XMM-Newton Calibration Updates

Michael Smith

11th IACHEC, Pune

29 Feb -03 Mar 2016

Recent Calibration Files

- Astrometry: Time Variable Boresight Update — XMM_BORESIGHT_0025
- Change in Sign of the Boresight Ψ Angle — XMM_BORESIGHT_0026
- RGS Offsets – Update of ADUCONV CCFs — RGS2_ADUCONV_0029,RGS2_ADUCONV_0030, RGS2_ADUCONV_0031,RGS2_ADUCONV_0032
- Update of the RGS Gain and CTI — RGS1_ADUCONV_0026, RGS1_CTI_0014, RGS2_ADUCONV_0033, RGS2_CTI_0015
- Update of the RGS to EPIC-pn Rectification Factors — RGS1_EFFAREACORR_0010, RGS2_EFFAREACORR_0010
- EPIC MOS Fixed Offset Tables — EMOS1_DARKFRAME_0036, EMOS1_DARKFRAME_0032
- February 2016: New SAS release: **SAS14.0 -> SAS 15.0**

Astrometry: Time-Variable Boresight Update

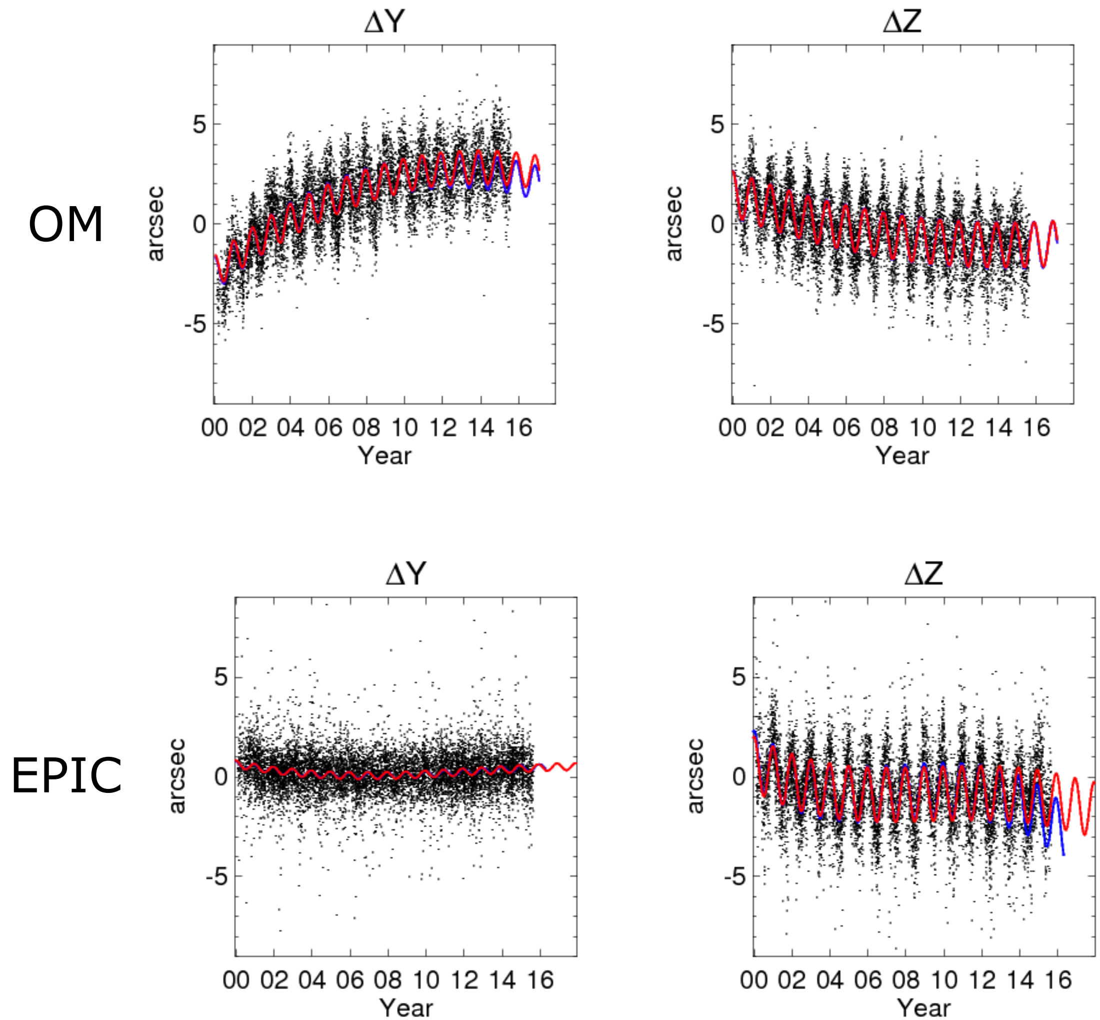
A. Talavera and P. Rodríguez, 2015, XMM-CCF-REL-330

- Time-dependent boresight implemented in 2012 in order to address variability in star-tracker and instrument alignments.

- Updated in 2014.

- Recent observations show slight deviations of measured astrometry offsets with respect to model predictions, esp. For EPIC.

- Deviations of the order of 1″-2″ for EPIC and RGS corrected in new CCF: **`XMM_BORESIGHT_0025.CCF`**.

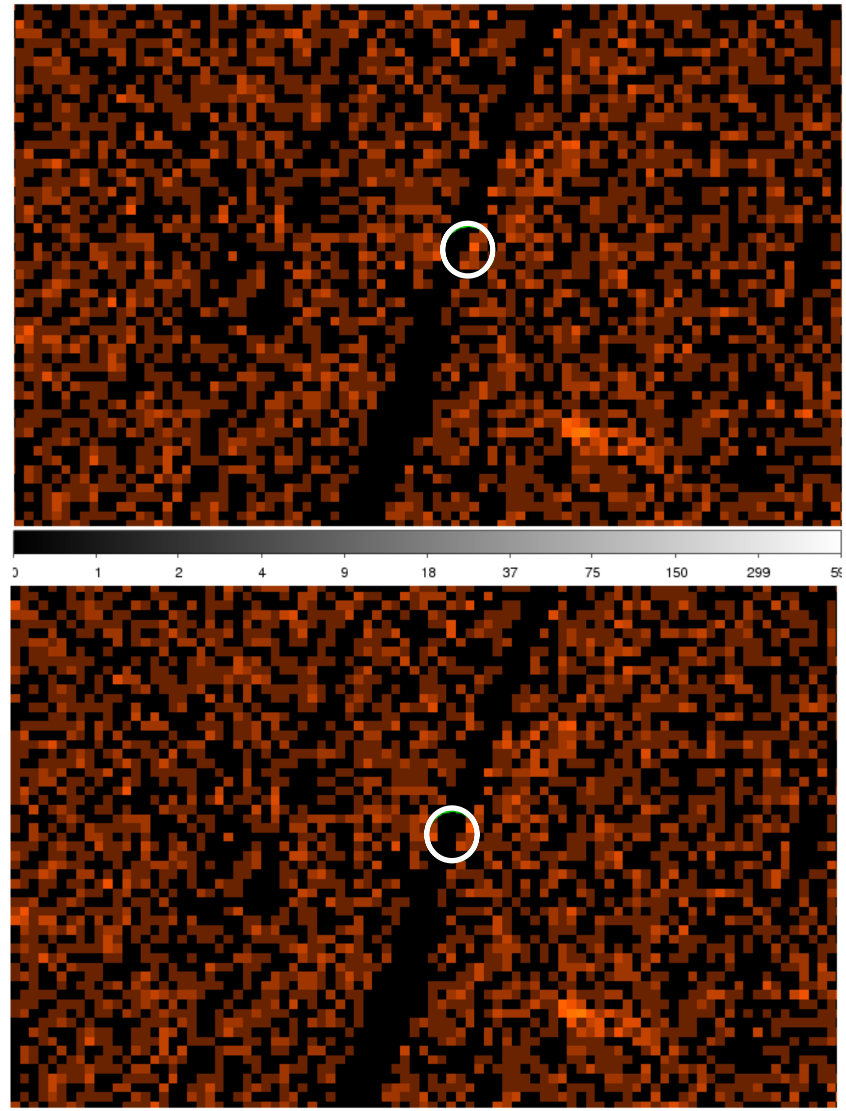


Astrometry: Boresight Ψ Angle Changed

R. Saxton, 2015, XMM-CCF-REL-332

- Wrong sign of the boresight Euler angle ψ in the respective calibration file.
- Most relevant SAS tasks used formulas expecting -ψ, thus cancelling out the error.
- However, tasks expecting the correct ψ gave erroneous celestial <-> detector conversions.
- The ψ sign has now been corrected in the CCF, along with respective s/w:

  `XMM_BORESIGHT_0026.CCF` + SAS15.
- Only EPIC is affected, and esp. MOS2 and pn.



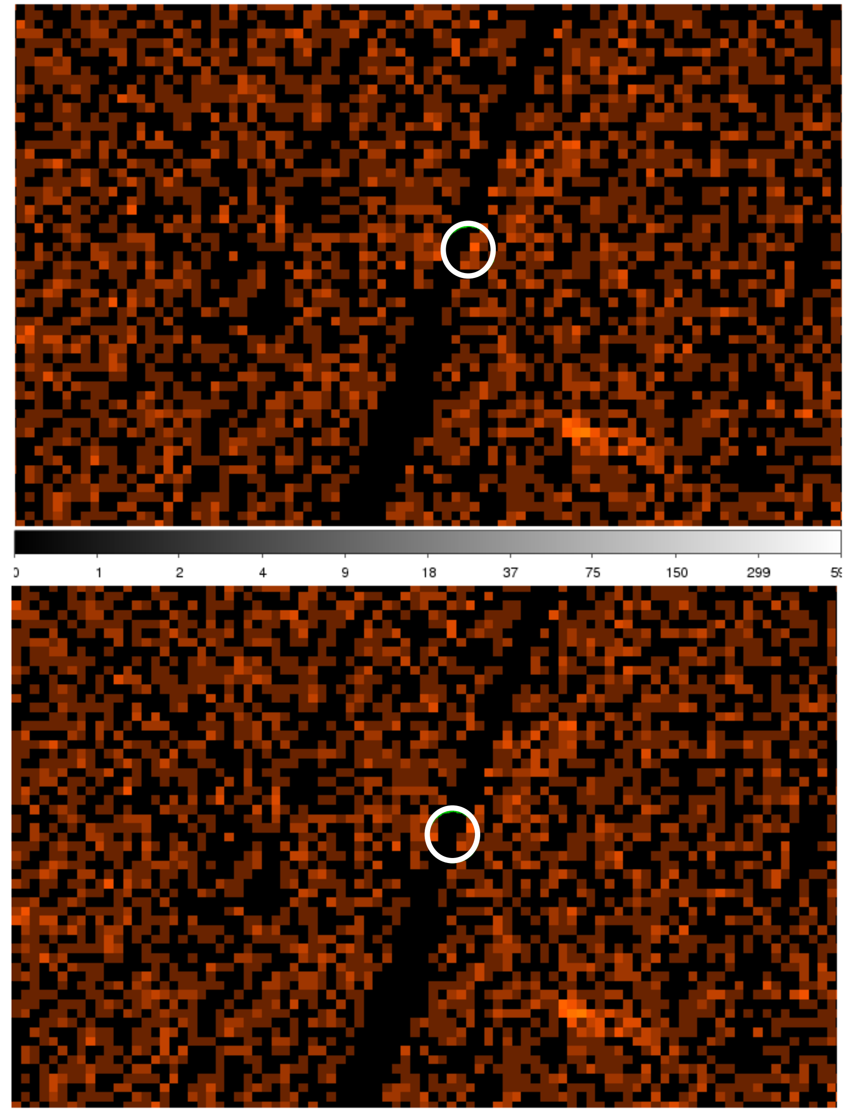
Astrometry: Boresight Ψ Angle Changed

R. Saxton, 2015, XMM-CCF-REL-332

Scientific impact of the changes:

- Source detection:
  - only in RAWX/Y coordinates of source lists created by **`emldetect`**;
  - detector and sky coordinates, WCS header values and exposure times **not affected**.

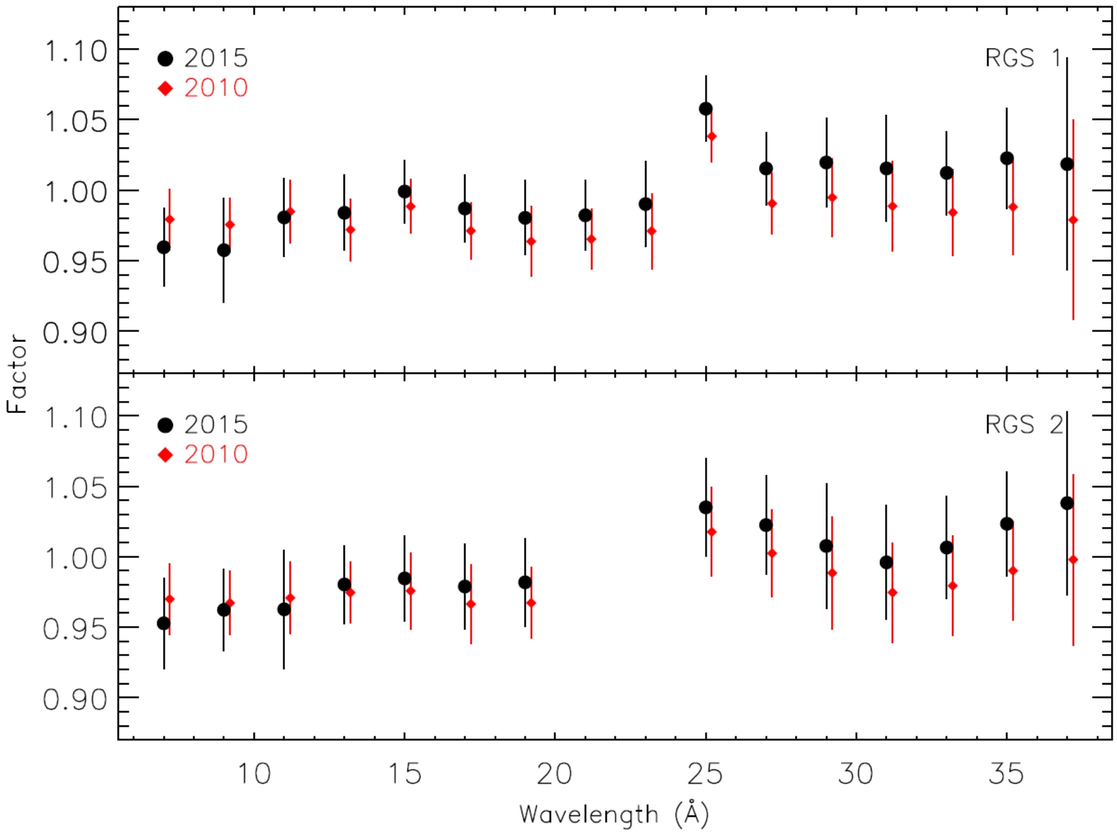
- Effective area calculation:
  - treatment of chip gaps and bad pixels was affected, which may have resulted in erroneous effective area corrections;
  - potential errors increased towards the edge of the field-of-view.



Update of RGS-to-PN Rectification Factors

R. Gonzalez-Riestra, 2015, XMM-CCF-REL-328

- Originally implemented in 2010 in order to reconcile RGS and pn flux differences.
- Changes in calibration required a re-evaluation of the values.
- New values derived from 42 observations of PKS 2155-304 and 3C 273 processed with SAS14.0 and calibration of November 2014:
  RGS1/2_EFFAREACORR_0010.CCF



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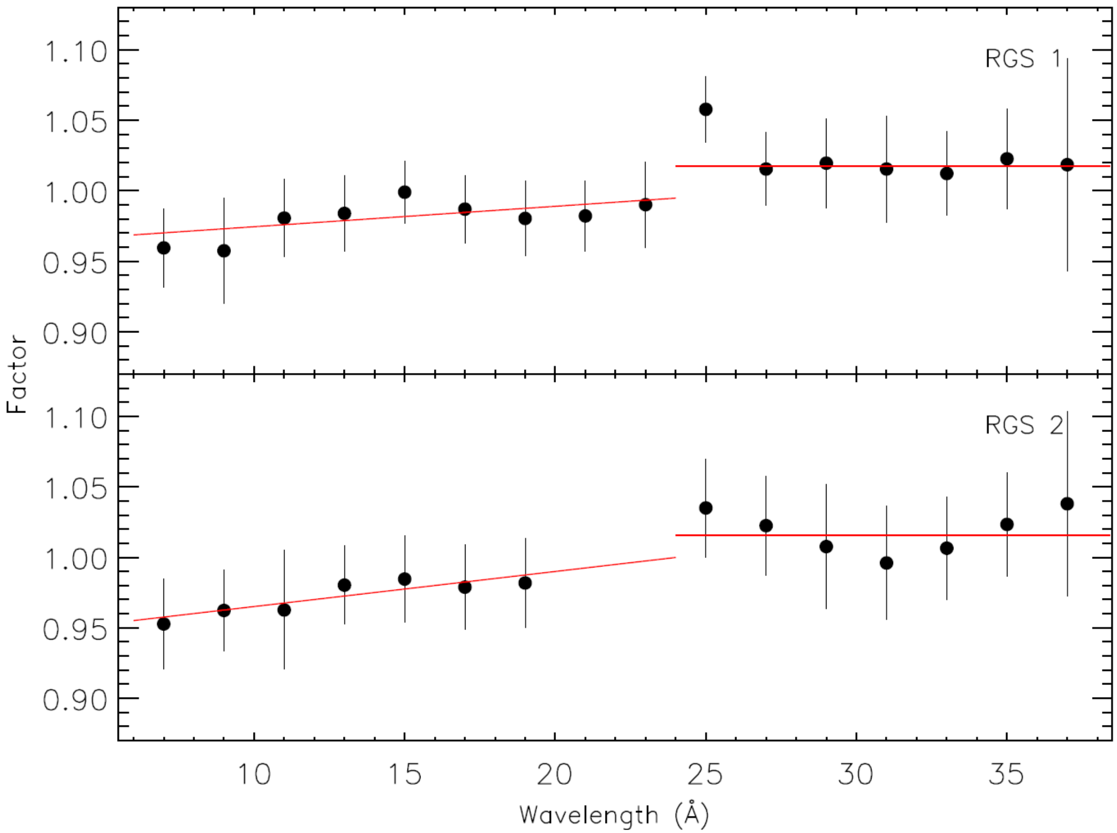
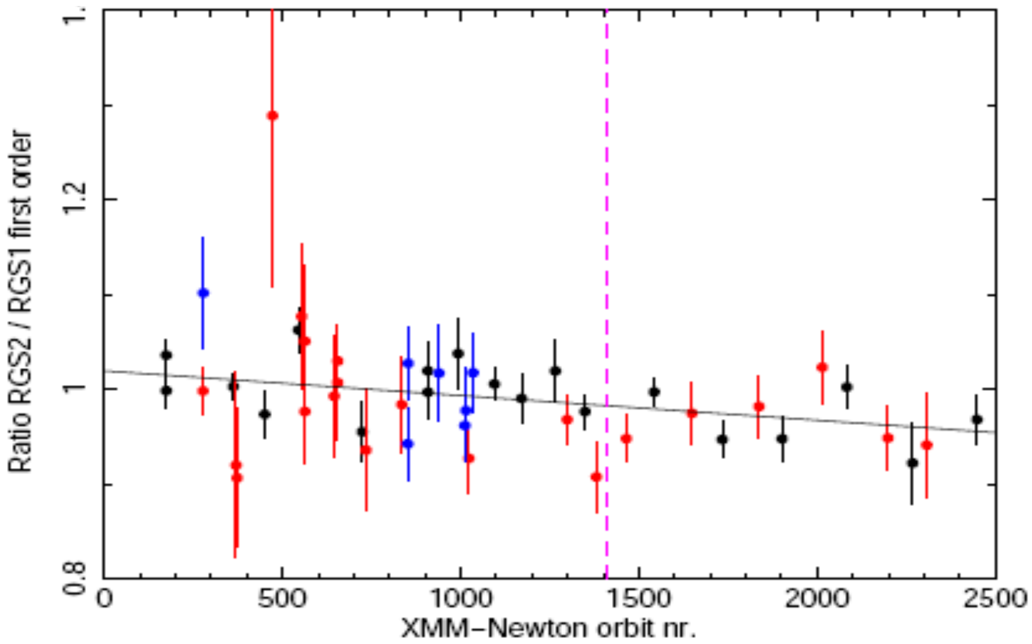
- Modelling:
  - λ ≤ 24 Å: a + b * λ
  - λ > 24 Å: constant



RGS2 / RGS1 Flux Ratio

- There are indications of a decrease in the ratio of the fluxes derived from RGS2 w.r.t. RGS1
- This issue is being investigated using spectra of bright blazars
- On average, the flux ratio RGS2/RGS1 decreases linearly by ≈ 0.4% / yr



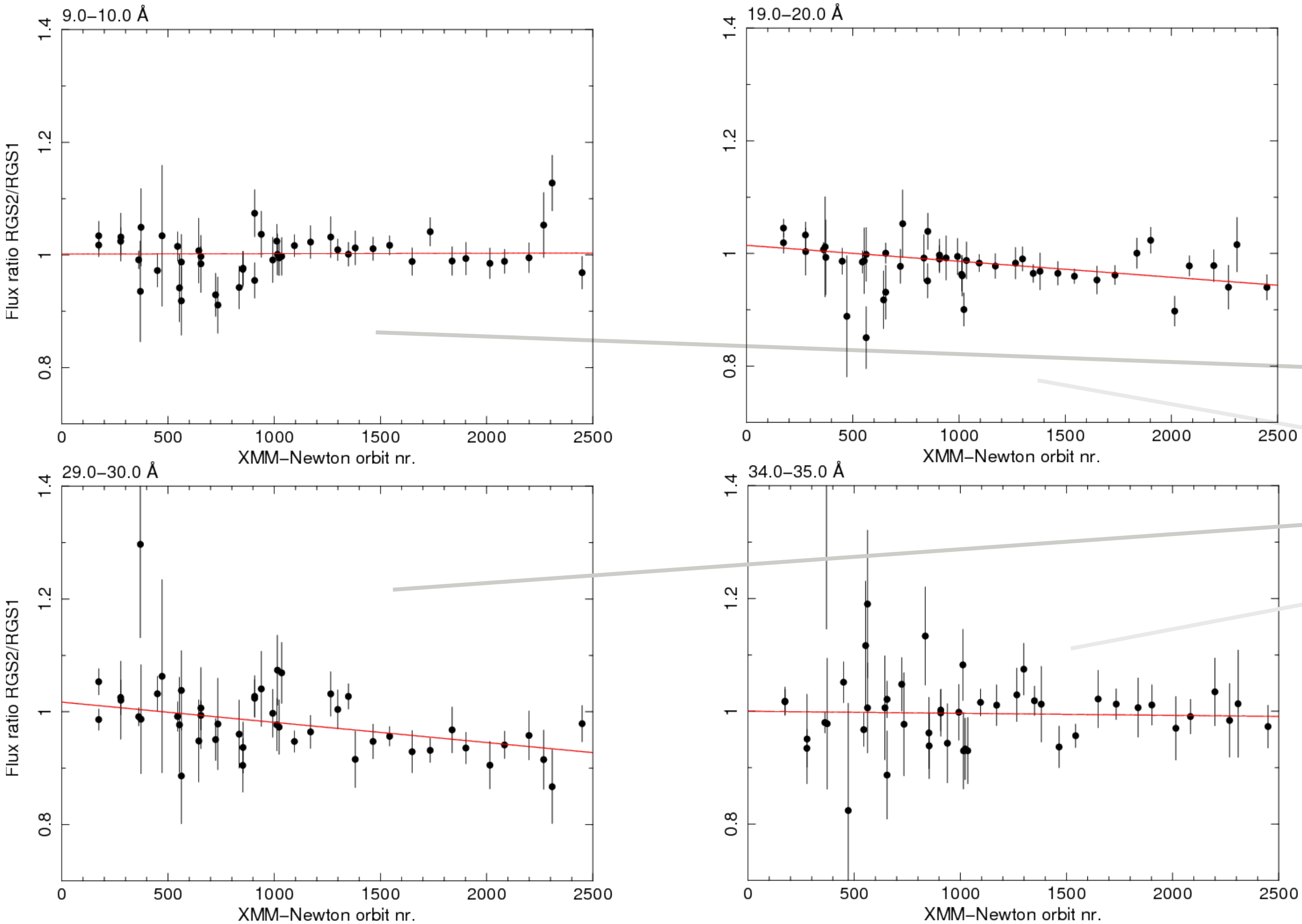
J. Kaastra, C. de Vries

RGS2 / RGS1 Flux Ratio

Closer examination shows that the rate of change depends on wavelength:

•significantly below zero in the range 15-30 Å

•closer to zero or positive at shorter and longer wavelengths.



λ (Å)	change per rev	% per year	% in 15 years
9.5	-0.4 10^{-5}	-0.1	-1
19.5	-3.5 10^{-5}	-0.6	-10
29.5	-2.5$10^{-5}$	-0.5	-7
34.5	-1.0 10^{-5}	-0.2	-3

J. Kaastra, C. de Vries

EPIC-pn: BU Mode Rate-Dependent PHA Correction

- Implementation and calibration of the EPIC-pn Burst Mode **rate-dependent PHA** correction

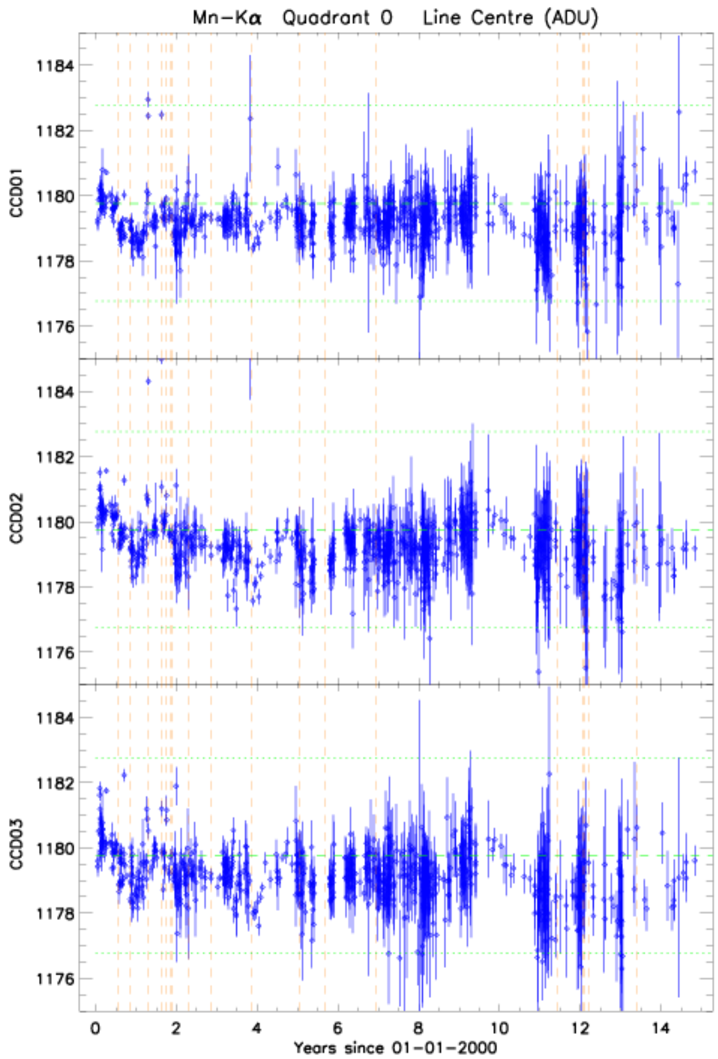
- Fast-mode energy scale correction which is an alternative to the **rate-dependent CTI** correction (in use since 2008, BU Mode parameters updated in 2015).

- This method avoids potential issues of the rate-dependent CTI correction:

Rate-dependent CTI	Rate-dependent PHA
Requires spectral modelling of source emission	No model assumptions necessary
Requires XSPEC "`gainfit`", which shifts response as opposed to data	Energy shift determined from data in PHA space
Applied after gain corrections	Applied before gain corrections

- Already calibrated and implemented for EPIC-pn Timing Mode (2013)

EPIC-pn: Quiescent Background Dependent Gain



- Current time-dependent energy scale correction based on empirical long-term CTI correction
- Entangles a pure CTI component and a time-dependent gain component
- Unravelling the gain component…

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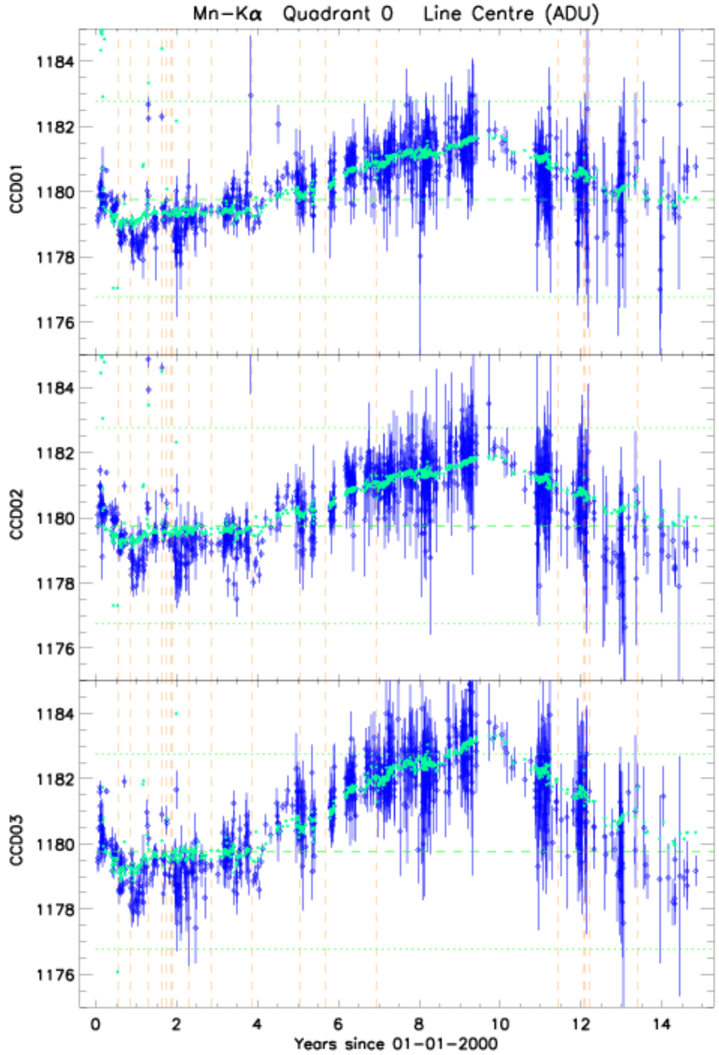

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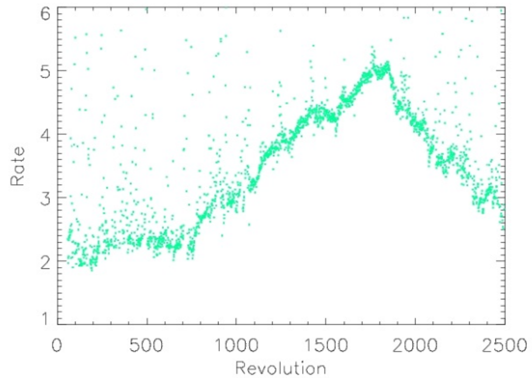


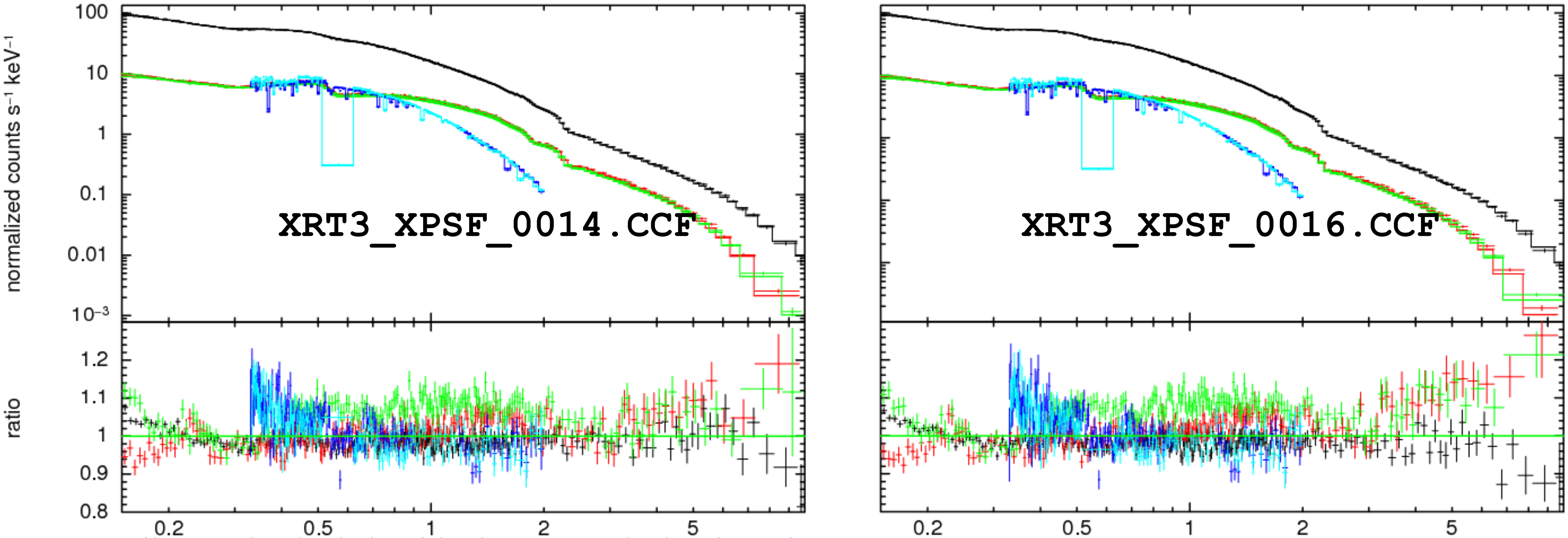
… shows a correlation with the quiescent background

- Correcting for the quiescent background dependent gain should improve temporal and spatial dependence of the EPIC-pn energy scale calibration

EPIC: XRT PSF Wings

- A refinement of the high-energy XRT3 (=PN) PSF was released in March 2014 (**XRT3_XPSF_0016.CCF**)
- Based on analysis of EPIC-pn Timing Mode data (Mkn 421).
- Optimise parameters describing the XRT3 PSF wings in order to obtain constant measured EPIC-pn flux independent of number of excised columns.
- When applied to imaging mode data with annular extraction regions: increased MOS – PN discrepancies above 3.5 keV
- EPIC PSF wings currently being investigated

PKS 2155-304

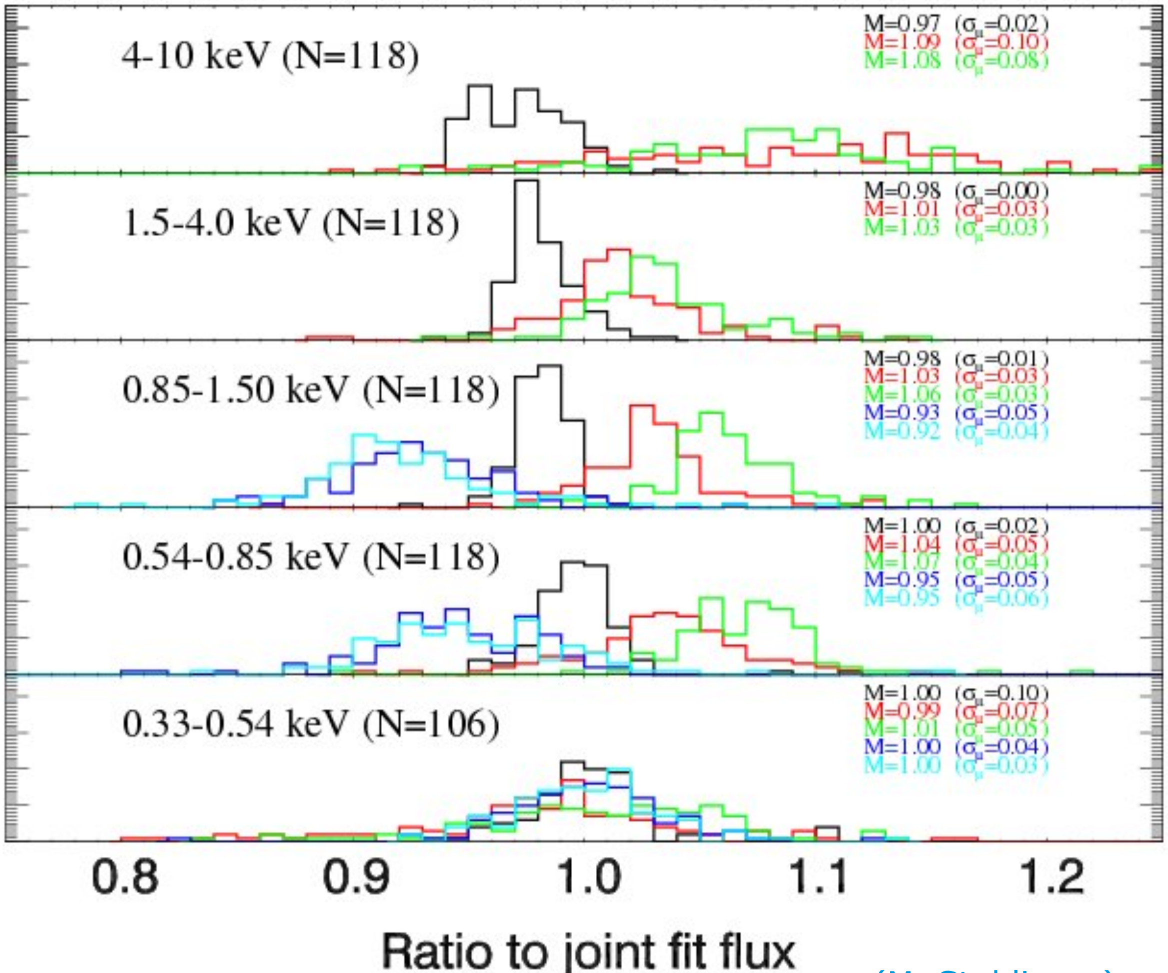


XMM-Newton Cross Calibration Status

esa

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

- MOS1 / pn:
  - ≈ 0.98 (E < 0.54 keV)
  - ≈ 1.04 (E > 0.54 keV)
- MOS2 / pn:
  - ≈ 1.00 (E < 0.54 keV)
  - ≈ 1.06 (E > 0.54 keV)
- MOS / pn above > 3 keV under investigation.
- RGS / pn: From 1.01 to 0.95 with increasing E (using χ^2 statistic)



(M. Stuhlinger)