



eROSITA observations of isolated neutron stars

Contamination monitoring

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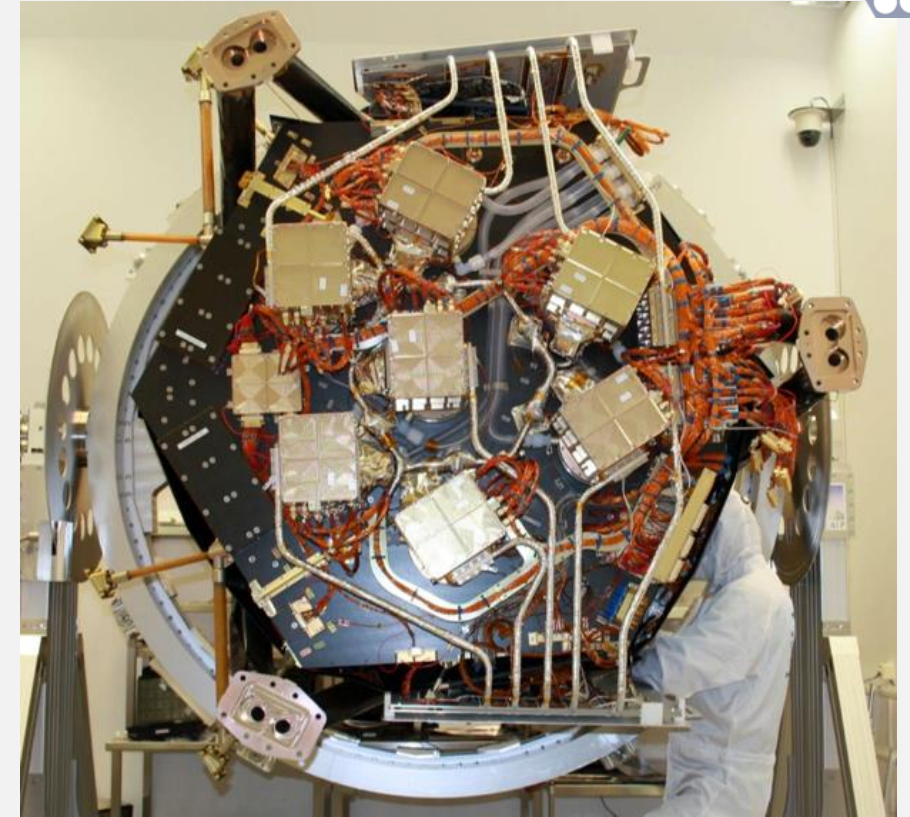
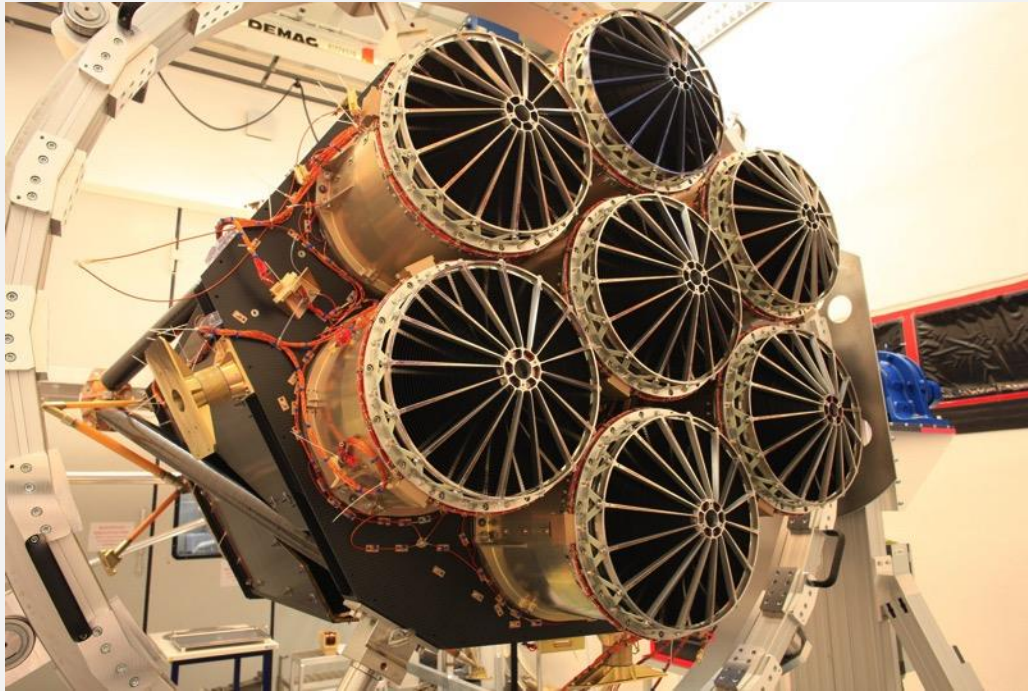


Baikonur, July 13th, 2019

Source: Roscosmos

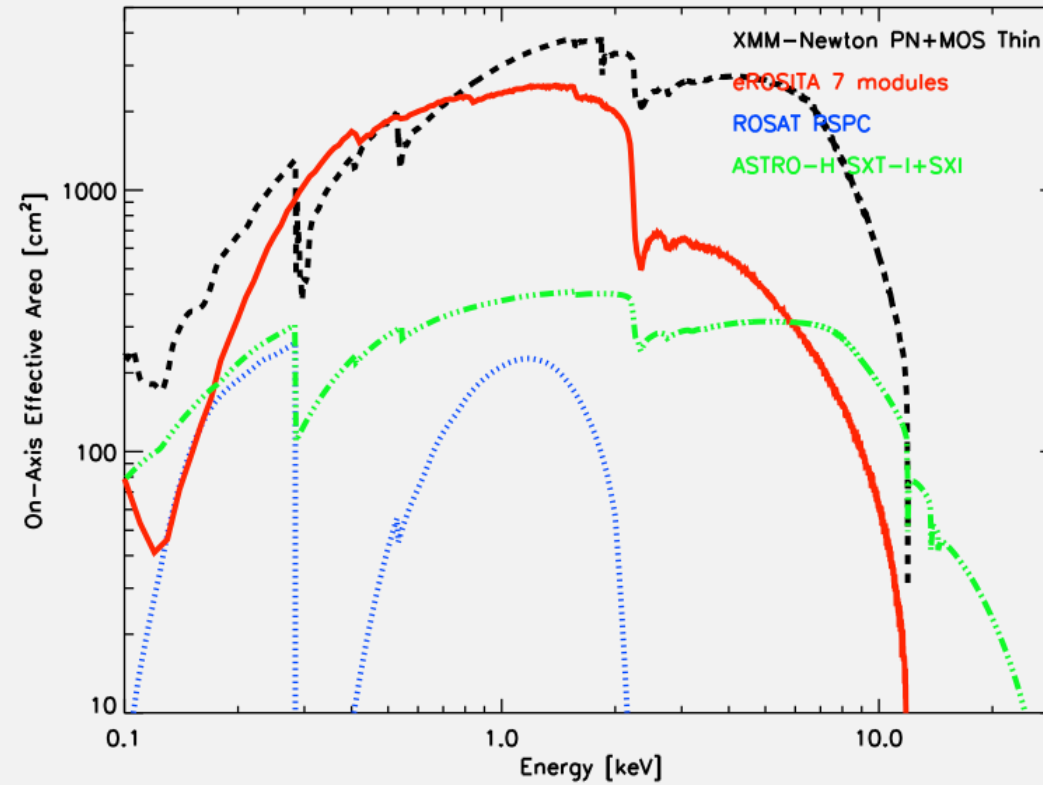
Quelle: Roscosmos

7 Mirrors + pnCCDs



- Focal length: 1.6 m. **Field of view:** 1 degree (diameter)
- Half-Energy width (HEW) $\sim 18''$ (on-axis); $27''$ (FoV avg.)
- **Spectral resolution** at all measured energies within specs ($\sim 80\text{eV}$ @ 1.5keV)
- Strongly reduced redistribution at low energies
- pn CCDs with 384×384 pixels, frame-store area
- Extremely good detector **uniformity, no chip gaps**

Effective Area



- Effective area at 1keV comparable with XMM-Newton
- Effective Area: $\sim 1700 \text{ cm}^2$ (FoV avg. @1keV)



RX J1856.5-3754 (main target)
RXS J214303.7+065419 (=RBS1774)
RX J1605.3+3249

Telescope modules

TM1, TM2, TM3, TM4, TM6 on-chip 200nm Al layer + external 200nm PI foil
TM5, TM7 external 100nm Al + 200nm foil (light leakage)

Event patterns

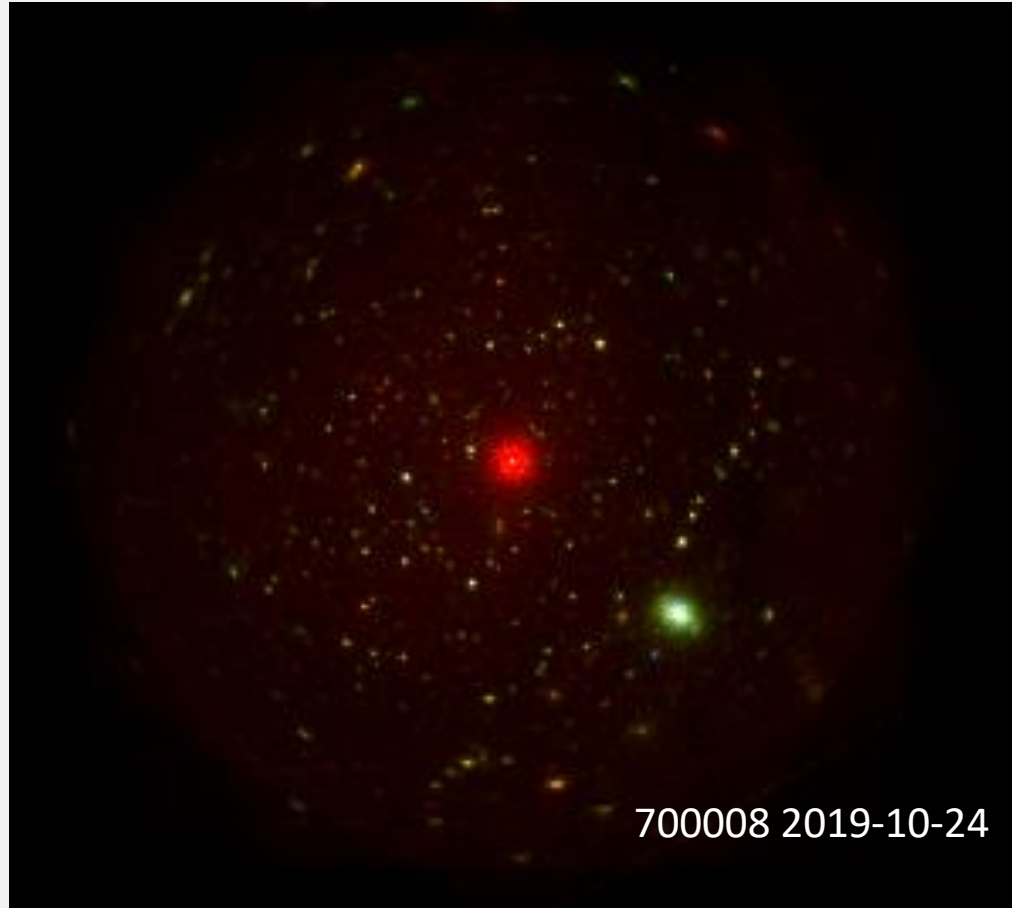
Singles, Doubles, Triples, Quadruples
S (PAT=1), S+D (PAT=3), S+D+T+Q (PAT=15)



The observations (after SRG orbit correction maneuvers):

Target	Obsid	Time	Net Exposure (ks)				
			TM1	TM2	TM3	TM4	TM6
RXJ1856	700008	2019-10-24 11:15 - 2019-10-25 08:55	75.97	75.99	75.99	75.98	76.00
RXJ2143	700198	2019-12-02 20:01 - 2019-12-03 11:18	55.20	55.23	55.23	55.22	55.24
RXJ1856	710001	2020-04-02 00:00 - 2020-04-02 10:00	32.62	27.05	32.90	32.89	32.90
RXJ1605	720000	2020-08-06 05:00 - 2020-08-06 15:00	33.12	33.16	33.08	33.16	33.10
RXJ1856	720002	2020-10-07 20:00 - 2020-10-08 13:00	60.85	55.94	60.71	58.98	56.99
RXJ2143	720005	2020-11-25 18:00 - 2020-11-26 10:30	56.99	56.67	56.81	55.85	55.77
RXJ1605	730000	2021-03-07 17:30 - 2021-03-08 10:10	60.14	59.70	60.16	60.16	60.16
RXJ2143	730031	2021-05-25 20:59 - 2021-05-26 17:00	58.36	58.36	58.36	9.22	58.35
RXJ1605	740001	2021-09-07 18:30 - 2021-09-08 11:00	59.56	59.56	59.56	38.07	59.55
RXJ2143	740005	2021-11-25 21:00 - 2021-11-26 11:00	60.0 planned				

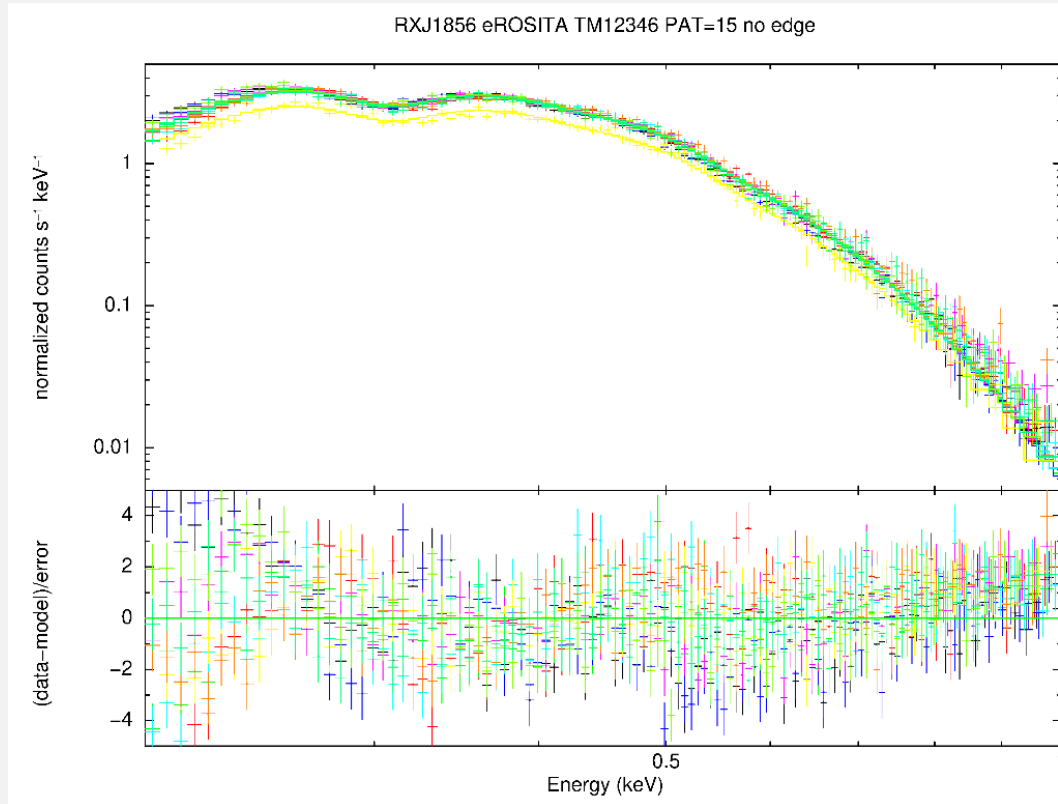
RX J1856.5-3754



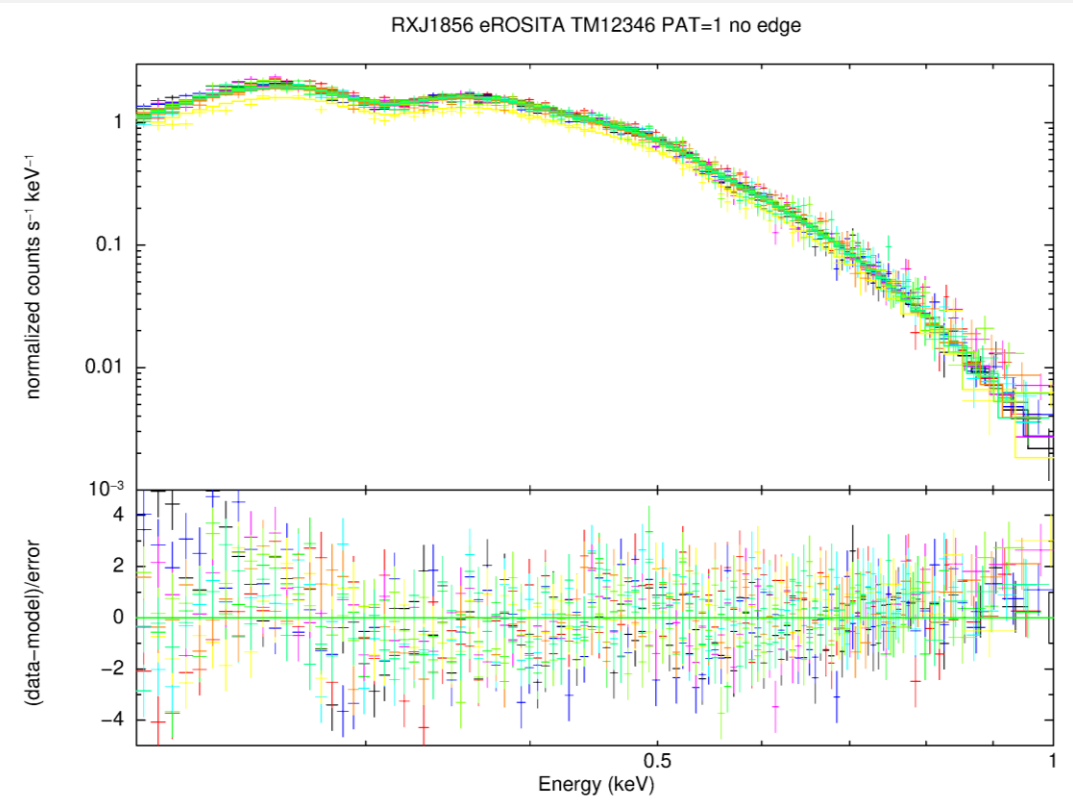
RX J1856.5-3754

- Isolated neutron star
- Black-body spectrum
 - $kT \sim 63 \text{ eV}$
 - Low NH ($5\text{-}10 \times 10^{19} \text{ cm}^{-2}$)
- (e.g. Burwitz+2013)
- Used as calibration standard
 - Low-energy response
 - Contamination

Black-body model PAT=15 vs. PAT = 1



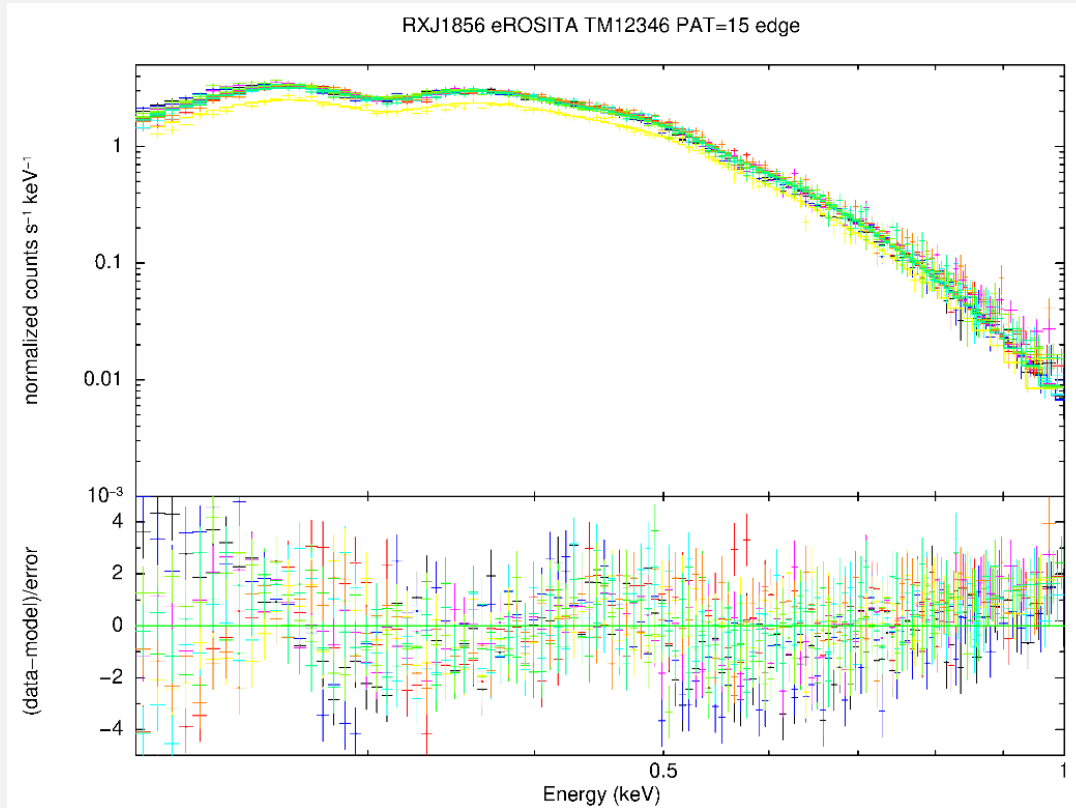
$\chi^2 / \text{dof} = 2990.4 / 1294$
 $NH = 0$



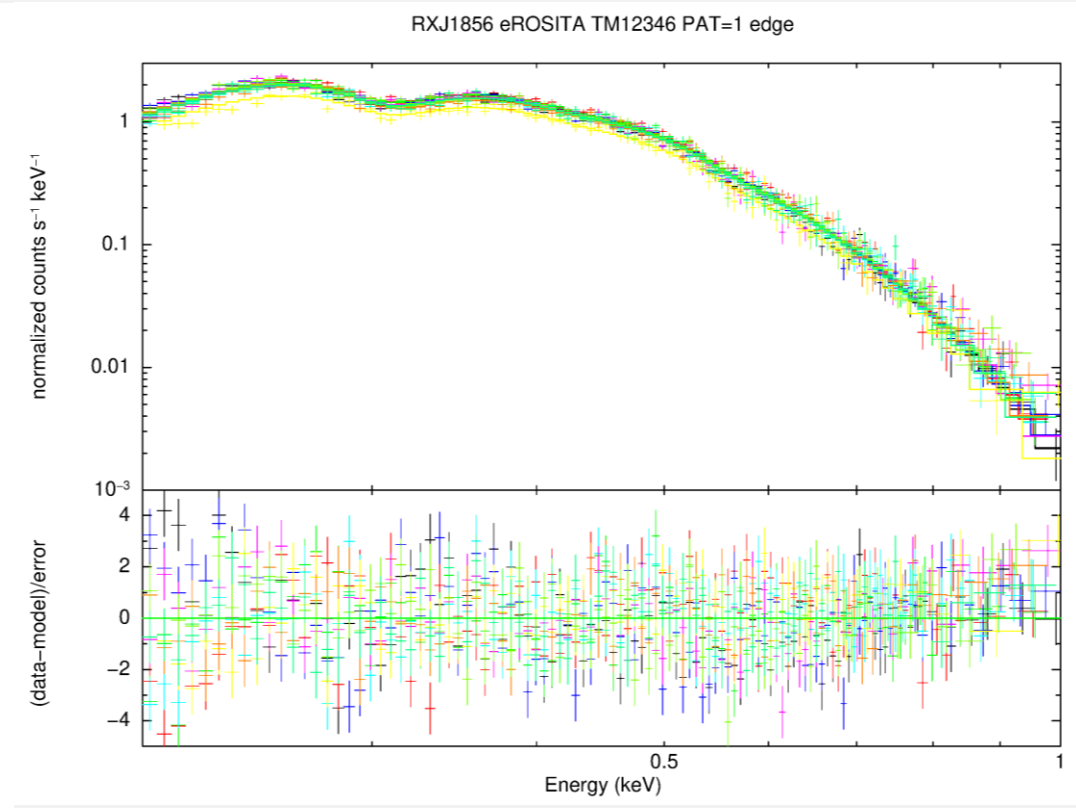
$\chi^2 / \text{dof} = 1957.5 / 1059$
 $NH = 0$

Simultaneous fits with most parameters linked
 $T_{\text{babs}} * \text{bbodyrad} * \text{constant}$ (constant factors free)

Black-body with edge model PAT=15 vs. PAT = 1

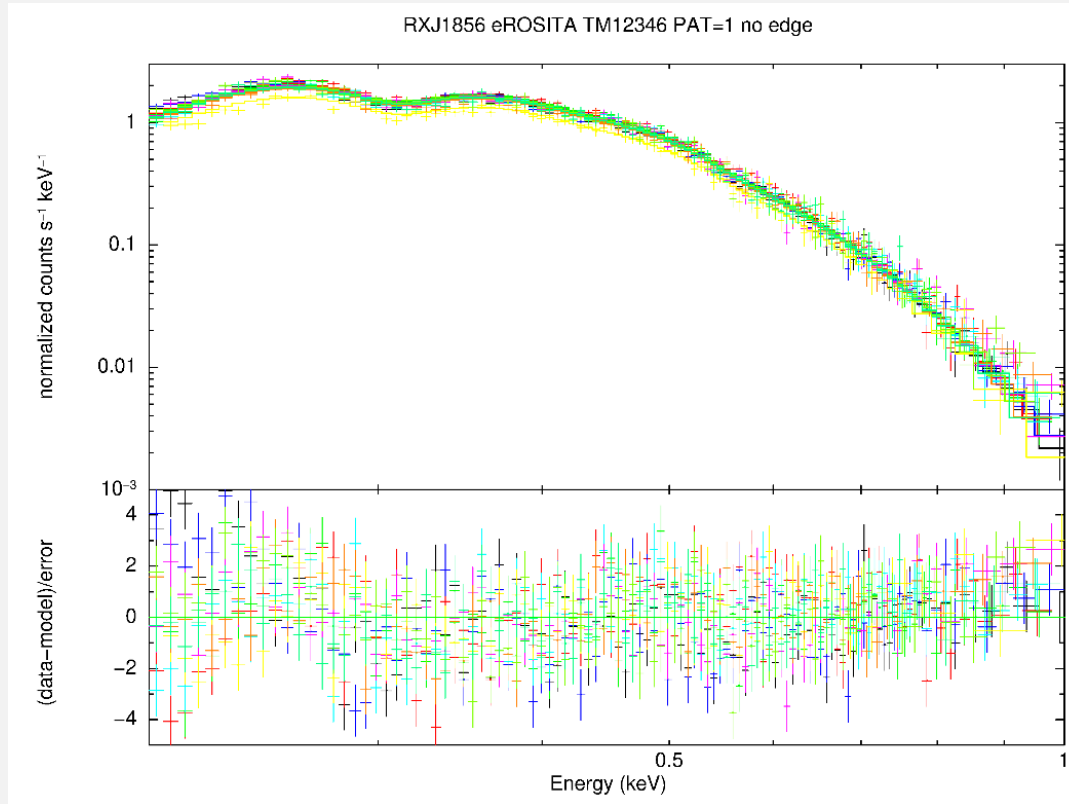


$\chi^2 / \text{dof} = 2754.7 / 1283$
 $NH = 0$

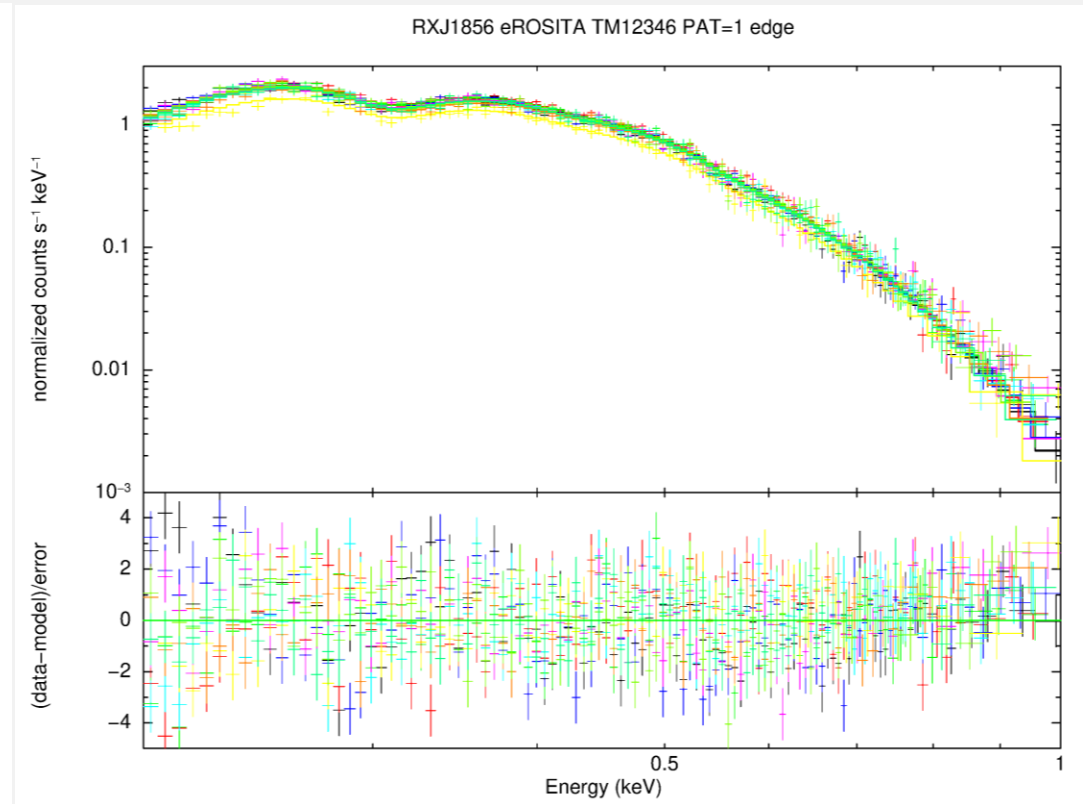


$\chi^2 / \text{dof} = 1784.5 / 1048$
 $NH = 0.52 (<1.2) \times 10^{19} \text{ cm}^{-2}$
 Edge E = 286.5 (282.3-294.3) eV
 C-K edge = 283.8 eV

PAT = 1 no edge vs. edge



$\chi^2 / \text{dof} = 1957.5 / 1059$

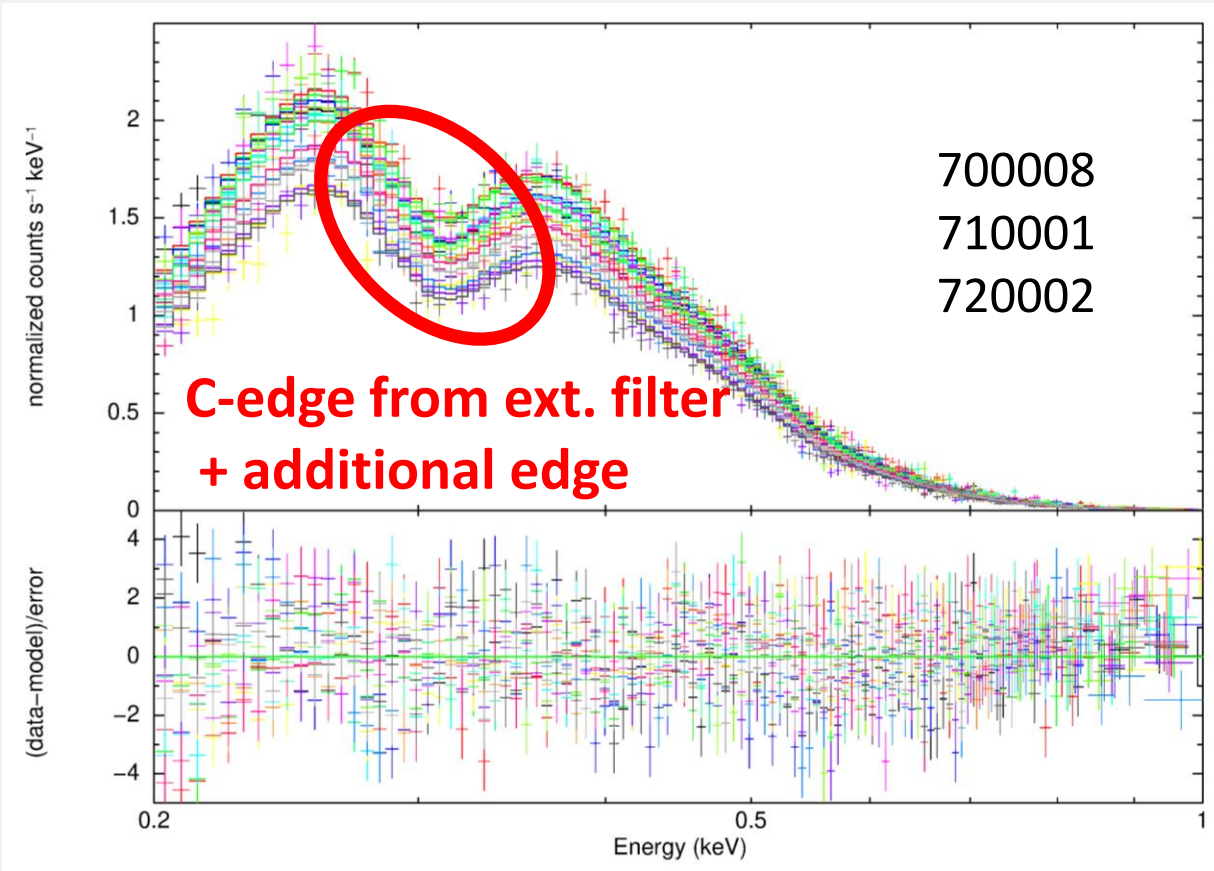


$\chi^2 / \text{dof} = 1784.5 / 1048$

$NH = 0.52 (<1.2) \times 10^{19} \text{ cm}^{-2}$

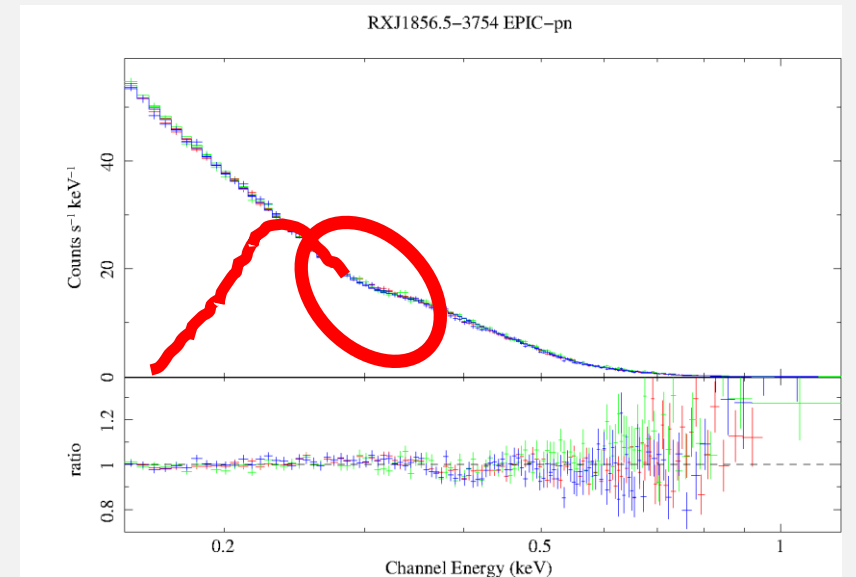
Edge $E = 286.5 (282.3-294.3) \text{ eV}$

C-K edge = 283.8 eV

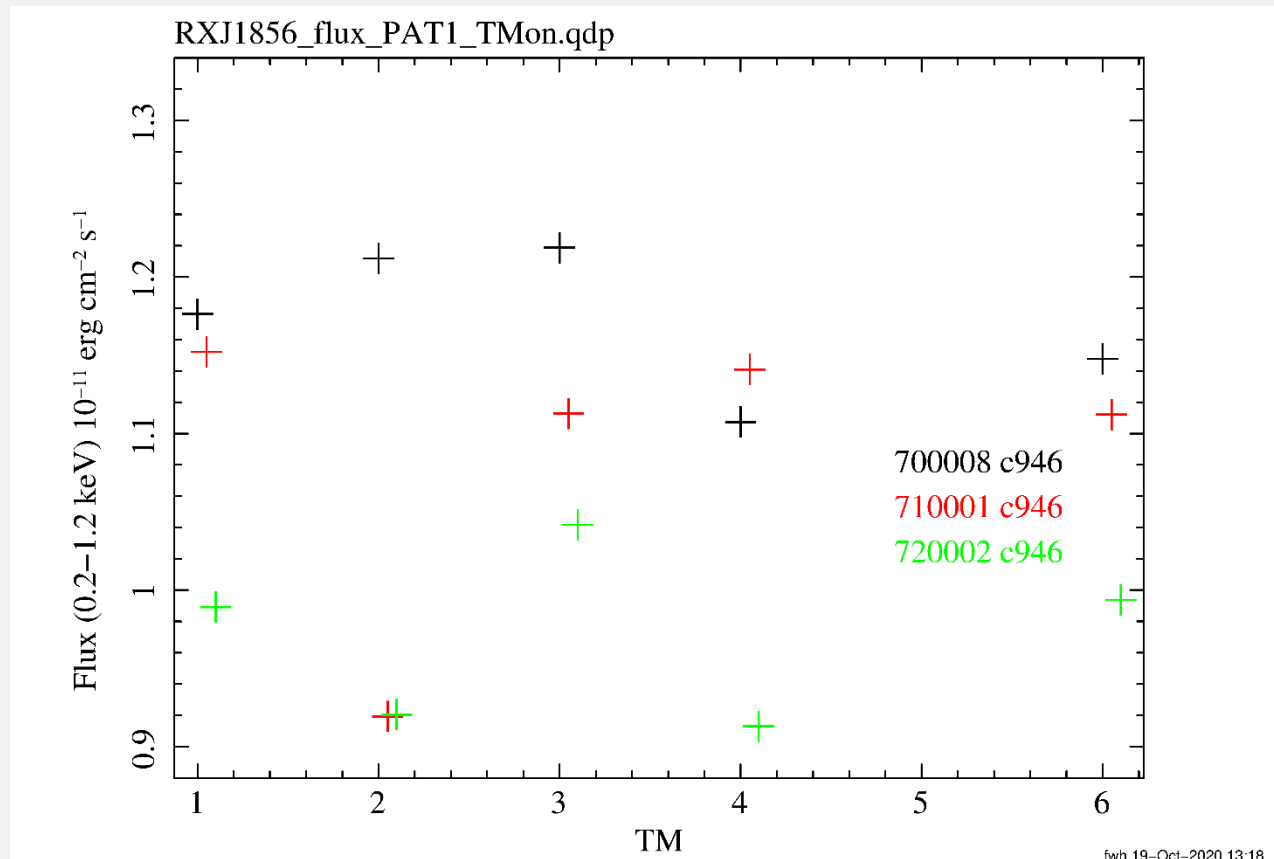


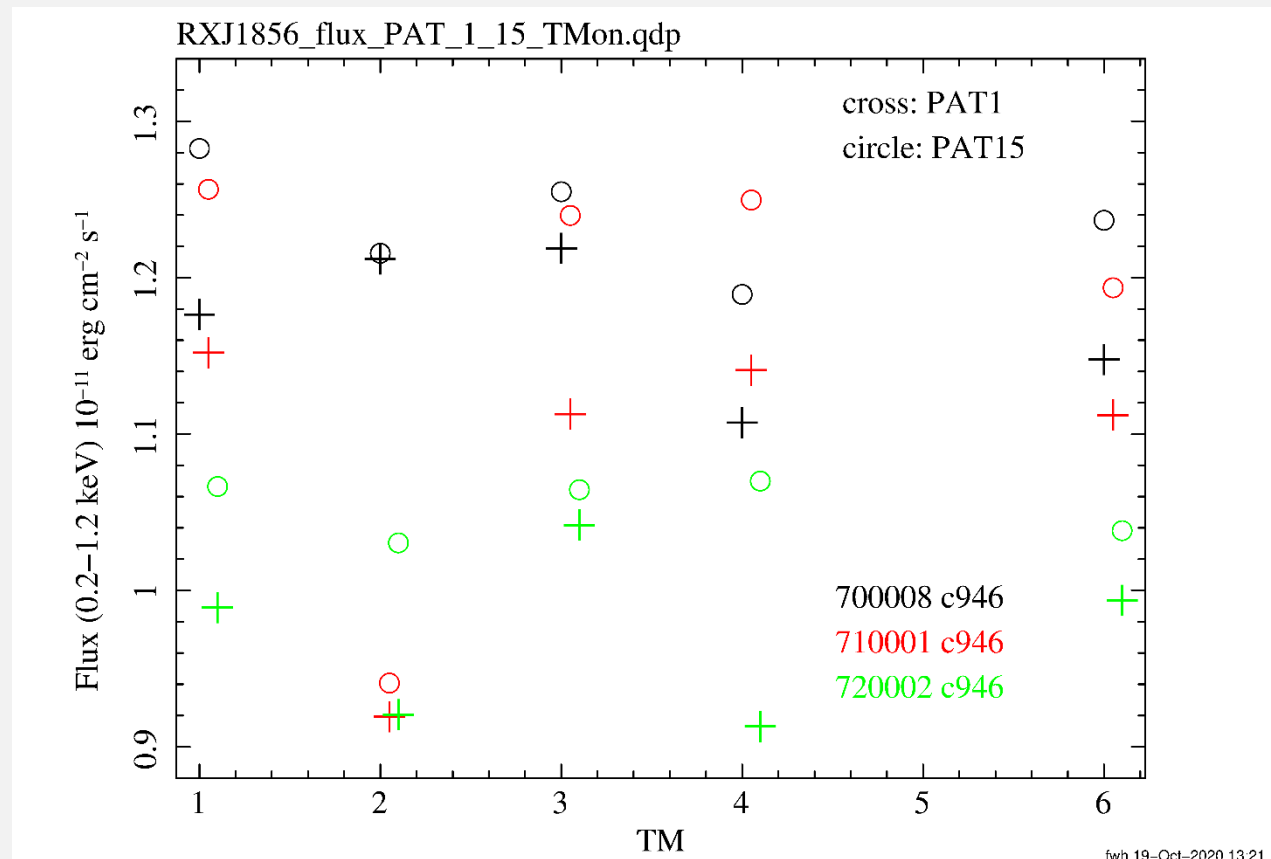
Chi² / dof: 2567.5 / 1601 = 1.60
 NH: 0.79 (<1.3) x 10¹⁹ cm⁻²
 Edge E: 286.0 (283.0-290.9) eV

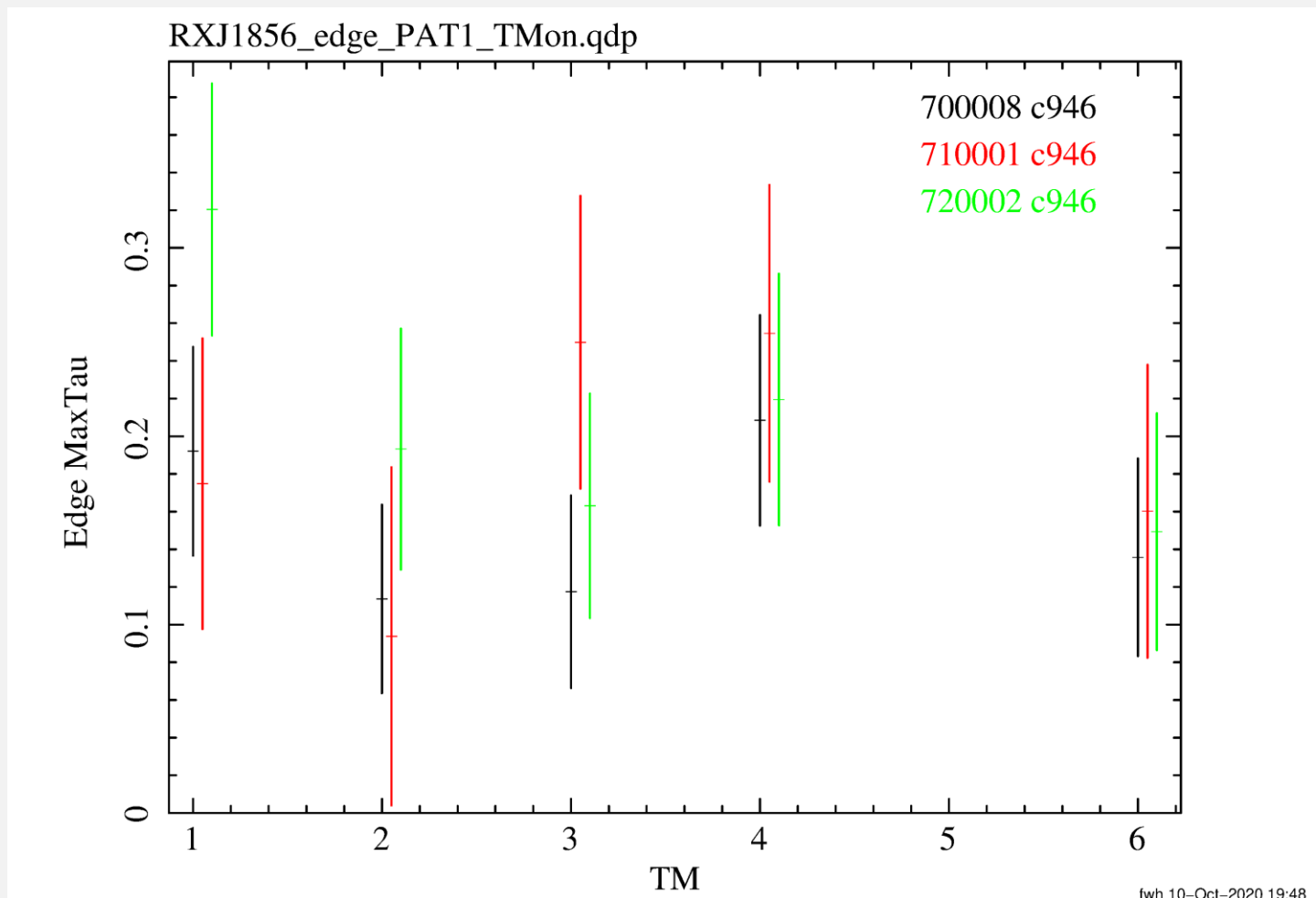
C-K edge = 283.8 eV



Black-body * edge model PAT = 1

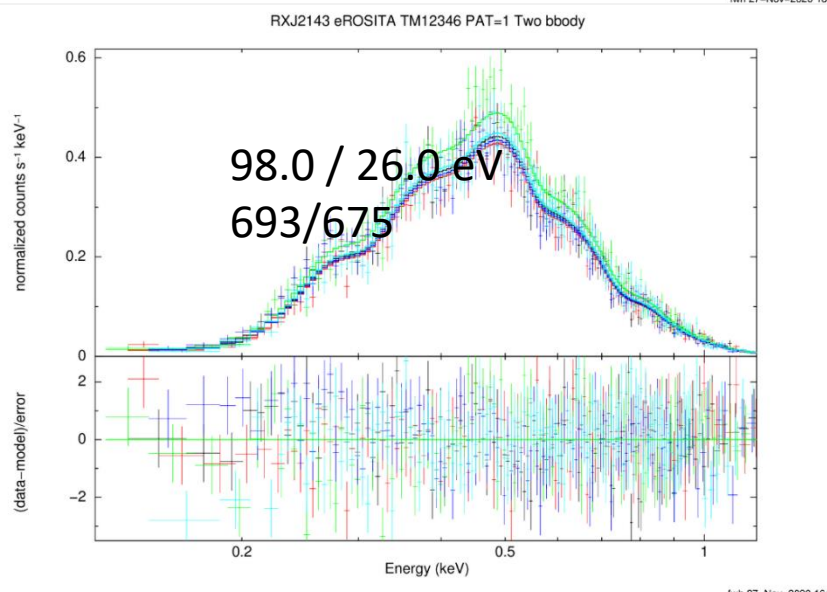
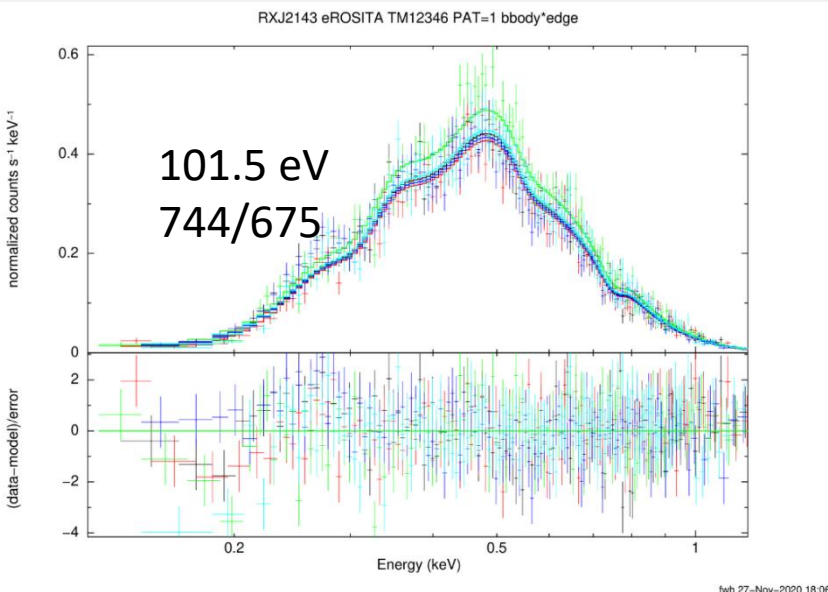
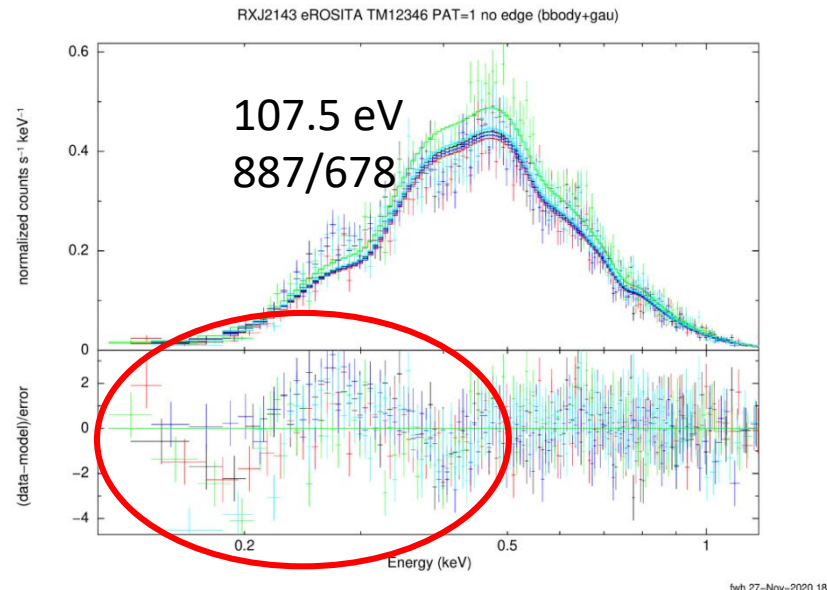
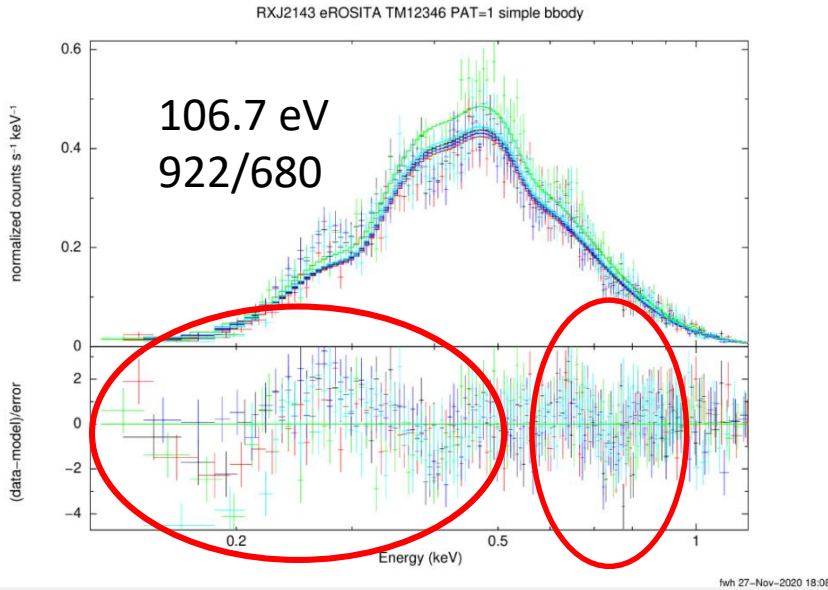








RXS J214303.7+065419

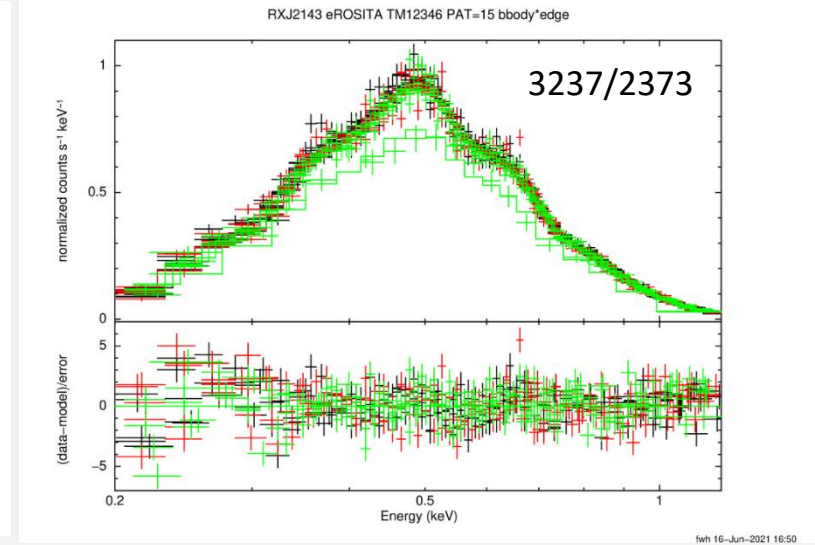
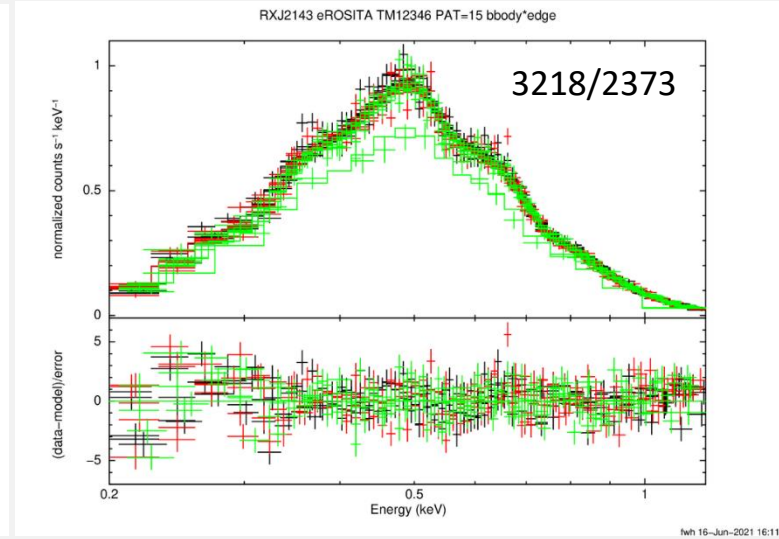
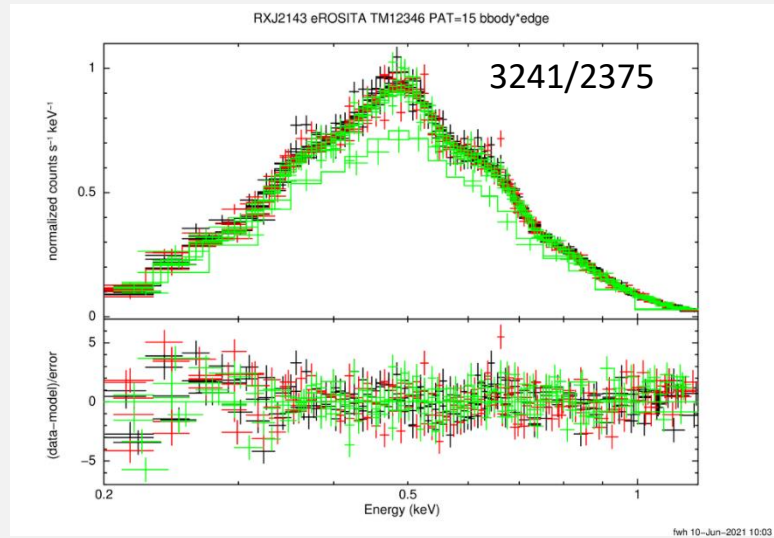
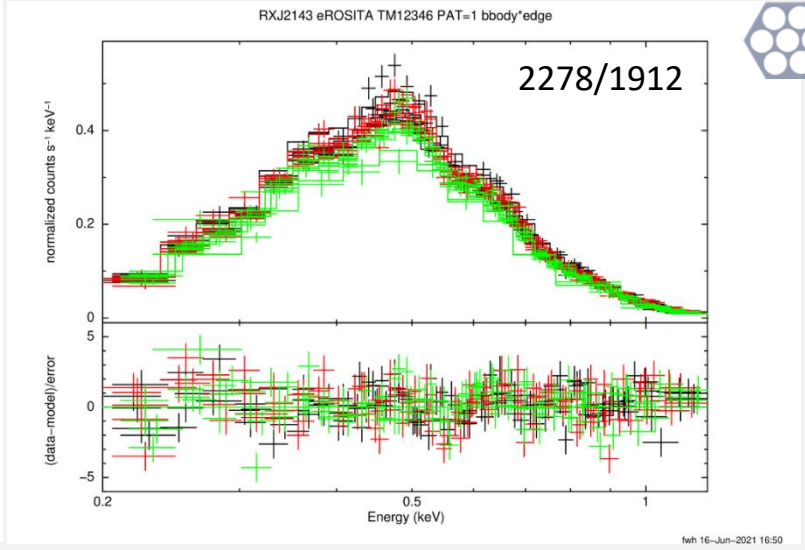
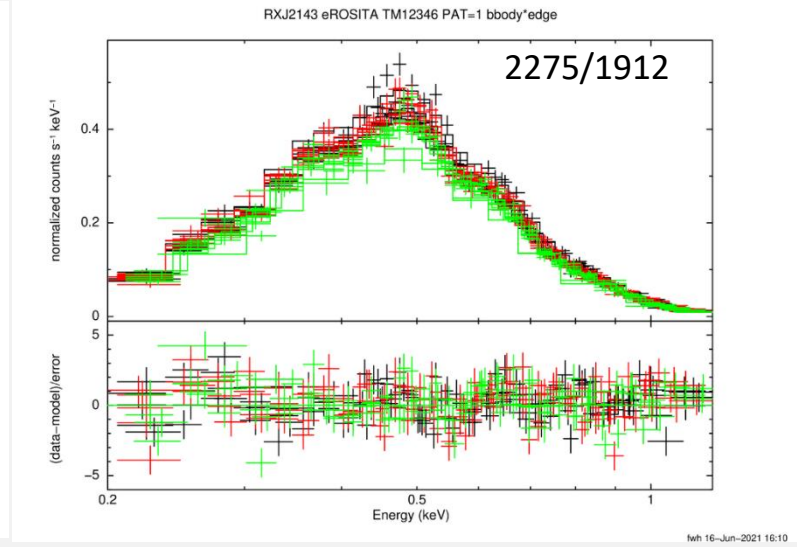
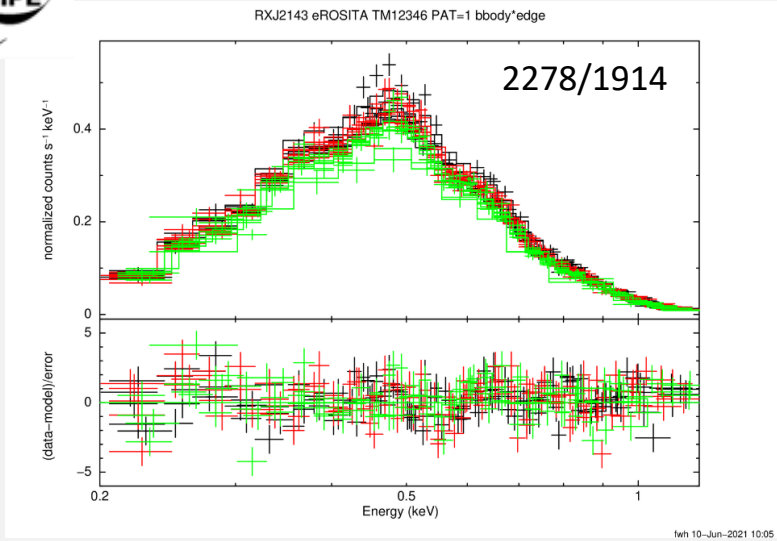


Absorption line
 $E = 750 \text{ eV}$
 $\text{Sigma} \sim 0$

Edge ($E = 366 \text{ eV}$)
 or
 2nd BB ?
 but:
 radius = 360 km
 (for $d=300\text{pc}$)
 $NH = 11e20 \text{ cm}^{-2}$
 RGS:
 $NH = 1.4e20$ fixed
 soft BB not significant

Single - pixel events

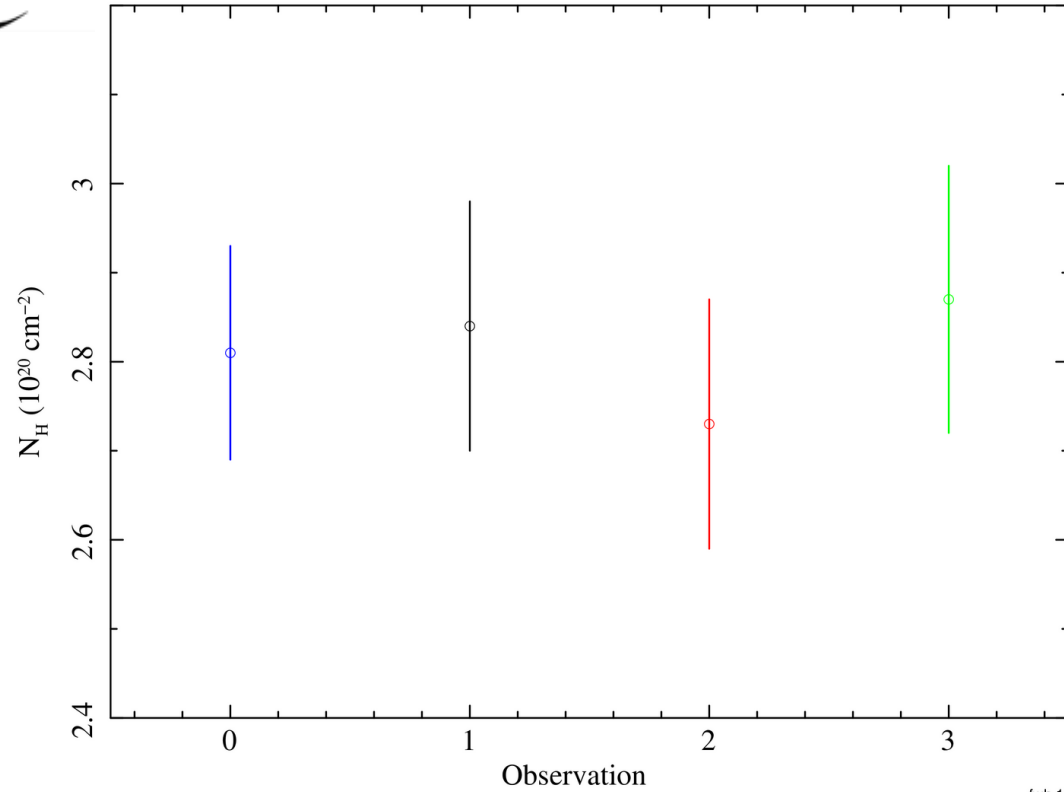
All valid patterns



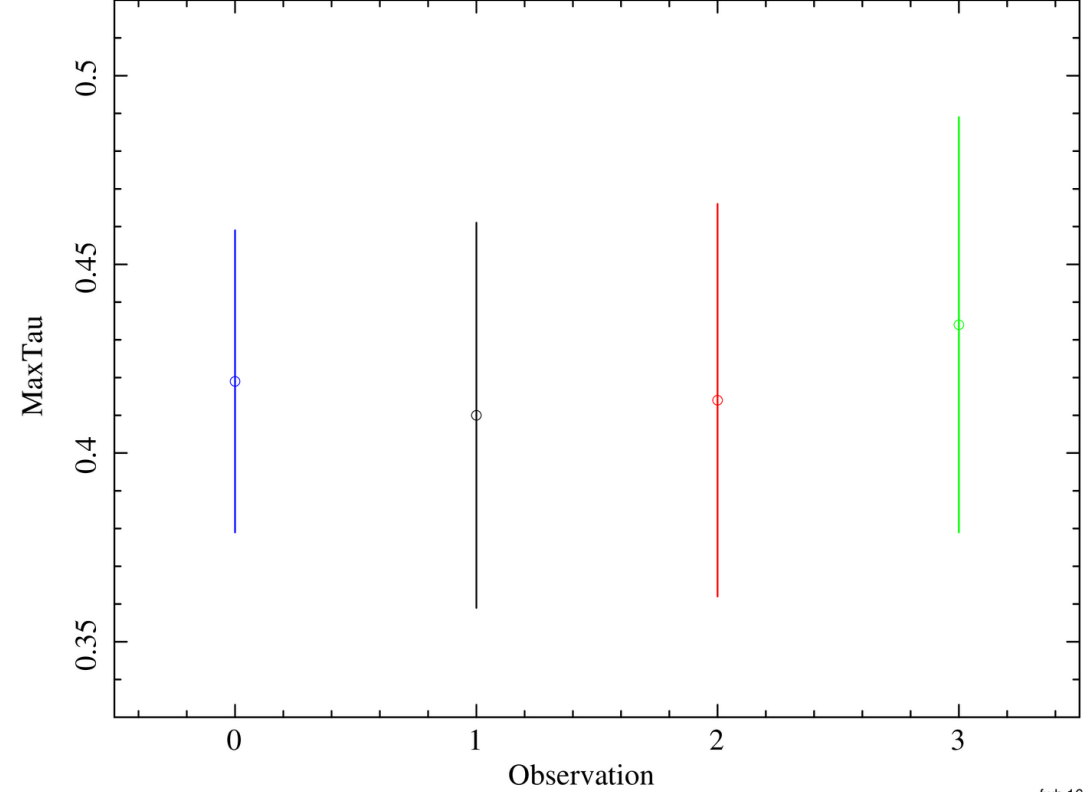
NH Common MaxTau
 $2.81 \times 10^{20} \text{ cm}^{-2}$ 0.419

3 NH values (for each observation)
 $2.84 / 2.73 / 2.87 \times 10^{20} \text{ cm}^{-2}$ 0.419

3 values for MaxTau
 $2.81 \times 10^{20} \text{ cm}^{-2}$ 0.410 / 0.414 / 0.434



fwh 16-Jun-2021 22:07



fwh 16-Jun-2021 22:11

PAT=1
Edge energy 367 +/- 3 eV



Conclusions

PAT = 1 spectra yield better fits than PAT = 15 spectra

Flux variations from camera to camera and from observation to observation

Outliers could be explained by improper handling of GTIs!

Remainder is caused by variations in the pattern fractions

Fluxes from PAT=15 spectra are more reliable

RXJ1856: low NH

low-energy threshold effects, redistribution?

Adding absorption edge improves fit

RXJ1856:

Edge energy consistent with C-K edge

RXJ2143:

Edge energy not consistent with C-K

No significant change of model parameters with time

No evidence for contamination build-up



