

# ACIS Contaminant and Cross-Cal Implications Now, with even more Oxygen!

Herman L. Marshall

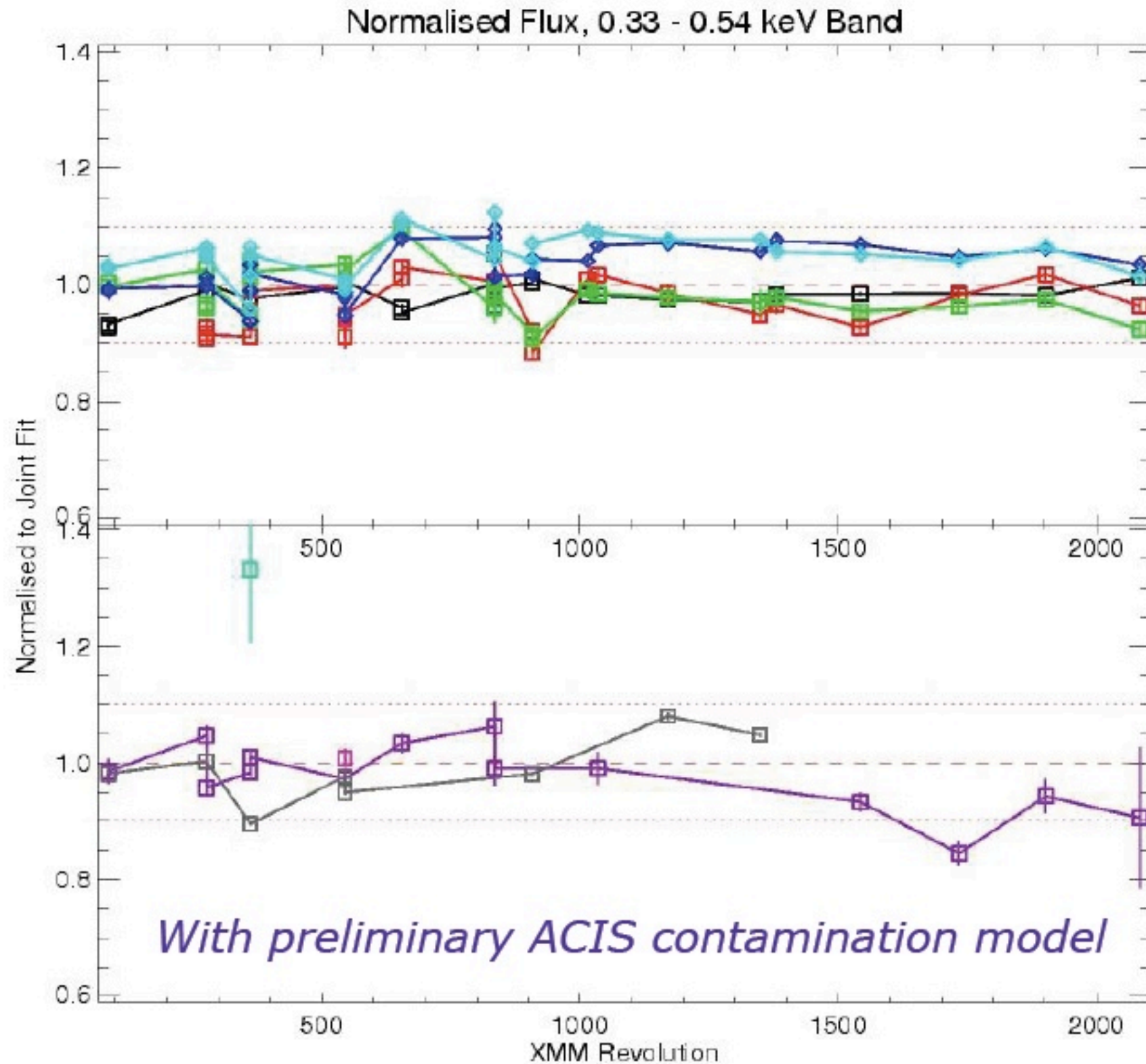
Mar. 26, 2014

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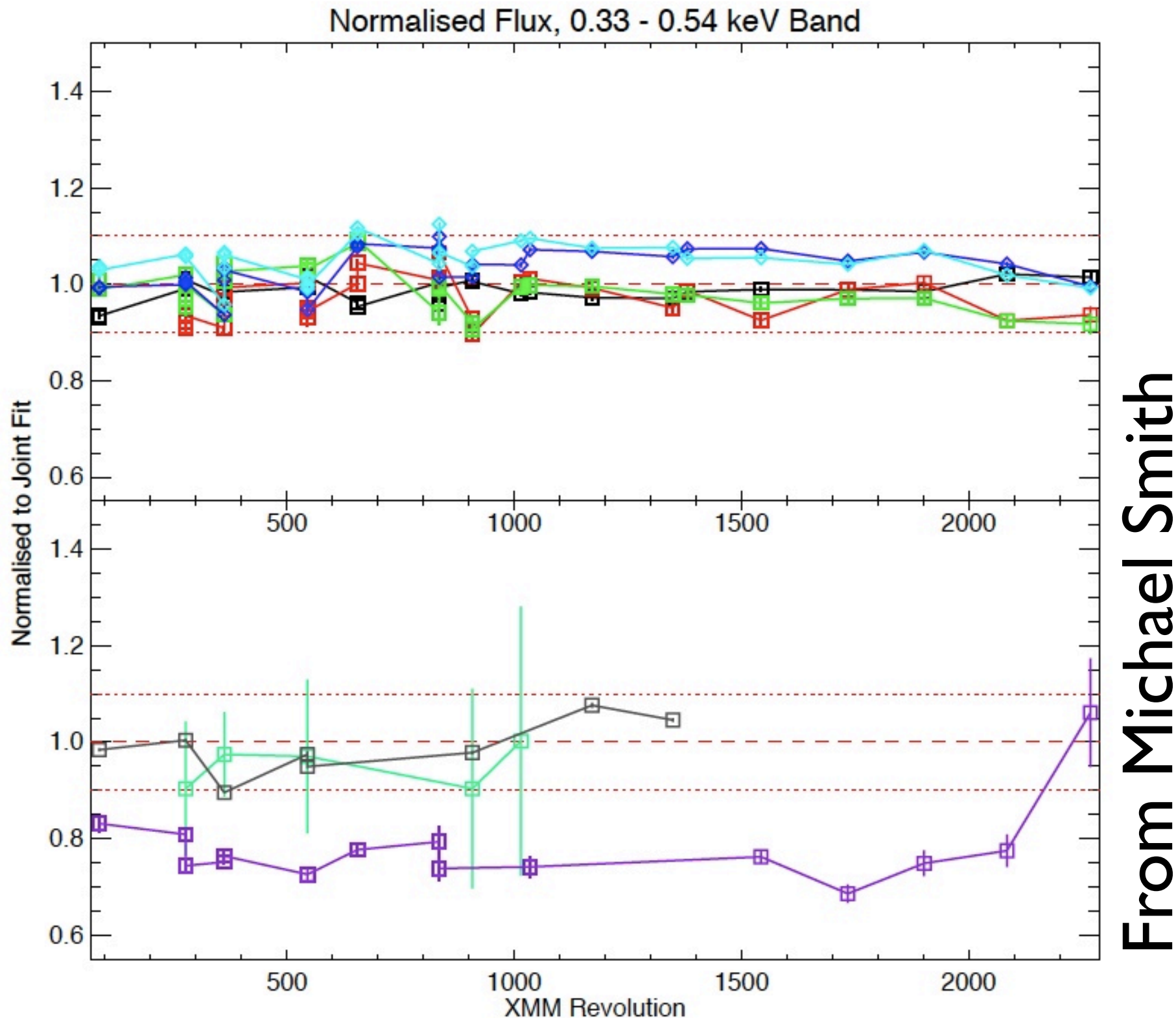


# Cross-Cal Context



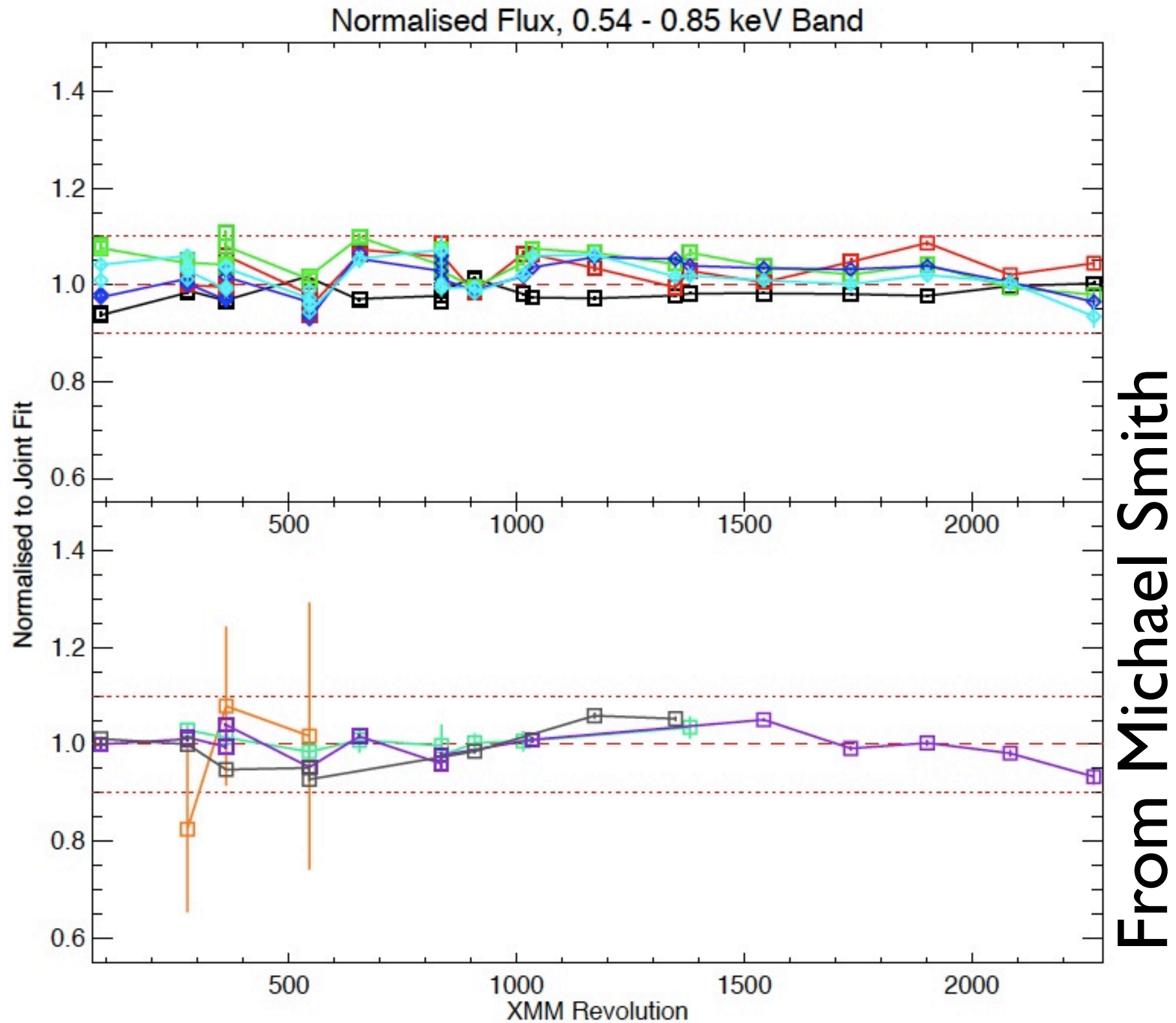
From Michael Smith

# Cross-Cal Context





# Cross-Cal Context



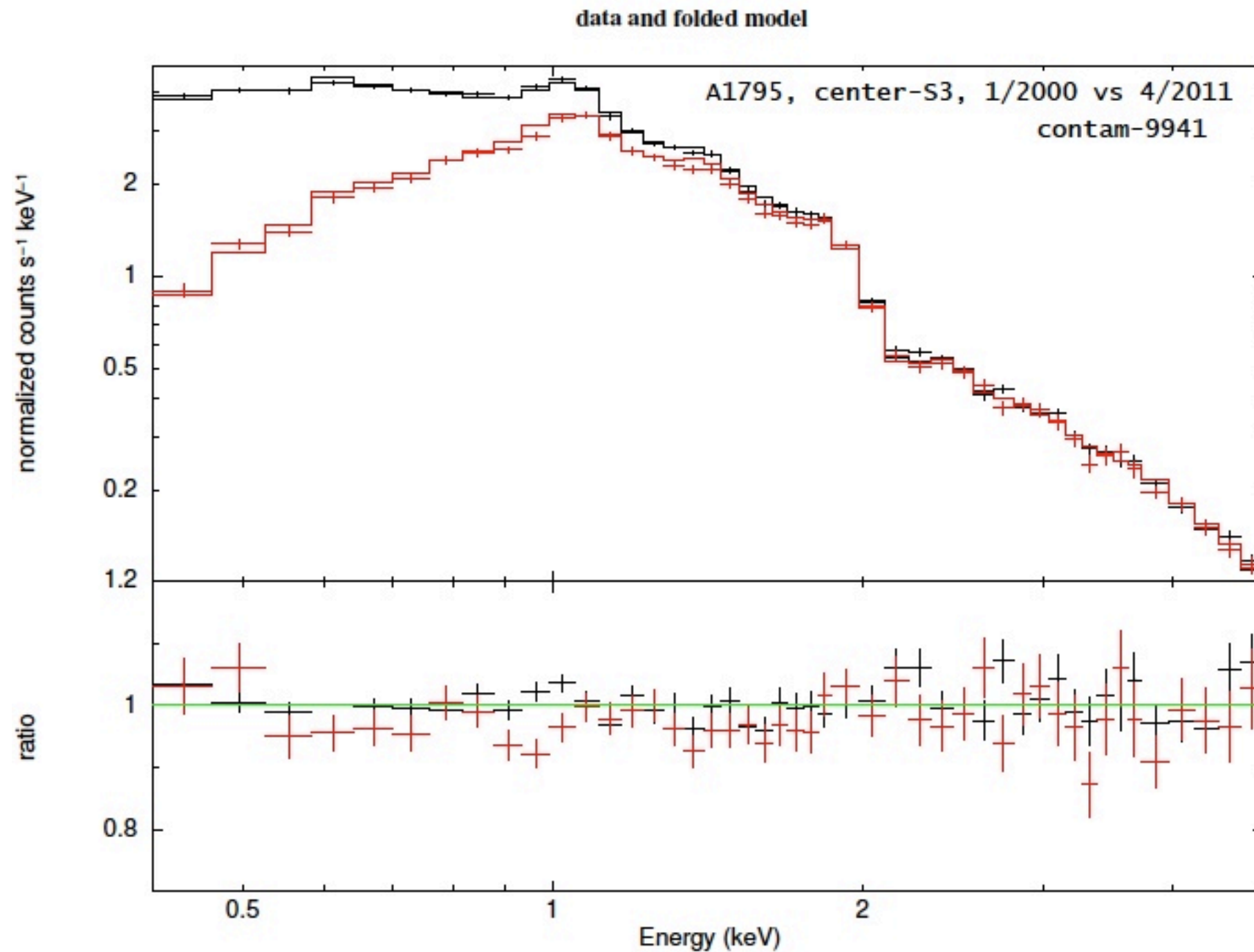
# A Short History

- 1999: Chandra Launch
- 2000: Anomalous C-K edge — LETG only?
- 2001: Contaminant thickens
- 2002: Composition determined (COF), edge NEXAFS indicates C-C single bonding
- 2003: Spatial variation found: thin at FoV center
- 2004: Fluffium invented as LETG/ACIS and cal source disagree; new model released
- 2010: Deposition accelerates, Gaussium replaces fluffium

# Progress since 2012

- LETG/ACIS:  $N_o/N_c$  varies in time
- 2013 Released Model
  - Foundation is Cluster based, Gaussium is eliminated
  - Adjusted nonphysically to fit LETG/ACIS data
  - Verified with 1E0102, Clusters
- Developments
  - A1795 observations continue
  - LETG/ACIS of Mk 421 (3/14): “Big Dither”

# Clusters Drive Model

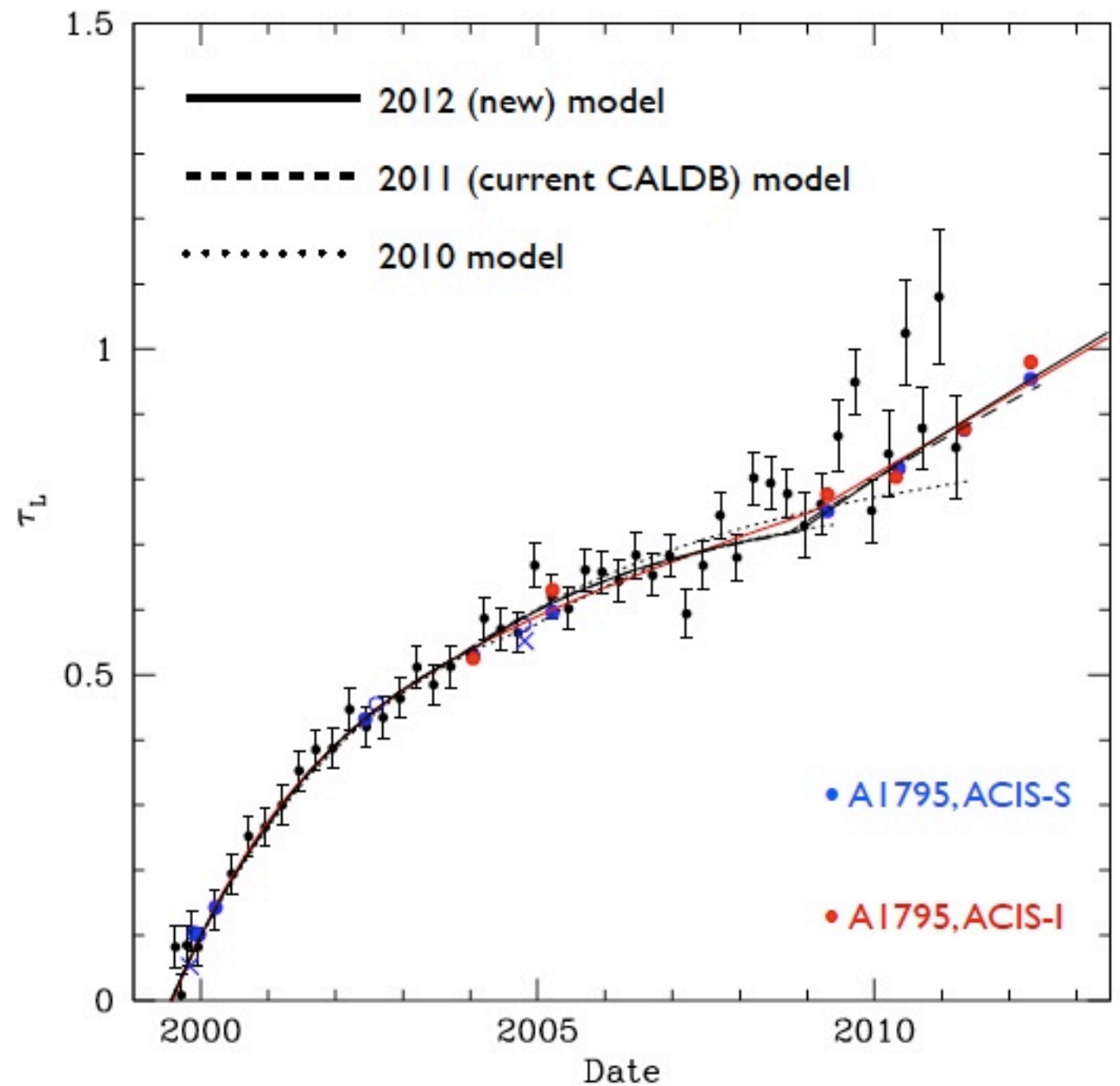


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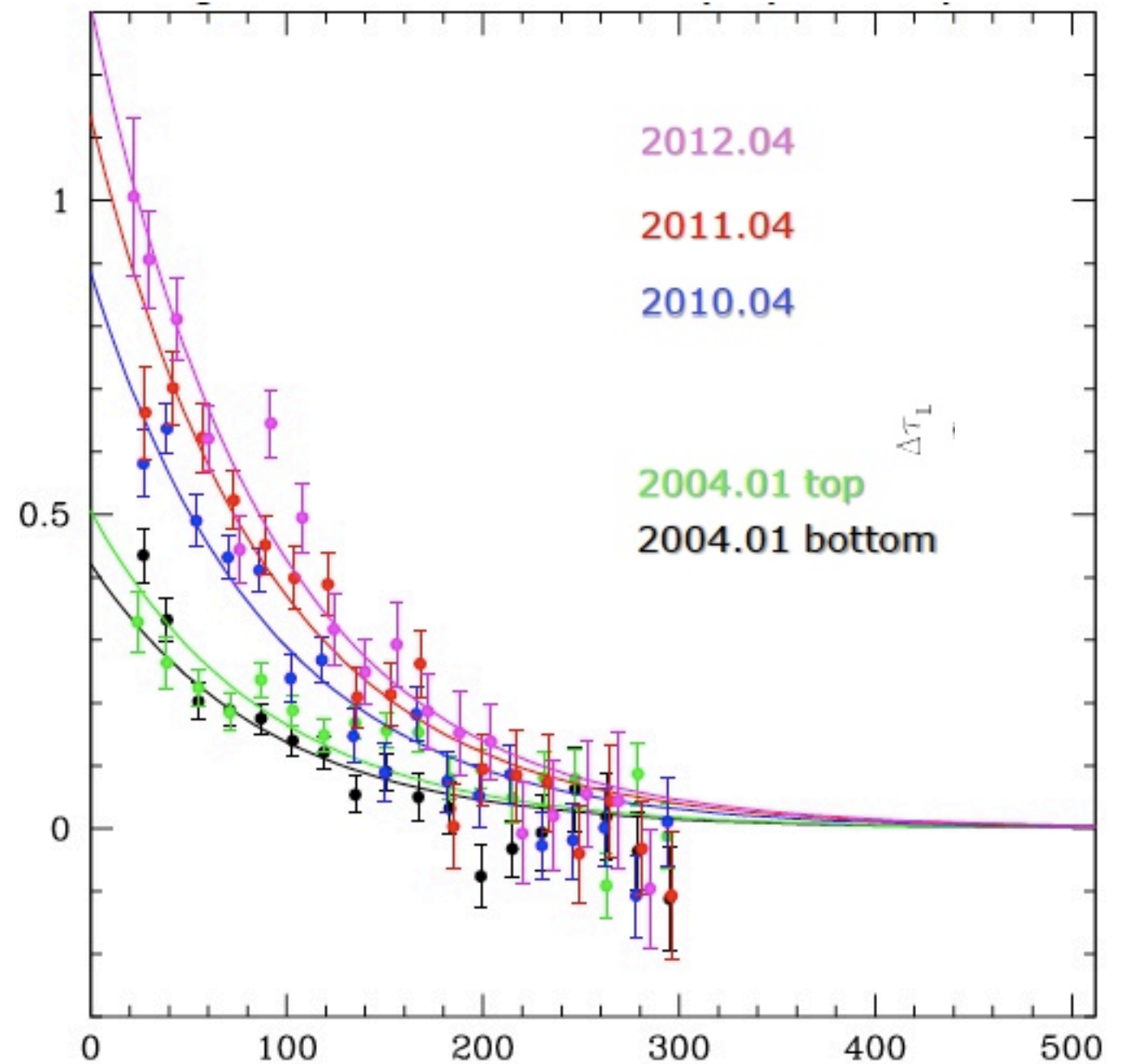
# Clusters replace ECS

- External Cal Source gives  $\tau(700 \text{ eV})$  using Mn-L/Mn-K
- ECS Mn-L is getting too faint
- Cluster spectral model is simple
- Problem:  $\tau$  at launch?



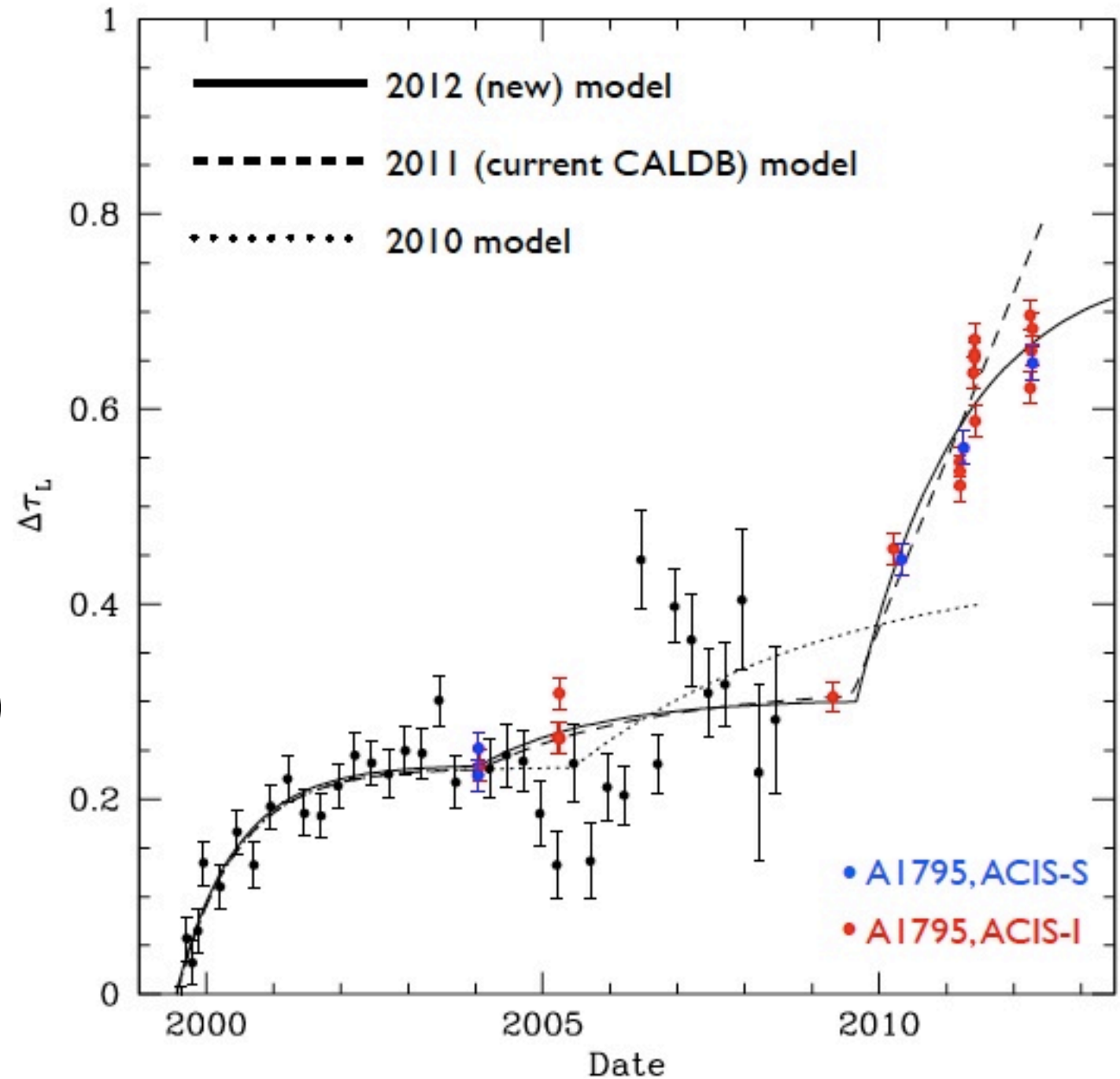
# Setting Spatial Model

- Again, ECS Mn-L is now too faint
- A1795 used at different positions
- Jump apparent in 2010
- ACIS-I and ACIS-S are similar



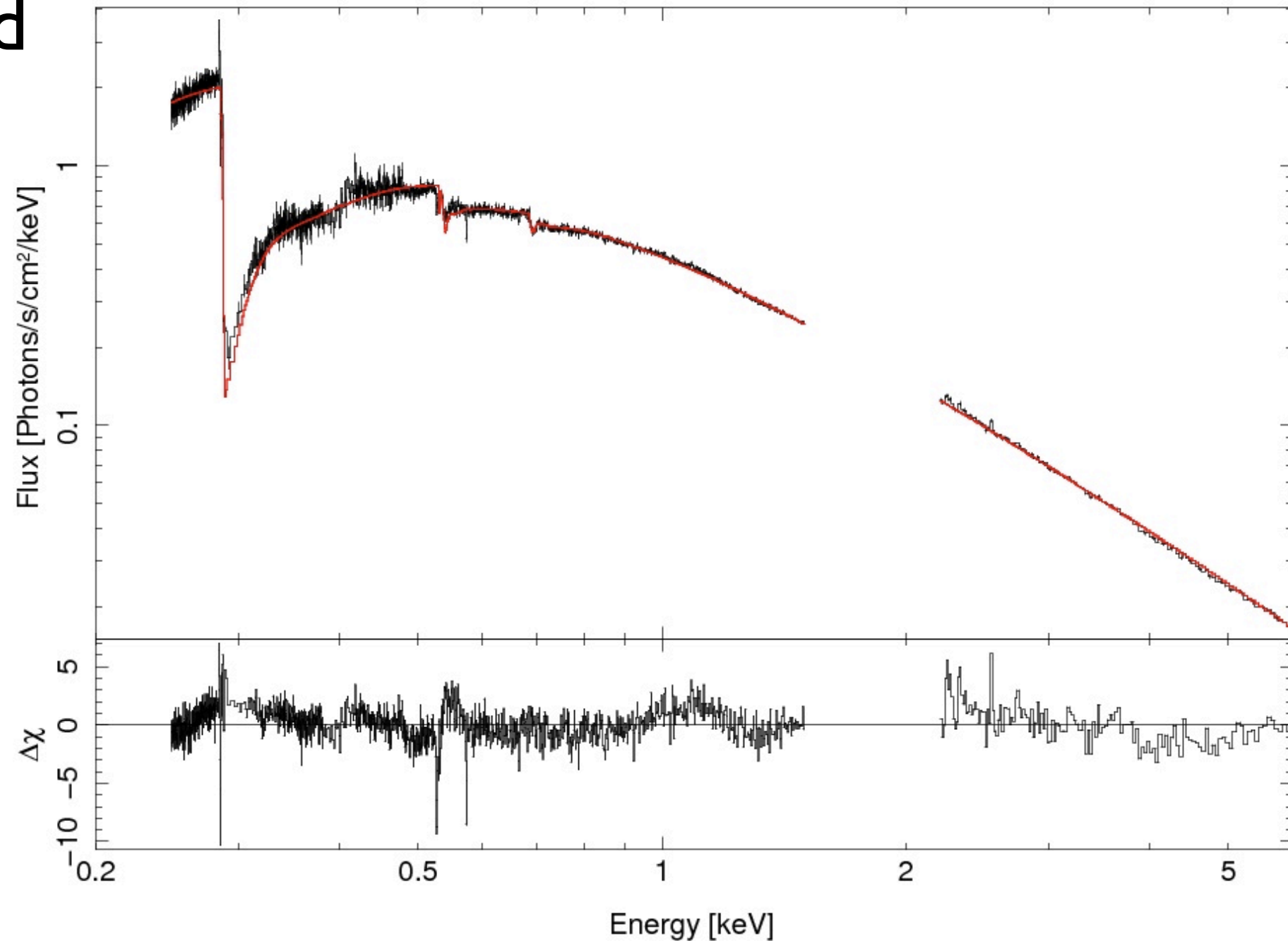
# Setting Spatial Model

- Again, ECS Mn-L is now too faint
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- Jump apparent in 2010
- ACIS-I and ACIS-S are similar



# Spectral Model

- LETG/ACIS used
- C, F, O edges observed
- Composition doesn't match on-board materials
- LETGS doesn't match ECS





# EXAFS & NEXAFS

Mk 421 LETGS TOO

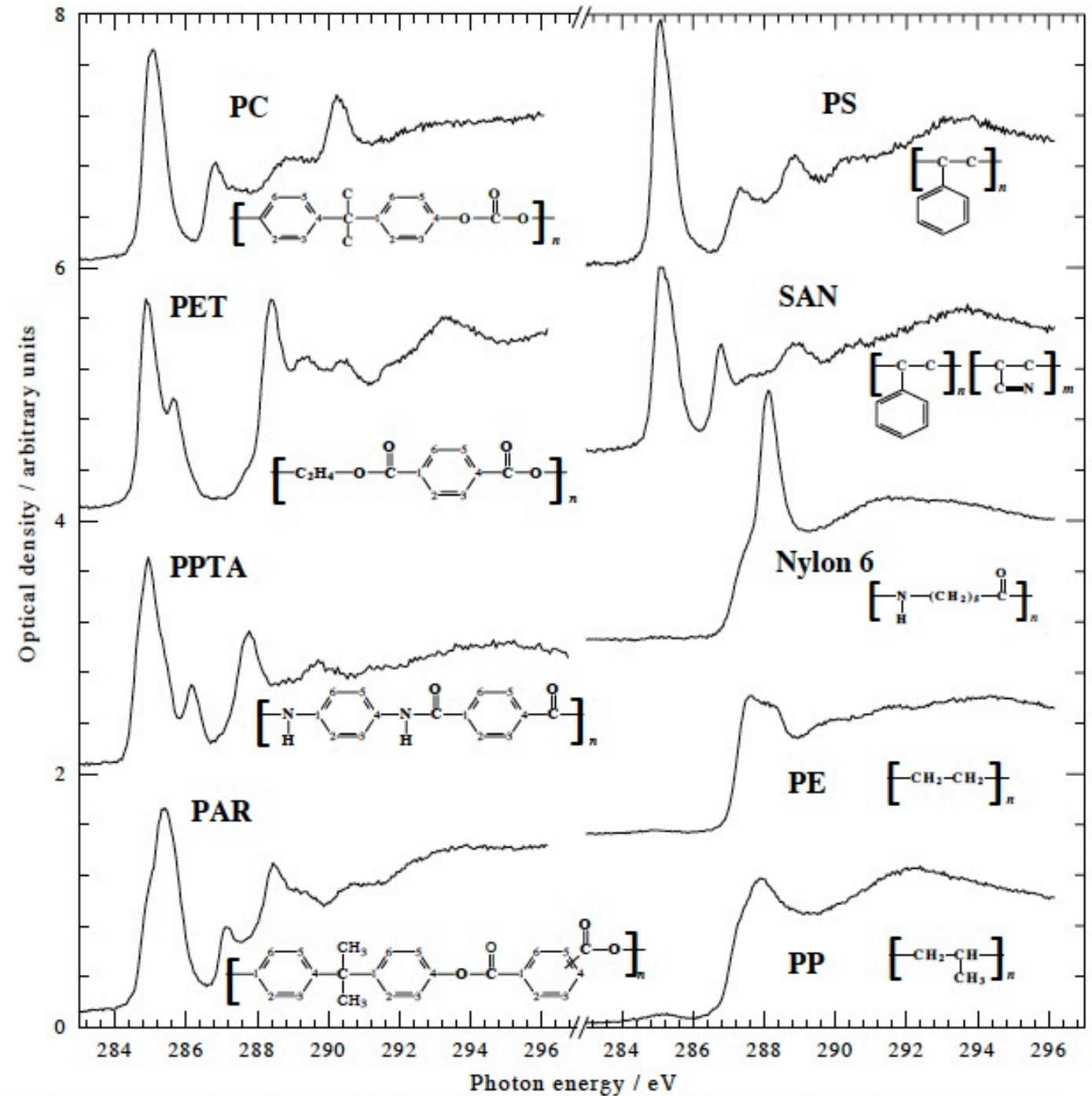
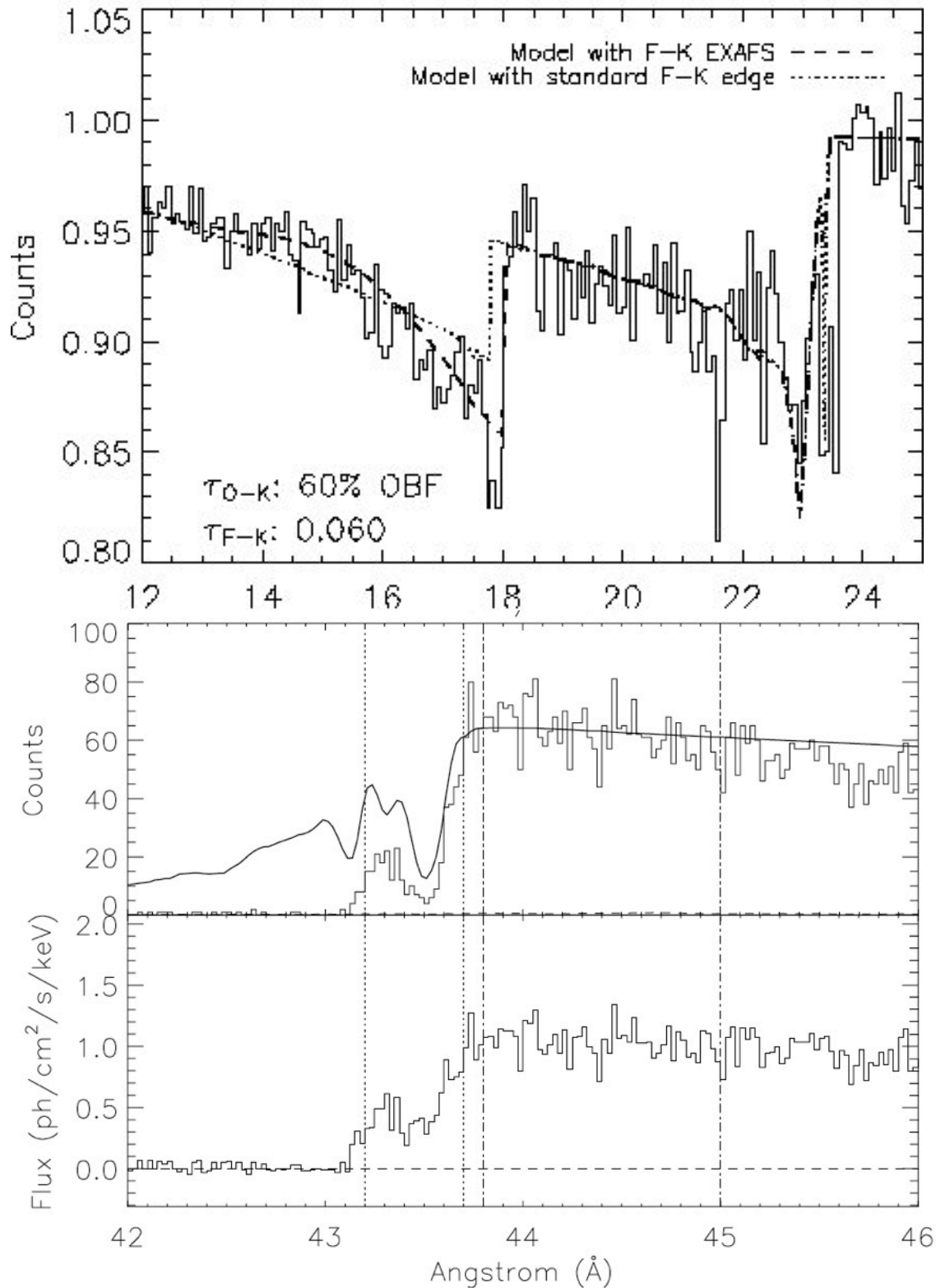
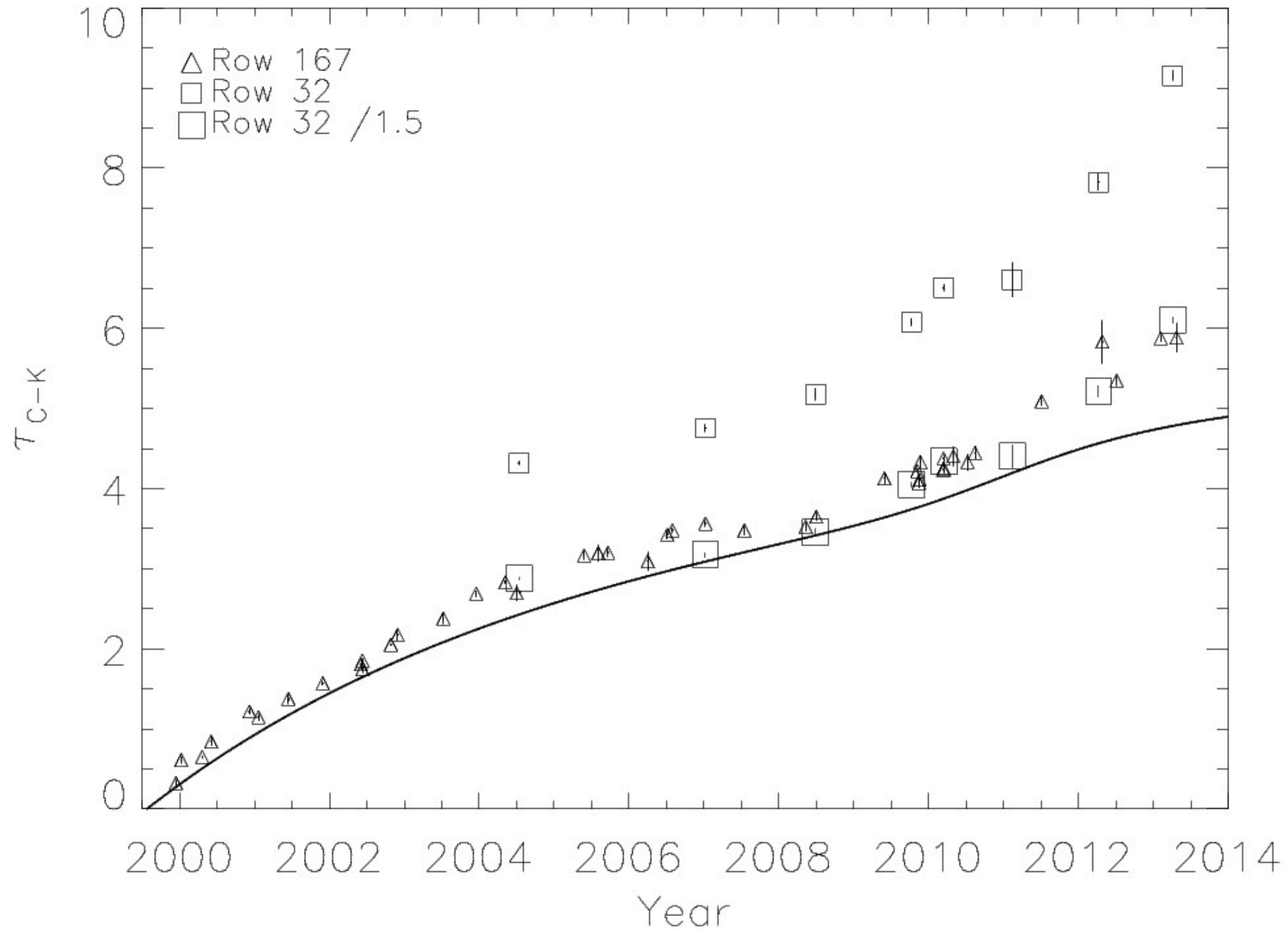


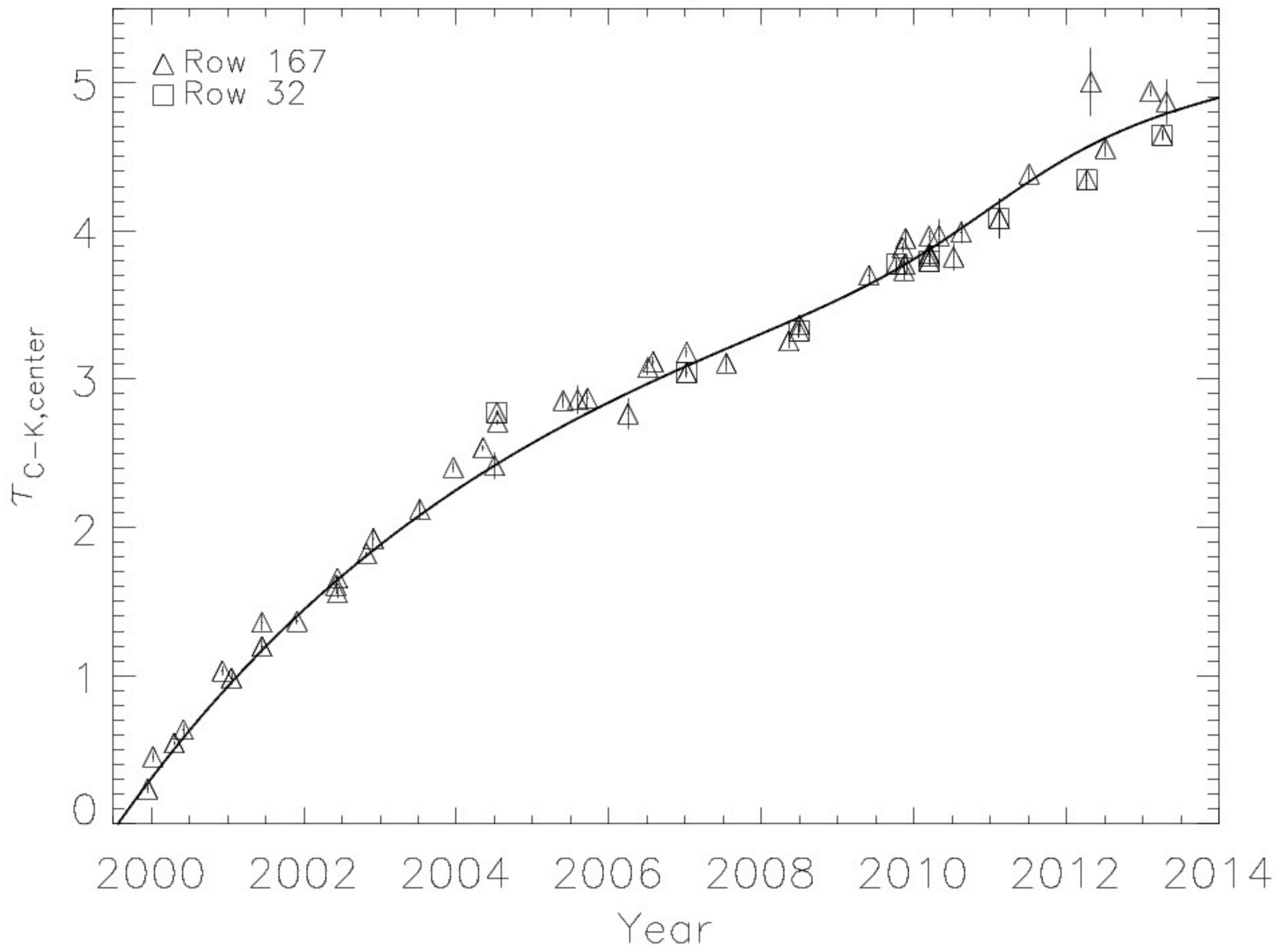
Fig. 3 C 1s NEXAFS spectra of some common polymers. Abbreviation as follows: PC, polycarbonate; PET, poly(ethylene terephthalate); PPTA, poly(p-phenylene terephthalamide); PAR, polyacrylate; PS, polystyrene; SAN, styrene-acrylonitrile; Nylon-6, poly( $\epsilon$ -caprolactam); PP, polypropylene; PE, polyethylene. (Figure adopted from [Ade 97])

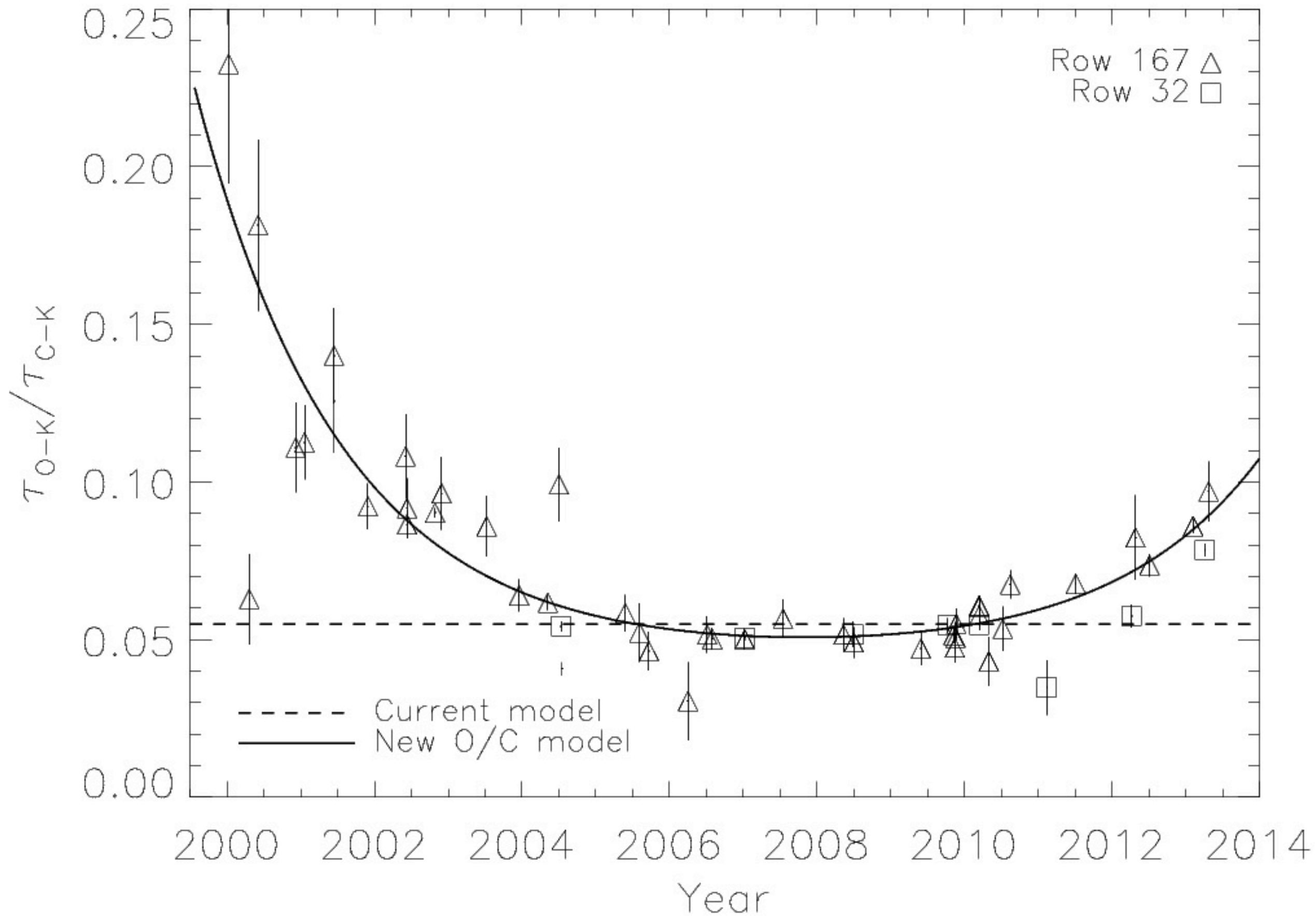
# LETG/ACIS Fit Results

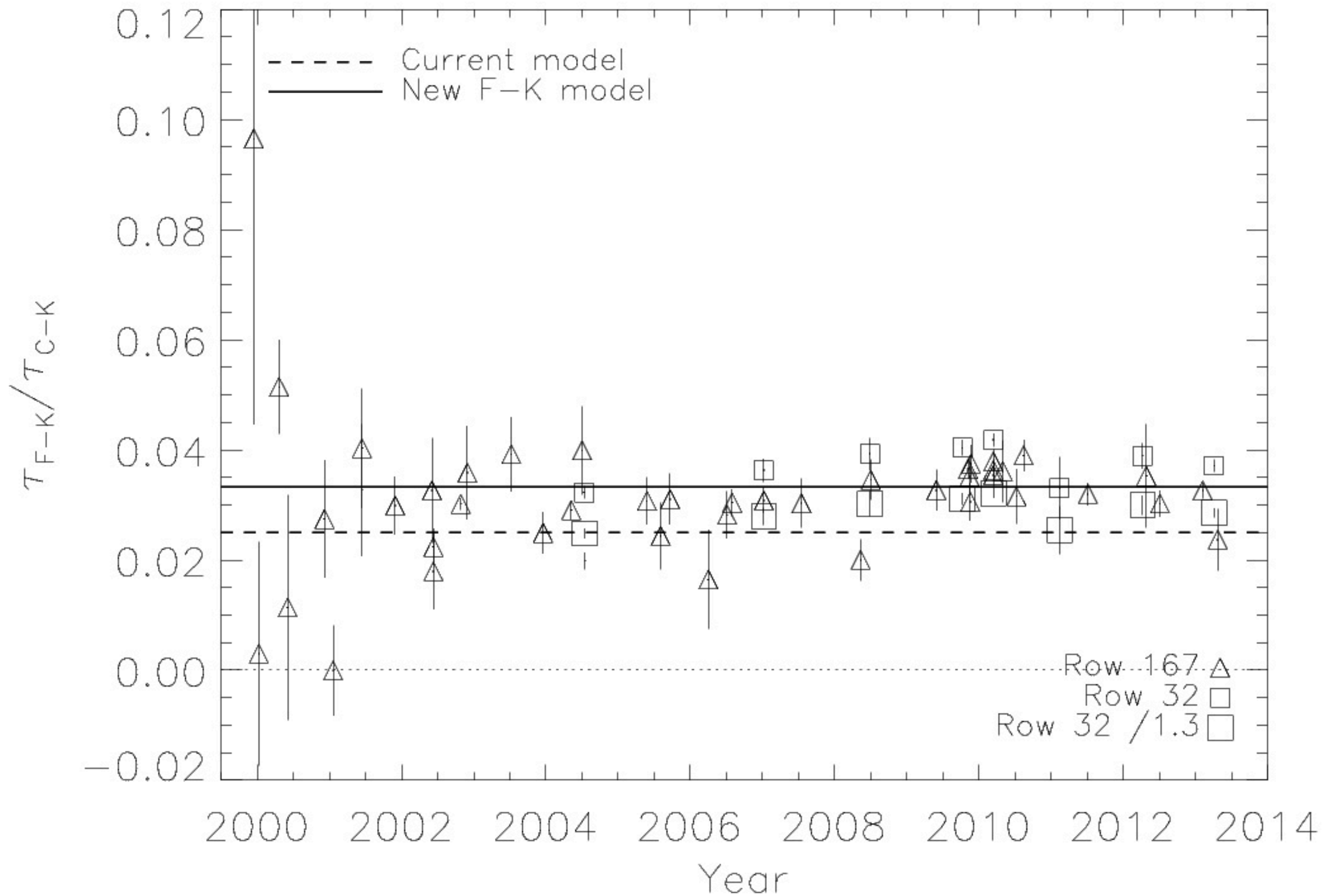


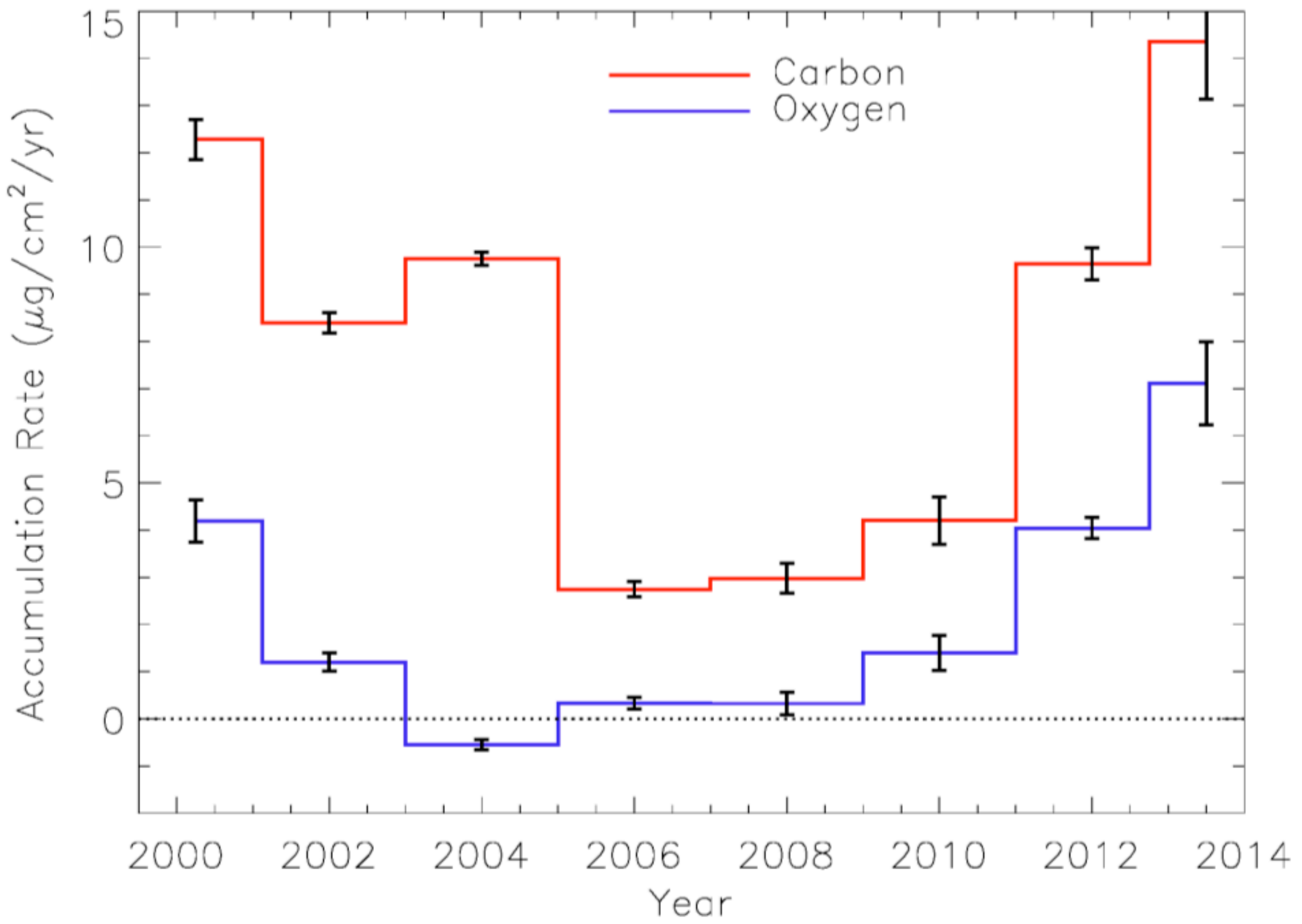


Corrected using 9942 factor



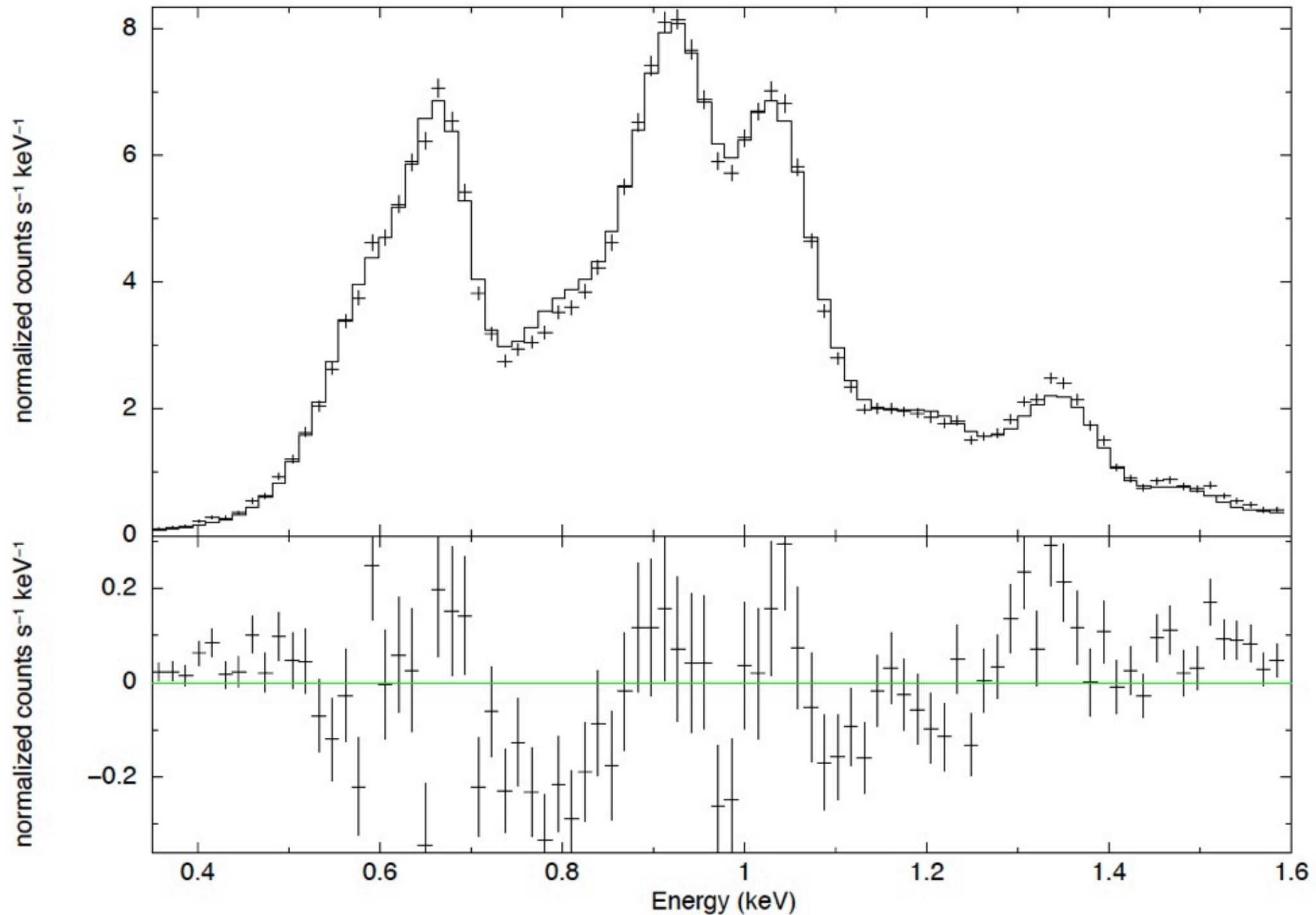






# Adding O-K Variation

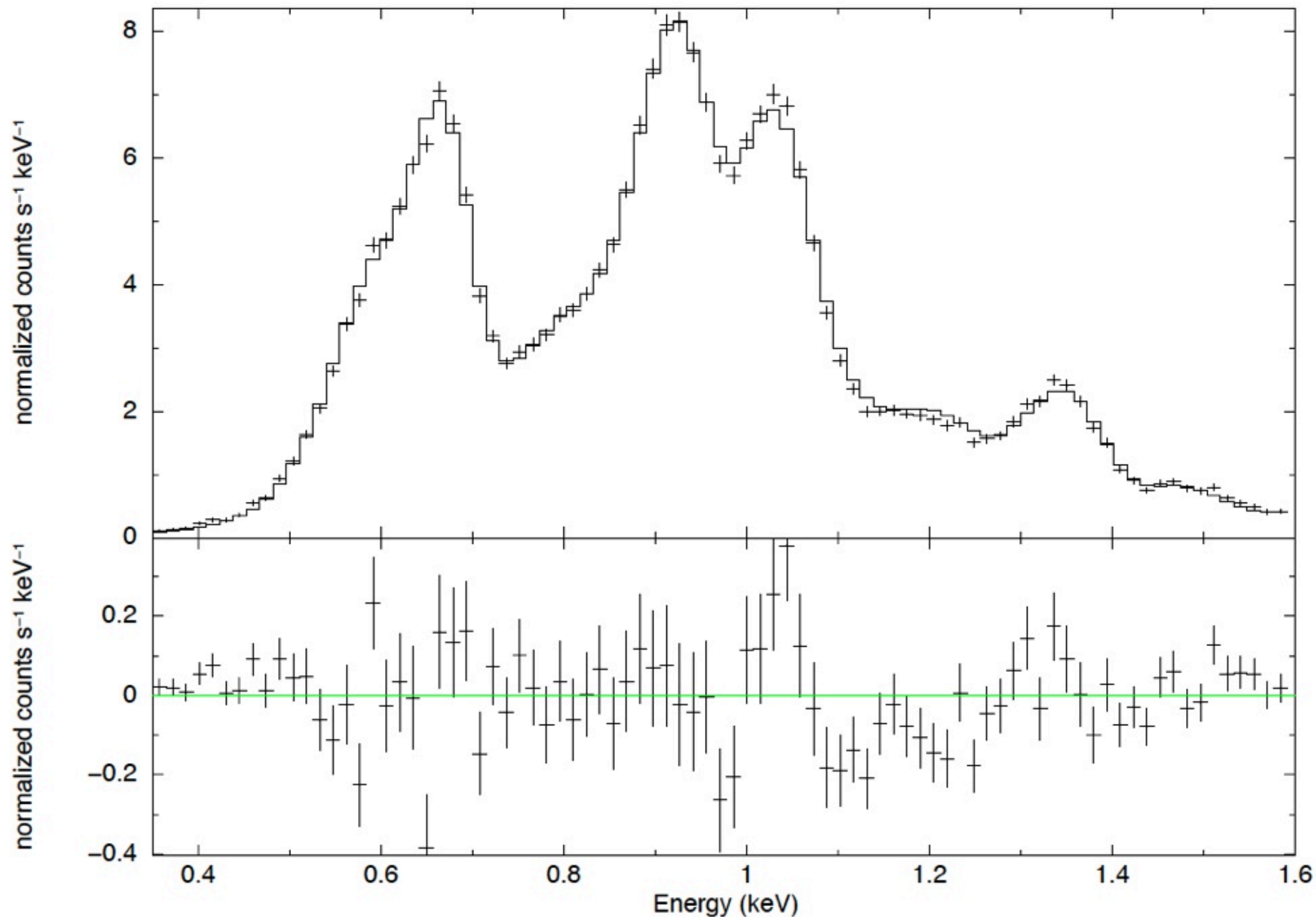
S3, ObsID 15559, C-stat=228.530, dof=80, Q-stat=235.2, reduced Q stat=2.94



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# Adding O-K Variation

IACHEC E0102 model + O-K edge  
S3, ObsID 15559, C-stat=148.554, dof=79, Q-stat=151.1, reduced Q stat=1.91

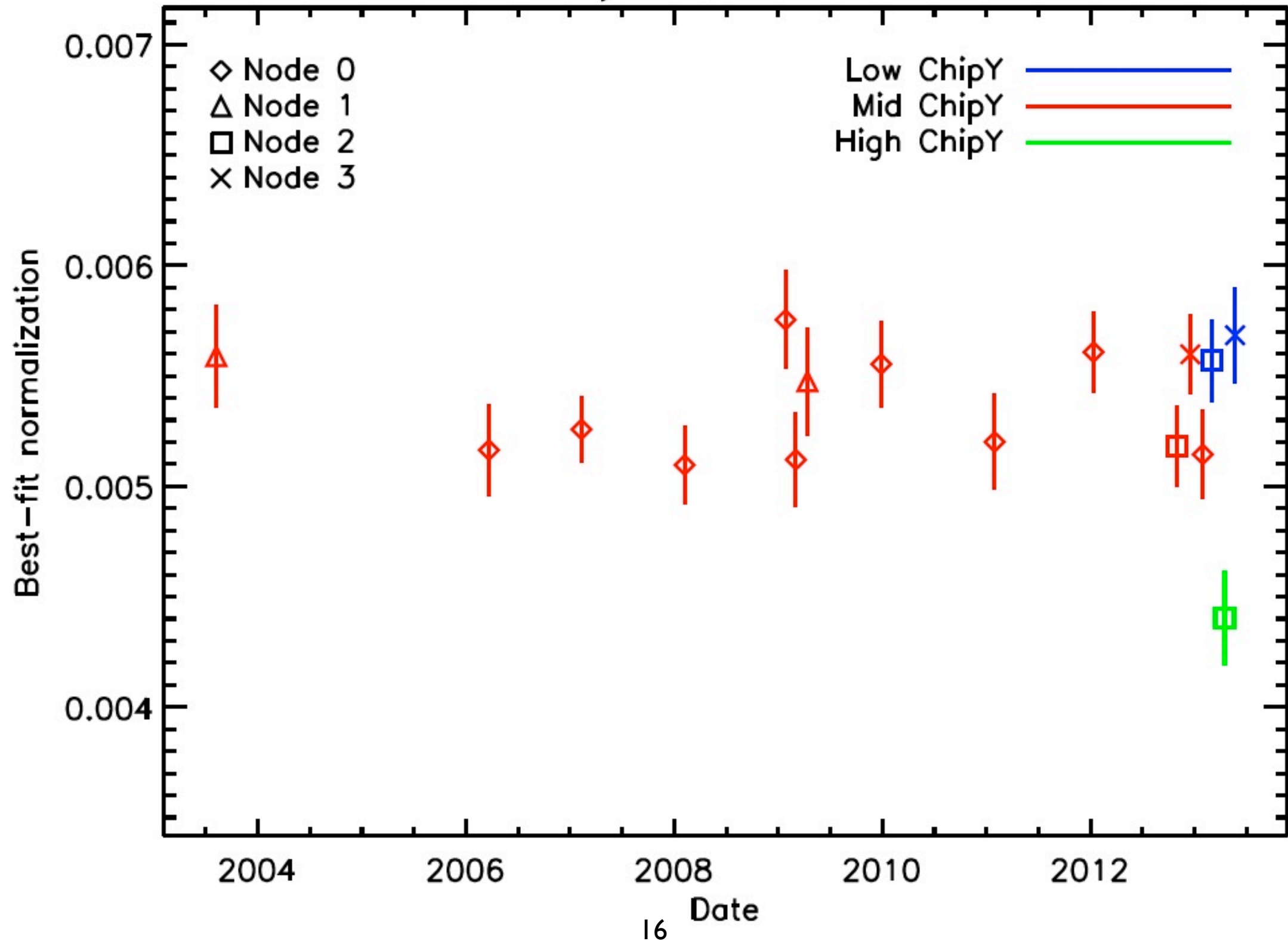


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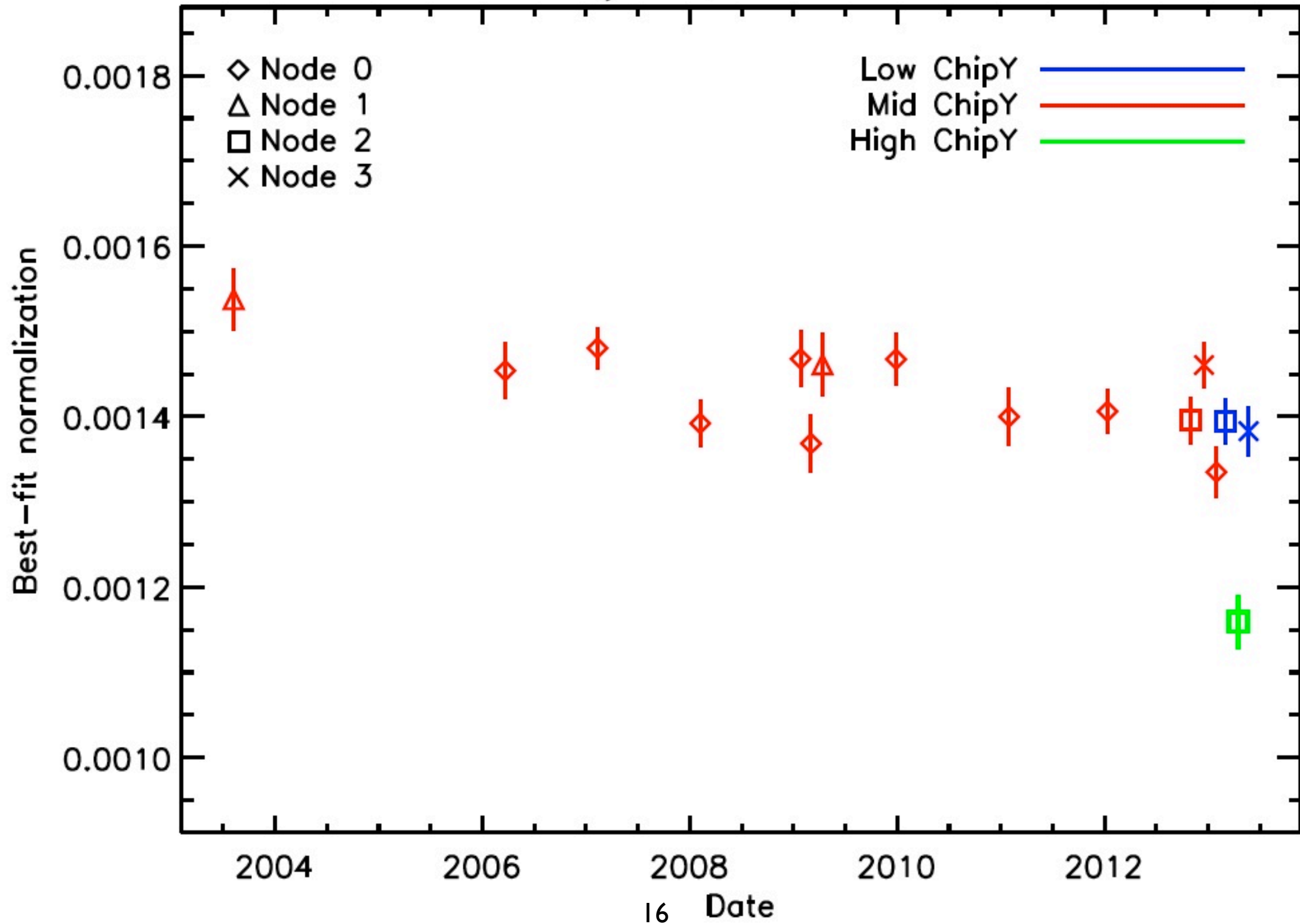
# Revised I E0 I 02 Fluxes

S3 subarray fits: 08 normalization



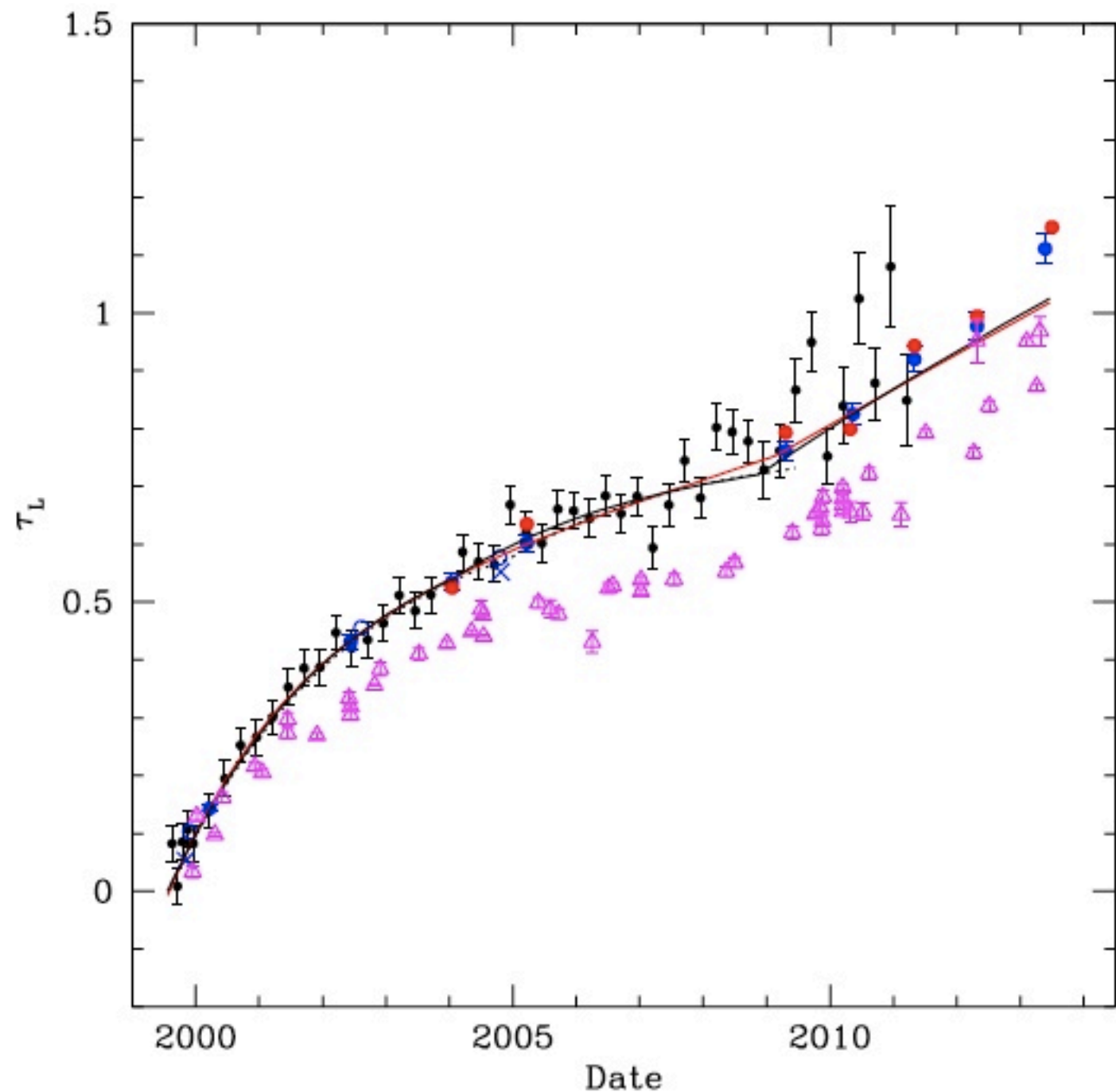
# Revised |E0|02 Fluxes

S3 subarray fits: Ne9 normalization



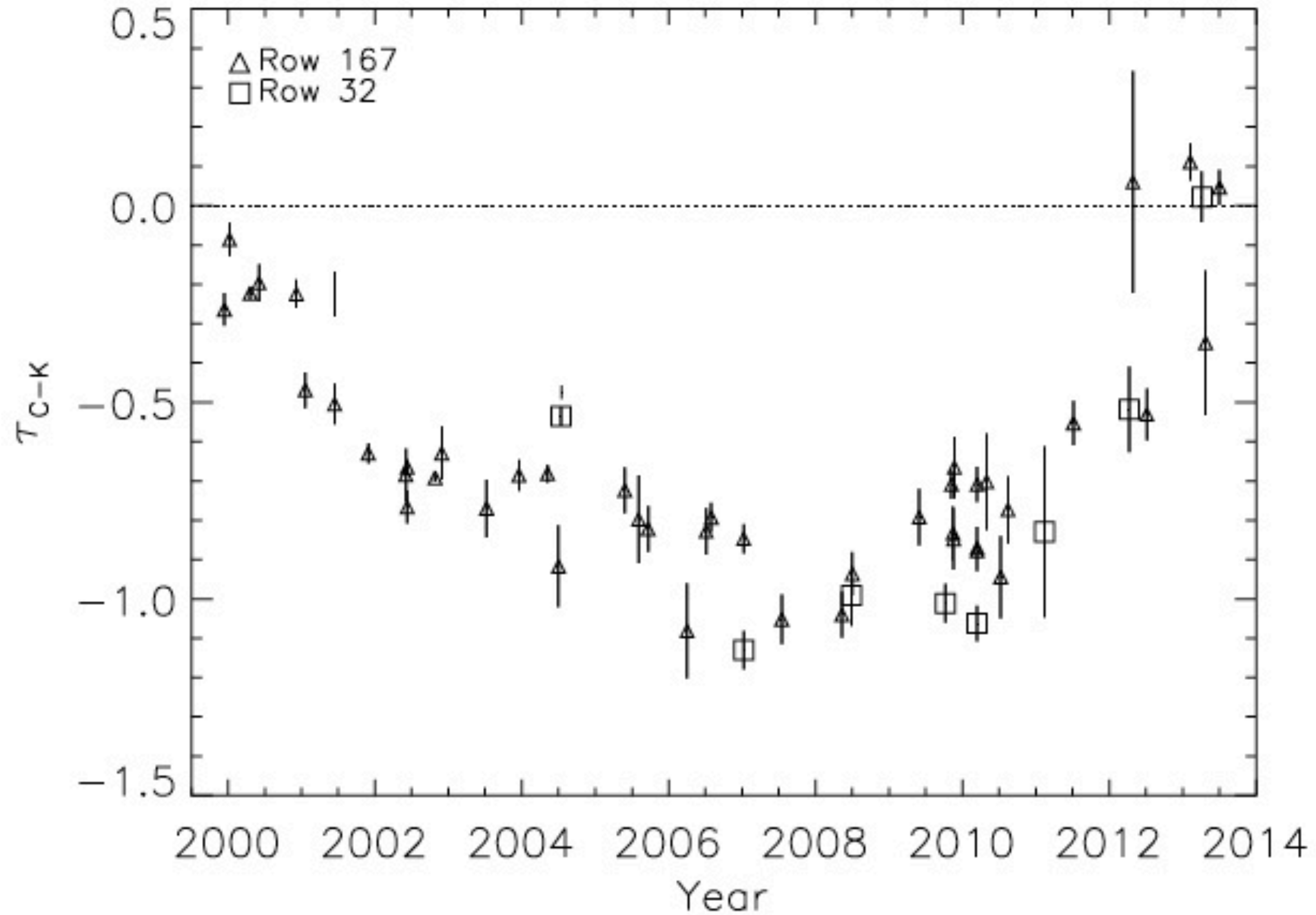
# LETG-ECS Problem

- Model fitting ECS and clusters doesn't fit LETGS (purple)
- Offsetting ECS doesn't fix problem entirely



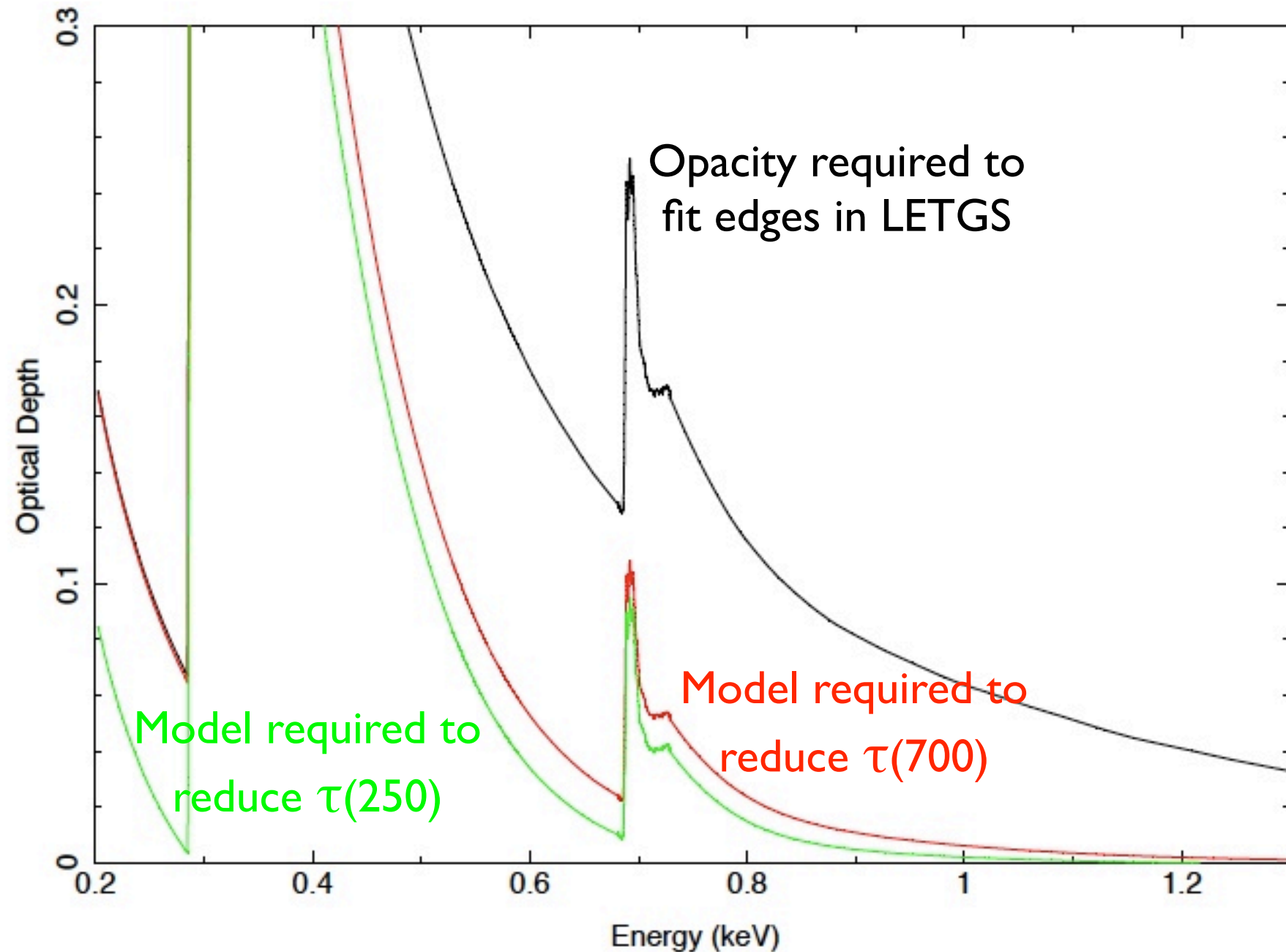
# Less C-K needed!

Fits using Model 9951

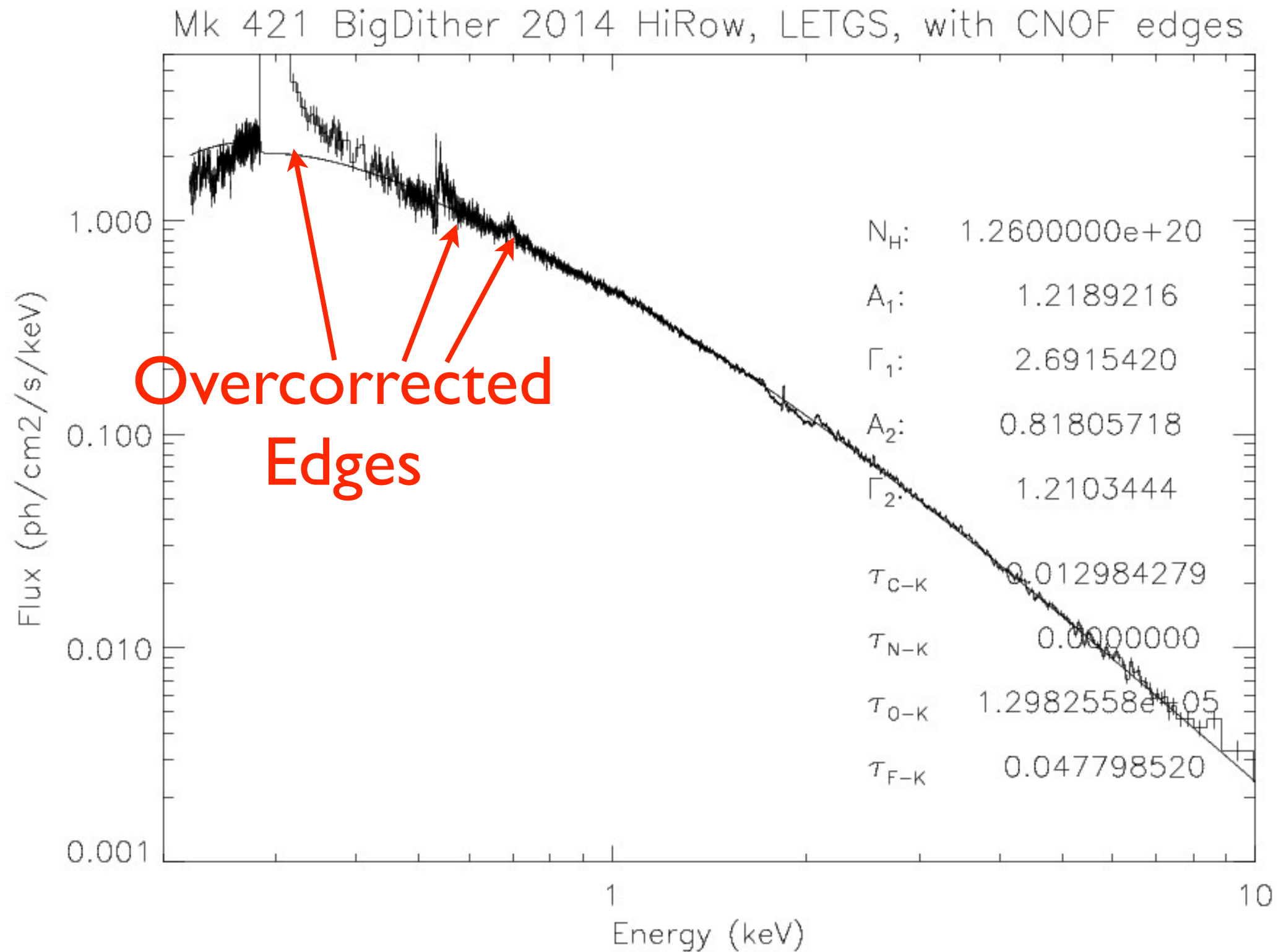


# Hack in Released Model

- Adjust edges of C-K, F-K to match LETGS
- Force  $\tau(700)$  to below 2%
- Component varies with time

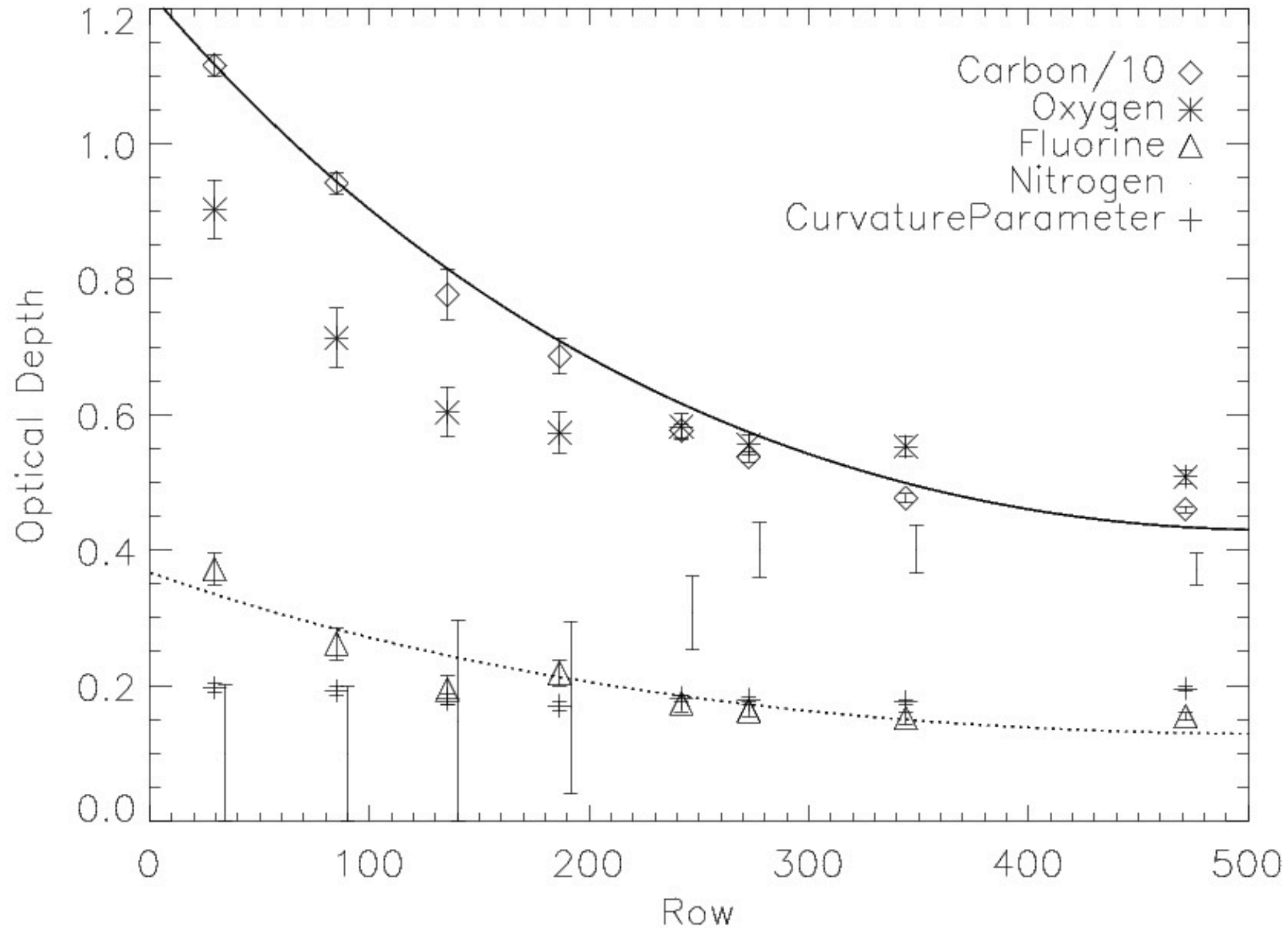


# Spectra fit now bad





# Big Dither!



# Contaminant Summary

- It's still growing: Why? Filter is colder?
- Spatial variations are time-dependent
  - CCD/housing temperature difference?
  - N and O don't match C and F
- Composition is time-dependent
  - Two components implicated, one is C-rich
  - ECS-LETGS disagreement unresolved
- Origin is unknown — not in original form
  - No on-board substance has CFO ratios
  - Radiation-induced organic fracturing?