Cross-calibration of the EPIC MOS and PN cameras on-board XMM-Newton using sources with continuum spectra


Introduction

• Comparison of MOS/pn continuum spectra using several sources in various modes
• All MOS data processed using SAS 5.2
• All pn SW data processed by instrument team (latest CTI correction), other modes processed using SAS 5.2
• Response files used
  (public - m<1/2>_<filter>v9q19t5r5_all_15.rsp)
  MOS: m<1/2>_<filter>v9q20t5r6_all_15.rsp
  pn: epn_<mode>_sY9_<filter>.rsp (ver. 6.1)
• Piled-up sources: core of PSF excluded
  same region of PSF used for MOS and pn
  ⇒ no encircled energy correction made
• Spectrum split into hard (> 2 keV) and soft band (< 2 keV)

The Hard X-ray band (> 2 keV)

Sources analysed: PKS 2149-306
Mrk 3
3C273
PKS 2155-304

Model used: power-law to 2-10 and 3-10 keV band
(except Mrk 3 – Gaussians used for Fe Kα complex)
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<tr>
<th>Source</th>
<th>Mode</th>
<th>Extraction region (arcsec)</th>
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<td>PKS 2149-306</td>
<td>FF</td>
<td>FF LW</td>
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<td>3C273 (a)</td>
<td>SW</td>
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<td>3C273 (b)</td>
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<td>PKS 2155-304</td>
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PKS 2149-306  MOS1 – black, MOS2 – red, PN – green

2-10 keV

3-10 keV
Mrk 3

MOS1 – black, MOS2 – red, PN – green

2-10 keV

3-10 keV
Statistical evaluation of EPIC flux calibration using large sample of sources (R. Saxton WA2-10)

Good agreement between the MOS instruments
MOS flux is higher than pn at hard energies

→ effect is to make MOS slope flatter by about 0.05

Band 4: 4.5–7.5 keV
3C273  MOS1 – black, MOS2 – red, PN – green

Observation A

2-10 keV

3-10 keV

New Visions of the X-ray Universe in the XMM-Newton and Chandra era
26-30 November 2001

University of Leicester
3C273

Observation B

2-10 keV

3-10 keV

MOS1 – black, MOS2 – red, PN – green
PKS 2155-304 MOS2 – red, PN – green

2-10 keV

3-10 keV

New Visions of the X-ray Universe in the XMM-Newton and Chandra era
26-30 November 2001
Soft X-ray band ($< 2$ keV)

PN SW mode data unreliable below 0.7 keV

Sources analysed: Coma
A1795
A1835
MS1229.2+6430
MS0737.9+7441
PKS 0558-504

Model used: single temp. thermal model + absorption
power-law model + absorption

Comparison of derived $N_H$ with Galactic values ($N_{\text{HGal}}$).
Look for systematic differences between MOS and pn
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</table>
MOS – red, PN green,

\[ N_{\text{HGal}} \]
MOS1 – black, MOS2 – red, PN green, ____ $N_{\text{HGal}}$

**MS 0737.9+7441**

$N_{\text{H}}$ (10$^{20}$ cm$^{-2}$)

**MS 1229.2+6430**

$N_{\text{H}}$ (10$^{20}$ cm$^{-2}$)

**PKS 0558-504**

Low energy cut (keV)
Summary

Hard X-ray band
- Generally good agreement between MOS and PN (5% level)
- Evidence that MOS flux is few % higher than PN at high energies
- For bright sources when MOS and PN in SW mode we see differences in spectral slope of ~ 0.1-0.15 in 3-10 keV band → CTI correction for PN SW is a factor

Soft X-ray band
Good agreement between MOS and PN for Full Frame observations However :-
- For low $N_{HG\text{al}}$ sources $N_H$ is typically lower for MOS than for PN by approx. $1 \times 10^{20} \text{ cm}^{-2}$
- $N_H$ for the BL Lacs is considerably higher than $N_{HG\text{al}}$ (fitting low energy curvature of spectrum?)