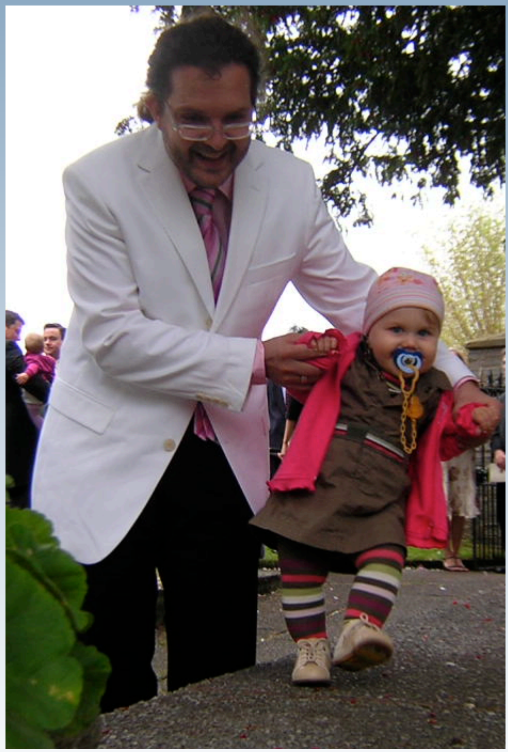
European Space Astronomy Centre
European Space Agency

XMM-Newton ready for the next decade?!!!!



Chandra calibration meeting
25 October 2007

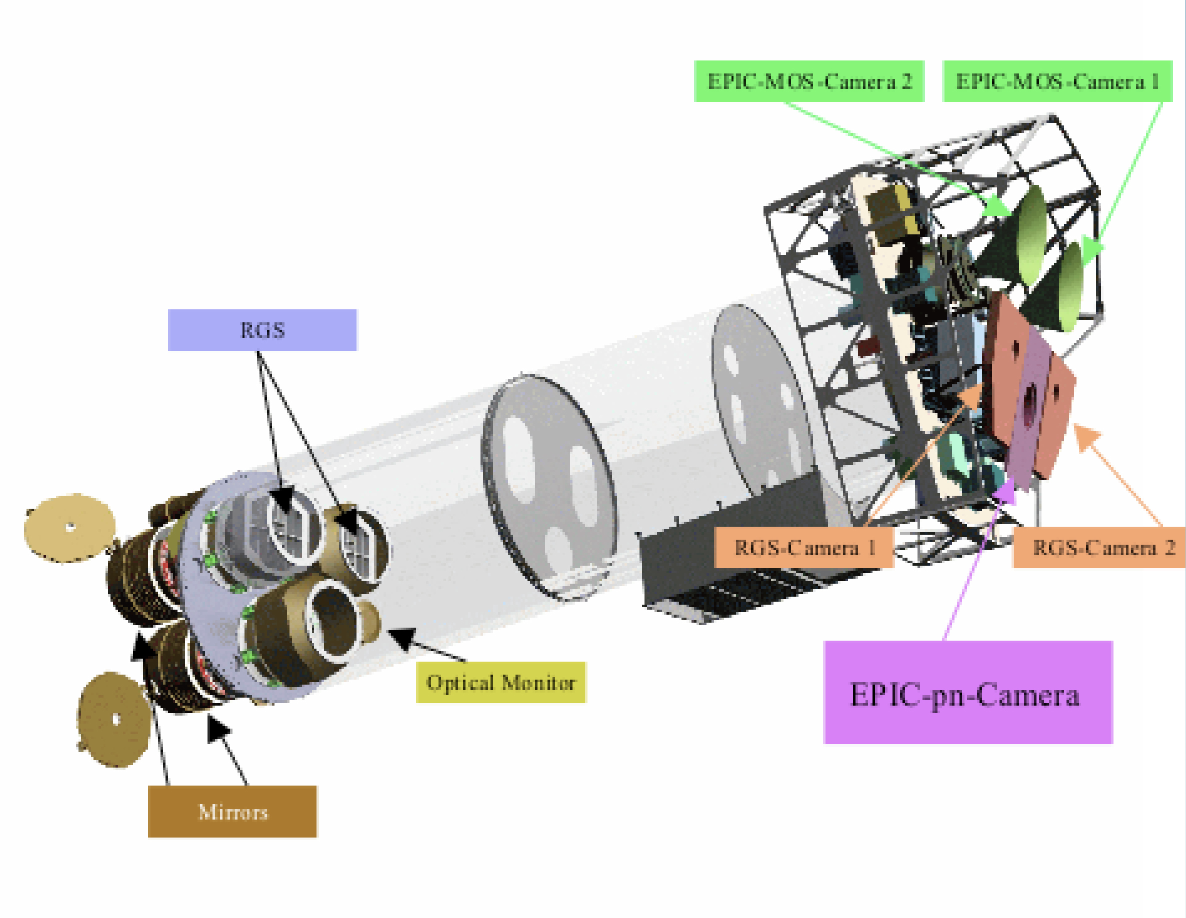
Marcus G. F. Kirsch

European Space Agency (ESA)

- health status of XMM
  - funding
  - spacecraft
  - instruments
  - calibration

- Cross Calibration
  - cross calibration archive
  - Chandra
  - Integral
  - Suzaku
  - Swift
  - IACHEC

XMM-Newton

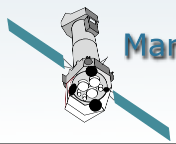


- launched December 1999
- high elliptic orbit today rev: 1442
- published papers by today 1623
- AO7 closed
- ODFs in archive ~ 7500
- **mission life --> pending SPC approval until END 2012 ---> further extension targeted**

spacecraft

Overview of consumables and limited life items		
Fuel: 2018	remaining estimated usage per year "mileage" left	95 kg 8.6 kg 11 years
Solar array power output	maximum required current margin margin at end-of-2012	1350 W 520 W 360 W
Battery lifetime	according to user handbook	15 y
Gyros	usage	< 15%
Reaction wheels	usage	< 15%
RF switches	usage	20% main 0% redundant

No radiation damage expected before 2012. Design margins should allow a much longer operation (reasonable design margin 50 %)



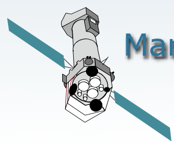
instruments: healthy and clean - what does it mean?

- Instrument performance is unchanged or change is understood and can be modeled
- Health risks:
  - micro-meteoroids
  - Soft protons funneled by mirrors
  - Hard particles

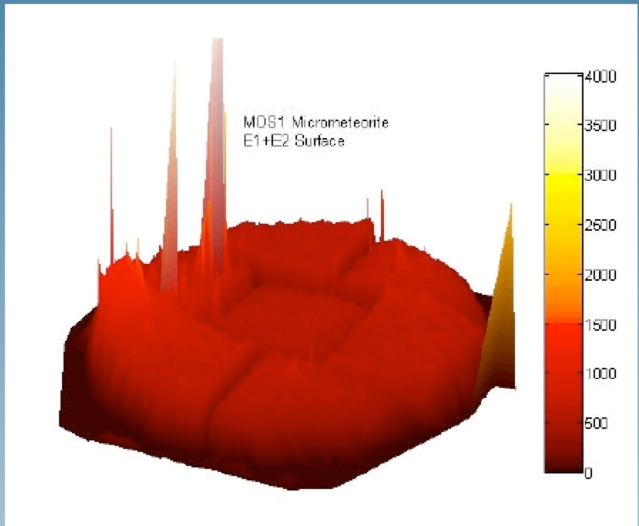
➡ Reduction of Charge Transfer Efficiency and energy resolution

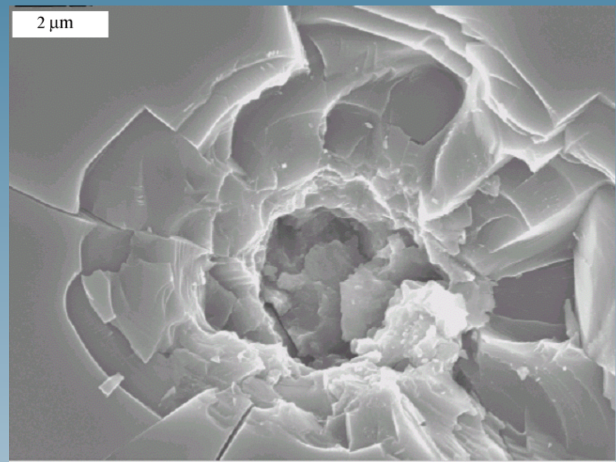
- Instruments show no contamination
  - Particulate contamination
  - Molecular contamination
  - Contamination risk: Out-gassing material

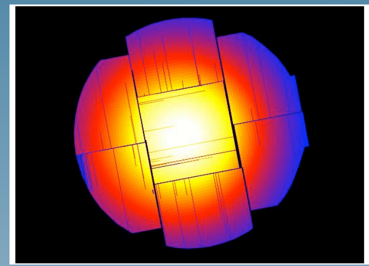
➡ Reduction of effective area and creation of edges in spectra

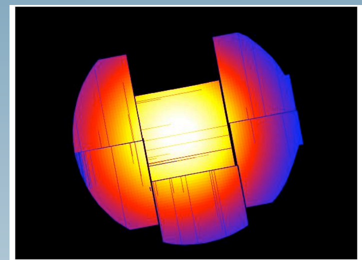


micro-meteoroids





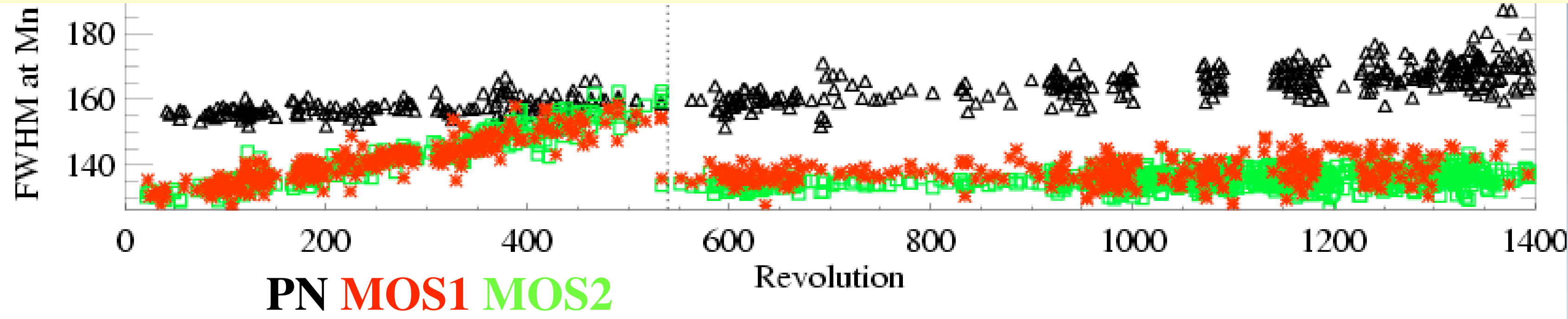




- 4 impacts so far in the mission
- Last one in rev 961 (March 05) caused the loss of MOS1 CCD6 and a new hot column passing very close to the MOS1 boresight.
- After a sudden optical flash, bright hot pixels appear
- Interpreted as a dust micro-meteoroid scattered off the mirror surface under grazing incidence and reaching the focal plane detector.
- Typical size ~< 1 micron
- Interplanetary (or interstellar) dust but not linked to meteor shower (higher sizes/masses)

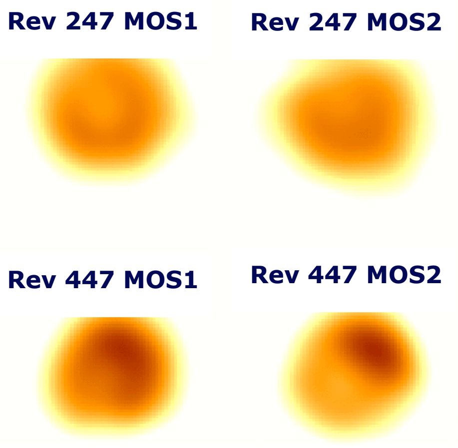
resolution by 2015

CAMERA	FWHM @ MN AFTER LAUNCH	FWHM @ MN AFTER COOLING	FWHM @ MN IN 2015	FWHM @ AL AFTER LAUNCH	FWHM @ AL AFTER COOLING	FWHM @ AL IN 2015
MOS1	135	140	156	75	75	86
MOS2	135	135	148	77	77	82
pn	155	NA	185	120	NA	141

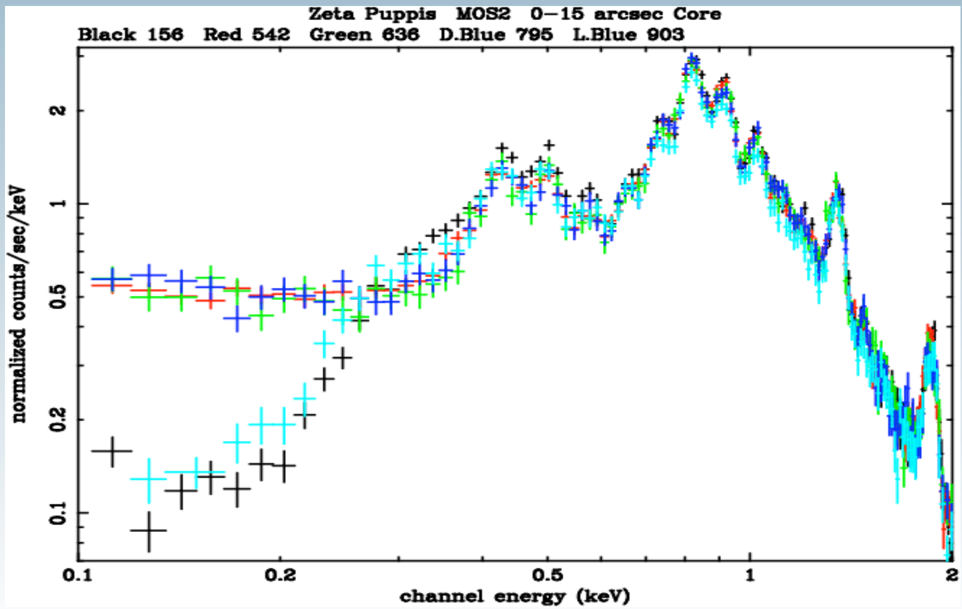


- at high energies EPIC-MOS energy resolution was degrading up to the cooling of the EPIC-MOS cameras --> after cooling nearly back to launch values
- no major effects are anticipated during the next solar cycle
- resolution @2015 is still near to launch values
  - factor FWHM@Mn: M1:1.16, M2: 1.10, pn: 1.20

EPIC-MOS patch

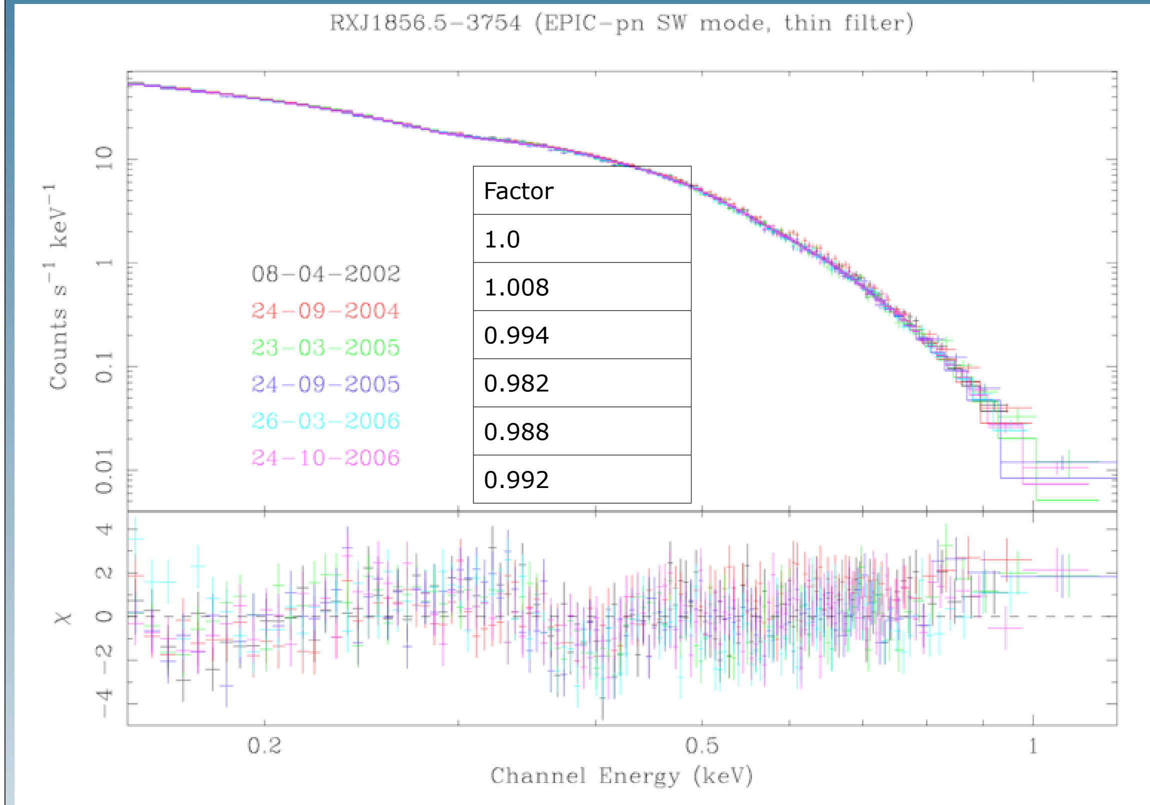


smoothed images 1ES0102
0.1-0.35 keV



- small patch on each detector has been discovered using all archived 1ES0102 observation and performing in addition a raster scan to identify position and time variability.
- patch has degraded over time.
- broadens the redistribution function at energies around 0.5 keV
- coincident with the nominal position of sources when placed at EPIC-pn and RGS boresights, i.e :the peak in received photon dose of the detectors
- causes a significant change in the low energy redistribution characteristics of the EPIC-MOS cameras, which is spatially and temporarily dependent
- the situation seems to have stabilised
- no evidence for contaminant
- Epoch & spatial dependent Response Matrices
- **detailed spatial re-analysis planned**

contamination monitoring-EPIC



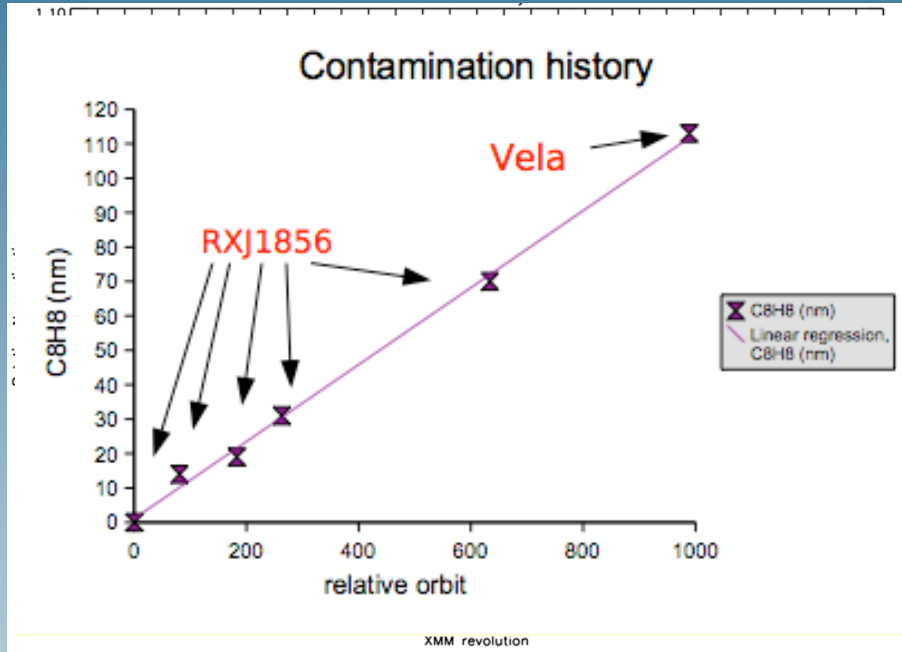
- isolated neutron star RXJ1856-3754 is used as a target to monitor contamination on the EPIC cameras
- very soft spectrum → well suited to measure possible contamination, which would affect the low energy regime most strongly
- observations can be used to derive upper limits for contamination for carbon and oxygen
- SNRs N132D and 1ES0102 are used to measure contamination and stability of the energy calibration of the EPIC cameras.
- This analysis showed that the EPIC-MOS cameras have changed in their redistribution characteristics but not in a way consistent with contamination.

CAMERA	CARBON	OXYGEN
EPIC-pn	$< 2.7 \cdot 10^{-7}$ gcm^{-2}	$< 2.5 \cdot 10^{-6}$ gcm^{-2}
EPIC-MOS	$< 7.2 \cdot 10^{-7}$ gcm^{-2}	$< 1.3 \cdot 10^{-5}$ gcm^{-2}

RGS

- engineering
  - no further problems of CCD failure after revolution 135 early in the mission
  - RGS2 single-node readout
    - recurring set-up electronics problems
    - operating since 2007 August 18 in single-node readout
    - initial re-calibration CCFs in place
    - requires SAS v7.1
    - pile-up considerations

- contamination



- flux deficit due to carbon absorption -->linear build up model in calibration
- New RGS effective area CCFs based on linear increase with time of pure carbon contamination layer
- Fixed polynomial blazar power-law correction
- Improved Crab nebula model
- corrected RGS flux constant within ± 5 %

esa European Space Astronomy Centre
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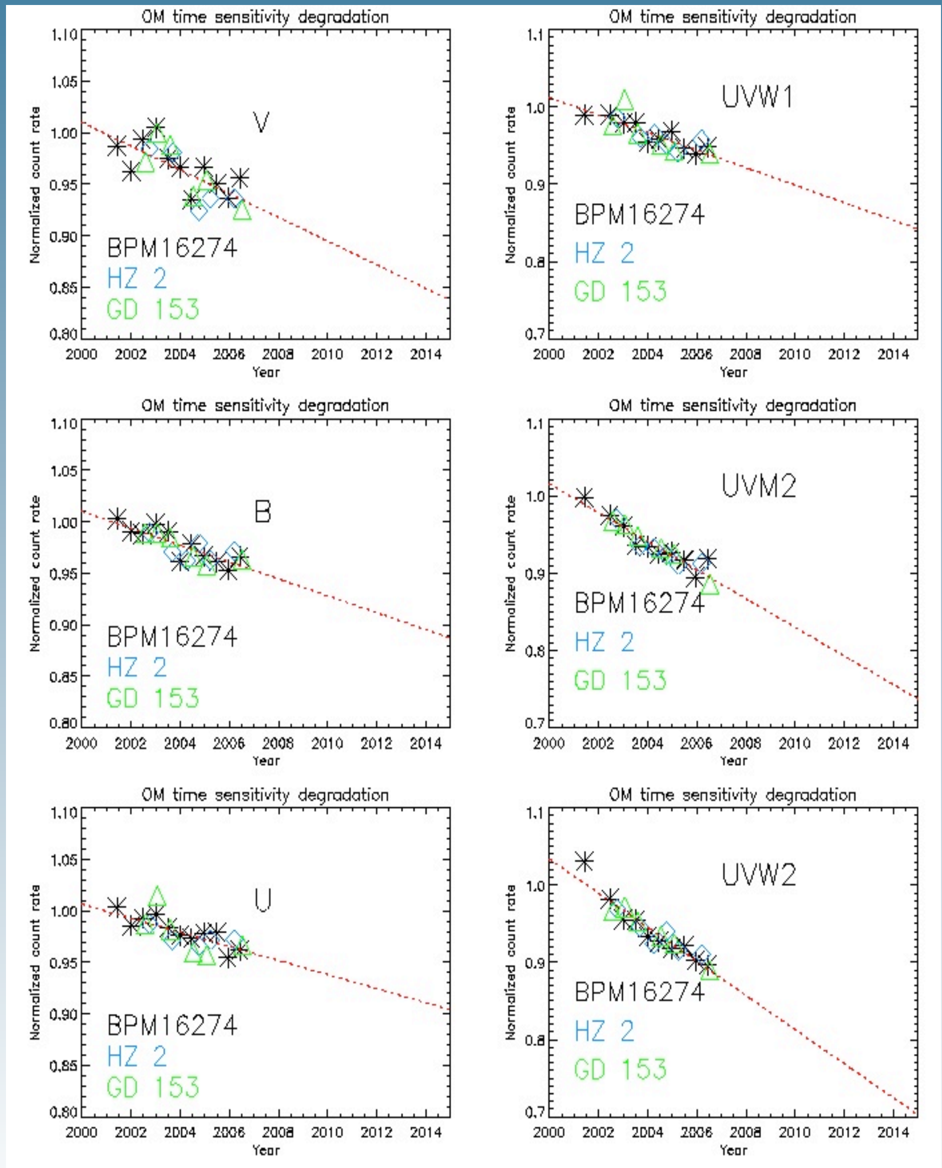
OM time sensitivity degradation



- Laboratory measurements of all Optical Monitor components allowed to predict the throughput of the OM system
- after launch in-flight throughput measured by observing standard stars was found to be lower than expected (in particular in the UV filters)
- deficit observed in the in-flight throughput, as low as 16 % at 212 nm, is independent from the time sensitivity degradation of the OM detector, which is much smaller.

Sensitivity loss by 2015

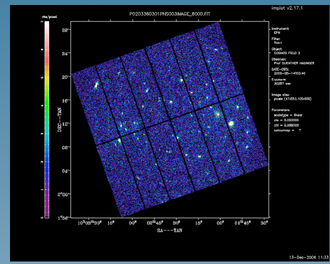
- U, B, V, UVW1 : < 15 %

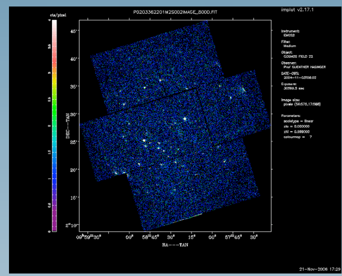
- UVM2, UVW2 : < 30 %

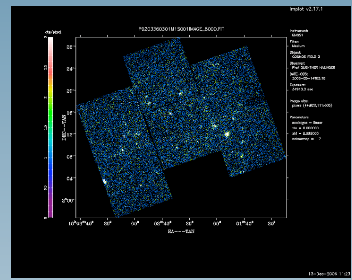
Marcus G. F. Kirsch
XMM-Newton

summary instruments

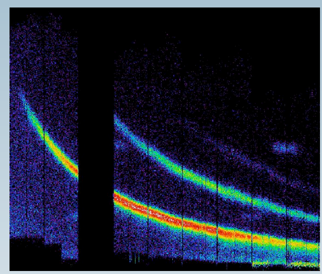
- EPIC:
  - loss of 5 % EA (at the outer FOV)
  - rock solid super clean pn instrument
  - controlled MOS redistribution changes
  - CTI changes as expected
  - no contamination

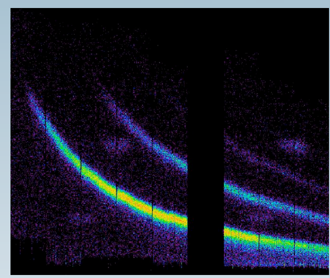






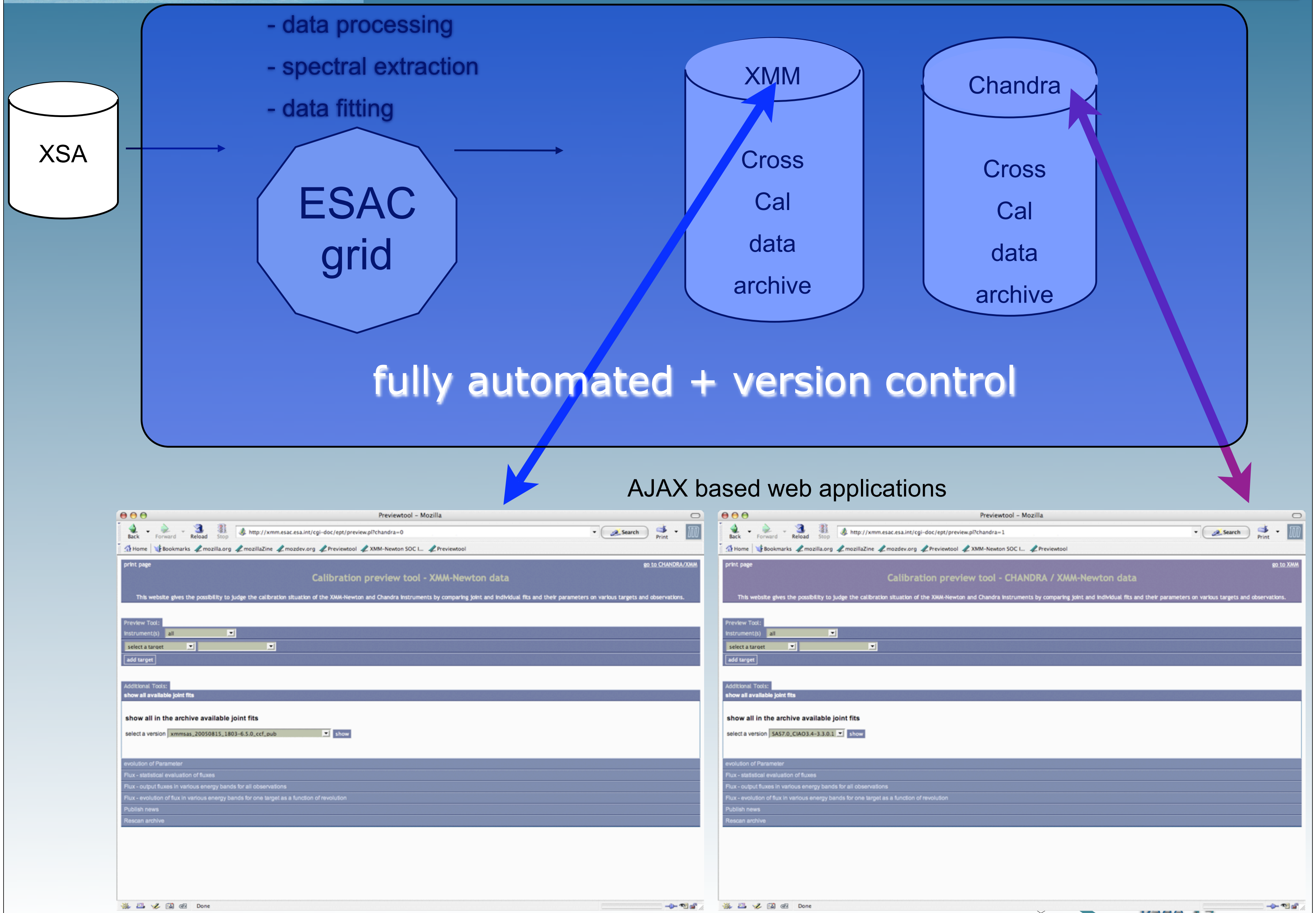
- RGS:
  - loss of 2/18 CCDs shortly after launch (however redundant)
  - controlled contamination (by 2015: 50 % EA reduction at 30 Å)





- OM:
  - wavelength dependent sensitivity reduction by 2015: 20% (optical), 20-30 % (UV)

cross calibration archive

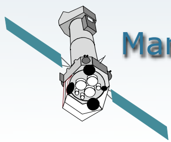


cross calibration archive -2

- to go public by end 2007

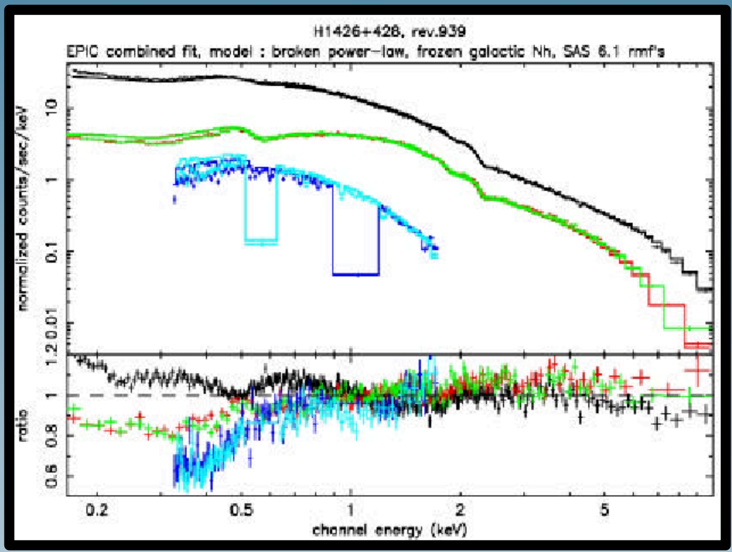
- Current content:
  - ~ 250 observations
  - ~ 150 checked in for automated processing (XMM only)
  - ~ 20 checked in for automated processing (XMM-Chandra)
  - all will be checked in by end 2007 (definition of extraction region/times and check for pile up needs to be checked and iterated ONCE manually)
- Using ESAC grid:
  - 10 nodes so far, each node has 2 CPUs Intel(R) Xeon(TM) 3.00GHz with 6GB of memory

  ➡ process and fit **150 Observations /24 hours**

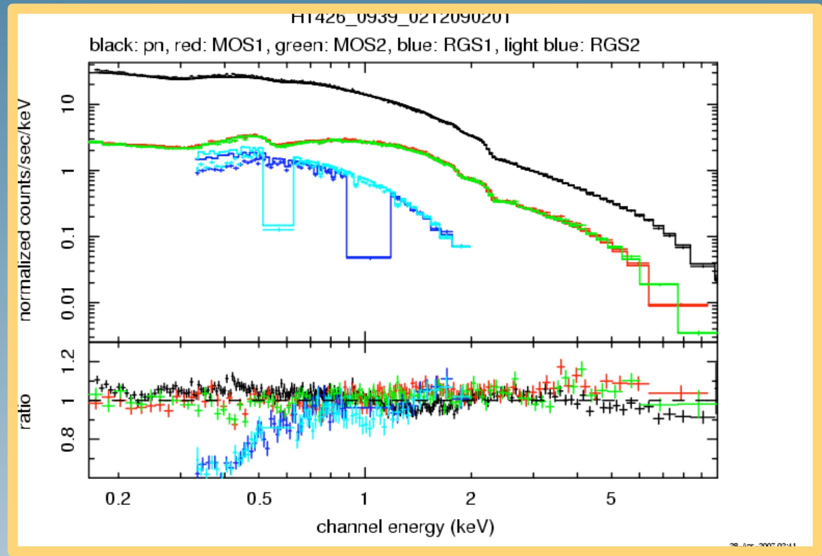


calibration - example H1426+428

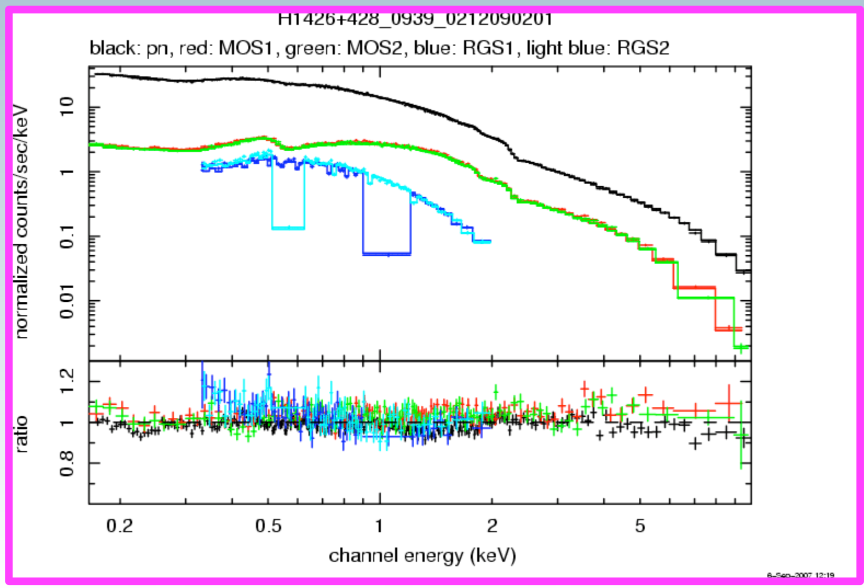
EPIC-pn MOS1 MOS2 RGS1 RGS2



SAS 6.1 (December '04)

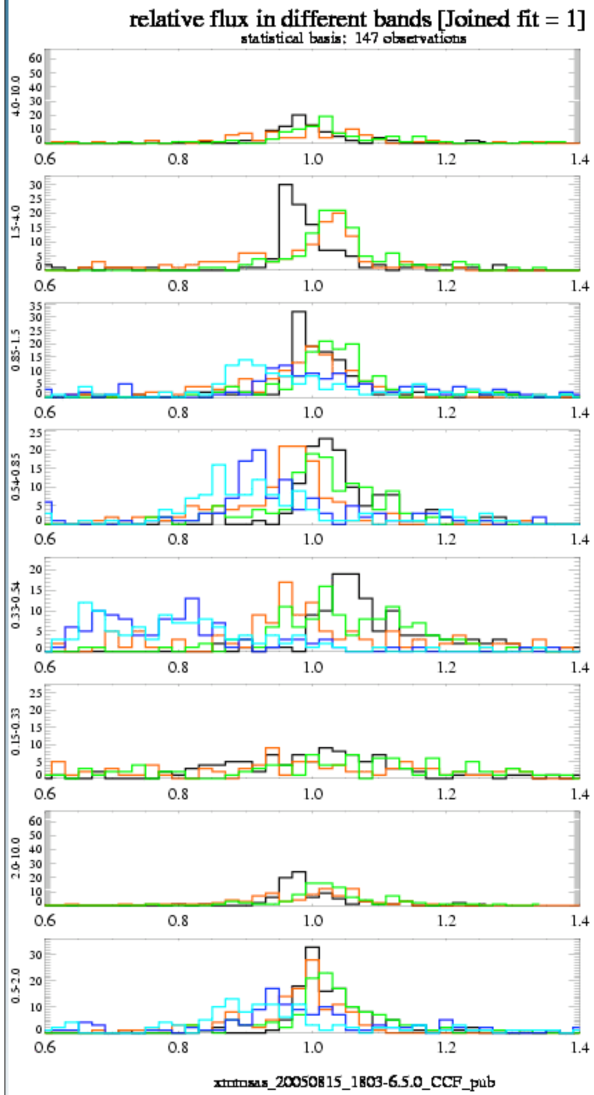


SAS 6.5 (August '05)

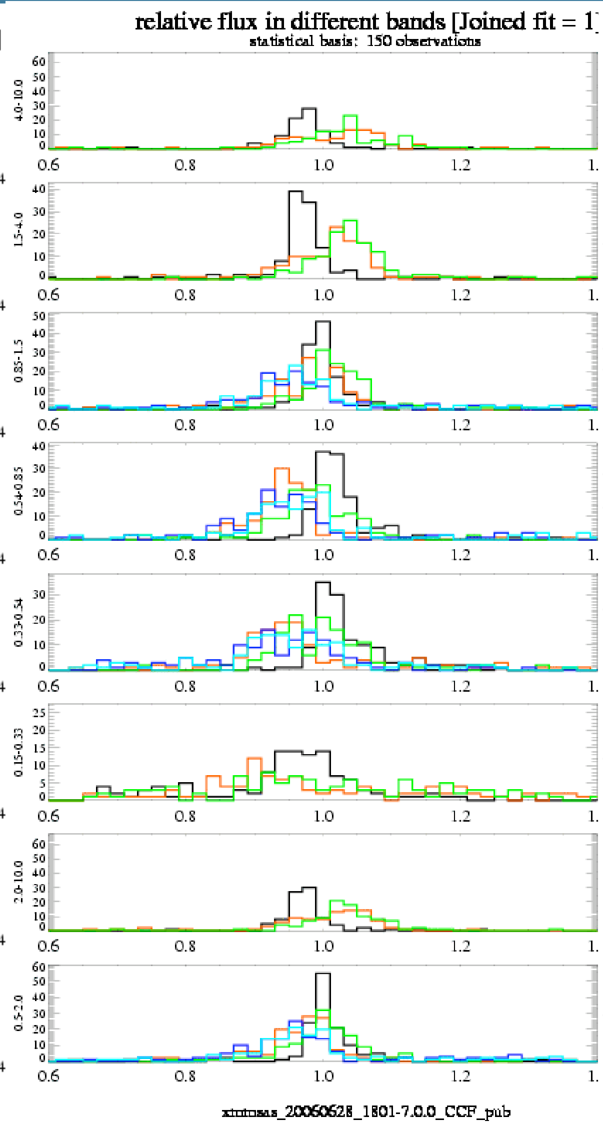


SAS 7.1 + new RGS EA
September 2007

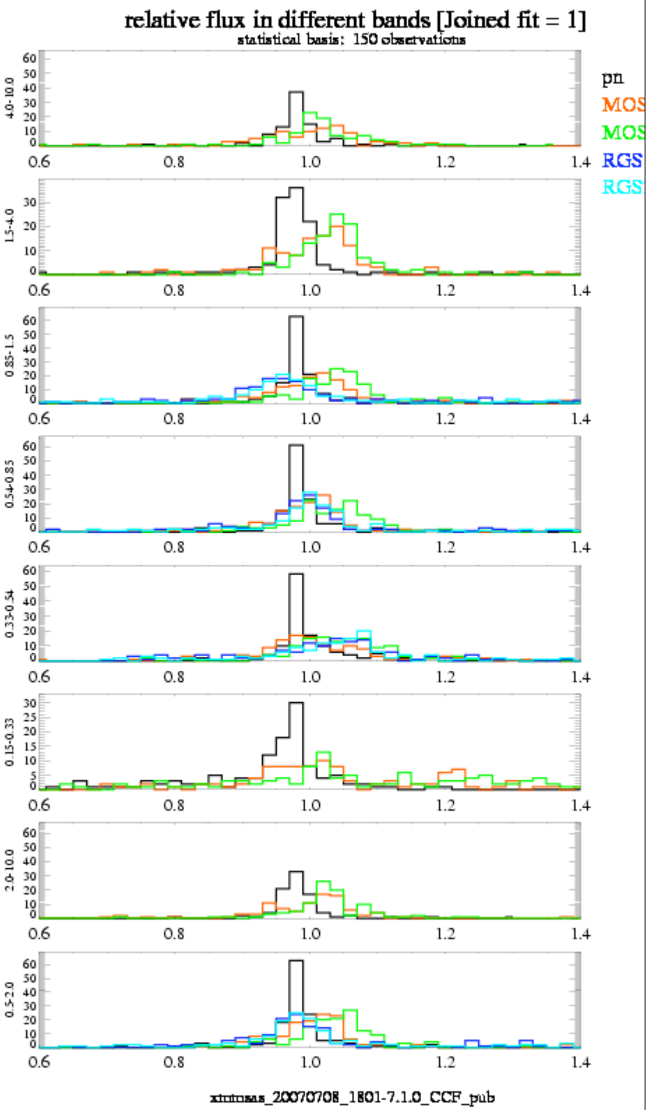
calibration - statistics



2005

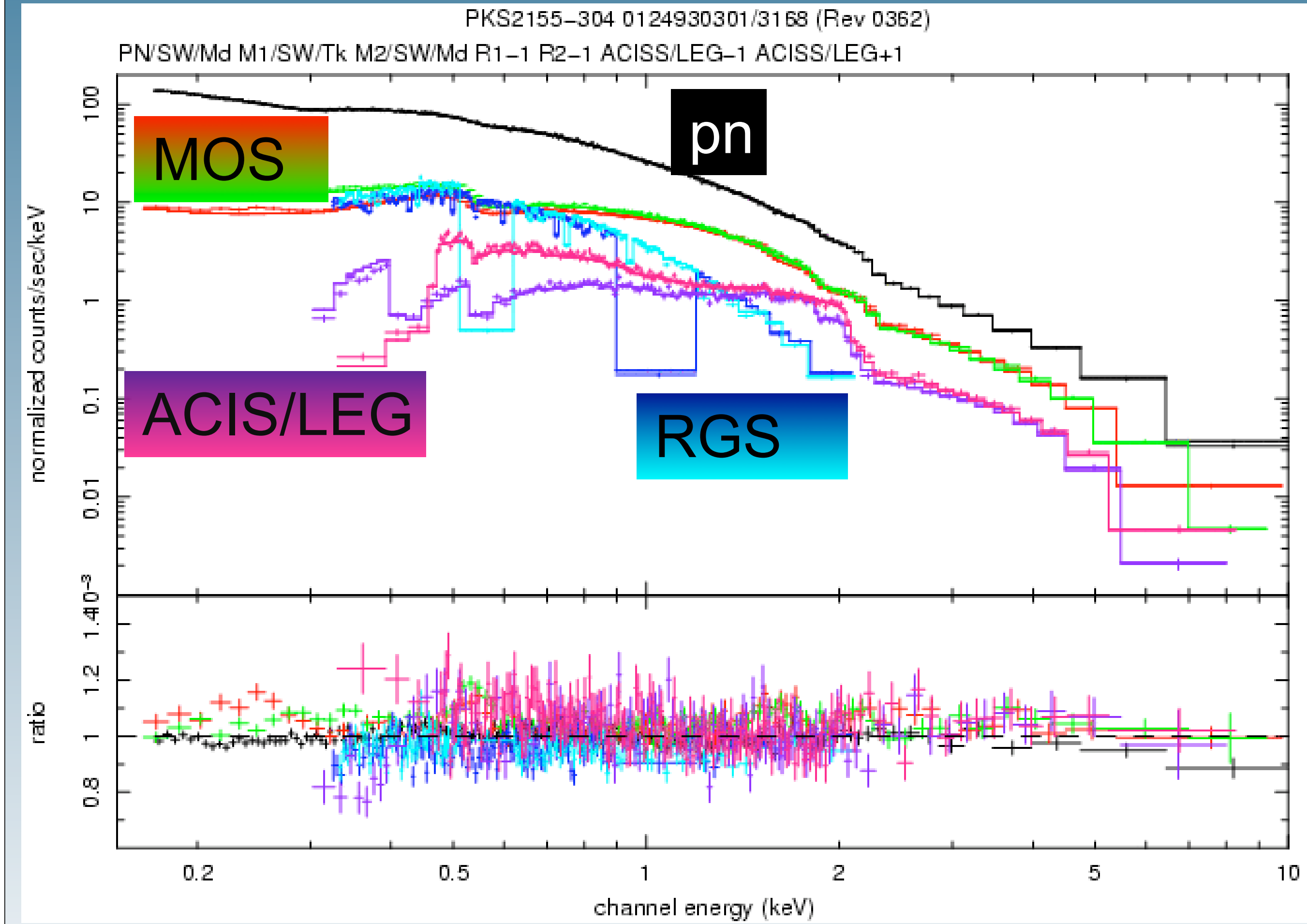


2006



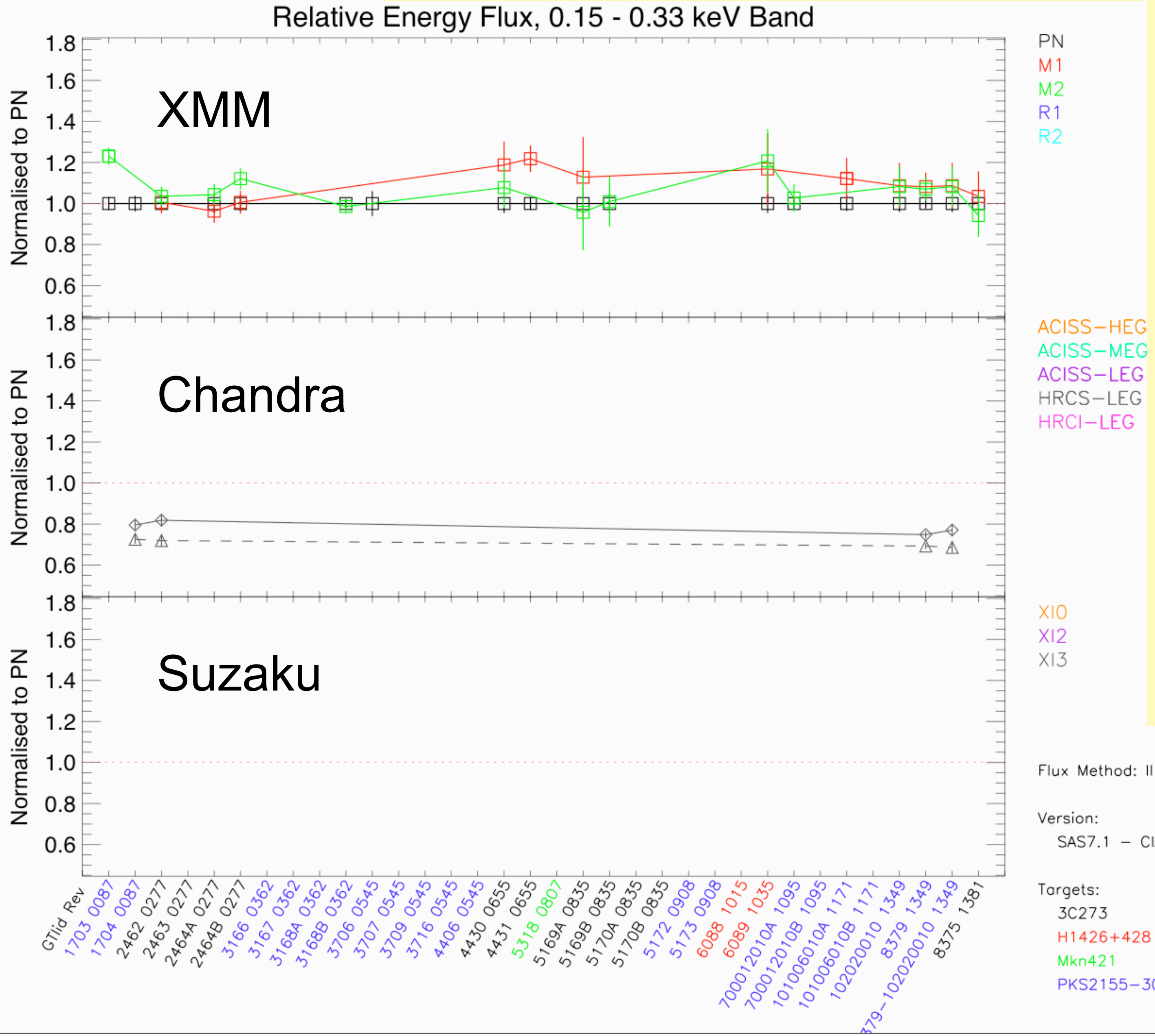
2007

XMM-Newton vs. Chandra ACIS/LETG



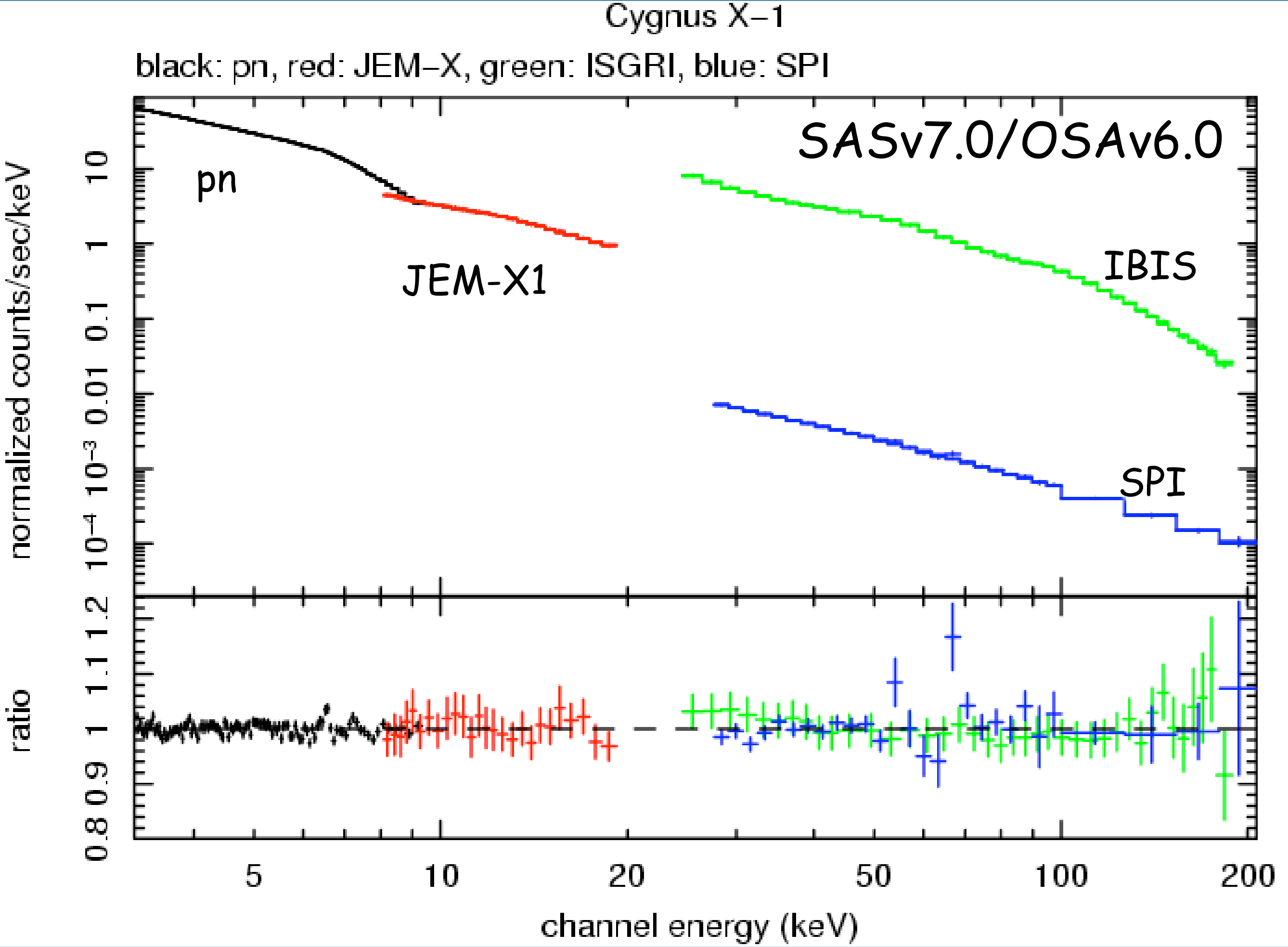
- PKS2155-304
- XMM rev. 0362
- Good agreement above 1 keV
- ACIS/LETG has higher normalisation than the EPICs below 1 keV
- Above ~2 keV, ACIS/LETG agrees with MOS

Cross calibration (time)



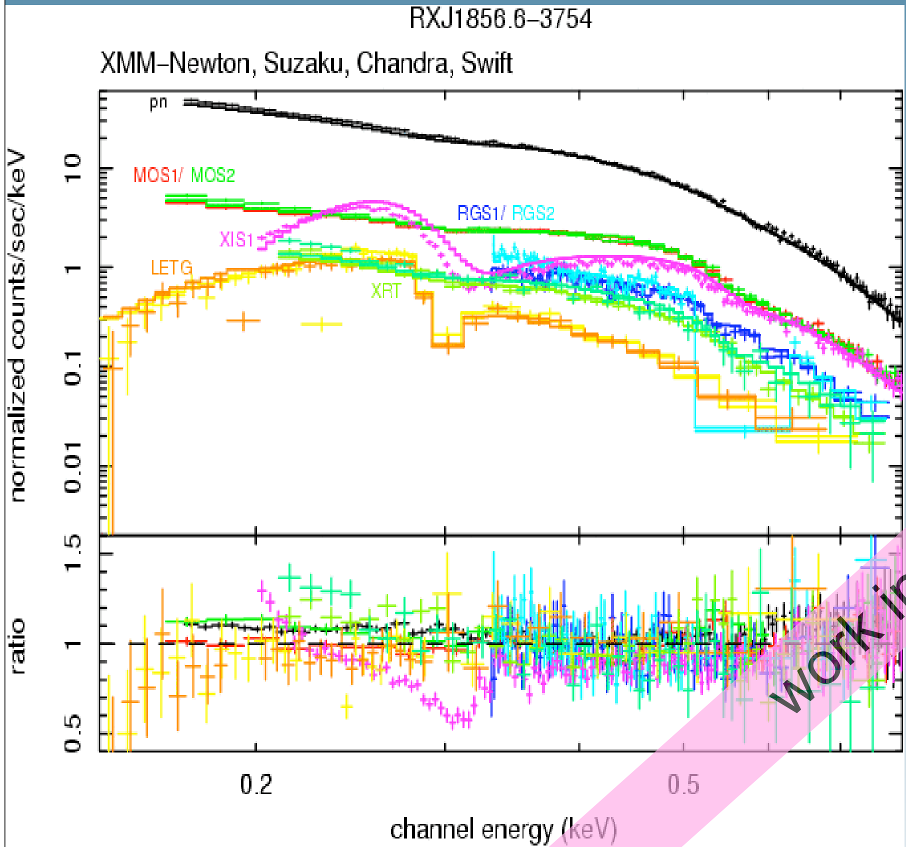
- 1. HRCS-LETG deficit below 1 keV (as e.g. the Beuermann et al. 2006 results comparing with ROSAT), and excess above 1.5 keV (HRC LETG flux derived from combining orders 1 to 5)
- 2. ACISS-LETG deficit similar to that of HRCS-LETG in 0.33-0.54 keV band
- 3. Overall, where EPIC diverge, ACISS-HETG follows MOS rather than PN

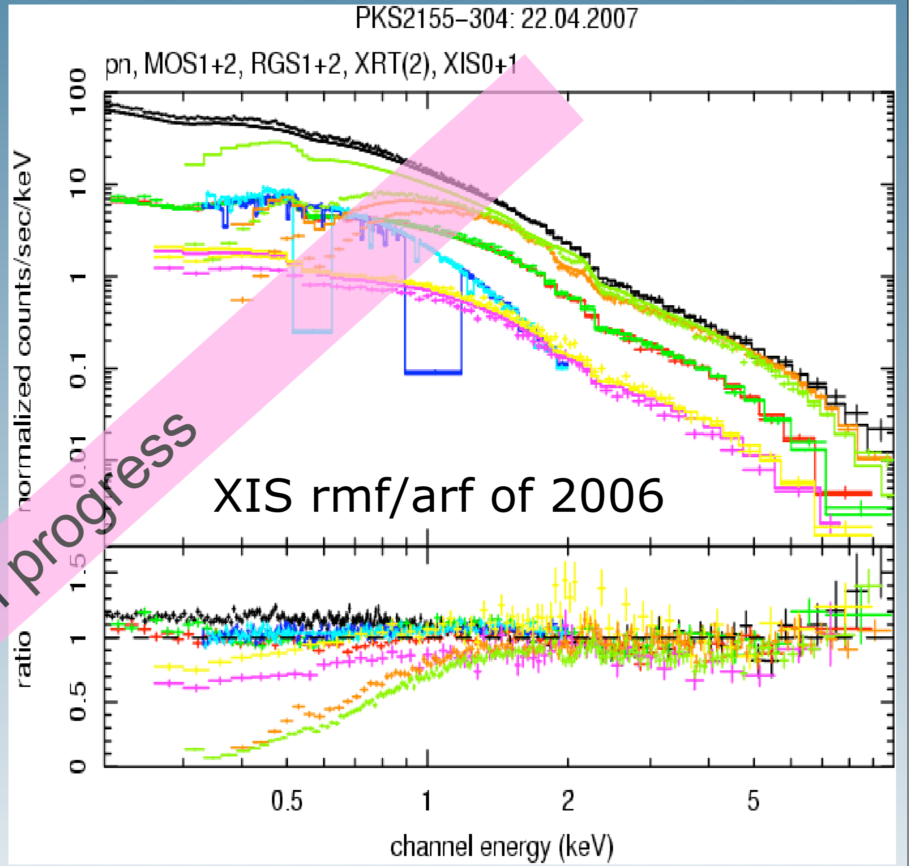
XMM-Newton versus INTEGRAL



- Cygnus X-1
- XMM rev. 0907
- pn modified timing mode
- Unique BH model
- Joint fit with norm. constants
- Data by courtesy of S. Fritz, IAAT

XMM-Newton versus Suzaku/Swift





International **A**stronomical **C**onsortium for **H**igh **E**nergy **C**alibration (IACHEC)

XMM-Newton, Chandra, Suzaku, INTEGRAL, Swift, RXTE, BeppoSax, Rosat, Einstein, (Astrosat,Symbol-X, E-Rosita)

Goals:

- **supervise cross calibration efforts**
- **paper on X-ray calibration standard candles**
- **paper on X-ray calibration targets for standard calibration issues**

Conclusion

- XMM-Newton is ready to perform high-end observation until at least **2018**
- funding most probably until end 2012
- all mission elements are stable and trouble free
- outstanding publication rate of ~300 papers/year
- half of all XMM-Newton papers are in the top 10 % of cited astrophysical papers
- calibration under control and in good shape
- A07 involvement: over-subscription factor ~7

- **keep on making rock an' roll**