XMM-Newton Calibration Status Update

Michael Smith, ESAC

IACHEC On-line Symposium, 23-24 Nov 2020

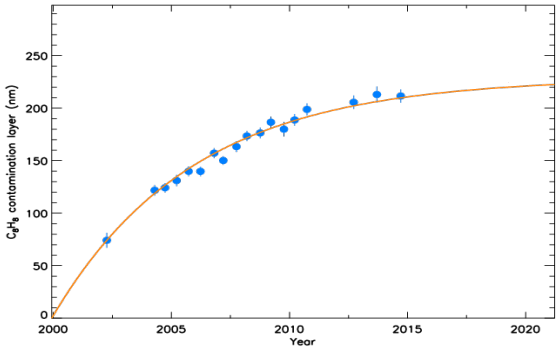
Recent calibration updates

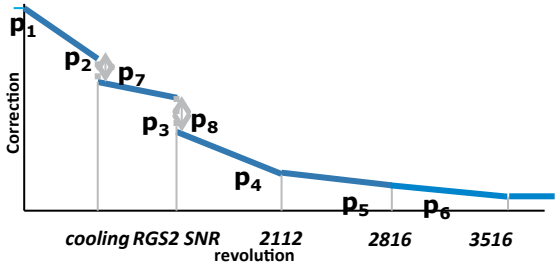
Relevant calibration file releases	XMM-CCF-REL-	Release Date
• RGS:		
○ Update of the effective area correction	371	Jun 2019
○ Time-dependent rectification factors	372	Oct 2019
• EPIC-pn energy scale:		
○ Long-term CTI for Small Window and Large Window modes	376	Jun 2020
○ Rate and energy dependent PHA correction for Burst Mode		
• Astrometry: time variable boresight update	375	Feb 2020
• OM:		
○ Grism	377	Apr 2020
○ Photometry	378	May 2020

RGS: Effective Area Model

Includes:

Hydrocarbon contamination →



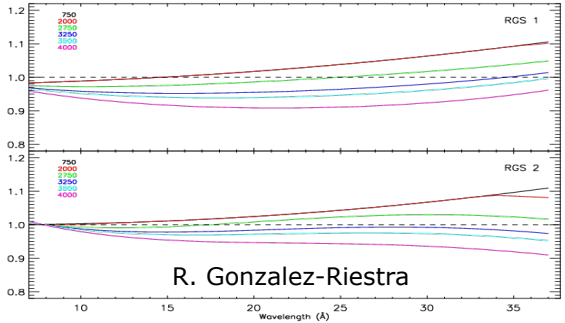


← Small scale Effective Area variations (RGS1 vs RGS2)

Correction in bins of 0.05 mÅ
Improved algorithm implemented in June 2019
Applied by default in SASv19 (as of October 2020)
XMM-CCF-REL-371 (R. Gonzalez-Riestra)

Effective Area changes with respect to EPIC-pn → (aka Rectification Factors)

Time dependence implemented in December 2019
Non-default option in SASv19
XMM-CCF-REL-372 (R. Gonzalez-Riestra)

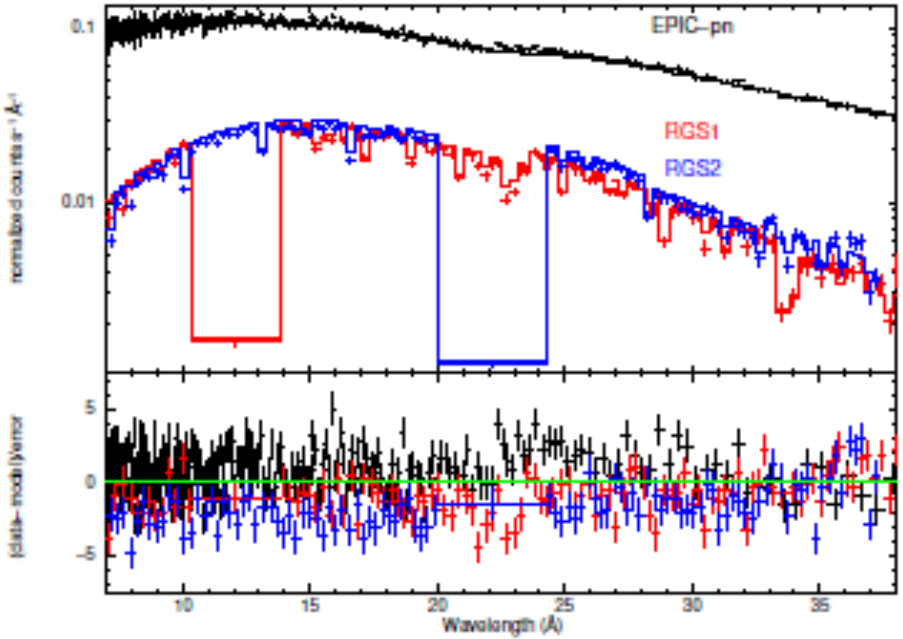


RGS: Effective Area Model

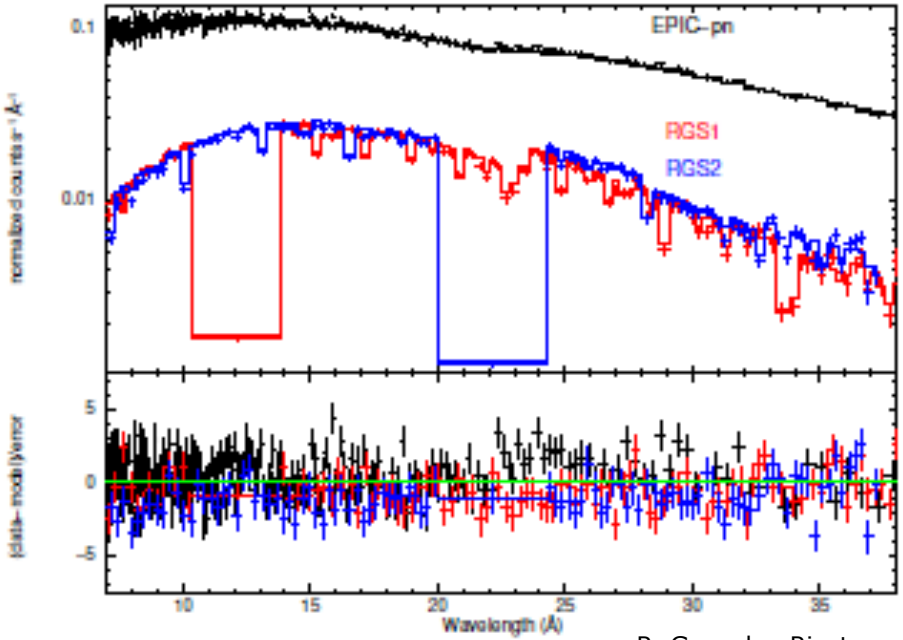
Example of the application of Effective Area Corrections:

Joint RGS1 / RGS2 / pn fit to 1E 1553+513:

w/o correction



w/ corrections



C-statistics decreasing from 6371 to 5985 (for 5398 d.o.f.)

R. Gonzalez-Riestra

EPIC-pn: Rate-dependent PHA correction

PN Timing and Burst mode energy scale shows a dependency on rate of shifted charge

Corrected through the RDPHA correction

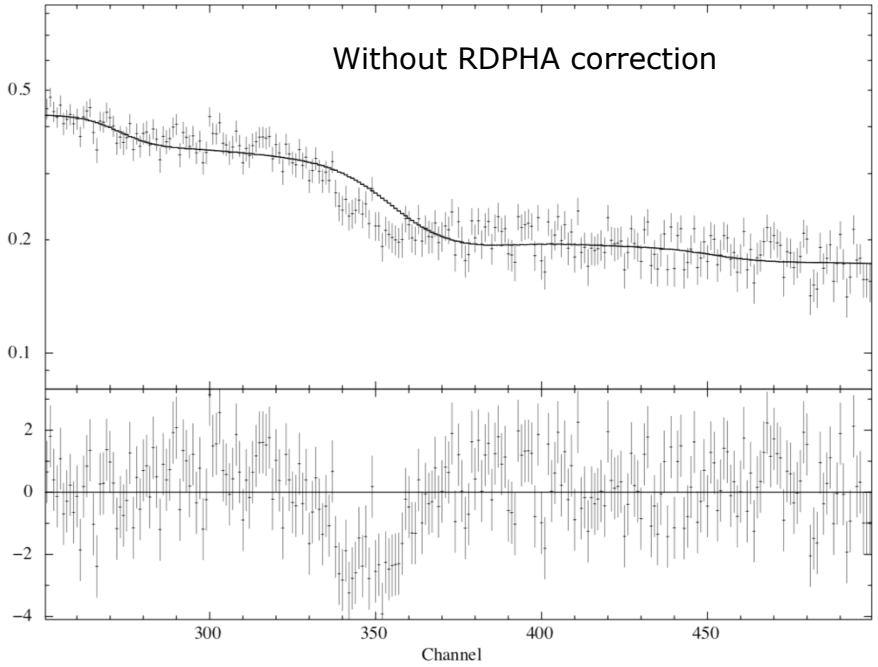
Calibrated at the Si K (1.8 keV), Au M (2.2 keV) and Au L (11.9 keV) edges

Based on analysis of a sample of Burst mode observations

Timing mode RDPHA correction already available since 2013 (updated in 2019)

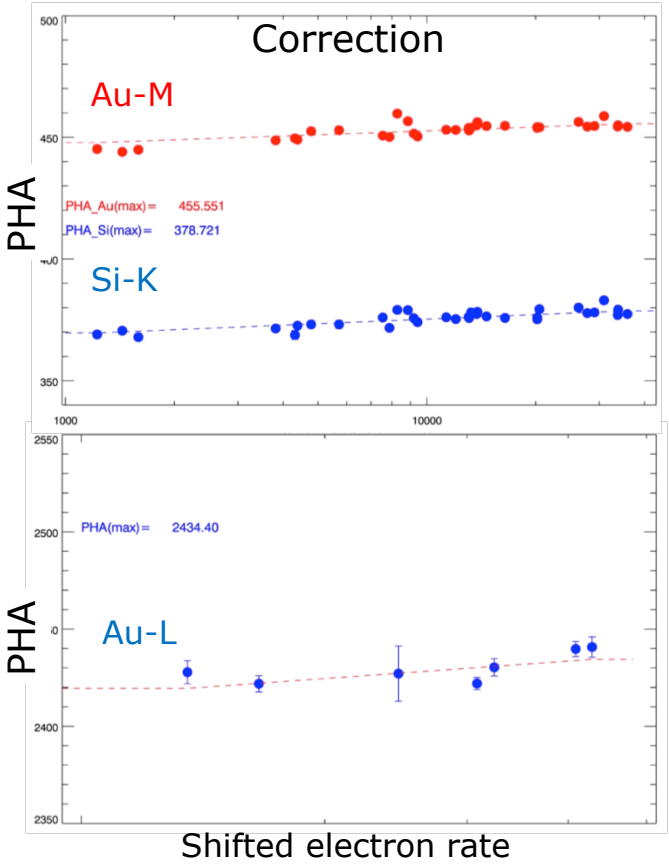
Burst mode RDPHA has been implemented in SAS 19 (released Oct 2020).

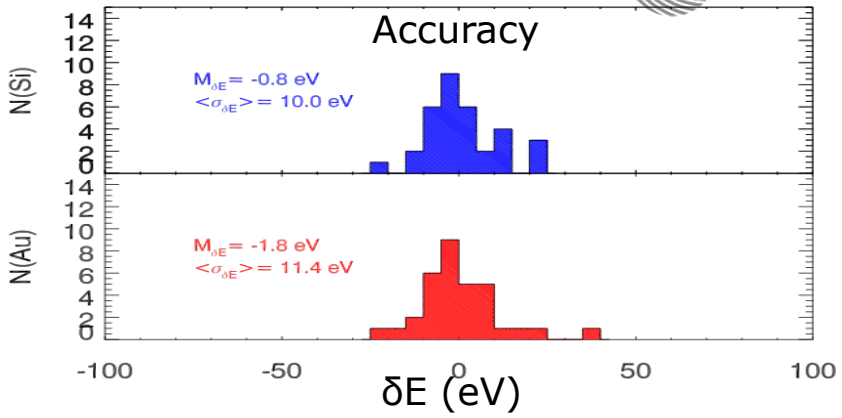
XMM-CCF-REL-376 (S. Migliari)



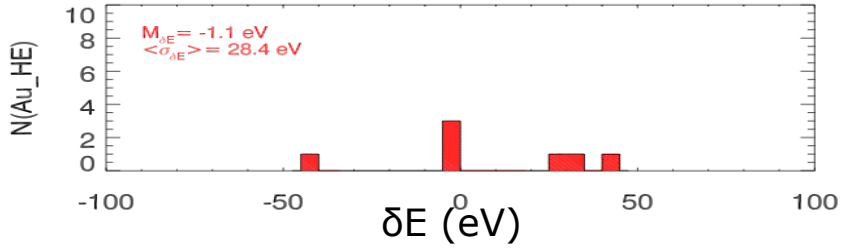
S. Migliari

EPIC-pn: Rate-dependent PHA correction





at ~2 keV: average systematics ~0.6%, tail to 40 eV (2%)



at ~12 keV: average systematics ~0.2%, tail to 50 eV (0.4%)

S. Migliari

EPIC-pn: Rate-dependent PHA correction

Current RDPHA implementation uses a global rate of shifted charge.

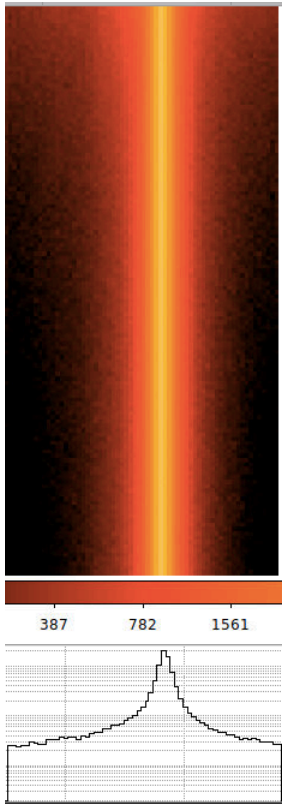
Does not take into account column dependency of the rate

-> blurring of energy scale across PSF

Implementation of column-dependent rate currently underway:

- Validation of rate dependency for wider range of rates
- Software change

Foreseen for SAS 20 (mid 2021)



EPIC-pn: LW mode long-term CTI correction

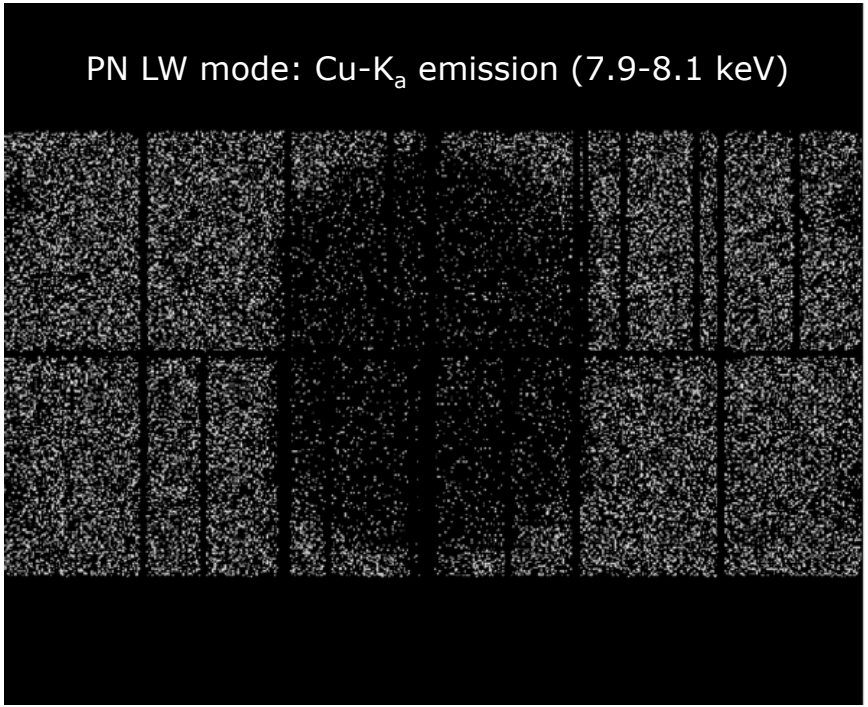
PN LTCTI correction derived from:
- CalClosed exposures (Al K and Mn K)
- Suitable science exposures (Fe K) -> SW mode

For LW mode: too few of either for independent LTCTI derivation

Resort to use of fluorescent Cu Kα emission:
- Presented at last IACHEC meeting
- Mentioned that "Cu hole" is problematic, esp. for energy scale @ B/S

Recent LW mode LTCTI recalibration:
- For Cu-Kα derive a per-quadrant LTCTI correction
- Drop the Mn Kα calibration point (derived from FF mode data)

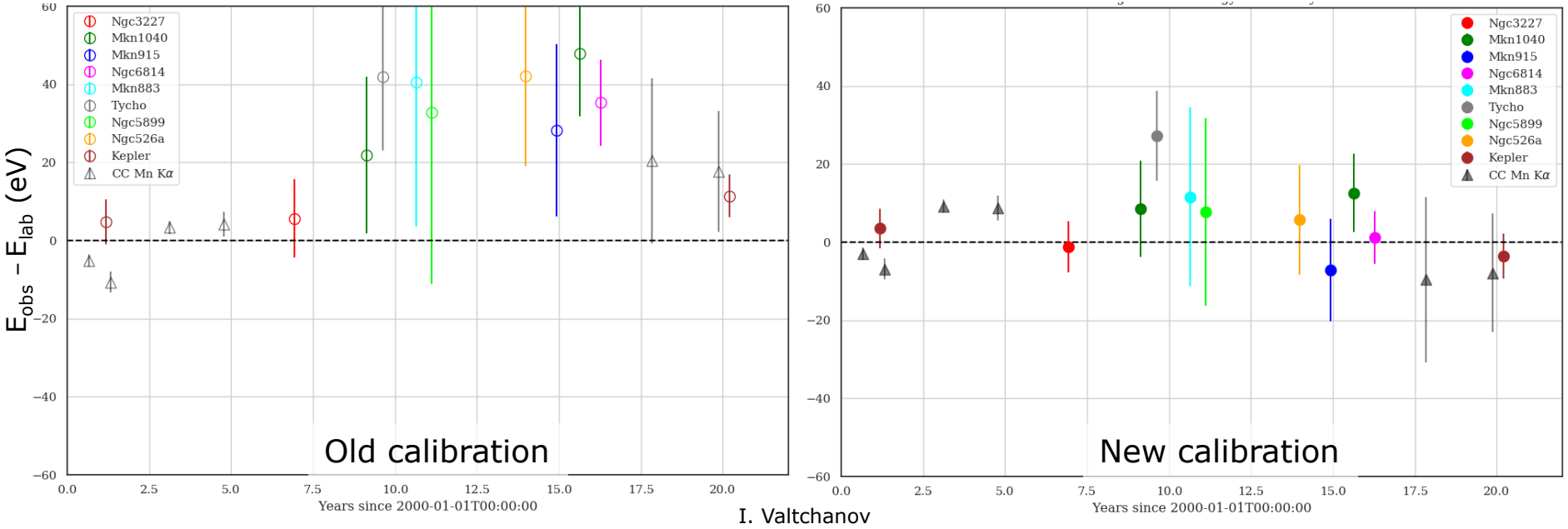
XMM-CCF-REL-376 (I. Valtchanov)



EPIC-pn: LW mode long-term CTI correction

Corrected Mn Kα and Fe Kα energies at B/S, using the per-quadrant LTCTI modelling:

Improvement in general, esp. for the Fe Kα energy reconstruction

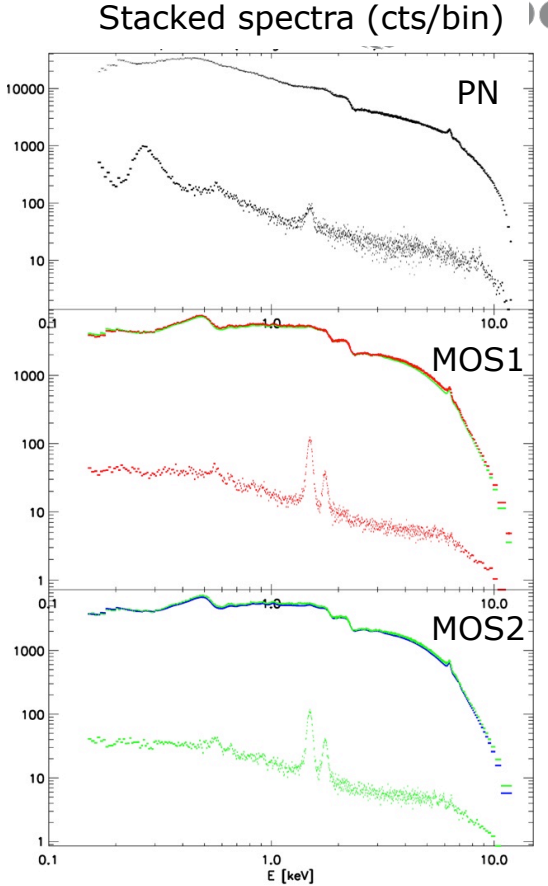


I. Valtchanov

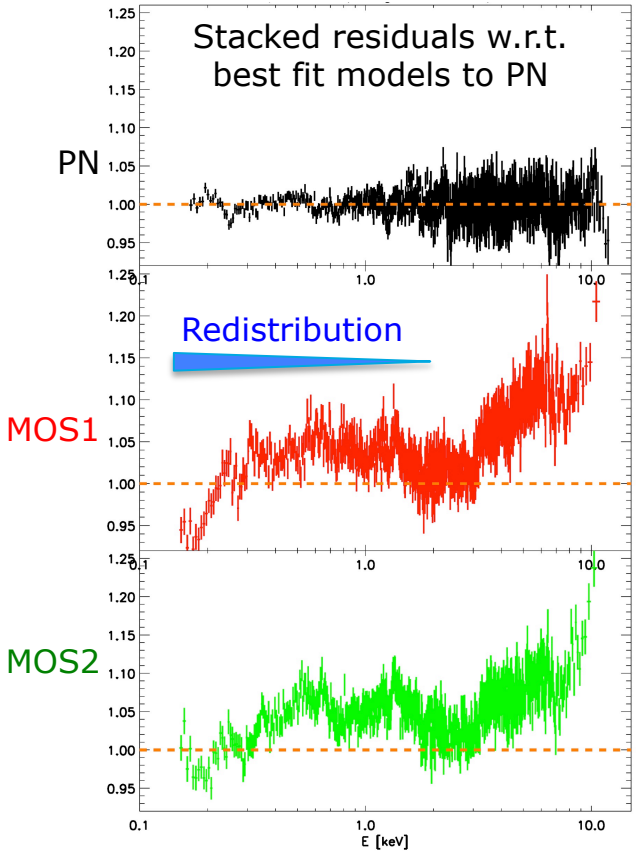
EPIC Cross-Calibration

A recalibration of the EPIC empirical Aeff correction (CORRAREA) has been on-going:

- Combined effort of IAAT and SOC
- Larger source sample (262 observations)
- Additional instrument modes (LW, SW) and filters (Thick)
- Revised screening: background selections, pile-up evaluation
- Fit-and-stack (previously stack-and-fit)
- Largely automated pipeline from data reduction to spectral and residual modelling
- Extend modelling to full energy band



EPIC Cross-Calibration



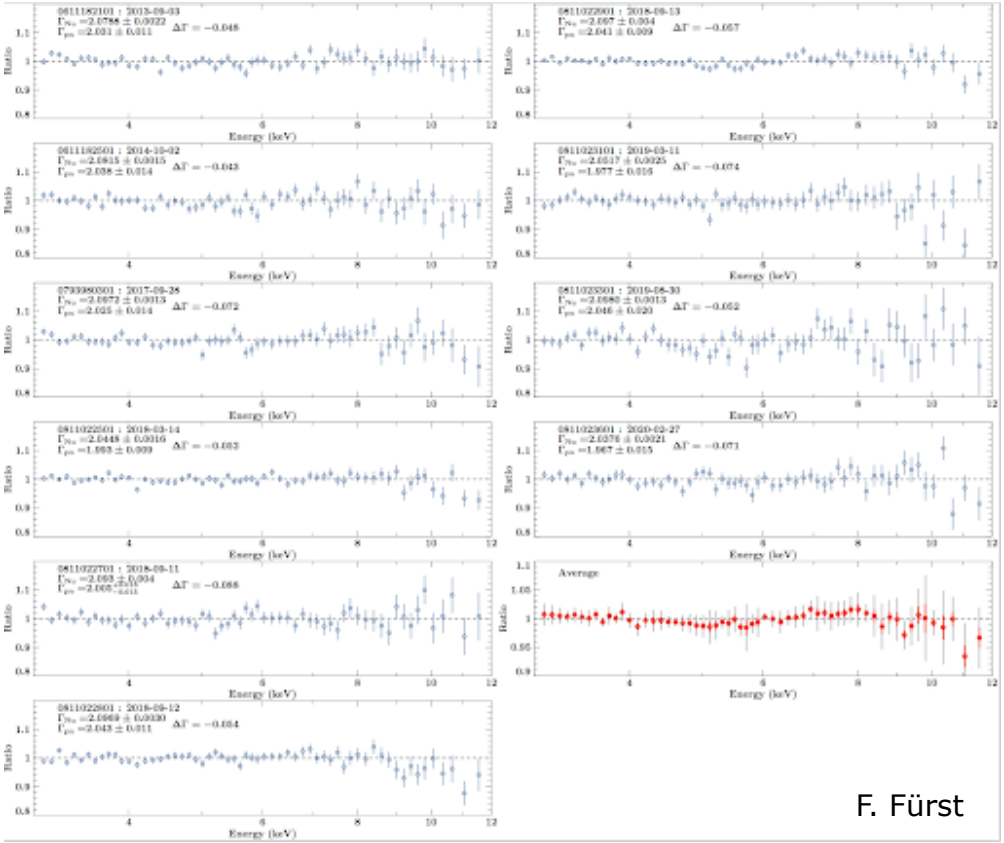
MOS-to-PN residuals:

> 2 keV: likely related to A_{eff}

< 2 keV: combination of A_{eff} and redistribution

Empirical A_{eff} correction should not introduce features in spectra

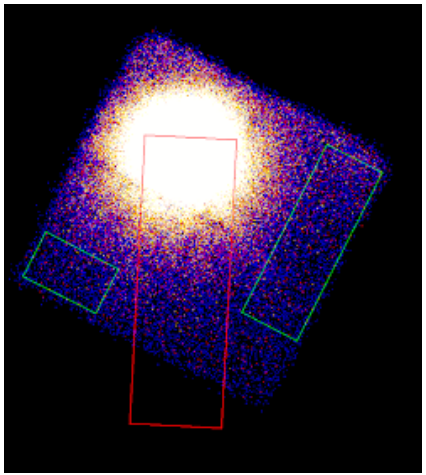
EPIC-pn / NuSTAR Cross-Calibration



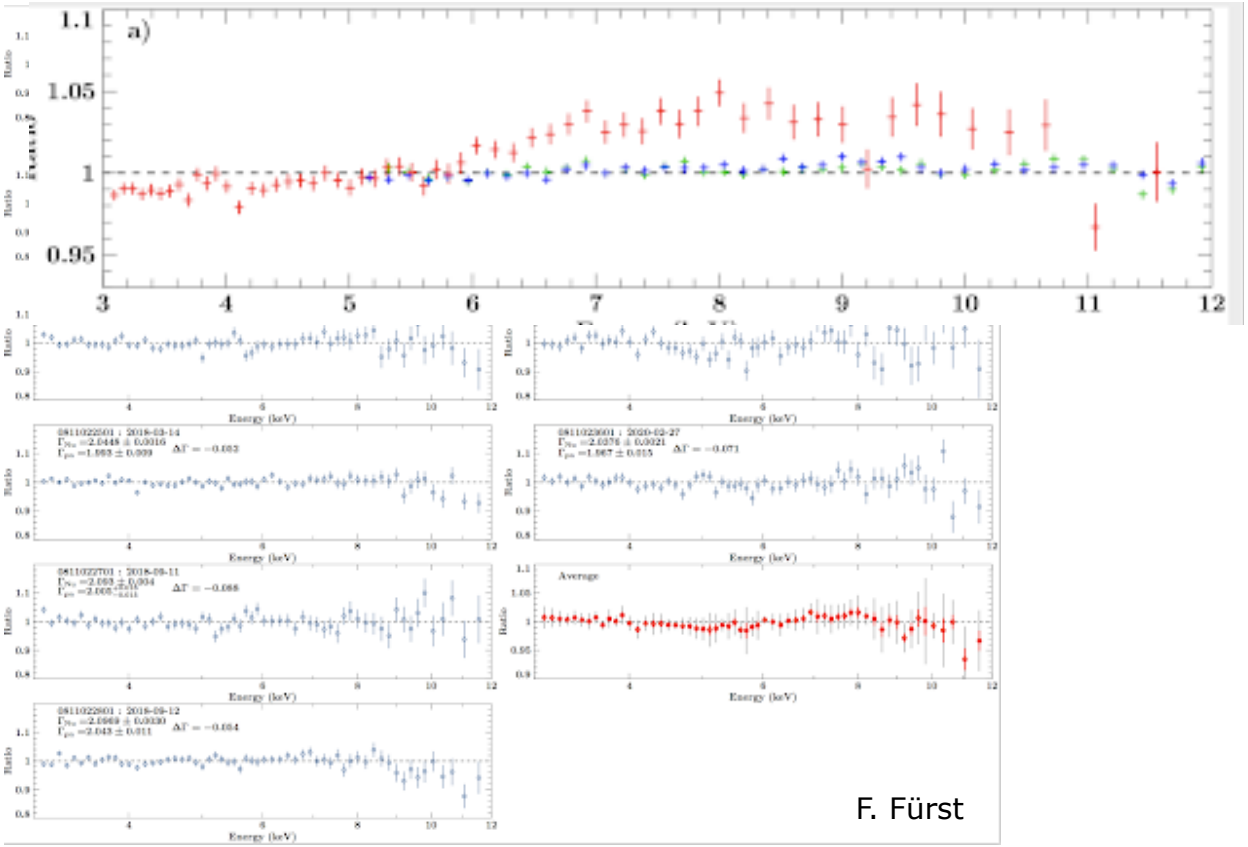
F. Fürst

Simultaneous observations of the Crab (PN in Burst mode)

Cross normalisations left free.



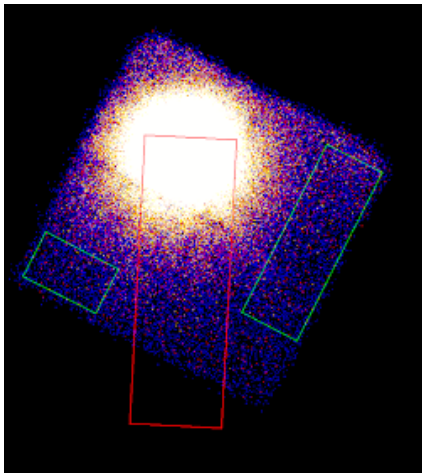
EPIC-pn / NuSTAR Cross-Calibration



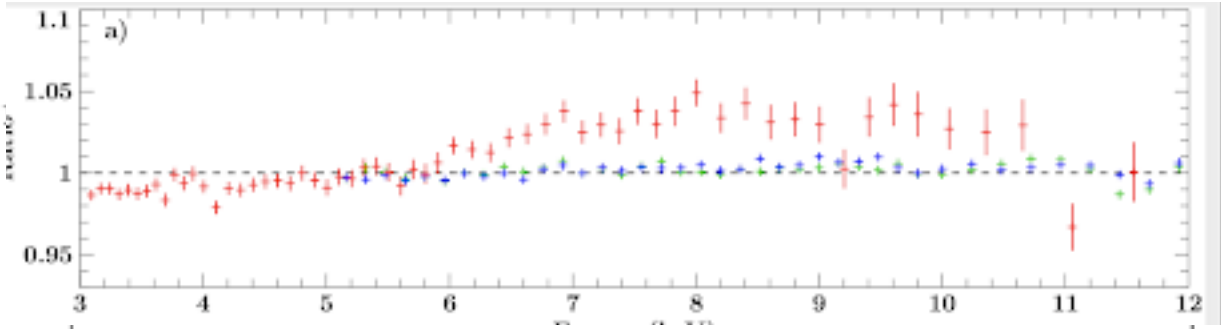
Simultaneous observations of the Crab (PN in Burst mode)

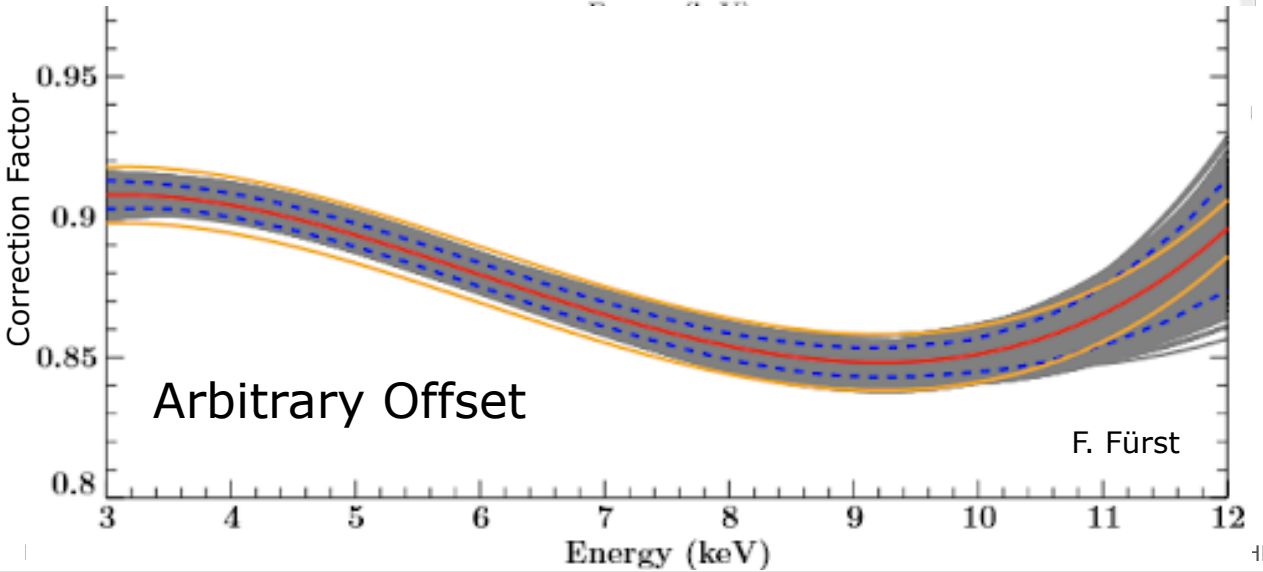
Cross normalisations left free.

Stack PN residuals to NuSTAR model



EPIC-pn / NuSTAR Cross-Calibration



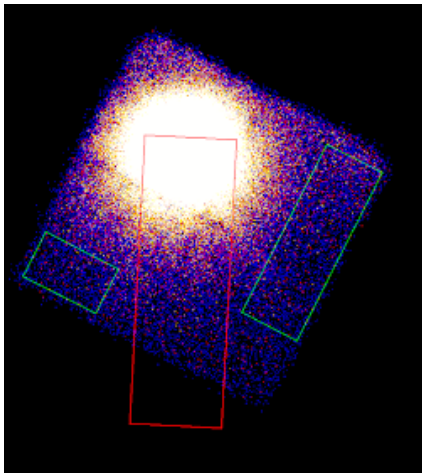


Simultaneous observations of the Crab (PN in Burst mode)

Cross normalisations left free.

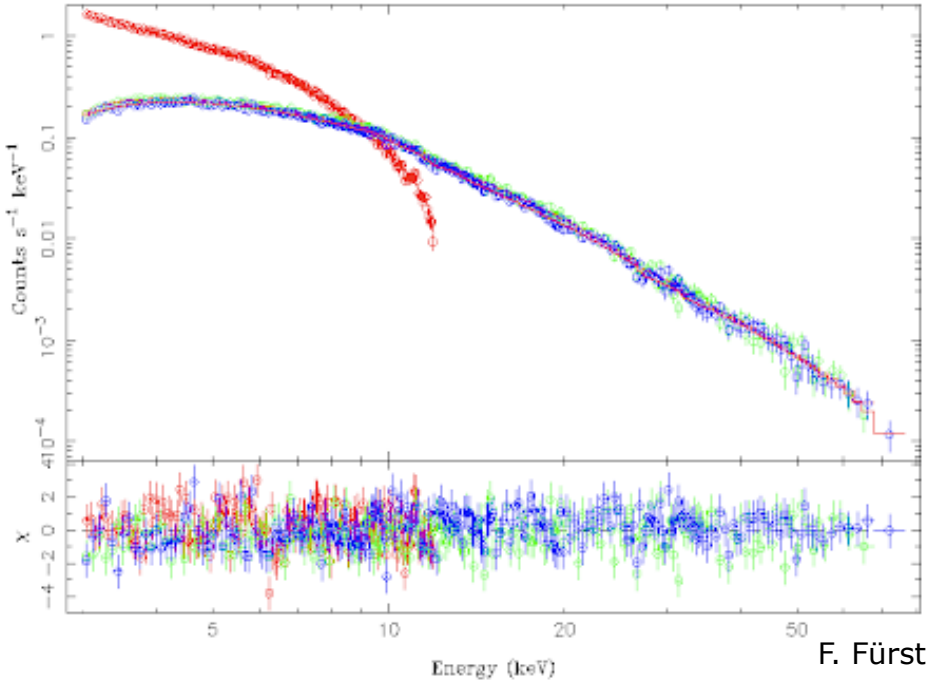
Stack PN residuals to NuSTAR model

Model stacked residuals with spline



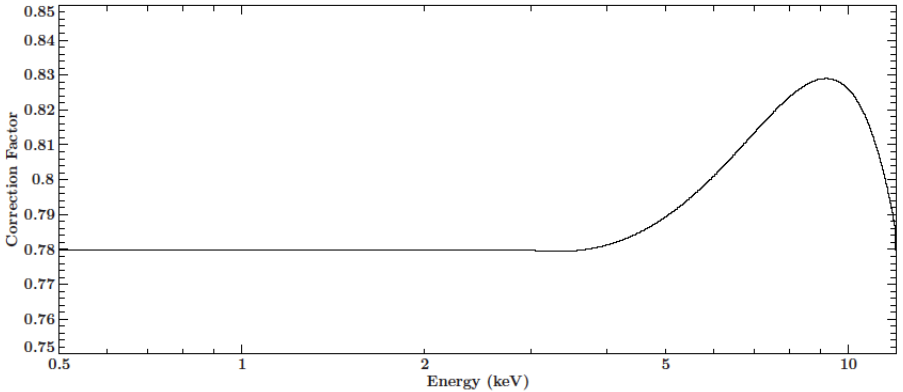
EPIC-pn / NuSTAR Cross-Calibration

7 simultaneous observations of 3C 273
(PN in Small Window mode)



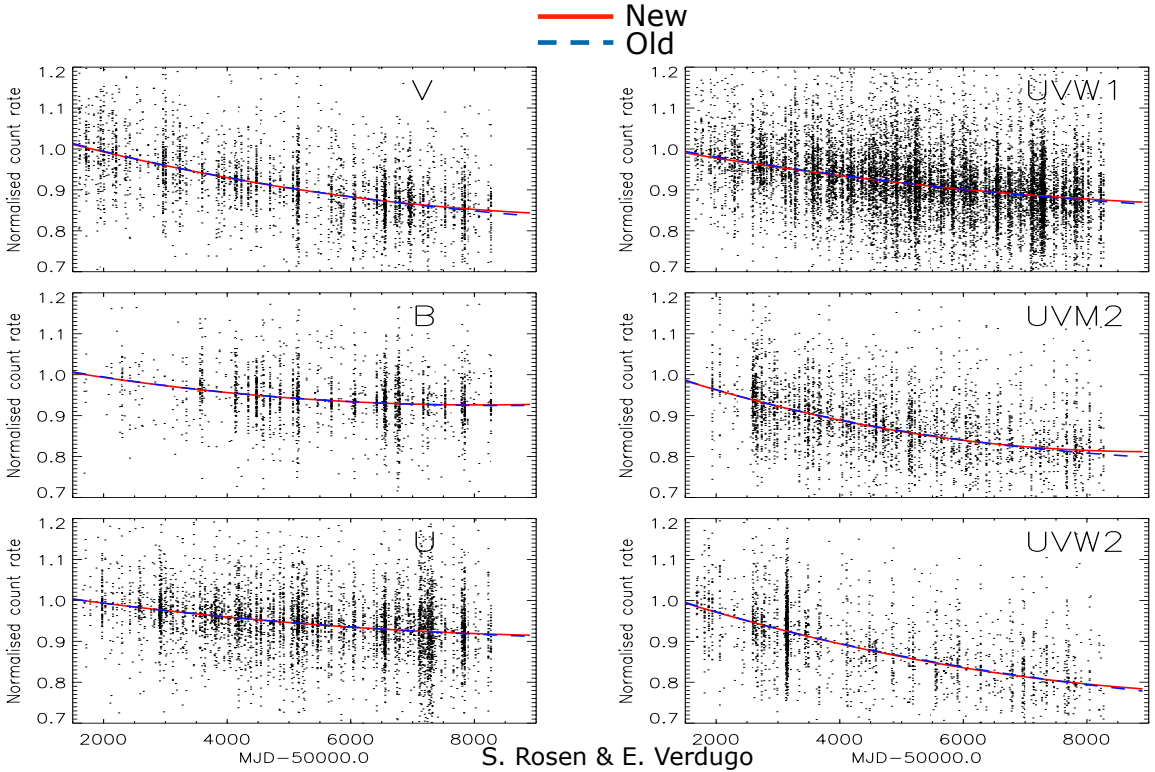
F. Fürst

- Define suitable physical model
- Apply spline Aeff correction (with common cross-calibration constant for all observations) to PN model
- Apply NuSTAR focussed-to-straylight normalisation of 0.867 to NuSTAR model
- Simultaneous fit gives:
  cross-calibration normalisation of 0.77
- Correction to be included in PN calibration (pending "official" NuSTAR calibration update)



OM: Time-dependent sensitivity degradation

Fits to 'constant' sources (> 5 obs) in the SUSS4 catalogue (per filter)



S. Rosen & E. Verdugo

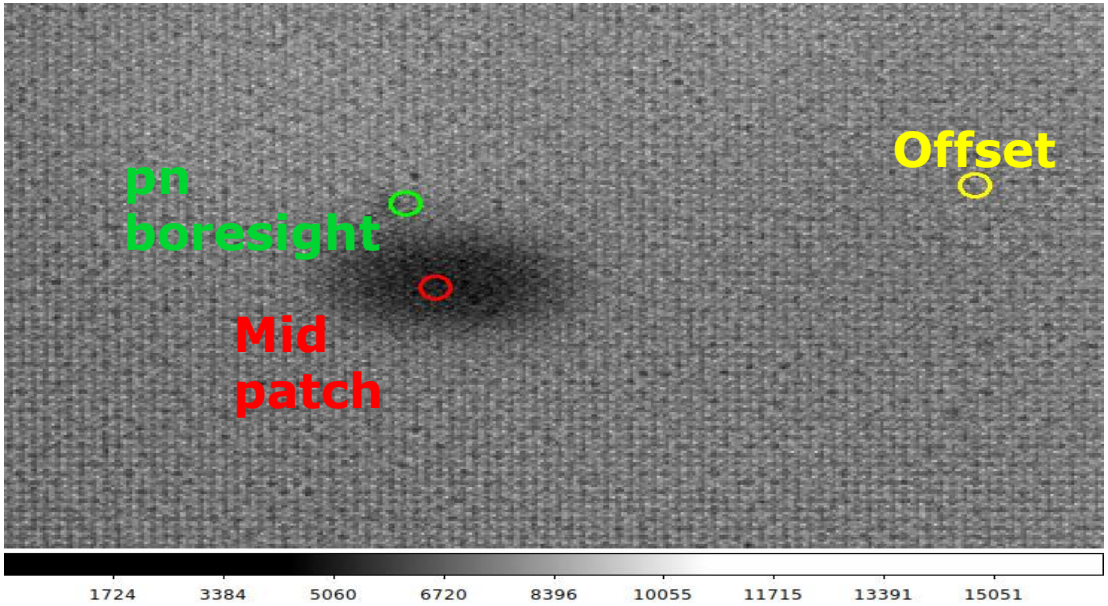
OM throughput (2020.0)

Filter	Throughput
V	0.84
B	0.93
U	0.92
UVW1	0.87
UVM2	0.81
UVW2	0.78

Decline continues to flatten in all filters

This is corrected in the SAS
most recent correction from 05/2020
XMM-CCF-REL-378 (S. Rosen & E.Verdugo)

OM: Monitoring the Jupiter patch



S. Rosen

Accidental Jupiter V band exposures in July 2017 (rev 3224)

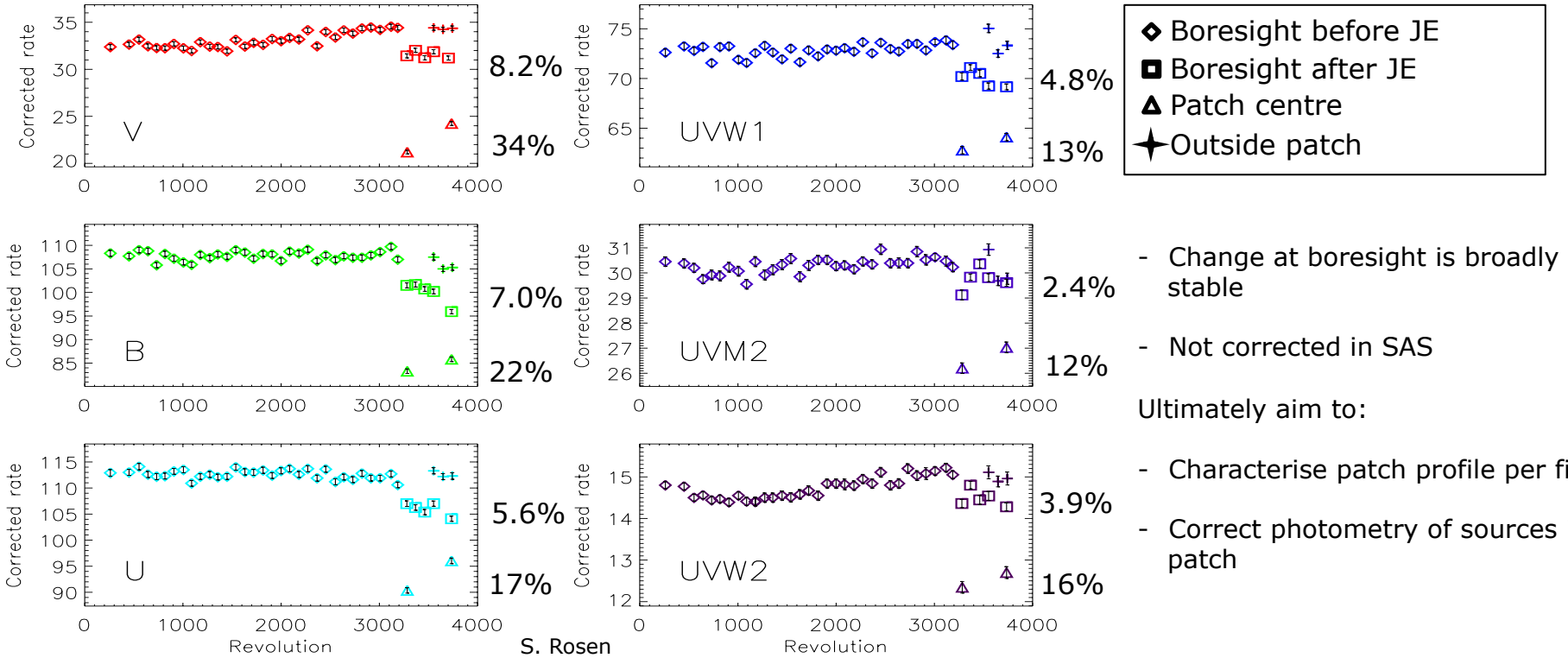
Photocathode damaged. Area affected ~105” x 60” (~0.5% of FoV)

pn boresight lies within outer wings of patch

Monitoring programme with standard stars

OM: Monitoring the Jupiter patch

BPM 16274 – rates corrected for general TDS decline



◆ Boresight before JE
■ Boresight after JE
▲ Patch centre
✦ Outside patch

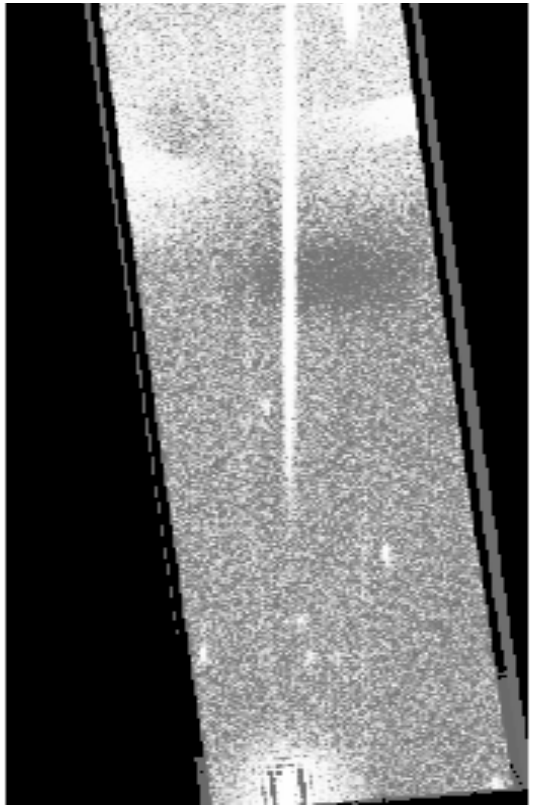
- Change at boresight is broadly stable
- Not corrected in SAS

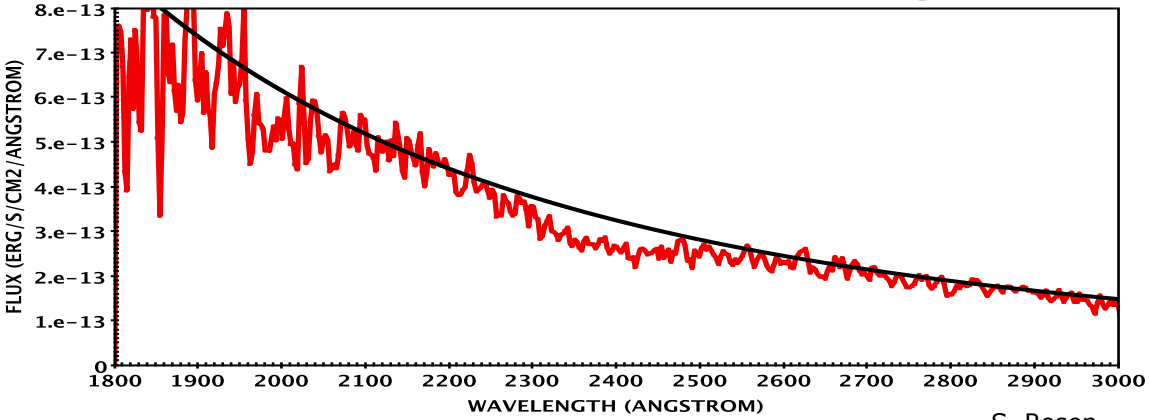
Ultimately aim to:

- Characterise patch profile per filter
- Correct photometry of sources in patch

S. Rosen

OM: Jupiter region impact on grism data





S. Rosen

In default grism window, sources cross the Jupiter region where they can suffer up to 25% additional degradation

UV: ~2220Å-2600Å, max depth at ~2350Å
VIS:~3440Å-4180Å, max depth at ~3860Å

Dependent on offset from patch core