



X-ray Mission Cross Calibration



Comparison of XMM-Newton EPIC, Chandra ACIS-S3, ASCA SIS and GIS, and ROSAT PSPC results for G21.5-0.9, 1ES0102-72.3, and MS1054.4-0321

A “Man on the street” view of the current status of the cross calibration.

- Publicly available software (SAS 5.2, mostly CIAO 2.1) and current calibration data bases (well almost)
- Will not address “Truth” but “Beauty” is a relative concept

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Dave Lumb – ESTEC

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Richard Mushotzky – GSFC

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Caveats

Calibration and software as current in the last month or two

→ The calibration and software are moving quantities which are improving with time, i.e., in the last 8 months these results have changed for the better.

Fudge for the ACIS-S3 fits: a carbon Kalpha edge of optical depth 1.0 has been added which improves the fits

There are sensitivities to the energy range, background selection, spectral model, which data are being fit, what parameters are being fit simultaneously, etc.

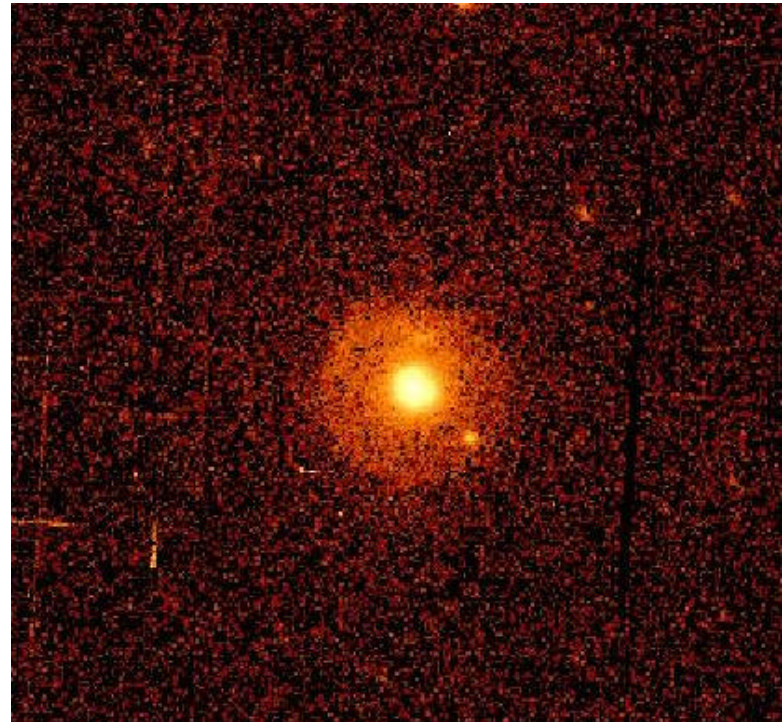
ACIS results are for the S3 CCD only.

G21.5-0.9

Crab-like SNR with an extended
X-ray halo

In order to compare XMM and
Chandra results with those
from ASCA, full remnant
extracted (XMM/Chandra 165''
radius, ASCA 240'' radius)

Power-law spectrum dominates
PN, MOS1, MOS2, ACIS-S3,
SIS0, SIS1, GIS2, GIS3

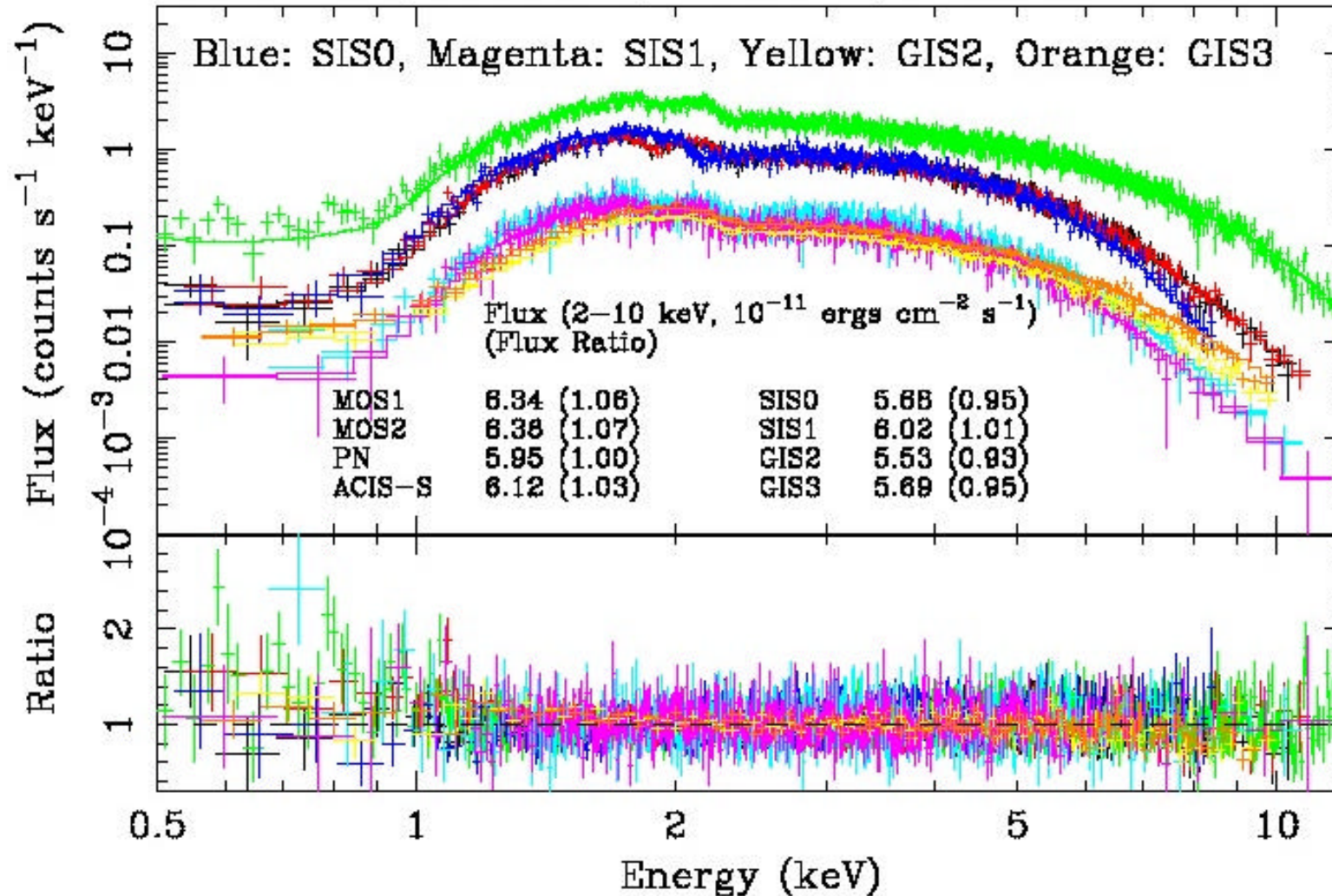


G21.5-0.9 Spectra - All

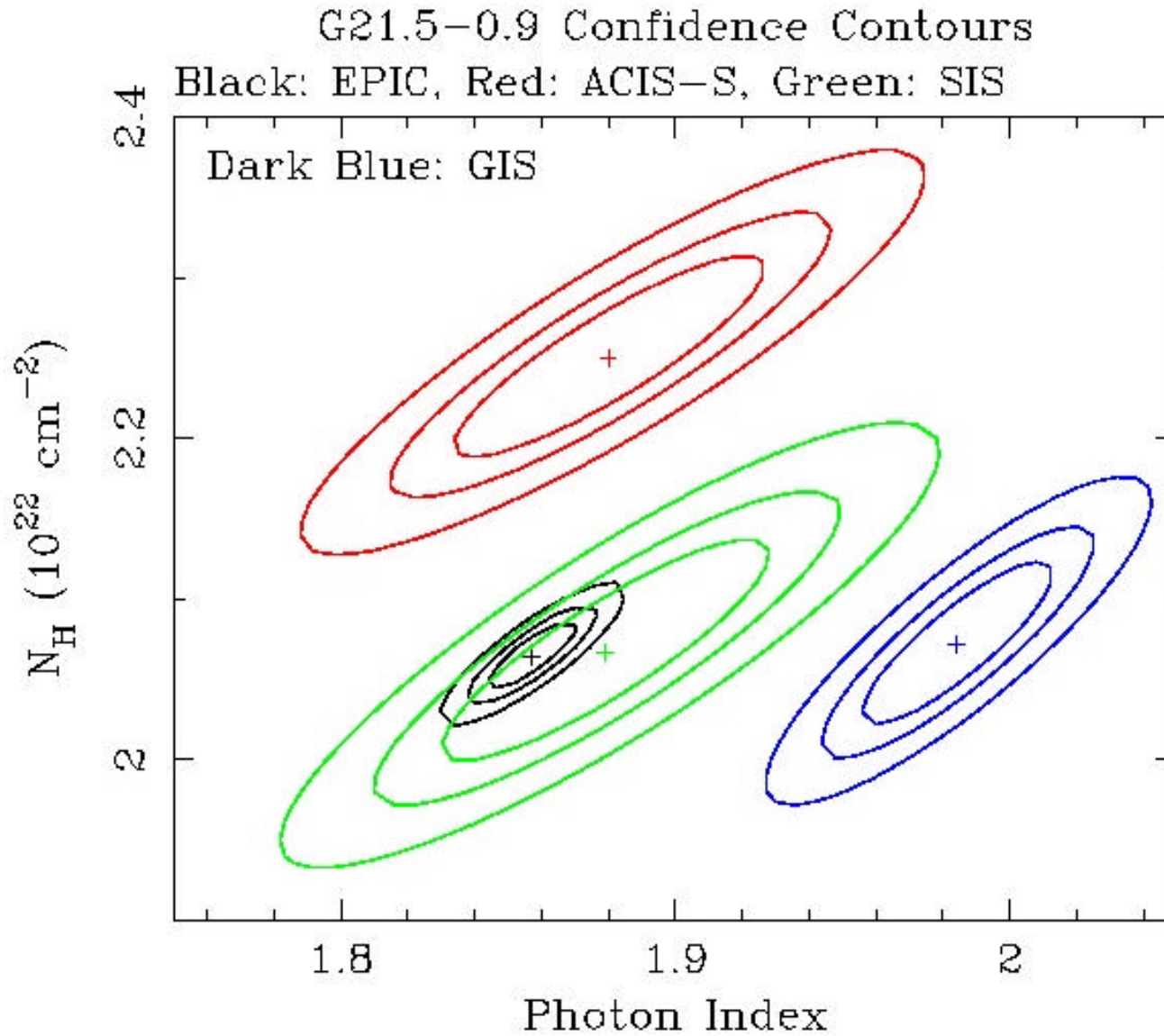
G21.5-0.9 Spectral Fits

Black: MOS1, Red: MOS2, Green: PN, Dark Blue: ACIS-S

Blue: SIS0, Magenta: SIS1, Yellow: GIS2, Orange: GIS3



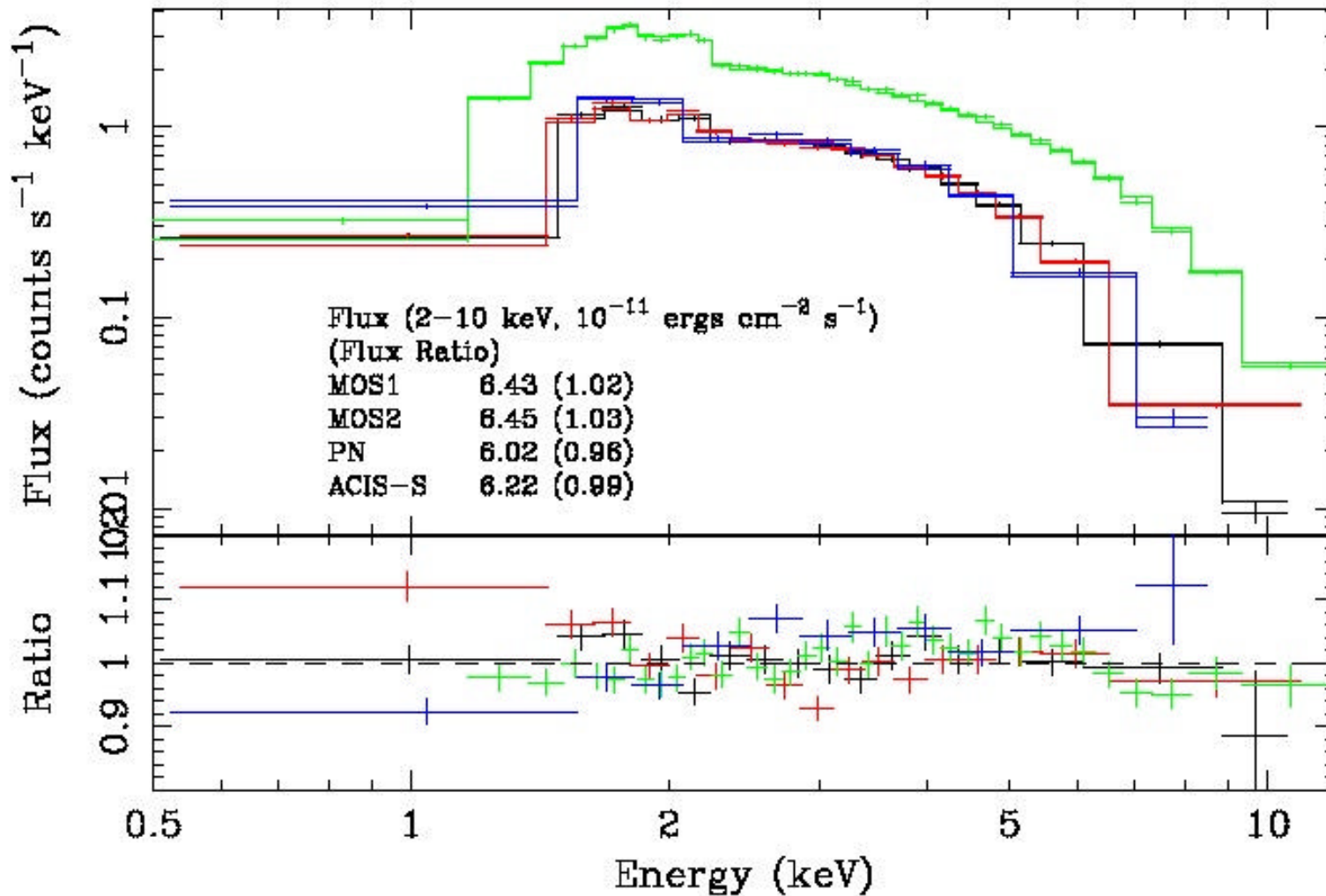
G21.5-0.9 Confidence Contours - All



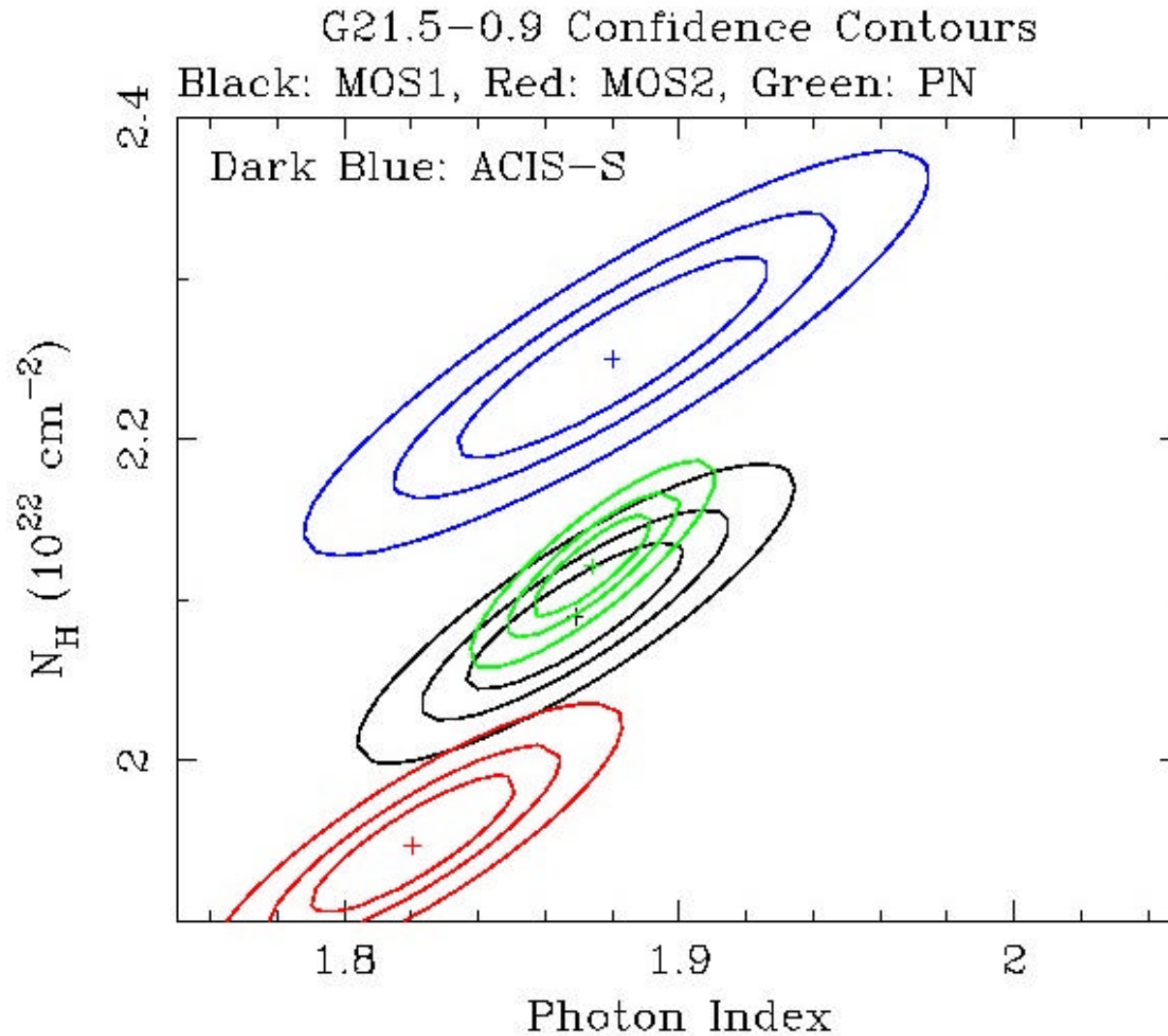
G21.5-0.9 Spectra – EPIC/ACIS

G21.5-0.9 Spectral Fits

Black: MOS1, Red: MOS2, Green: PN, Dark Blue: ACIS-S



G21.5-0.9 Confidence Contours – EPIC/ACIS



1ES0102-72.3

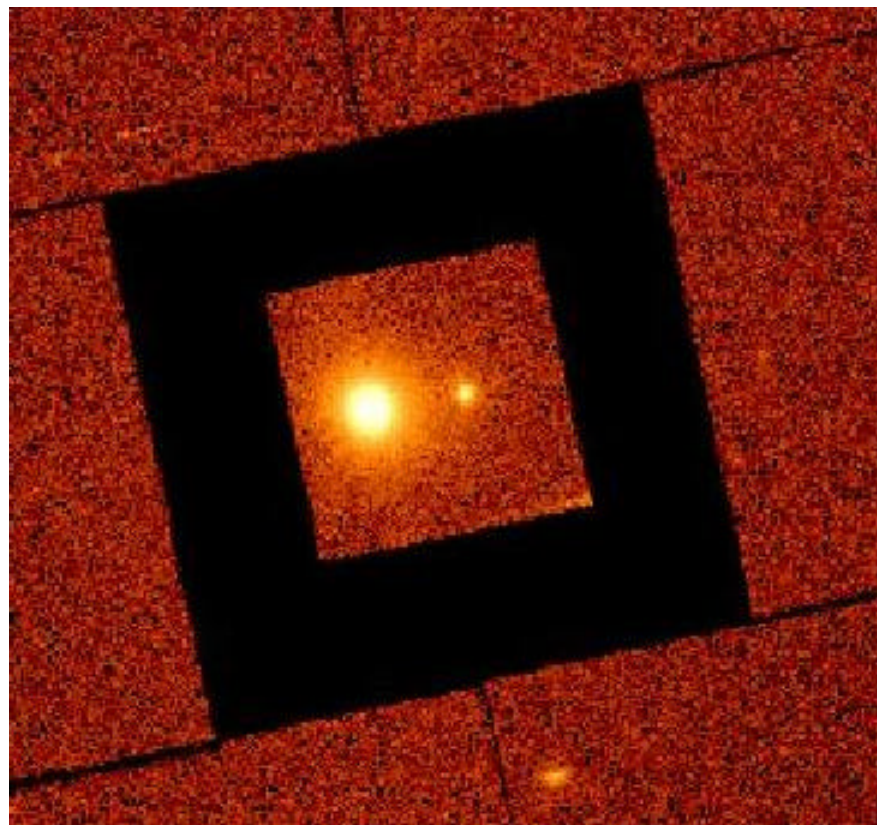
SMC SNR

Very line rich

MOS1, MOS2, ACIS-S3,
SIS0, SIS1, GIS2, GIS3,
PSPC, RGS1, RGS2

Spectrum: 2 absorbed
APEC thermal spectra
with variable abundances

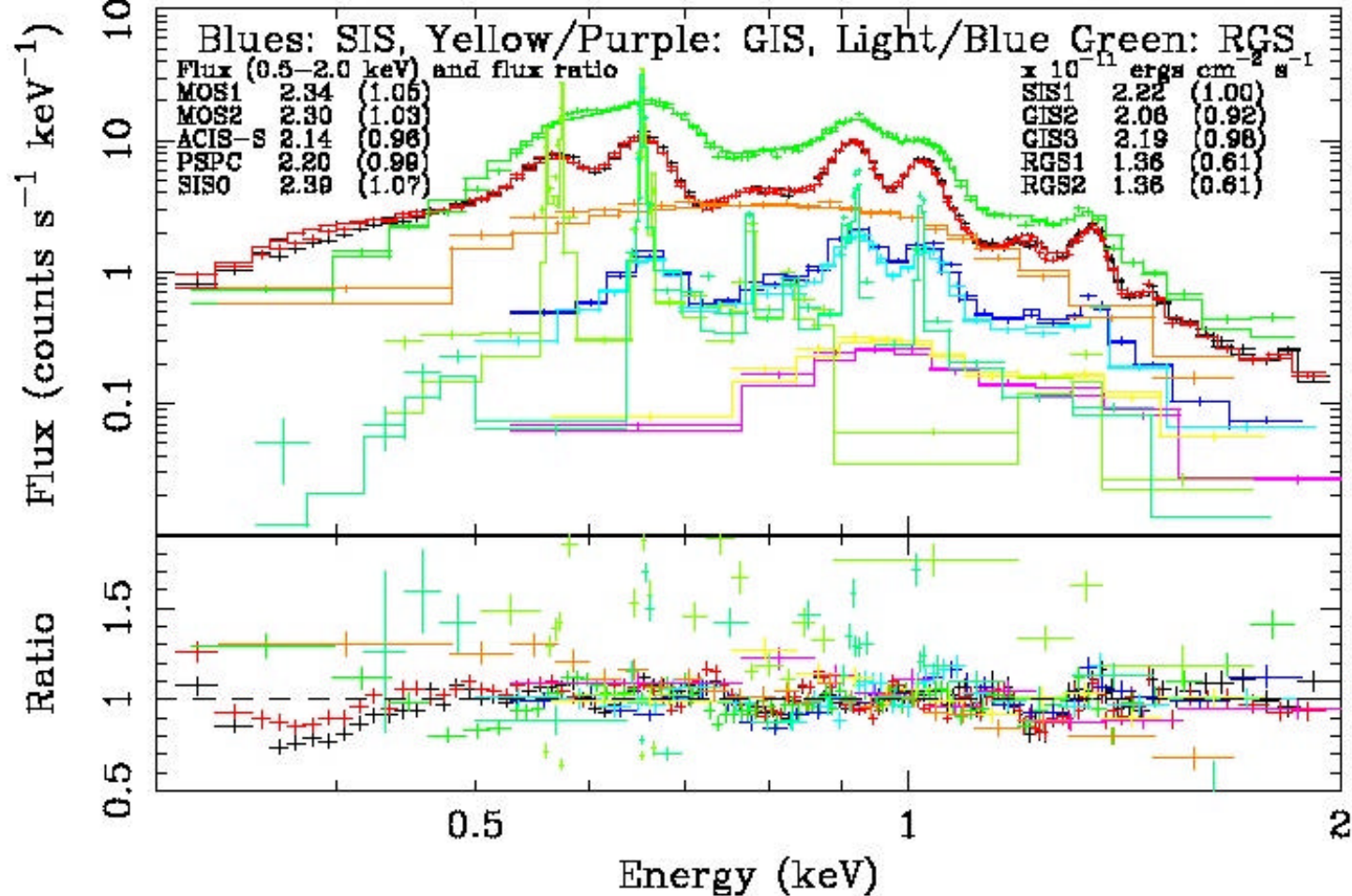
Terrible fit in terms of χ^2_{ν}
but good enough for
fitted flux comparison



1ES0102-72.3 Spectra - All

1ES0102-72 Spectral Fits

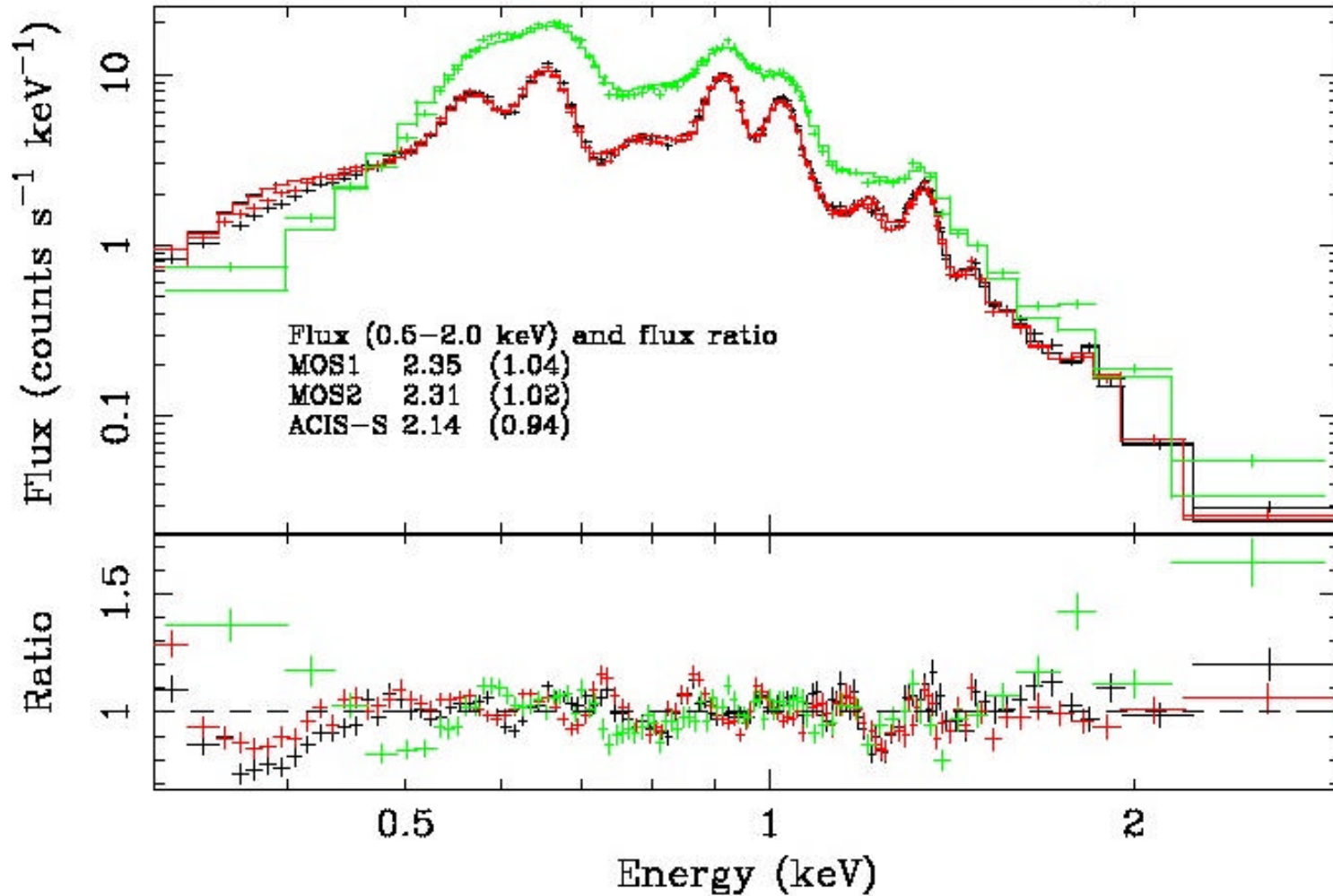
Black: MOS1, Red: MOS2, Green: ACIS-S, Orange: PSPC



1ES0102-72.3 Spectra – MOS/ACIS

1ES0102-72 Spectral Fits

Black: MOS1, Red: MOS2, Green: ACIS-S, Orange: PSPC



MS1054.4-0321

High redshift cluster

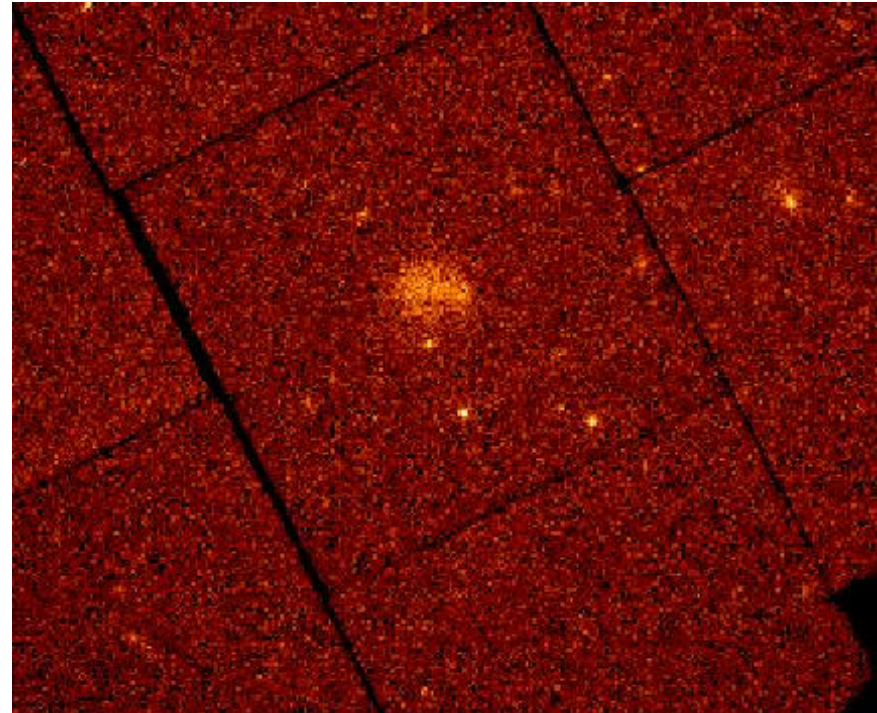
Low absorption

MOS1, MOS2, ACIS-S3

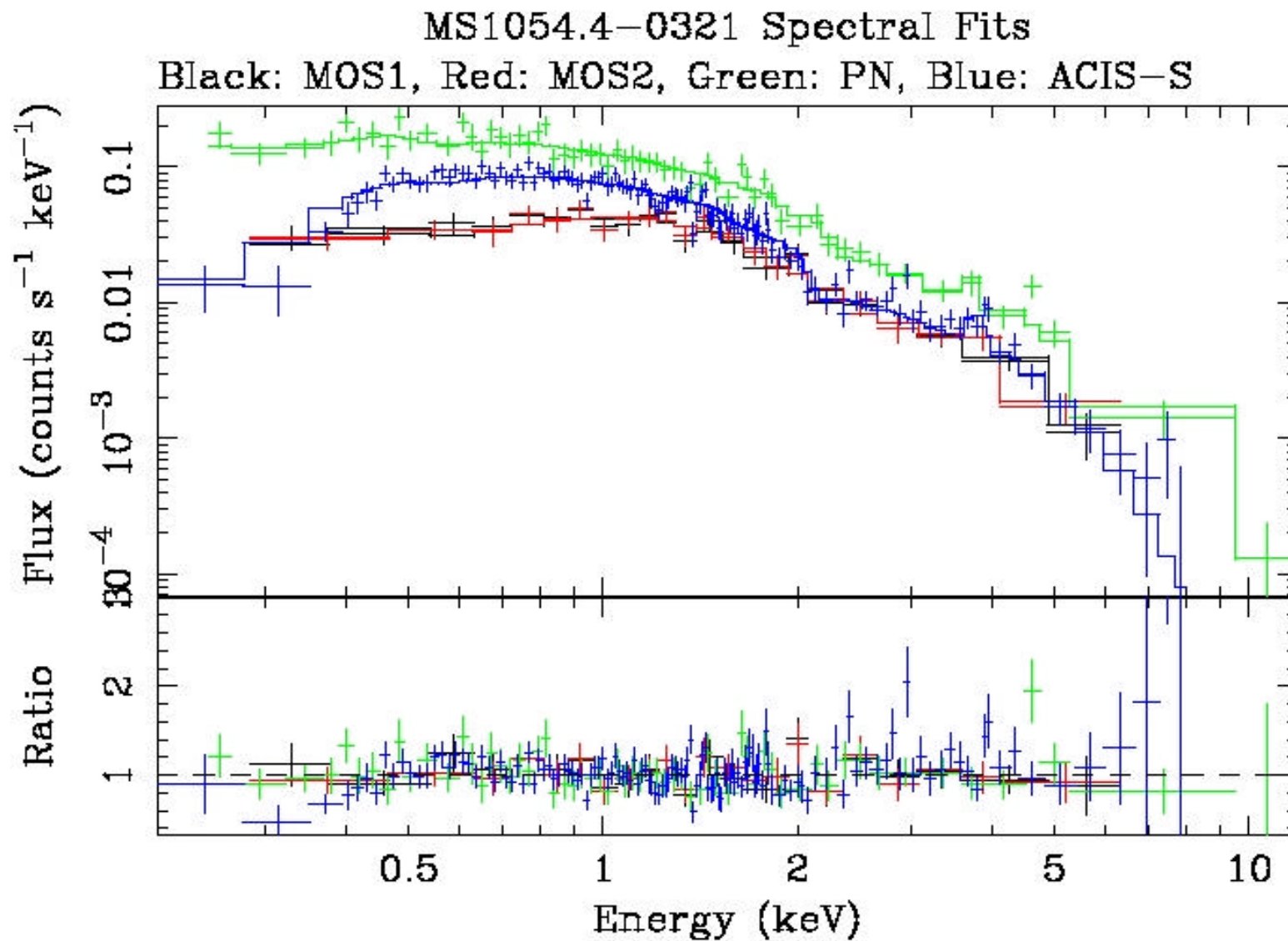
One absorbed high-
temperature spectrum

Relatively poor statistics

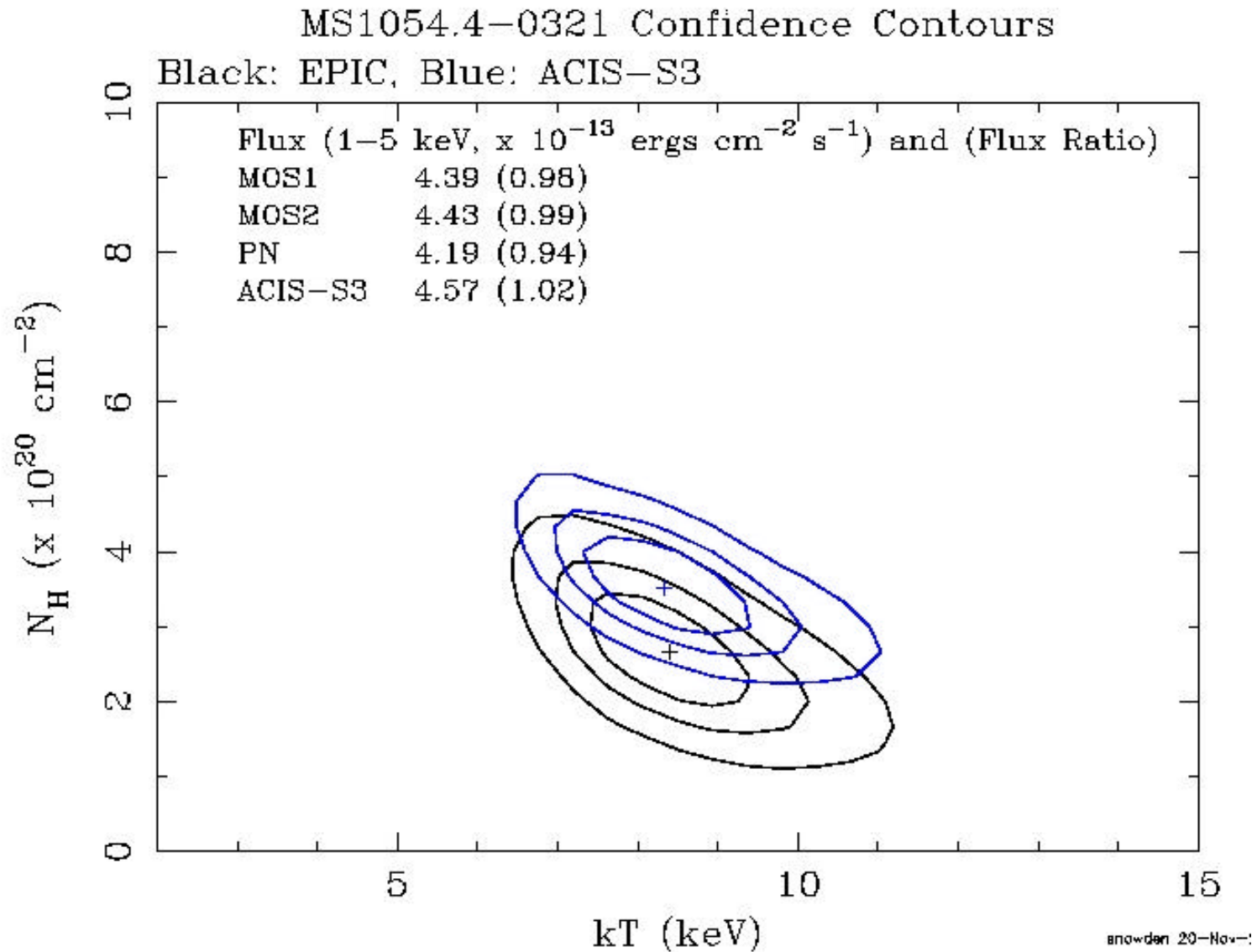
XMM proprietary data
courtesy of Mike
Watson



MS1054.4-0321 Spectra



MS1054.4-0321 Confidence Contours



Relative Flux Summary

Simultaneous Fits, normalized to the MOS1, MOS2, ACIS-S3 average

	G21.5-0.9 2 – 10 keV	1ES0102-72.3 0.5 - 2.0 keV	MS1054.4-0321 1 – 5 keV
PN	0.95	----	0.94
MOS1	1.01	1.04	0.98
MOS2	1.01	1.02	0.99
ACIS-S3	0.98	0.95	1.02
SIS0	0.91	1.06	----
SIS1	0.96	0.99	----
GIS2	0.88	0.91	----
GIS3	0.91	0.97	----
PSPC	0.85*	0.97	----

* Flux compared over the 0.5-2.5 keV band

Conclusions

Pretty good, but work left to do.

- EPIC/ACIS flux calibration good to +/- 5%
- Power law indices good to < 0.1
- EPIC MOS/PN inconsistency must be resolved
- ACIS-S3 low energy response must be fixed

- And, of course, more comparisons need to be done
 - Different spectra
 - EPIC vs ACIS-I