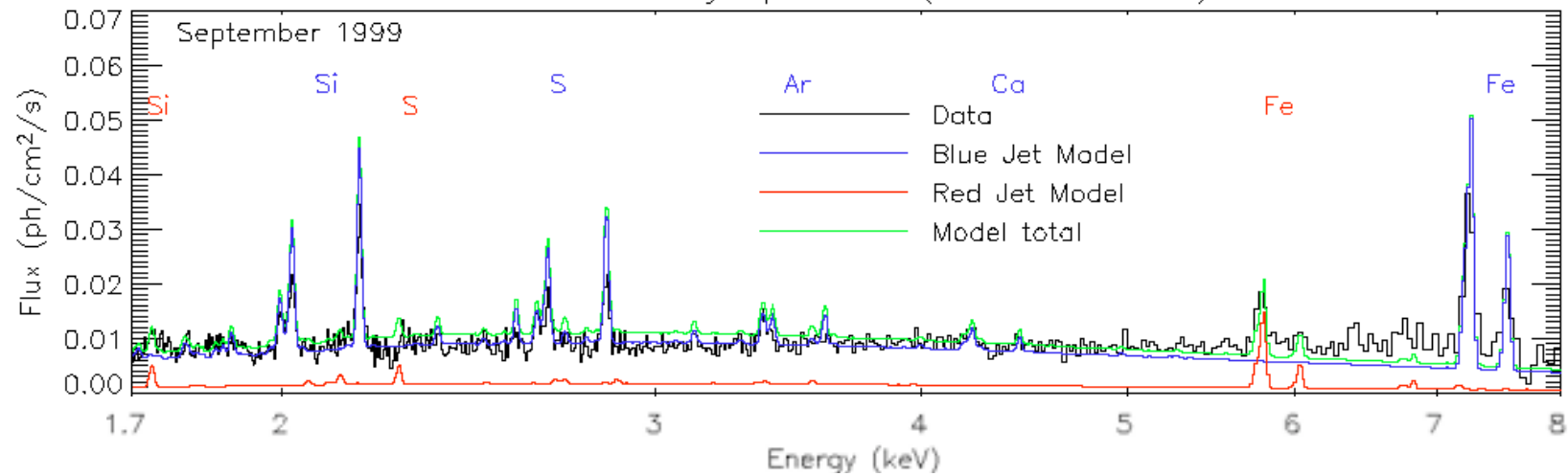
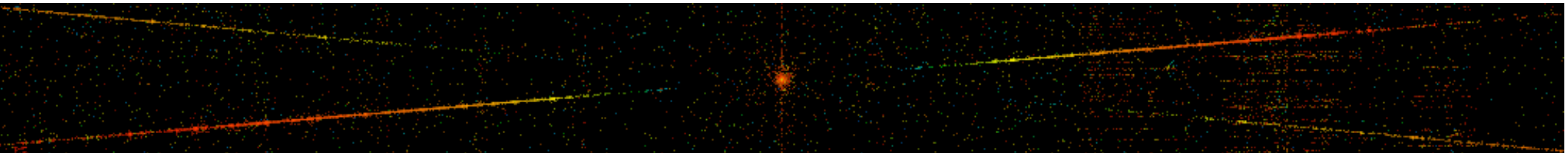


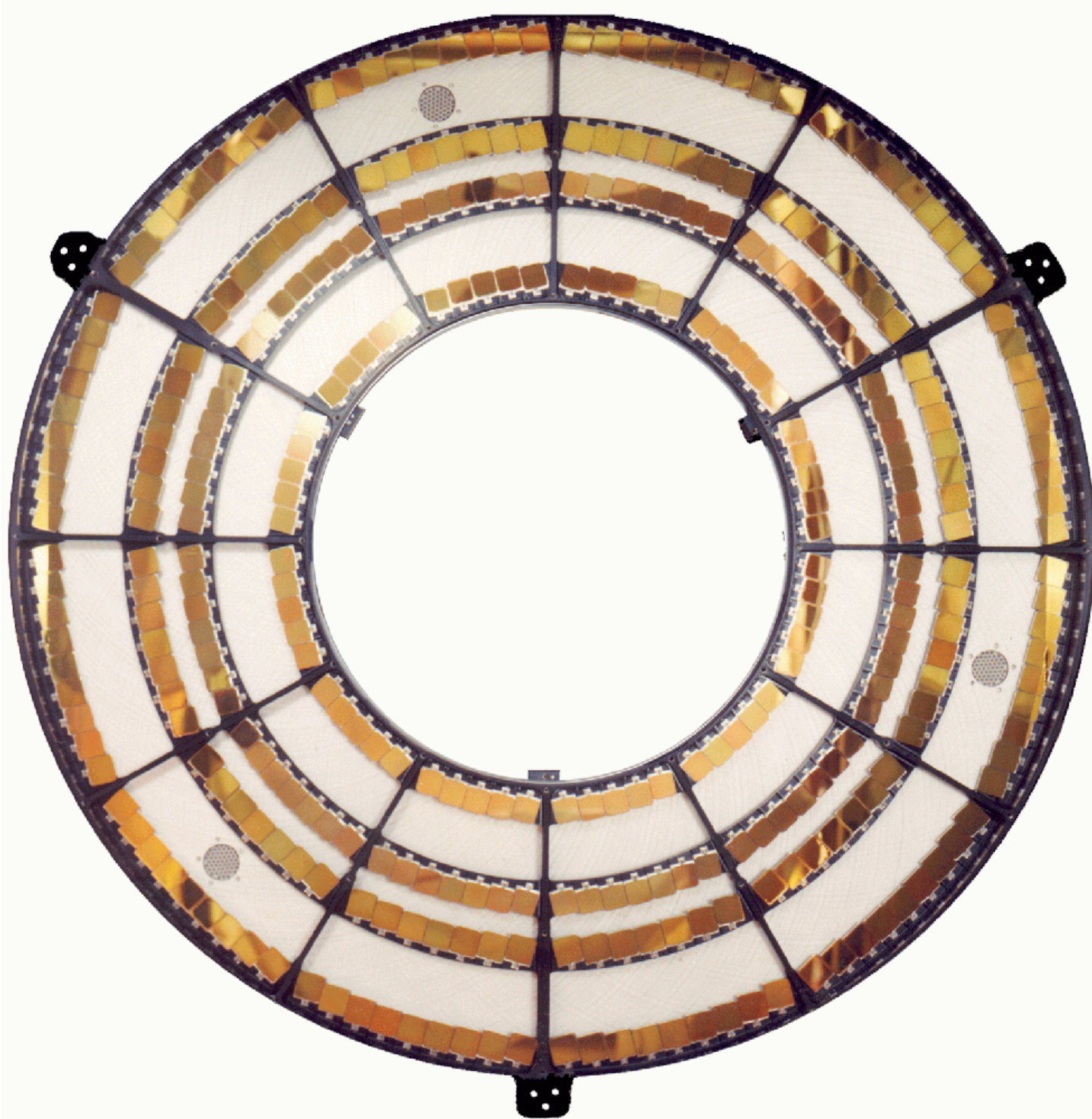
## SS 433 X-ray Spectrum (Chandra HETGS)



# Effective Area Analysis using the Chandra HETGS

Herman L. Marshall  
Chandra X-ray Center (MIT)







# HETGS Effective Area Calibration

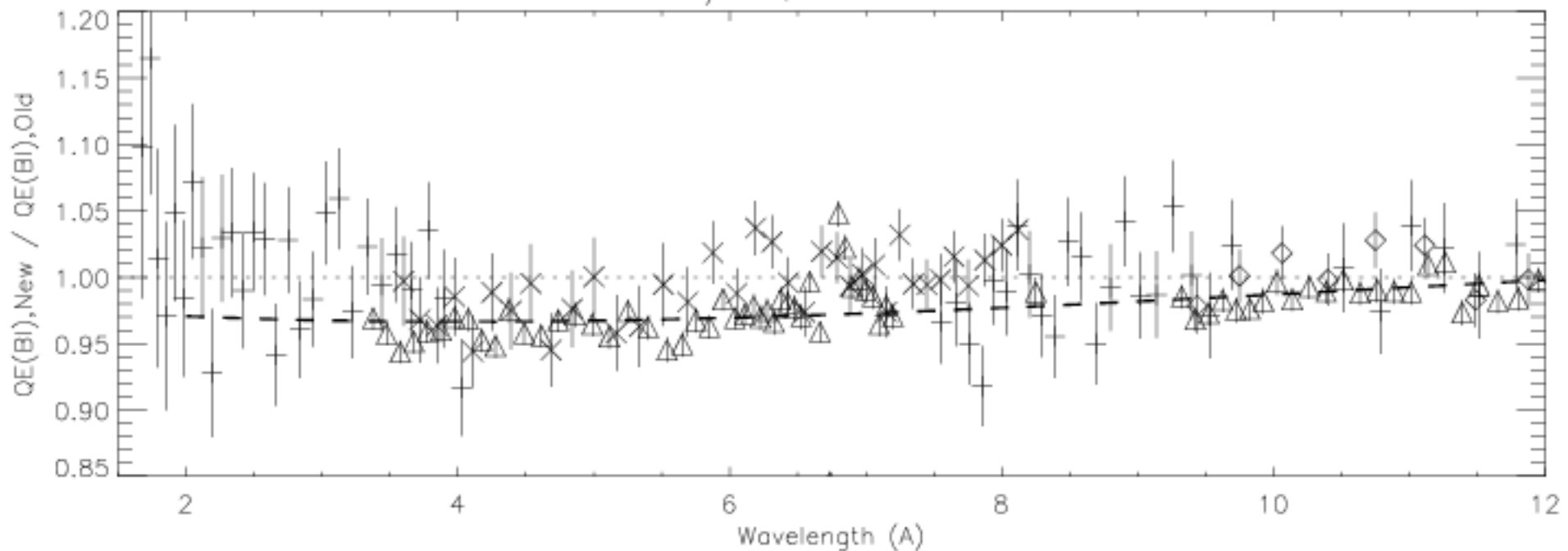
- ACIS-S
  - BI QE vs. FI QE — now down from <15% to <5%
  - Pileup — impact depends on source brightness
  - Si-K edge — 6% edge residual
  - N-K edge in FI chips — more important for LETG/ACIS
  - Contamination — not this talk
- ACIS OBF
  - C-K edge energy shift — only important for LETG/ACIS
  - O-K edge — incomplete, depends on contamination
- HETG Efficiency
  - MEG/HEG ratio update ready — <7% for  $E > 0.8$  keV
  - Compare LETG to HETG — incomplete
- HRMA Effective Area
  - Ir-M edge — 10% jump at 2.075 keV



# ACIS BI/FI QE

- New BI QEs improve matters considerably
- FI loss due to CR blooms is included
- At most 3-4% differences in 2-10 keV range
- No problems within HETGS data

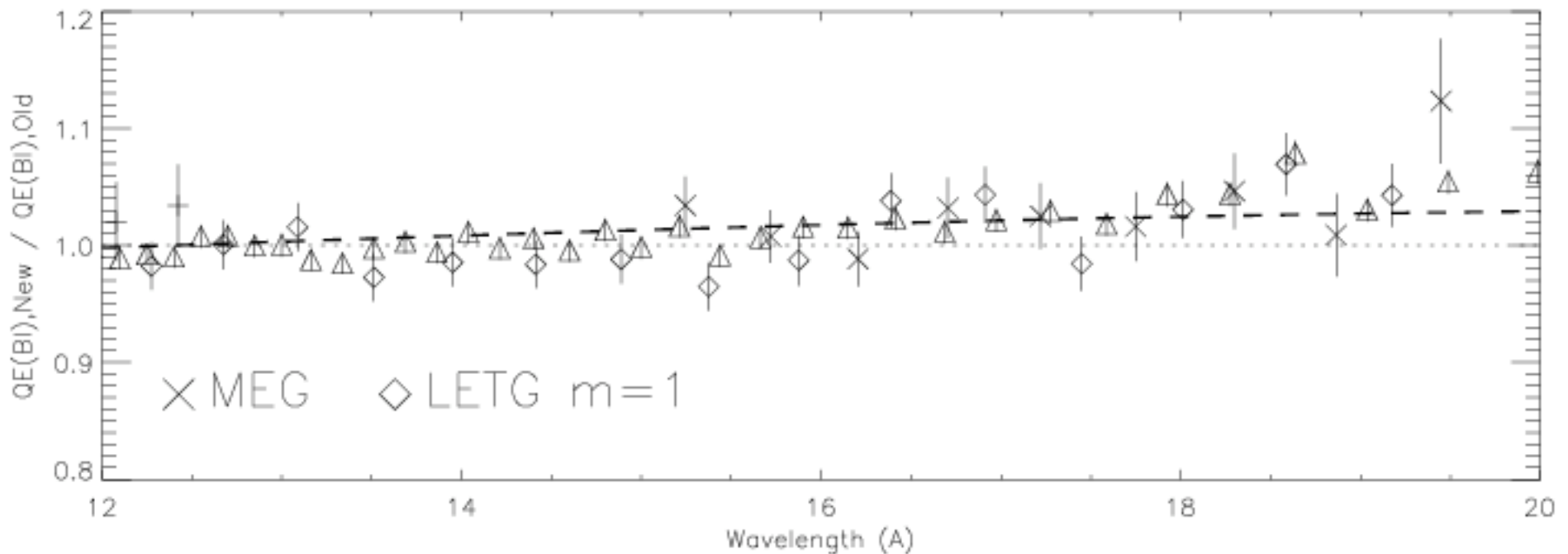
BI/FI QE Correction





# ACIS BI/FI QE

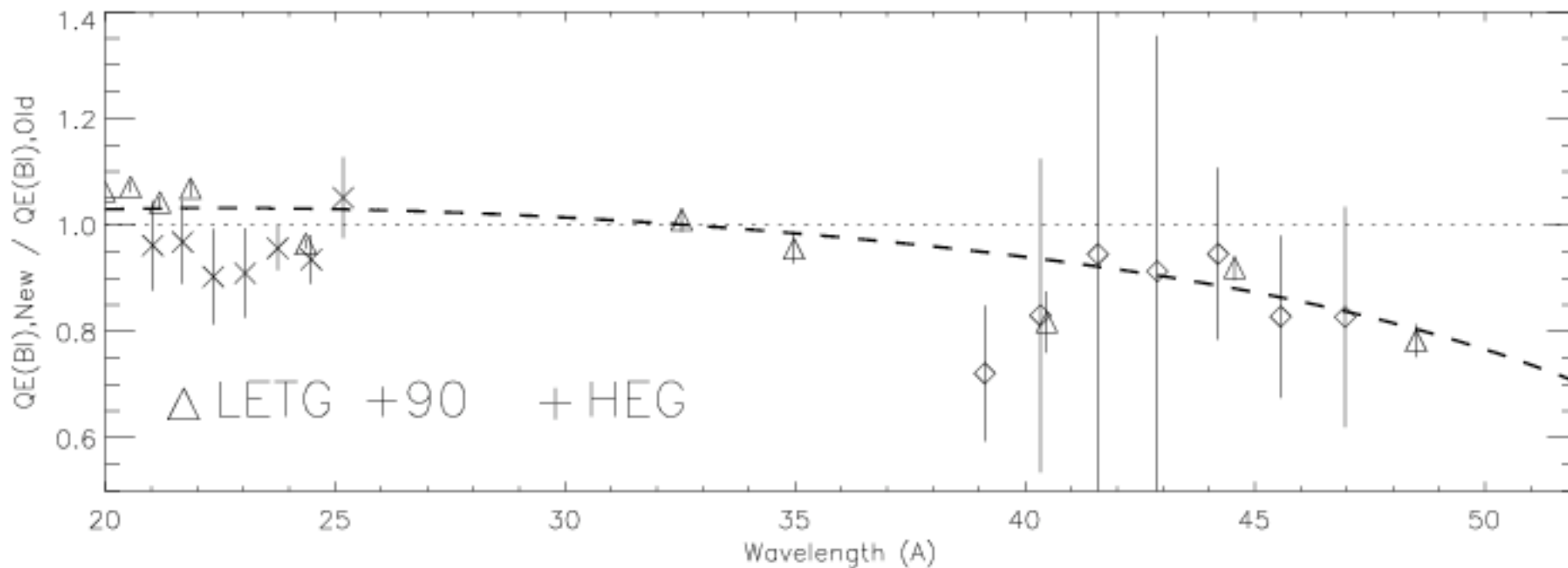
- New BI QEs improve matters considerably
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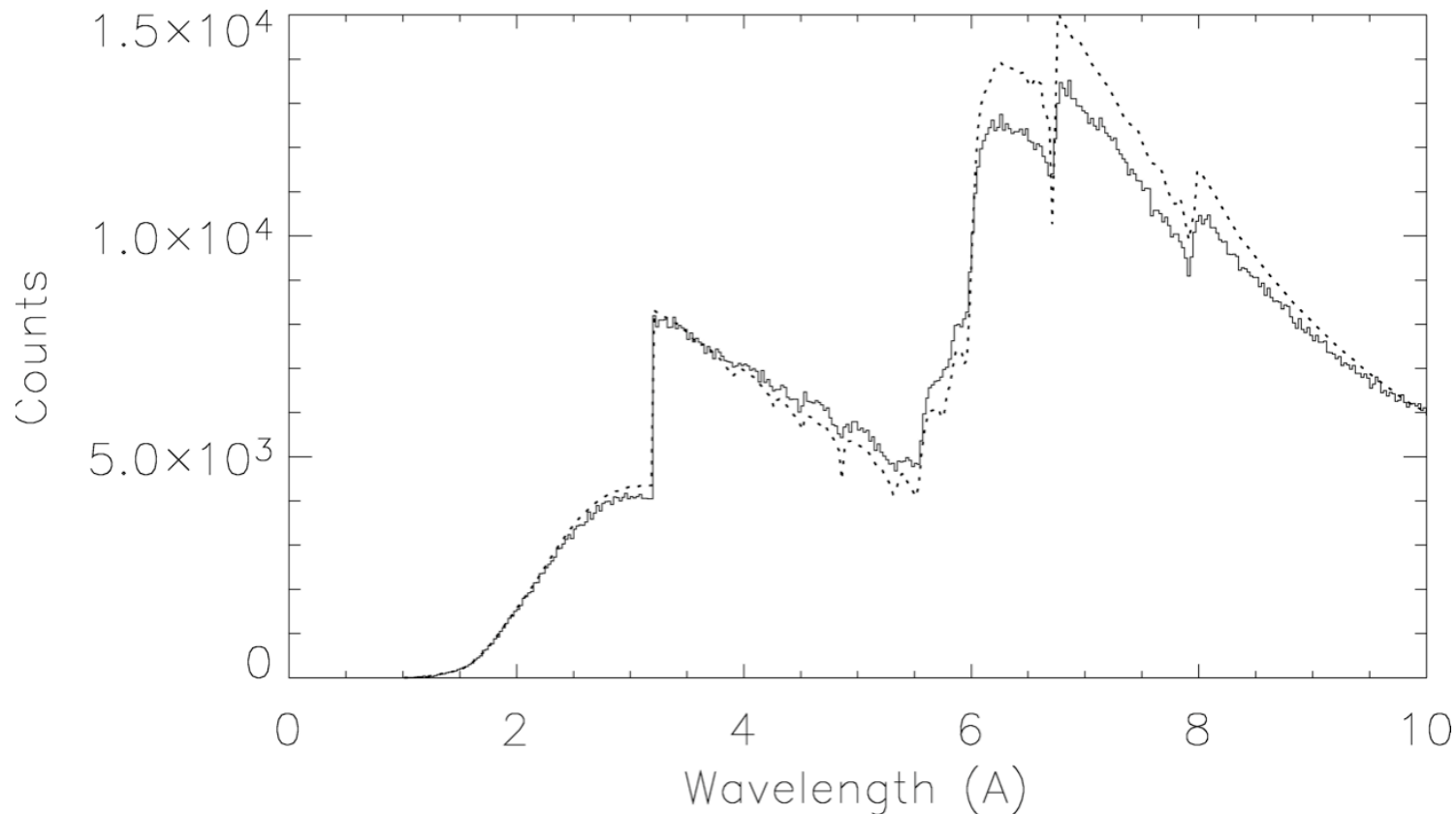


# HETGS Effective Area Calibration

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# HETGS and LETGS Pileup

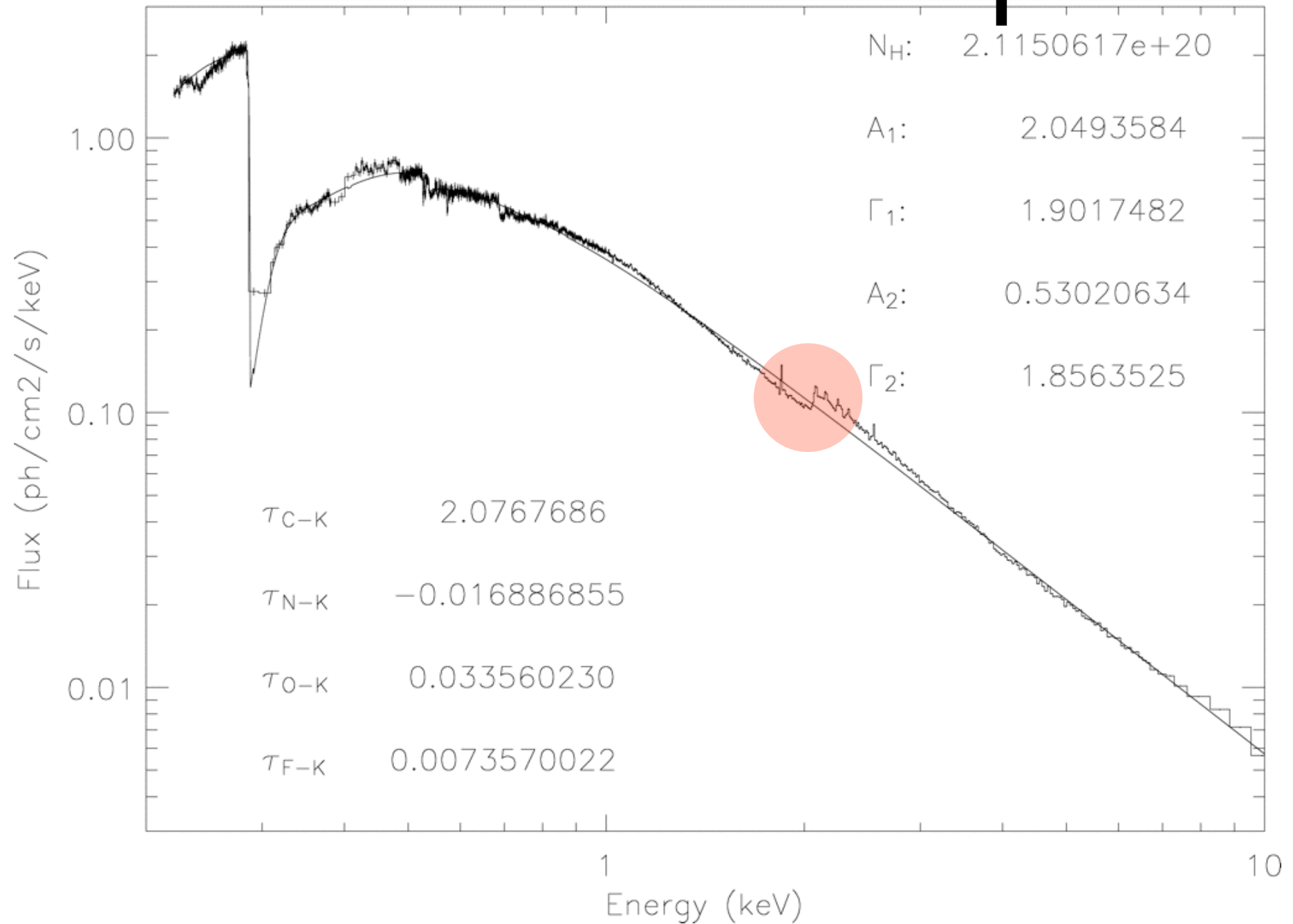
- Edge appears at 2.1 keV due to EA jump
- Rate (Rf)  $\sim 0.01$  ct/frame/col., 5% loss
- Mk 421 (4148): Rf = 0.05, giving jump of 19%







# LETGS — Pileup





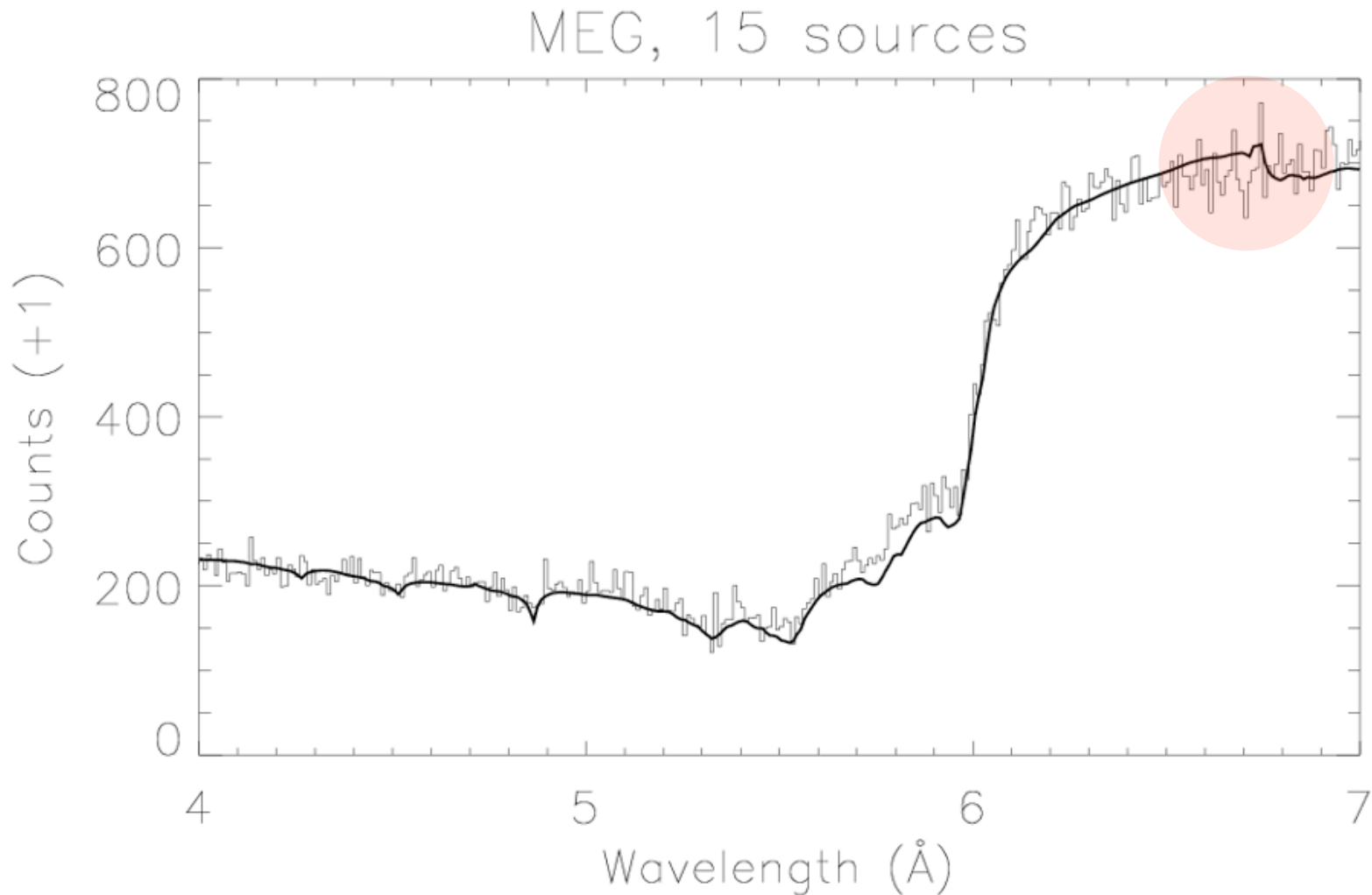
# HETGS Effective Area Calibration

- ACIS-S
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  - Contamination — see later talk
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# Si-K Edge in BI QE

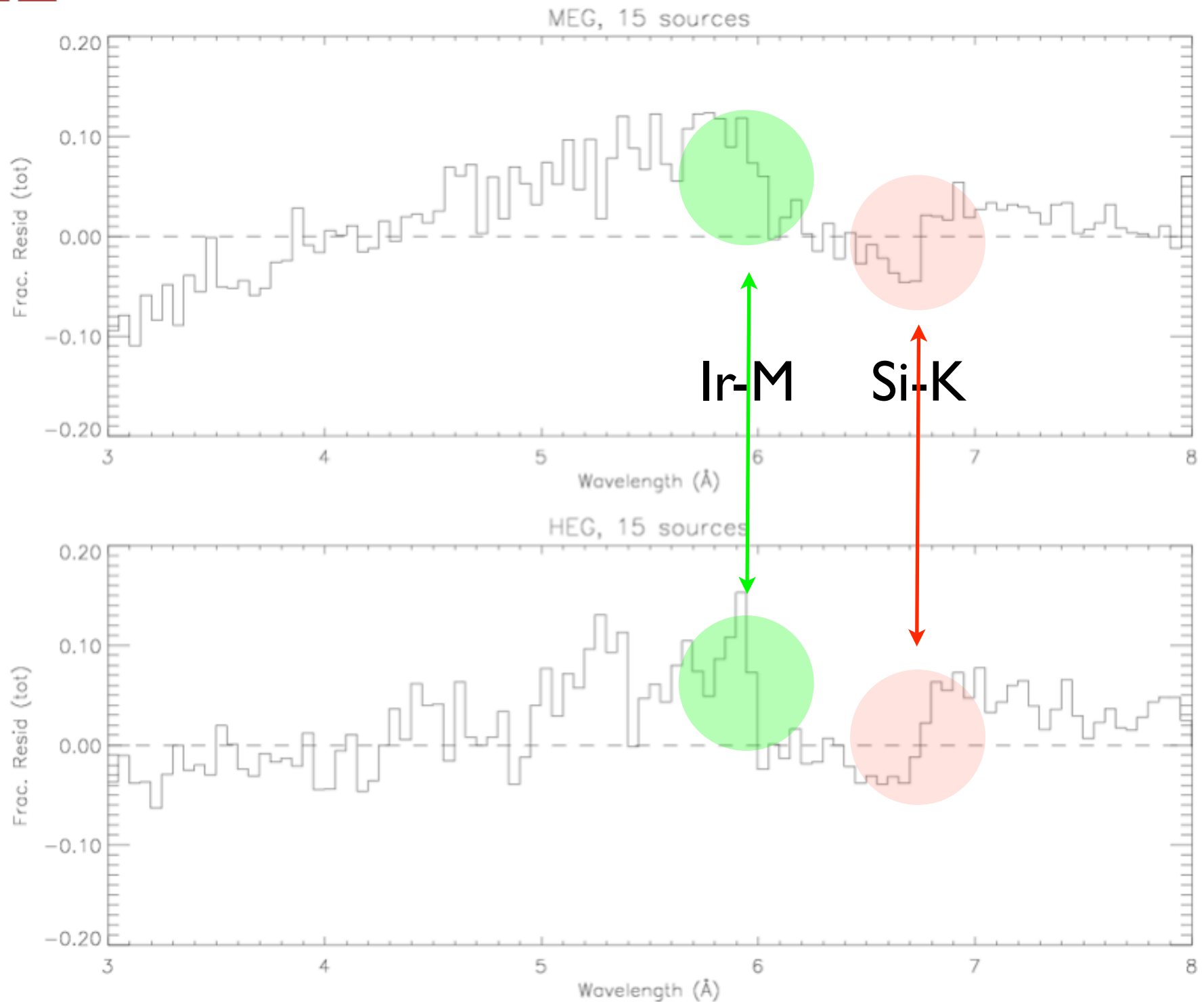
- Appears when using the new BI QE models
- Effect is an inverse, reversed edge
- Jump is about 6%





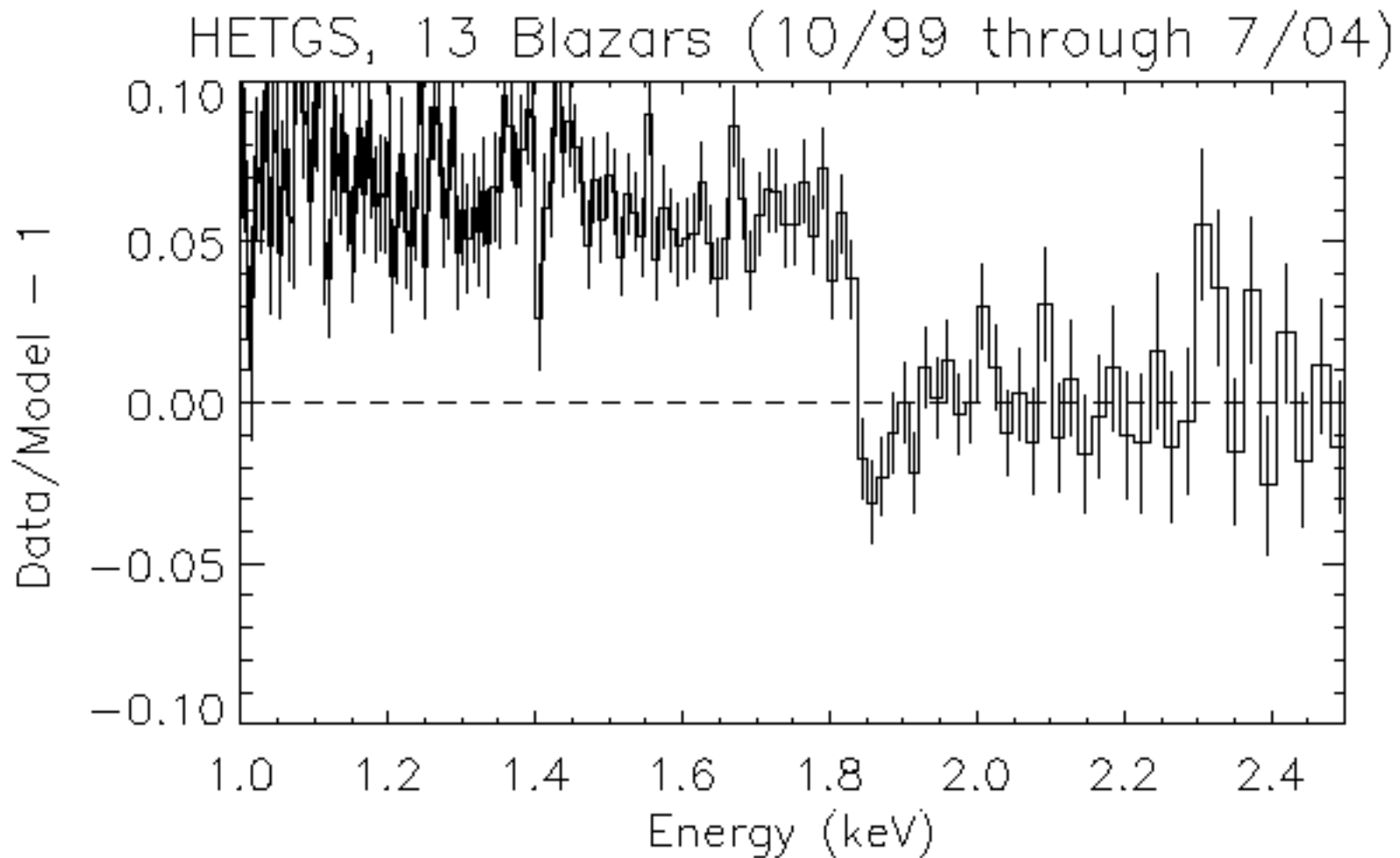
# Fitting Si-K Edge in HETGS Residuals

- Use 13 blazar observations
- Si-K is near Ir-M
  - Fixing Ir-M edge requires good fit to Si-K
  - Use 2 steps: approx. Si-K to get Ir-M, then use good Ir-M fix to finish Si-K fix adjustment
- Residual has near edge structure — use Si-K opacity from ACIS team

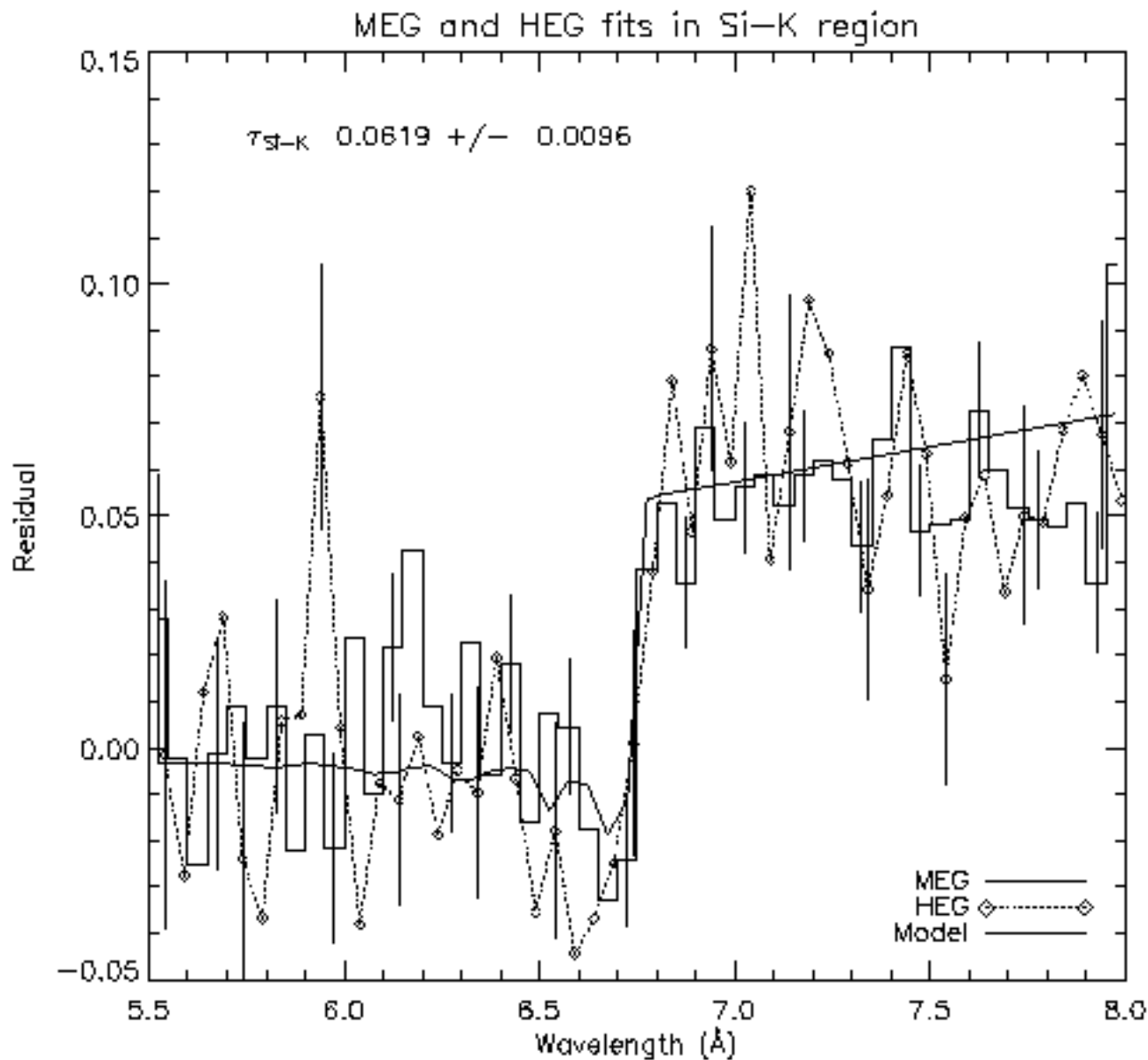




# HETGS Residuals after fixing Ir-M edge



# Fit to Si-K edge





# HETGS Effective Area Calibration

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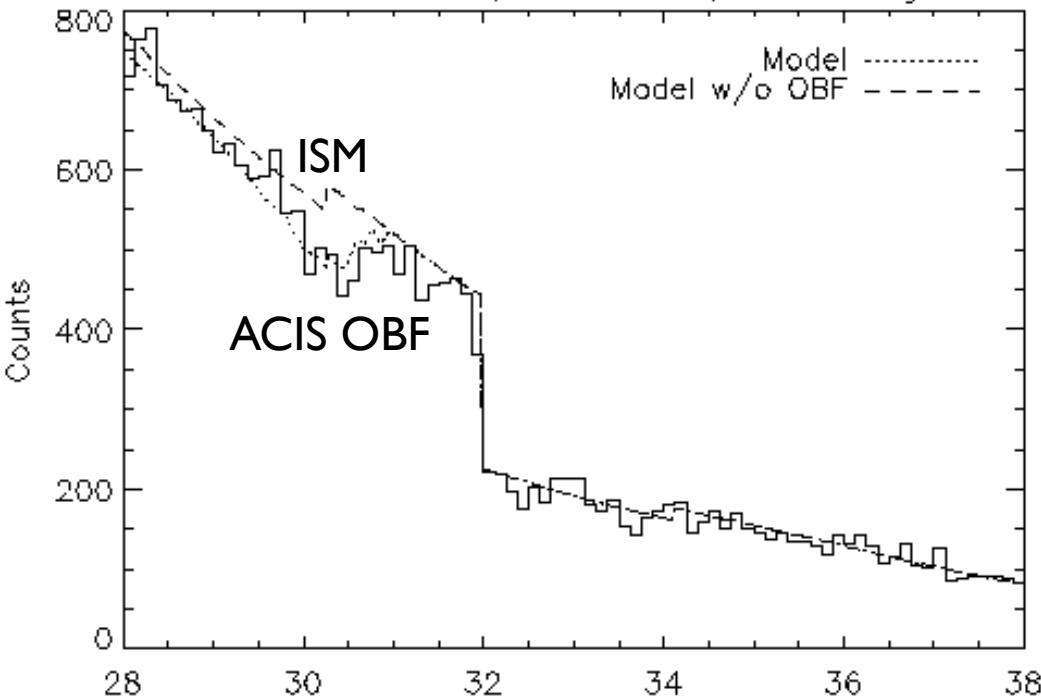




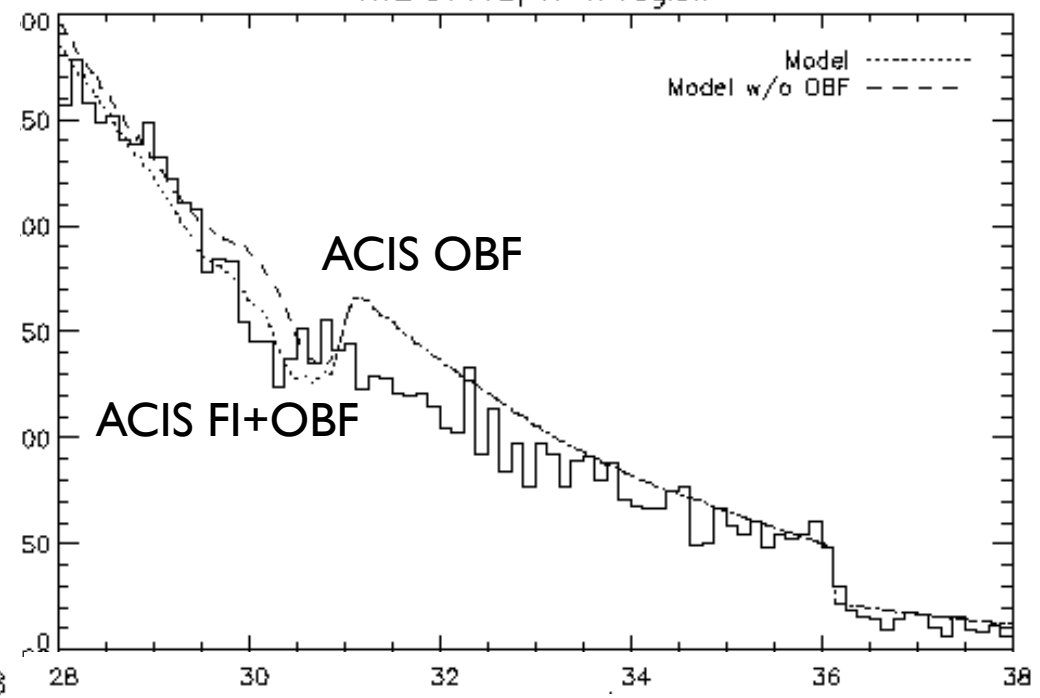
# N-K Edge in FI QE

- Found 2 yr ago in PKS 2155-304 data
- Objective was to find N-K in contaminant
- Target was offset to put N-K on BI chip
- N-K is OK in filter, not in FI chip

PKS 2155-304 (June 2002), N-K region



XTE J1118, N-K region





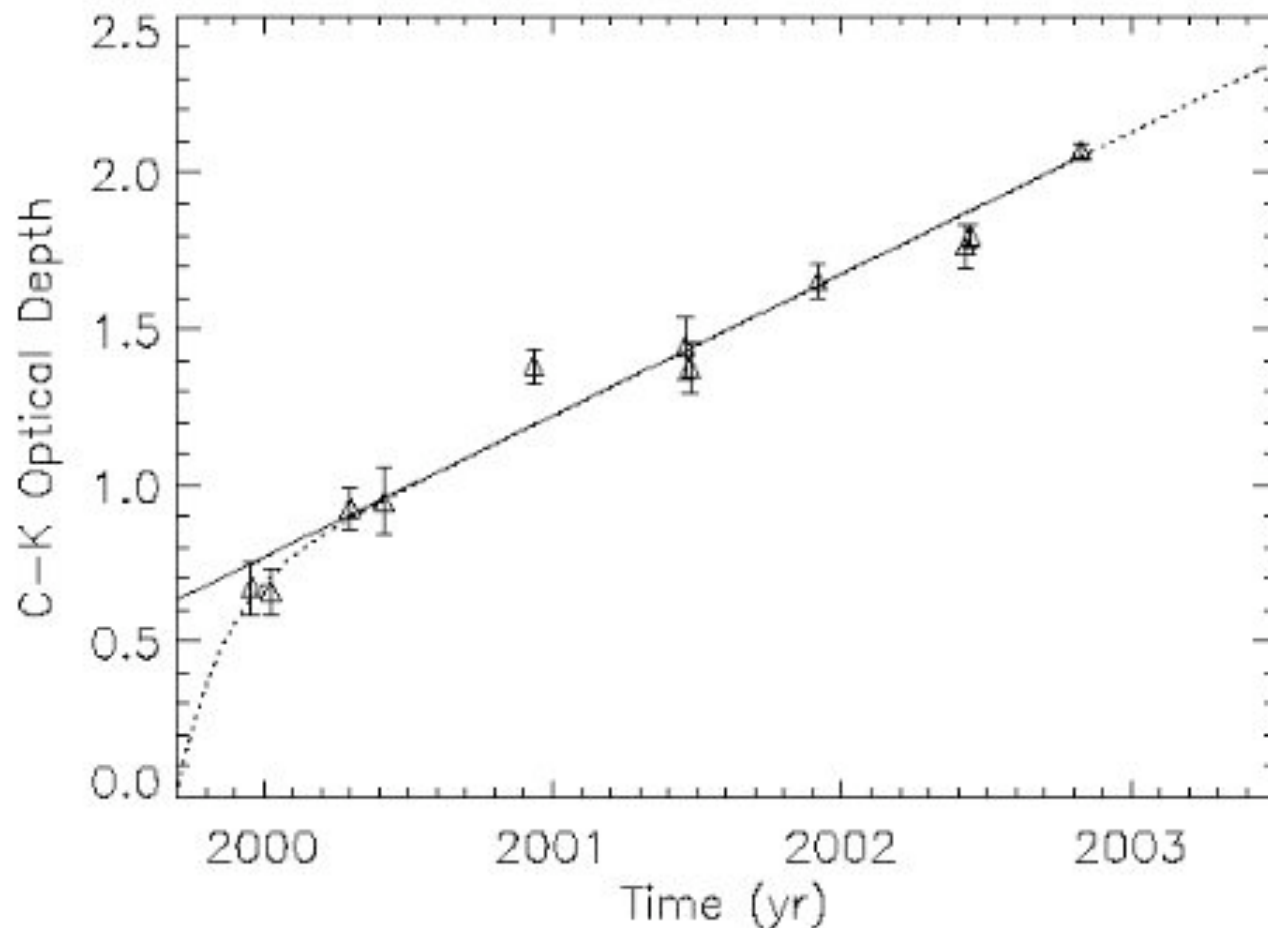
# HETGS Effective Area Calibration

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  - Contamination — not this talk
- **ACIS OBF**
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  - O-K edge — incomplete, depends on contamination
- **HETG Efficiency**
  - MEG/HEG ratio to be updated — <7% for  $E > 0.8$  keV
  - Compare LETG to HETG — incomplete
- **HRMA Effective Area**
  - Ir-M edge — 10% jump at 2.075 keV



# Contamination

- Filter dominates below .2867 keV, contaminant above
- Composition from edges: C:O:F:N ~ 55:5:4:<2
- ECS gives slower deepening than elemental model



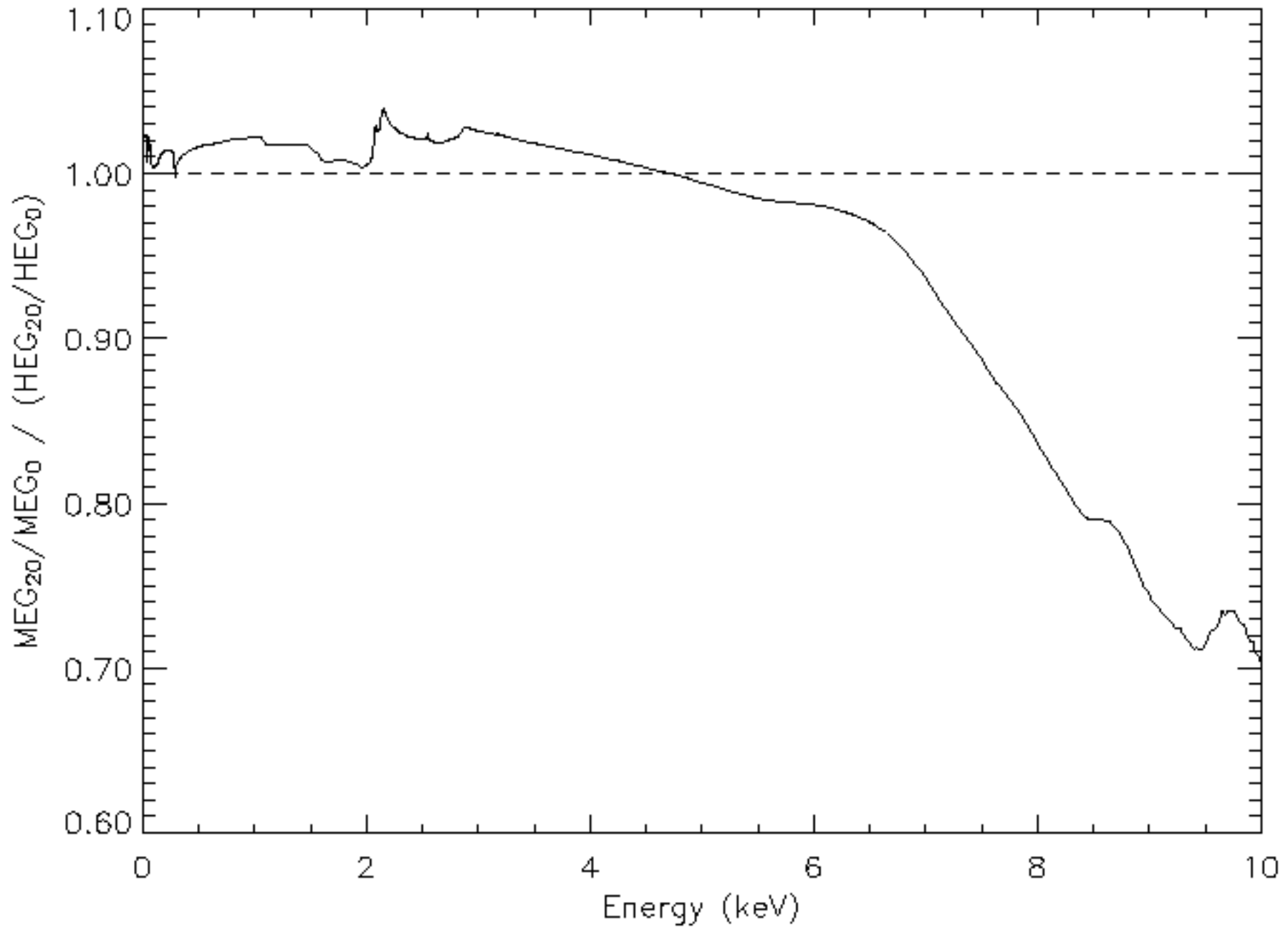


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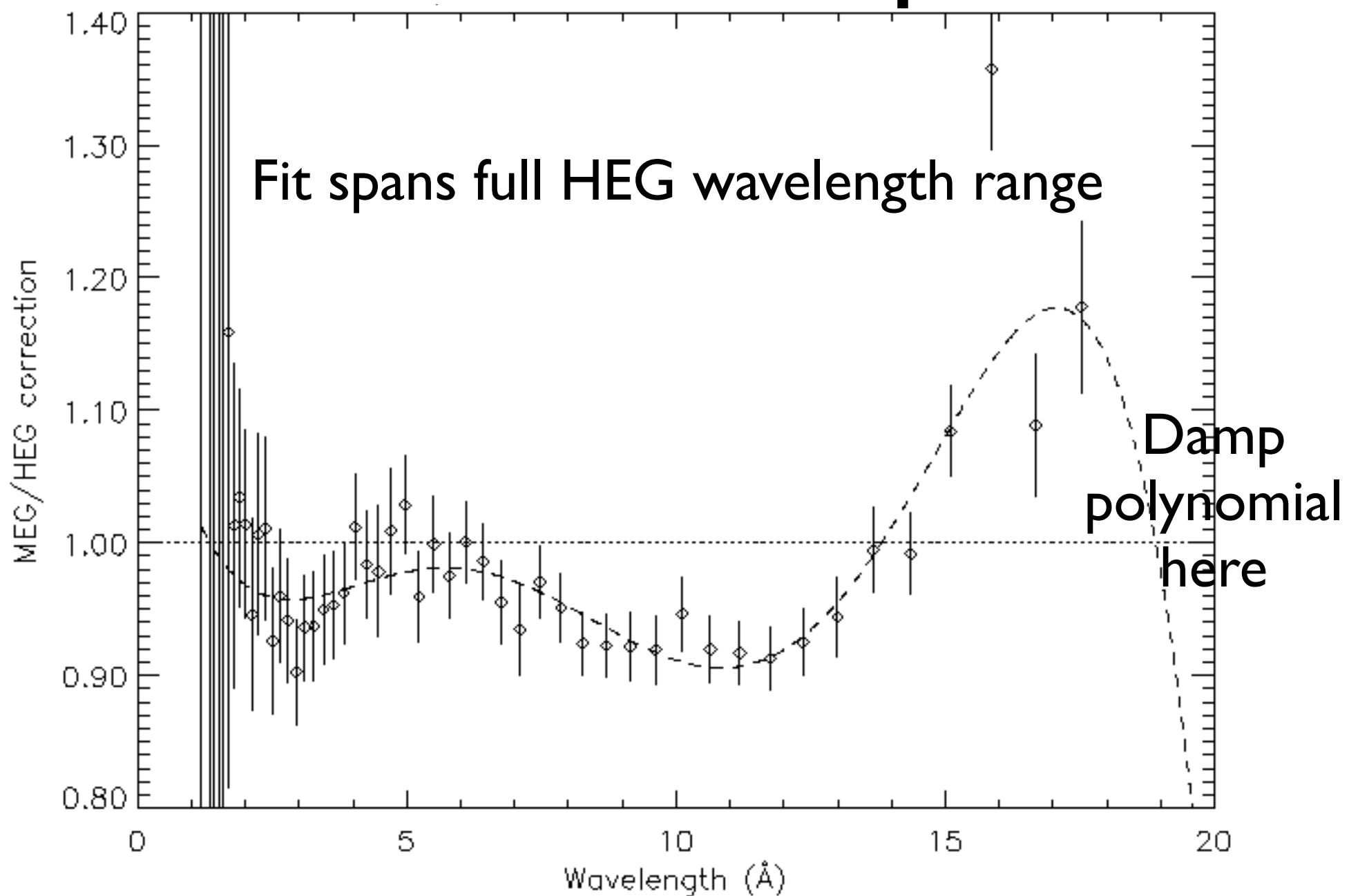


# HRMA Ir-M fix & HETGS





# HEG/MEG Comparison





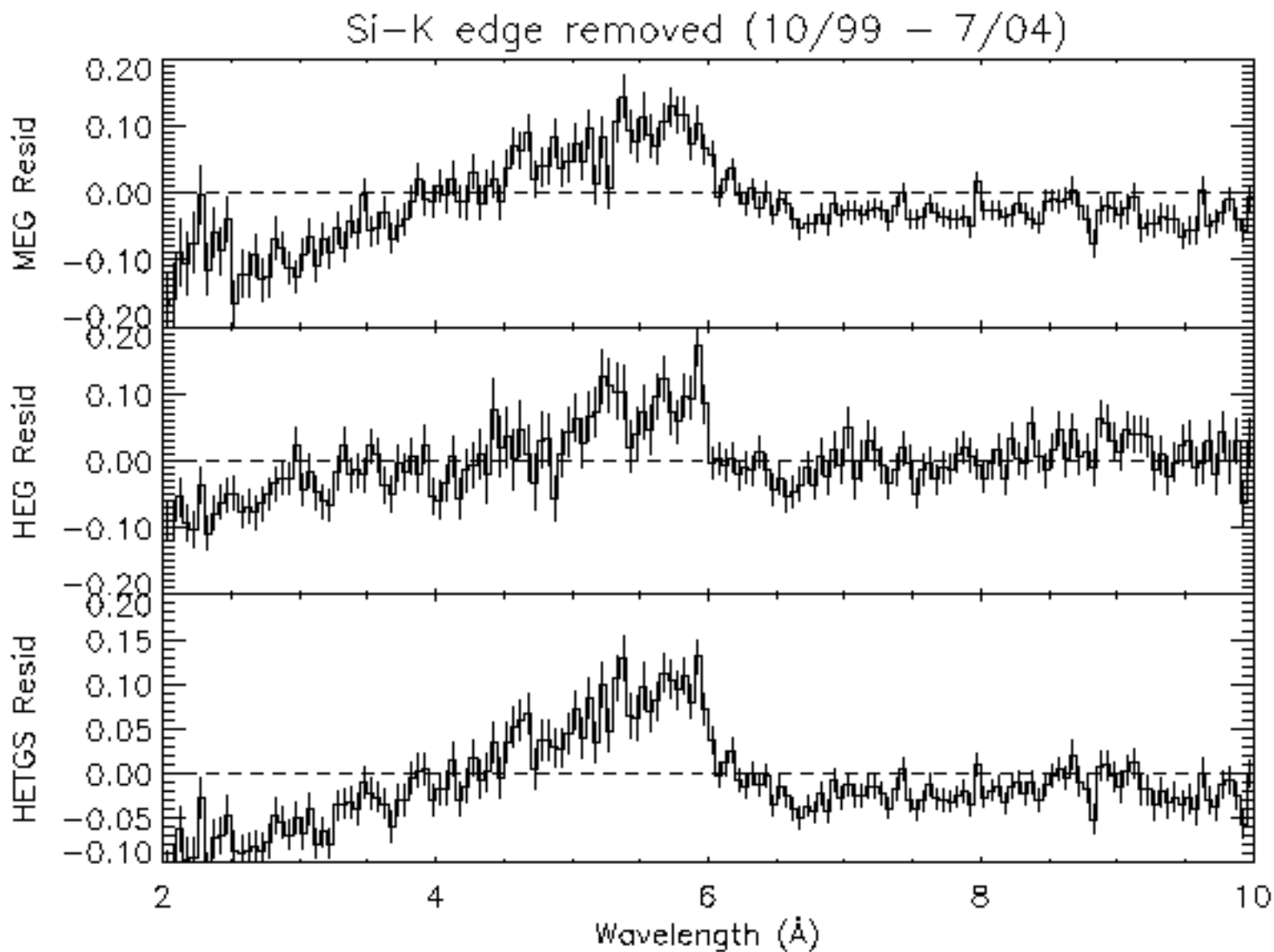
# HETGS Effective Area Calibration

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- HRMA Effective Area
  - Ir-M edge — 10% jump at 2.075 keV



# HRMA Ir-M edge

- Jump is about 10%
- MEG and HEG agree
- See Diab Jerius' talk

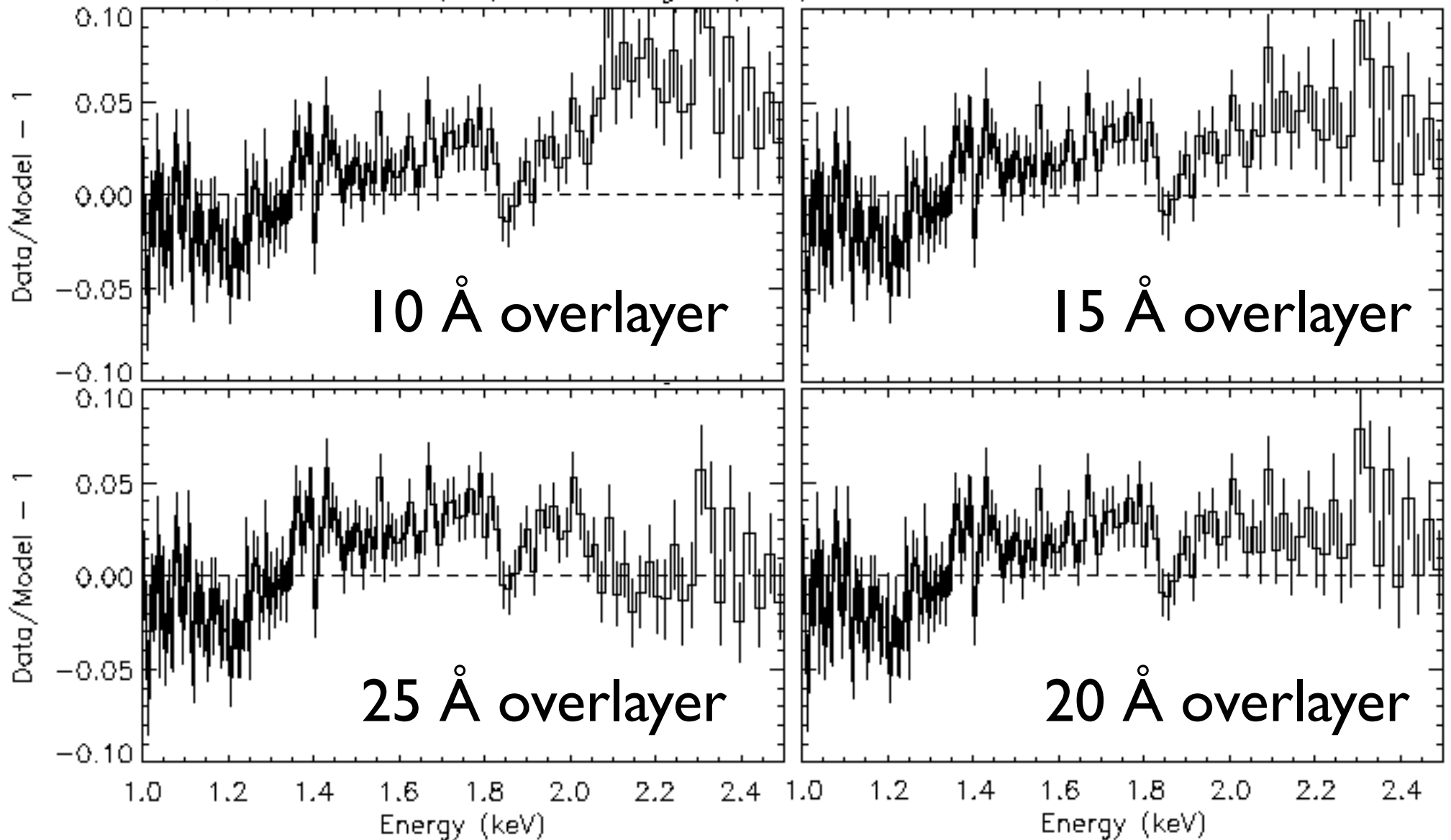






# HRMA Overlayer Study

HETGS, 13 Blazars (10/99 through 7/04)

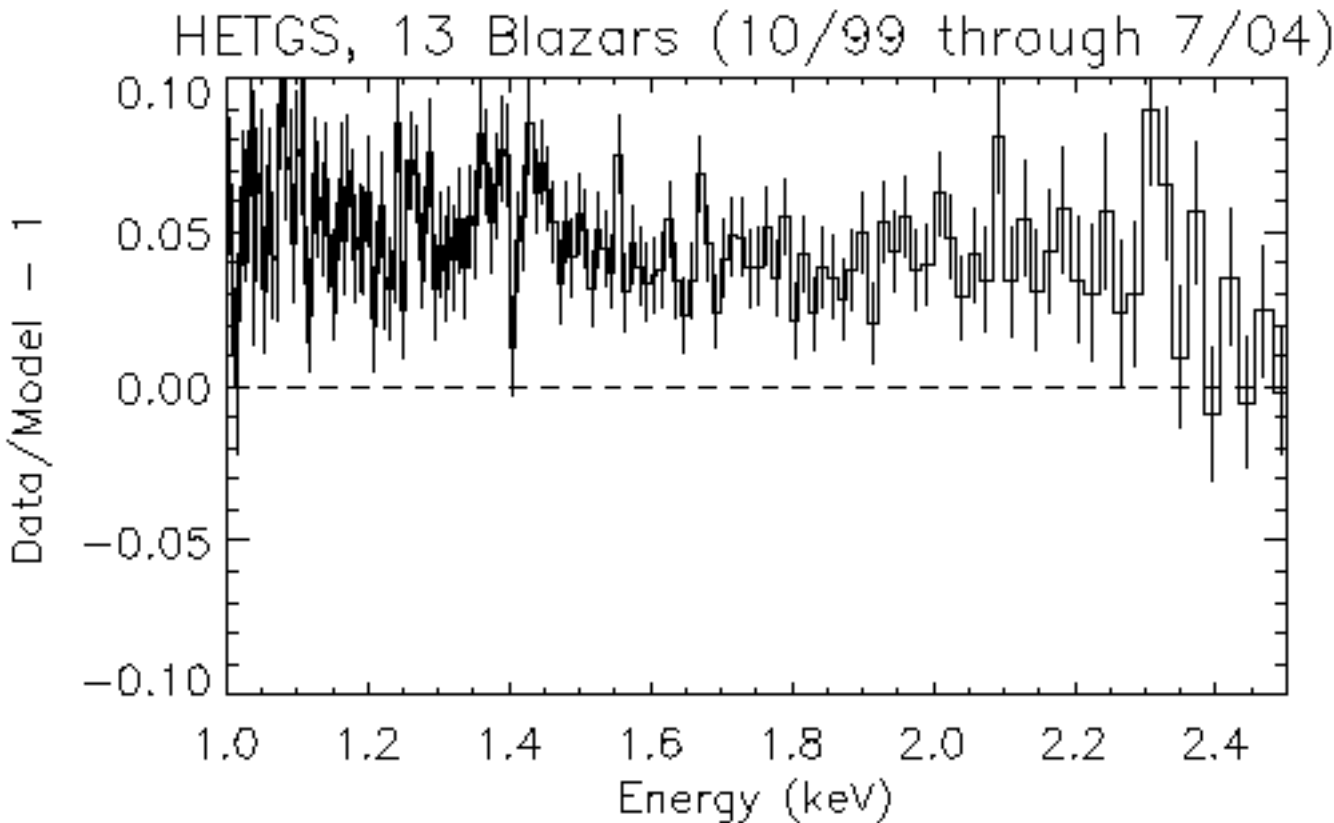




# HRMA Overlayer: $20 \pm 5 \text{ \AA}$

(Updated Optical Constants)

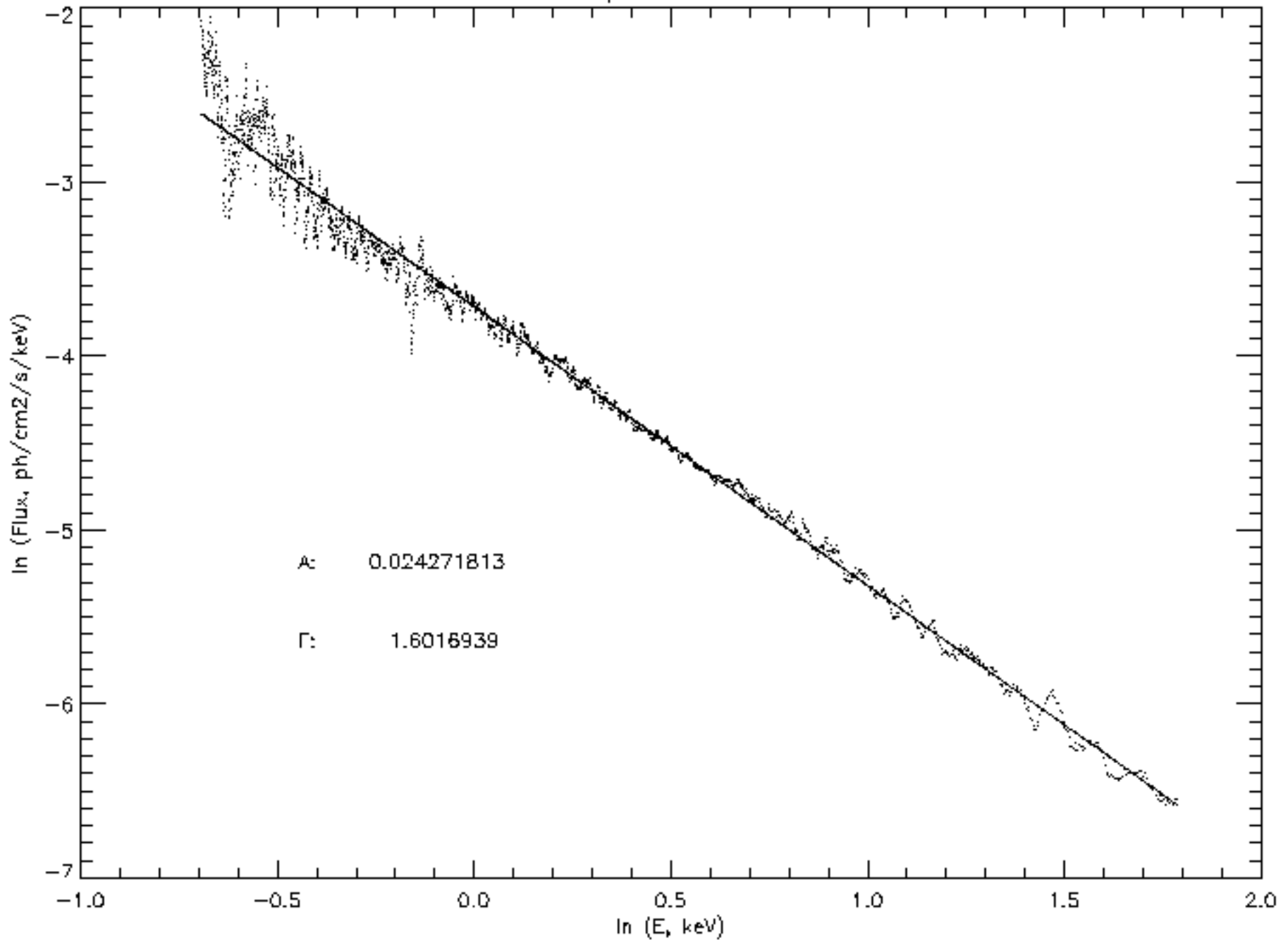
- $20 \text{ \AA}$  overlayer is best now
- Si-K edge was updated, no residual observed
- Offset of 5% due to poor fit to PL models





# Fit Results

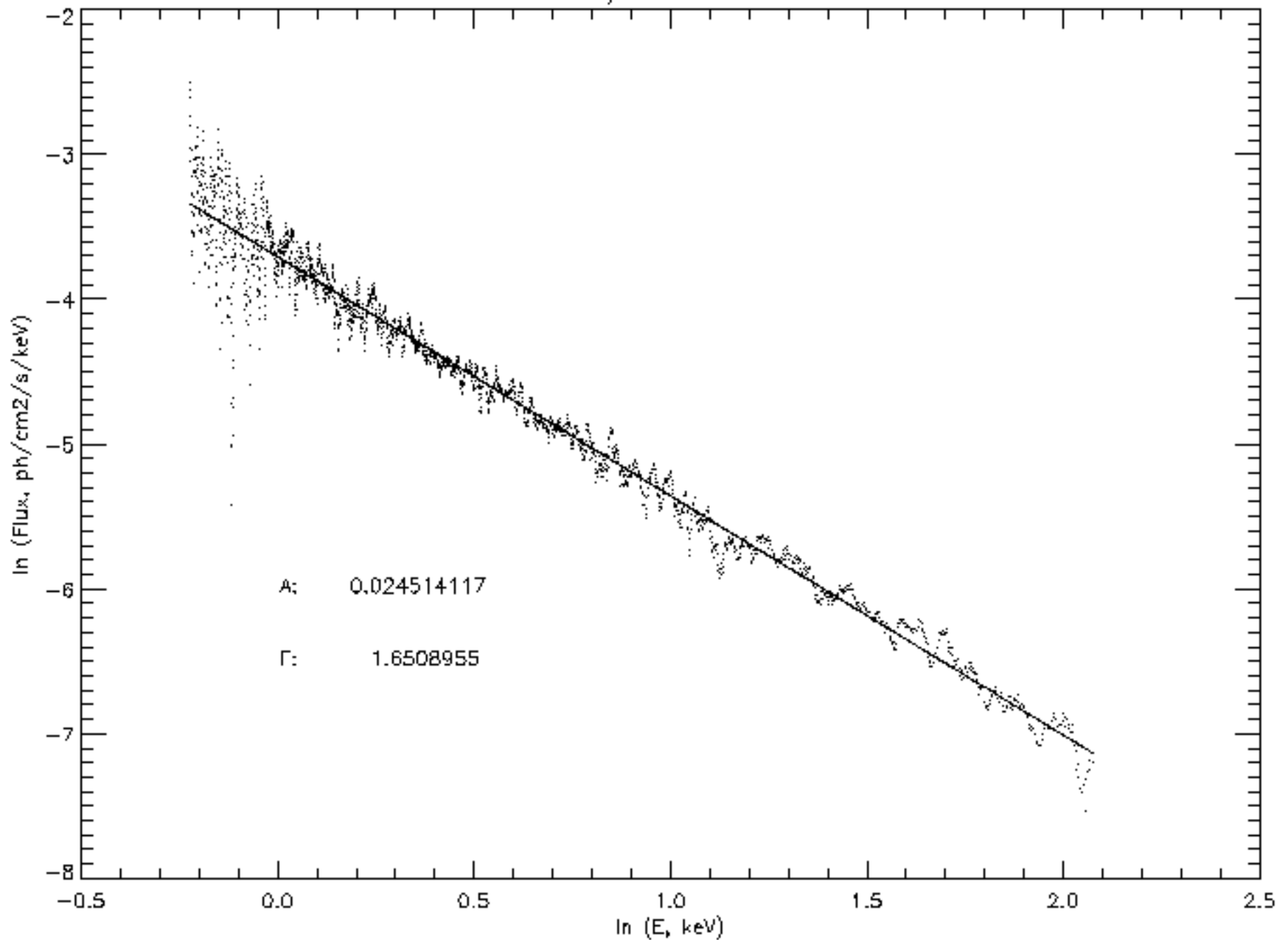
3c273/459 HETG MEG





# Fit Results

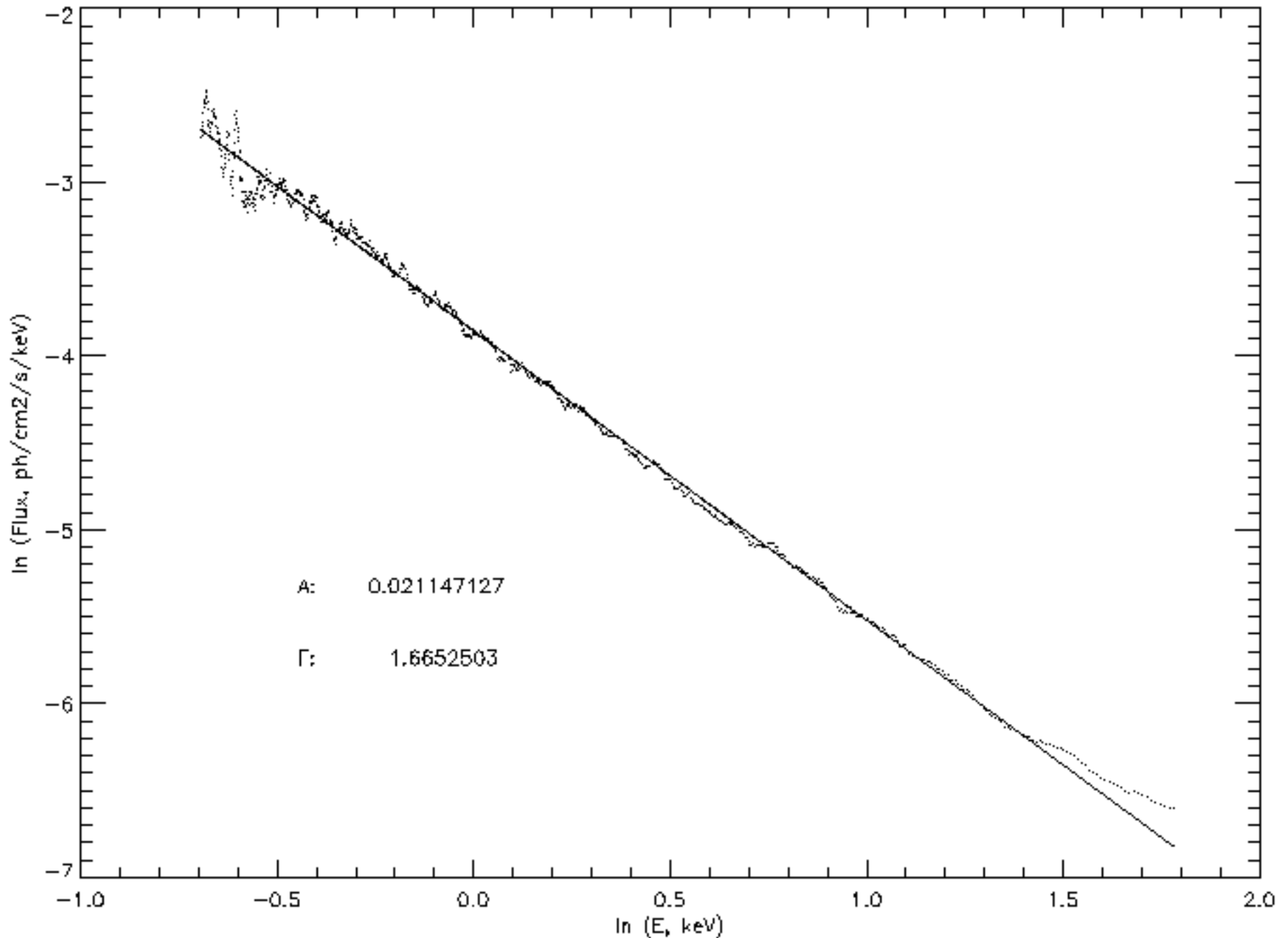
JG273/459 HETG HEG





# Fit Results

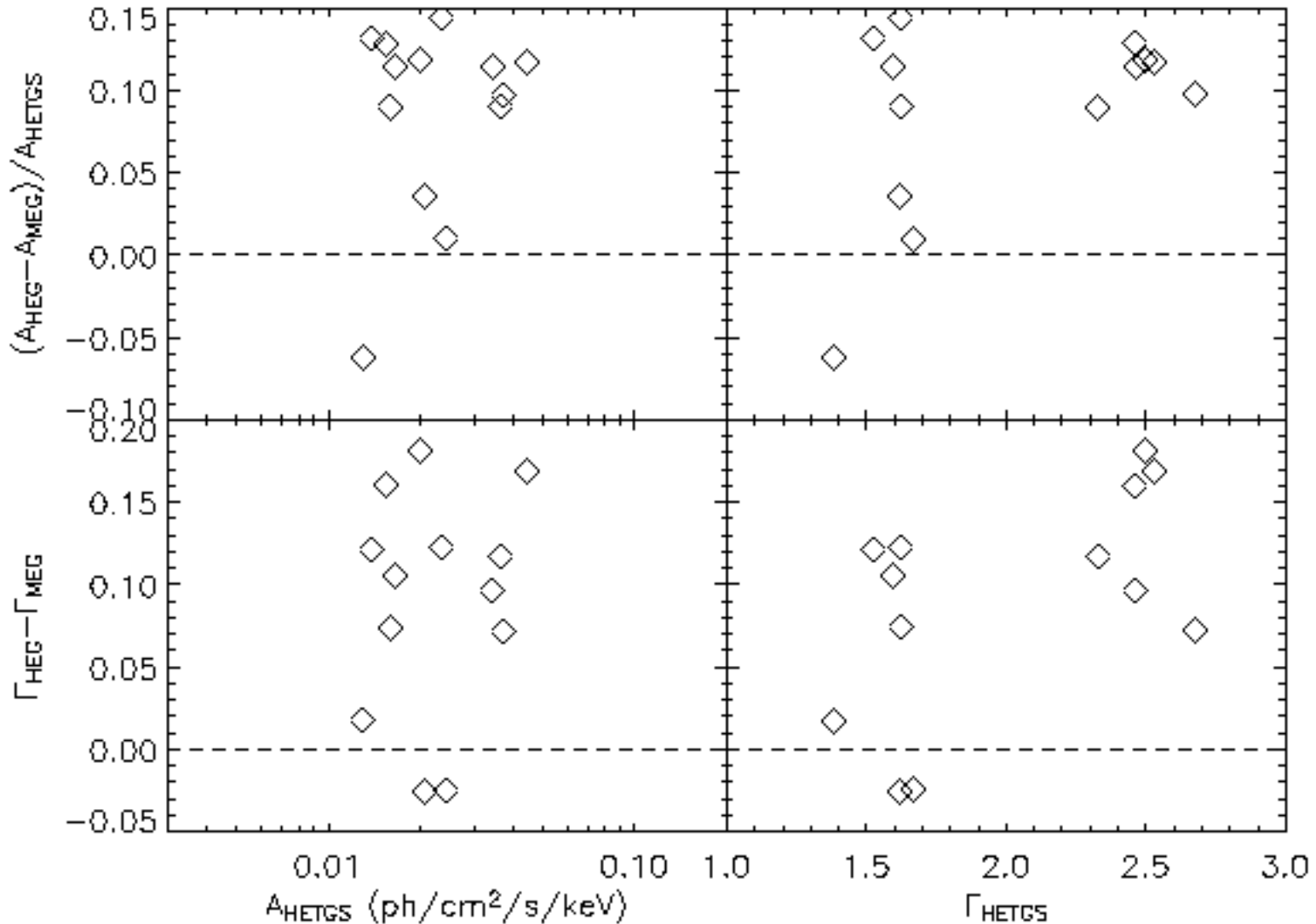
50273 1198 LETG





# MEG-HEG Consistency

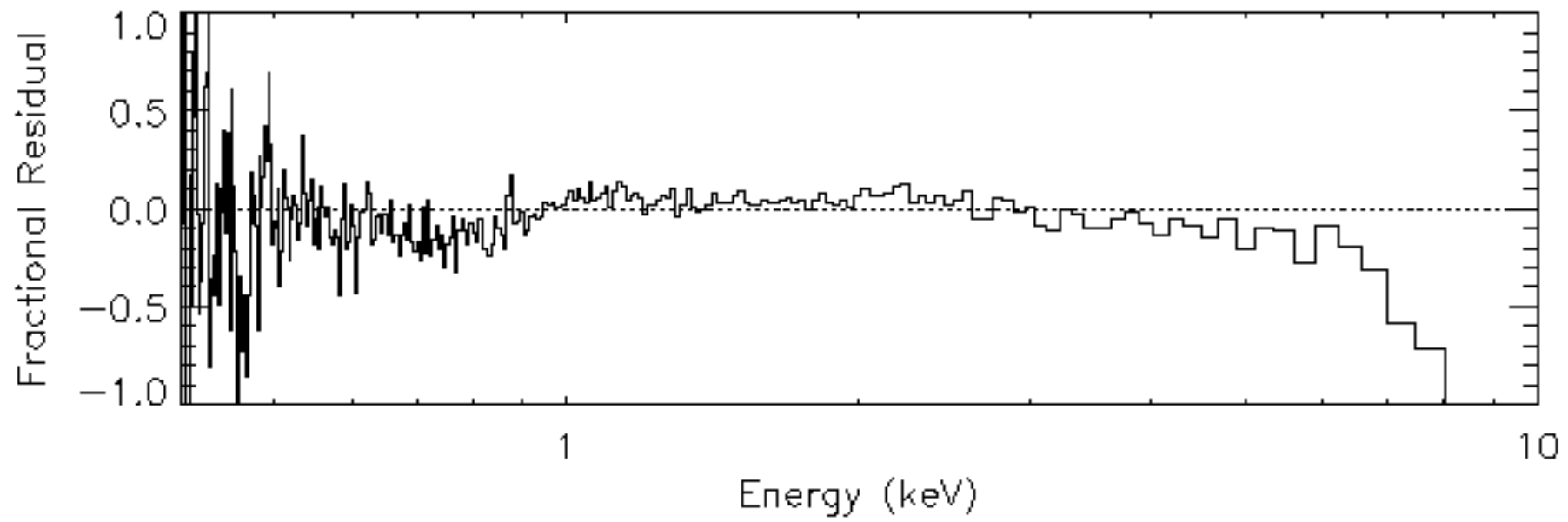
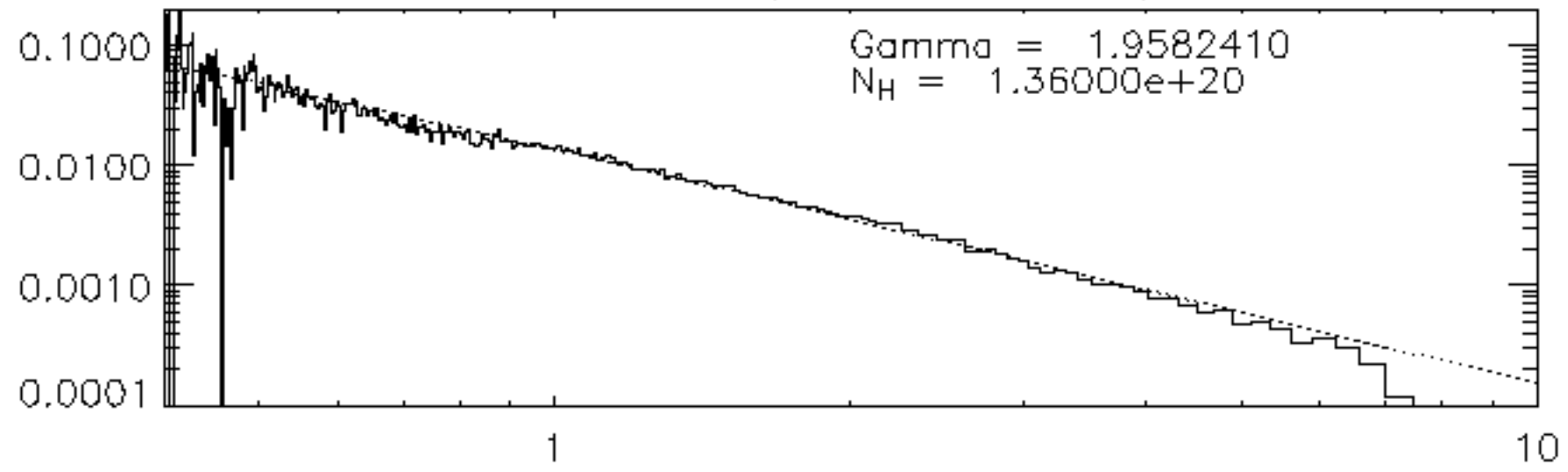
- Fit PL models to MEG and HEG independently
- Fit parameters show slight calibration biases





# HETGS of 1H1426+42

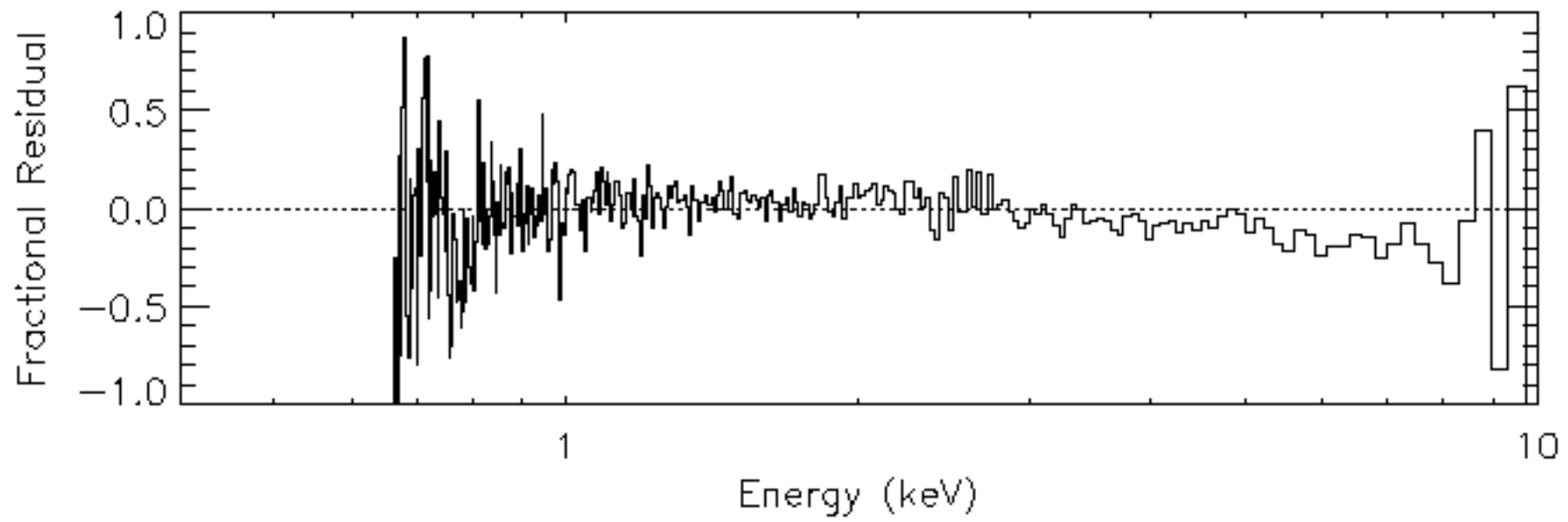
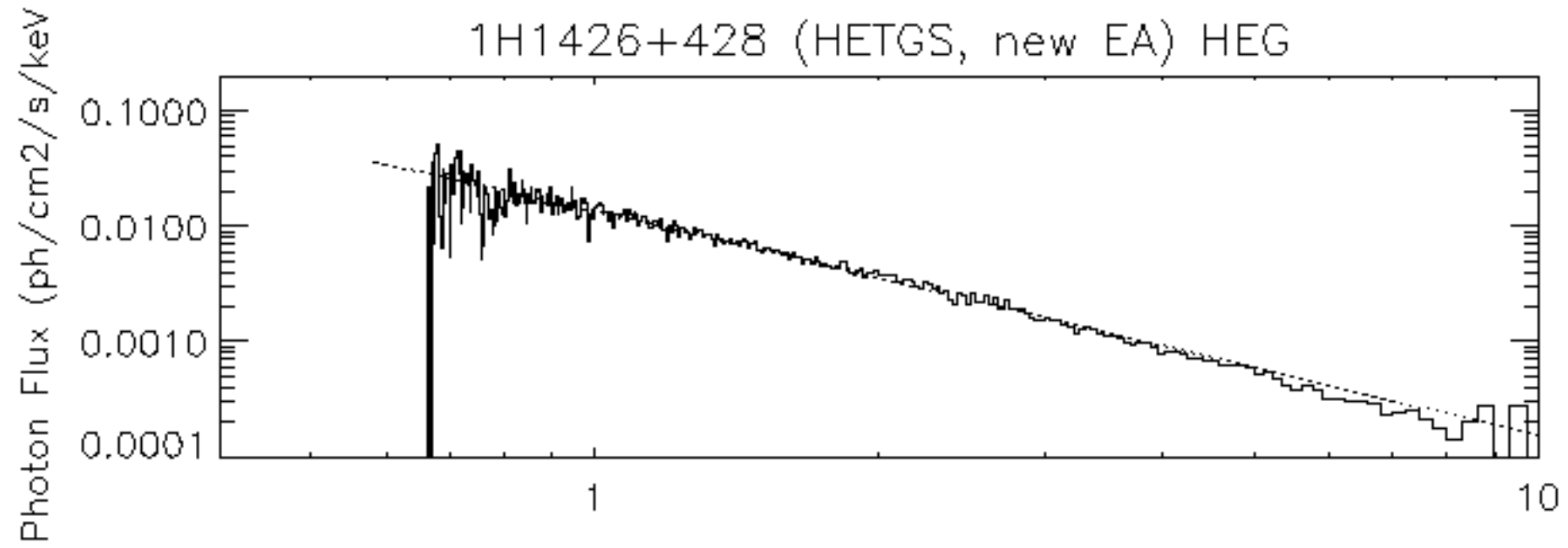
1H1426+428 (HETGS, new EA) MEG





# HETGS of 1H1426+42

1H1426+428 (HETGS, new EA) HEG







# Summary

- Most spectral edges and narrow features are fixed (or fixable)
- HRMA and ACIS EA require 2 more adjustments
  - Si-K edge
  - Ir-M edge
- MEG fix relative to HEG is still not right
  - Smoother spectra are possible
  - Cross-calibration with XMM will help