

XRISM-NuSTAR-XMM-Newton-Chandra Effective Area Cross-calibration using 3C 273

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Tümer, 18th IACHEC, 20 April 2026, Pelham, Germany

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74 total members

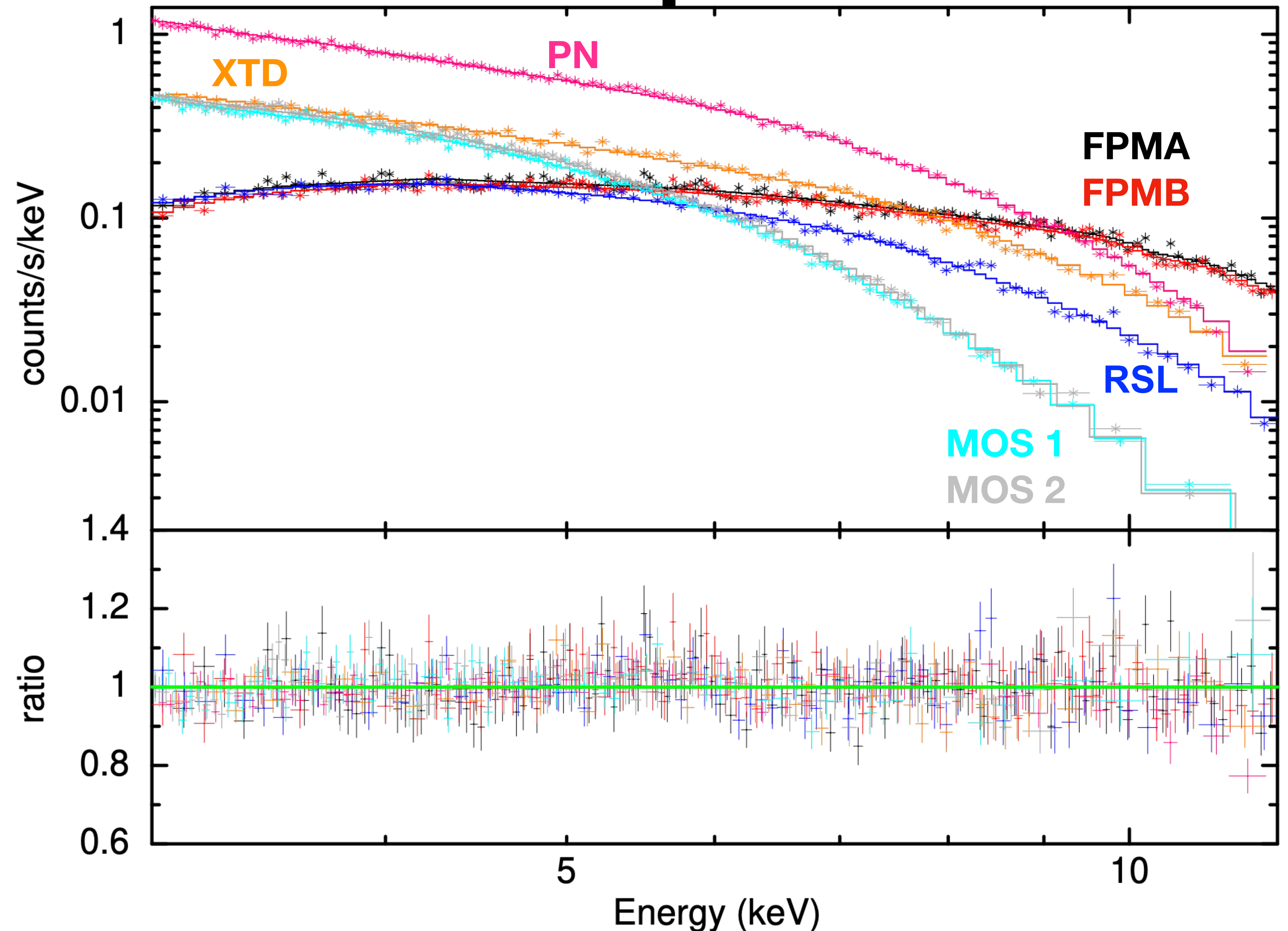
From E. Miller

*Previously on
Cross-calibration...*

**(2024 results from 17th IACHEC
presentation by E. Miller)**

3C273 3.0-12.0 keV Spectra

- NuSTAR and XMM have similar GTI coverage
- Modeled with single power law
- Each instrument has PL index and norm free
- PL index measures the *relative* Aeff error
- Flux measures the *absolute* Aeff error

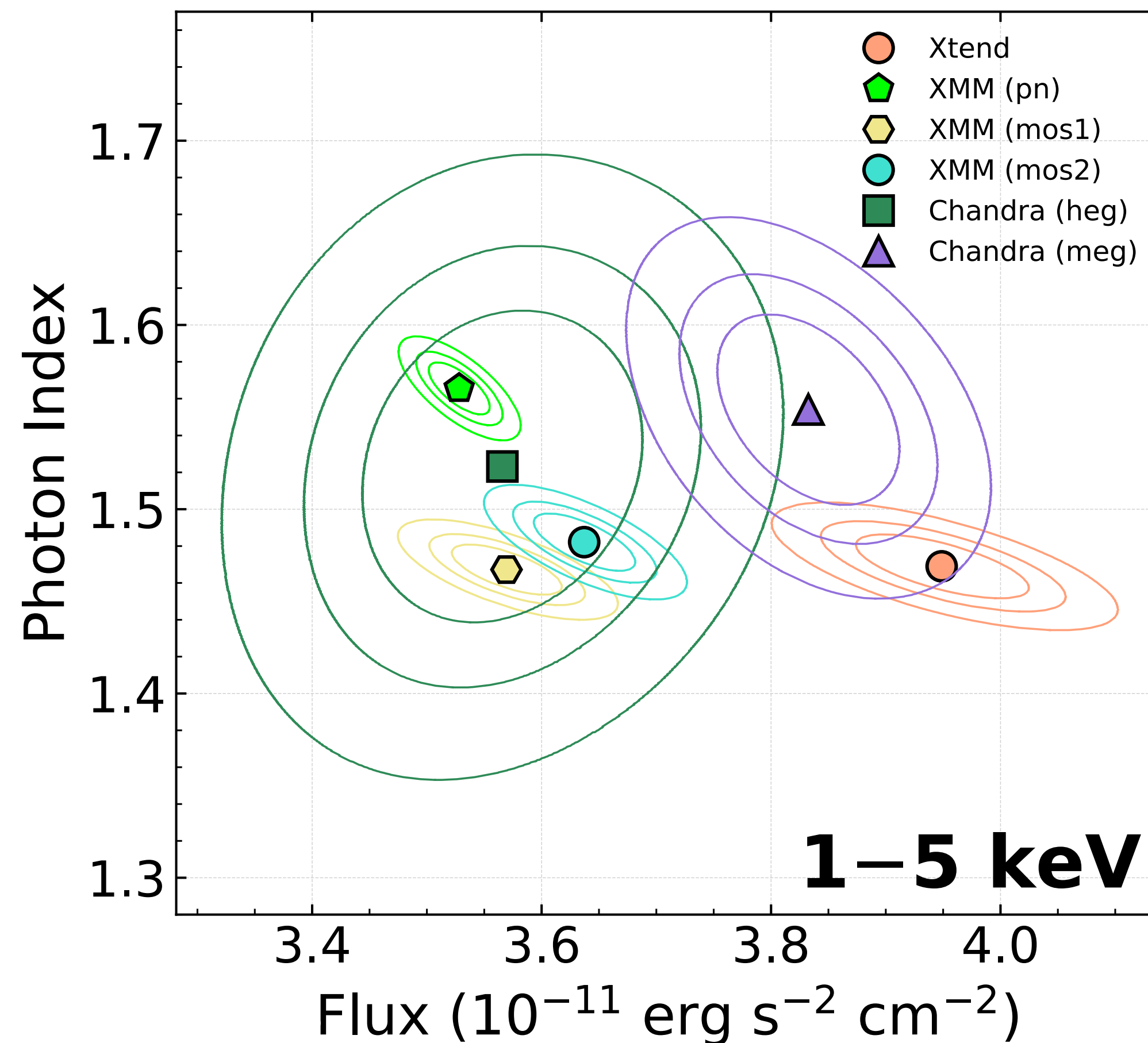


3C273 FLUX-Gamma: XTD - HEG/MEG - PN

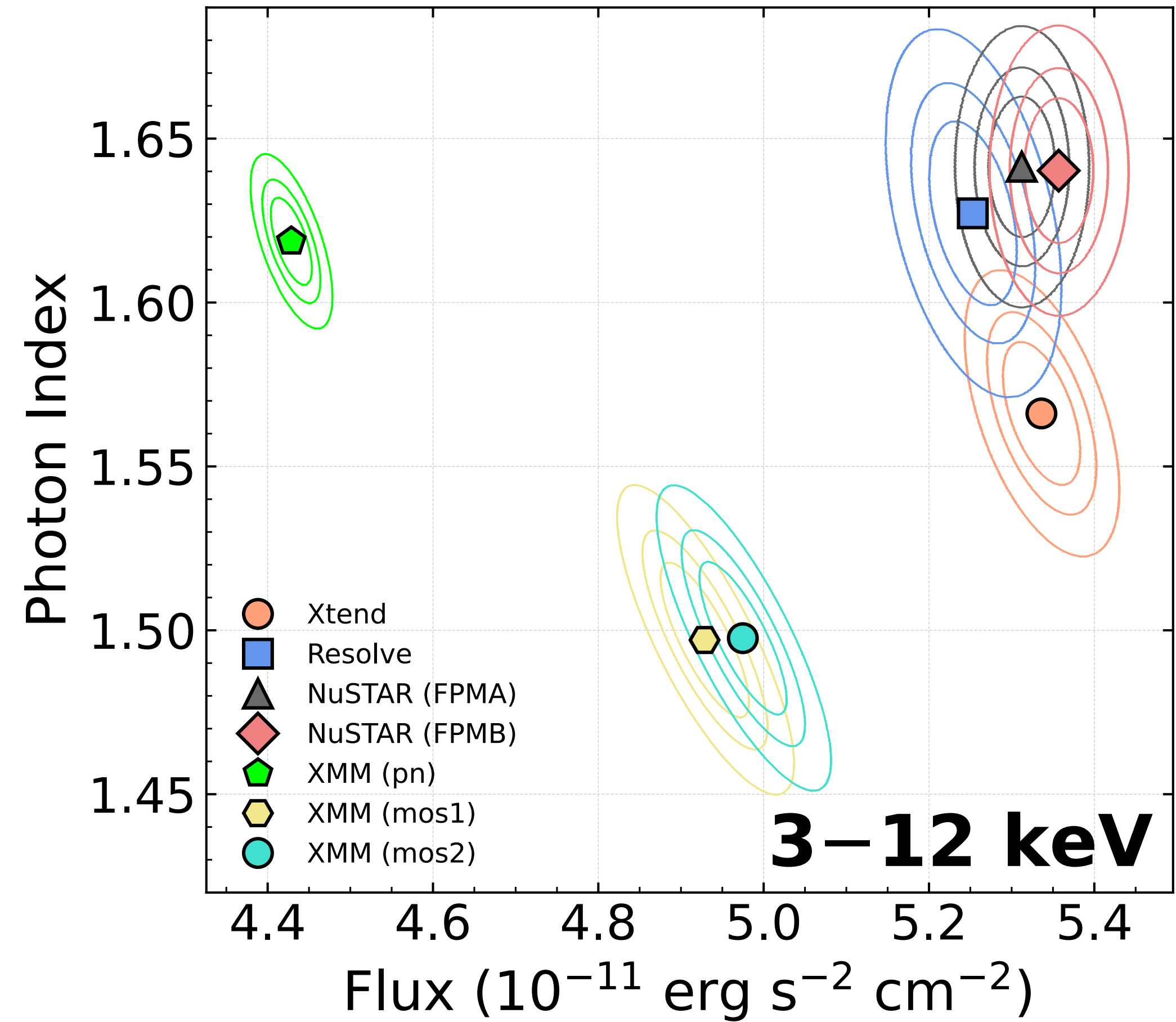
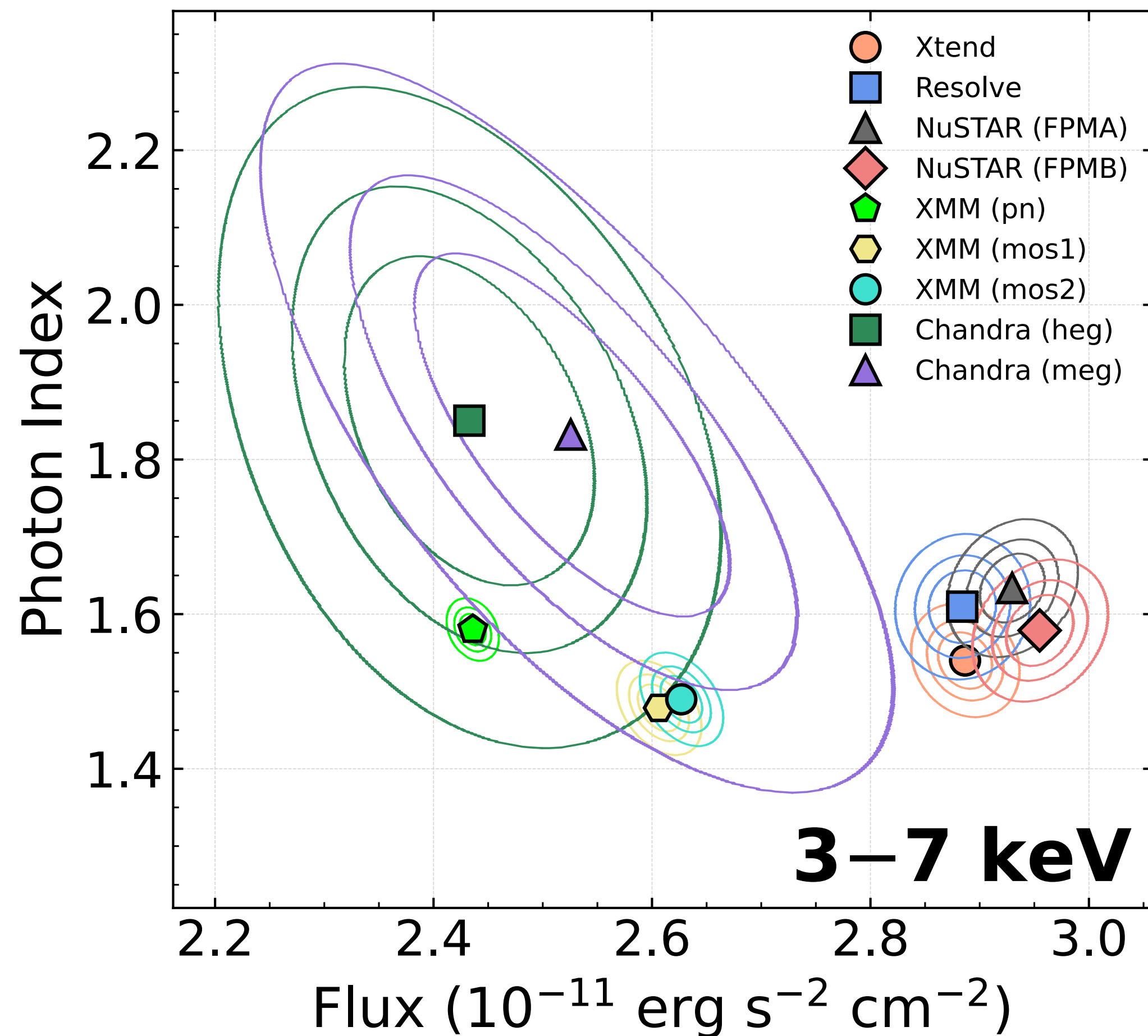
Model: $T_{\text{babs}} * \text{Powerlaw}$

XMM-Newton and
Chandra is fitted using
reduced
Chi square statistics.

XTEND, XMM-Newton favor :
Model: $T_{\text{babs}} * \text{Bknp}$



3C273 FLUX-Gamma: FPMA/B - RSL/XTD - HEG/MEG - MOS/PN



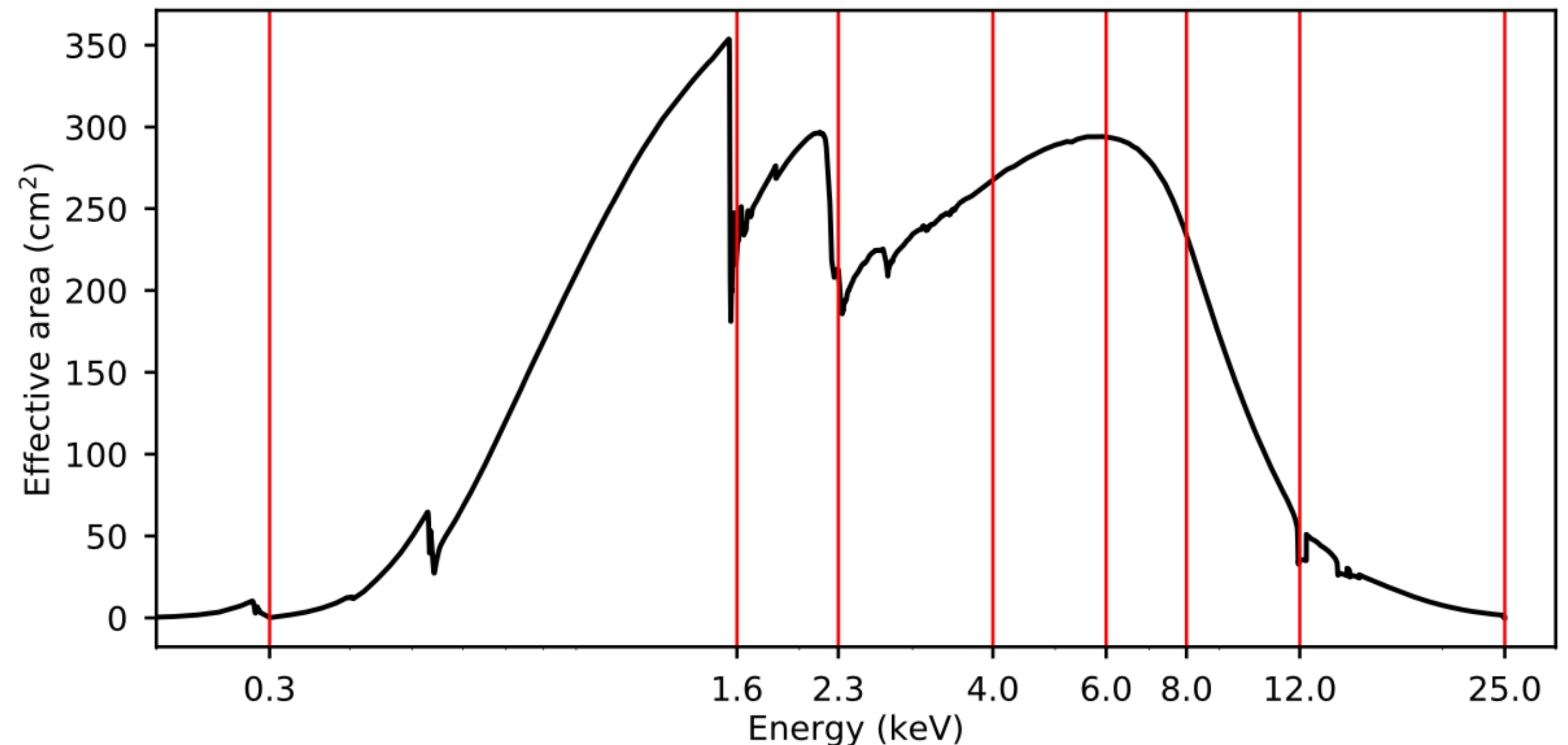
Narrow Bands

Motive:

- Narrow bands defined to avoid edges
- Flux is measured in each band for full fit
- Fit is repeated in each band with flux free
- Ratio is plotted

XRISM: HEASOFT 6.34, CALDB xtd: 20240815 rsl: 20240315

NuSTAR: HEASOFT 6.34 CALDB: 20250122



Method:

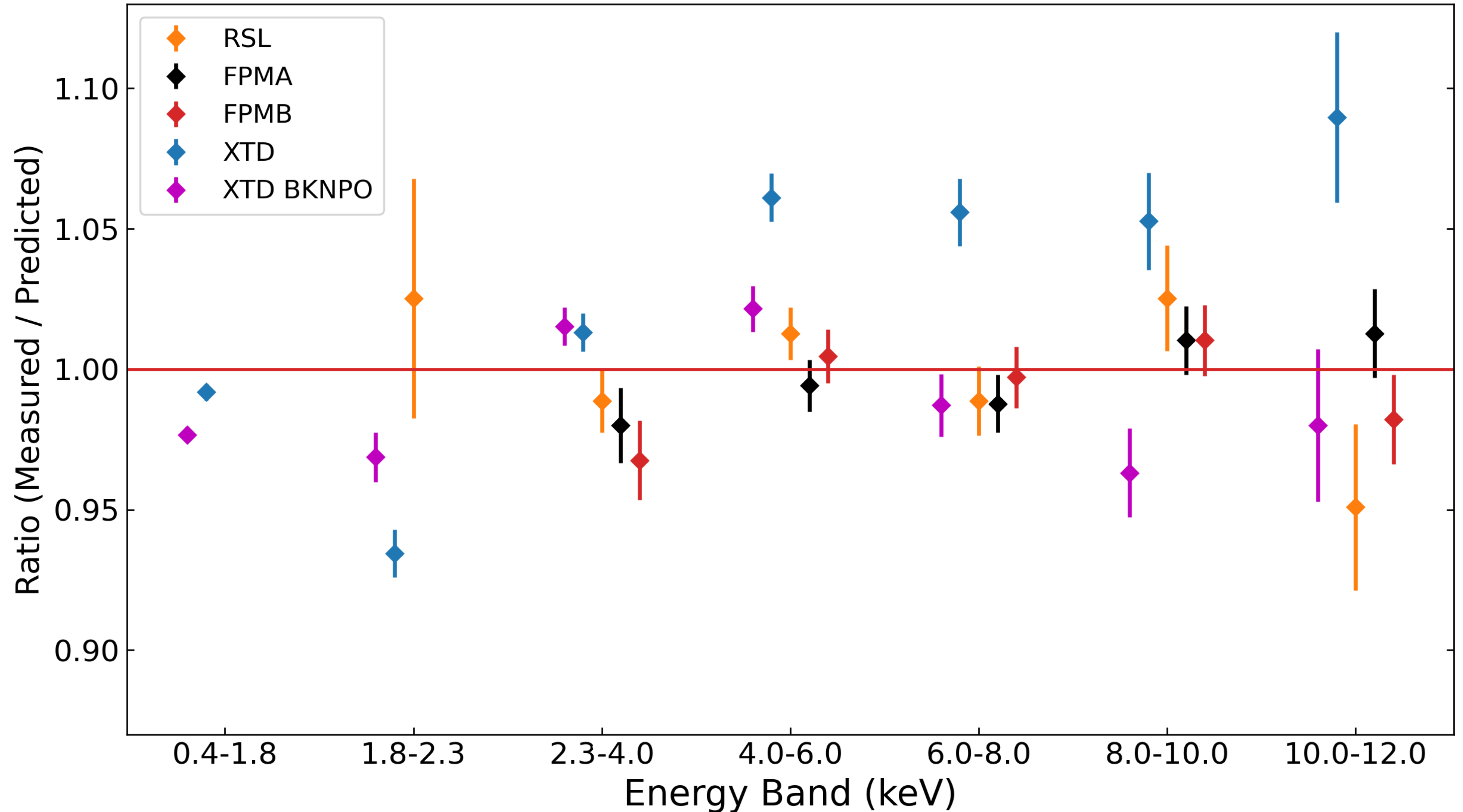
- Fit full band spectra (**1.8-12.0 keV for all Instruments**), then estimate the fluxes in narrow energy bands: 1.8-2.3, 2.3-4.0, 4.0-6.0, 8.0-10.0, 10.0-12.0 in XSPEC with flux command, i.e.; flux 1.8 2.3 (**PREDICTED**)
- Then ignore the data beyond the desired narrow band and fit the data
- Record cflux parameter values and calculate 1 sigma errors (**MEASURED**)
- Repeat the fit for both fixed gamma (to the full band value) and free gamma

Caveat: In the 2.3-4.0 keV band; NuSTAR ratios are for 3.0-4.0 keV band

Flux Ratios 3C273 XRISM-NuSTAR 1.8 - 12.0 keV

3C273: Measured vs Predicted Flux Ratio (Fixed Gamma)

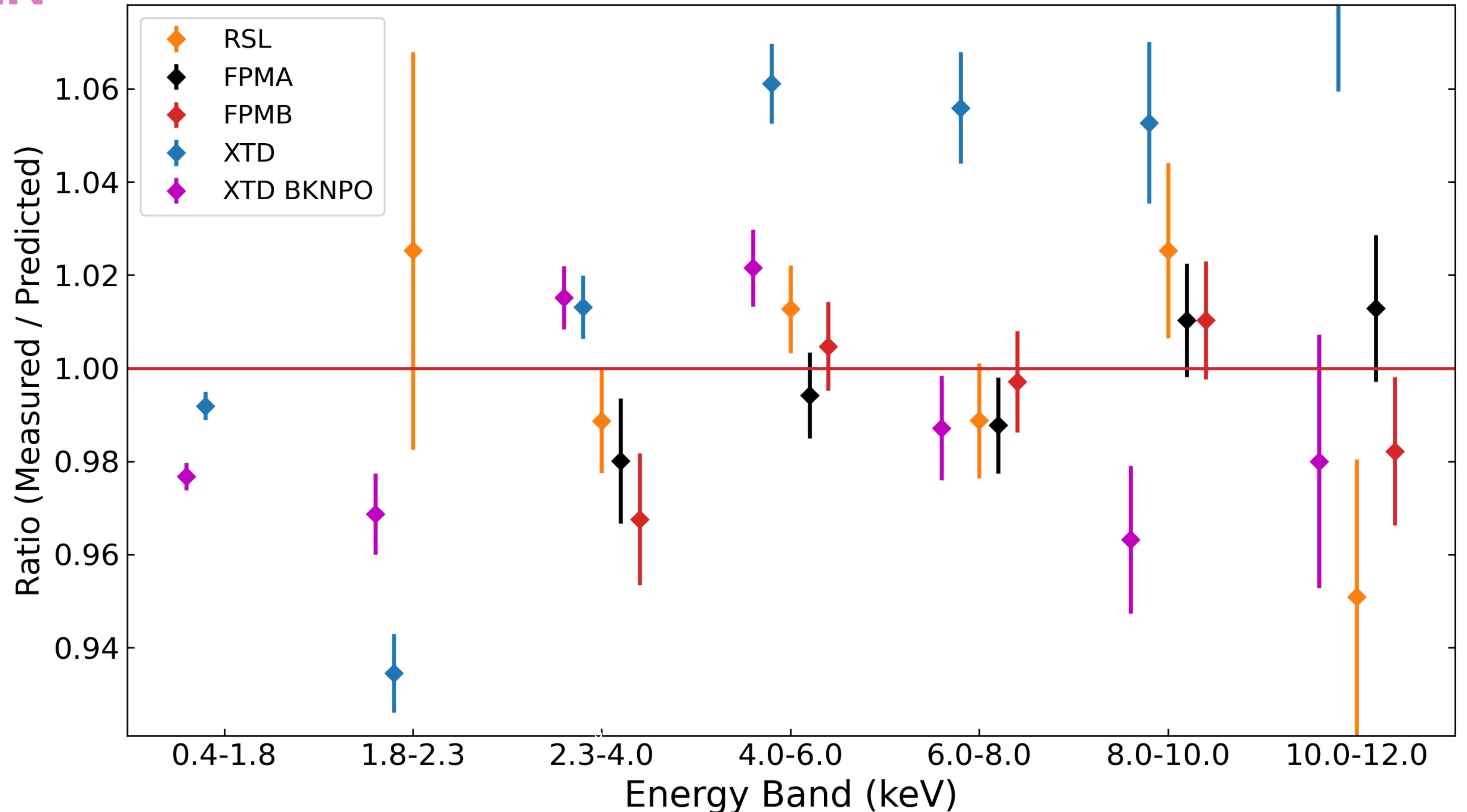
Model:
Powerlaw
FIXED
Gamma
(XTD: PO
and
BKNPO)



Flux Ratios 3C273 XRISM-NuSTAR 1.8 - 12.0 keV

ZOOMING IN

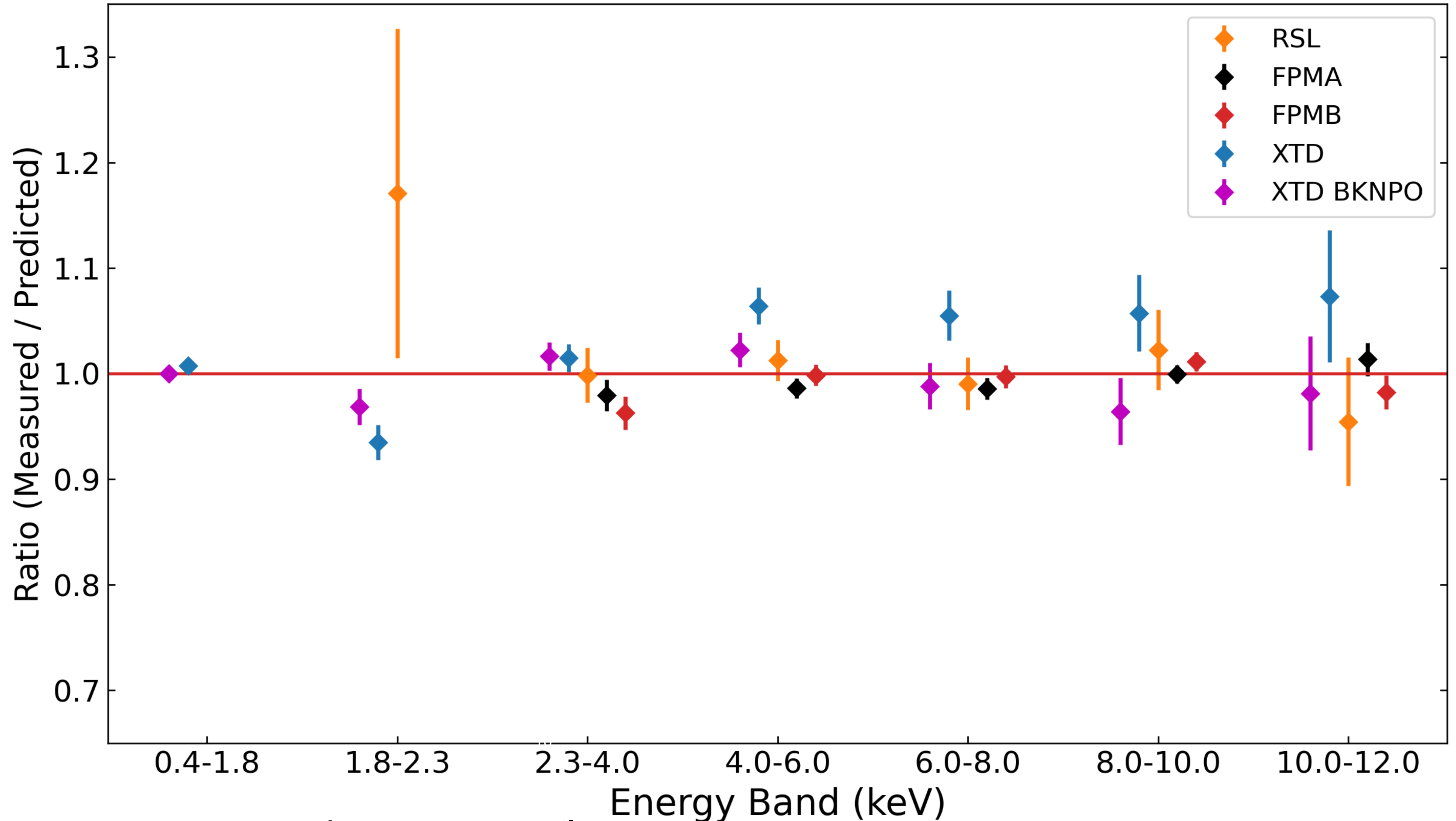
3C273: Measured vs Predicted Flux Ratio (Fixed Gamma)



Flux Ratios 3C273 XRISM-NuSTAR 1.8 - 12.0 keV

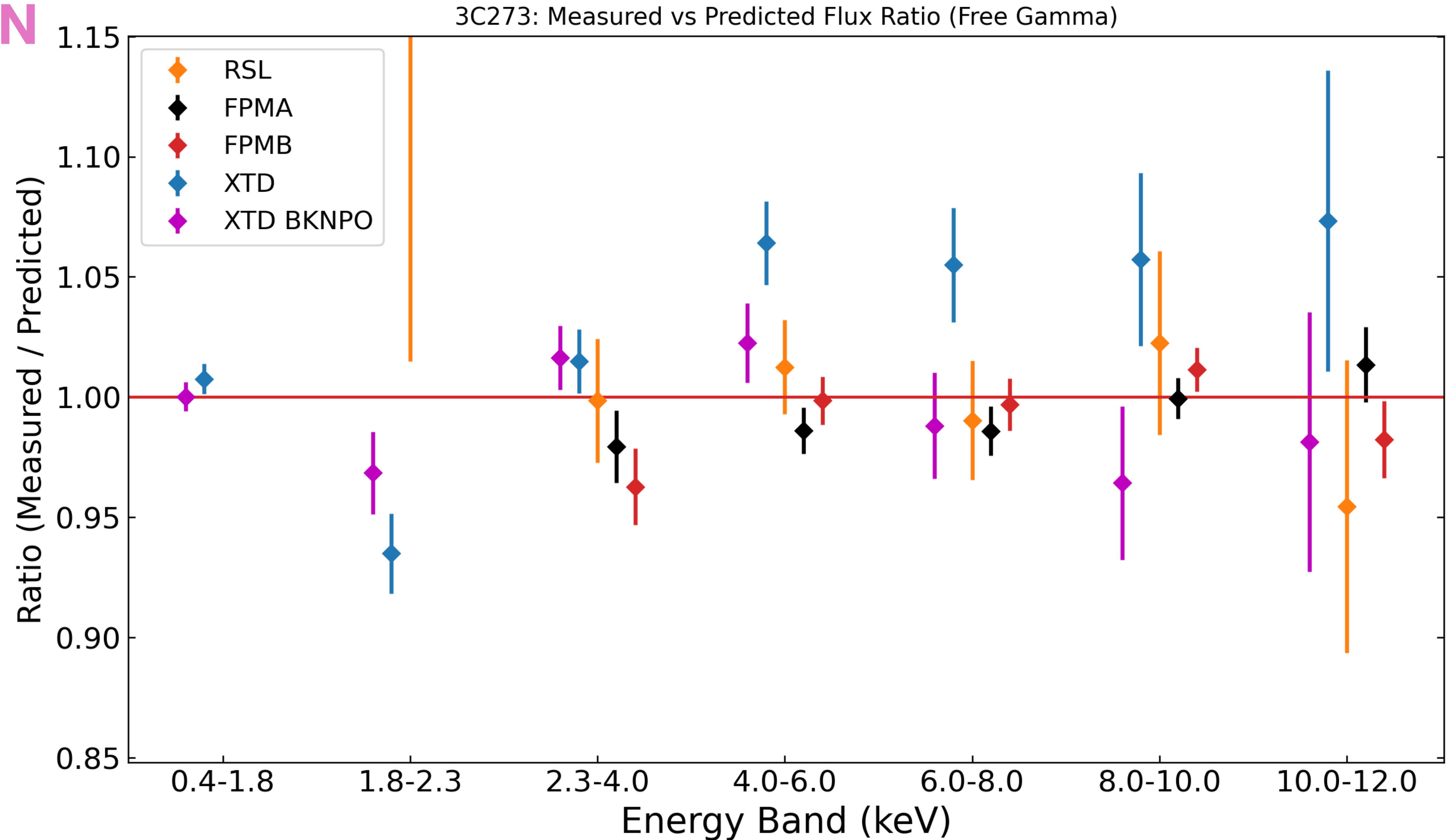
3C273: Measured vs Predicted Flux Ratio (Free Gamma)

Model:
Powerlaw
FREE Gamma
(XTD: PO
and
BKNPO)



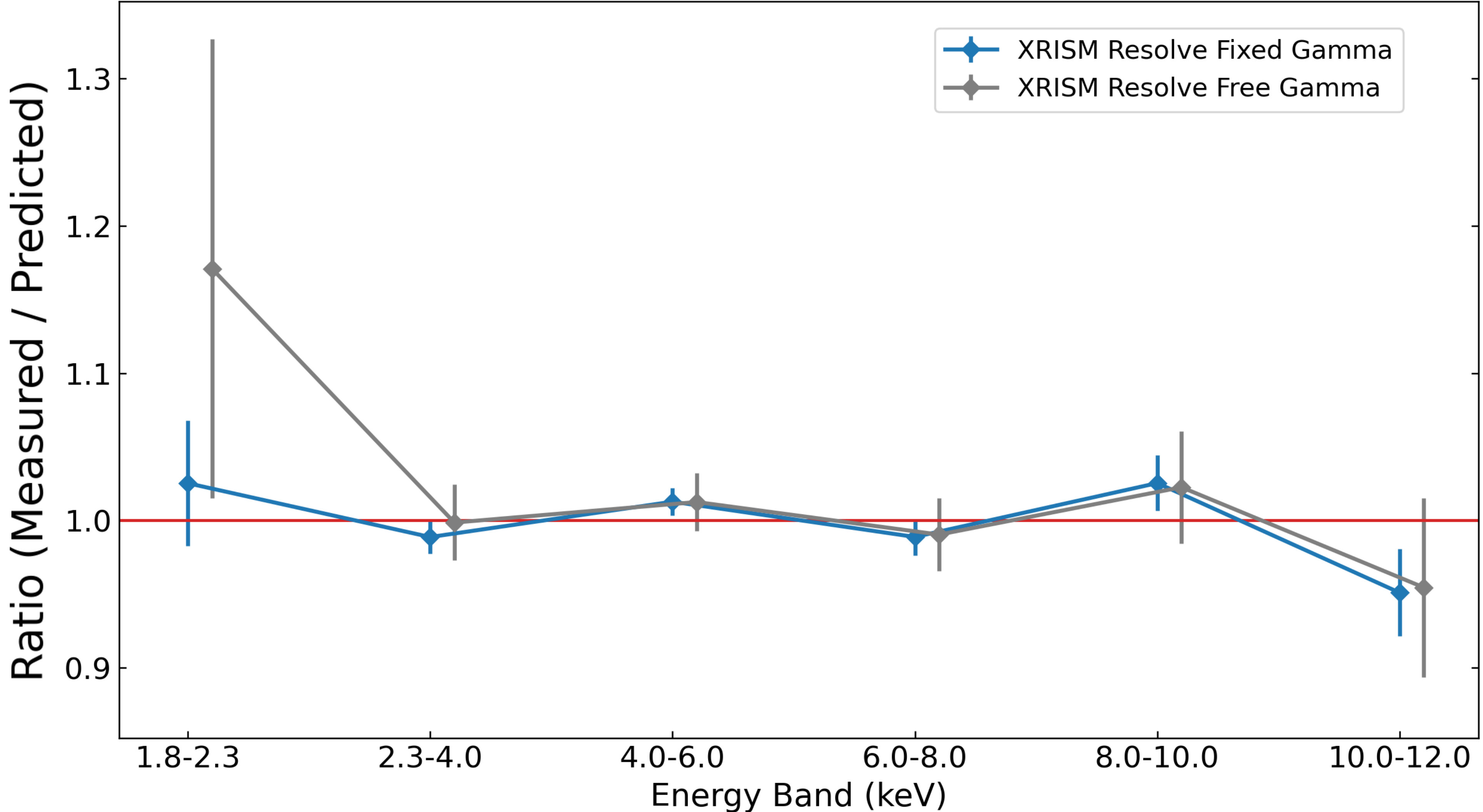
Flux Ratios 3C273 XRISM-NuSTAR 1.8 - 12.0 keV

ZOOMING IN

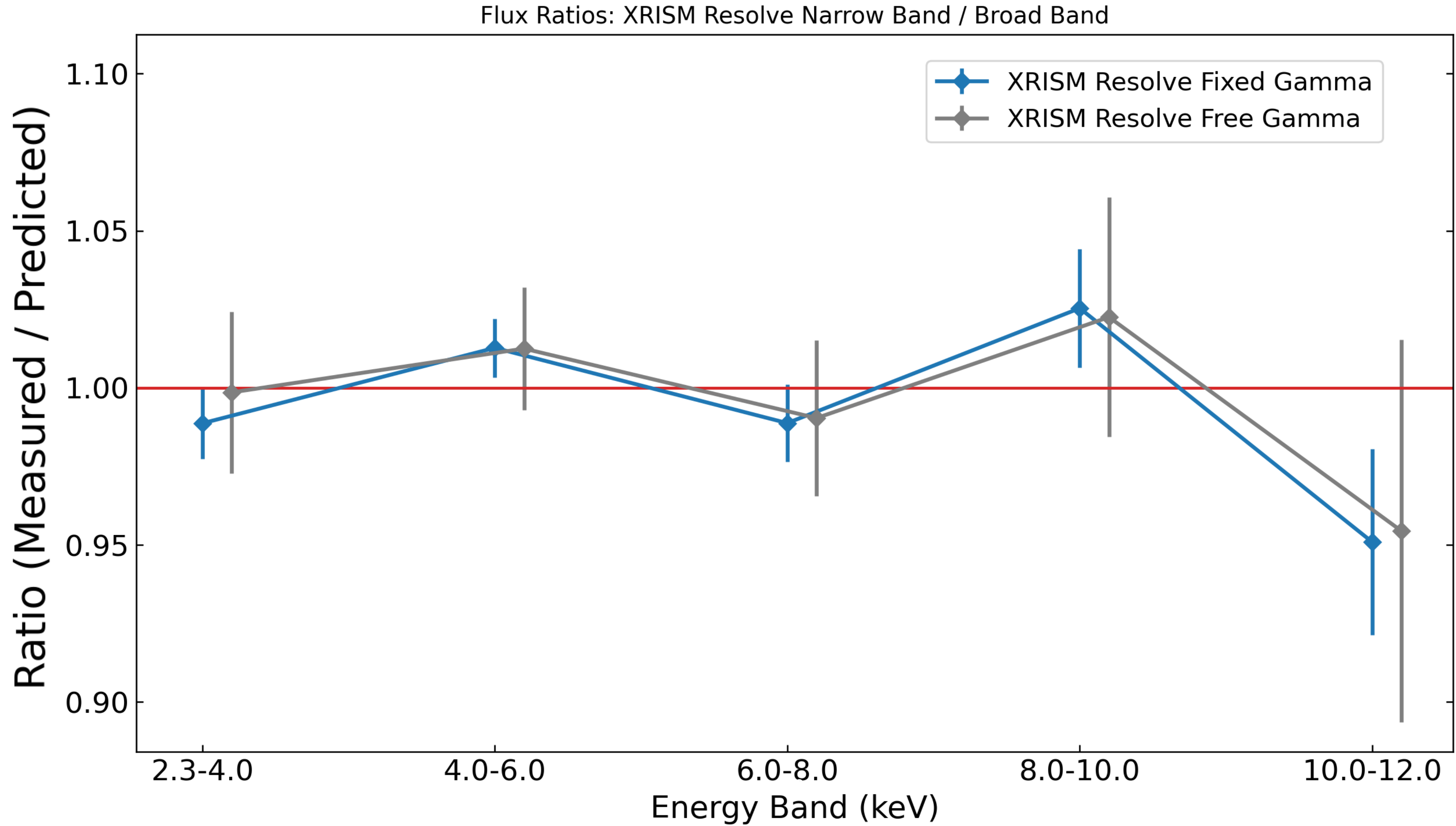


Flux Ratios **3C273** **Resolve** 1.8 - 12.0 keV Powerlaw

Flux Ratios: XRISM Resolve Narrow Band / Broad Band

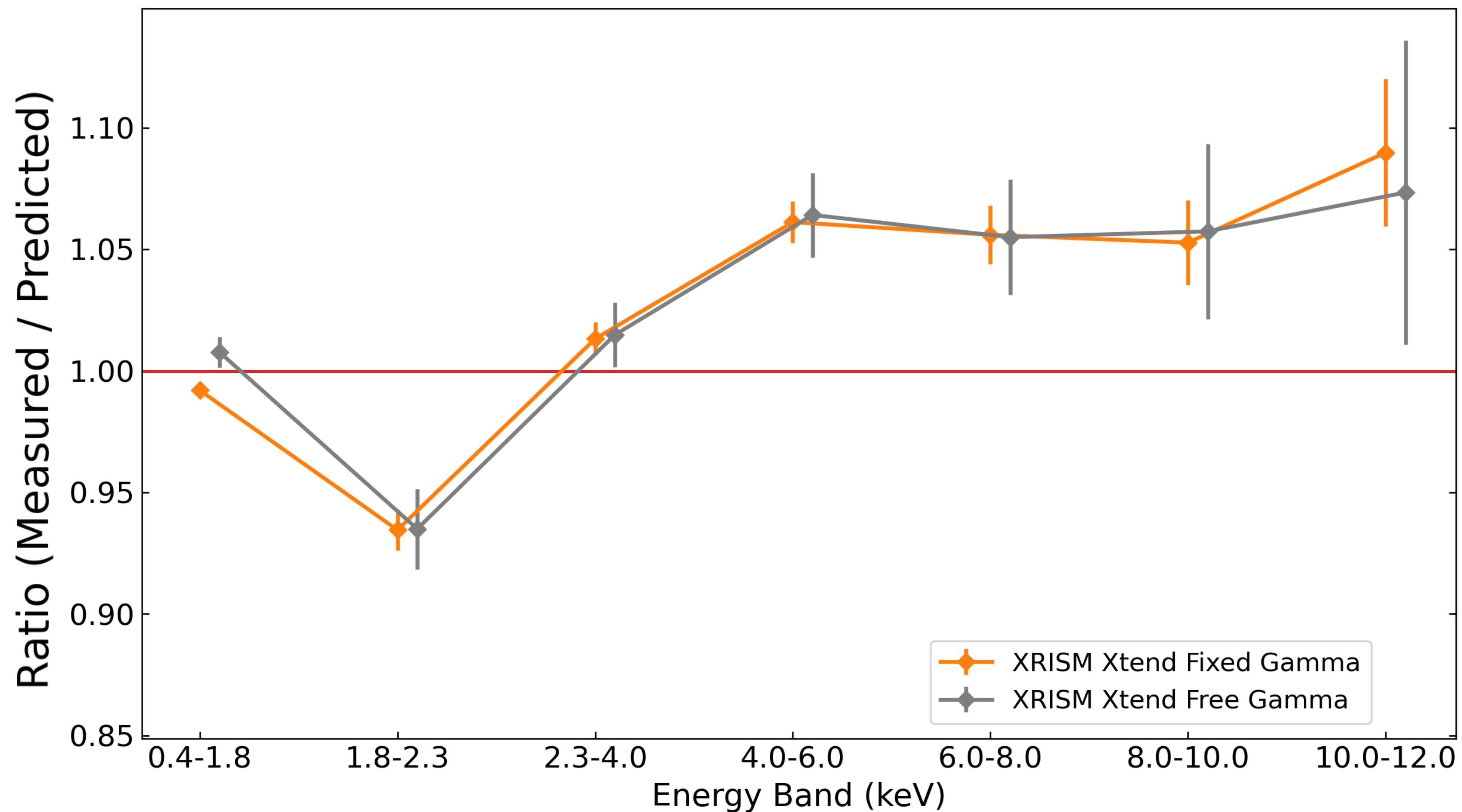


Flux Ratios 3C273 Resolve 2.3 - 12.0 keV Powerlaw (zoomed in)

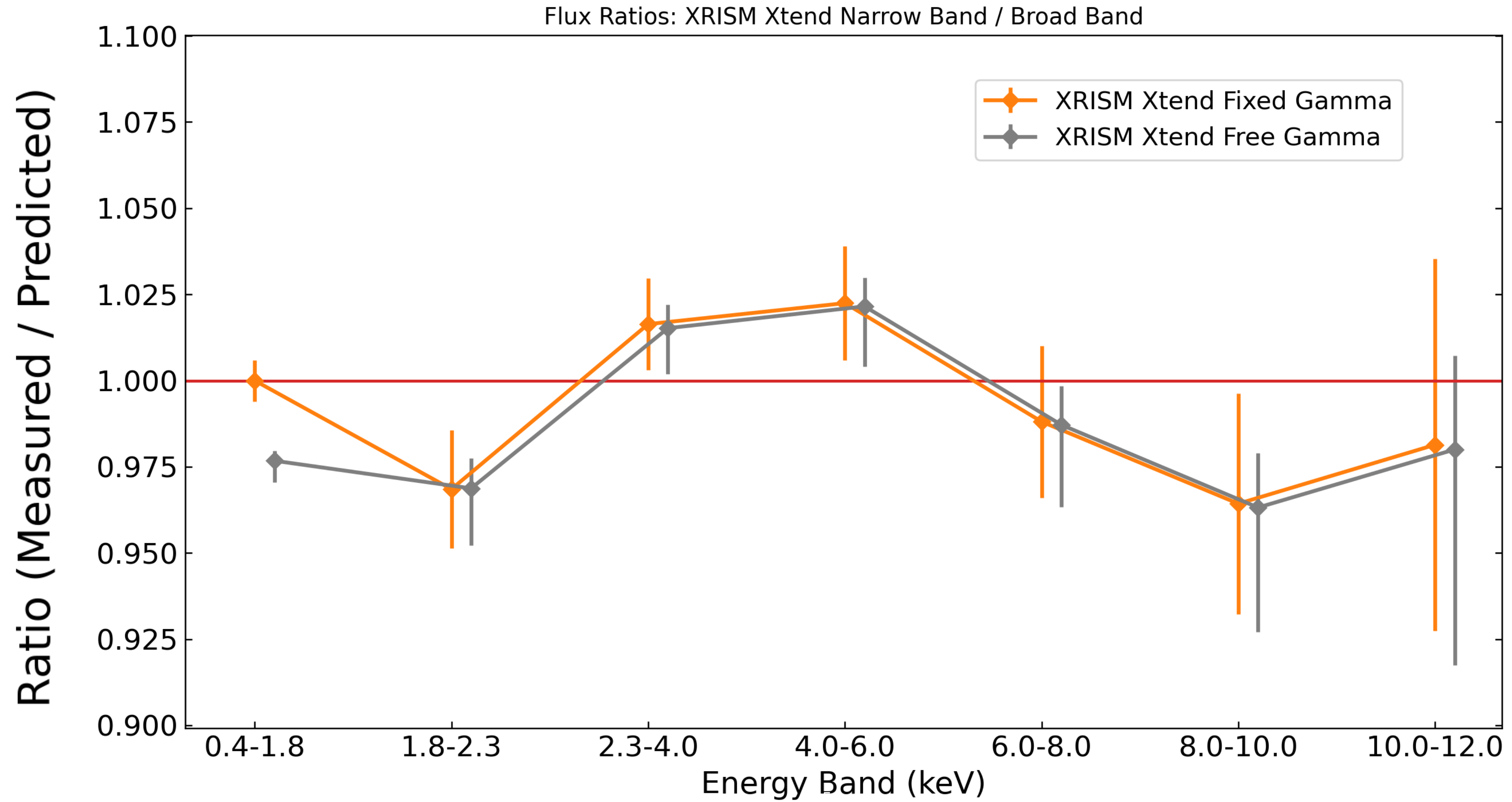


Flux Ratios 3C273 Xtend 0.4 - 12.0 keV, Powerlaw

Flux Ratios: XRISM Xtend Narrow Band / Broad Band

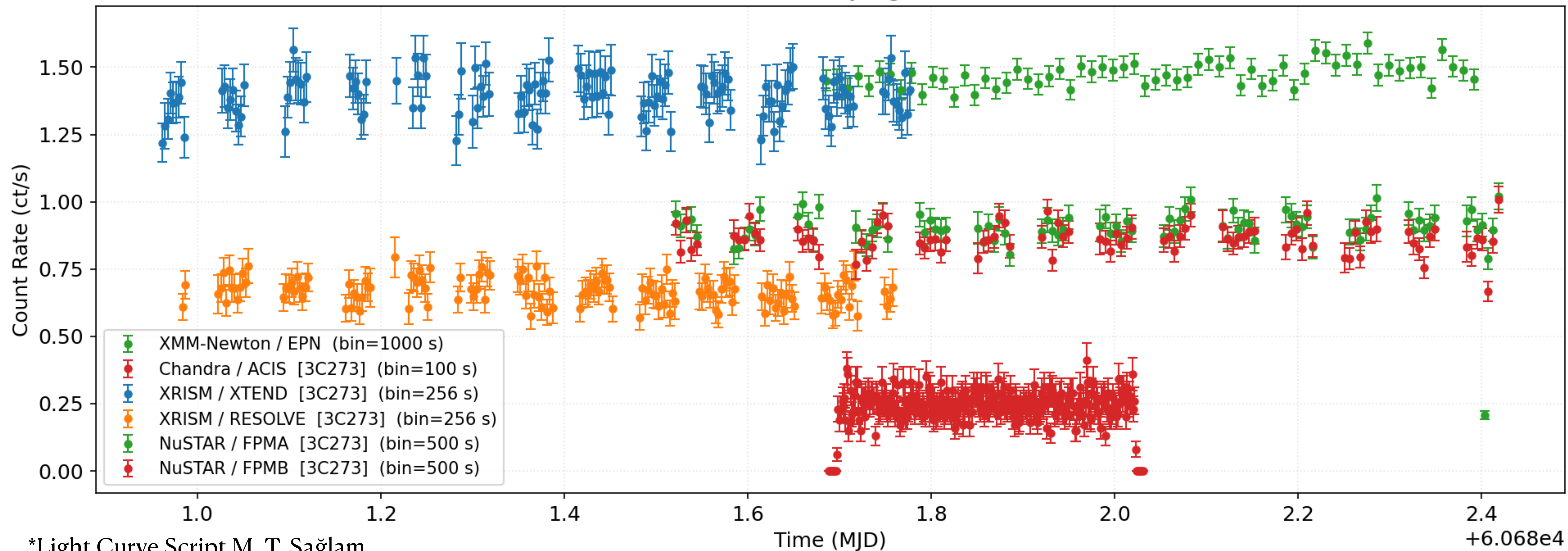


Flux Ratios 3C273 Xtend 0.4 - 12.0 keV. BKN Powerlaw



2025

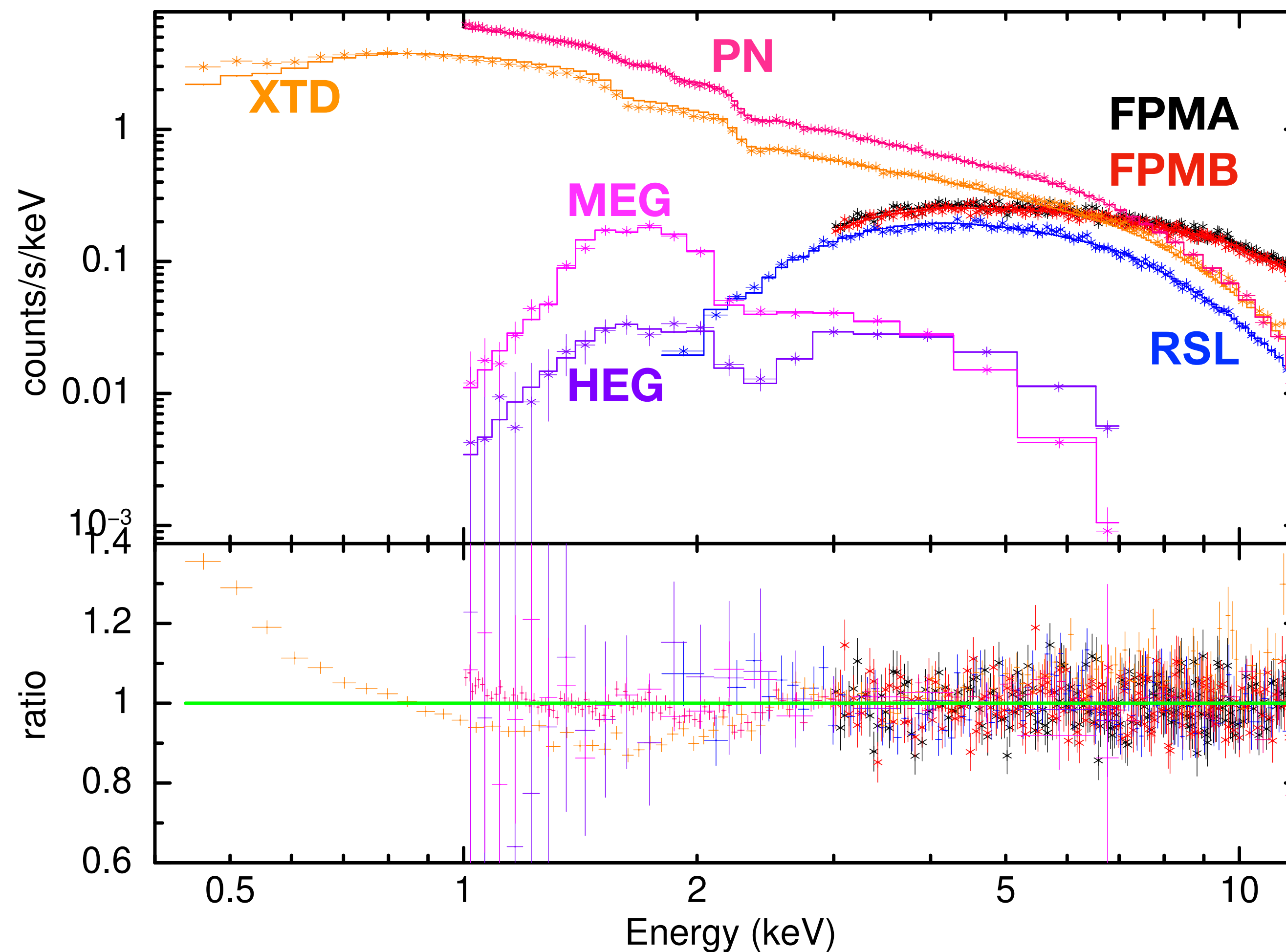
Multi-Mission X-ray Light Curves



Spectra In Operating Bands (up to 12 keV)

3C273 2025 NuSTAR–XRISM–Chandra–XMM

Xtend and PN
spectra below 3 keV
requires a BKNPO
(Maybe even 2)

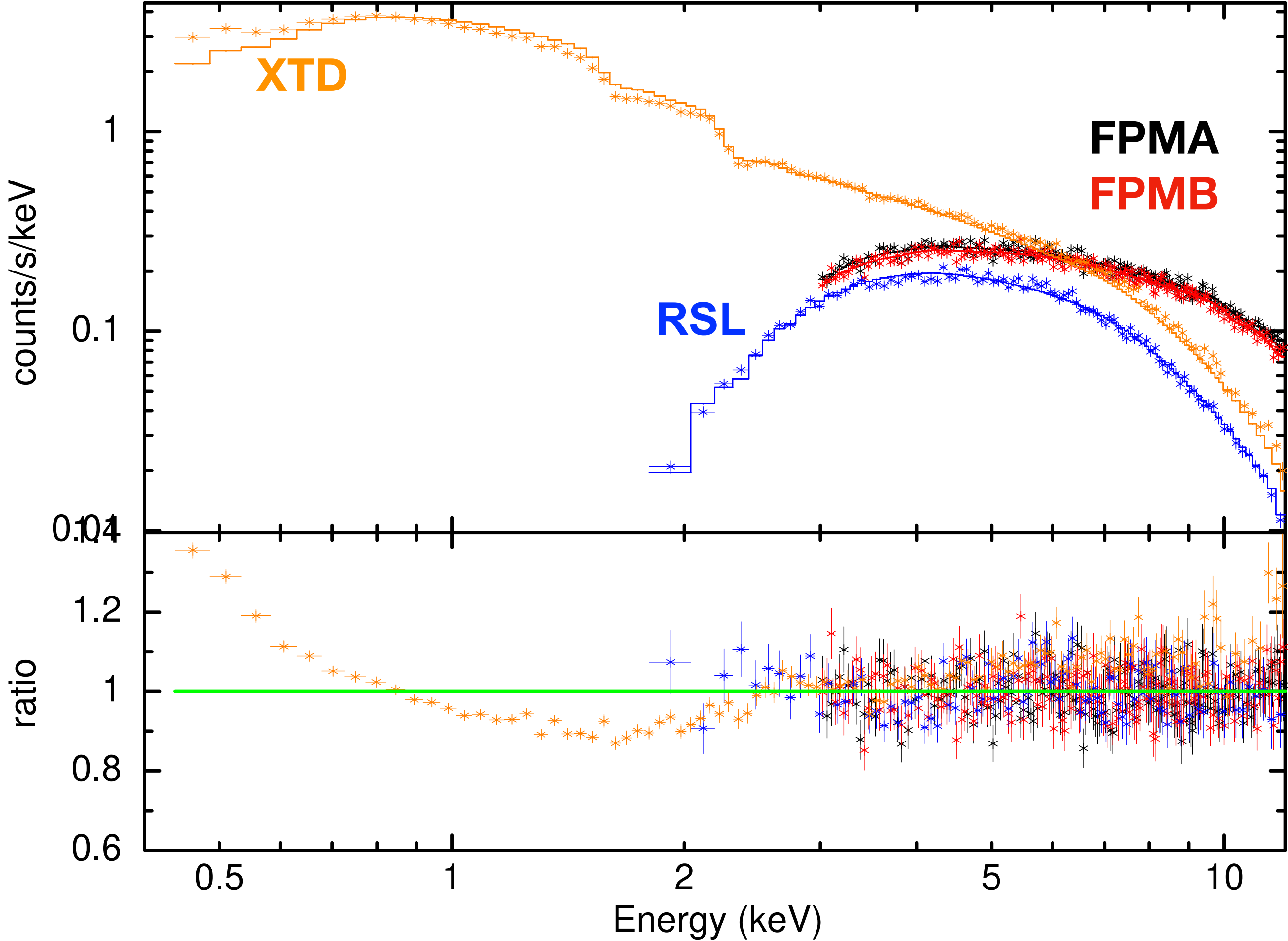


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NuSTAR XRISM

3C273 2025 NuSTAR-XRISM

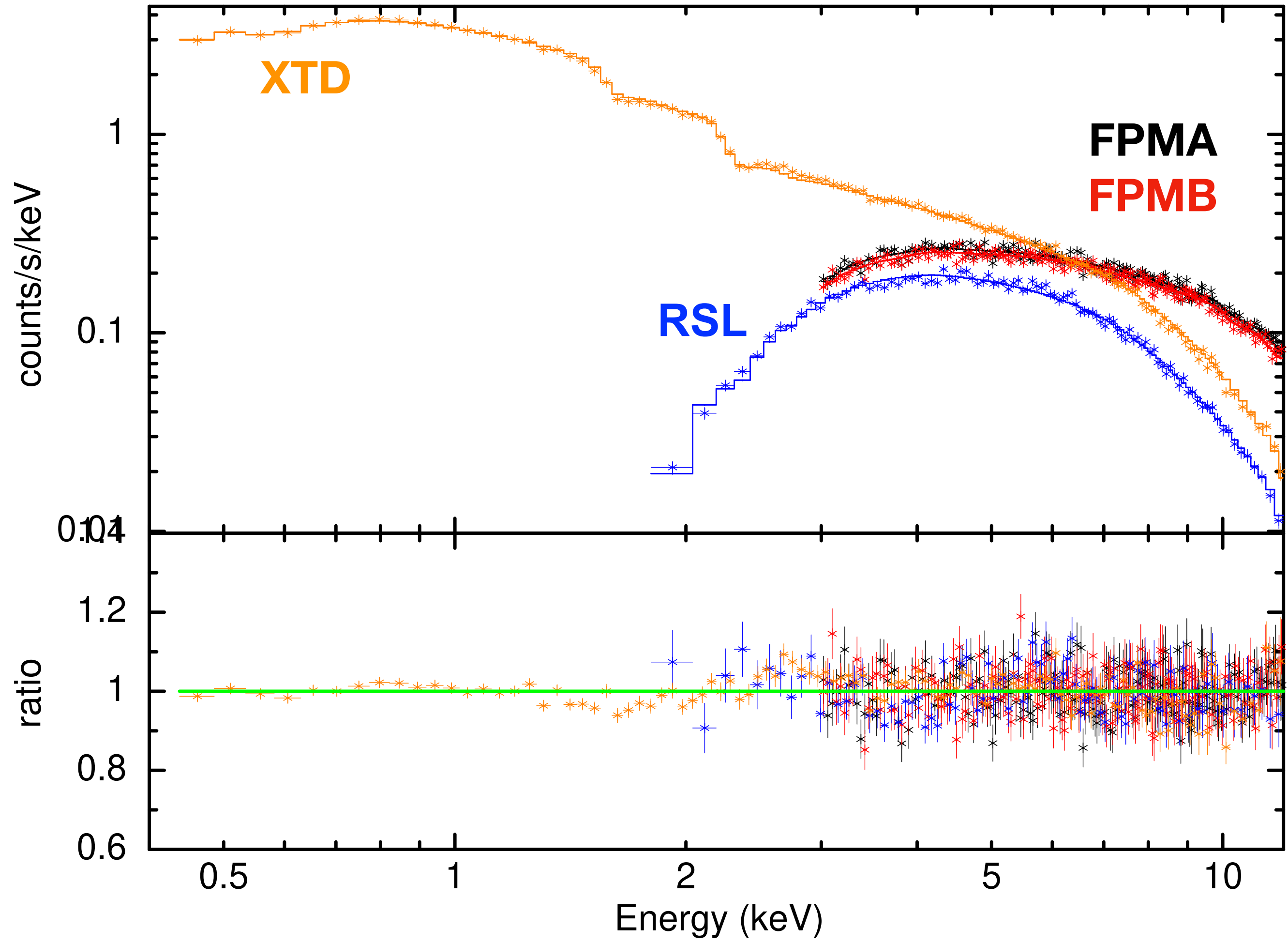
Just Powerlaw



NuSTAR XRISM

3C273 2025 NuSTAR-XRISM

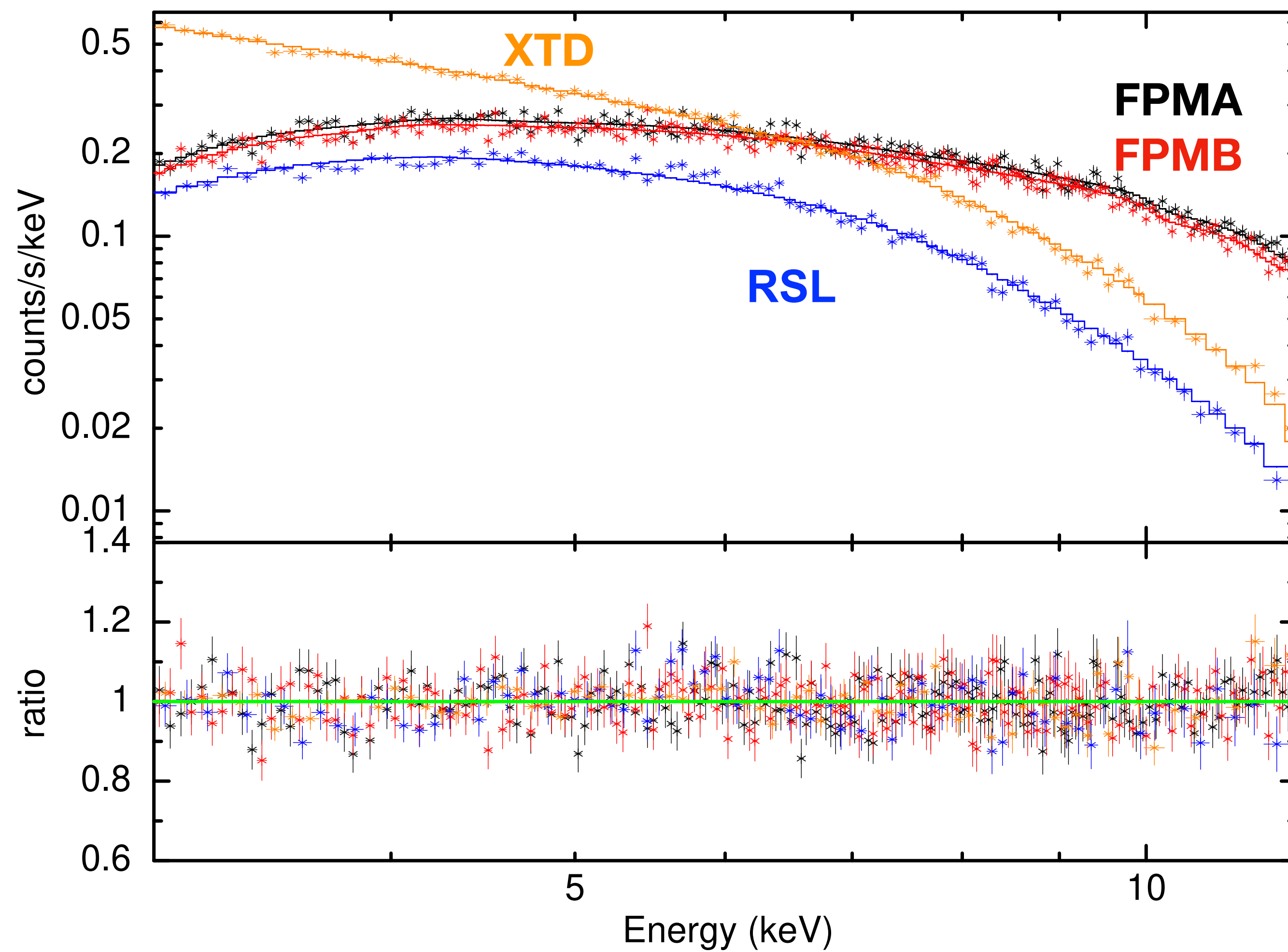
Powerlaw + BKN



NuSTAR XRISM

3C273 2025 NuSTAR-XRISM

3-12 keV

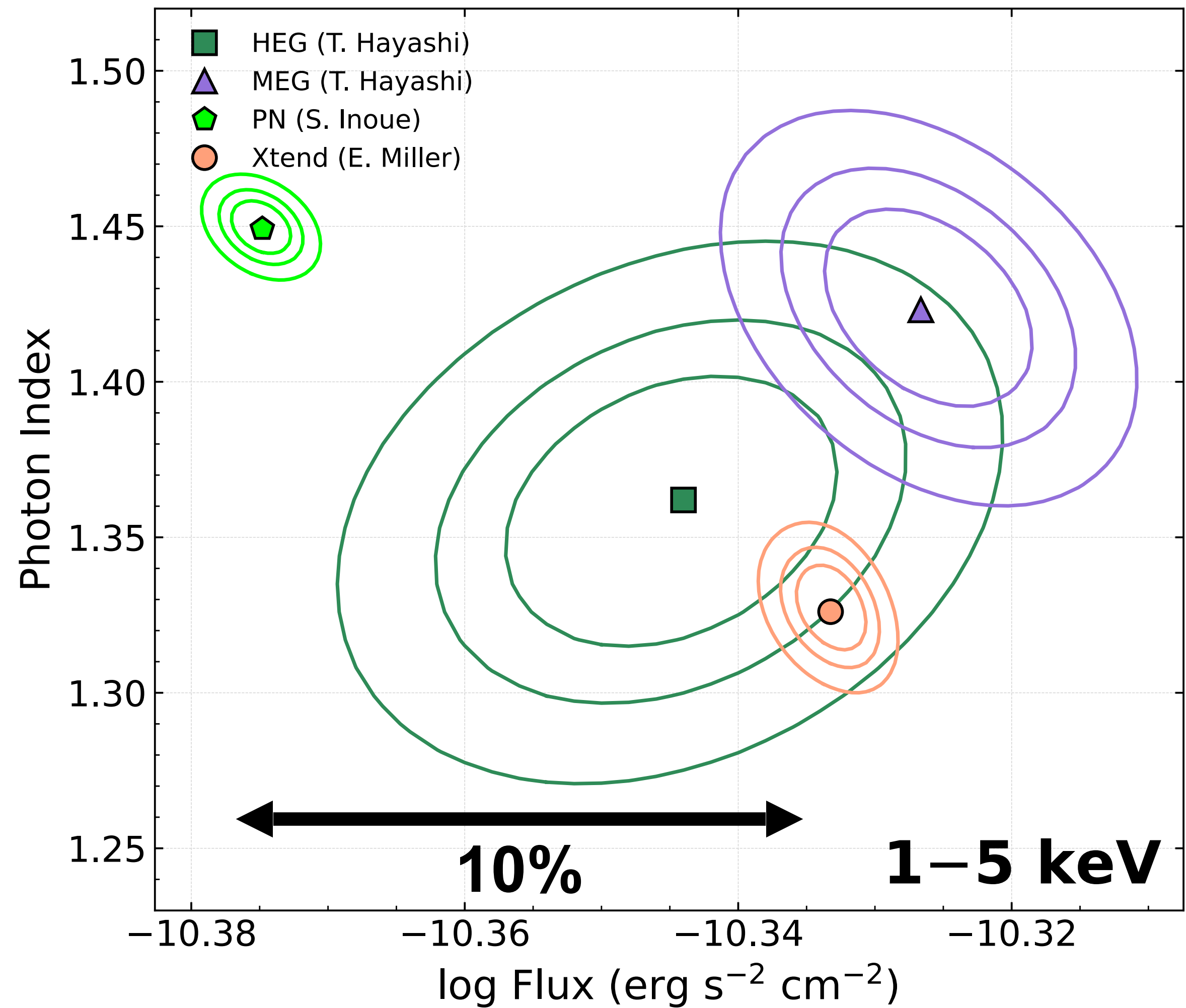


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3C273 FLUX-Gamma: XTD - HEG/MEG - PN

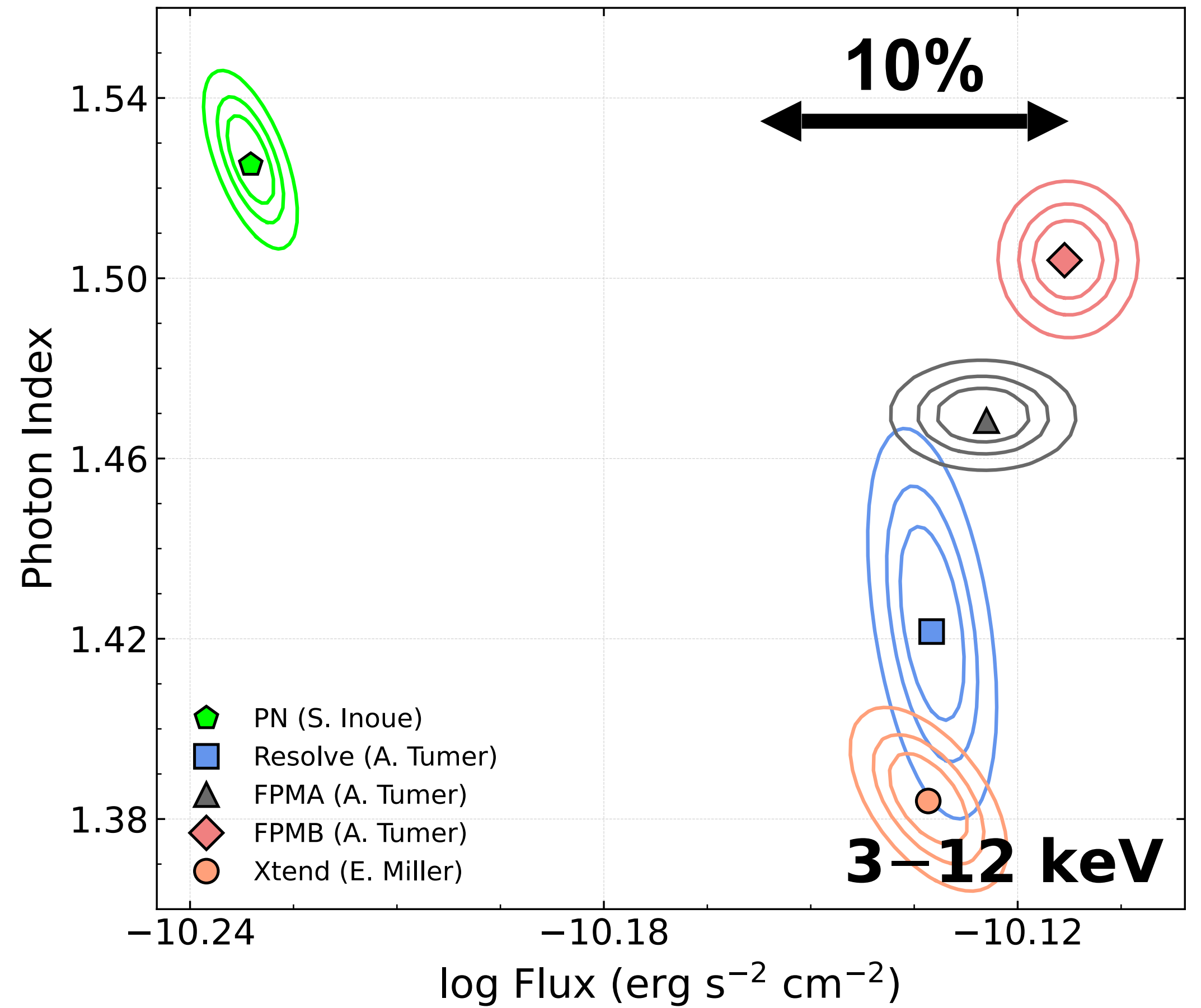
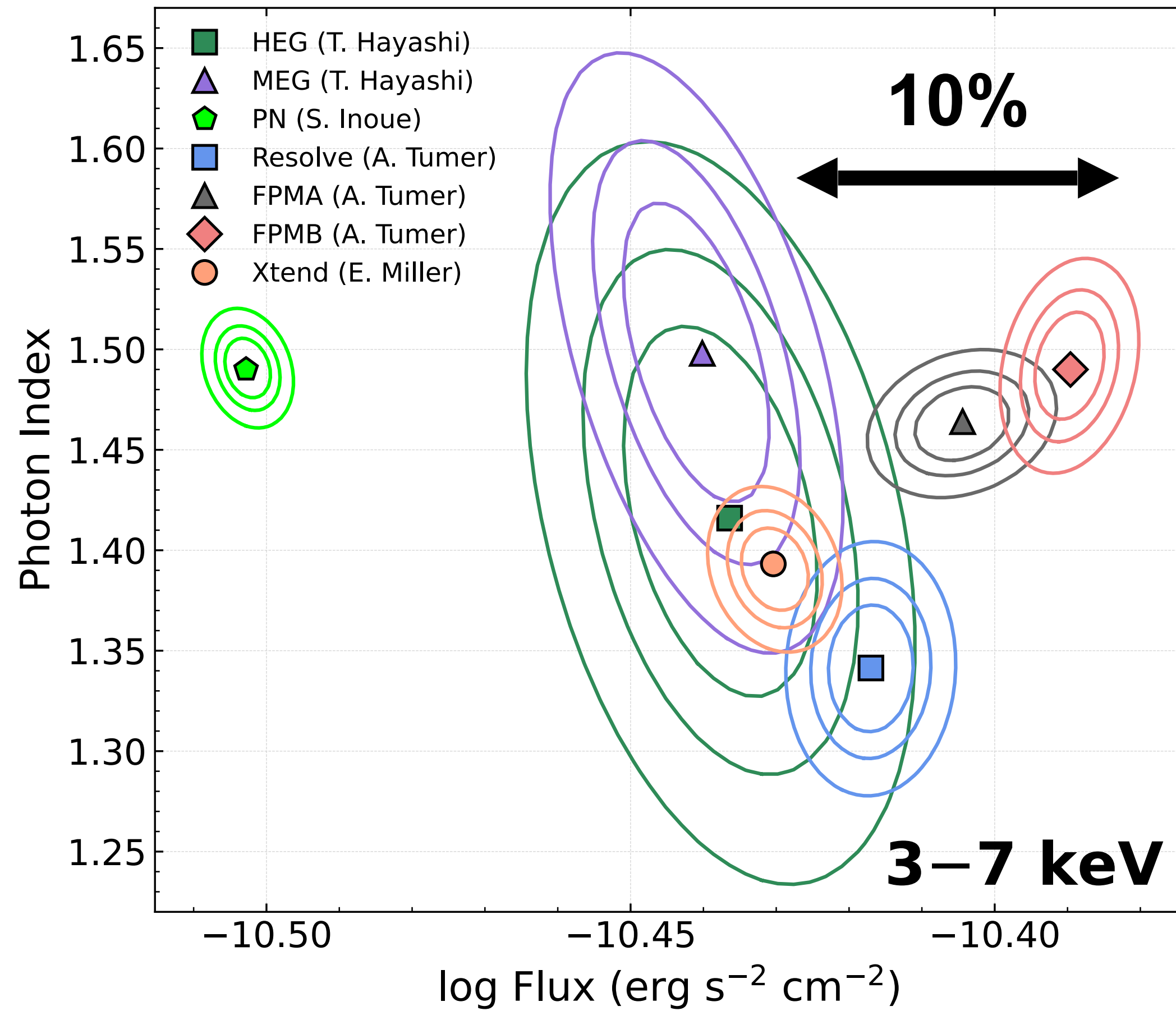
Model: Tbabs*Powerlaw

XTEND, XMM-Newton favor 1-5 keV :
Model: Tbabs*Bknpo



3C273 FLUX-Gamma:

FPMA/B - RSL/XTD - HEG/MEG - PN

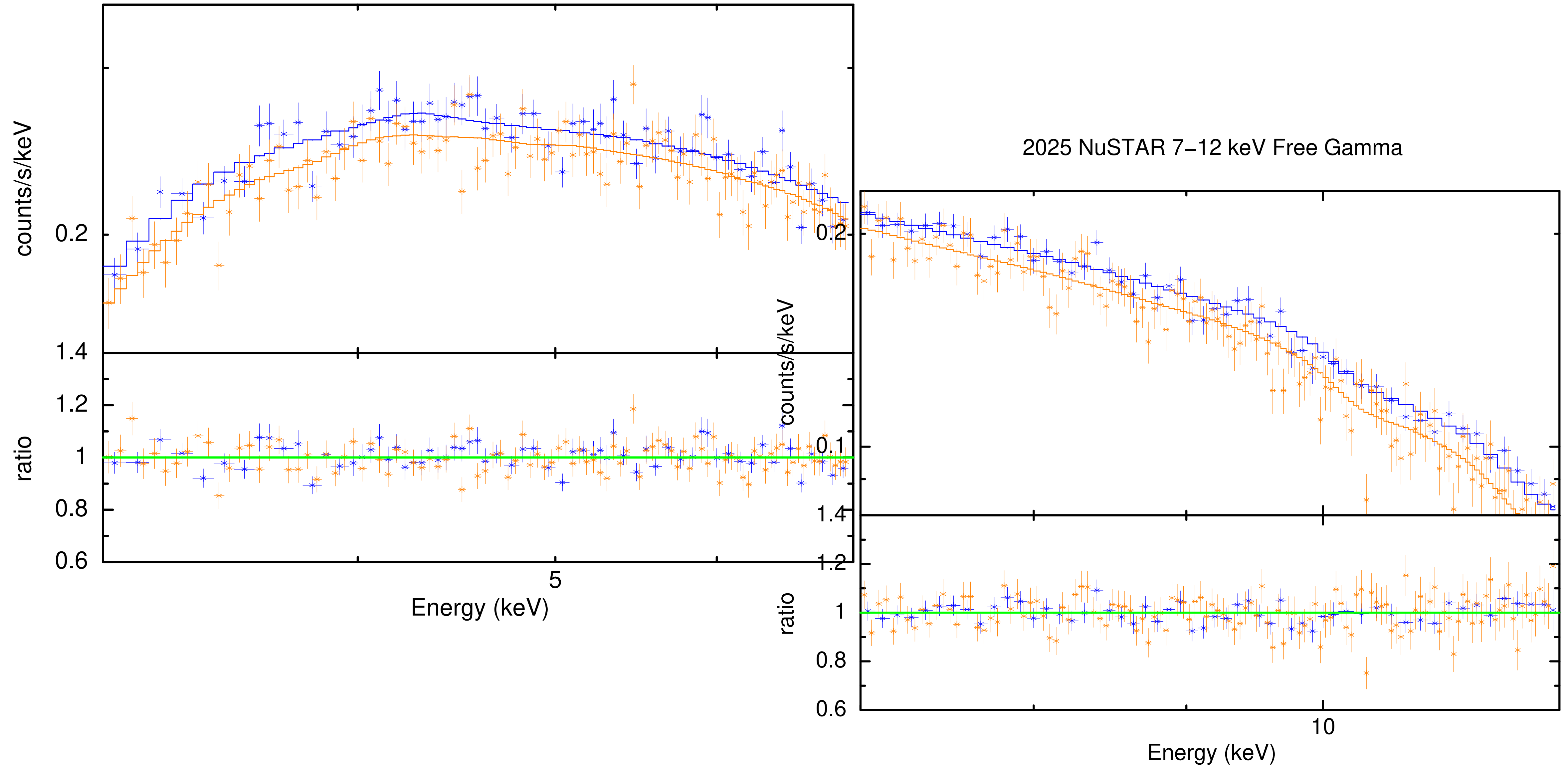


**NuSTAR: IF Gamma IS TIED BETWEEN FPMA AND FPMB
IN THE 3-12 KEV, FLUXES AGREE WITHIN 1 SIGMA**

3C273 NuSTAR

2025 NuSTAR 3–7 keV Free Gamma

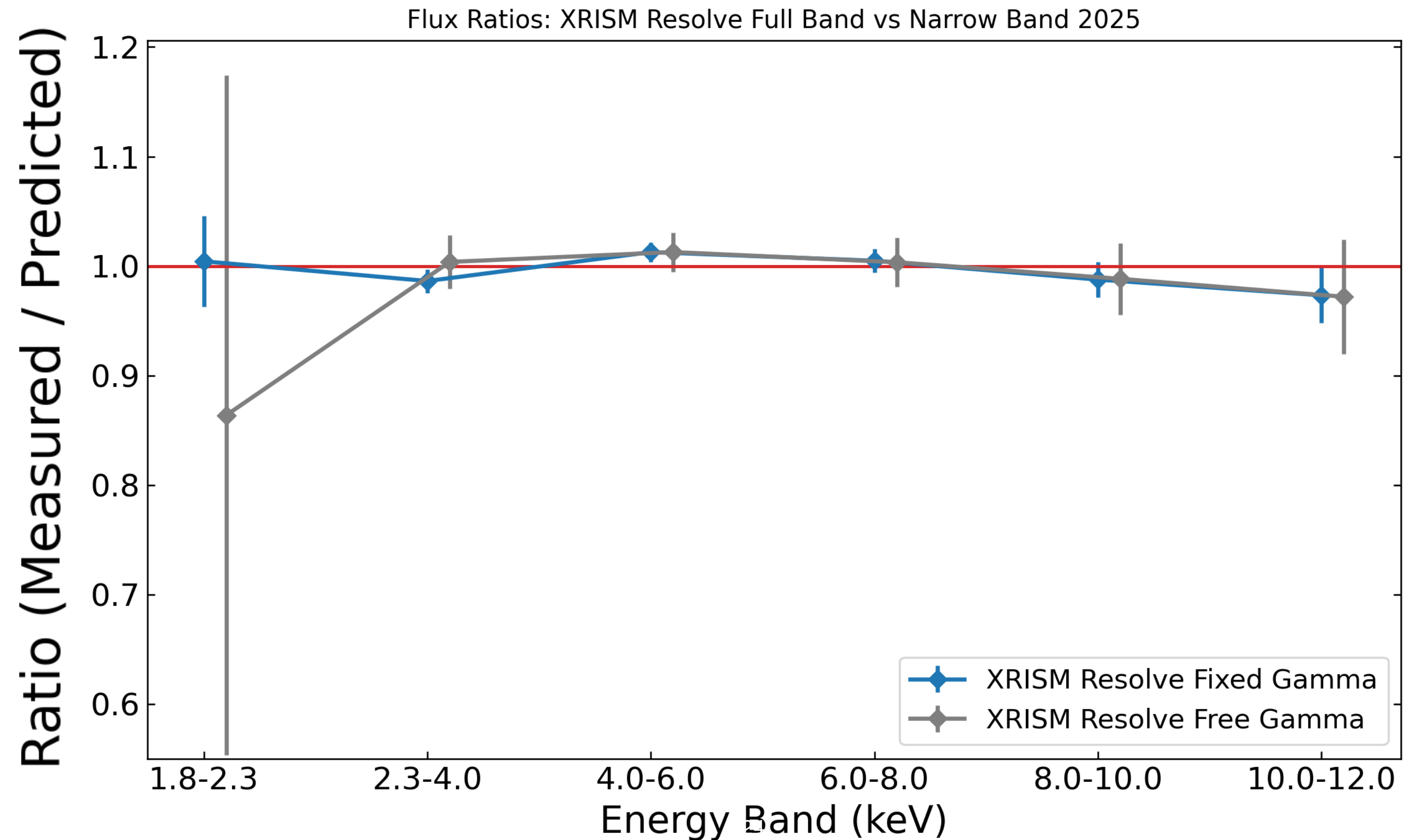
2025 NuSTAR 7–12 keV Free Gamma



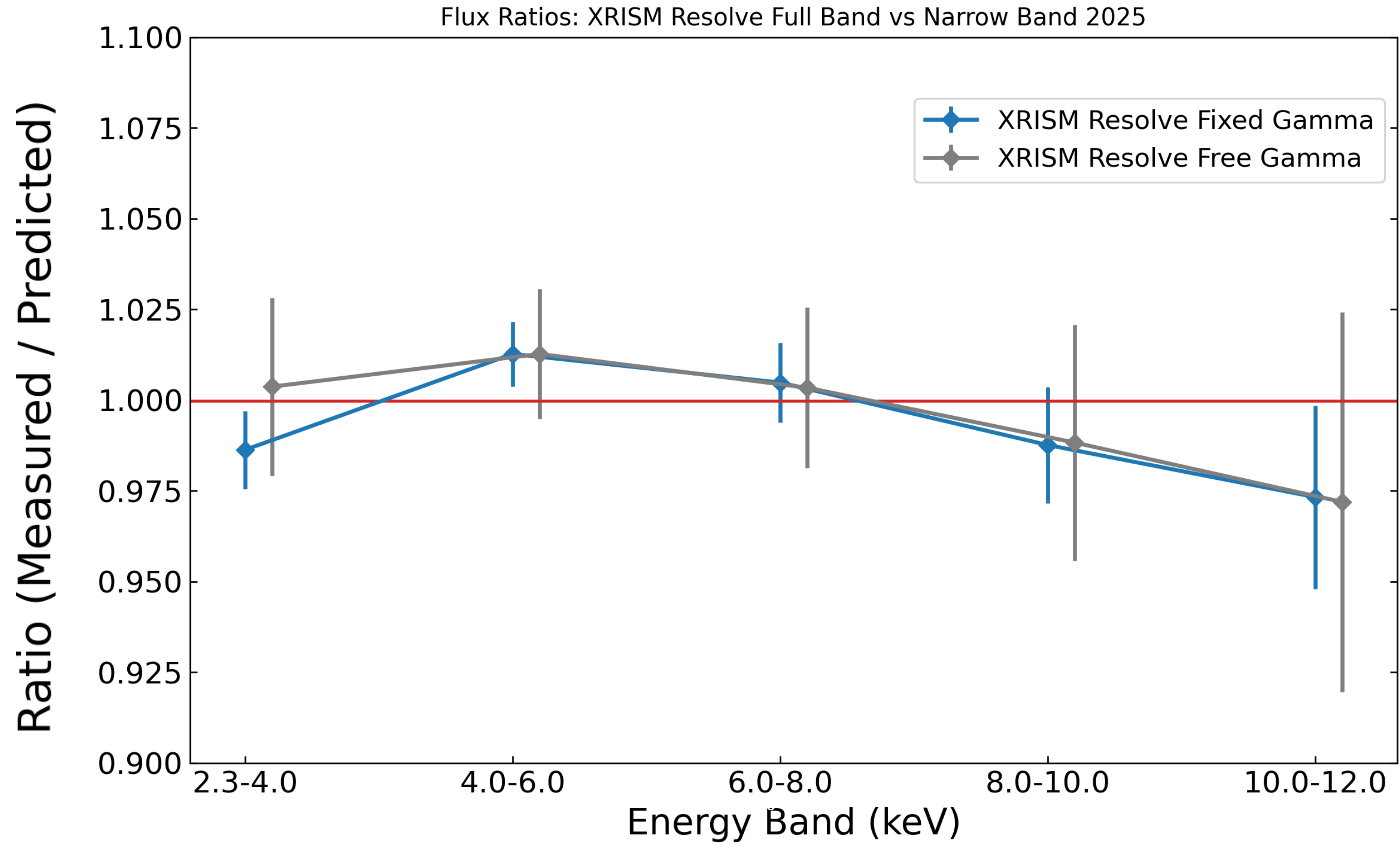
Flux Ratios **3C273 XRISM Resolve 1.8 - 12.0 keV**

Model: Powerlaw **FIXED & FREE Gamma**

HEASOFT 6.36, *CALDB* xtd: 20260315 rsl: 20260315

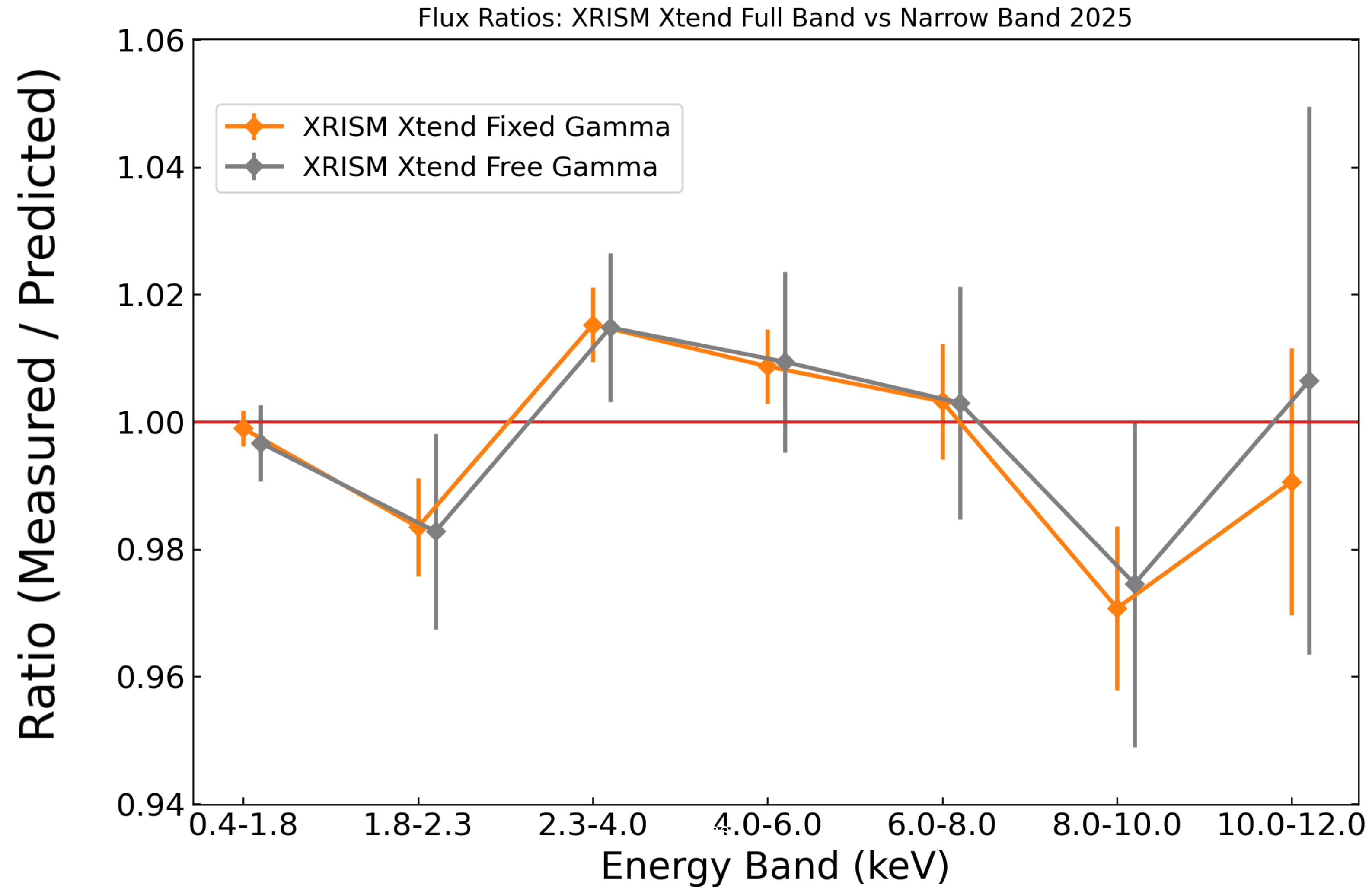


Flux Ratios 3C273 XRISM Resolve 2.3 - 12.0 keV



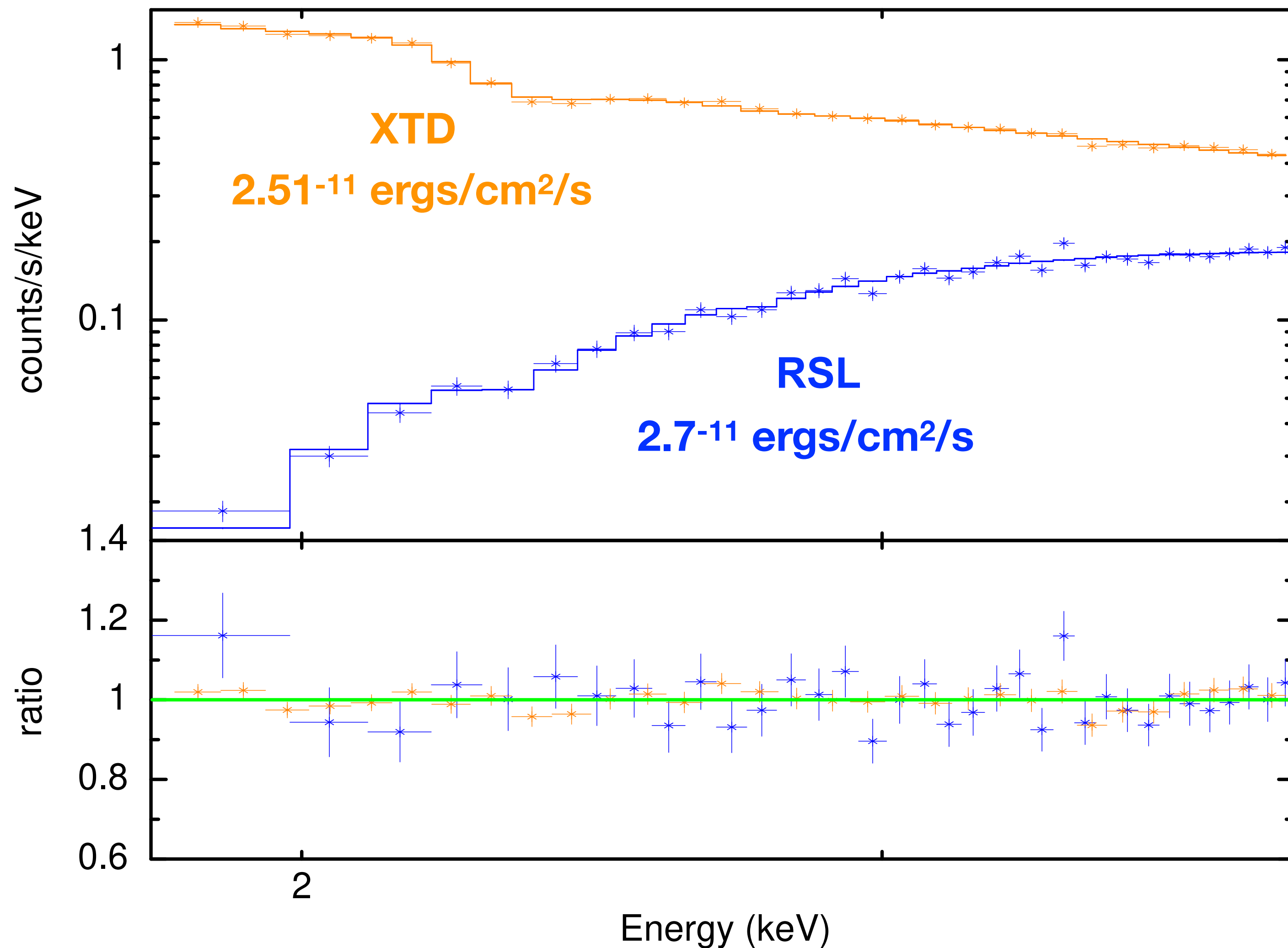
Flux Ratios 3C273 XRISM Xtend 0.4 - 12.0 keV

Model: BKNPO FIXED & FREE Gamma



Xtend-Resolve 1.8-4.0 keV

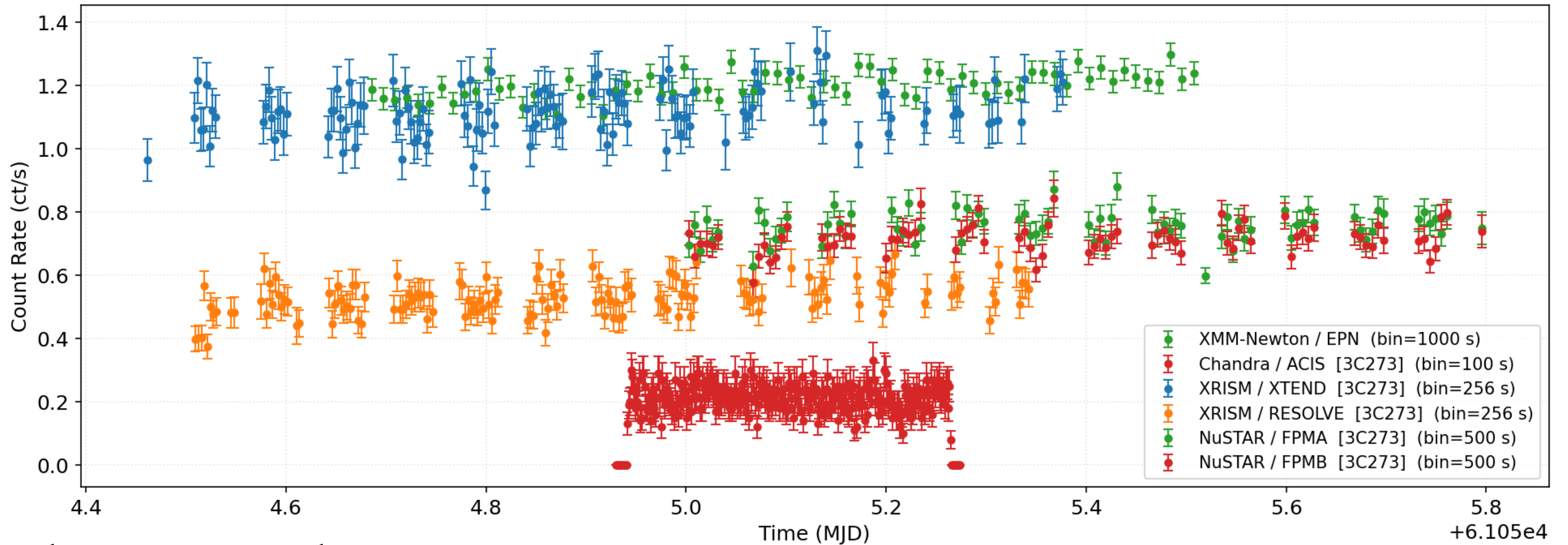
1.8-4.0 keV Resolve-Xtend



	RSL	XTD
PhoIndx1	1.03	1.18
BreakE	2.41	2.76
PhoIndx2	1.70	1.54

2026

Multi-Mission X-ray Light Curves



*Light Curve Script M. T. Sağlam

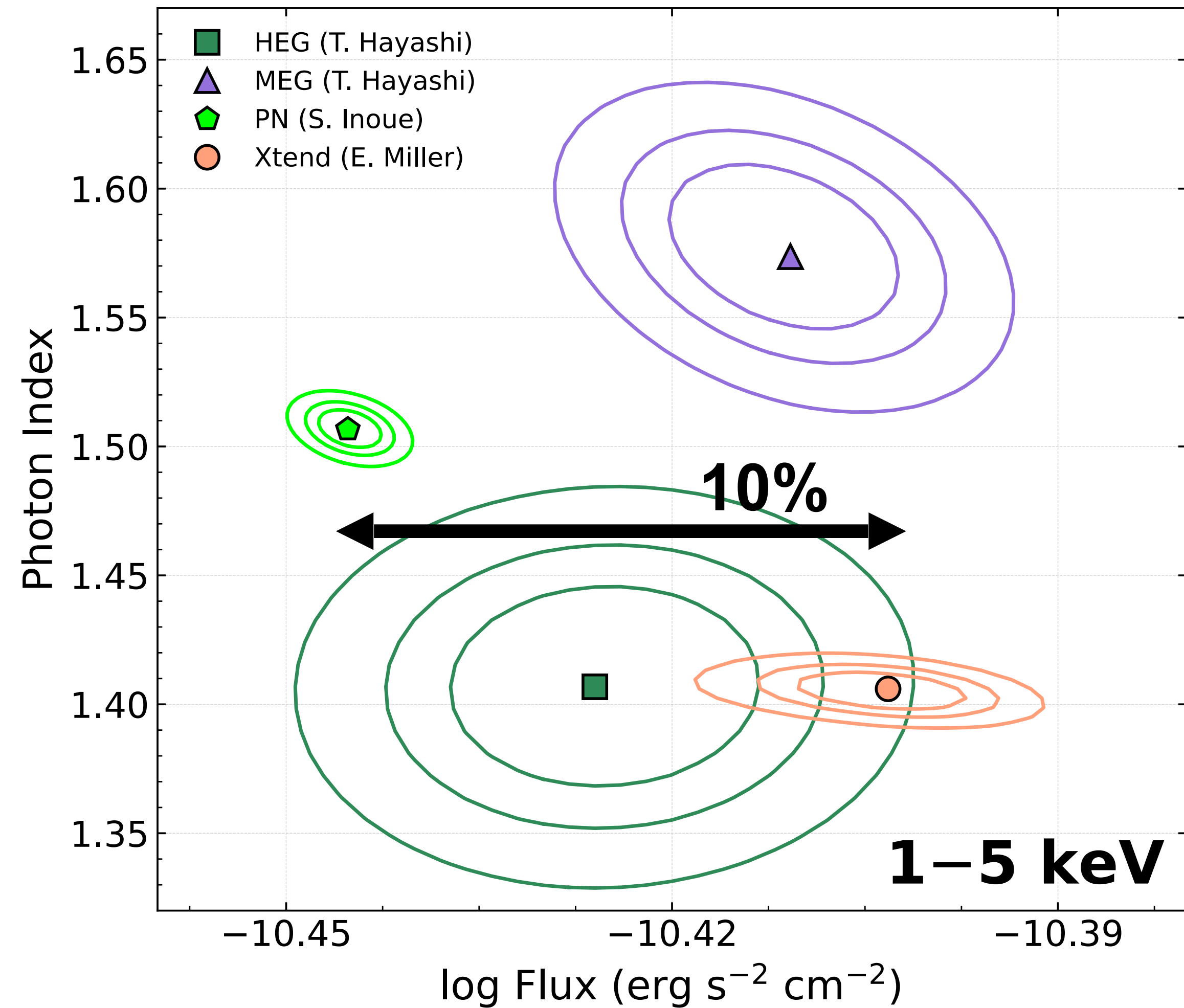
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3C273 FLUX-Gamma: XTD - HEG/MEG - PN

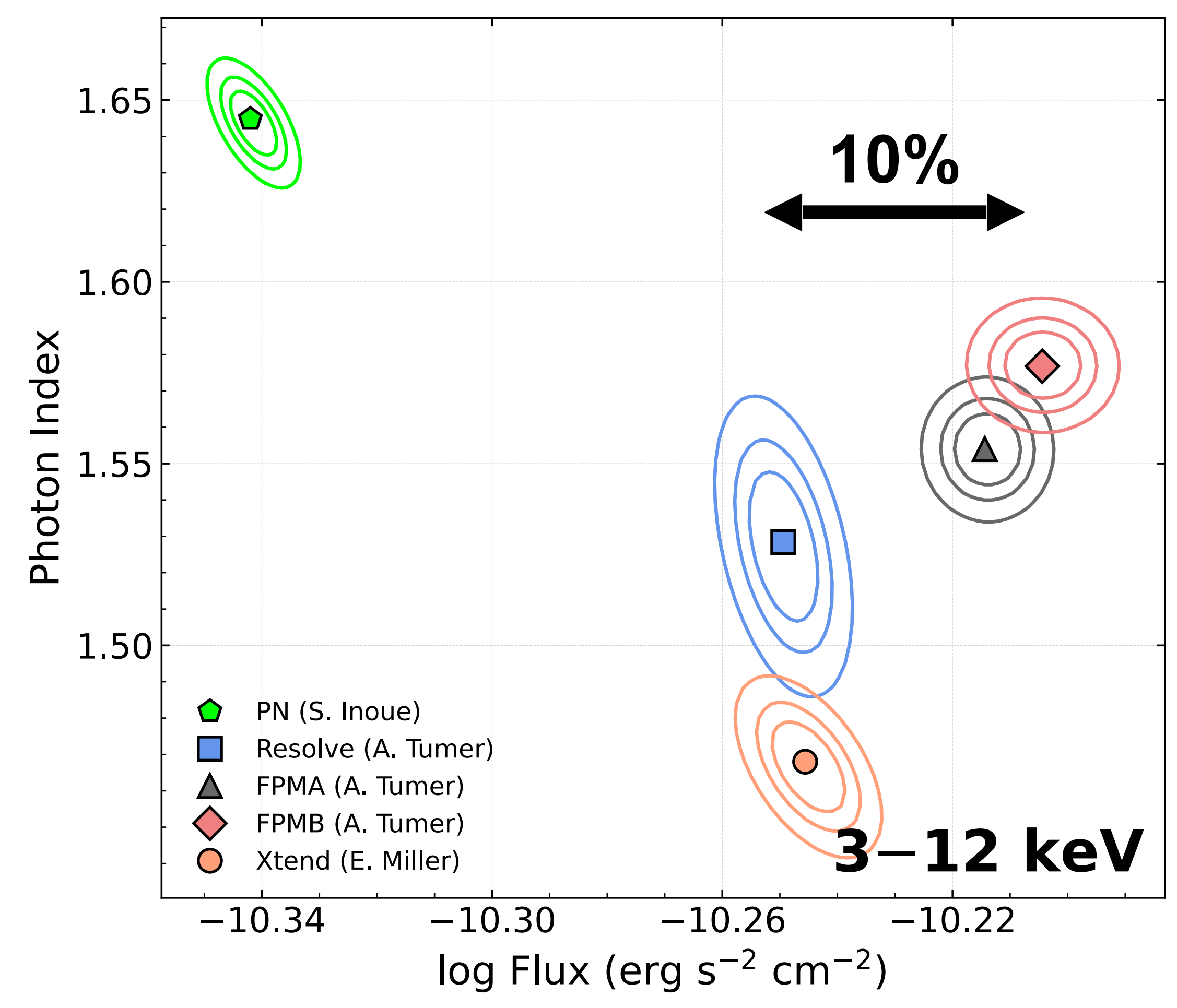
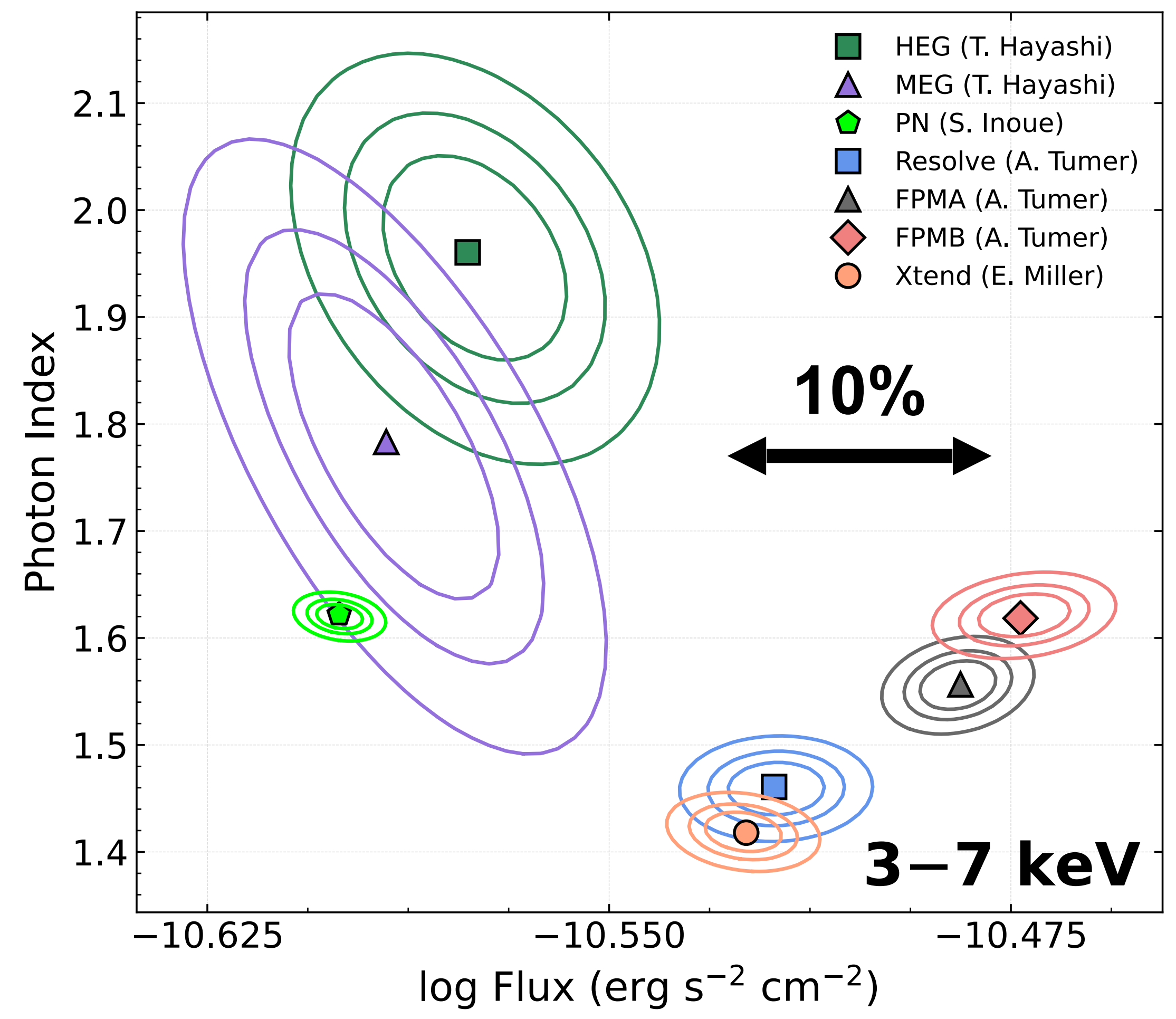
Model: $Tbabs * Powerlaw$

XTEND, XMM-Newton favor:

Model: $Tbabs * Bknp$



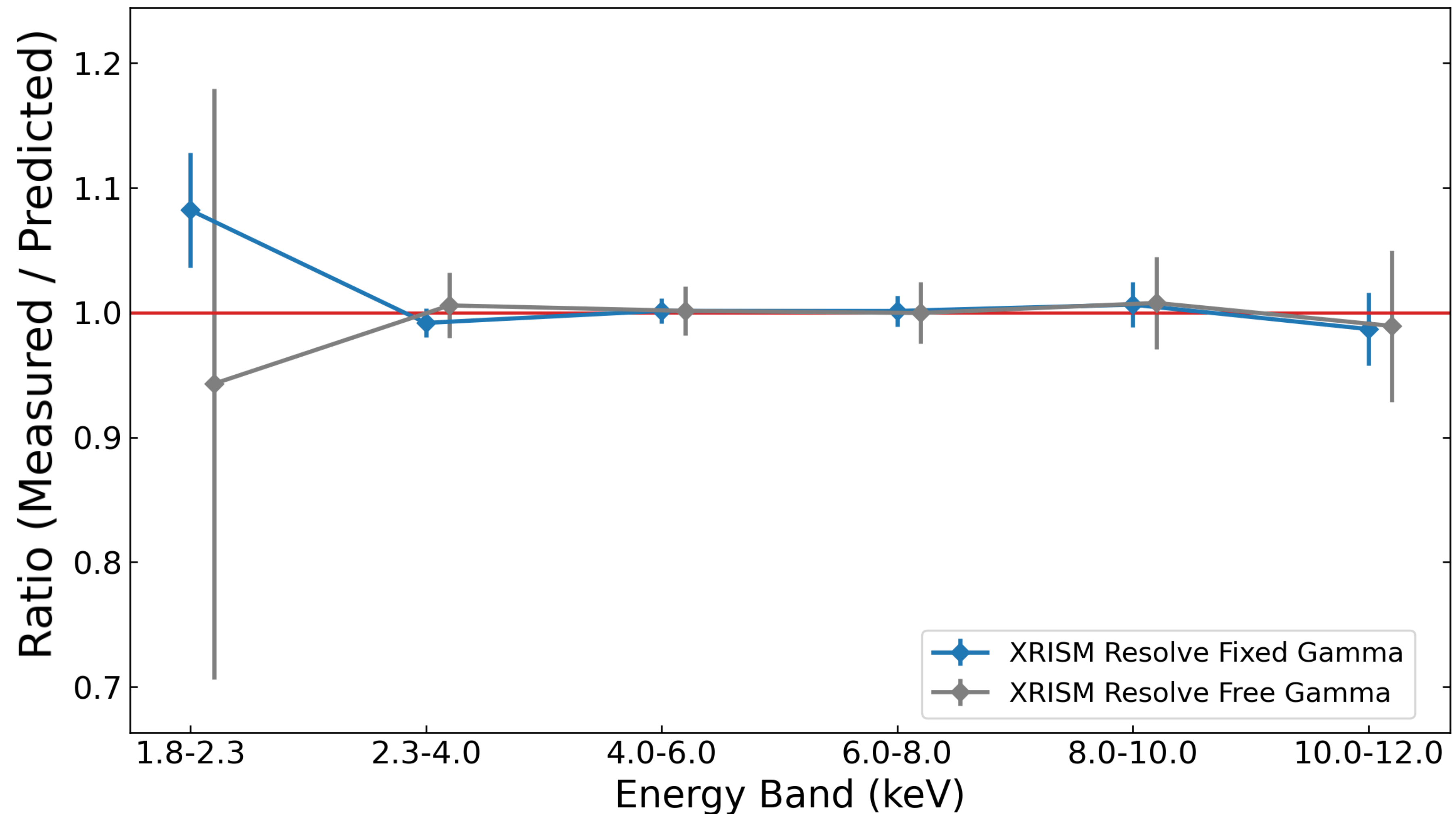
3C273 FLUX-Gamma: FPMA/B - RSL/XTD - HEG/MEG - PN



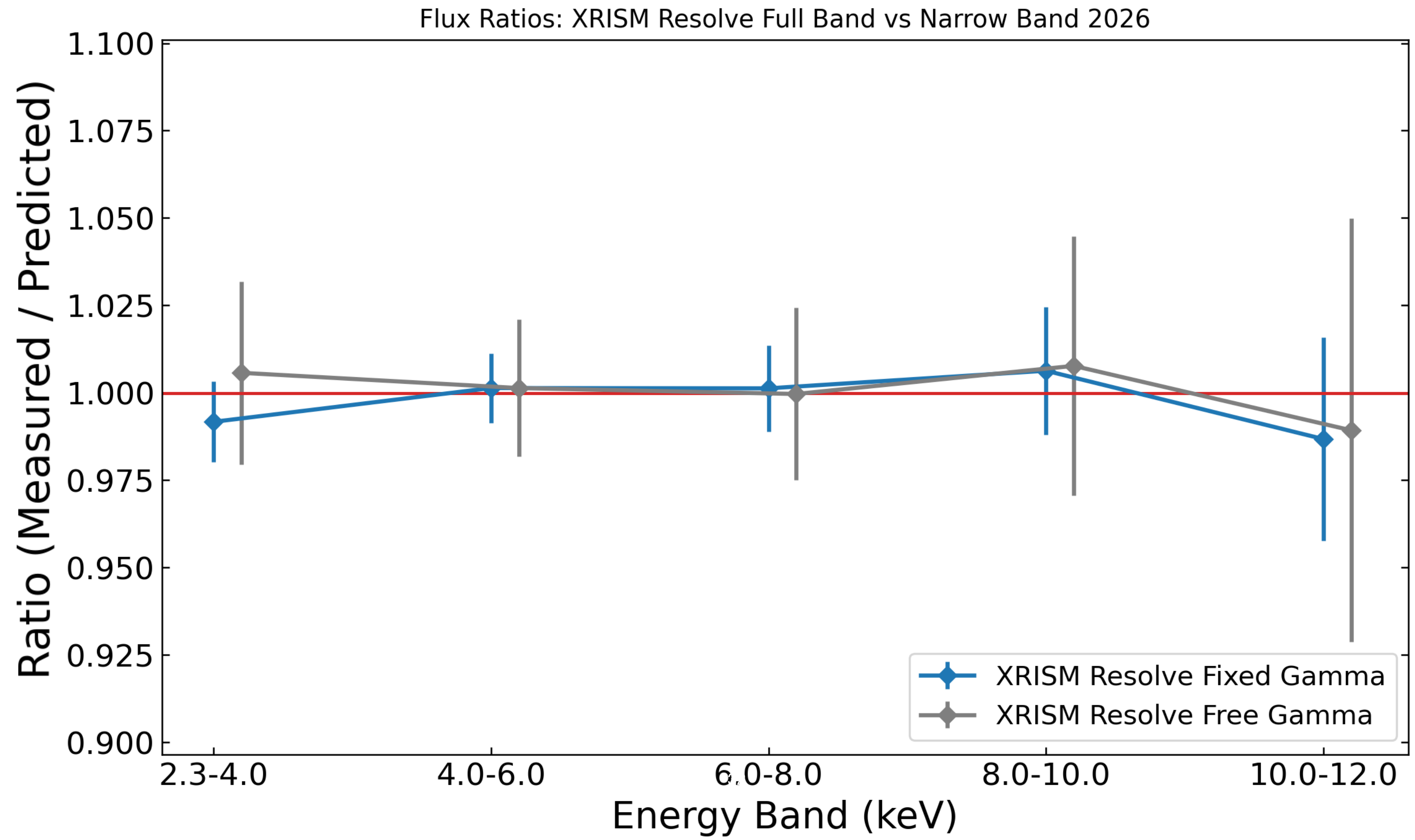
Flux Ratios 3C273 XRISM Resolve 1.8 - 12.0 keV

Model: Powerlaw FIXED & FREE Gamma

Flux Ratios: XRISM Resolve Full Band vs Narrow Band 2026



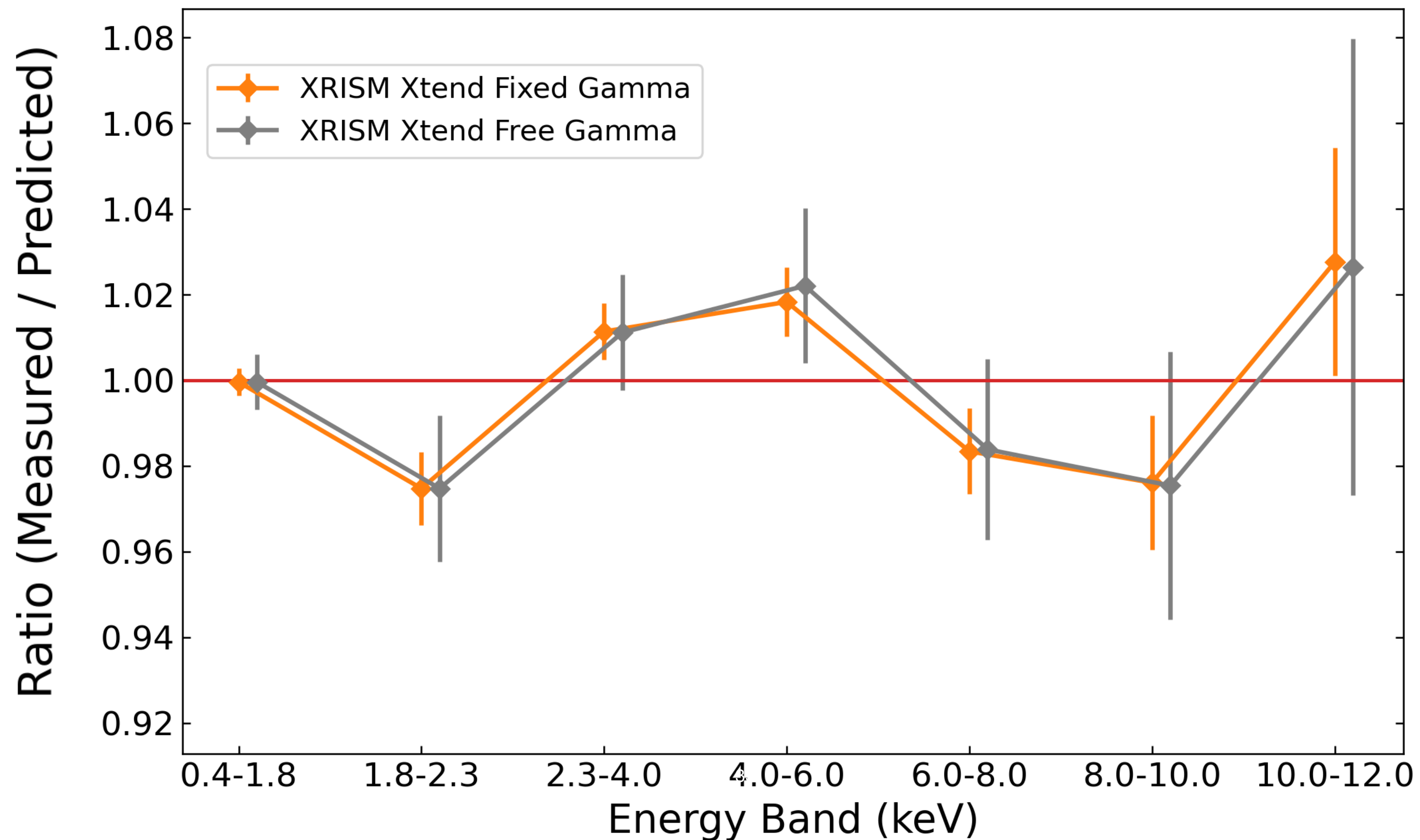
Flux Ratios **3C273** XRISM Resolve 2.3 - 12.0 keV



Flux Ratios 3C273 XRISM Xtend 0.4 - 12.0 keV

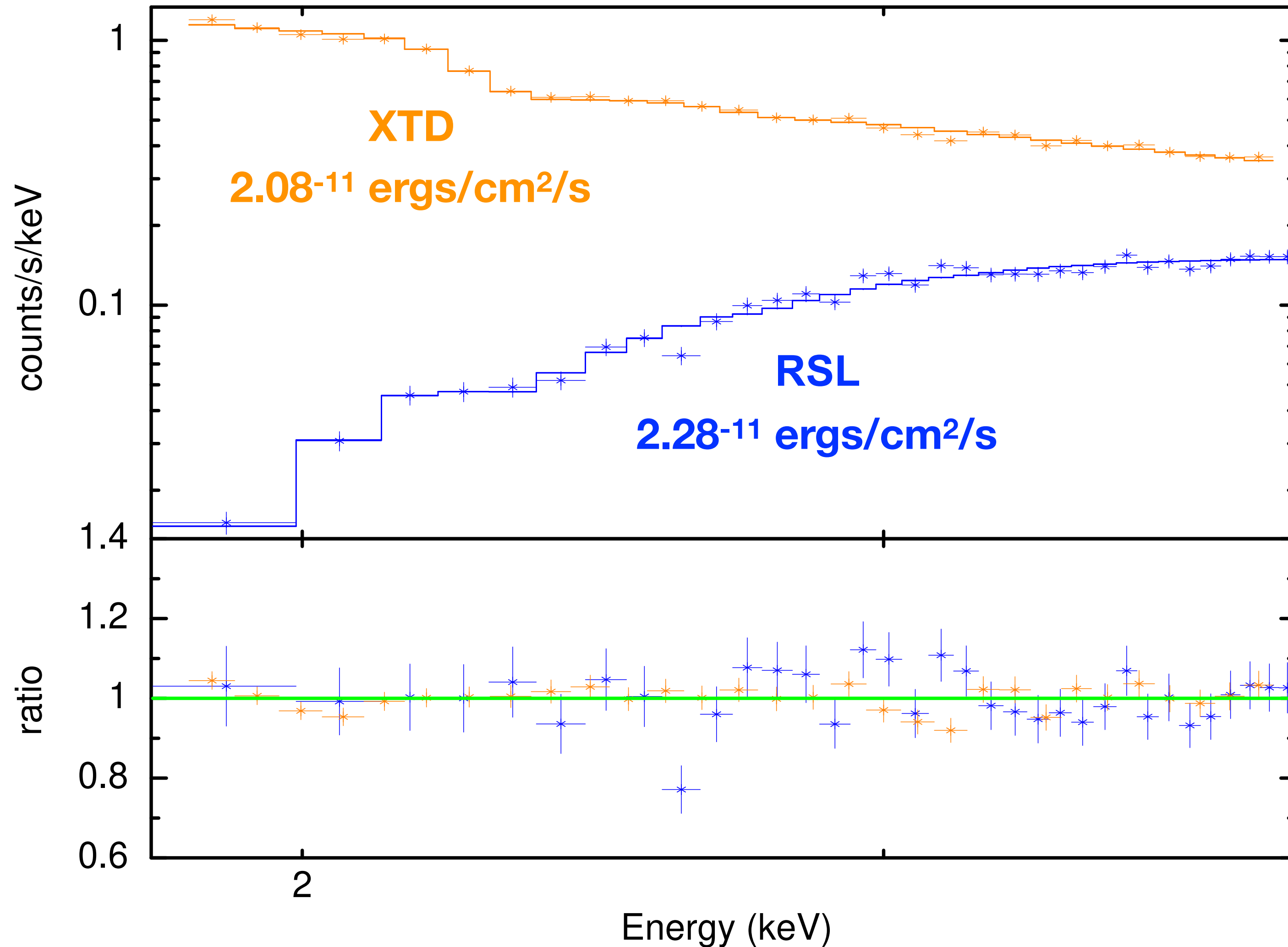
Model: BKNPO FIXED & FREE Gamma

Flux Ratios: XRISM Xtend Full Band vs Narrow Band 2026



Xtend-Resolve 1.8-4.0 keV

1.8-4.0 keV Resolve-Xtend



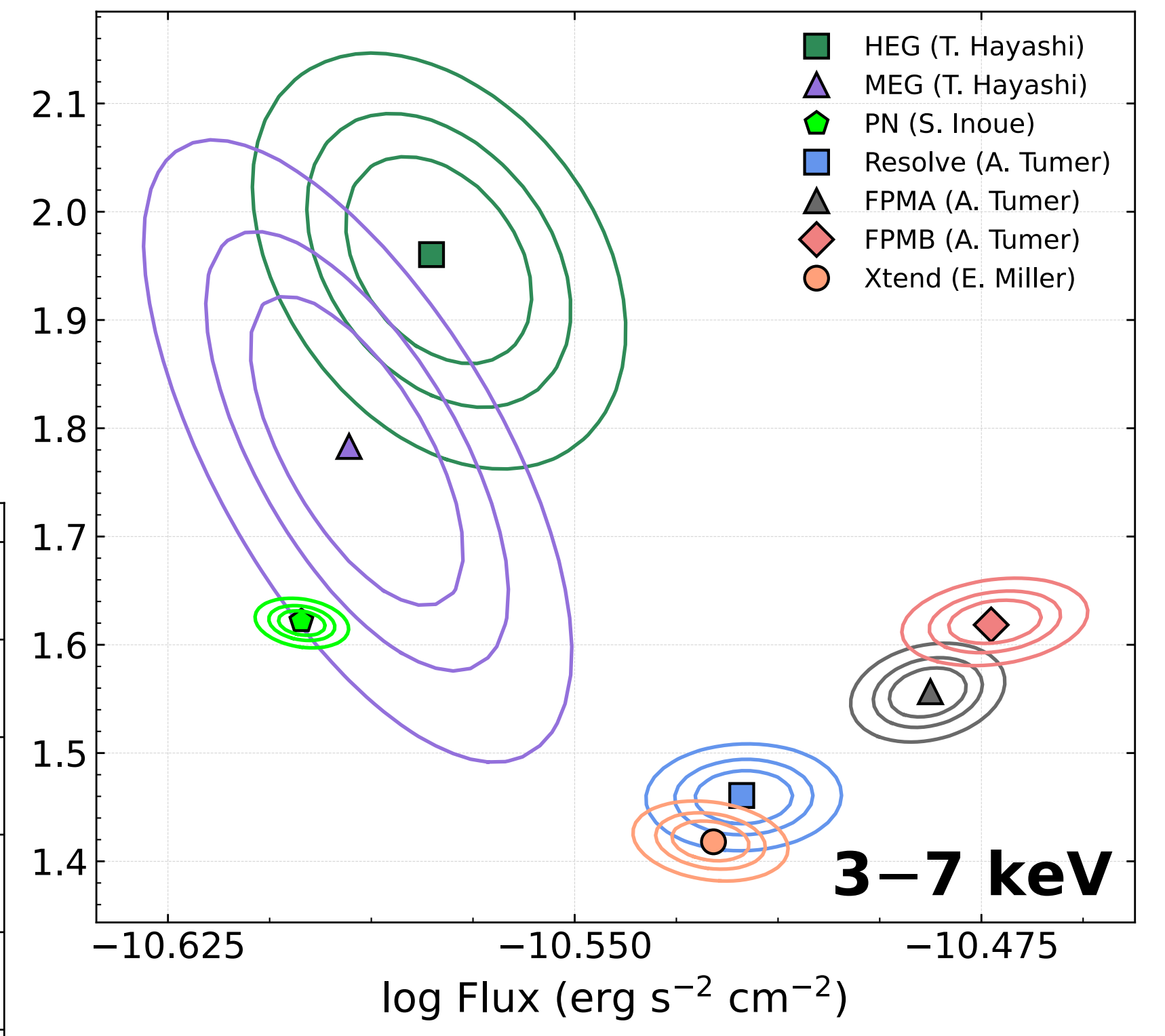
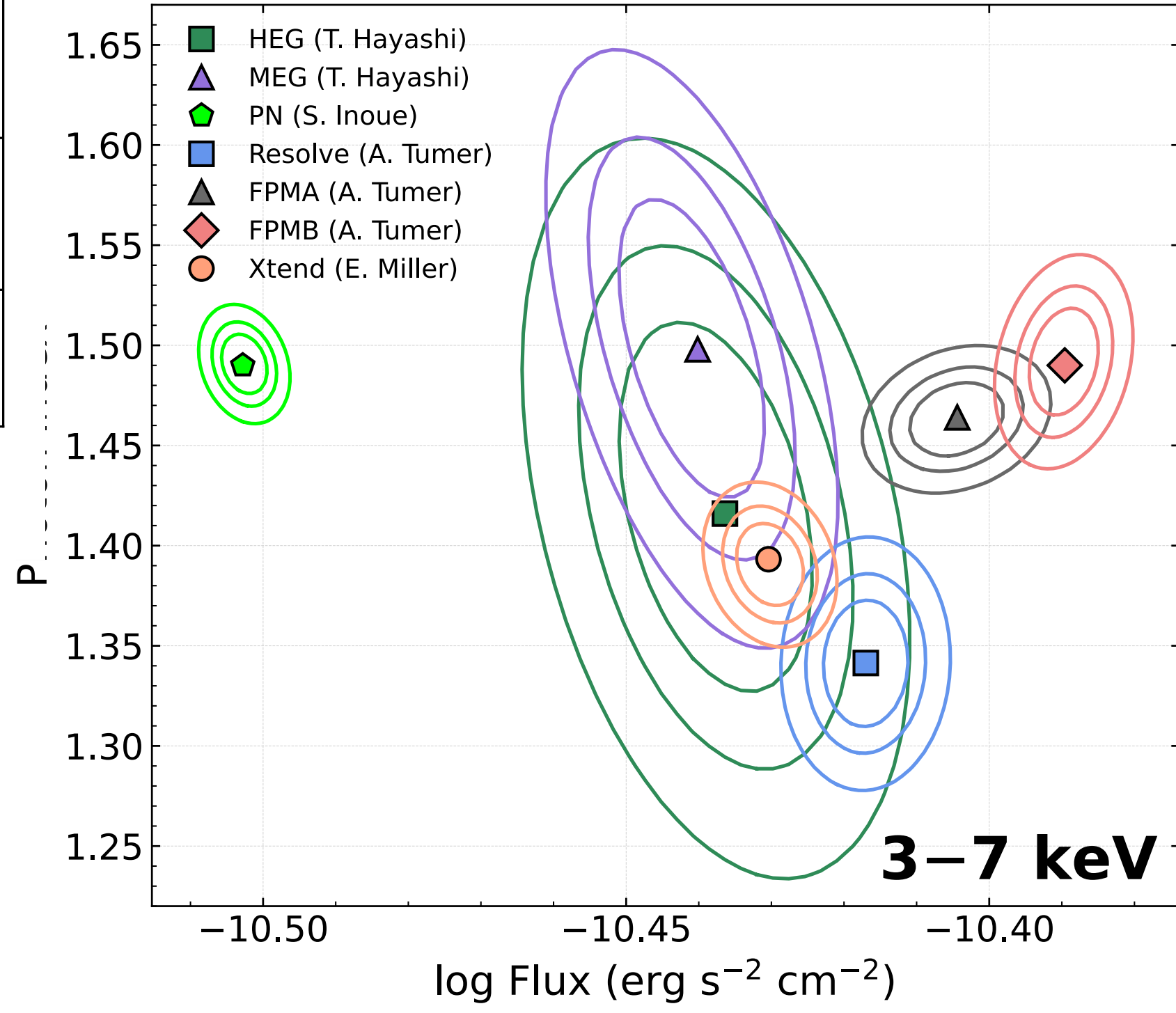
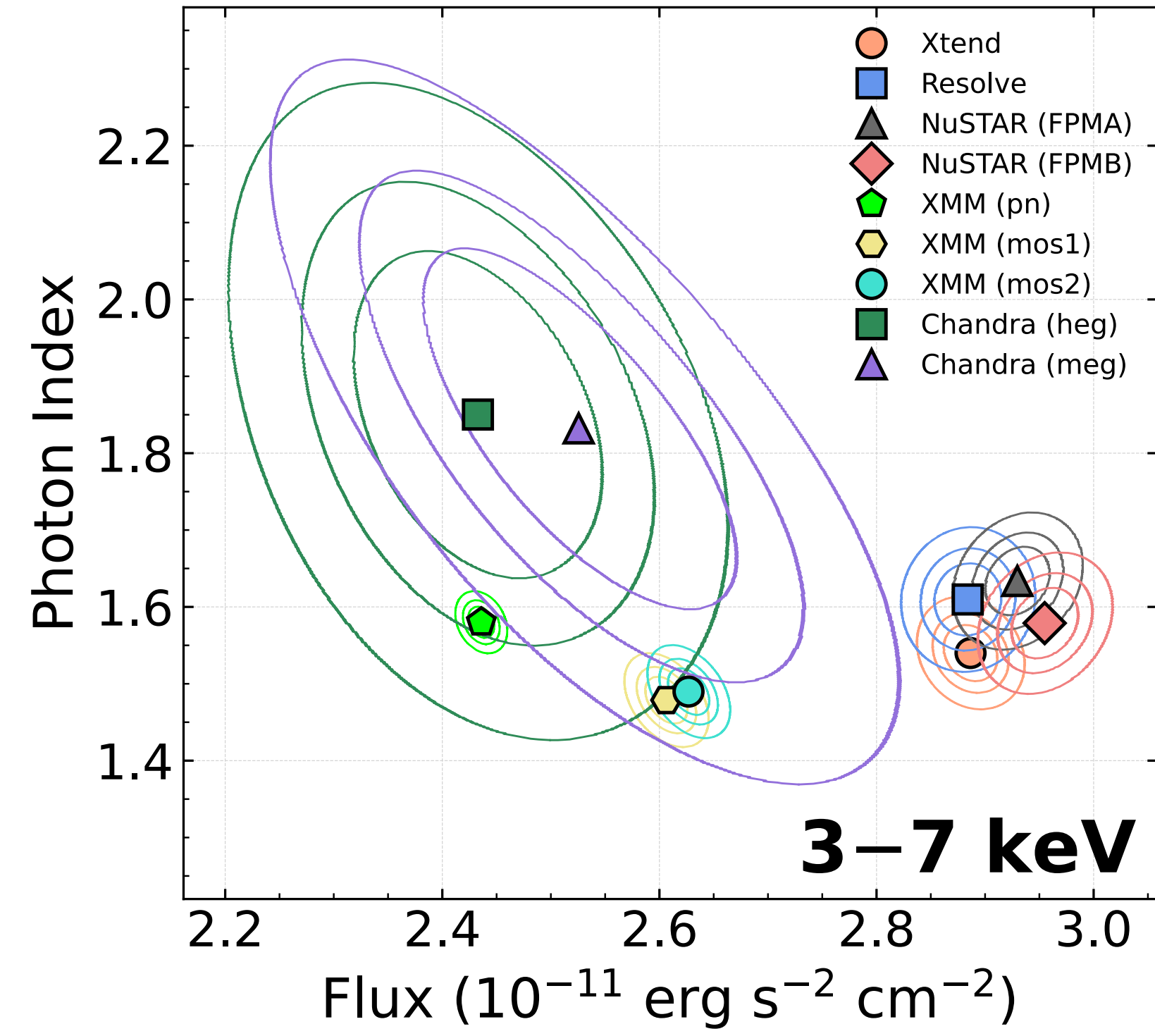
	RSL	XTD
PhoIdx1	0.91	1.18
BreakE	2.11	2.48
PhoIdx2	1.77	1.56

TIME EVOLUTION

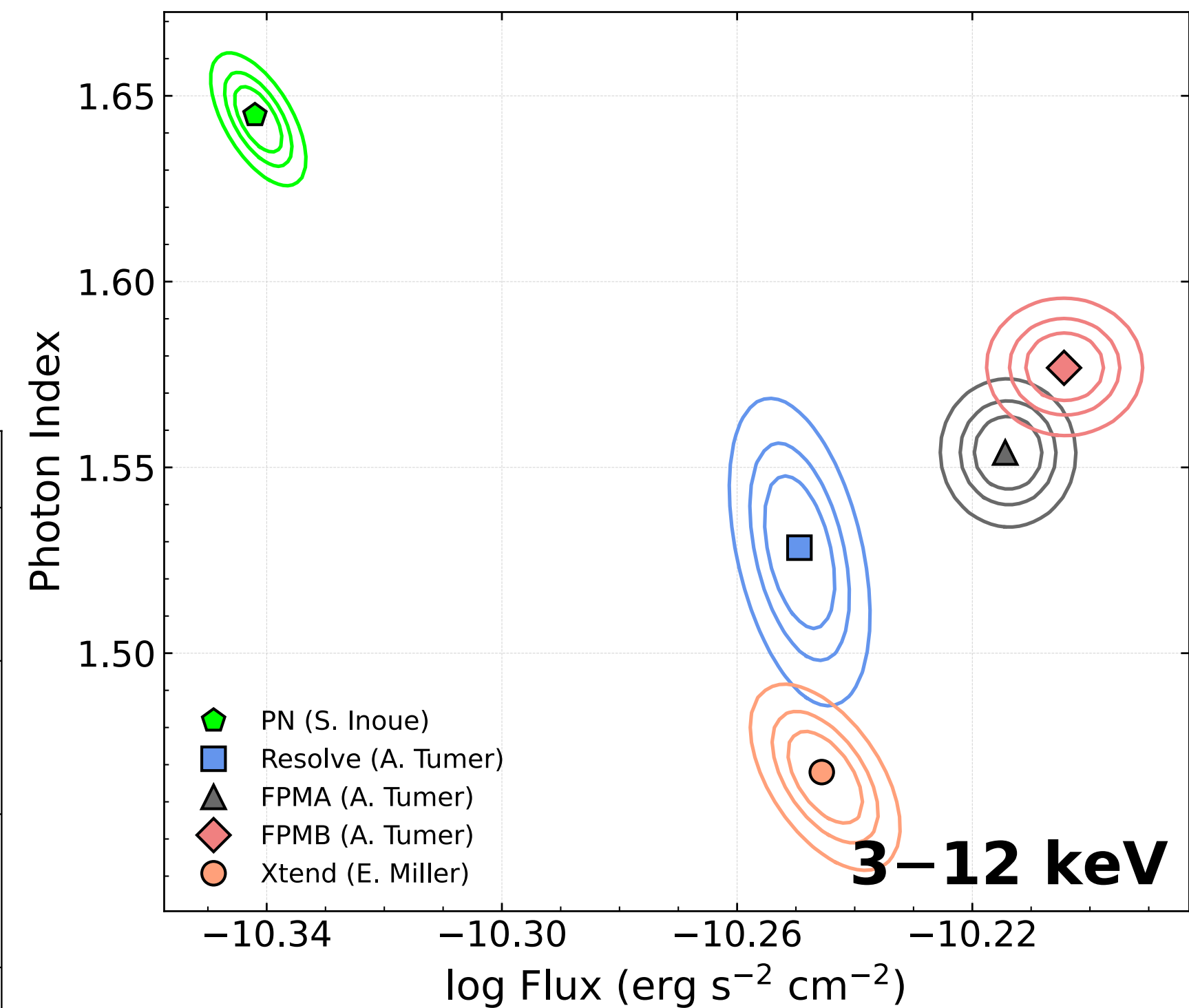
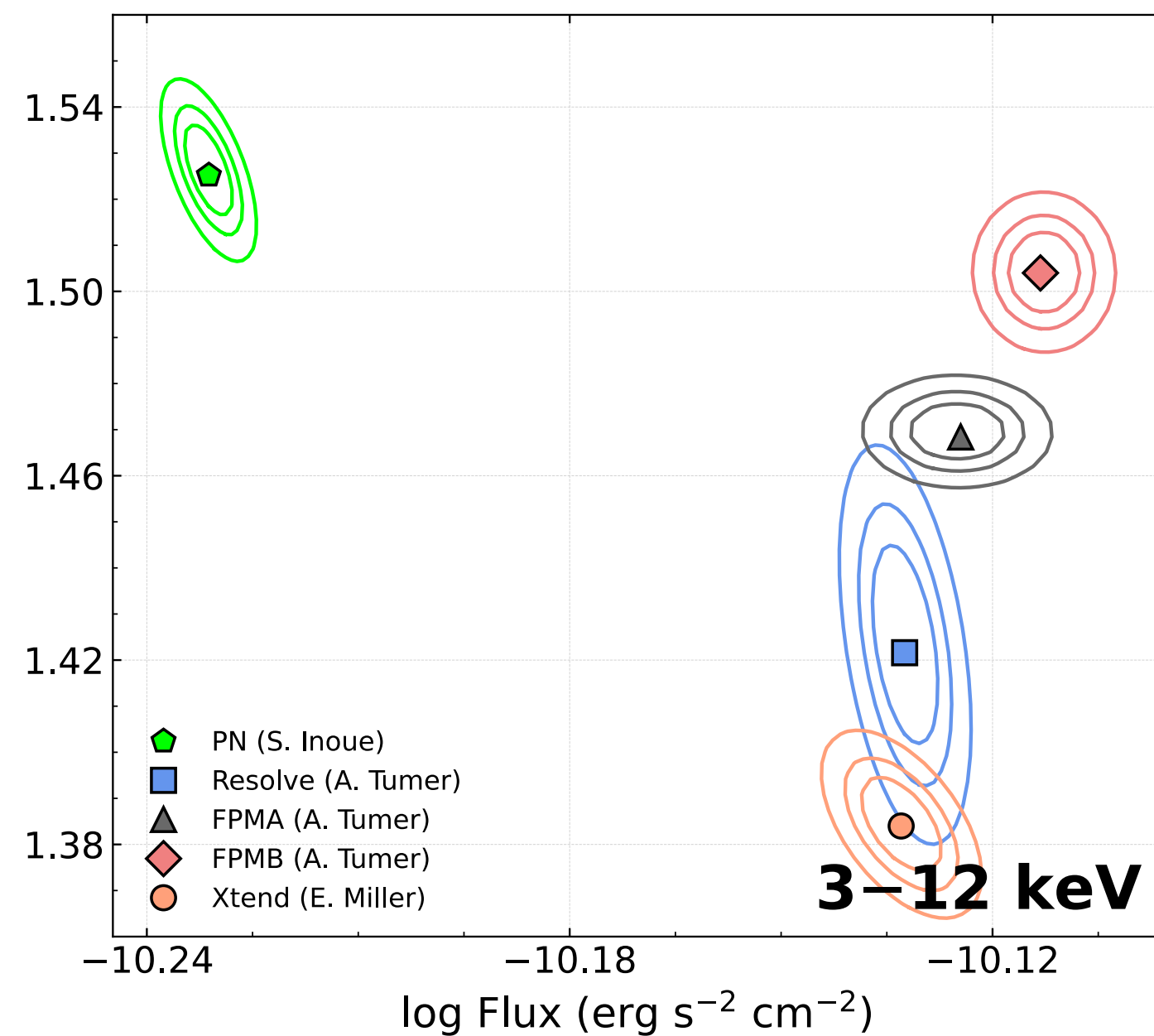
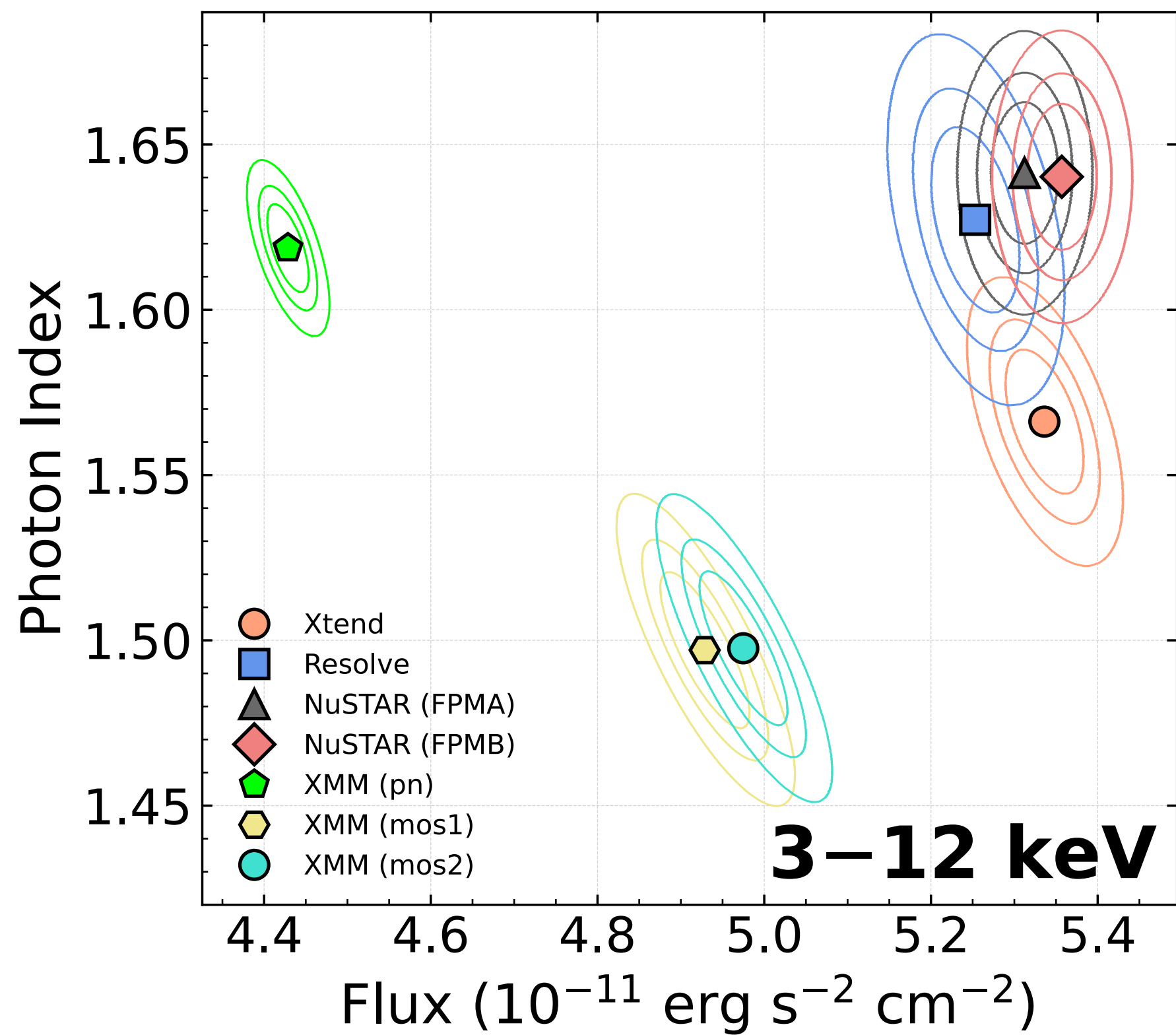
Comparing 2024-25-26

A_{eff}

2024-2025-2026

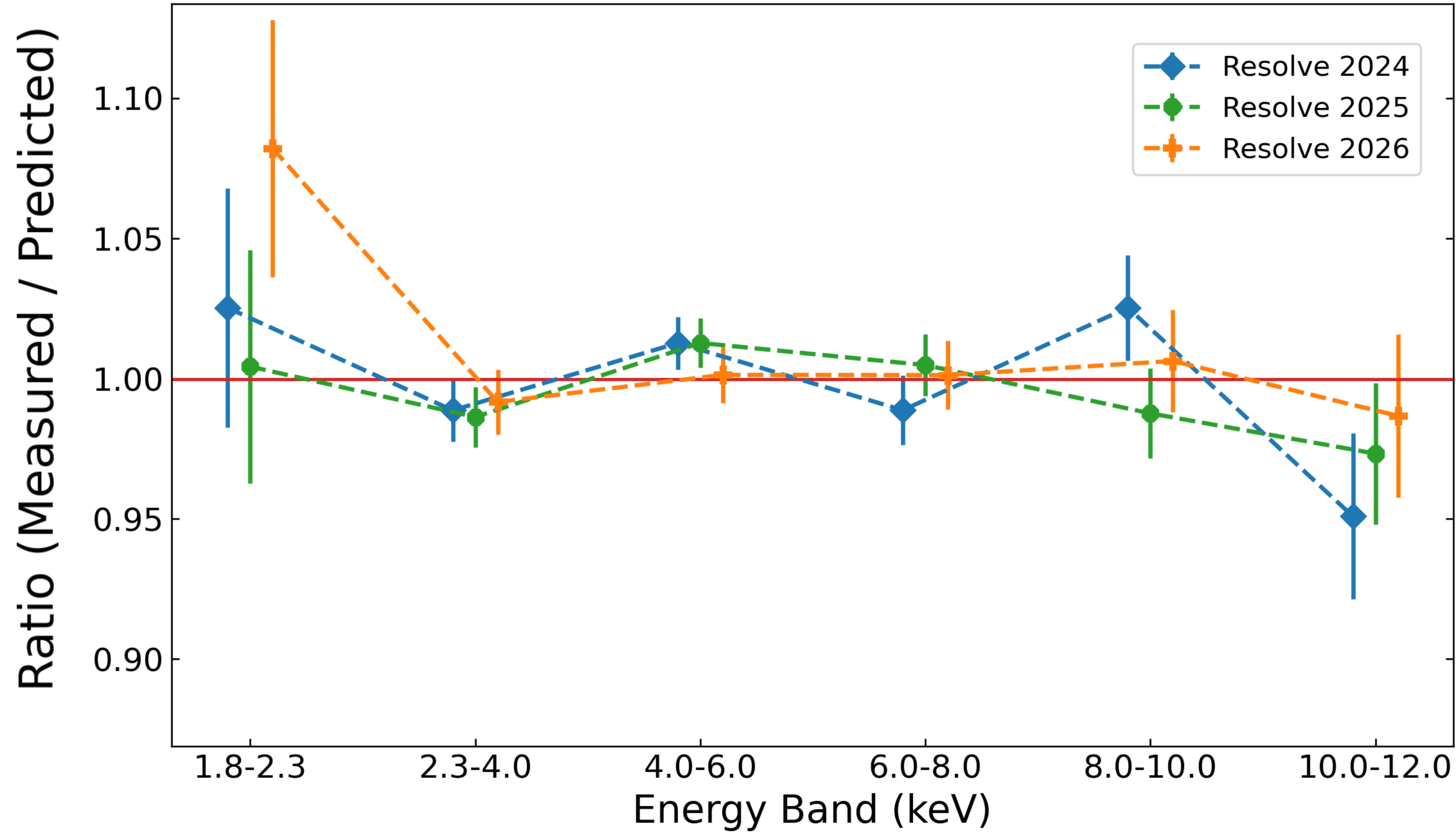


A_{eff} 2024-2025-2026



Resolve Flux Ratio 2024-2025-2026

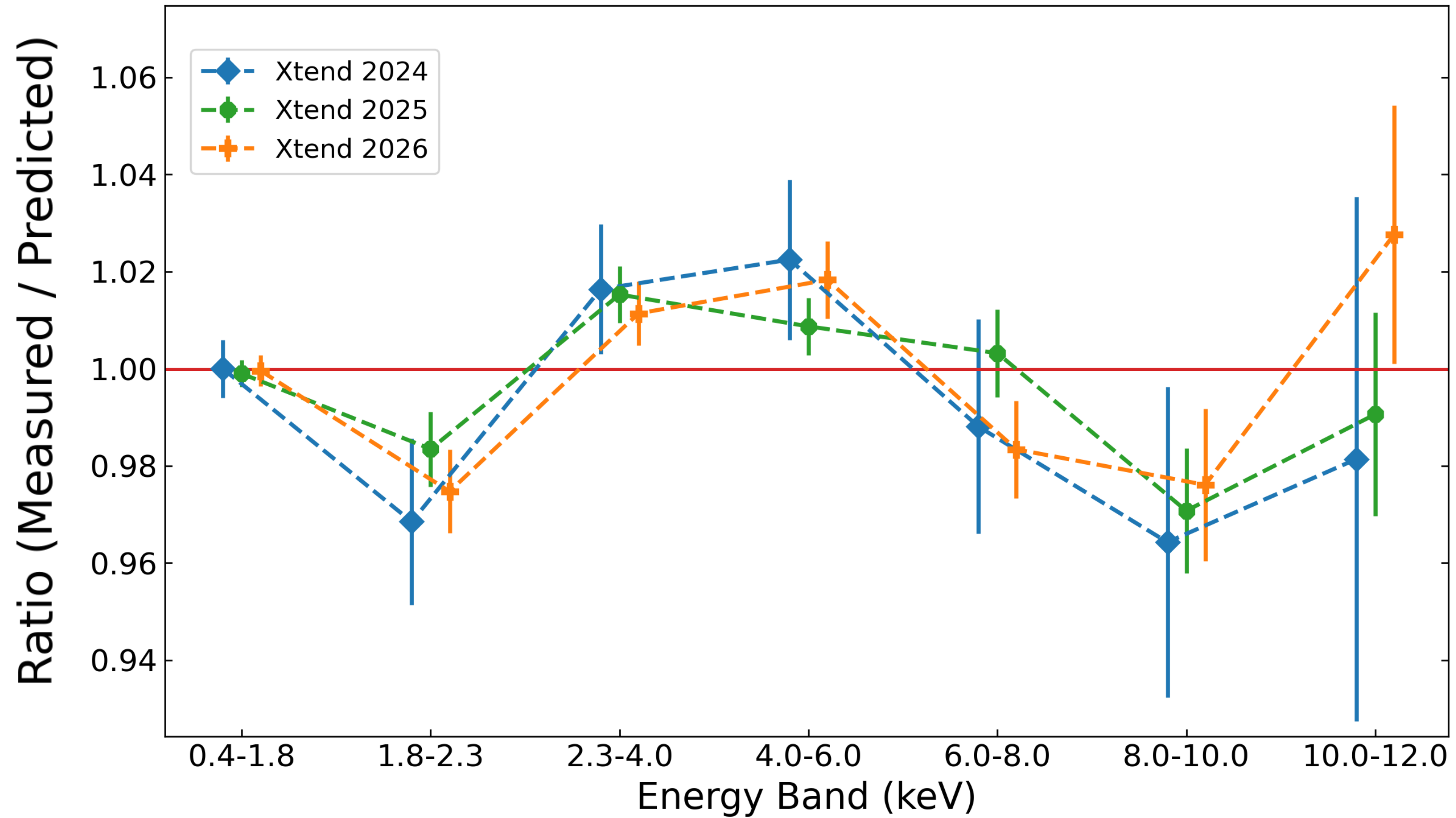
Flux Ratios: 2024-2025-2026



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Xtend Flux Ratio 2024-2025-2026

Flux Ratios: 2024-2025-2026

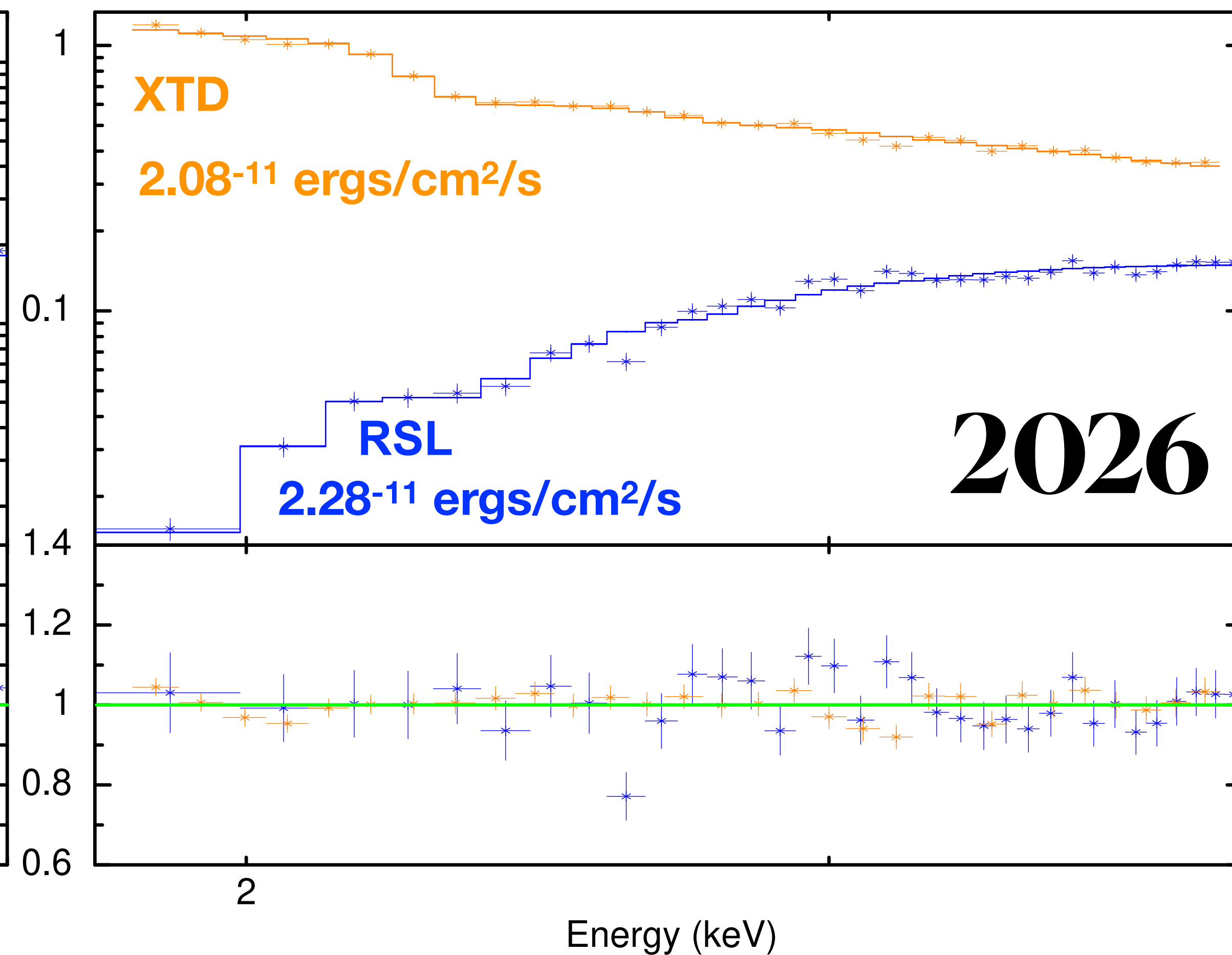
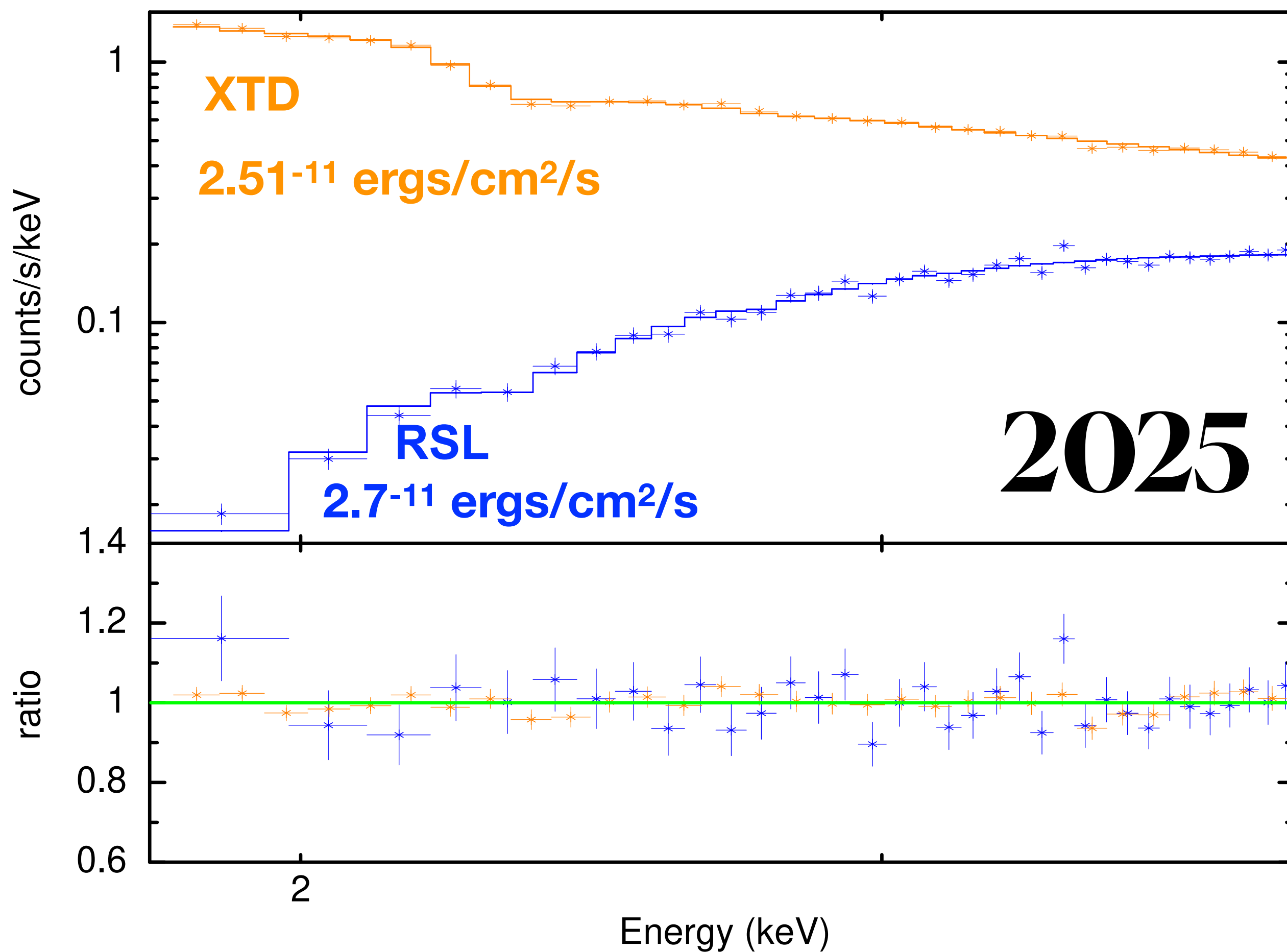


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Xtend-Resolve Soft Band

1.8–4.0 keV Resolve–Xtend

1.8–4.0 keV Resolve–Xtend



SUMMARY

	2024	2025	2026
•Above 3 keV	COMMON GTI START/STOP	FULL OBSERVATIONS (10% overlap for all)	FULL OBSERVATIONS (50% overlap for all)
-Resolve and Xtend	agree to 2%	agree to 2%	agree to 2%
-Resolve/Xtend and FPMA/B	agree to 2%	agree to 10%	agree to 10%
-FPMA and FPMB	agree to 1%	agree to 3% GAMMA OFF (3-12 keV)	agree to 3%
-Resolve/Xtend and MOS	agree to 10%	MOS Contamination	MOS Contamination
-Resolve/Xtend and HETG, PN	disagree by 15%	disagree by 20%	disagree by 15% (3-7keV) 20%(3-12 keV)
•From 1 to 5 keV			
-Xtend and PN	agree to 10%	agree to 10%	agree to 10%
-Resolve and Xtend around 2 keV	disagree by 20–40%	Ongoing work (M.T.Saglam)	Ongoing work (M.T.Saglam)

Conclusions & Future Work

- 2025-2026 agreements are weakened from 2024 (not too much)
—> GTI was not restricted—Source Variability

NEXT STEPS:

- Apply NuSTAR MLI table to refit 3-7 keV band.
- Find a new cross-calibration source that has a simpler shape in the soft band

**Don't miss the talk by Shun Inoue
in the XRISM session tomorrow
for more
in-flight cross-calibration analysis results**