

# Calibration Statistics

## Working Group Report

Vinay Kashyap : IACHEC 2024 May 12-16 : Paradores de La Granja

# About the CalStats WG

## Basic information

*A forum for the discussion of statistical, methodological, and algorithmic issues that affect the calibration of astronomical instruments, of how calibration data are used in data analysis, and how the analysis results are interpreted.*

### \* Membership: 45 members

- \* to join, send email to join the mailing list at the iachec-calstats google group [iachec-calstats+subscribe@cfa.harvard.edu](mailto:iachec-calstats+subscribe@cfa.harvard.edu)
- \* To unsubscribe, send email to [iachec-calstats+unsubscribe@cfa.harvard.edu](mailto:iachec-calstats+unsubscribe@cfa.harvard.edu)

### \* WWW

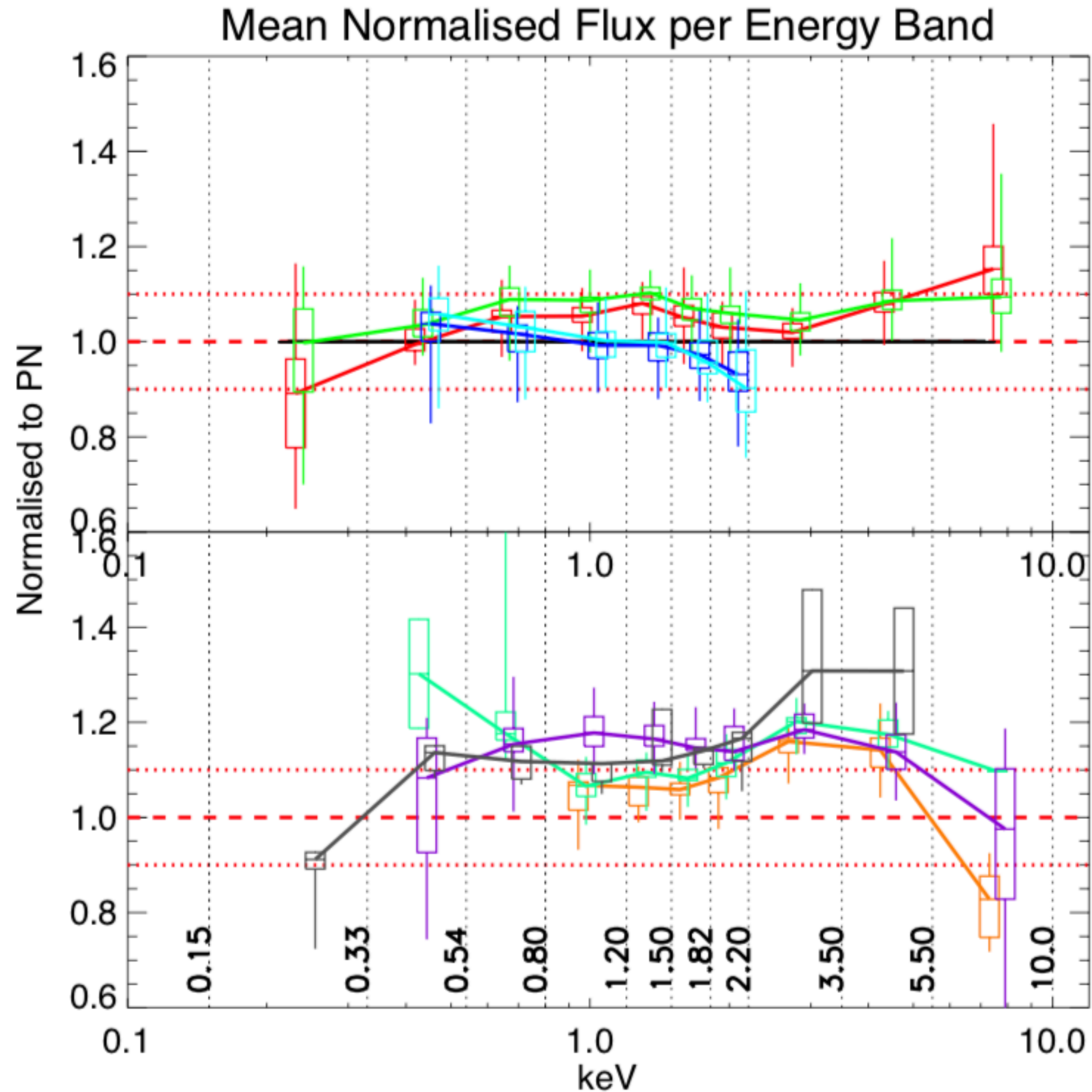
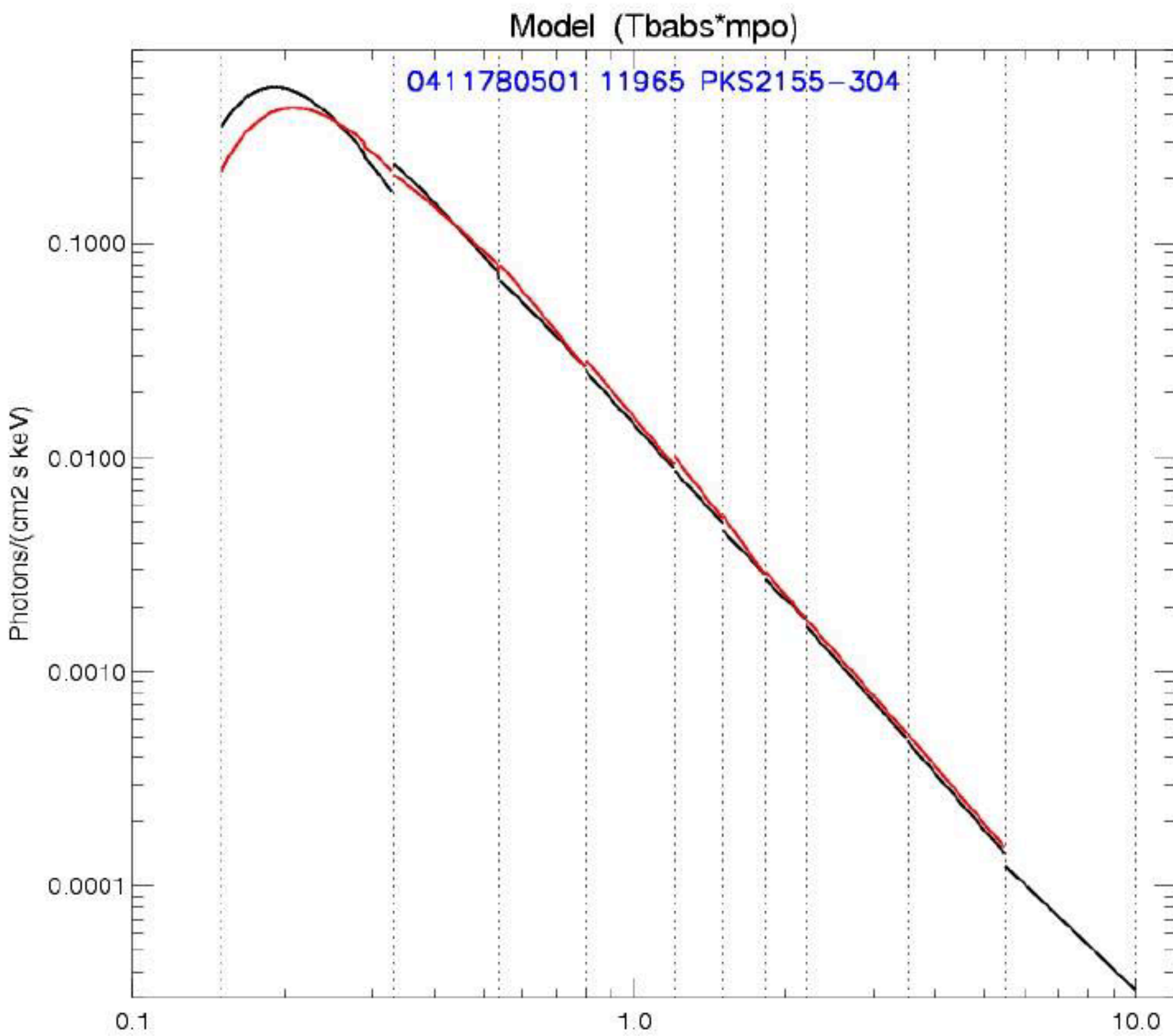
- \* Webpage: <https://iachec.org/calibration-statistics/>
- \* Library: <https://iachec.org/calibration-statistics/#library>
- \* Wiki: <https://wikis.mit.edu/confluence/display/iachec/Calibration+Statistics>
- \* Slack: [#calstats](https://iachec.slack.com)

# WG session

## combined session with Hi-Res WG

- **Concordance** update by Herman Marshall, pointed out the necessity of accounting for source spectral correlations and showed preliminary results of the analysis of a number of AGNs using multiple instruments with fluxes measured via piecewise power-law fitting in narrow passbands

# Paper 3: XMM/Chandra XCAL



PN □  
M1 □  
M2 □  
R1 ◇  
R2 ◇

ACISS-LEG □  
ACISS-MEG □  
ACISS-HEG □  
HRCS-LEG □

Flux Method: III

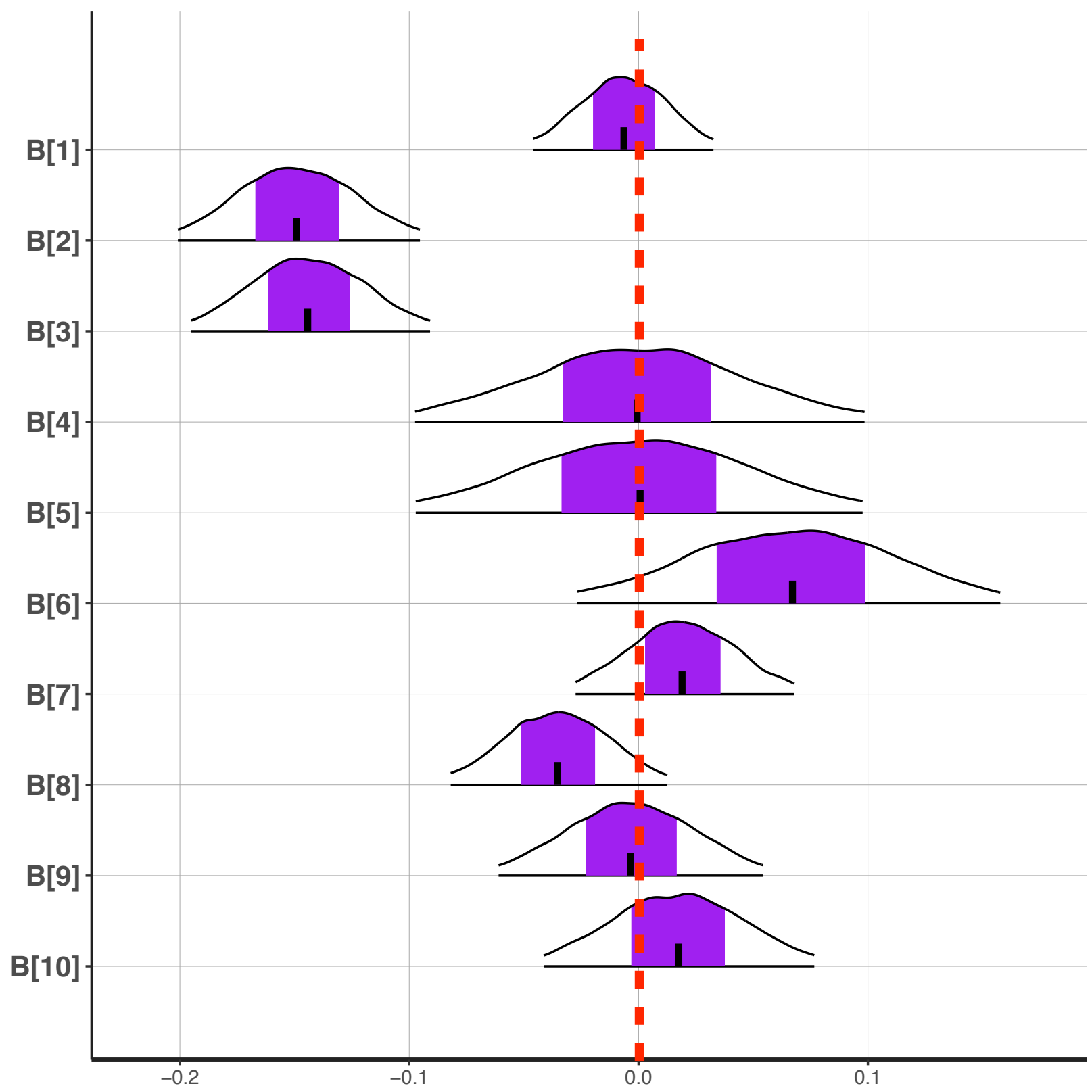
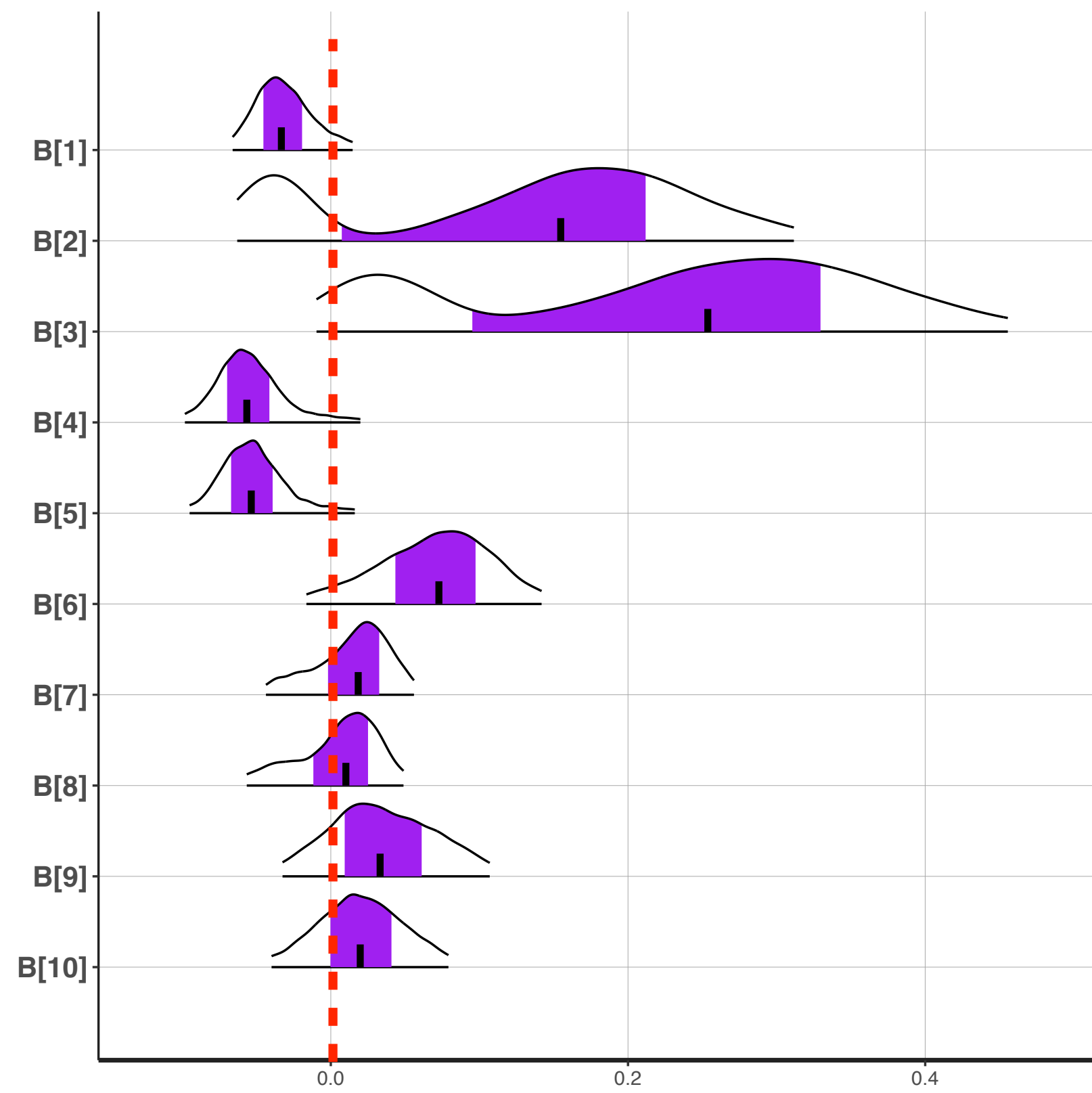
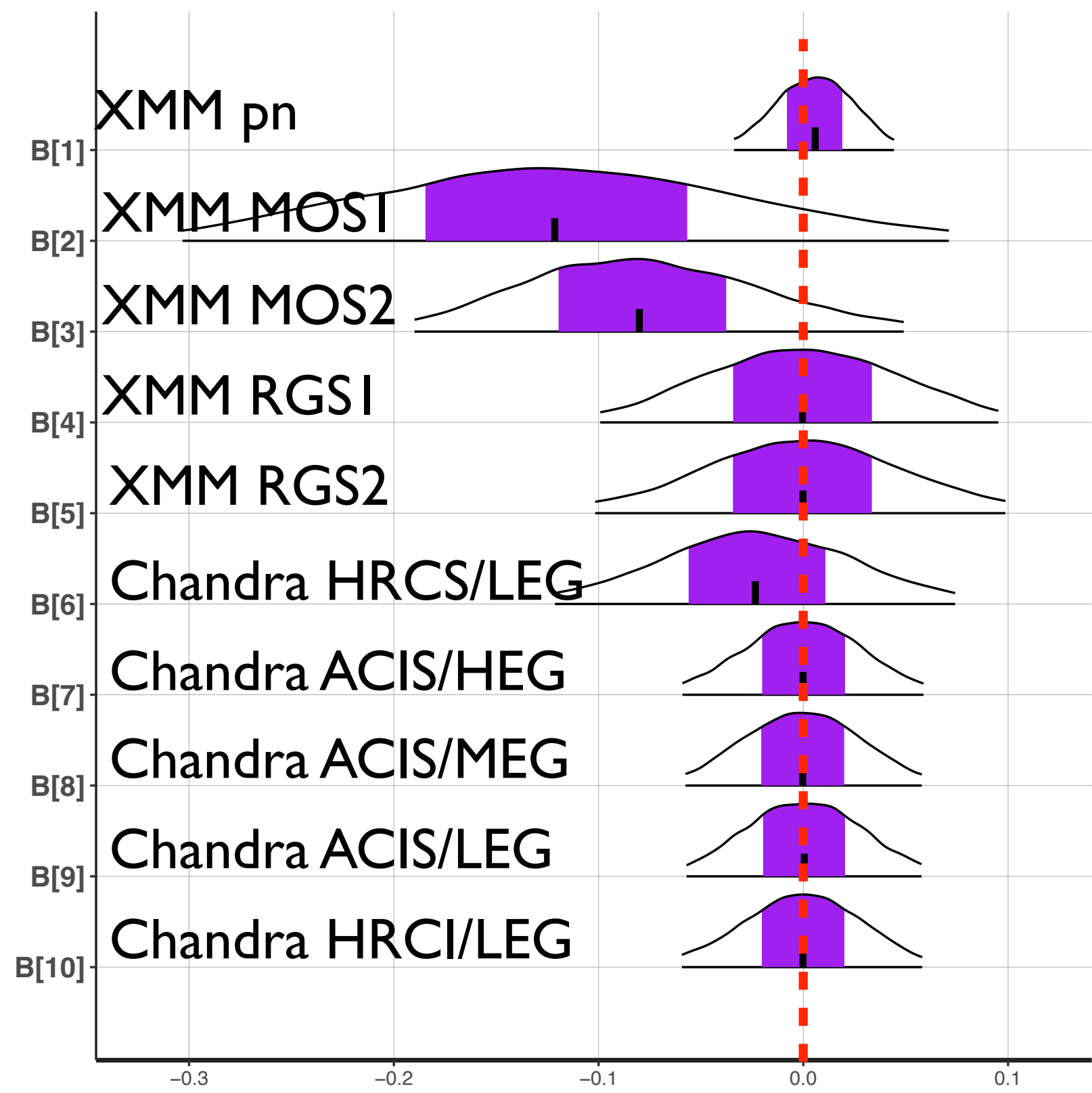
Version:  
SAS19.1 cash groupm

# Some Preliminary Results

0.15-0.33 keV

0.80-1.20 keV

3.5-5.5 keV



# Update Priors

Tau\_Matrix (May 5, 2024)

	.15-.33	.33-.54	.54-.8	.8-1.2	1.2-1.5	1.5-1.8	1.8-2.2	2.2-3.5	3.5-5.5	5.5-10	15-25	25-50	50-100	100-300
<b>XMM pn</b>	2	2	2	2	2	2	2	2	2	3				
<b>XMM M1</b>	20	10	6	6	6	6	6	6	6	10				
<b>XMM M2</b>	20	10	6	6	6	6	6	6	6	10				
<b>XMM R1</b>		8	5	5	5	5								
<b>XMM R2</b>		8	5	5	5	5								
<b>Chandra HRCS-LEG</b>	5	7	7	7	7	7	7	7	10	10				
<b>Chandra ACIS-MEG</b>		20	10	5	4	4	4	4	5	7				
<b>Chandra ACIS-HEG</b>				5	4	4	4	4	5	7				
<b>Chandra ACIS-LEG</b>	10	10	7	5	4	4	4	4	5	7				
<b>Chandra HRCI-LEG</b>	5	7	7	7	7	7	7	7	10	10				

# Updating the $\tau$ matrix

Current values are on the wiki

<https://wikis.mit.edu/confluence/display/iachec/>

[Calibration+Statistics#CalibrationStatistics-The \$\tau\$ -matrixofeffectiveareauncertainties](https://wikis.mit.edu/confluence/display/iachec/Calibration+Statistics#CalibrationStatistics-The%CF89-matrixofeffectiveareauncertainties)

Need estimates of  $\tau$  in the various passbands, and passband correlations, from new instruments:

Einstein Probe FXT, WXT; eROSITA; IXPE; NICER; NinjaSat; SMILE SXI; SVOM; XRISM  
Resolve, Xtend

Send numbers to either Herman ([hermanm@mit.edu](mailto:hermanm@mit.edu)) or me ([vkashyap@cfa.harvard.edu](mailto:vkashyap@cfa.harvard.edu)) or send to [iachec-calstats@cfa.harvard.edu](mailto:iachec-calstats@cfa.harvard.edu)

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- **Polarimetry statistics** by Herman Marshall, highlighted the effect of polarized background



# Further Development of Event-Based Analysis of X-ray Polarization Data

[Herman L. Marshall](#) (1) ((1) MIT Kavli Institute)

An event-based maximum likelihood method for handling X-ray polarimetry data is extended to include the effects of background and nonuniform sampling of the possible position angle space. While nonuniform sampling in position angle space generally introduces cross terms in the uncertainties of polarization parameters that could create degeneracies, there are interesting cases that engender no bias or parameter covariance. When including background in Poisson-based likelihood formulation, the formula for the minimum detectable polarization (MDP) has nearly the same form as for the case of Gaussian statistics derived by Elsner et al. (2012) in the limiting case of an unpolarized signal. A polarized background is also considered, which demonstrably increases uncertainties in source polarization measurements. In addition, a Kolmogorov-style test of the event position angle distribution is proposed that can provide an unbinned test of models where the polarization angle in Stokes space depends on event characteristics such as time or energy.

# Summary

- Variances are underestimated if BG polarization is assumed to be zero
  - Traditional formula is valid only for known unpolarized BG
  - OK if there are external reasons to assume unpolarized BG
  - Generally, should assume it is possibly polarized
- Error contours will depend on polarization EVPA
  - Effect may be small unless  $\Pi_b$  and/or  $\zeta = \Omega_s/\Omega_b$  are large
  - Will only increase uncertainty

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- Line location and velocity shift analysis of HR 1099 with Chandra and XRISM (see summary by Eric Miller)

# elsewhere

## other presentations relevant to Calstats

- Pileup modeling schemes for ACIS and other instruments by Vinay Kashyap
- Several presentations on ARF and RMF modeling in XMM and eROSITA by Konrad Dennerl
- Exploration of the causes of differences in cluster temperature estimates in hard bands of Chandra and XMM compared to NuSTAR by Dan Wik
- Modeling of low counts spectra to understand effects of temperature dependent flux on exoplanets by Suri Rukdee
- XRISM/Xtend Transient Search system by Marina Yoshimoto
- Stringray spectral+timing algorithms by Matteo Bachetti
- Background in IXPE by Stefano Silvestri

# Goals

## Osaka and Beyond

- \* **Concordance:** incorporate time variability and spectral correlations into Concordance algorithm; more  $\tau$ 's and correlation matrices for more instruments and passbands; Paper 3 in preparation — Marshall et al
- \* **EA uncertainties:** release MCCal; get more instrumental samples, compute passband correlations for Concordance
- \* **C-stat:** improve statistical foundation; paper in preparation — Meng et al
- \* Continue to
  - \* schedule talks of interest as and when opportunities arise, on topics from statistics methods to machine learning applications (watch for announcements on mailing-list and on Slack channel #calstats)
  - \* coordinate with other WGs: Hi-res (line lists and velocity shifts in HR 1099), Detectors and Background (pileup modeling)
  - \* maintain library [<https://iachec.org/calibration-statistics/#library>] and keep updating wiki [<https://wikis.mit.edu/confluence/display/iachec/Calibration+Statistics>]