1ES 0229 with XMM-Newton

And its impact on calibration

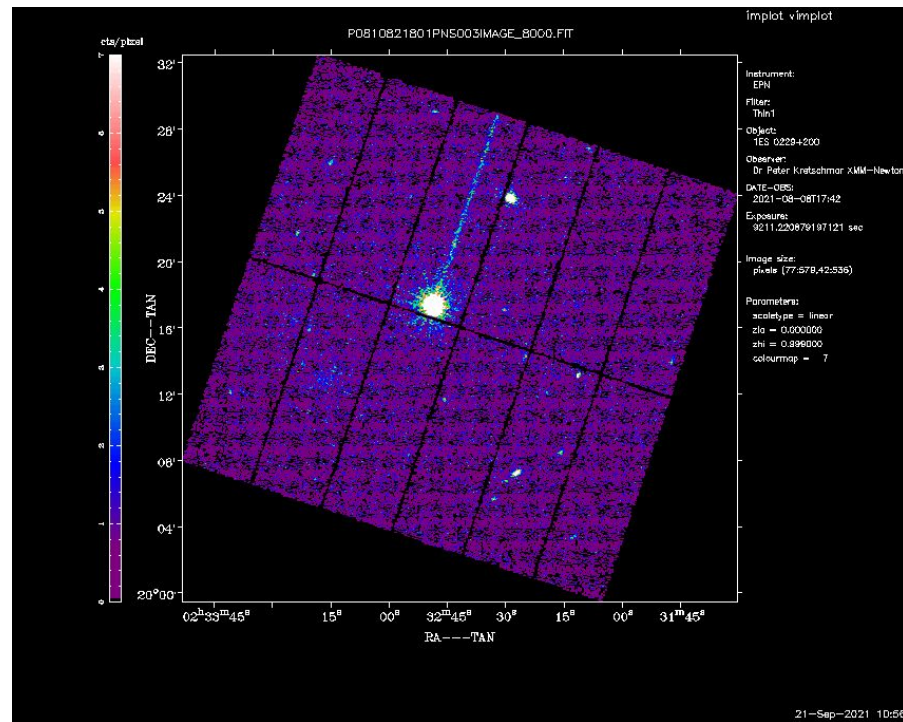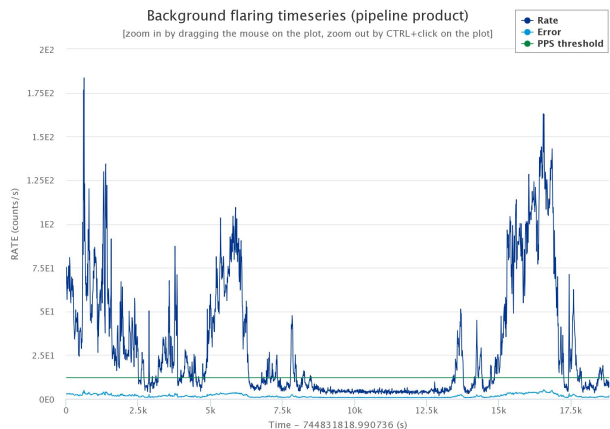Felix Fürst for the EPIC IDT at ESAC
2021/10/22
IACHEC Coordinated Obs WG meeting

ObsID 0810821801 on 2021-08-08 to 08-10

For EPIC-pn

- Full Frame exposure with 18.8ks and very bad background flaring
- **Small Window** exposure with 103ks, resulting in 60ks GTI
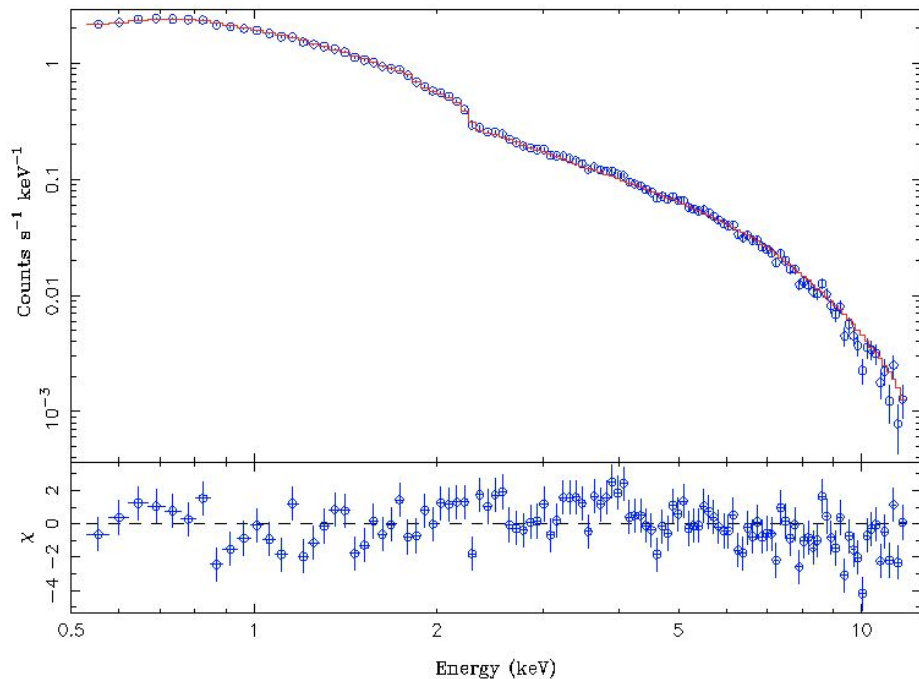
pn-only fits

tbnew*powerlaw

N_H = 0.140 +/- 0.005 e22

Γ = 2.101 +/- 0.012

Flux (2-10keV) = 5.36 +/- 0.06 e-12 erg/s/cm^2

χ^2_{red} = 1.64 (184/112)
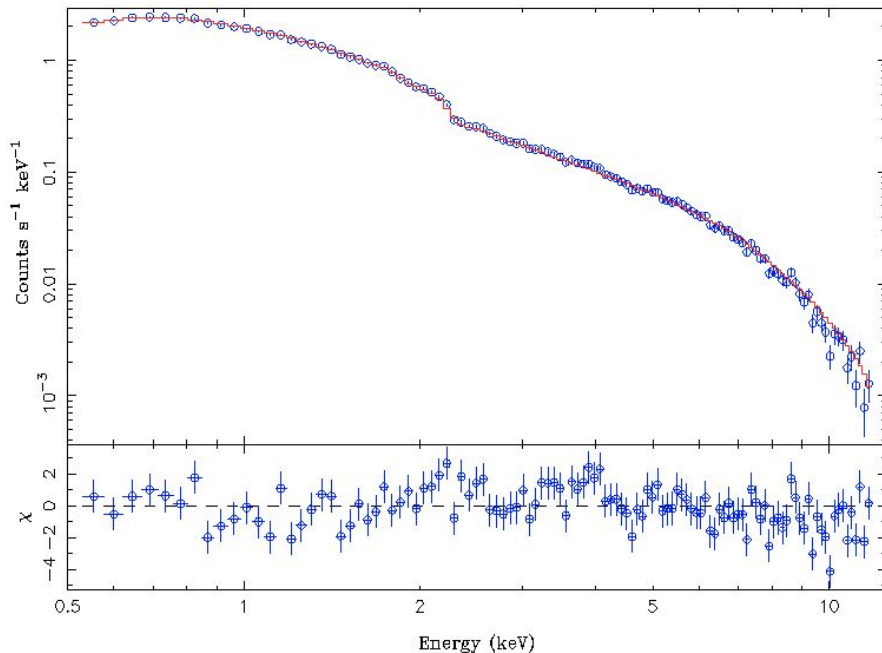
pn-only fits

Gainshift (tbnew*powerlaw)

N_H = 0.150 +/- 0.009 e22

Γ = 2.115 +/- 0.015

Flux (2-10keV) = 5.43 +/- 0.07 e-12 erg/s/cm^2

Intercept = -0.017 +/- 0.010

χ^2_{red} = 1.57 (174/111)

pn-only fits

tbnew*cutoffpl

N_H = 0.114 +/- 0.008 e22
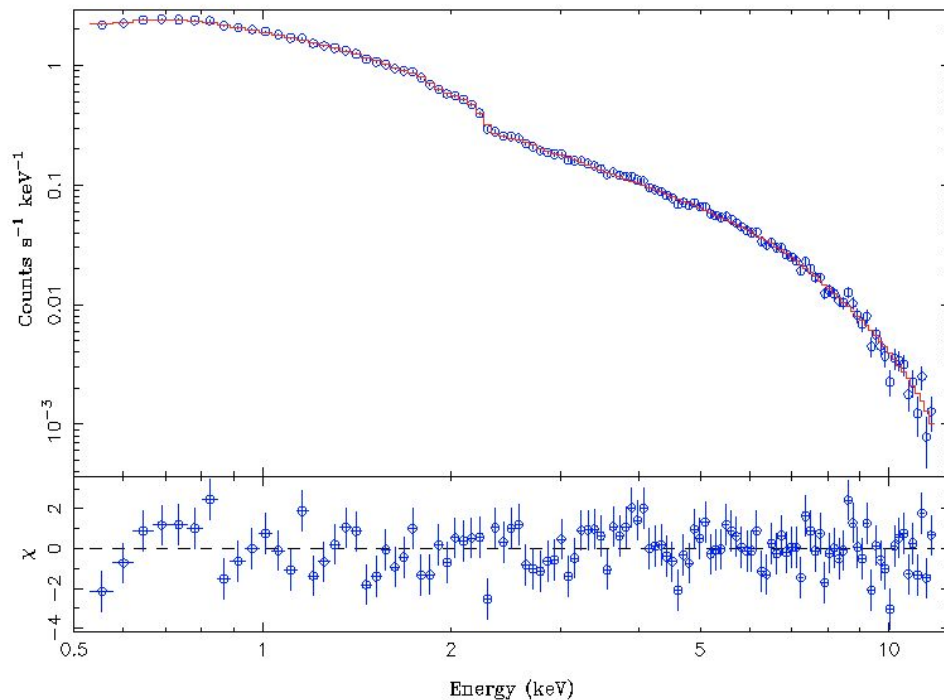
Γ = 1.93 +/- 0.05

E_cut = 19^{+6}_{-4} keV

Flux (2-10keV) = 5.28 +/- 0.06 e-12 erg/s/cm^2

χ^2_{red} = 1.20 (133/111)

Joint fits (NuSTAR + pn)

tbnew*powerlaw

CALDB v20210908

N_H = 0.147 +/- 0.005 e22
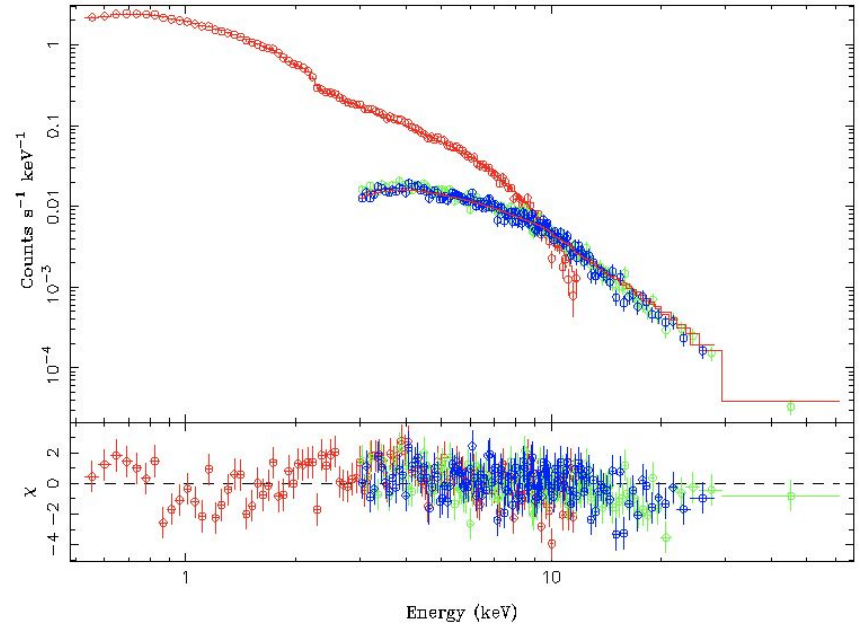
Γ = 2.123 +/- 0.011

C_FPMA = 1.036 +/- 0.024

C_FPMB = 1.069 +/- 0.025

χ^2_{red} = 1.26 (477/379)

Joint fits (NuSTAR + pn)

tbnew*powerlaw

CALDB v20210806 (NEW)

N_H = 0.148 +/- 0.005 e22
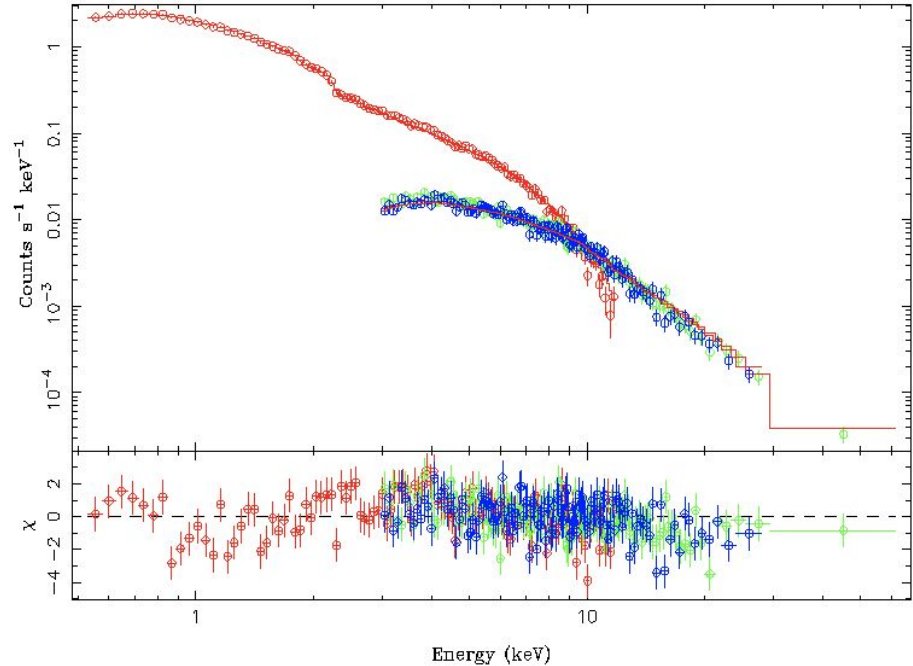
Γ = 2.125 +/- 0.011

C_FPMA = 1.131 +/- 0.026
C_FPMB = 1.131 +/- 0.026

χ^2_{red} = 1.28 (487/379)

Joint fits (NuSTAR + pn)

tbnew*cutoffpl
CALDB v20210806 (NEW)

N_H = 0.125 +/- 0.006 e22

Γ = 2.000 +/- 0.024
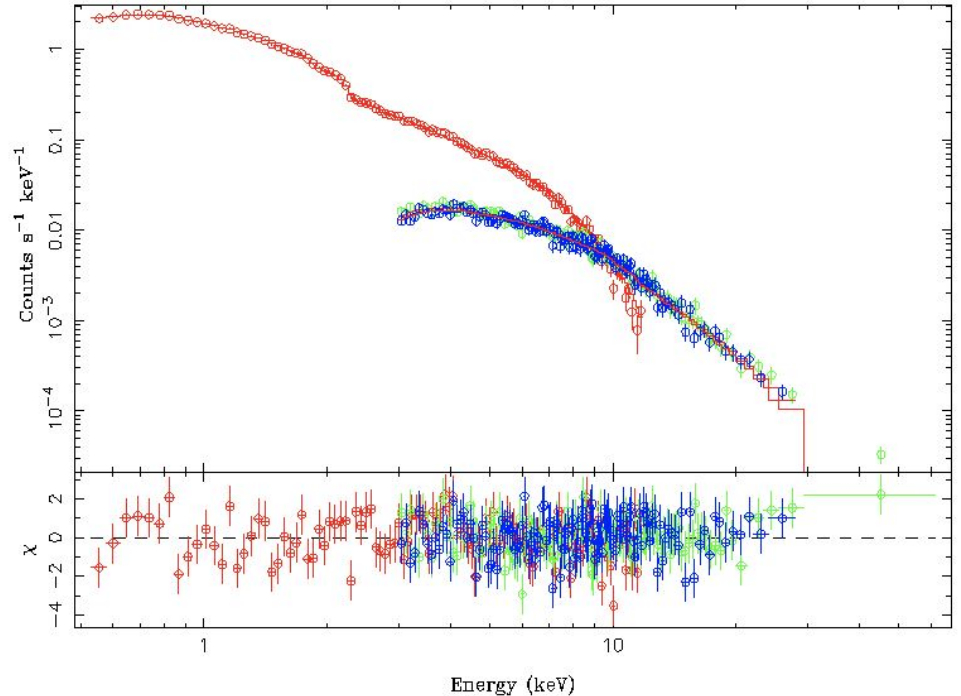
E_{cut} = 32^{+7}_{-5} keV

C_{FPMA} = 1.157 +/- 0.026
C_{FPMB} = 1.152 +/- 0.026
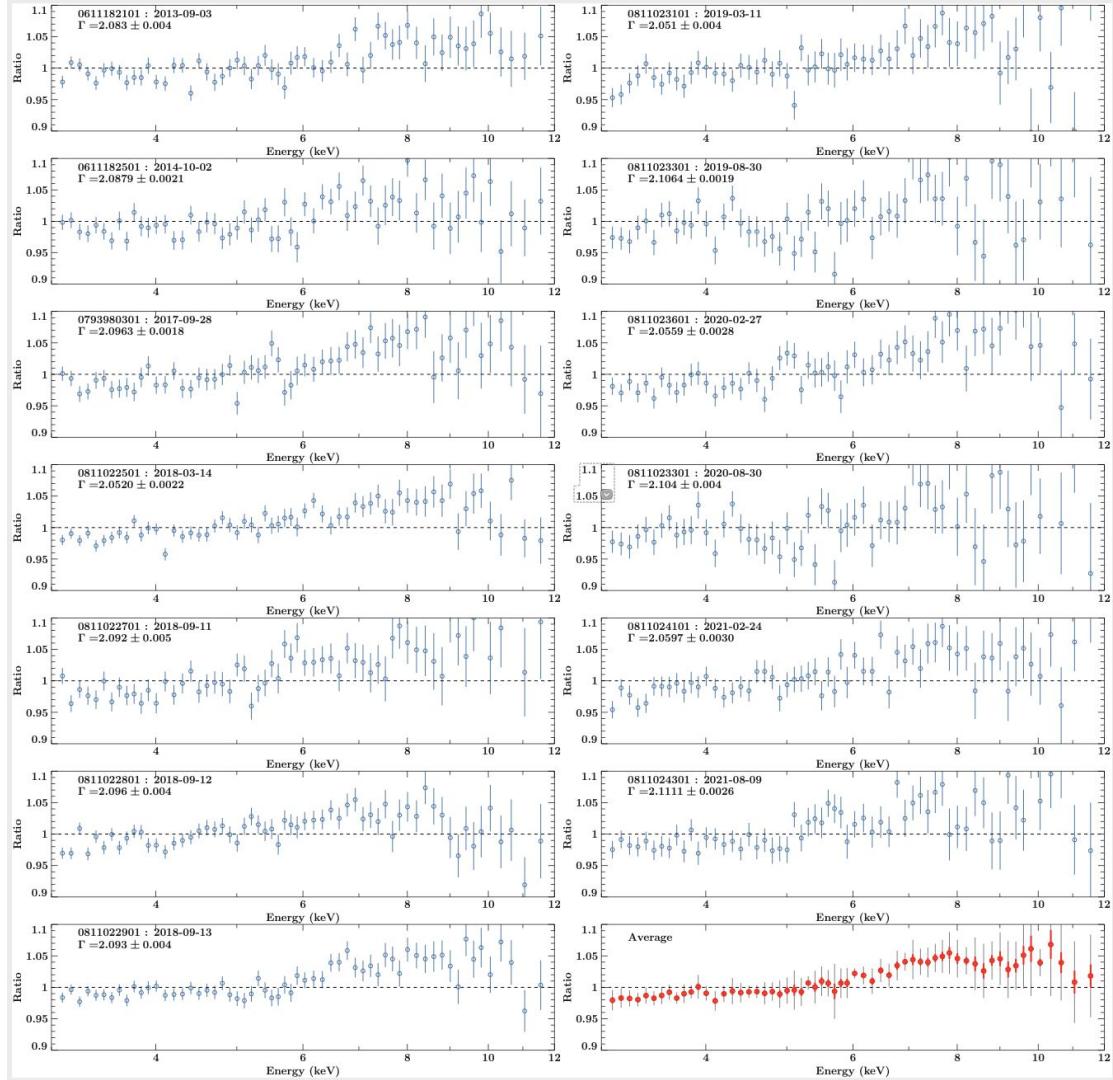
χ^2_{red} = 0.99 (374.5/378)

Crab Calibration

Joint observations every 6 months.

EPIC-pn in burst mode, which causes all kinds of difficulties.

Used to create a correction function of EPIC-pn ARF, but can't tell us about absolute flux difference.
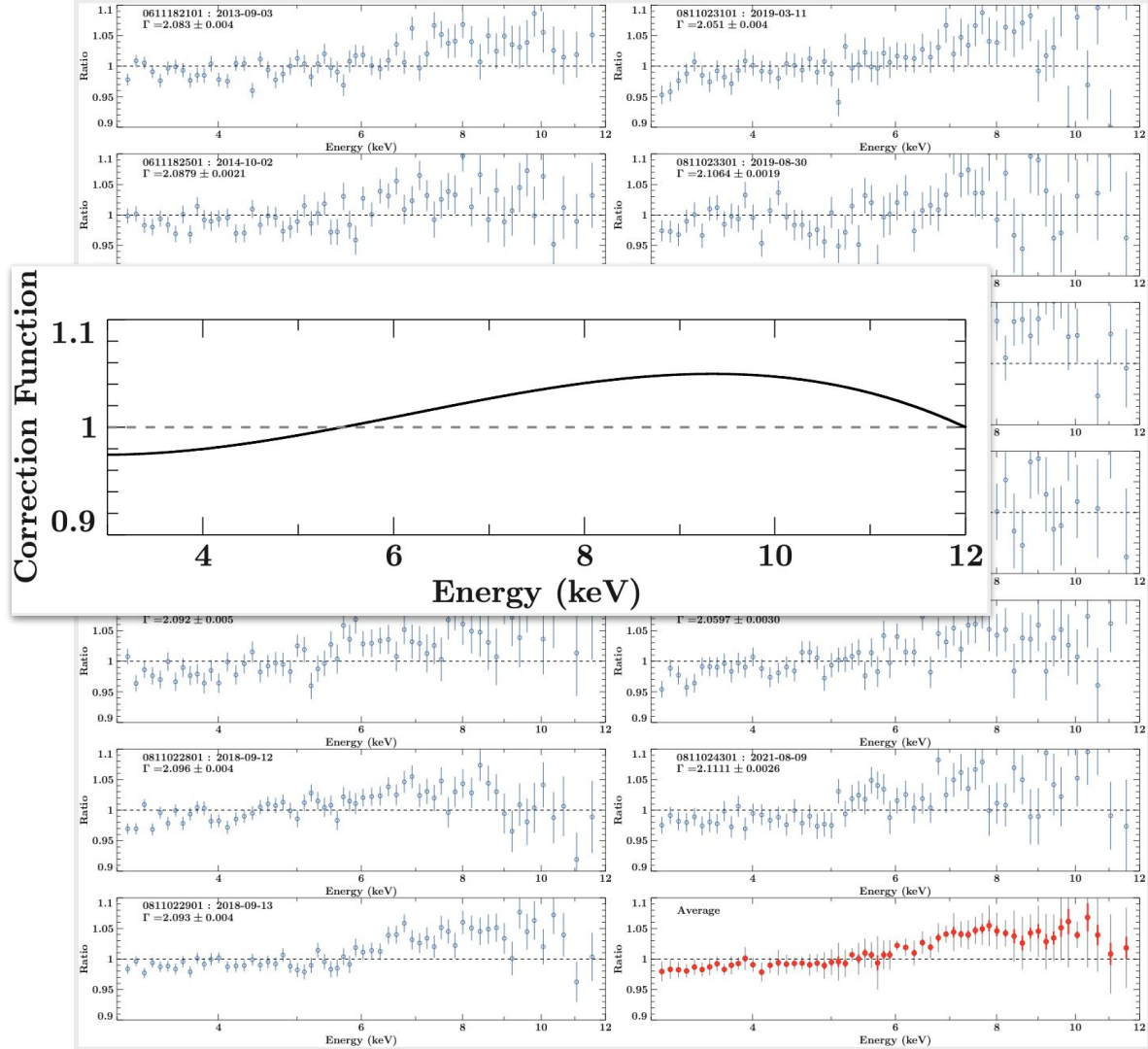
Crab Calibration

Joint observations every 6 months.

EPIC-pn in burst mode, which causes all kinds of difficulties.

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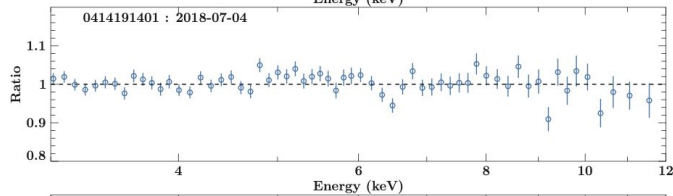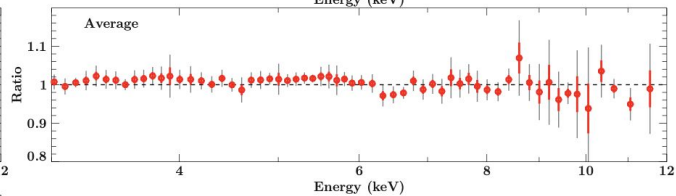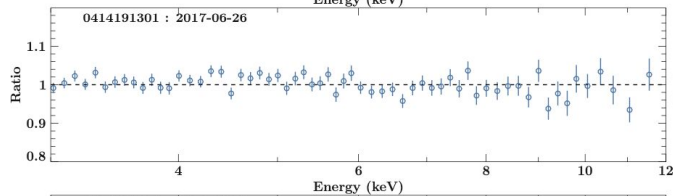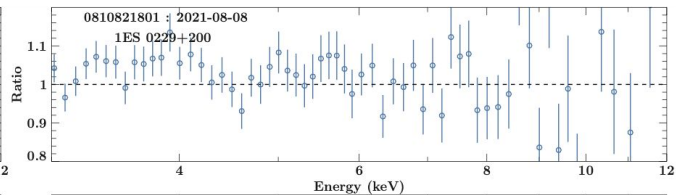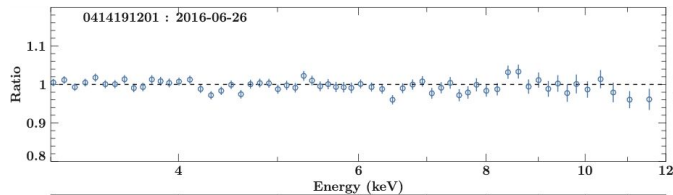
3C 273: ye olde calibration targhet

7 epochs of 3C 273 data between 2012-2020.

Fitted with `cutoffpl` + `xillver` (`xiller` normalization fixed in all epochs, distant reflection, see Madsen et al. 2015).
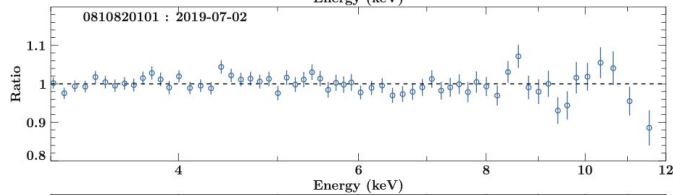
Complex model makes calibration more tricky, flux is a very close to / above pile-up limit
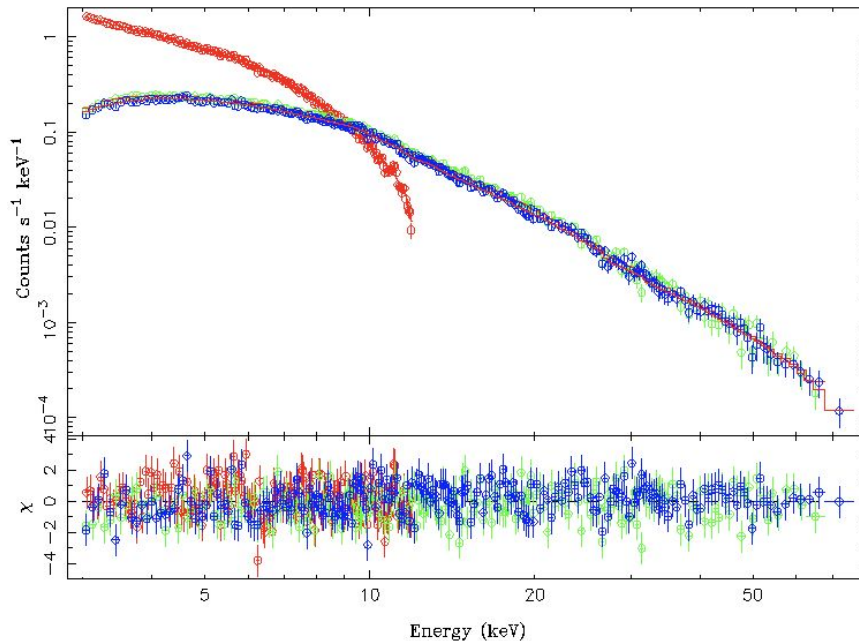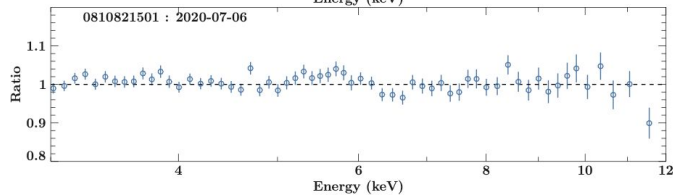
3C273 + 1ES 0229: the new dream team?

1ES 0229 (right) has clearly worse S/N in this observation than the average 3C 273 observation (left column).

Effects of correction likely lost within the noise.

This is for CALDB v20210806 (NEW)

pn = 0.91*FPMA

Absolute flux correction with current available calibration

pn = 0.83*FPMA

Absolute flux correction with new NuSTAR calibration

Conclusion

(preliminary)

- 1ES 0229+200 has a nice, simple spectrum
- However, its so much fainter than 3C 273 that it is hard to build up enough S/N
- Unclear if 1ES has a different cross-calibration than in 3C 273
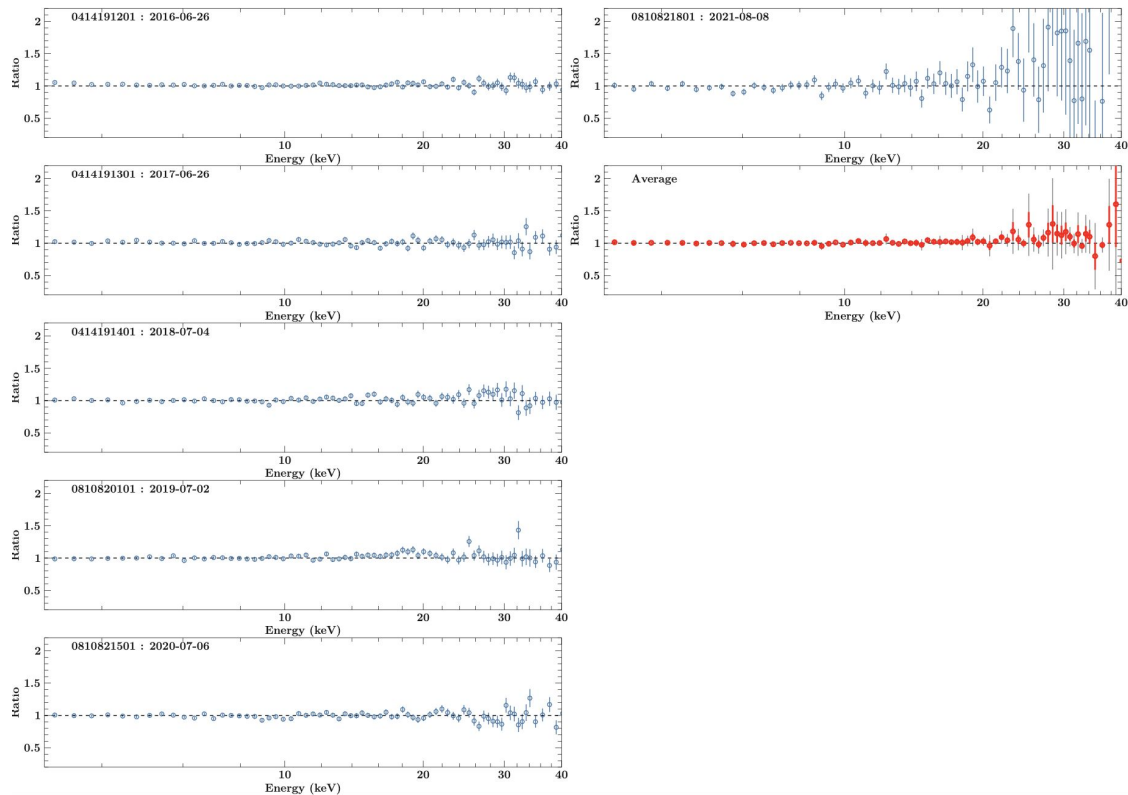
Outlook

(future work)

- Power Law slope of 1ES 0229 needs to be validated with MOS and OM, as well as Swift/XRT and UVOT
- Correction function needs to be vetted with larger array of observations and uncertainties calculated with MCMC

Appendix

3C273 +1ES 0229 for NuSTAR/FPMA

Crab is extended

EPIC-pn is operated in timing mode.

We need to make sure that *NuSTAR* data is extracted from same source region as CCD4 pn footprint on the sky.

Seasonal change between Northern and Southern are of the remnant.

NuSTAR FPMA