

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

G. Griffiths, U. Briel, M. Dadina, P. Ferrando, F. Haberl,
J.-W. den Herder, D. Lumb, S. Molendi, R. Saxton, S. Sembay,

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

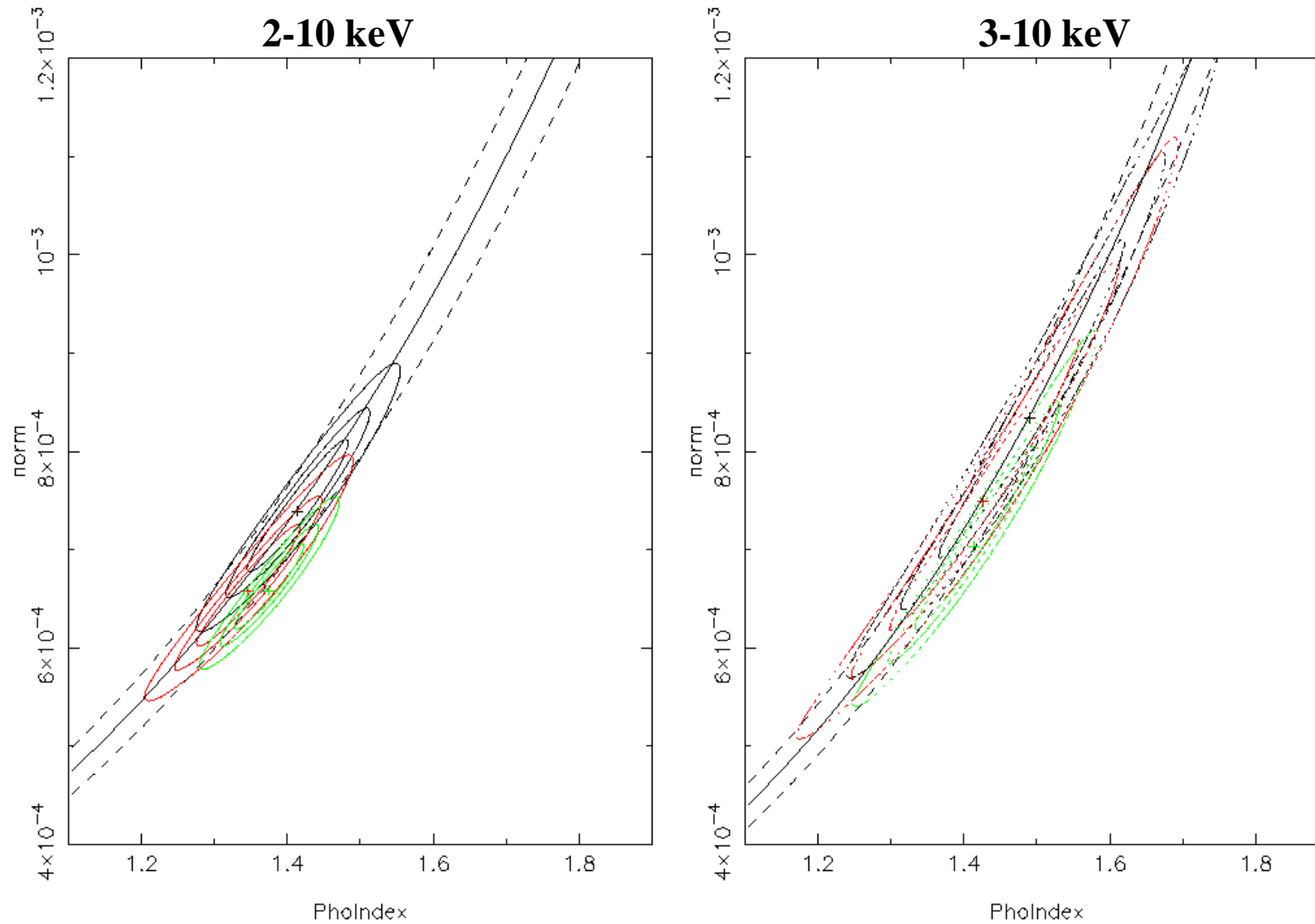
Model used: power-law to 2-10 and 3-10 keV band
(except Mrk 3 – Gaussians used for Fe K_{α} complex)



| Source | Mode | | | Extraction region (arcsec) |
|--------------|------|----|----|-------------------------------|
| | M1 | M2 | PN | |
| PKS 2149-306 | FF | FF | LW | 0-31 |
| Mrk 3 | FF | FF | FF | 0-40 |
| 3C273 (a) | SW | SW | SW | 5-42 |
| 3C273 (b) | SW | SW | SW | 5-42 |
| PKS 2155-304 | -- | SW | SW | 10-42 |
| | | | | |



PKS 2149-306 MOS1 – black, MOS2 – red, PN – green

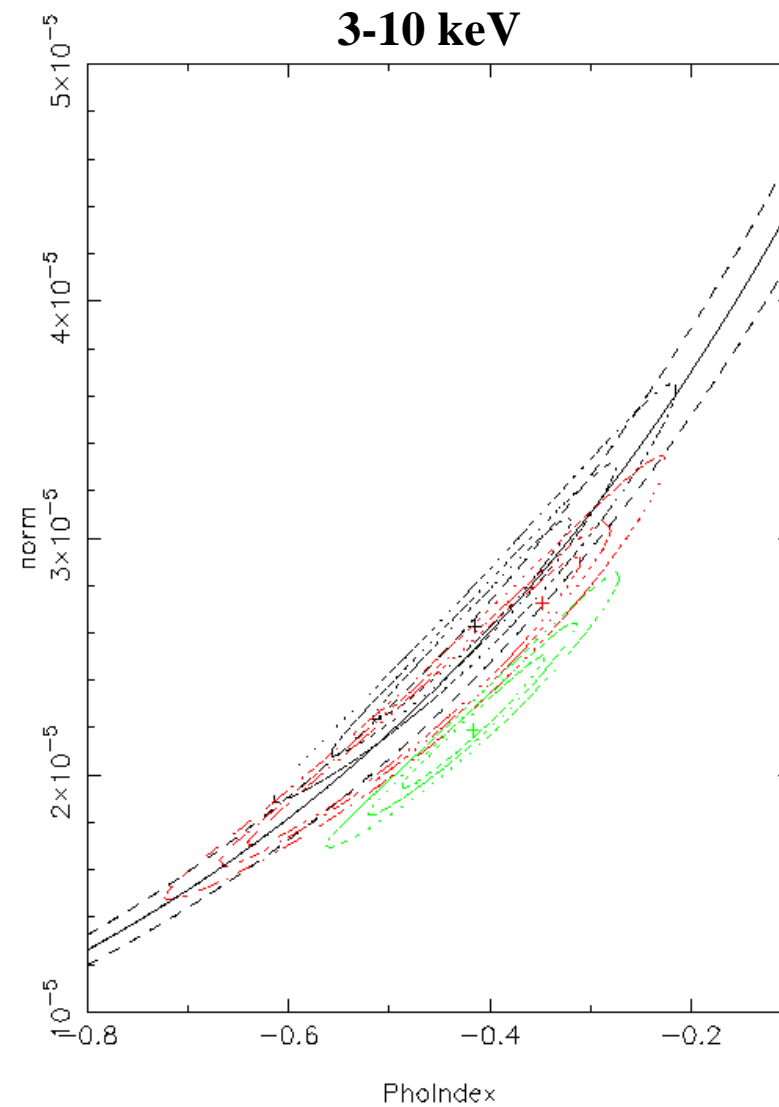
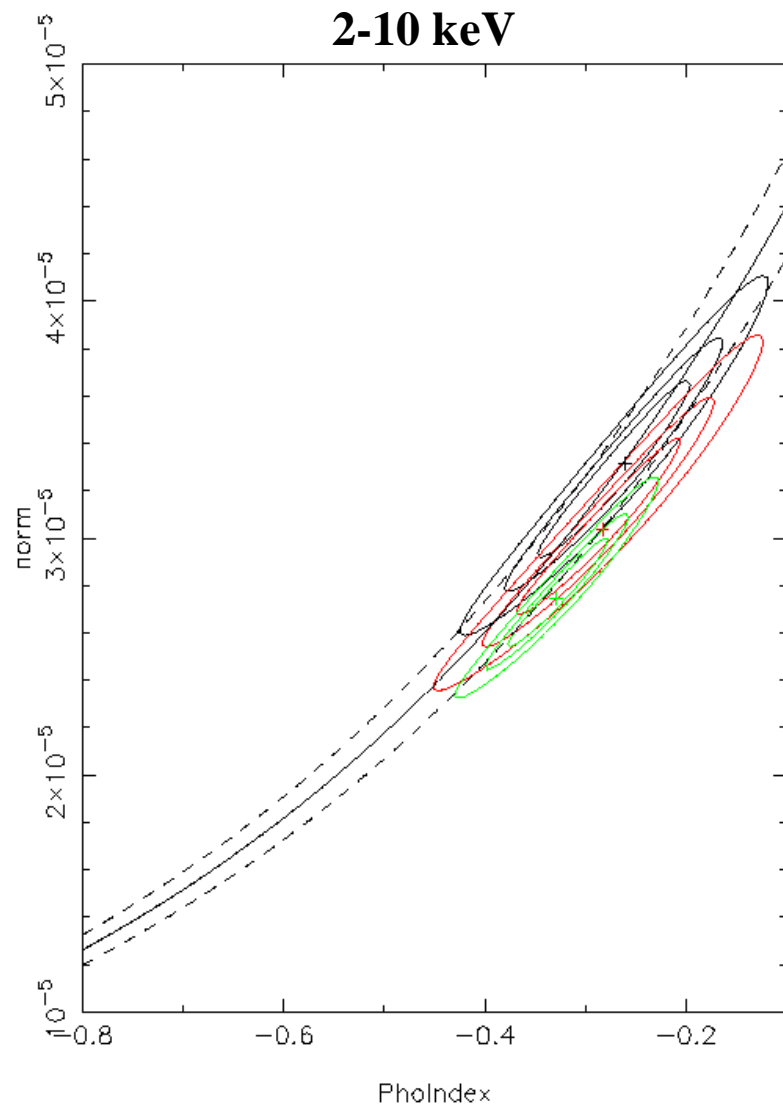


New Visions of the X-ray Universe in the
XMM-Newton and Chandra era
26-30 November 2001



Mrk 3

MOS1 – black, MOS2 – red, PN – green



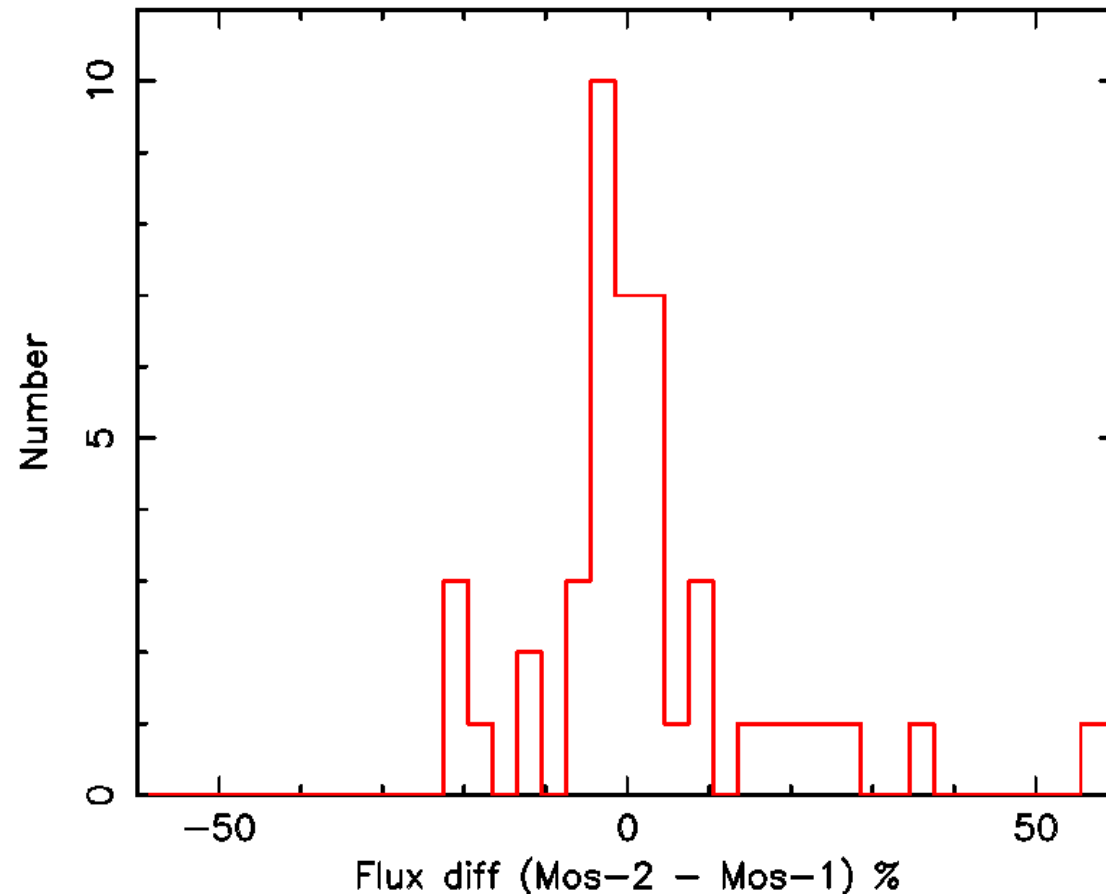
New Visions of the X-ray Universe in the
XMM-Newton and Chandra era
26-30 November 2001



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

Band 4: 4.5–7.5 keV

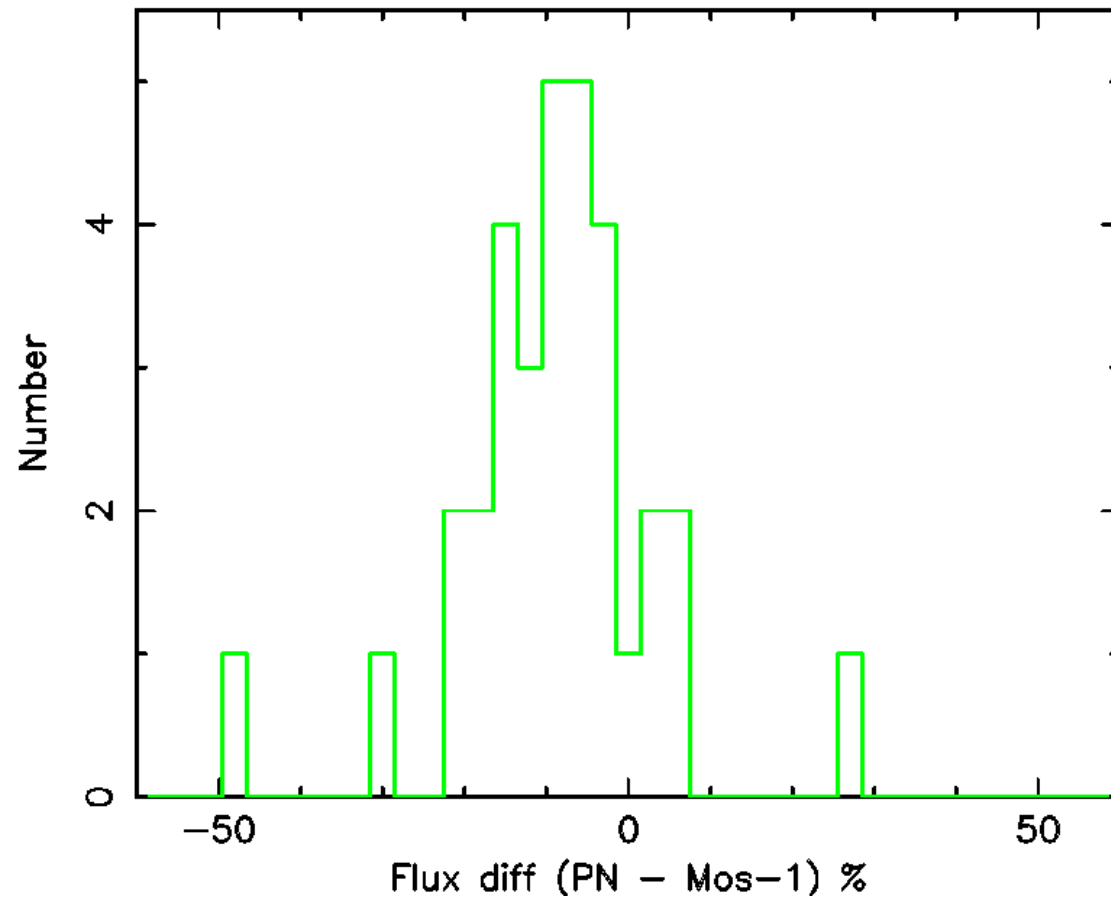
Good agreement
between the MOS
instruments



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

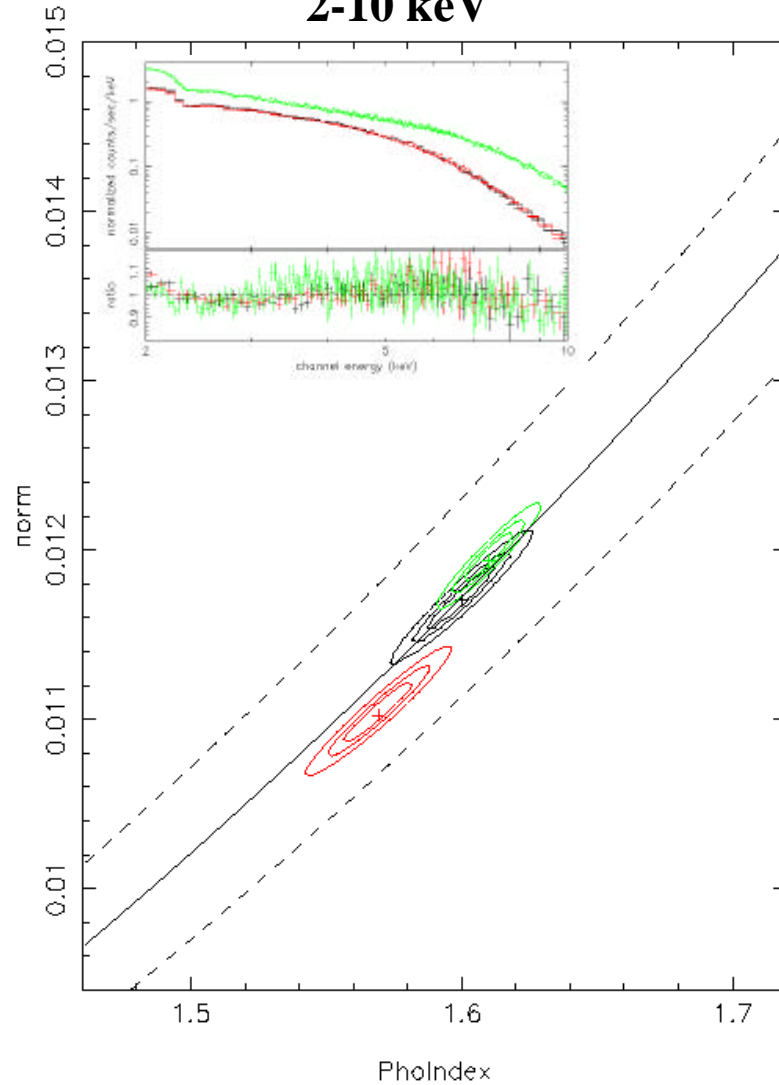


3C273

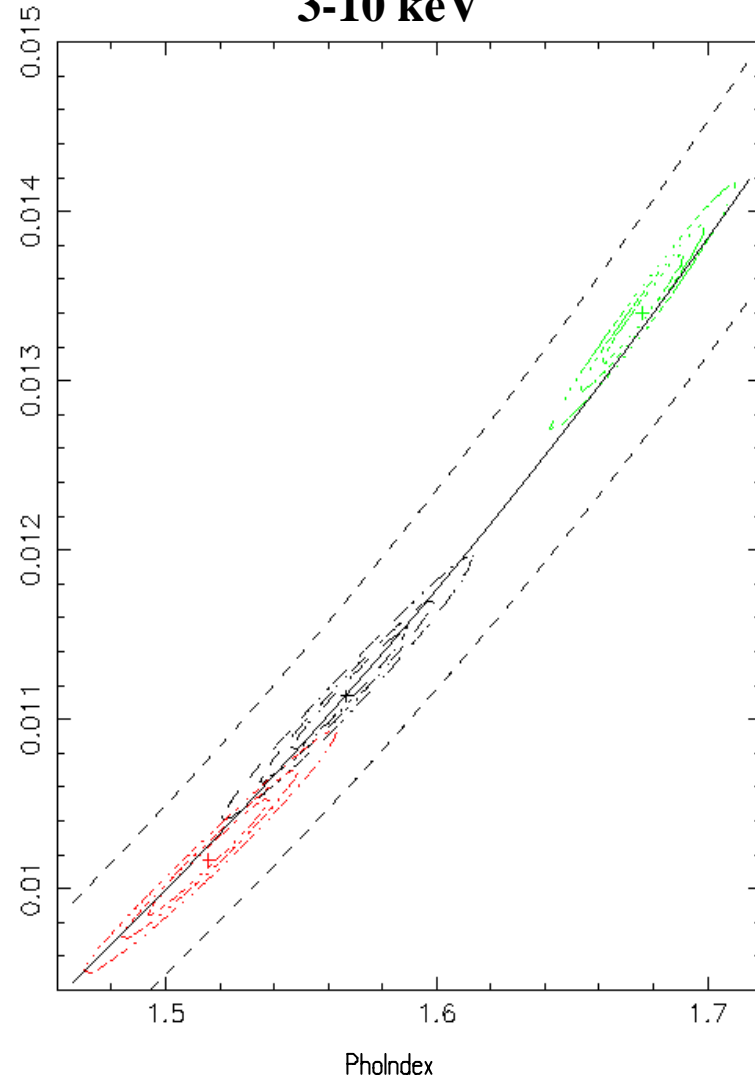
MOS1 – black, MOS2 – red, PN – green

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

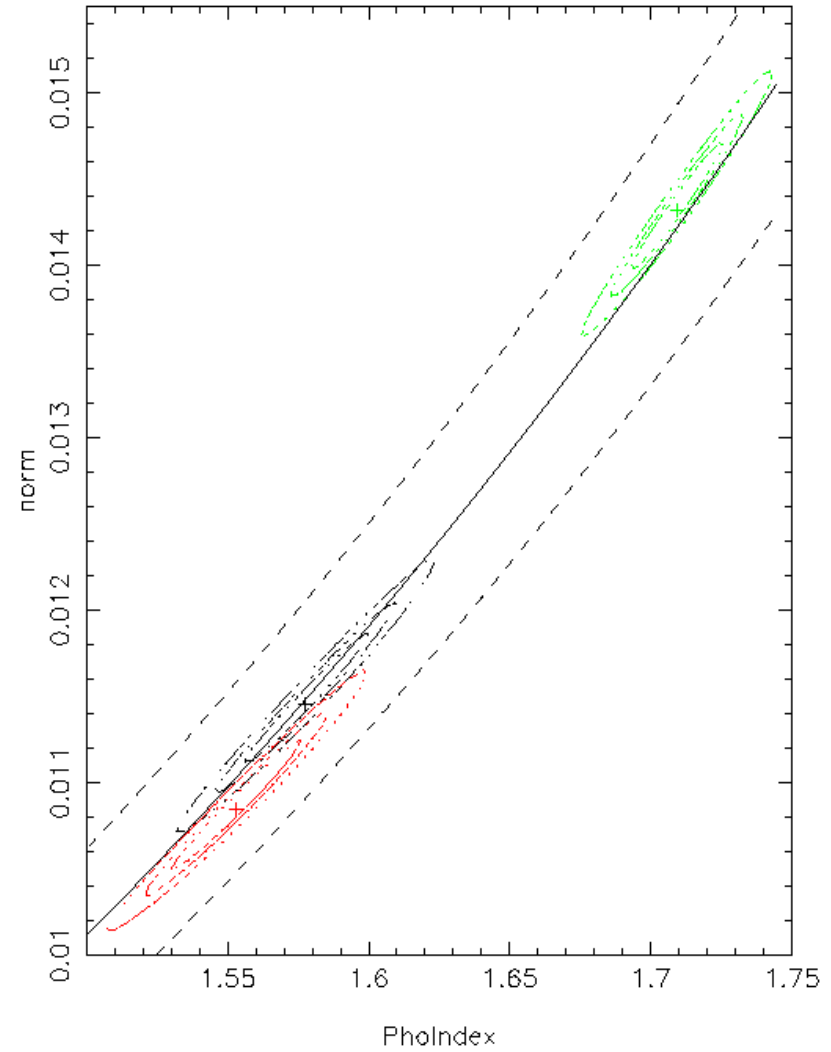
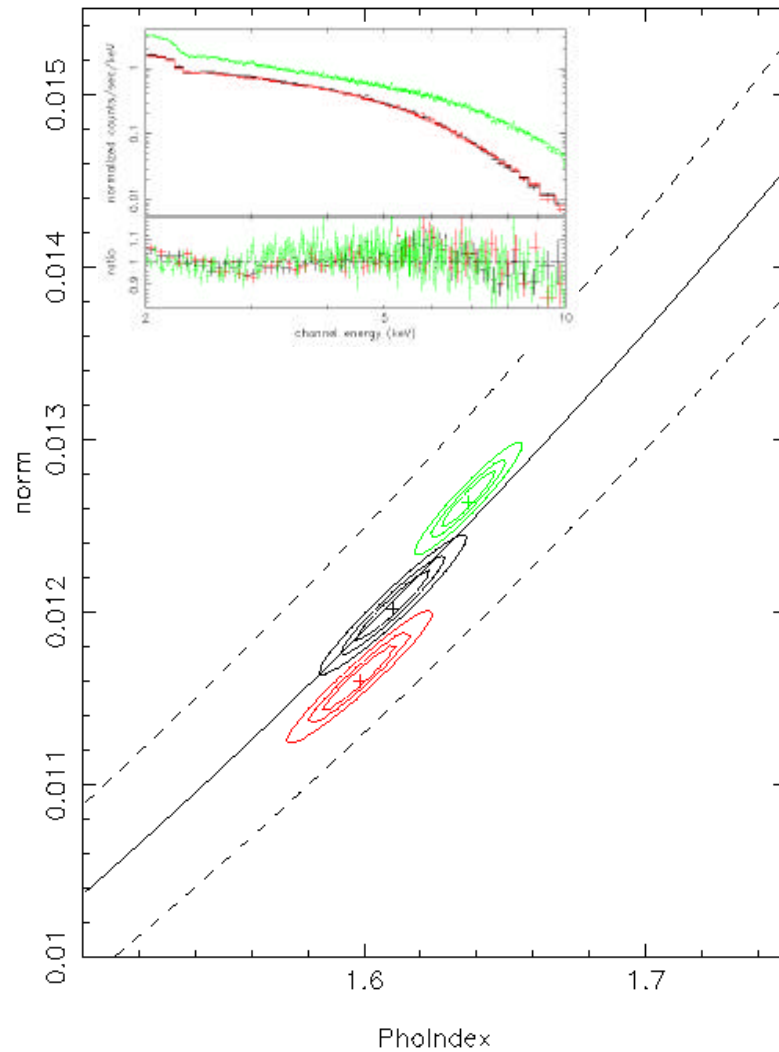


3C273

MOS1 – black, MOS2 – red, PN – green

Observation B 2-10 keV

3-10 keV



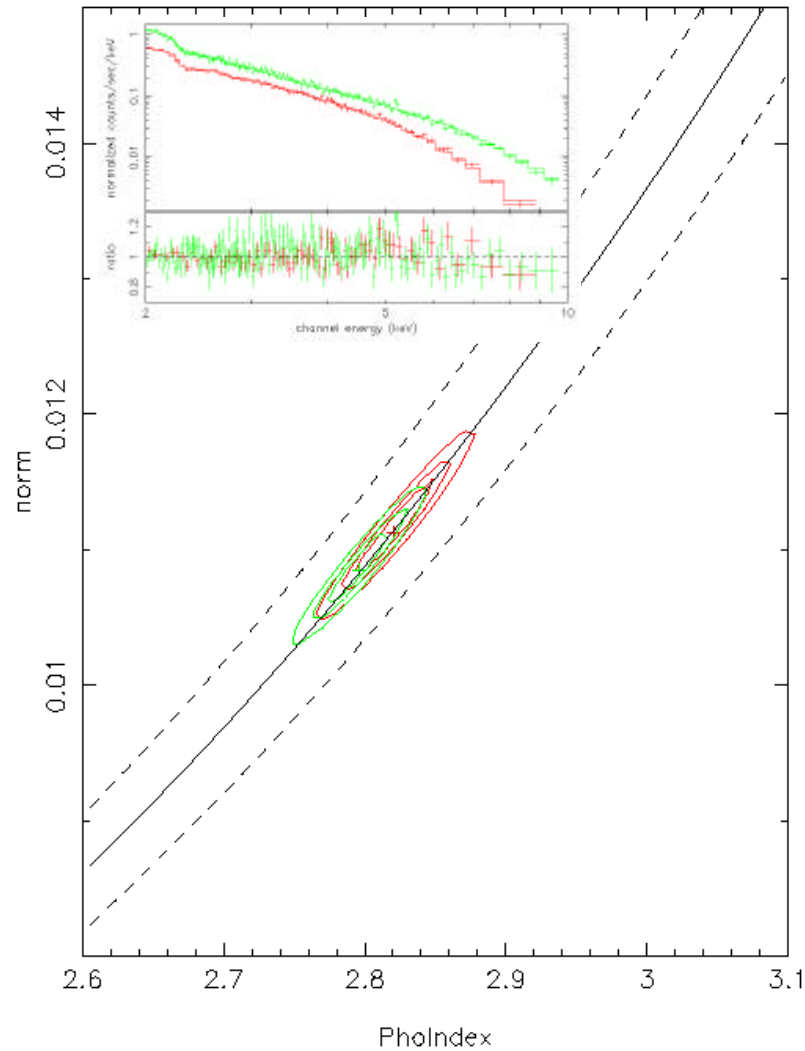
New Visions of the X-ray Universe in the
XMM-Newton and Chandra era
26-30 November 2001



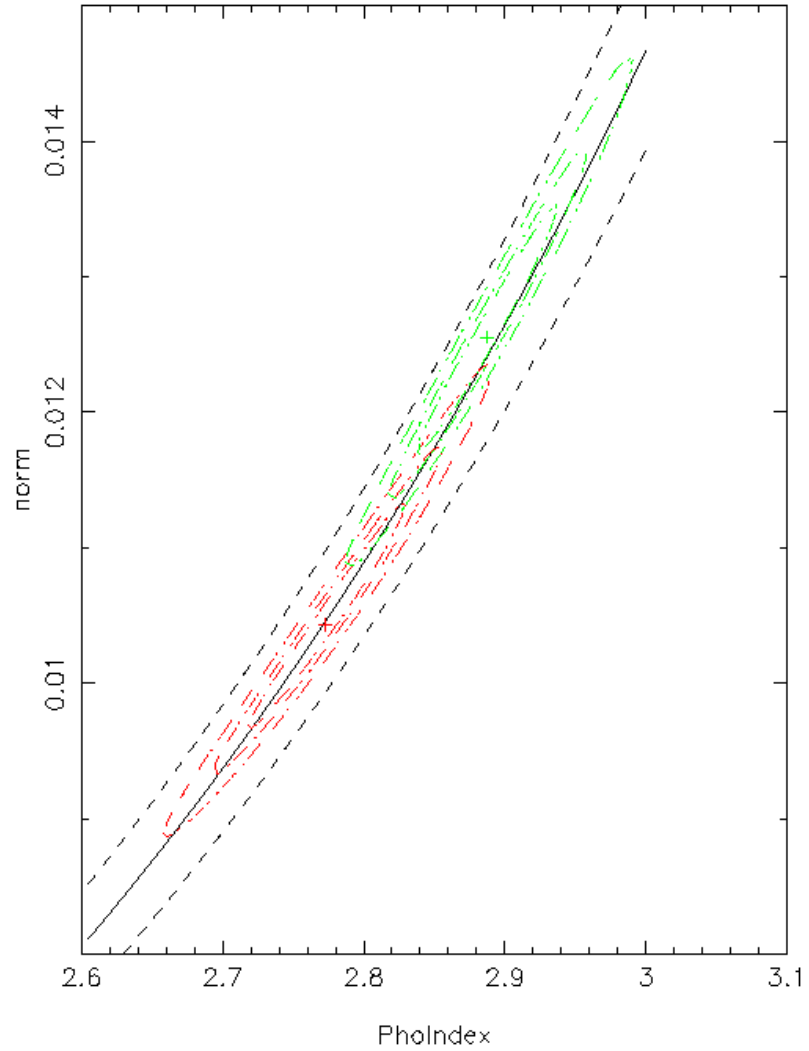
PKS 2155-304

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_{HGal}).
Look for systematic differences between MOS and pn

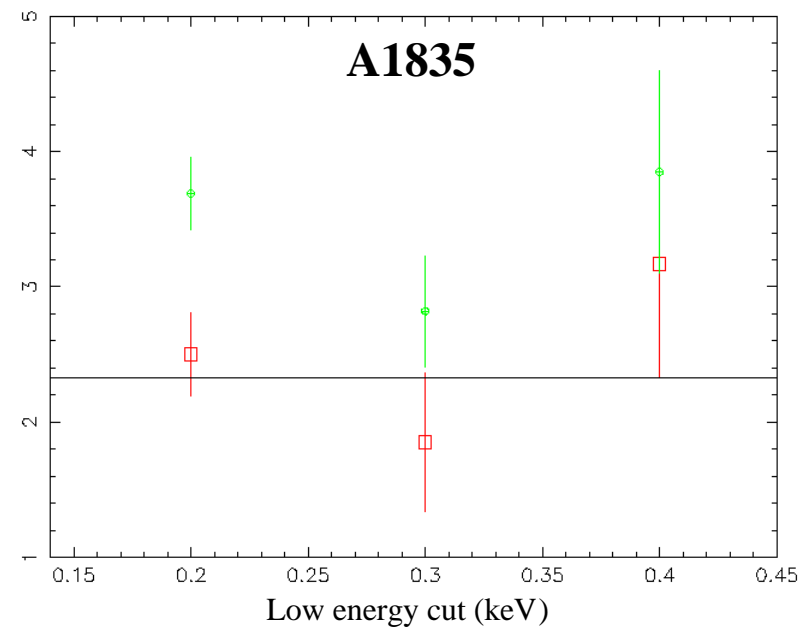
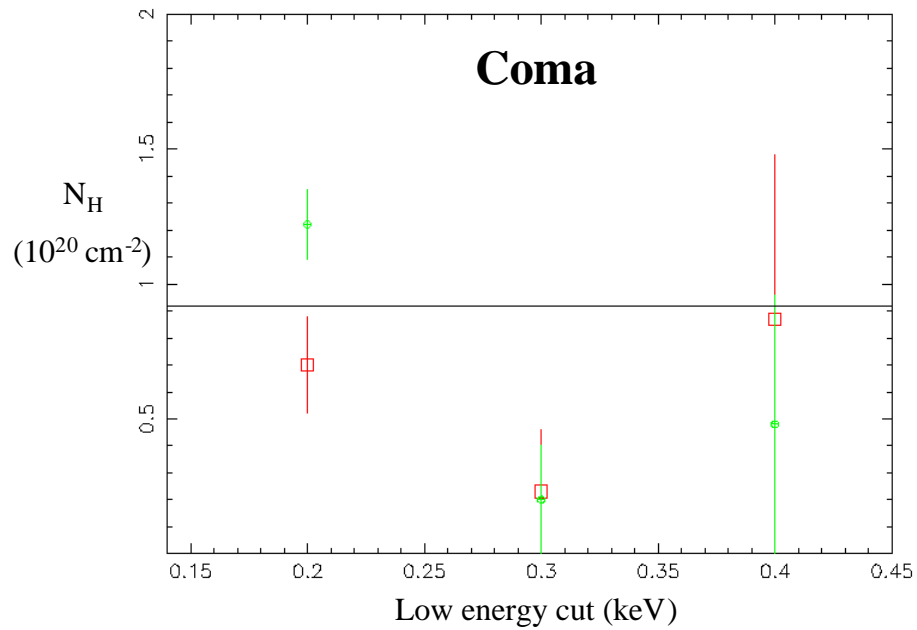
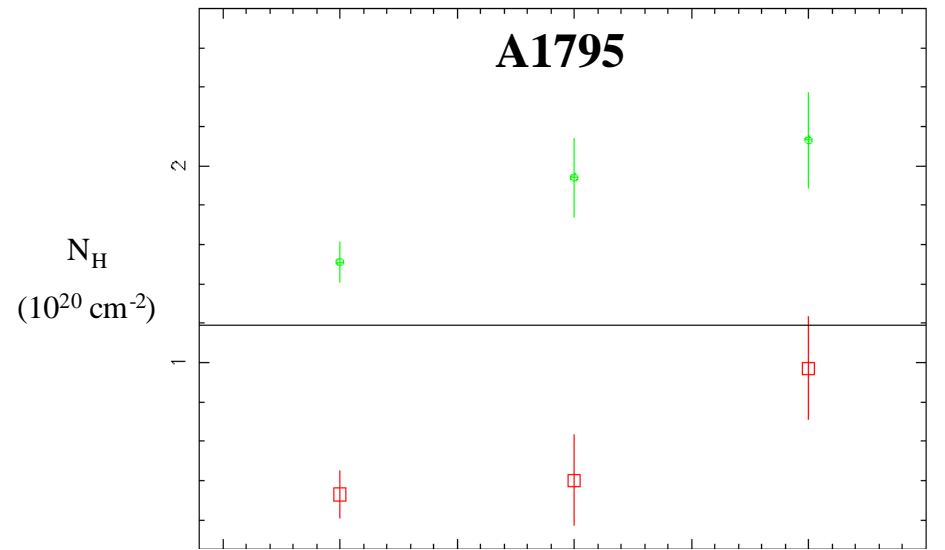


| Source | Mode | | | Extraction region (arcsec) |
|---------------|------|----|-----|-------------------------------|
| | M1 | M2 | PN | |
| Coma | FF | FF | EFF | 0-120 |
| A1795 | FF | FF | FF | 120-180 |
| A1835 | FF | FF | FF | 60-120 |
| MS1229.2+6430 | FF | FF | FF | 0-40 |
| MS0737.9+7441 | FF | FF | FF | 0-30 |
| PKS 0558-504 | FF | FF | FF | 5-40 |



MOS – red, PN green,

— N_{HGal}

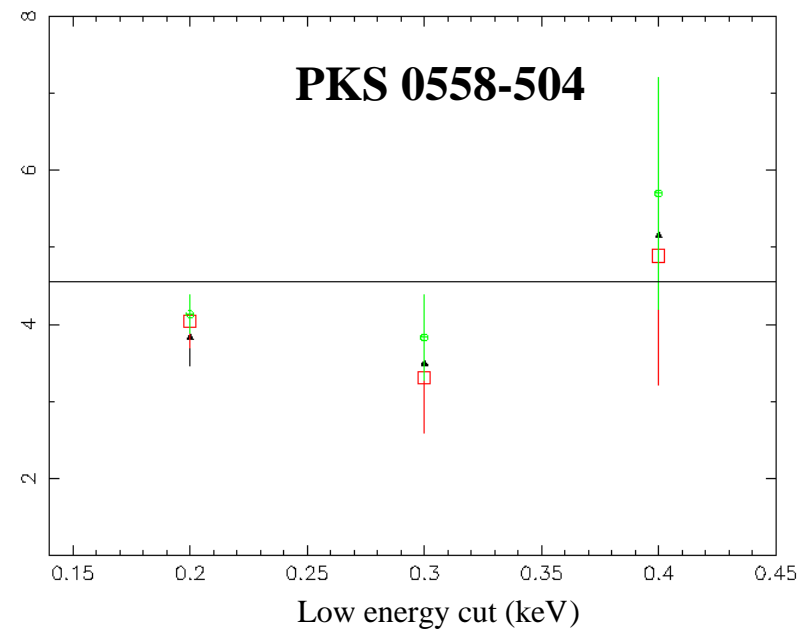
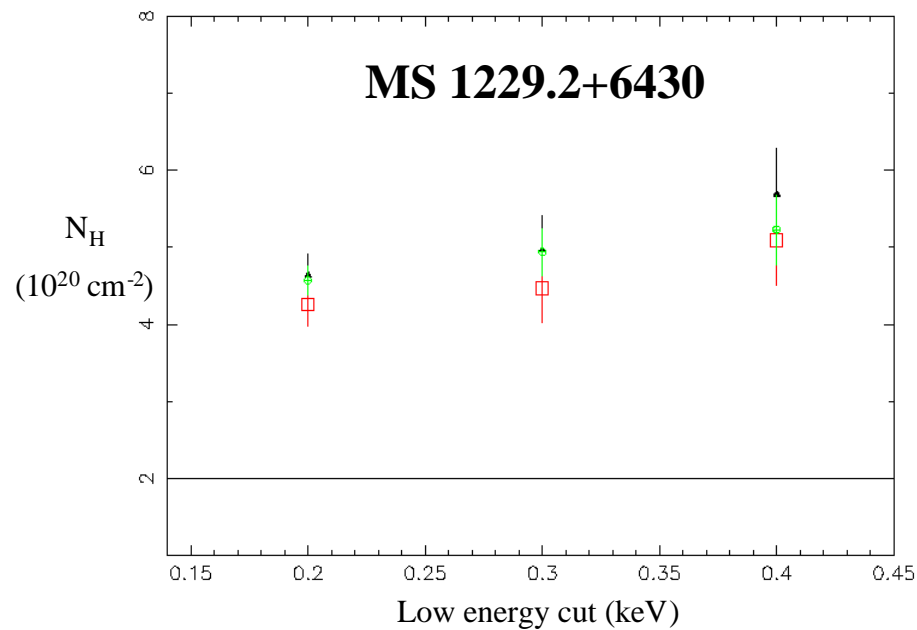
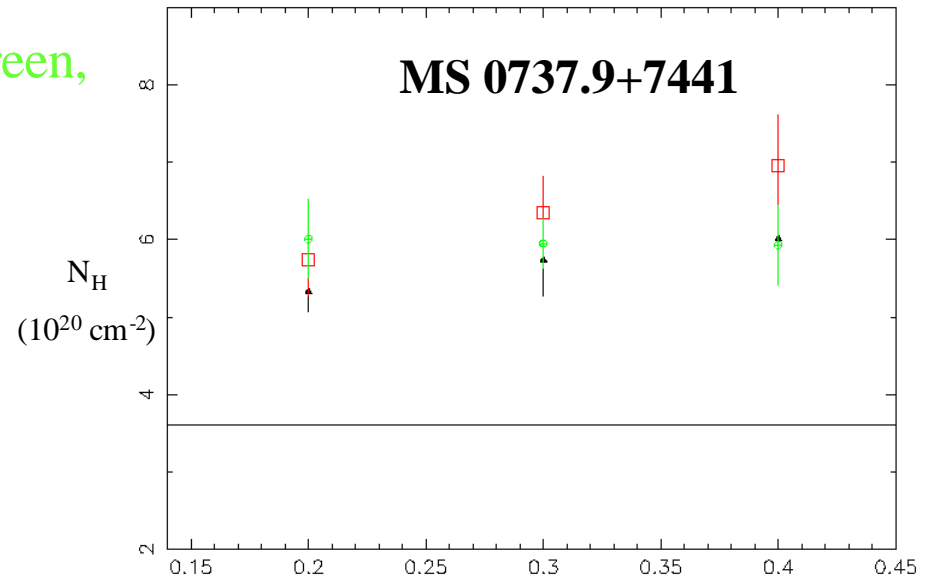


New Visions of the X-ray Universe in the
XMM-Newton and Chandra era
26-30 November 2001



MOS1 – black, MOS2 – red, PN green,

— N_{HGal}



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



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 $\sim 0.1-0.15$ 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_{HGal} 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_{HGal} (fitting low energy curvature of spectrum?)

