Handling Systematic Errors in the Effective Area

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Background (see IACHEC 2007)

- Objective is to give meaning to "bad" fits
- HLM suggestion using Gaussian adjustments
  - Not yet successful (x2 not close to 1)
  - Change Gaussians to spline method?
- JD method to use many EA models
  - Works in the limited cases:
    - parameter ranges no longer biased
    - parameter error bars are larger
  - Paper in progress

Taming χ^2 (from DD)

- Data-model agreement given by:
  χ = (D - M) / sigma(D)
  and chi-squared = sum(χ^2).
- Statistical error: sigma(D) ~ sqrt(D).
- Of course, sigma(D) would also include instrumental uncertainties on D…
- --> Even so, is that all there is to it ?

Science relevance

- --> There's also "science relevance" - What sigma(D) is "acceptable" given the expected model fidelity ?
- Depends on analysis, but can be larger than instrumental uncertainties.
- Specifying and including science relevance can give science meaning to chi-squared values across data sets.

Science relevance in print

- " … the quality of the fits is generally fair, with all but a few values of the χ^2 per degree of freedom falling below 2. While not formally acceptable in a statistical sense, we consider it [scientifically] acceptable given that the model is simple and many of the spectra [contain] a few tens of thousands of counts or more."
- Hwang, Petre, and Flanagan 2008, ApJ 676, 378.

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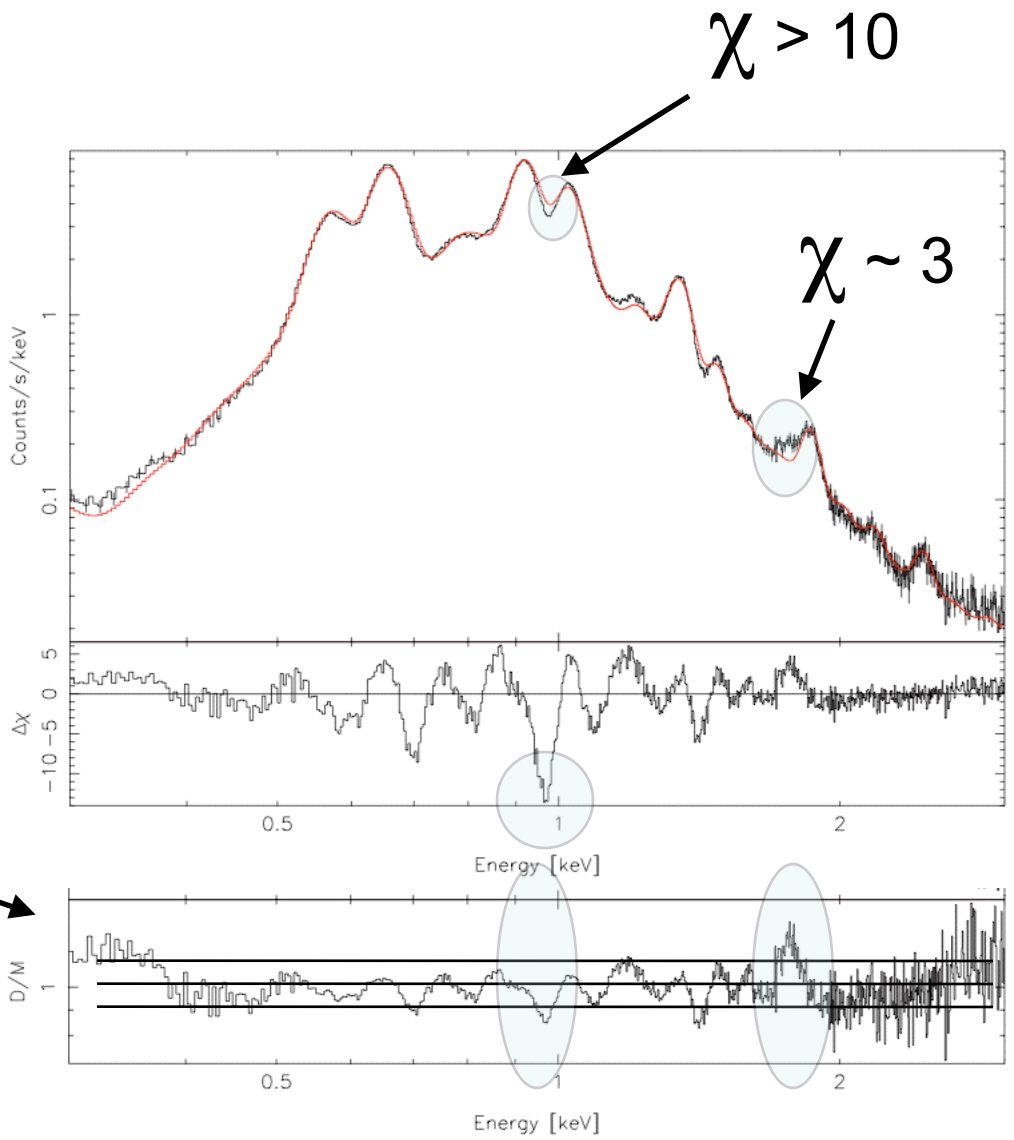
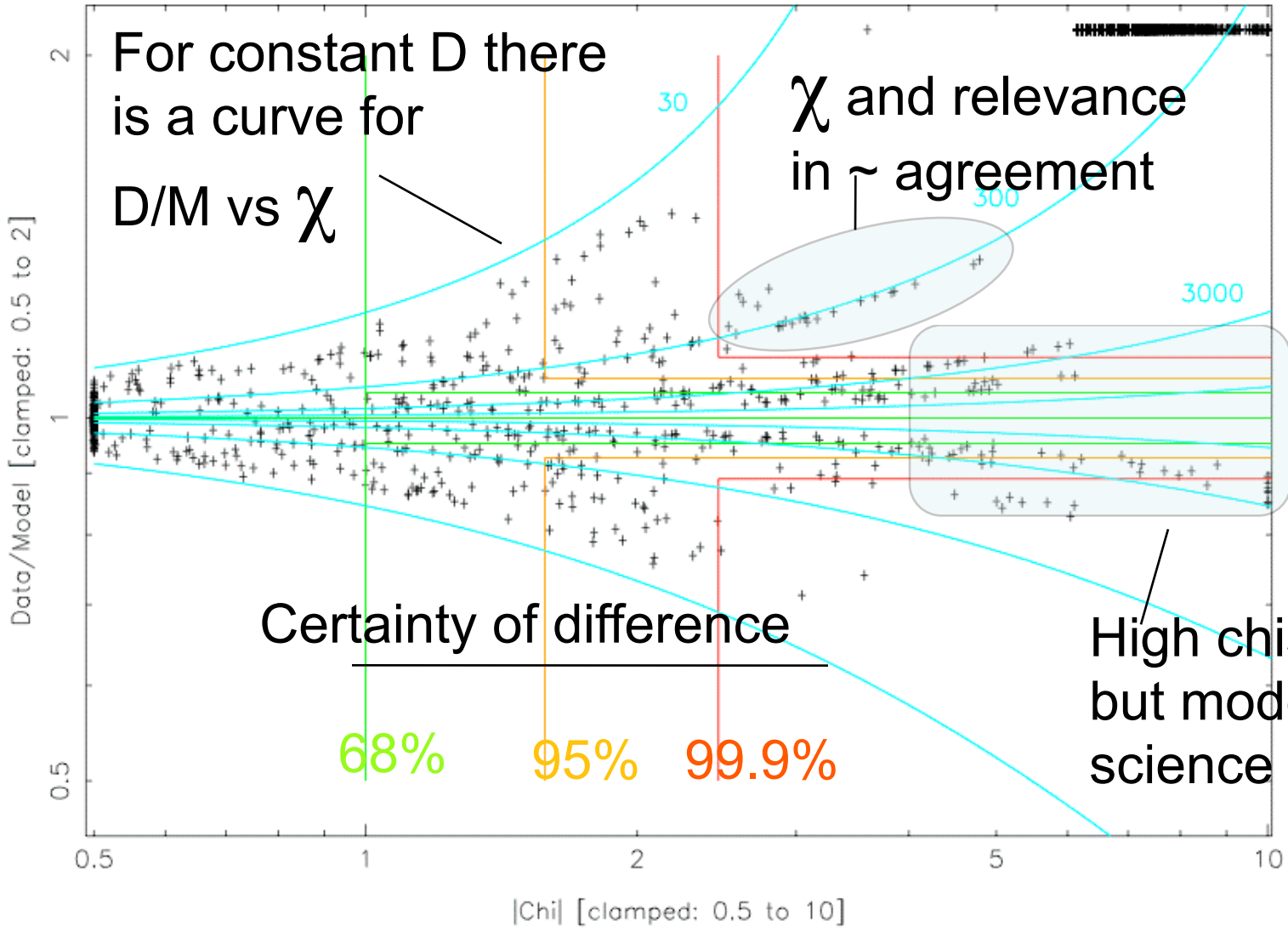
- Hwang, Petre, and Flanagan 2008, ApJ 676, 378. What about when there are a million counts in an SNR spectrum ?

E0102: Chi vs D/M

- E0102 w/Suzaku, Eric Miller data
- Model fit is "unacceptable":
- $\chi^2/\nu \sim 7.0$
- But D/M is within ~10%, not bad…



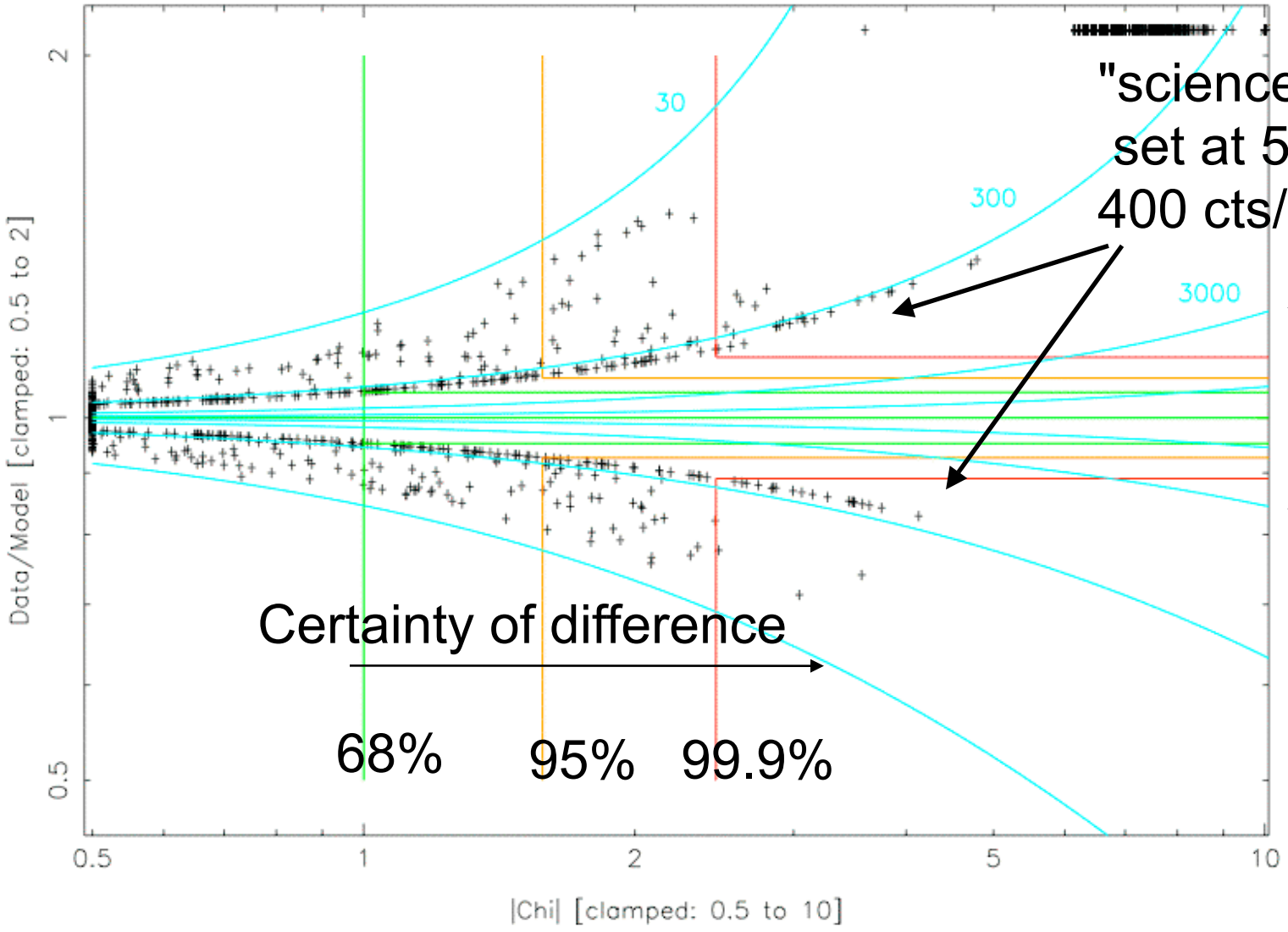
Relation of Chi and D/M



Science sigma

- Chi is a measure of the "certainty" of a difference -- not a measure of the "science relevance" of the difference.
- Modify sigma(D) to be given by:
  greater_of (sigma_sci*D, sqrt(D))
- Sigma_sci is a fractional error limit that encodes the science relevance.
- Generally appropriate for high dynamic-range data (e.g., if using a log-Y axis.)

Using modified Chi_sci



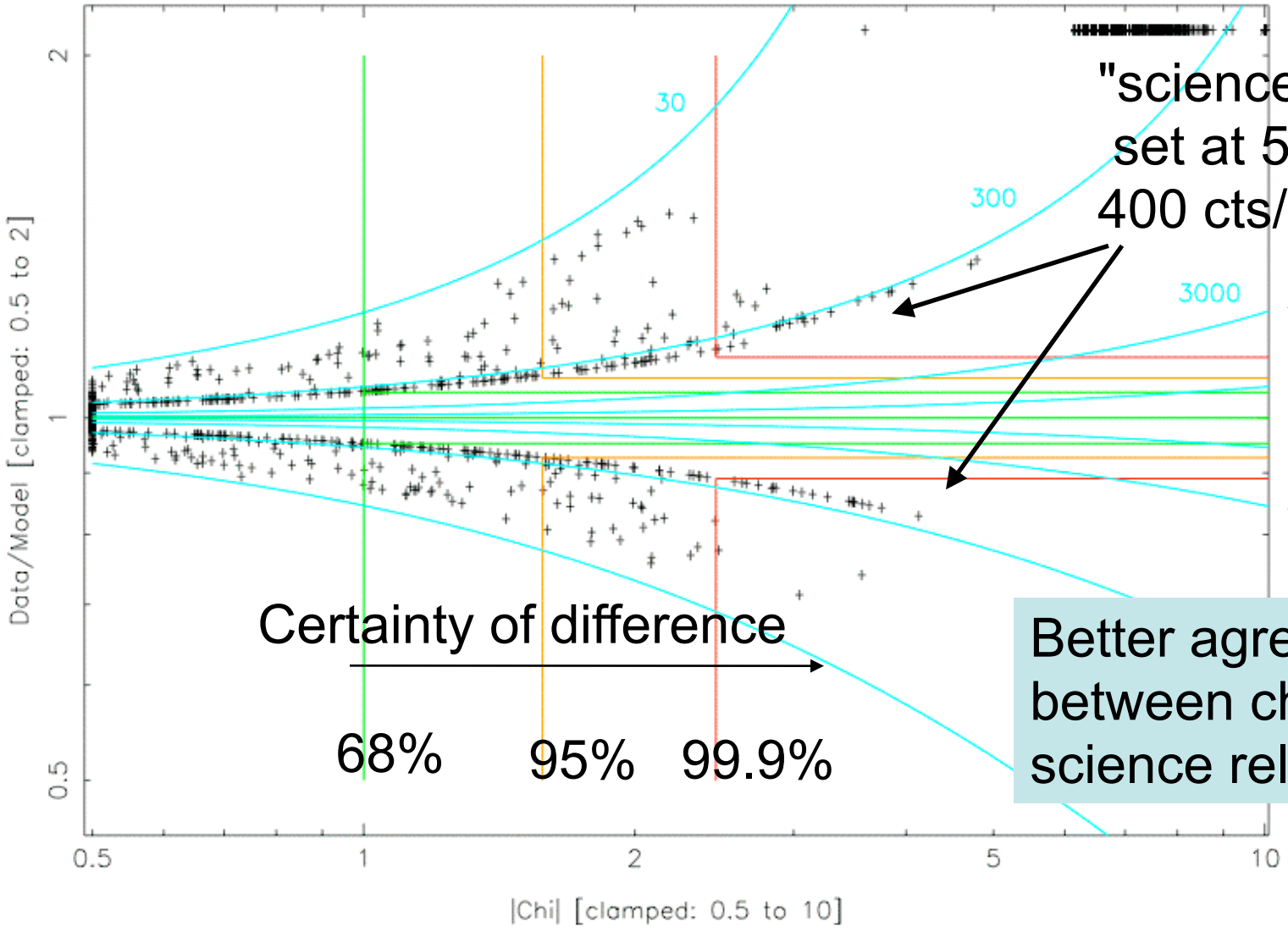
"science sigma" set at 5% (equiv. to 400 cts/bin max)

Science relevance of difference

Certainty of difference

68% 95% 99.9%

Using modified Chi_sci



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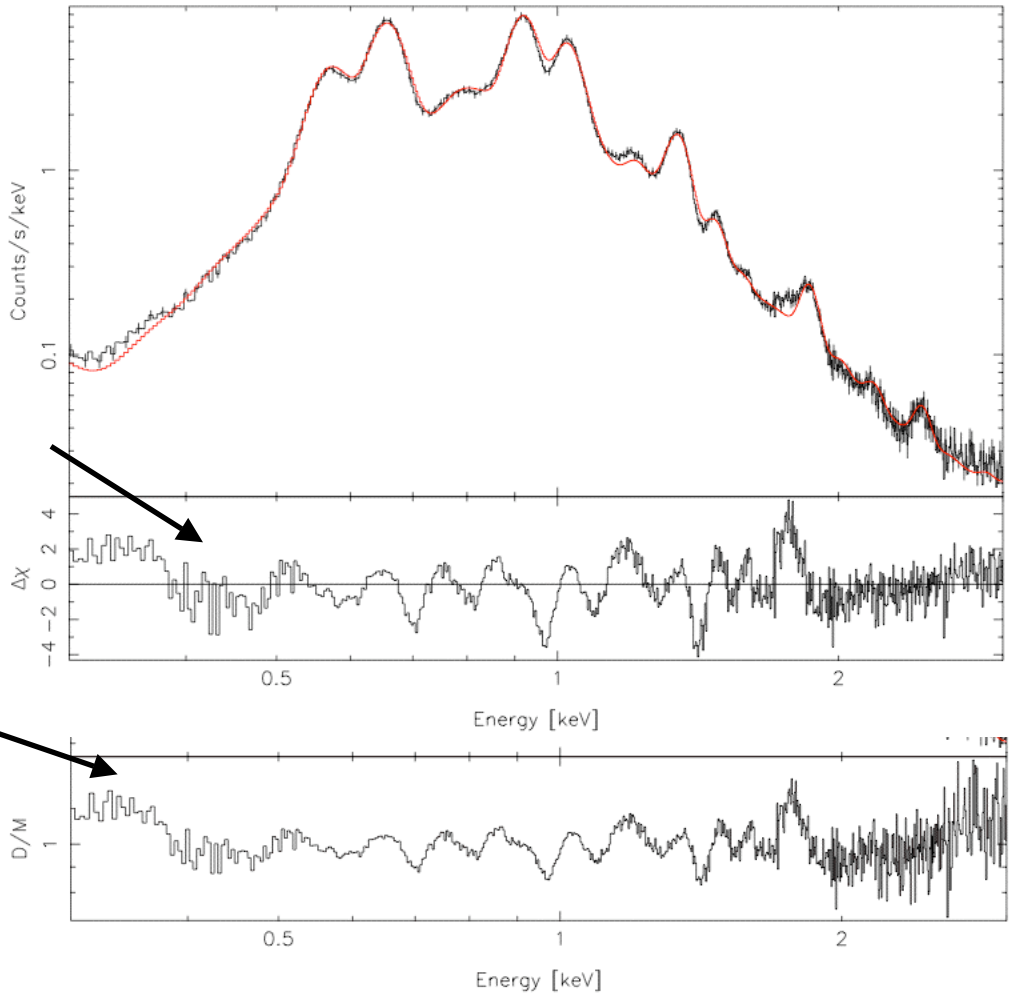
Better agreement between chi and science relevance

E0102: Chi_sci and D/M

- Science sigma of 5% used.
- Equiv. to 400 cour bin "observation".
- " $\chi^2_{sci}/\nu \sim 1.8$ [5%]
- Agrees better with ratio.



Summary

- Currently, data-model agreement is only set, fit, and expressed by statistics.
- For high-counts, high dynamic range data the χ^2 can deviate from a measure of "scientific agreement of data and model."
- Using a "science sigma" fractional error limit can improve the meaningfulness and inter-comparison of χ^2.