Status of the Concordance Project

Herman L. Marshall

Yang Chen, Xiao-Li Meng, Xufei Wang, David van Dyk, Vinay Kashyap, Paul Plucinsky, Matteo Guainazzi

The Goal

- The problem: in-flight data show discrepancies
  - Cluster temperatures and fluxes
  - Blazar fluxes from simultaneous observations
  - SNR line fluxes
  - No absolute calibrators across all bands
- Missions characterize systematic uncertainties internally and independently
- Assuming we *should*, how does IACHEC *change* a mission's calibration?
- Specifically: derive EAs changes for optimal agreement

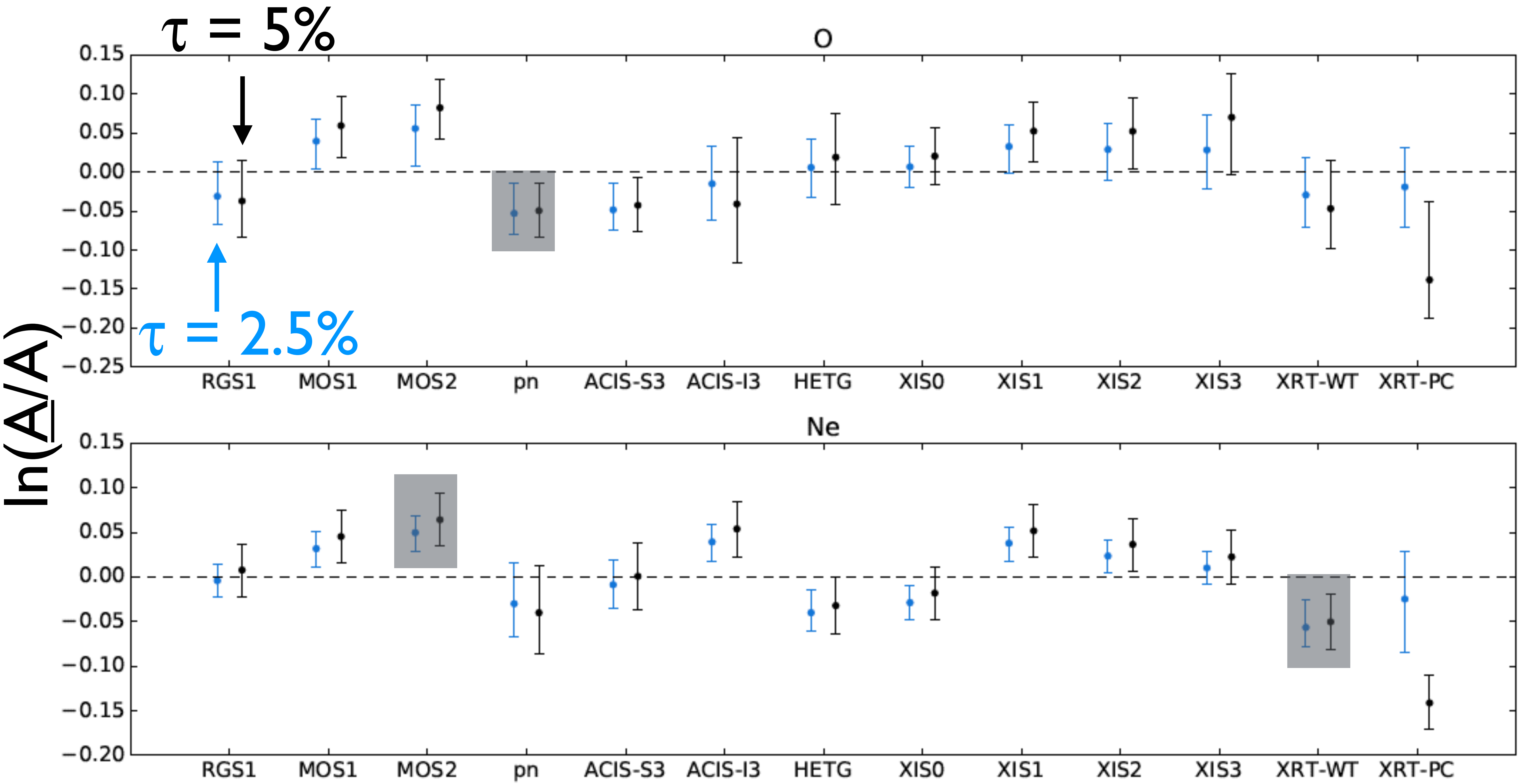
Concordance Overview

- Shrinkage method (Meng, 2015 IACHEC)
  - Start with C_{ij} = Counts for instrument i (1..N), source j (1..M)
  - Assume "true" areas A_i, "true" fluxes F_j, σ_{ij} = st. dev. in $\ln(C_{ij})$
  - Estimate F_j by $f_j = C_{ij} / a_i$ (a_i = prior estimate of A_i)
  - Method determines "best" $\underline{F}_j$ and "better" EAs $\underline{a}_i = a_i^w (C_{ij}/\underline{F}_j)^{1-w}$
    - $w = 1/(1+M\tau^2/\sigma_{ij}^2)$, τ = "a priori" st.dev. in ln(a)
    - w = 0 means data dominate, drive change in EA
    - w = 1 means data are mediocre, EA isn't changed
    - brings $\underline{f}_j = C_{ij} / \underline{a}_i$ closer to *but not precisely* to $\underline{F}_j$
- IACHEC team sets τ, runs shrinkage analysis
  - IACHEC team recommends changes from a_i to $\underline{a}_i$
  - Process runs for each of many bandpasses "independently"

Concordance Actions & Plan

- Done:
  - Nail down the math
  - Simulate & analyze sample data sets
  - Supply "real", trial data sets (1E0102, 2XMM, XMM blazars)
  - Apply method to trial data, test goodness of fits
- Plan:
  - Publish method (Chen+ '17, JASA)
  - Publish trial results (Marshall+'17, AJ)
  - Add more IACHEC cross-cal results, present at IACHEC # 12
  - Add complexity
    - use smoothness from global models
    - consider handling of RMF uncertainties
    - compare to MCCAL, pyBLoCXS (with J. Drake)

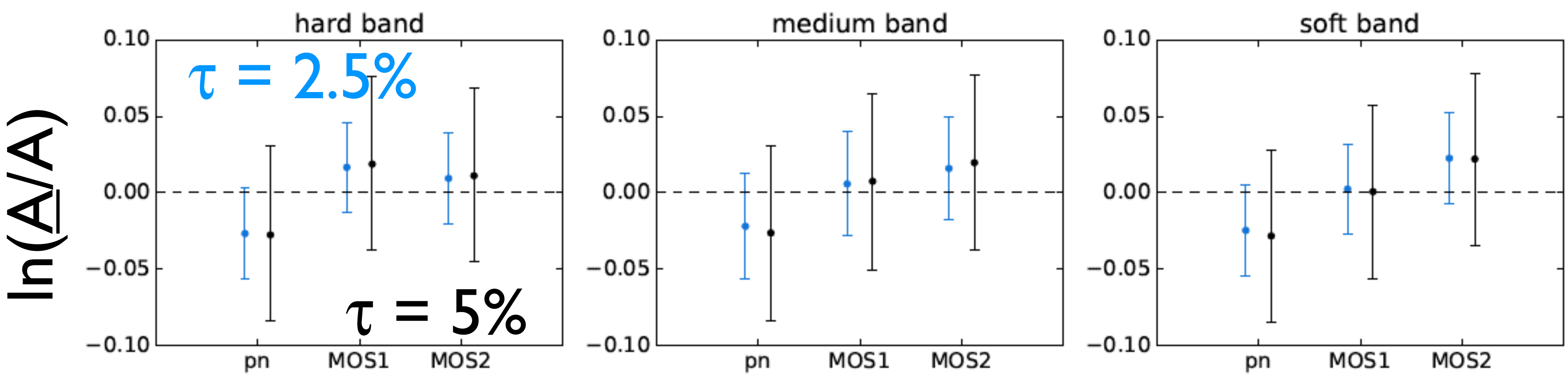
Concordance I: 1E0102



Chen+ '17

Concordance 2: 2XMM

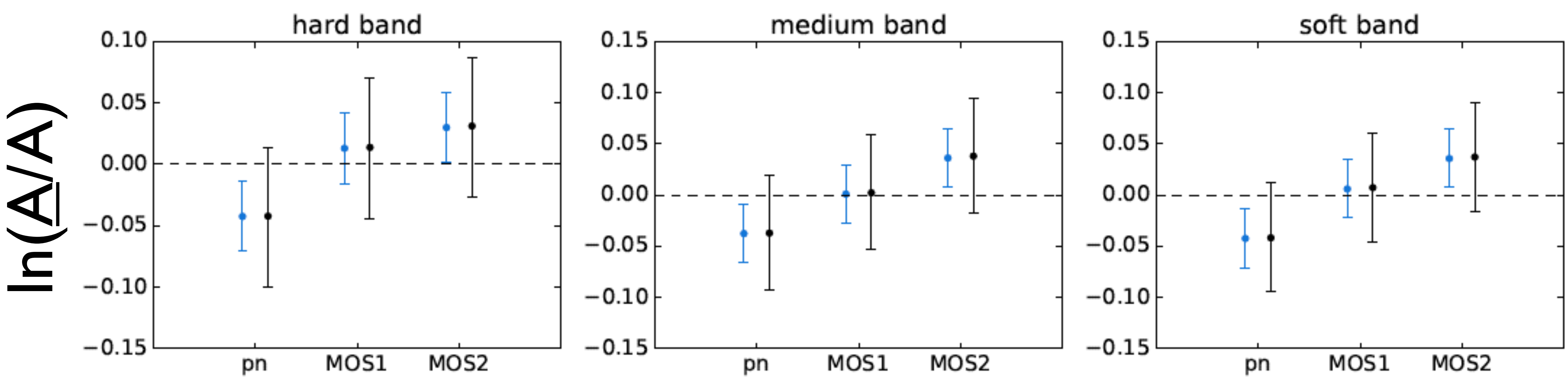
- Data from Matteo Guainazzi
- Based on 42 sources from the 2XMM catalog
- Unaffected by pileup; no EA change required



Chen+ '17

Concordance 3: XMM Blazars

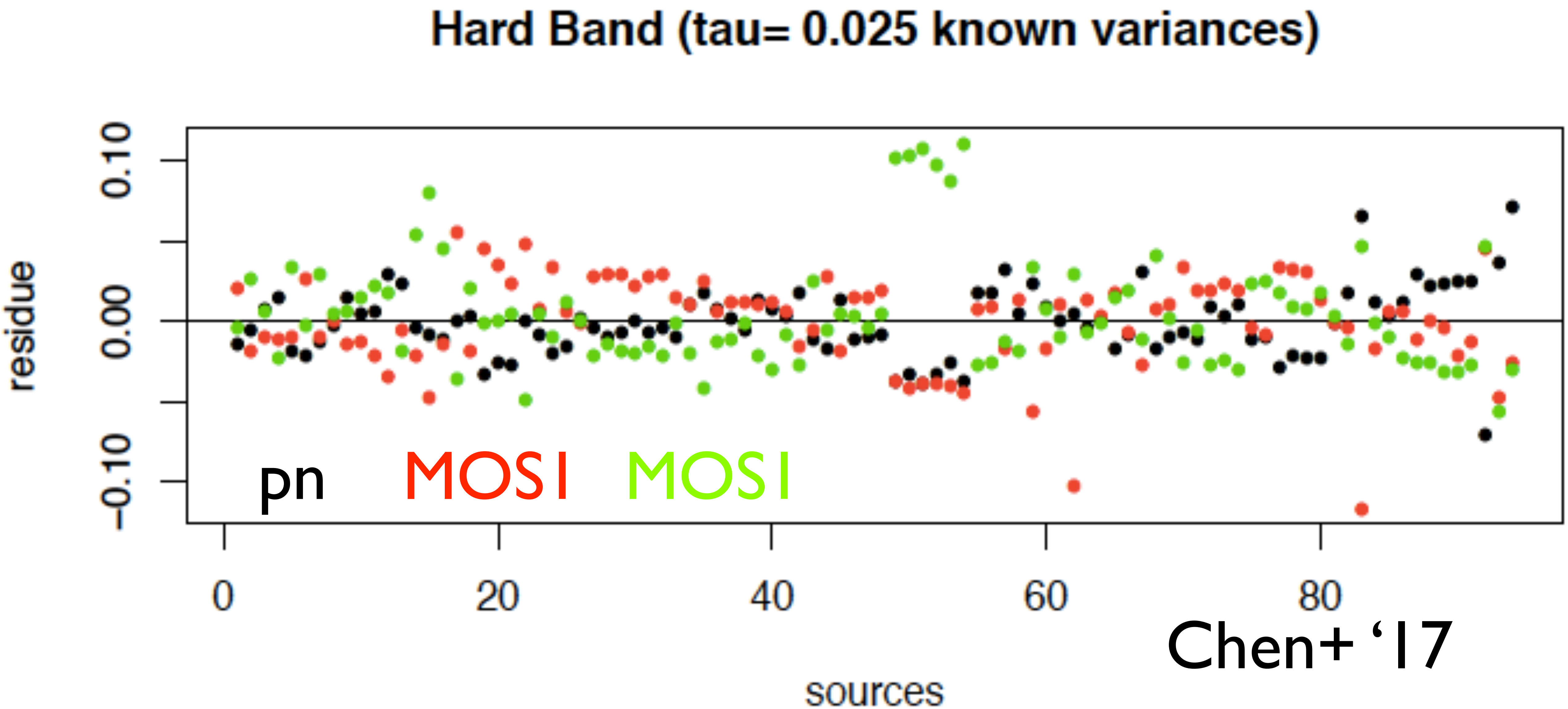
- 117 bright XMM sources from Matteo Guainazzi
- PSF clipped to reduce effect of pileup
- Result: 5% adjustment to pn indicated, 1-2% for MOS



Chen+ '17

Data Validation

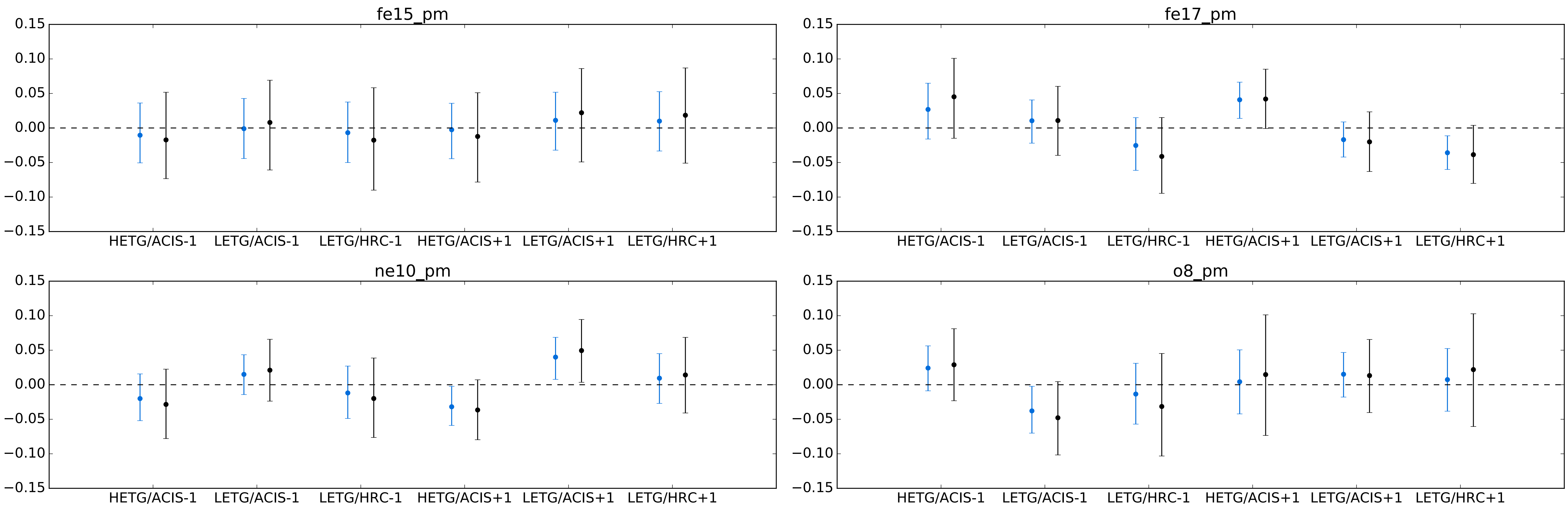
- Goal: find outliers in XMM blazar set
- Sources 49-54 (EXO 0748-676): MOS2 too high
- Source 62, 83 (H2356-309,3C 111): MOS1 too low



Chen+ '17

Concordance 4: Capella

- Lines from Chandra grating spectra
  - Ne x, Fe xxvii (15 Å), Fe xxvii (17 Å), O viii
- 5 sets of adjacent observations compared
- Not all instruments used each time



Marshall+ '17

Concordance Plan

- Publish method (Chen+ ‘17, JASA)
  - Outlier handling with t-distribution
  - Poisson distribution for fainter samples
- Publish trial results (Marshall+’17, AJ)
  - Oriented to astronomers
  - Add Capella emission lines observed with Chandra
- Add more IACHEC cross-cal results (See WG and Roundtable)
- Add features
  - Use smoothness from global source models
  - Use covariances from EA models
  - Consider handling of RMF uncertainties
- Work with MCCAL, pyBLoCXS (Drake et al.)
- Complete the instrument-energy matrix

The Matrix

	Chandra ACIS	Chandra HETGS	XMM pn	XMM MOS1	XMM MOS2	Swift WT	Suzaku XIS0
.15-.33		—					
.33-.54		—					
.54-.8		0.05					
.8-1.2		0.03					
1.2-1.8		0.03					
1.8-2.2		0.03					
2.2-3.5		0.03					
3.5-5.5		0.03					
5.5-10		0.05					

The Future…