XMM-Newton Calibration Status Update

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14th IACHEC, Shonan Village Center, 20-23 May 2019

Outline

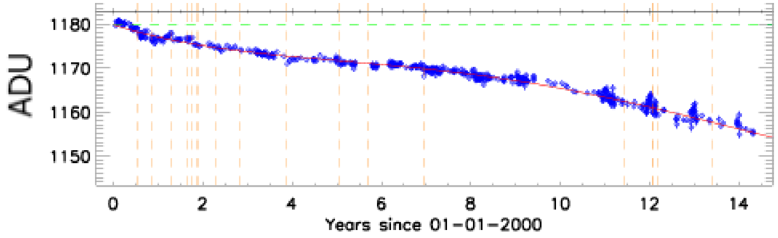
1. Recent calibration file releases

	XMM-CCF-REL-
• OM photometry: update of time-dependent sensitivity degradation	356
• EPIC-pn energy scale:	
o Long-term CTI and quiescent background gain correction	358
o Long-term CTI for Small Window and Large Window modes	366 & 367
o Rate and energy dependent PHA correction for Timing Mode	369
• Astrometry: time variable boresight update	361
• EPIC-MOS energy scale: update of gain and CTI	363 & 364

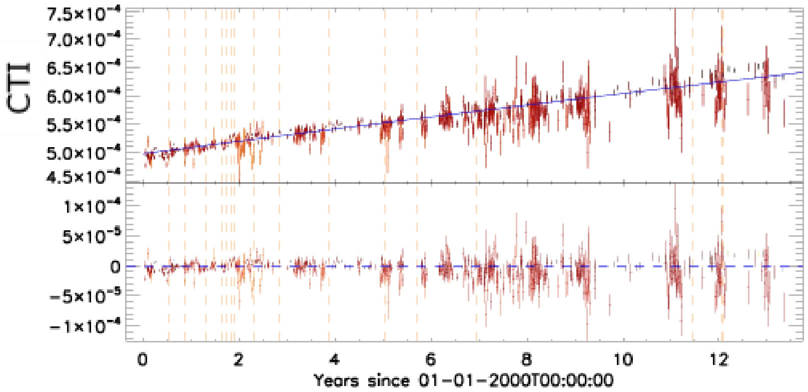
2. On-going calibration topics

PN: Quiescent Background Gain Correction

"Empirical" method: derive LTCTI correction from polynomial fit to non-LTCTI corrected energies



QBGC: (1) fit to measured CTI -> LTCTI correction



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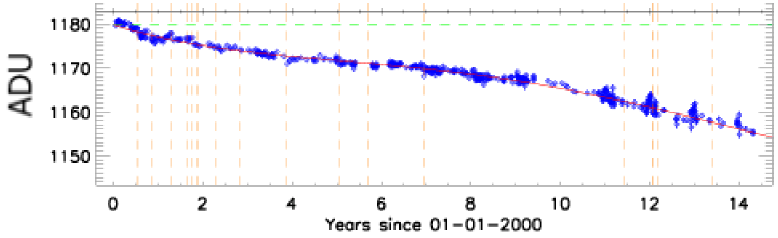

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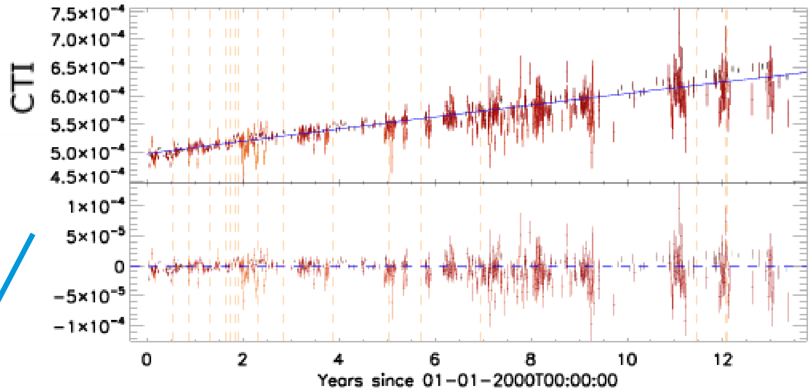
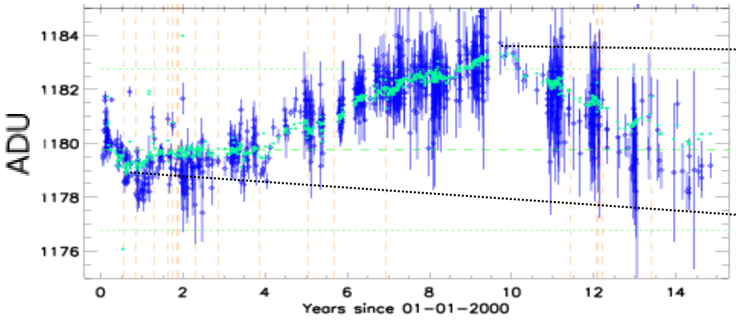
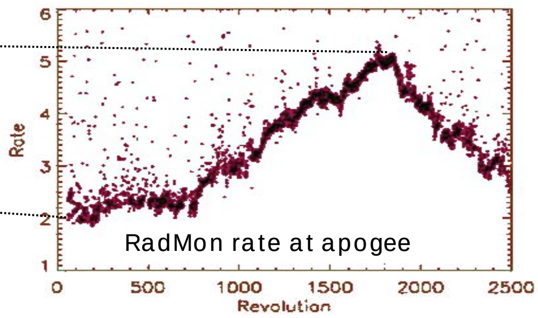


QBGC (2): residuals are due to QB dependent gain component; correct using NDISLIN(t) as proxy for QB





PN: Quiescent Background Gain Correction

- Dependency of the EPIC-pn energy scale on the quiescent particle background rate: quiescent background-dependent gain (QBG)
- Time-dependent QBG correction implemented in SAS 17 (June 2018)
- QBG correction decoupled from the long-term CTI correction ➔ XMM-CCF-REL-358 (Oct 2018). Calibrated for FF and EFF modes.

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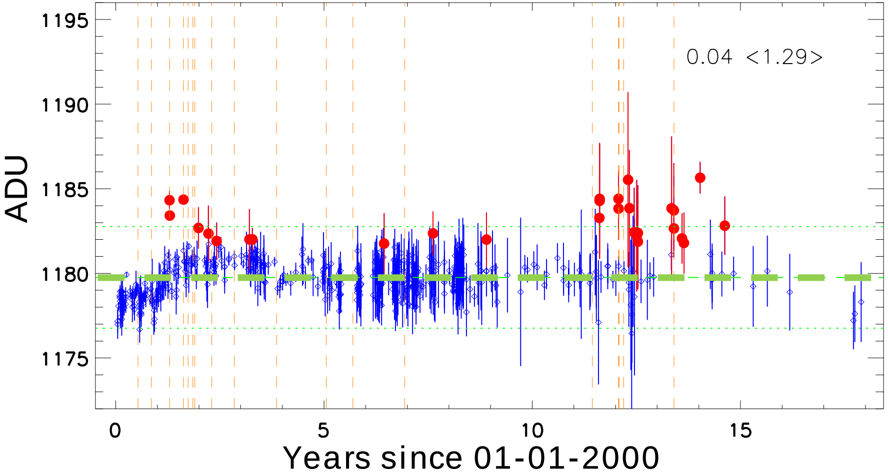
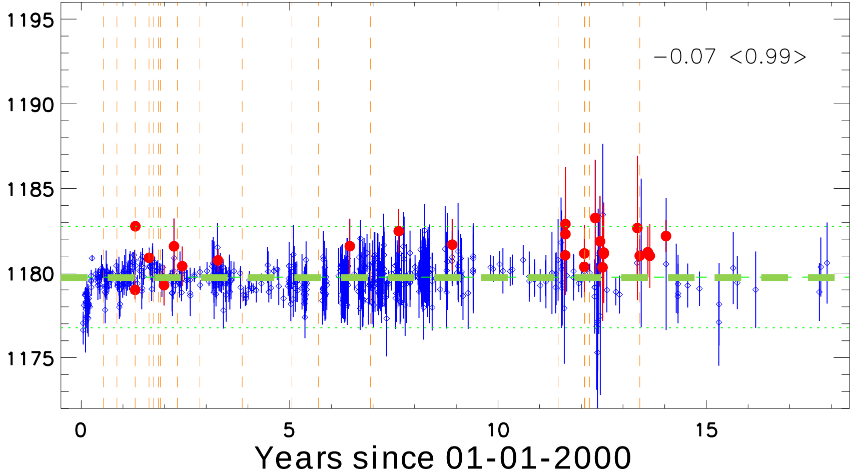
Energy reconstruction at Mn-Ka for the boresight:

w/ “Empirical” LTCTI correction



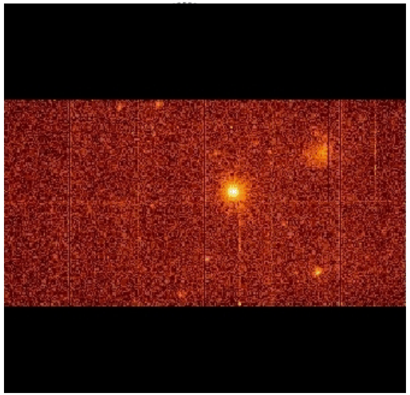
w/ LTCTI + QBG corrections

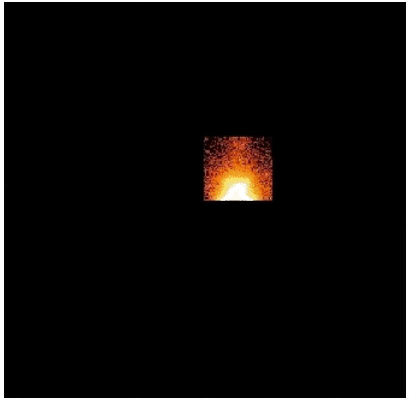


PN: Energy Scale for Window Modes

PN Large and Small Window Modes long-term CTI correction:

- Derivation more problematic than for Full Frame Mode
- Very sparse sample of CalClosed exposures in window modes
- Use other data to derive LTCTI behaviour:
  - Fe-Ka emission from AGN
  - Cu-Ka fluoresence
  - Calibration released: XMM-CCF-REL-366 & 367 (2019)





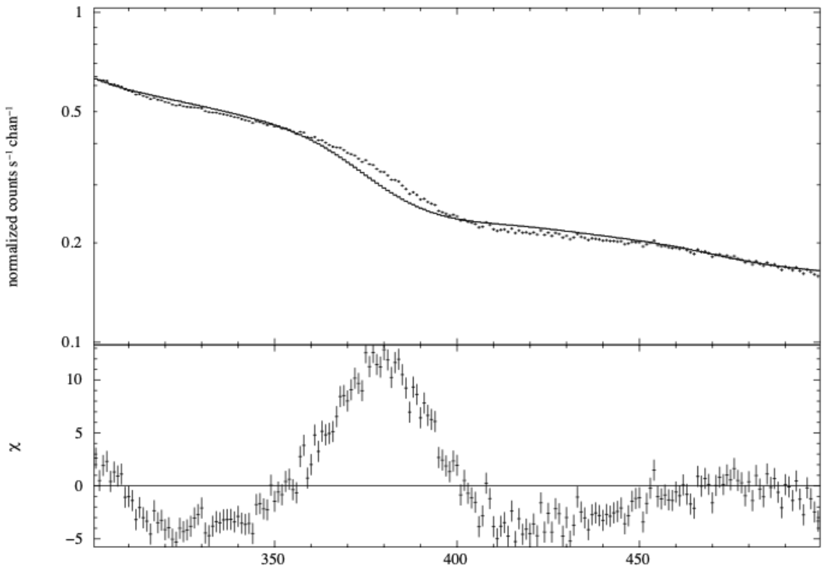
➢ See Ivan Valtchanov's presentation in Detectors & Background working group

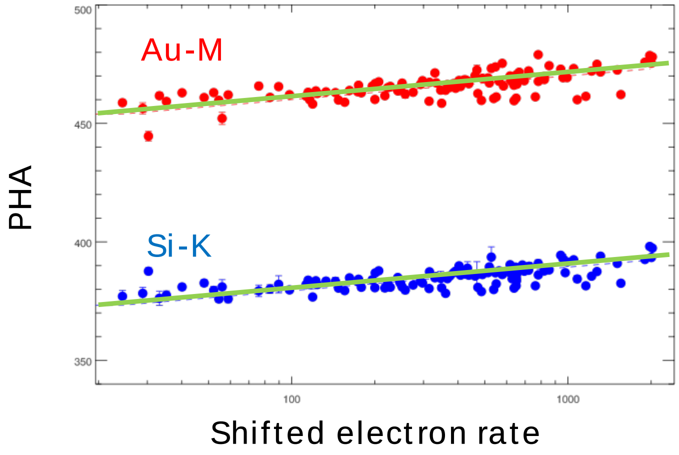
PN: Rate & Energy Dependent PHA Correction

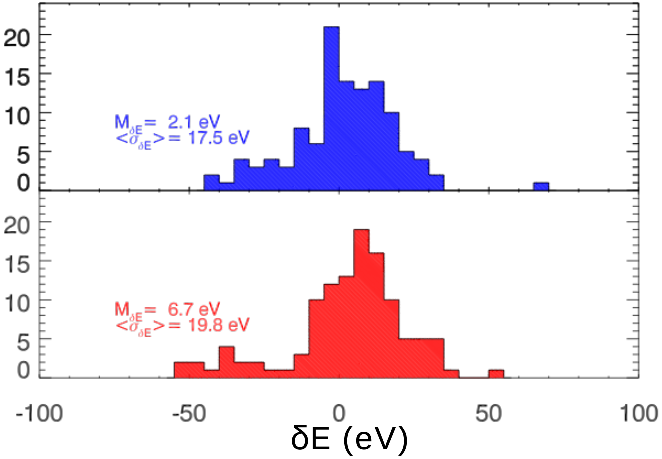
Calibration update to the rate-dependent PHA correction for **PN Timing Mode**

This new correction builds on that of Guainazzi et al. (2013, 2014):

- Derived from a significantly larger sample (~ 150 sources)
- In addition to the instrumental edges at Si-K (1.8 keV) and Au-M (2.2 keV) now includes high energy data point at Au-L (11.9 keV)
- Details in XMM-CCF-REL-369 (Migliari et al. 2019)



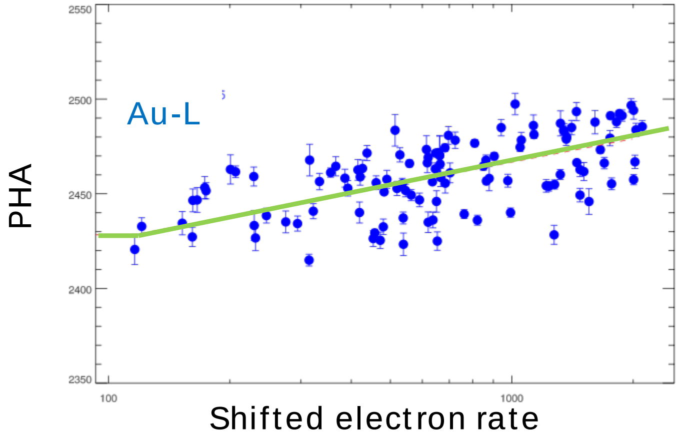


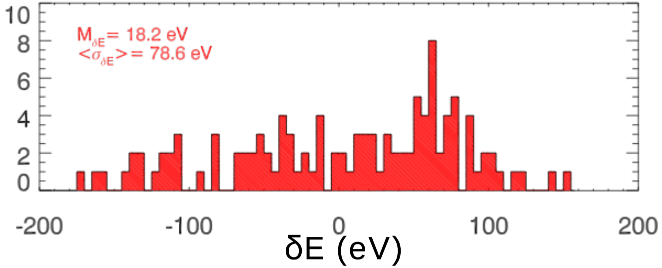


at ~2 keV:

average systematics ~1%

tail to 70 eV (3.5%)





at ~12 keV:

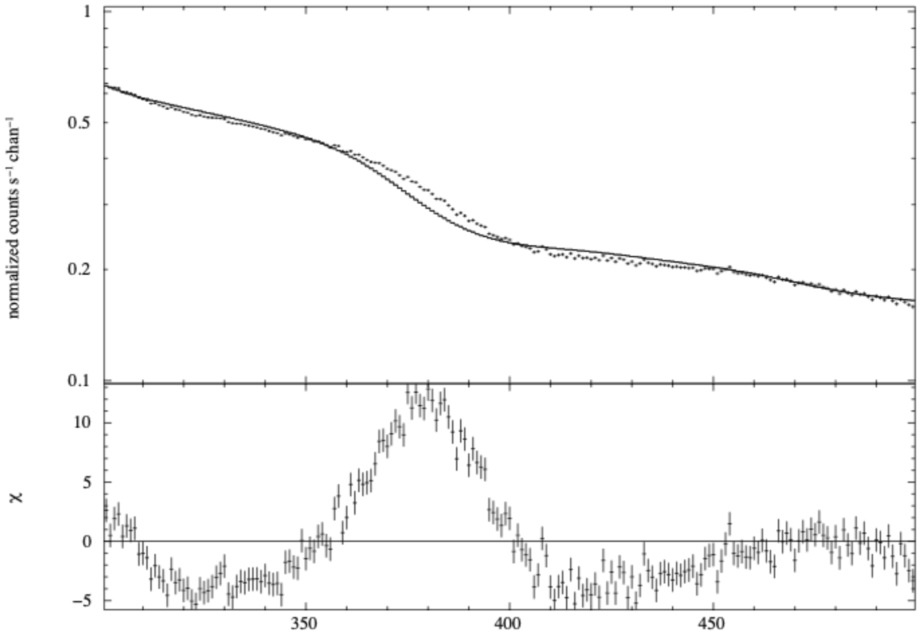
average systematics ~0.7%

tail to 180 eV (1.5%)

S. Migliari

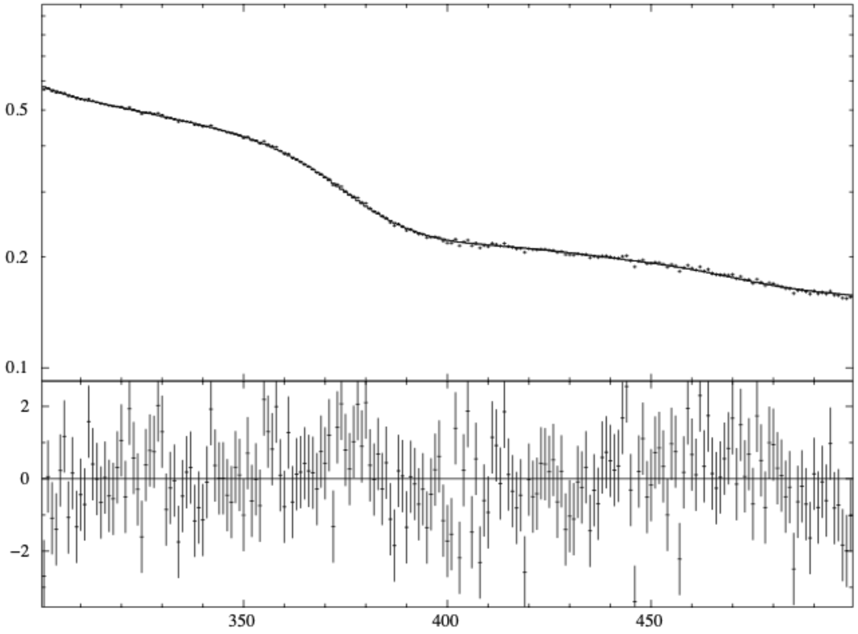
PN: Rate & Energy Dependent PHA Correction

No RDPHA correction



Channel

With RDPHA correction



Channel

S. Migliari

OM: Release of SUSS4.1

Release of the Serendipitous UV Source Survey v4.1 (the "OM Catalogue"):

- Version 4: SUSS4.1, released in December 2018 (available via XMM XSA)
- All public observations up to July 2017

- Full reprocessing with SAS 17:

- 8.18×10^6 detections of 5.5×10^6 unique sources, from 9749 XMM-Newton pointings
- 4.45×10^6 detections with UV data (3.05×10^6 unique sources)

- Source variability from multiple pointings (1.04×10^6 sources observed > once)

- 82% of cleanest, point-like OM sources have a match in GAIA DR2 catalogue
  - 98% of those are within 2", median offset 0.45"

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OM: Grism t-Dependent Sensitivity Correction

OM is subject to time-dependent sensitivity degradation

A correction for visible + UV filter data implemented in 2006

Correction for V and UV grism data will be released soon:

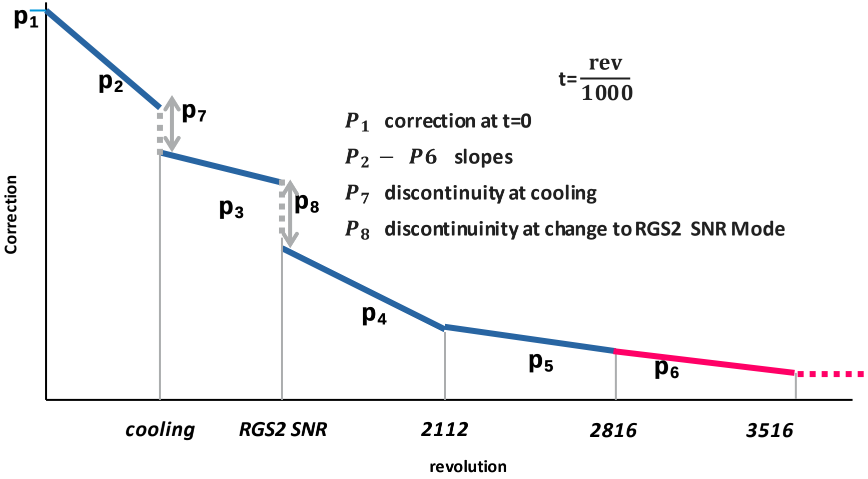
OM_GRISMCAL_0005.CCF

(with SAS 18)

Year	UV_Grism	V_Grism
2000	1.00	1.00
2002	1.01	1.01
2004	1.02	1.02
2006	1.04	1.02
2008	1.05	1.03
2010	1.07	1.04
2012	1.08	1.04
2014	1.10	1.05
2016	1.12	1.06
2018	1.13	1.07
2020	1.15	1.07

RGS: A_{eff} Correction Update

- Evidence for a systematic change in time in the RGS1 to RGS2 flux ratios
- Corrected through epoch and energy dependent model (**RGSn_EFFAREACORR** CCFs)
- Updated correction with improved algorithm and validity range → to be released soon



$t = \frac{rev}{1000}$

P_1 correction at t=0

$P_2 - P6$ slopes

P_7 discontinuity at cooling

P_8 discontininity at change to RGS2 SNR Mode

For each 0.05 Å bin:

t<0.538	$P_1 + \left(\frac{t}{0.538}\right) P_2$
0.538 ≤t<1.408	$P_1 + P_2 + P_6 + \left(\frac{t-0.538}{0.870}\right) P_3$
1.408 ≤ t< 2.112	$P_1 + P_2 + P_3 + P_7 + P_8 + \left(\frac{t-1.408}{0.704}\right) P_4$
2.112≤t<2.816	$P_1 + P_2 + P_3 + P_4 + P_7 + P_8 + \left(\frac{t-2.112}{0.704}\right) P_5$
2.816≤t<3.516	$P_1 + P_2 + P_3 + P_4 + P_5 + P_7 + P_8 + \left(\frac{t-2.816}{0.700}\right) P_6$

+narrow gaussians at specific wavelengths

J. Kaastra, C. de Vries & J.W. den Herder, 2019

RGS: Changing A_{eff}

Evidence for decreasing effective area

- Flux decrease observed in:

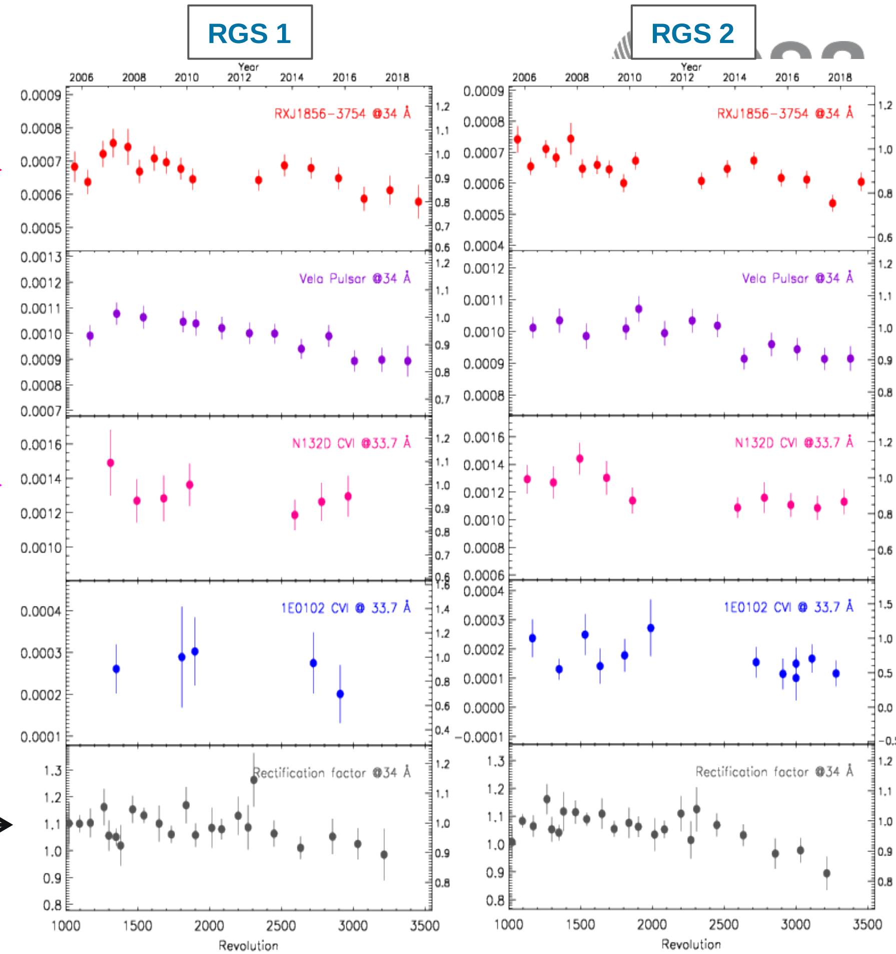
ISN RXJ1856-3754

Vela Pulsar

Emission lines in compact SNRs
N132D

1E0102

- Decrease of the ratio of fluxes RGS/EPIC-pn (aka "Rectification Factors")



RGS: Changing A_{eff}

Evidence for decreasing effective area

Possible instrumental causes:

- Increase in the thickness of the C_8H_8 contamination layer

X very different wavelength dependence

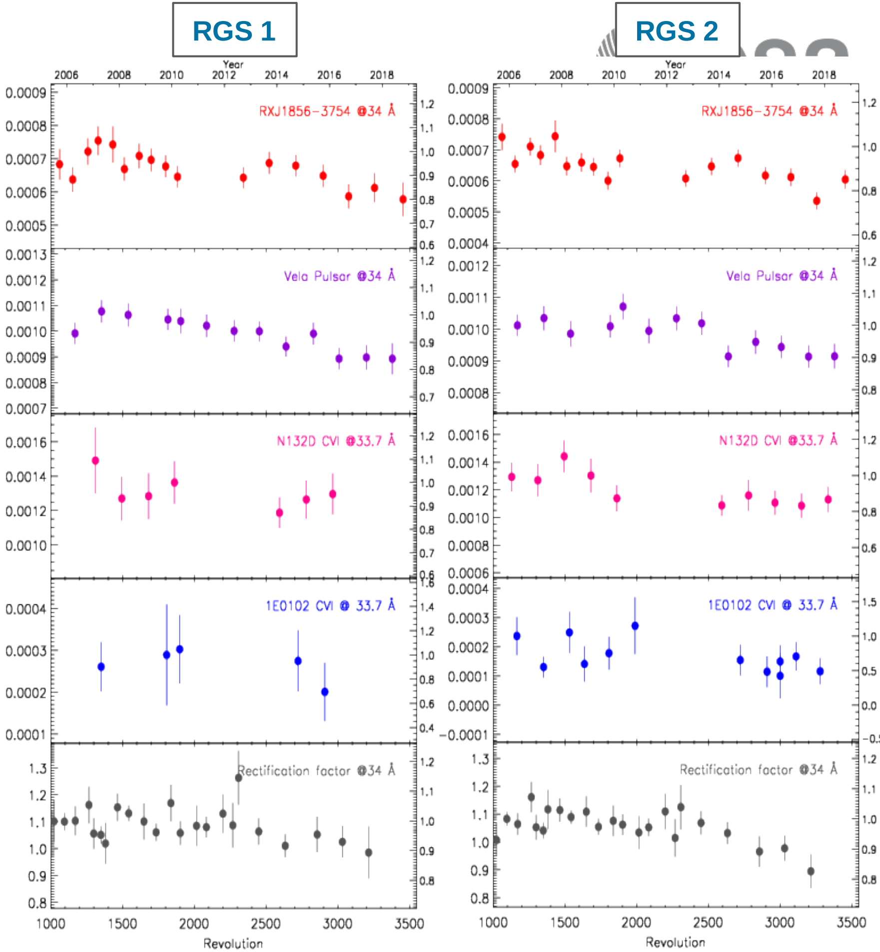
- Increase in the thickness of the O layer

X would require an increase of 300 nm

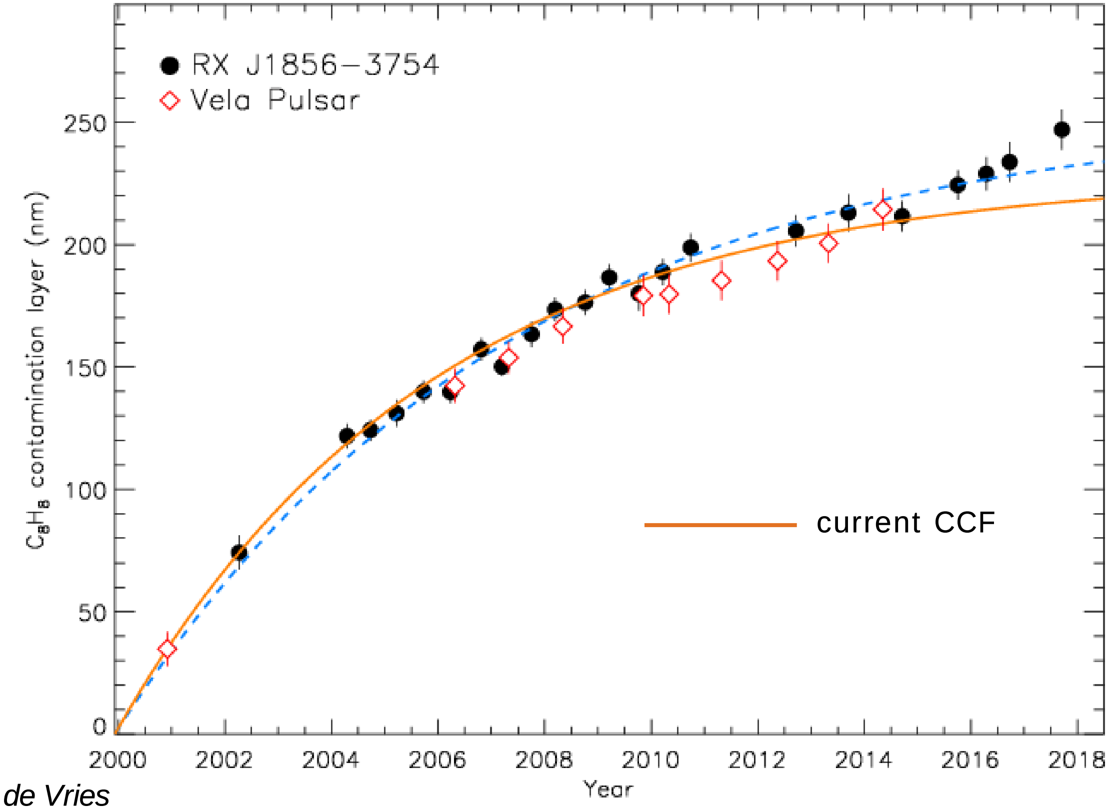
- Mismatch in the PI selection regions

X would imply an unrealistic error in gain

→ work in progress…

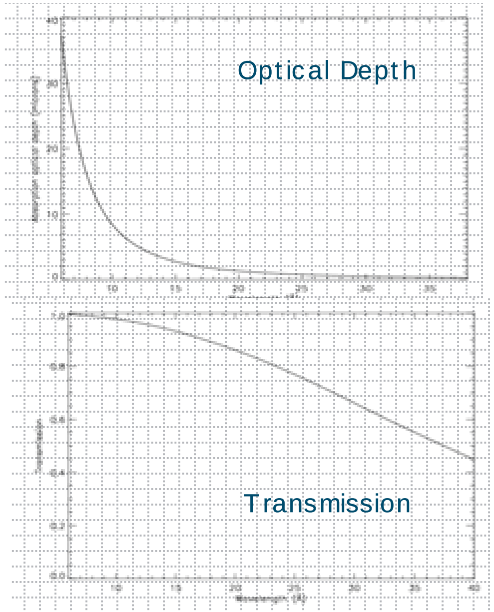


RGS: Contamination Monitoring



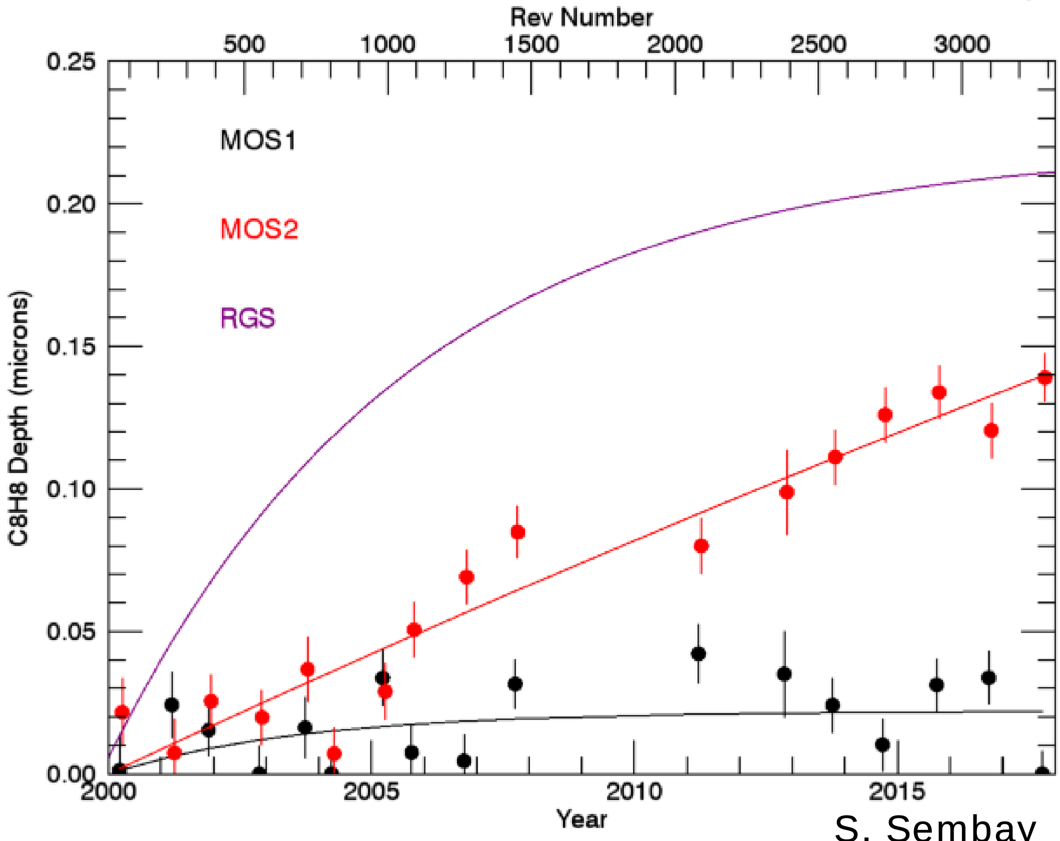
C. de Vries

Thickness of layer ∝ flux @35Å



Indications of increasing contamination?

MOS: Contamination Monitoring



S. Sembay

Primary monitoring source:

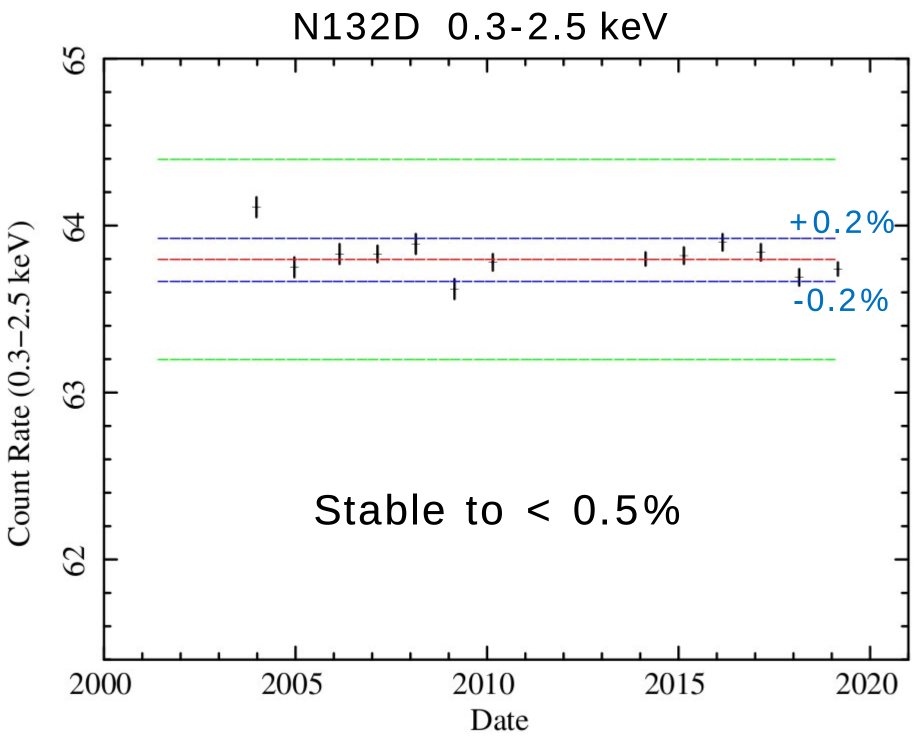
SNR 1E0102.

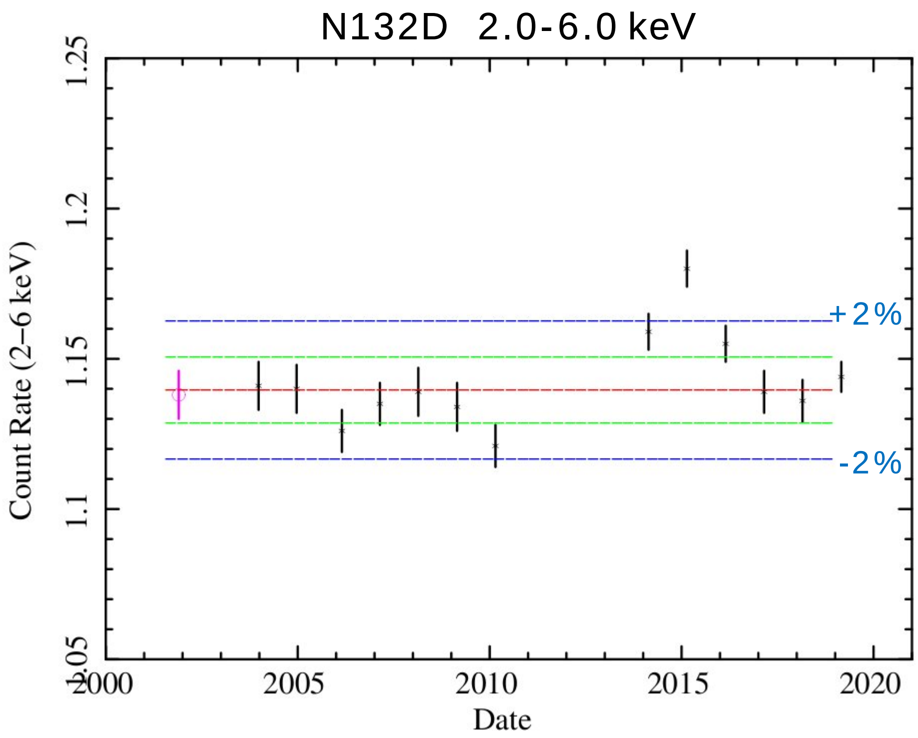
Contamination status in 2018 shows no change in trend:

- MOS1 stable
- MOS2 steadily increasing:

  ~14% A_{eff} loss @ 0.5 keV in 2018

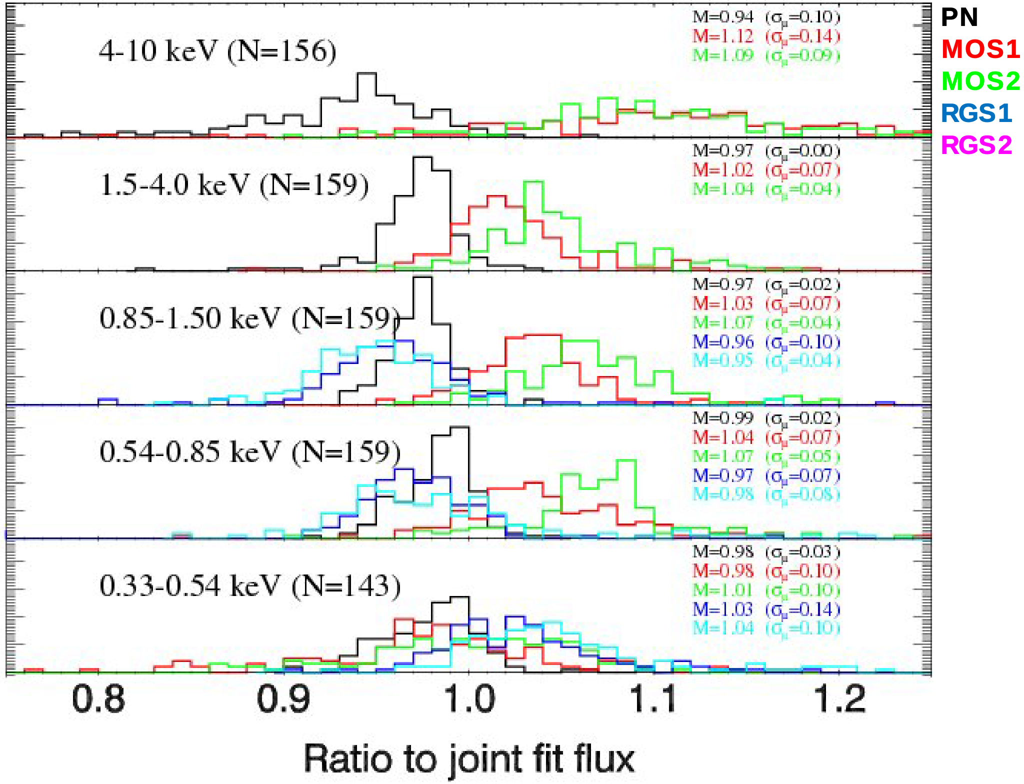
PN: Stability Monitoring





Details in R. Saxton, 2019, XMM-SOC-CAL-TN-0212

Cross Calibration Status



Instrumental flux ratios derived from a set of ≈ 120 observations in the XMM-Newton Cross-Calibration Database.

- MOS1 / pn:
  - o ≈ 1.00 (E < 0.54 keV)
  - o ≈ 1.05 (E > 0.54 keV)
- MOS2 / pn:
  - o ≈ 1.03 (E < 0.54 keV)
  - o ≈ 1.08 (E > 0.54 keV)
- MOS / pn above > 4 keV: ≈ 1.1
- RGS / pn: From 1.05 to 0.98 with increasing E

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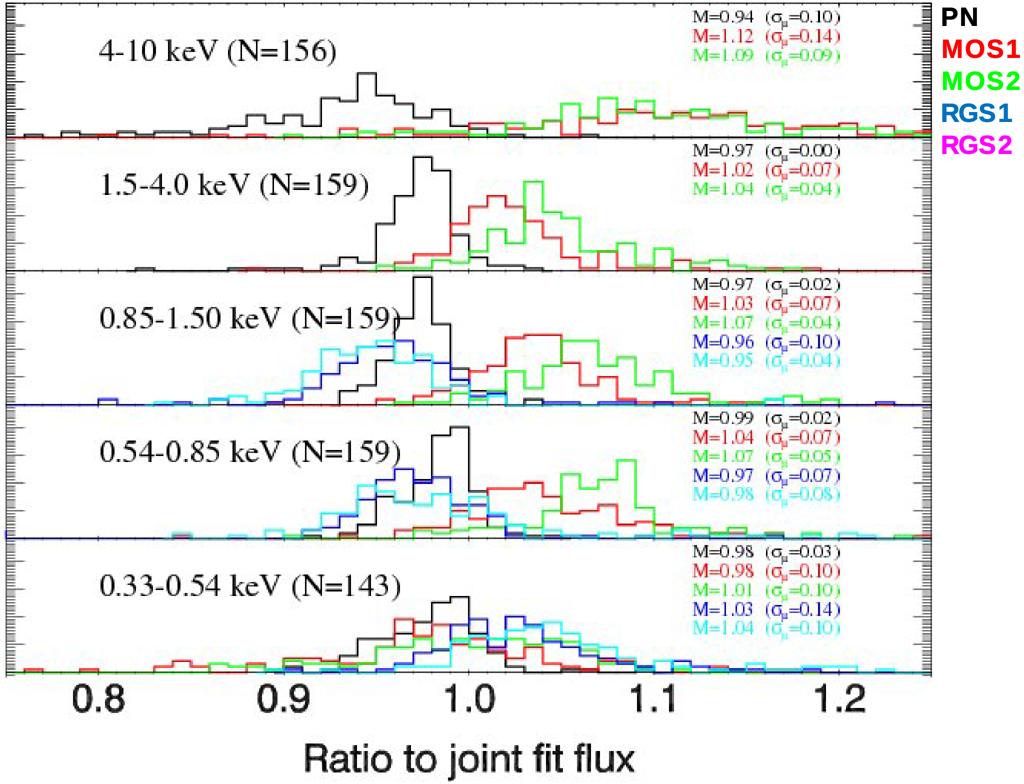

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The CORRAREA MOS / pn correction is currently being recalibrated:

Applies an empirical A_{eff} correction to the EPICs.

➢ See talk by Christian Pommranz in Calibration Methods session.