XMM-Newton EPIC Current Status

2008 April – EPIC Cal/Ops meeting in Mallorca

2008 May – International Users Group – This presentation liberally borrows from Matteo Guainazzi's talk

http://xmm.esac.esa.int/external/xmm_user_support/usersgroup/20080506/index.shtml

XMM-Newton Calibration Page

http://xmm2.esac.esa.int/external/xmm_sw_cal/calib/index.shtml

EPIC Calibration Status Document

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

XMM-Newton EPIC

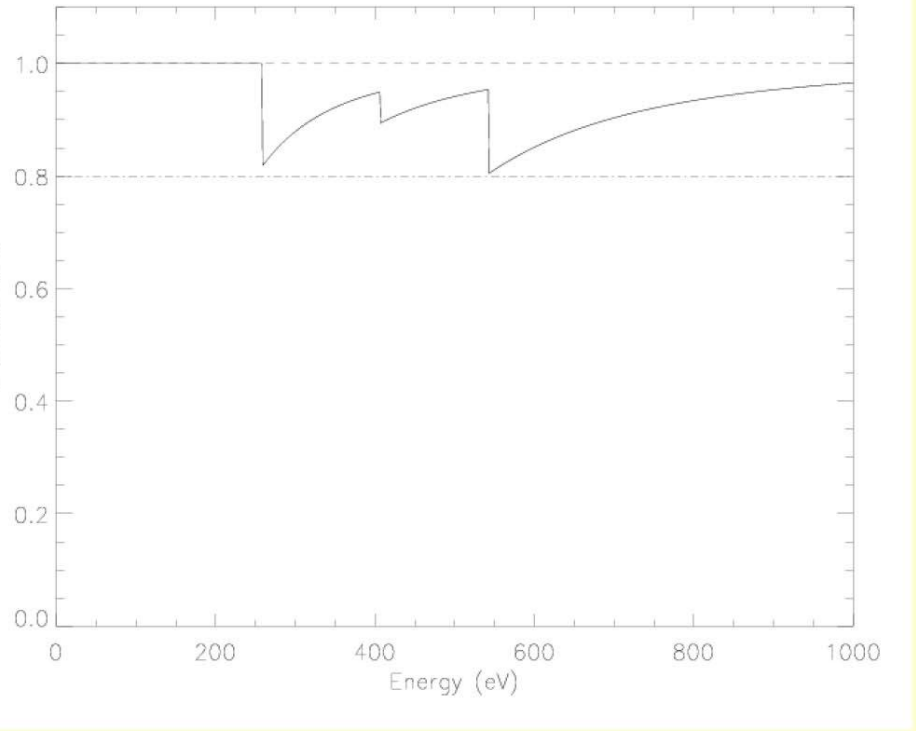
- EPIC, both PN and MOS detectors are functioning very well after eight and a half years
  - All instruments essentially stable
  - Loss of one MOS CCD due to a micrometeorite hit
- This is not to say that more calibration isn't necessary or that there aren't any issues that need to be addressed, however, there have been major improvements and the status now is quite good. No resting, however.

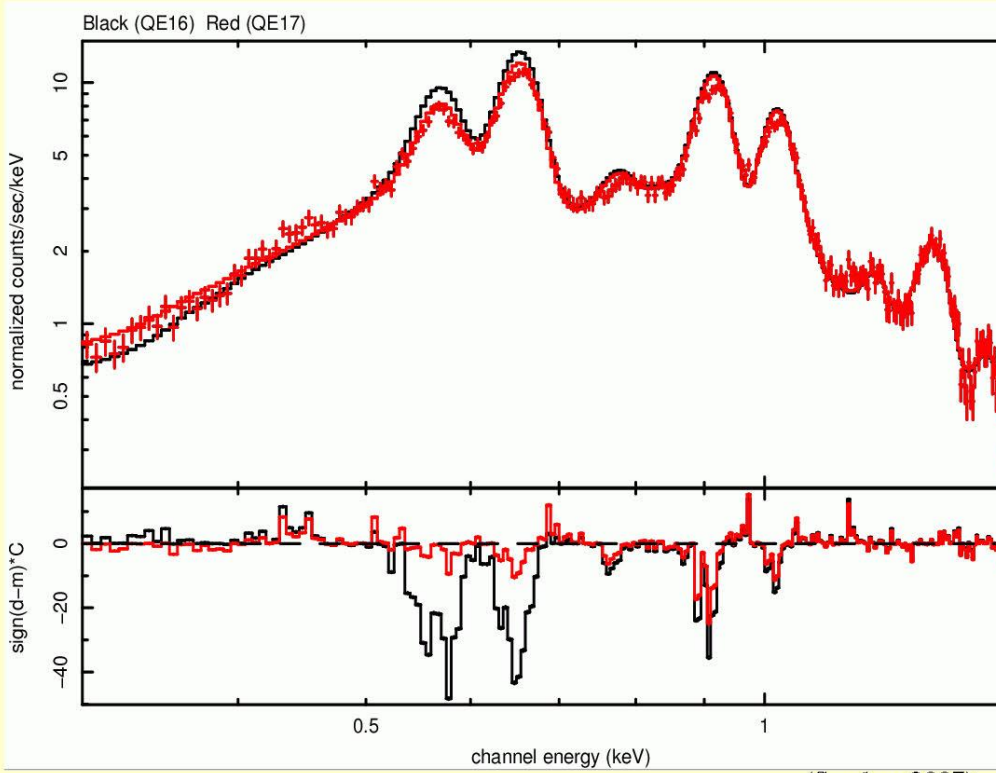
XMM-Newton EPIC

Main Areas of Calibration/Software Improvements

- **MOS QE refinements**
- **Pn CTI and gain correction refinements**
- **Rate-dependent CTI correction for pn fast modes**
- **Corrections for pn time jumps**
- **Calculation of encircled energy correction with a 2-D elliptical PSF**

Adjustment of the MOS Quantum Efficiency at the C, N, O edges





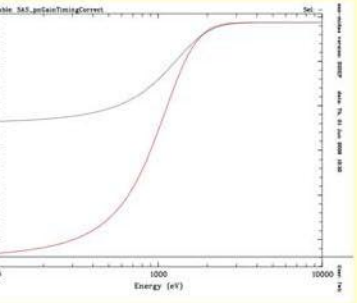
(Sembay 2007)

Impact:

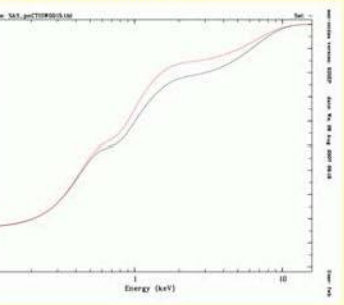
- Significant improvement at the Oxygen lines once compared with models based on high-resolution (RGS, HETG) data
- Better pn-MOS imaging mode cross-calibration → *Stuhlinger*

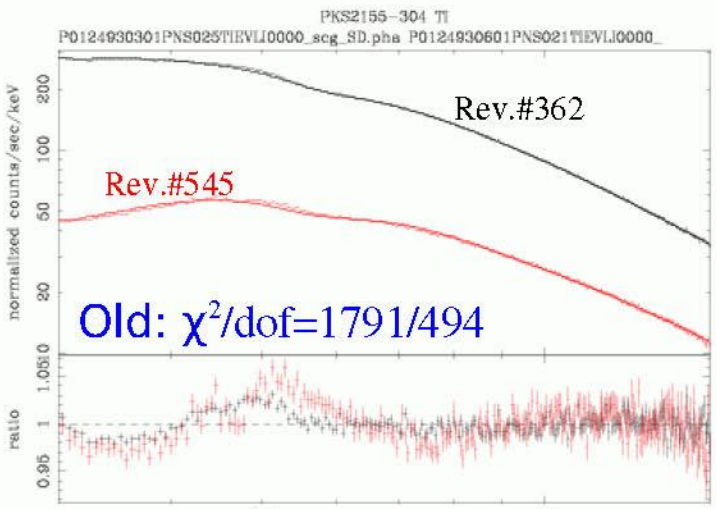
n mode-dependent gain/CTI refinements

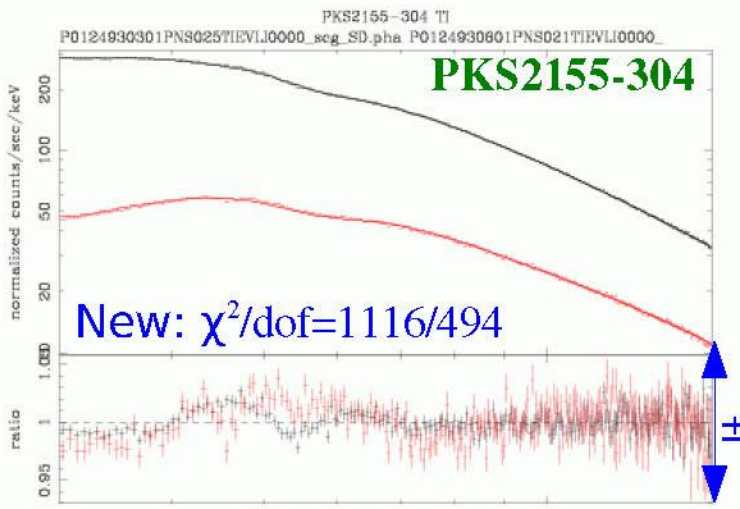
Timing Mode

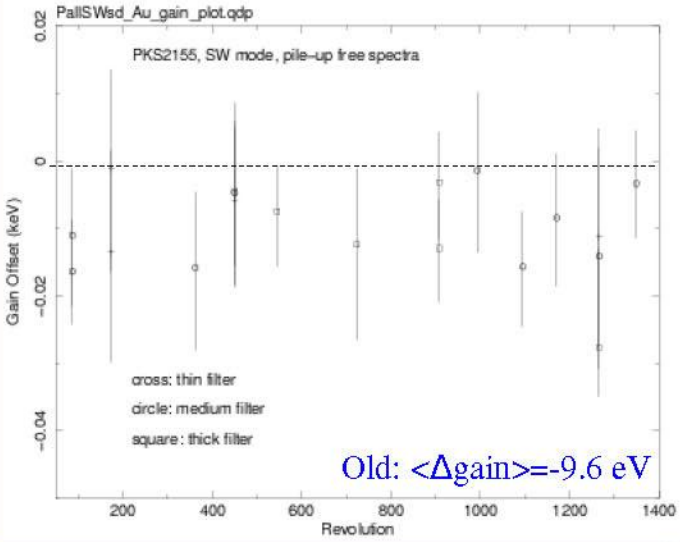


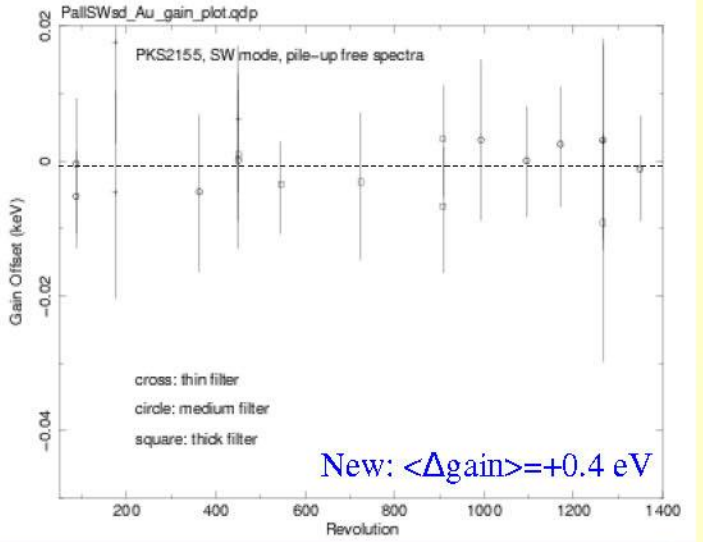
Small Window







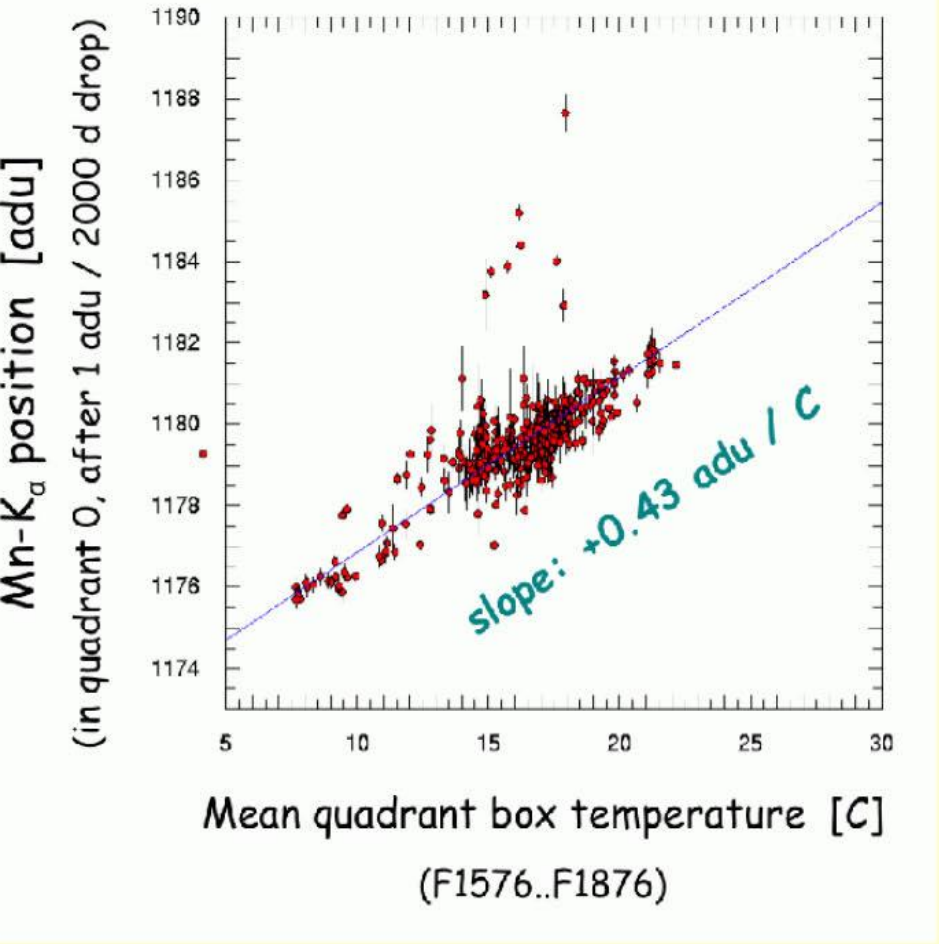




PANTHER-based CTI refinement for Large Window mode (small impact)

Improvement of long-term CCD-based CTI for FF and eFF modes

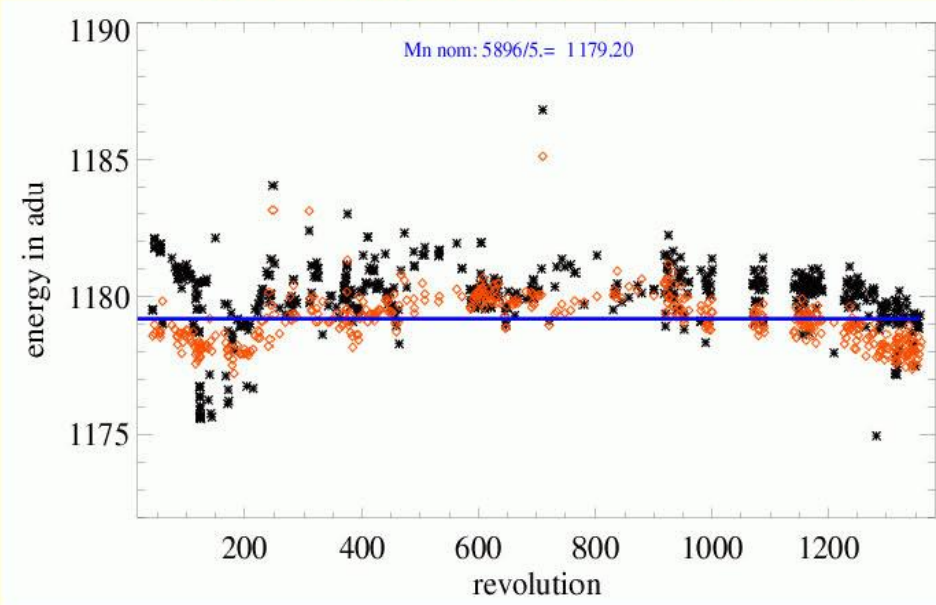
n FF gain temperature-dependence



Without temperature correction

With temperature correction

(pn energy accuracy ≤5-10 eV)

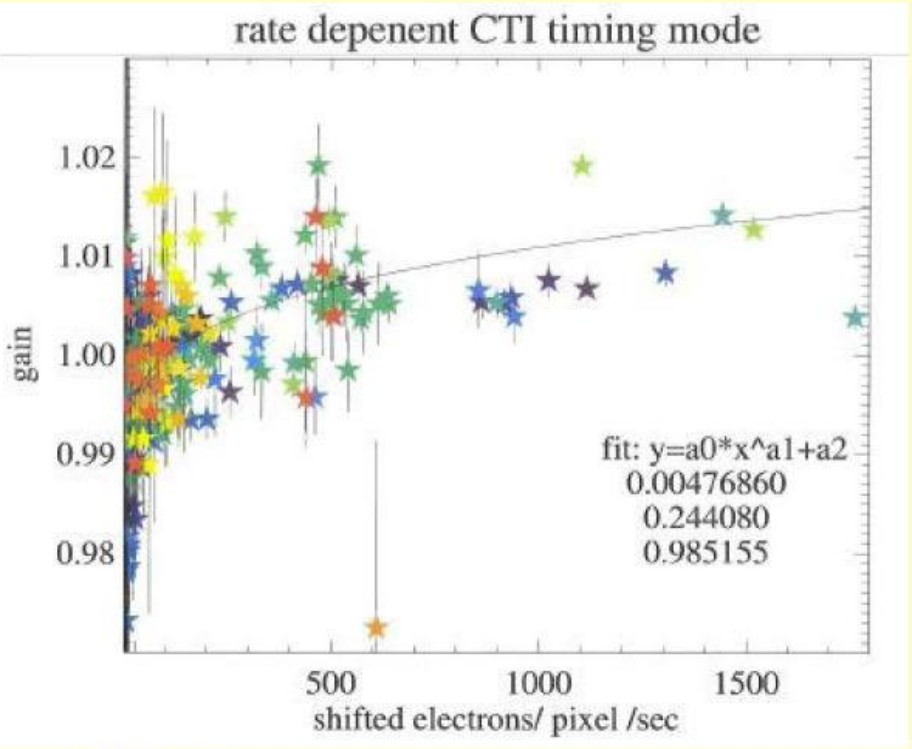


(Kirsch, Haberl, Dennerl, Freyberg 2007

Temperature-correction is the default as of SASv7.1.2

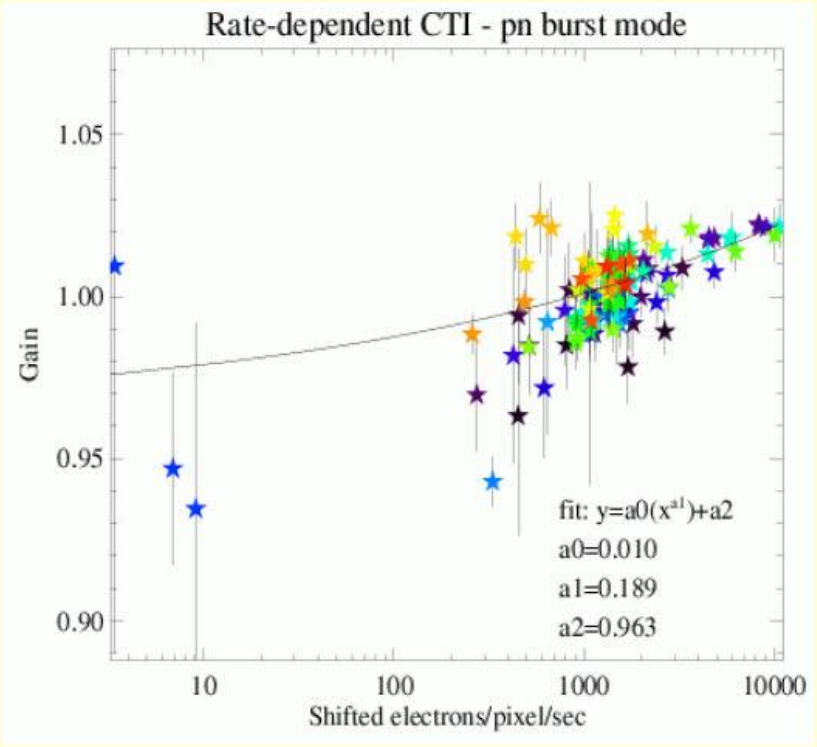
n Rate-dependent CTI

Timing Mode



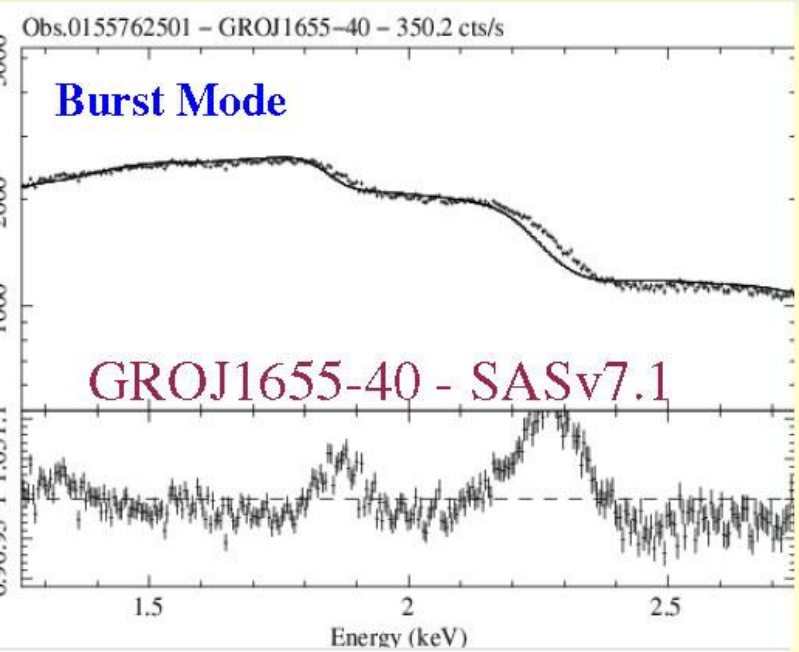
urtesy of M.Kirsch)

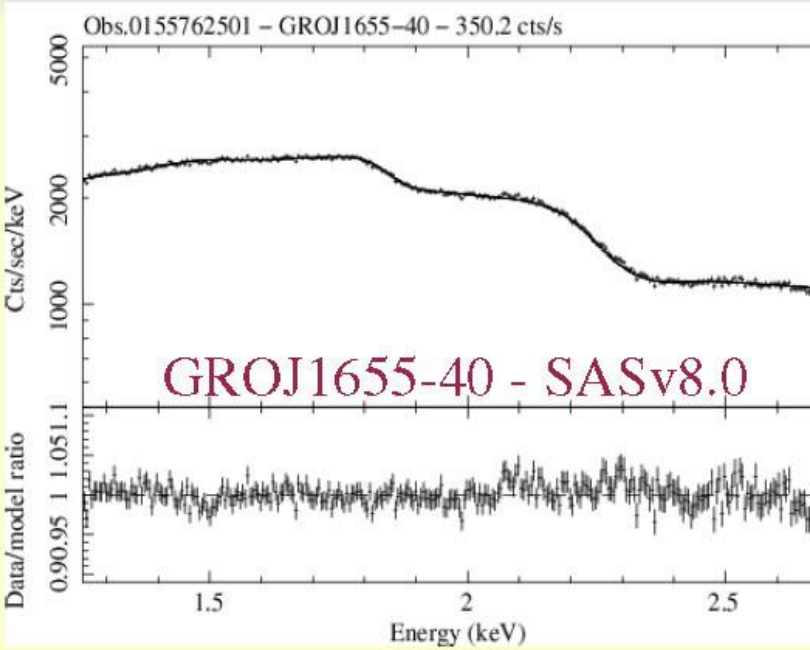
Burst Mode



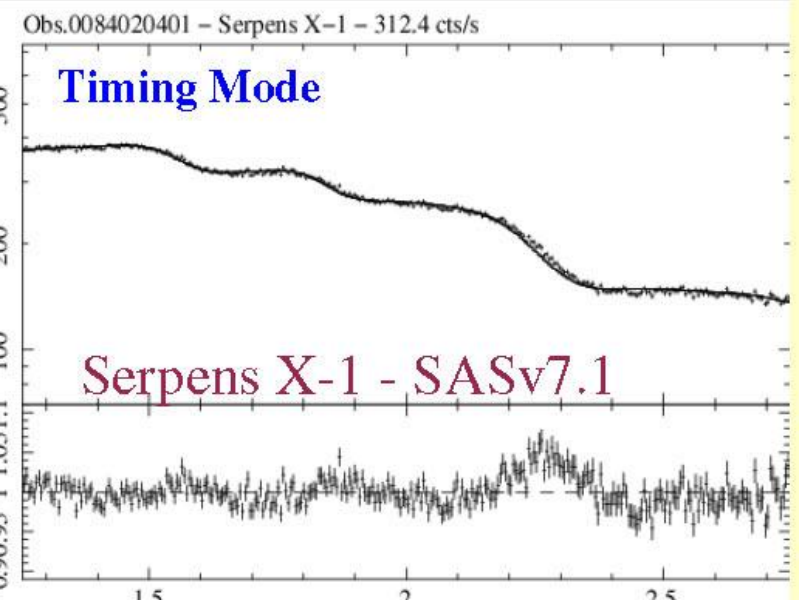
Empirical correction to re-align the Si and Au edges

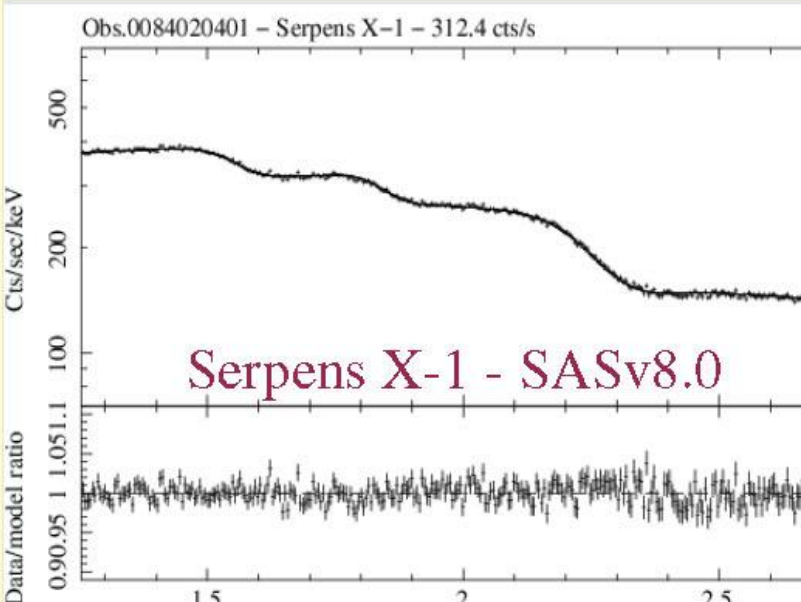
cientific impact





±10%





±10%

n time jump correction

New SASv8.0 algorithm to correct for time jumps takes into account

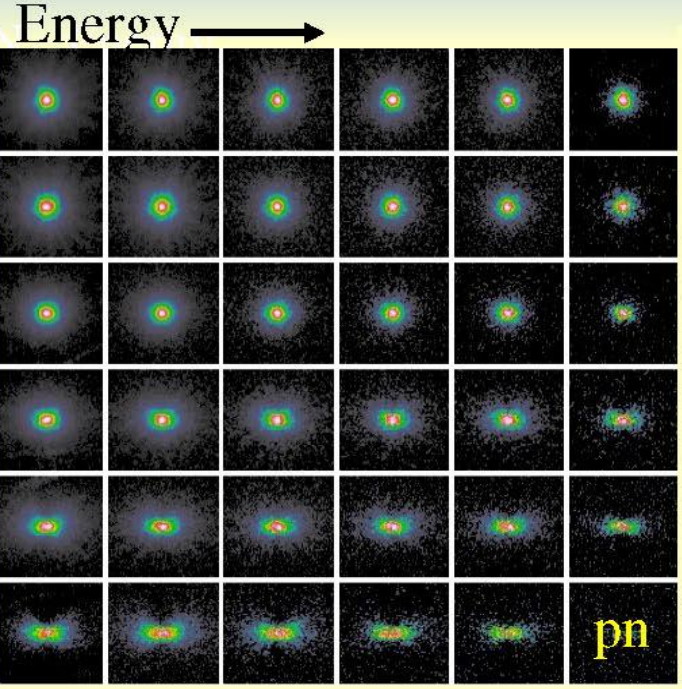
- More accurate determination of time frames (`New FT`)
- Drifts in time frames due to (`new algo`):
  - Temperature-dependence
  - Ageing

Percentage (%) of observations affected by non-detected time jumps in SASv8.0

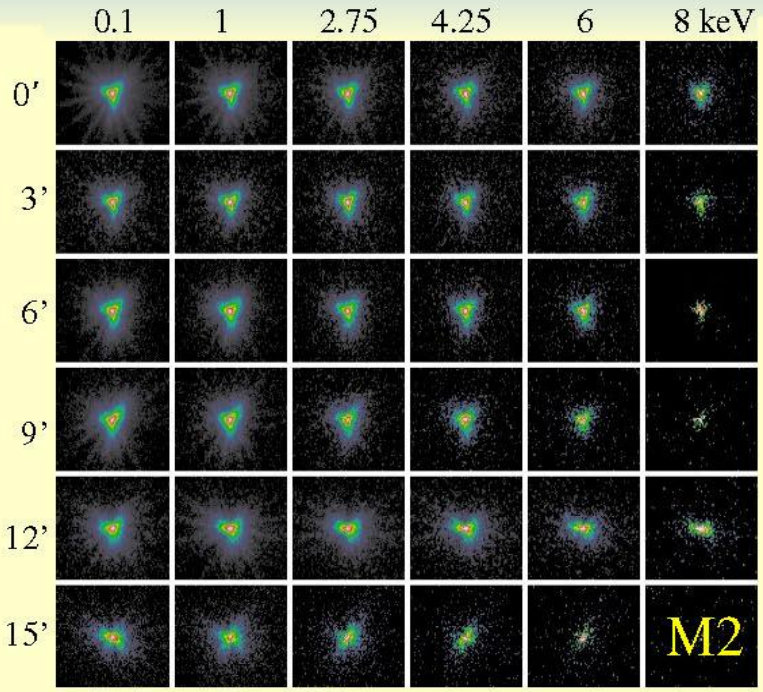
Mode	Old FT + old algo	New FT + old algo	New FT+new algo
FF	5.8	0.6	1.9
eFF	20.8	20.2	2.3
SW	37.2	12.5	6.6
LW	39.0	1.6	1.4
Timing	12.0	1.9	1.1
Burst	52.9	4.2	3.2
Sum	15.6	4.9	2.2

(courtesy of M.Kirsch)

-D parametrized EEF calculation



(courtesy of A.Read)



Stacked images were fit with a "beta-model": $\{A/[1+(r/r_0)^2]^{\alpha}\}$

New CCF PSFs [ELLBETA] were generated with core radius, ellipticity, and power
aw index as a function of camera, energy, off-axis

SASv8.0 `arfgen` will use this "2-D PSF" to calculate the encircled energy fraction

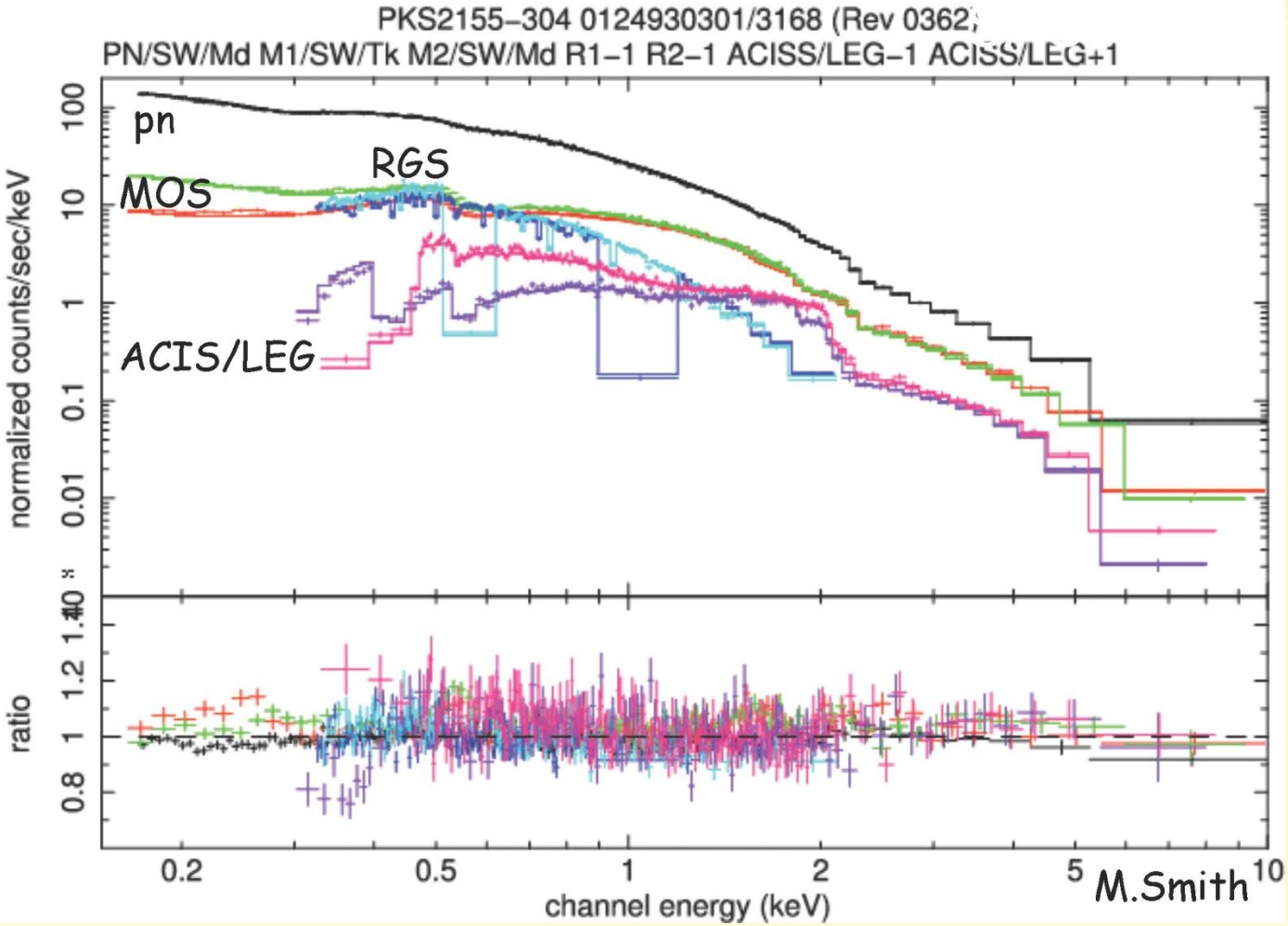
Scientific validation of this CCF is ongoing with 24 2XMM off-axis bright sources

XMM-Newton EPIC Calibration Status

- PSF: 2% on axis
- Astrometry: Relative 1.5” rms, Absolute 2.0” rms
- Relative Effective Area: +/- 5%
- Absolute Effective Area: +/- 10%
- Absolute Energy Scale: +/- 10 eV
- Relative Timing: $\Delta P/P < 10^{-8}$
- Absolute Timing: $<10^{-4}$ s
- RGS Cross Cal: +/- 15%
- Chandra Cross Cal: +/- 20%

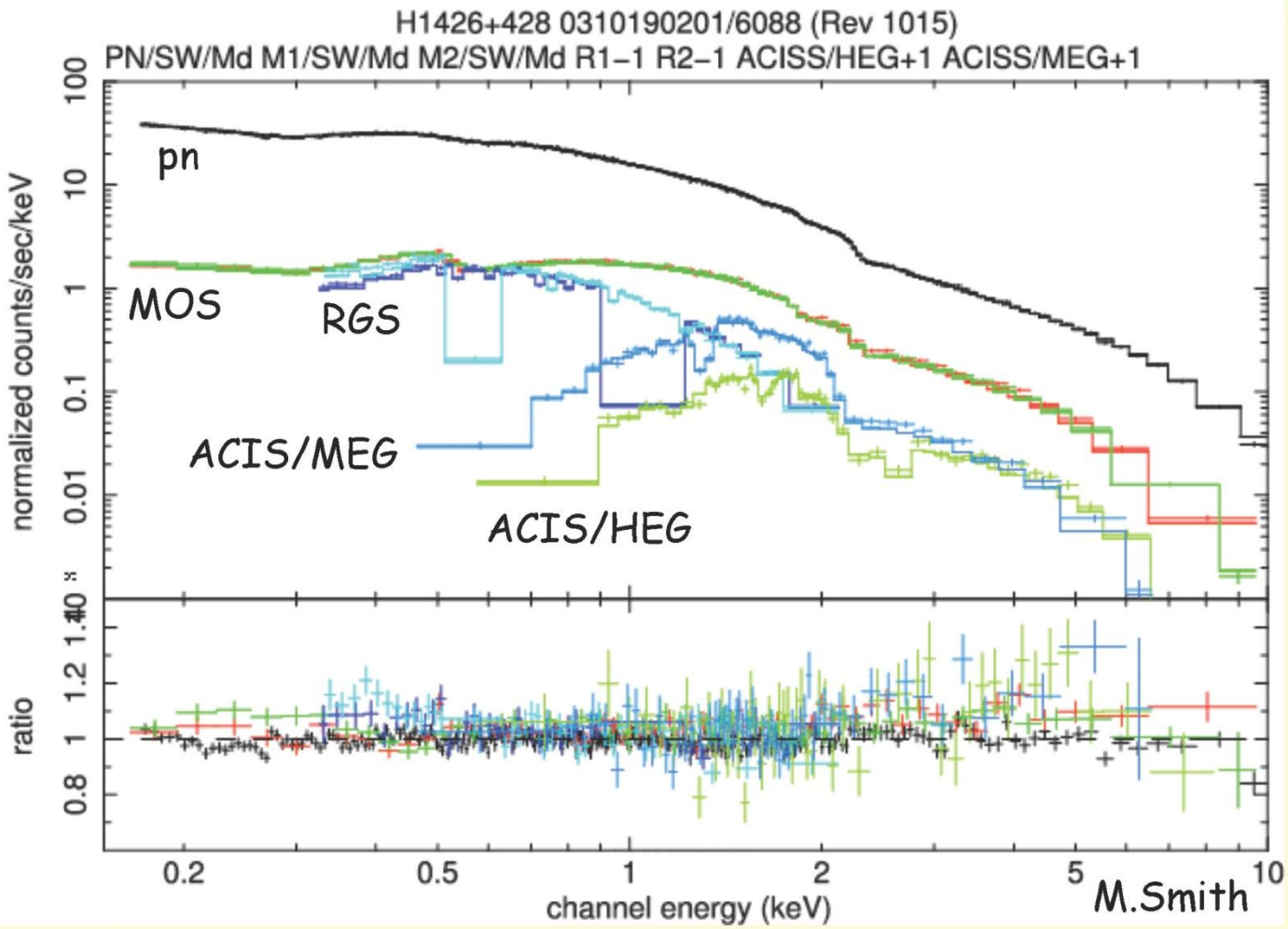
Martin Stuhlinger’s USG Presentation

XMM-Newton vs. Chandra ACIS/LETG



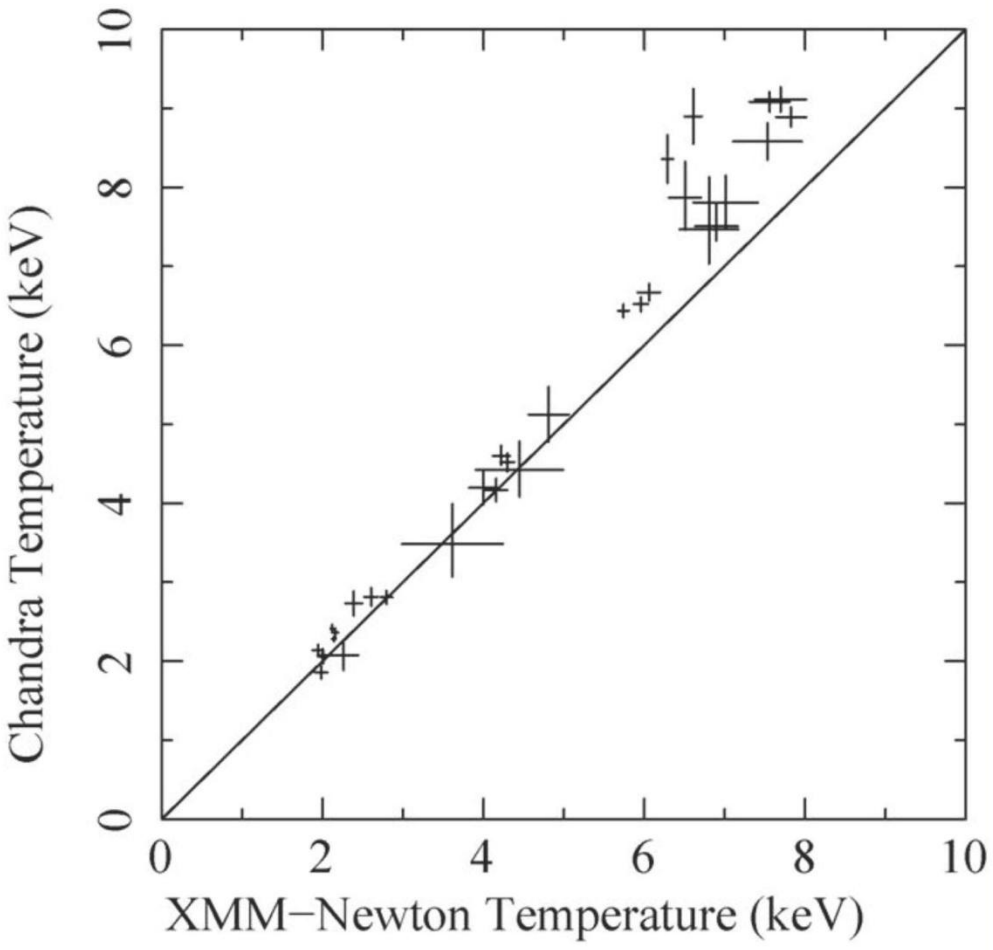
- PKS2155-304
- XMM rev. 0362
- Good agreement above 1 keV
- ACIS/LETG (this obs.) has higher normalisation than the EPICs below 1 keV
- Above ~2 keV, ACIS/LETG matches with MOS

XMM-Newton vs. Chandra ACIS/HETG



- H1426+428
- XMM rev. 1015
- Good agreement below 2 keV
- Above 2 keV, ACIS/ HEG shows a flatter slope than the EPICs
- Above 2 keV, MOS is closer to ACIS/ MEG than pn

Cluster temperature discrepancy

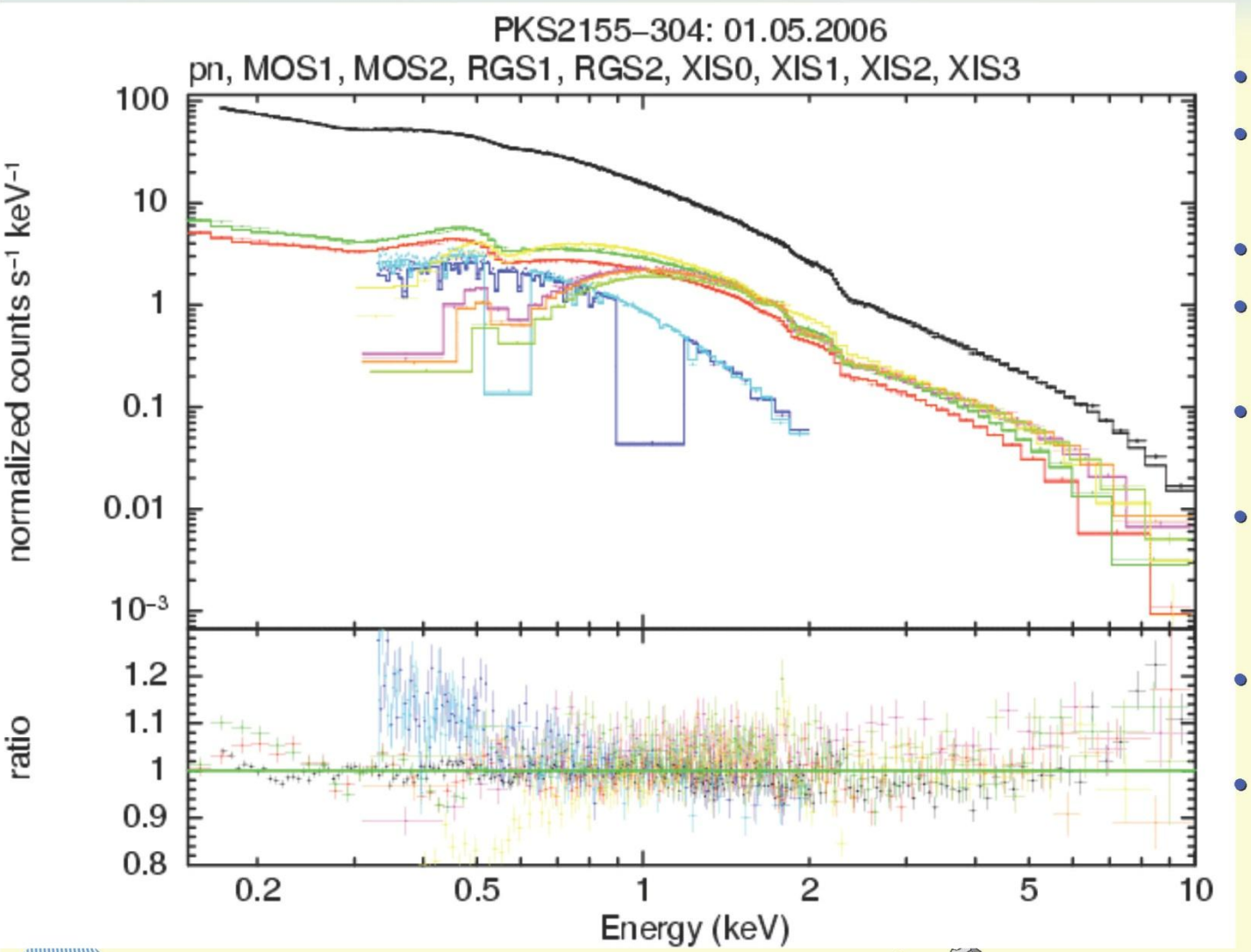


S. Snowden

S. Snowden,
EPIC CAL meeting Nov.2007:

- Comparison of multiple galaxy clusters show a significant and systematic discrepancy between XMM-Newton and Chandra.
- The higher the cluster temperature, the greater the Chandra temperature relative to XMM.
- Problem identified: Chandra mirror effective area.

XMM-Newton versus Suzaku



- PKS2155-304
- XMM rev. 1171

- FTOOLS 6.4
- Joint fit to all instruments.
- Absorbed single power law model
- Red. Chi^2 = 1.36 / 10439 dof

- Good general slope agreement.
- XIS fluxes slightly higher than EPICs.

XMM-Newton EPIC Future Work

EPIC

Off-axis 2-D psf characterization/calibration

Off-axis RGS obscuration correction

Improve gain/redistribution calibration

PN

PN rate dependent CTI correction – should work for burst and timing modes

Spatial exposure corrections

MOS

Improve the “patch” calibration