

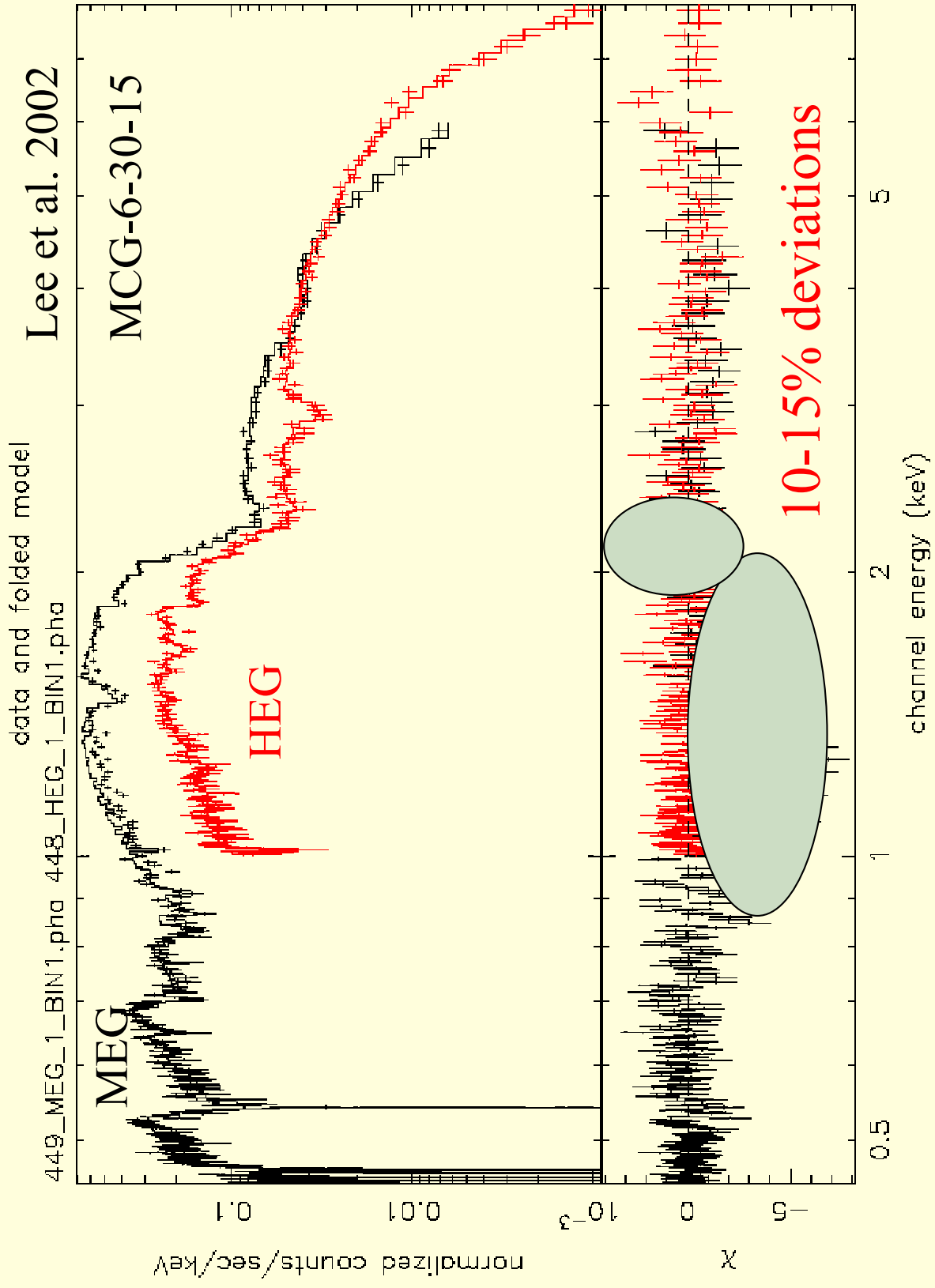


Updating the HETGS Effective Area

Herman L. Marshall
MIT CXC



Motivation for EA Adjustments





Components of Effective Area

- Define $C_\lambda = A_{\text{eff}} T Q n_\lambda \delta\lambda$
 - LRF wings are weak \rightarrow ignore the RMF
- HRMA Area (A)
 - Ir-M edge testable using continuum sources
 - Absolute area checked with cross-calibration
- Grating Efficiencies (ϵ)
 - Compare MEG against HEG using any source
- OBF (T) and Contaminant (c) Transmission
 - Test at edges (C-K, N-K, O-K, Si-K, Al-K)
- ACIS Quantum Efficiency (Q)
 - Test by comparing chips in +1 order to those in -1
 - Require $Q < 1$



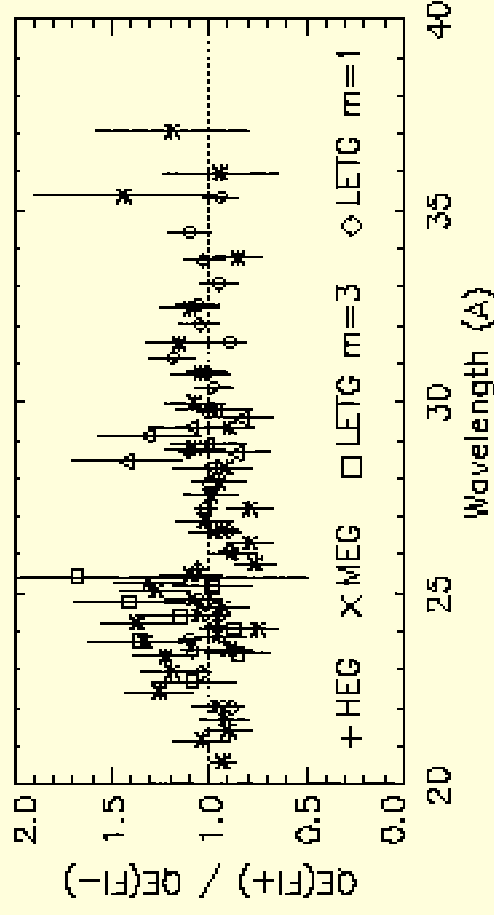
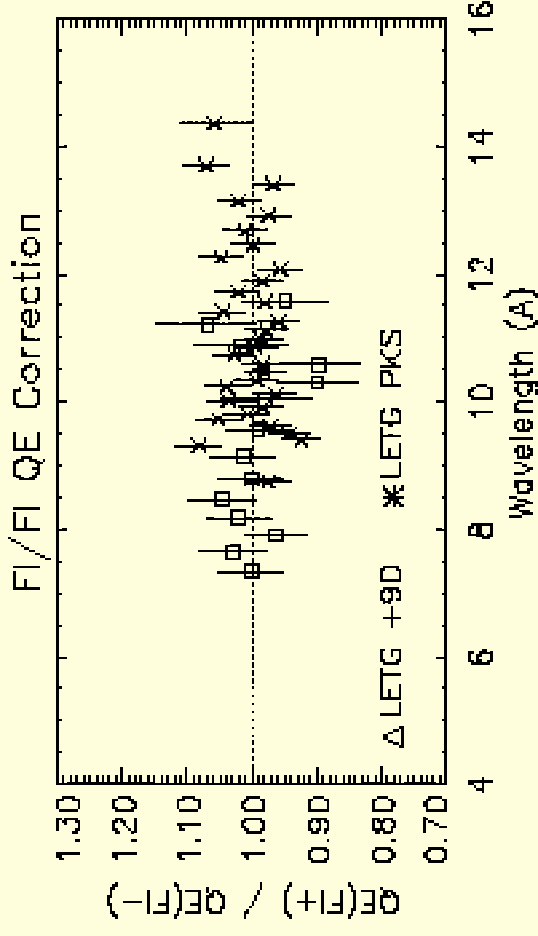
Method for Adjusting ACIS QEs

- Define EA via $C_i^+ = n_i A_{\text{tec}} T Q^+ \delta\lambda$
 - $[\lambda, \lambda + \delta\lambda]$ is the wavelength interval
 - Q^+ is the (pileup corrected) ACIS QE on +1 side
 - n_i is the flux of source i at λ (in $\text{ph}/\text{cm}^2/\text{s}/\text{\AA}$)
 - C_i^+ gives the counts in the bin
 - t is the exposure time
 - ε is the grating efficiency, which has no +/- asymmetry
- Form ratios independent of all but Q
 - $r_i = C_i^+ / C_i^- = Q^+ / Q^-$
 - Sum over source: $R = \Sigma_i C_i^+ / \Sigma_i C_i^-$ (bias, variance better than $\Sigma_i r_i$)
 - Sum over short wavelength intervals
- When $R \neq 1$, then adjust Q^+ or Q^-
 - No absolute reference yet
 - I currently correct FI chips (see later)
- See: http://space.mit.edu/ASC/calib/letg_acis/letg_acis_cal.ps.gz



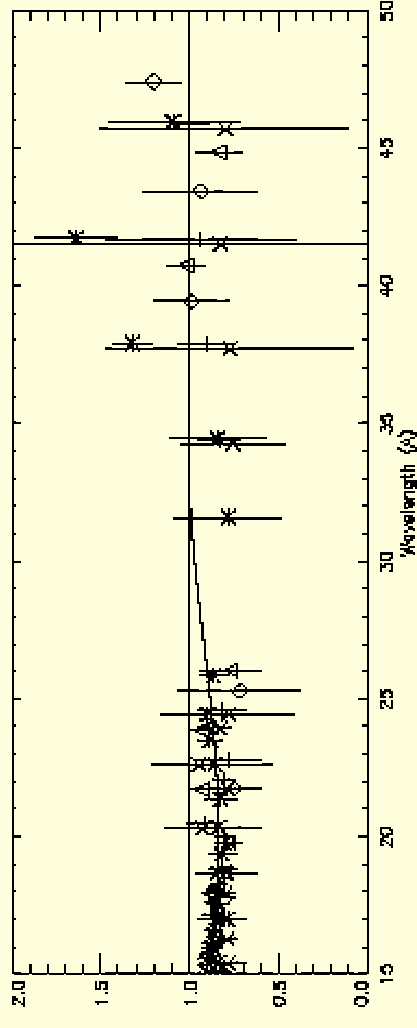
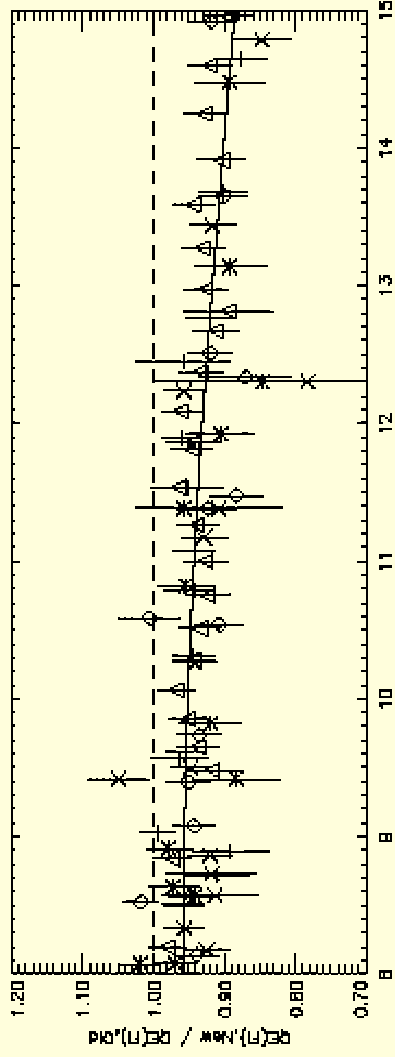
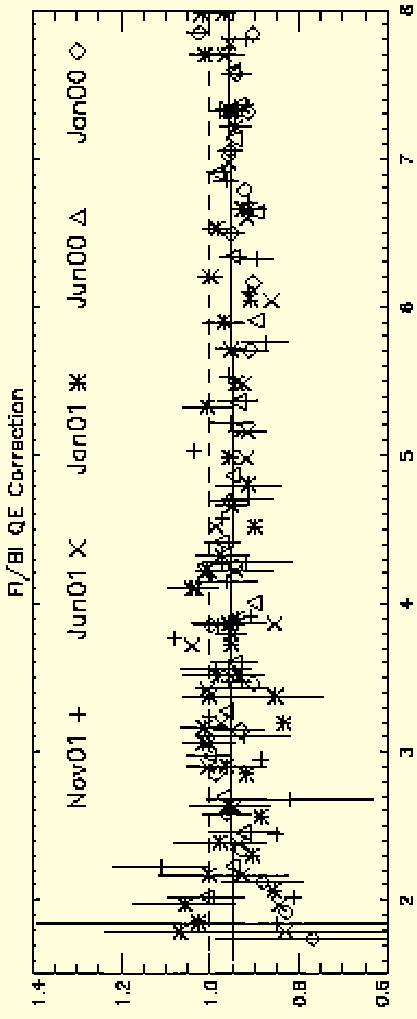
FIs Have Good Relative QEs

- Compare +1 to -1 when both are FI chips
- R is consistent with 1
- Pileup is no concern
- CTI-induced QE variations minor for these offsets, energies





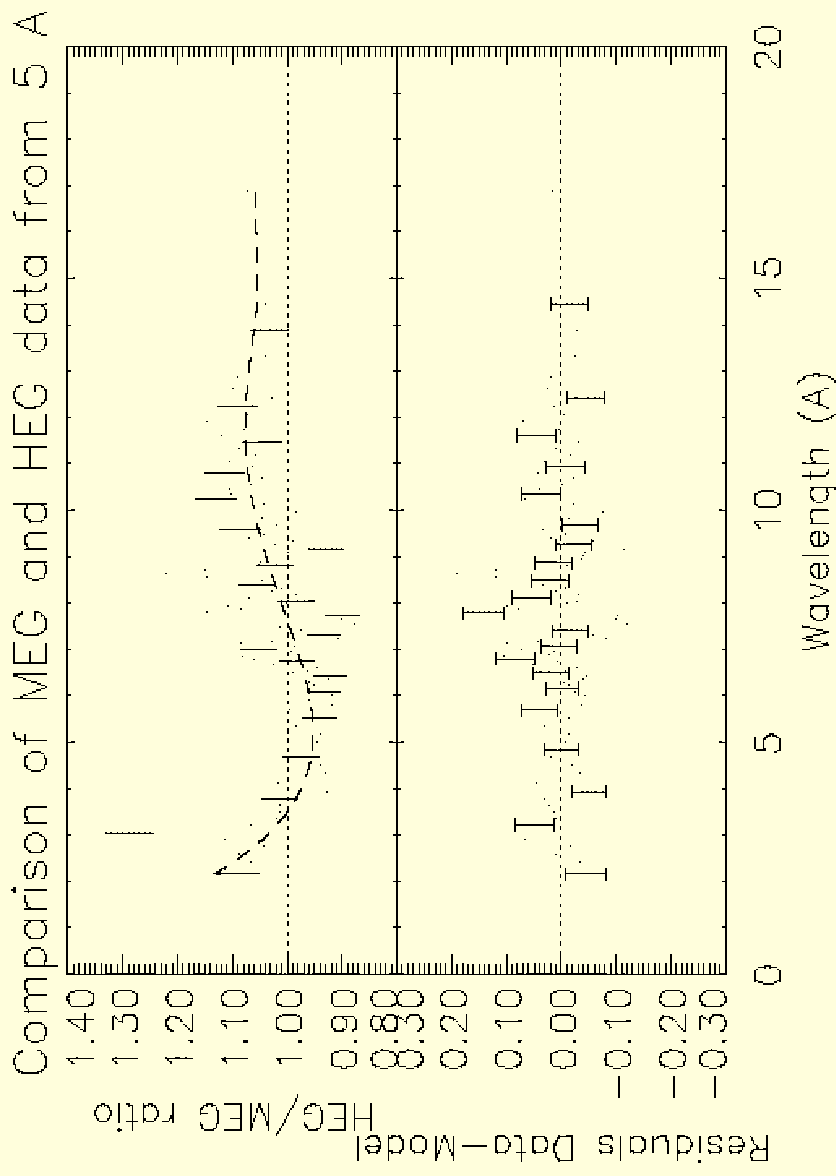
- Compare BI to FI
- 8-20% differences found
- Corrected BI QE is 99-101% in 0.7-1.5 keV range \rightarrow fix FI QEs as a group
- Obtain correction in ascii file at:
<http://space.mit.edu/ASC/calib/ficorr.txt>





Comparing MEG to HEG

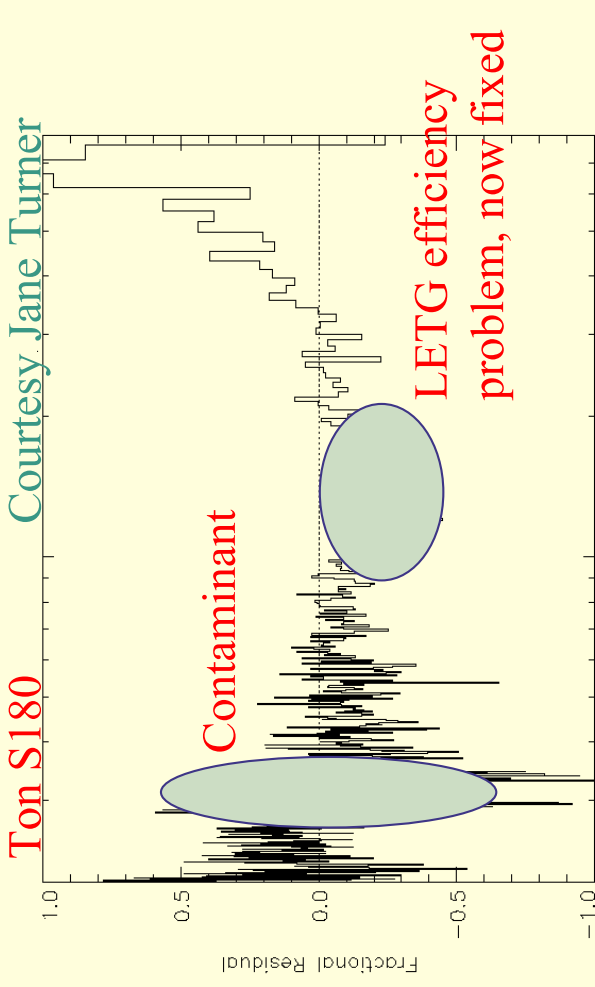
- Before efficiency update, analysis gave 5-8% differences
- Result needs to be updated and released
- MCG data already corrected for BI/Fl, implicates MEG
- See POG fig. 8.26





OBF and Contaminant Edges

- Observations of AGN with ACIS/LETG led to discovery of contaminant C-K edge
- Early repair was a one-time fix, good for observations in early 2000
- Later observations showed systematic edge deepening
- Depth now up to x10, still no sign of N-K

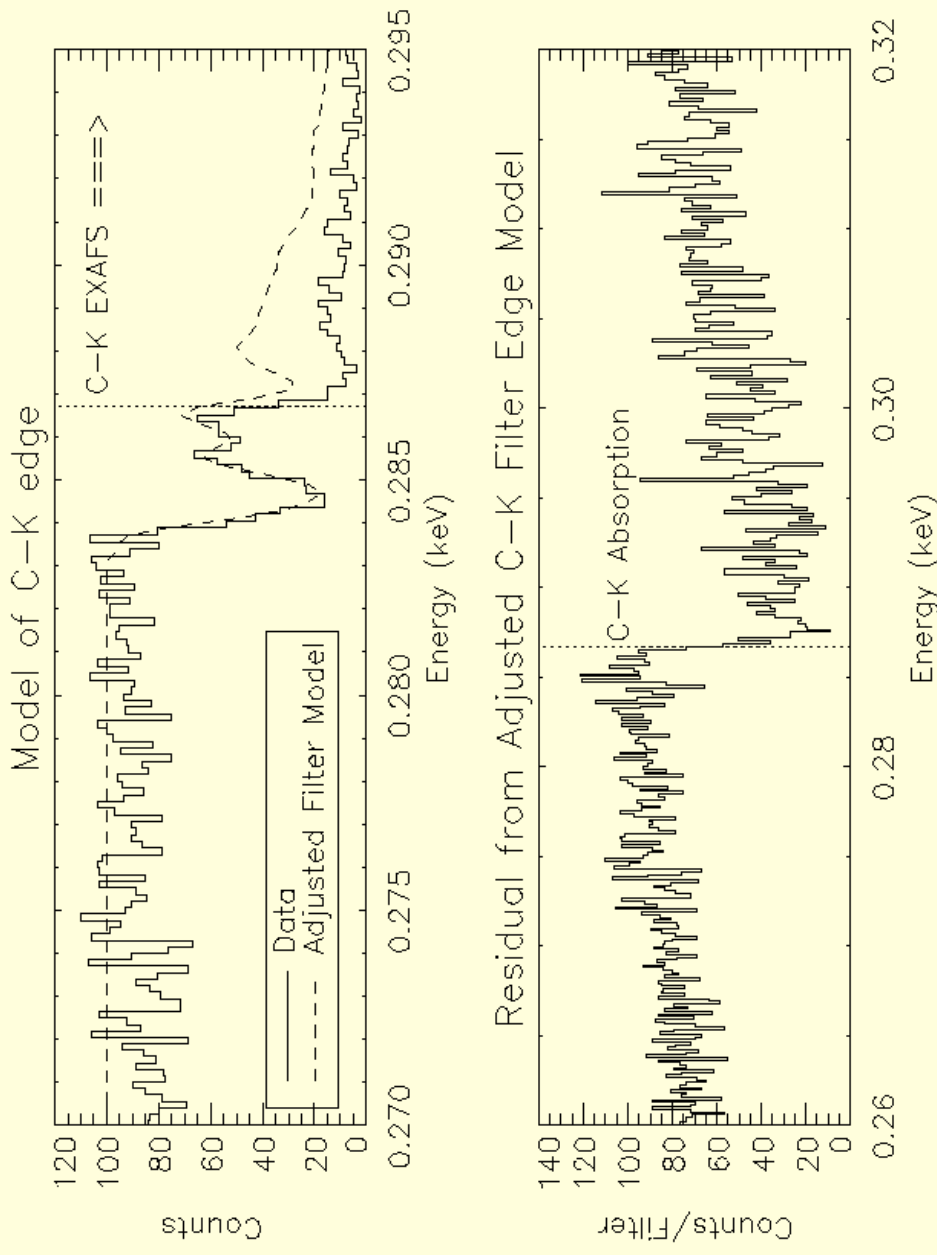


- Count spectrum from XTE J1118+480
- Filter dominates below .2867 keV, contaminant above



Motivation for C-K Edge Analyses

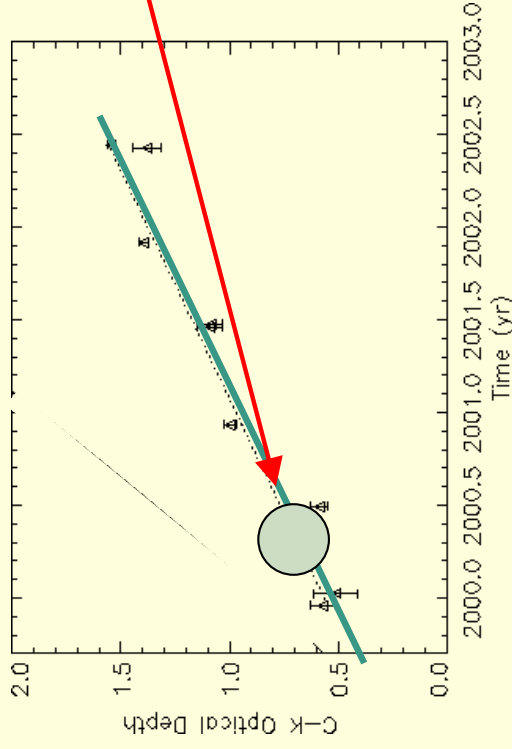
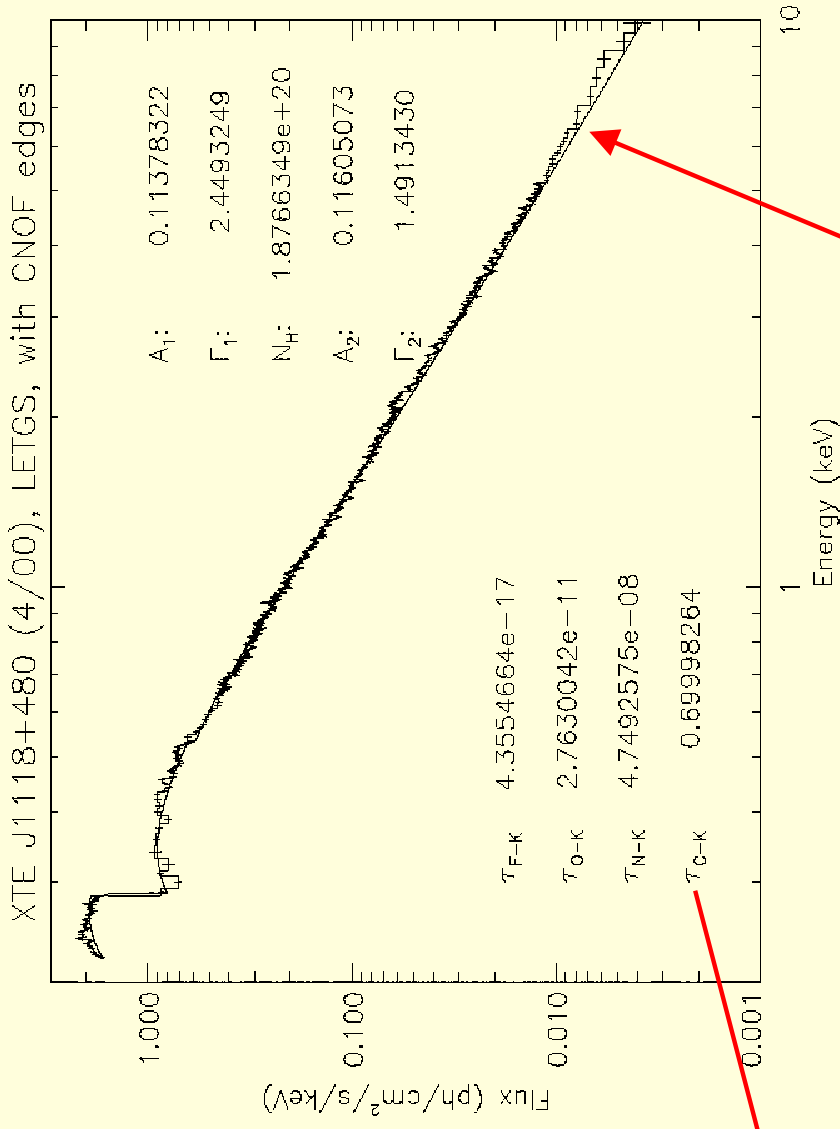
- Current composition shows little N, F and possible O from K edges
- Large optical depth at C-K shows NEXAFS in many compounds
- NEXAFS shape is related to bonding within compound





LETG/ACIS Spectral Fits

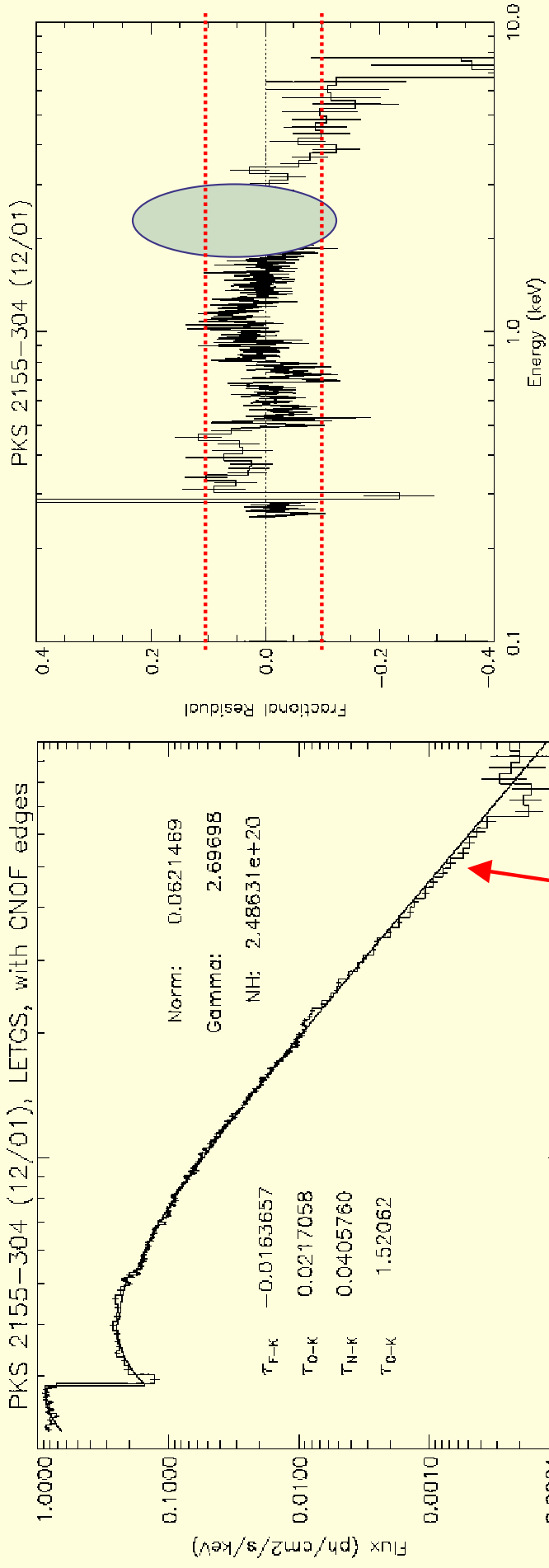
- Nine continuum sources: 2PL fits
- C-K edge depth measured for all



Spectrum curves upward —
suspected to result from broad Fe-K



LETG/ACIS Fit Residuals



• Systematic relative errors down to $\pm 10\%$

• Ir-M edge appears

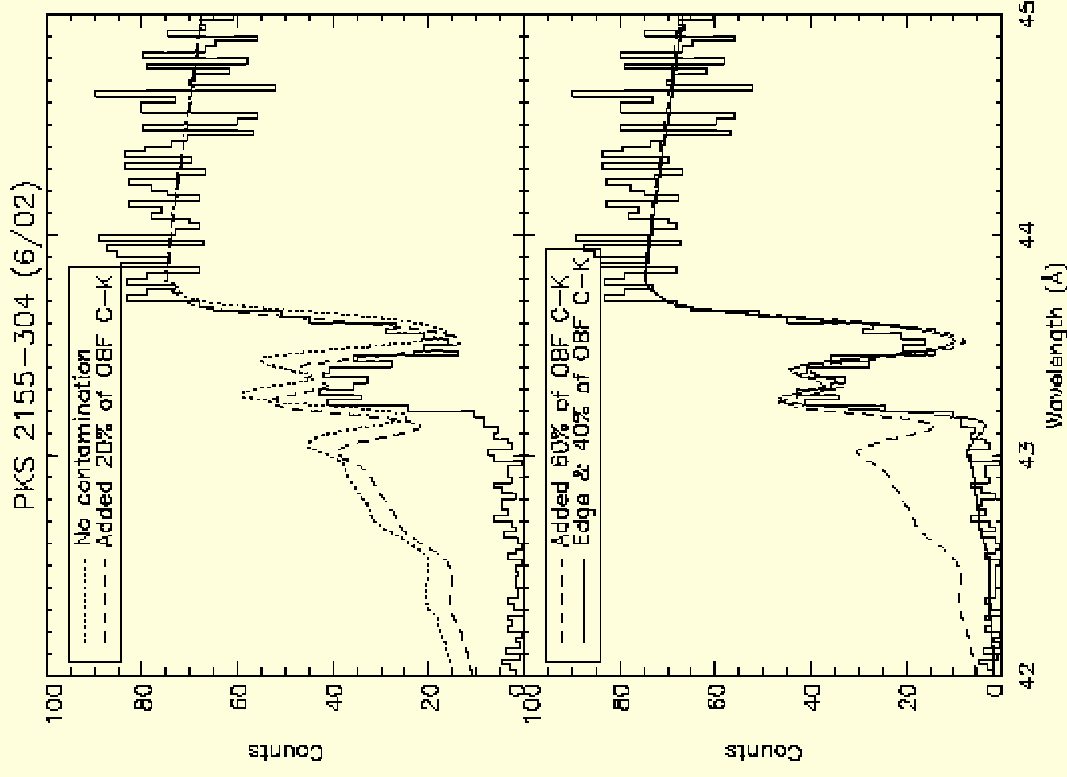
Spectrum curves downward

Refits use 2PL model



C-K Edge in Recent PKS 2155-304 data

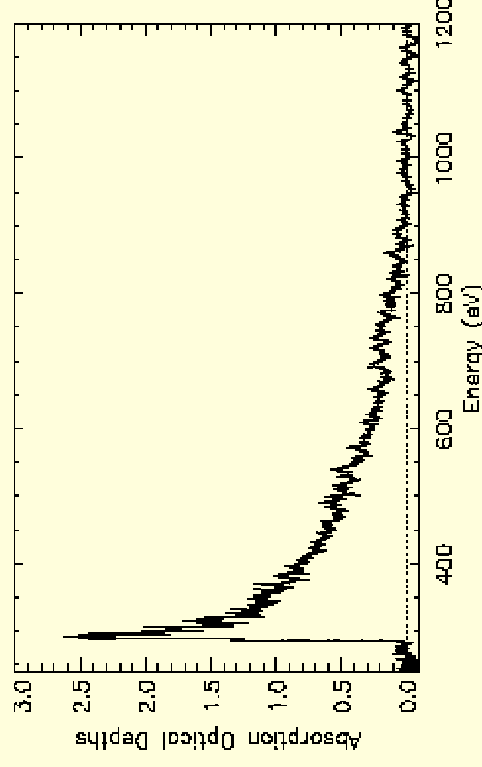
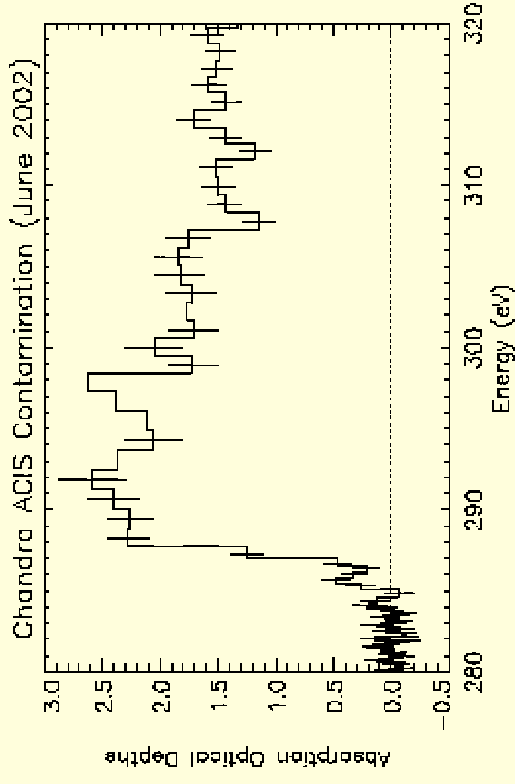
- Edge now shows deviation in resonance structure
- Additional component is not like C in OBF
 - Matching at 43.3 Å gives problem at 43.5 Å
 - Contaminant has no resonant feature at 43.5 Å





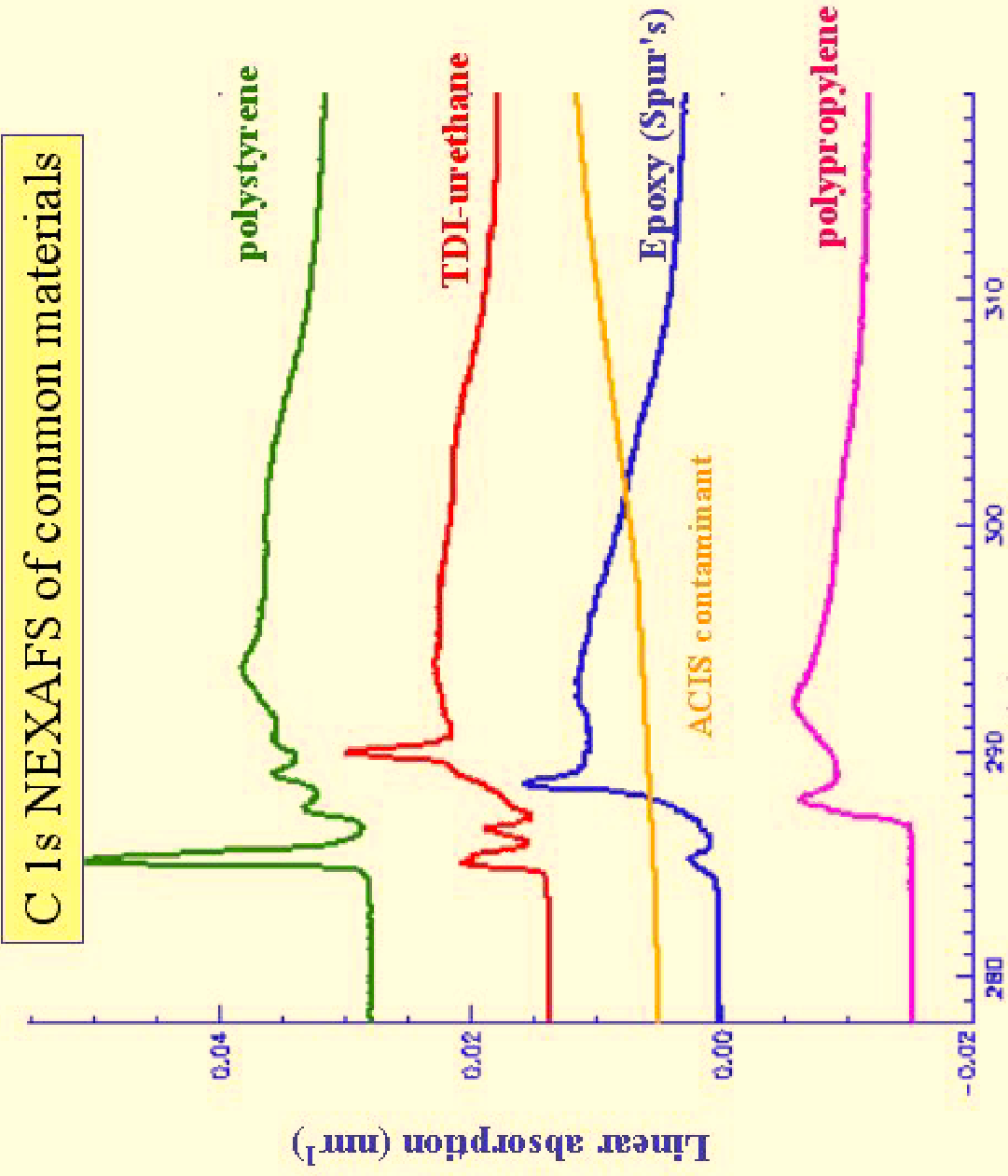
C-K Edge in Recent PKS 2155-304 data (cont'd)

- 1-2% uncertainties obtained at high spectral resolution
 - More detail now appears at C-K
 - Model will be released after testing
- Slight edge at O-K
 - Low abundance of O relative to C
- N-K is practically absent
 - N-K was on both BI chips where QE is high and has no N-K edge; OBF is OK
 - Observations on FI chips show possible modeling error
- F-K edge, if present, is not simple





Data from Adam Hitchcock (McMaster U.)

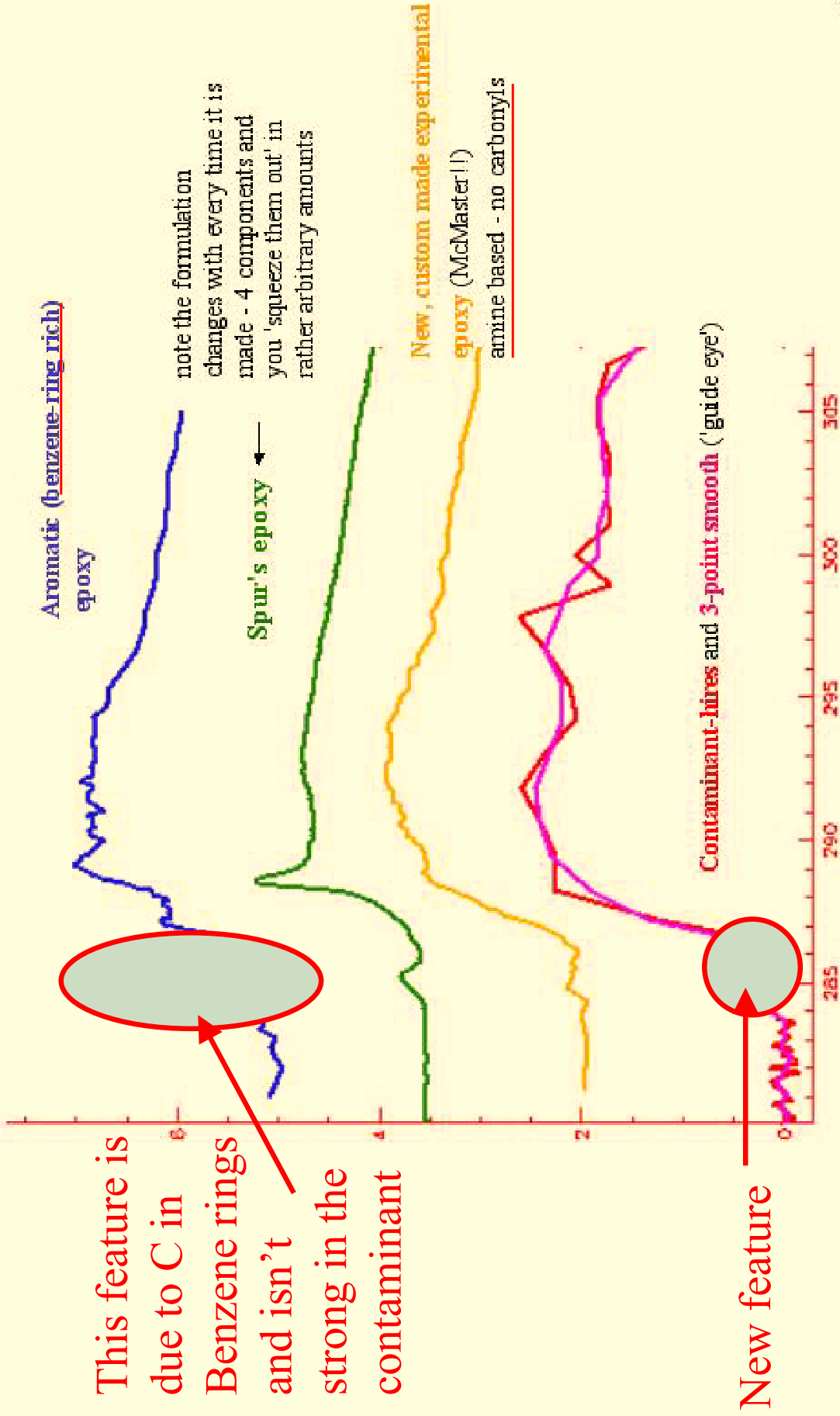


Without higher resolution / sampled spectra, it will be very difficult to say more than already deduced



Data from Adam Hitchcock (McMaster U.)

Comparison of 3 different epoxies to high resolution ACIS data





Summary of HETGS EA Studies

- HRMA Area (A)
 - Ir-M edge : 10-15% deviation over 2.1-2.5 keV region
- Grating Efficiencies (ϵ)
 - MEG efficiencies require 5-10% adjustments
 - Next item to be released (12/02)
- OBF (T) and Contaminant (c) Transmission
 - OBF is fine at C-K, N-K; other edges in progress
 - Contaminant being characterized at C-K, O-K, no N-K
- ACIS Quantum Efficiency (Q)
 - FI chips appear to require 10-20% adjustments, see: <http://space.mit.edu/ASC/calib/ficorr.txt>
 - In progress: 10-15% off at N-K, narrow spike at Si-K
- Absolute EA: $\pm 10\%$ cross-check with ASCA
- More work in progress cross-calibrating with XMM