MOS Pn cross calibration with a sample of Galaxy Clusters

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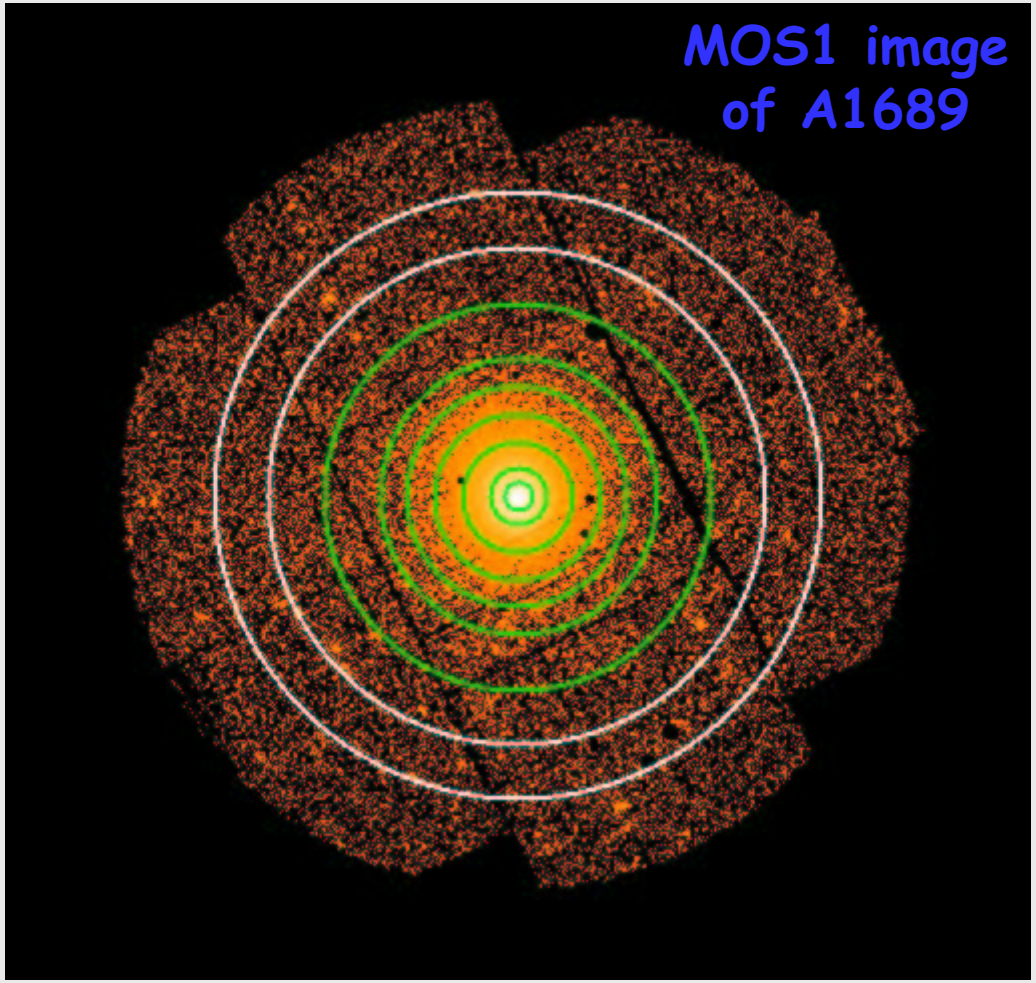
The Exercise

- Sample of 21 , high gal latitude, hot, intermediate redshift Galaxy Clusters observed with XMM-Newton.
- About 80 high quality spectra (bkg is not an issue)
- All reduced with SAS 6.0 (rerun with 6.1 to begin soon)
- Emchain & Epchain correction for OOT applied
- Effective areas generated using arfgen with extended source options
- Rmfs generated using rmfgen
- MOS1, MOS2 (pattern 0-12) and pn (0-4)
- flag==0 for MOS and pn

The Exercise



Spectral accumulated in concentric annuli (from 5 to 8 depending on source SB). Important for testing full FOV

hich ban

- esting spectral cali ration it t ermal spectra is some at different t an it po er la s.
- For ig (eV) t e scientific alua le information is all in t e ard and o e er for I and man ot er ra e periments most of t e statistics is in t e softer and.
- erforming spectral fits using a cumulati e statistics suc as ^{2} on a road and ill put lots of eig t on t e insensiti e soft part of t e spectrum and relati el less on t e ard scientificall important part.

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Two possible points of view

Observer: forget the soft band, it only cmplicates things!

Calibrator: if I can get the right temperature fitting the broad band than my calibration must really be good!

Spectral fits in

0.5-10 keV 1.5-10 keV 2-10 keV

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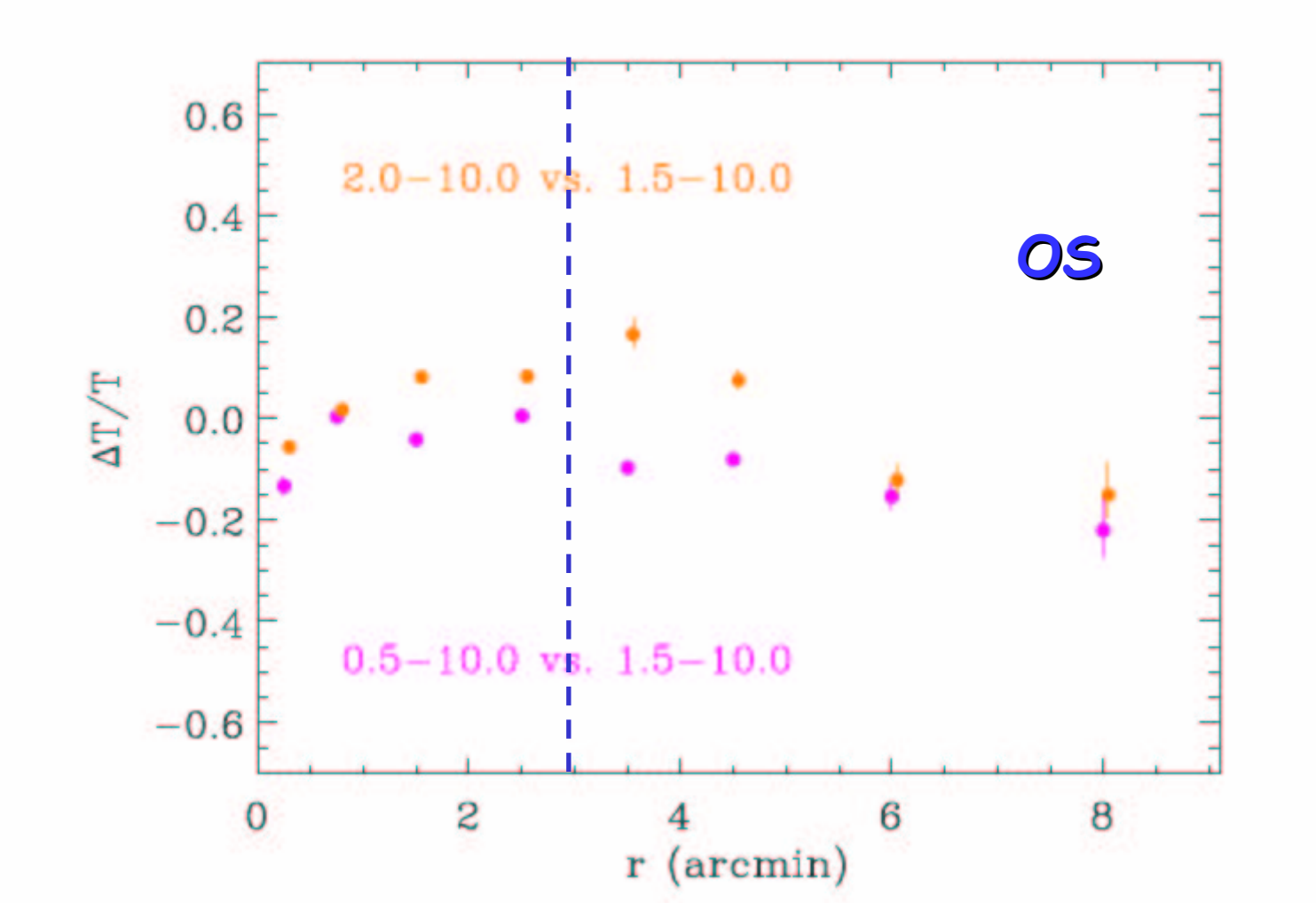
Spectral fits in

.5 .5 for OS and OS

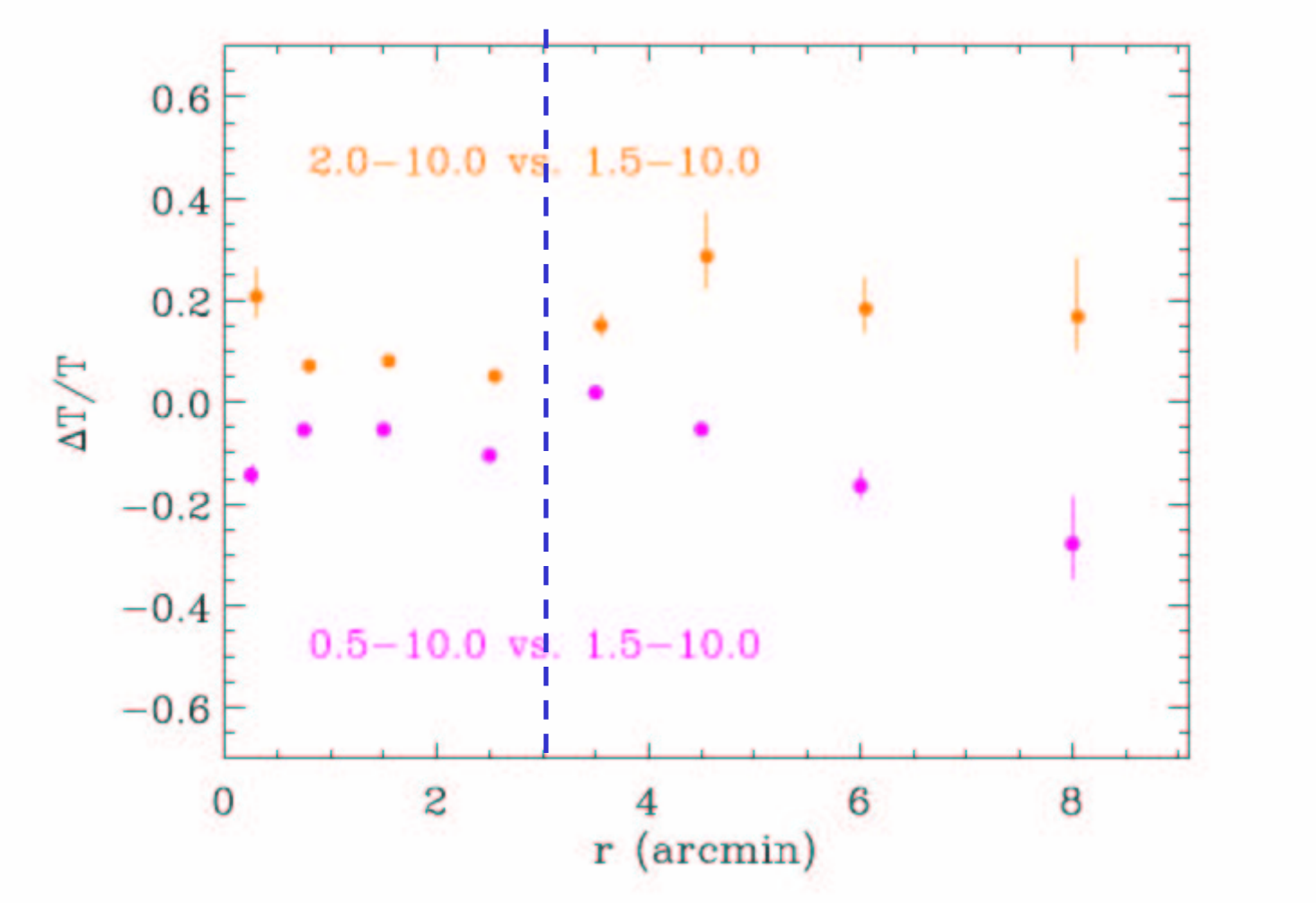
.5 . .5 . . for pn

1. For each band comparison btwn detectors.
2. For each detector comparison btwn T measures in different bands

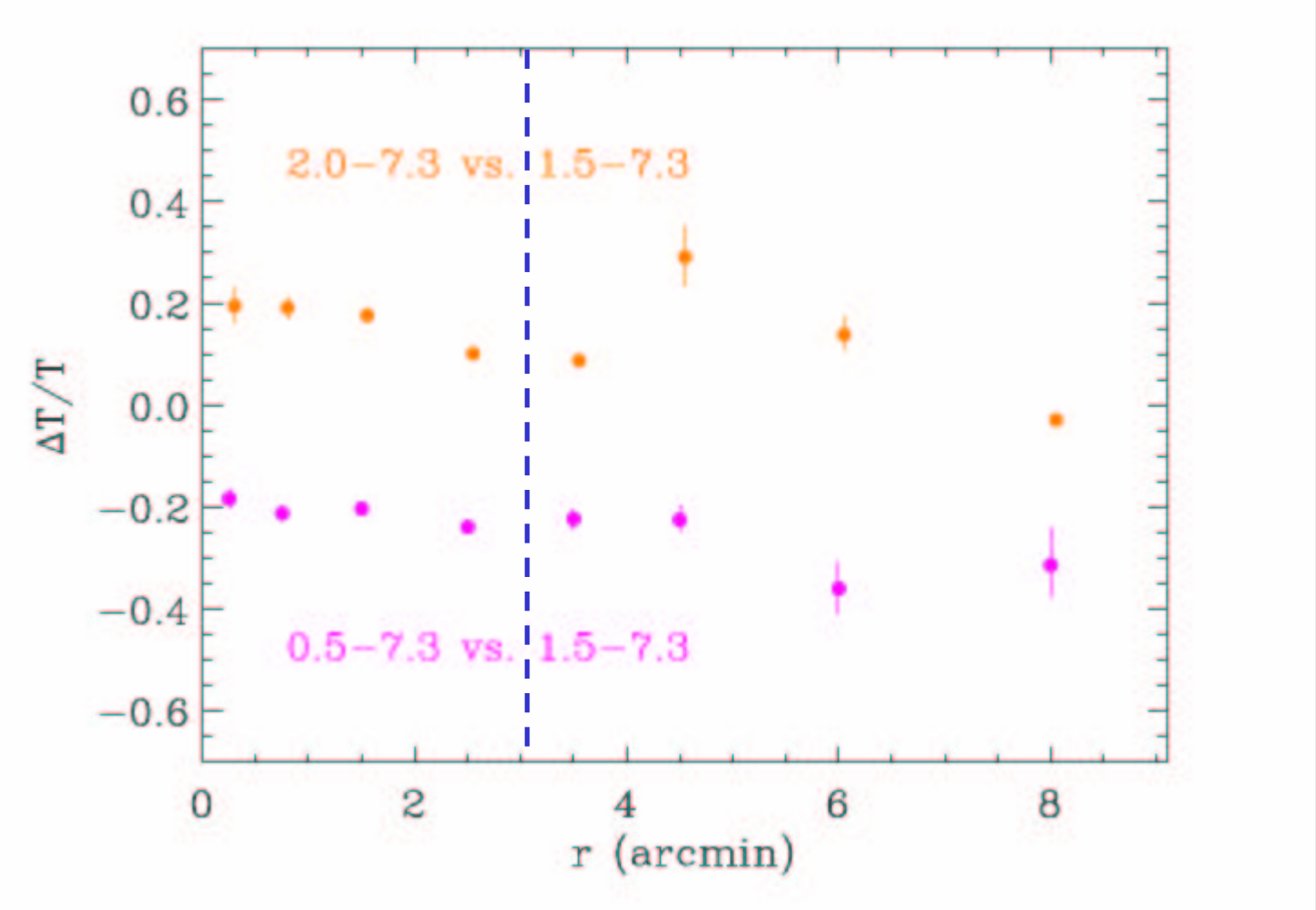
typical case



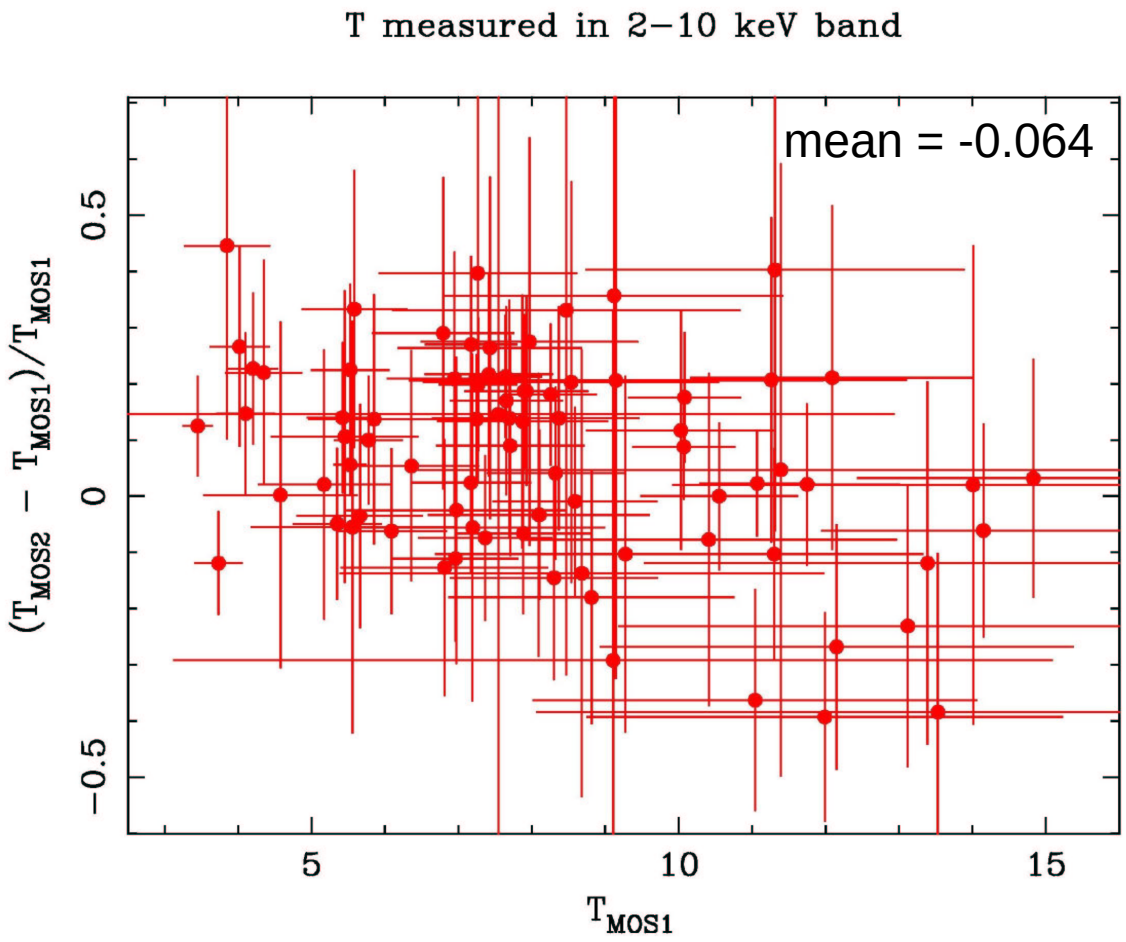
MOS


2.0−10.0 vs. 1.5−10.0
0.5−10.0 vs. 1.5−10.0
ΔT/T
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
2
4
6
8
r (arcmin)

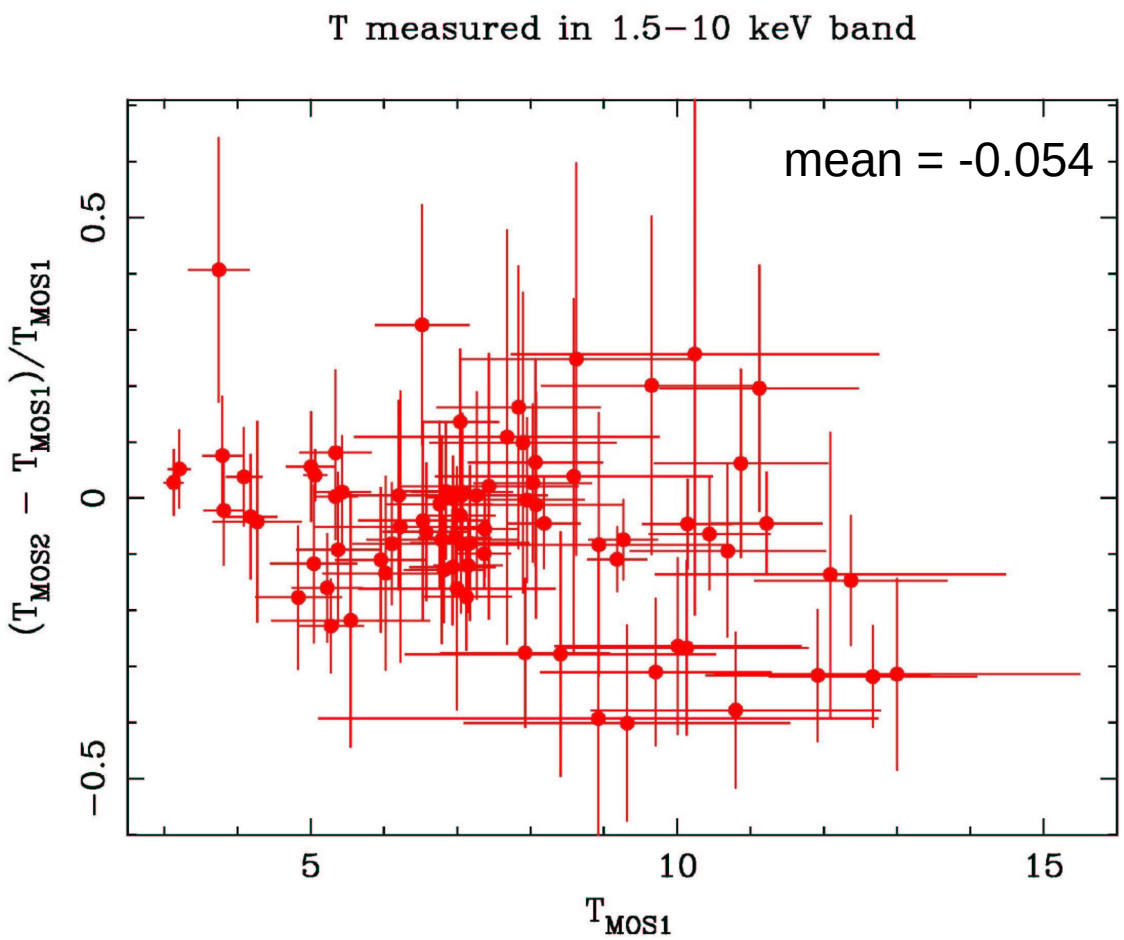
Pn



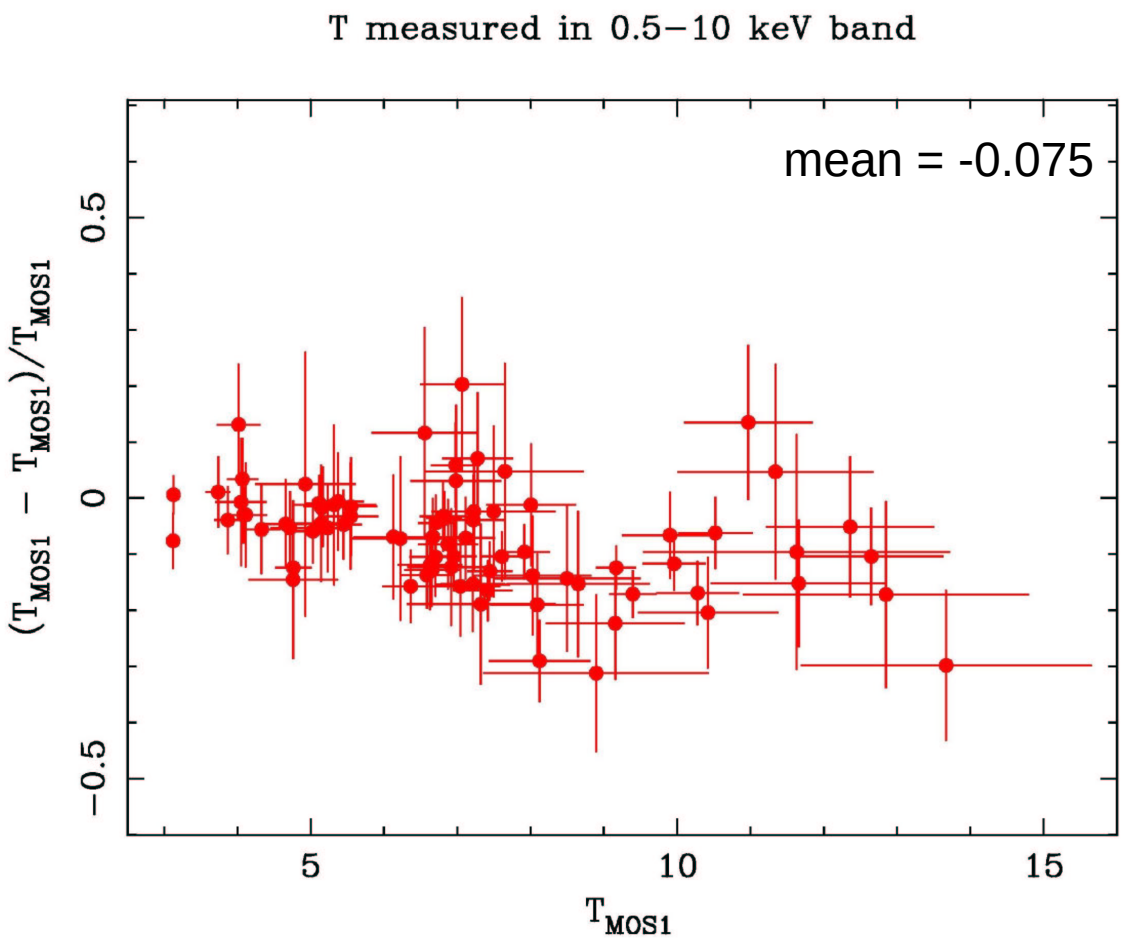
MOS s MOS


T measured in 2−10 keV band
mean = -0.064
$(T_{MOS2} - T_{MOS1})/T_{MOS1}$
0.5
0
−0.5
5
10
15
T_{MOS1}

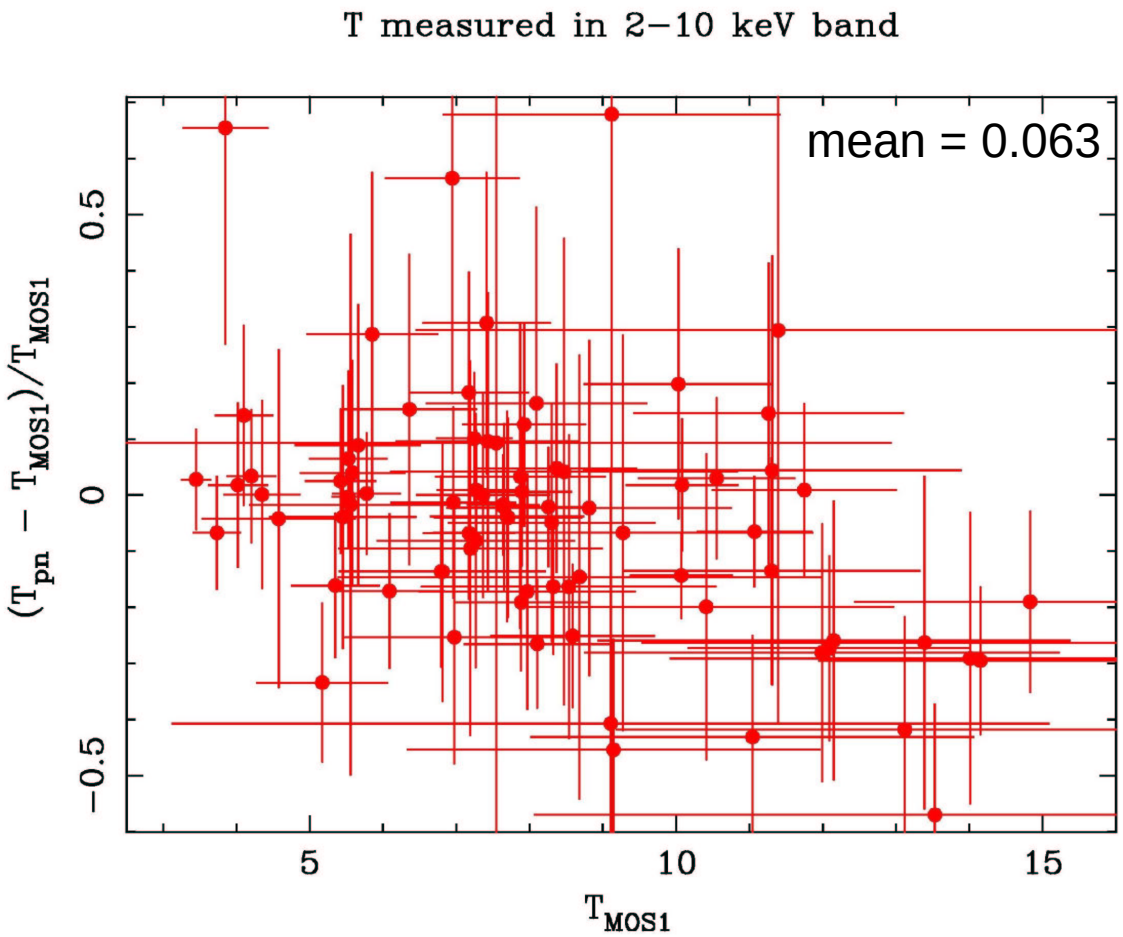
MOS s MOS


T measured in 1.5−10 keV band
mean = -0.054
$(T_{MOS2} - T_{MOS1})/T_{MOS1}$
0.5
0
−0.5
5
10
15
T_{MOS1}

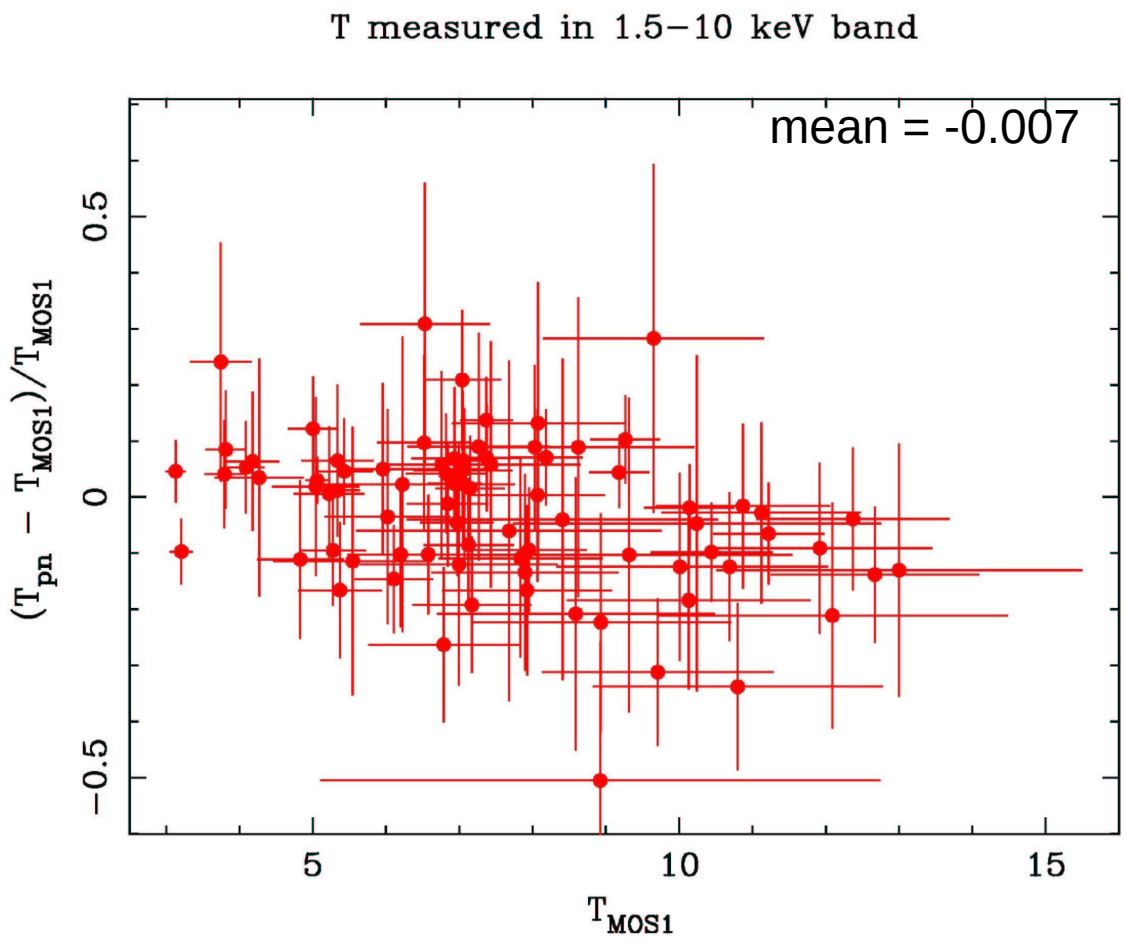
MOS s MOS


T measured in 0.5−10 keV band
mean = -0.075
$(T_{MOS1} - T_{MOS1})/T_{MOS1}$
0.5
0
−0.5
5
10
15
T_{MOS1}

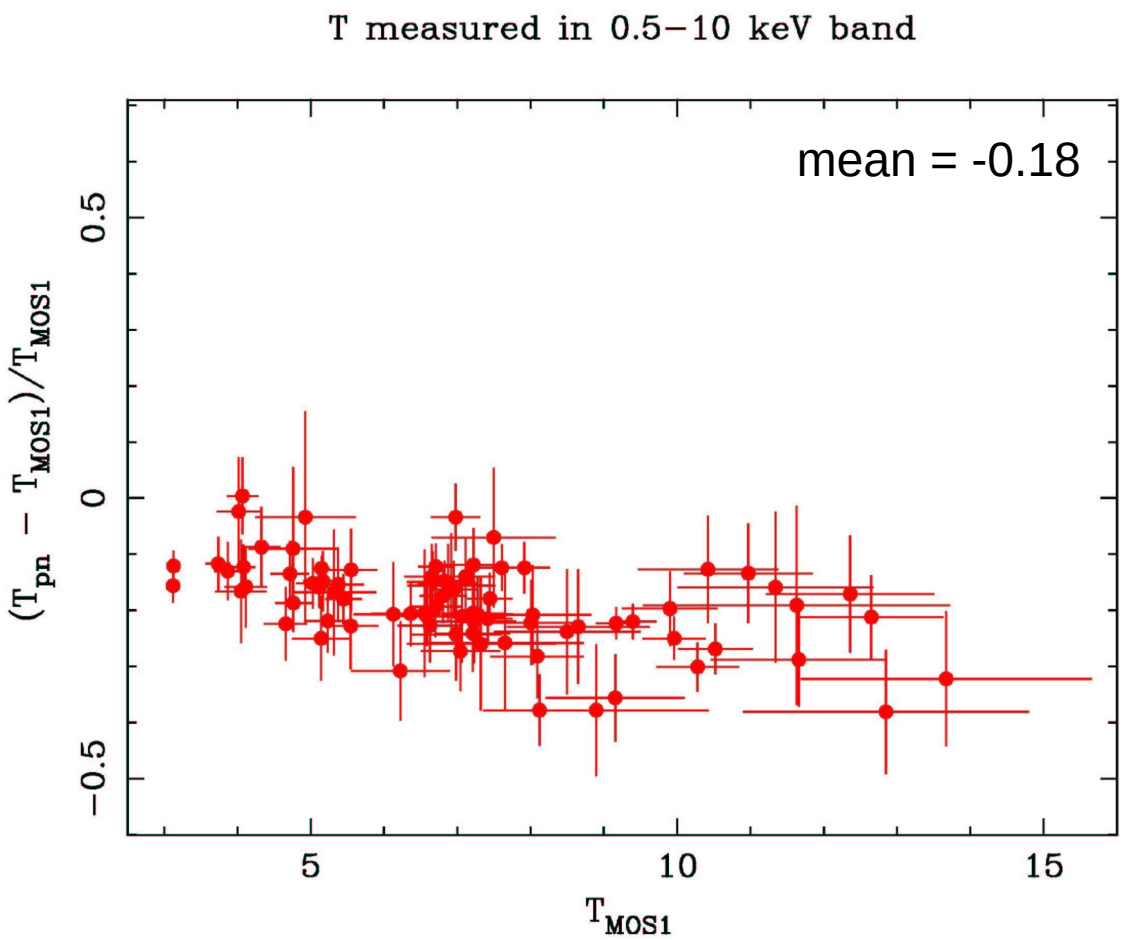
MOS s pn


T measured in 2−10 keV band
mean = 0.063
0.5
0
−0.5
5
10
15
$(T_{pn} - T_{MOS1})/T_{MOS1}$
T_{MOS1}

MOS s pn


T measured in 1.5−10 keV band
mean = -0.007
0.5
0
−0.5
5
10
15
$(T_{pn} - T_{MOS1})/T_{MOS1}$
T_{MOS1}

MOS s pn

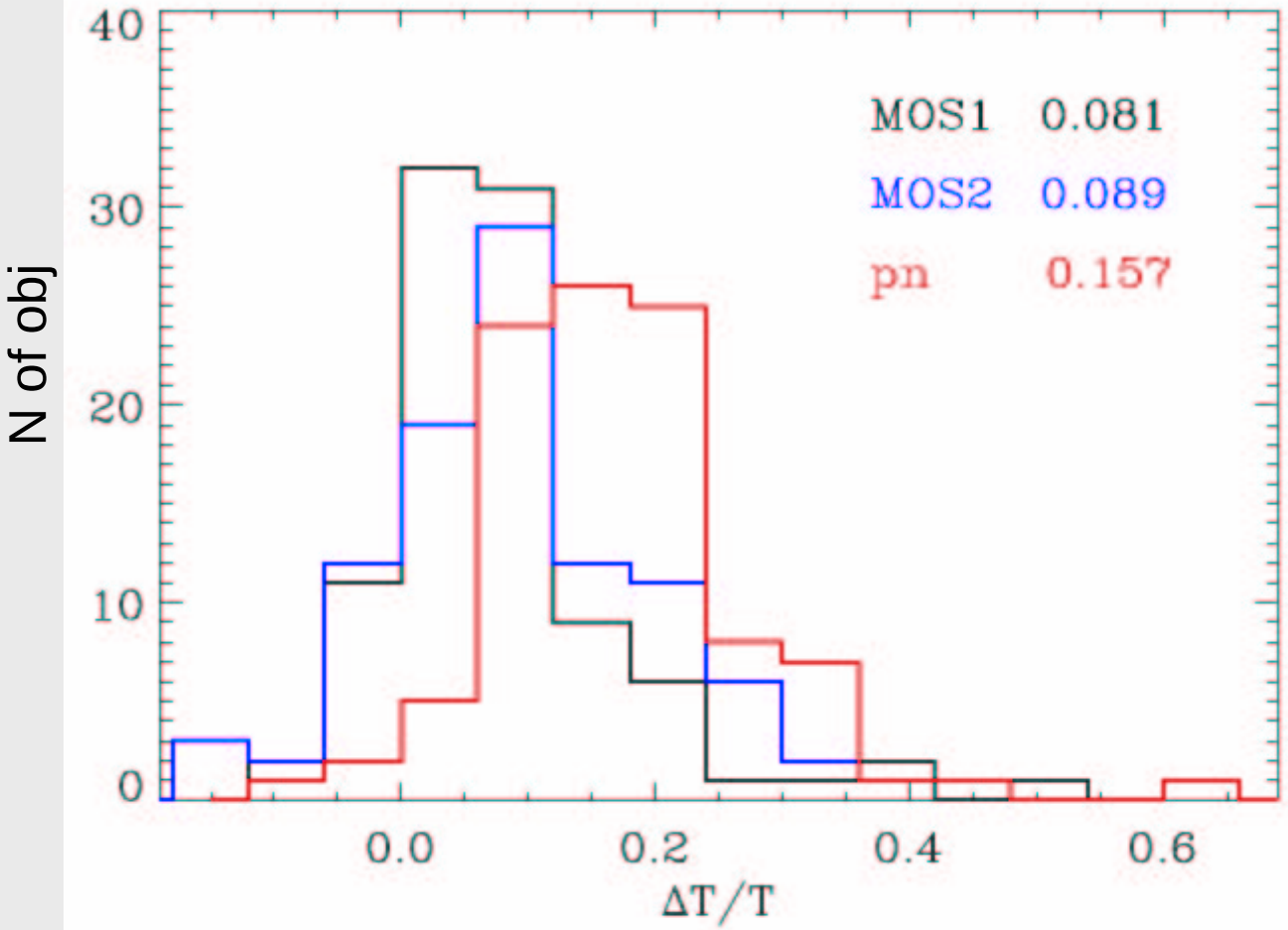

T measured in 0.5−10 keV band
mean = -0.18
$(T_{pn} - T_{MOS1})/T_{MOS1}$
0.5
0
−0.5
5
10
15
T_{MOS1}

Summary MOS s pn

1. For hard bands reasonable agreement btwn all instruments.
2. Broad band MOS and PN are clearly discrepant

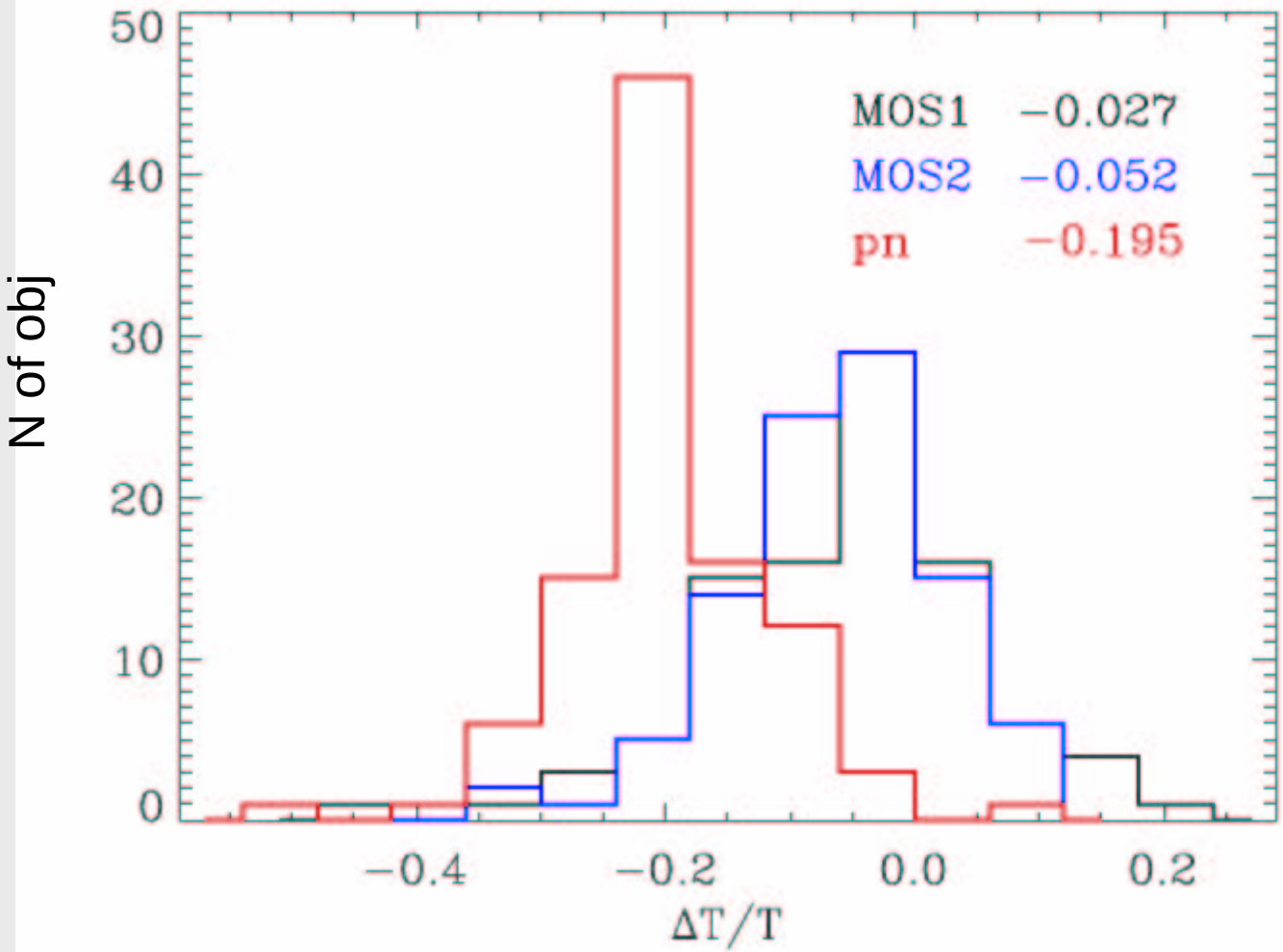
1. For each band comparison btwn detectors.
2. For each detector comparison btwn T measures in different bands

e s e



$(T_{2\text{-}10}-T_{1.5\text{-}10})/T_{1.5\text{-}10}$

0.5-10 keV vs 1.5-10 keV



$(T_{0.5\text{-}10}-T_{1.5\text{-}10})/T_{1.5\text{-}10}$

Summary

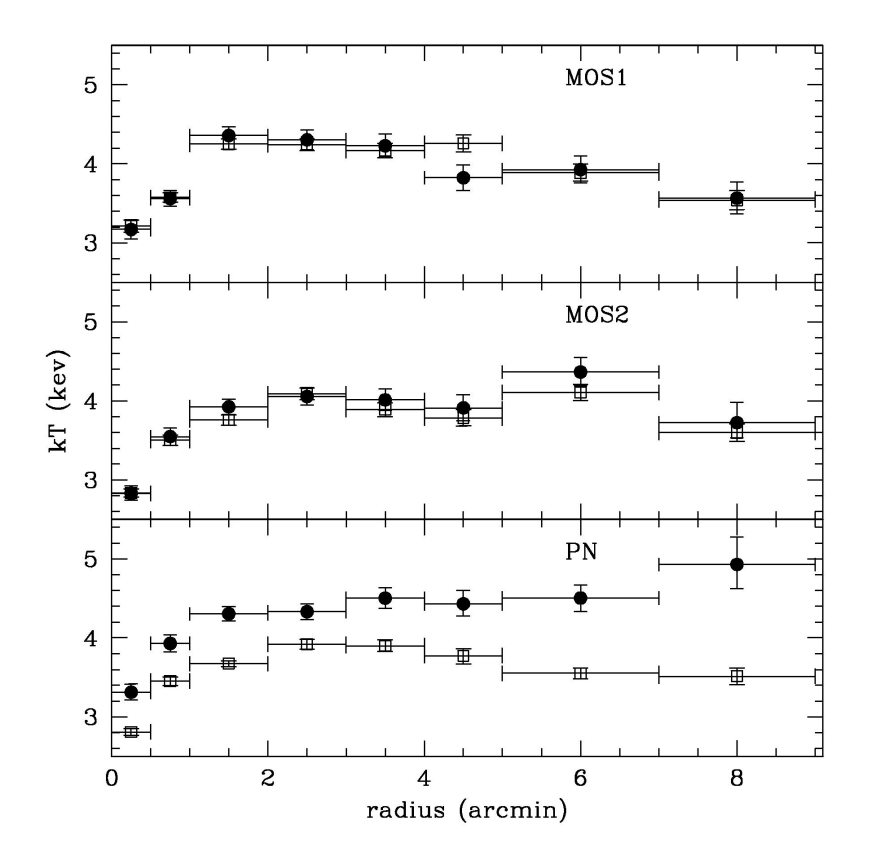
1. drops as you include so ter parts o the spectrum at least part o this is not due to calibration
2. the Pn temperatures ary considerably more than the MOS

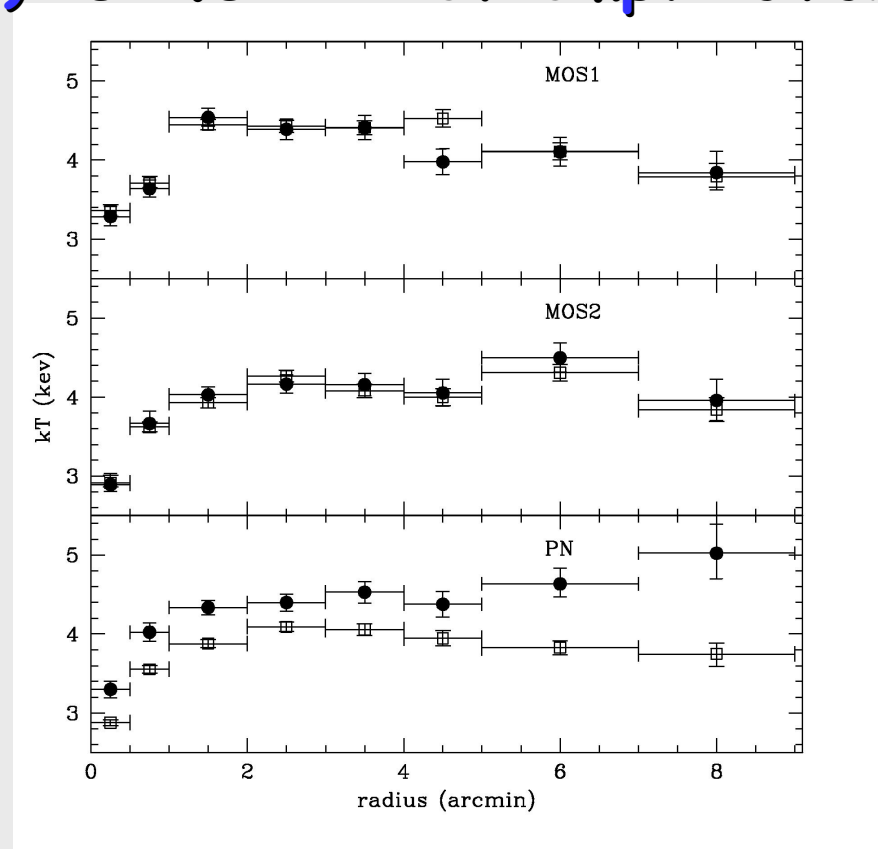
. Bigest problem is 2 pn ariation when going rom 1. 1 e to . 1 e

S S

For one o ect e compared old and ne S S

.5 eV (filled circles) s .5 eV empt circles





SAS

SAS

S S

Table 2. Comparison between percentual differences in PN temperature profiles obtained with version 6.0 and 6.1 of the SAS analysis package.

ring	SAS6.0	SAS6.1
$0'$-$0.5'$	15.2%	10.8%
$0.5'$-$1'$	12.1%	11.7%
$1'$-$2'$	14.7%	10.6%
$2'$-$3'$	9.5%	6.7%
$3'$-$4'$	13.4%	10.4%
$4'$-$5'$	14.8%	9.9%
$5'$-$7'$	21.1%	17.4%
$7'$-$9'$	27.2%	25.4%
mean values	13.3±2.2%	10.5±0.7%

Summary

1. n the hard bands we ha e reasonable agreement btwn instruments better than 1
2. n the so t band there is a large discrepancy btwn. MOS and pn the act that pn in 1. 1 e and pn in . 1 e show a similar discrepancy indicates that the problem is a pn rather than a MOS problem.

. Pn changes in S S .1 sol e only part o the problem