XMM-NEWTON CALIBRATION STATUS

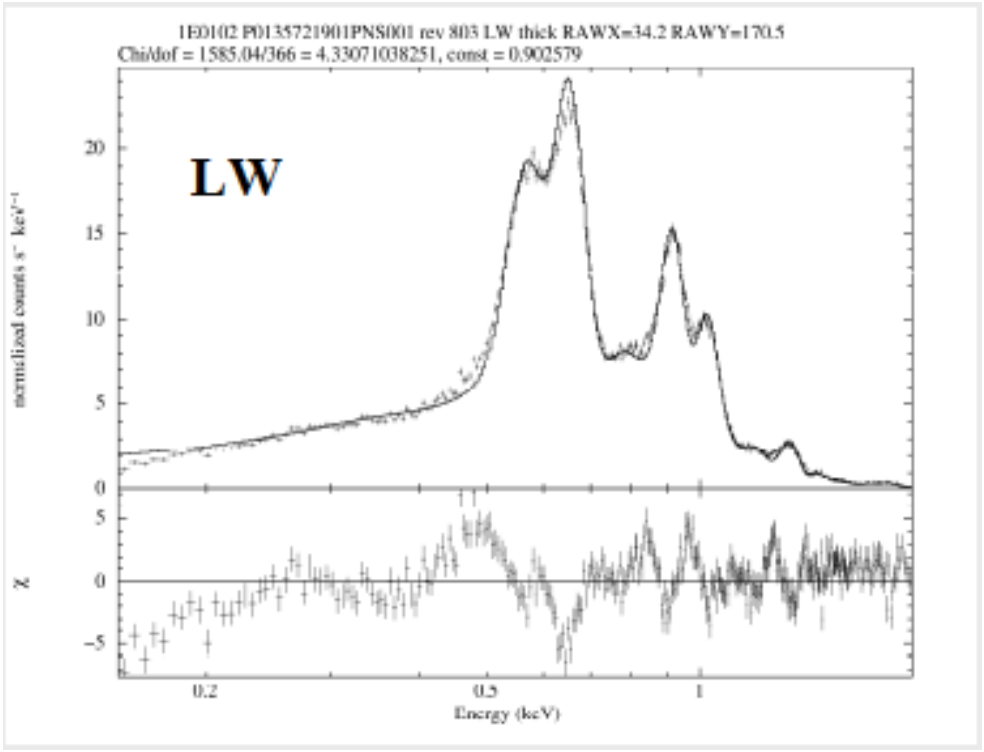
Matteo Guainazzi (ESA-ESAC) with inputs from the whole XMM-Newton calibration team

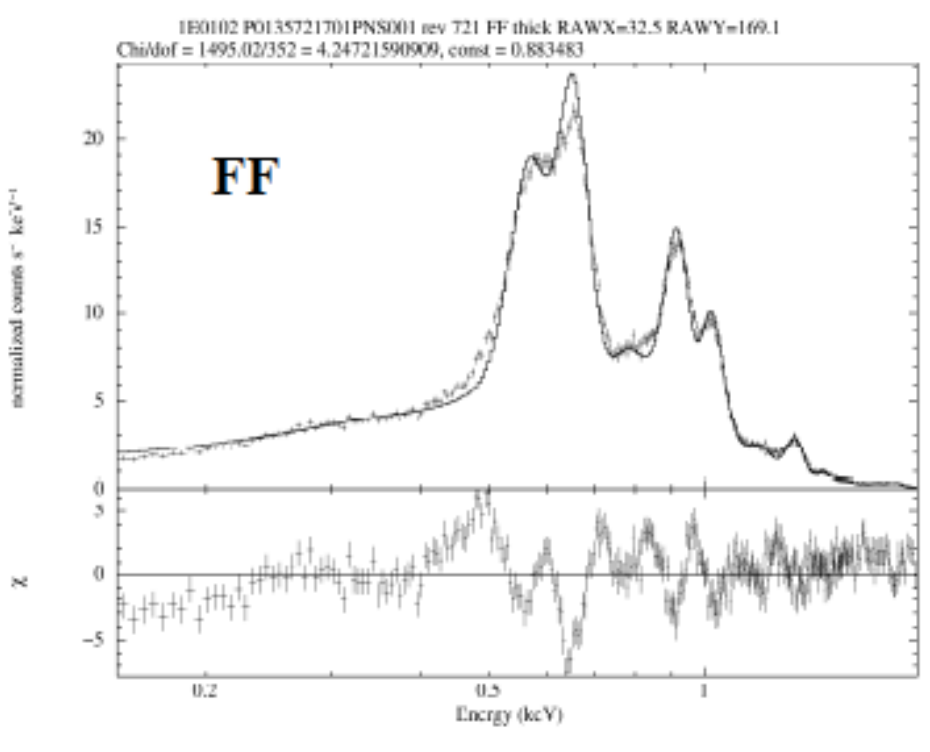
Outline

- EPIC-MOS redistribution recalibration
  - See S.Sembay's talk
- Refinement of the EPIC-pn soft X-ray redistribution
- Recalibration of EPIC-pn resolution at 6 keV
- 2-D PSF
- Recalibration of PATTERN fraction in EPIC-pn Timing Mode
- Status of soft MOS noise
- Recalibration of RGS contamination time evolution
- XMM-Newton cross-calibration status
- SASv10 news

EPIC-pn redistribution : the problem

Once accurate RGS-based models of line-rich sources are available, stronger-than-calibration shoulder become apparent in the spectra of bright line-rich sources (here 1E0102-7219)

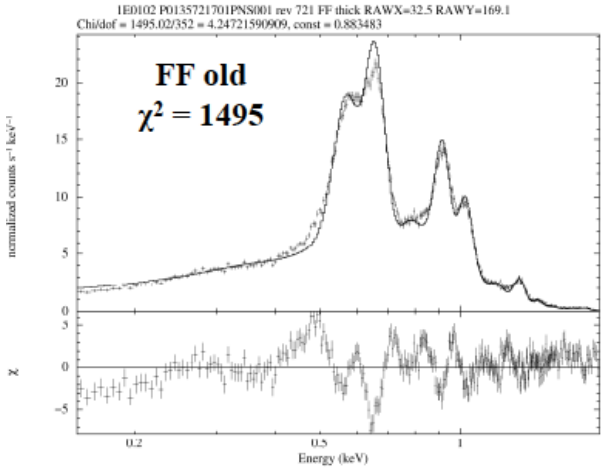




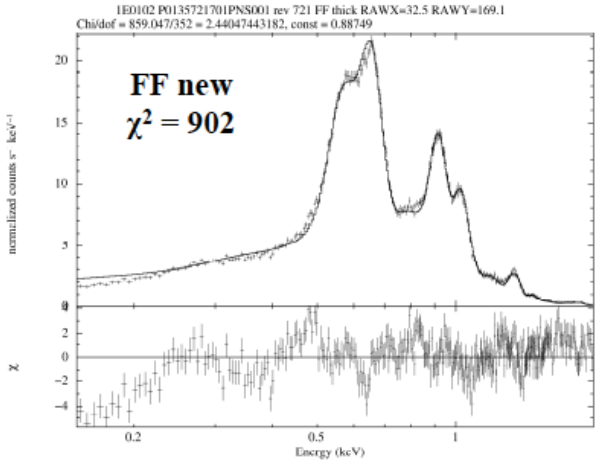
(courtesy of Frank Haberl)

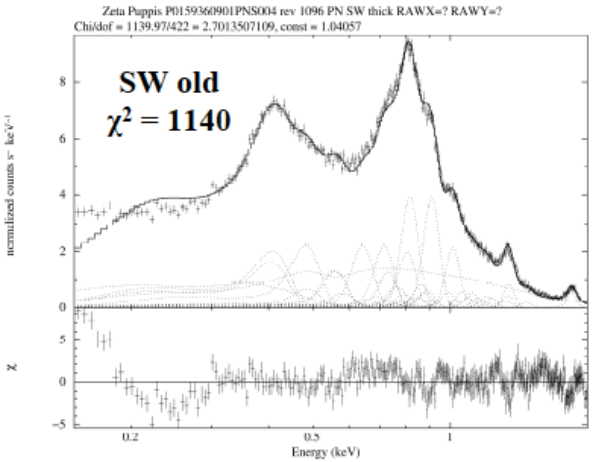
EPIC-pn redistribution: the solution

Recalibration of the redistribution parameters is undergoing validation.
SAS-independent CCF release expected in the next months

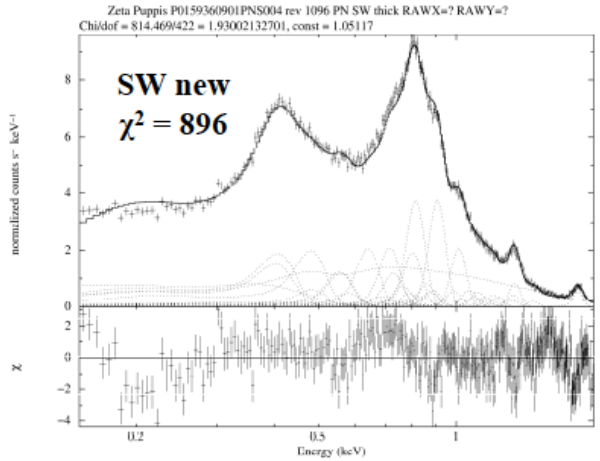


1E0102-7219





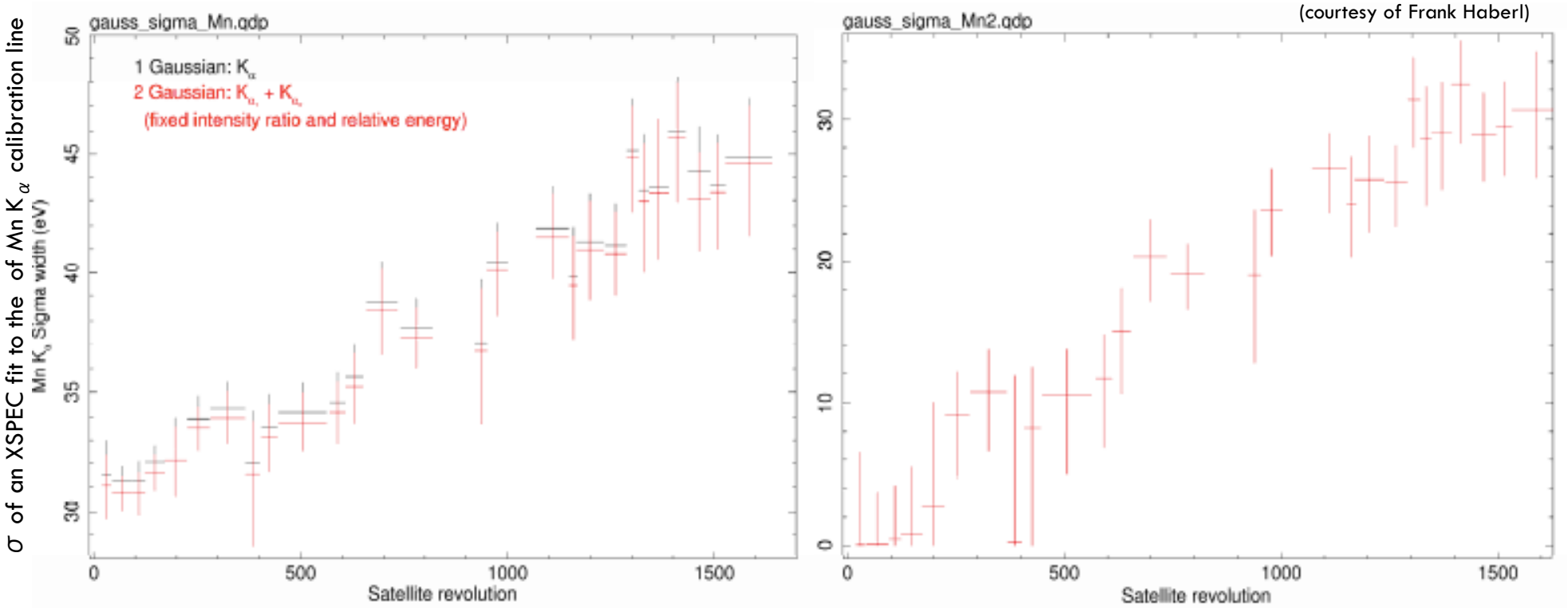
Zeta Puppis



(courtesy of Frank Haberl)

EPIC-pn resolution at 6 keV

Current redistribution matrix underestimates the EPIC-pn resolution at 6 keV



Current public matrix

Matrix being validated

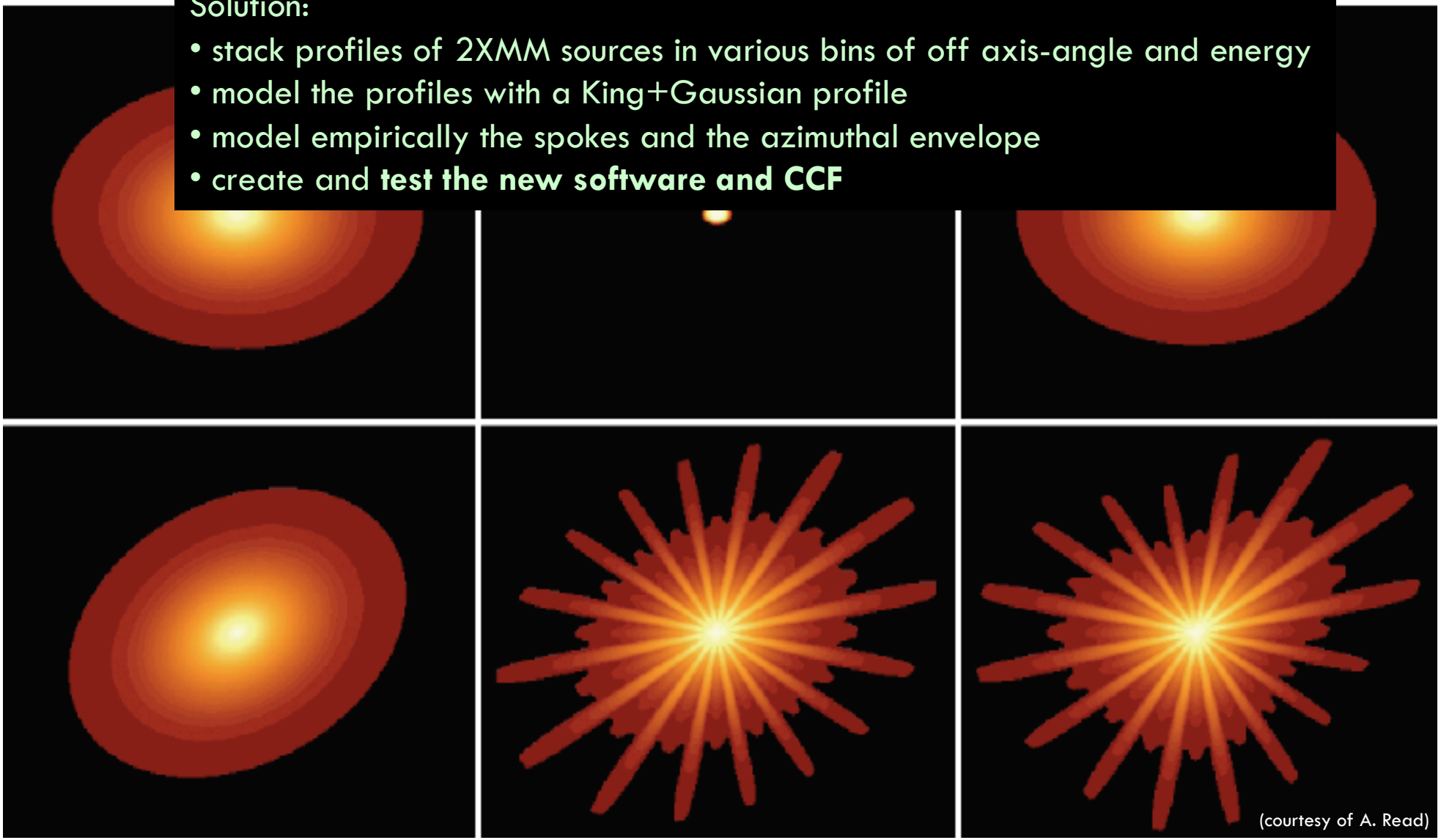
2-

The current public parameterization of the PSF does not include:

- Gaussian "core" (≈2% flux in the MOS)
- "Spokes" due to obscuration by the mirror support structure
- Azimuthal modulation (triangular in MOS1, pentagonal in MOS2 and pn)

Solution:

- stack profiles of 2XMM sources in various bins of off axis-angle and energy
- model the profiles with a King+Gaussian profile
- model empirically the spokes and the azimuthal envelope
- create and **test the new software and CCF**



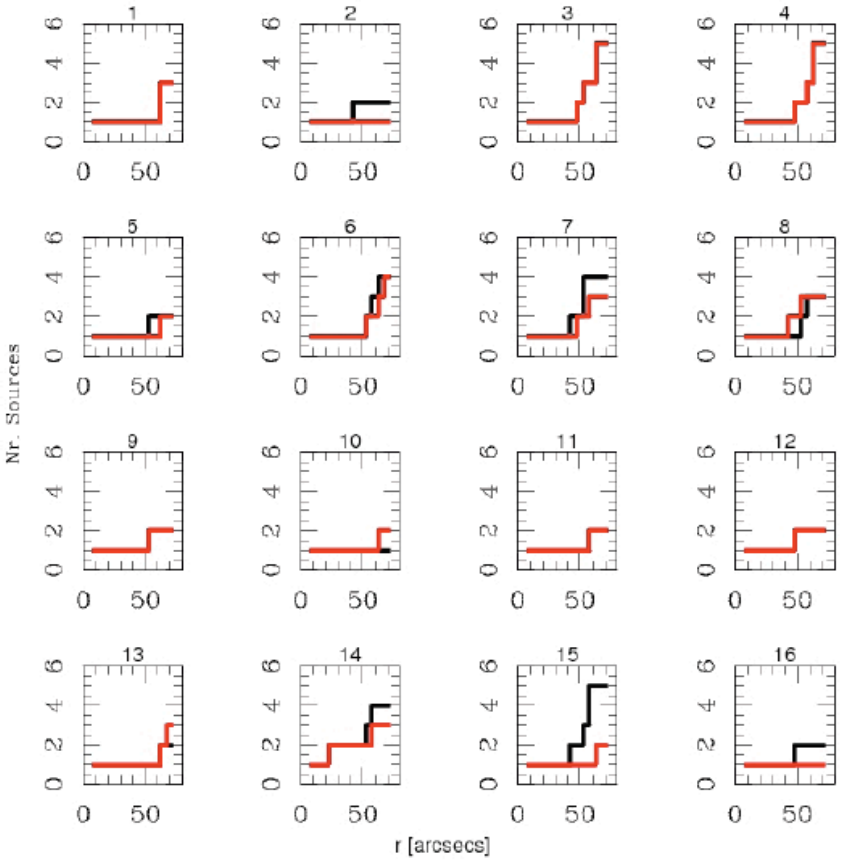
(courtesy of A. Read)

2-D PSF: expected improvements

Smaller number of spurious sources around bright sources

Old

New

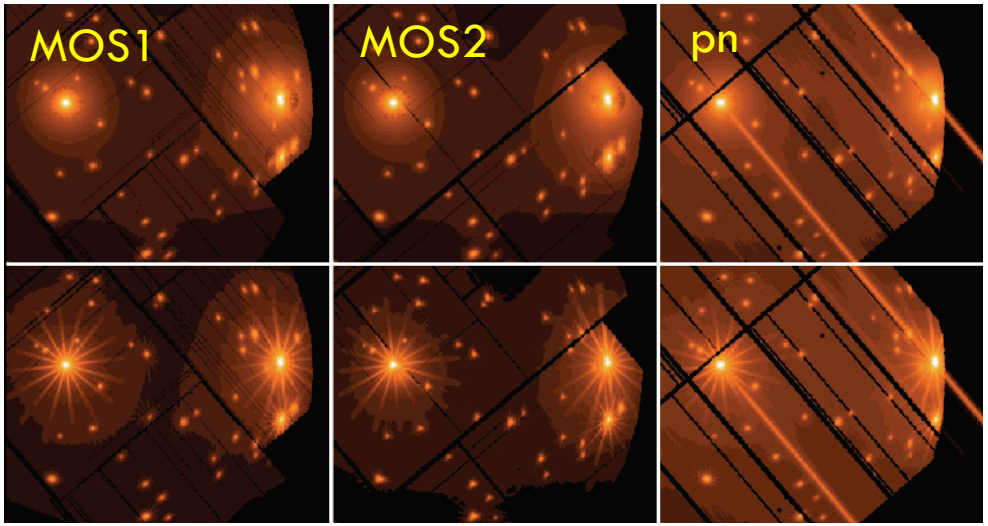


(courtesy of J. Ramirez)

Better characterization of the source profile, flux determination

Current MEDIUM PSF

(courtesy of A. Read)



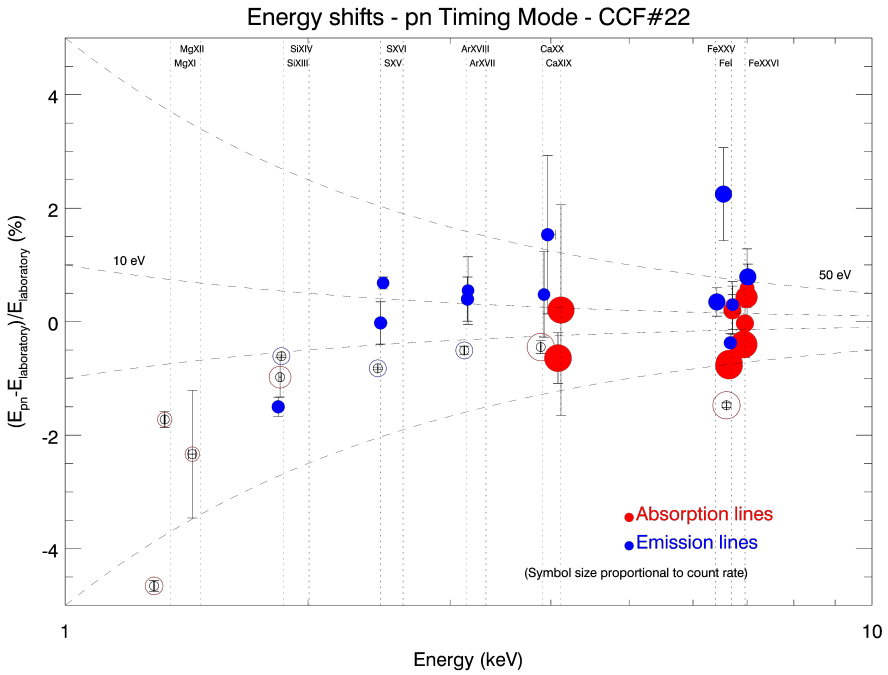
Future ELLBETA PSF

Next SAS version (10, to be released this week) supports the new CCF structure. Scientific validation ongoing

EPIC-pn Timing Mode

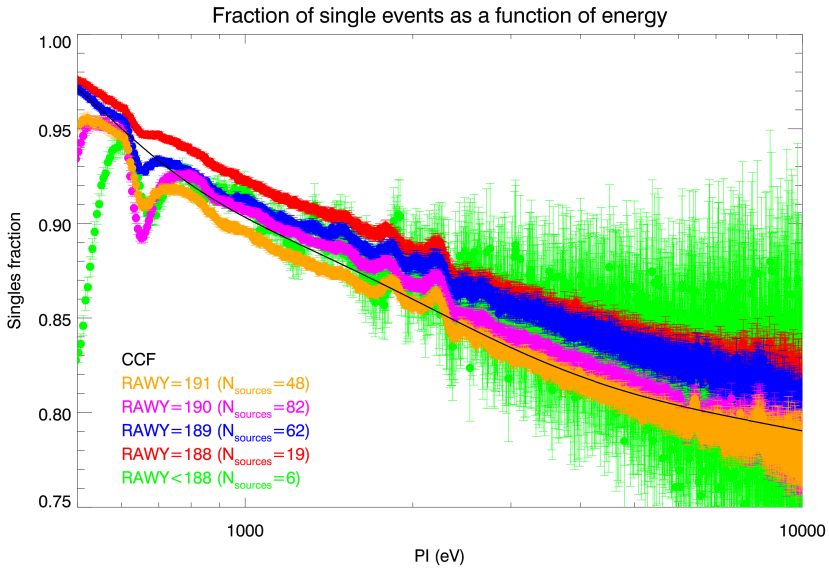
Energy accuracy in pn Timing Mode
E≤4 keV ≈20 eV, E>4 keV≈50 eV

(Guainazzi et al. 2009)



Comparison of measured vs. laboratory energies on astrophysical lines

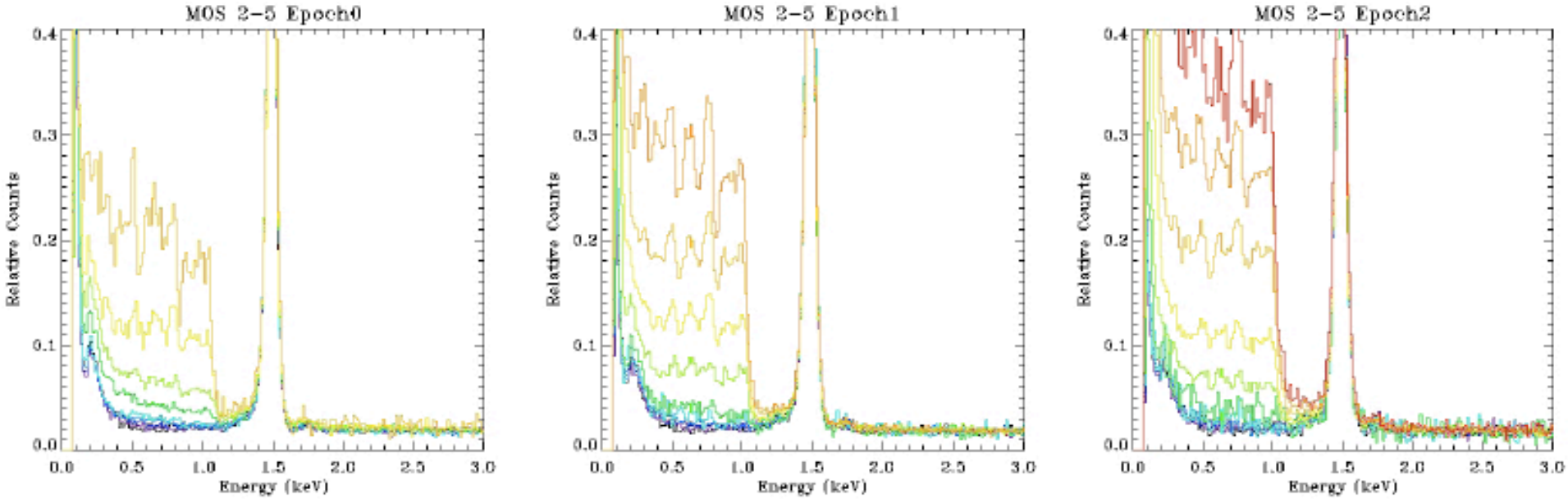
First improvement step: source-position dependent calibration of the PATTERN



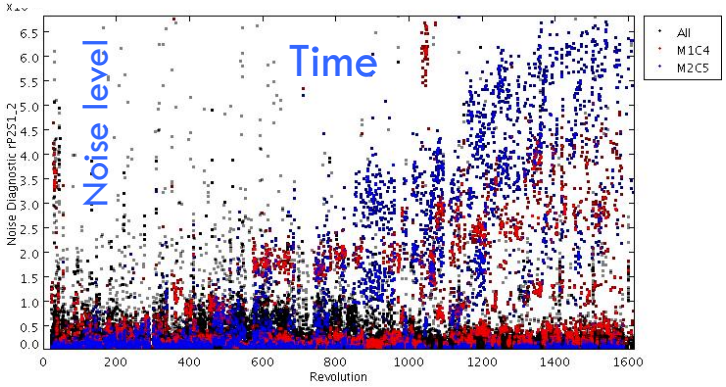
SASv10 support the new CCF structure.
CCF undergoing scientific validation

MOS noise

MOS2CCD5 and MOS1CCD4 are often affected by low-energy noise plateau. Cause unknown.
It's getting more frequent and more intense



(courtesy of A. Read)



Possible correlation between noise triggering and the radiation level is under investigation. As of SASv9 a task exists (`emtaglenoise`) to filter all affected events

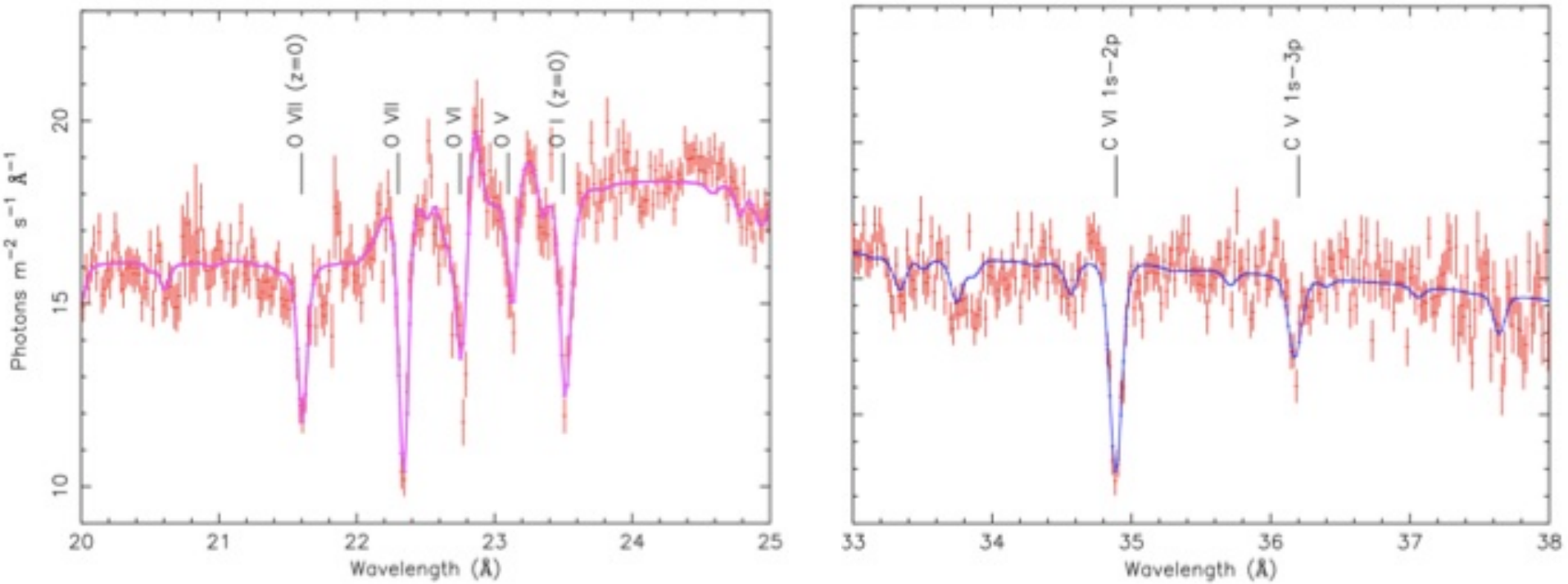
EPIC today

Effect	Max. Error	Energy dependent	Off axis angle dependent
Accuracy of the XMM-Newton frame with reference to optical frame	1''(r.m.s.)	NO	NO
Relative Astrometry	1.5''(r.m.s)	NO	YES
Absolute Astrometry	2.0''(r.m.s)	NO	YES
Point Spread Function (PSF)[1]	2 %	YES	YES
Relative Effective Area	± 7 %	YES	YES
Absolute Effective Area	± 10 %	YES	YES
Absolute Energy scale[2]	± 10 eV	YES	YES
Relative Timing	$\Delta P/P<10^{-8}$	NO	NO
Absolute Timing	100 μs	NO	NO

http://xmm2.esac.esa.int/docs/documents/CAL-TN-0018.pdf

RGS today

(courtesy of A. Pollock)



600 ks of RGS exposure time on the Seyfert 1 galaxy Mkn509 (PI: Kaastra)
[Statistics equivalent to the famous 900 ks *Chandra* observation of NGC3783]
Best warm absorber model superposed

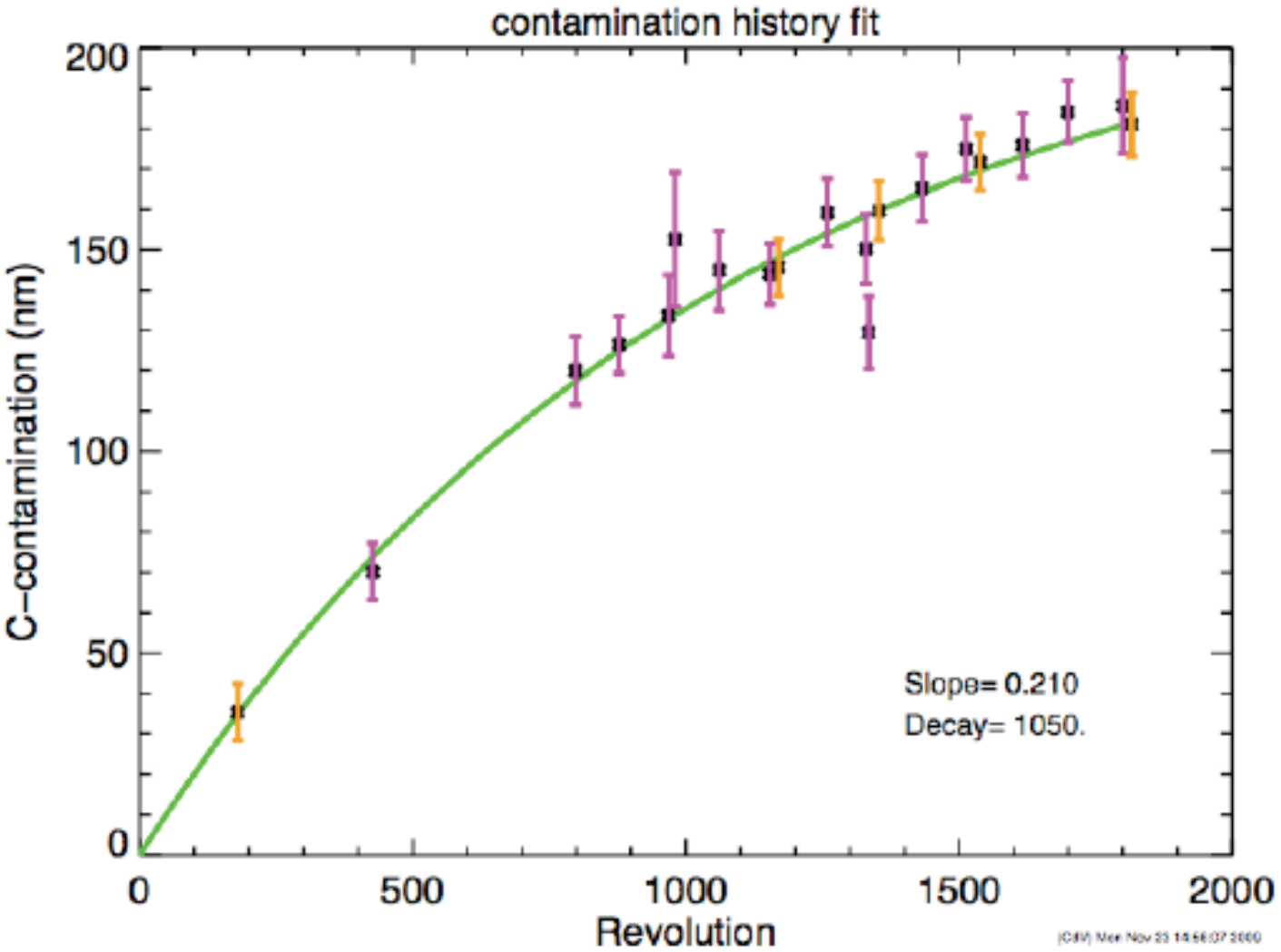
RGS contamination

Recalibration of RGS contamination time evolution suggests an exponential rather then a linear build-up

SASv10 supports the new law.

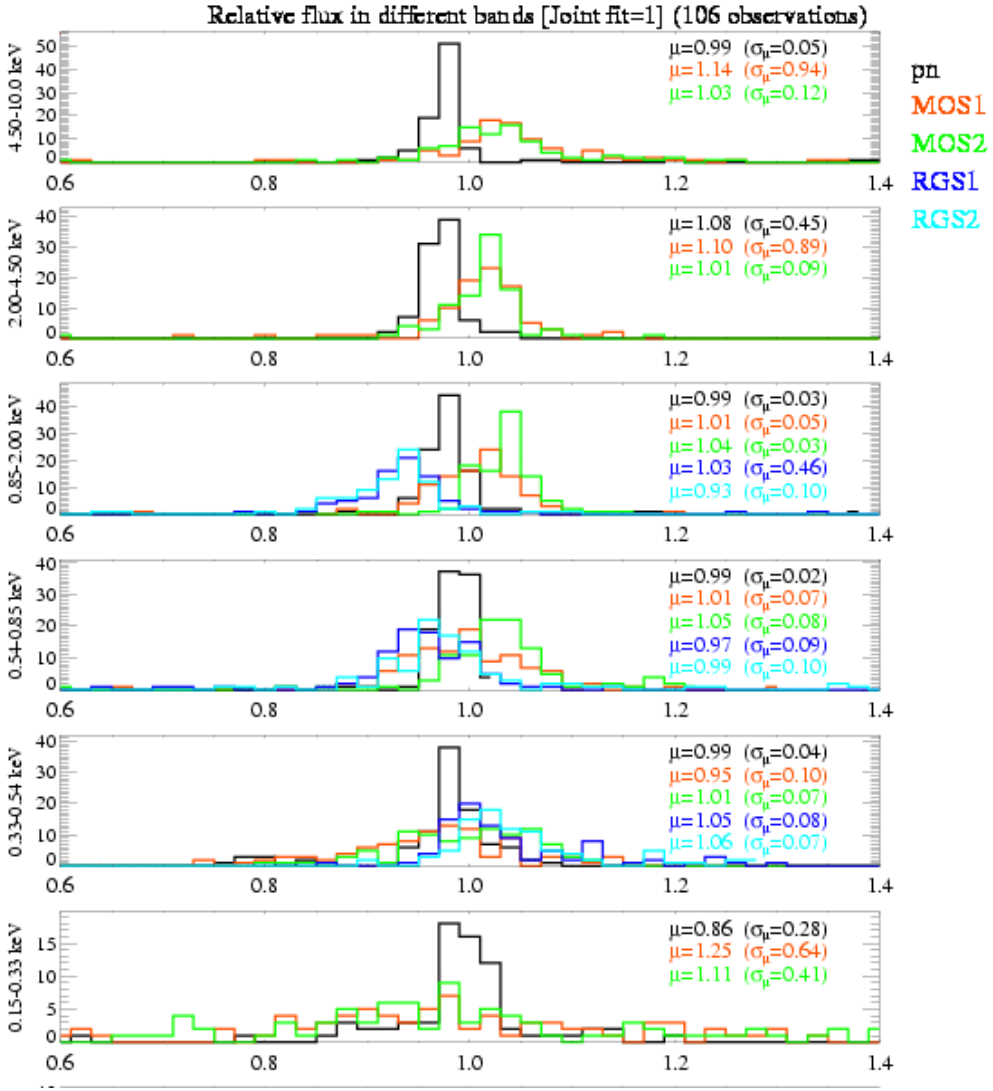
CCF under scientific validation

(courtesy of A. Pollock)



Cross-calibration status

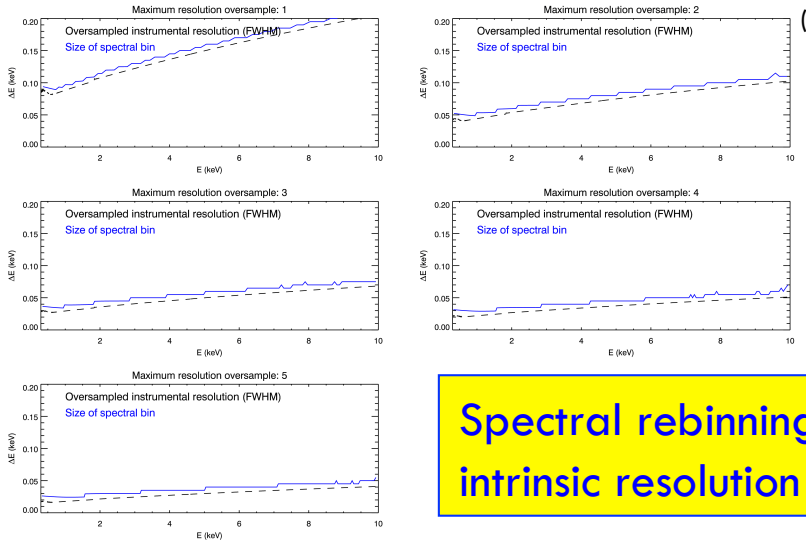
(courtesy of M. Stuhlinger)



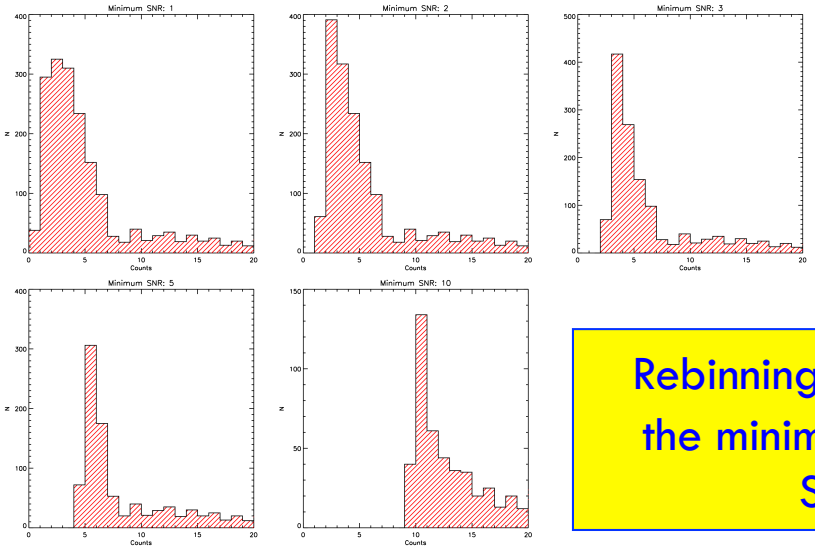
Summary of XMM-Newton cross-calibration status (pre RGS-cont.on)

- MOS fluxes above 2 keV are larger then pn by 5-8%
- RGS excess by ≥10% below 0.5 keV
- Otherwise agreement within a few %
- RGS versus EPIC flux ratio evolves this time
  - Probably cured by RGS contamination recalibration
- E<0.85 keV MOS versus pn flux ratios evolve with time
  - Improved calibration of the MOS soft X-ray redistribution patch should improve this → S.Sembay's talk
- The EPIC cross-calibration is consistent when individual bright sources or large samples of 2XMM sources are considered

New in SAS10



(courtesy of R.Saxton)



Spectral rebinning on the intrinsic resolution

Rebinning on the minimum SNR

(courtesy of P. Rodriguez-Pascual)

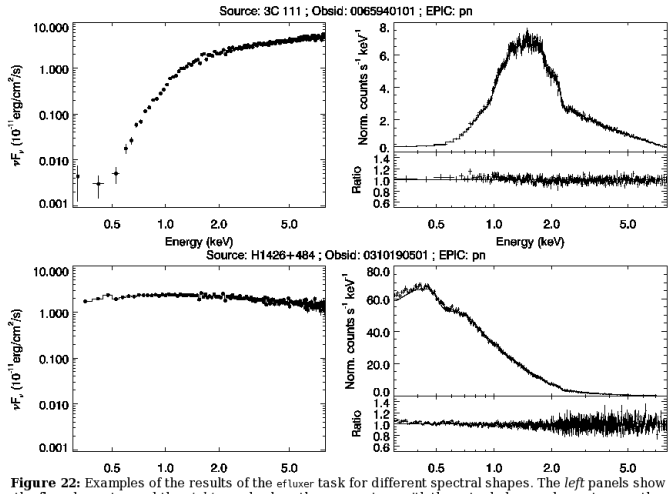
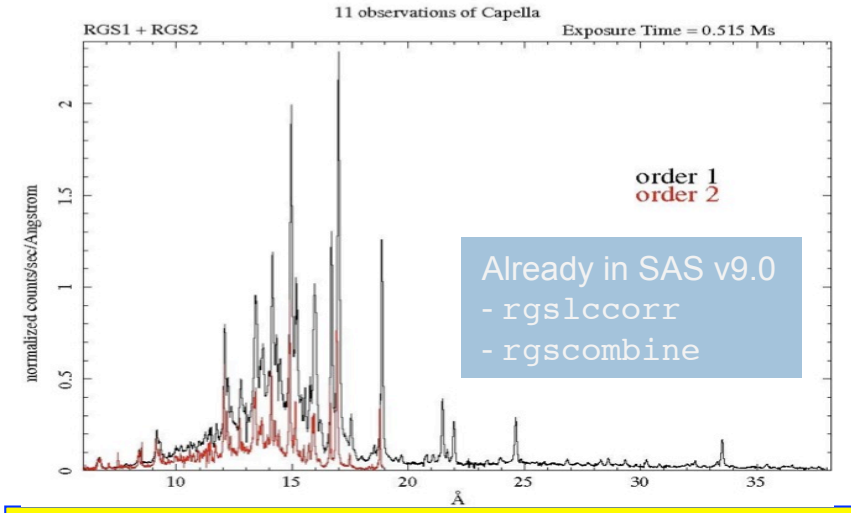


Figure 22: Examples of the results of the `efluxer` task for different spectral shapes. The *left* panels show the fluxed spectra and the *right* panels show the comparison with the actual observed counts once the fluxed spectra have been folded with the effective area and the response matrix (*solid* lines). The *top*

Done

EPIC fluxer



(courtesy of A. Ibarra)

Already in SAS v9.0
- `rgslccorr`
- `rgscombine`

`rgsproc` spectra in λ-space by default

Summary

- EPIC-MOS redistribution recalibration
  - See S.Sembay's talk
- Refinement of the EPIC-pn soft X-ray redistribution
  - Status: validation – Release: a few months
- Recalibration of EPIC-pn resolution at 6 keV
  - Status: validation – Release: a few months
- 2-D PSF
  - Status: validation – Release: ≥6 months
- Recalibration of PATTERN fraction in EPIC-pn Timing Mode
  - Status: validation – Release: a few months
- Status of soft MOS noise
  - Status: investigation still ongoing – Drastic (data filtering) solution available as of SASv9.0
- Recalibration of the RGS contamination time evolution
  - Status: validation – Release: with SASv10
- XMM-Newton cross-calibration status
  - Improvements expected in the RGS to EPIC flux ration below 0.5 keV
- SASv10 news
  - Status: validation – Release: this week