Handling Systematic Errors

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Summary: IACHEC-1

- Goal: avoid two problems
  - A: claims of new physics due to calibration errors
  - B: features ignored due to presumed systematics
- Triage for handling systematic errors
  - Easy and hard cases are clear
    - line fluxes, energies, ratios should be easy
    - separating source and instrument edges may need PI help
  - Middle ground requires new tools
    - Multiple adjustment functions (HLM) — bad
    - Vary instrument models (Drake et al.) — good

Summary: IACHEC-1

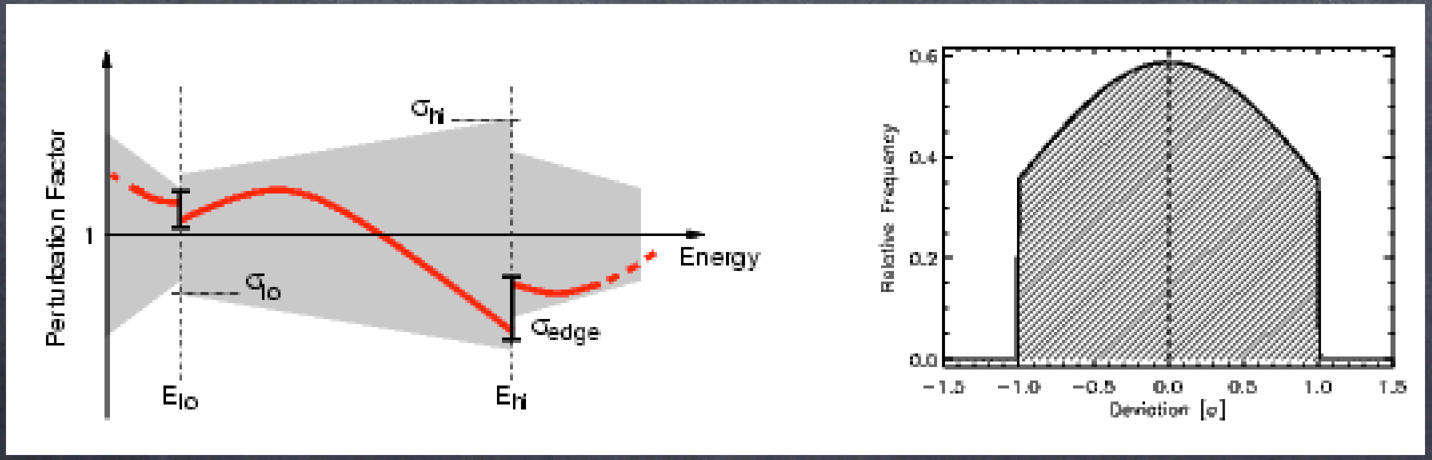
- Recommendations to Cal scientists
  - Tell users to avoid xspec syserr generally
  - Try a (Drake-type) multi-RF method
  - Publish methods to estimate parameter errors using simulated data
  - Maintain user feedback and post as needed
- Recommendations to missions
  - Develop caveats or "watch out" pages
  - Provide standard reductions
  - Provide background models
  - Provide examples of handling systematic errors

Adjustment Method

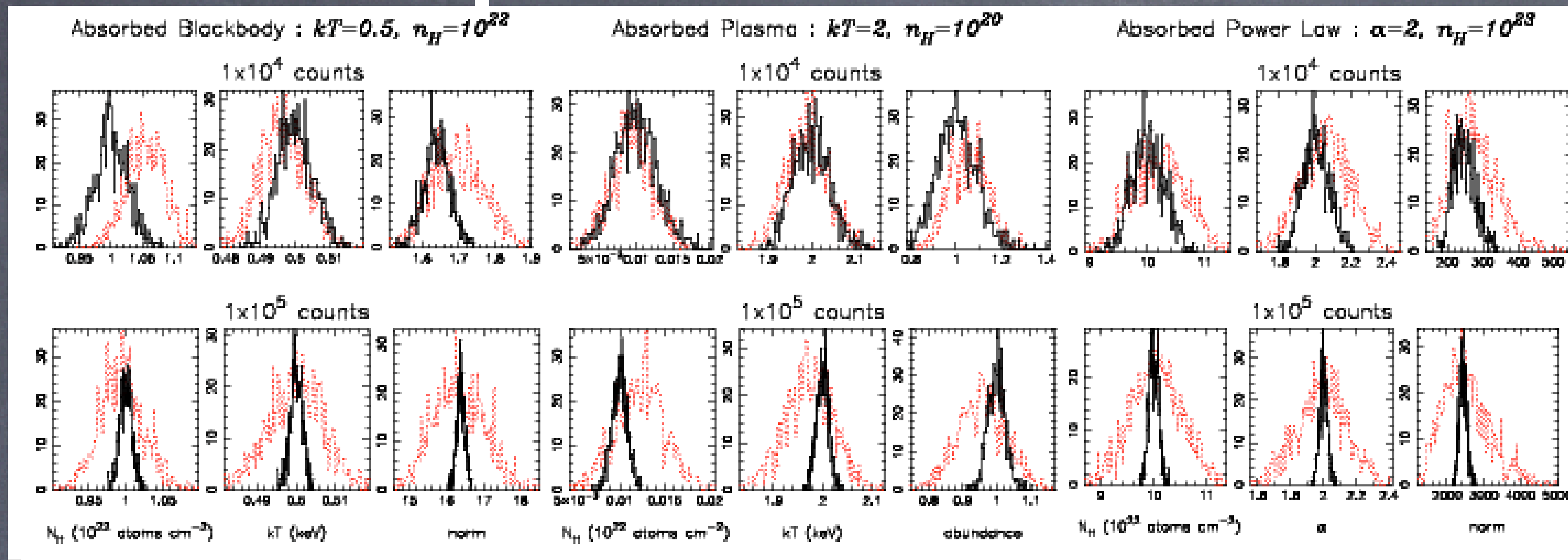
- Method proposed: Use penalty function
  - Minimize $\Lambda = \sum_j A_j^2 + \exp(\frac{(\chi^2_{\nu j} - 1)^2}{\nu_j})$
  - where $\chi^2_{n\nu} = \frac{1}{\nu_n} \sum_{i=1}^{I_n} \frac{[y_{in} - f(x_{in};\vec{\alpha})(1 + \sum_j A_{nj} g(x_{in};\vec{\beta}_j))]^2}{s^2_{in}}$
- Problems:
  - min χ^2/ν achieved jointly: 2.62, 1.48
  - Model is “ugly”
- Solutions?
  - Different basis functions
  - Evolve toward Drake et al. method

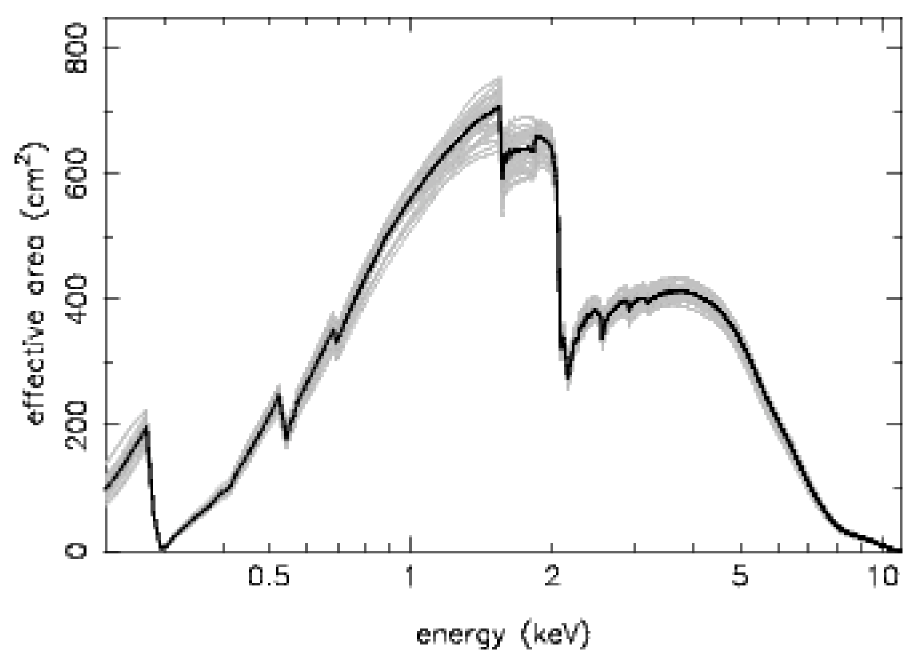
Multiple Fit Methods

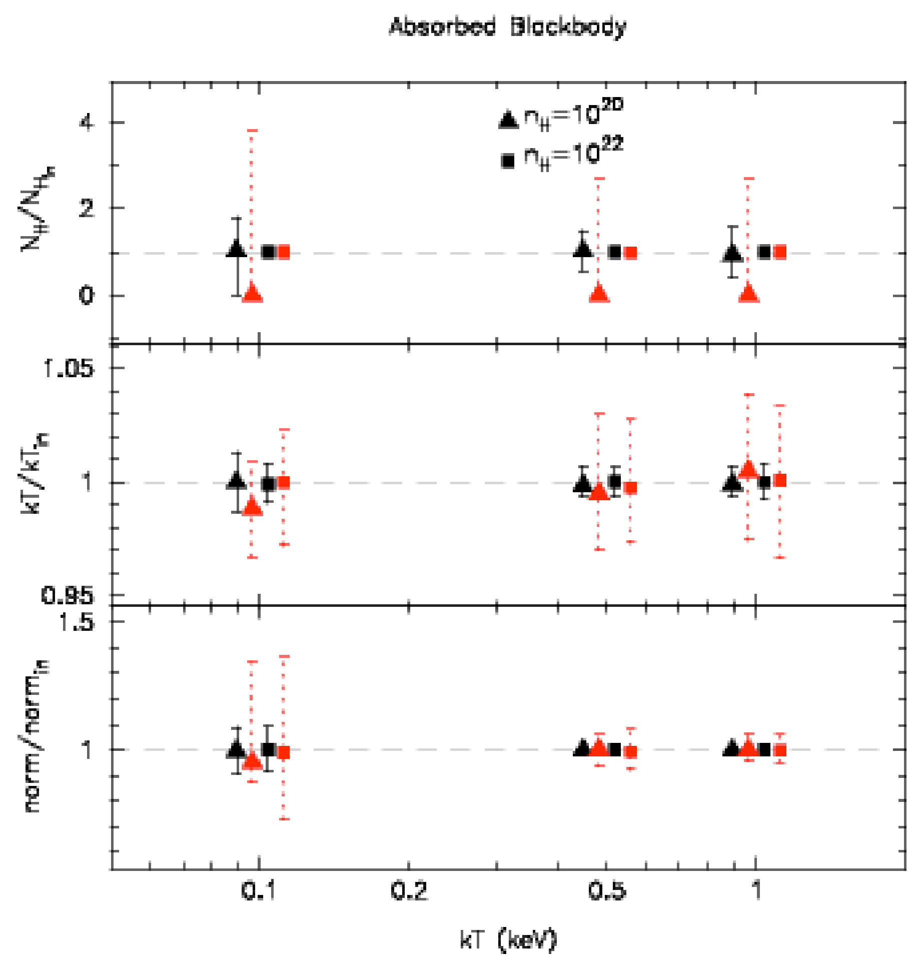
- Monte Carlo method (Drake et al. 2006)
  - Systematic errors assigned to each component of the effective area (mirror, detector, filter, ...)
  - EAs are perturbed within bounds in piecewise continuous fashion, weighted by truncated Gaussian
  - RMFs also adjustable via a separate model
  - Run model fits with many EAs
- Library method (Drake et al., in prep.)
  - Use PCA to make EA perturbation basis vectors
  - Proceed as in MC method



Multiple Fit Results







Drake et al. 2006

Uses of MC/PCA Method

- Calibration work is setting bounds
  - Adjust bounds until $\chi^2/\nu = 1$ for bright sources
  - Still requires expert knowledge of source
- Observation planning
  - Observer guide gives bounds on systematic errors
  - Users may try out different systematic errors before proposing
- Analysis would be "correct"
  - Can detect model errors if $\chi^2/\nu > 1$
  - Parameter error estimates are valid