XMM-Newton Calibration Status Update

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Outline

1. Recent calibration file releases
   - OM photometry: update of time-dependent sensitivity degradation 356
   - EPIC-pn energy scale:
     - Long-term CTI and quiescent background gain correction 358
     - Long-term CTI for Small Window and Large Window modes 366 & 367
     - 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
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

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

RadMon rate at apogee
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)
PN: Quiescent Background Gain Correction

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Energy reconstruction at Mn-Ka for the boresight:

- w/ "Empirical" LTCTI correction
- w/ LTCTI + QBG corrections

![Graph showing energy reconstruction with and without QBG corrections](image-url)
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 fluorescence

➤ 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)
Shifted electron rate

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%)
PN: Rate & Energy Dependent PHA Correction

No RDPHA correction

With RDPHA correction

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:
  - 8.18x10^6 detections of 5.5x10^6 unique sources, from 9749 XMM-Newton pointings
  - 4.45x10^6 detections with UV data (3.05x10^6 unique sources)

- Source variability from multiple pointings (1.04x10^6 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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2. On-going calibration topics
**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)

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RGS: $A_{\text{eff}}$ Correction Update

- Evidence for a systematic change in time in the RGS1 to RGS2 flux ratios
- Corrected through epoch and energy dependent model ($\text{RGSn\_EFFAREACORR}$ CCFs)
- Updated correction with improved algorithm and validity range → to be released soon

For each 0.05 Å bin:
- $t<0.538$: $P_1 + \left(\frac{t}{0.538}\right)P_2$
- $0.538 \leq t<1.408$: $P_1 + P_2 + P_3 + \left(\frac{t-0.538}{0.870}\right)P_4$
- $1.408 \leq t<2.112$: $P_1 + P_2 + P_3 + P_7 + \left(\frac{t-1.408}{0.704}\right)P_5$
- $2.112 \leq t<2.816$: $P_1 + P_2 + P_3 + P_4 + P_7 + P_8 + \left(\frac{t-2.112}{0.704}\right)P_6$
- $2.816 \leq t<3.516$: $P_1 + P_2 + P_3 + P_4 + P_5 + P_7 + P_8 + \left(\frac{t-2.816}{0.700}\right)P_6$

+ Narrow gaussians at specific wavelengths

J. Kaastra, C. de Vries & J.W. den Herder, 2019
RGS: Changing $A_{\text{eff}}$

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 $A_{\text{eff}}$

Evidence for decreasing effective area

Possible instrumental causes:

• Increase in the thickness of the C$_8$H$_8$ 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

Indications of increasing contamination?

Thickness of layer $\propto$ flux @35Å
MOS: Contamination Monitoring

Primary monitoring source:
SNR 1E0102.

Contamination status in 2018 shows no change in trend:

- MOS1 stable
- MOS2 steadily increasing:
  \( \sim 14\% A_{\text{eff}} \) loss @ 0.5 keV in 2018
**PN: Stability Monitoring**

N132D 0.3-2.5 keV

Stable to < 0.5%

N132D 2.0-6.0 keV

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

Instrumental flux ratios derived from a set of \( \approx 120 \) observations in the XMM-Newton Cross-Calibration Database.

- **MOS1 / pn:**
  - \( \approx 1.00 \) (\( E < 0.54 \) keV)
  - \( \approx 1.05 \) (\( E > 0.54 \) keV)

- **MOS2 / pn:**
  - \( \approx 1.03 \) (\( E < 0.54 \) keV)
  - \( \approx 1.08 \) (\( E > 0.54 \) keV)

- **MOS / pn above > 4 keV:** \( \approx 1.1 \)

- **RGS / pn:** From 1.05 to 0.98 with increasing \( E \)
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- MOS / pn above > 4 keV: ≈ 1.1
- RGS / pn: From 1.05 to 0.98 with increasing E

The CORRAREA MOS / pn correction is currently being recalibrated:
Applies an empirical $A_{\text{eff}}$ correction to the EPICs.

➢ See talk by Christian Pommranz in Calibration Methods session.