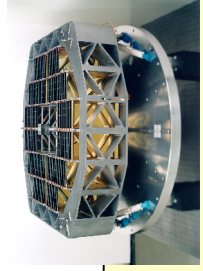


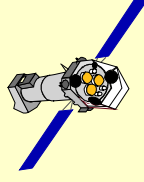
# Status of the XMM-Newton Calibration



M.G.F. Kirsch

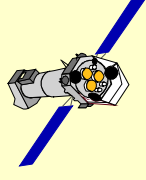
EPIC consortium

VILSPA EPIC & RGS IDT

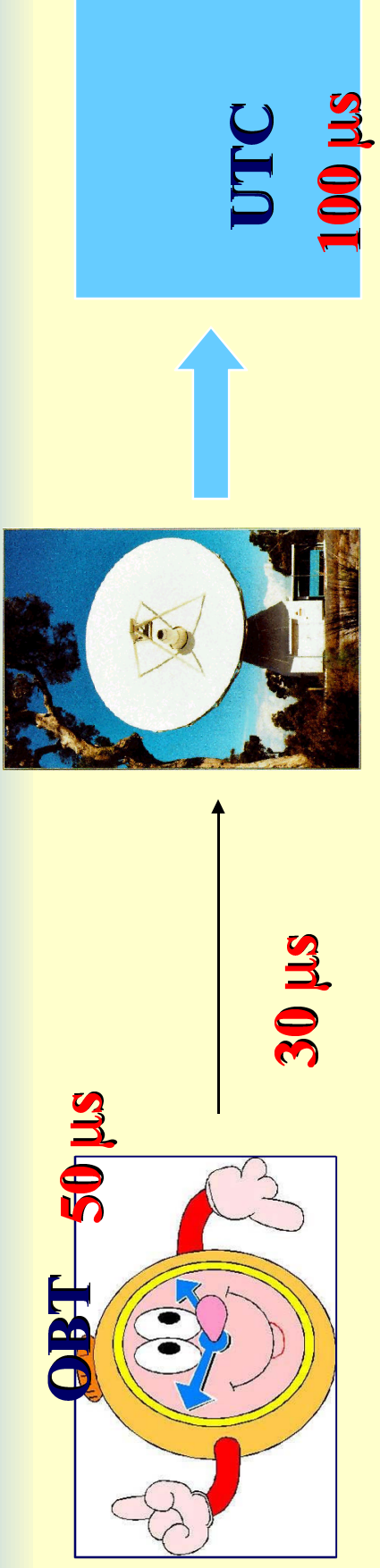


## menu

- status of calibration
  - general: timing, Vignetting, PSF: re-calibration
  - MOS: QE, RMF, cooling
  - pn: QE, RMF
  - long term stability
  - RGS: see talk by A. Pollock
- cross calibration campaign



# th. absolute accuracy



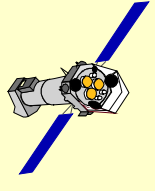
orbit prediction

**20 μs XMCS**

EPIC-pn

**+ - 10 μs**  
quadrant clocks

- theoretical upper limit for absolute time
- uncertainties is <100 μs
- the limited number of analyses conducted so far indicated in the past that the actual error is larger (~1ms)



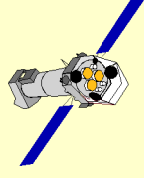
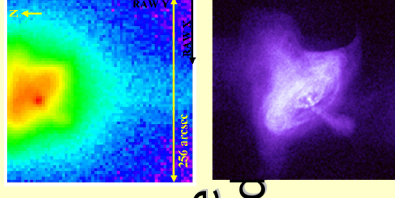
# a. accuracy: the bug

(for details see Kirsch et al. Proc. SPIE 5165)

- wrongly corrected CDMU delay (626.17 μs)
- delay was erroneously subtracted instead of added  
--> shift of 1252.34 μs.
- correction will be implemented in new time correlation

$$UTC(OBT) = ERT + \delta(CDMU) - \delta(Flight) - \delta(G/S)$$

- absolute timing accuracy now: ~300-600 μs
- in agreement with Crab observations performed by RXTE and Chandra
- **Crab observation with Chandra, XMM and in the optical** using an MPE developed fast photometer to get a radio-ephemeris independent phase solution between the optical and X-ray pulses performed, to be analysed



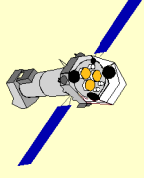
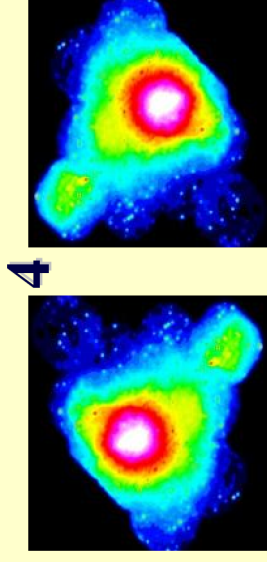
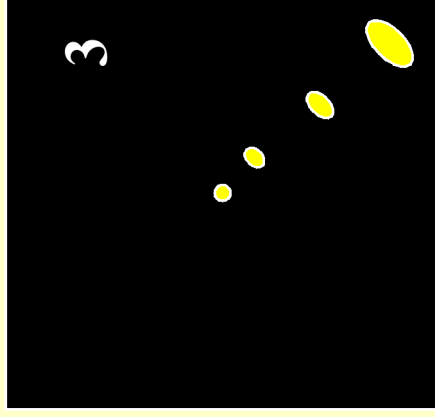
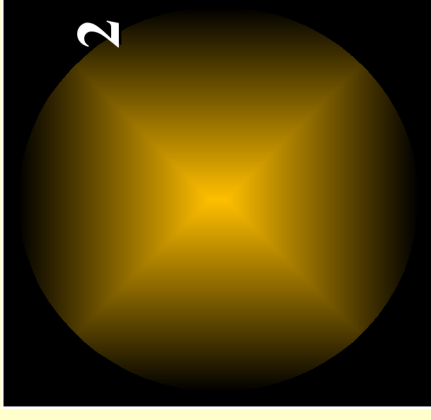
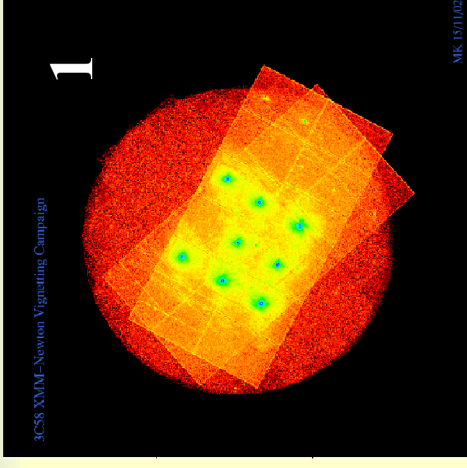
**XMM-Newton**

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Research & Scientific Support Department

**Marcus Kirsch**

# Signetting: the 4 methods

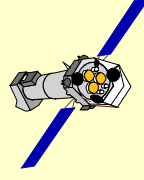
- source at different position
- diffuse background
- source elongation
- coma cluster



# position of optical axis

Coma Cluster	110 +/-40	(-)200 +/-70	550 +/-60	(-)1255 +/-30	1243 +/-30	402 +/-30
3C58 + G21.5 - 09	200 +/-200	(-)50 +/-200	340 +/-200	(-)1300 +/-200	1300 +/-500	450 +/-500
optics_X/Y (PIXCOORD)	305	291	325	243	23	183
optics_X/Y MISC_0019	300	300	300	300	39	188
difference in pixel	-5	9	-25	57	16	5
difference in arcsec	-5.5	9.9	-27.5	62.7	65.6	20.5

currently under testing in DT SAS

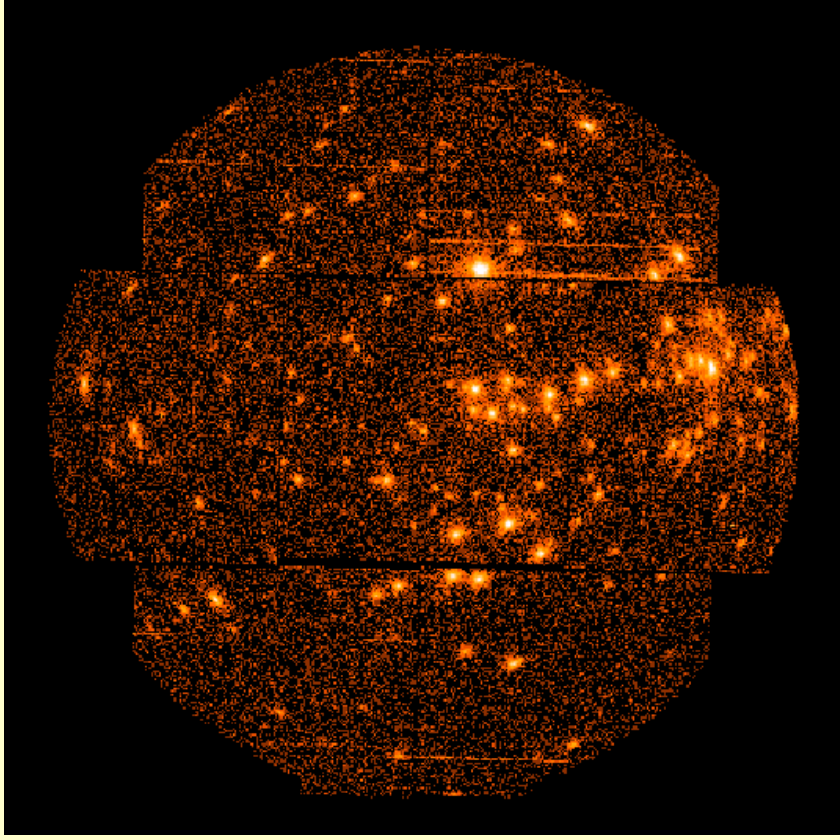


**XMM-Newton**

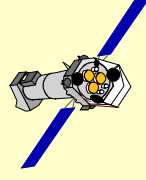
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# calculate new BS angles

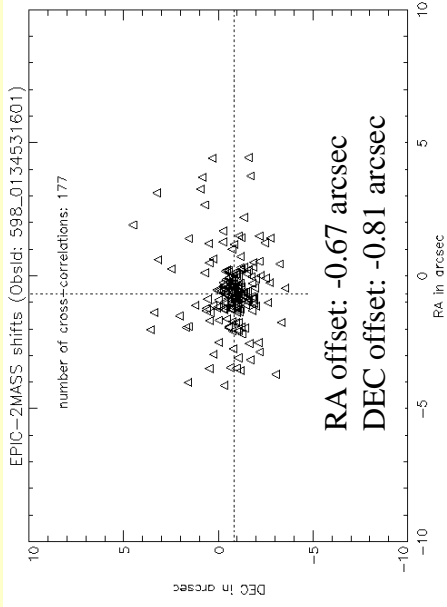
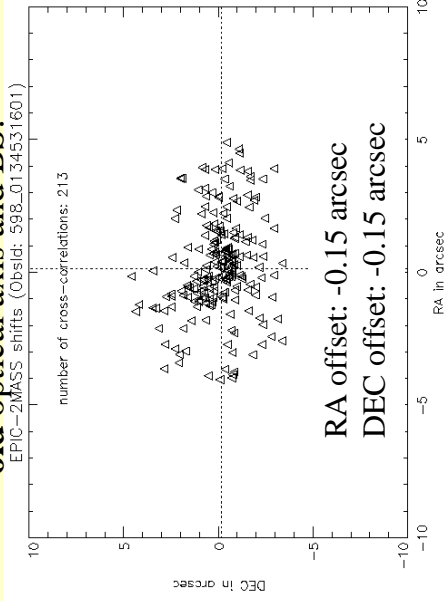
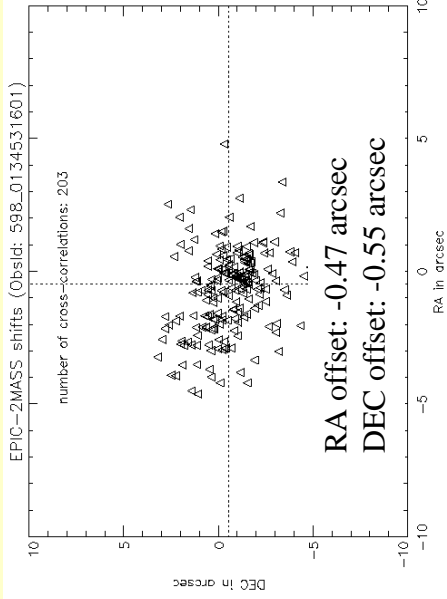


- the new optical axis position required a set of new Boresight CCFs which hold for each instrument a triple of three angles describing the misalignment of the respective instrument boresight with respect to the satellite coordinate frame
- using the OMC2/3 field new BS misalignment angles for all the three cameras have been calculated
- goal: astrometry should not change!!!!!!!

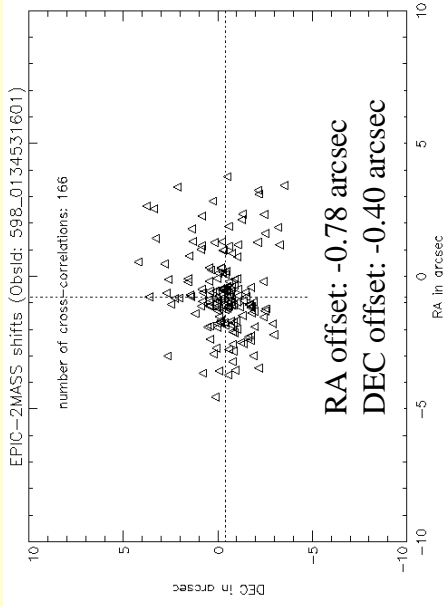
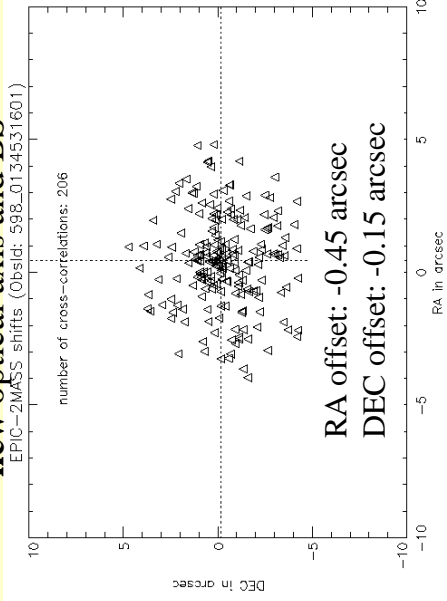
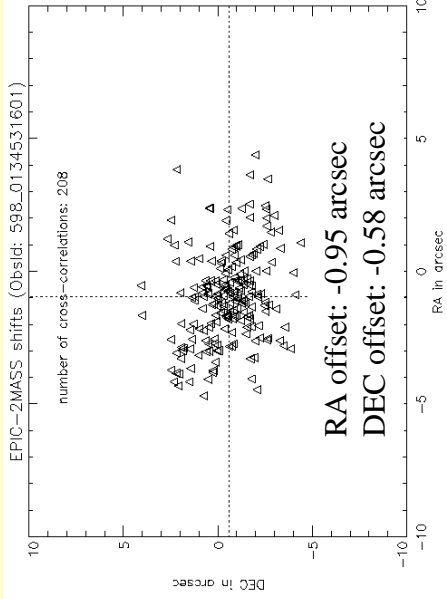


# astrometry: EPIC-2MASS

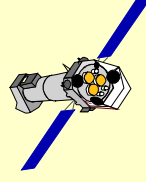
## old optical axis and BS:



## new optical axis and BS



B. Altieri

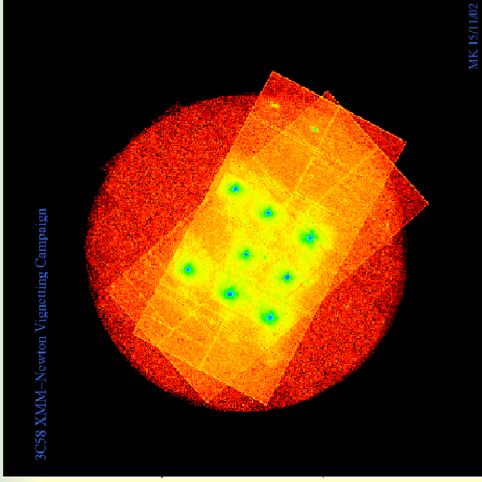


**XMM-Newton**

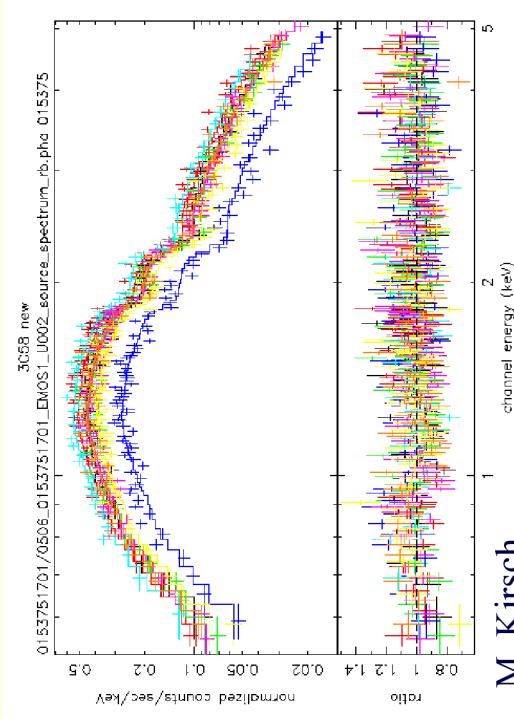
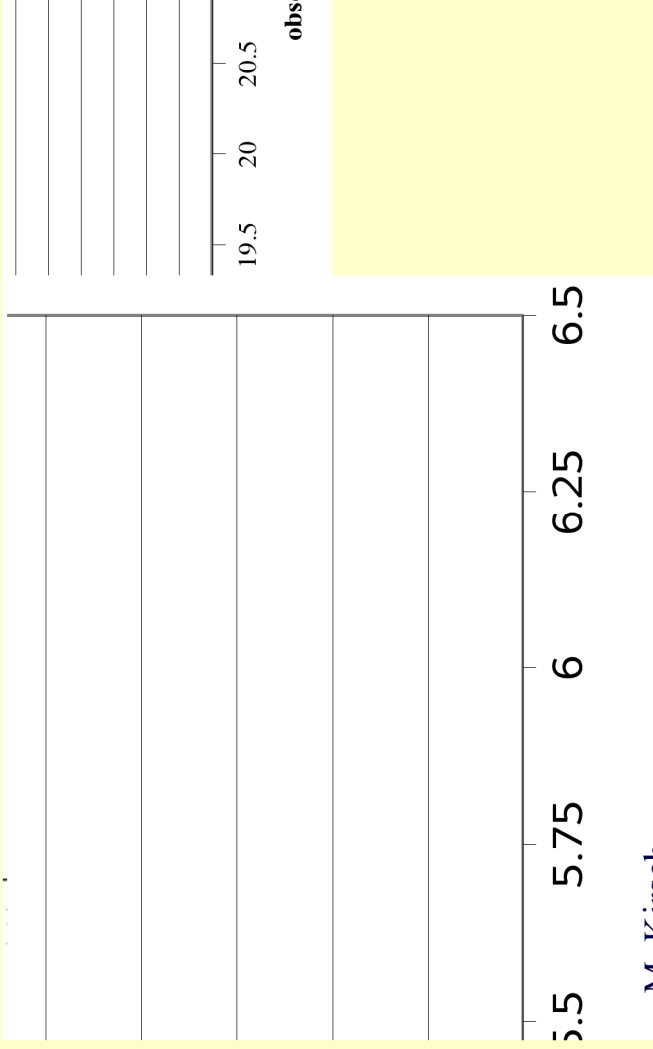
**Marcus Kirsch**  
Science Operations & Data Systems Division  
Research & Scientific Support Department



# 3C58 results for MOSS



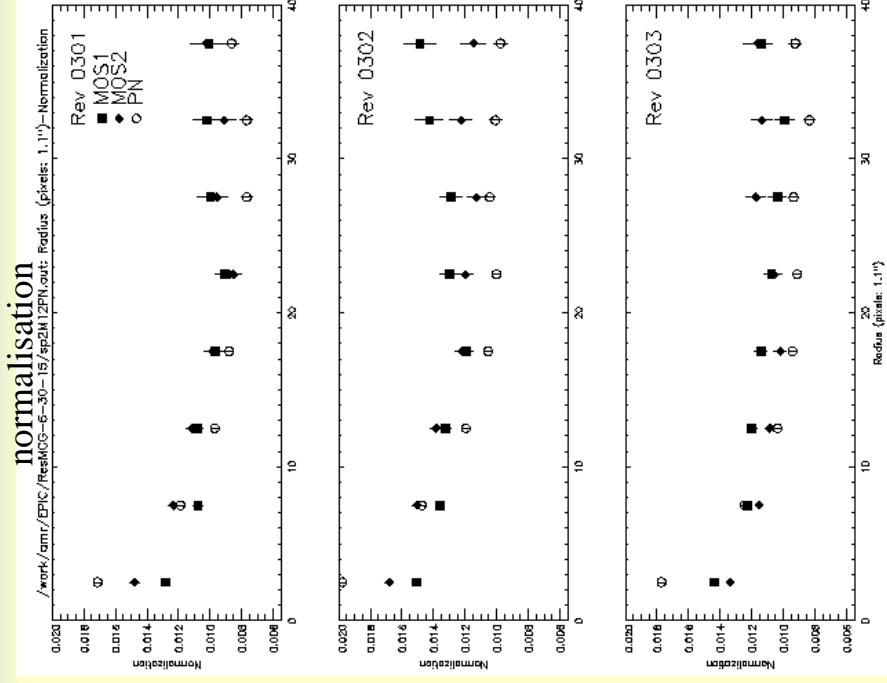
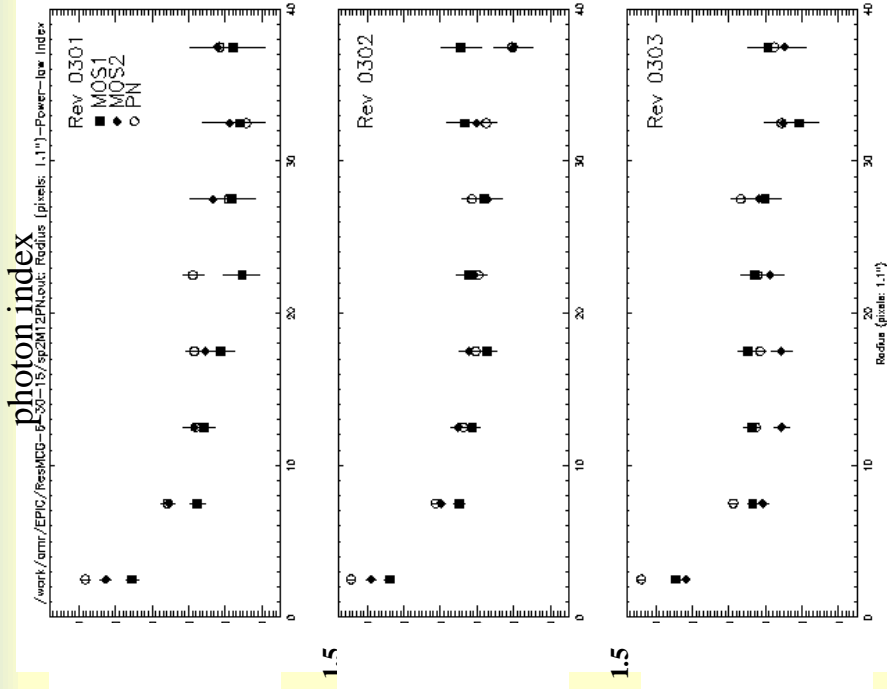
Model: constant[1]\*wabs[2]( powerlaw[3] )



- flux variation off axis reduced from  $\pm 10\%$  down to  $\pm 2-3\%$  for both MOSS
- pn to be checked with Coma/G21.5-09



# PSF: re-calibration



- spectra from annuli at 0, 5, 10, 15,...40 pixels of MCG-6-30-15
- created appropriate RSPs and ARFs
- fit (power-law modelling) on the 2-10 keV single events.
- derived spectral slope for non-piled-up point sources is not independent of the extraction radius

1.5

0

20

40

0

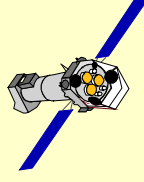
20

40

extraction radius in pixels  
A. Read



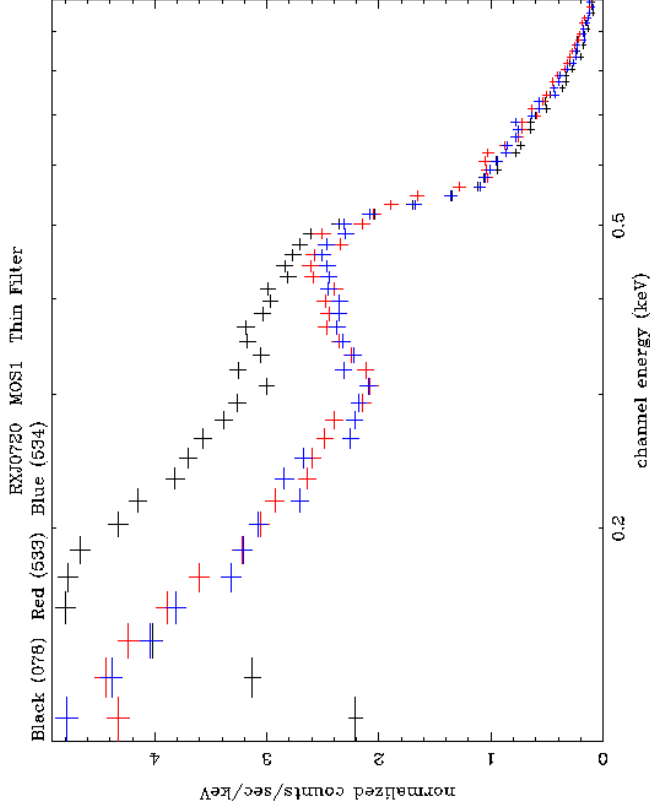
extraction radius in pixels



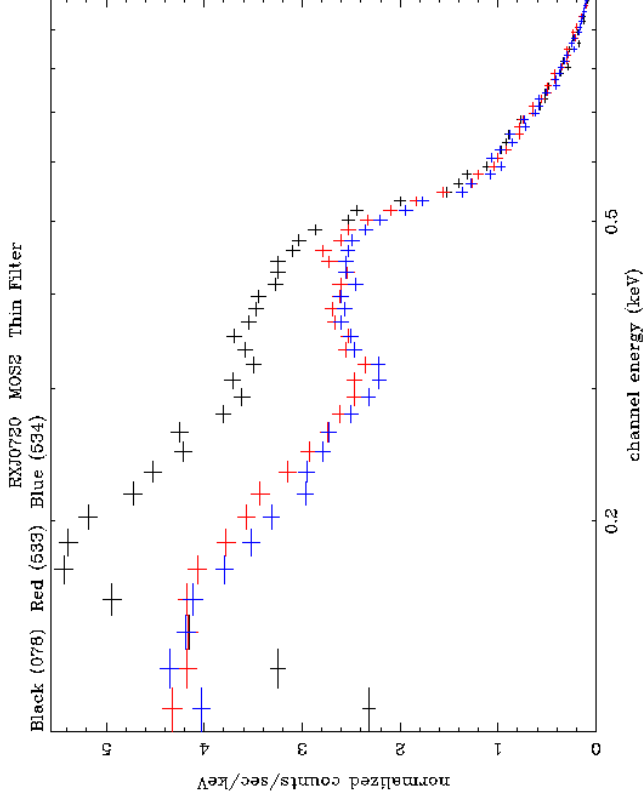
XMM-Newton

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# MOS: Low Energy Epoch Dependent Response Variation

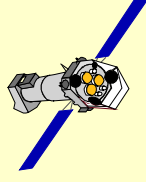
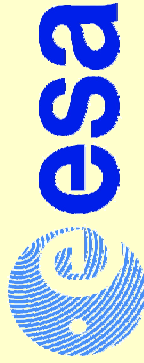


S. Sembay



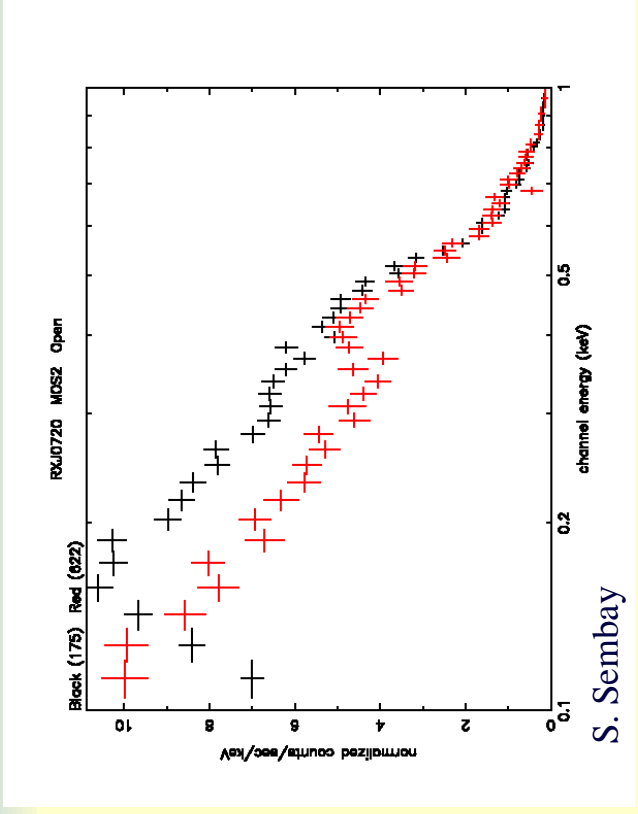
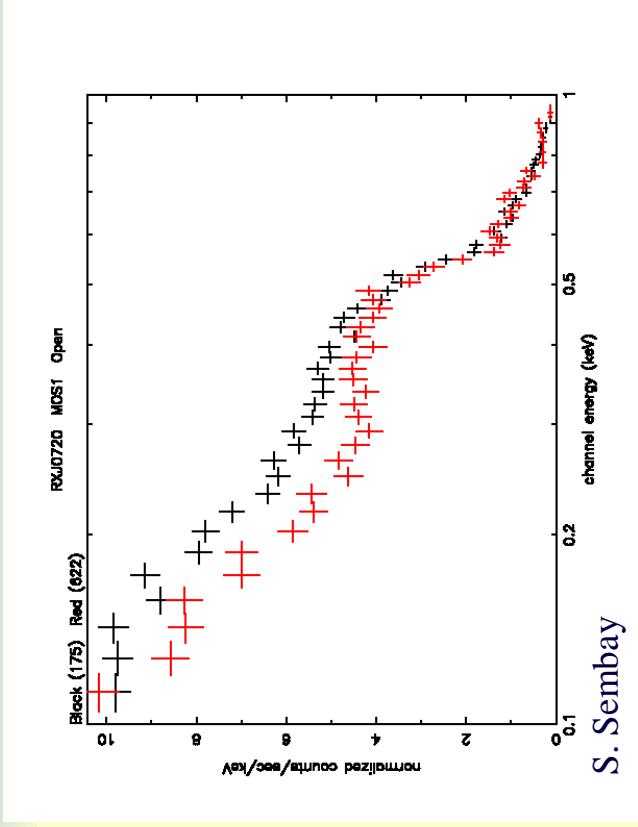
S. Sembay

Significant change in spectrum between Rev 78 and 533/534



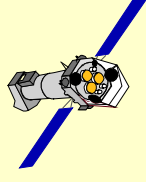
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 Science Operations & Data Systems Division  
 Research & Scientific Support Department

# what happened?



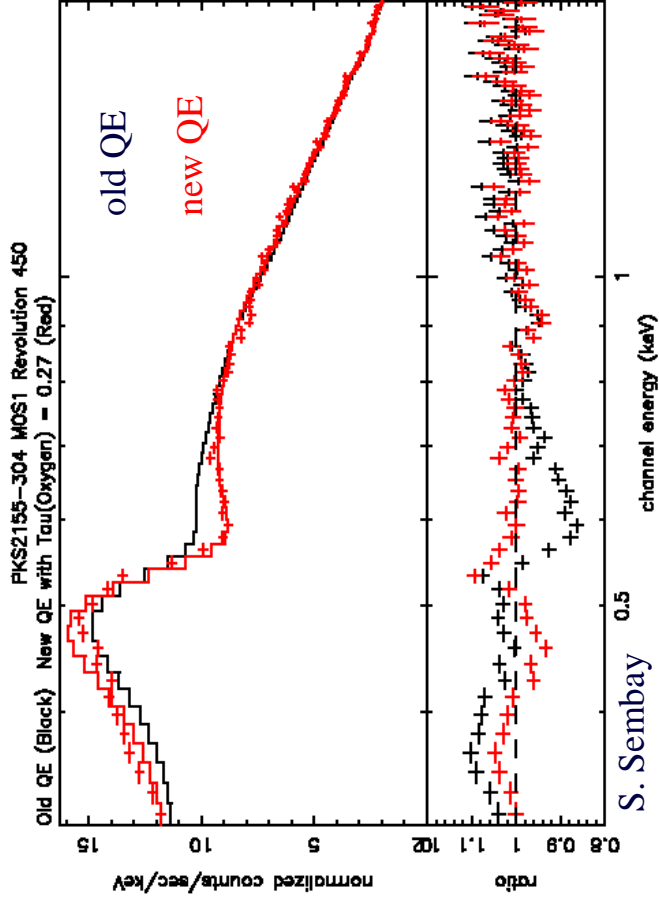
## RXJ0720.4-3125, mos1 and mos2, in OPEN between Revolutions 175 and 622

- no filters, so the CCDs have changed
- difference in the change in the spectrum below 200 eV for MOS1 and MOS2
- combination of time dependent QE and rmf change which has affected both cameras, but not exactly at the same times

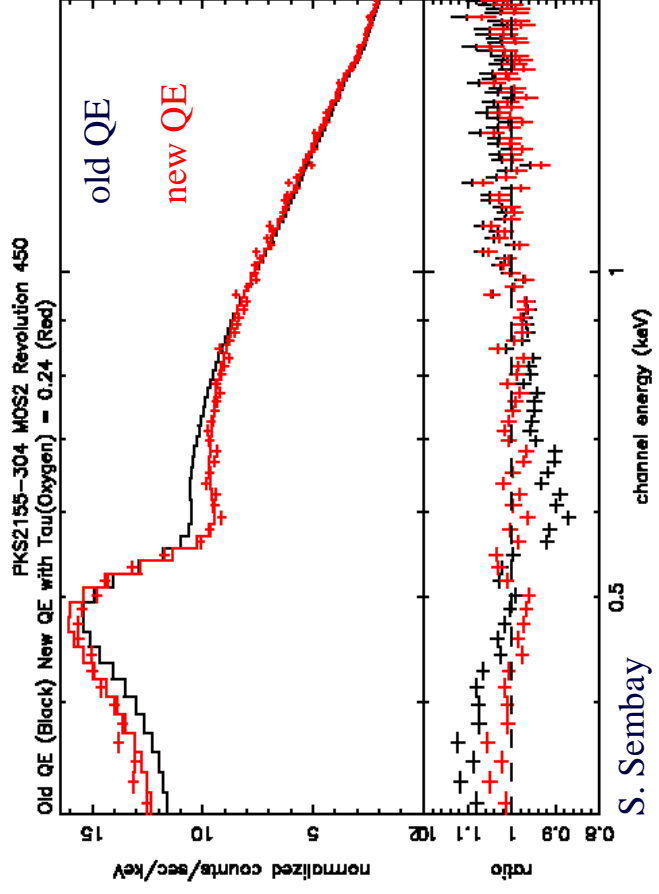


# MOS: oxygen absorption

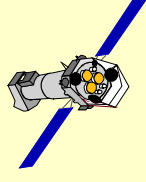
MOS1



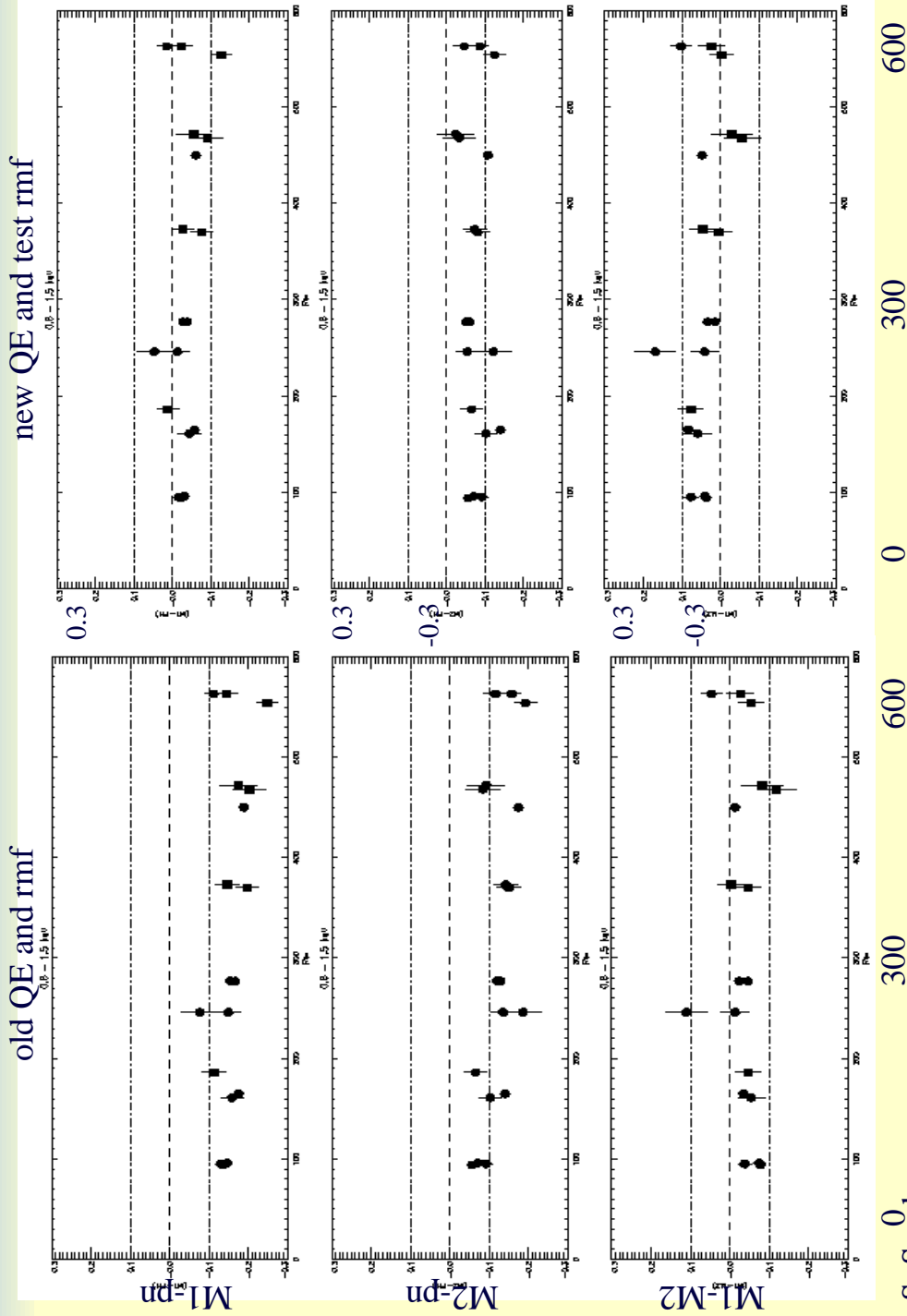
MOS2



- PKS2155-304 MOS1 and MOS2 from Rev 450 showing the difference at oxygen of the old and new QE
- MOS2 fits pretty well, but MOS1 still has some residuals, probably due to inaccuracy in the new test rmf



# MOS: oxygen absorption



- differences in fitted spectral slope to a group of AGN in the band 0.6-1.5 keV
- all cameras now agree to within 0.05 in slope whereas the difference before between MOS and pn was  $\sim 0.15$

S. Sembay



Rev

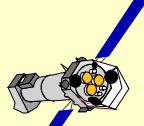
300 600

-0.3

0

300 600

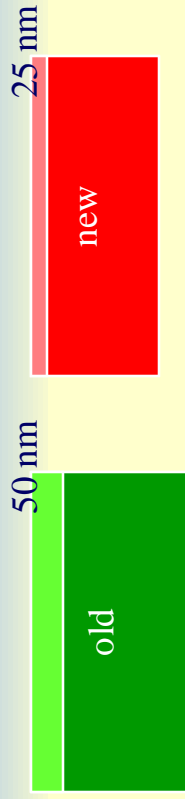
Rev



XMM-Newton

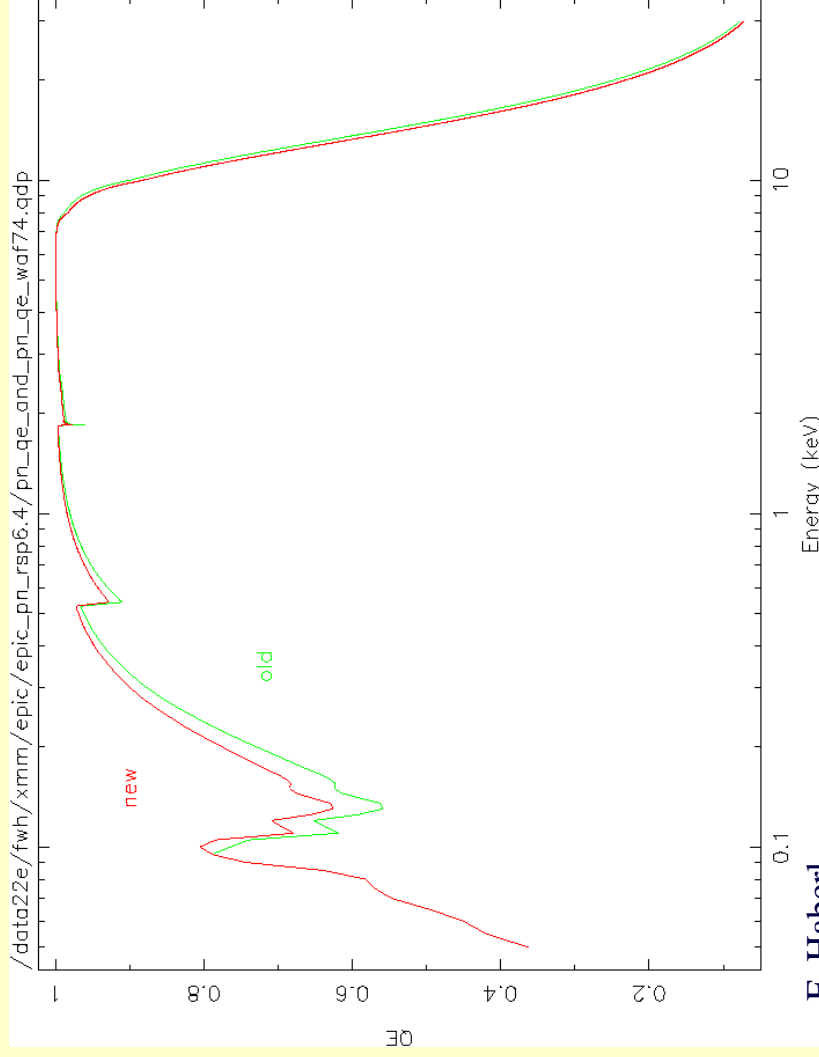
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# pn: spectral response in SAS5.4.1



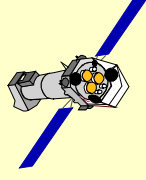
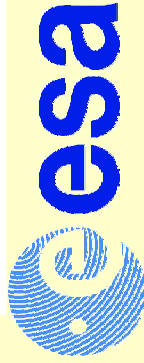
- Now implemented (SAS5.4.1)

- newly determined thickness of the SiO<sub>2</sub> entrance window
- New Quantum Efficiency curve
- RX J1856.5-3754: Redistribution re-adjustment



F. Haberl

fwf-29-jan-2003 11:21

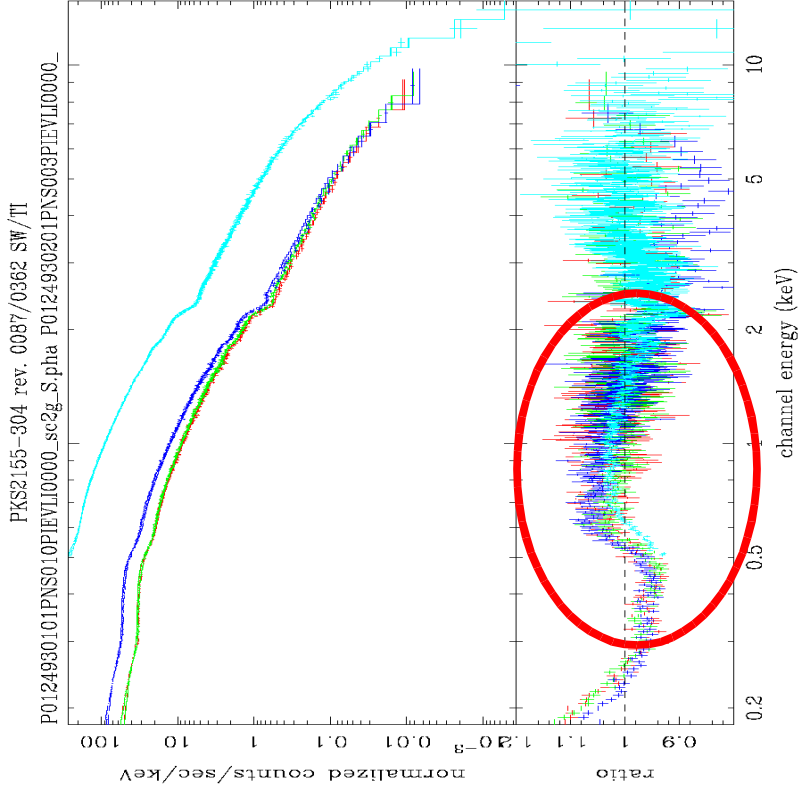


XMM-Newton

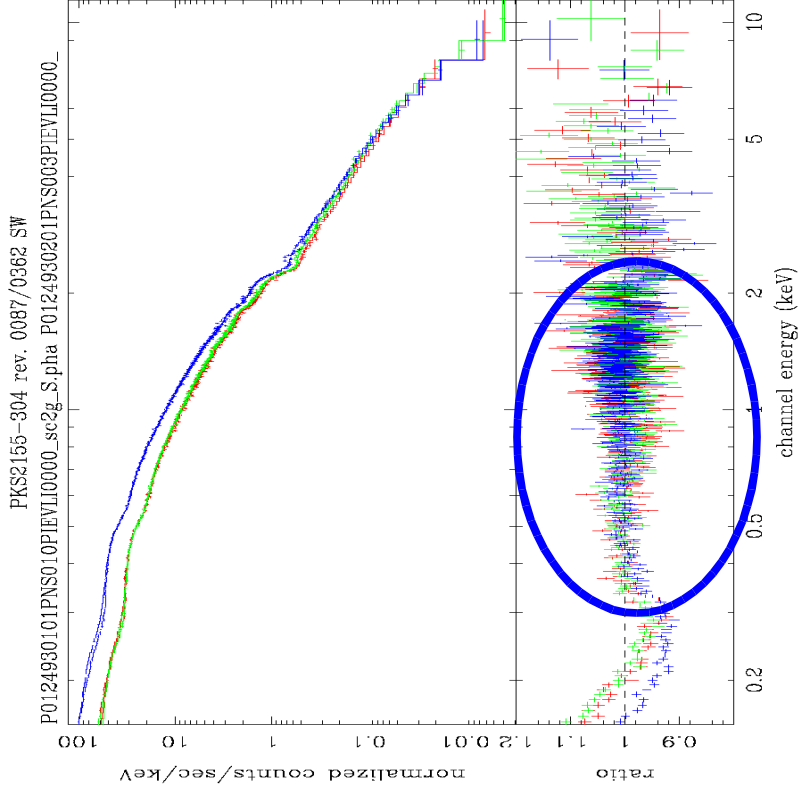
Marcus Kirsch  
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Research & Scientific Support Department

# pn: PKS2155-304

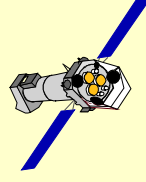
without and with new QE and redistribution for pn



F. Haberl

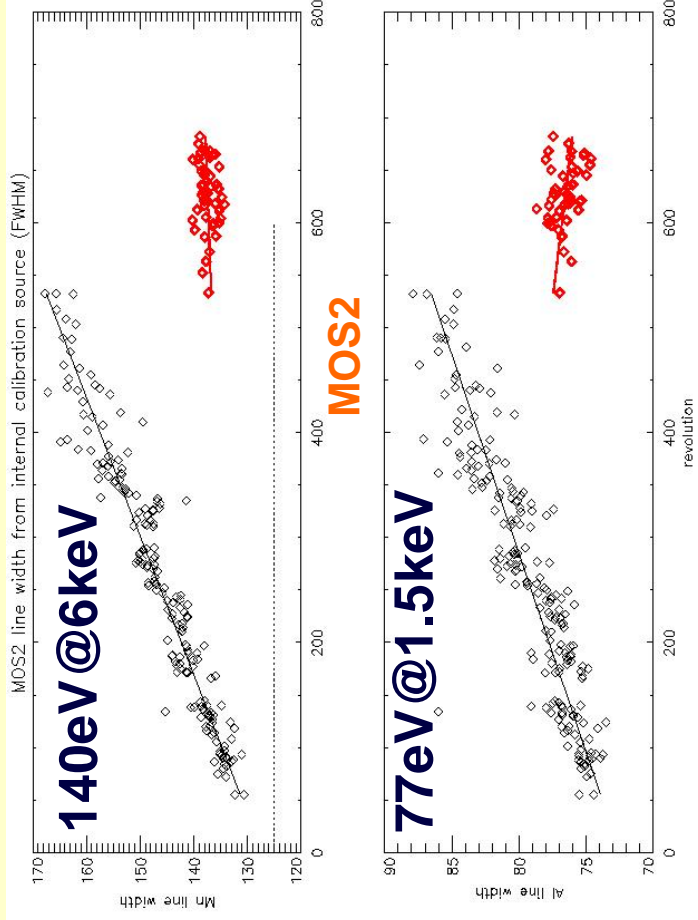


F. Haberl



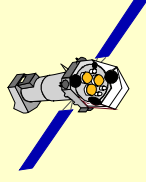


# MOS: long term trends

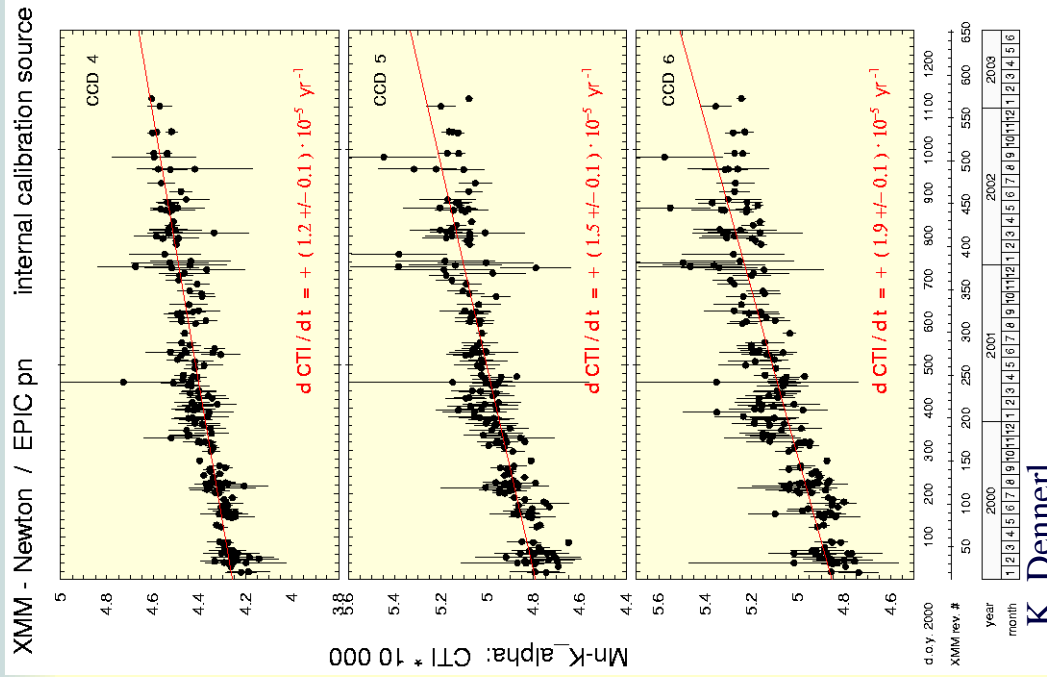


cooling

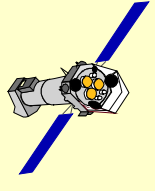
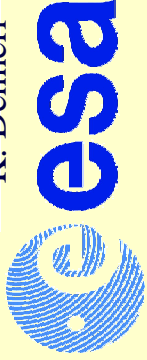
- Energy resolution rather constant since cooling



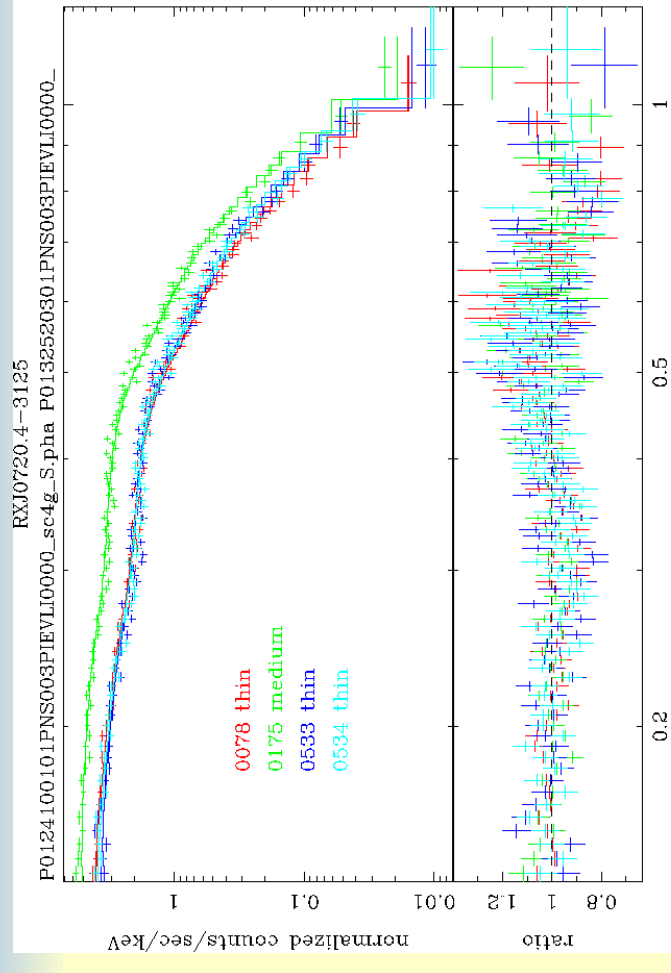
# pn: long term trends



K. Dennerl



**XMM-Newton**    **Marcus Kirsch**  
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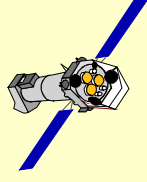
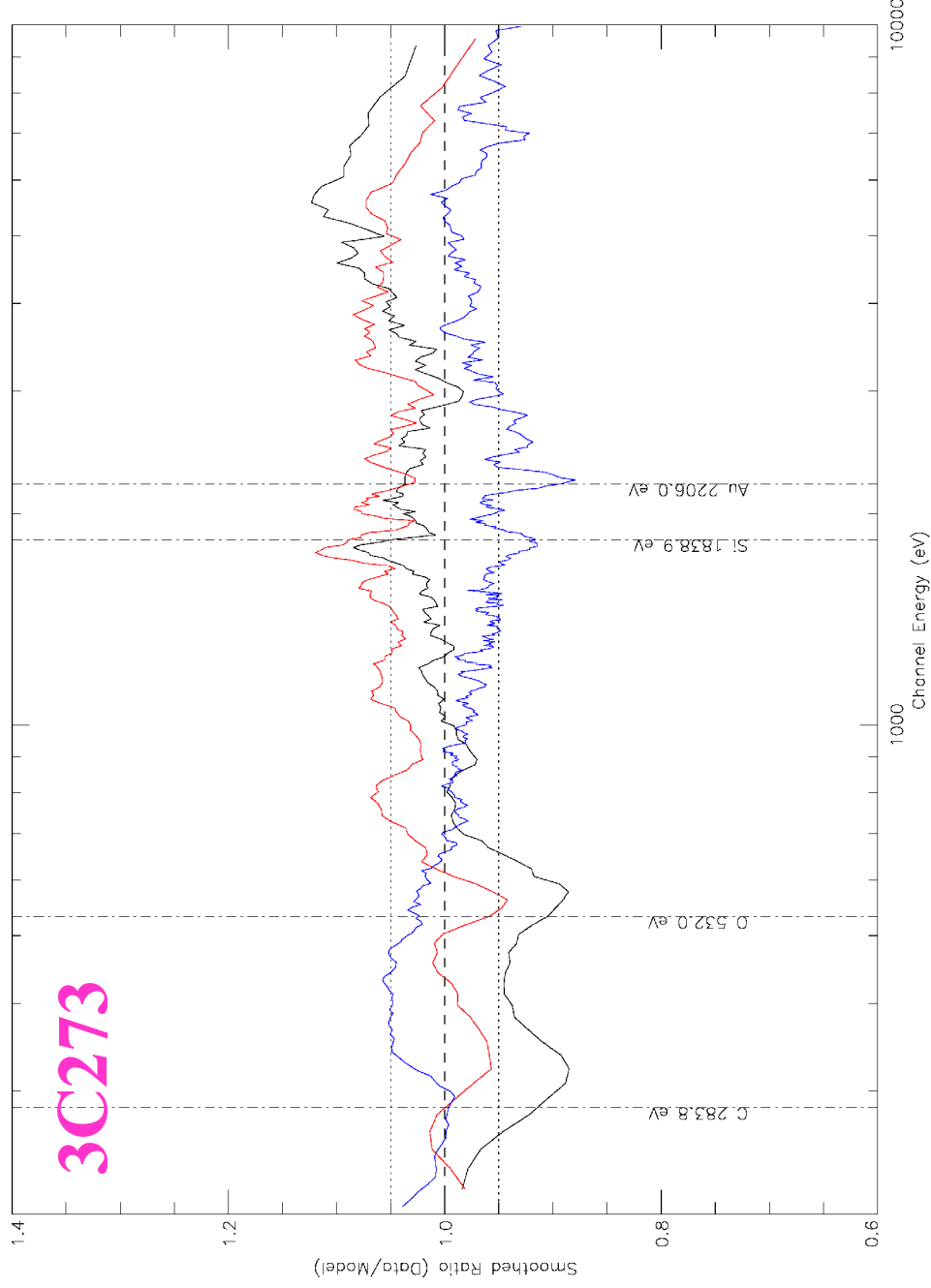
F. Haberl

1wh 23-Jun-2003 14:07

- no change in soft response
- CTE degradation seems to slow down (some further monitoring before action)

# cross calibration: EPIC

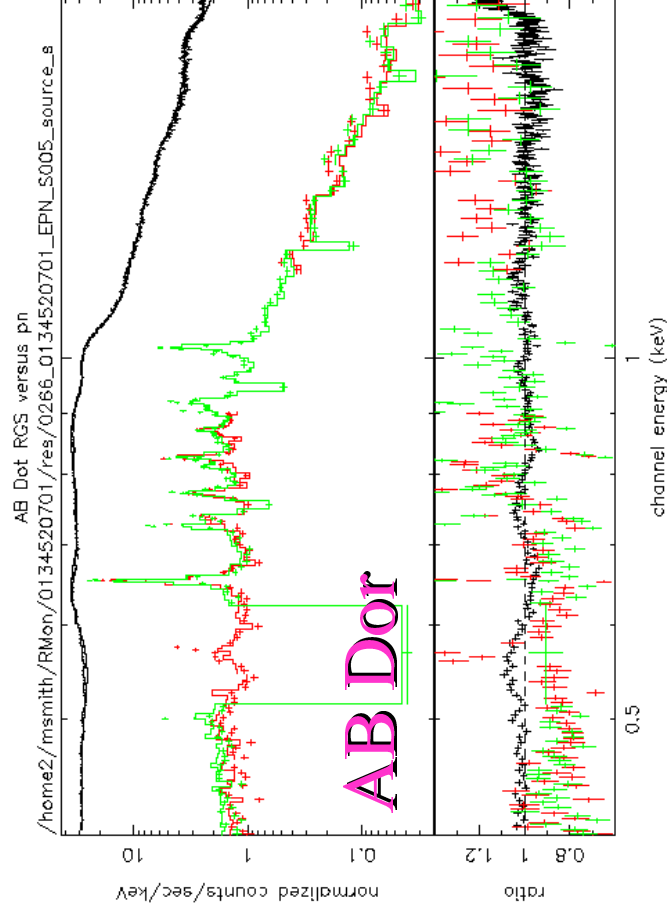
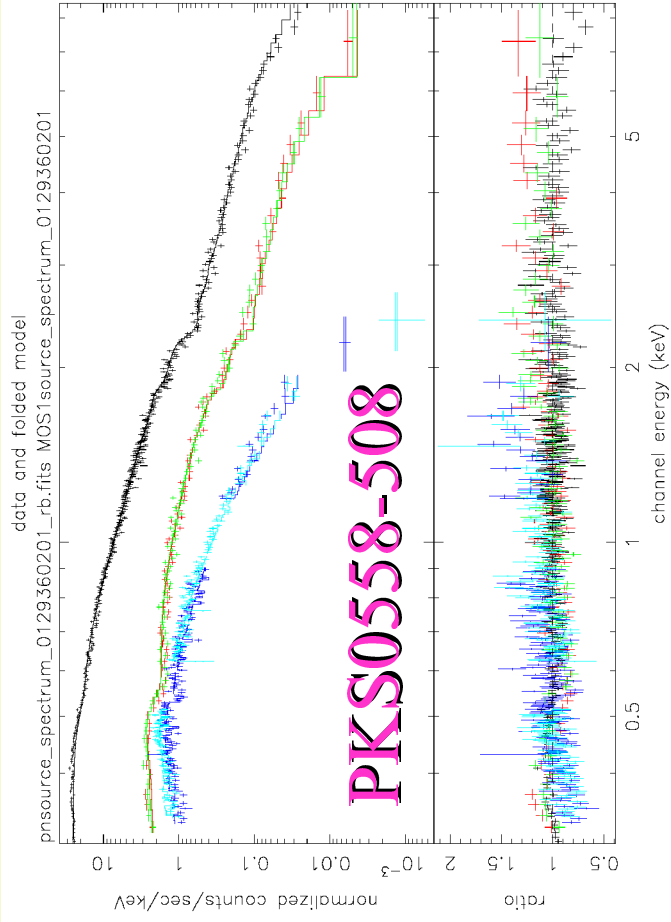
3C273



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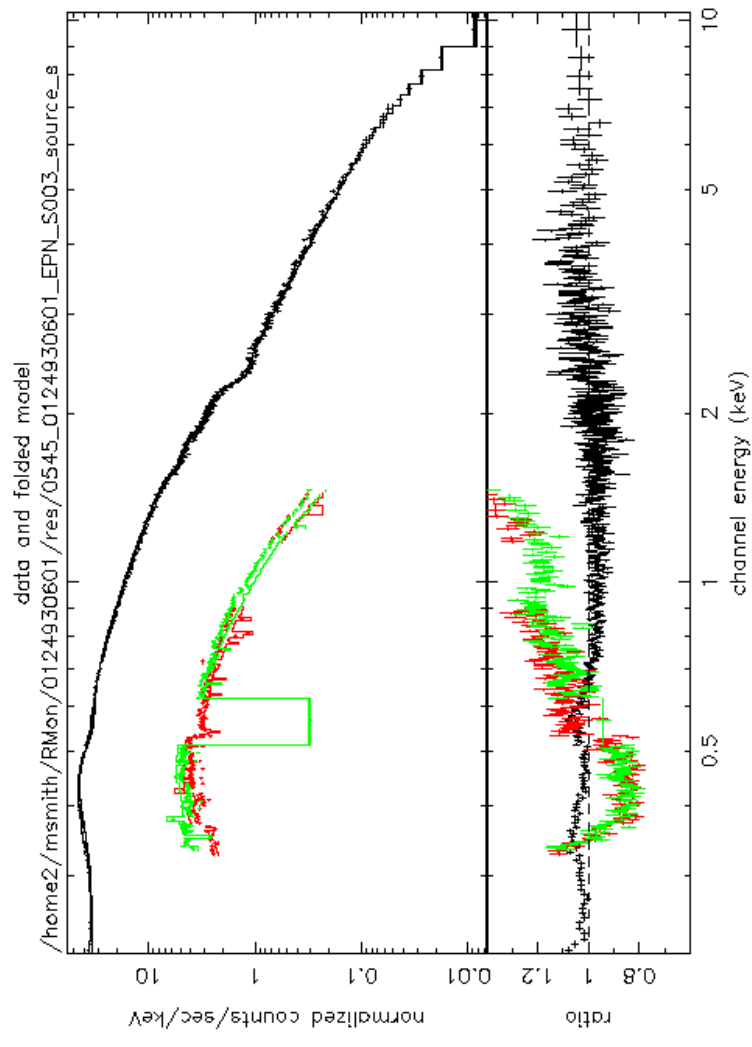
# cross calibration: EPIC-RGS



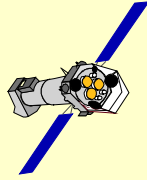
- systematic cross calibration for 25 targets, 200 observations underway
- understand the up to  $\pm 20\%$  differences in flux between EPIC and RGS
- line-rich spectra RGS  $\Rightarrow$  EPIC
- continuum spectra EPIC  $\Rightarrow$  RGS

# results: PKS2155-304

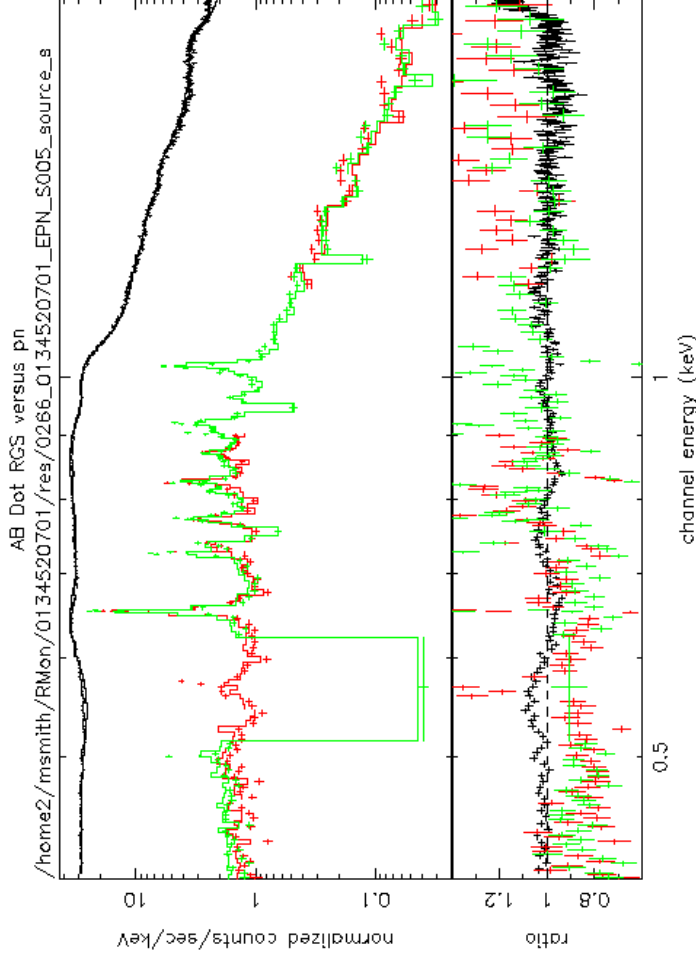
- Model: constant  
\*wabs \*powerlaw  
where constants for RGS are free (0.91,0.89), all other parameters are fitted simultaneously  
up to  $\pm 20\%$  differences in flux  
same trend also observed for PKS0558-504



mKirsch 18-Sep-2003 15:36

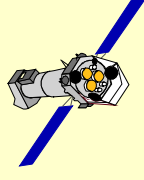


# results: AB Dor

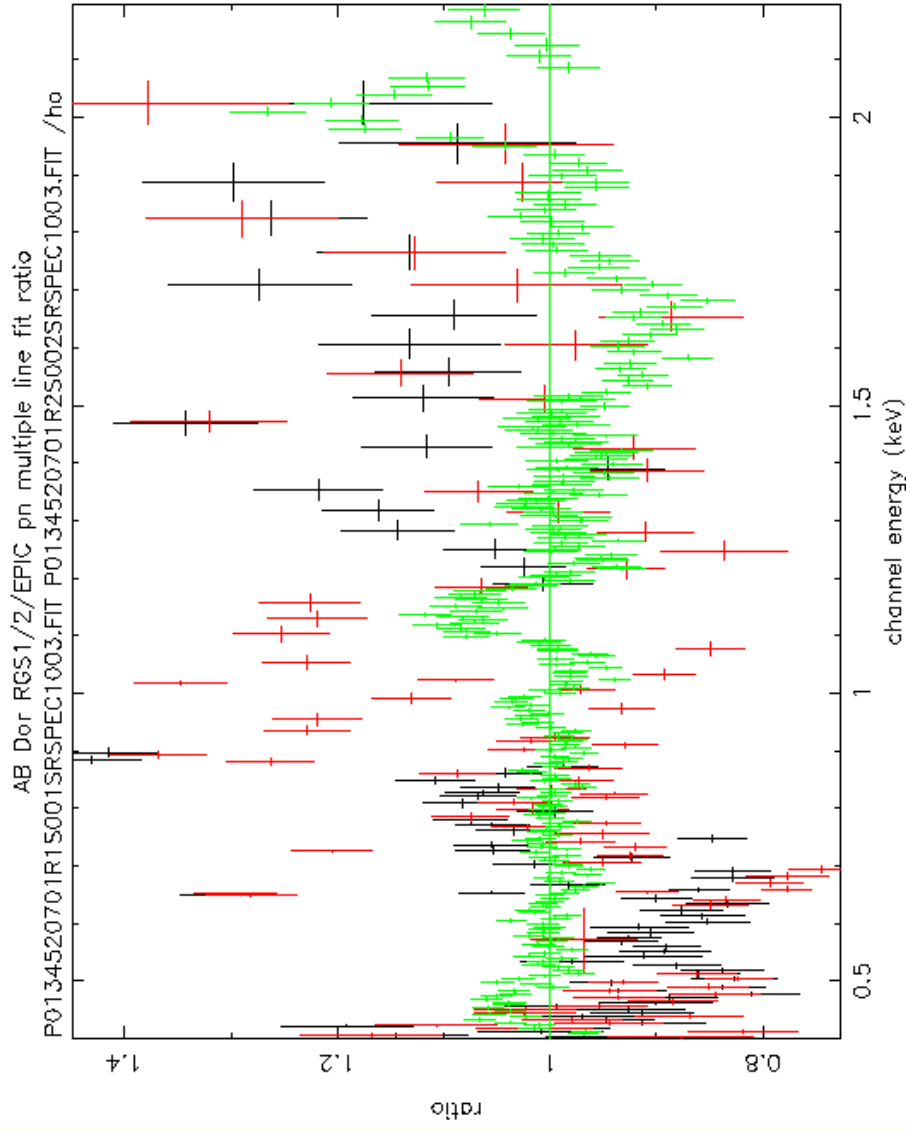


mlkrsch 16-Sep-2003 14:27

- Model: constant \*wabs \*(vmekal+bremss) where constants for RGS are free (0.85,0.87), all other parameters are fitted simultaneously
- the spectrum's many lines are not perfectly fit but the model is good enough for this comparison
- up to  $\pm 20\%$  differences in flux

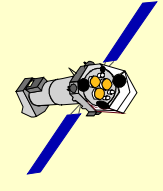


# results: AB Dor



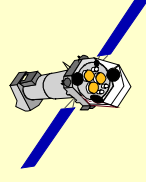
- **Model:**
  - constant
  - \*brems+ (some gaussians)
  - where constants for RGS are free
- up to  $\pm 20\%$  differences in flux

\*wabs



# EPIC calibration summary

Effect	Max. Error	Energy dependent	Off axis angle dependent
Relative Astrometry	1''(r.m.s.)	NO	YES
	2'' (r.m.s.)	NO	YES
PSF	2 %	YES	YES
Relative Effective Area	± 5 %	YES	YES
Absolute Effective Area	± 10 %	YES	YES
Line Energies	± 10 eV	YES	YES
Relative Timing	$\Delta P/P < 10^{-8}$	NO	NO
Absolute Timing	300-600 $\mu$ s	NO	NO



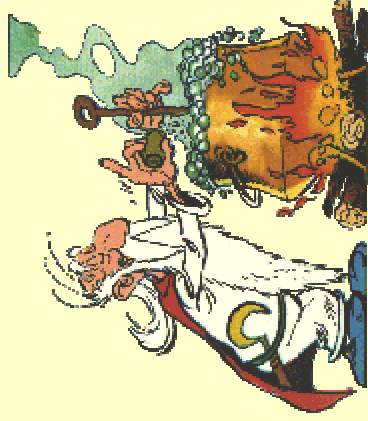


## for detailed information

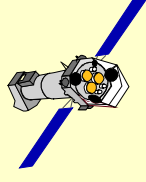
### XMM-Newton Calibration Portal

[http://xmm.vilspa.esa.es/external/xmm\\_sw\\_cal/calib/index.shtml](http://xmm.vilspa.esa.es/external/xmm_sw_cal/calib/index.shtml)

- ↑ Updated: EPIC Calibration Status Version 2.2  
for new SAS release
- ↑ Release notes for every new CCF
- ↑ General Calibration Documentation



we keep on calibrating



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Page 25