Report:
CalStats Working Group

IACHEC XVIII Seeblick Pelham

Vinay Kashyap (CXC/CfA) : 2026-apr-24

iachec-calstat@cfa.harvard.edu

About the CalStats WG

Vinay Kashyap (CfA; Chair) & Ivan Valtchanov (ESA; co-Chair)

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-calstat google group iachec-calstat+subscribe@cfa.harvard.edu
  - To unsubscribe, send email to iachec-calstat+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
    - τ matrix for Concordance, Background models and scripts
  - Slack: iachec.slack.com #calstats

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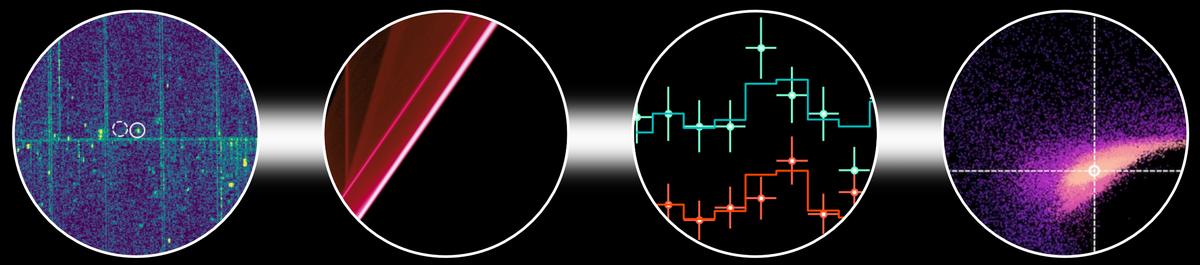
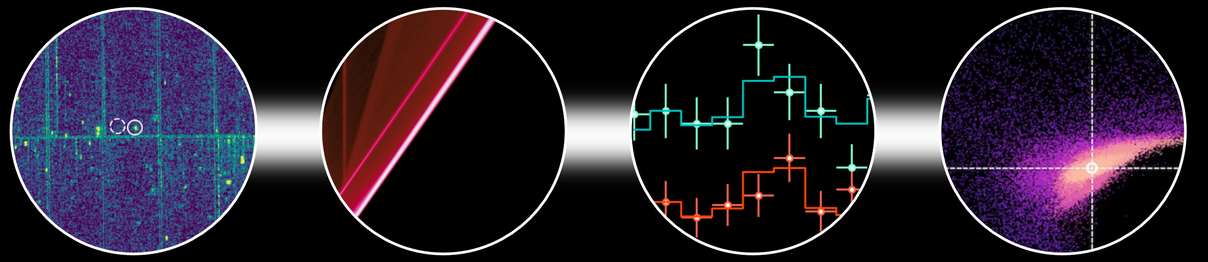
I. WG activities

Concordance, BXA tutorial

1. [Wed Apr 22] Peter Boorman & Johannes Buchner: *Tutorial on BXA*

Statistical Aspects of X-ray Spectral Analysis





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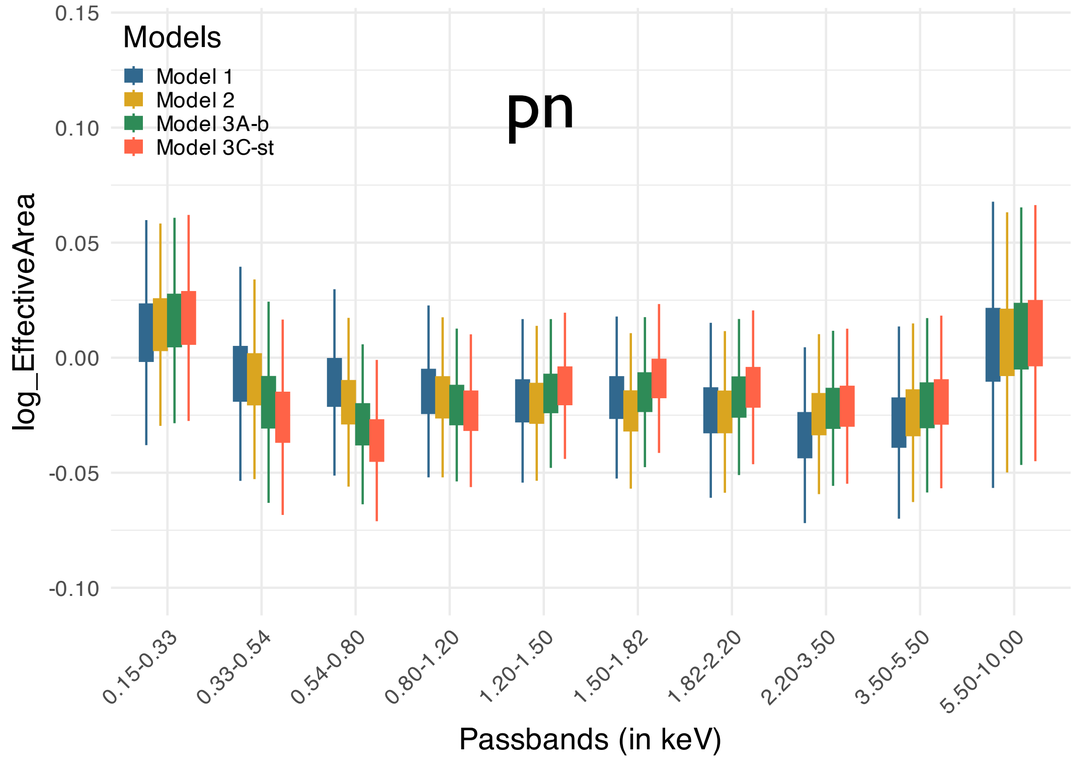
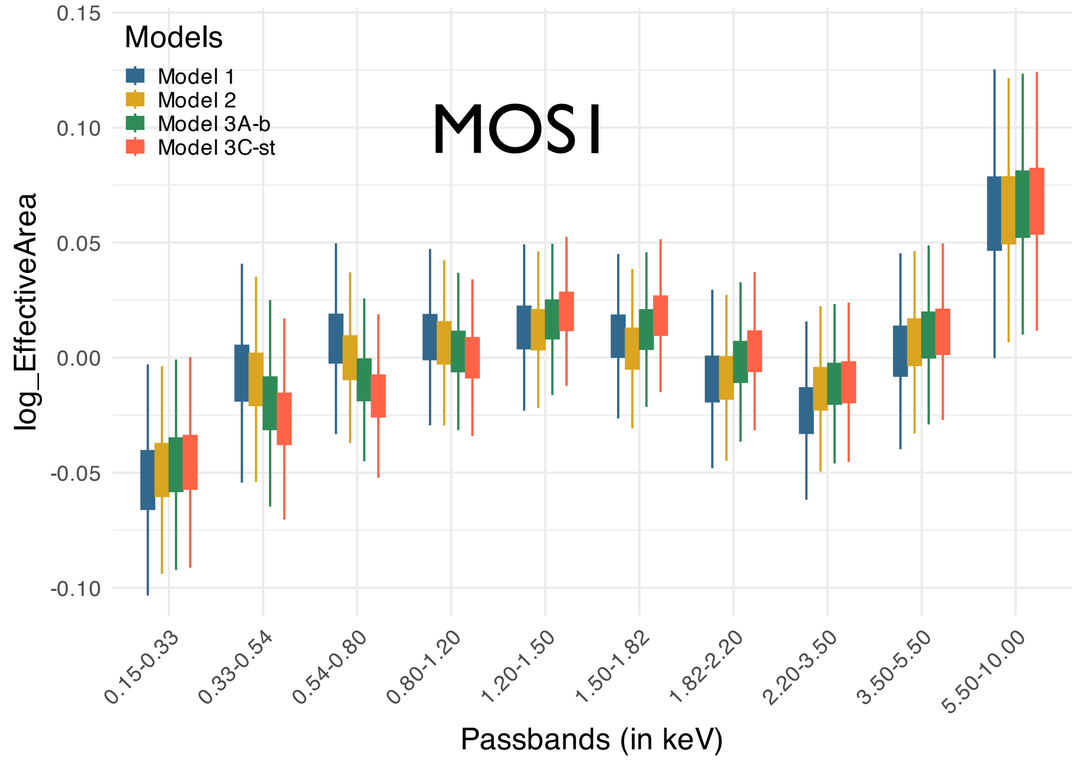
I. WG activities

Concordance, BXA tutorial

2. [Wed Apr 22] Herman Marshall: *Concordance: XMM/Chandra Blazar Cross-calibration*





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II. Updates

We maintain a Library and a Wiki

1. library of useful papers maintained by WG leads; send us pointers to any interesting paper, preprint, white paper, or calculation
    1. *New:* Bonamente et al. 2026 on biases in WStat

A comparison of methods for Poisson regression in the presence of background

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ABSTRACT

This paper provides a statistical analysis of three common methods of regression for Poisson data in the presence of Poisson background, namely the joint fit with two parametric models for the source and the background, the use of a non-parametric model for the background known as the *wstat* method, and the regression with a fixed background. The non-parametric background method, which is a popular method for spectral data, is found to be significantly biased, especially in the low-count and background-dominated regimes. Similar conclusions apply to the fixed-background regression. The joint-fit method, on the other hand, simultaneously affords reliable hypothesis testing by means of the usual *Cash* statistic and unbiased reconstruction of source parameters. We also investigate the effect of non-parametric regression on the number of effective degrees of freedom by means of the Efron degree of freedom function. We find that the *wstat* method adds a significantly larger number of degrees of freedom, compared to the number of free parameters in the source model. The other two methods have a number of degrees of freedom consistent with the number of adjustable parameters, at least for the simple models investigated in this paper.

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    1. *New:* Bonamente et al. 2026 on biases in WStat
    2. *Anticipated soon:* X.Li et al. on **cstat** goodness-of-fit, S.Das et al. on Concordance
2. wiki of background models
    1. New: eROSITA, XRISM/Resolve, XRISM/Xtend
3. wiki of Concordance τ-matrix
    1. Changes to ROSAT, XMM-pn, NuSTAR

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III. Nuggets

Innovative uses of statistical techniques

1. [Mon Apr 20] Gabriel Matzeu on cross-calibrating XMM pn and NuSTAR using hardness ratio trends in spectral model parameter estimates
2. [Mon Apr 20] Dimitrios Maniadakis on cross-calibrating via energy dependent pulse fractions of Vela X-1
3. [Mon Apr 20] Ayşegül Tümer on cross-calibrating by flux correction trends over narrow passbands
4. [Mon Apr 20/Tue Apr 21] Manan Agarwal on developing UltraSPEX and doing a spatio spectral modeling of Cas A with it
5. [Tue Apr 21] Megan Eckart on estimating and using XRISM/Resolve gain and uncertainty

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IV. The Road to IACHEC XIX

Plans for the next year

1. Finish papers being worked on by Drake et al. (MCCal), Zimmerman et al. (pileup, a Bayesian approach), J.Yang et al. (pileup, neural network approach)
2. MCCal implementations
3. Talks/tutorials focused on applications of AI/ML to calibration problems
    1. ML Uncertainties: aleatoric [≡ randomness, data fluctuations] vs epistemic [≡ lack of knowledge, incomplete information]
    2. Agentic AI, foundation models, embeddings
4. Synergies with other WGs: Hi-res (line locations for energy scale and gain calibration), Ground Calibration (analysis calibration; see talk by Vadim B), Background (models)