

Relative Energy Calibration Accuracy of XRISM/Resolve and NuSTAR

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Simultaneous XRISM & NuSTAR observations

As of Apr 15, 2026,

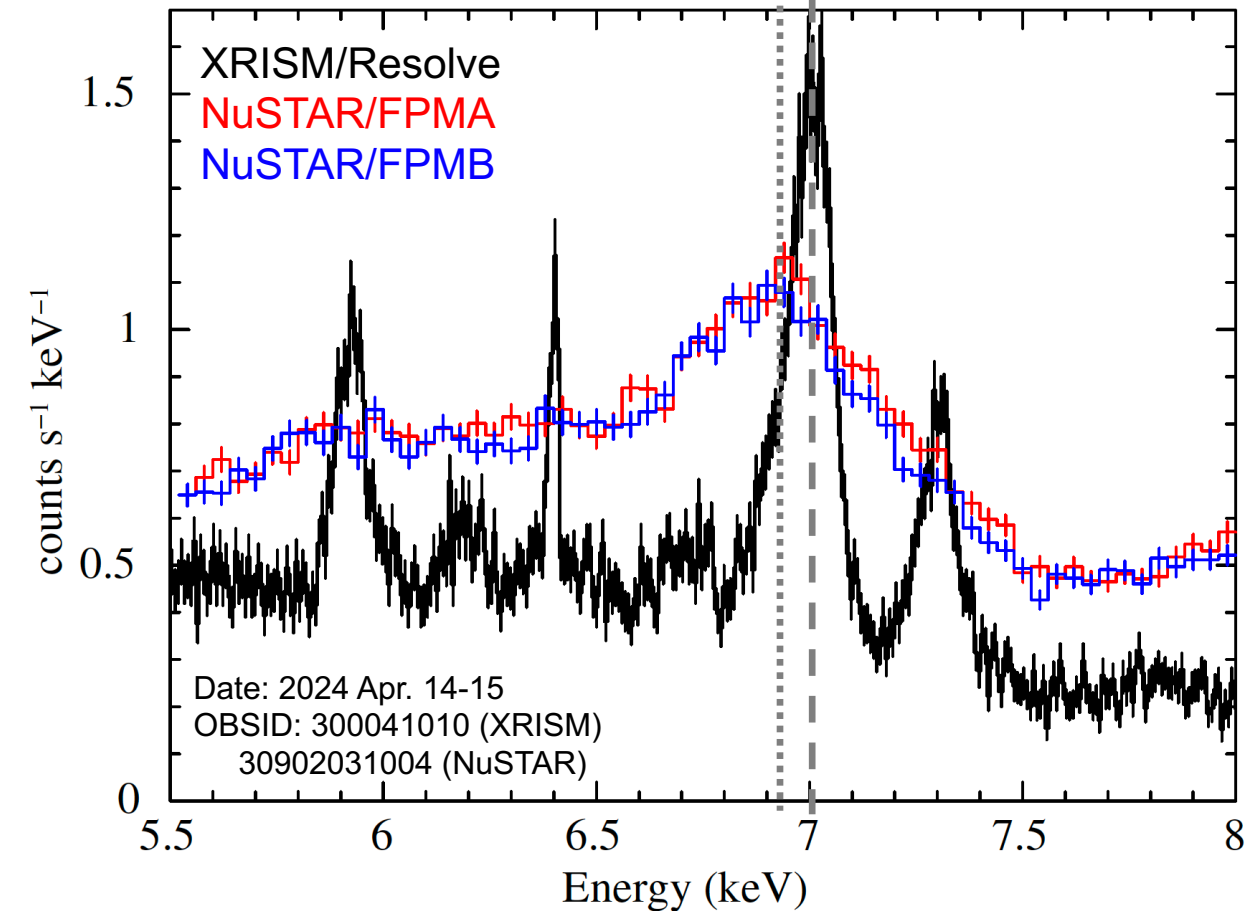
80 simultaneous XRISM and NuSTAR observations have been carried out (with even more when quasi-simultaneous observations are considered) out of **408** XRISM observations.

*1: start/end times of the overlapped period

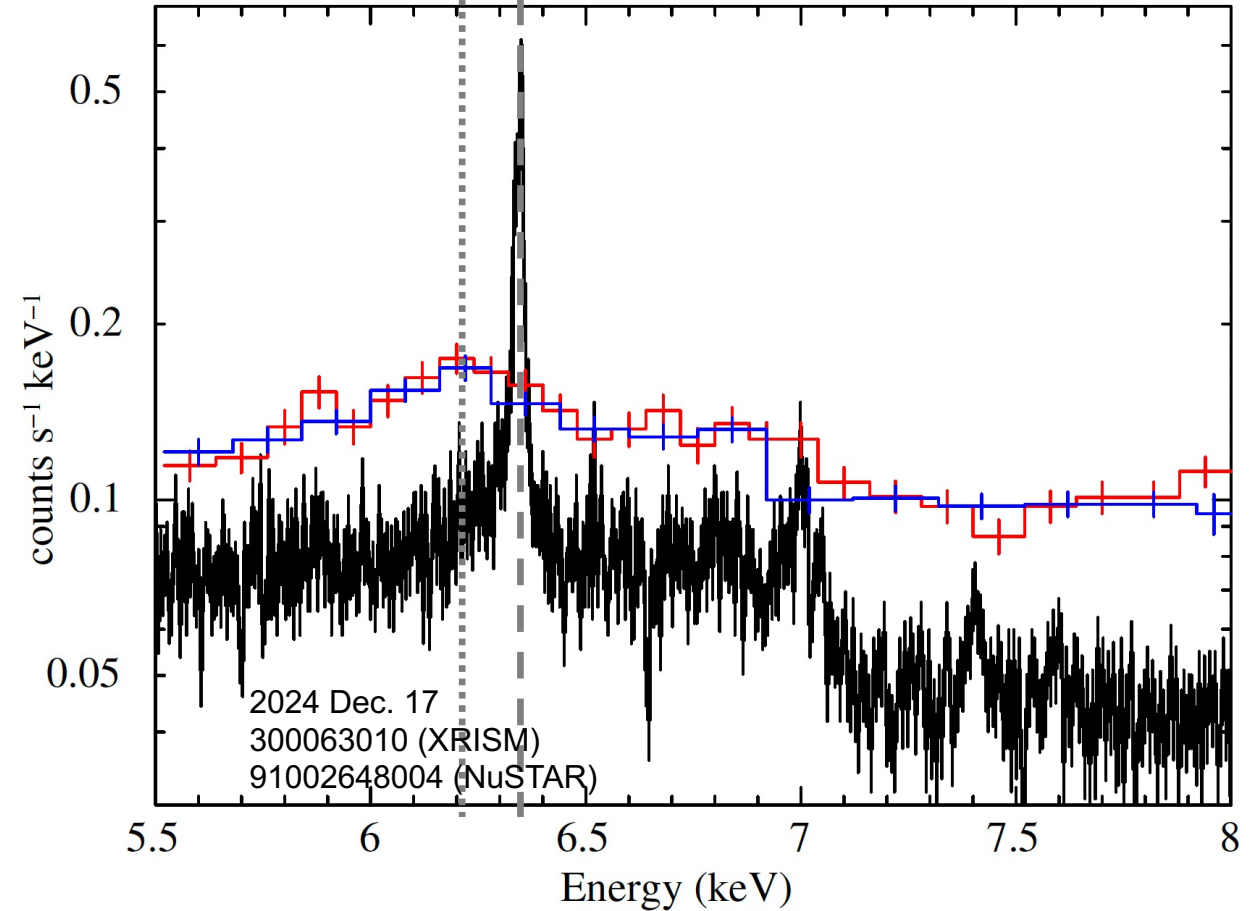
Target	XRISM OBSID	NuSTAR OBSID	Start time *1	End time *1
PKS2155-304	000127000	11001611002	60285.94800	60286.93750
NGC4151	000137000	60902010002	60305.44110	60306.53472
3C273	000145000	11002608002	60316.46882	60317.45486
MCG-6-30-15	000161000	60902004002	60346.02102	60349.15278
Cen_X-3	300003010	30901020002	60353.88902	60354.68403
		⋮		
GRS1758-258	202050010	91201316002	61121.26043	61121.81597

XRISM/Resolve + NuSTAR simultaneous data

SS 433



NGC 4388



Only fully overlapping XRISM and NuSTAR observation periods are included.

Peak energies of emission lines differ between XRISM/Resolve and NuSTAR.
What is the typical magnitude of the offset and how does it vary over time?

Data selection & Reduction

We used publicly available simultaneous datasets with prominent spectral lines.

We omitted:

- GO observations conducted within the past year (not yet public), except for DDT observations
- observations of diffuse sources
- observations of point sources without strong narrow lines

→ **31 datasets**

(mainly type-2 AGNs,
X-ray binaries, CVs)

XRISM/Resolve

- Spectra extracted from cleaned event data (Hp events only; pixels 12 & 27 excluded)
- RMF file type: “extra large”

NuSTAR

- Standard pipeline processing performed with nupipeline
- Source/background region: circular regions with $r = 60'$ centered on the target/in a source-free area
- Spectra, RMF, and ARF generated with nuproducts

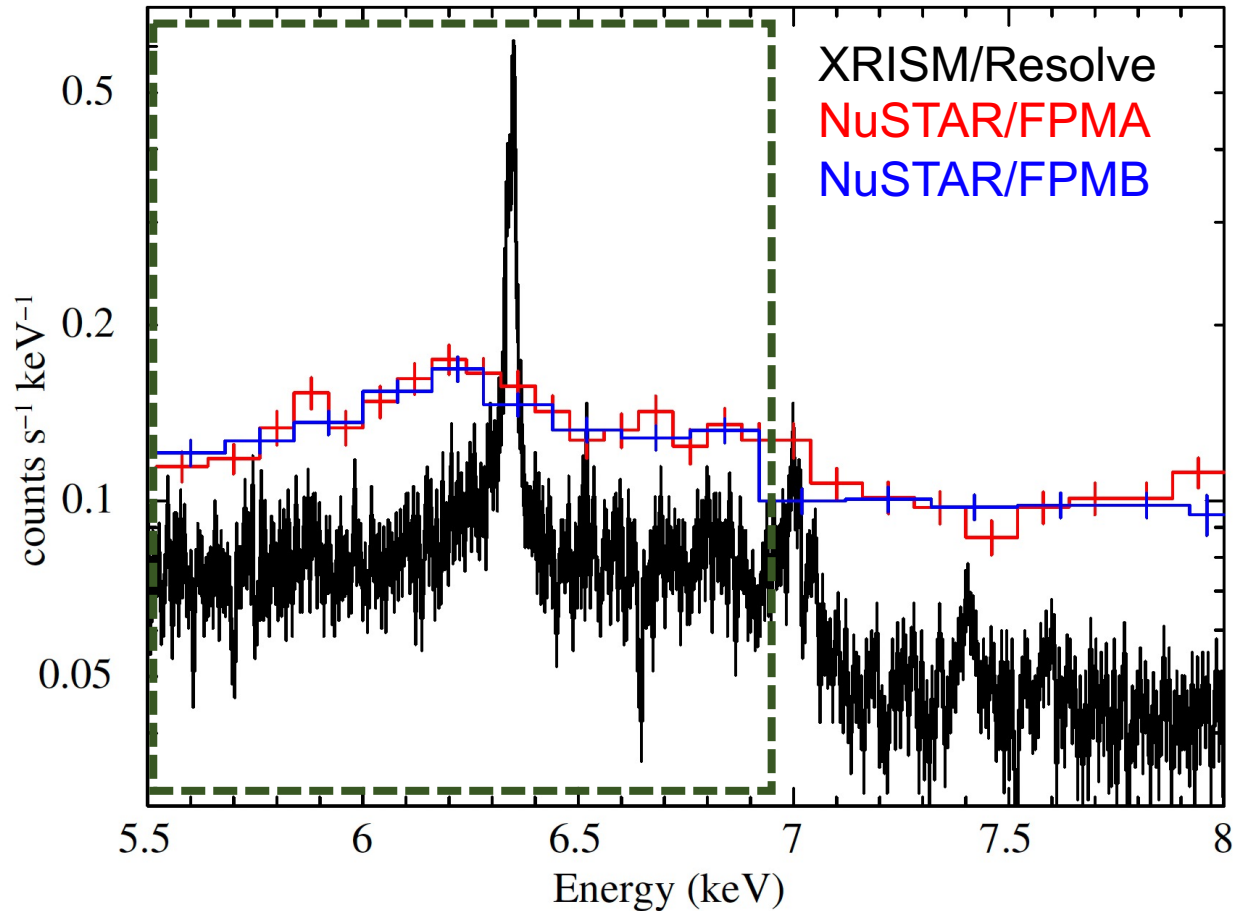
CALDB:

latest versions available
as of April 30, 2025

We selected the data of the overlapping period to extract XRISM/Resolve and NuSTAR spectra.

Analysis

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We analyzed all the selected simultaneous spectra focusing on the the energy around strong lines.

model:

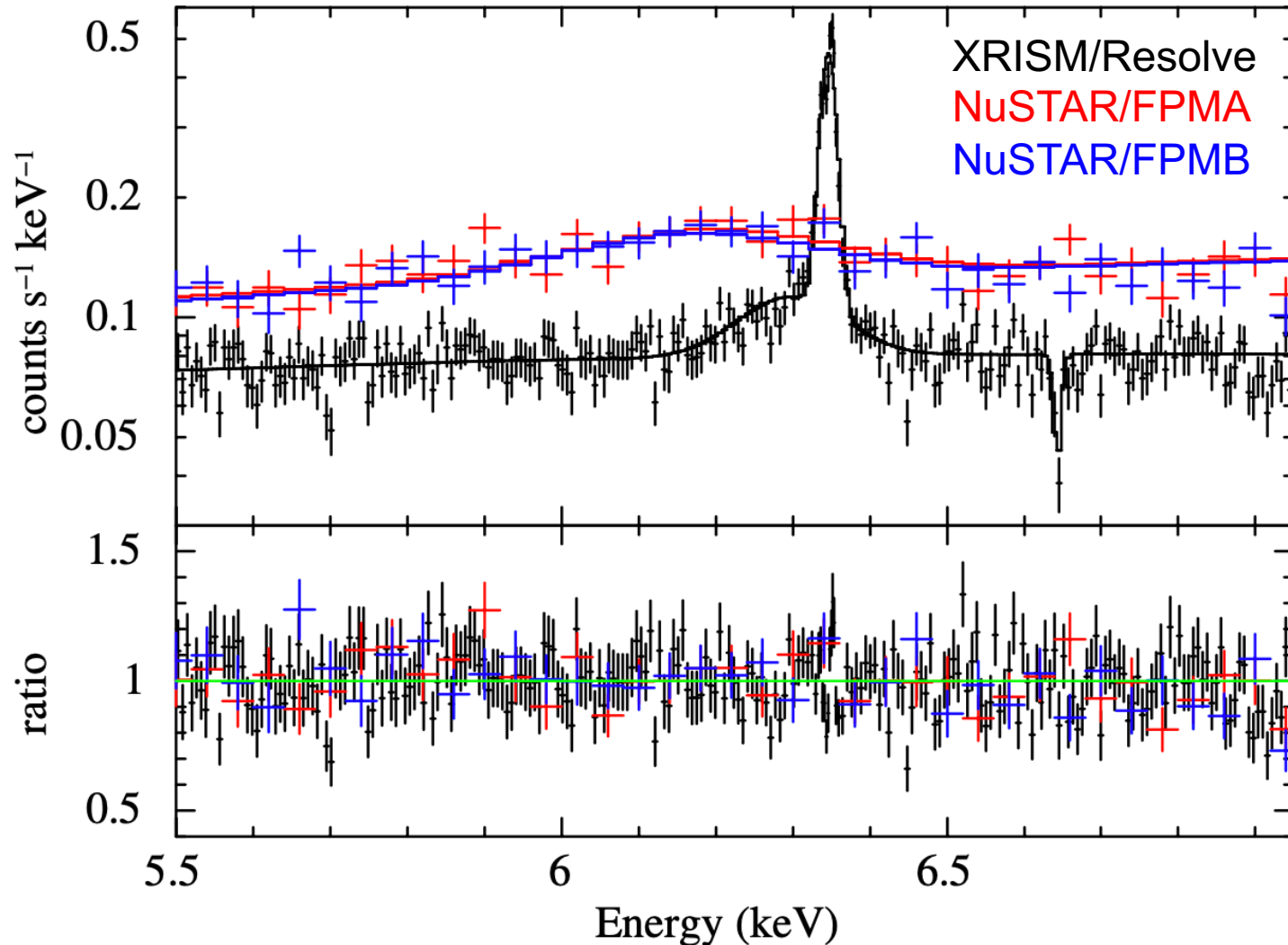
powerlaw + zashift * (gauss + gauss + ...)

- Continuum: a **power-law**
- Line: **Gaussian(s)**
(additional Gaussian components were included, if they improve the fit)
- Line centroid energy offsets between XRISM/Resolve and NuSTAR: a **convolutional Doppler shift model** (zashift)

All the parameters except for the **Doppler shift z** and the normalizations were linked between the Resolve & NuSTAR data.

Results

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Best-fit values

Doppler-shift offset
(NuSTAR w.r.t. Resolve)

$$\text{FPMA: } z = 0.021 \pm 0.008$$

$$\text{FPMB: } z = 0.025 \pm 0.008$$

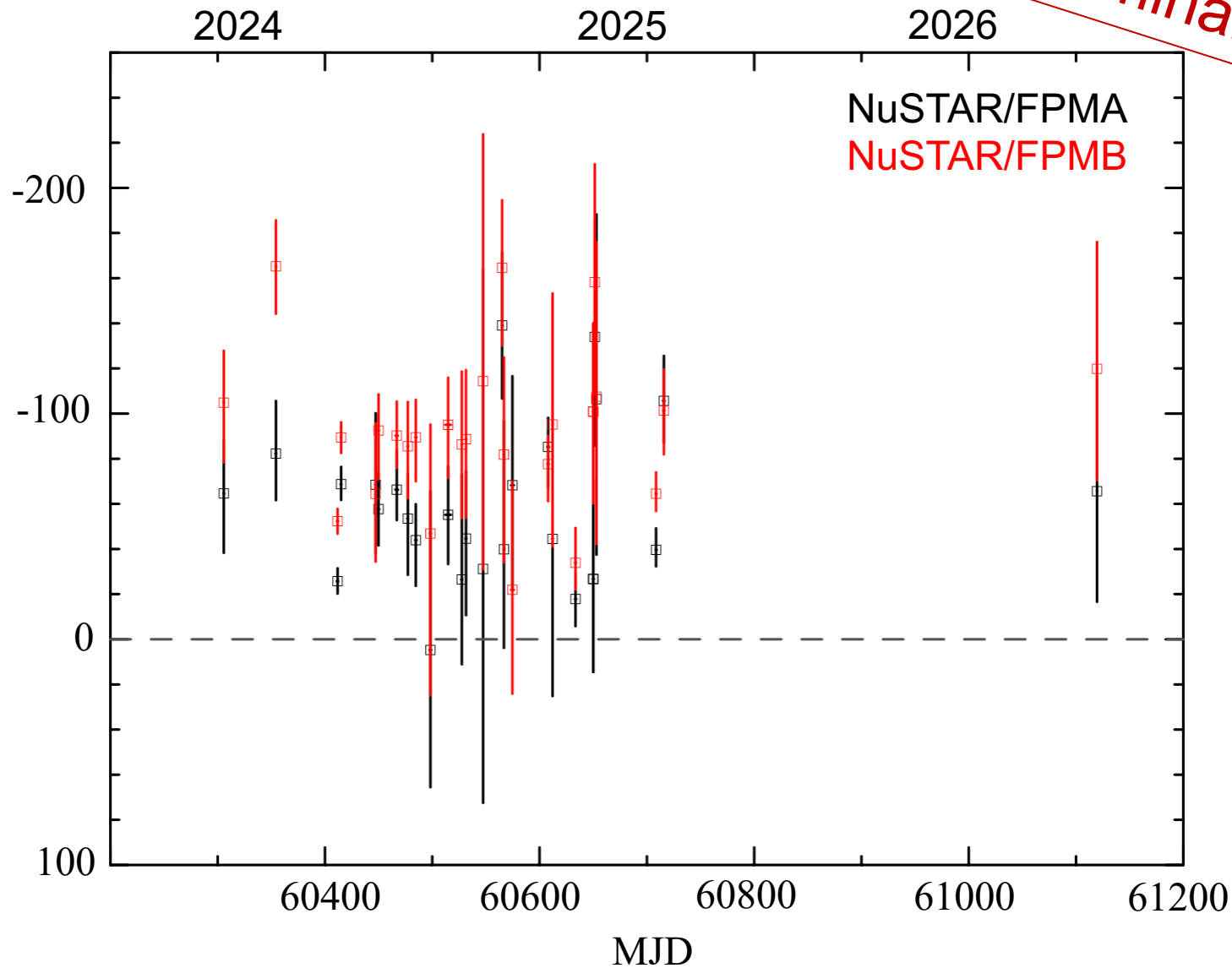
Energy offset @ 6.4 keV
(NuSTAR w.r.t. Resolve)

$$\text{FPMA: } \Delta E = -130 \pm 50 \text{ eV}$$

$$\text{FPMB: } \Delta E = -160 \pm 50 \text{ eV}$$

Results

Preliminary



FPMB has a larger offset than FPMA

Weighted average of Energy offset @ 6.4 keV (NuSTAR w.r.t. Resolve)

FPMA: $\Delta E = -49 \pm 6$ eV

FPMB: $\Delta E = -76 \pm 6$ eV

Gain calibration methods

XRISM/Resolve

- Gain calibration is performed for each observation using the on-board filter wheel calibration source (^{55}Fe)
- systematic energy uncertainty:
~0.4 eV @ ~6 keV

Eckert et al. (2025) JATIS, 11, 4, 042018

NuSTAR

- Gain calibration is based on the data from a calibration source (^{155}Eu) and the high energy lines in the instrumental background.
- The background lines are derived from data accumulated over ~6 months.
- systematic energy uncertainty:
~40 eV @ ~6.4 keV

Madsen et al. (2015) ApJS, 220, 8

Grefenstette et al. (2025) arXiv:2206.04058

The energy offset detected in this study is likely attributable to NuSTAR and is comparable to its systematic energy uncertainty.

Summary

- We have investigated offset in line centroid energies between XRISM/Resolve and NuSTAR around the FeK band.
- The line peaks in the NuSTAR spectra are redshifted by ~ 50 eV (FPMA) and ~ 80 eV (FPMB) with respect to the XRISM simultaneous spectra.
- These offsets are almost comparable to the systematic energy uncertainty of NuSTAR.

