Improvements to the HRC-S QE Uniformity & LETGS Effective Area
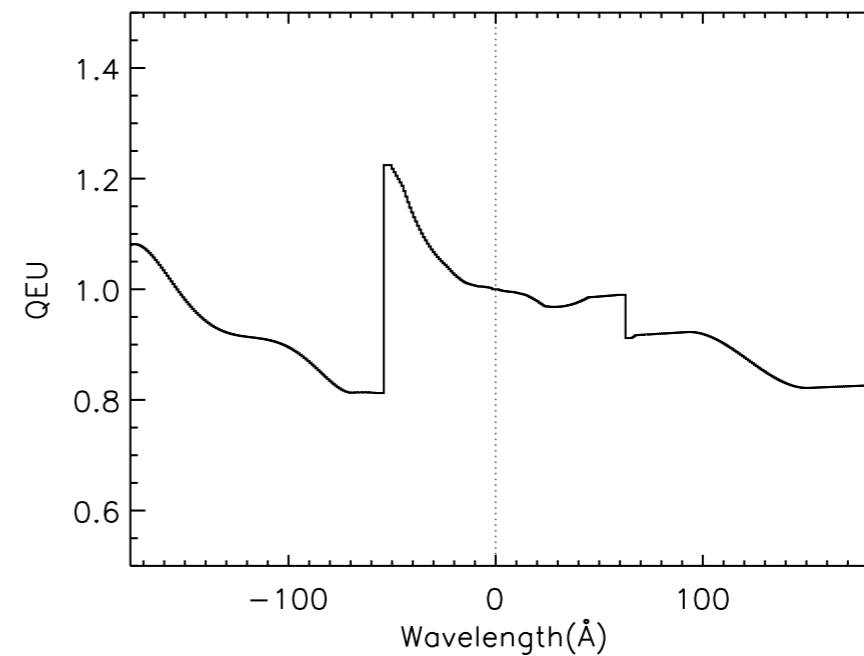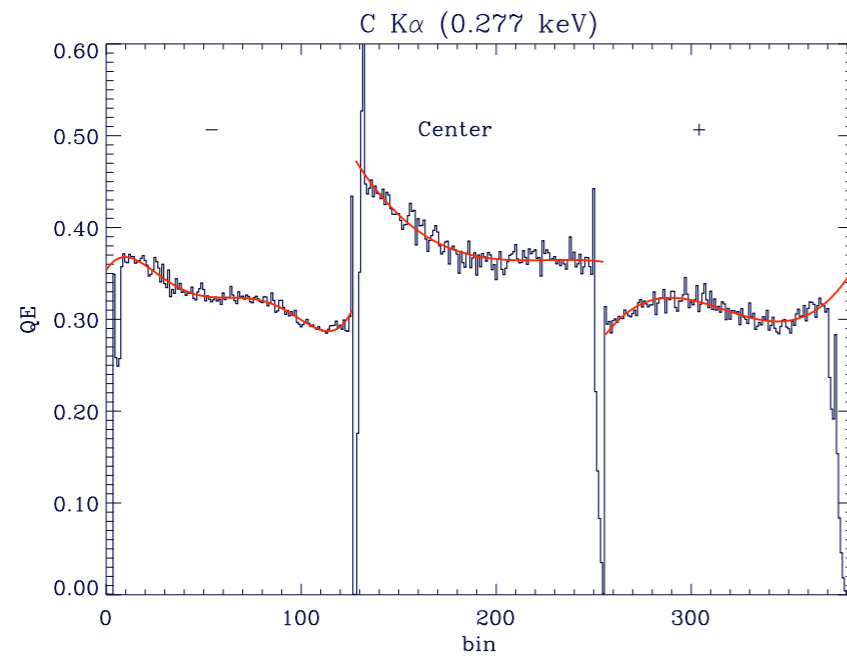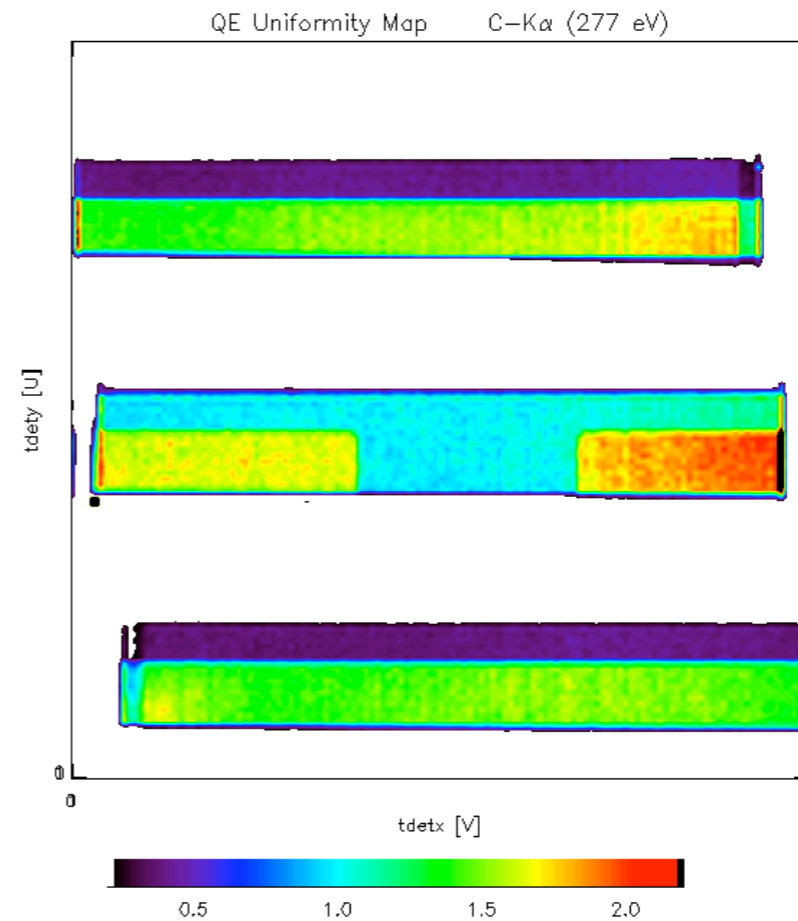
Deron Pease,
Jeremy Drake, Herman Marshall,
Vinay Kashyap, Brad Wargelin

Outline

1. HRC-S QEU update from in-flight data

2. Update to Low-E effective area & Mid-E adjustment

3. $\Rightarrow$ Improved On-Axis QE

QEU Basics

- v1 - QEU=1.0

- v2 - HRC Lab FlatField
  - Fe-Kα, Ti-Kα, Al-Kα, Ni-Lα, O-Kα, C-Kα, B-Kα
  - ~3% stat. err. 1/2-tap bins
  - 3-tap slice along nominal LETG dispersion

QE Uniformity Map   C–Kα (277 eV)

C Kα (0.277 keV)

QEU In-Flight Tune-Up

Data

- **Center -** PKS 2155-304 + MKN 421 ~160ks

- **Wings -** HZ 43 (8 obs) ~178ks

- **Extract in TDET coords.**
  - add obs. with similar aimpoints
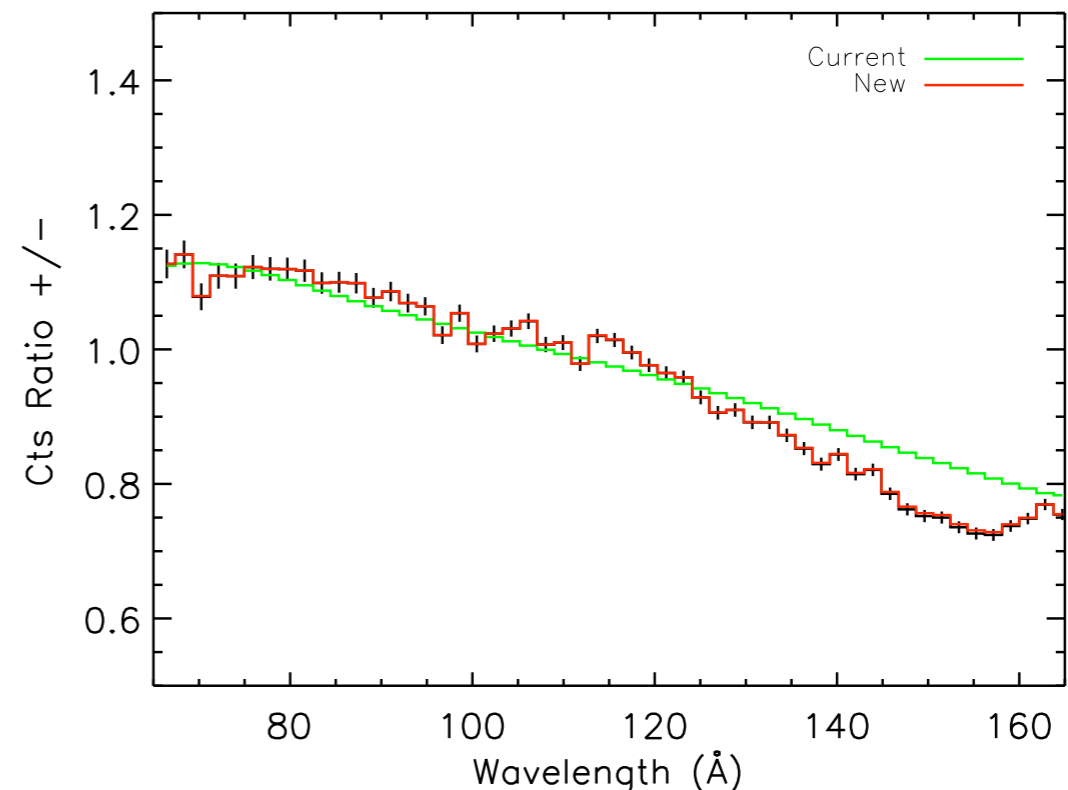 - 1/4-tap bins with ≤ 2% stat. err.

-
-

Method

- **Ratio +/- Counts Spectra vs. Ratio +/- QEU**
  - Independent of other model components
  - QEU correction = slope of line defined by the deviation of the QEU Ratio from the Counts Ratio at each wavelength
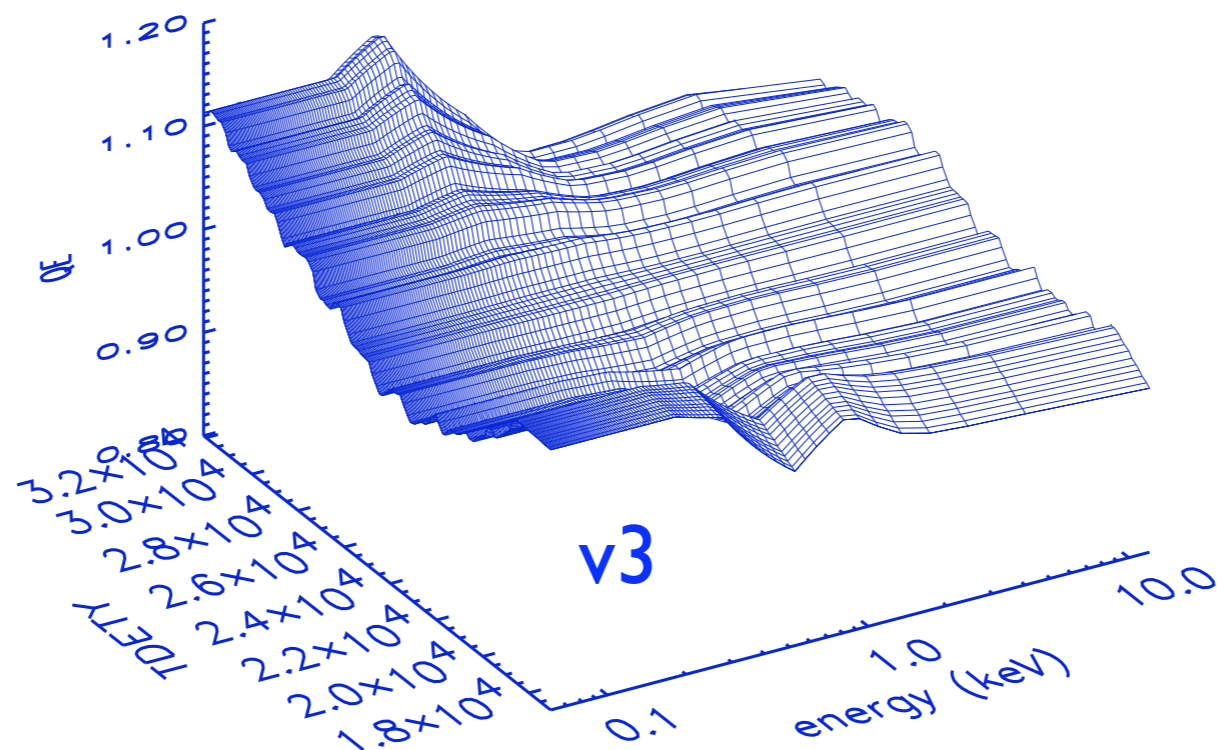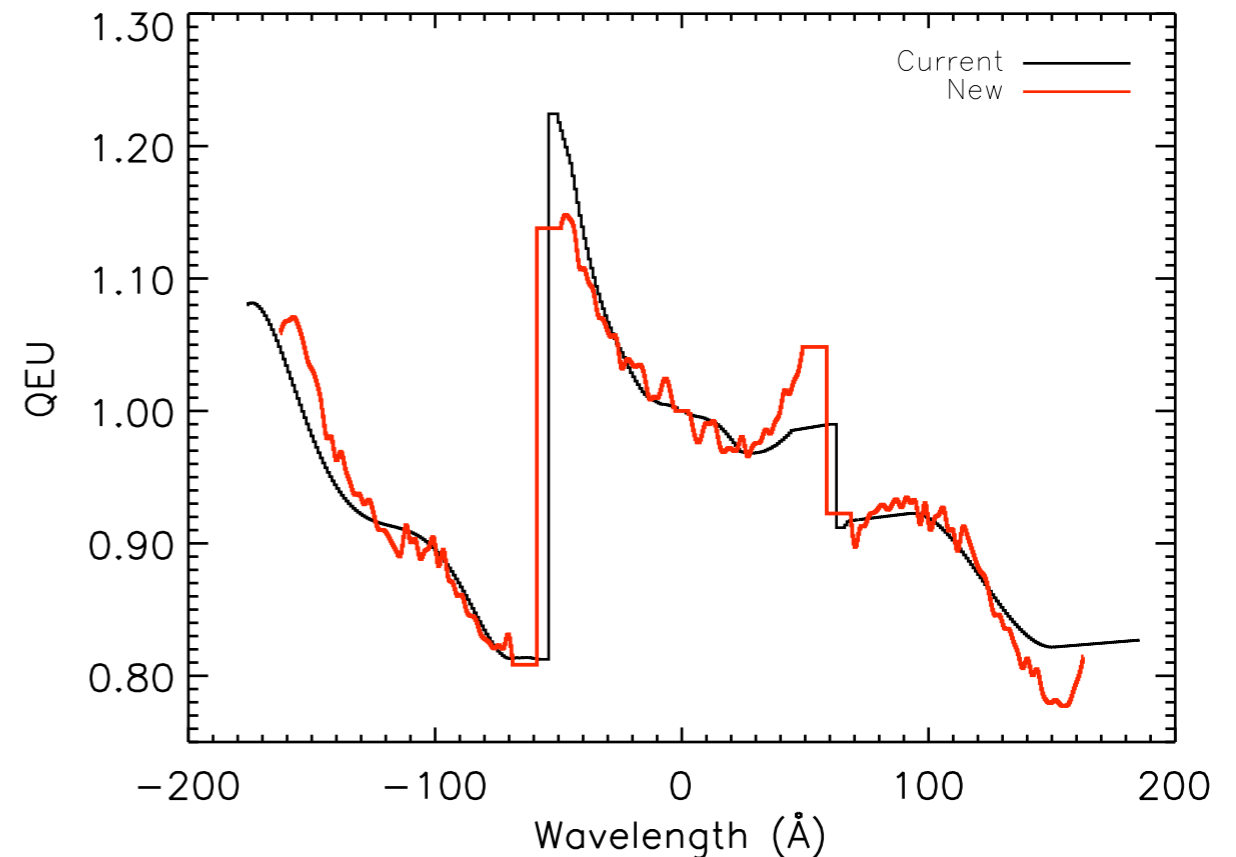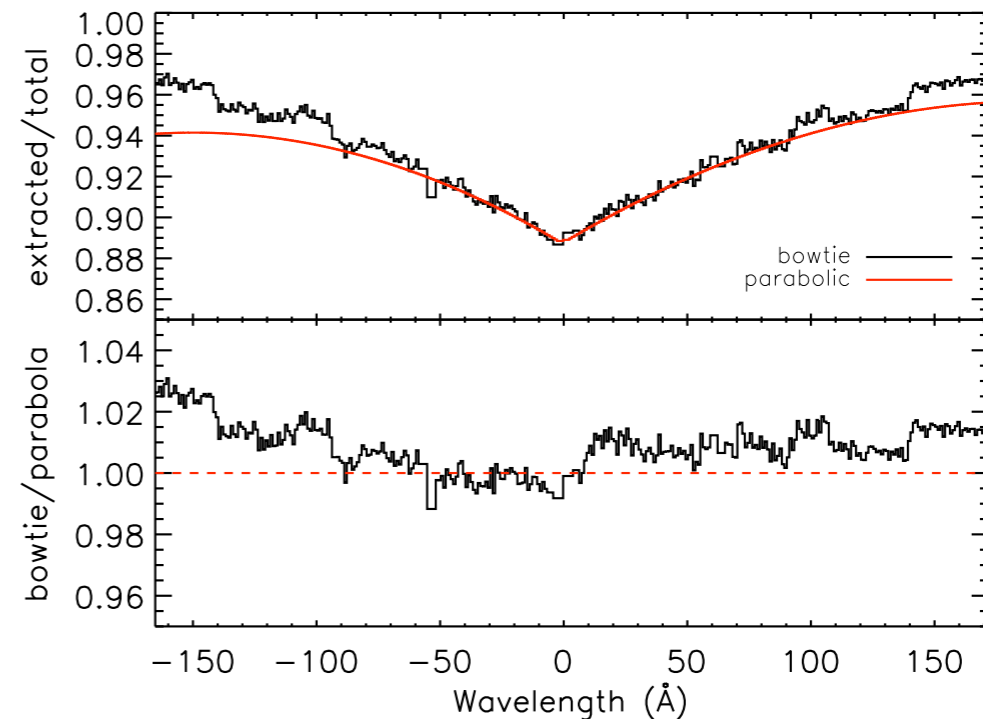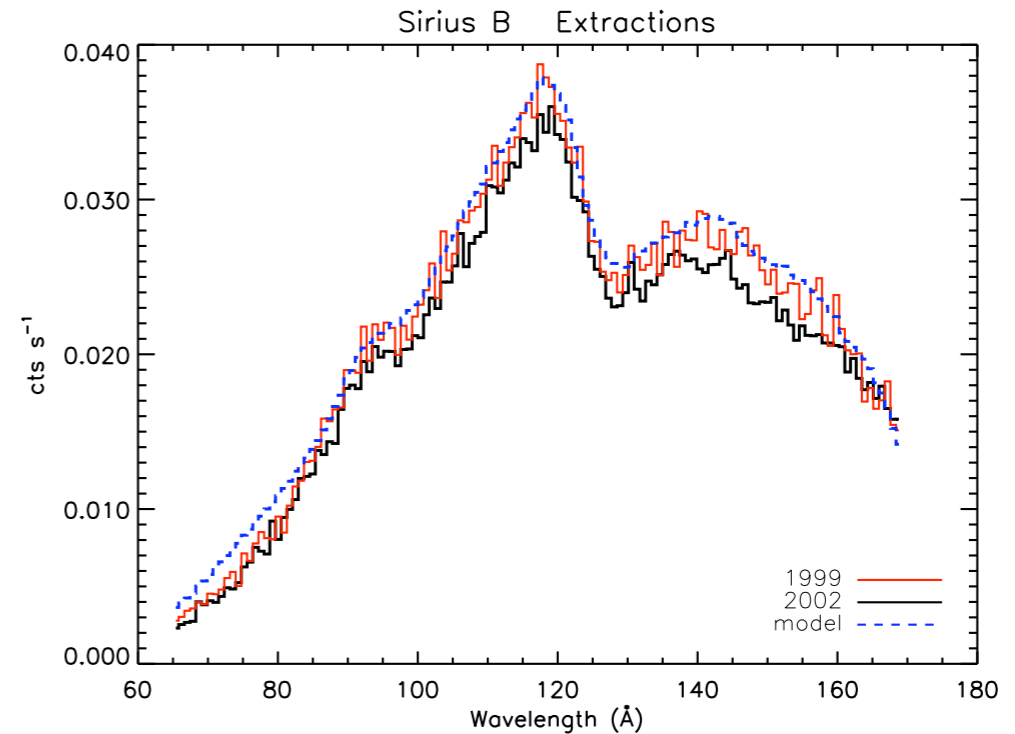
PKS 2155−304 + MKN 421
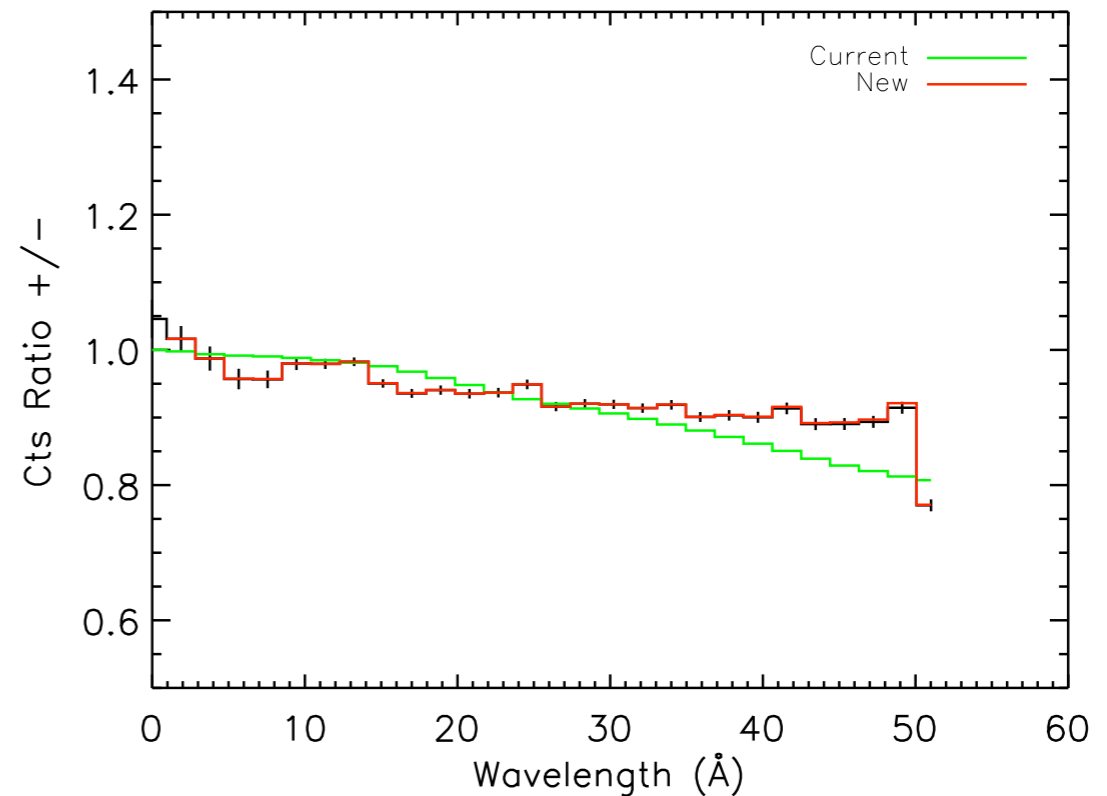
HZ 43

QEU Improved

- Separation of Pos. & Neg. is not possible

- Apply correction oppositely to Pos. & Neg. QEU v2

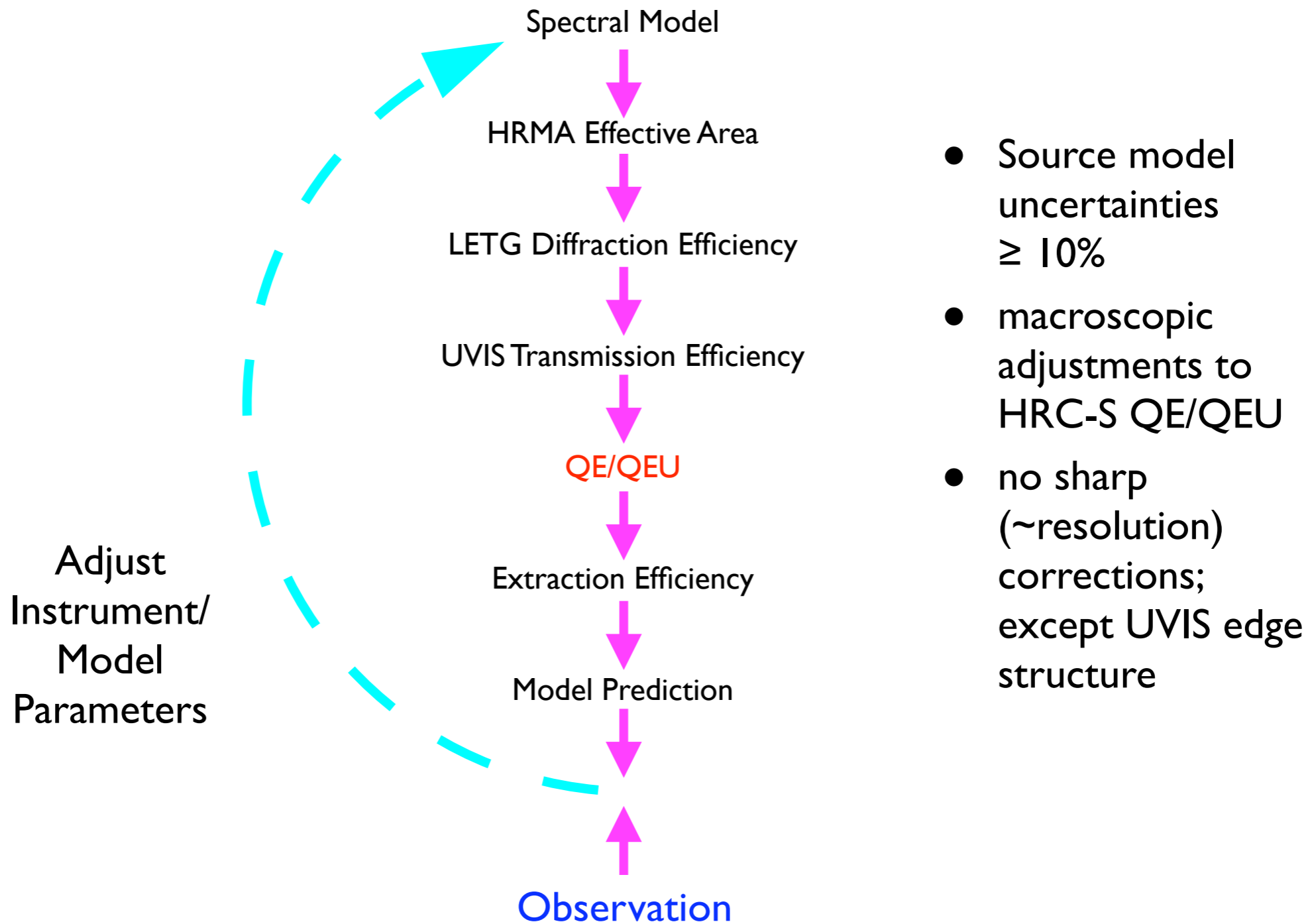- Anti-symmetric wobbles required to transform on-axis QE to LETG dispersed Effective Area

v3

Low-E Revisited:
LETGS Effective Area

- Sirius B Extraction Discrepancy ~10%   1999 vs 2002
  - dead-time corrections & GTIs
  - total exposure times
  - status bit filtering
 - extraction region - parabolic vs bow-tie

Effective Area Adjustments

Spectral Model

↓

HRMA Effective Area

↓

LETG Diffraction Efficiency

↓

UVIS Transmission Efficiency

↓

QE/QEU

↓

Extraction Efficiency

↓

Model Prediction

↓

Observation

Adjust
Instrument/
Model
Parameters

- Source model uncertainties ≥ 10%

- macroscopic adjustments to HRC-S QE/QEU

- no sharp (~resolution) corrections; except UVIS edge structure

Low-E Improved: Thanks, Sirius B

- Sirius B 3 obs   1999   ~60ks
- best WD atmosphere model uncertainties ~10%
- "good" range $\lambda > 80$ Å
- data binned to $\leq 3\%$ stat
-
-
- Error evaluation:
  - Low-E + QEU   20% ⇒ 15% ??
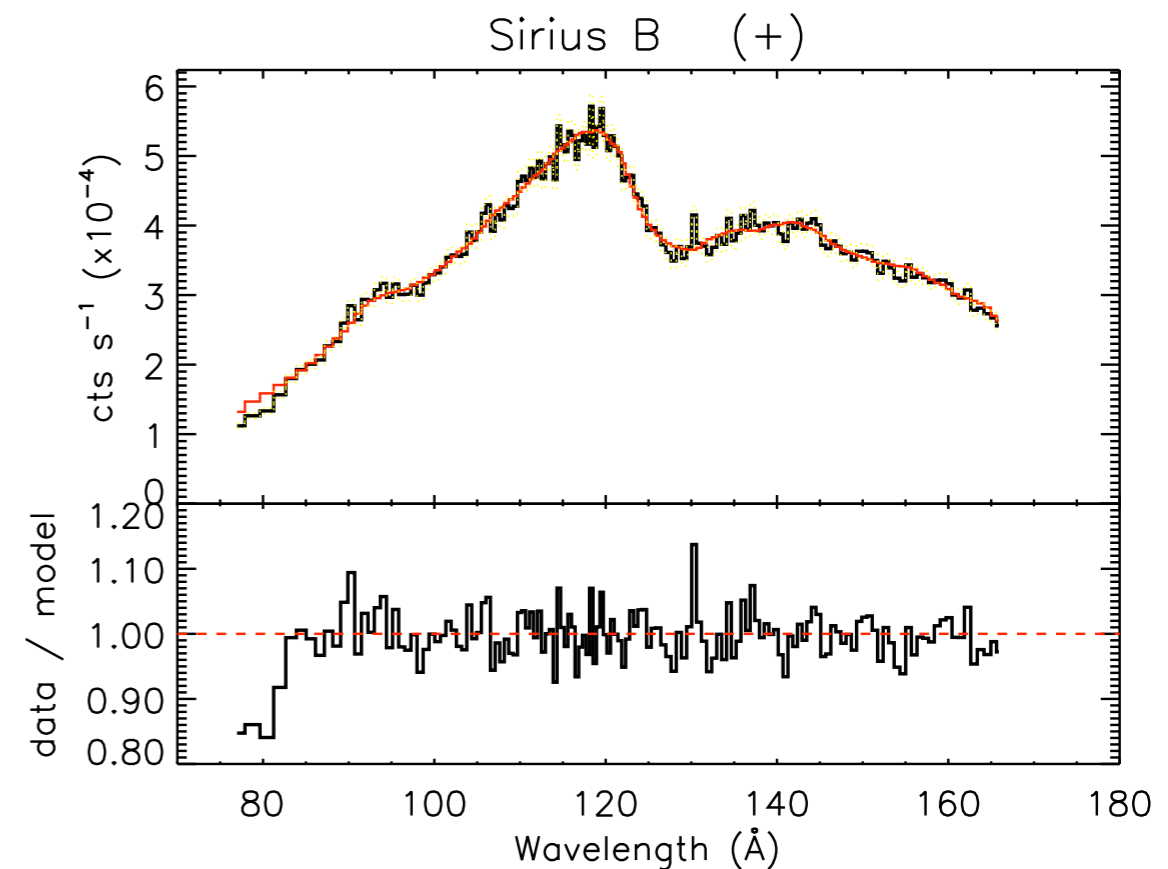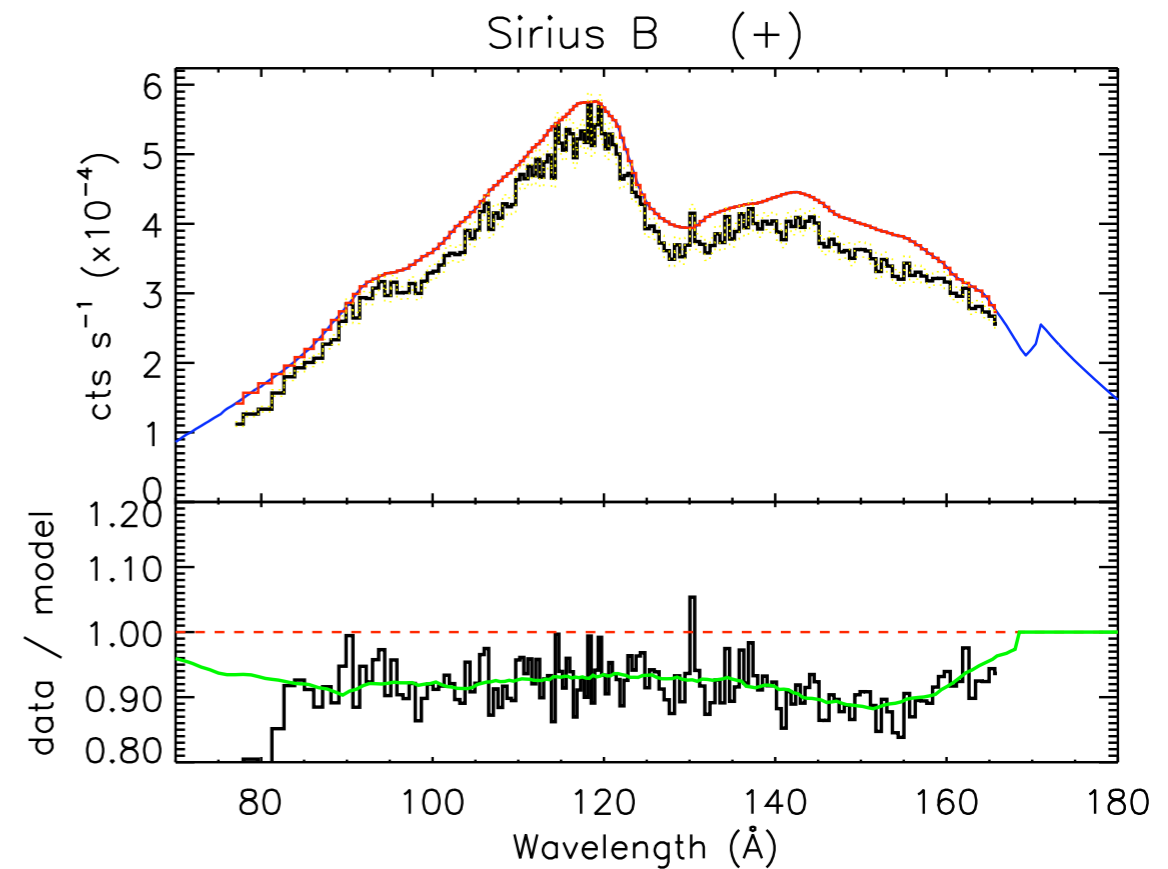
Mid-E Adjustment

- LETG efficiencies update
-
-

- PKS 2155-304   1999   ~60ks
- Single power-law model*
- range   λ < 60 Å
- data binned to ≤ 2% stat
- Modest smooth adjustment < 5%
-
- uncertainties ~10%

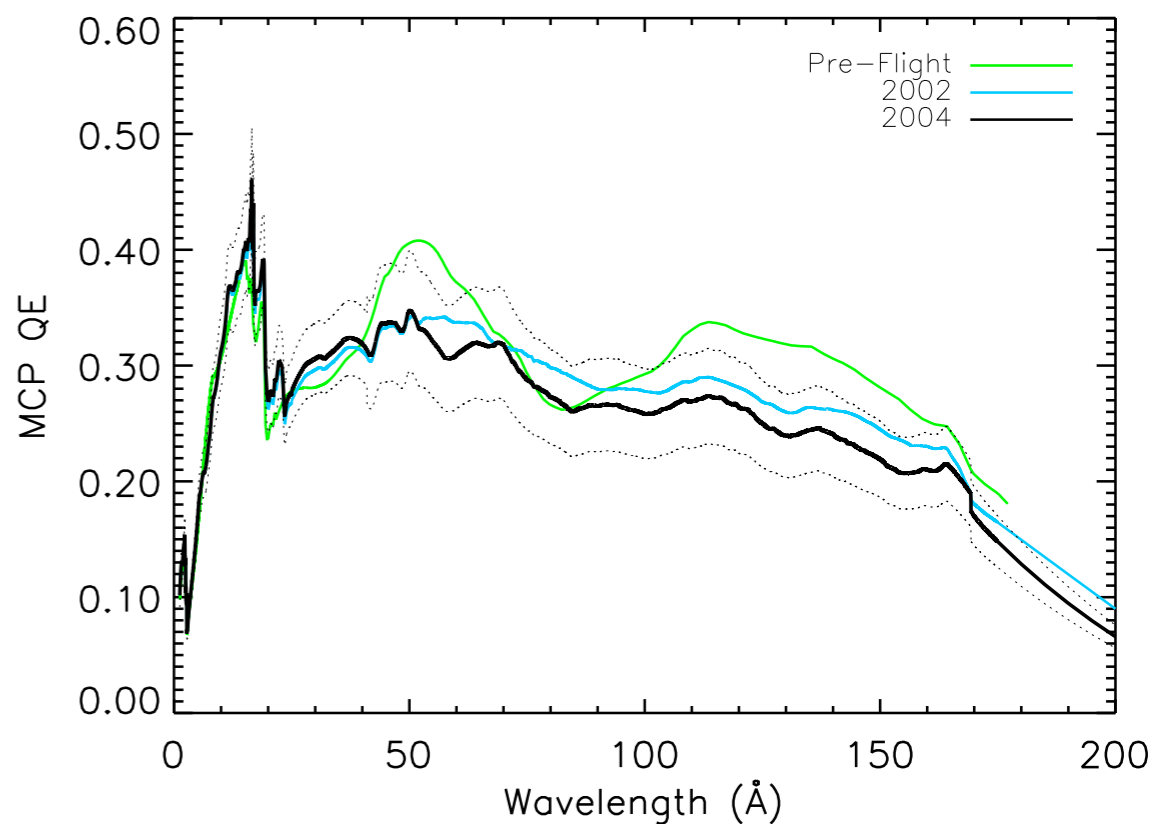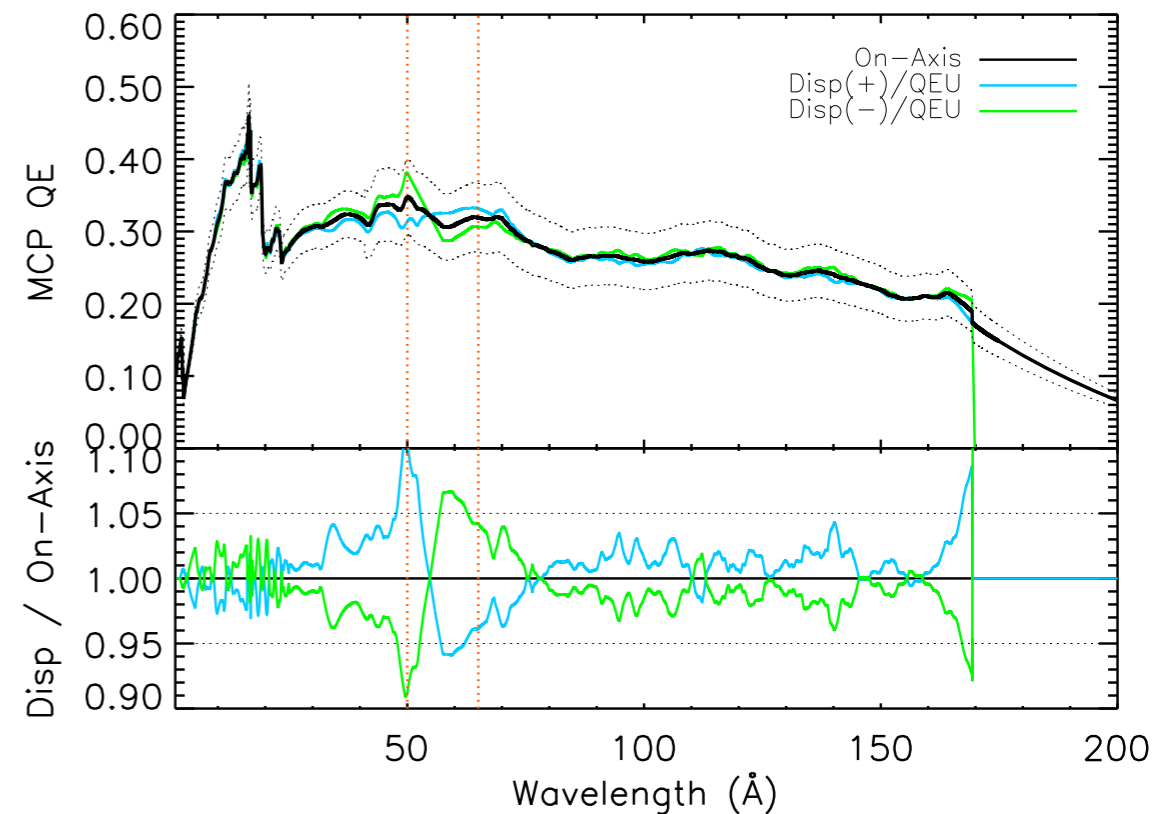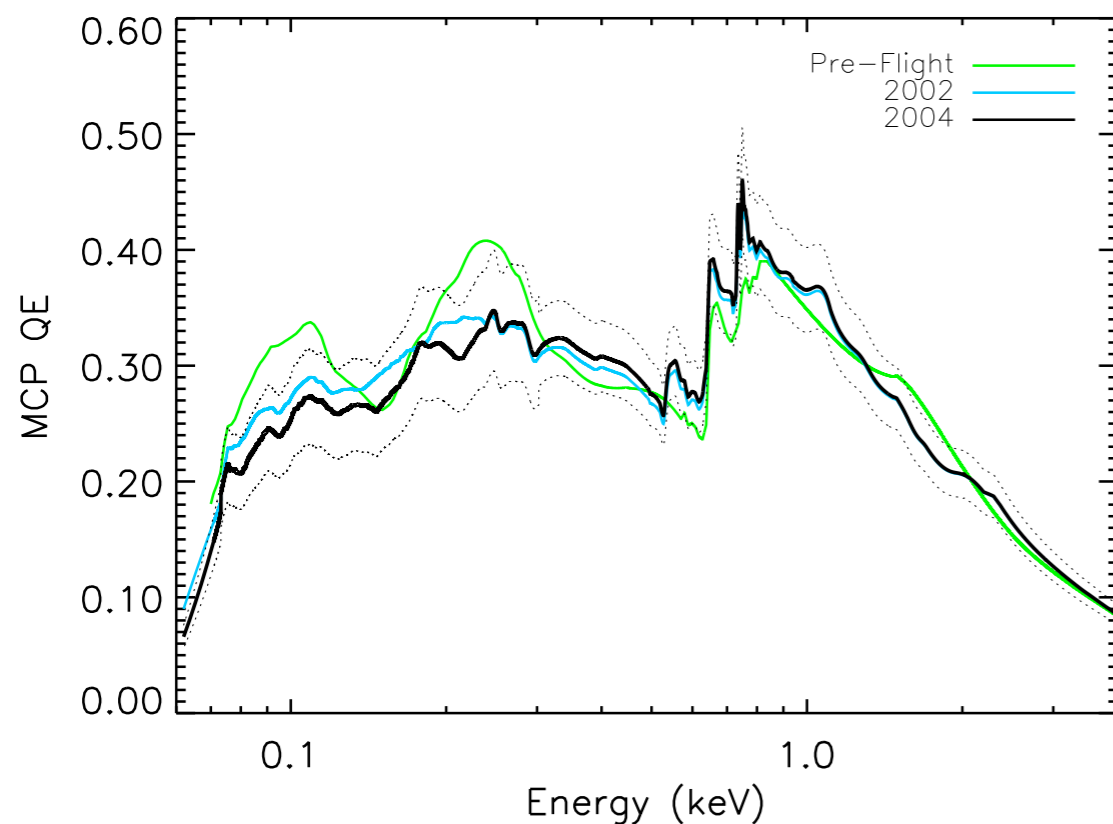PKS 2155−304   Dec 1999   (+)

PKS 2155−304   Dec 1999   (+)
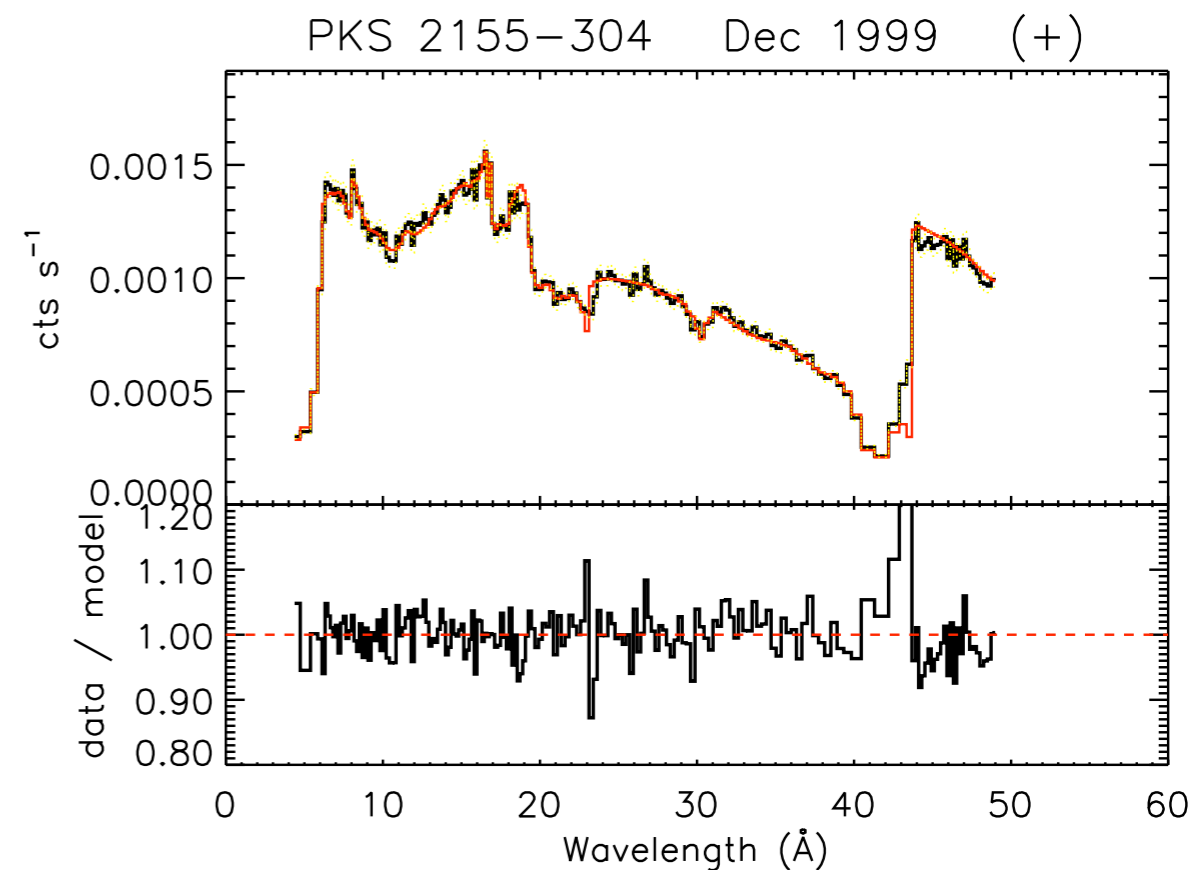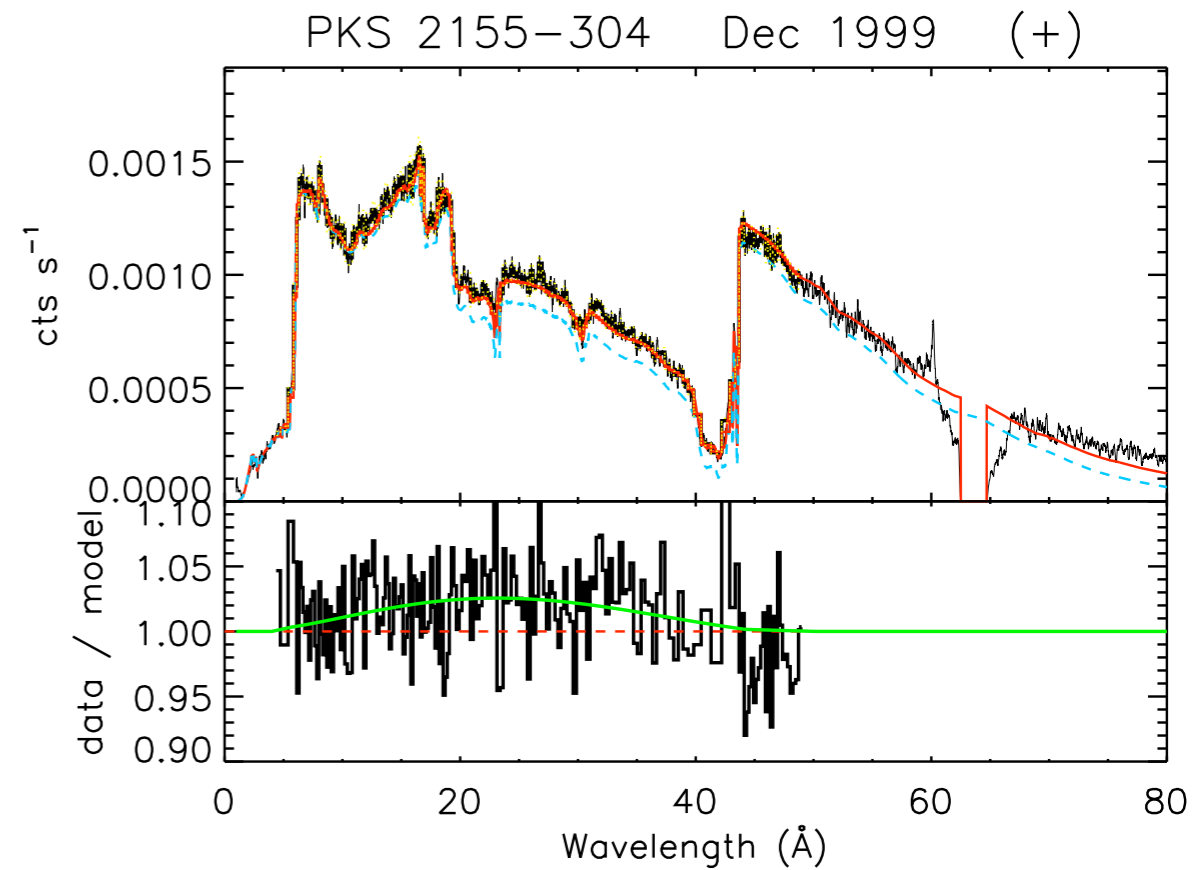
Apply the Improvements

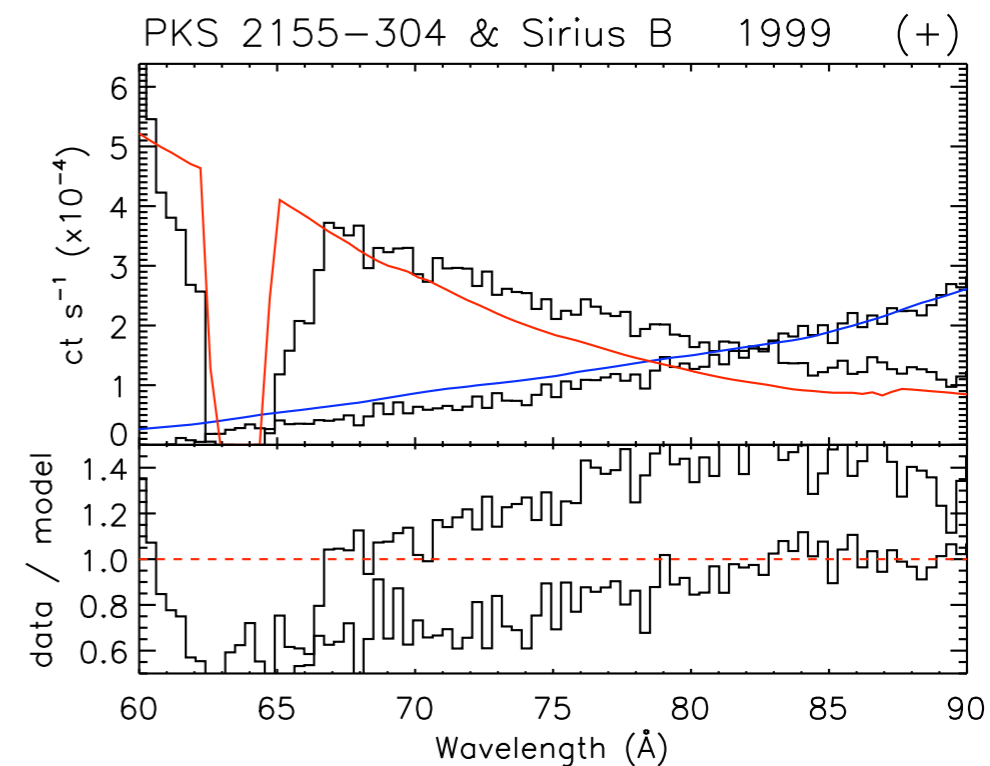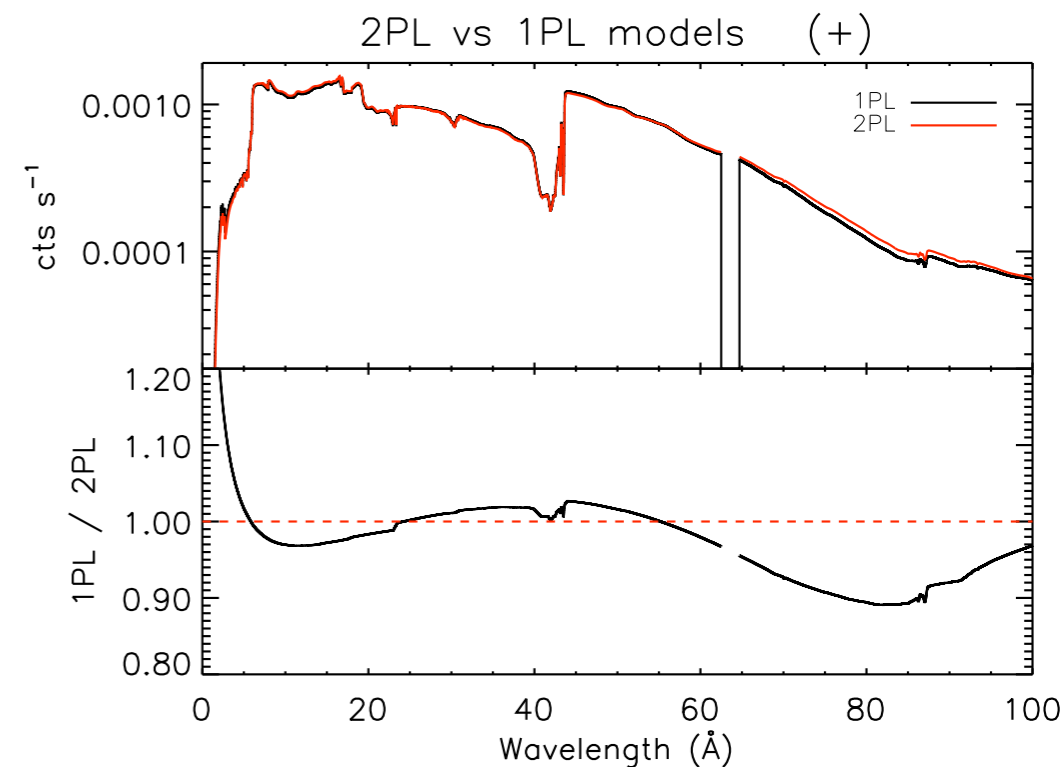Employ QEU to derive on-axis QE
from Low-E & Mid-E EA updates

- R.M.S. deviation   ~1.9%

History of on-axis QE

Remaining Ideas/Issues

- ## PKS 2155-305 PL Model
  - clearly complex data
  - 2PL vs. 1PL
    - $\lambda < 60$ Å   effect < 5%
  -

- ## 60 Å < λ < 80 Å
  - poor statistics, no data
    - no strong source
    - plate gaps
    - binning gets messy
  - SB & PKS indicate opposite
  - Can HZ 43 & MKN 421 help?

2PL vs 1PL models   (+)

PKS 2155-304 & Sirius B   1999   (+)

Conclusions/Speculations?

Go Sox!!!