

Cross-Calibration of Chandra with XMM-Newton

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Contributors

- Chandra X-ray Center
 - Coordinated observations: Marshall, Drake
 - ACIS QE: Edgar, Grant, Plucinsky
 - ACIS Contamination: Plucinsky, Marshall, Grant, Vikhlinen, others
 - HRC-ACIS: Drake, Wargelin, Marshall
 - LETG-HETG: Marshall, Wargelin
- XMM-Newton
 - Coordinated observations: Kirsch, Pollack
 - EPIC PN: Haberl
 - RGS-PN-MOS comparison: Kirsch, Pollack
 - RGS: den Herder

Coordination Efforts

- Ongoing cross-calibration observations
 - Observing 3C 273 and PKS 2155-304 once per year
 - XMM is “on-call” to coordinate with Chandra bakeout
- Face-face meetings
 - HLM met with Jan Willem den Herder and RGS scientists in July 2002
 - Marcus Kirsch and Andrew Pollack attended the Chandra Calibration workshop in October 2003
 - HLM meeting with Kirsch and Pollack in June 2004 cancelled due to airline delays
- Other communication
 - XMM cal presentations passed along to Cal group
 - Kirsch is spearheading coordination for XMM

Chandra Internal Cross-Calibration

- First tried with 3C 273 in January 2000 using LETG/HRC, LETG/ACIS, HETG/ACIS
 - Effect of contaminant first found — -70% at 288 eV
 - BI/FI QE discrepancy first noted — -15% at 600 eV
 - Also obs'd by ASCA, RXTE — Agree to <10% (1-8 keV)
- Contaminant is still under scrutiny
 - Edges known but continuum absorption is uncertain
 - Time dependence found in 2002 is well characterized
 - Spatial dependence found in 2003
 - More observations planned for July 2004
- BI/FI issues may be solved
 - BI QE has been revised — in testing
 - FI QE affected by cosmic rays residuals

Chandra Internal Cross-Cal: Methods

- BI QE compared to FI QE
 - LETGS and HETGS comparison of +I against -I
 - Use spectral fitting of SN and galaxy clusters
 - Reanalyze XRCF data
- HEG compared to MEG
 - Use any bright target (without pileup)
 - Compare after correcting for BI/FI
- ACIS-S compared to HRC-S
 - Use back-back LETGS observations of PKS 2155-304
 - Update high order efficiencies using LETG/ACIS
- LETGS compared to HETGS
 - Use back-back observations of 3C 273, PKS 2155-304
 - Renormalize due to variability via XMM, XTE, or ASCA

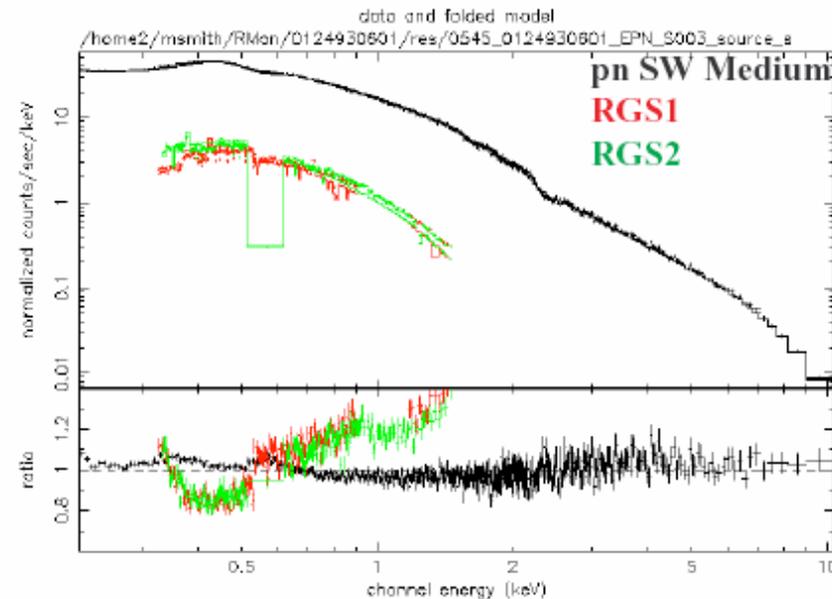
XMM-Newton Internal Cross-Calibration

- All observations are simultaneous, so many targets are used
 - N-stars and blazars are good for checking RGS and PN
 - More extended sources can be used than in Chandra cal
 - Several modes and filters are alternated
- Pileup is important in bright point sources
 - Imaging mode: do not use core of PSF
 - Timing mode: no pileup but not often used
- Technique: fit jointly, allow normalizations to vary by instrument

XMM-Newton Internal Cross-Cal. (cont.)

- PN results (timing mode, by Haberl)
 - Still some residuals at 0.5 keV of $\pm 5\%$
 - Thin and thick filters do not yet agree
- PN — MOS — RGS
 - MOS require -17 to +15% adjustment relative to PN
 - RGS require -27 to -9% adjustment
- Features remain in fits
 - PN: Si-K and Au-M edges appear in residuals
 - MOS: low E response seems to be time-dependent
 - PN: RMF requires adjustments below 1 keV

PKS2155-304 rev. 545

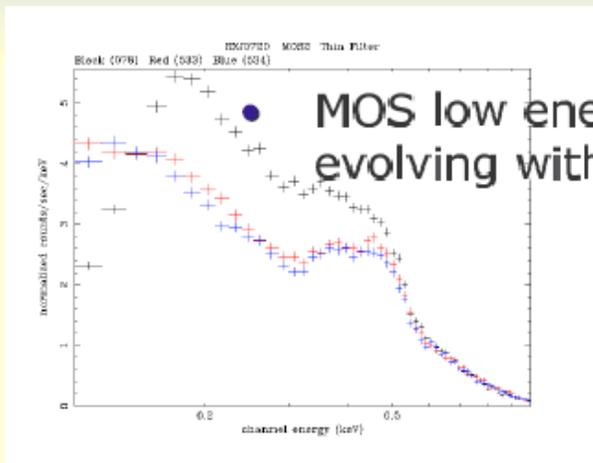


Example of fit by Kirsch et al.

cross normalization

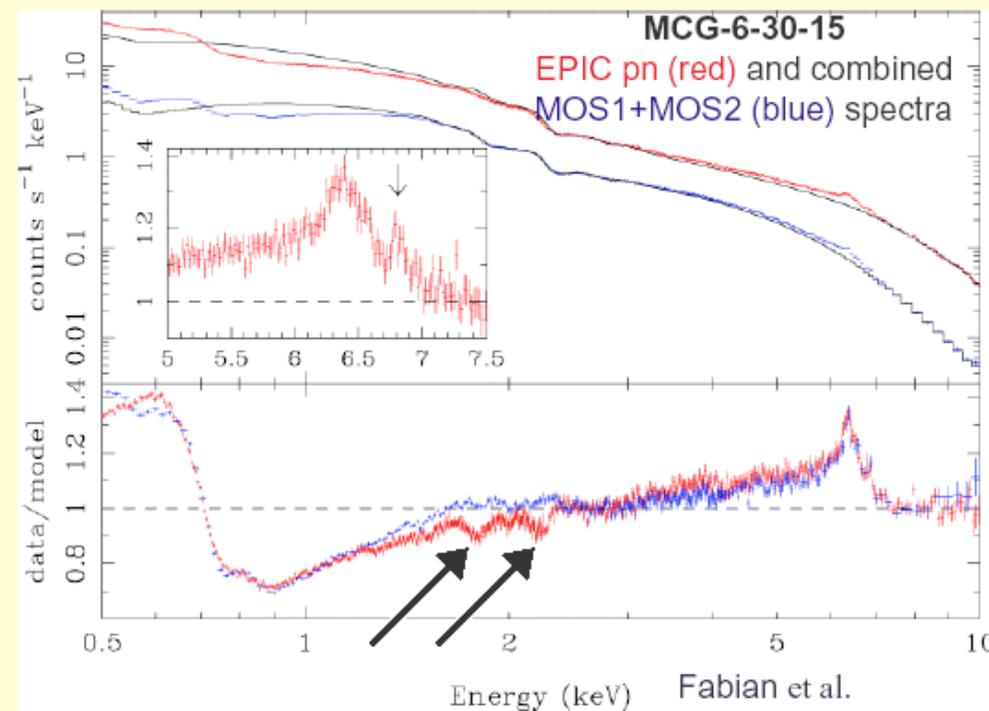
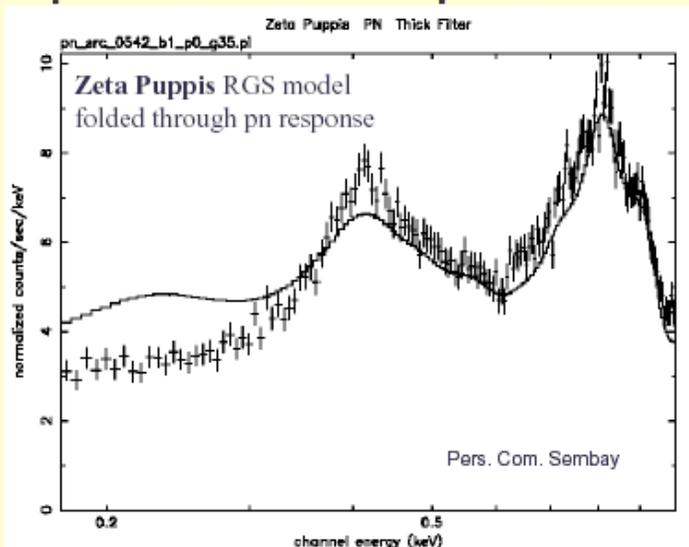
Target	Rev.	Class	Pile-up		const				
			pn	MOS	pn	MOS1	MOS2	RGS1	RGS2
PKS2155-304	545	AGN	no	yes	1	-	-	0.82	0.83
PKS0558-504	153	AGN	no	mild?	1	0.93	0.93	0.82	0.83
RXJ0806	168	INS	no ?	no ?	1	0.93	1.02	0.86	0.73
RXJ0720	533	INS	no	no	1	0.83	0.89	0.73	0.72
AB Dor	266	Stars	?	?	1	-	-	0.85	0.87
zeta Puppis	542	Stars	no	no	1	0.95	0.92	0.89	0.89
1E0102-7219	447	SNR	no	no	1	0.96	1.02	0.85	0.84
A1689	374	Cluster	no	no	1	1.11	1.12	0.81	0.82
A2052	128	Cluster	no	no	1	1.14	1.15	0.91	0.91





- The old fellows for RGS and EPIC
 - Si-edge
 - Au-edge

- pn-redistribution problem



Other XMM Results

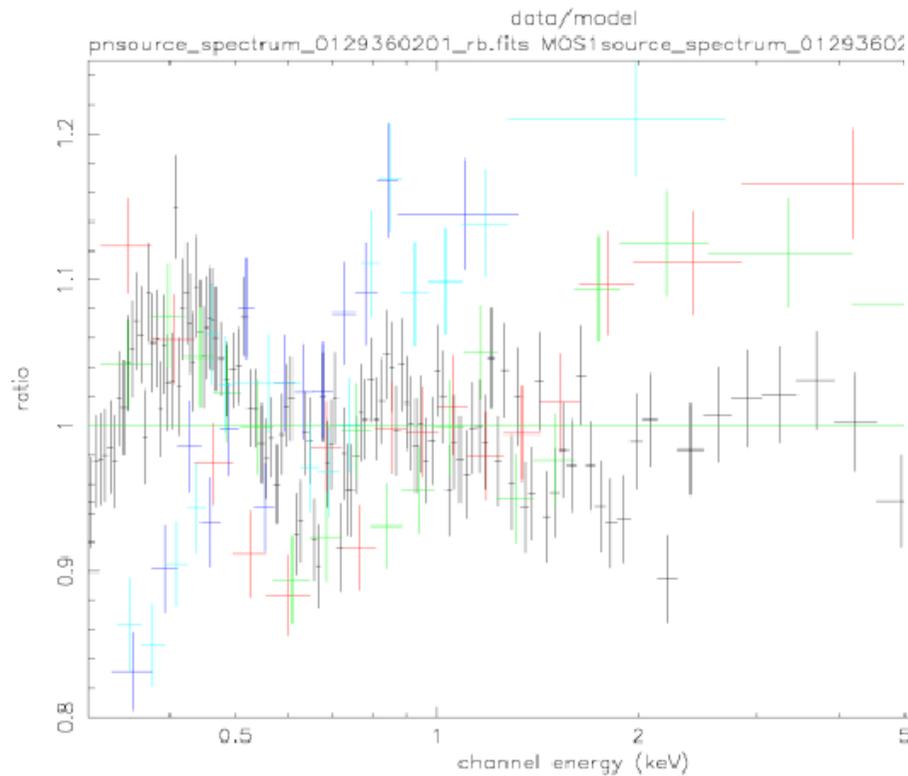


Figure 1-17: Simultaneous spectral fits to PKS0558-508. Back: pn, red, MOS1, green: MOS2 and blue RGS1, light blue RGS2. The zoomed ratio (lower panel) has been binned more for clarity.

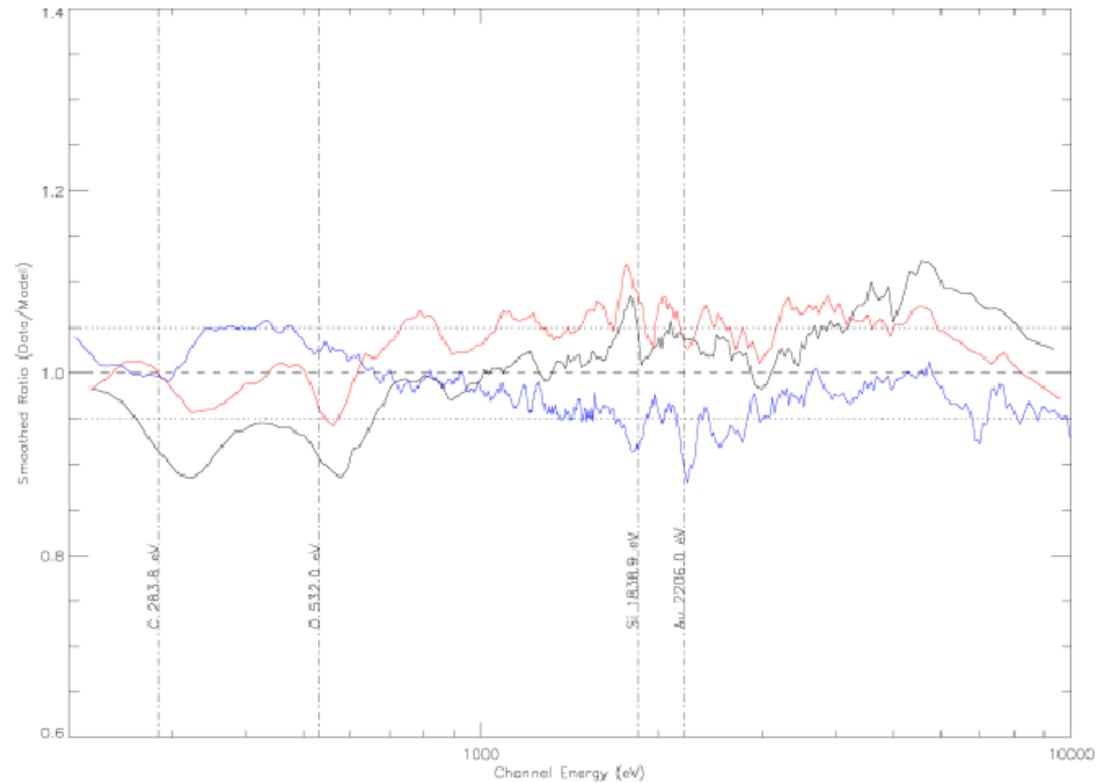


Figure 1-16: 3C 273: blue: PN black: MOS1, red: MOS2. Expressed as a ratio, DATA/MODEL, with error bars removed for clarity

Upcoming Milestones

- July-August 2004
 - Complete/revise contaminant spectral model
 - Complete testing of BI QE and FI CR loss models
 - XMM: internal cross-cal meeting
- September 2004
 - Test/revise MEG-HEG efficiencies
 - Verify HETG-LETG cross-cal
 - Iterate XMM-Chandra cross-cal (PN, RGS — TGs)
- October 2004
 - Distribute reports
 - Chandra Calibration workshop
- Bakeout in September?