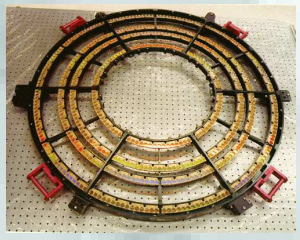
Low energy effective area of the Chandra low energy transmission grating spectrometer



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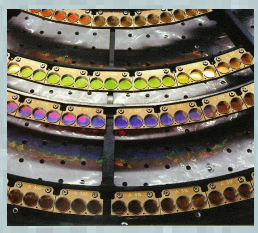


LETGS Calibration

Pre-flight calibration of the effective area covered E> 0.277 keV, $\lambda < 45$ Å

We extend calibration to low energies E= $0.07 - 0.277$ keV, $\lambda = 45 - 200$ Å

This work: Detailed description of in-flight low energy calibration

Targets & Model Parameters

Hot White Dwarfs:

- E= $0.07 - 0.27$ keV, $\lambda = 45 - 200$ Å
- Pure hydrogen non-LTE emission producing featureless continua

Sirius B: primary low-E target

- $T_{\rm eff} = 25000$ K & $\log g = 9.0$
- Uncertainties < 10%

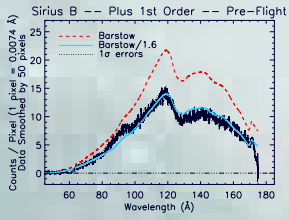
HZ 43: comparison & monitoring

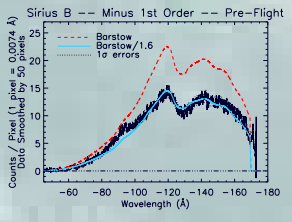
- $T_{\rm eff} = 51000$ K & $\log g = 7.9$

Quasar **3C 273**

- E= $0.2 - 0.8$ keV, $\lambda = 15 - 60$ Å
- Non-thermal (power-law) emission
- $\Gamma = 1.62$, norm = 0.025

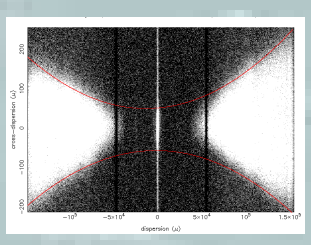
Initial Comparison





Comparison indicates pre-flight model is ~1.6 times greater than Sirius B data

LETGS dispersion & extraction region: Spectrum of HZ 43



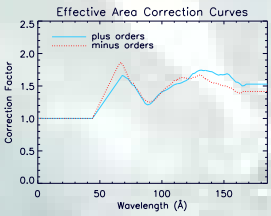
Correction Methodology

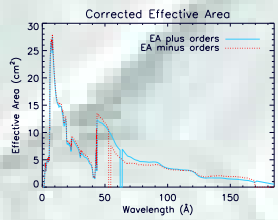
$A_{\rm eff} = A_{\rm eff:\ HRMA} \times \Phi_{\rm LETG} \times T_{\rm UVIS} \times Q_{\rm HRC-S\ MCP}$

Low-Energy Calibration

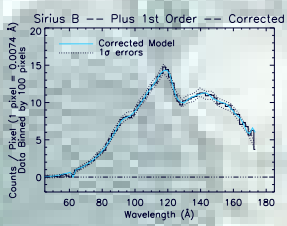
- Comparison of Sirius B model to observed spectrum indicates pre-flight HRC-S QE high by ~ 1.6
- Derive correction factor: ratio model to data
- Apply correction to HRC-S QE
- HZ 43 Test: Good agreement between models & data: 10–15%

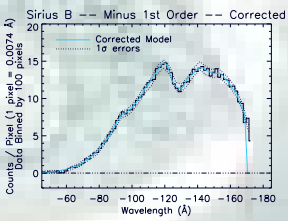
Use Sirius B model to derive LETGS effective area correction



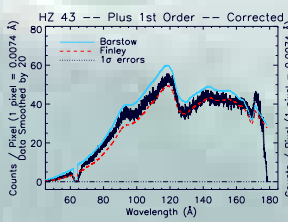


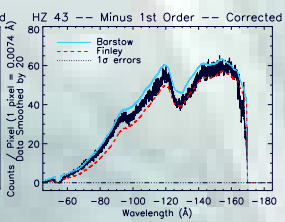
Correction process confirmation





Independent confirmation of correction process





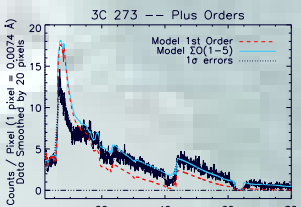
Comparison of corrected model to data with HZ 43 shows good agreement

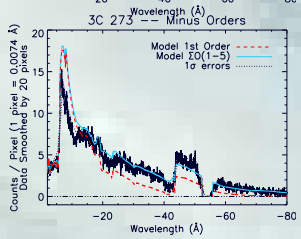
http://asc.harvard.edu/cal/Links/Letg/User

Mid-Energy Comparison

- 3C 273
- Complications
  - Power-law Γ uncertainties
  - Break in spectrum over 0.5–1.0 keV?
  - Order contributions

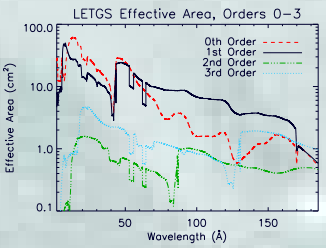
Comparison of corrected model to data with 3C 273 over mid-E range





With significant high order contribution mid-range agreement remains good

Corrected effective area model for orders 0-3



Conclusions & Future Directions

- Derived new low-E LETGS response for E< 0.277 keV, $\lambda > 45$ Å
- Monitor low-E response with HZ 43
- Continue mid-E calibration with 3C 273

Looking into the HRC Vacuum Housing