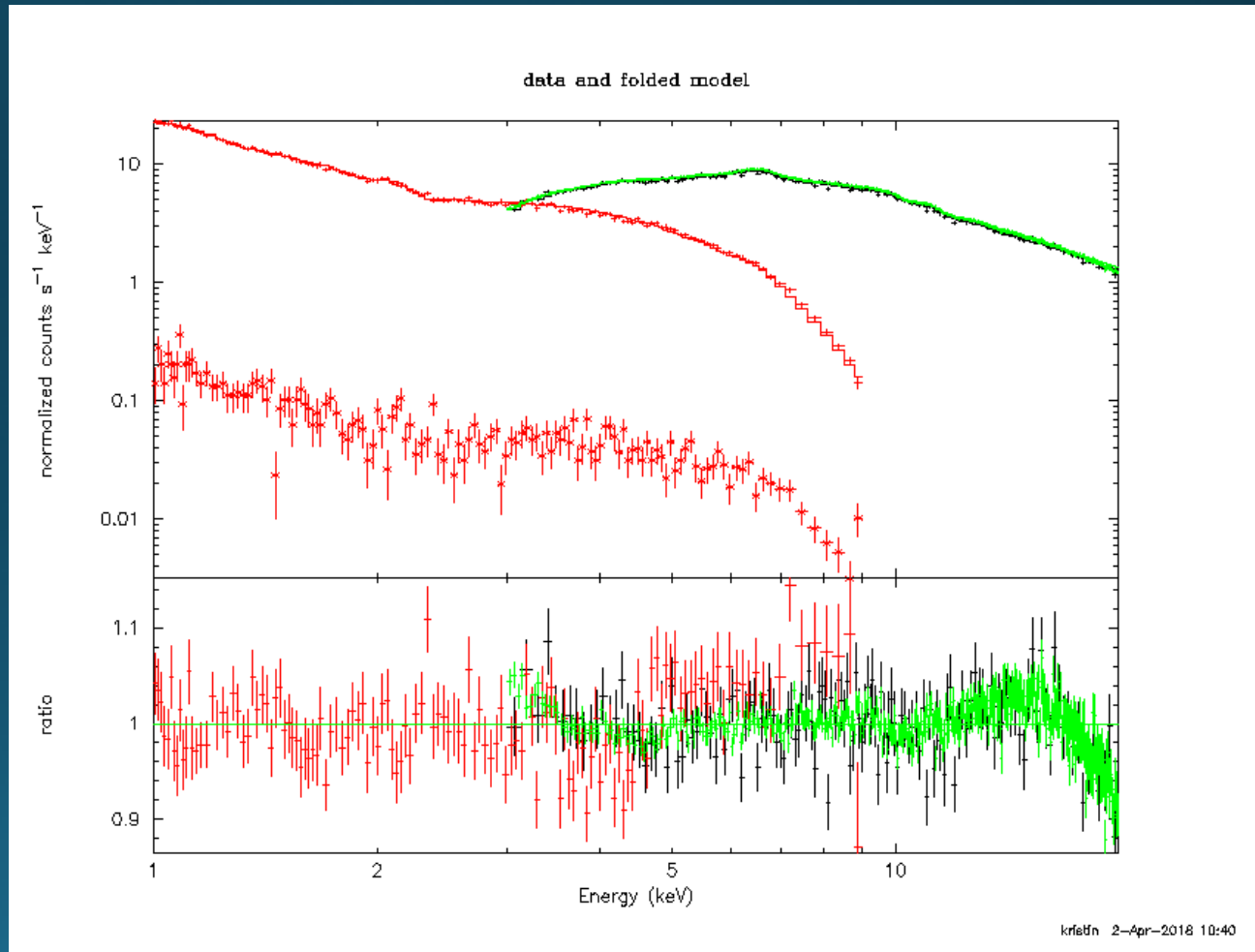
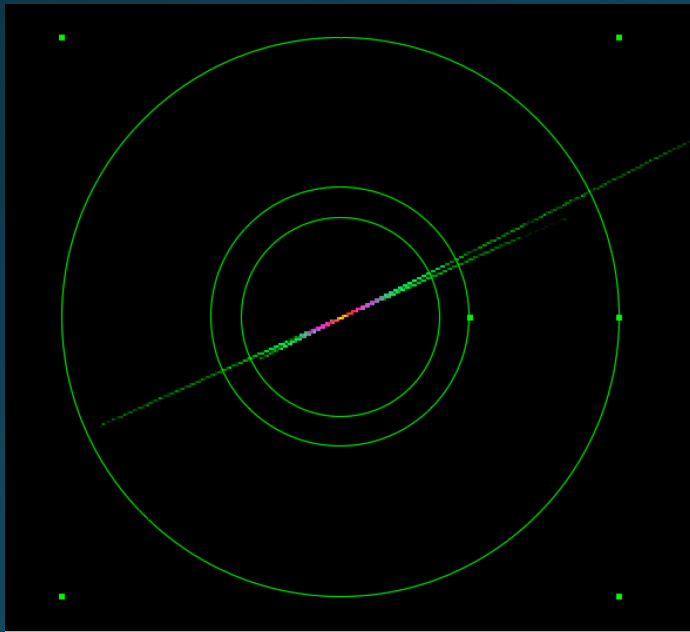


Her X-1: No problems

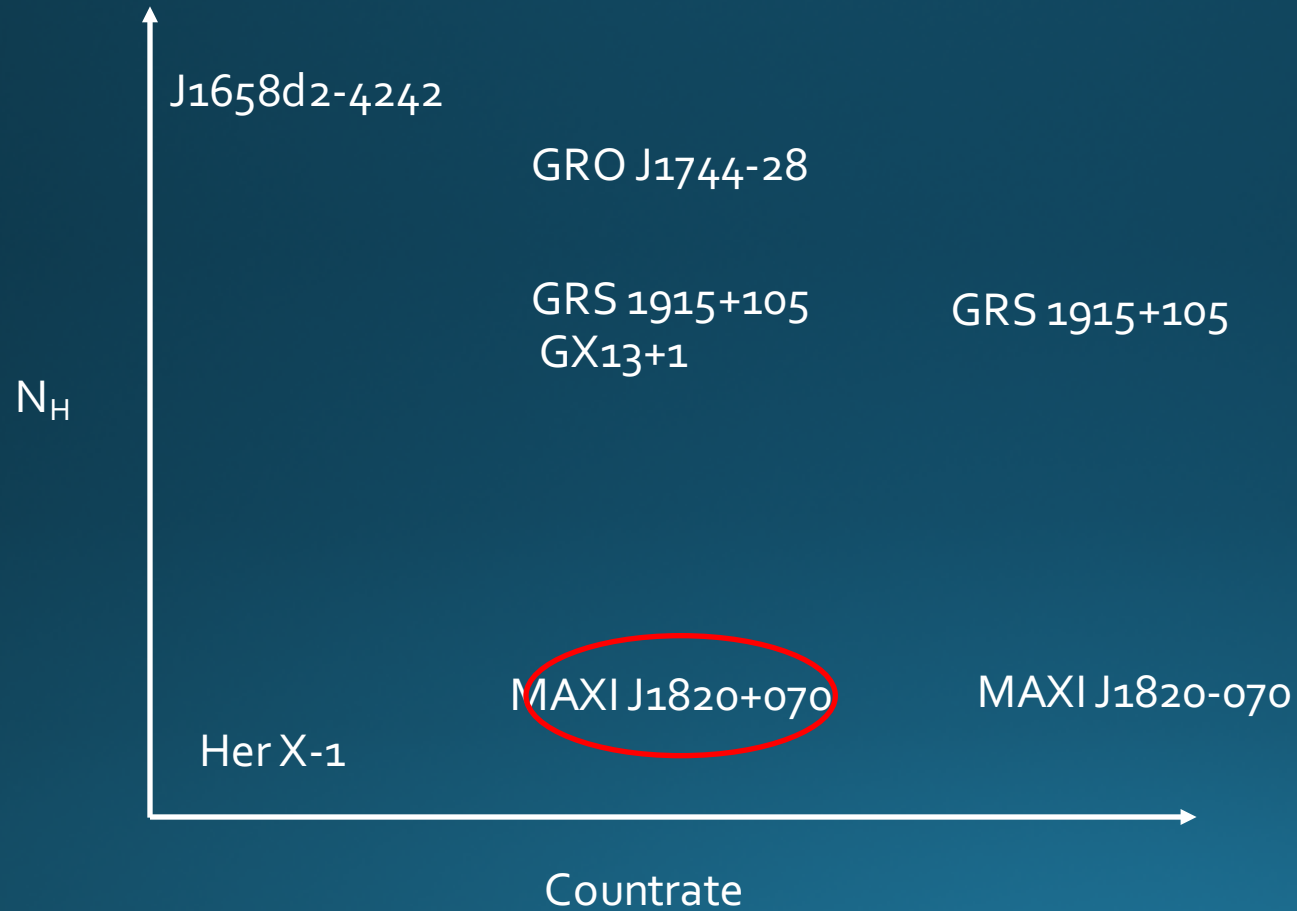
Black: Simultaneous NuSTAR with Swift.

Red: Swift (circle:100")

Green: Full NuSTAR observation



Phase space



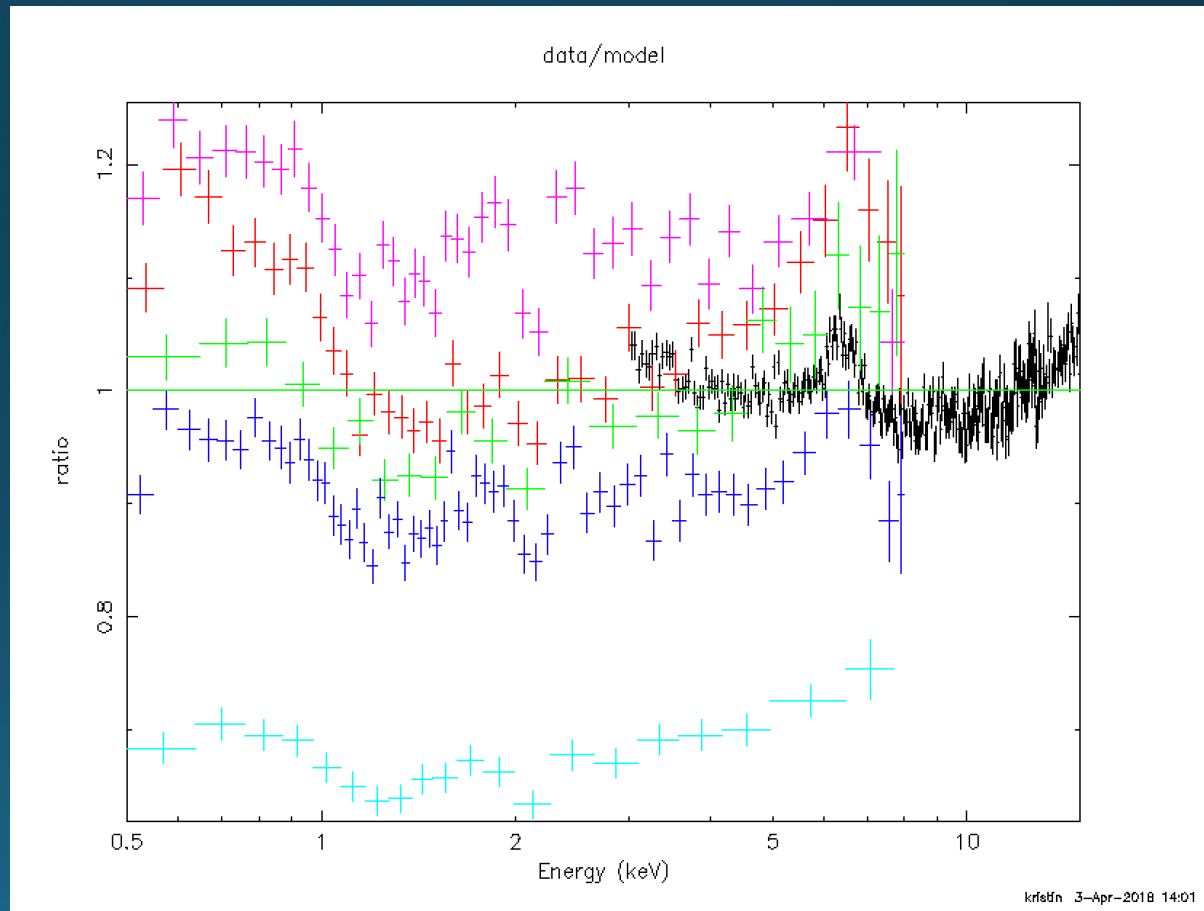
MAXI J1820+070 "low"

Different extraction from
different people!

Pink=red (003)

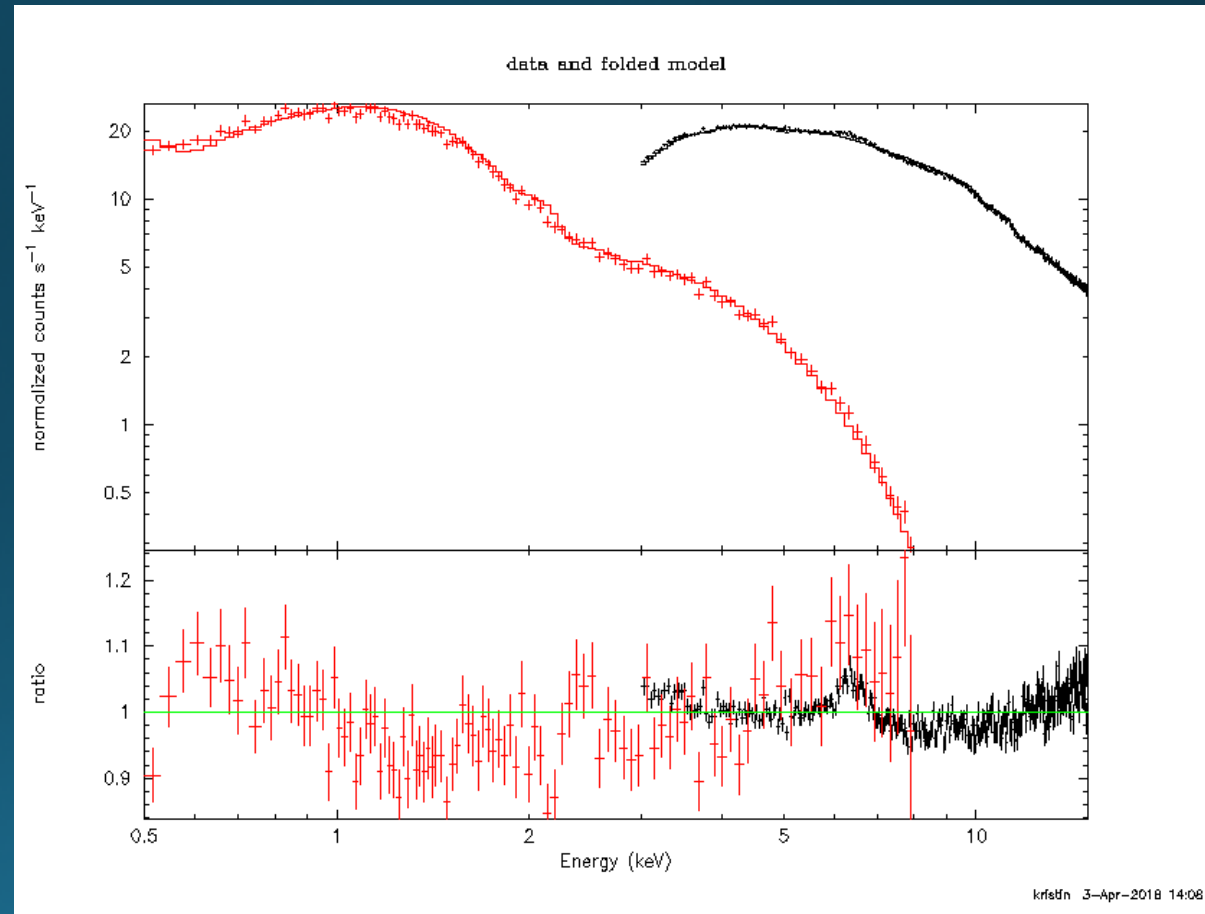
Green=cyan

Blue=cyan+pink (001)

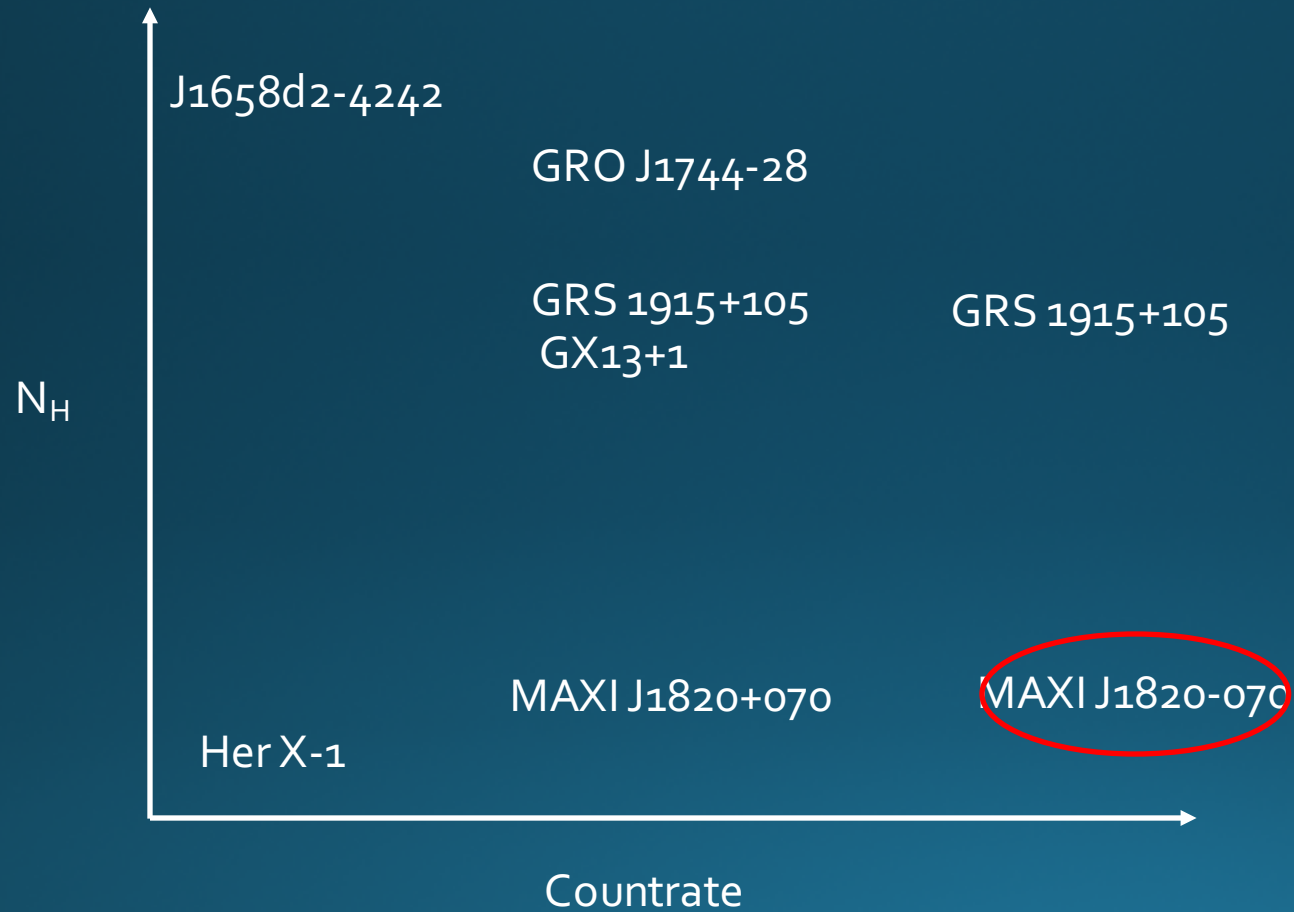


MAXI J1820+070 "low": OK

Swift: annulus 8-40"

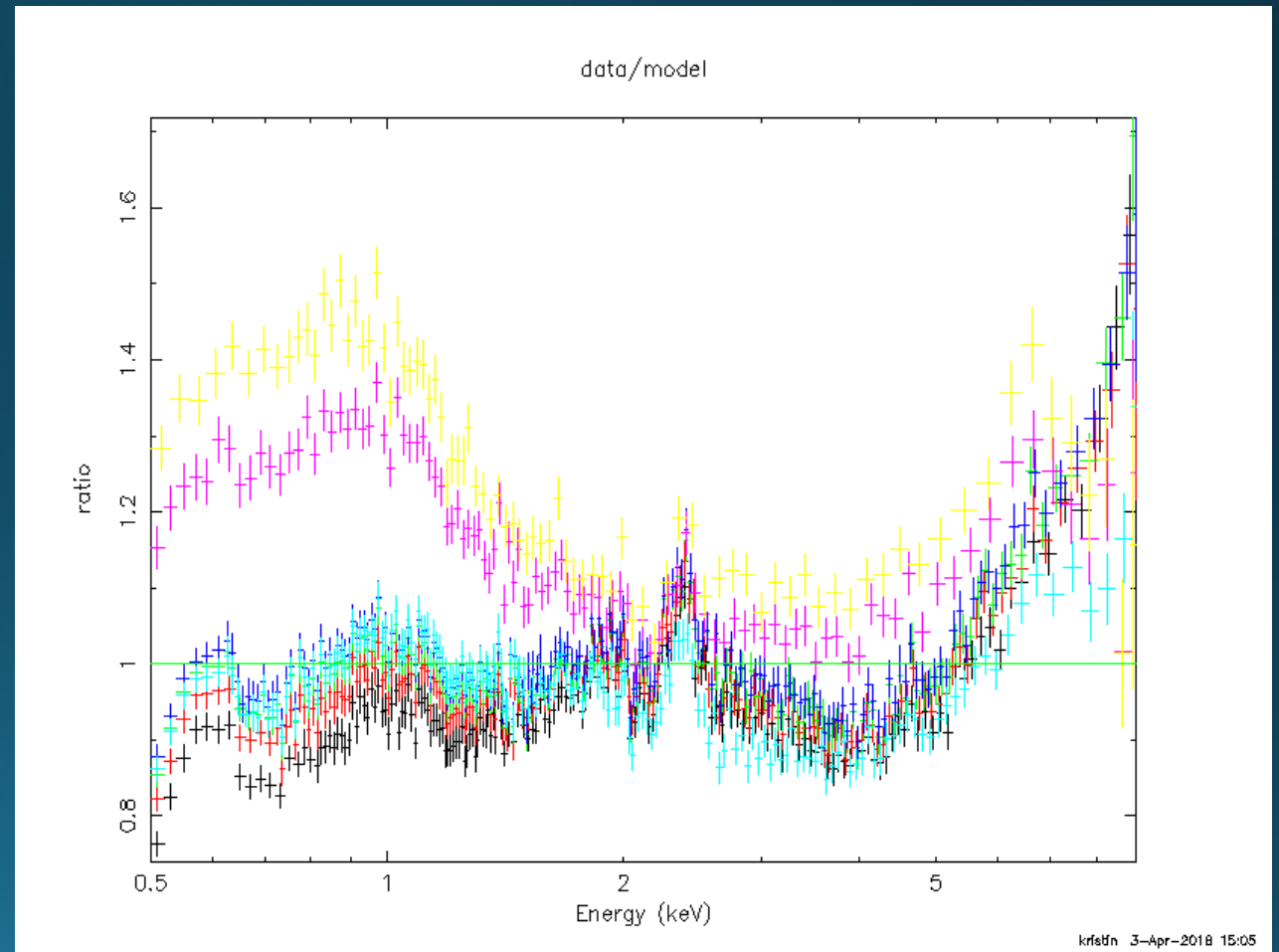


Phase space



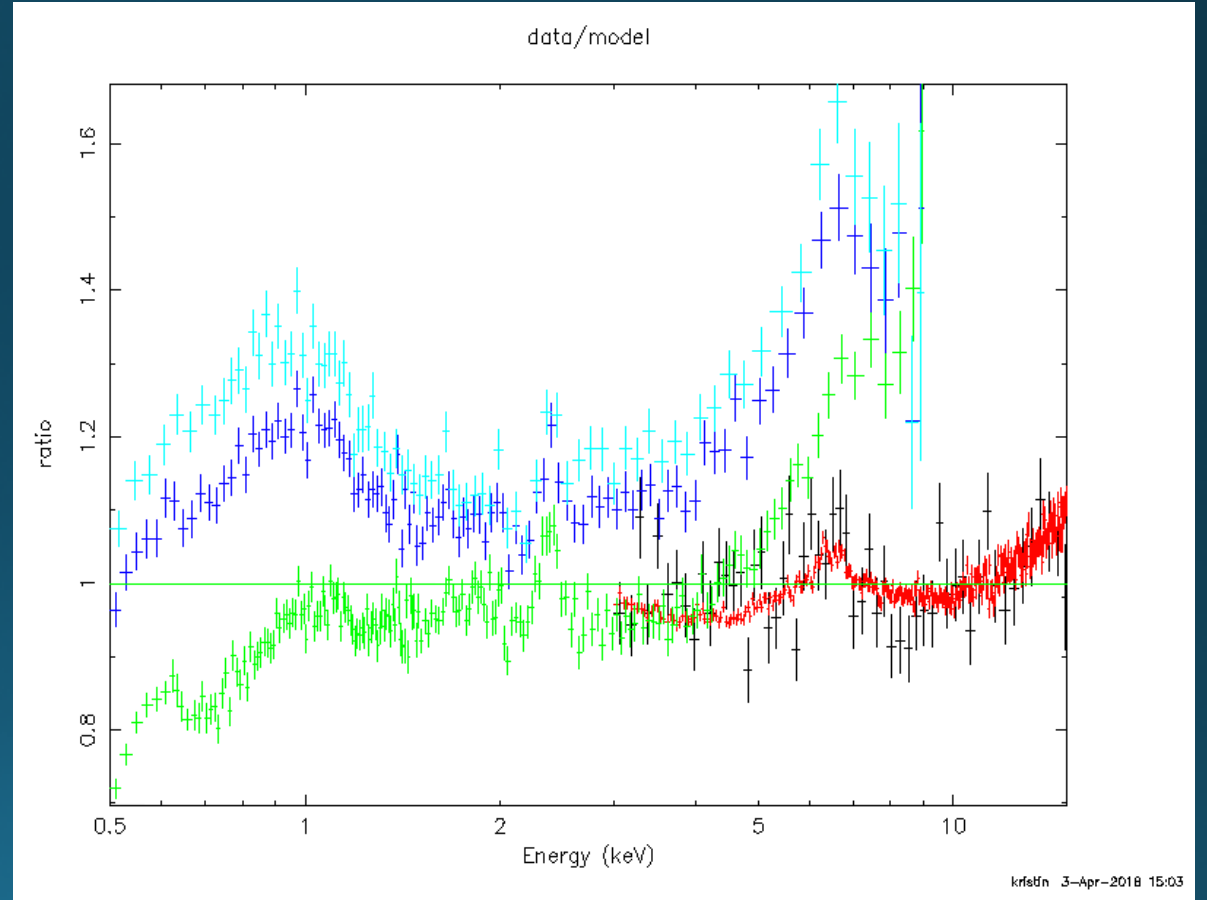
MAXI J1820+070 "high"

Black	annulus 8 - 40"
Red	annulus 8 - 60"
Green	annulus 8 - 80"
Blue	annulus 8 - 100"
Cyan	annulus 8 - 100", grade 0
Pink:	annulus 15 - 100", grade 0
Yellow:	annulus 20 - 100", grade 0



MAXI J1820+070 "high": Not good'ish

Green : annulus 8 – 100", grade 0
Blue : annulus 15 – 100", grade 0
Cyan : annulus 20 – 100", grade 0



Phase space



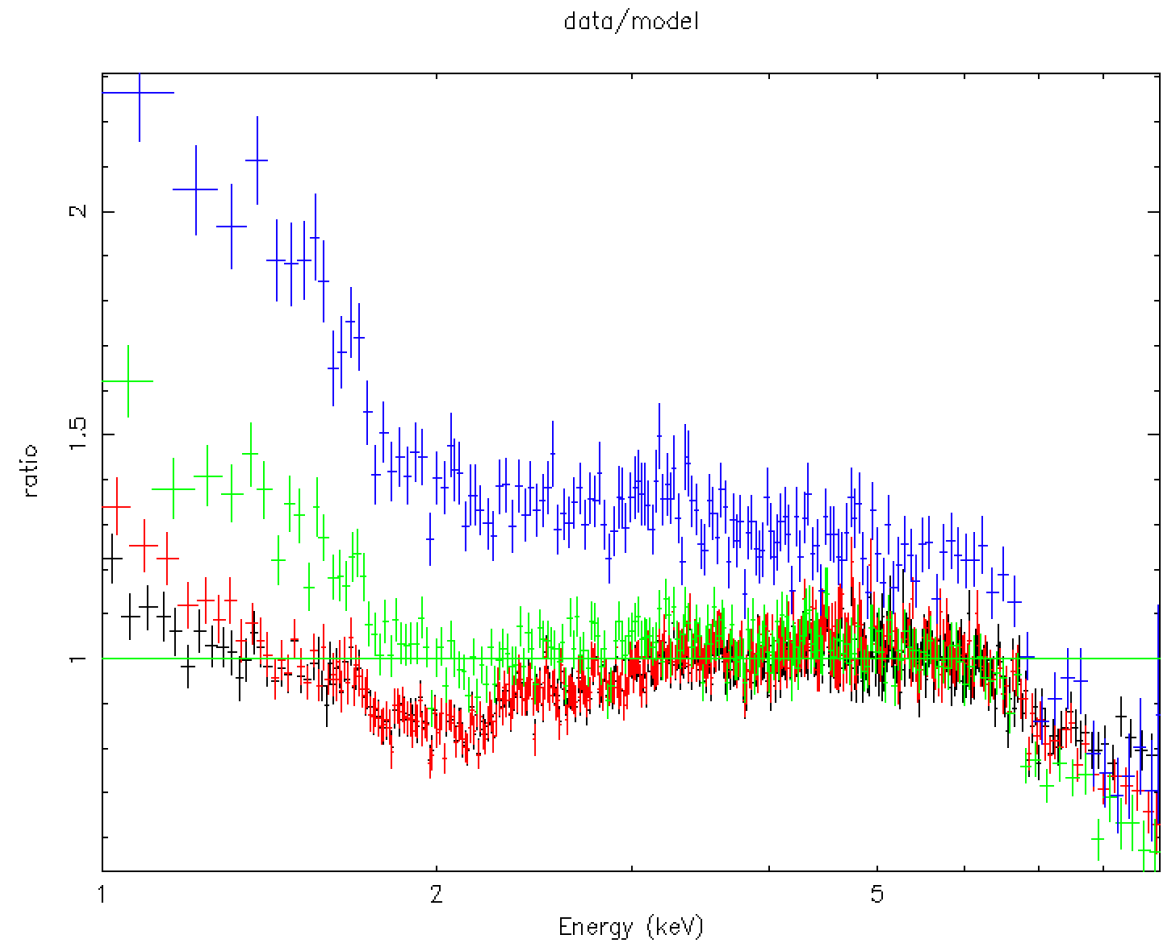
GX 13+1:

Black: Grade 0-2, circle

Red: Grade 0, circle

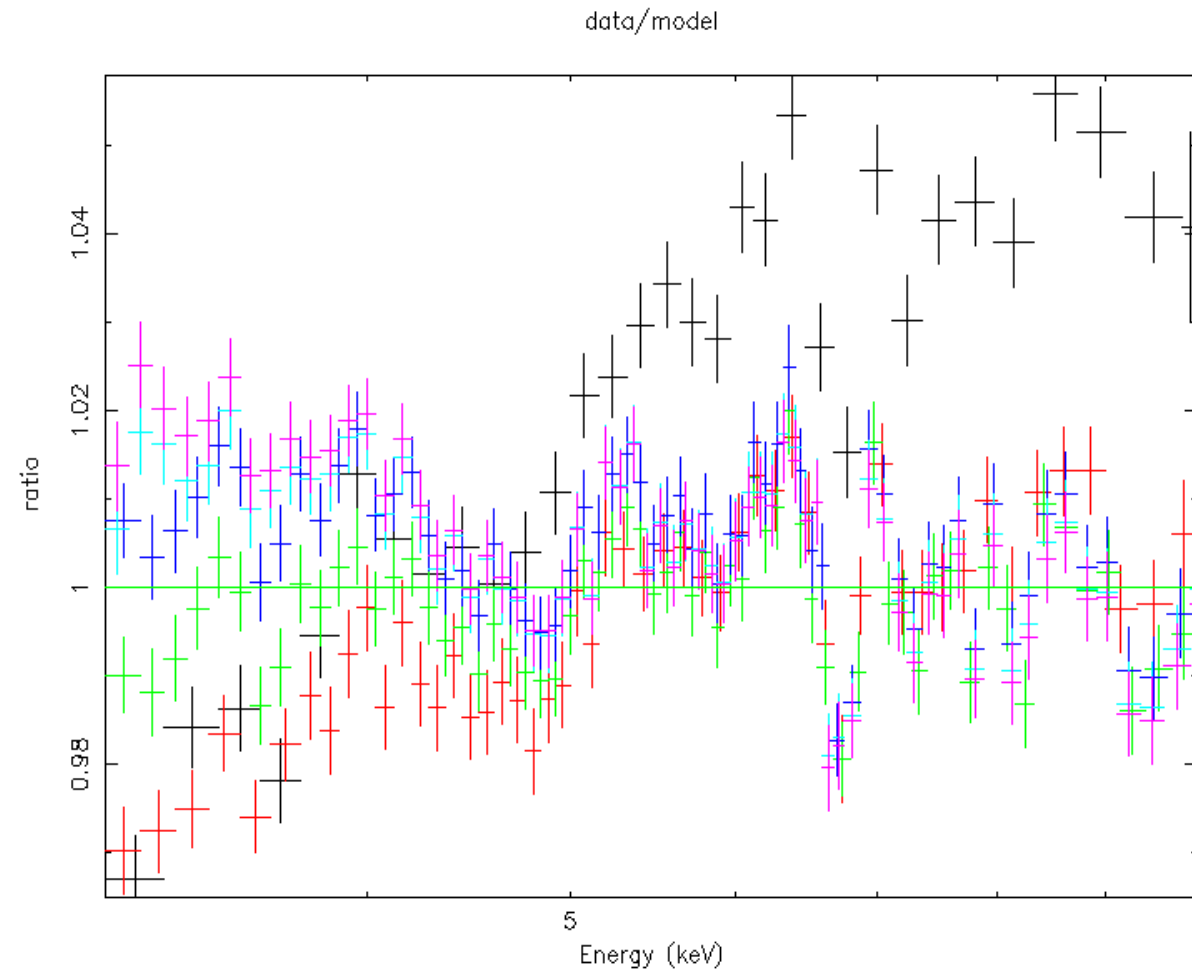
Green: Grade 0, annulus 8-100"

Blue: Grade 0, annulus 15-100"



GX 13+1:

The NuSTAR extraction shows that the halo is very peaked and it does not make a big difference with extraction region.

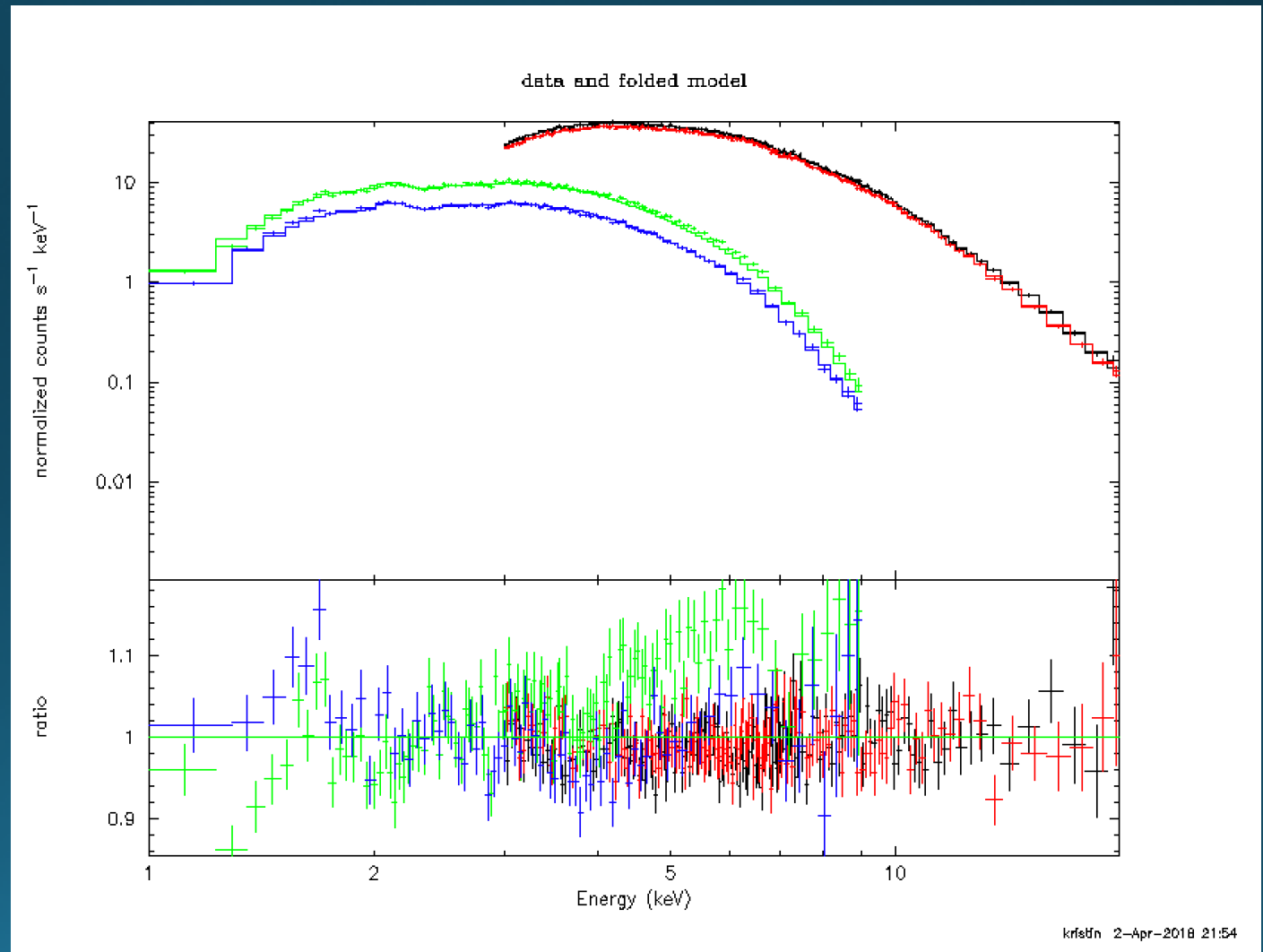


GX 13+1: OK

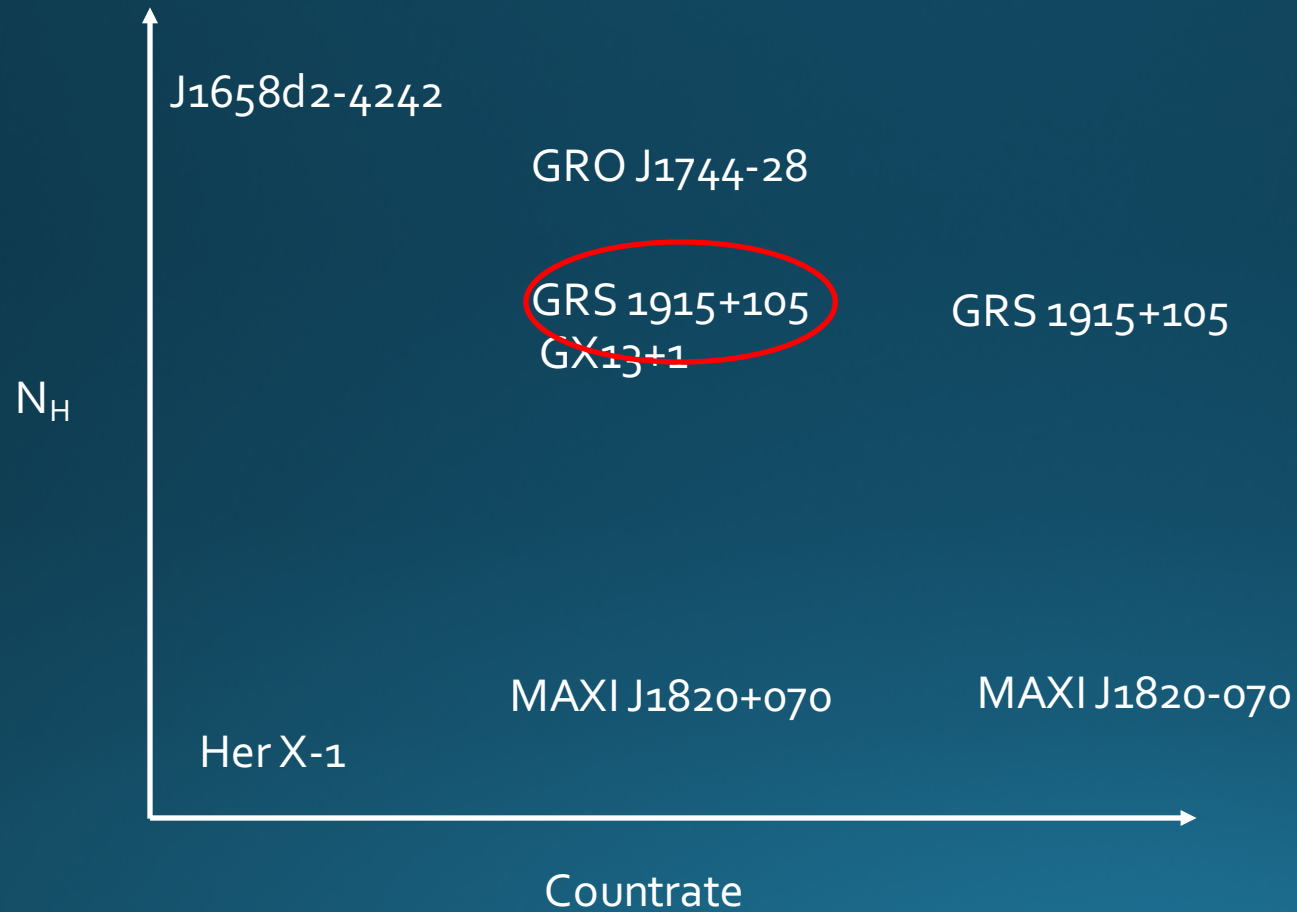
Green: Grade 0, annulus 8-100''
Blue: Grade 0, annulus 15-100''

Conclusion: Probably OK

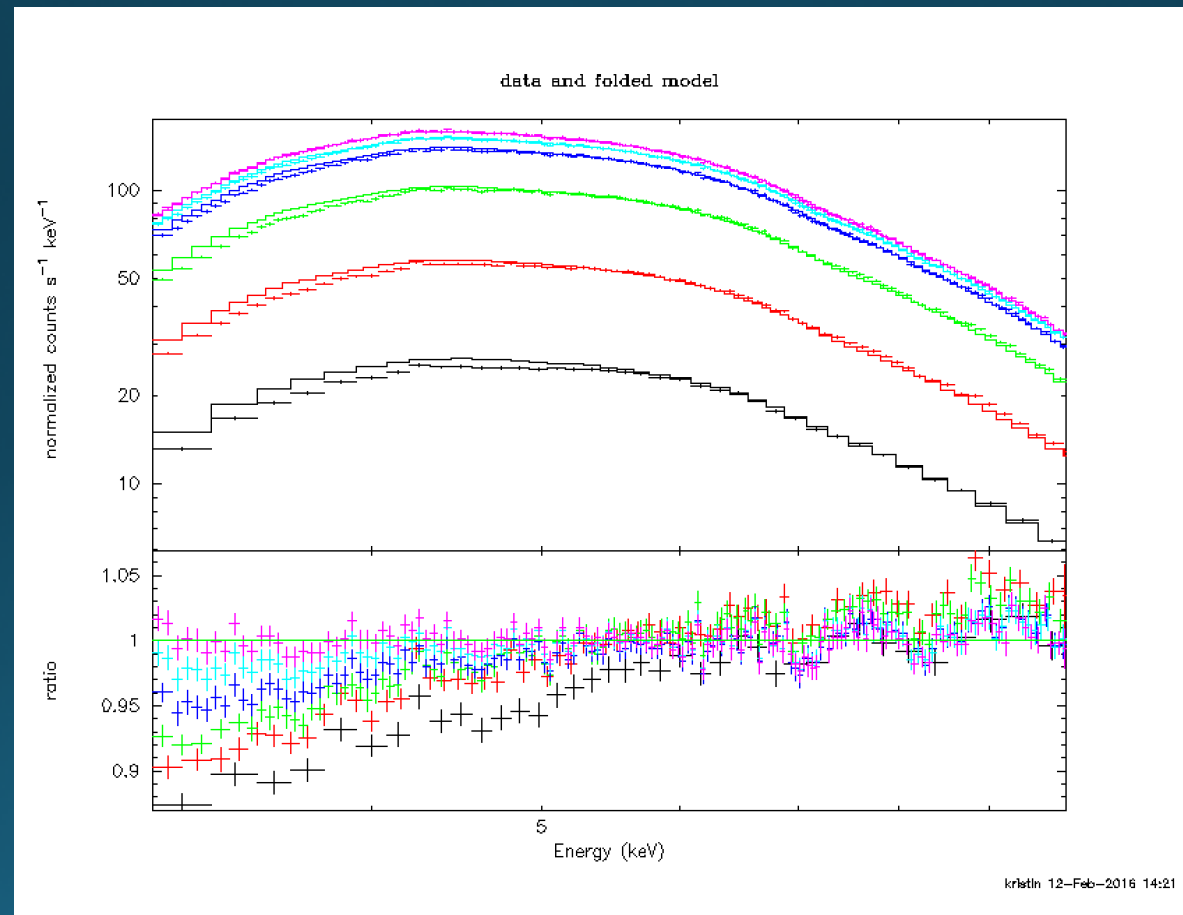
The source does have a dust scattering halo, and it concerns me that excising any part of the spectrum will make it incorrect to compare directly to NuSTAR, but the NuSTAR data shows there isn't too much difference between small and large extraction regions.



Phase space

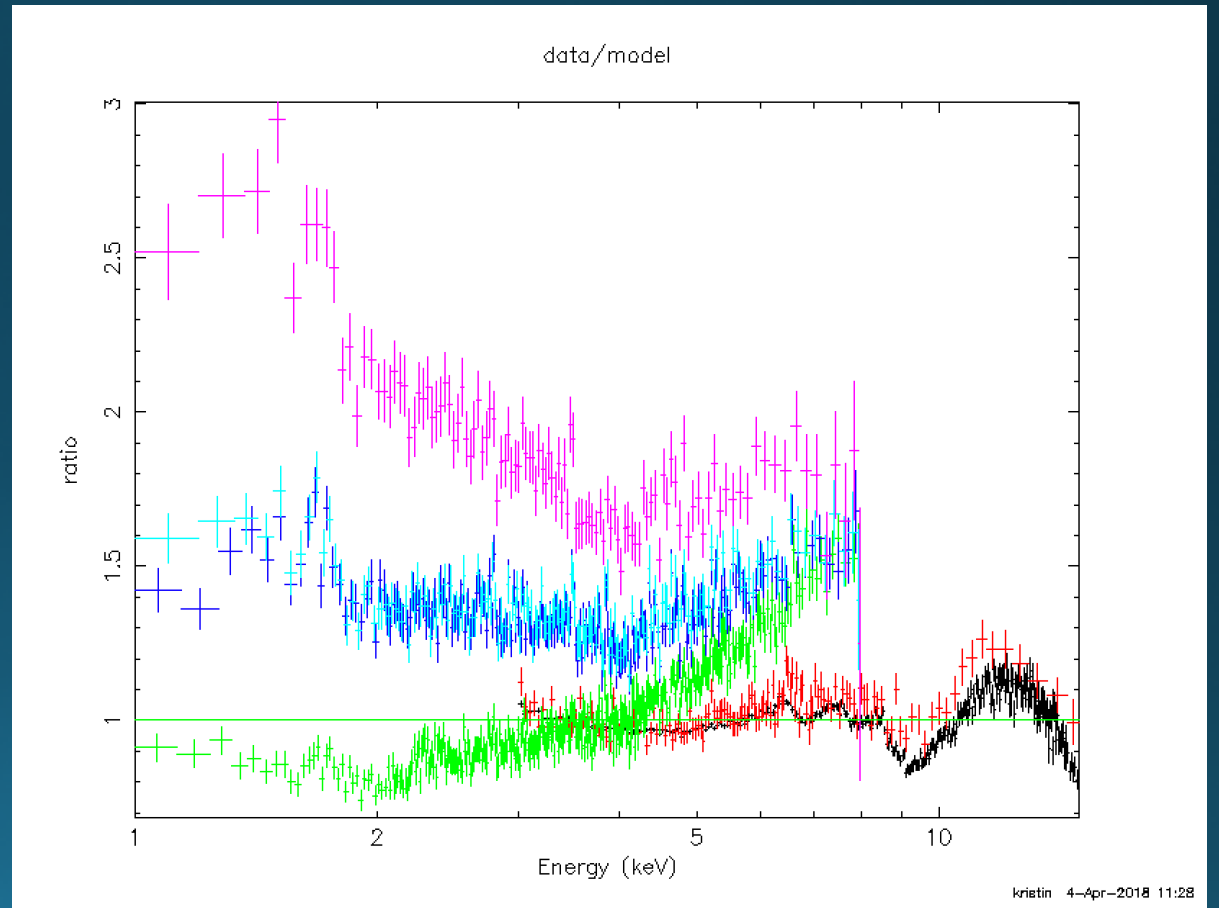


GRS 1915+105 "low"



GRS 1915+105 "low"

Black	Nustar
Red	NuSTAR (swift GTI)
Green	Circle 100", grade 0
Blue	Annulus 8-100"
Cyan	Annulus 8-100", grade 0
Pink	Annulus 15-100", grade 0

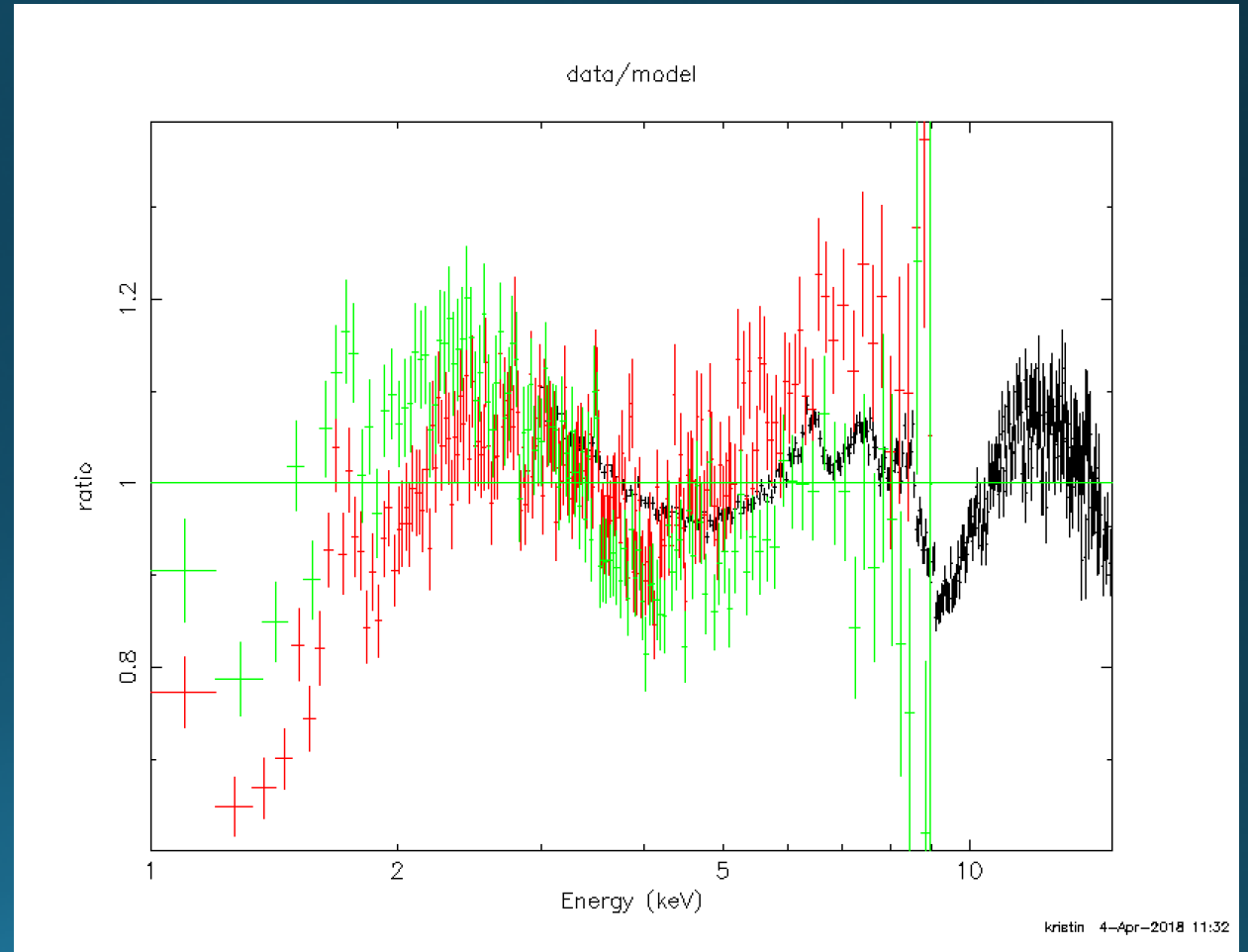


GRS 1915+105 "low": OK?

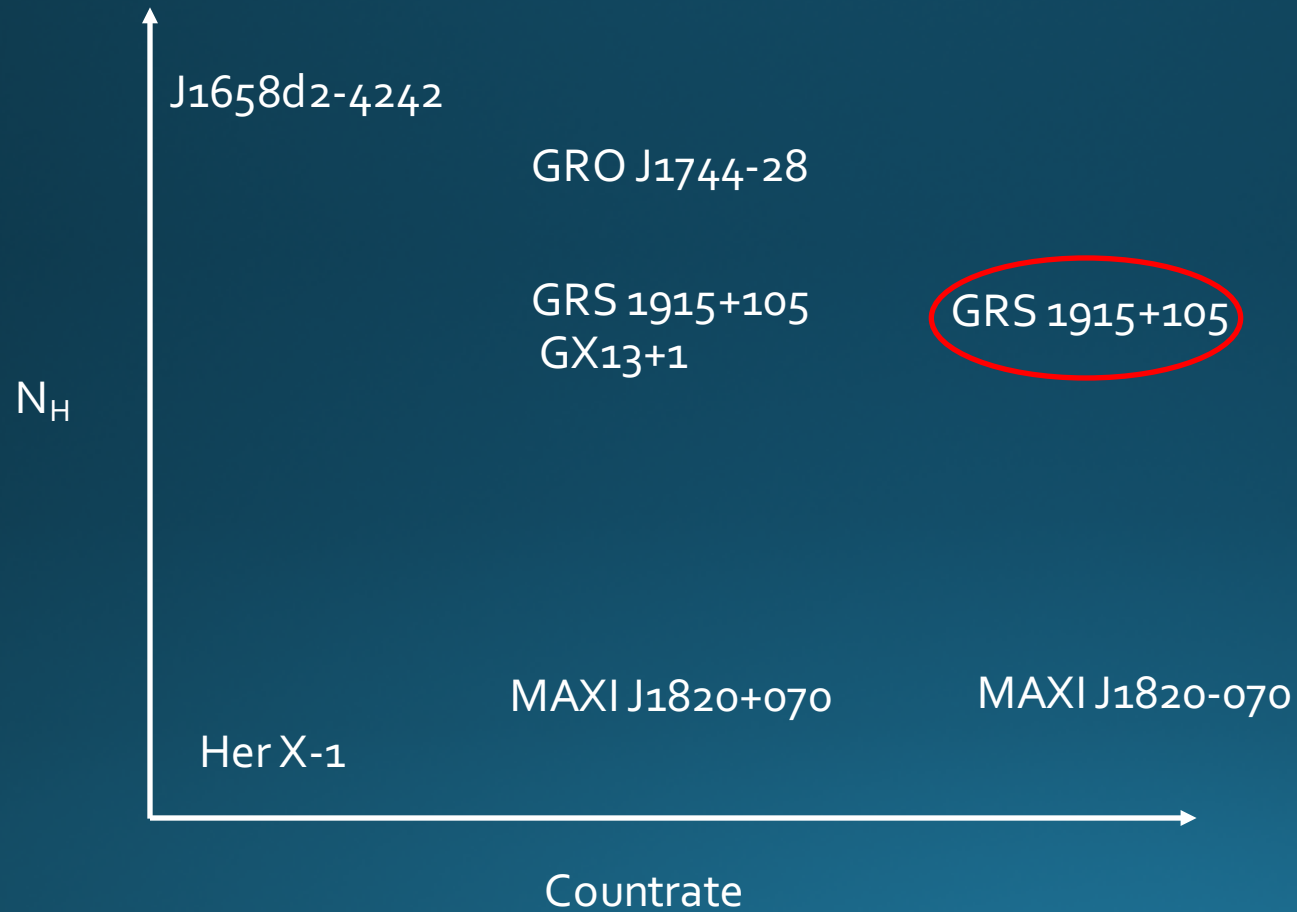
Black	Nustar
Red	Annulus 8-100", grade 0
Green	Annulus 15-100", grade 0

Conclusion: OK?

Like GX 13+1, this source definitely has a big dust halo and comparing directly with NuSTAR has to be done under those assumptions. It does appear that you can get a good fit, tails and all, by excising Swift, but how much is that simply due to luck, will have to be investigated a little better.



Phase space



GRS 1915+105 "high"

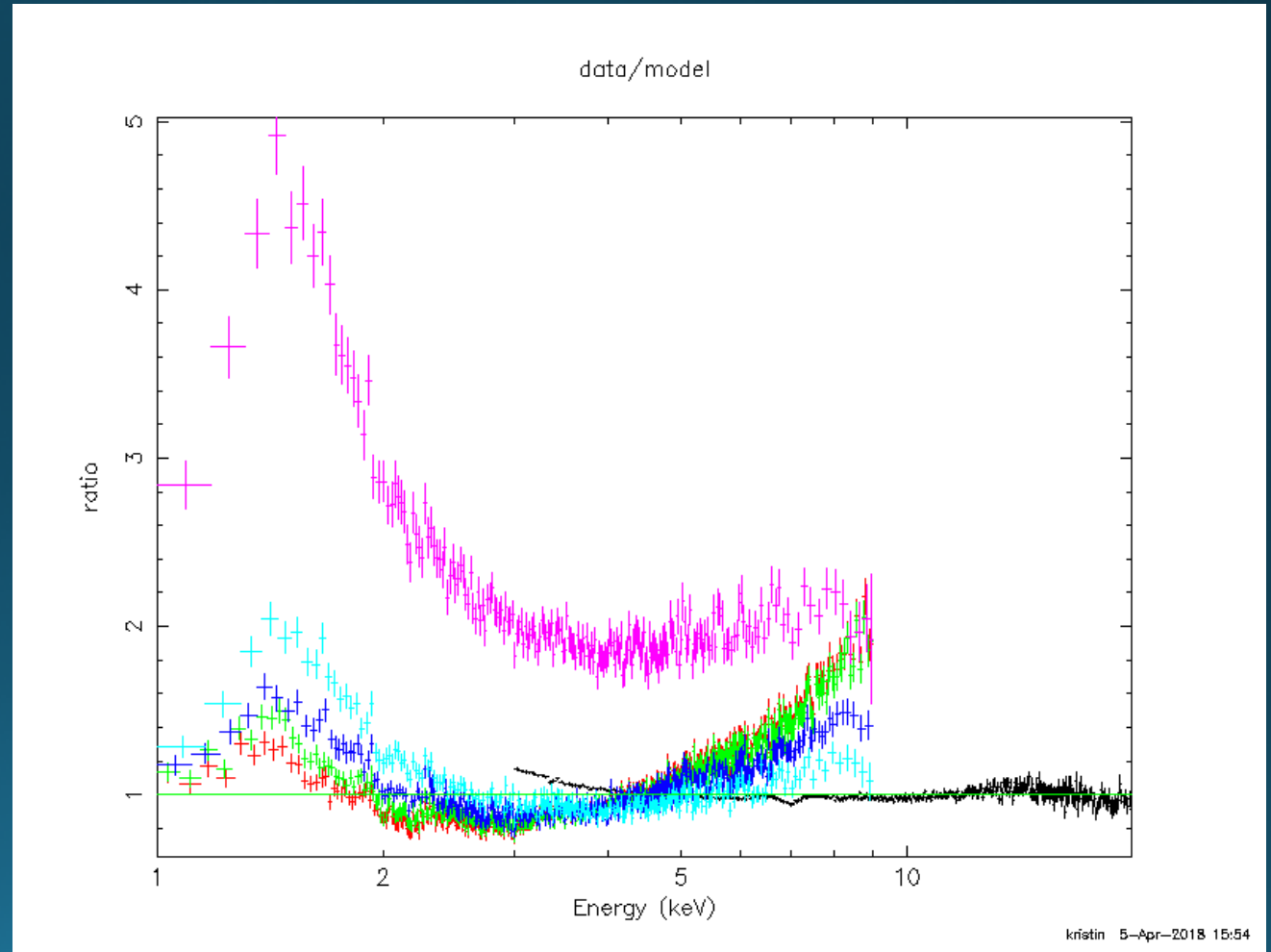
Red: circle 100", grade 0

Green: circle 150", grade 0

Blue: annulus 8 – 100", grade 0

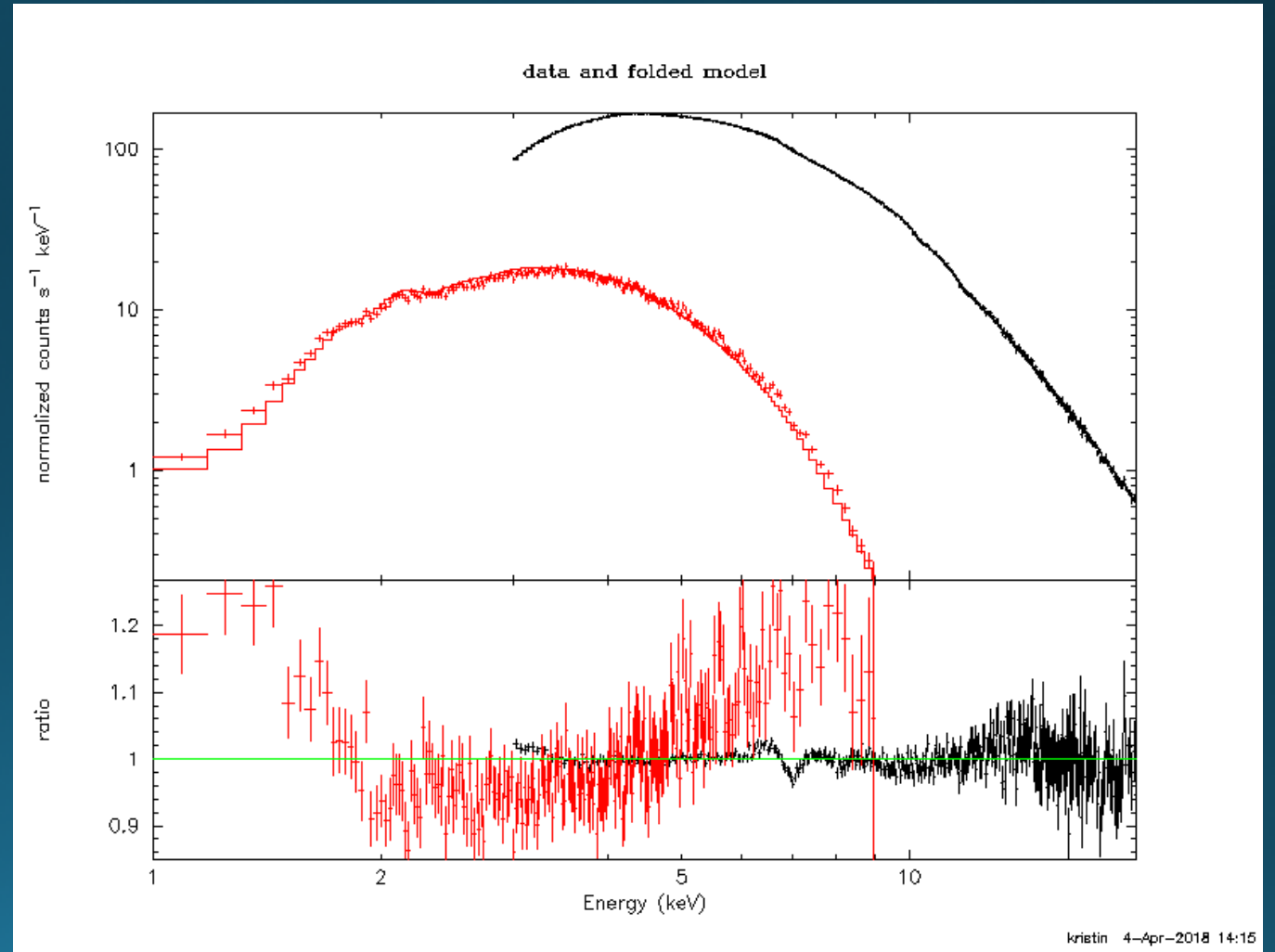
Cyan: annulus 15 – 100", grade 0

Pink: annulus 20 – 100", grade 0

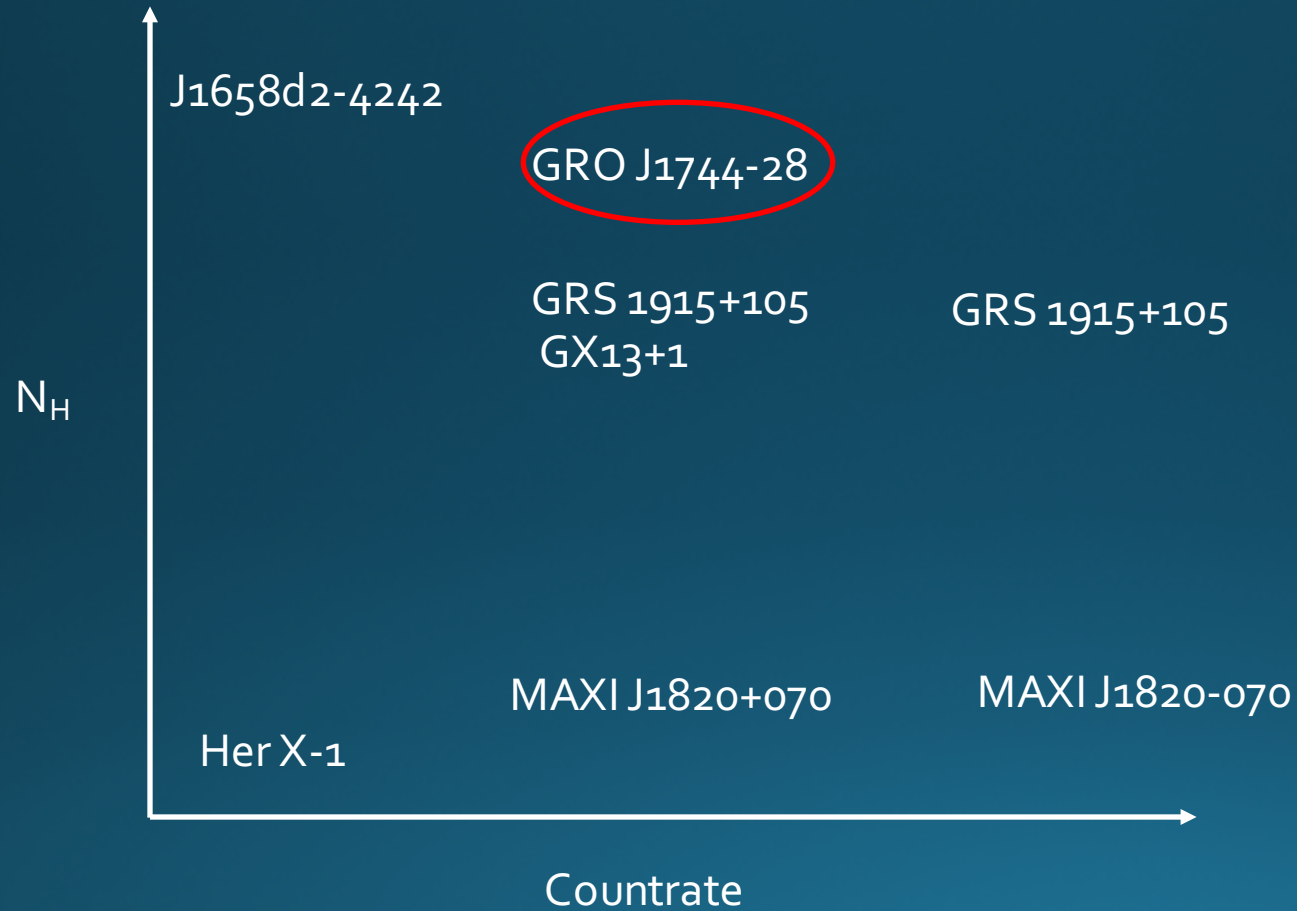


GRS 1915+105 "high": No good

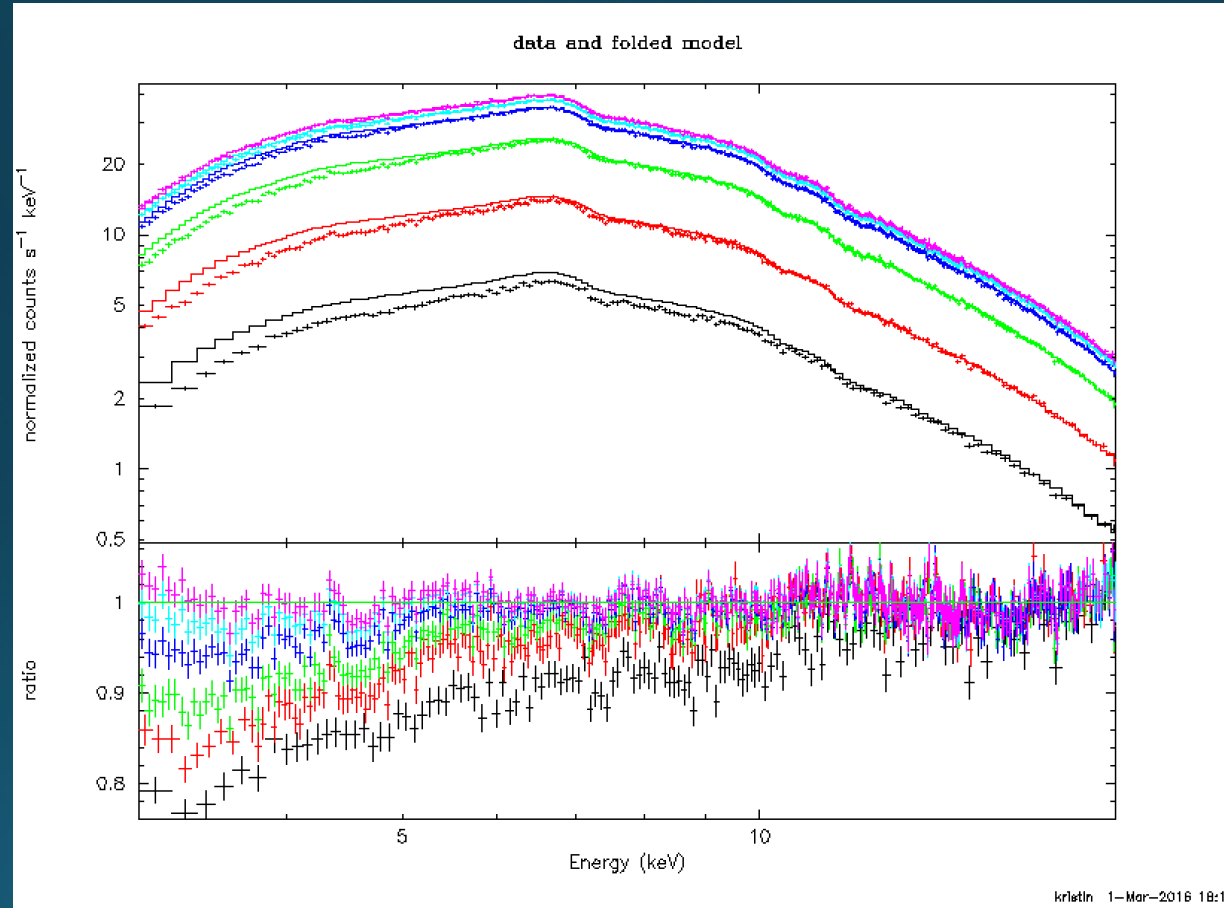
Best fit with 20-100"



Phase space

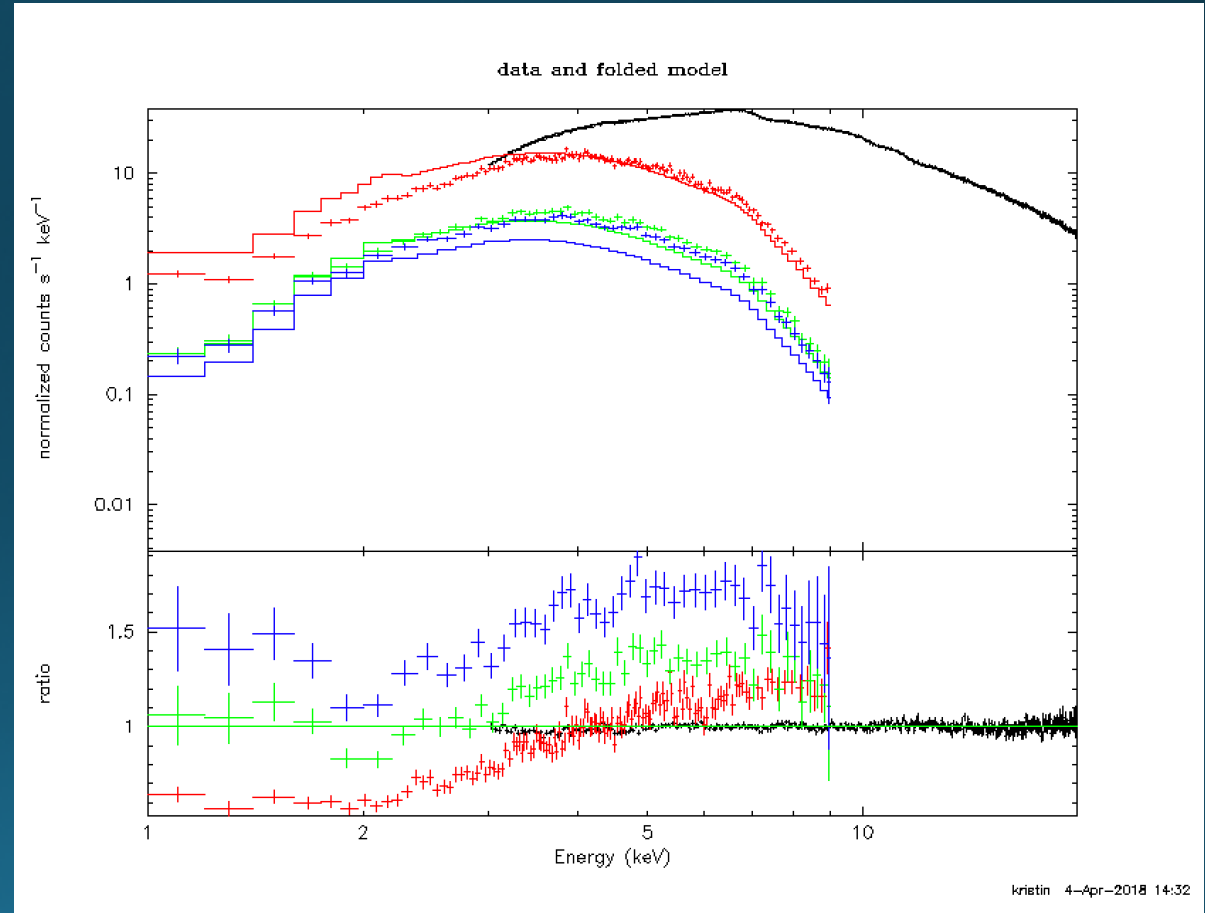


GRO J1744-28



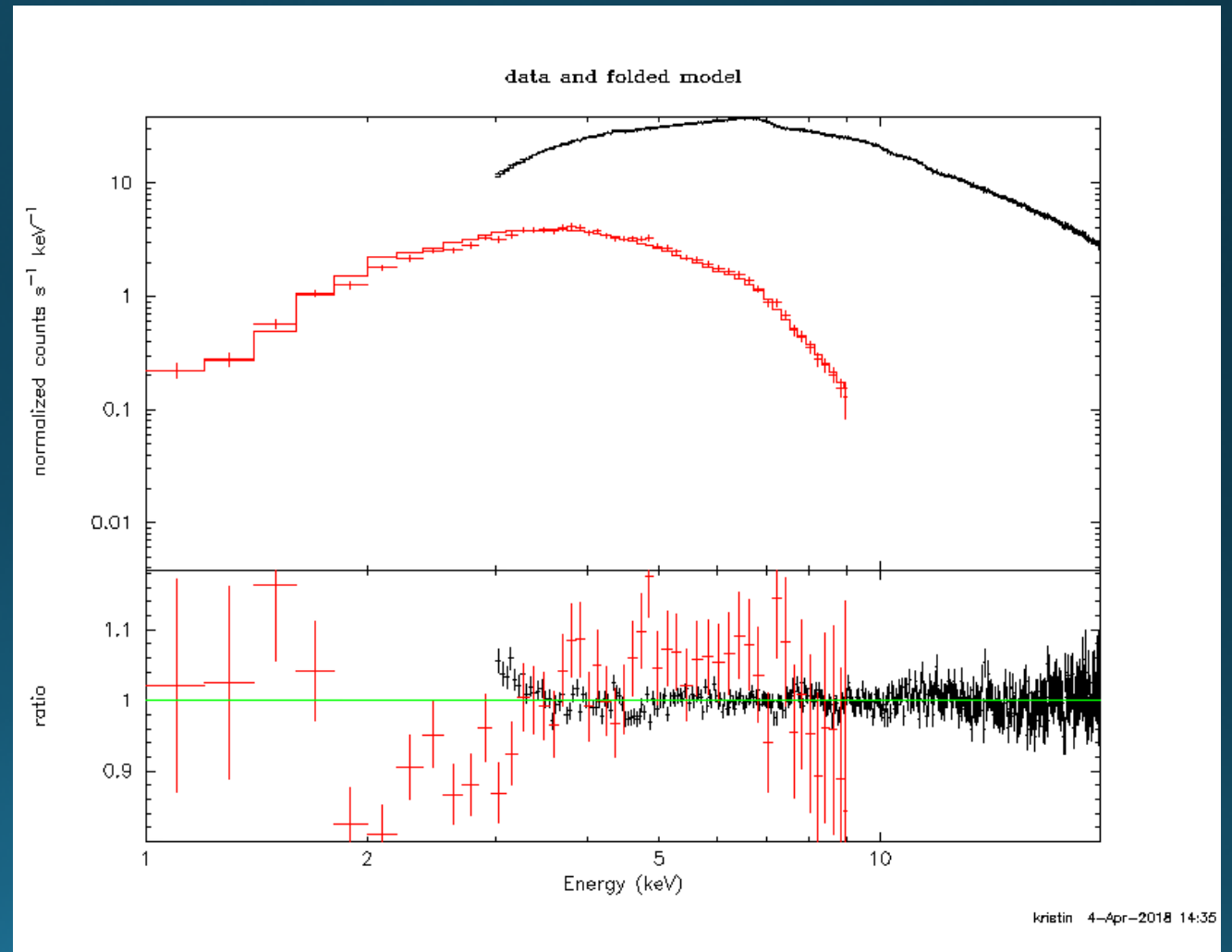
GRO J1744-28

Red: 150" circle
Green: annulus 10-100", grade 0
Blue: 15 - 100", grade 0

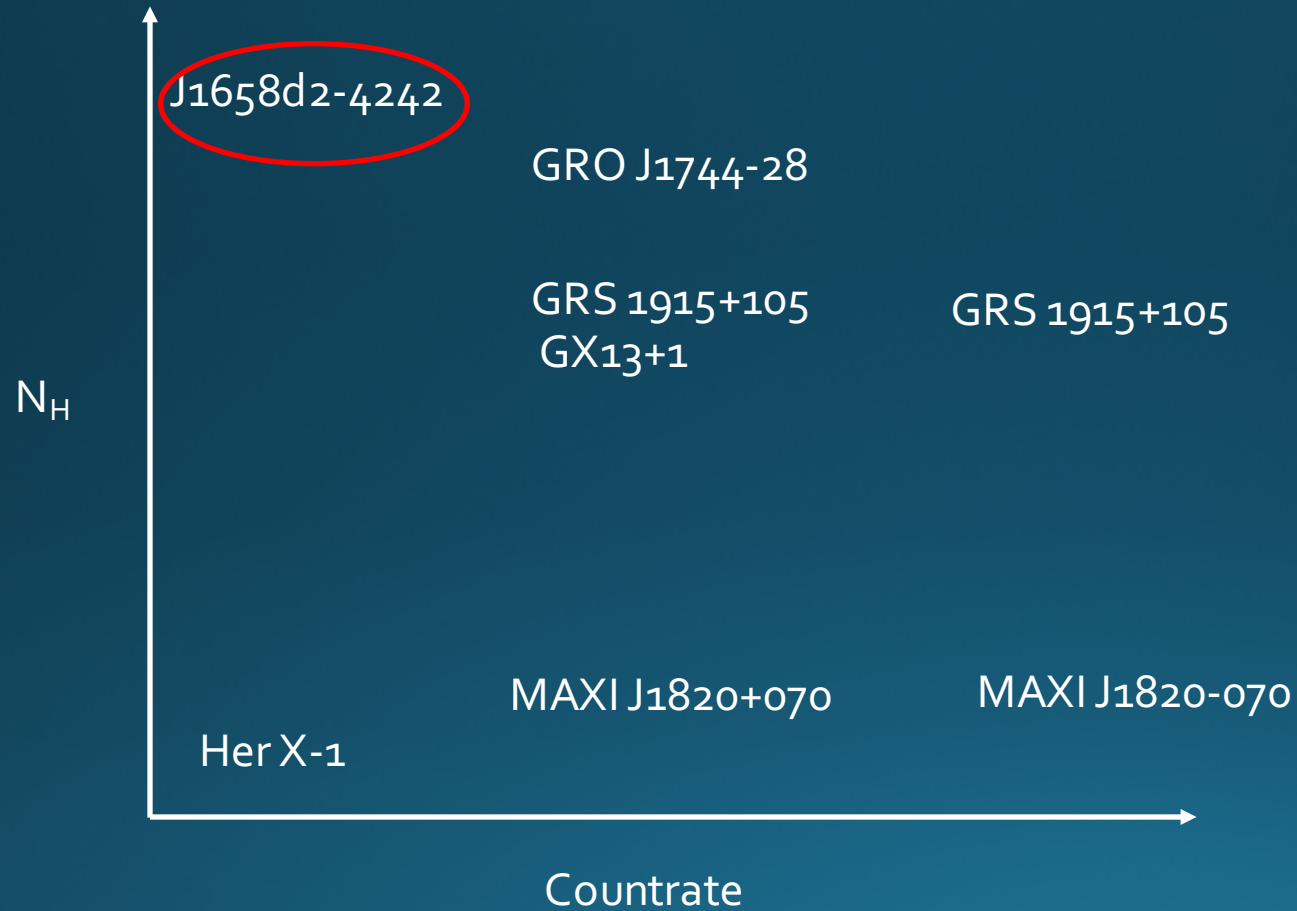


GRO J1744-28: Alright'ish

Best fit: 15 - 100a'', grade 0

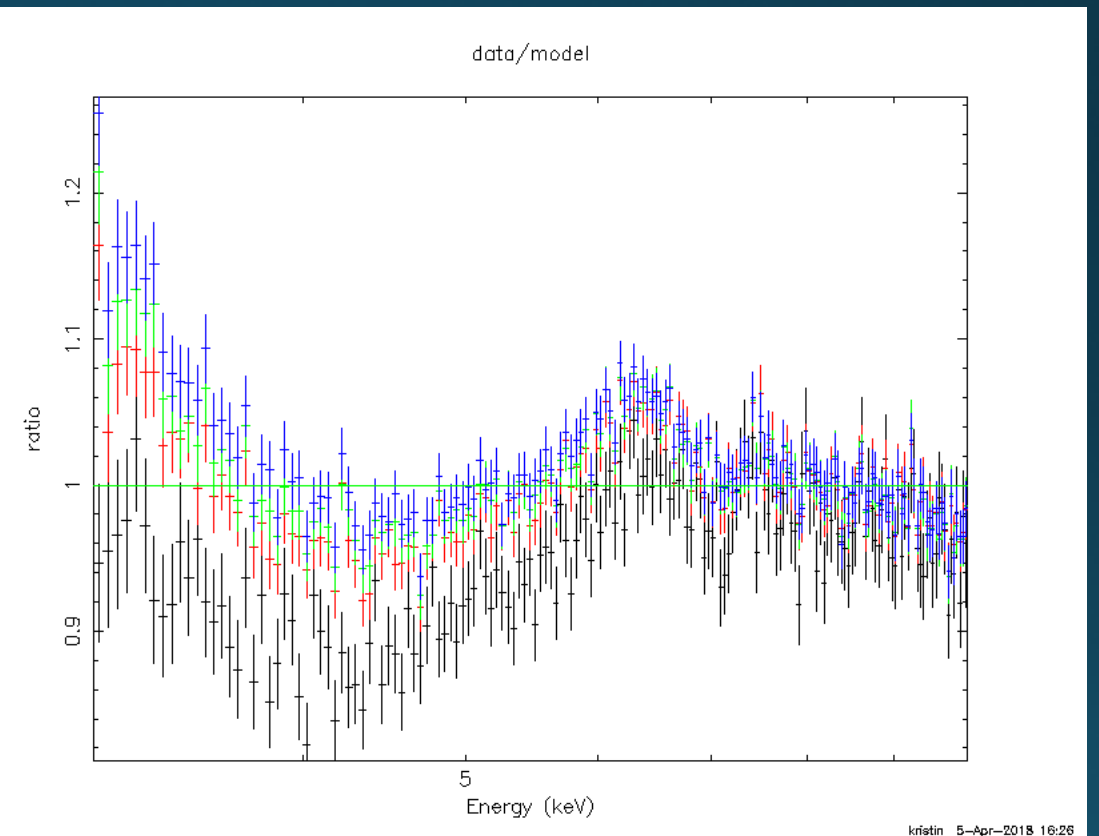


Phase space



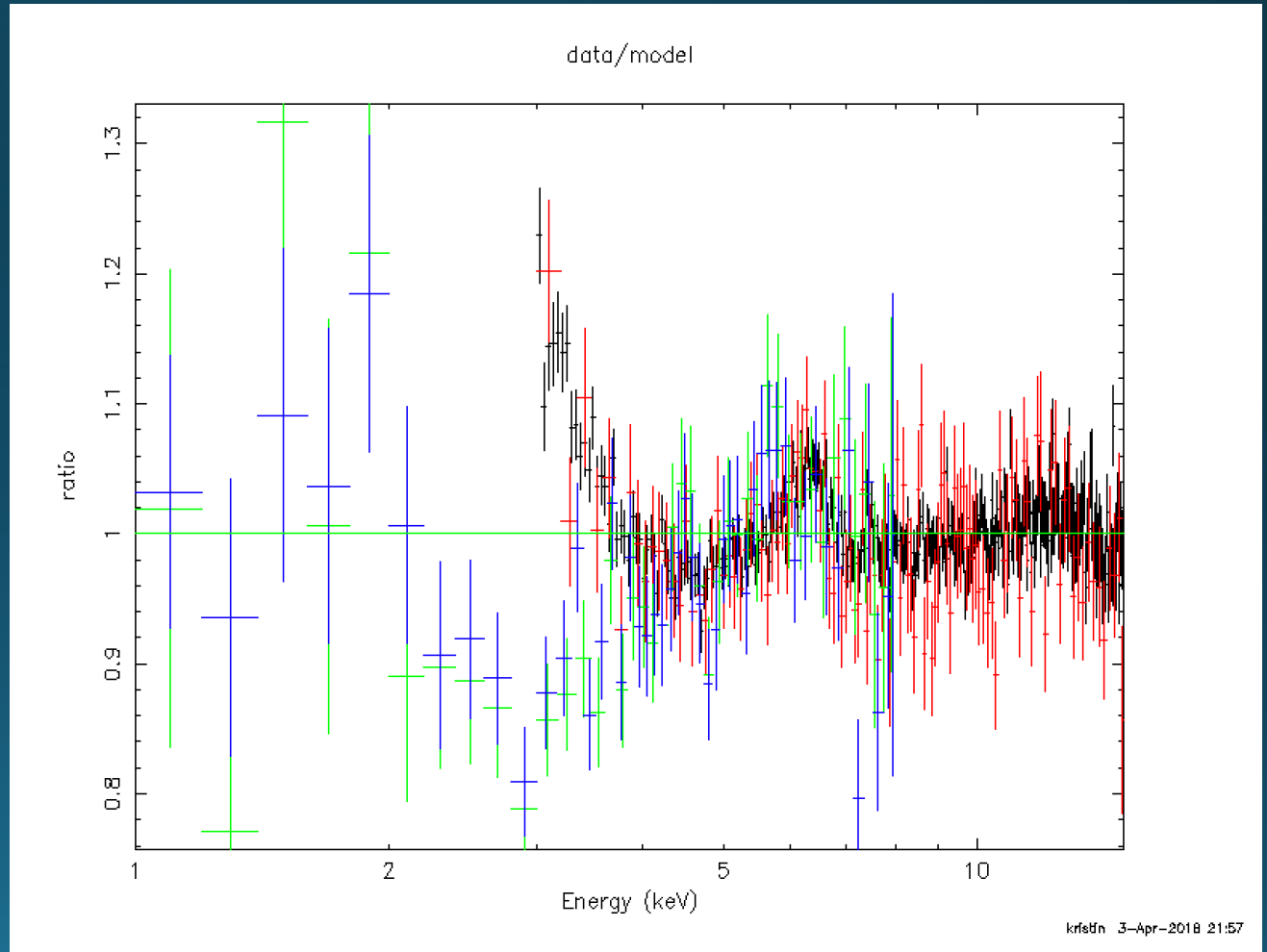
J1658d2-4242

Halo size comparable, if not bigger,
than GRO J1744-28

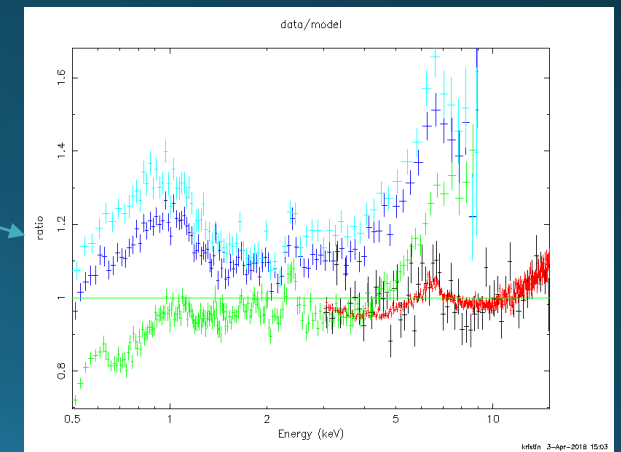
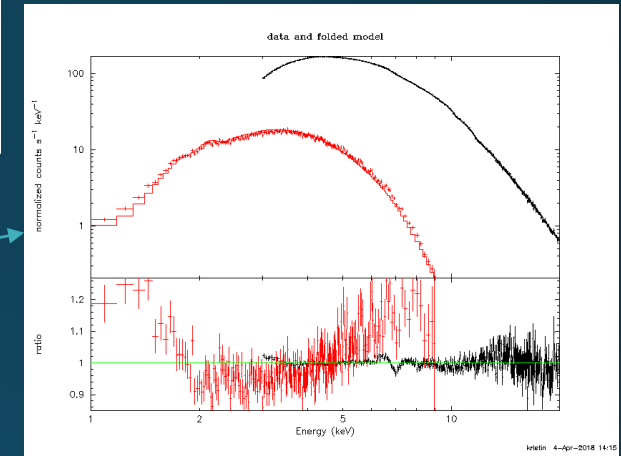
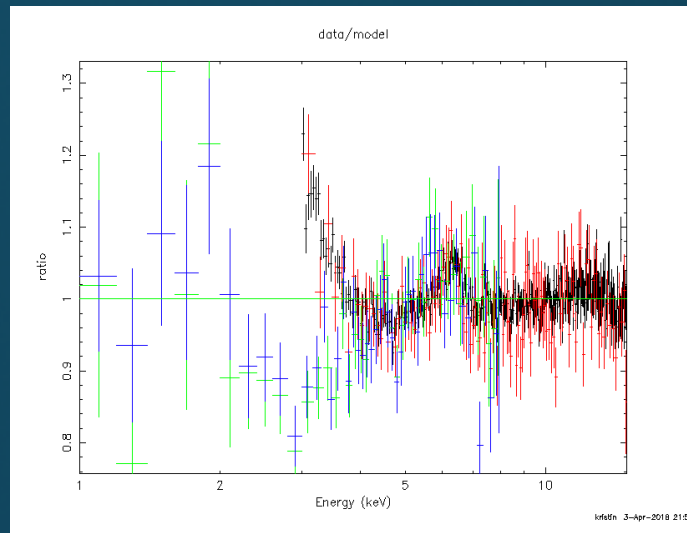
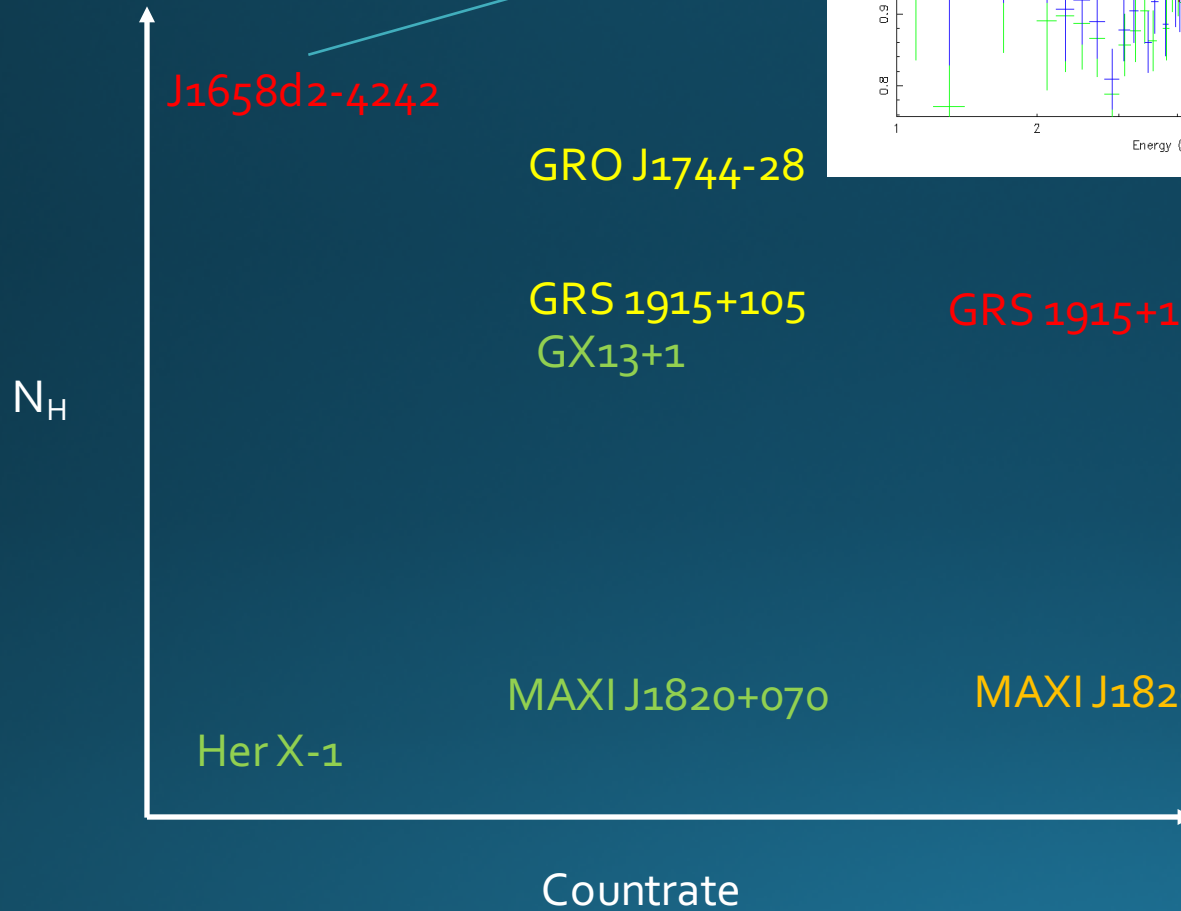


J1658d2-4242: Not good

Green: circle 40"
Blue: circle 40", grade 0



Phase space



Conclusions

- Grade 0 is a must
- More research on extraction regions
- More research on excision radius
 - Check Her X-1
- Position dependent RMFs?
- More observations of low N_{H} v. high N_{H} sources, and bright v. moderate bright
- NuSTAR low energy tails, $\sim 5\%$ can be attributed to calibration errors