

So you think the Crab is described by a  
powerlaw spectrum and other  
considerations: a presentation in two  
parts



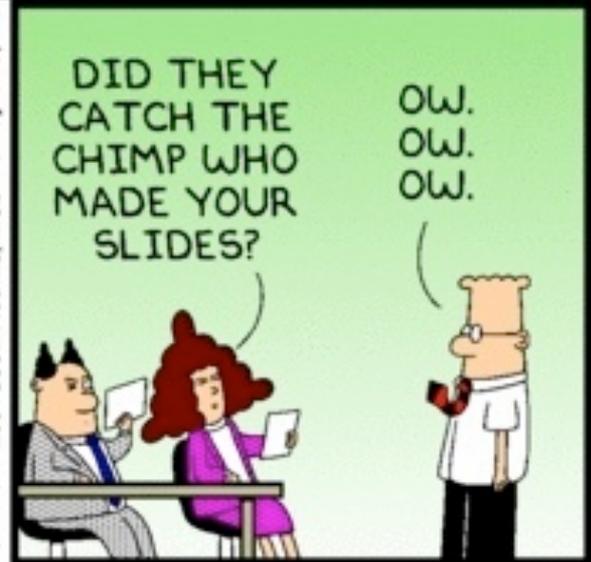
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Colleen Wilson-Hodge & Ron Elsner
- II. Allyn Tennant, Steve O'Dell & Ron Elsner



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# I. So you think the Crab is described by a powerlaw spectrum!



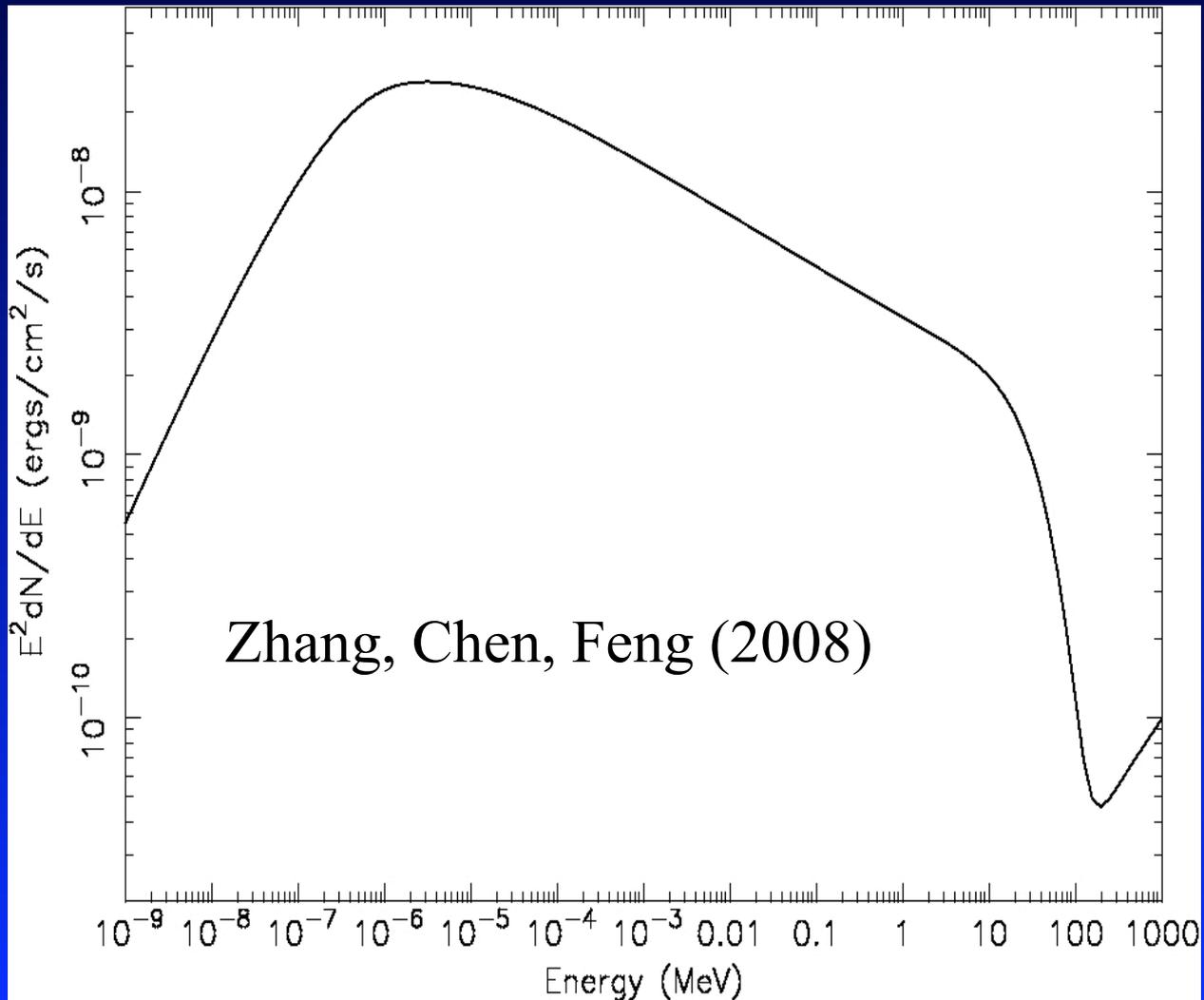


# We examine the consequences for three observatories under two hypotheses

- Rosat/PSPC (0.1-2.4 keV)
- RXTE/PCA (3-60 keV )
- XMM-Newton/EPIC-pn in burst mode (0.3-10.0 keV)
  
- The X-ray spectrum is described by a powerlaw
- The X-ray spectrum is not a powerlaw

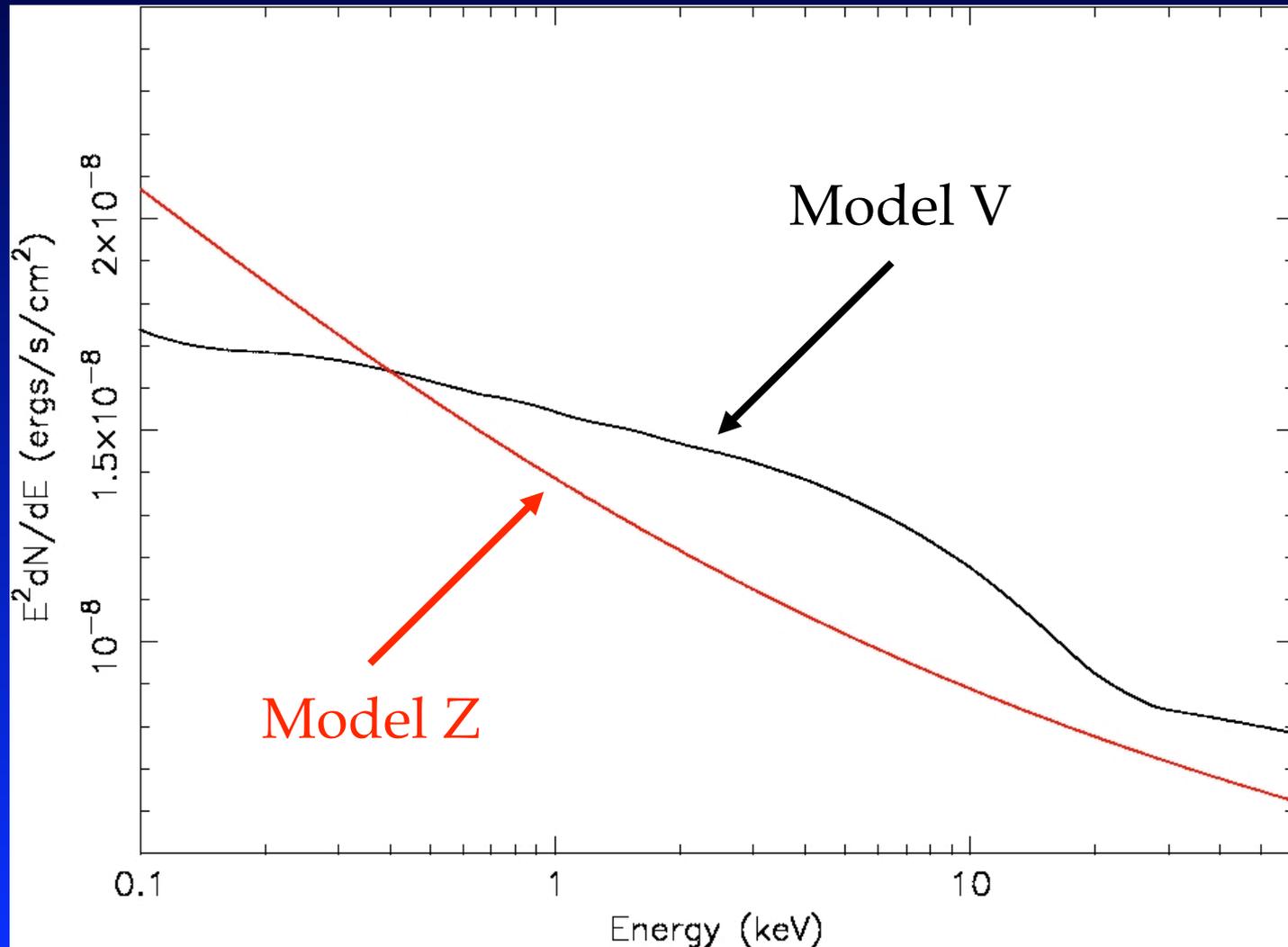


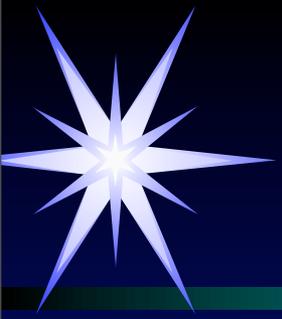
# What is the spectrum anyway?





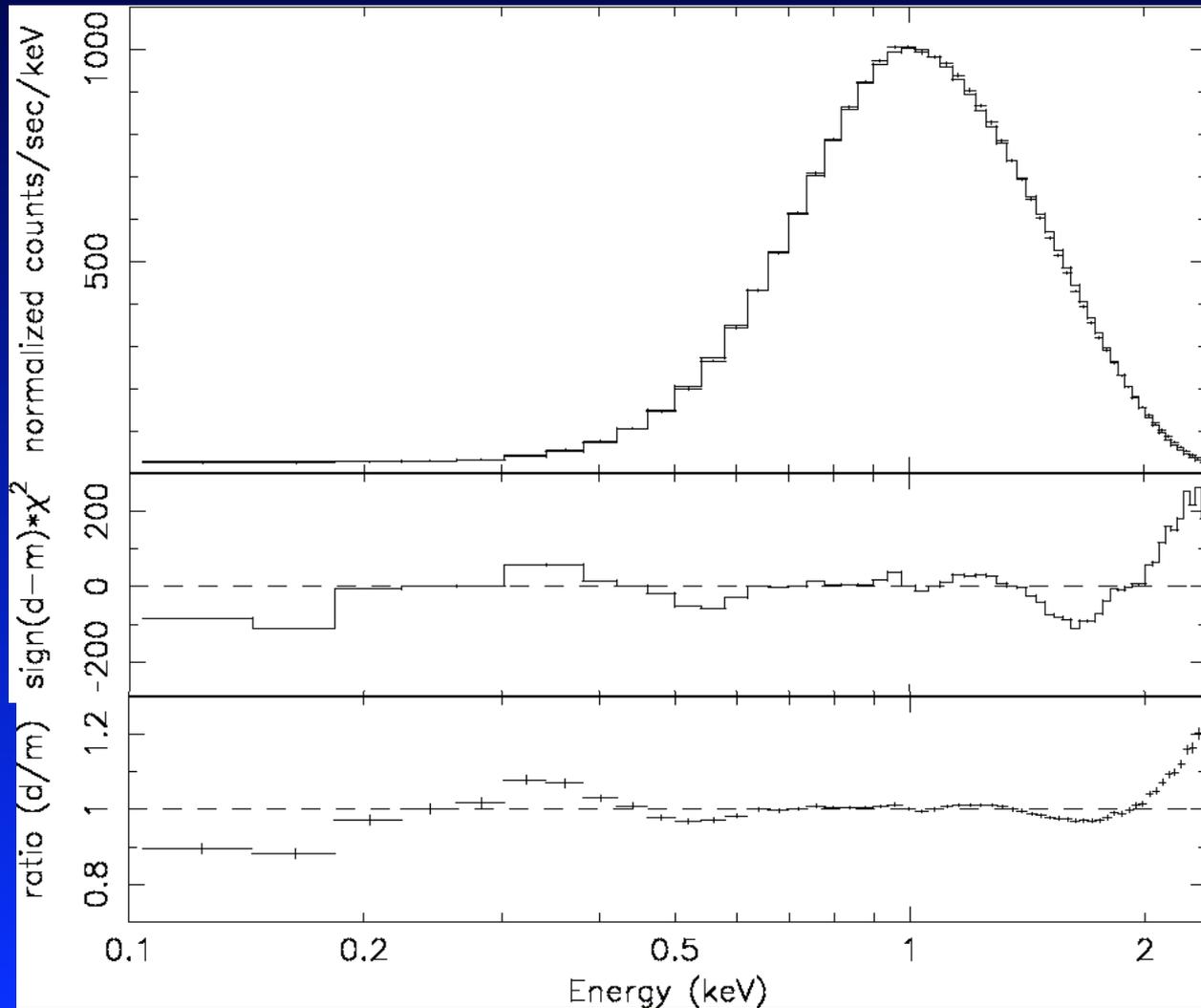
# There is also Volpi et al. 2008





# ROSAT/PSPC (0.1–2.4 keV) – the fit to a powerlaw is terrible!

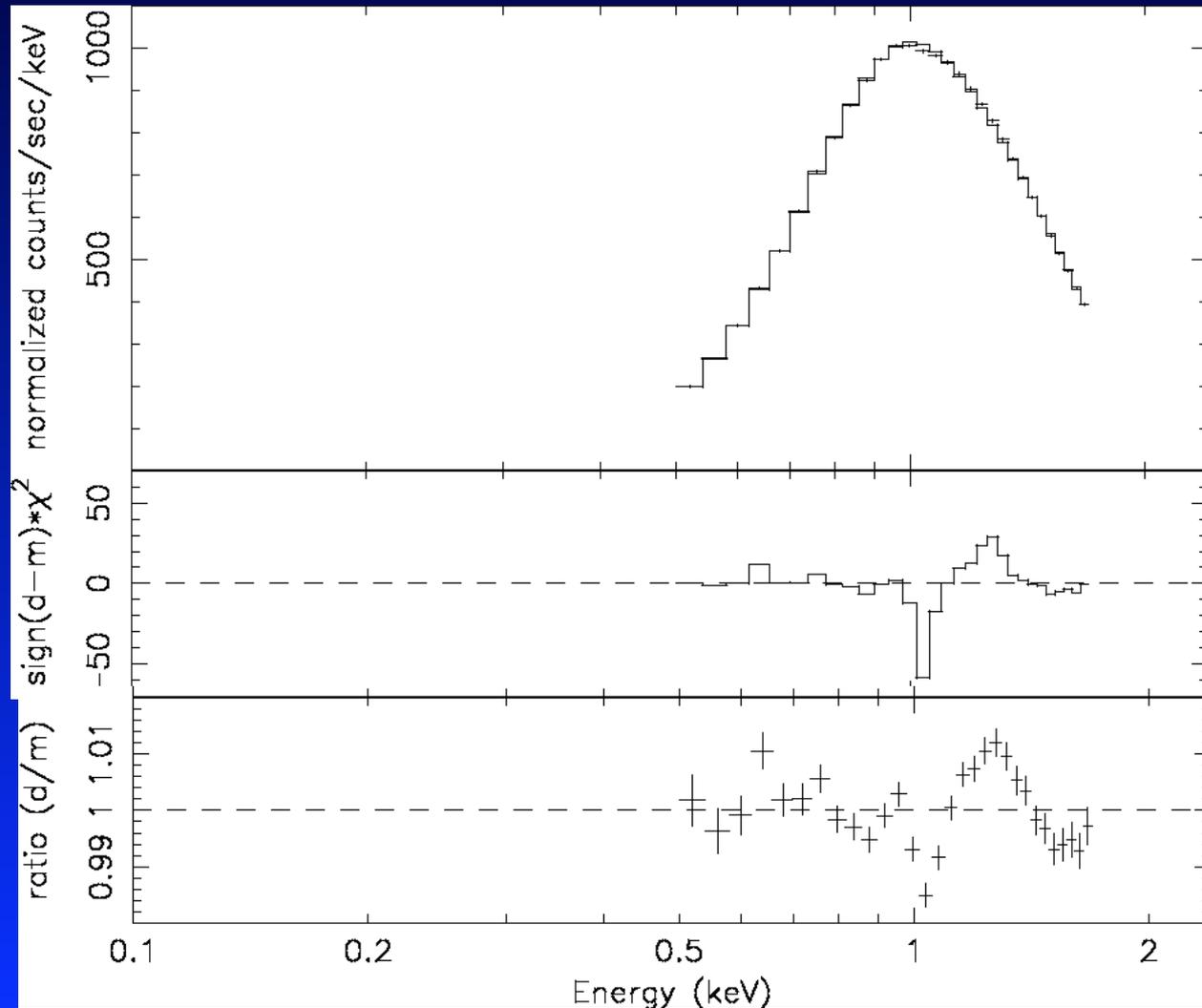
$$\chi^2/\nu = 3343/227$$





# ROSAT/PSPC - narrowing the band doesn't completely help

$$\chi^2/\nu = 331/116$$





ROSAT/PSPC - simulations indicate that the bad fits are not a consequence of hypothesis 1

Z  
V

| Counts/106 | $\chi^2/\nu$       | $\Gamma$                 | $N_H/10^{22}$            | [O]                    |
|------------|--------------------|--------------------------|--------------------------|------------------------|
| 6.16       | $(228 \pm 21)/227$ | $2.1921$<br>$\pm 0.0063$ | $0.4210$<br>$\pm 0.0020$ | $0.678$<br>$\pm 0.016$ |
| 6.16       | $(229 \pm 22)/227$ | $2.0701$<br>$\pm 0.0057$ | $0.4214$<br>$\pm 0.0021$ | $0.670$<br>$\pm 0.013$ |



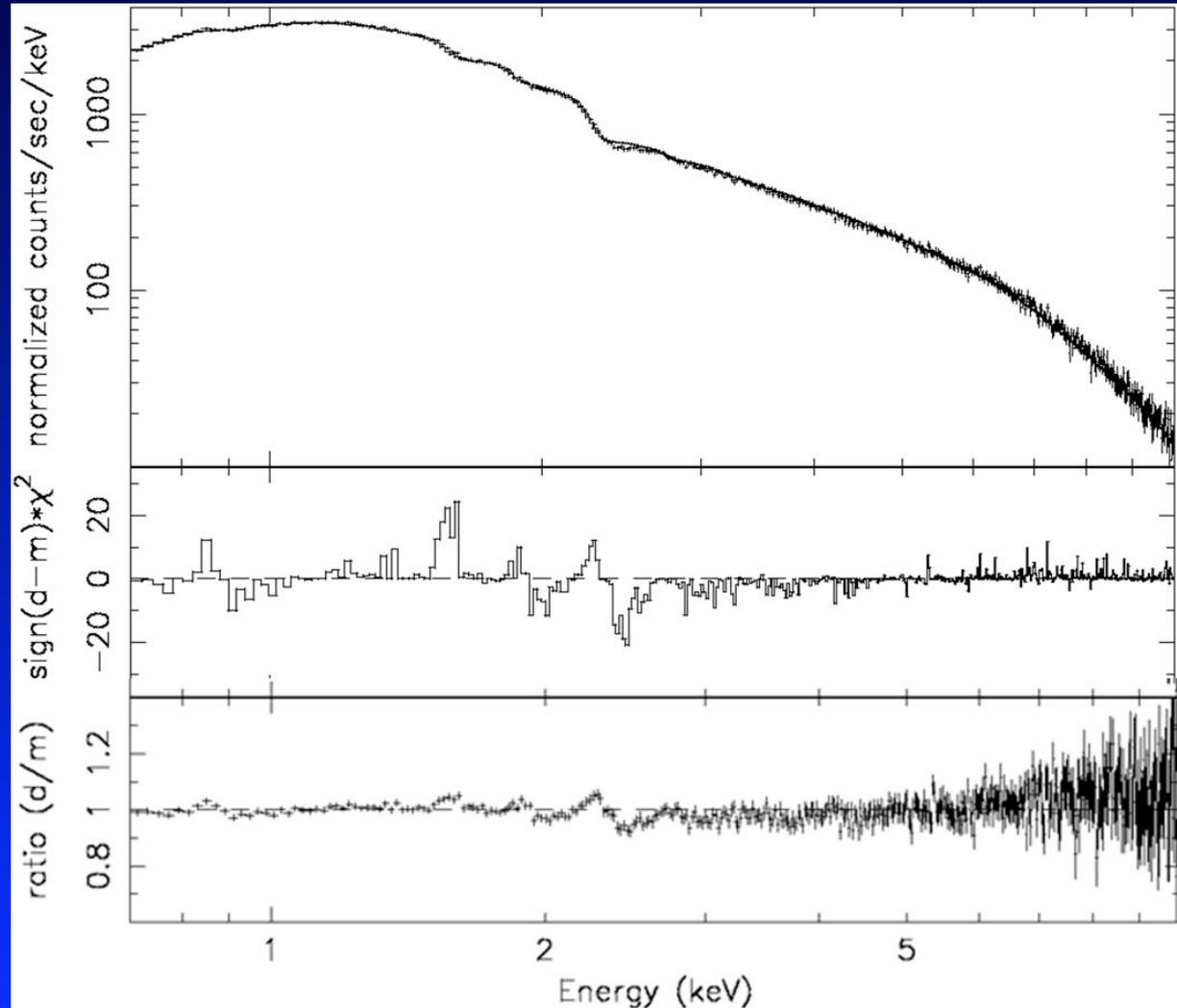
# ROSAT/PSPC - Conclusions

- The simulations indicate that the Crab ought to appear as a powerlaw to the instrument over the 0.1 to 2.4 keV band
- The response function is inaccurate at the 20% level over the full band
- The response function is inaccurate at the 1% level over the reduced (0.5-1.7 keV) band
- Rosat/PSPC data should *not* be used to establish powerlaw parameters



# XMM-Newton Epic-pn (bm)-analysis covering 0.3–10.0 keV yields poor fit

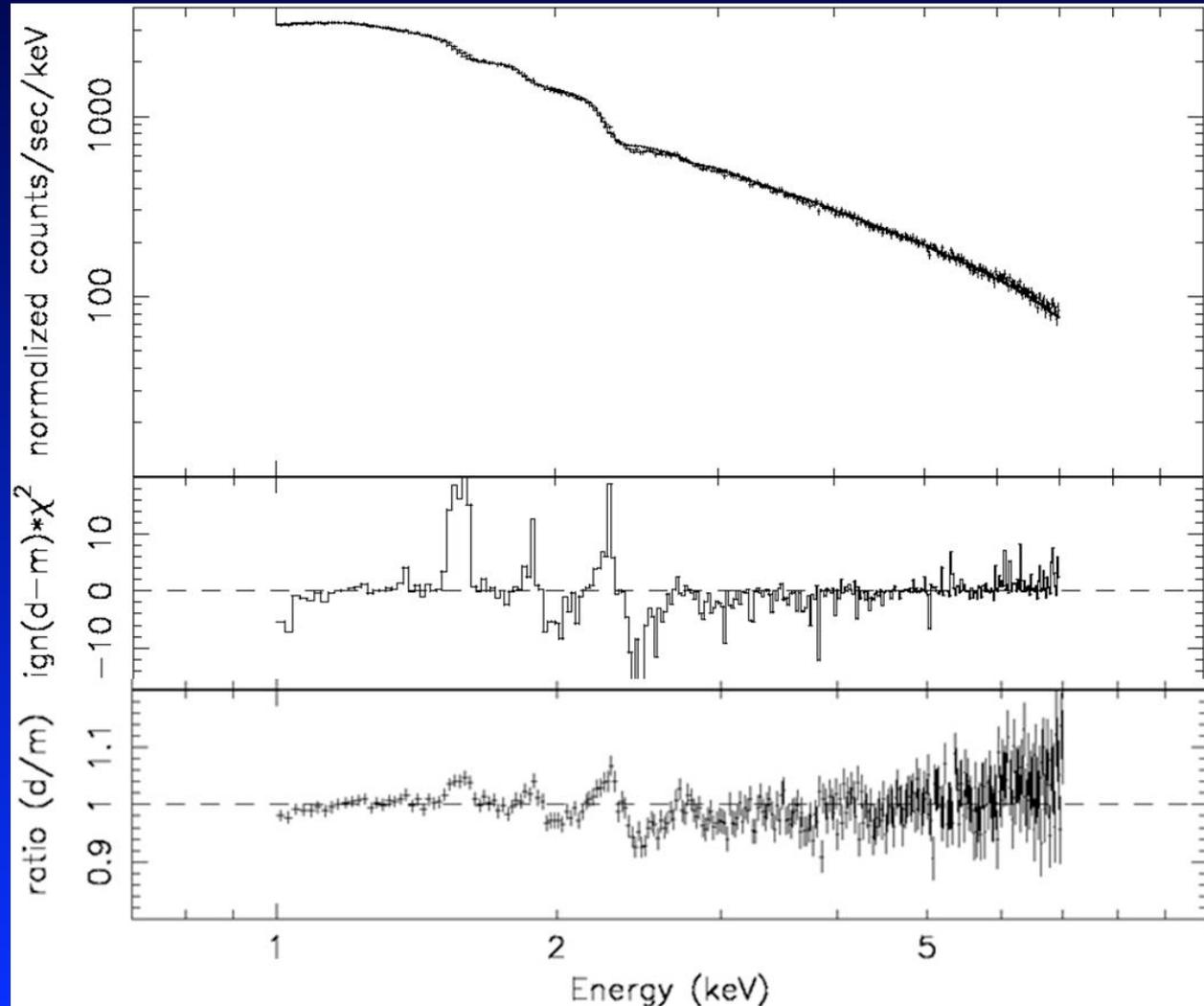
$$\chi^2/\nu = 2386/1860$$
$$(\chi^2 - \nu) / (2\nu)^{1/2} = 8.6$$





# XMM-Newton Epic-pn (bm) – reduce the bandwidth?

$$\chi^2/\nu = 1568/1200$$
$$(\chi^2 - \nu) / (2\nu)^{1/2} = 9.2$$





# XMM/EPIC-pn (bm) - What do the models say?

|   | Counts/ $10^6$ | $\chi^2/\nu$         | $\Gamma$            | $N_H/10^{22}$     | [O]             |
|---|----------------|----------------------|---------------------|-------------------|-----------------|
| Z | 2.44           | $(1877 \pm 62)/1860$ | $2.1991 \pm 0.0026$ | $0.440 \pm 0.019$ | $0.61 \pm 0.10$ |
| V | 2.44           | $(2038 \pm 74)/1860$ | $2.1143 \pm 0.0023$ | $0.524 \pm 0.020$ | $0.29 \pm 0.08$ |

$$V: (\chi^2 - \nu) / (2 \nu)^{1/2} = 2.9$$



## XMM/EPIC-pn (bm) - Conclusions

- The 1.0-7.0 keV response does not yield an acceptable fit of a powerlaw to the Crab data
- The Z and V models for the Crab spectrum would imply that both fits should be acceptable
- There are problems with the response function at the few percent level at the instrument edges
- Full-band data should *not* be used to establish powerlaw parameters

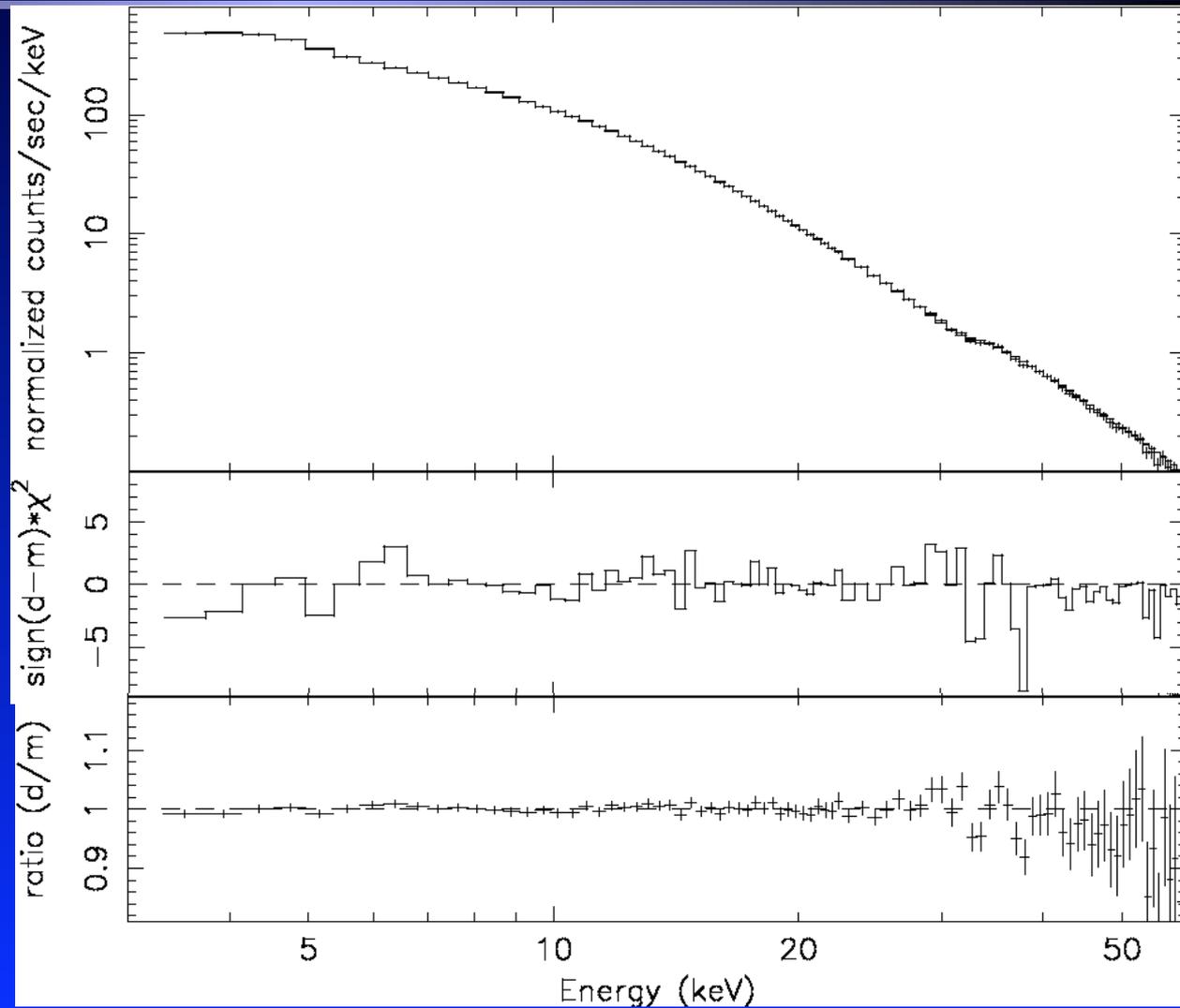


# RXTE/PCA – Latest version of response gives good fit!

$$\chi^2/\nu = 166/86$$

$$N_{\text{H}} \equiv 0.42 \times 10^{22} \text{ cm}^2$$

$$[\text{O}] \equiv 0.676$$





# RXTE/PSPC - What do the models say?

Z

V

| Counts/ $10^6$ | $\chi^2/\nu$        | $\Gamma$            | $N_H/10^{22}$ | [O]           |
|----------------|---------------------|---------------------|---------------|---------------|
| 6.66           | $(89 \pm 13)/86$    | $2.1958 \pm 0.0007$ | 0.42 (fixed)  | 0.676 (fixed) |
| 6.66           | $(3084 \pm 112)/86$ | 2.22                | 0.42 (fixed)  | 0.670 (fixed) |





# RXTE/PCA - Conclusions

- The 3-60 keV response yields an acceptable fit of a powerlaw to the Crab data
- The Z model for the Crab spectrum would imply that the fit should be acceptable, but the V model the opposite
- Hmmmm

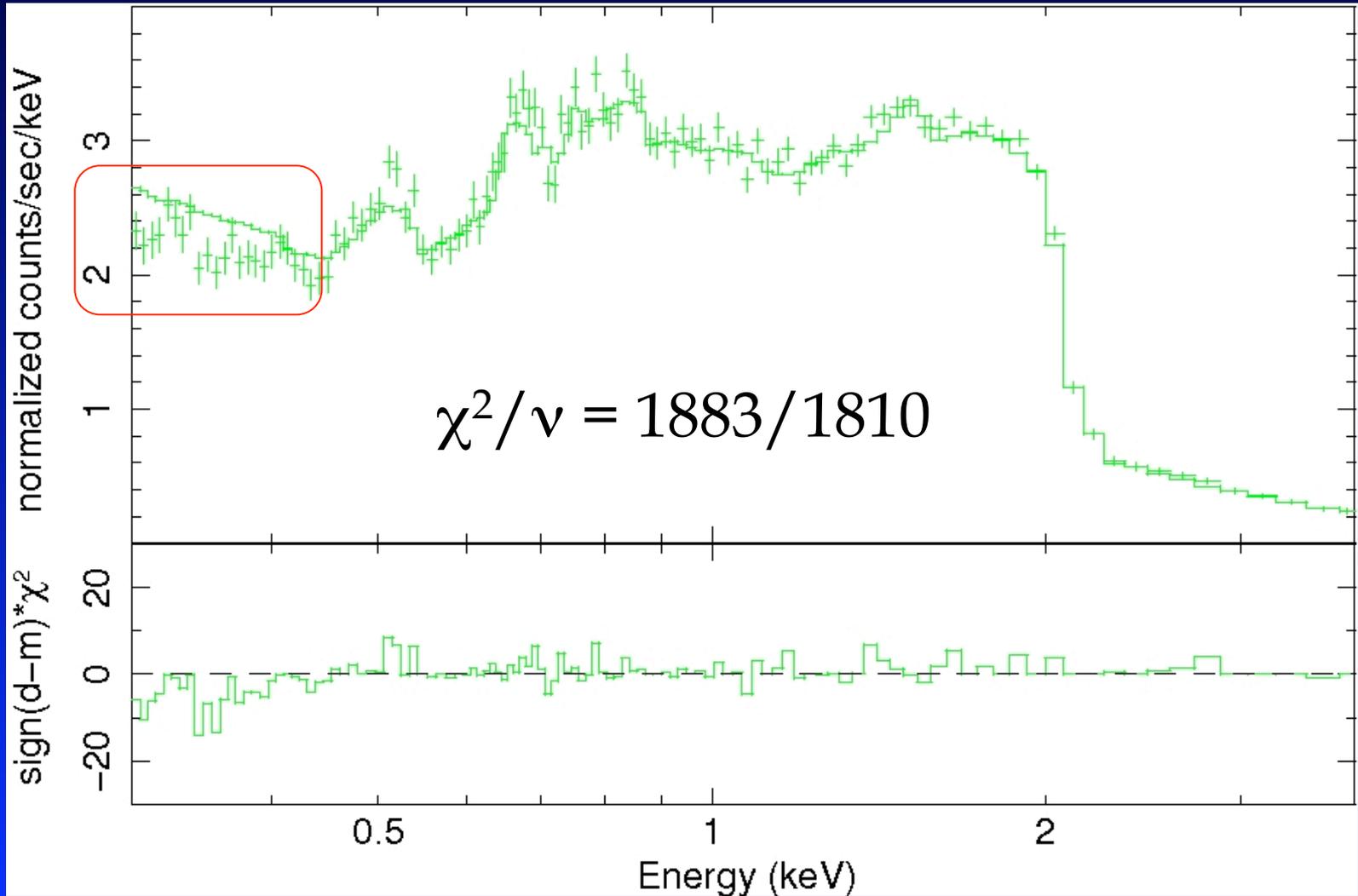


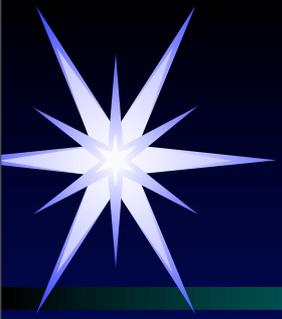
## II. The Crab Pulsar and the LETG

- Project to perform pulse-phased spectroscopy of the pulsar
- Acquired new data (blade in)
- CIAO responses have evolved
- Using updated HRC-QE maps
- Something(s) is (are) peculiar

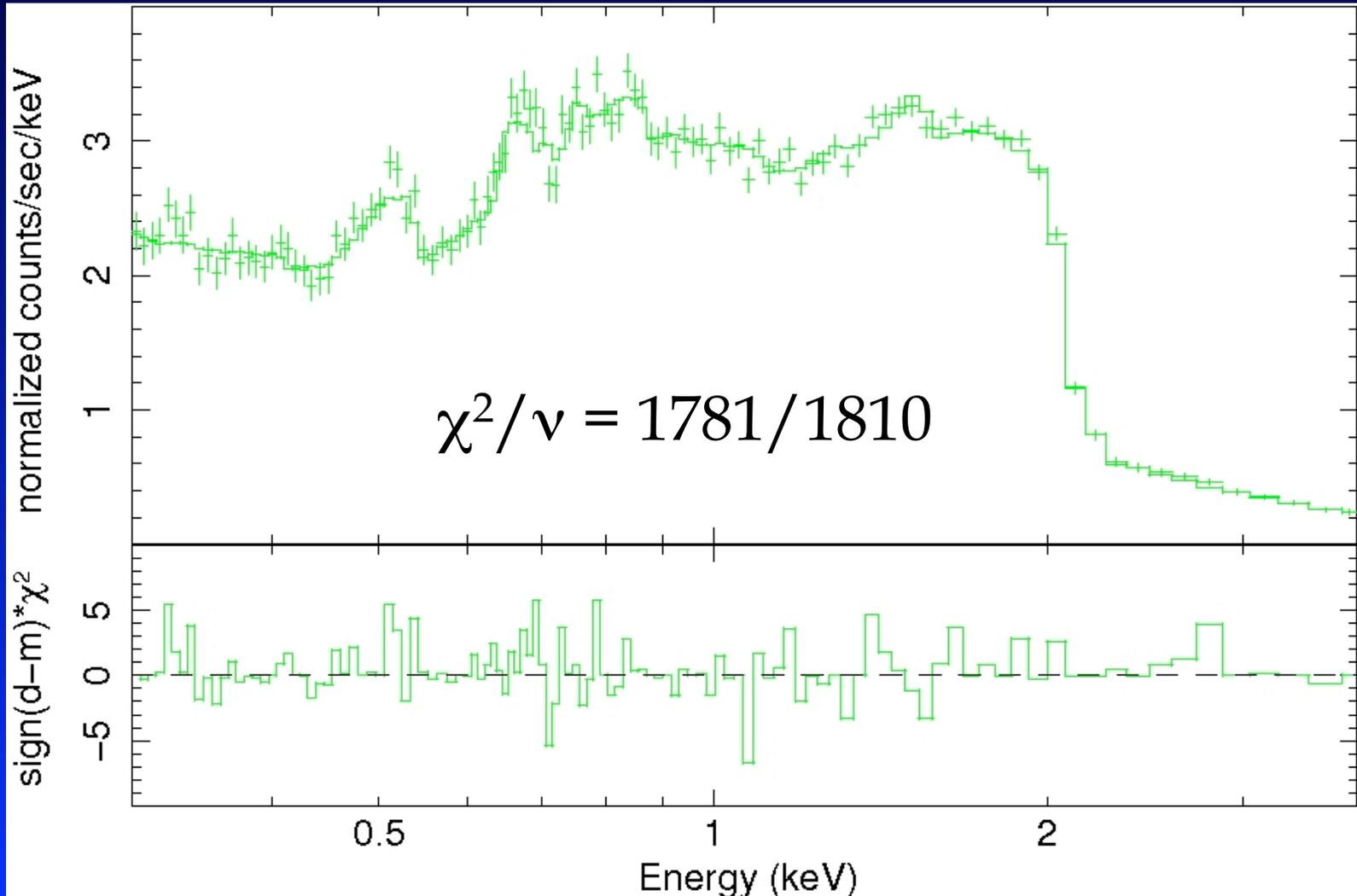


# The contribution of the higher orders simply cannot be correct (arf="try")



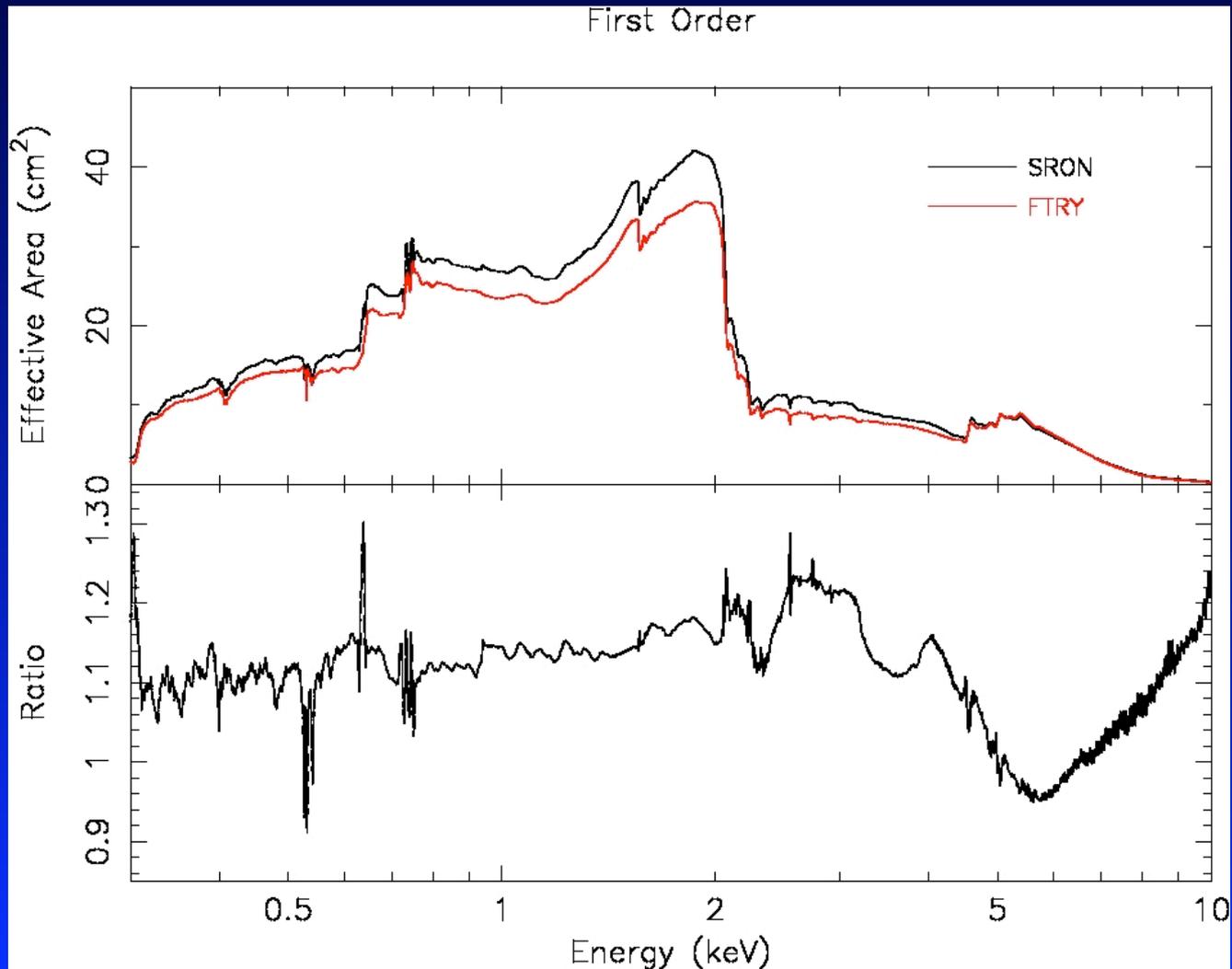


# Reanalyze with new response "ftry"



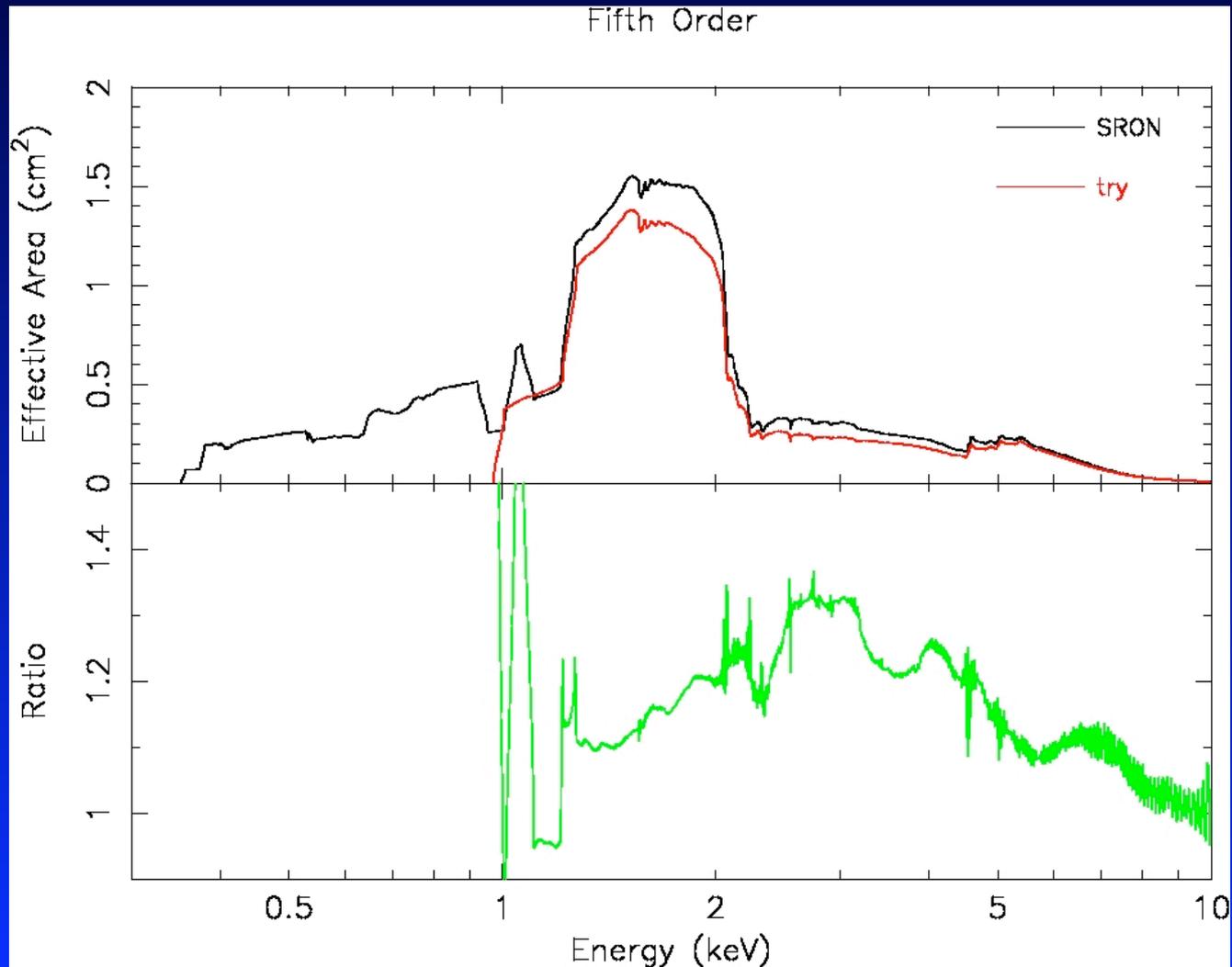


# Comparison with SRON's arfs





# Comparison with SRON's arfs Fifth Order





# Comparison with SRON's arfs Fifth Order

