IACHEC Meeting 2013 - Cluster Working Group

Chandra – XMM-Newton Cross Calibration using HIFLUGCS

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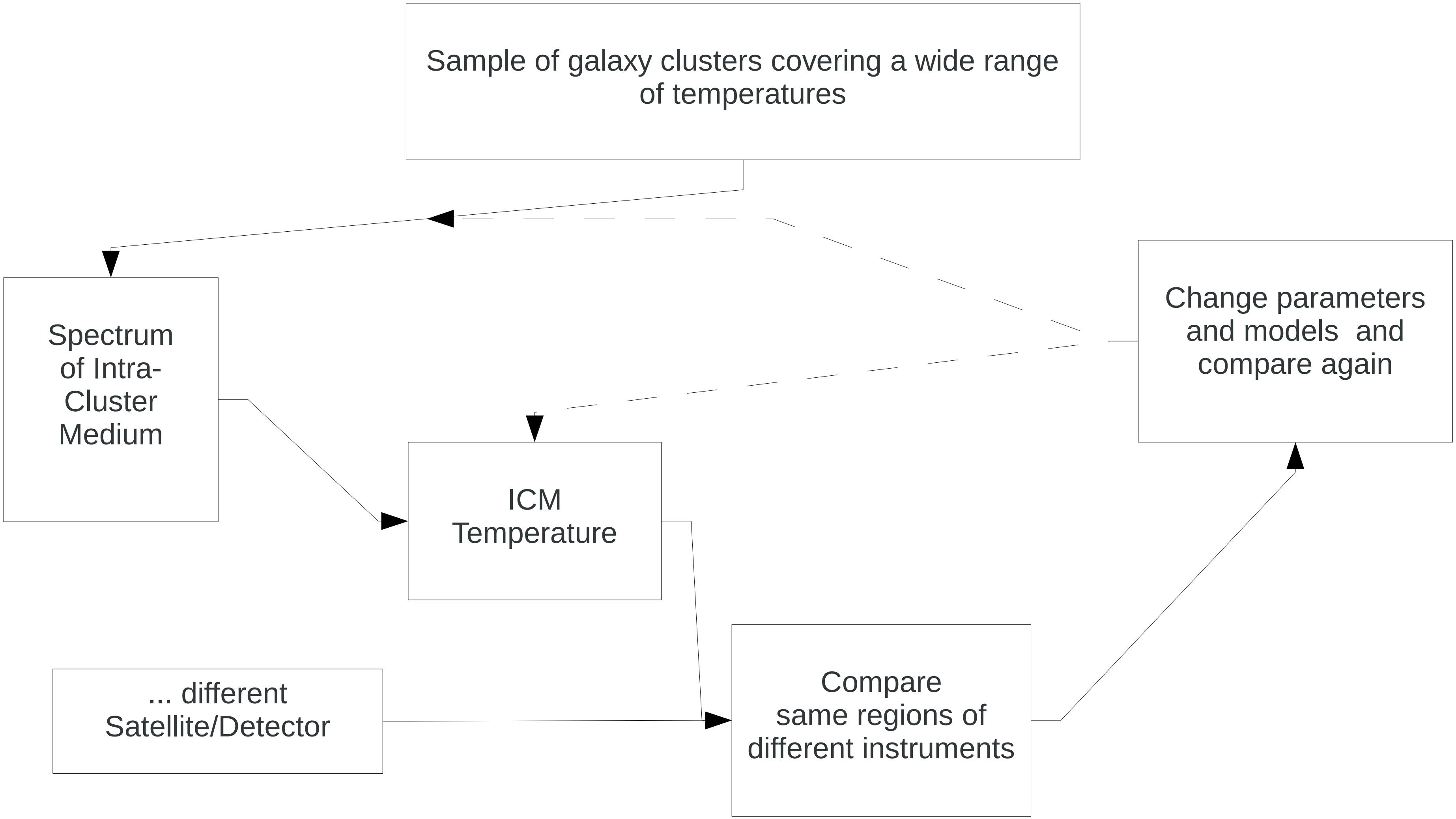
Overview

- What are we doing



HIFLUGCS

- Complete sample of 64 X-ray brightest clusters
- Chandra data for all, XMM data not for A2244

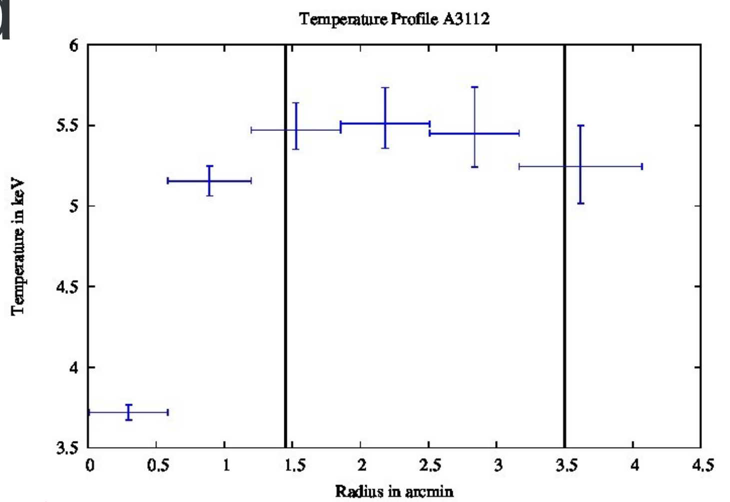
  -> 63 clusters for comparison
- 35 cool-core clusters: select isothermal region
  - Excluding cool-core from analysis
  - Outer boundary: 3.5 arcmin (Background, FOV)

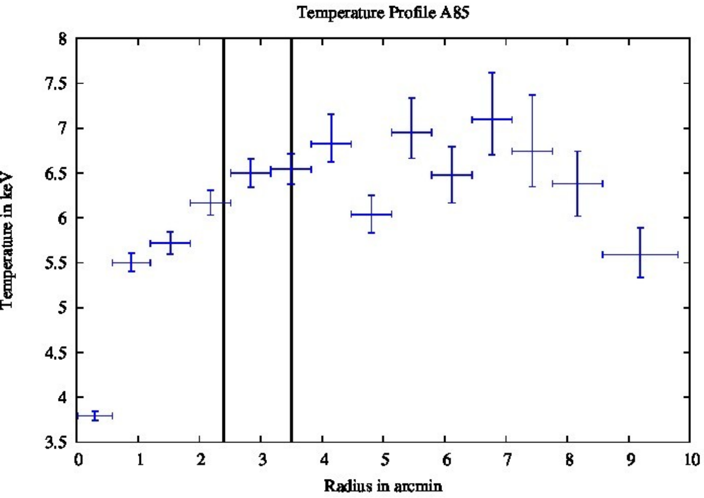
  ->Regions: CC-Cluster spectra from annulus

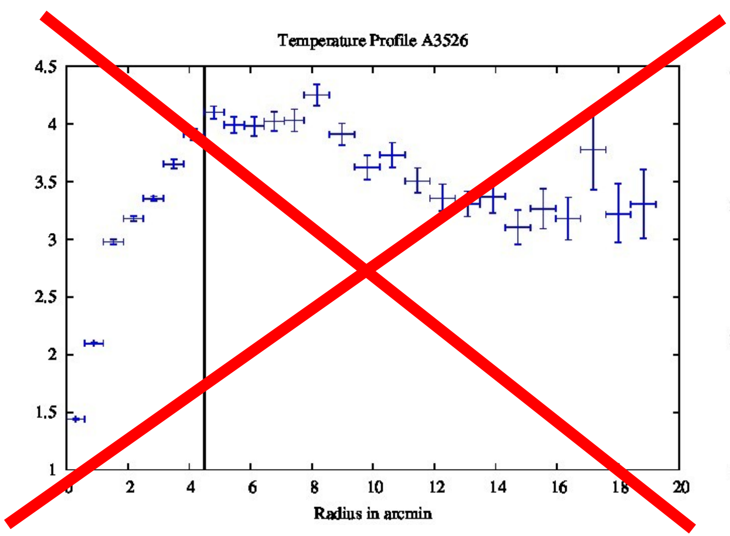
  NCC-Cluster spectra from circle R = 3.5'
- If cool-core Radius > 3.5' (6 cluster): -> excluded

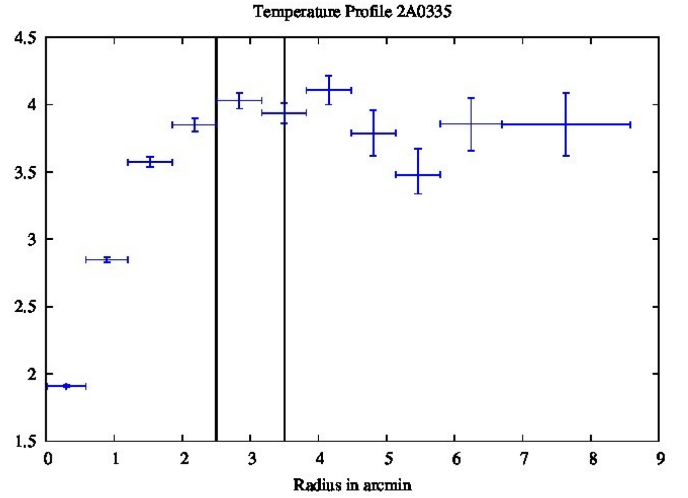
Core Region

- Core radius definition from Hudson et al. (2010) and virial radius from Evrard et al. (1996)
- 15'' were always added to avoid scattering of core emission (XMM PSF)







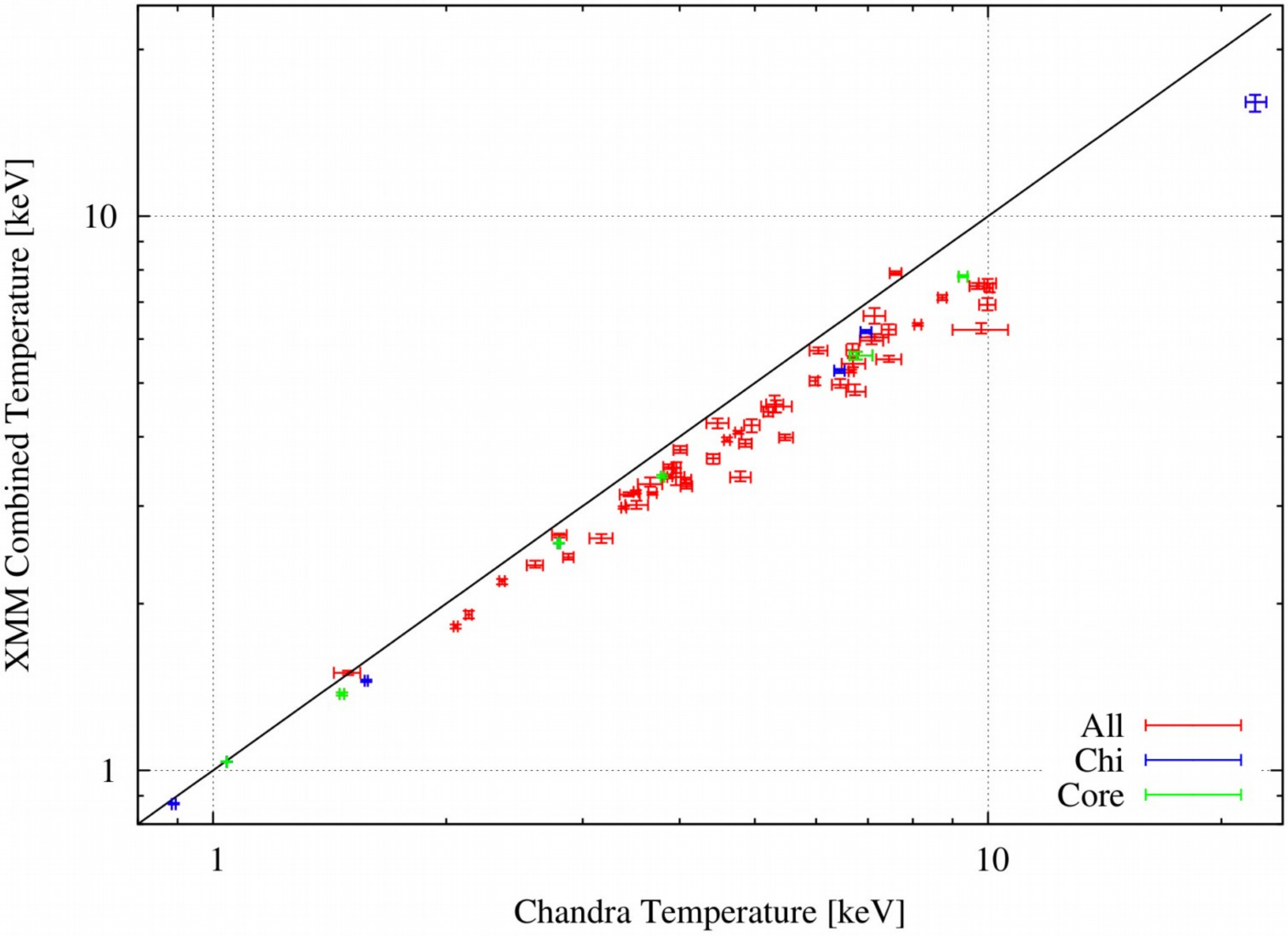


Spectral Fit

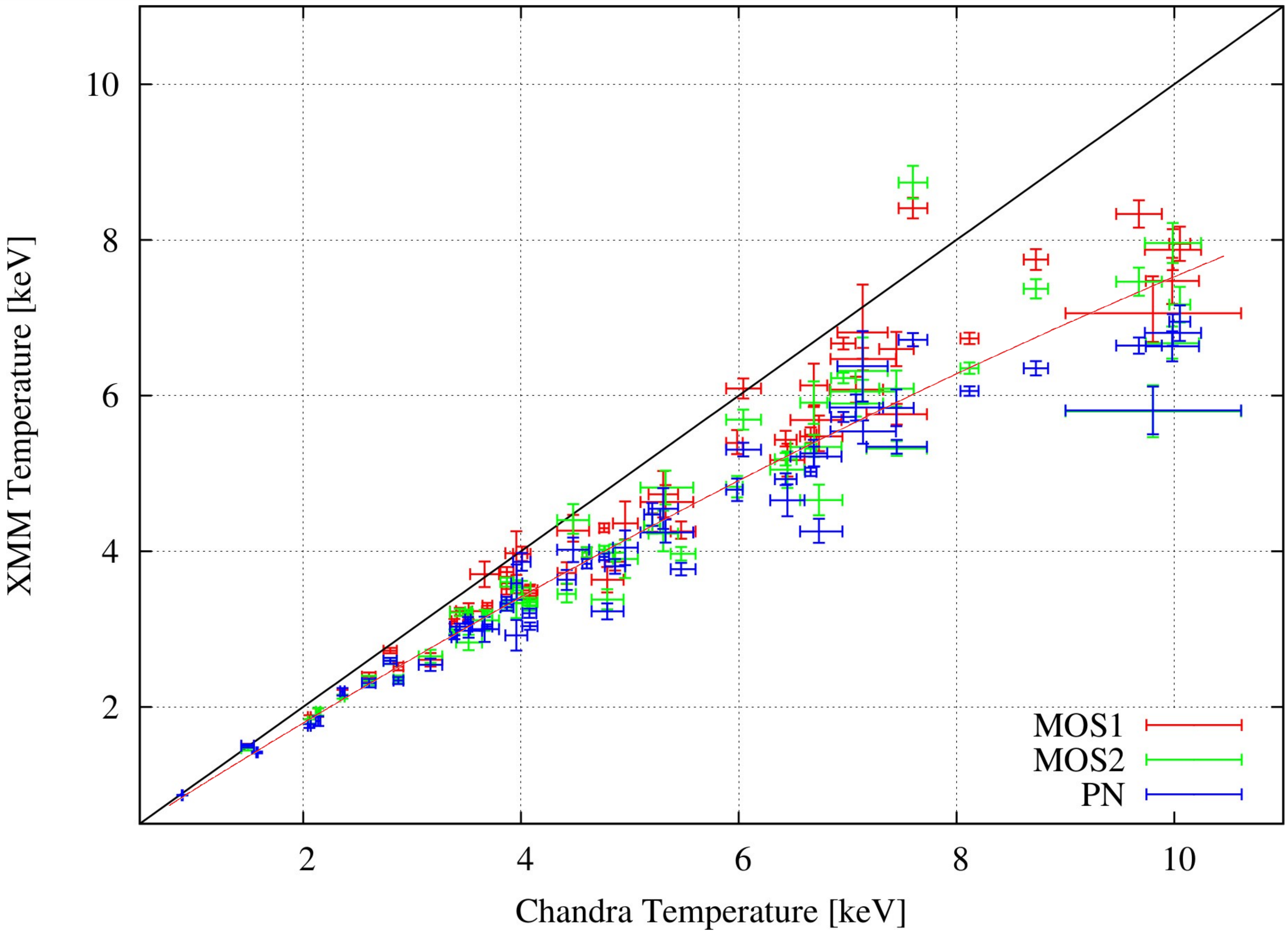
- apec model using AtomDB 2.0.2 and AnGr table
- phabs model for absorption, N_H and redshifts from Zhang et al. 2011 (except A478)
- cflux model for the flux measurement (errorbars)
- Energy band: 0.7-7 keV
- Background from Blank-Sky observations (Chandra & XMM) incl. check with +/- 10%
- Xspec 12.7.1d, CIAO 4.5 (CALDB 4.5.5), SAS 12.0.1
- Excluding all spectral fits with $\chi^2 > 1.6$

Final Sample

- Final number of clusters depending on configuration/detector... ~52-56 clusters

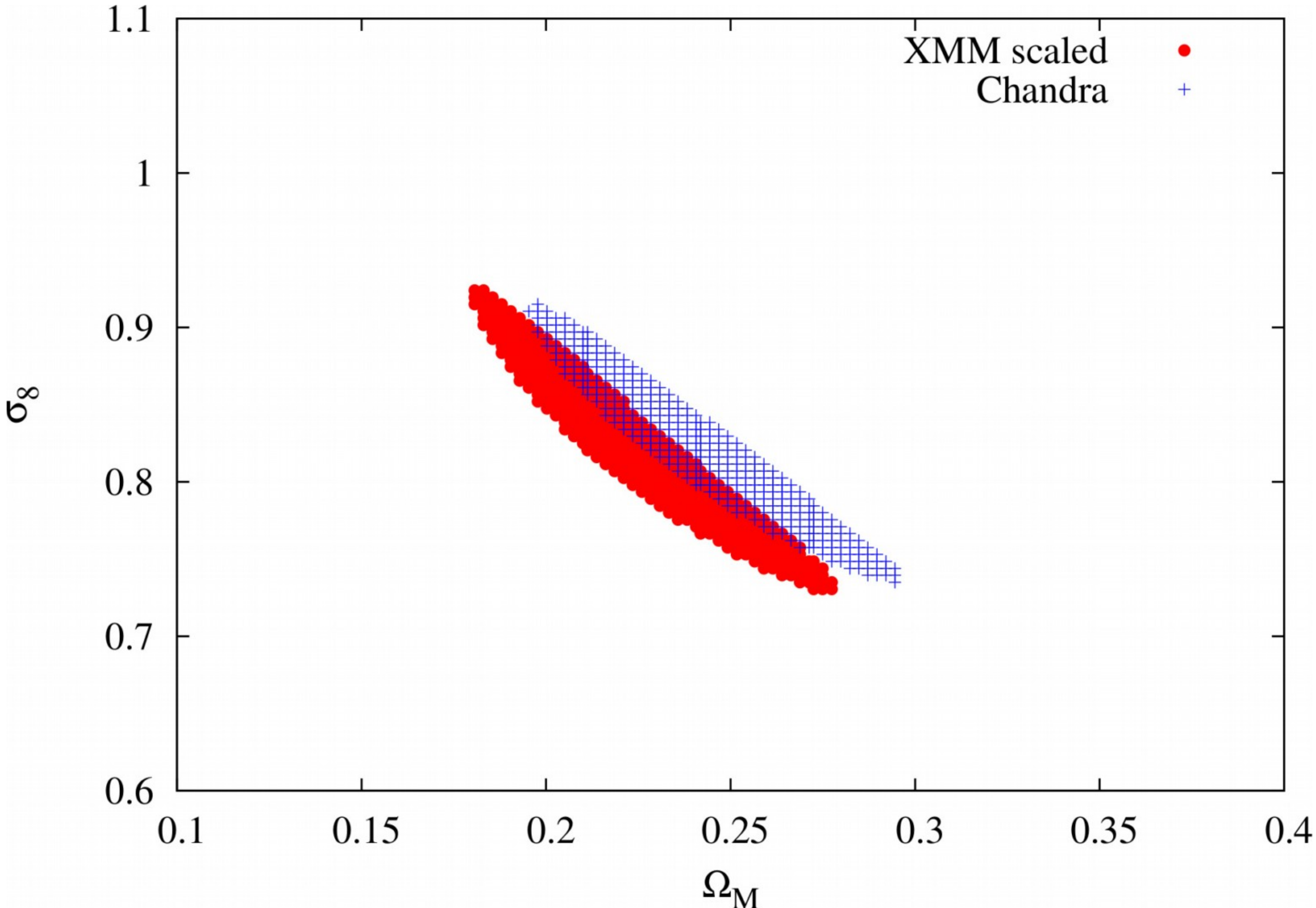


Final result



Cosmological Impact

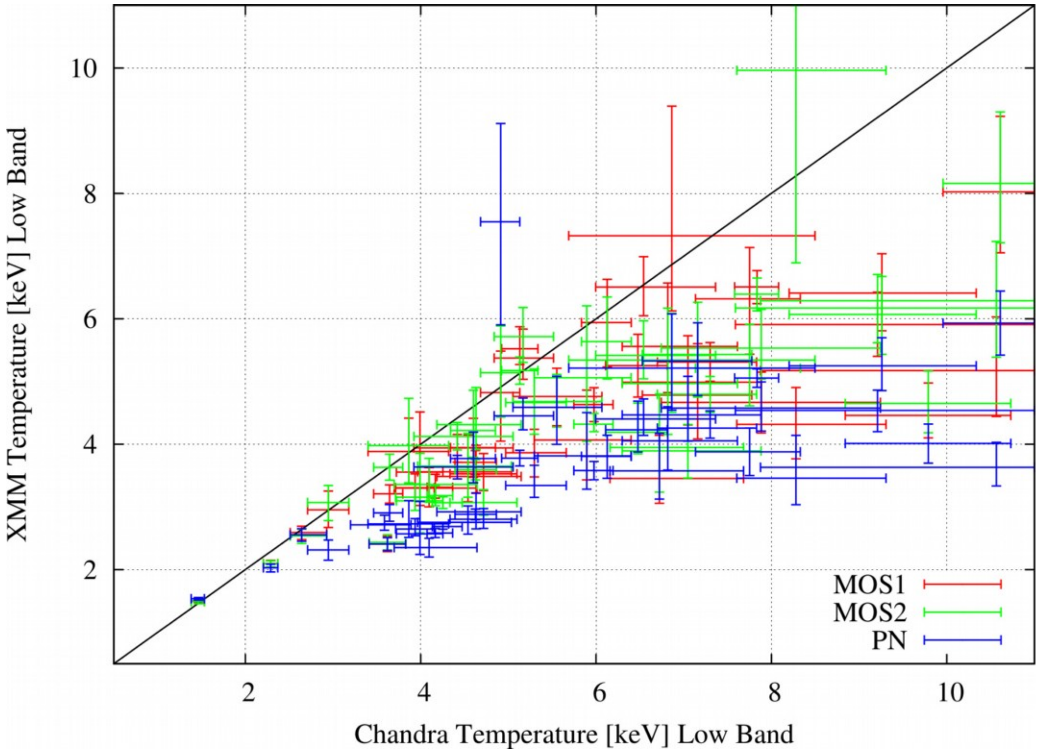
- Constructing CMF from complete sample
- Determination of cosmological parameters



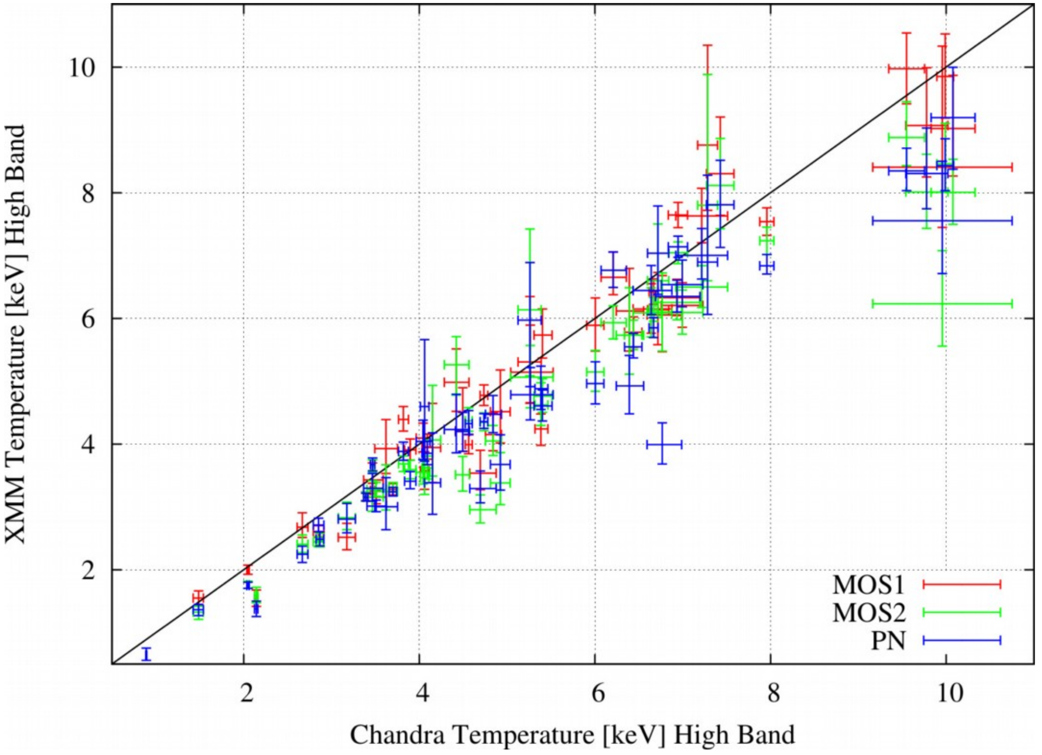
Energy Band Dependence

->Hard band gives much better agreement

Soft-band: 0.7-2 keV

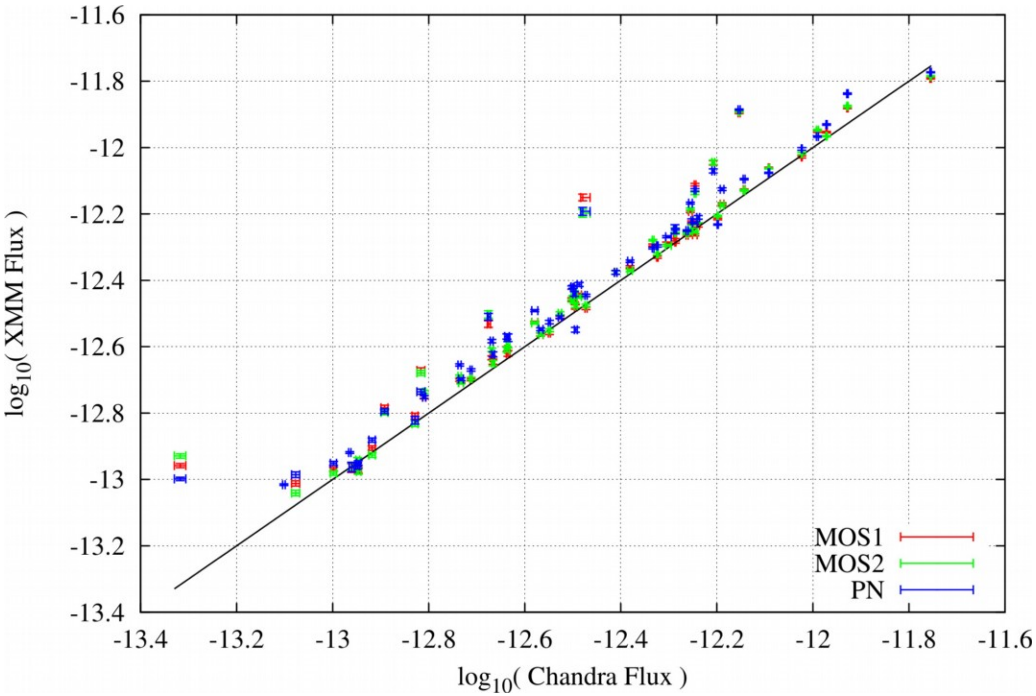


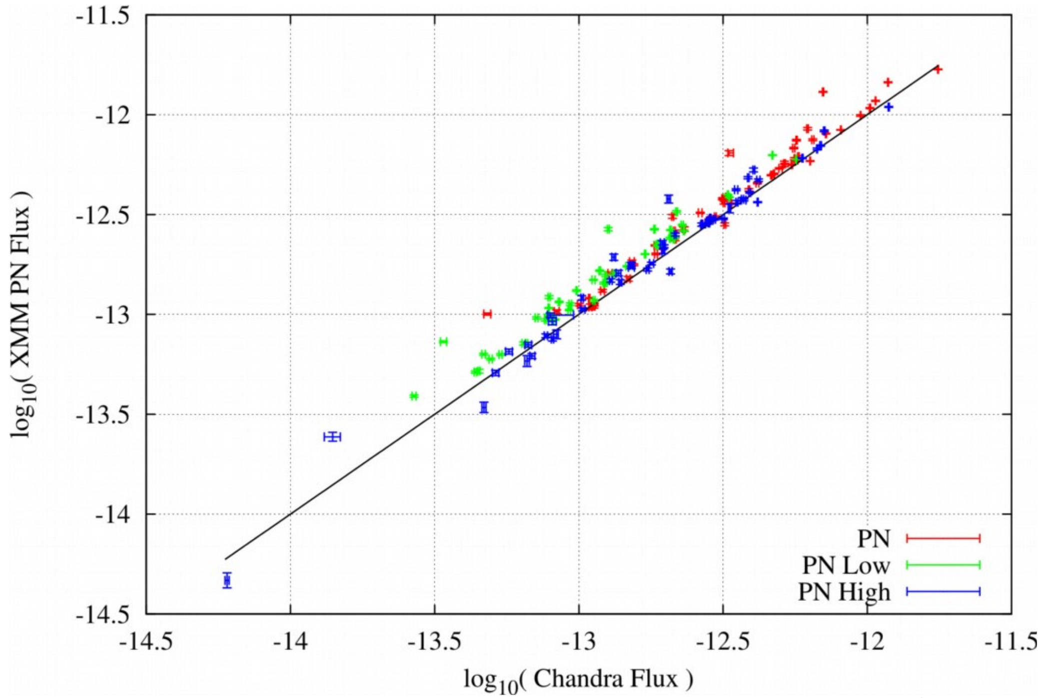
Hard-band: 2-7 keV



Flux measurement

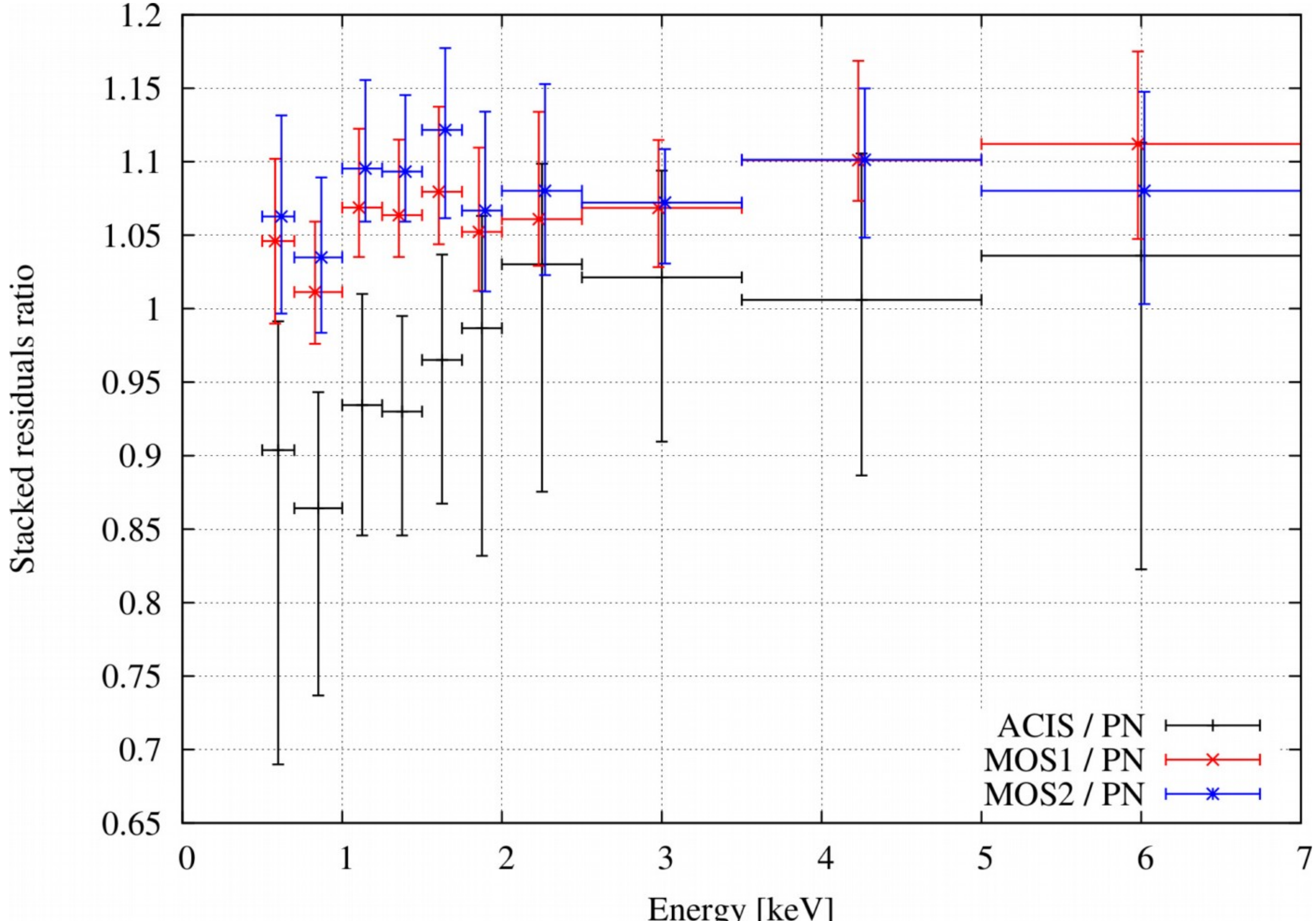
- Chandra has significantly lower flux (relative difference constant)
- Hard energy band: best agreement





Stacked residuals ratio

- Following Kettula et al. (2013) and Longinotti et al. (2008)
- 10 energy bands, $R_{Chan,PN} = \frac{Data_{Chan}}{Model_{PN} \otimes Resp_{Chan}} \times \frac{Model_{PN} \otimes Resp_{PN}}{Data_{PN}}$
- build median

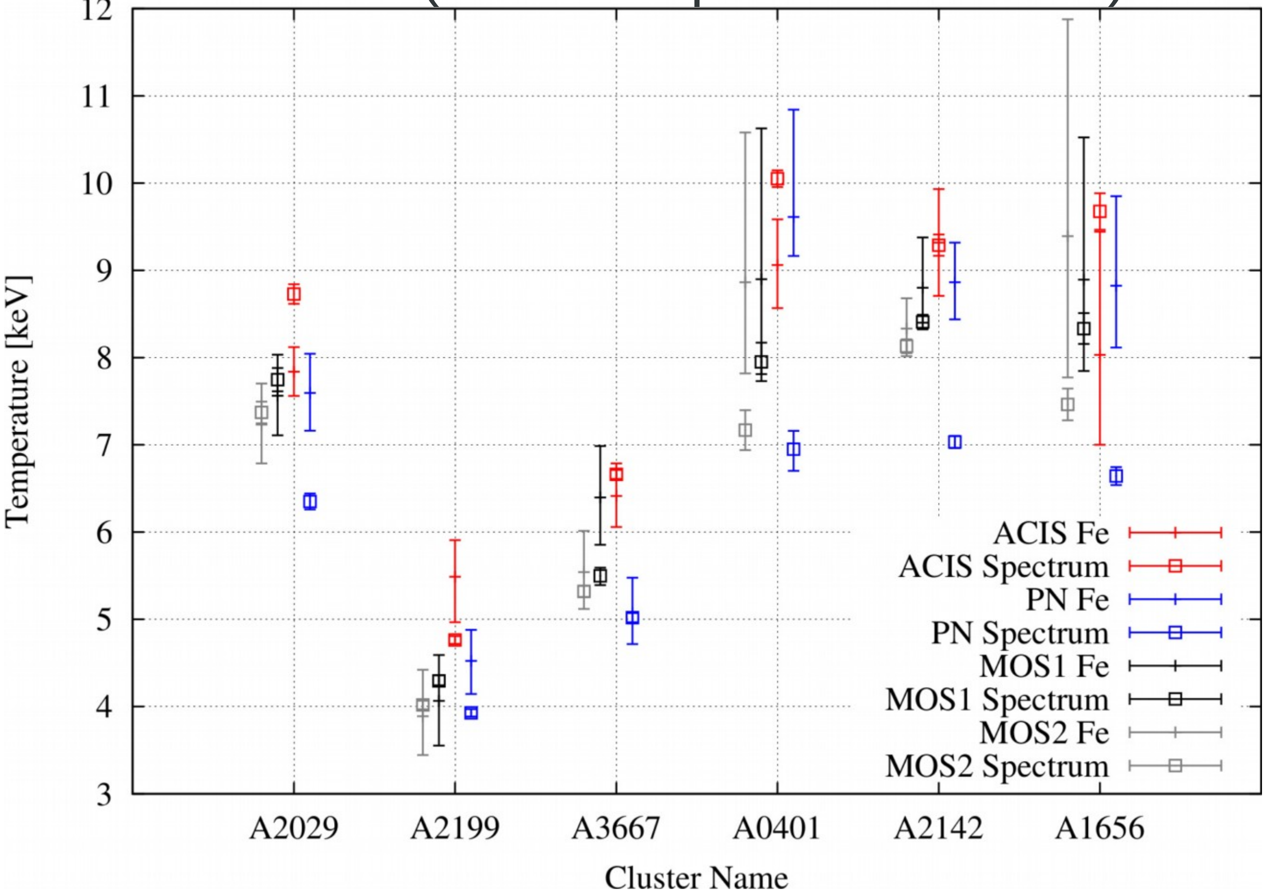


Stacked residuals ratio

- ACIS/PN:
  - Gradient in low energy range produces temperature difference
  - High energy band flat and consistent with PN prediction
  - Flux difference mainly present in low energy range
- MOS/PN:
  - Tiny gradient in low energy range present: small temperature difference
  - Flat in high energy range but too high flux
  - Fluxes slightly high than pn prediction

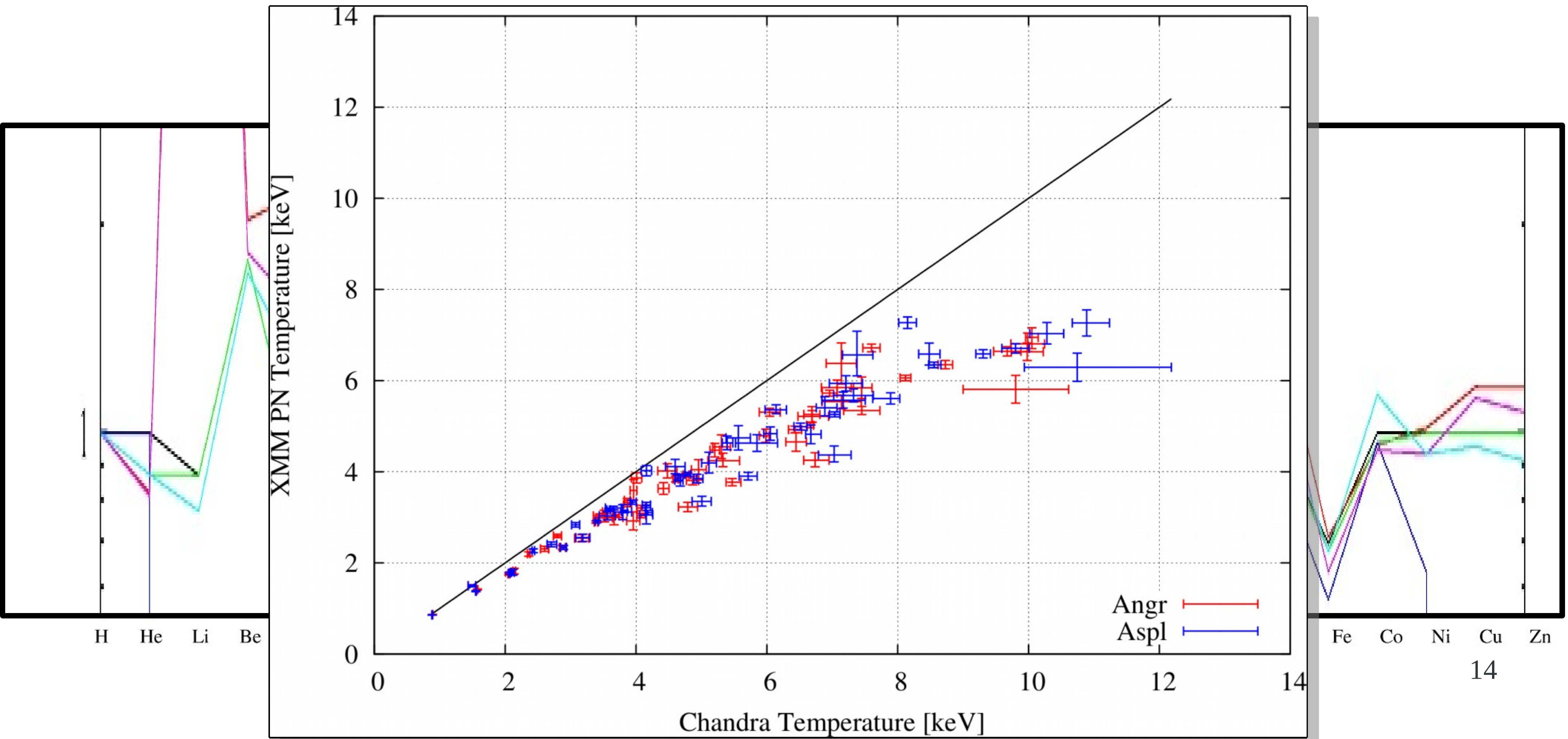
Emission Line Analysis

- Iron-K line around 6.8 keV, Sulfur lines at 2.5 keV (...) useful for temperature determination
- apec-model fit only at a small energy bandwidth around lines
- For comparison: Many counts in all detectors and temperature between 5.5 and 11 keV (7-8 keV optimal for Iron-K)



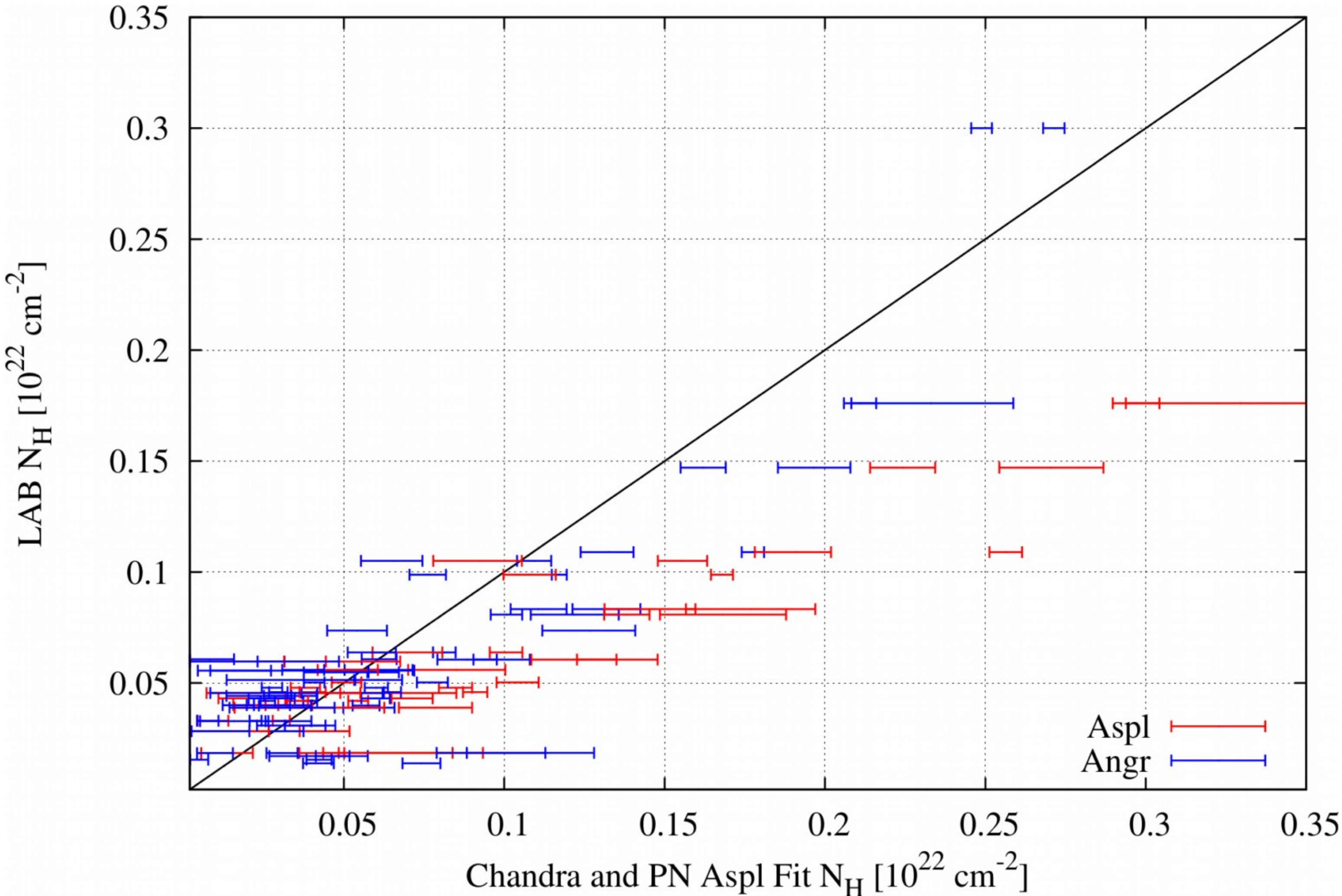
Relative Abundance Table

- Analysis using relative abundance table from Anders & Grevesse (1989)
- Same procedure with Asplund (2009)
- Systematic differences for all detectors (higher temperature)



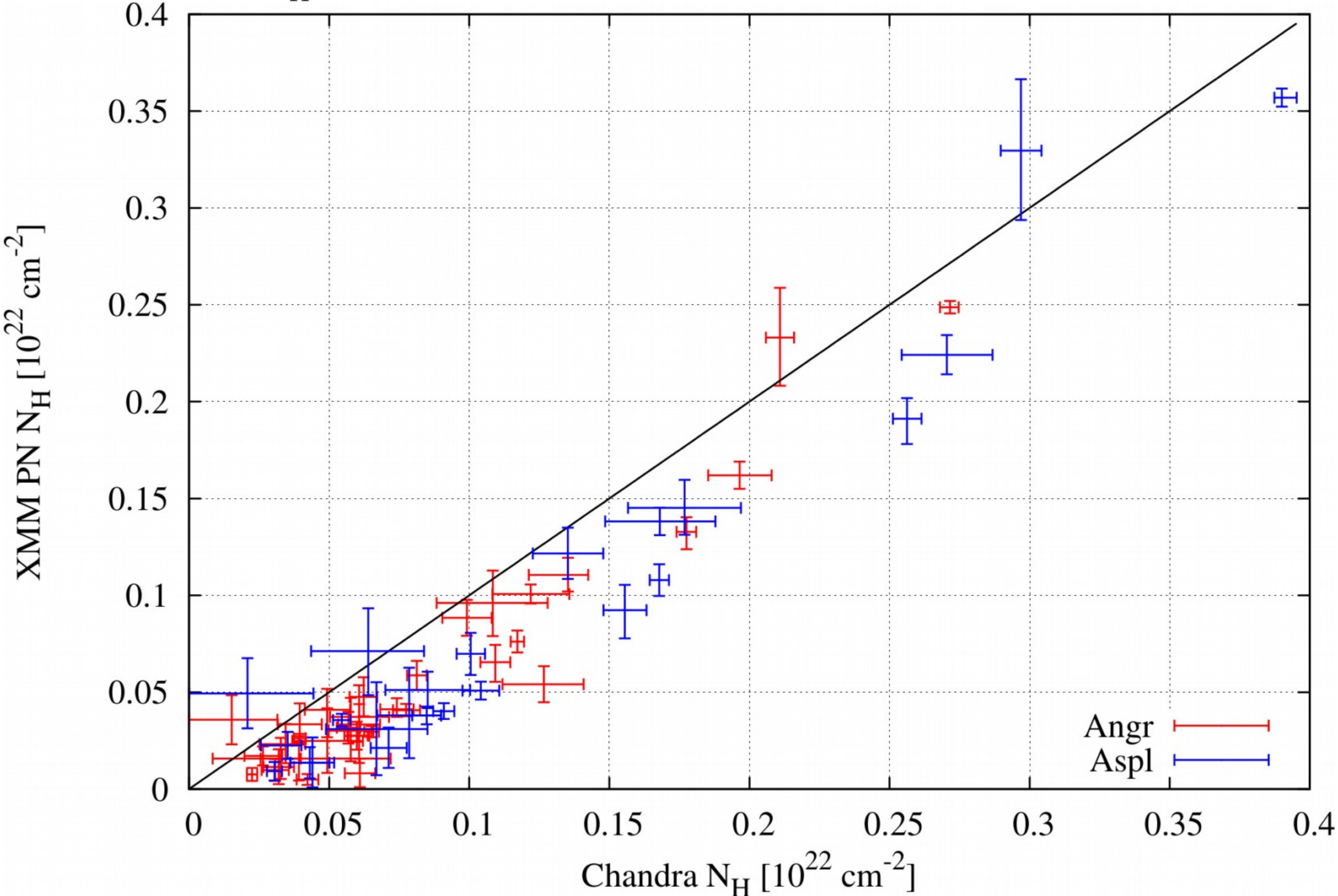
Relative Abundance Table

- Reason for the difference: Absorption (almost no difference when using wabs)
- Leaving N_H free to vary: Higher column density for Asplund



Relative Abundance Table

- Comparing best-fit N_H values of the different detectors shows a systematically higher column density for ACIS but relative difference is constant with N_H



Conclusion

- Chandra-XMM temperature difference dependent on kT (25% @ 9keV)
- MOS1/MOS2/PN systematically inconsistent (up to 20% pn/MOS1 and 12% MOS1/MOS2 at ~8keV)
- Low energy calibration probably the reason
- Flux not consistent