

XMM-Newton Calibration Updates

Michael Smith, ESAC

18th IACHEC Meeting, Pelham, 20-23 April 2026

XMM-Newton calibration releases over 2025/26

RGS:	Update of the RGS Time-dependent Rectification Correction (2025)	XMM-CCF-REL-418
	Evolution of the RGS CTI (2025)	XMM-CCF-REL-417
	RGS CTI: Change of Validity Dates	XMM-CCF-REL-416
General:	ABSCOEFS: Correction of units	XMM-CCF-REL-415
Astrometry:	time variable boresight – 2025 update	XMM-CCF-REL-414

Release notes: <https://www.cosmos.esa.int/web/xmm-newton/ccf-release-notes>

RGS effective area: Rectification Correction update

Three time-dependent RGS effective area corrections
(all applied in the default processing with `rgsproc / rgsrmfgen`):

- **Contamination correction:**

`rgsproc dyneffareacorr=yes`

- **Time-dependent Small scale Effective Area correction:**

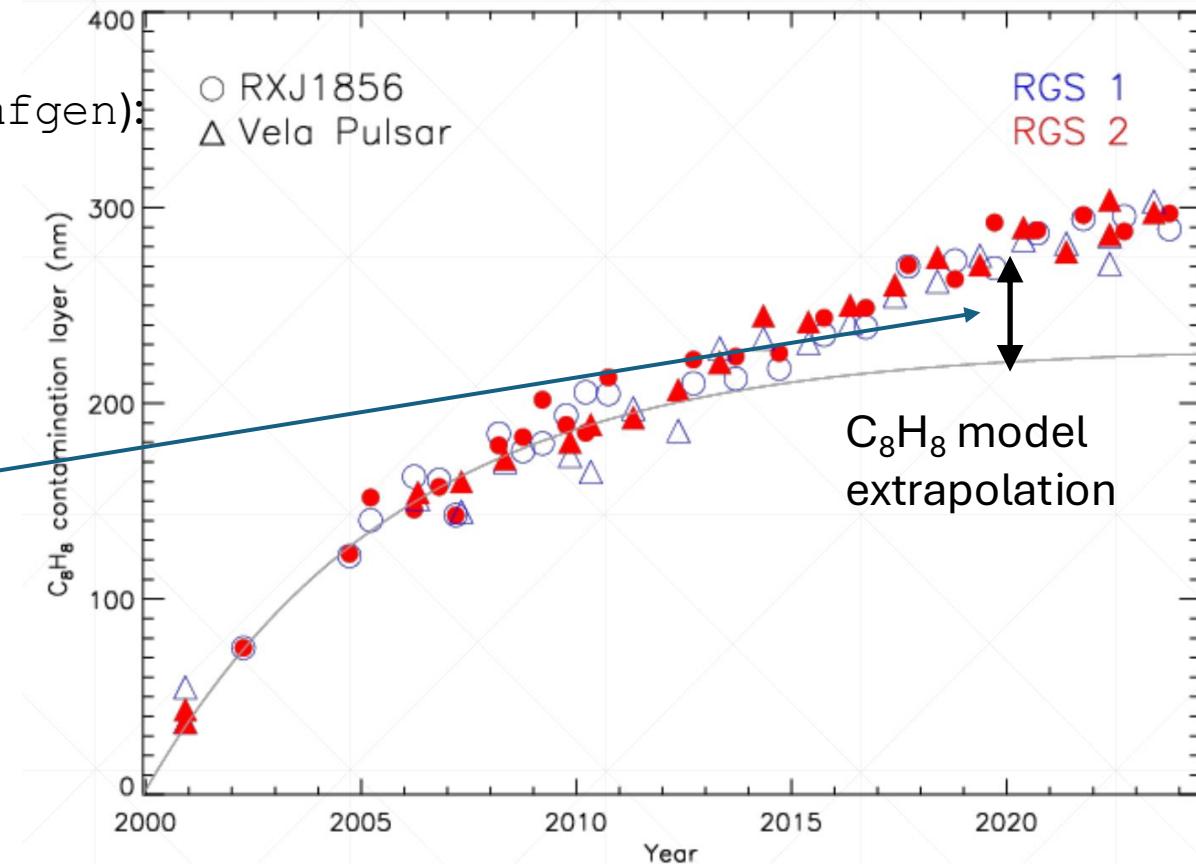
`rgsproc witheffectivaeracorrection=yes`

- **Rectification Correction:**

Correction with respect to EPIC-pn.

`rgsproc withrectification=yes`

Corrections regularly monitored & updated.



- C₈H₈ contamination layer building up slowly (2nm/yr)
- Thickness of contaminant proportional to flux @35Å
- Since ~2015, additional contamination component, inconsistent with C₈H₈
- Empirically corrected with Rectification Correction

RGS effective area: Rectification Correction update

RGS “Rectification Correction” introduced in 2010.

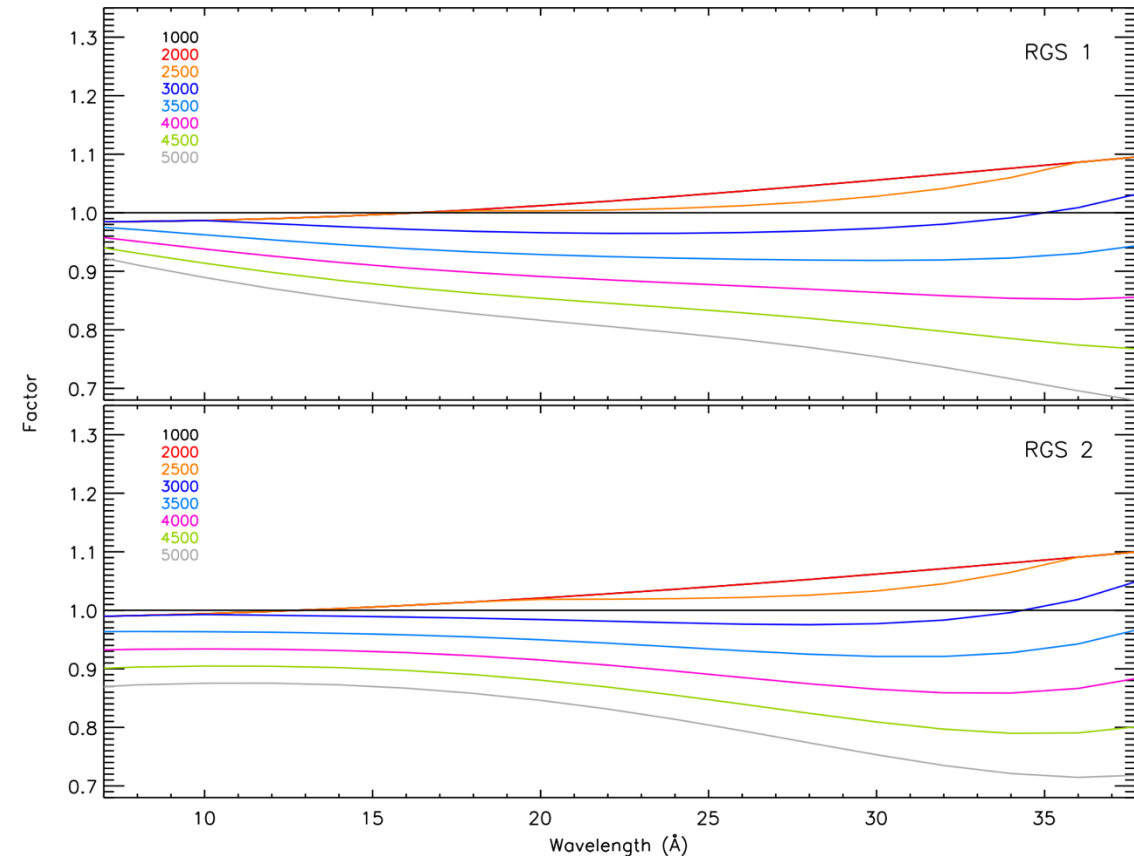
Provides an empirical correction to RGS to match PN fluxes, with time and wavelength dependencies.

Based on RGS and PN SW mode observations of 3C 273 and PKS 2155-304.

Latest calibration update (XMM-CCF-REL-418) extends the observations database until January 2025 (also, some early epoch data has been included, and algorithm slightly modified)

As of SAS 22 (released March 2025) the correction is being applied in the default processing:

```
rgsproc withrectification=yes
```



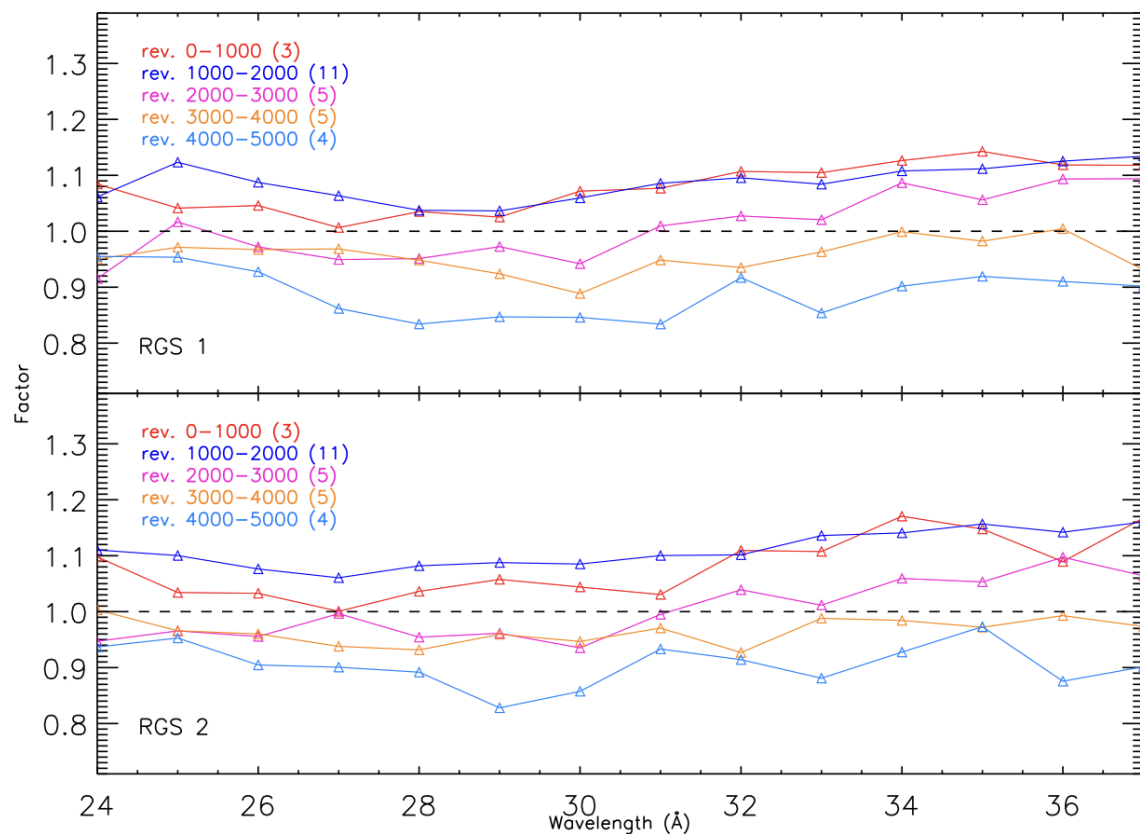
R. González-Riestra

RGS effective area: Rectification Correction update

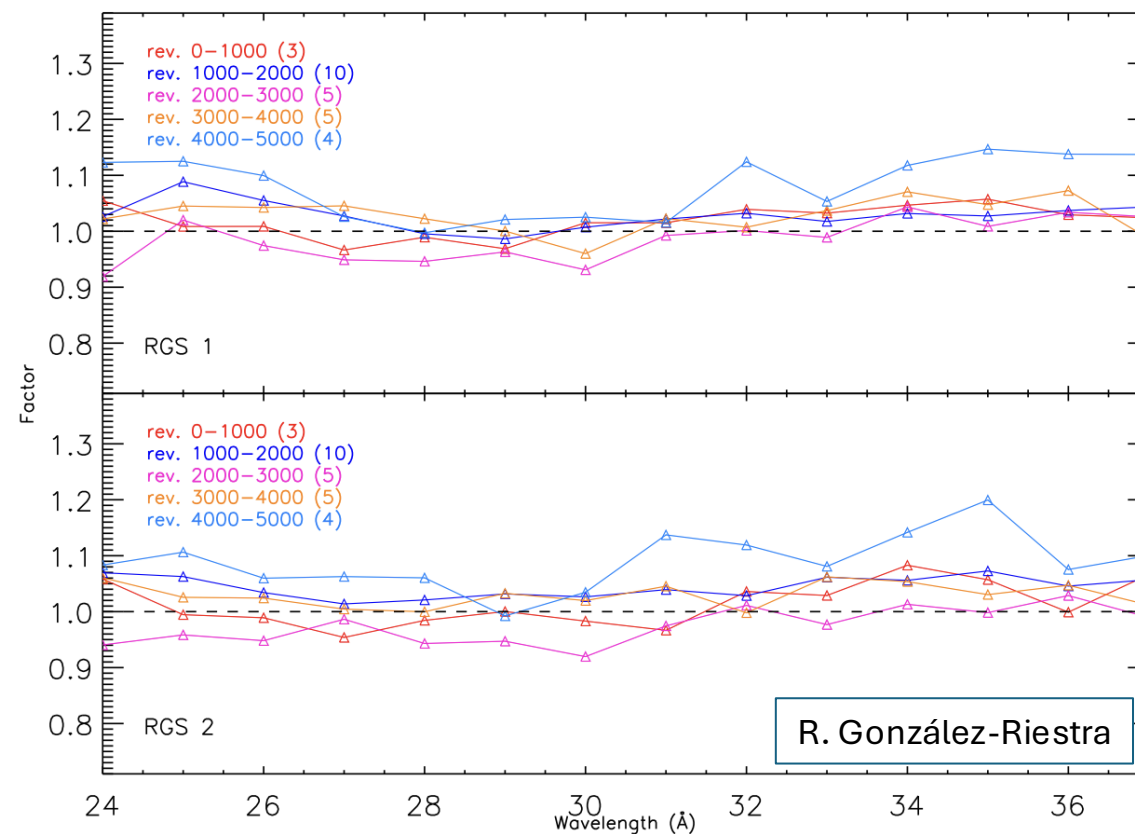
Validation of updated Rectification Correction using ISN RXJ 1856-3754:

RGS/EPIC-pn flux ratios (for various revolution ranges)

without correction



with correction



R. González-Riestra

OM time-dependent photometric corrections

Optical Monitor (OM) affected by

1. general, filter-dependent sensitivity degradation (of up to ~23% in UVW2) due to
 - contamination at early epochs
 - degradation of the photocathode

Corrected for in calibration + SAS.

OM time-dependent photometric corrections

Optical Monitor (OM) affected by

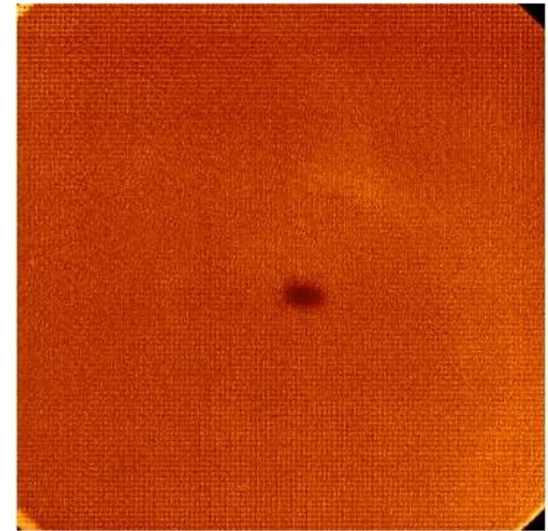
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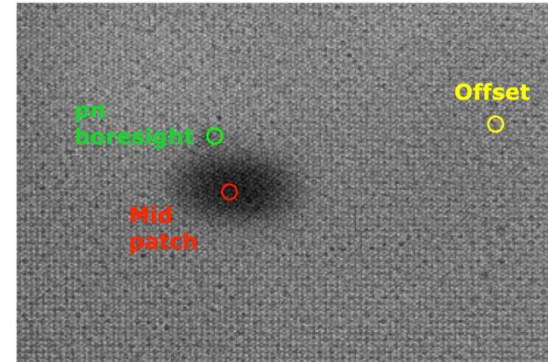
2. localised damage (“Jupiter patch”, rev 3224): targets at the pn boresight position (in the patch wings) by up to additional ~15% in V.

As of SAS 22 (March 2025): correction is now made for the localised extra sensitivity loss, for sources **at the pn boresight only**.

Depletion patch
Full Frame:



Zoomed in:



OM time-dependent photometric corrections

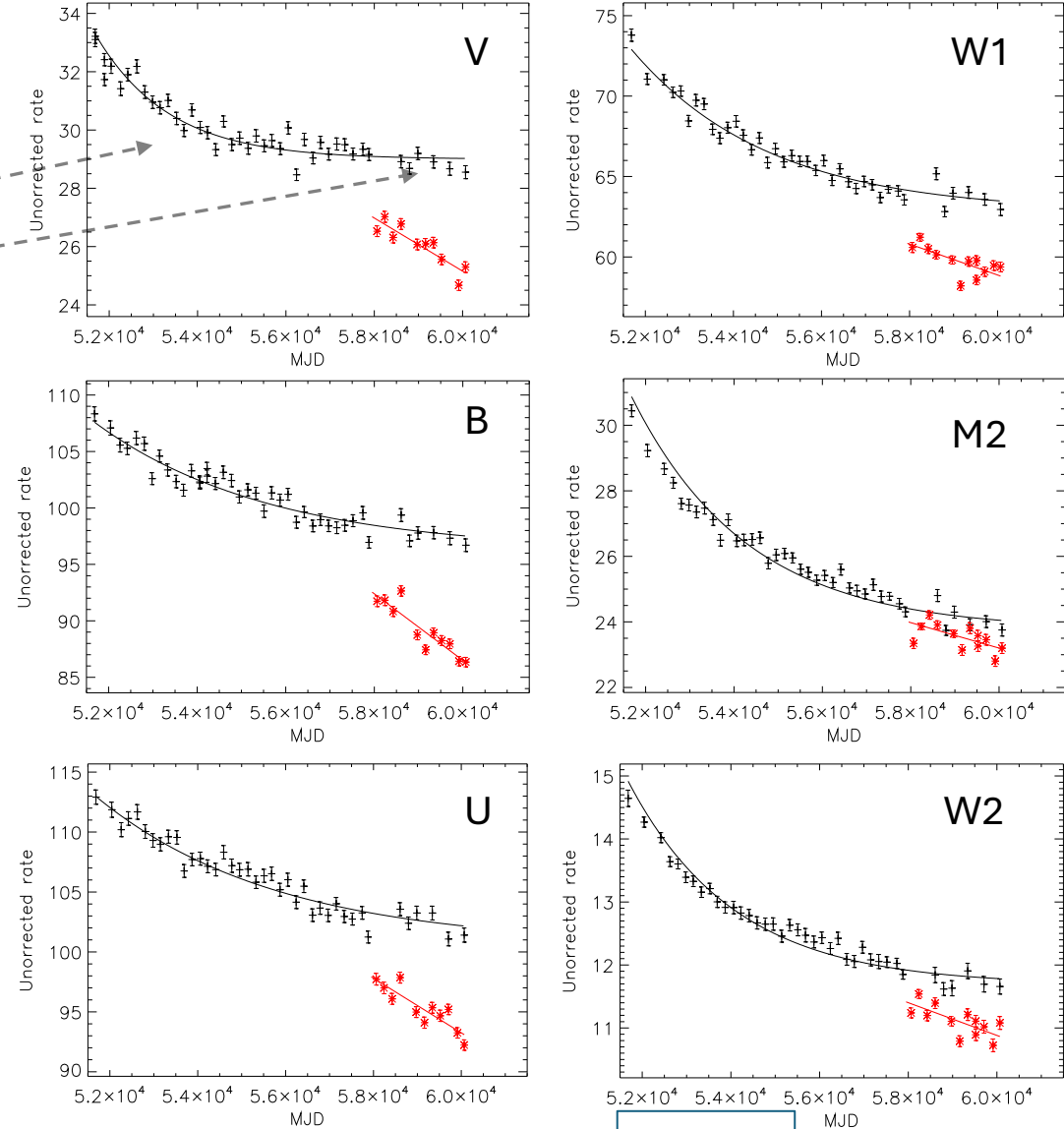
General & local time-dependent degradation:

Measured from declining count rates of OM calibration standard stars from observations taken at:

- the boresight (revs < 3224), and
- offset locations (revs > 3224)

(exponential decay curve overlaid)

Example: BPM16274



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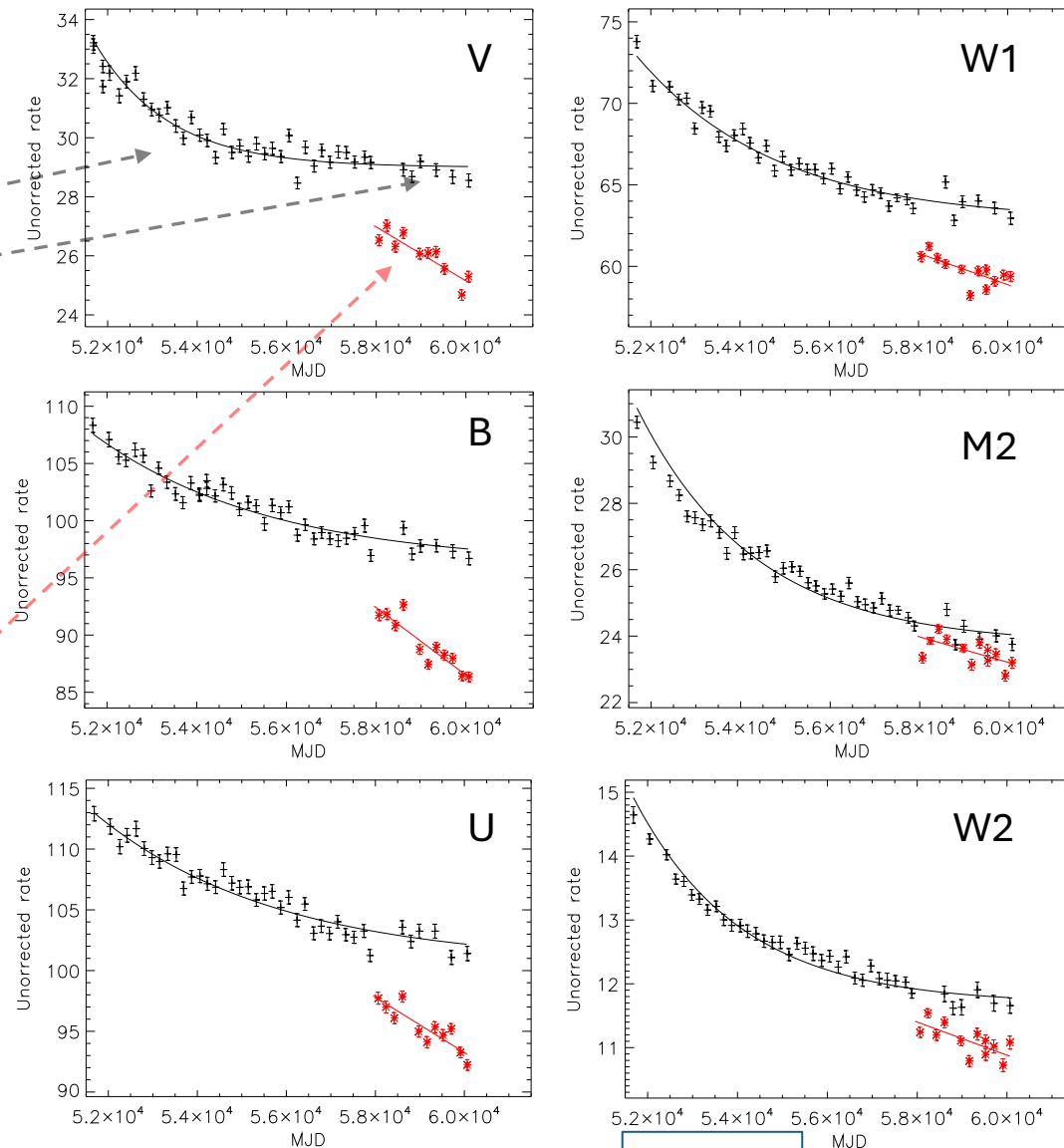
(exponential decay curve overlaid)

Measured count rates at the pn boresight after revolution 3224

(best-fit linear function overlaid)

SAS 22 corrects for both effects;
the correction at the pn boresight **ONLY** for objects within 7.5”
(generally target sources).

Example: BPM16274

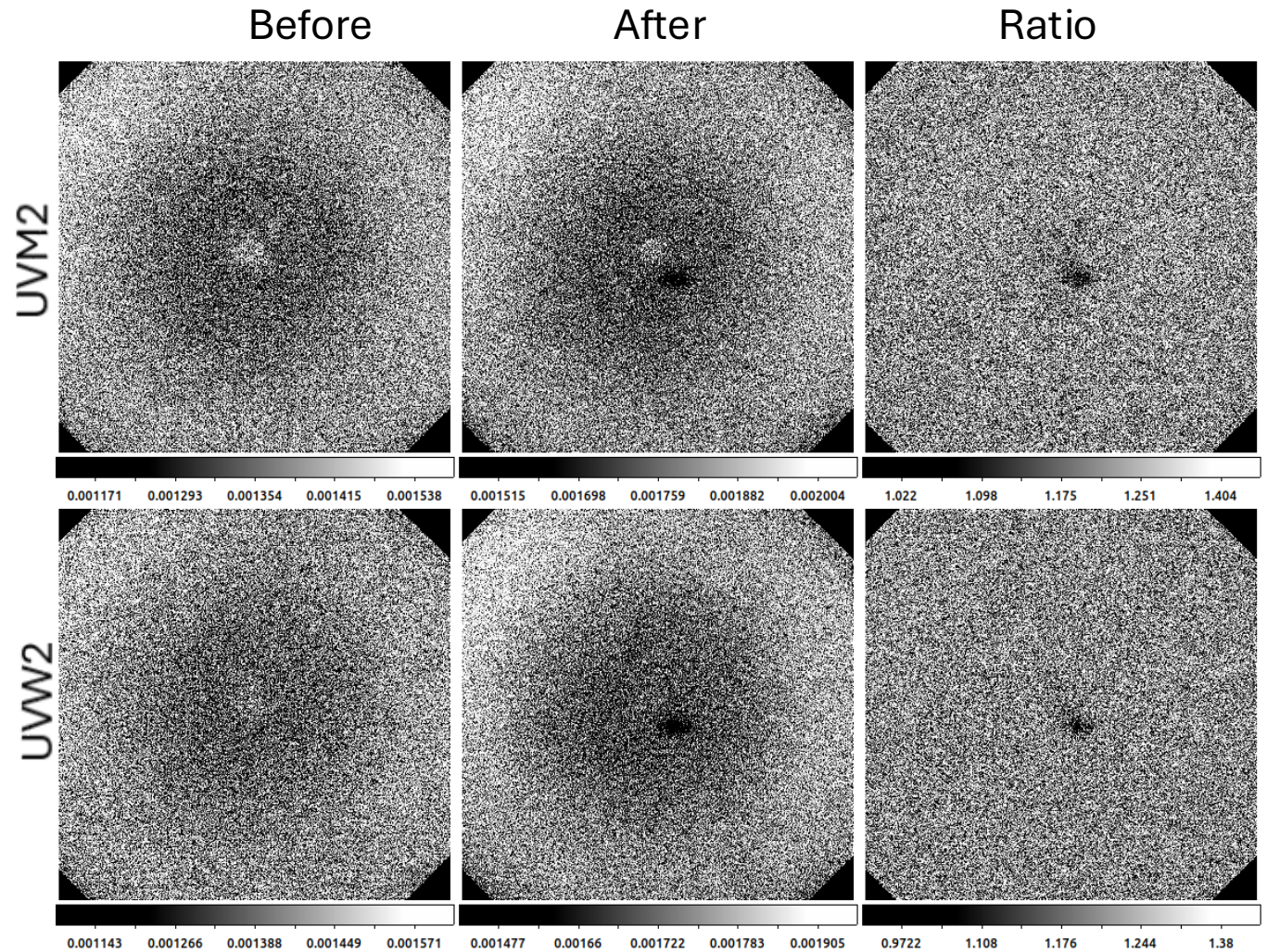


S. Rosen

OM time-dependent photometric corrections

Long-desired filter-dependent correction for the Jupiter patch is being derived.

- As patch depth \sim constant for rev $>$ 3224, create suitably filtered rate image cubes from real sky data “Before” (revs 2230-3223) and “After” (revs 3225-4650).
- Ratio these to minimize systematic, stable structures, e.g. central ring.
- Characterize ratio image via a 2-D elliptical Gaussian + constant profile, for each filter



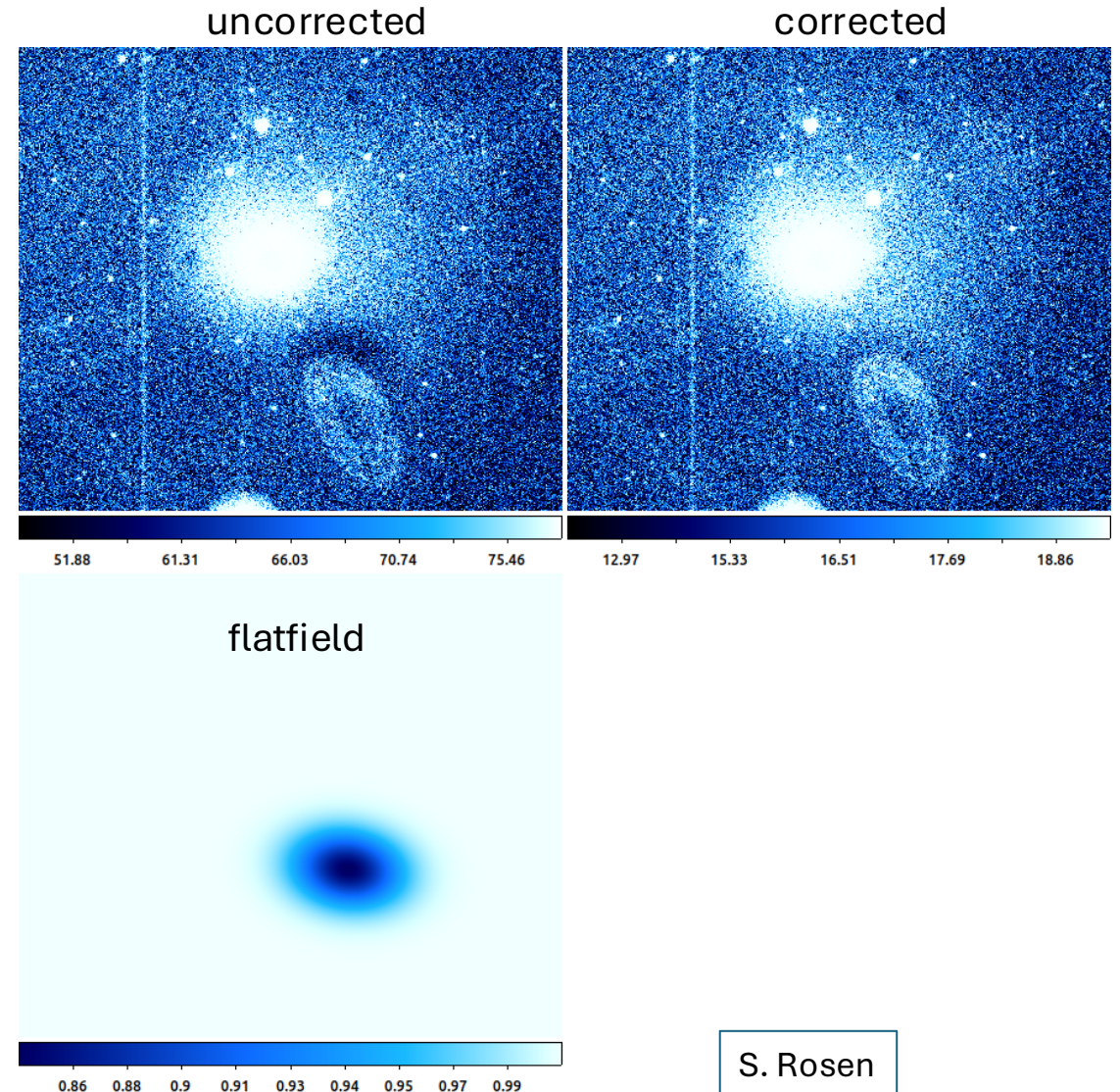
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- Ratio these to minimize systematic, stable structures, e.g. central ring.
- Characterize ratio image via a 2-D elliptical Gaussian + constant profile, for each filter
- Normalise to unity outside patch \rightarrow flat field image (2048x2048)

Ongoing work;
aim to have included in SAS 24 (late 2026)

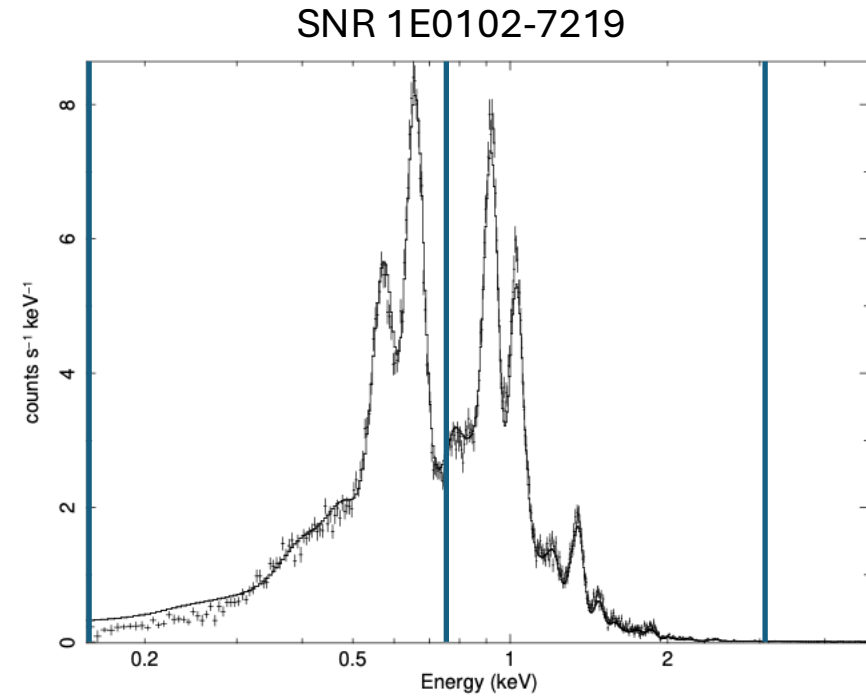
Example (U band image from obs=0821250601):



EPIC MOS contaminant update

MOS low energy (< 1 keV) response has deteriorated since launch; primarily affecting MOS2

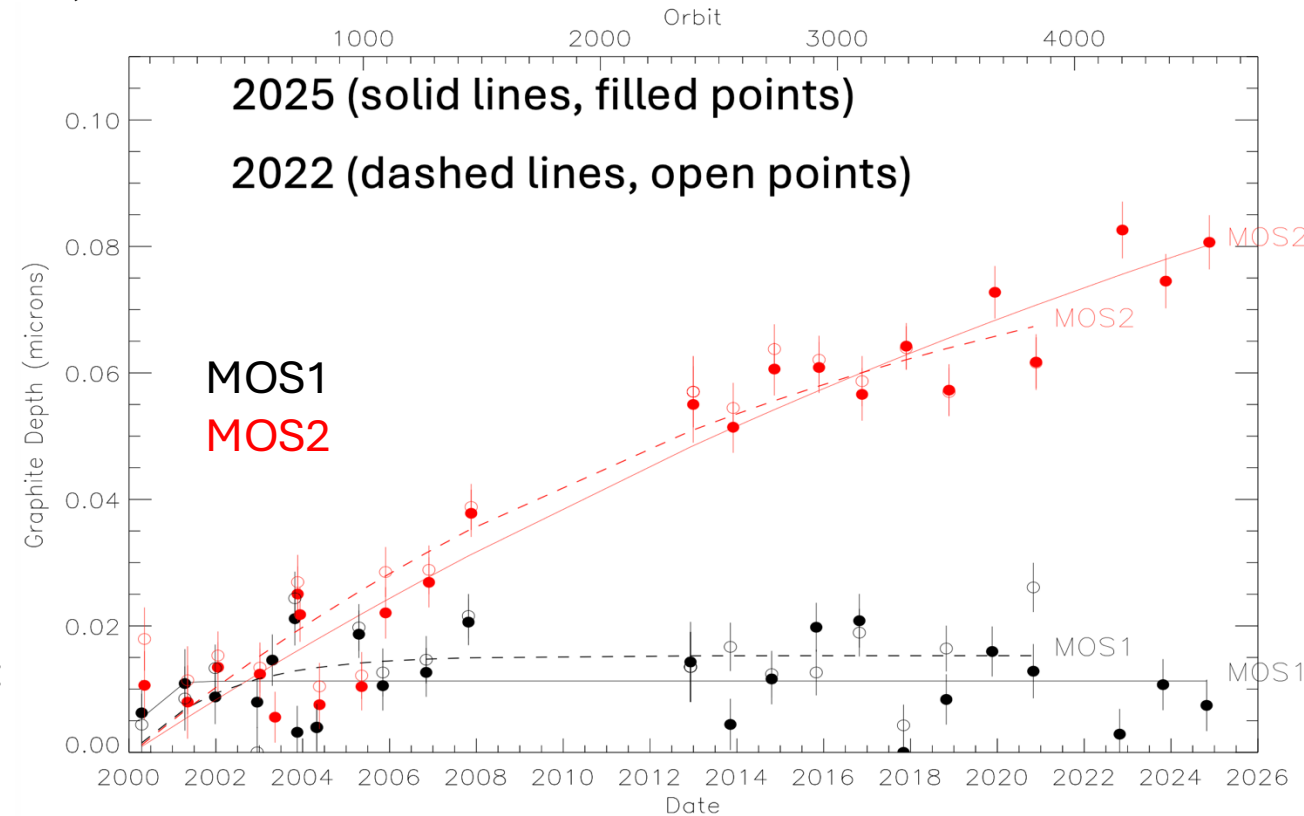
- believed to be due to contaminant build-up on detectors, currently modelled as pure C (graphite)
- measurement of contaminant based on regular observations of SNR 1E0102-7219 (0.1-0.75 keV / 0.98-3.0 keV rate ratio)



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- believed to be due to contaminant build-up on detectors, currently modelled as pure C (graphite)
- measurement of contaminant based on regular observations of SNR 1E0102-7219 (0.1-0.75 keV / 0.98-3.0 keV rate ratio)
- is corrected for in calibration, which is regularly updated
- latest modelling shows trend continues:
 - MOS1 stable (A_{eff} loss <5% @ all energies)
 - increase in MOS2 build up; A_{eff} loss w.r.t. launch: **~20% @ 0.5 keV, ~ 5% @ 1.0 keV**
- calibration files will be released in near future (pending update of MOS time-dependent response calibration)



S. Rosen

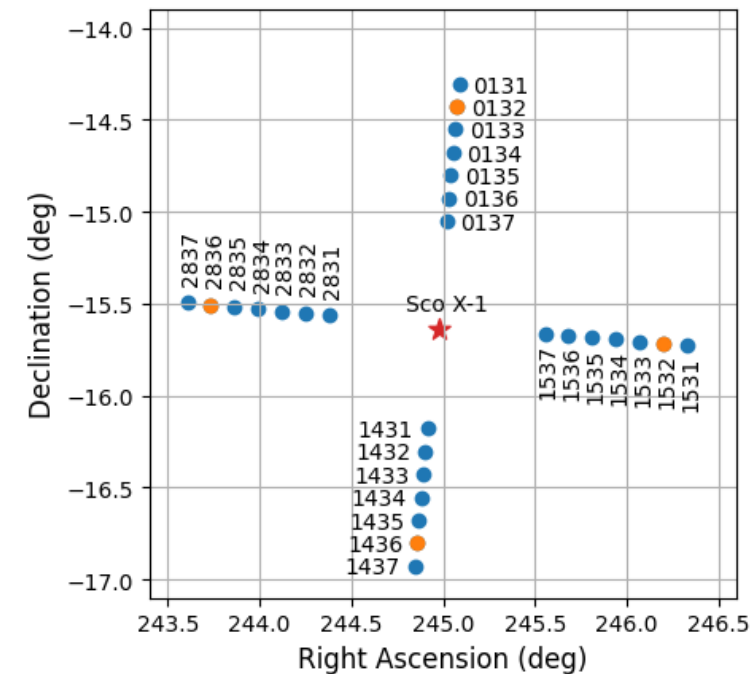
Mirrors: Sco X-1 single reflection observations

Single reflections (from hyperboloid mirror) reach detectors for offsets in the 35 – 79 arcmin range (for on-axis detections).

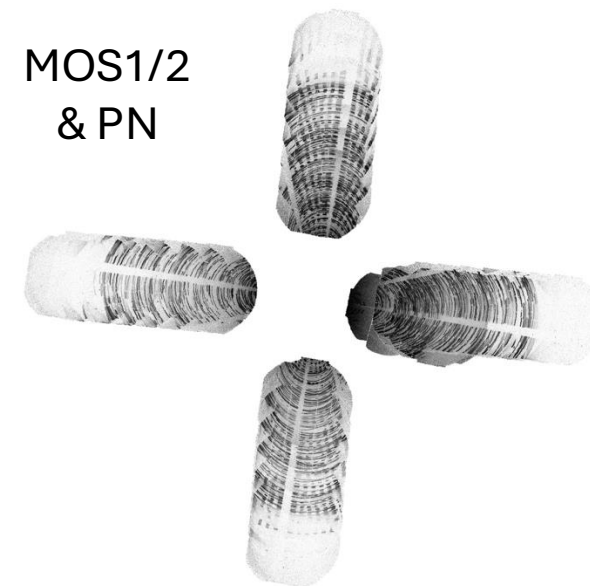
Set of calibration observations performed of Sco X-1 (offset) in March 2024.

- 4 mosaic observations:
 - azimuths of 0, 90, 180 and 270 degrees
- Each consisting of 7 exposures:
 - offsets from Sco X-1 stepped between 34.0 – 79.0 arcmins

Yields single reflection arcs observations for all mirror shells (over 4 segments) for all 3 mirror assemblies.



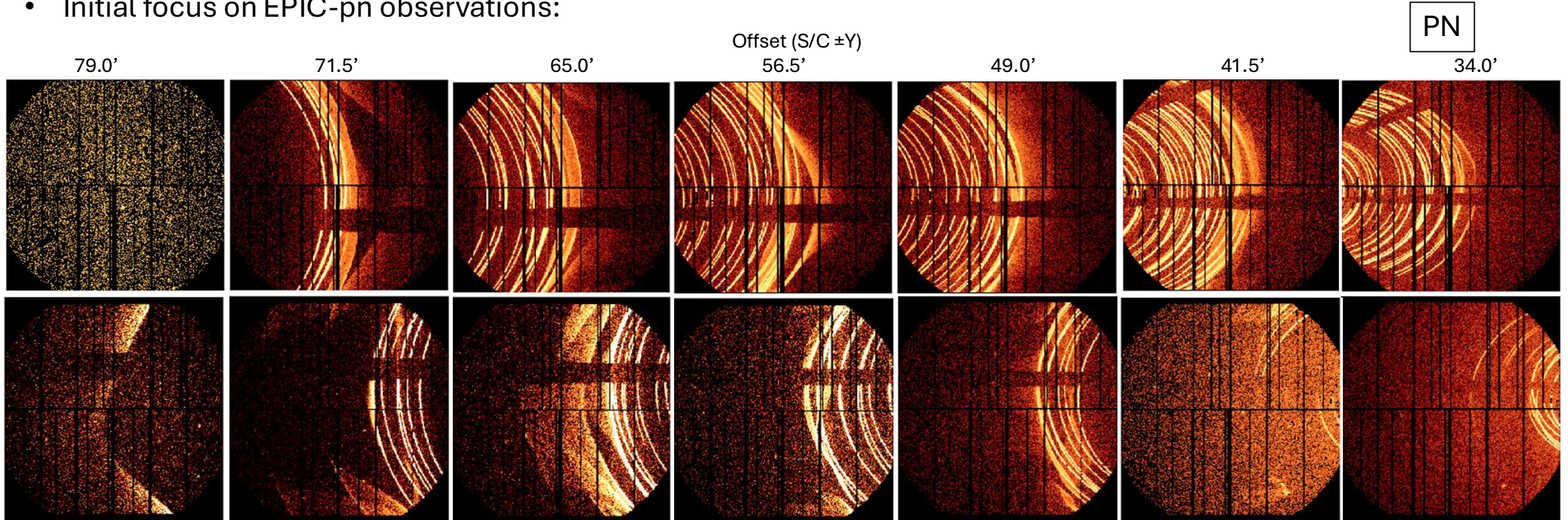
MOS1/2
& PN



Mirrors: Sco X-1 single reflection observations

The aim is to:

- Simulate data using ray-tracing and detector simulators (XMM-Newton SciSim, SIXTE)
- Attempt to replicate Sco X-1 observations by varying relevant mirror module / baffle parameters e.g. align simulated and measured reflection arcs via tilts / translations of mirror module
- Calibrate and update mirror model, assess impact on nominal telescope effective areas
- Initial focus on EPIC-pn observations:



Mirrors: Sco X-1 single reflection observations

Summary of current results:

Global tilt of the mirror assembly:

- not sufficient to reproduce the set of reflection arcs
- nevertheless, qualitatively, results do indicate systematic positive X & Y-axis tilts (but with different tilts per azimuthal data)

Individual mirror shell tilts:

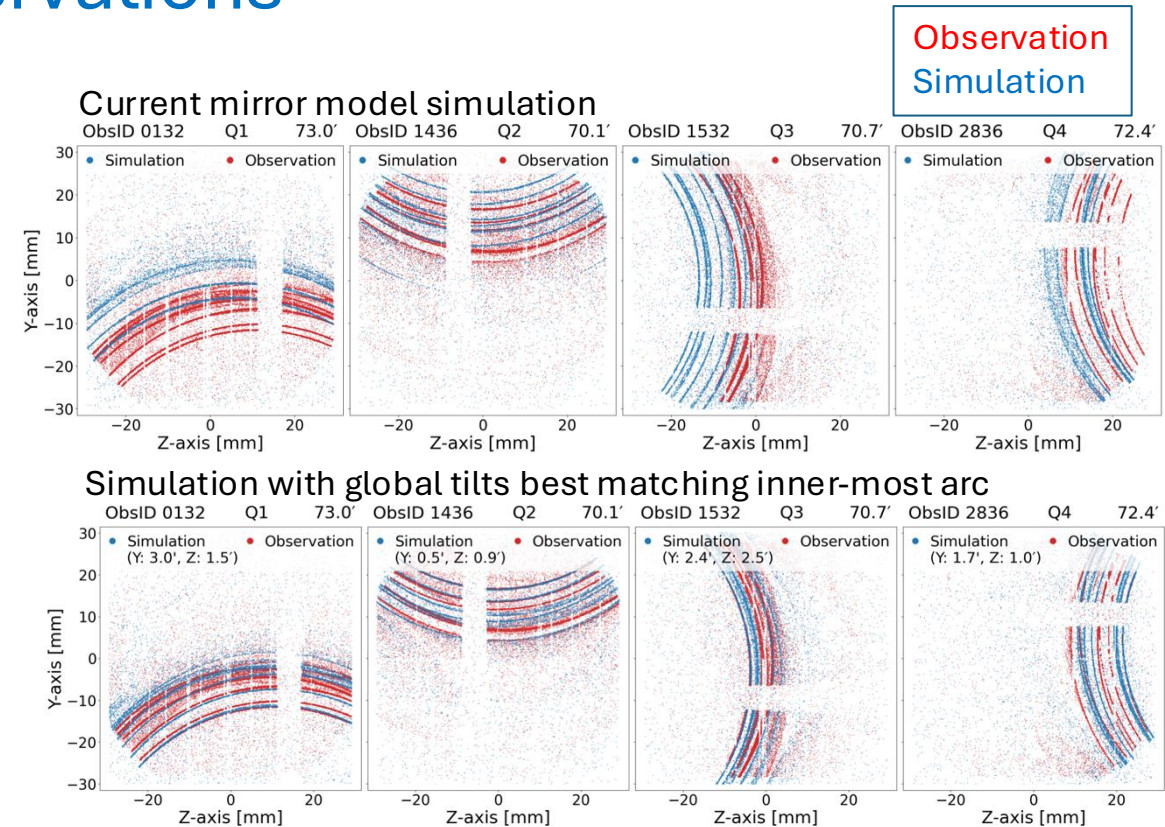
- required tilts not consistent across azimuthal observation sets
- points to modelled mirror shell distortions insufficiently representing true in-orbit distortions

X-ray Baffle shift:

- Z-axis shift of +0.3 mm qualitatively reproduces global azimuthal asymmetries

Impact of adjustments:

not expected to exceed 3-5% reduction of on-axis effective area



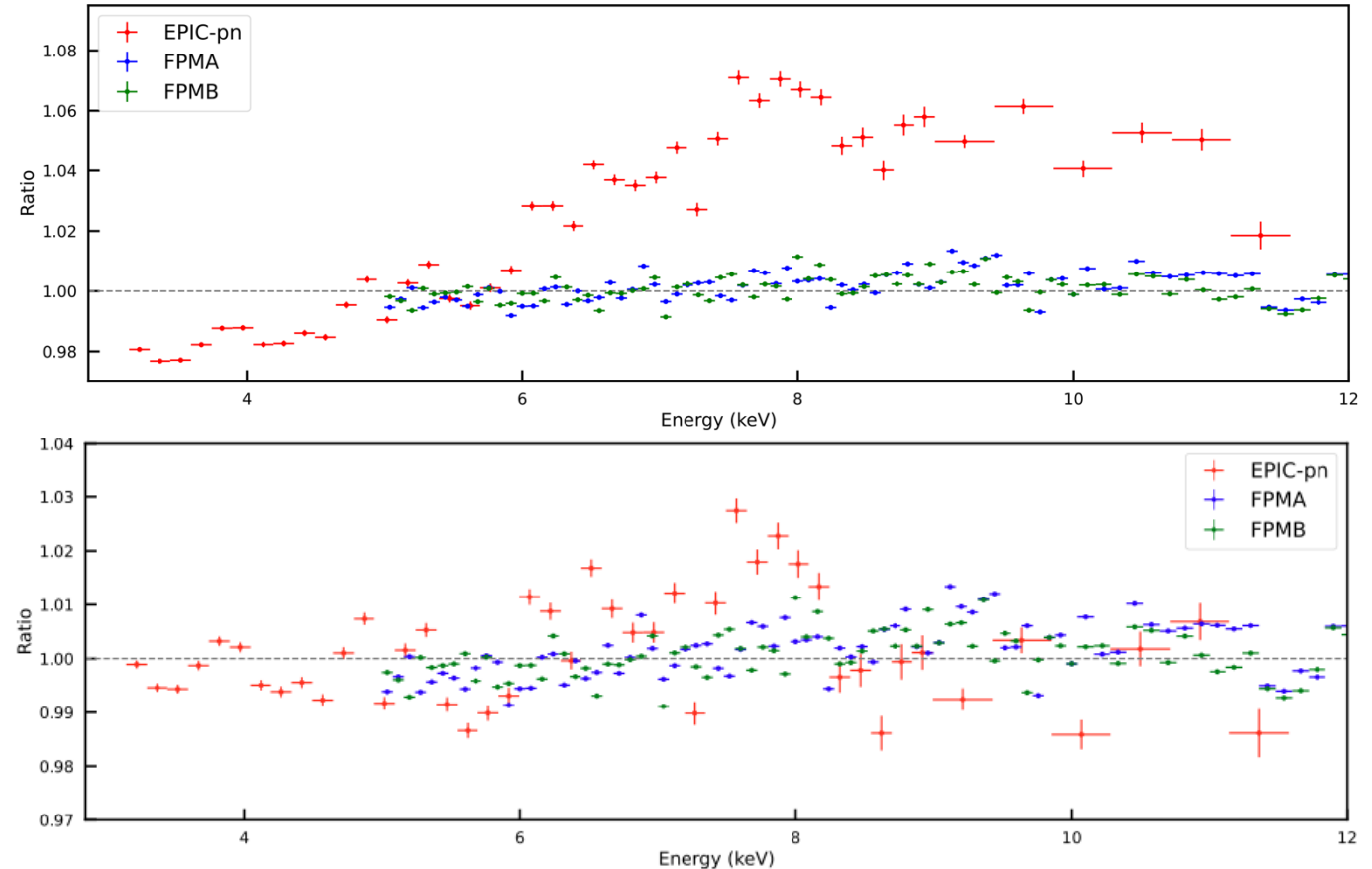
M. R. Alexandersen et al.

Pn-NuSTAR empirical effective area cross-calibration

EPIC-on effective area was corrected to better agree with NuSTAR in 2022 (XMM-CCF-REL-388) by removing a “bump” around 8keV.

Correction done through coordinated observations of the Crab every ~6 months.

Latest data show that correction is still applicable, no time-dependance evident (yet).



A. Borghese

Other ongoing work

- PN Timing mode v. NuSTAR cross-calibration
See Cross-Calibration Session talk by G. Matzeu:
“Investigating the cross-calibration between NuSTAR & XMM-Newton in timing mode”
- Investigation of EPIC vignetting accuracy → affects relative radial / azimuthal fluxes
- Update of MOS time and spatial dependent response (using new contaminant model)
- In-orbit calibration of MOS pattern fractions → should improve consistency between mono/multi-pixel events spectra
- Updates of long-term CTI corrections (EPICs & RGS); becomes challenging due to decay of ^{55}Fe on-board calibration source
- Make proton response matrices (based on Fioretti et al. Proc. SPIE, V 11822, id. 118221F (2021)) available in next SAS release.

XMM-Newton calibration information

<https://www.cosmos.esa.int/web/xmm-newton/ccf-release-notes>



XMM-NEWTON CURRENT CALIBRATION FILE RELEASE NOTES

The table lists the CCF release notes. The last four columns indicate to which component the CCF's described in this release note are relevant.

Additionally, look at

- [Release Notes listed per CCF](#)
- [List of Calibration Files](#)
- [Calibration documentation \(technical notes\)](#)

Reference	Title	Date	XRT	EPIC	RGS	OM
XMM-CCF-REL-418	Update of the RGS Time-dependent Rectification Correction (2025)	10-Dec-2025			X	
XMM-CCF-REL-417	Evolution of the RGS CTI (2025)	16-Jul-2025			X	
XMM-CCF-REL-416	RGS CTI: Change of Validity Dates	16-Jul-2025			X	
XMM-CCF-REL-415	ABSCOEFS: Correction of units	06-Jun-2025			X	
XMM-CCF-REL-414	Astrometry: time variable boresight - 2025 update	02-Apr-2025		X	X	X
XMM-CCF-REL-413	OM Grisms Calibration: time dependent sensitivity correction	06-Feb-2025				X
XMM-CCF-REL-412	Evolution of the RGS CTI (2024b)	11-Oct-2024			X	
XMM-CCF-REL-411	Time-dependent width of the EPIC-pn spectral response	23-Apr-2024		X		
XMM-CCF-REL-410	Update of the CORRAREA Empirical EPIC Effective Area Correction below 3.0 keV	30-Apr-2024		X		
XMM-CCF-REL-409	OM Photometry. Update of the Time Dependent Sensitivity Degradation.	11-Apr-2024				X
XMM-CCF-REL-408	Astrometry: time variable boresight - 2024 update	11-Mar-2024		X	X	X
XMM-CCF-REL-407	XMM-Newton EPIC-pn: updates to the long-term CTI correction	15-Mar-2024		X		