

EPIC Chandra Cross Calibration with the Perseus Cluster

**S. Molendi, F. Gastaldello & A. Tiengo
(IASF-MI)**

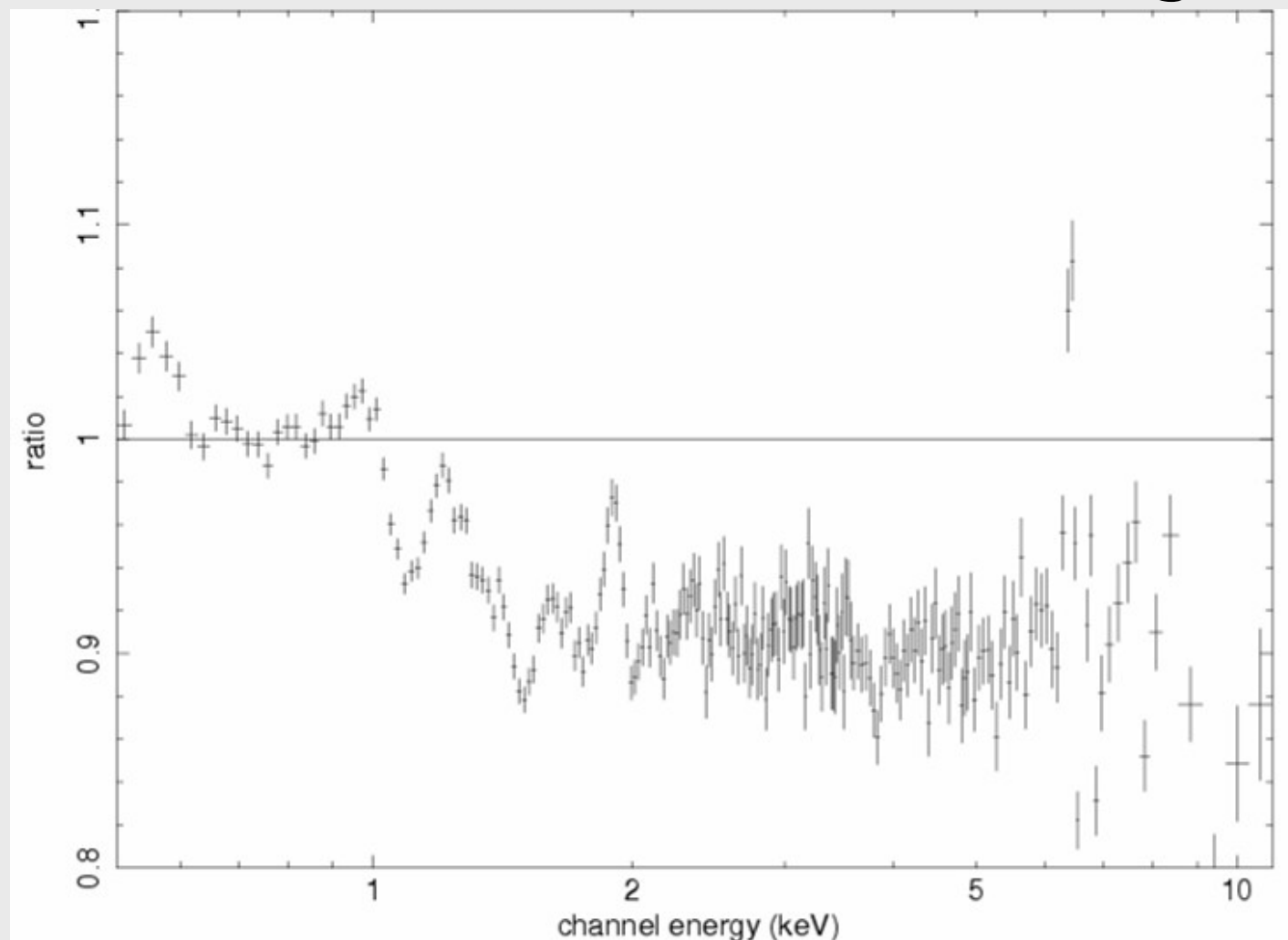
Cross Cal with Clusters

- Has enjoyed some success
- Perseus is the brightest cluster in the X-ray sky
- Lots of photons and no pile-up!
- In the past used to check pn/MOS cross calibration

Example of old vs new

pn/mos

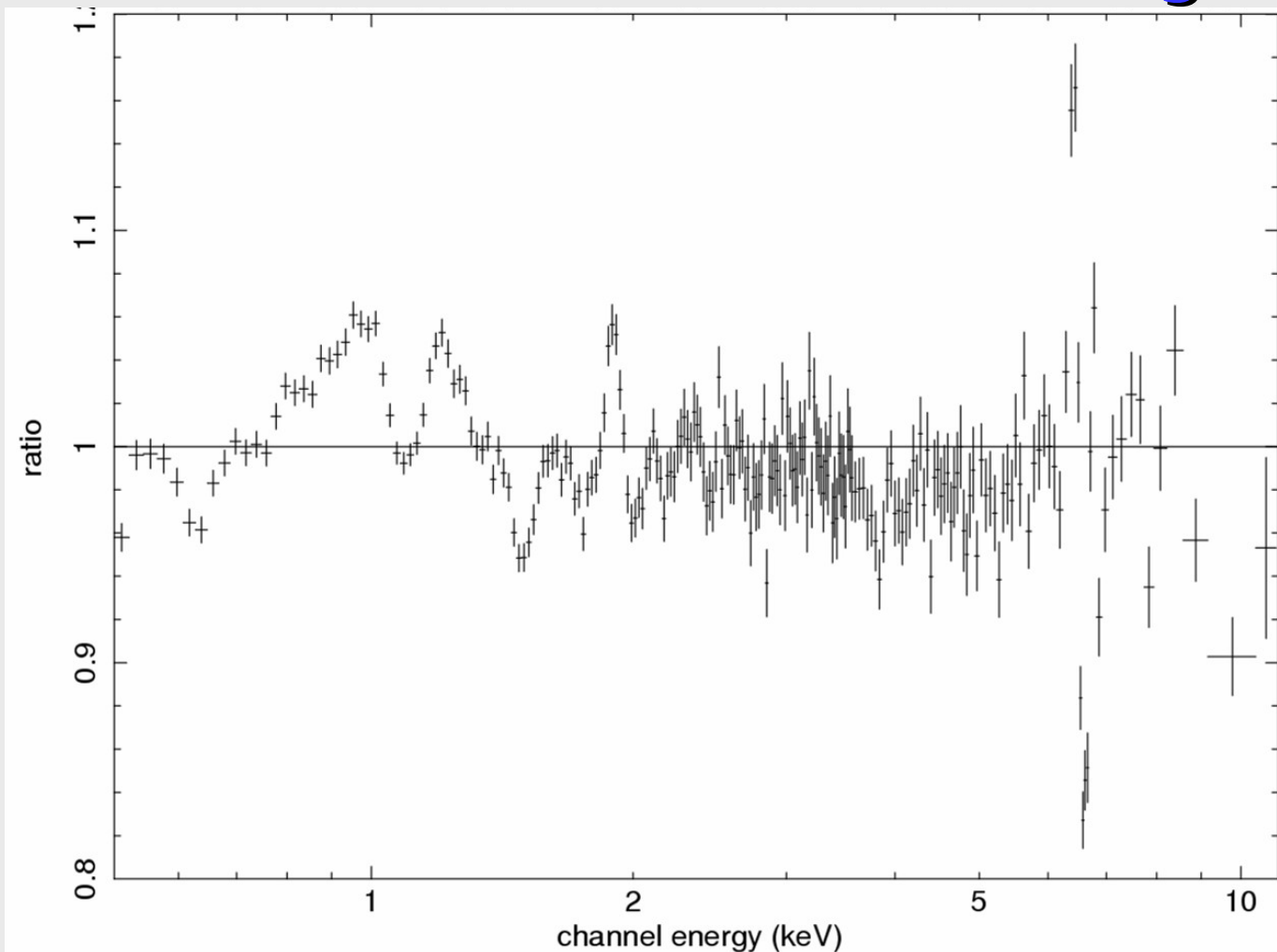
Residuals in the form of ratio data/model for PN data on MOS best fitting model



Example of old vs new

pn/mos

Residuals in the form of ratio data/model
for PN data on MOS best fitting model

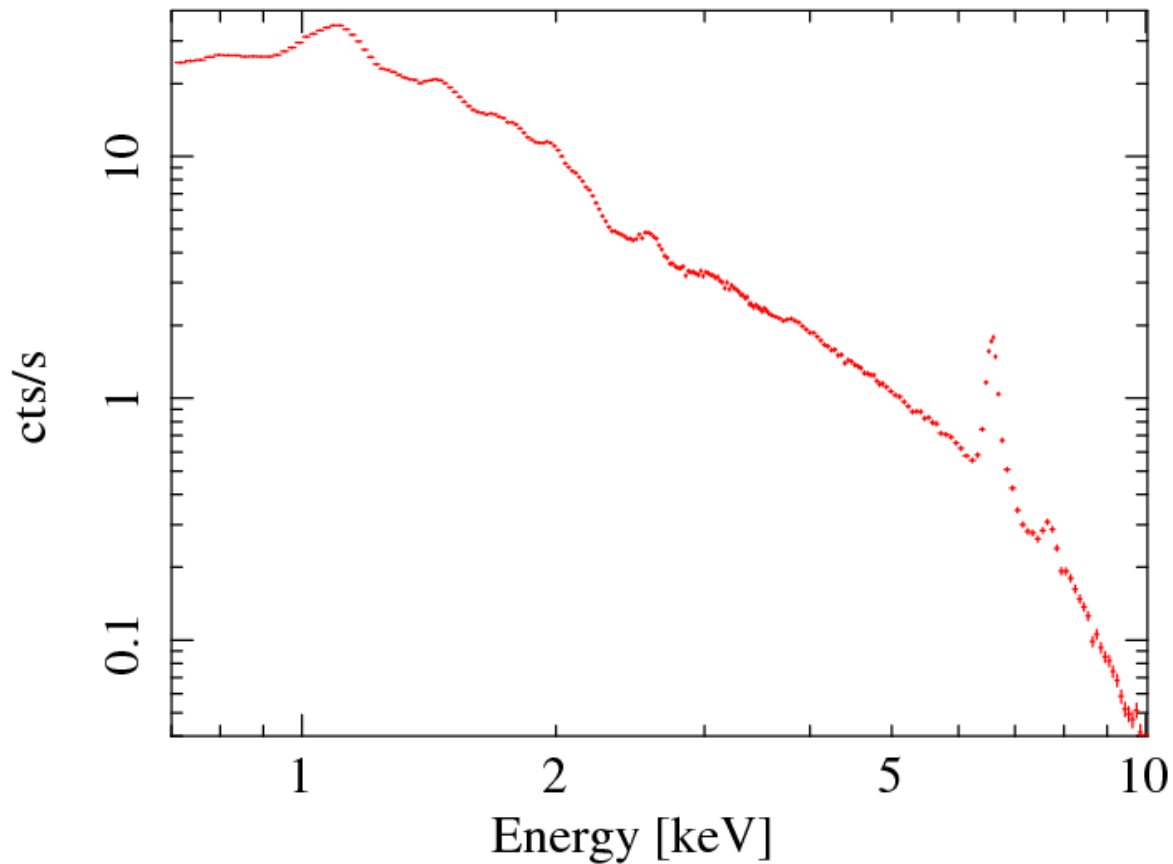


ACIS S3 vs EPIC pn

- We compare Chandra ACIS S3 with EPIC pn
- About 3×10^6 events for each spectrum extracted from annulus with bounding radii of 1' and 2'
- Used old and new Chandra calibrations (CALDB 4.1.1 with hrmaD1996-12-20axeffaN0008.fits)
- Multi T spectral model (Molendi & Gastaldello 09)

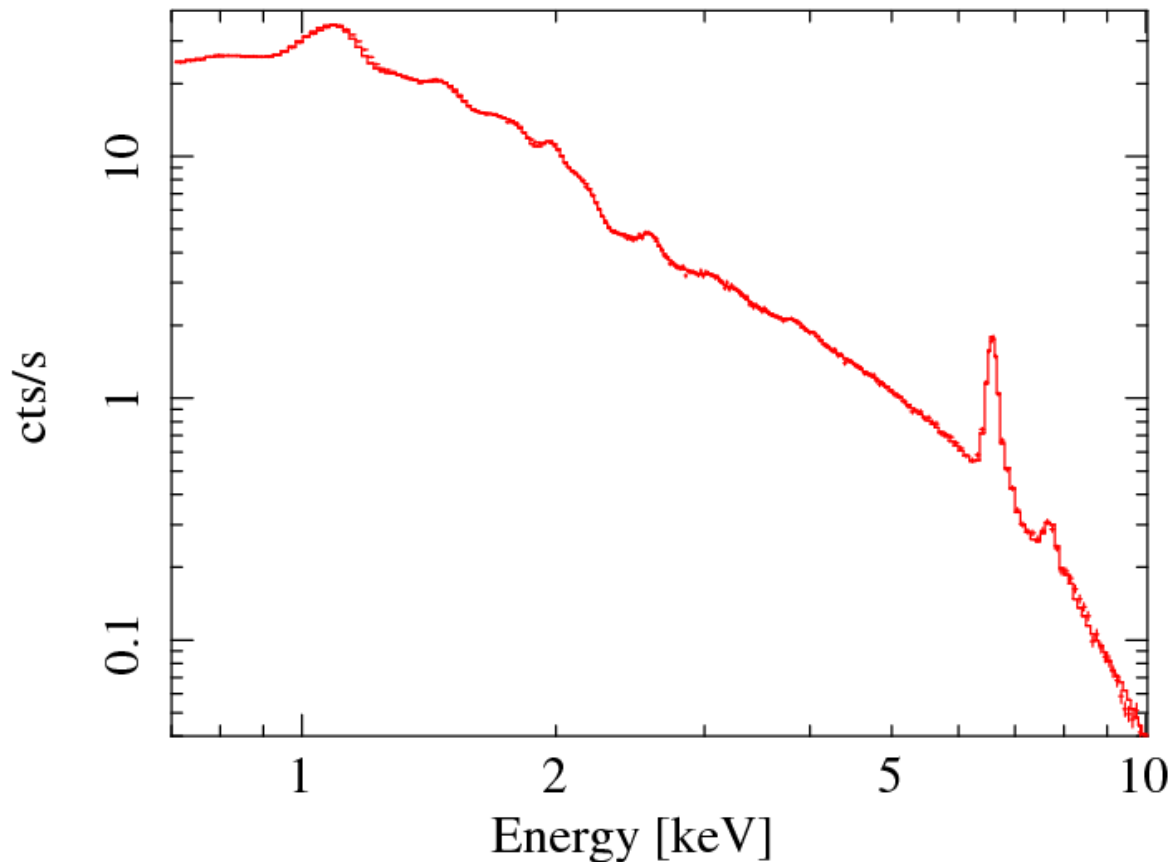
ACIS S3 vs EPIC pn

- We start from the EPIC pn spectrum



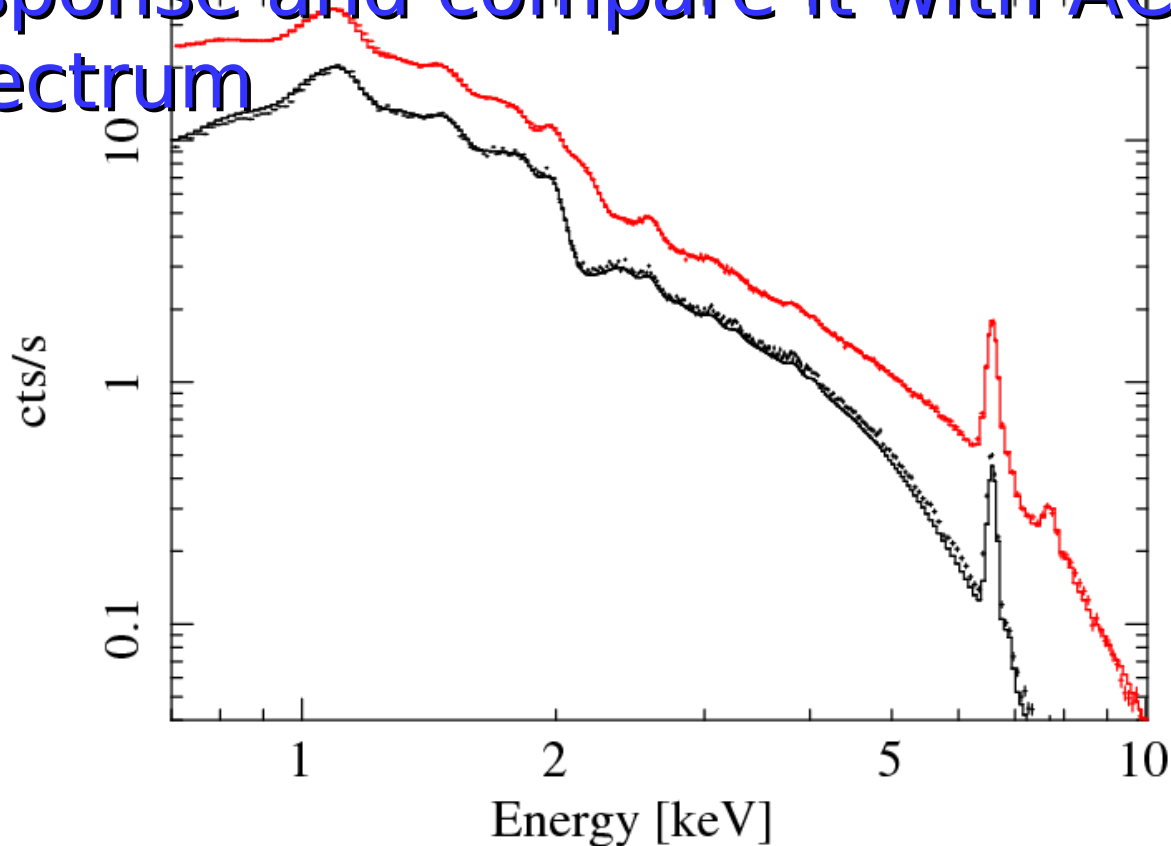
ACIS S3 vs EPIC pn

- We start from the EPIC pn spectrum
- Perform fit with multi T model



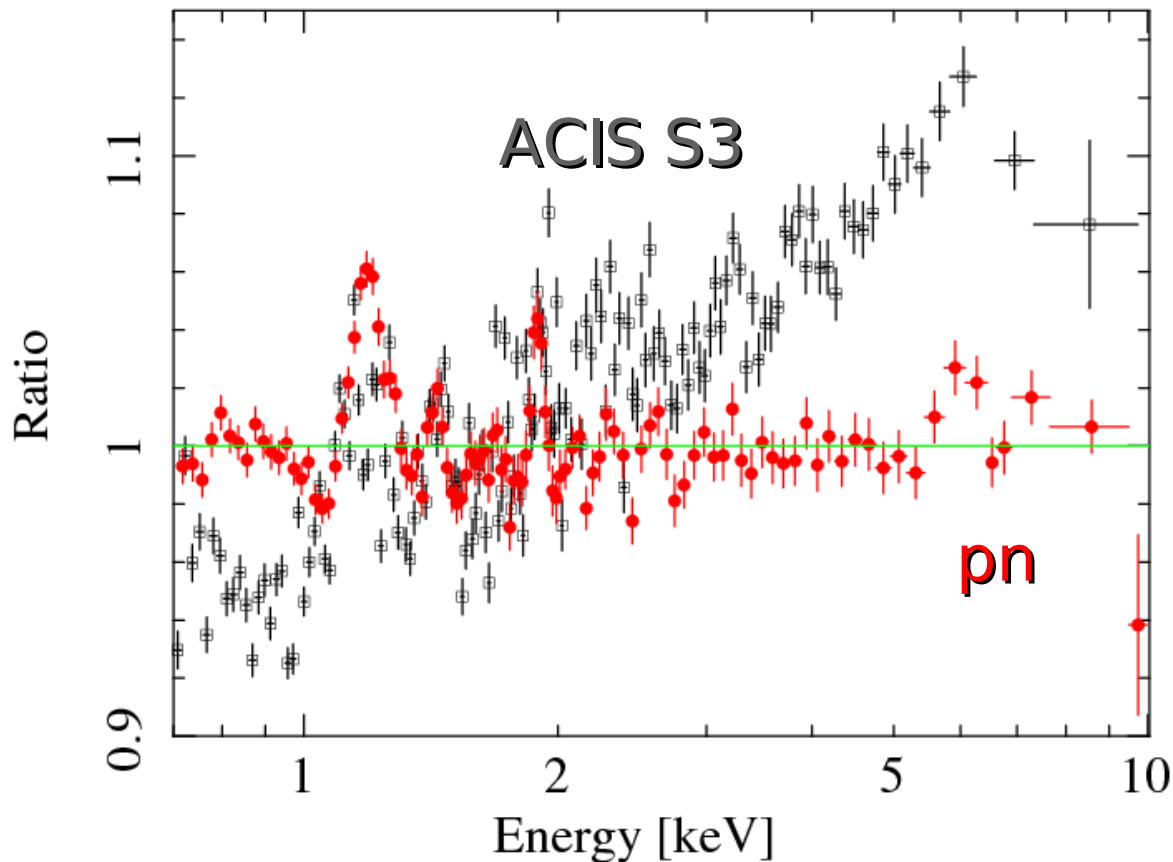
ACIS S3 vs EPIC pn

- We start from the EPIC pn spectrum
- Perform fit with multi T model
- Fold best fitting model with ACIS response and compare it with ACIS spectrum



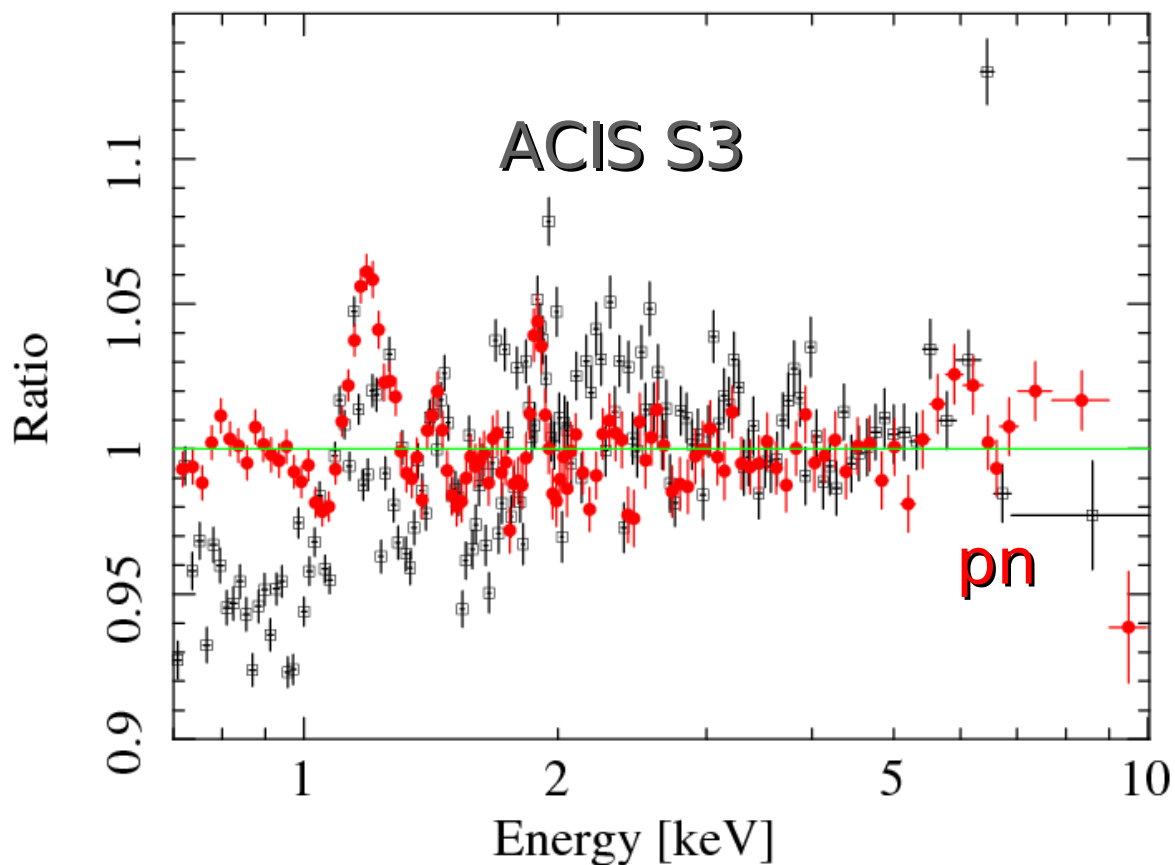
ACIS S3 vs EPIC pn

Plot residuals in the form of ratio data/model
Renorm applied to match spectra at 1.5 keV



ACIS S3 vs EPIC pn

Plot residuals in the form of ratio data/model
Renorm applied to match spectra at 1.5 keV

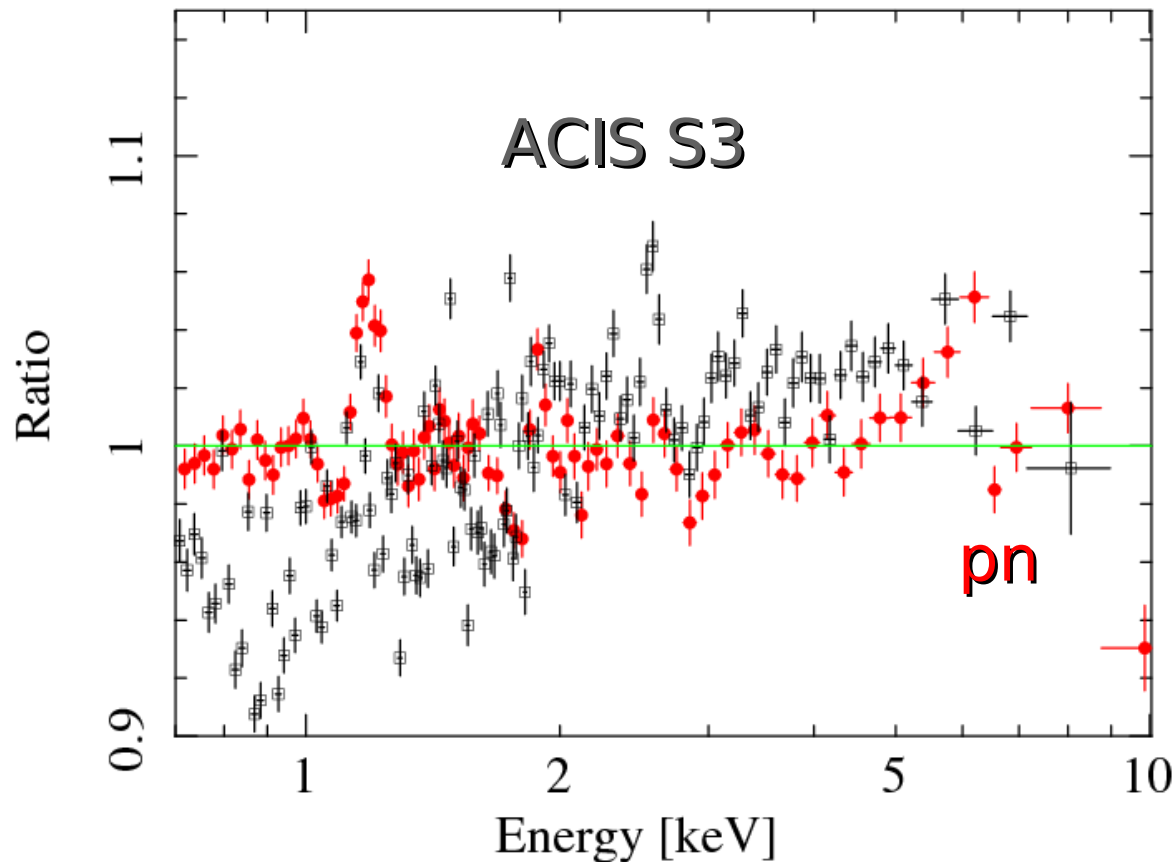


ACIS S3 vs EPIC pn

Similar result when using a different region

Annulus with bounding radii of 2' and 3'

Showing only plot with new ACIS calibrations



Cross Cal

pn and ACIS S3 spectral shapes are now in much better agreement!

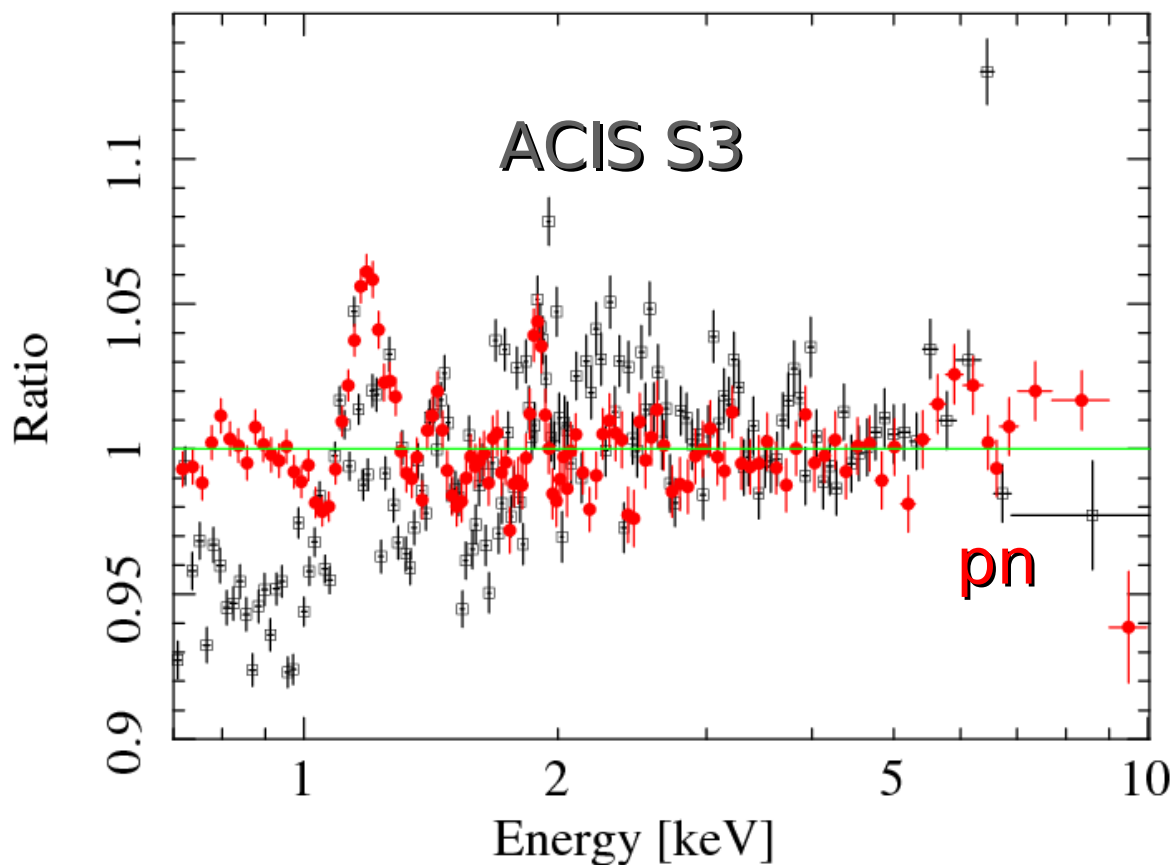
Differences are almost everywhere less than $\sim 5\%$

Major discrepancy in 0.7-1.0 keV range

ACIS S3 vs EPIC pn

Residuals in the form of ratio data/model

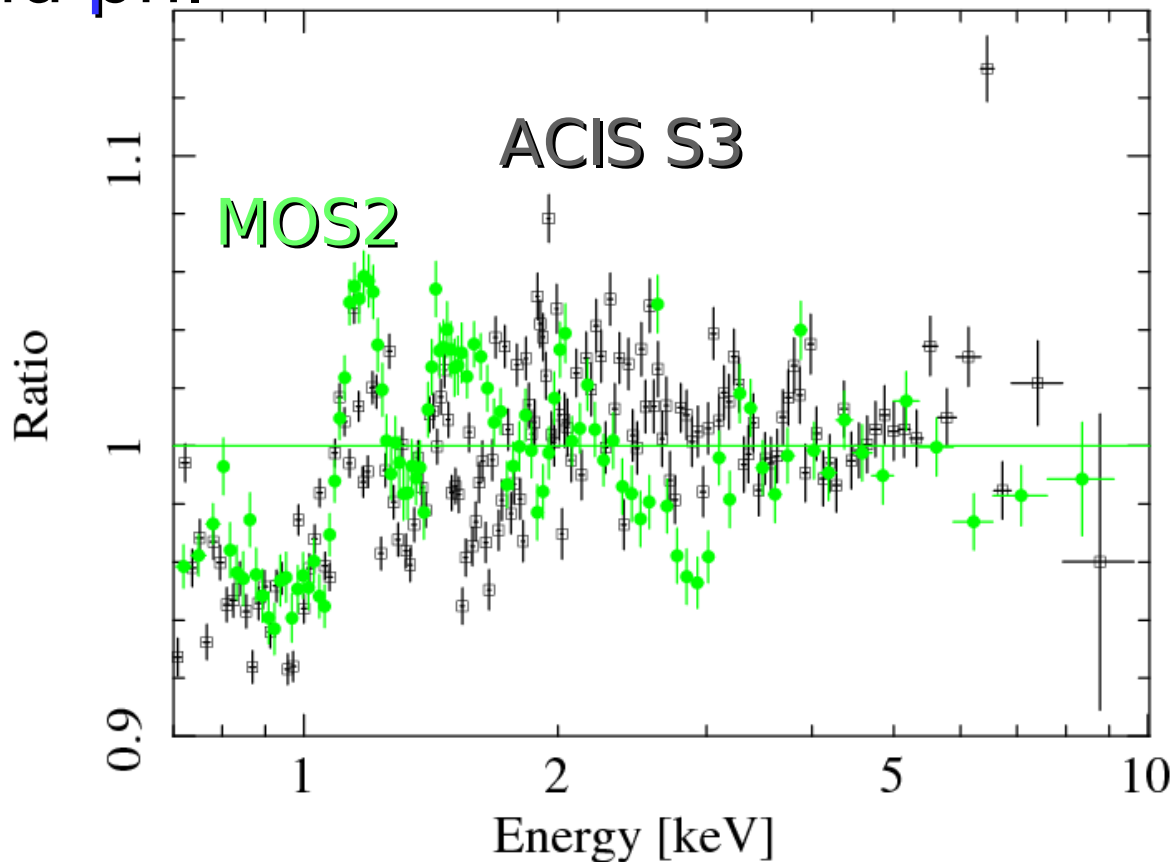
Renorm applied to match spectra at 1.5 keV



ACIS S3 vs EPIC MOS

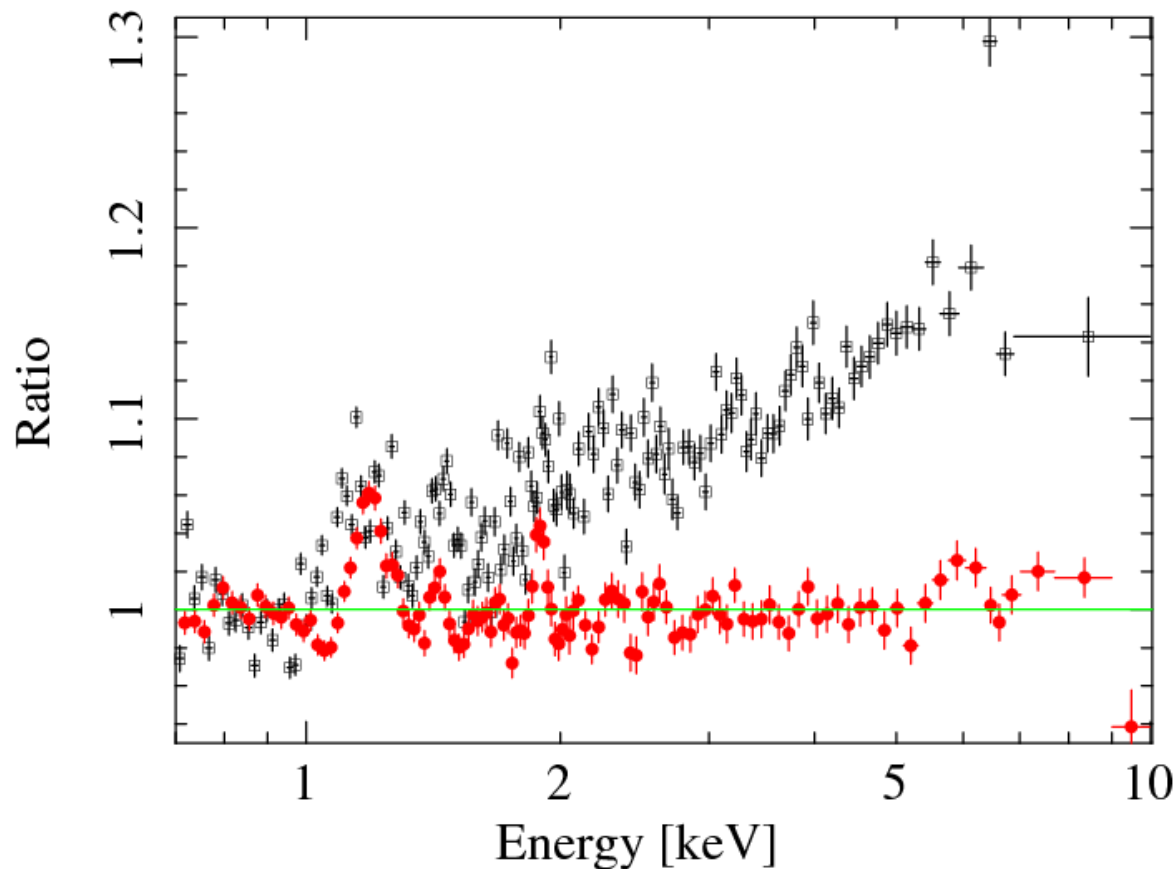
MOS2 appears to be more similar to ACIS in the 0.7-1 keV band.

MOS1 appears to be somewhere btwn. MOS2 and pn.



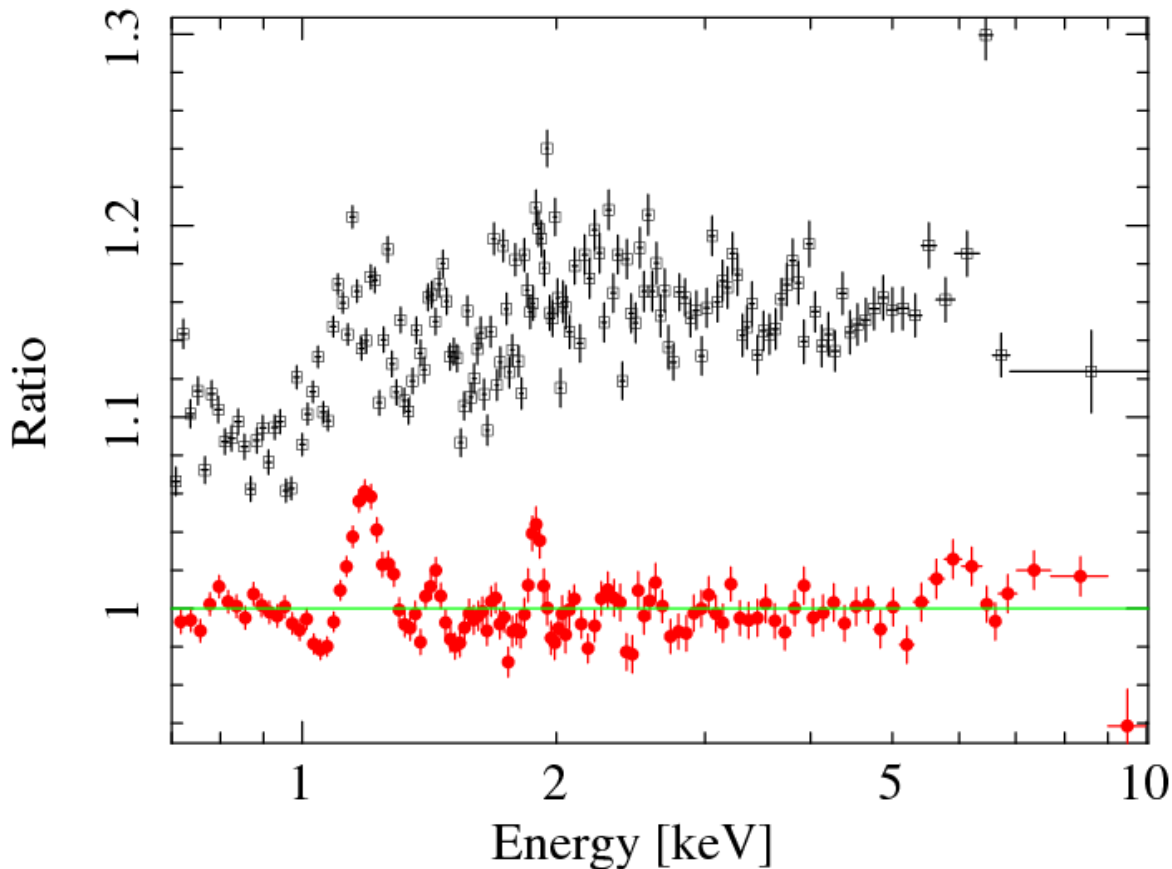
Flux cross-cal pn vs ACIS

- Both figures have renorm factors: 5% for the first; 15% for the second: let's take them out.



Flux cross-cal pn vs ACIS

- Both figures have renorm factors: 5% for the first; 15% for the second: let's take them out.



Flux cross-cal

- The new HRMA calibration impacts on the ACIS/EPIC flux cross calibration.
- Our analysis indicates that the flux cross calibration below ~ 2 keV will be shifted by about 10%.
- Although comparing spectra extracted from a given region of a cluster may not be the best way to go, our data indicates that the flux cross calibration change is not for the better.

Summary

- The new HRMA effective area reduces ACIS S3 vs pn residual calibration errors to less than 5%
this is no small achievement!
- Major remaining discrepancy in 0.7-1 keV band
- The new spectral calibration modifies by about 10% Chandra fluxes below 2 keV, ACIS vs EPIC flux cross calibration will be affected