

# Chandra Calibration Status



CUC Meeting Oct. 23, 2014

# Chandra Calibration Status

- Calibration updates since the 2013 CUC meeting
- Current calibration studies
- Internal cross-calibration results
- Calibration plans for the upcoming year

# Calibration products released over the past year

## ACIS

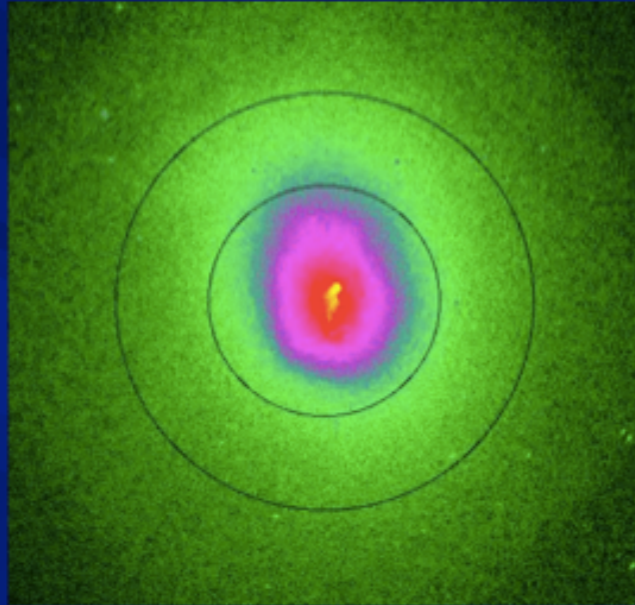
- Quarterly gain corrections for ACIS-I and ACIS-S
- Updated contamination models in Dec. 2013 and July 2014
- Posted a memo on the analysis of CC-mode data

## HRC

- Yearly gain maps for the HRC-I and HRC-S
- Yearly QE maps for the HRC-S
- Yearly HRC-I background image and spectrum

# Contamination on the ACIS Filters

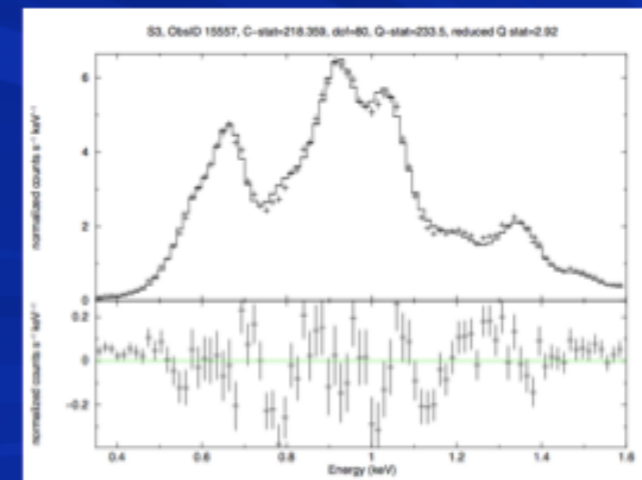
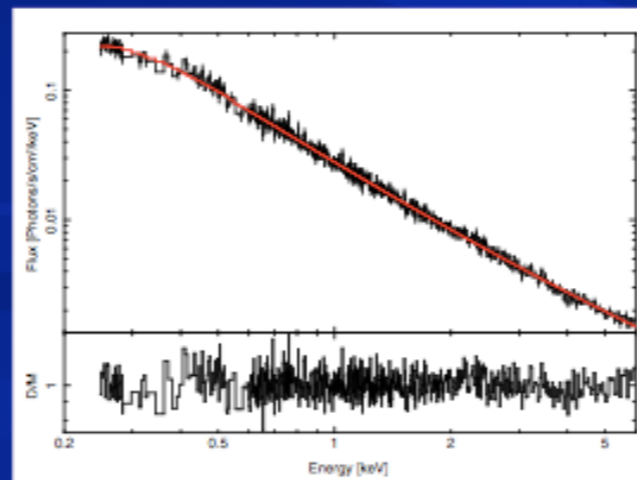
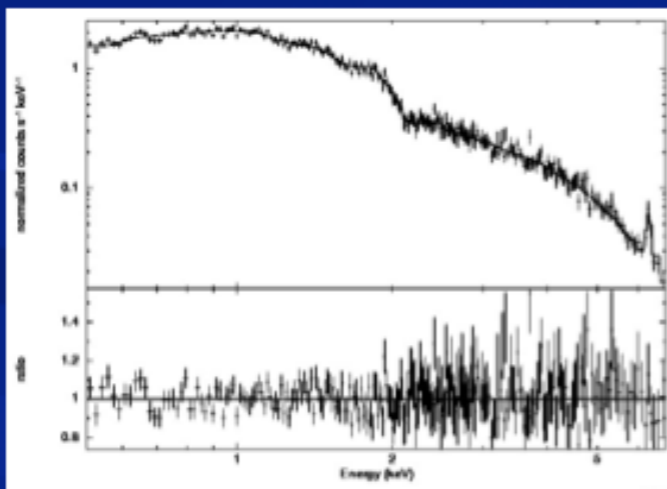
Abell 1795



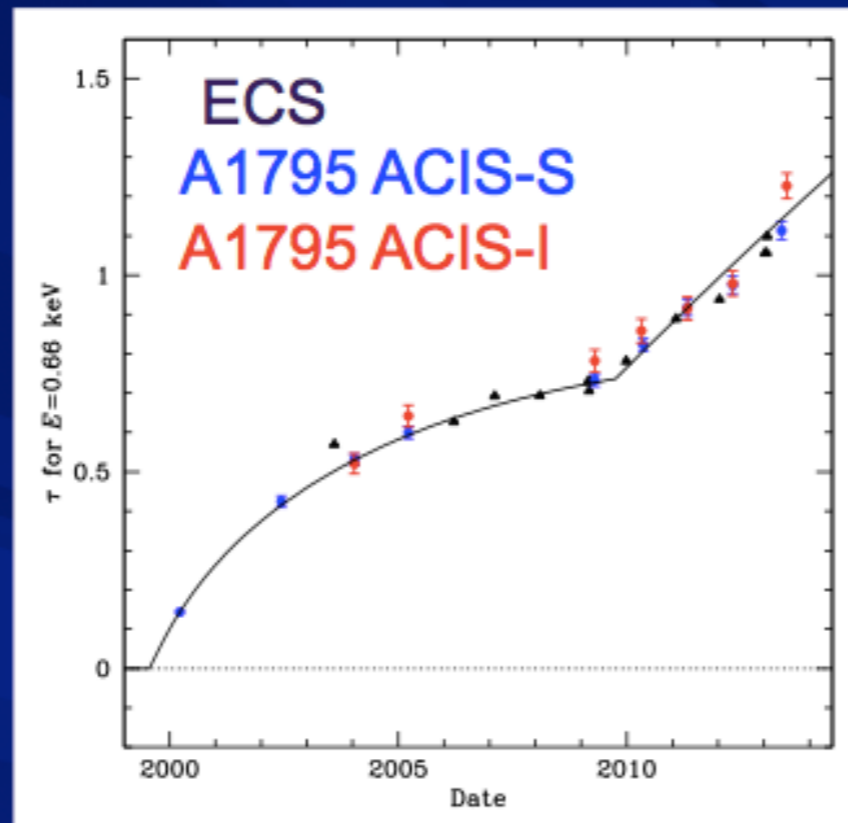
Blazars

Mkn 421  
PKS 2111-304

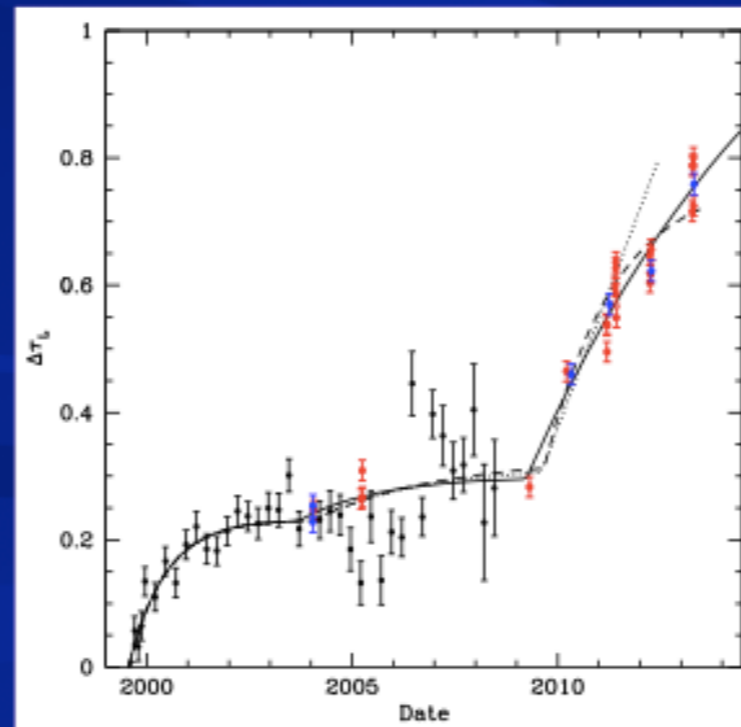
E0102-72



# Contamination on the ACIS filters

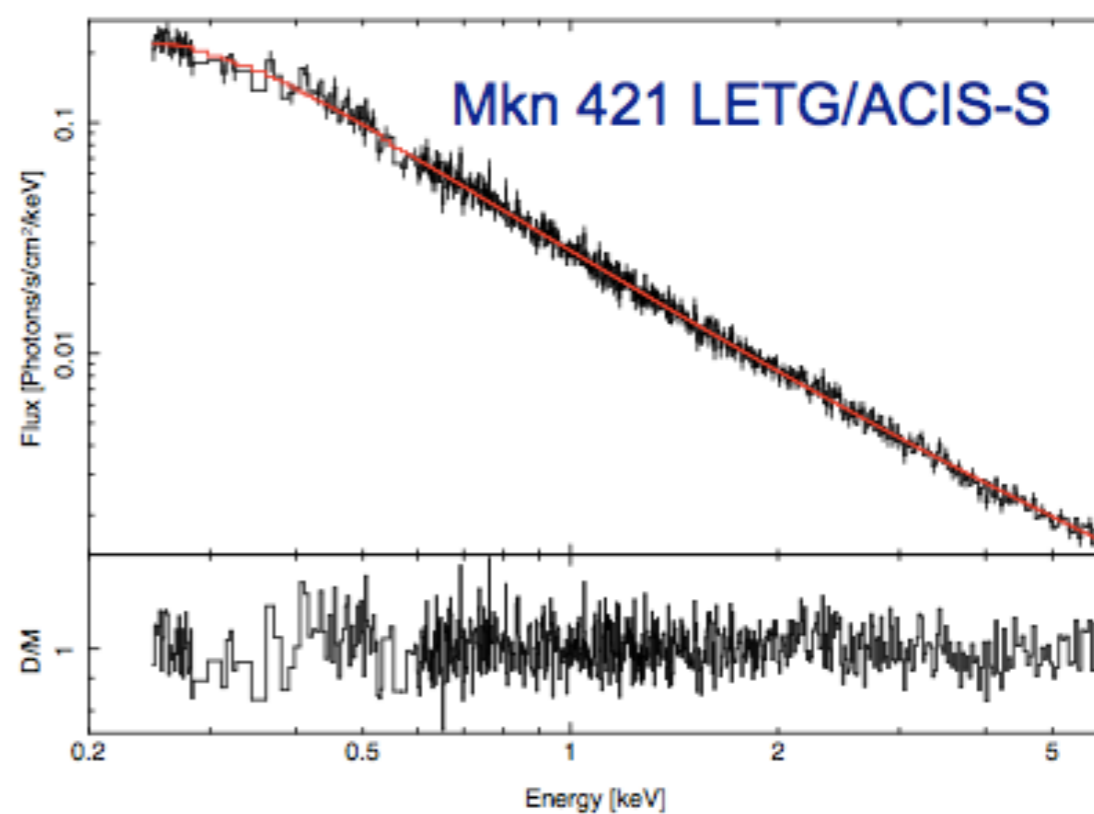
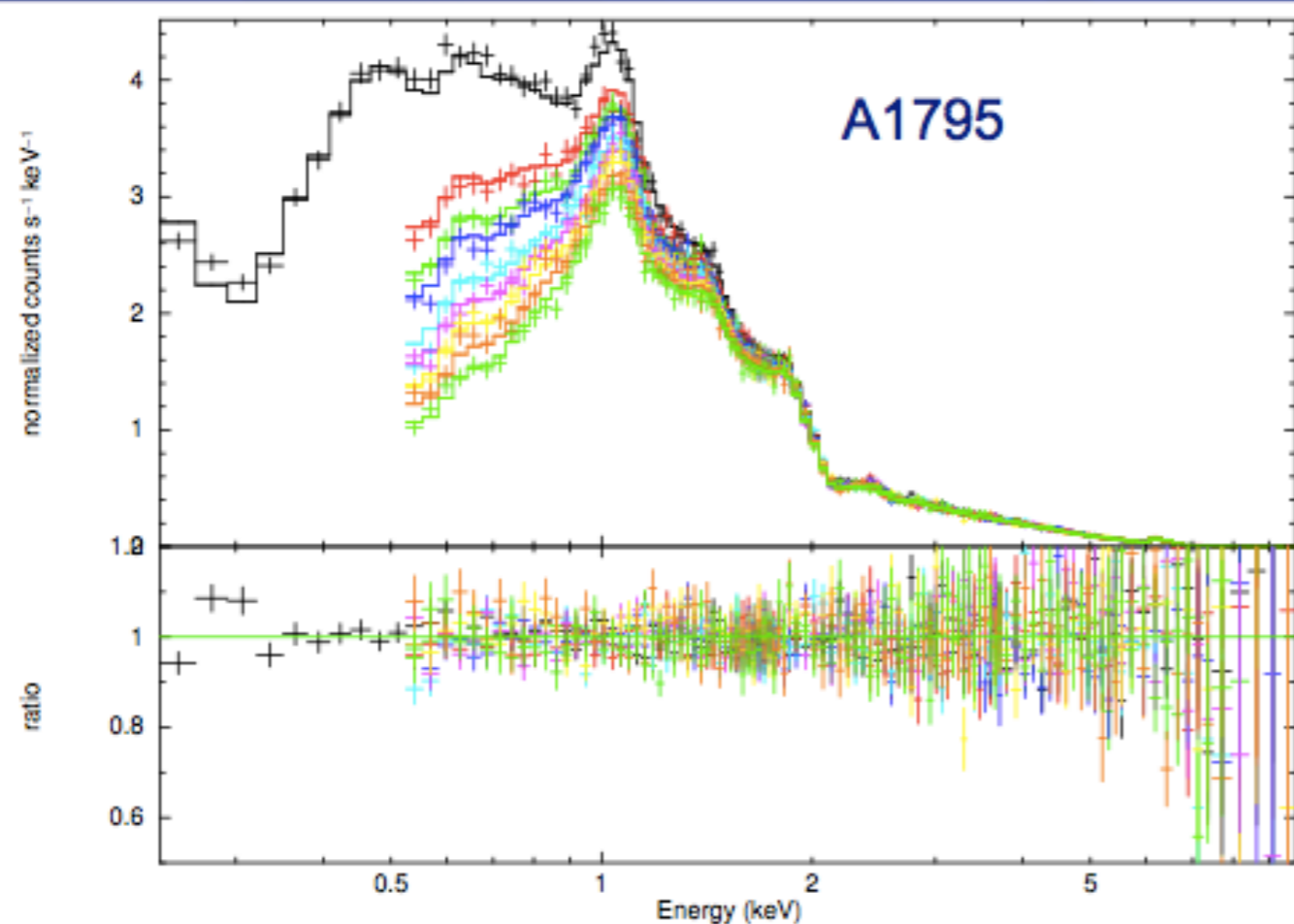


Plots from 2013 CUC meeting -  
based on data acquired through  
the end of 2013



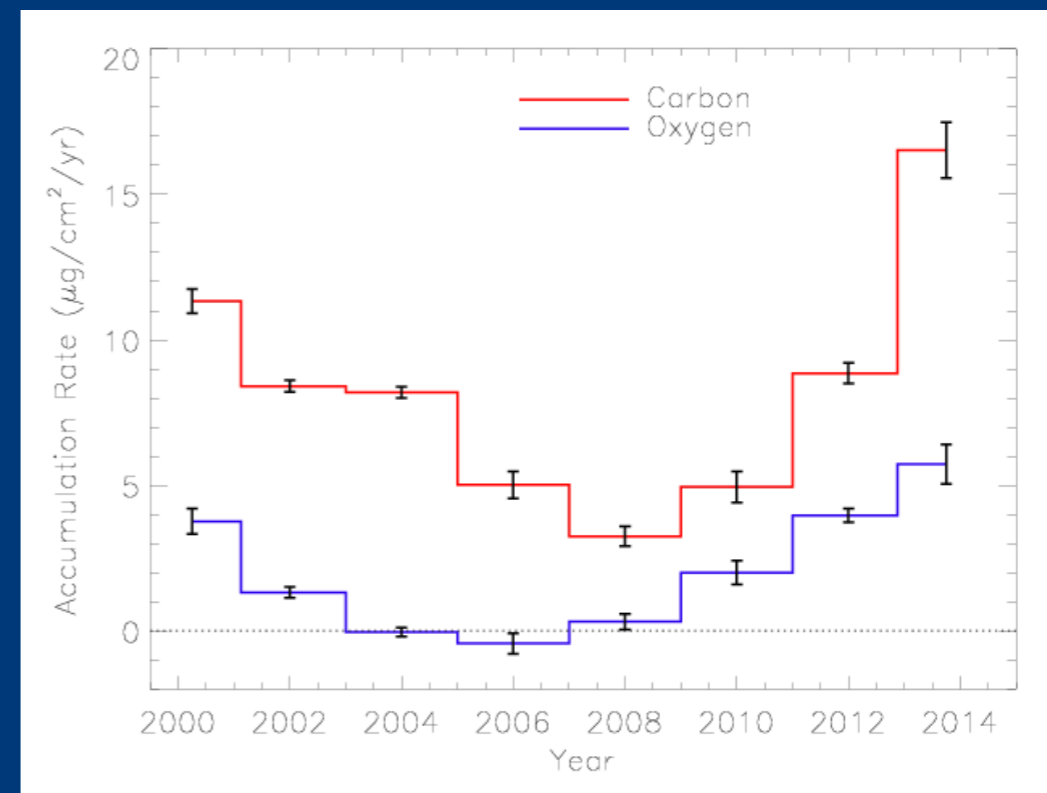
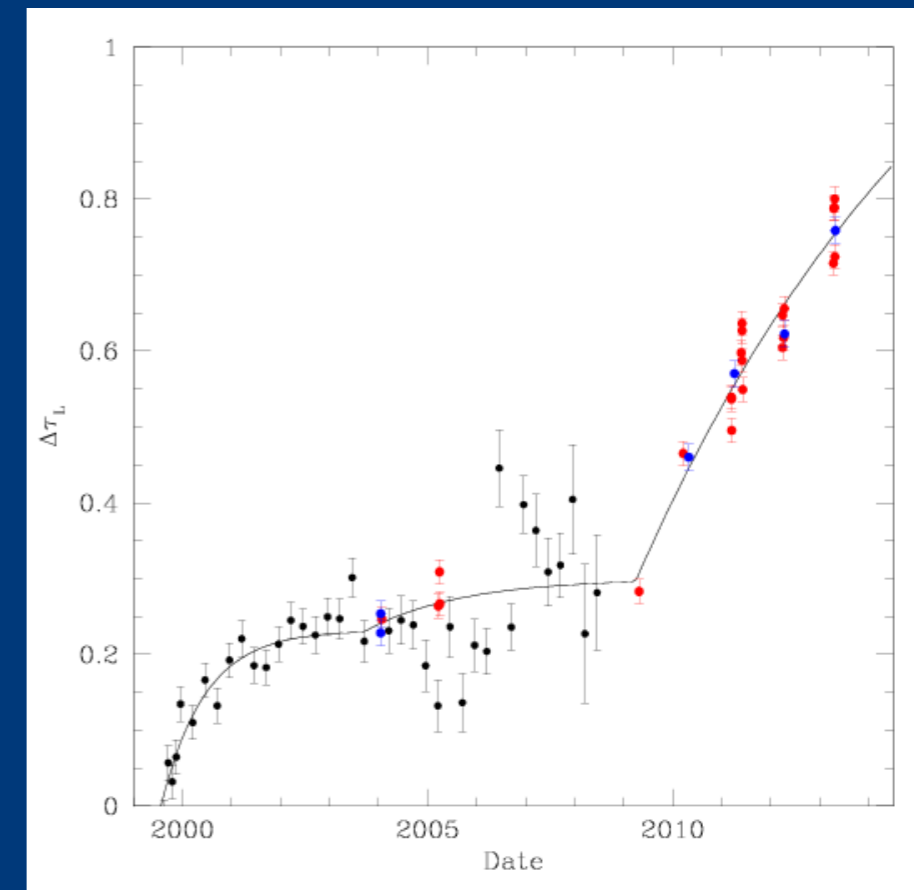
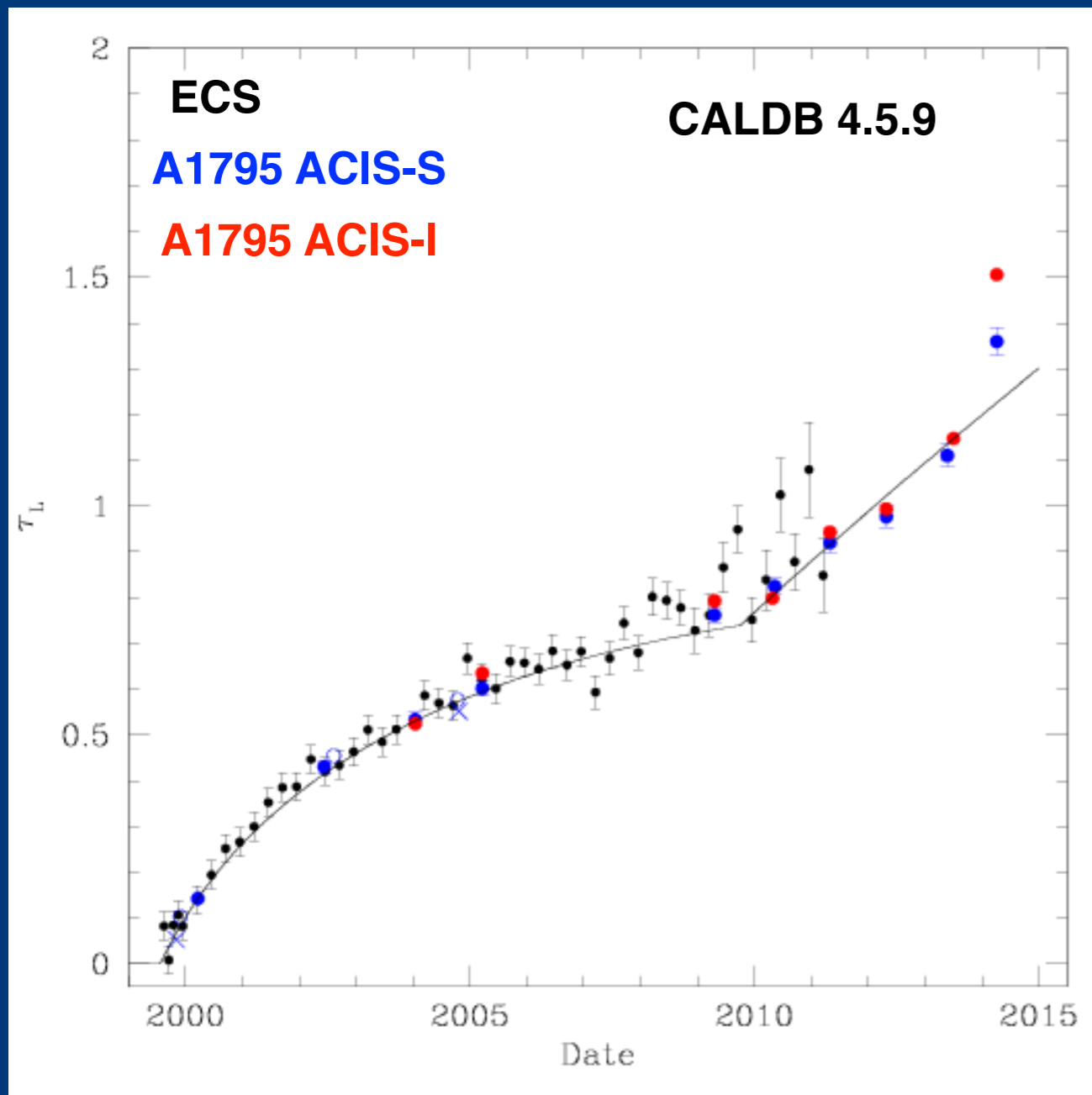
# Contamination on the ACIS filters

Data acquired through 2013 fit with the CALDB 4.5.9 version of the ACIS contamination model released in Nov. 2013.

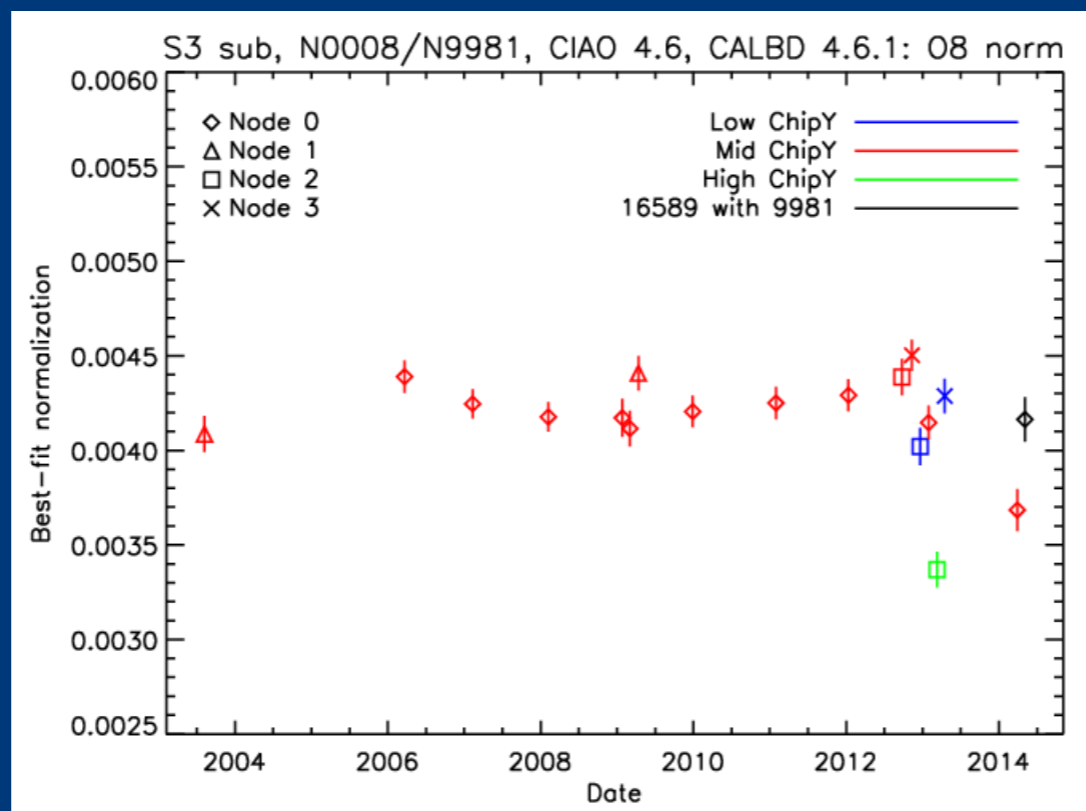
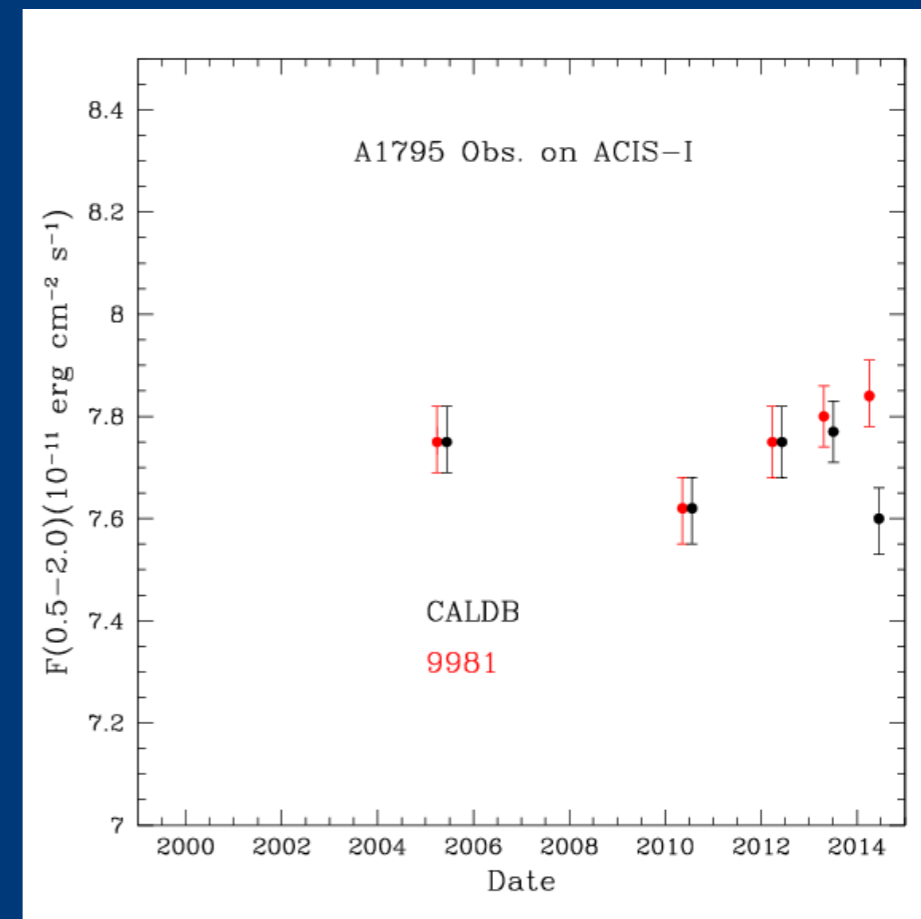
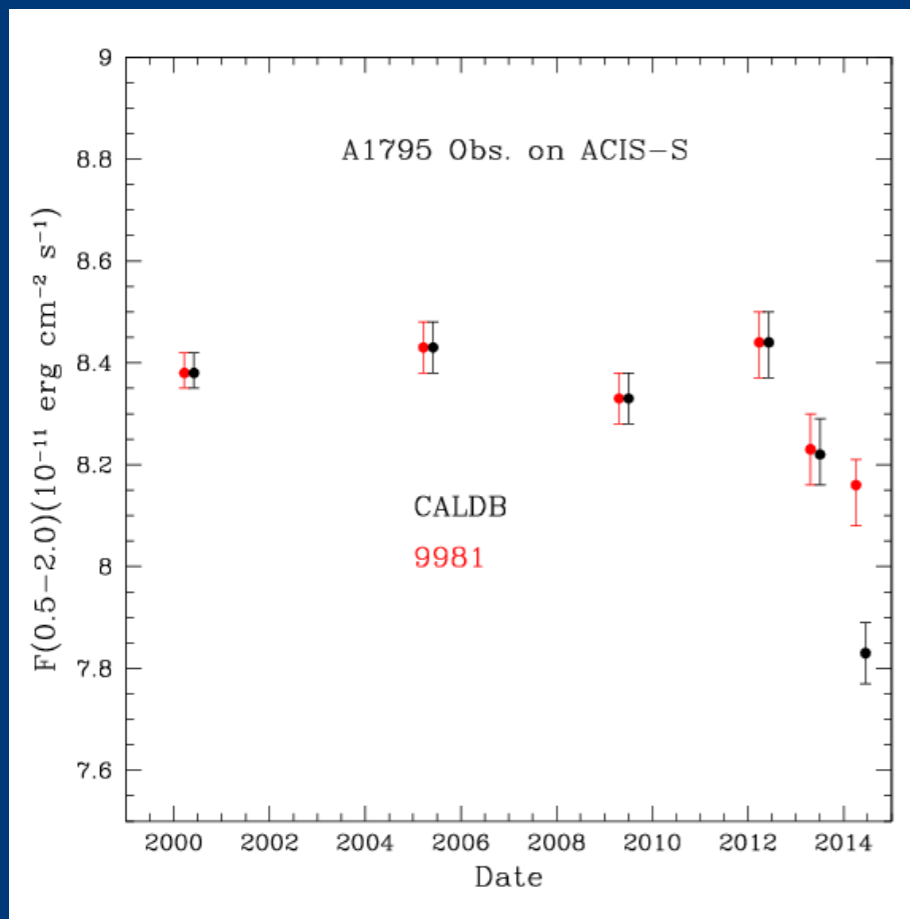


# Contamination on the ACIS filters

Data through June 2014



# Contamination on the ACIS filters



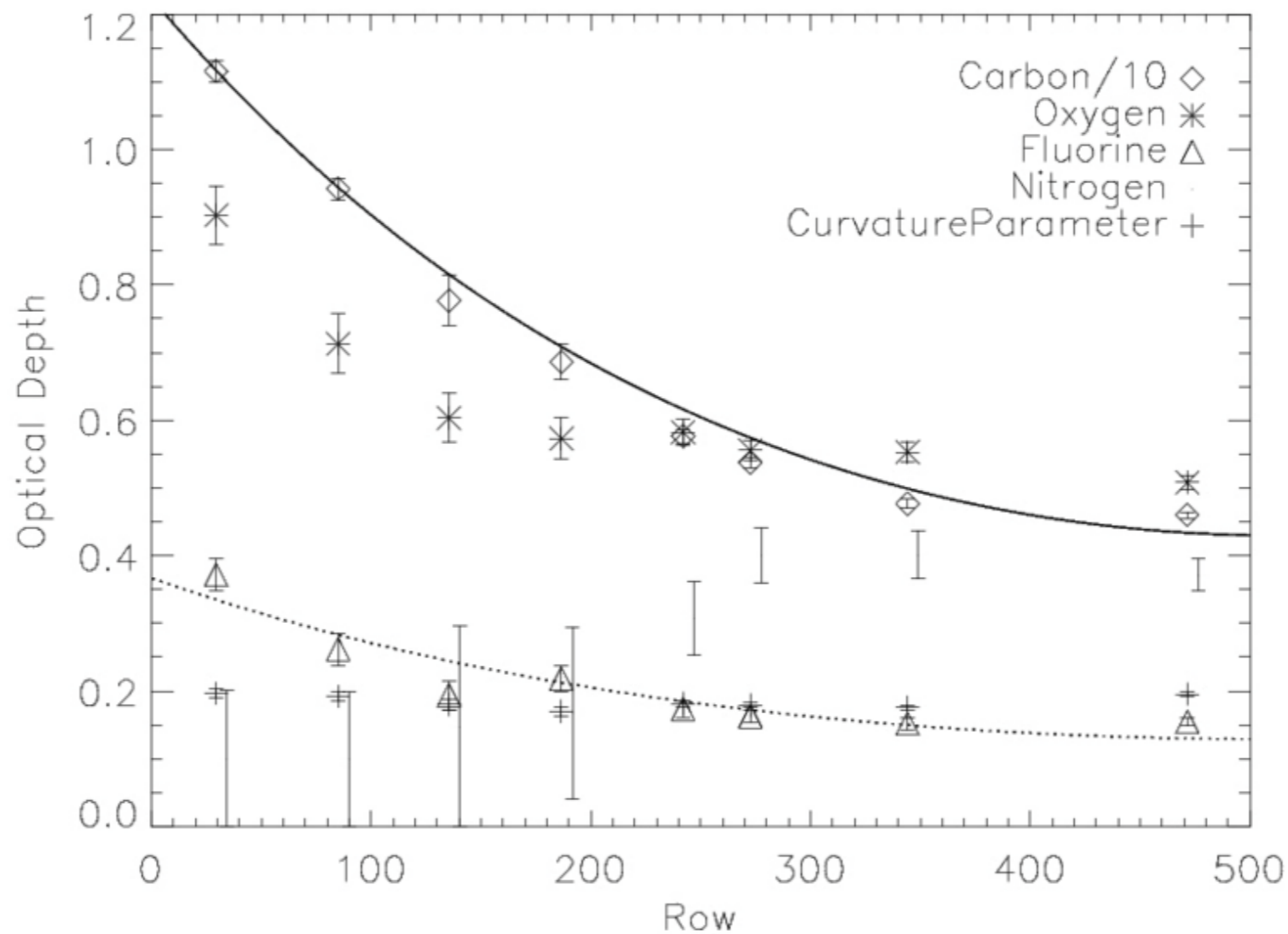
**Model 9981 was released in CALDB 4.6.2 in July 2014 which included an adjustment to the time-dependence only.**



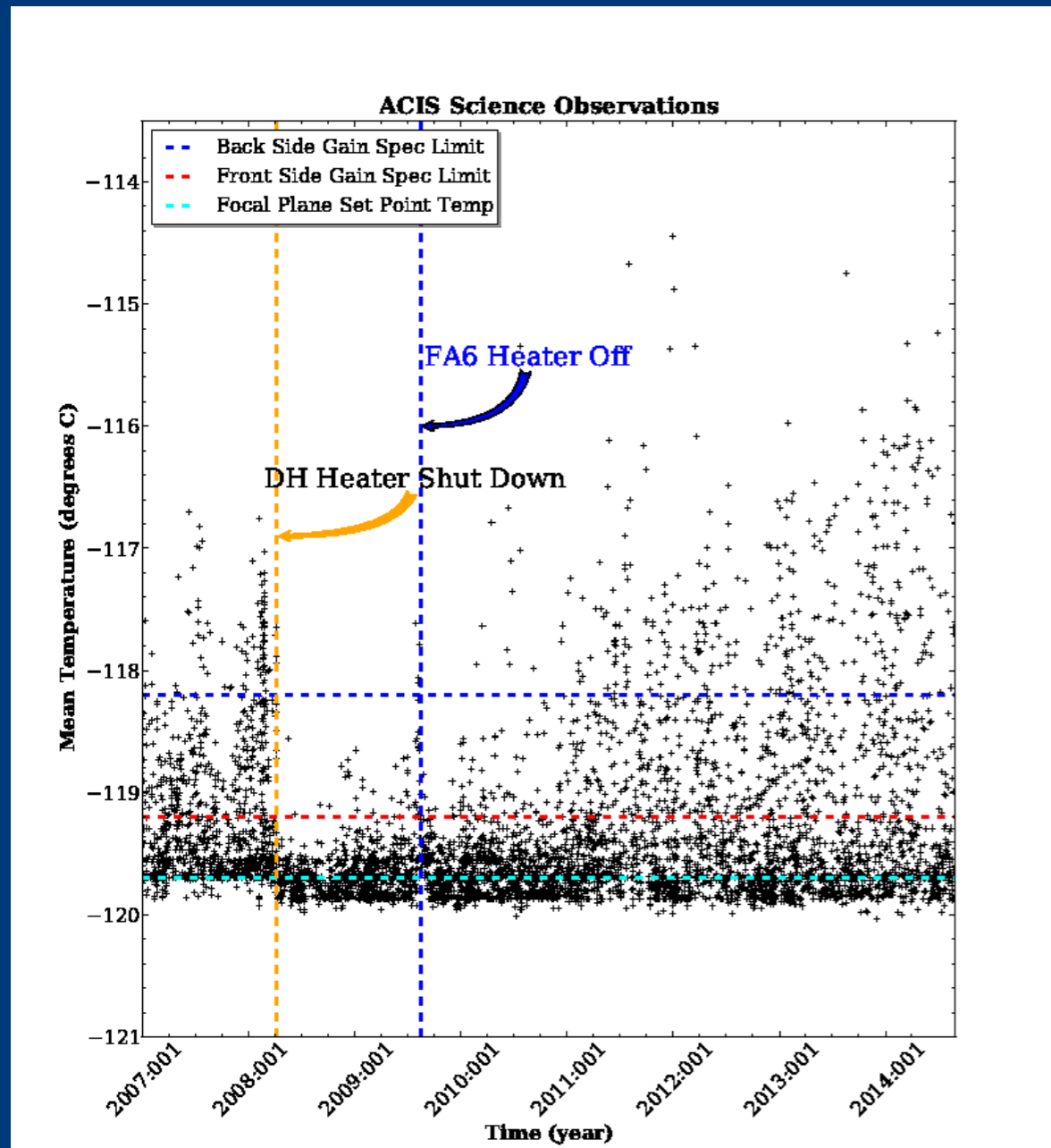
# Contamination on the ACIS filters

LETG/ACIS-S Observations of Mkn 421

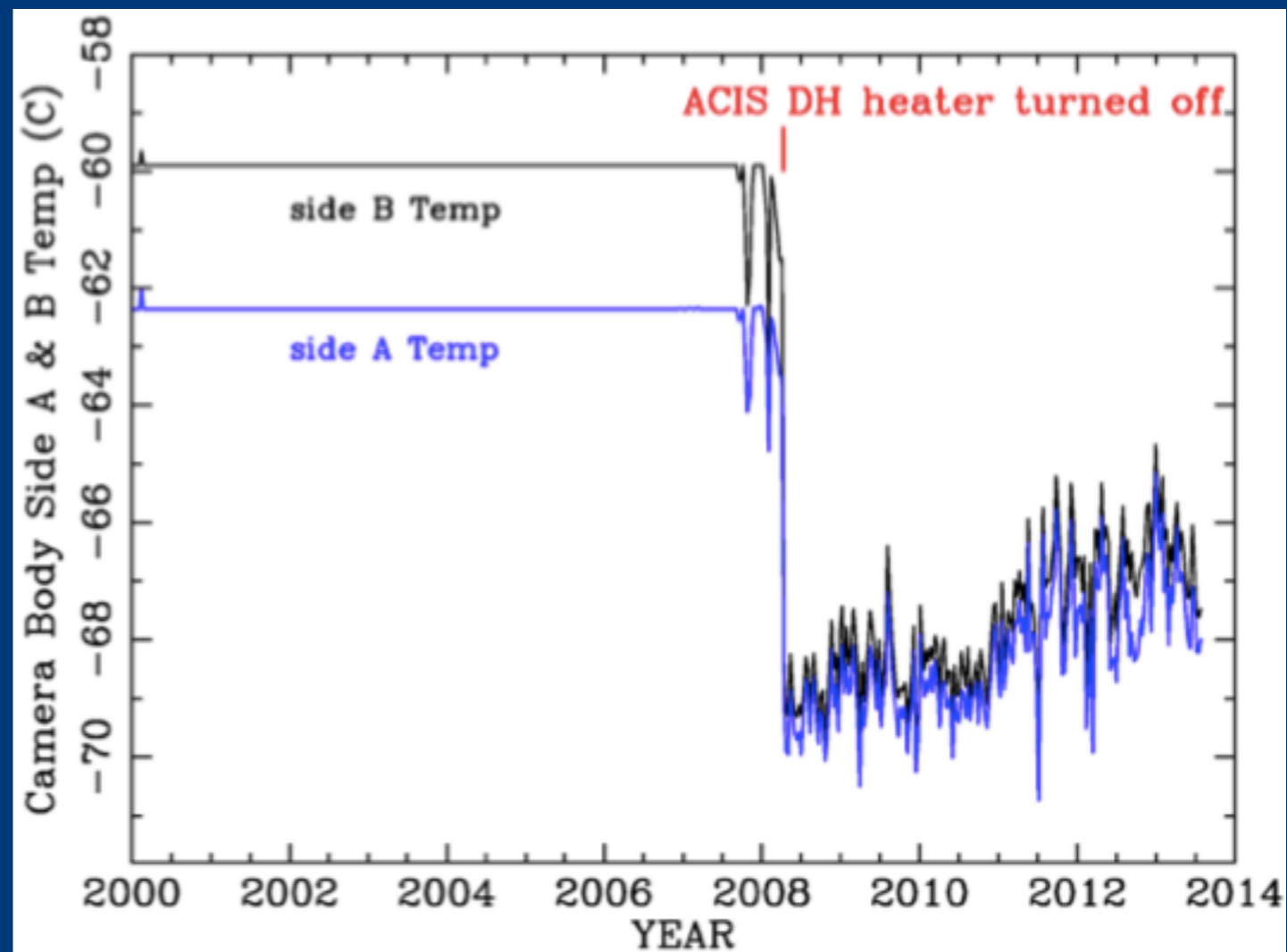
## Big Dither (Mar. '14)



# ACIS Temperatures



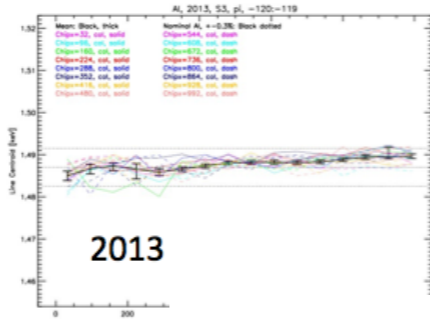
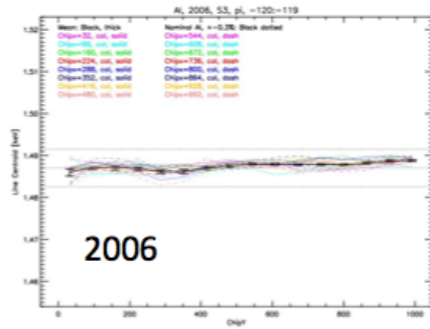
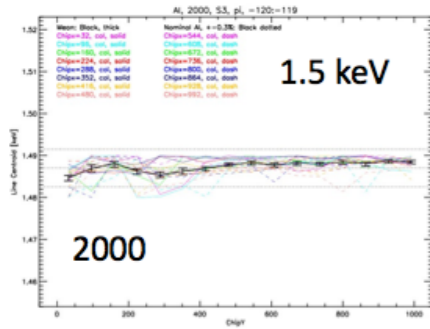
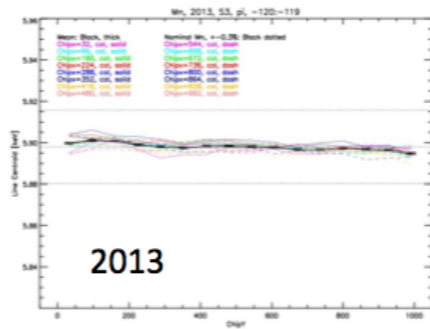
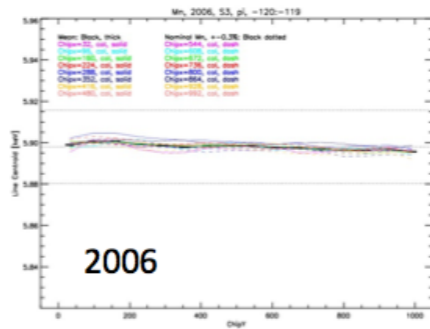
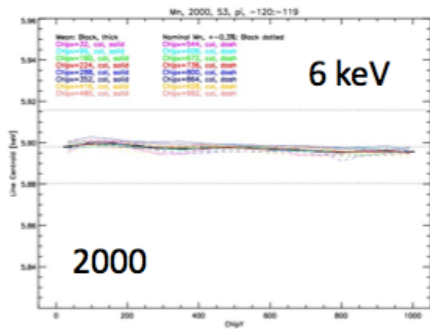
Focal Plane



Camera Body

# Temperature-dependent CTI correction

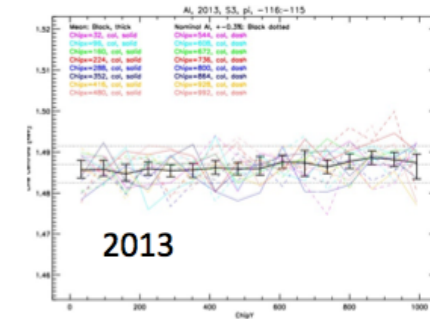
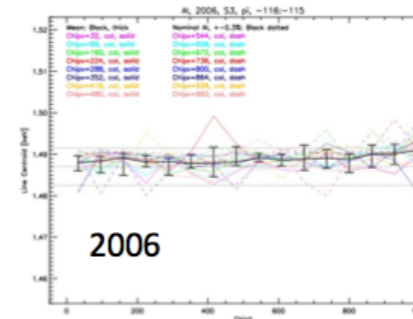
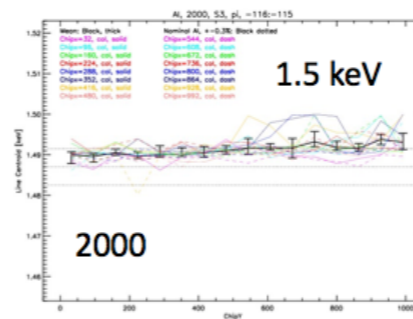
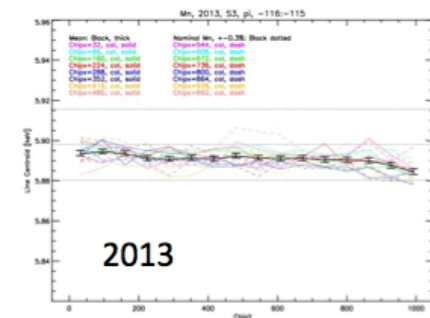
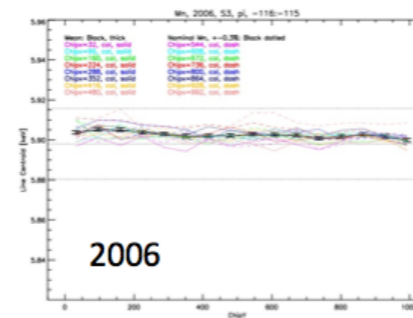
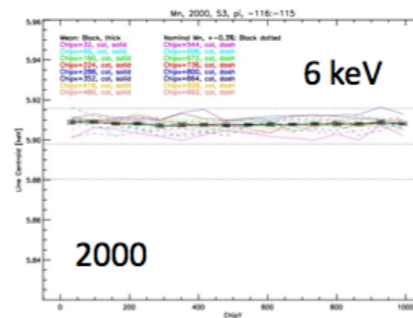
S3 @ -120C



ACIS-S3

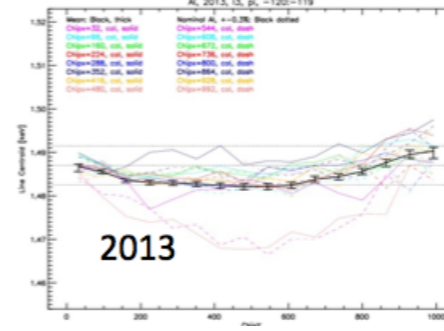
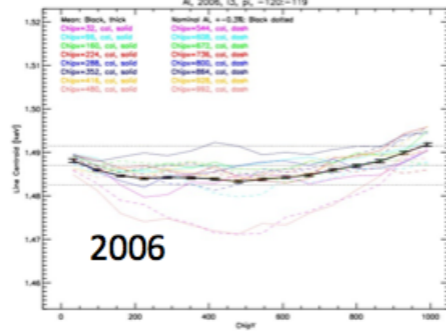
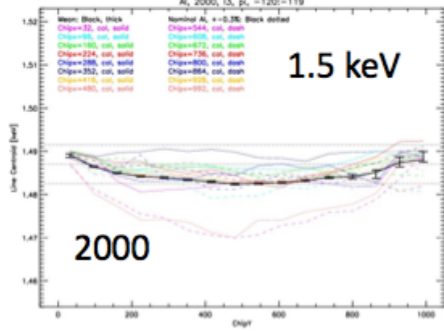
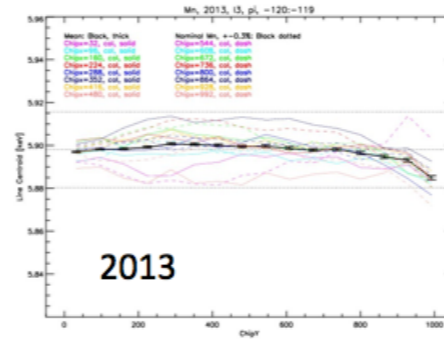
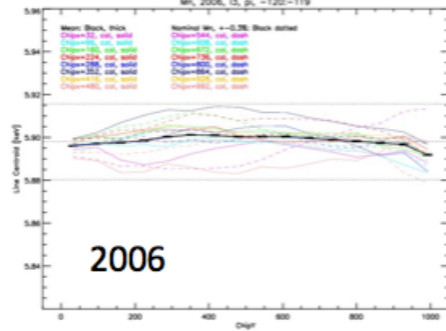
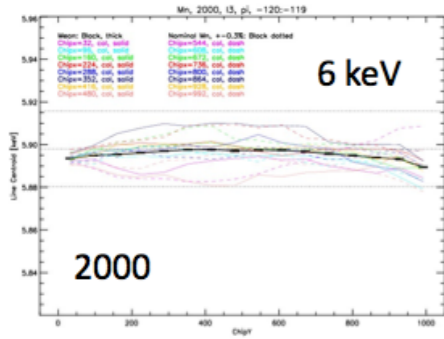
-116 < T < -115

S3 at warm temperatures



# Temperature-dependent CTI correction

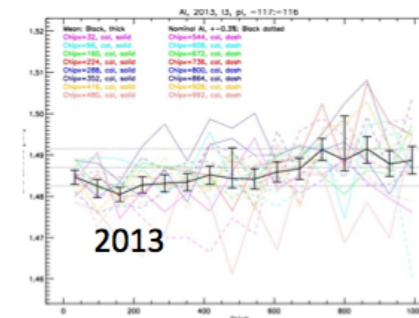
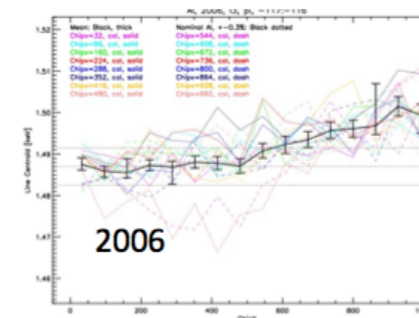
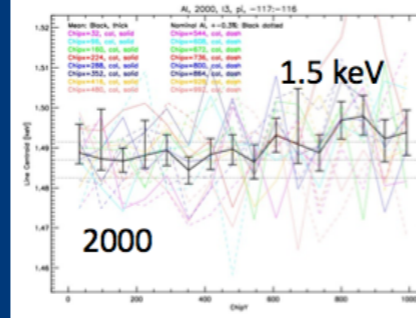
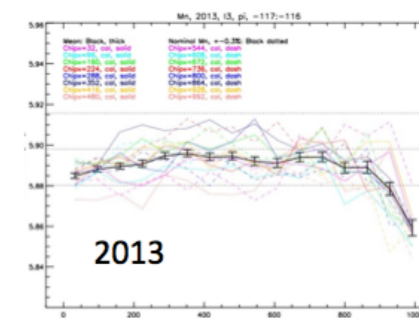
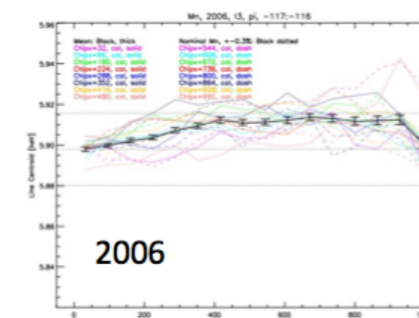
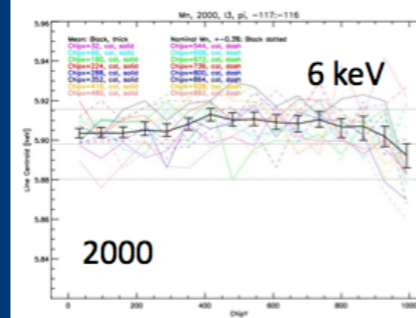
I3 @ -120C



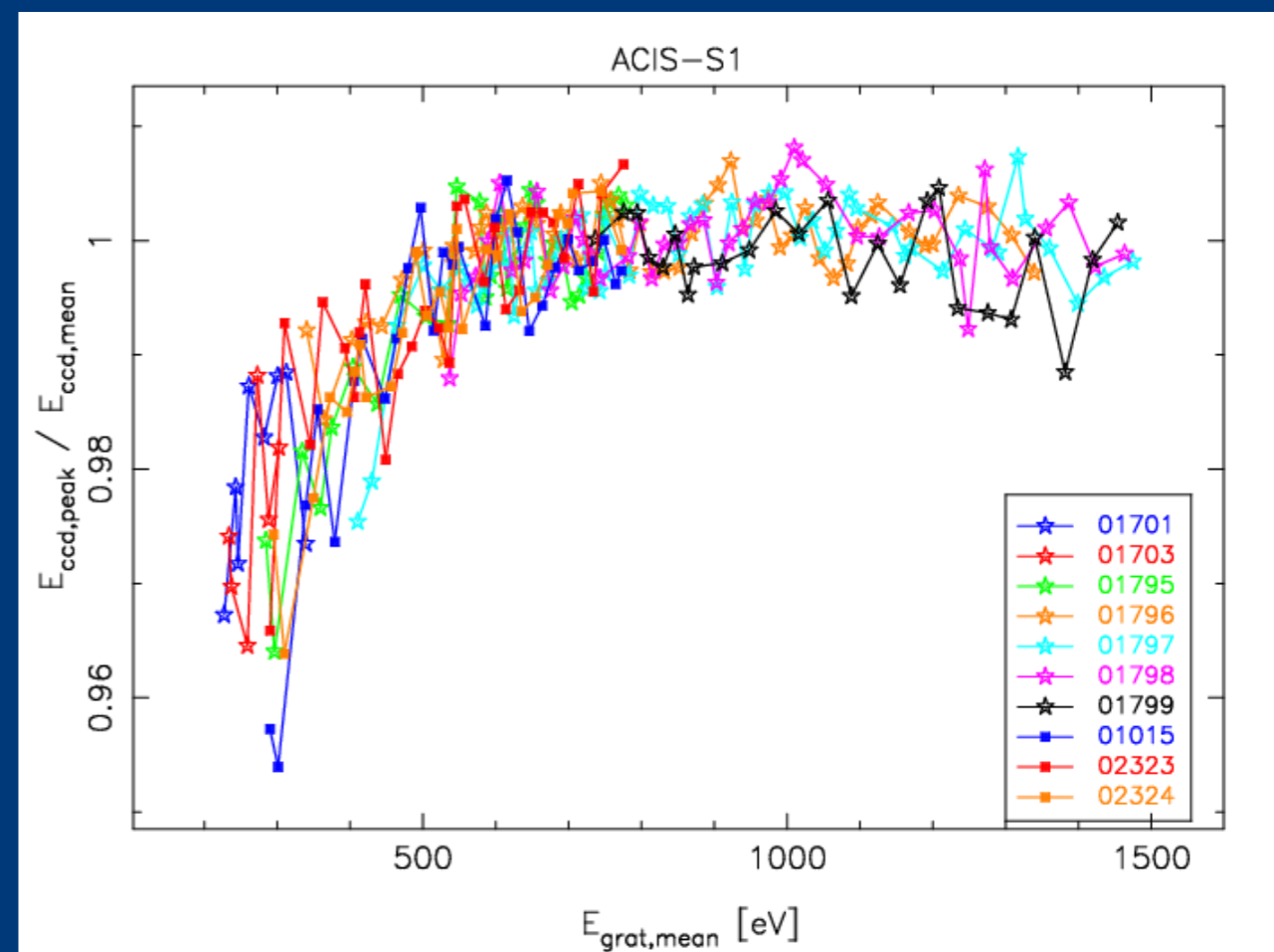
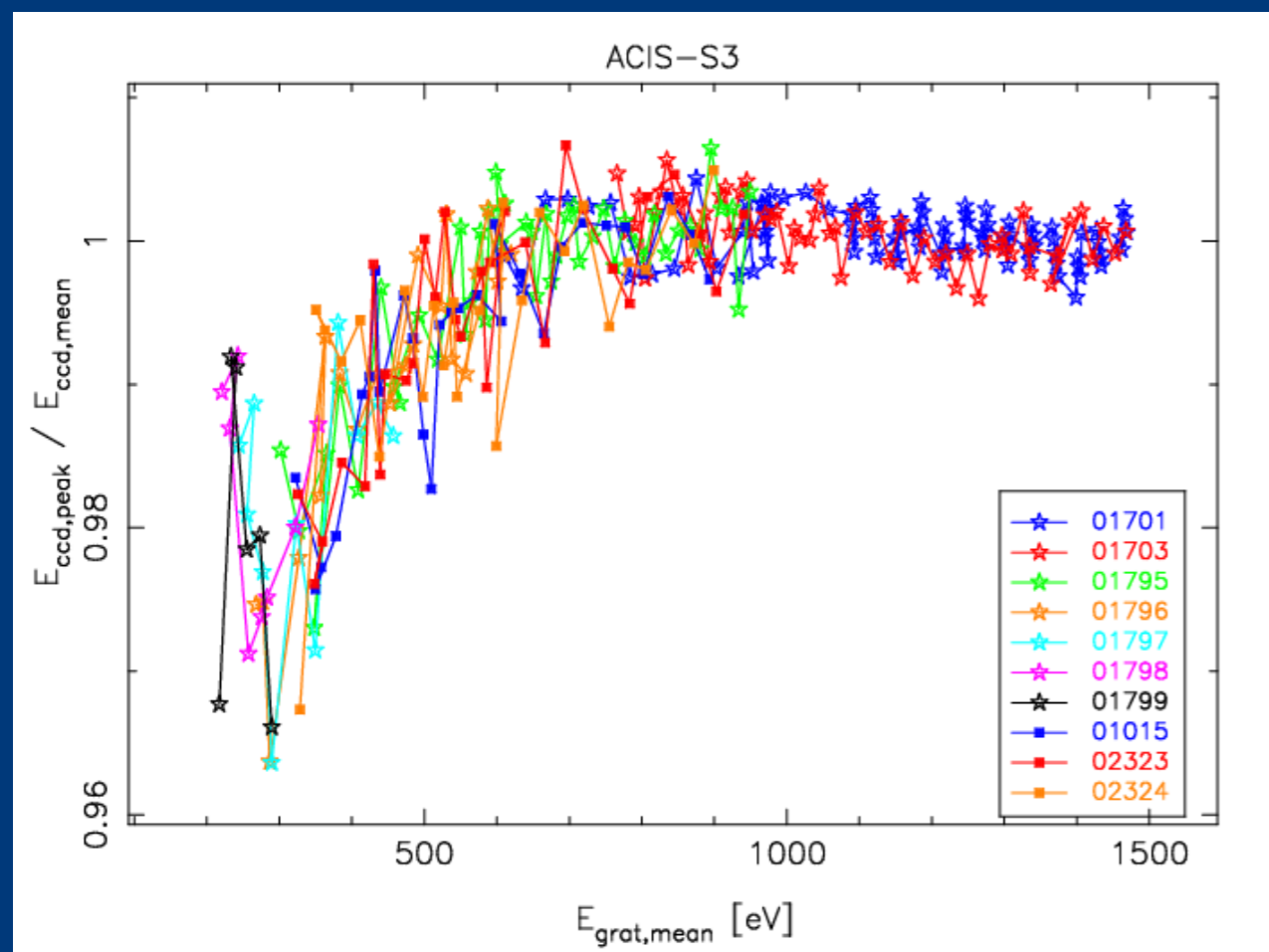
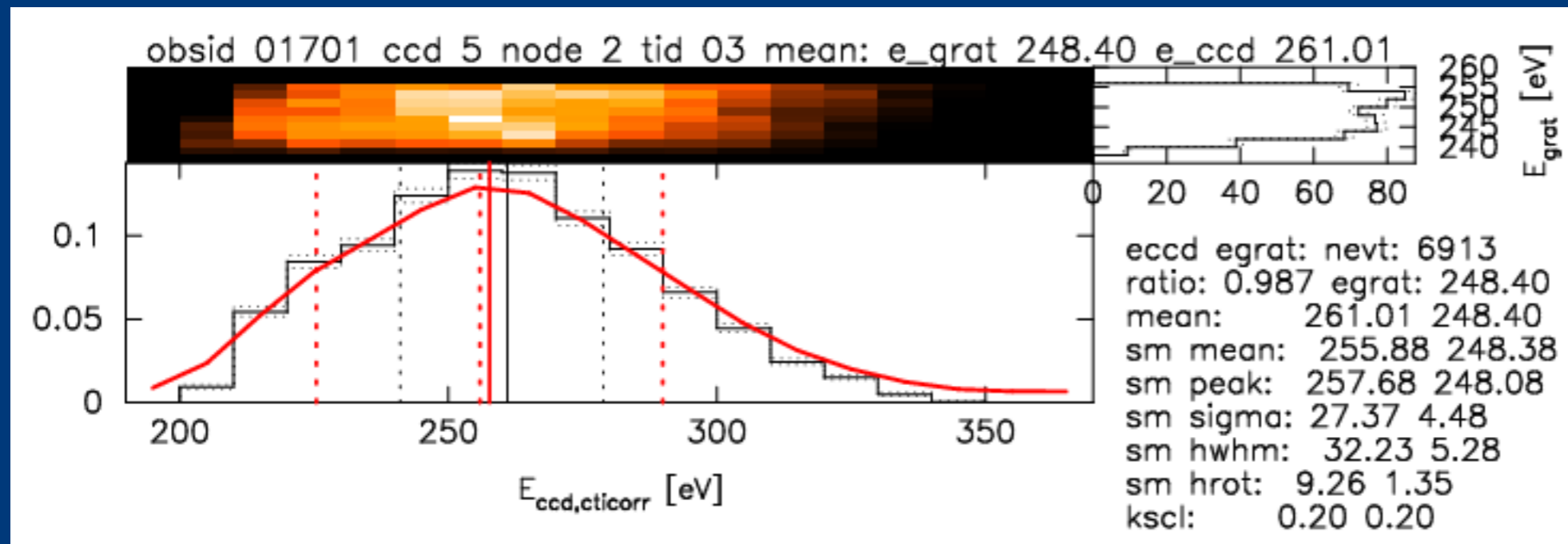
ACIS-I3

$-116 < T < -115$

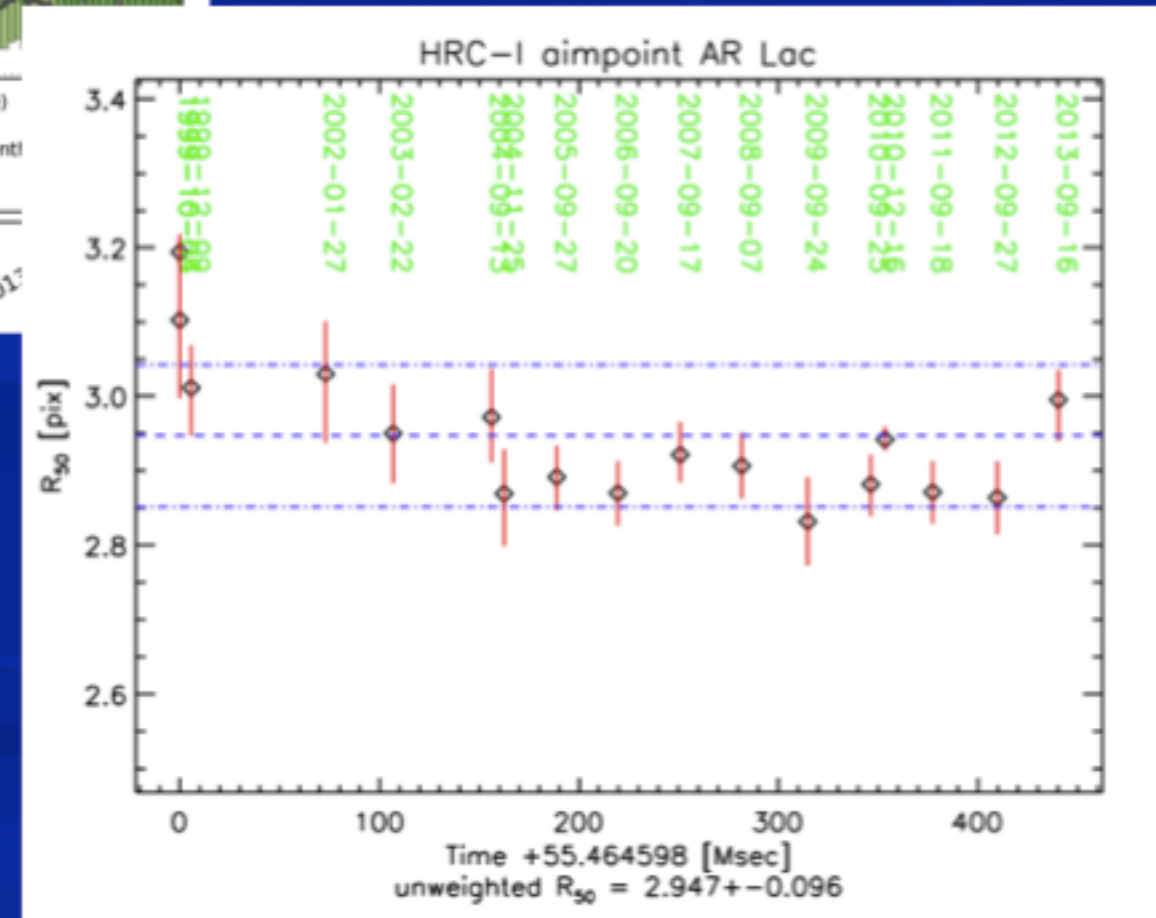
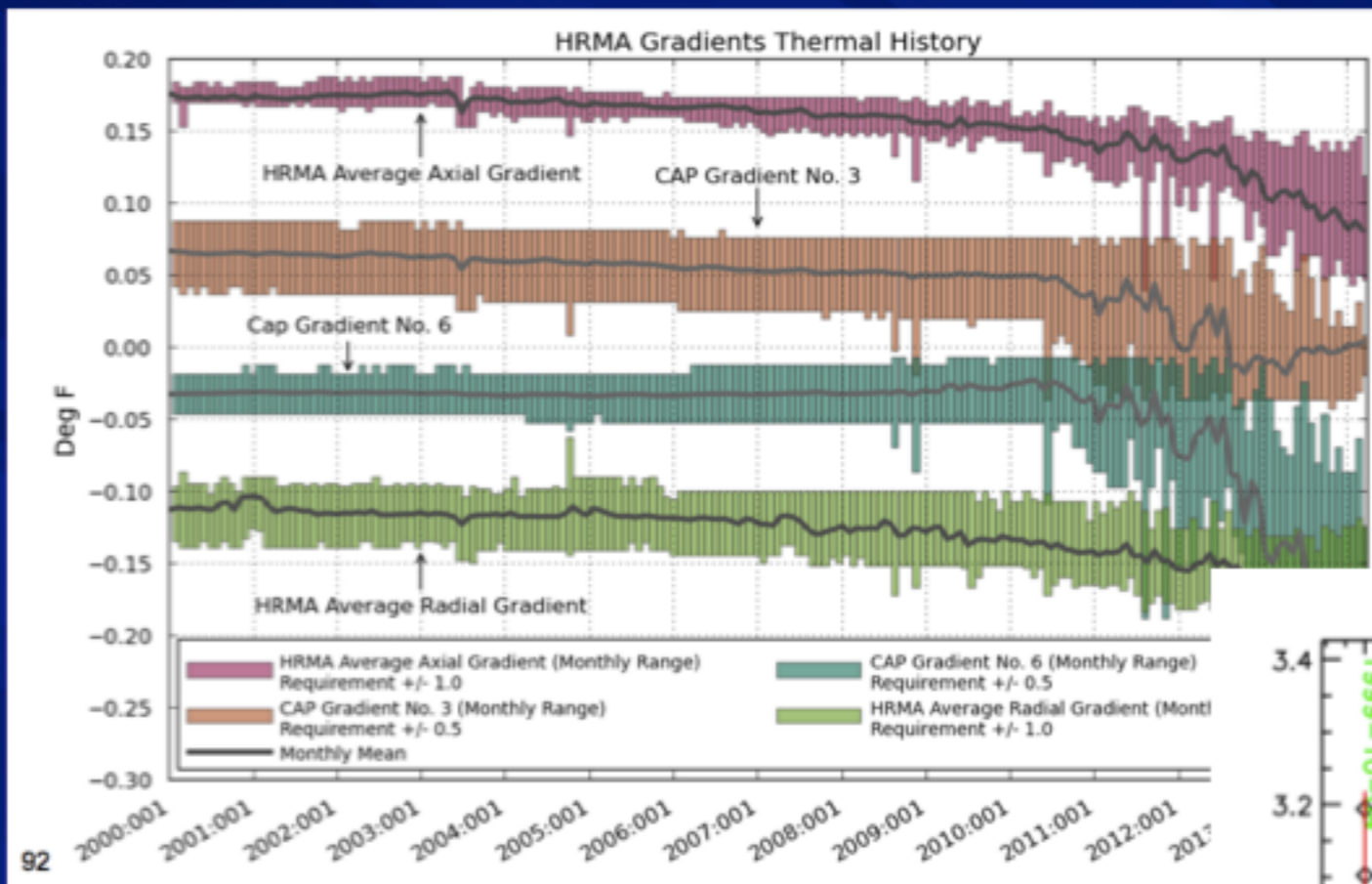
I3 at warm temperatures



# ACIS low energy gain ( $E < 500$ eV)

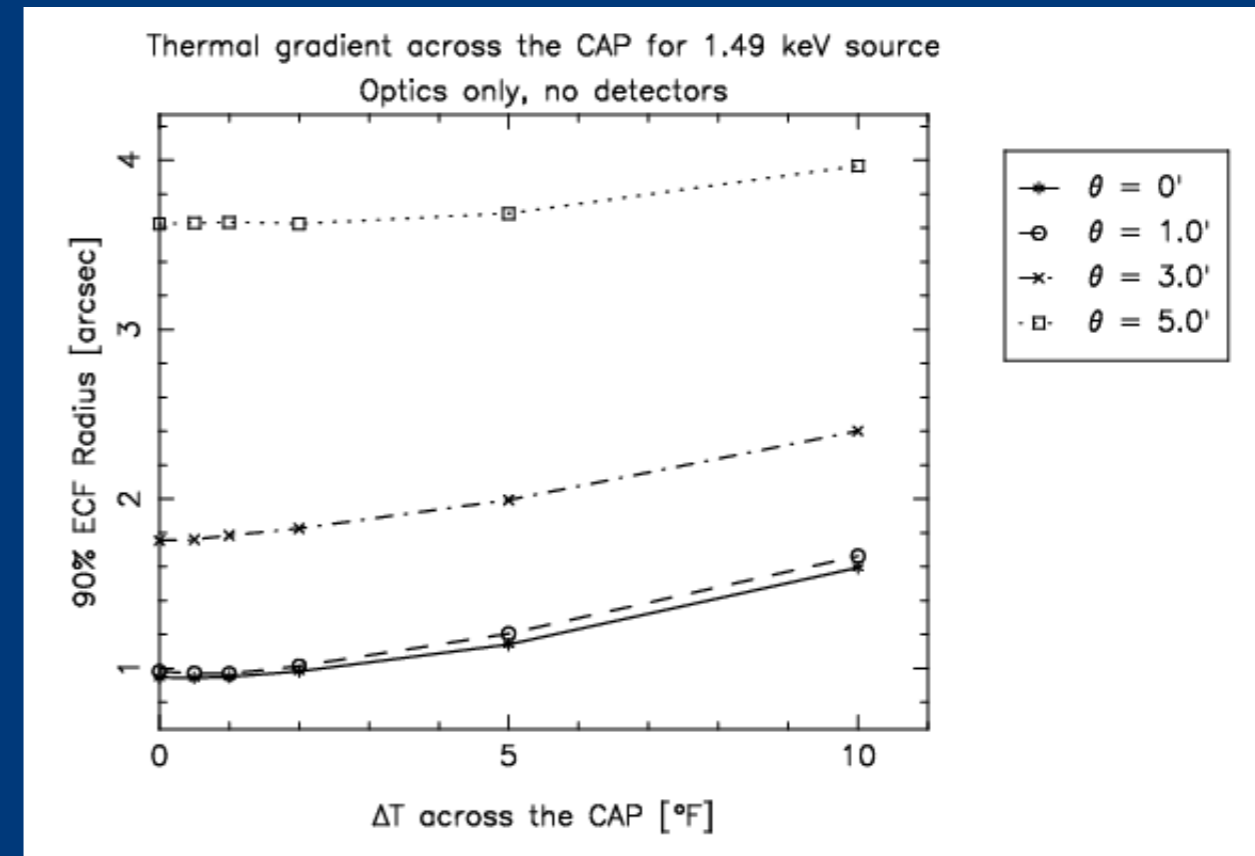
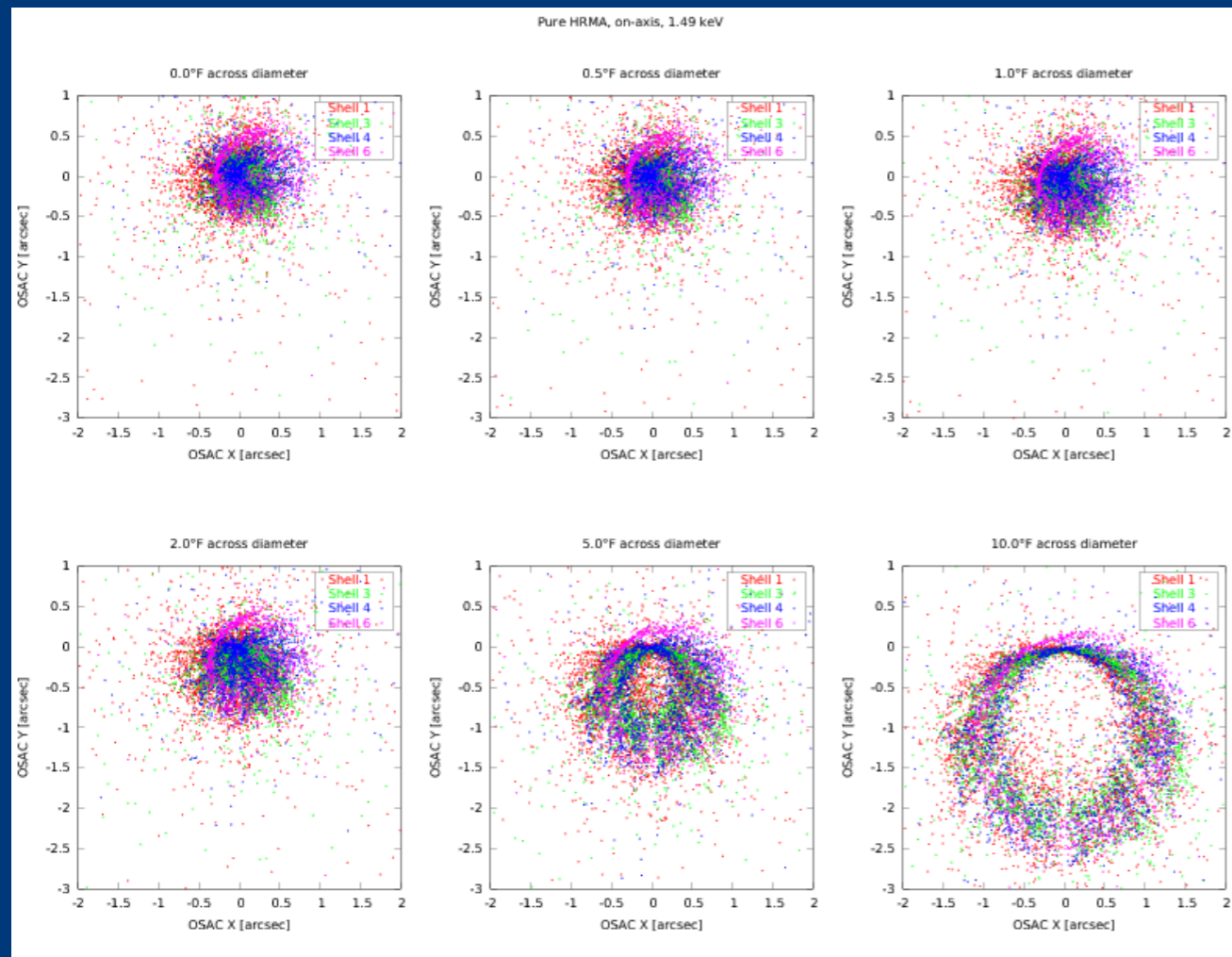


# Influence of Thermal Changes on Chandra Imaging



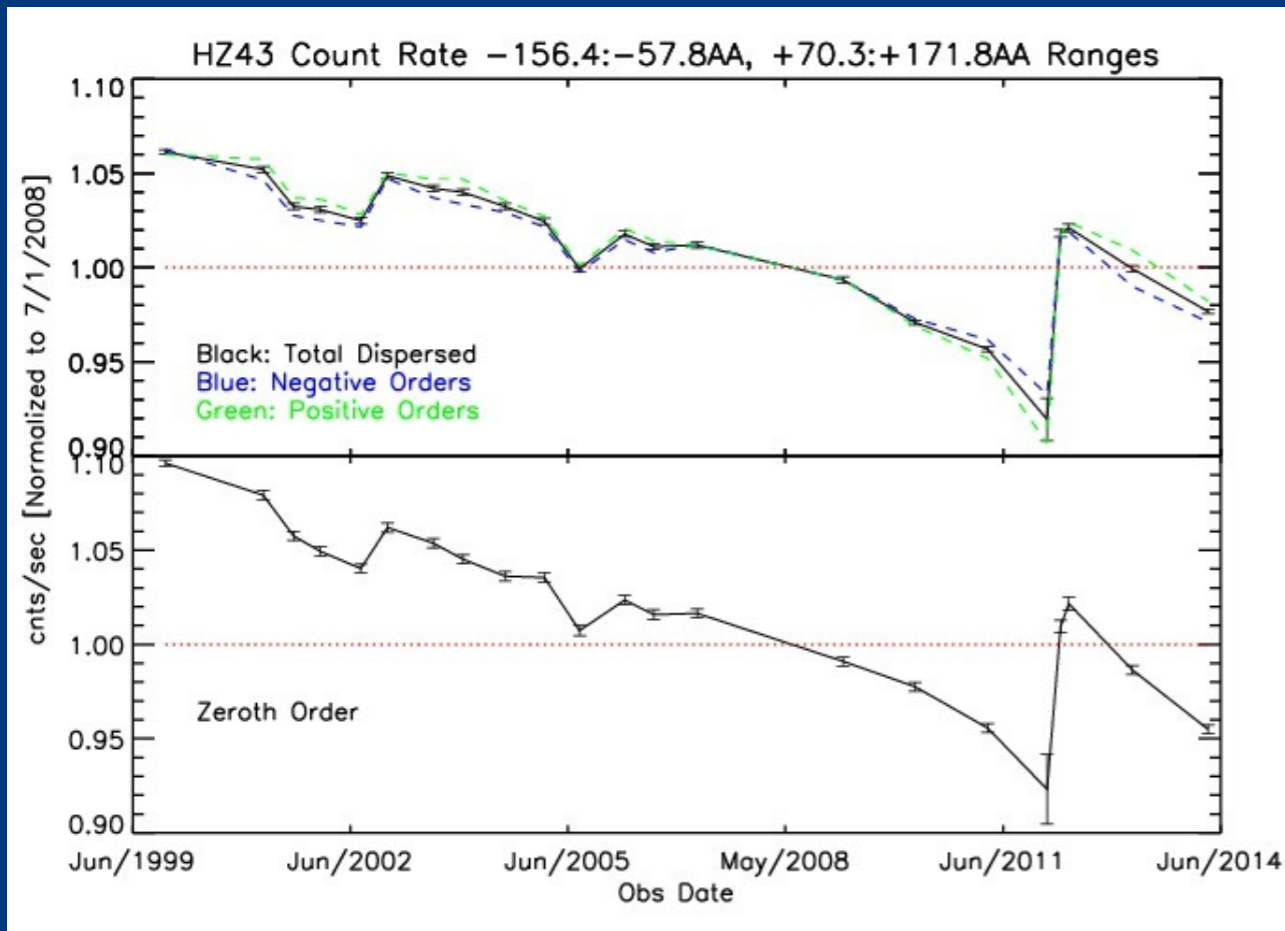
Thermal gradients across the HRMA in the top-to-bottom direction will affect the PSF in imaging data and the LSF in gratings data.

# Influence of Thermal Changes on Chandra Imaging



A thermal gradient of approximately 1 degree F is required to produce a measurable distortion in the PSF. The current thermal gradient is 0.2 degrees F across the CAP and increasing at a rate of 0.05 degrees F per year. Thus, it is unlikely that the thermal gradient across the CAP will have a noticeable affect is less than a decade.

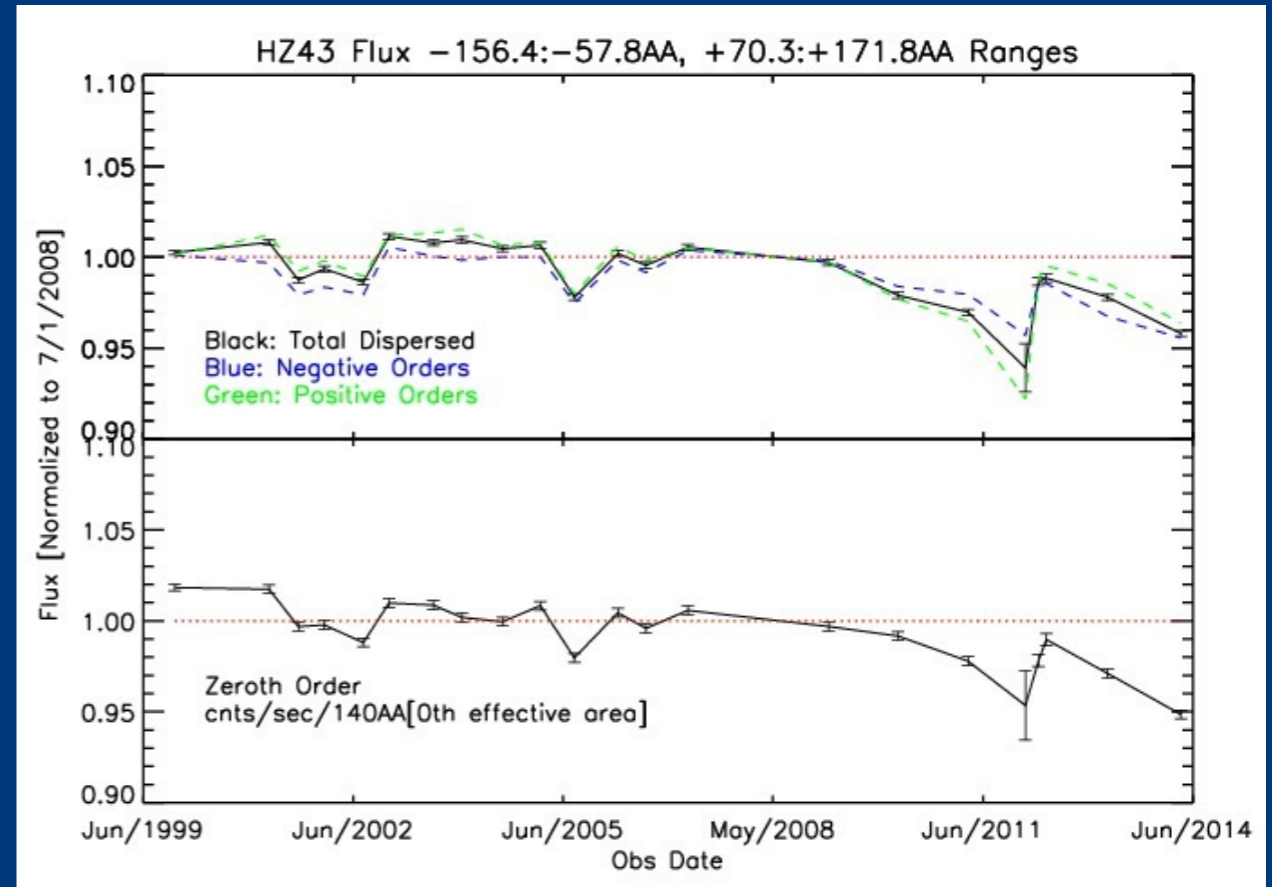
# LETG/HRC-S Effective Area



## LETG/HRC-S observations of HZ43

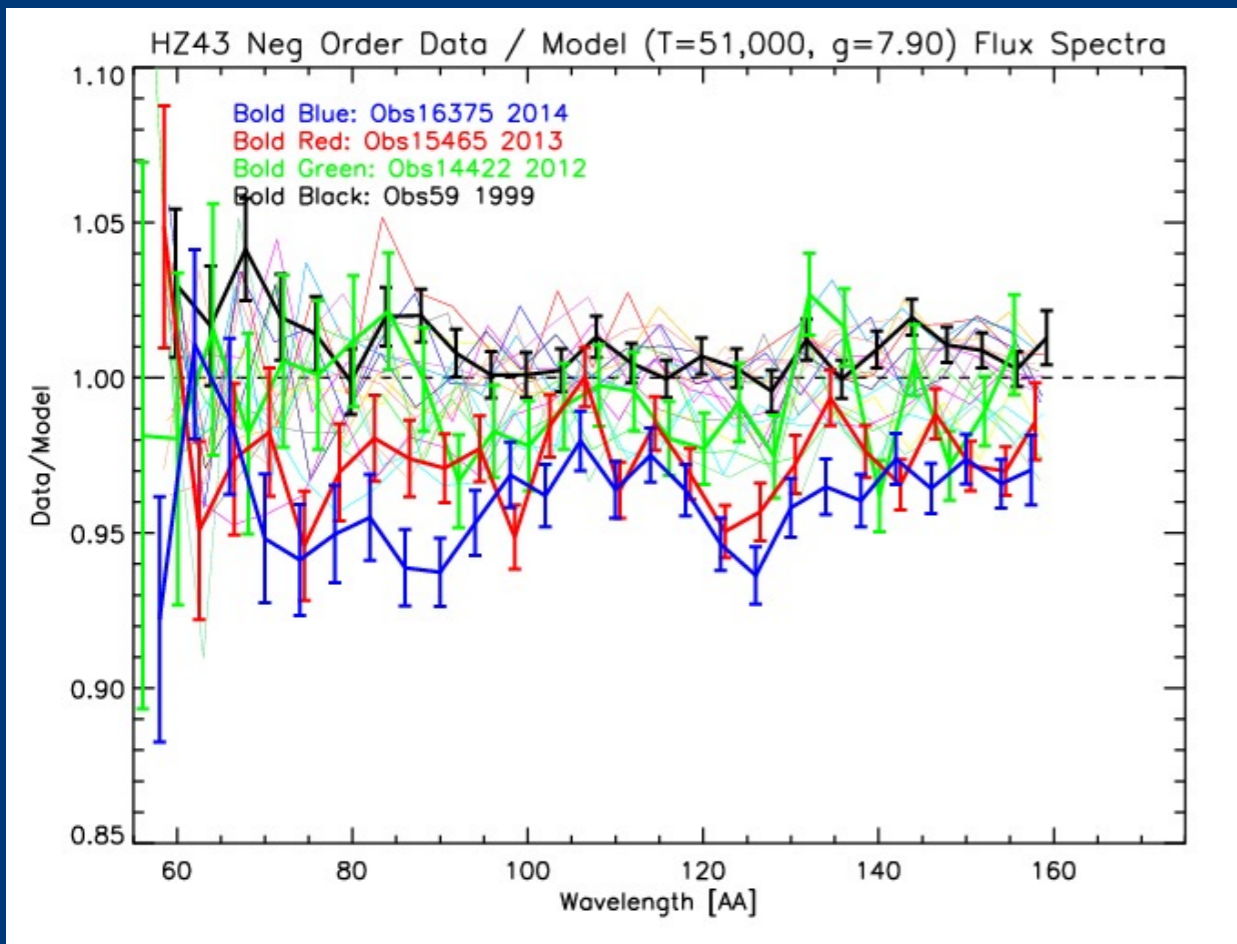
Essentially a linear decline in broad band count rate

Fluxes are derived using the set of HRC-S QE maps in CALDB 4.6.3



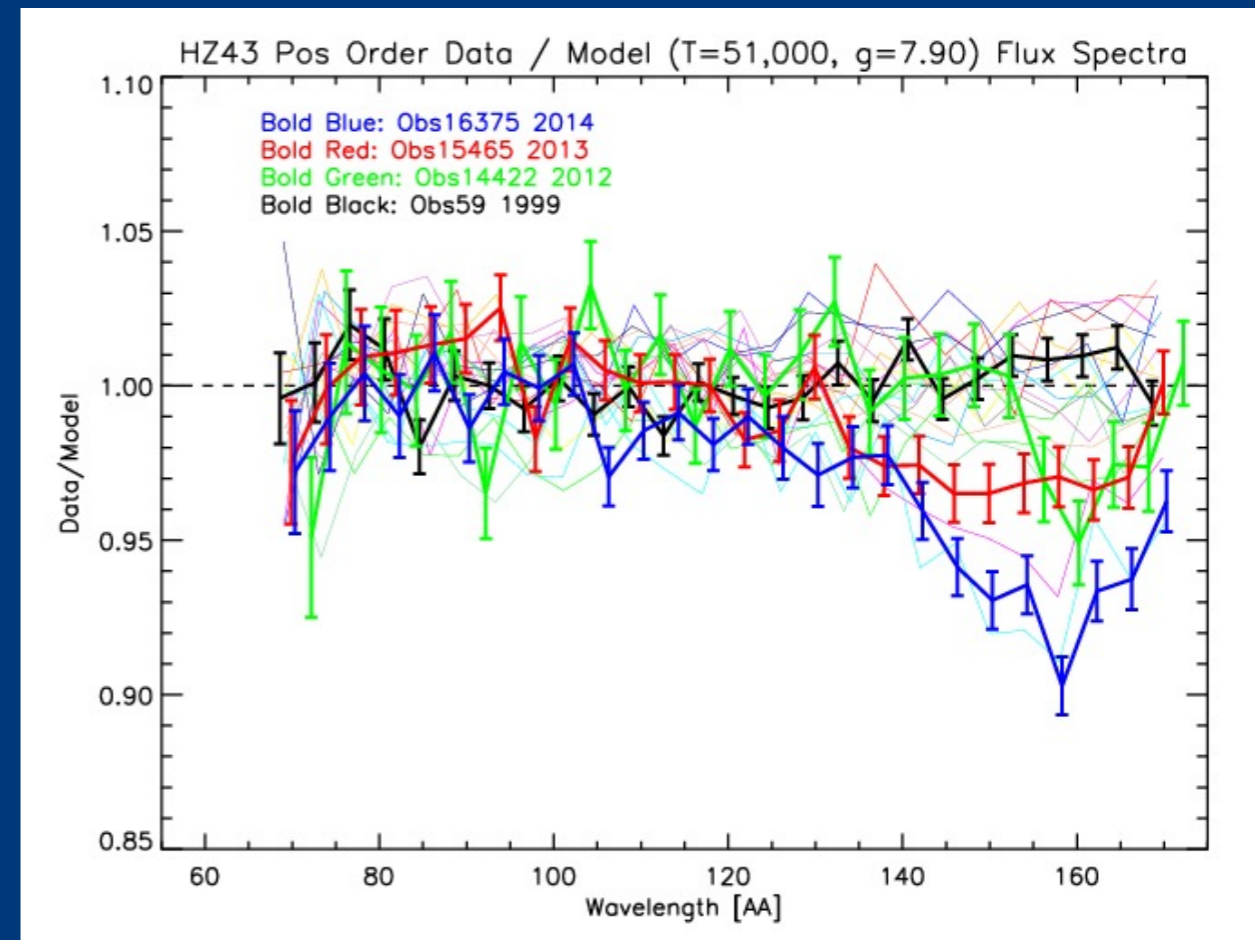


# LETG/HRC-S Effective Area



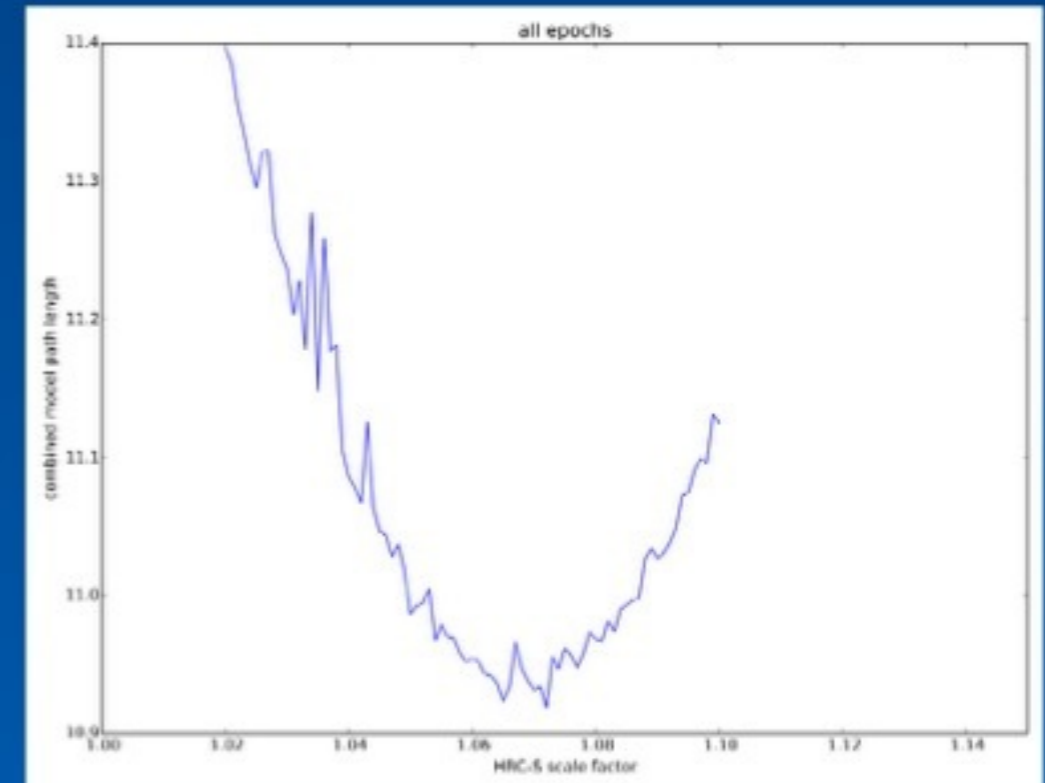
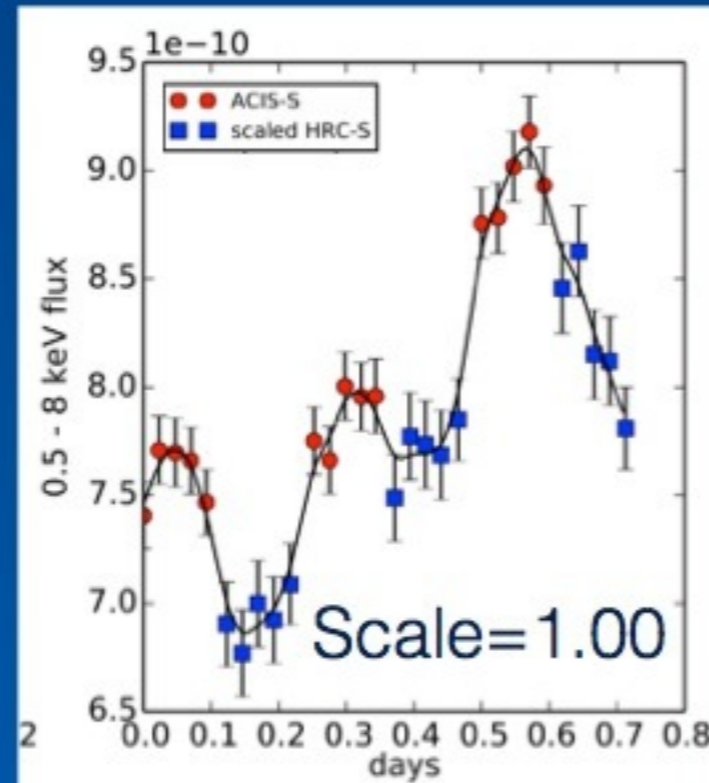
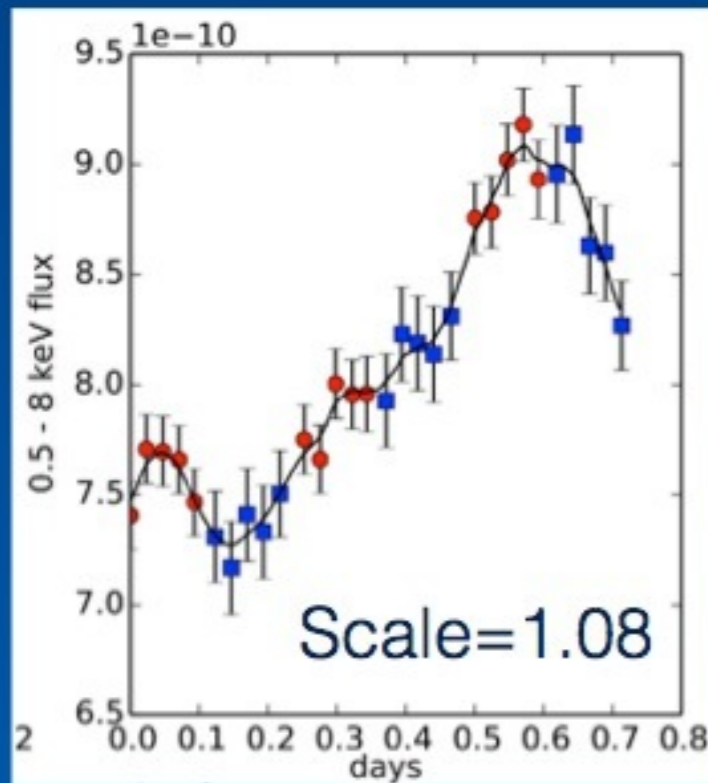
The rate of QE decline varies with order, but is nearly wavelength-independent for wavelengths longer than 140A.

An updated set of HRC-S QE maps will be released by the end of 2014. These will be wavelength-independent corrections. The next release will include wavelength-dependent QE corrections.



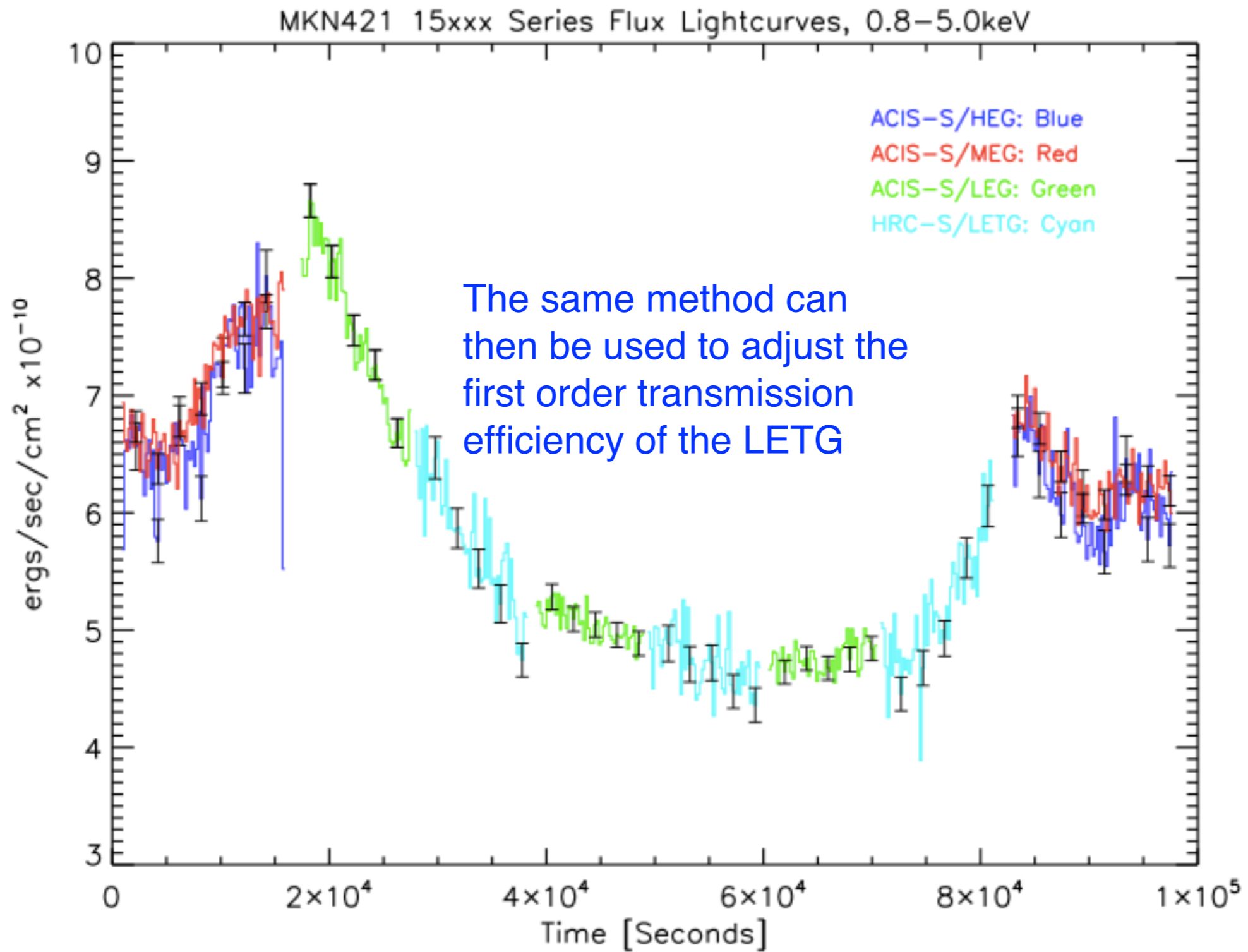
# HRC-S - ACIS-S Cross-calibration

- Interleaved LETG+(ACIS-S,HRC-S) observations of blazar Mkn 421

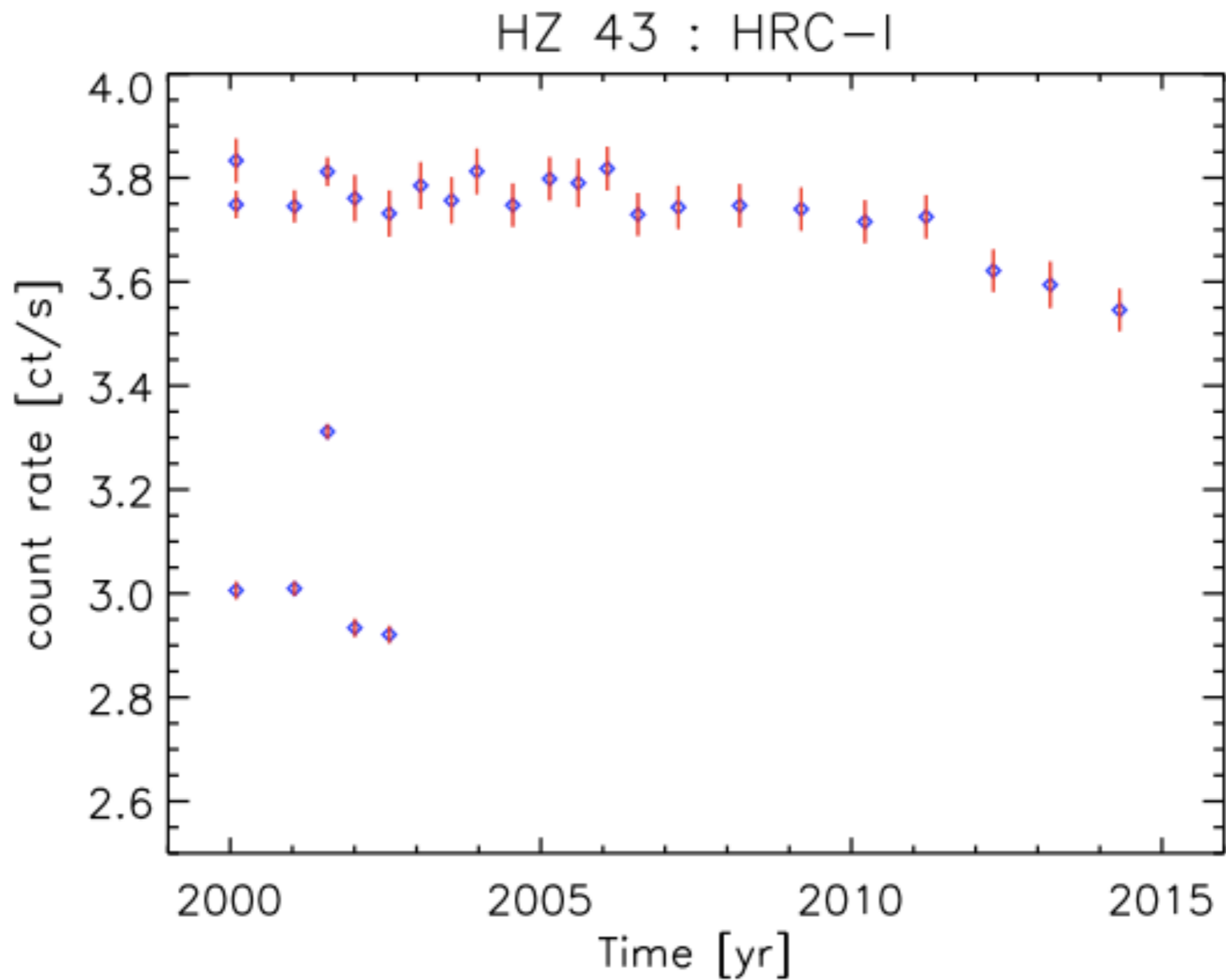


- Scale HRC-S flux to achieve minimum light curve “length”
- Five series of interleaved data combined ==> HRC-S QE needs downward revision of  $7 \pm 1.5\%$

# Internal cross-calibration



# HRC-I Effective Area



# Calibration Schedule

- Release revised ACIS contamination model with updated elemental ratios (C,O and F), spatial distribution and time-dependence.
- Generate test versions of the ACIS contamination model with different spatial gradients for each element in the contaminant.
- Investigate the spectral resolution of ACIS at warmer temperatures.
- Release updated gain tables for the BI chips with improved gains at low energies ( $E < 500$  eV).
- Release updated OSIP for LETG/ACIS-S data consistent with the updated gain table.
- Release a set of time-dependent HRC-S QE maps (one for each year).
- Release a revised QE for the HRC-S.
- Determine if an adjustment to the first order transmission efficiency of the LETG is required.
- Determine if adjustments to the first order transmission efficiencies of the HEG and MEG are required.
- Release a separate QE file for CC-mode ACIS data (mostly HETG/ACIS-S) for data taken prior to the telemetry of flight grade 66. This will increase the flux in such data by about 3% at wavelengths shorter than 3A
- Investigate the small decline in HRC-I QE.