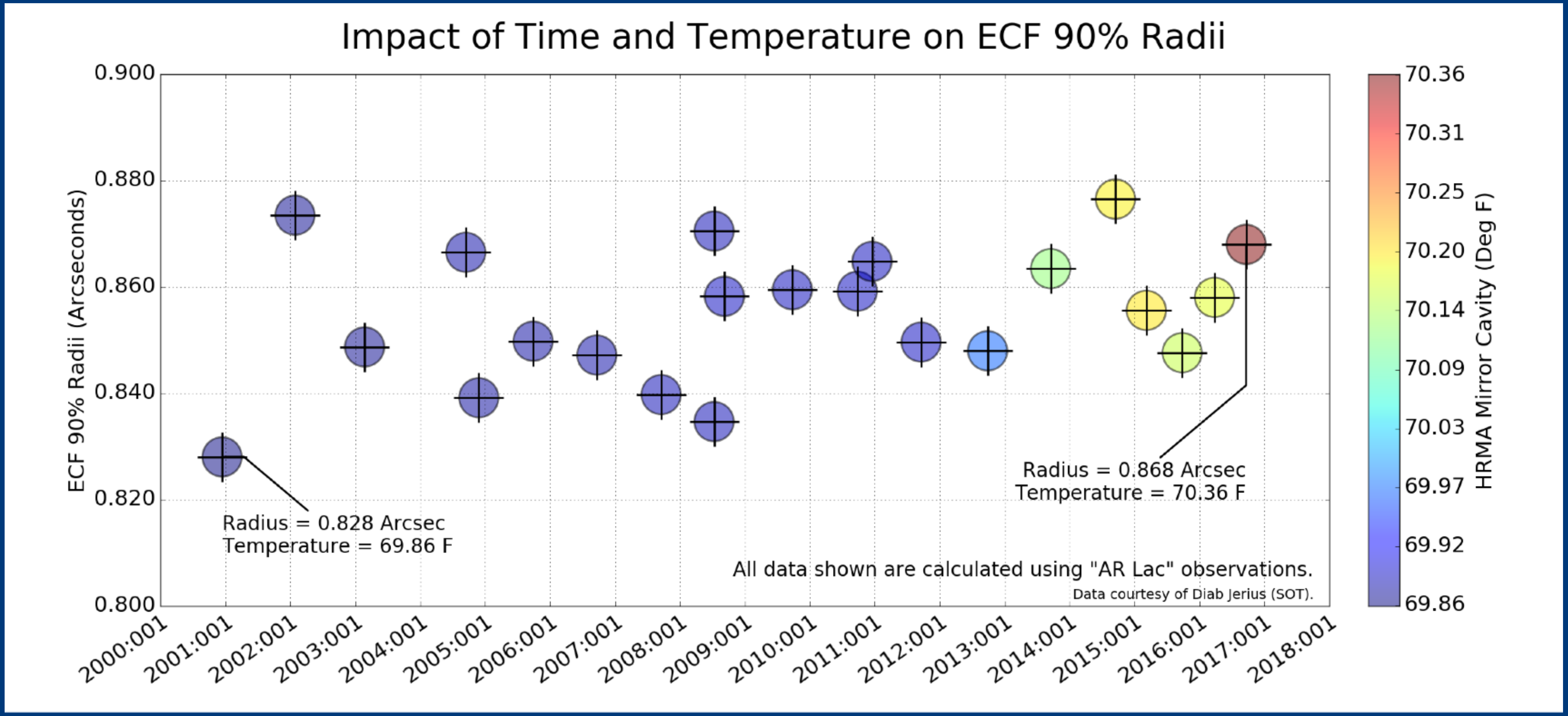
Chandra Calibration Status

CUC Meeting - Sep. 26, 2017

Mechanical Stability of X-Ray Telescope

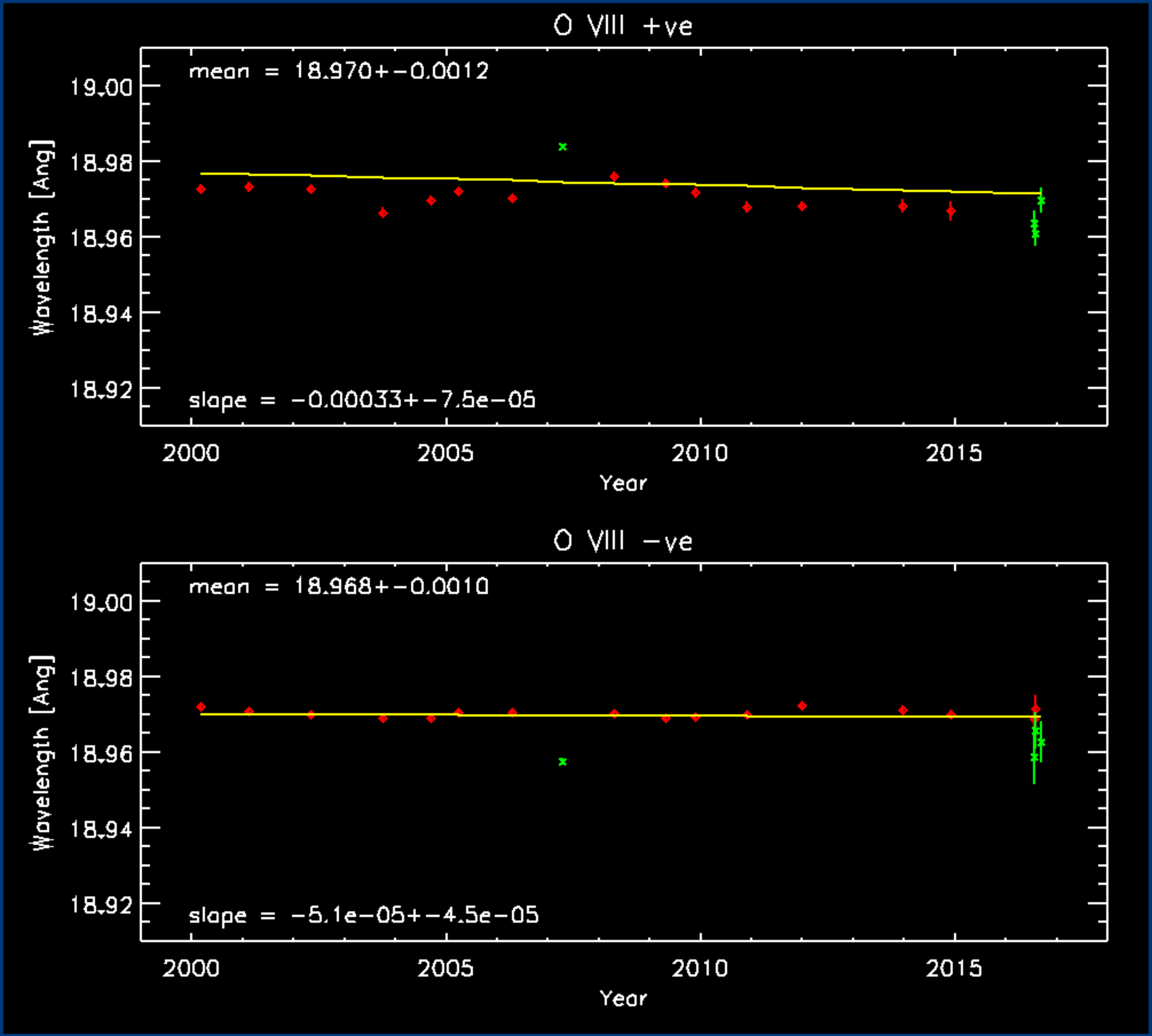
Stability of Chandra Imaging



While the aim-point has drifted by 20”-30”, the HRMA focal point has remained stable to within 6”, which is consistent within the measurement uncertainties.

Mechanical Stability

Stability of dispersion relation and plate scale

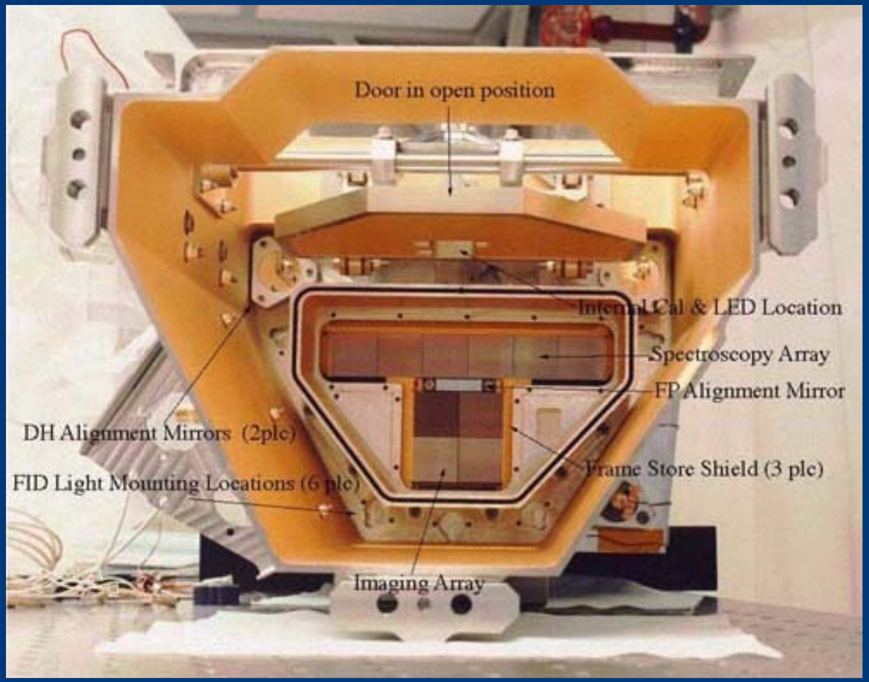


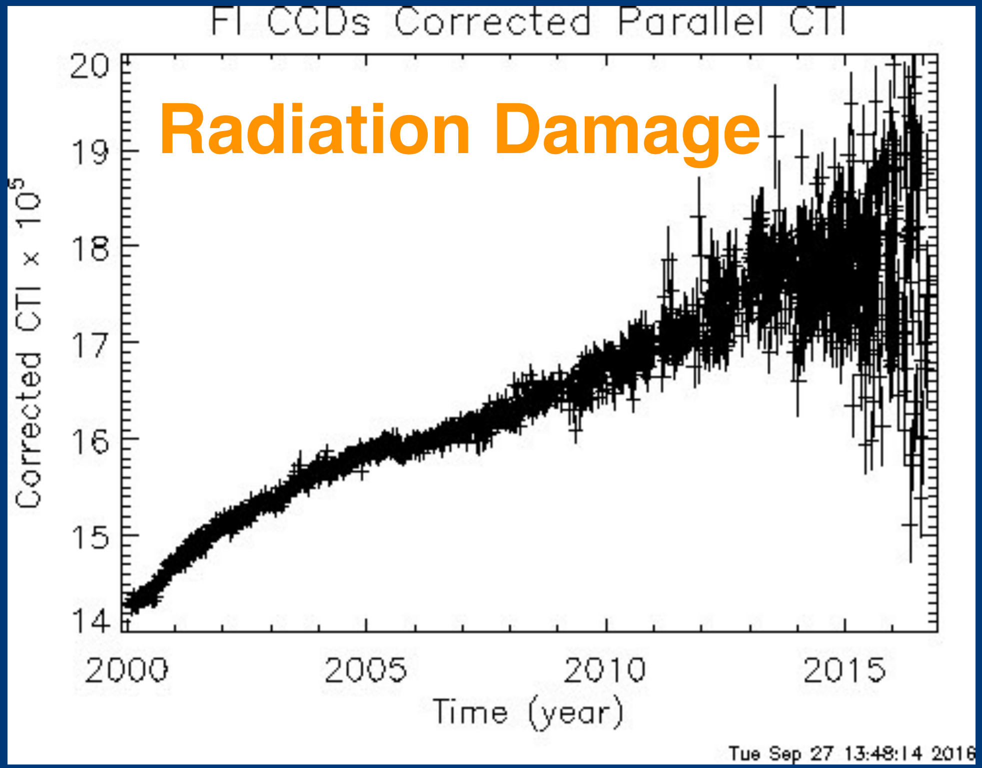
LEG

MEG

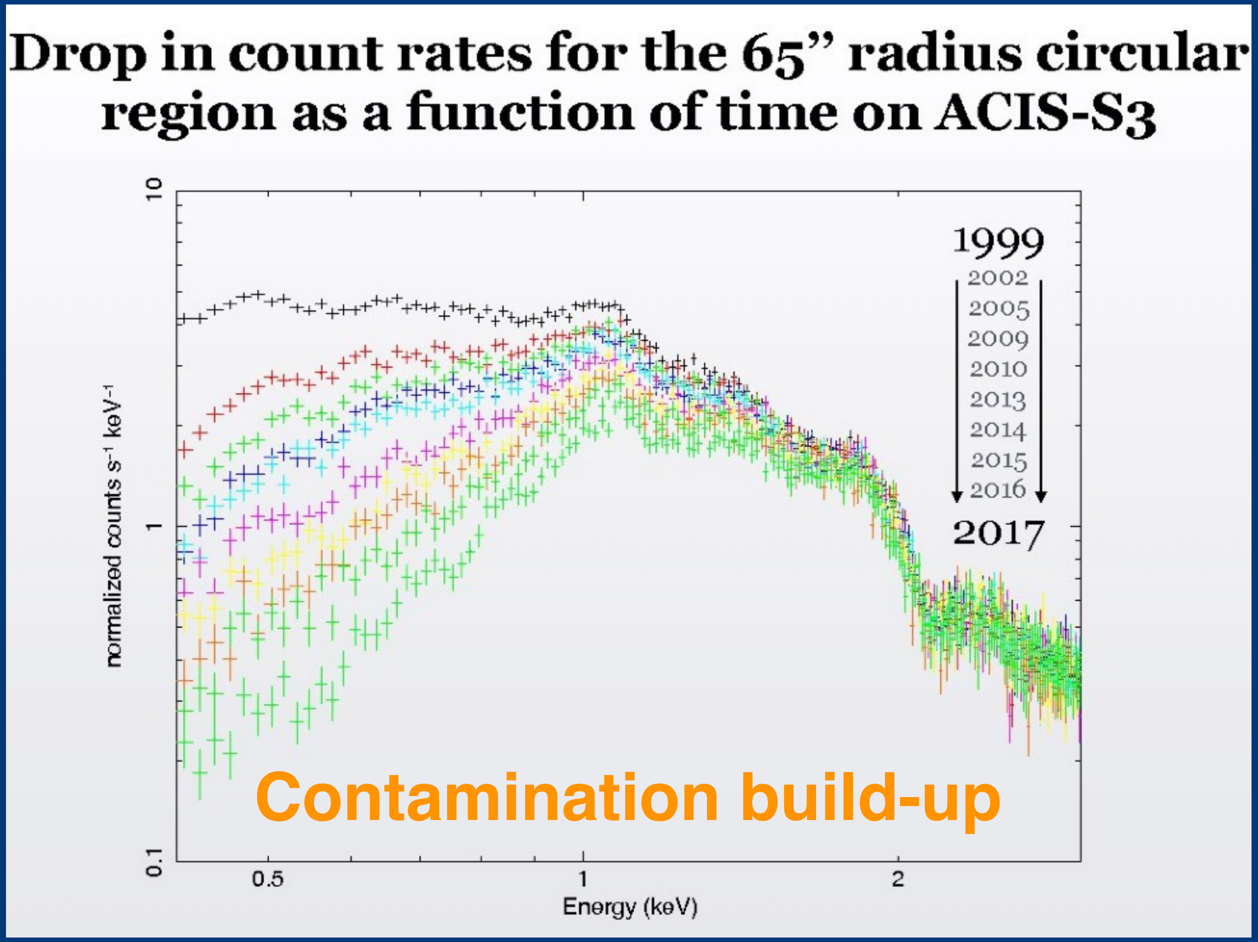
Less than 1:3000 change
in wavelength and plate scale.

ACIS - Three Main Culprits Affecting Calibration

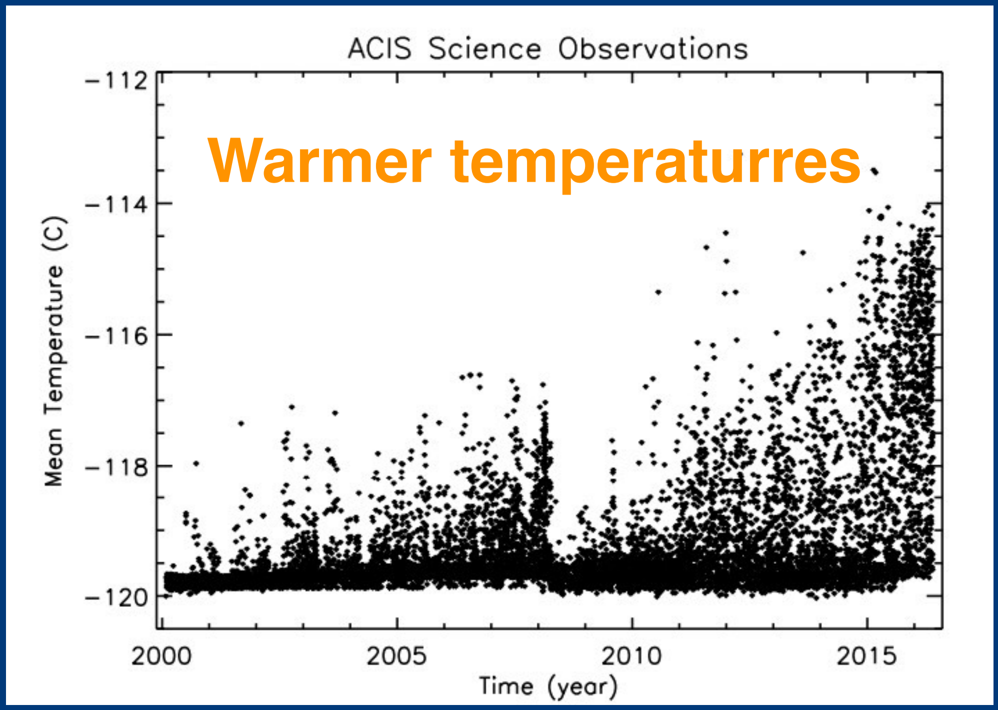




Gain and Spectral Resolution

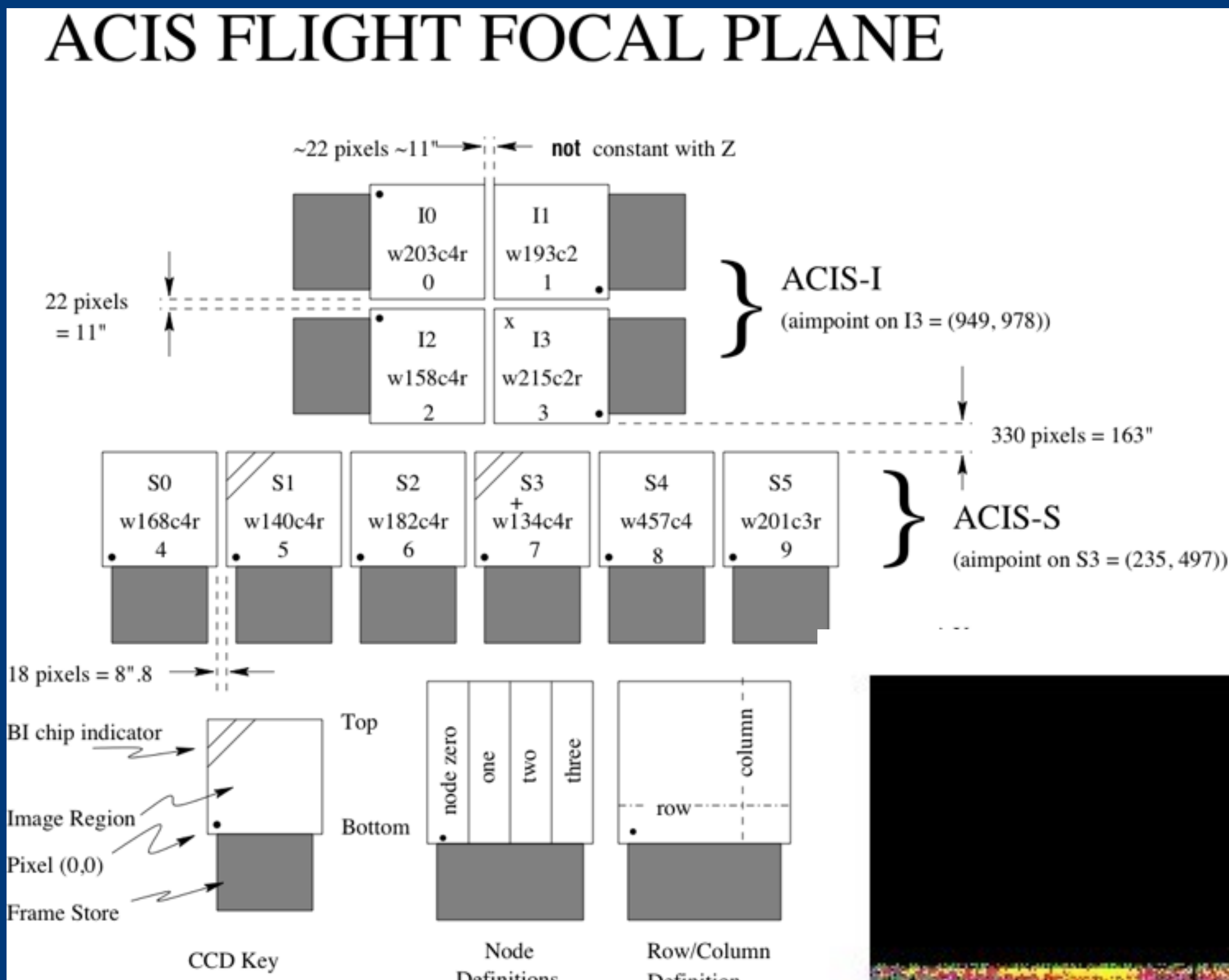


Effective Area



ACIS Effective Area - Monitoring the Contamination

Big Dither LETG/ACIS-S Observations of Mkn 421



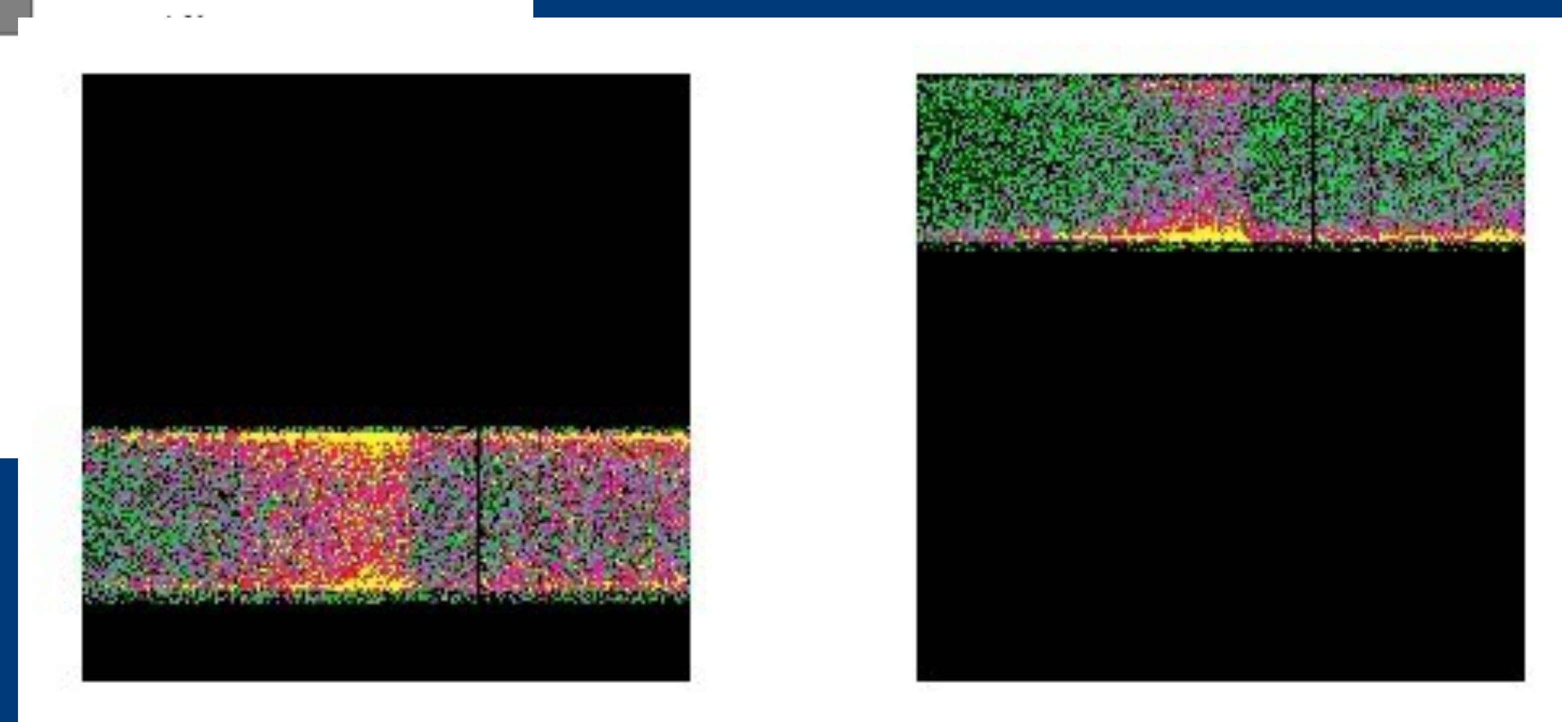
Recent Observations

July 2016

Jan. 2017

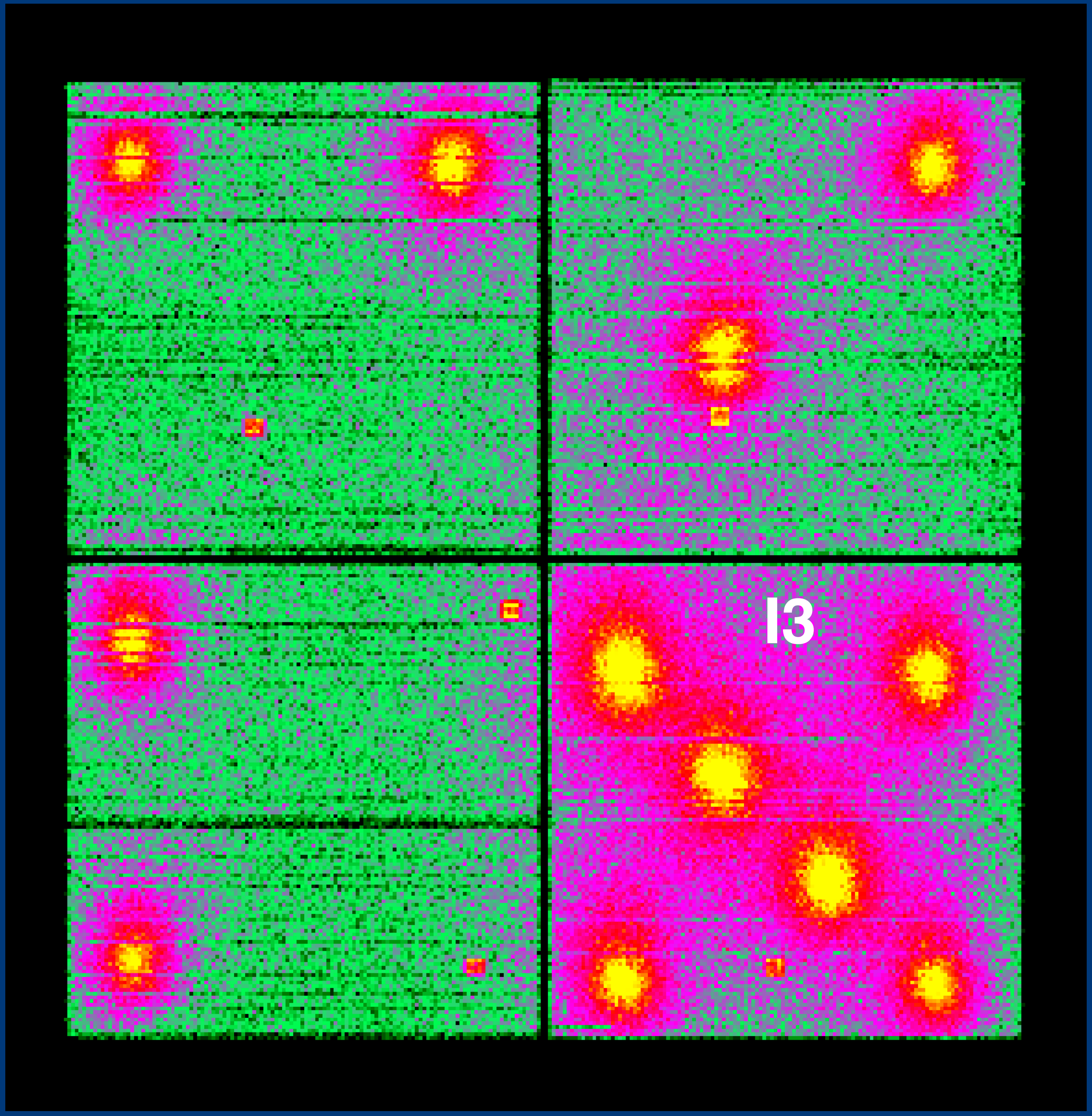
July 2017

ACIS-S1



ACIS Effective Area - Monitoring the Contamination

Raster Scan of Abell 1795 on ACIS-I



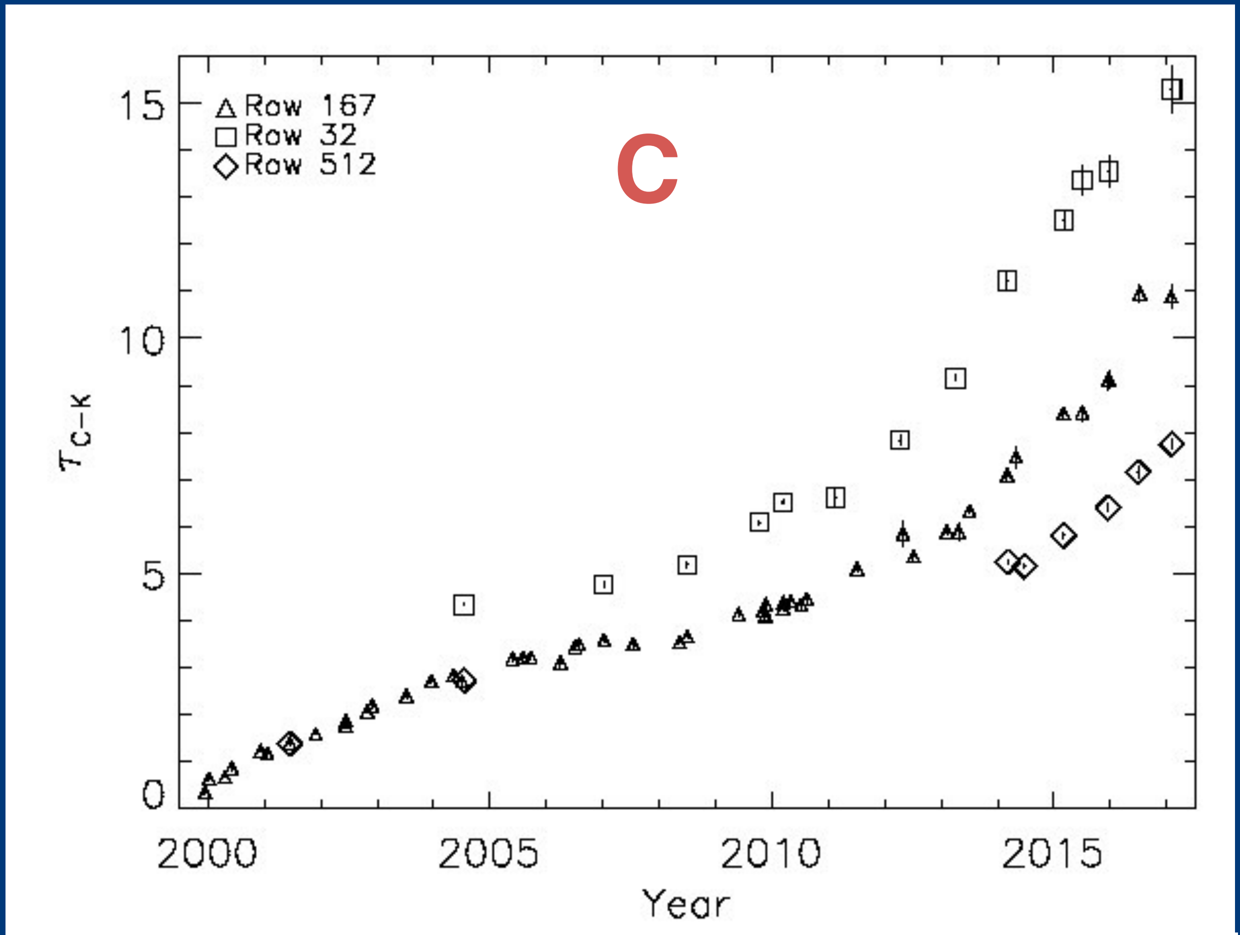
For AO-19: 720/984 ksec of the calibration time is dedicated to monitoring the build up of contamination on the ACIS filters.

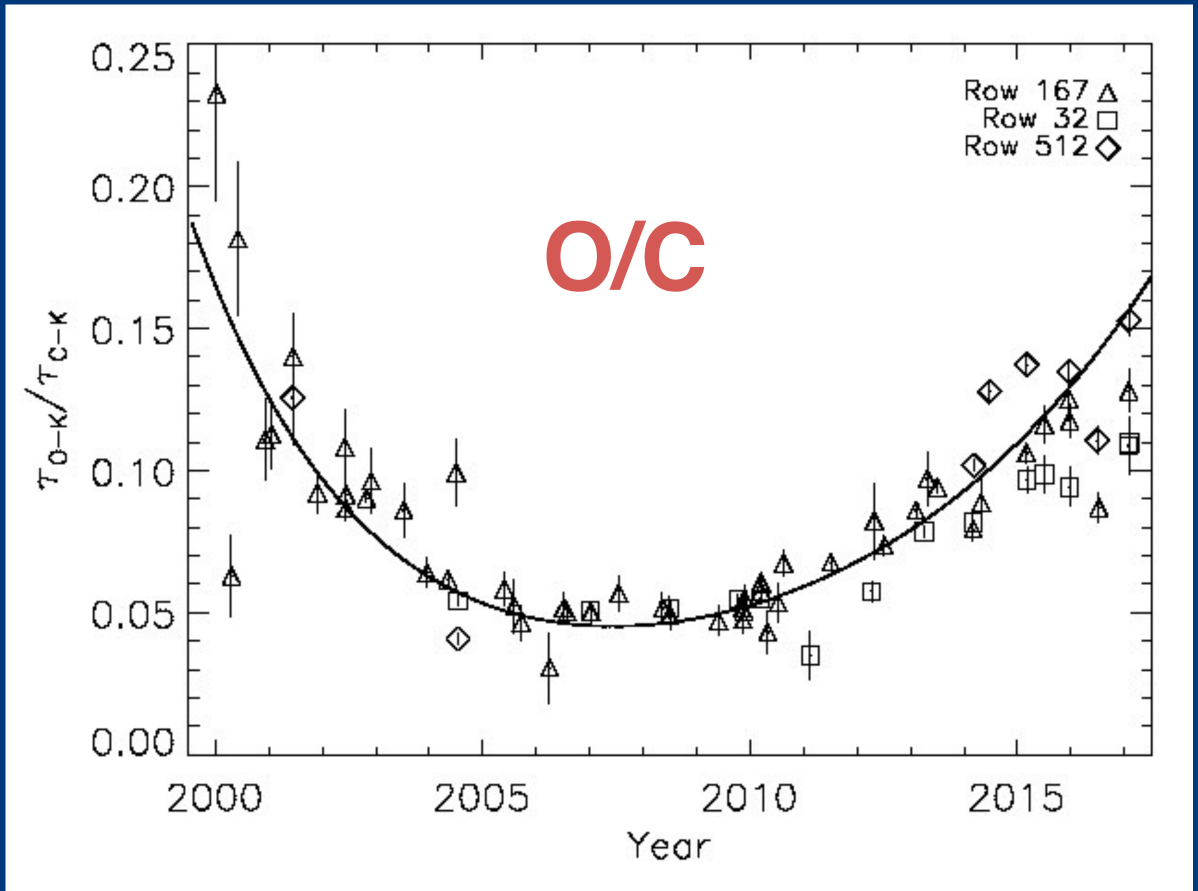
ACIS Effective Area - Monitoring the Contamination

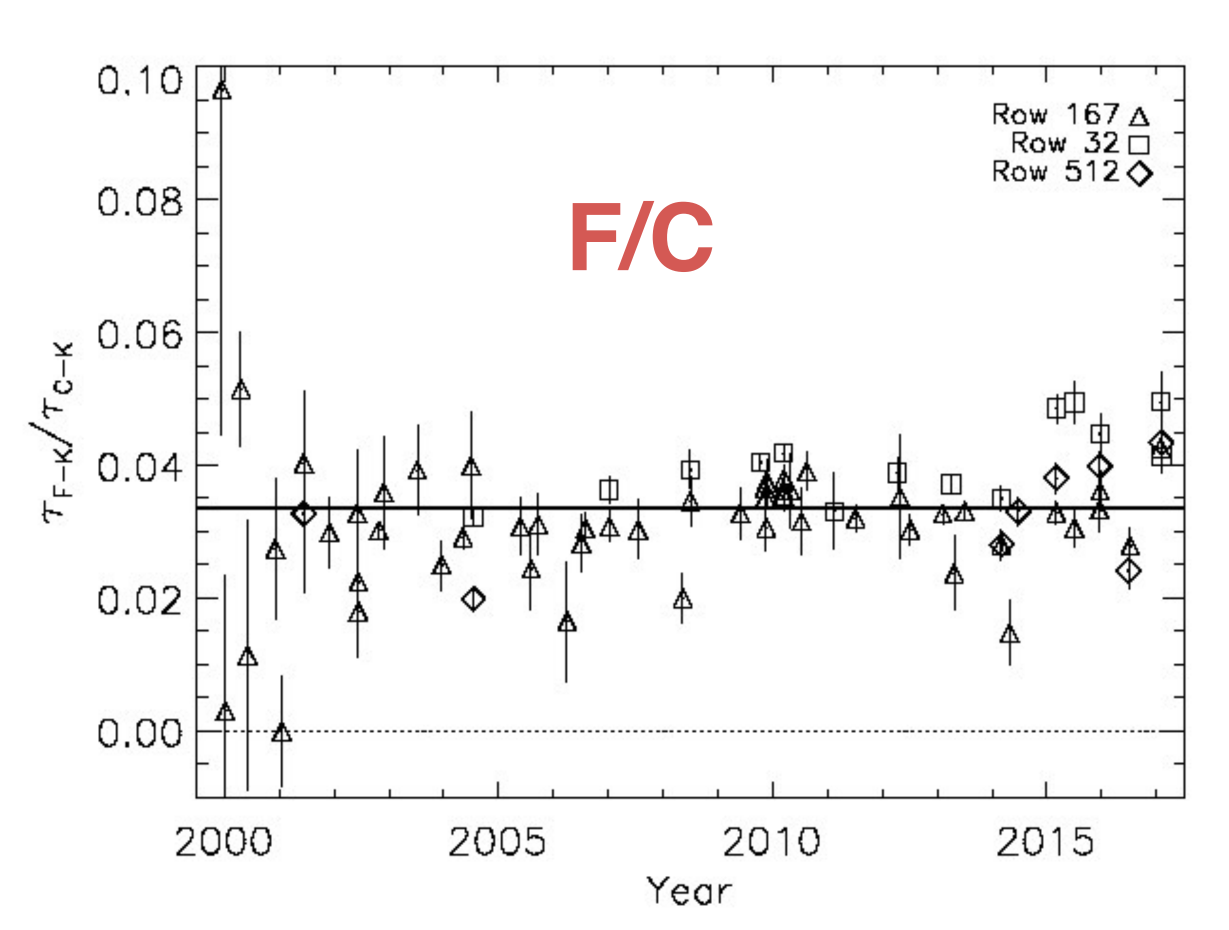
Three components to ACIS Contamination Model:

- Composition (C, O, and F)
- Time-dependence
- Spatial-dependence

Composition and Time-dependence



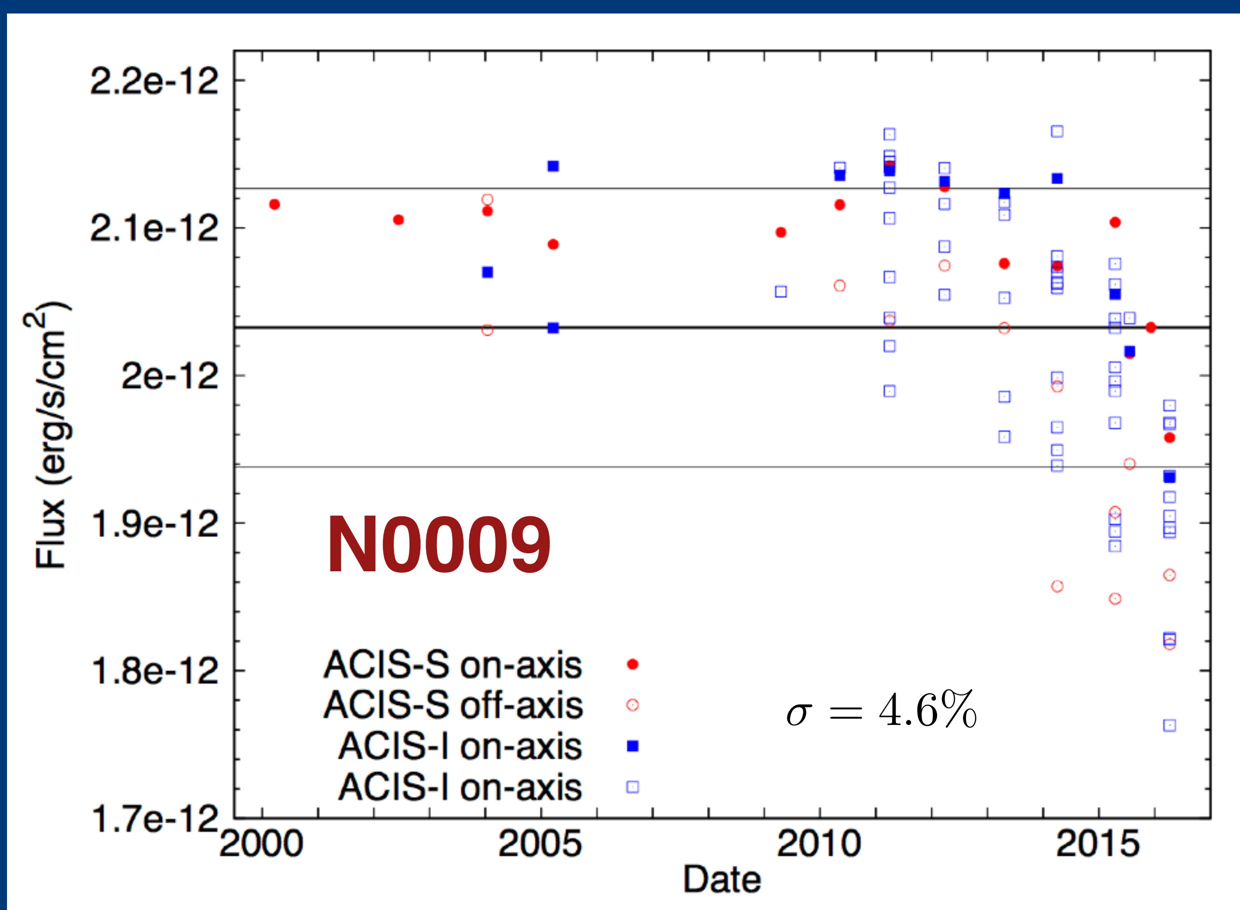


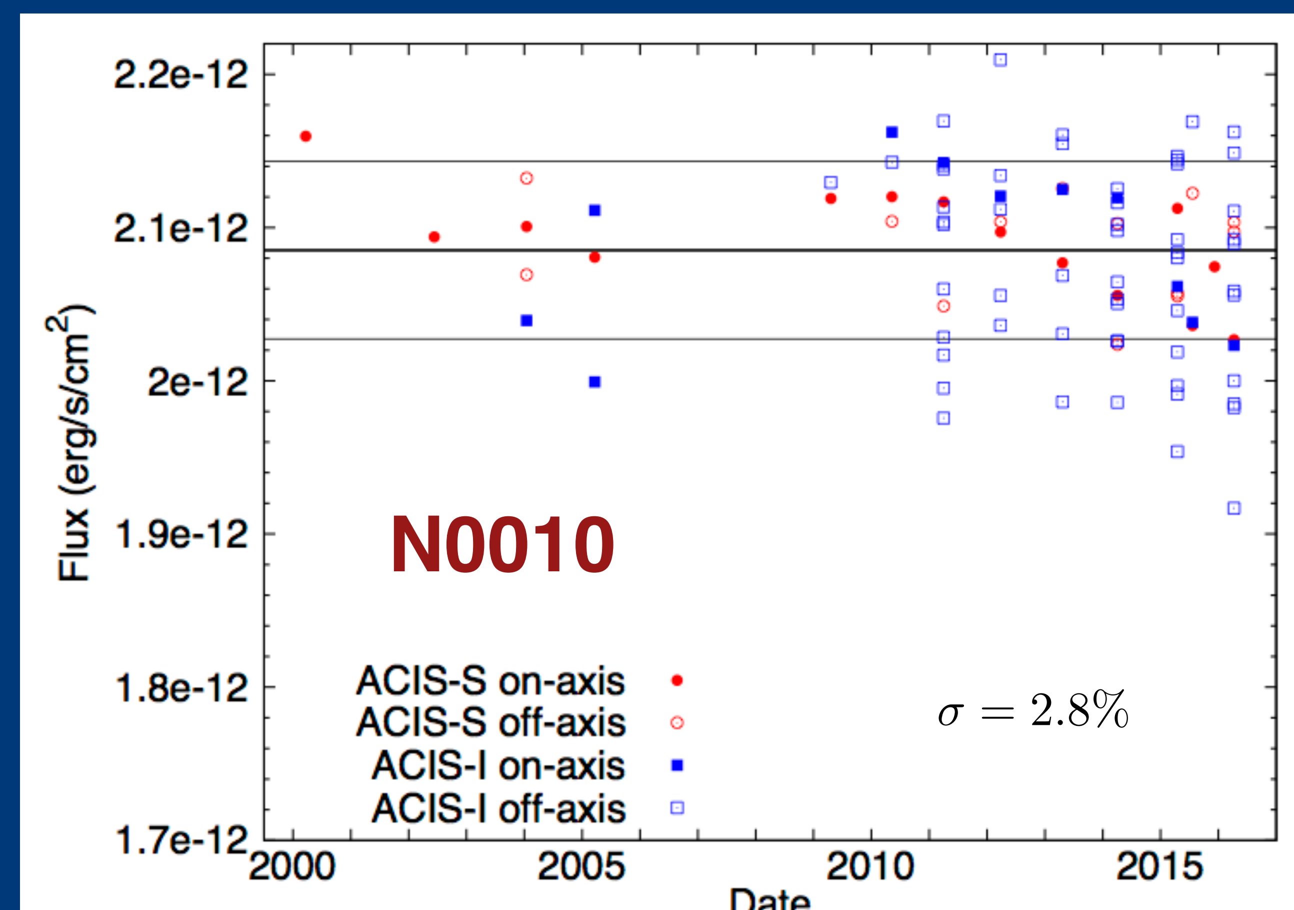


ACIS Effective Area - Monitoring the Contamination

Comparison of previous ACIS contamination mode (N0009) with the new and improved model (N0010-released in Dec. 2016)

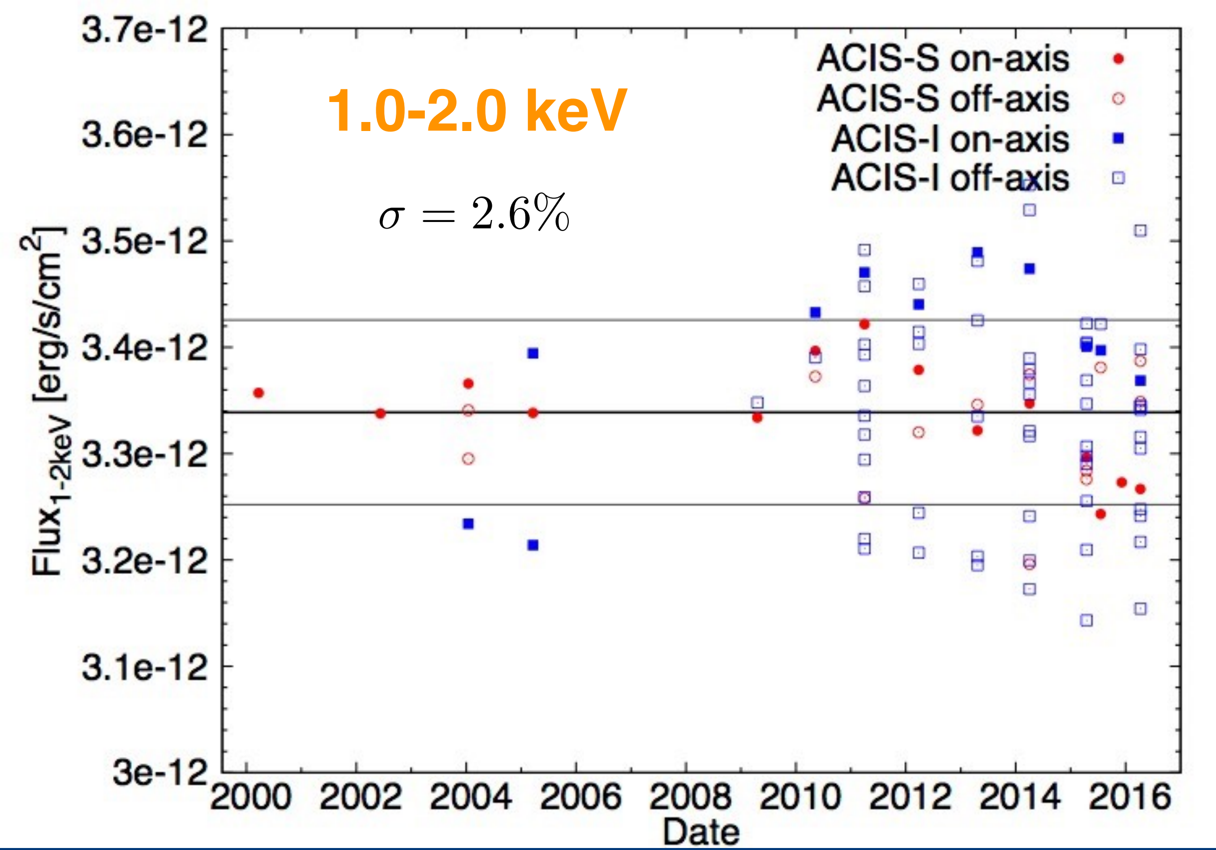
Abell 1795 (0.5-1.0 keV)

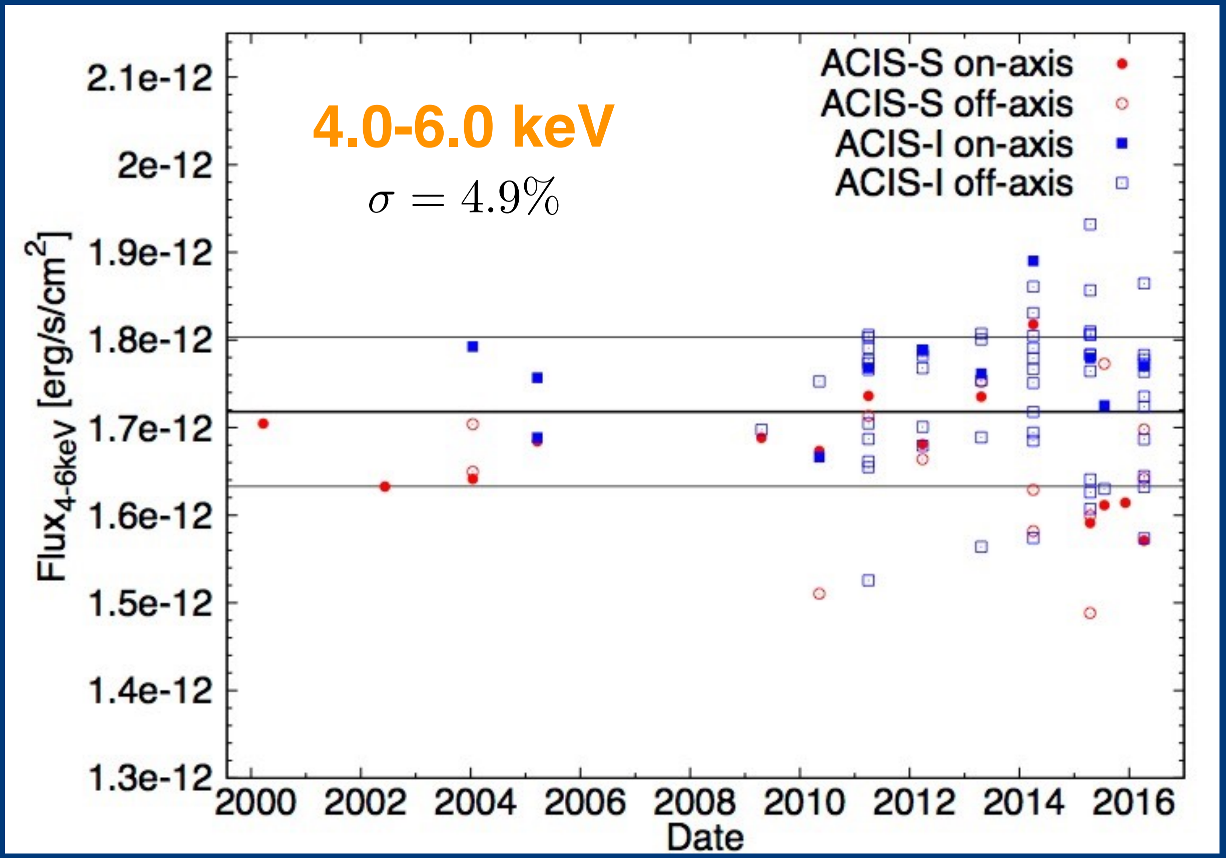


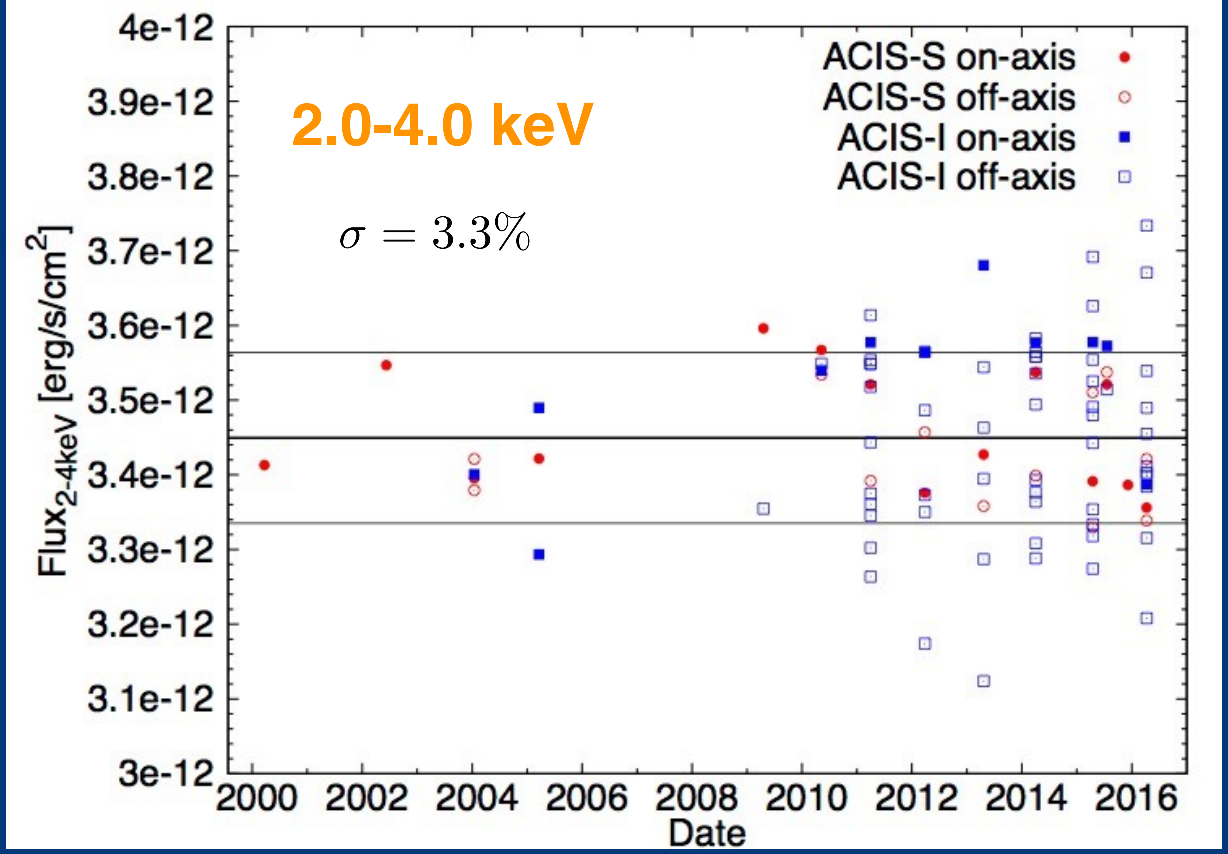


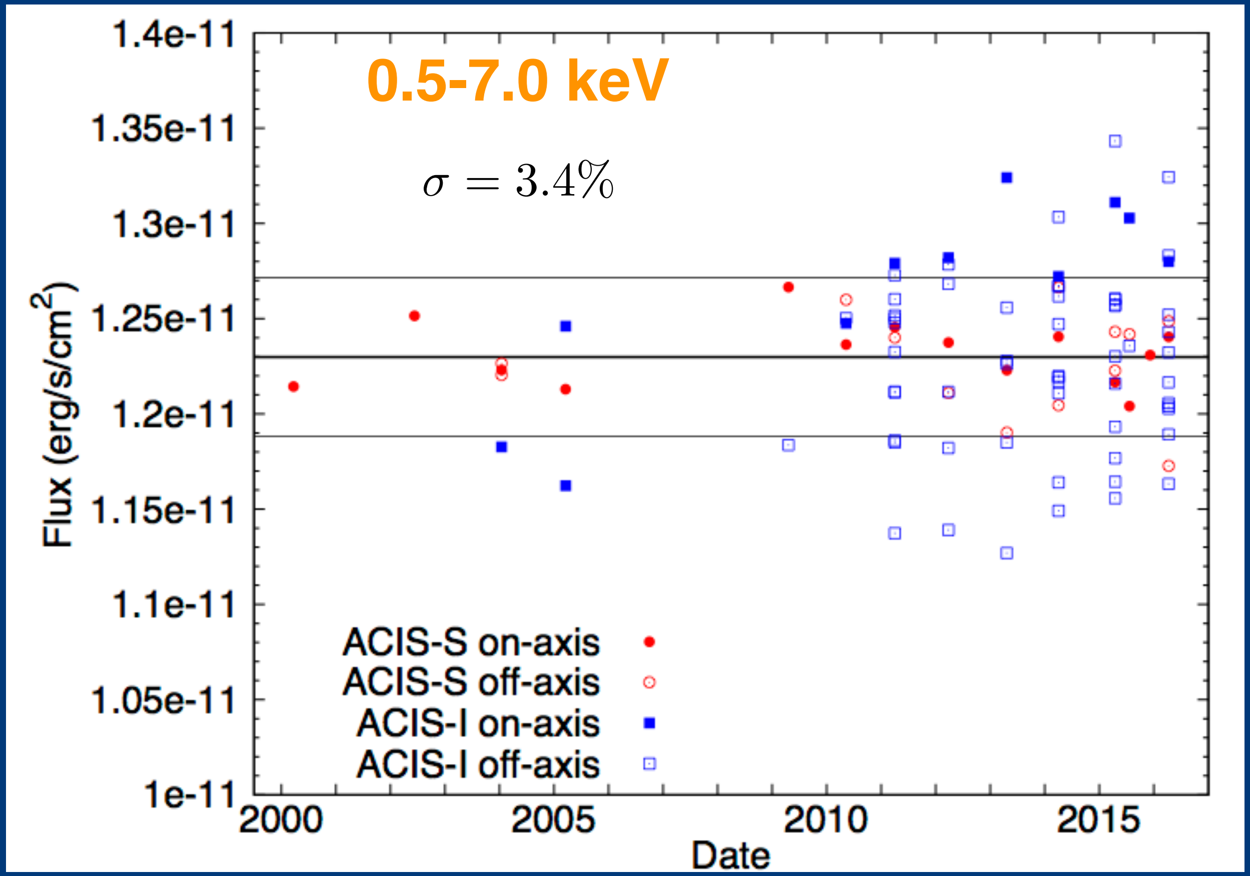
ACIS Effective Area

Abell 1795

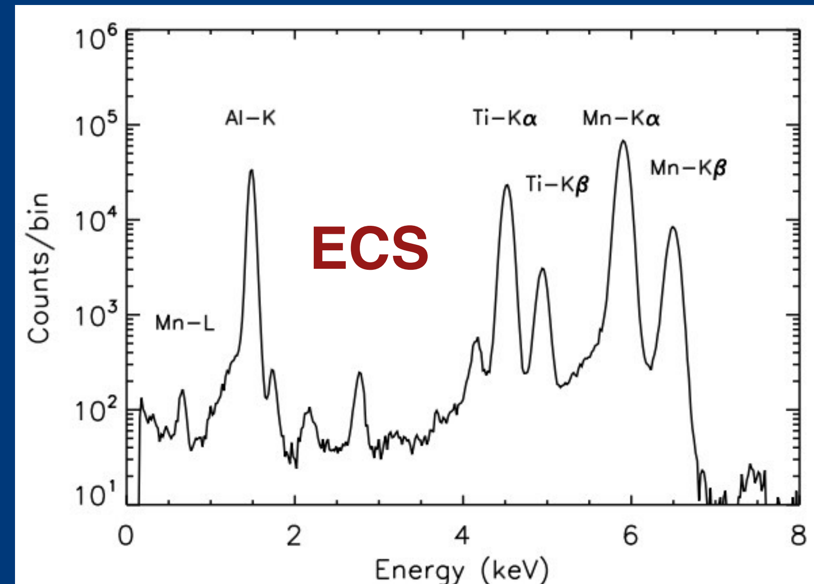






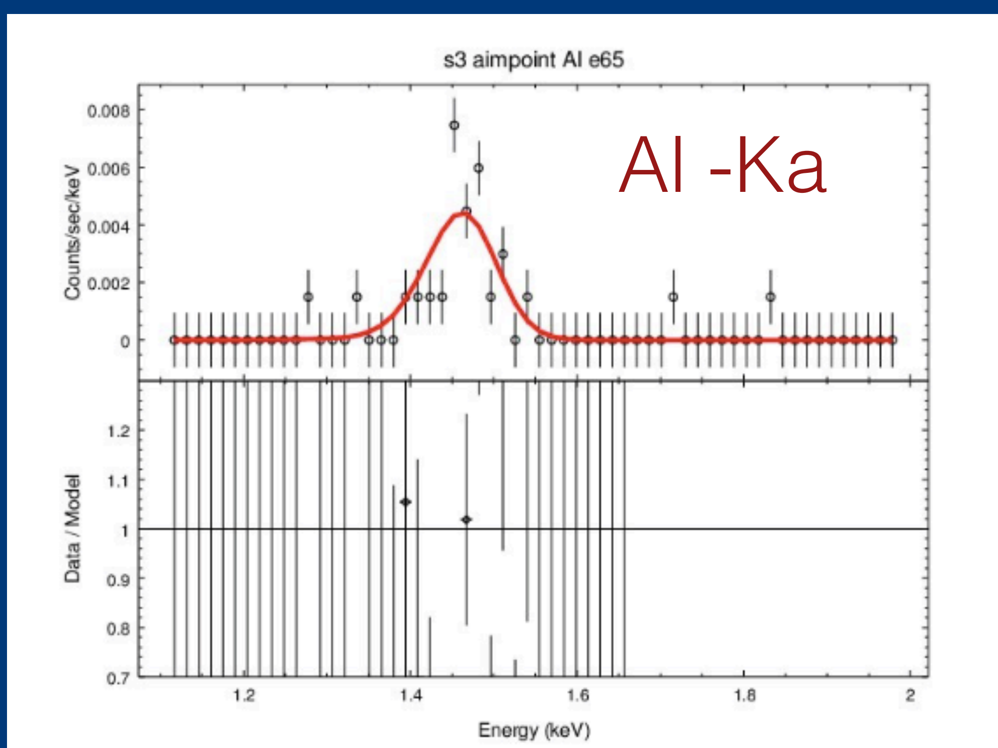


ACIS Gain - Time-Dependent Corrections



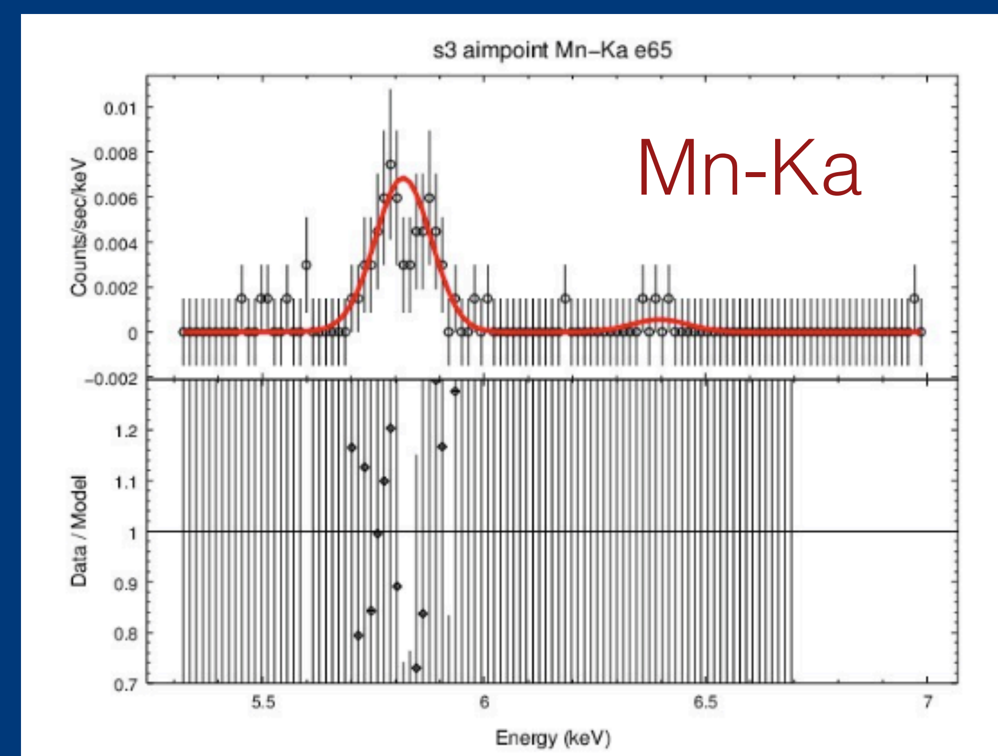
^{55}Fe half-life = 2.7 yr

2016 ECS data - ACIS-S3 aim-point



Old tgain files

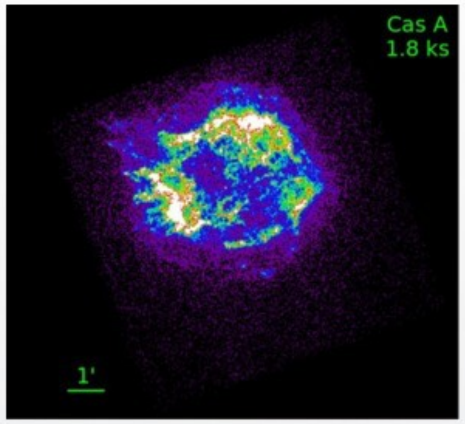
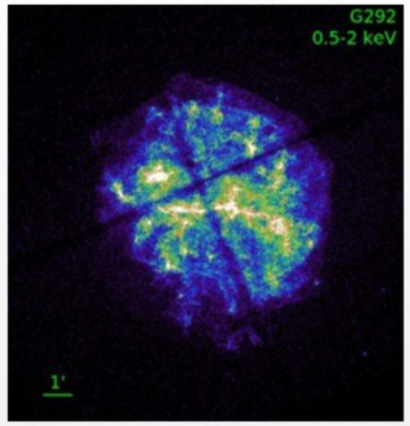
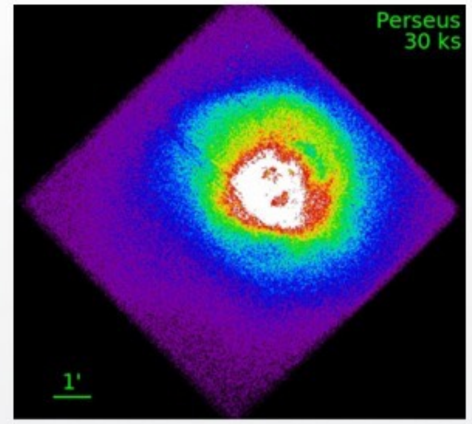
- **32 by 32 pixel regions**
- **every 3 months**



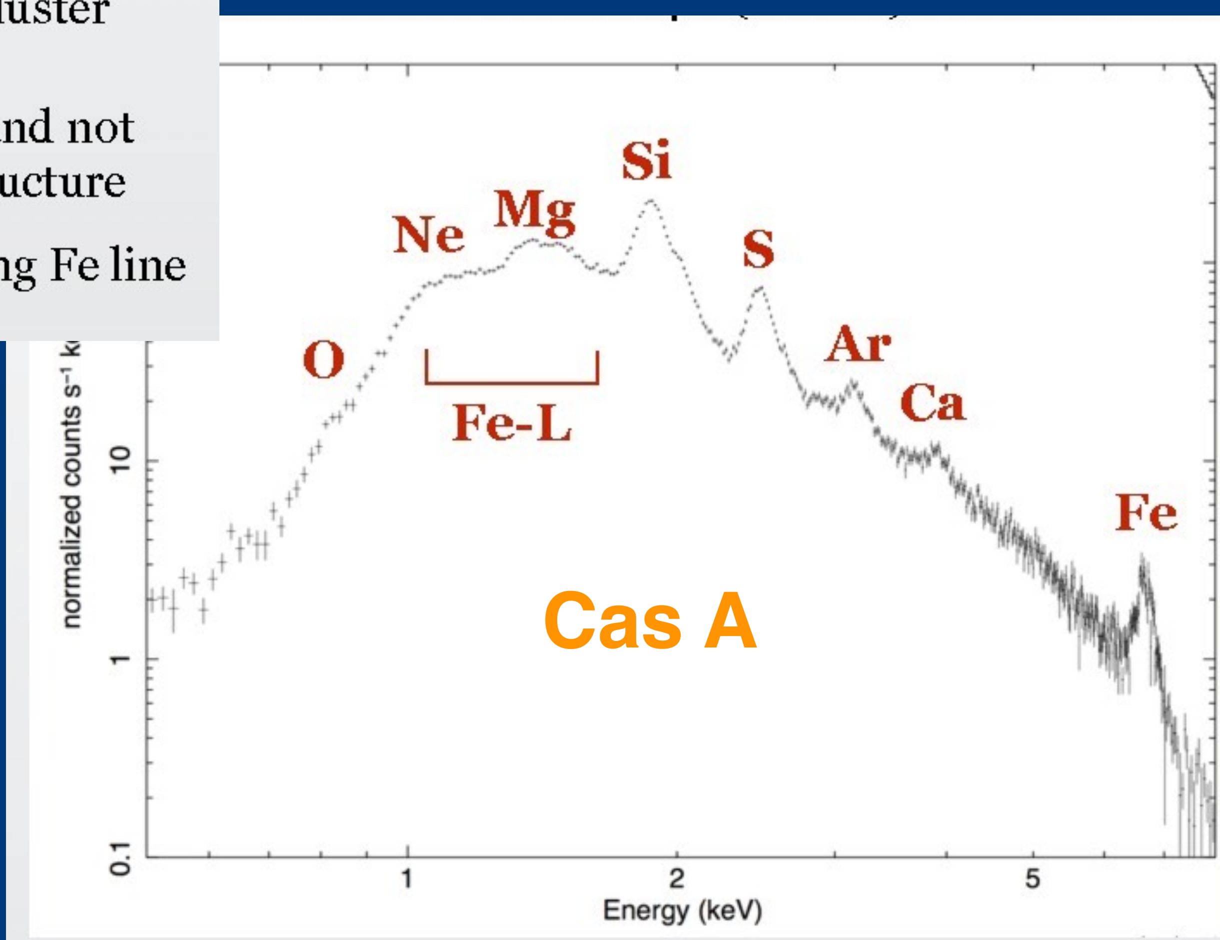
New tgain files (effective Dec. 2016)

- **32 by 32 pixel regions**
- **Every 6 months**

ACIS Gain Calibration in the Future (2020)

Cas A	G292	Perseus cluster
		
d = 6 arcmin	d = 9 arcmin	d = 7 arcmin
$C_{0.5\text{-}2keV}$ = 127 cts/s	$C_{0.5\text{-}2keV}$ = 27 cts/s	$C_{0.5\text{-}2keV}$ = 44 cts/s
~300 years old	few thousand years old	galaxy cluster
Complex morphology with energy dependence		Smooth and not much structure
Multiple strong emission lines		Only strong Fe line

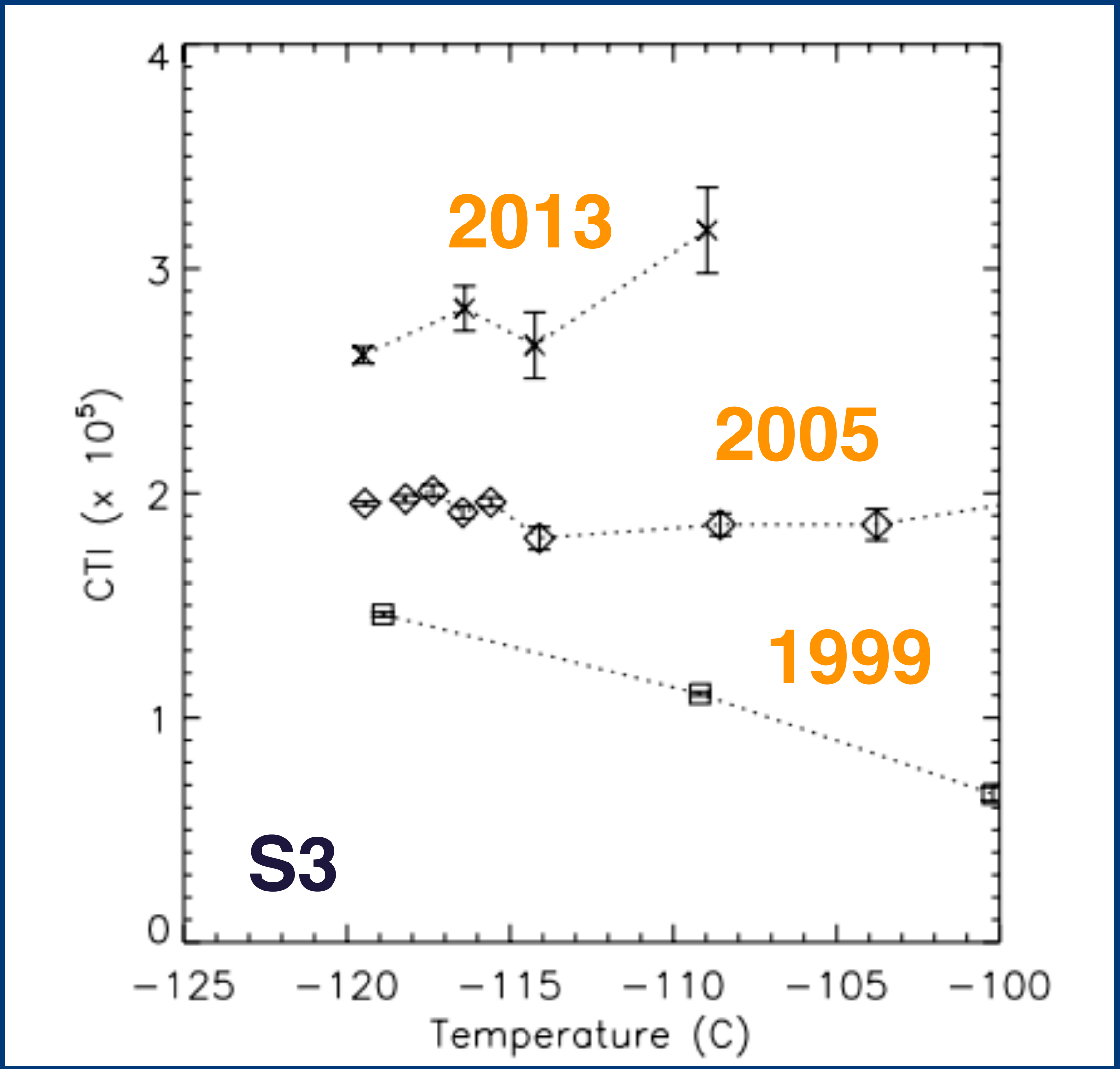
Given the flux and extent of Cas A, only ~80 ksec of exposure time is required to calibrate all 10 chips.

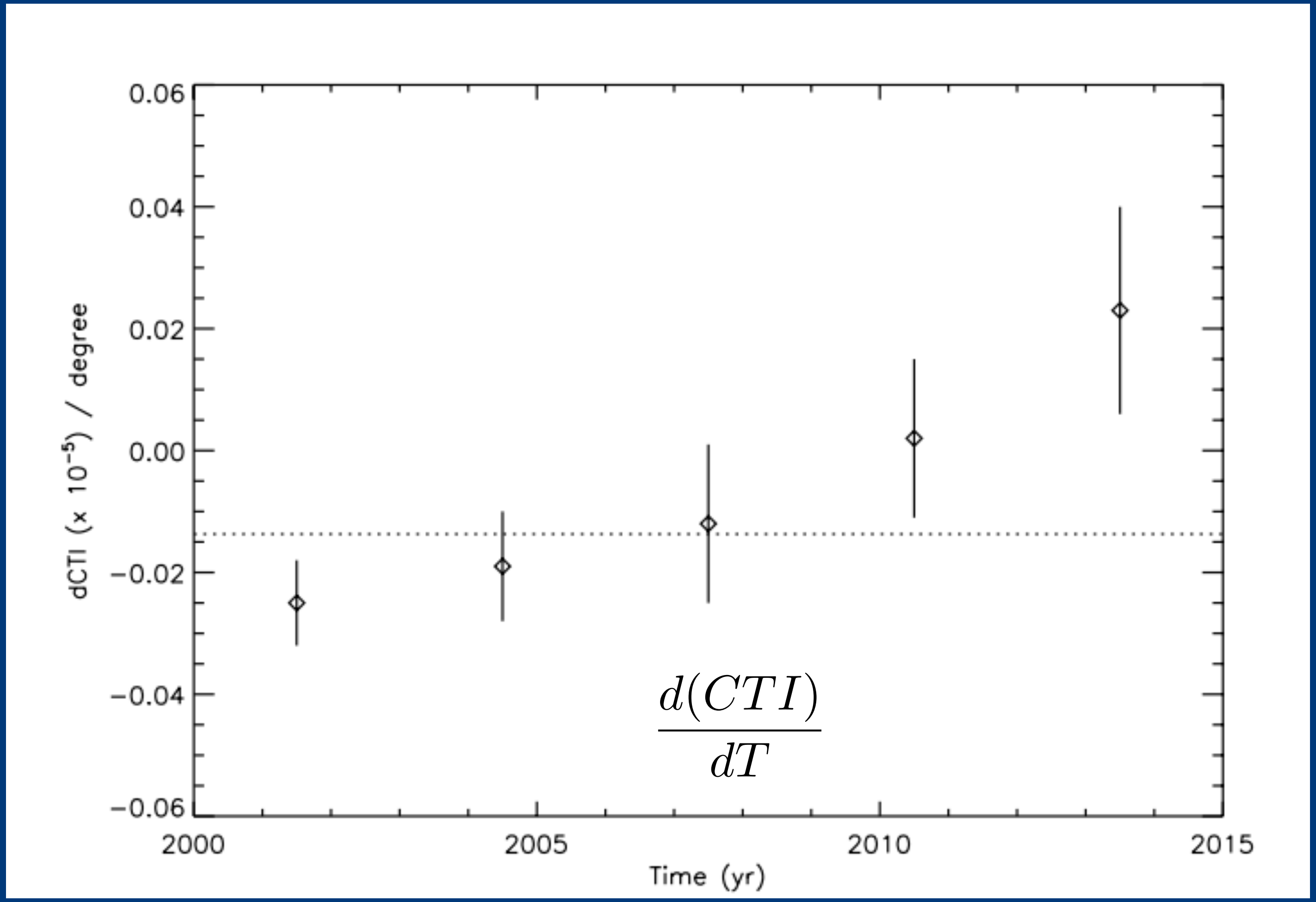


ACIS Gain: Temperature-Dependent CTI Correction

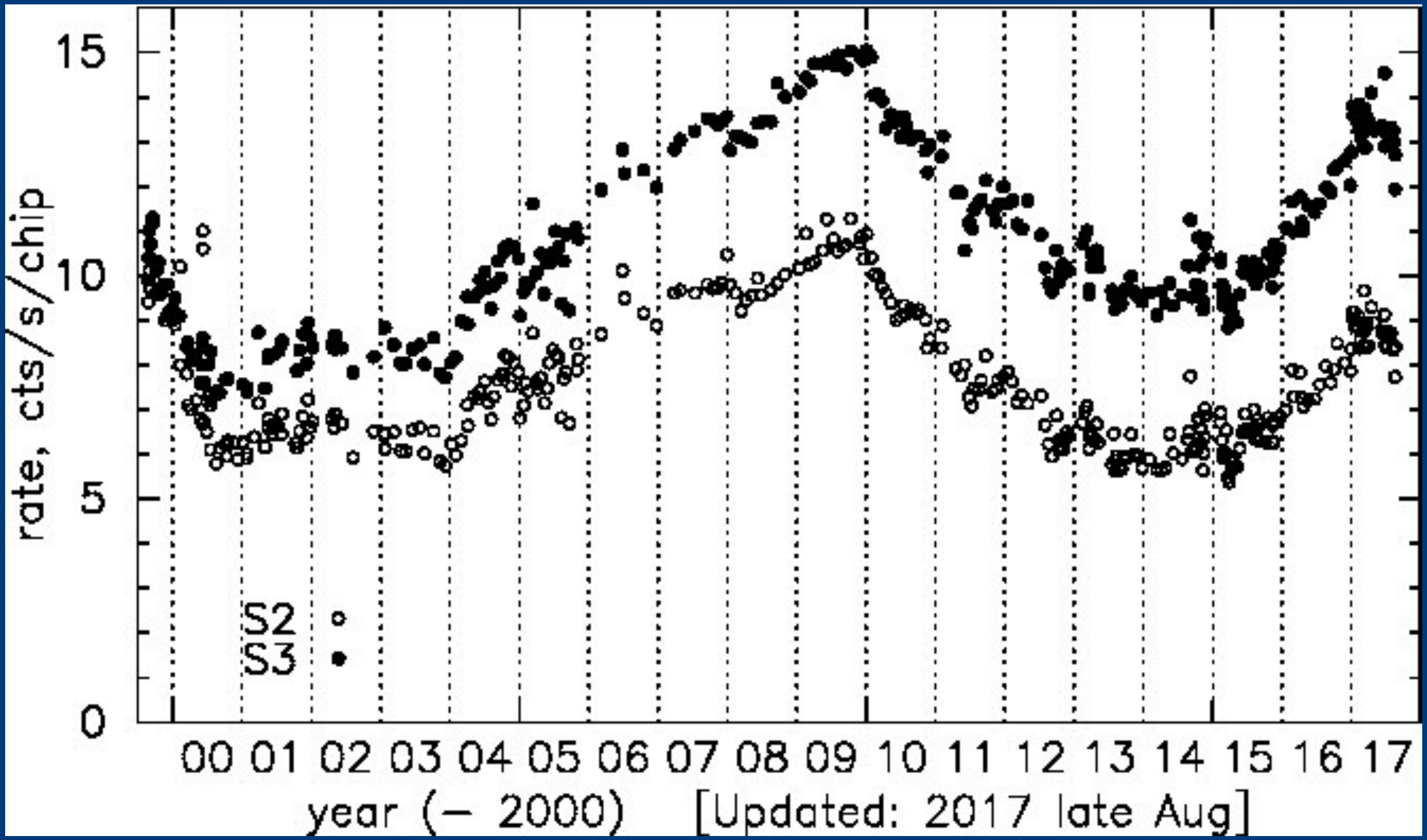
Two gain corrections are applied to ACIS data:

- Temperature-dependent CTI correction
- Time-dependent gain correction.





ACIS Background

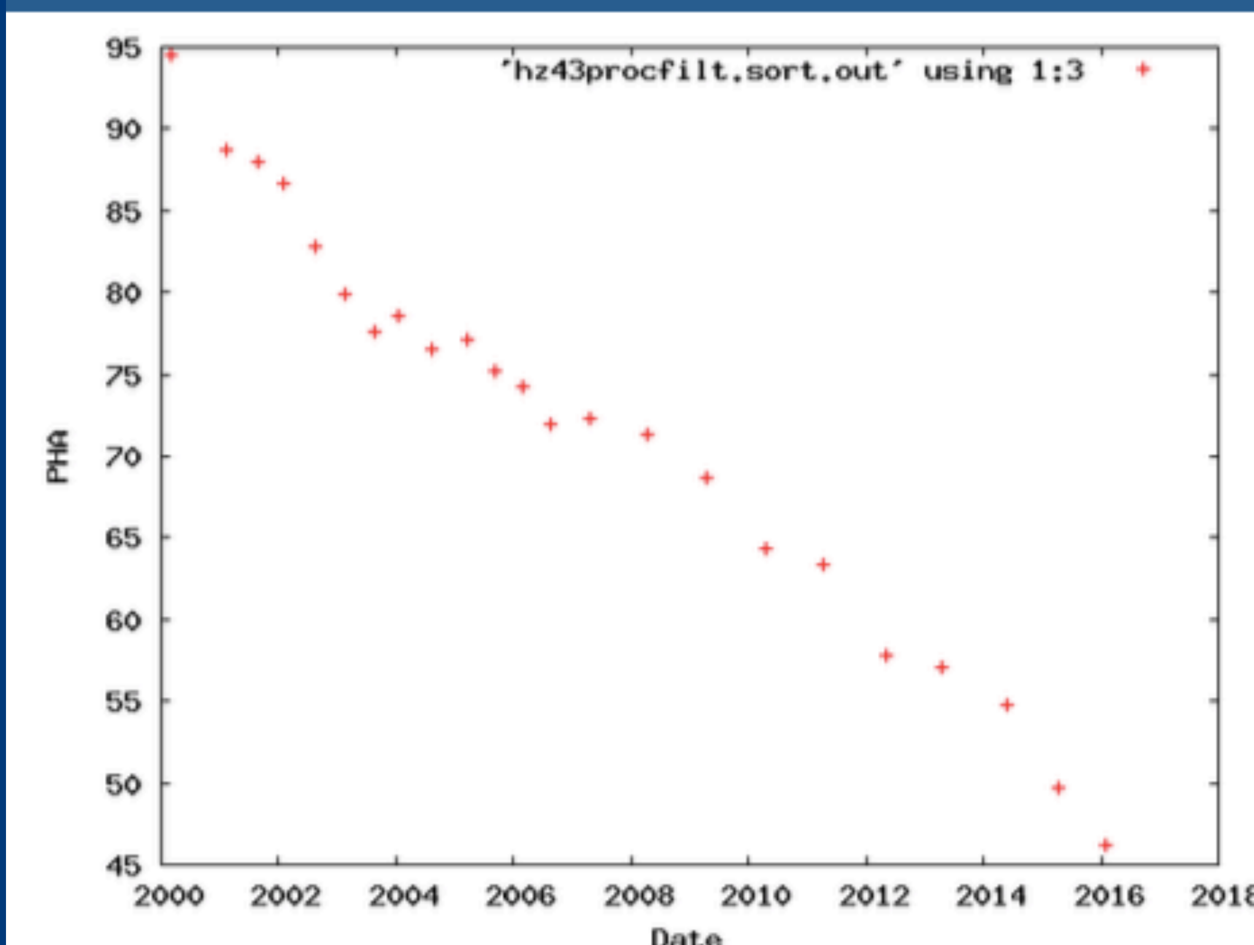


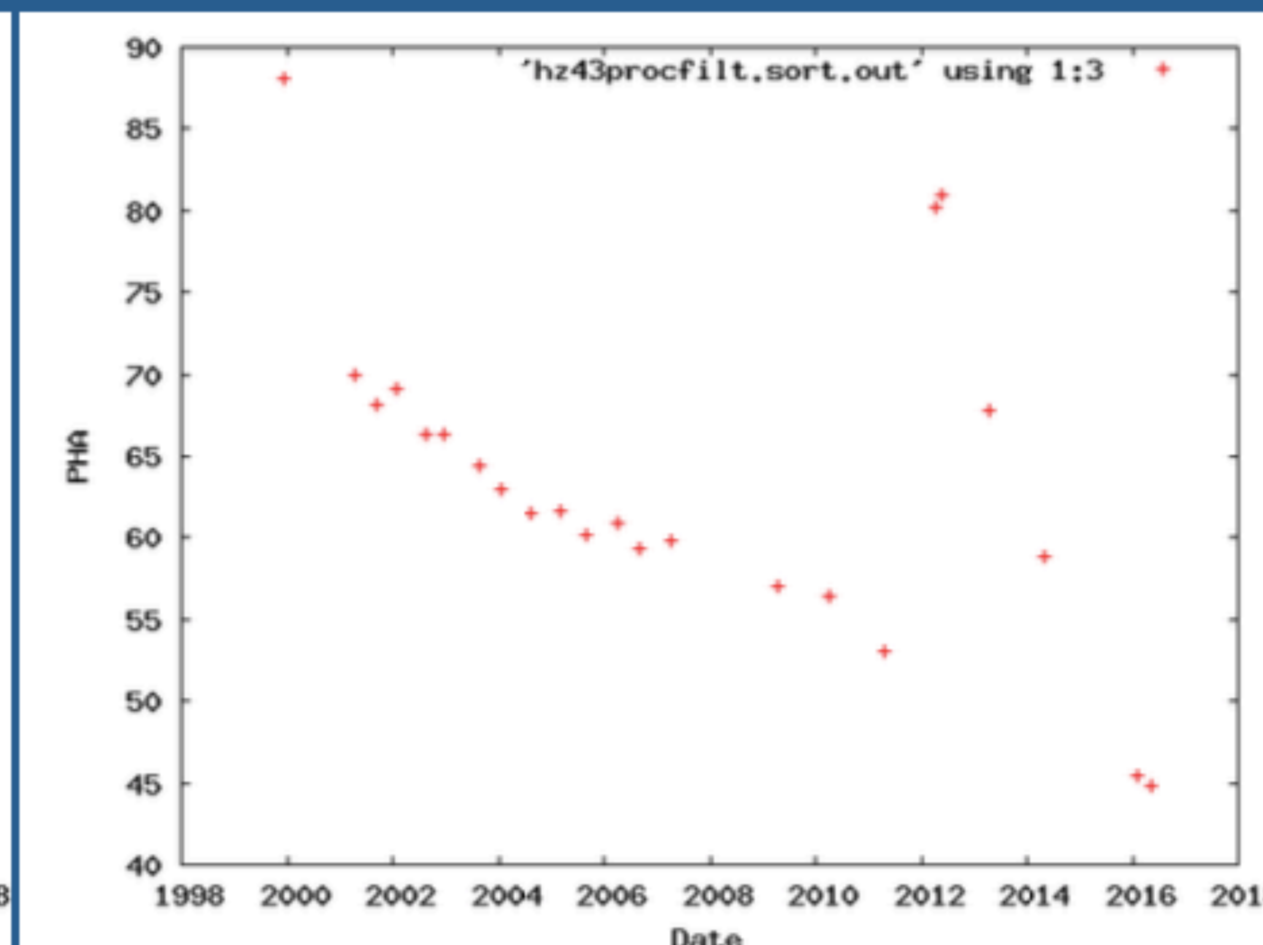
Total ACIS background rates (i.e., the telemetered rates) are updated every three months on the ACIS web page.

HRC Gain Calibration

The HRC-S gain is monitored with LETG/HRC-S observations of HZ43 every four months.

HRC gain (HZ 43 calibration observations – zeroth order)



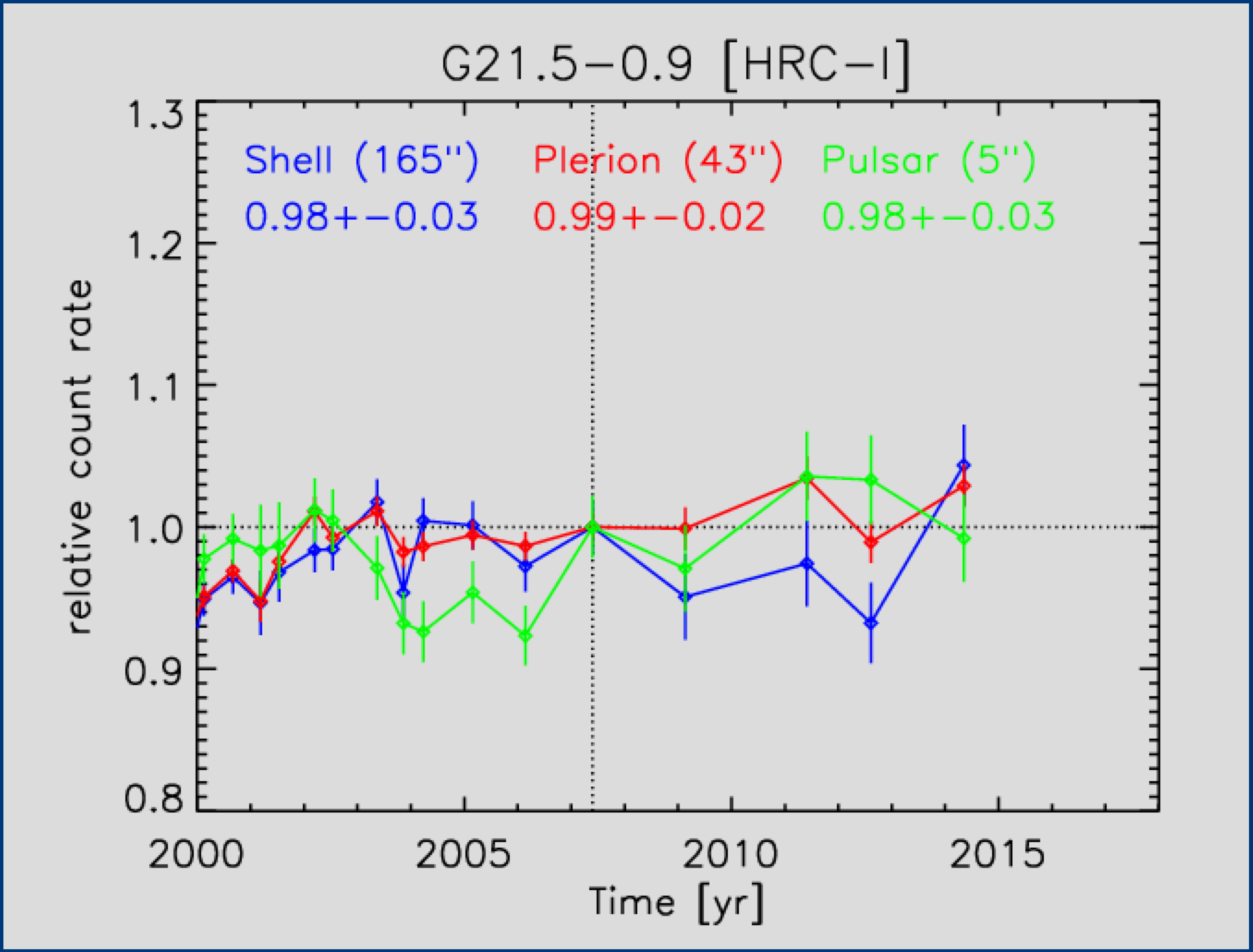


HRC-I HRC-S

~10% gain loss per year

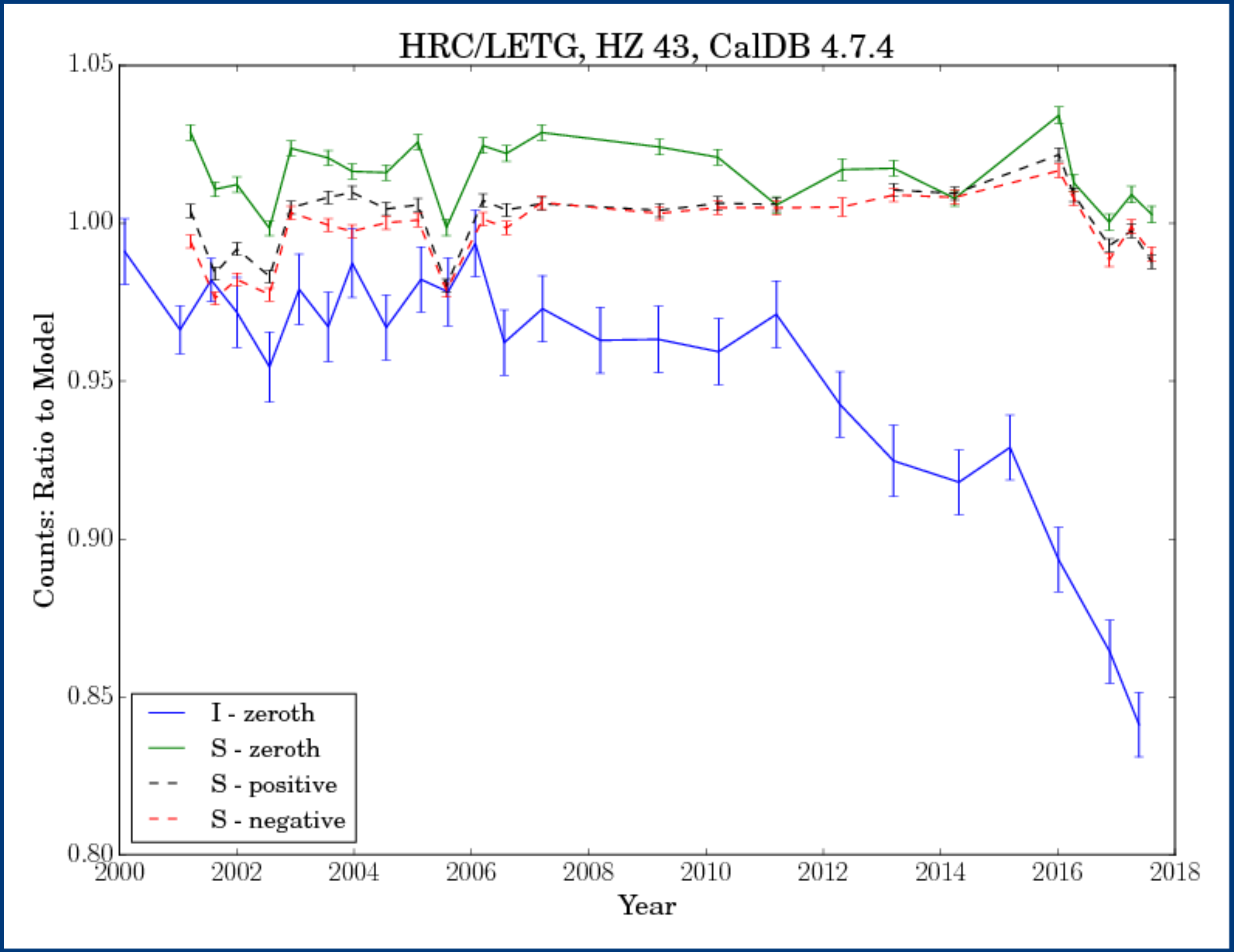
HRC Effective Area Calibration

Hard Source - G21.5-09



HRC Effective Area Calibration

Soft Source - HZ43



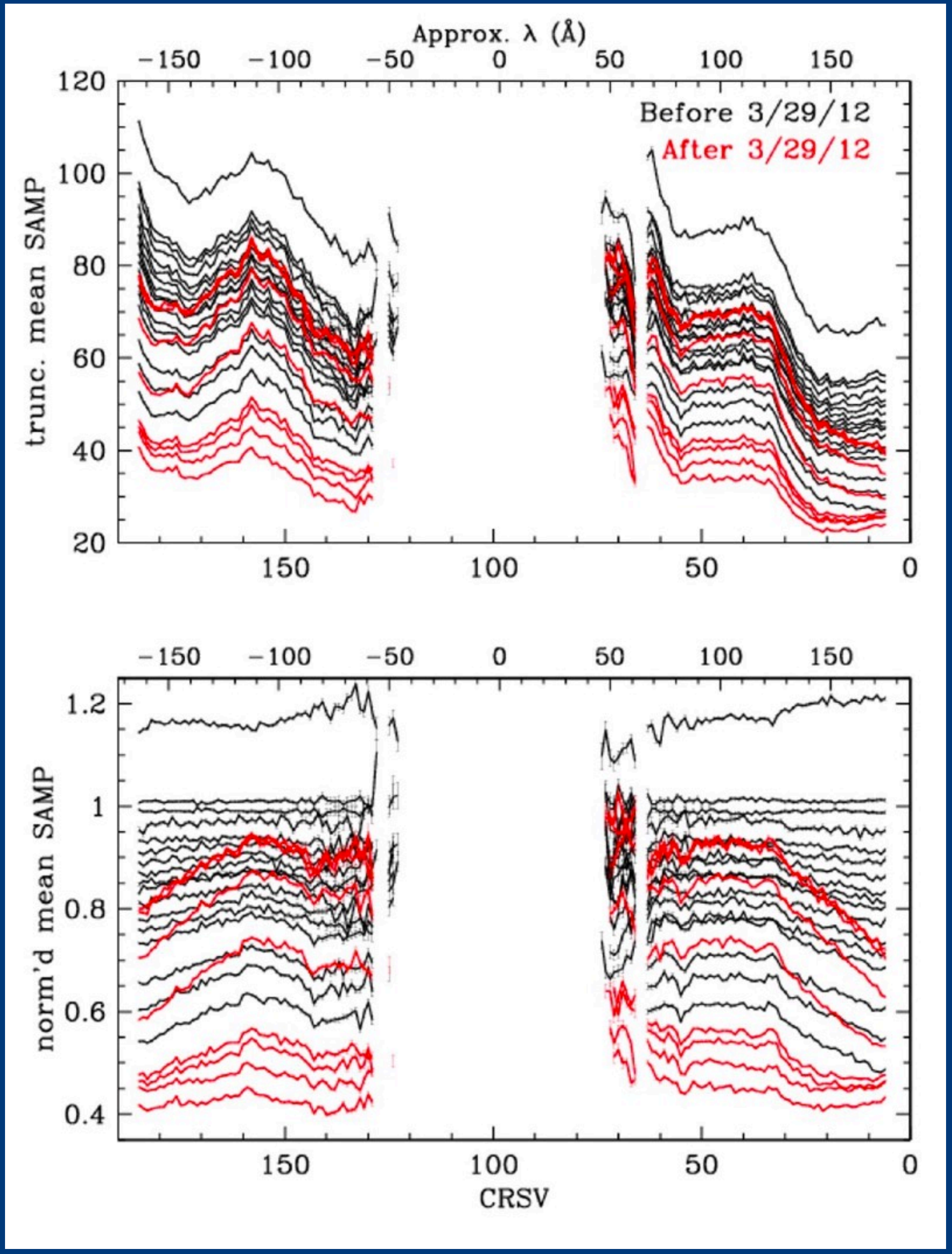
The decline in the HRC-S QE is corrected with annual updates to the HRC-S QE map.

Work is underway to develop a time-dependent HRC-I QE.

LETG/HRC-S Calibration

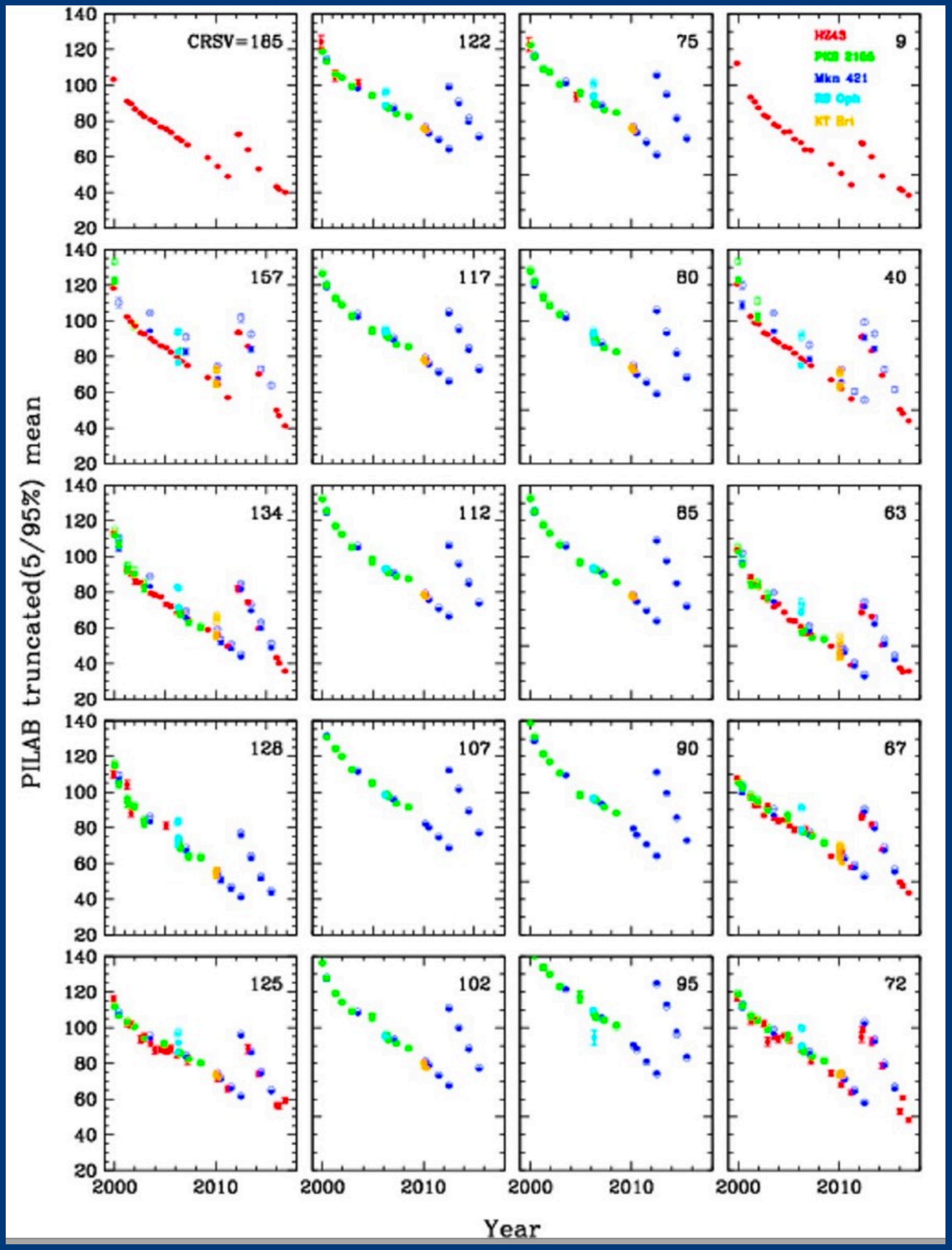
HRC-S gain calibration

- Improve post HV change (2012) calibration
- Calibrate time-dependent changes per tap
- More thorough removal of higher order emission and background
- Incorporate additional off-axis HZ43 LETG/HRC-S data near plate gaps

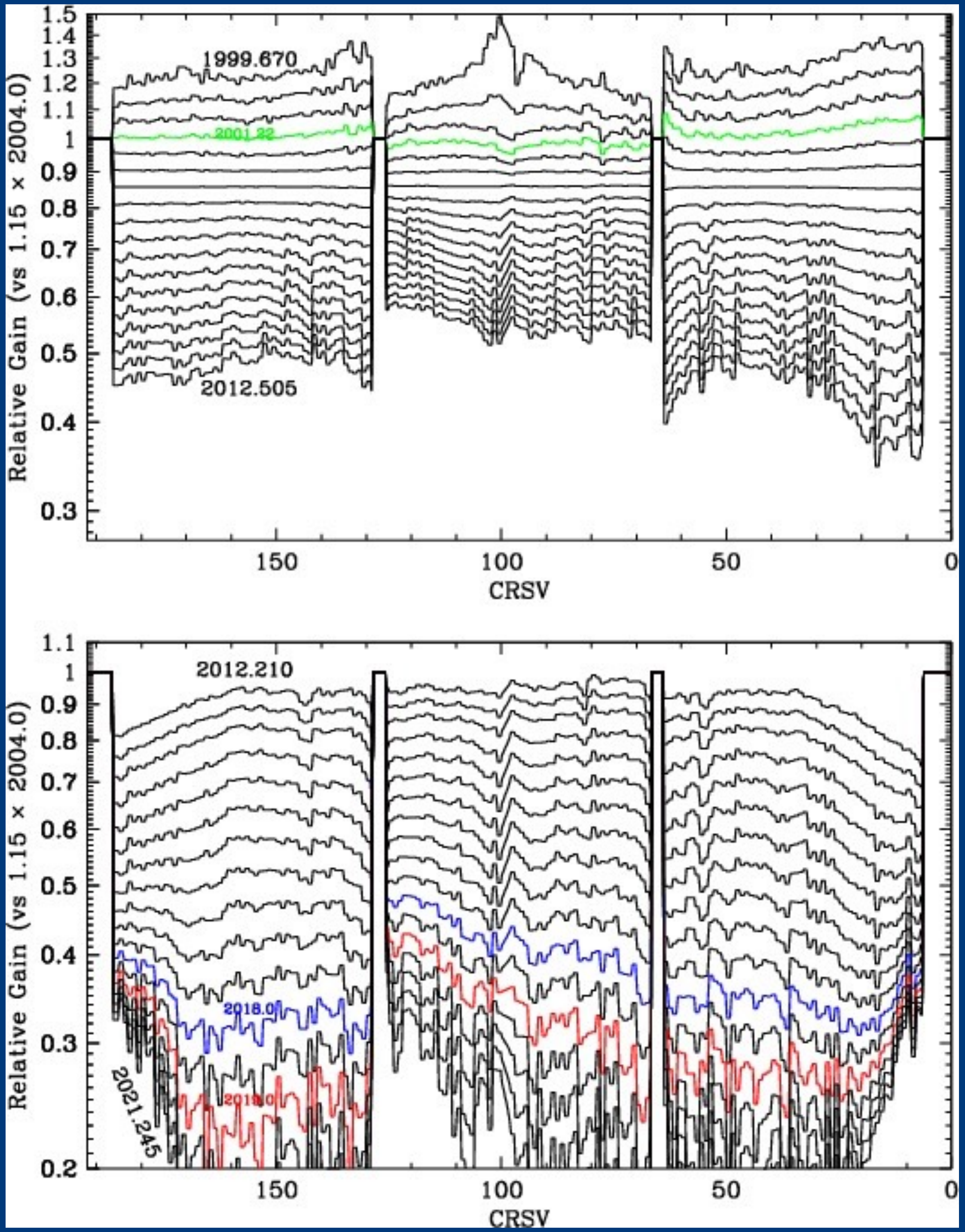


LETG/HRC-S Calibration

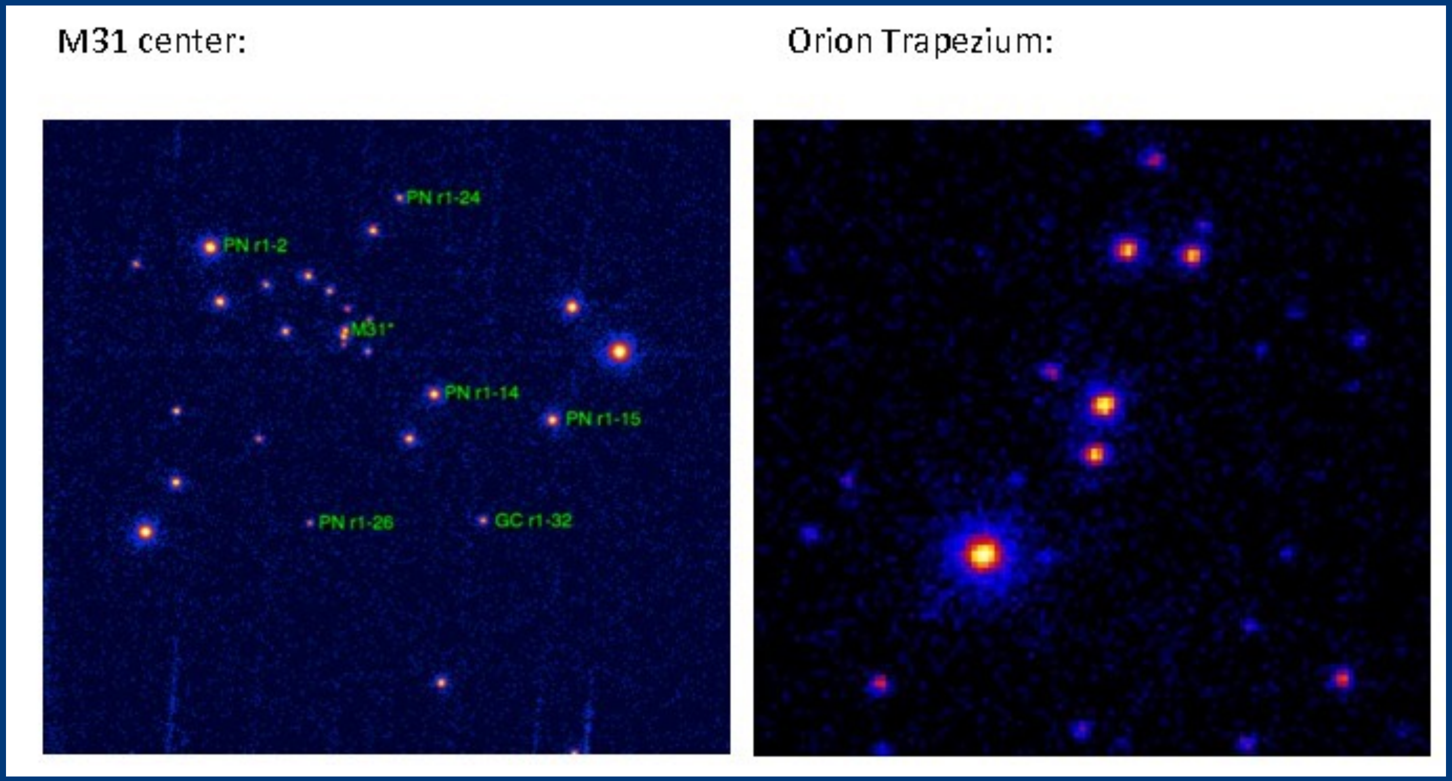
Time-dependent gain for a sample of HRC-S taps

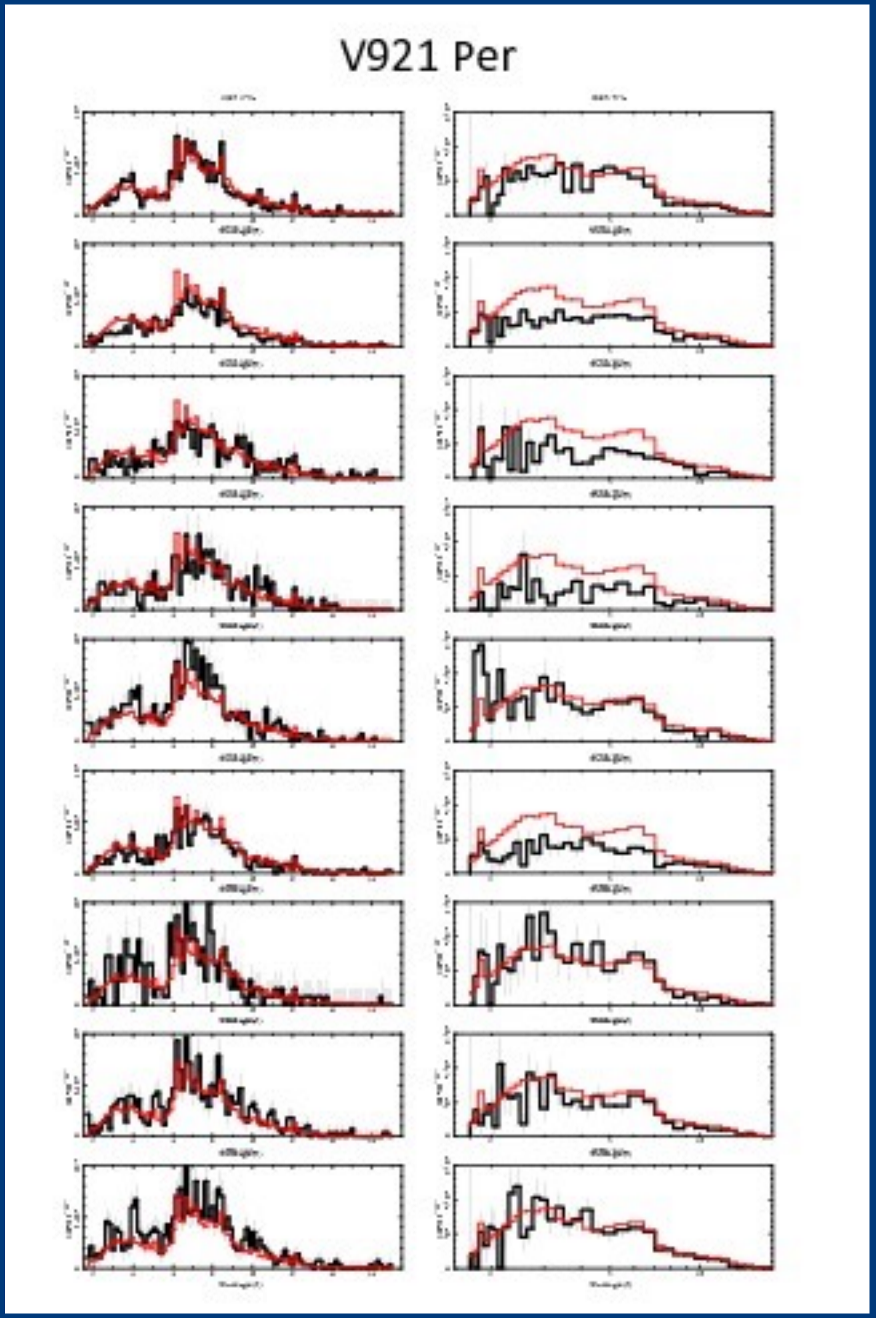


Relative Gain Corrections. One set per year.



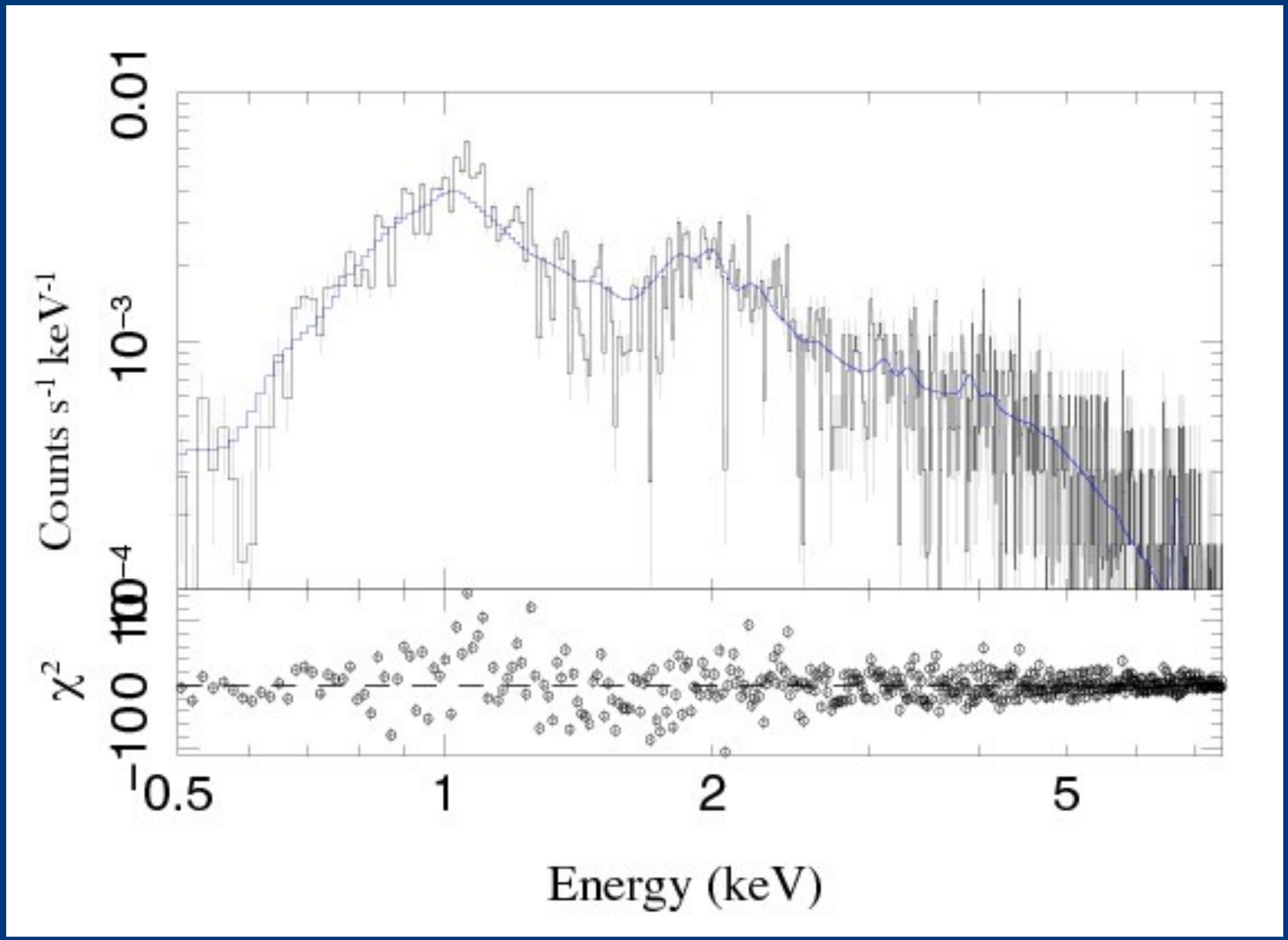
HETG Calibration (0th order)





The main difficulty in calibrating 0th order is finding a source faint enough to not produce pile-up in 0th order, but still bright enough to produce good statistics in 1st order. Targeted binaries and AGN are usually too bright.

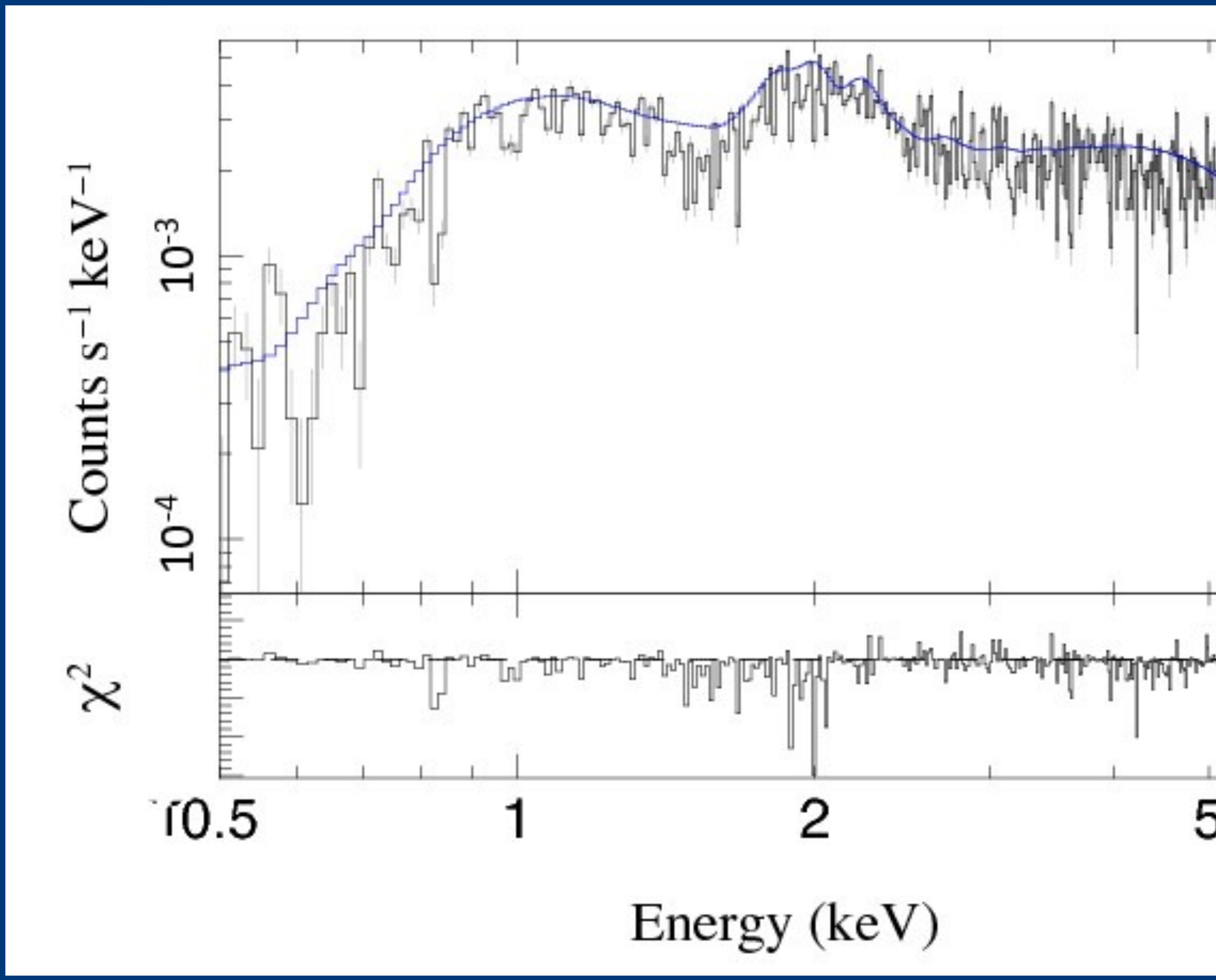
HETG Calibration (0th order)



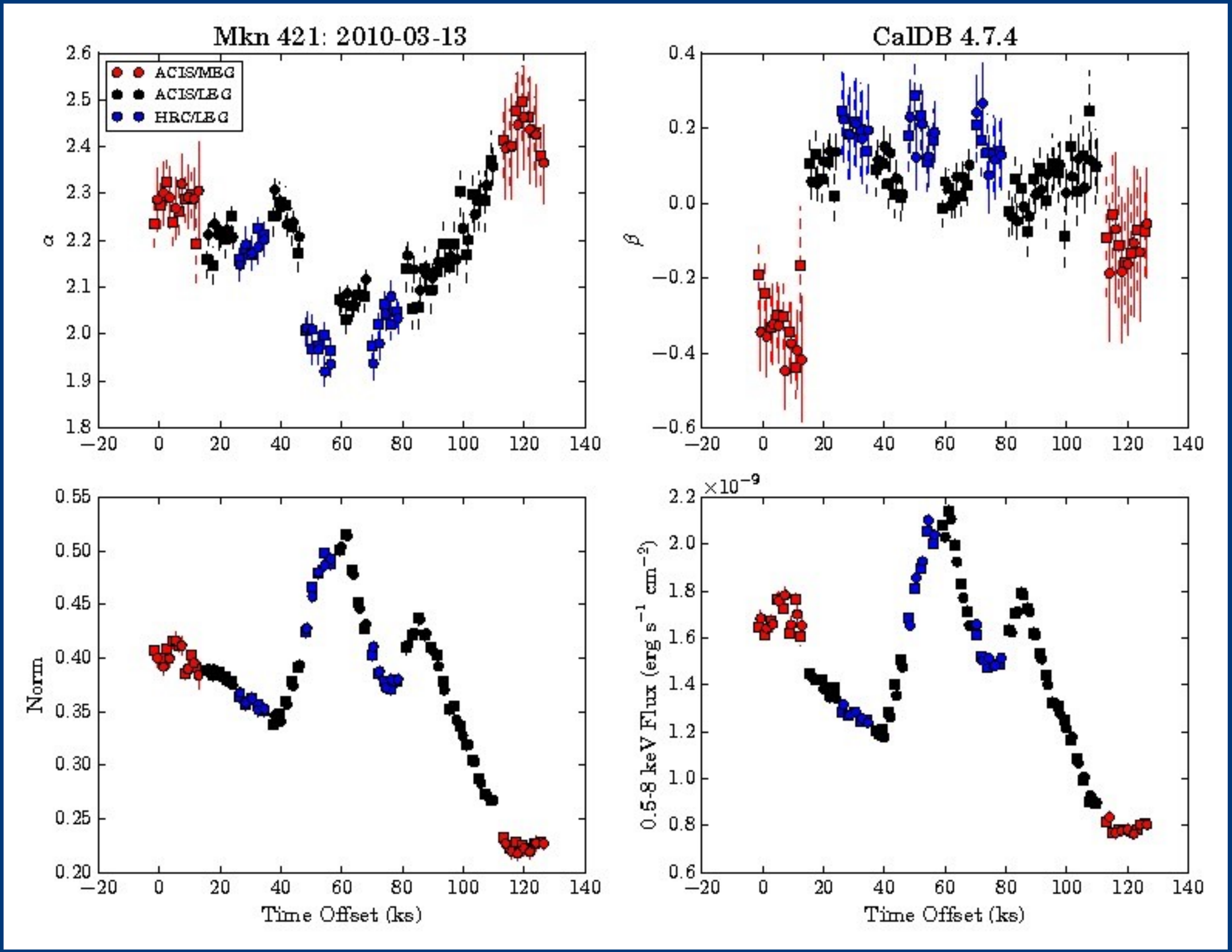
Orion Par 1842 - central pixel excluded

Even with the limited number of sources used for comparison, we can state that HETG 0th and 1st orders agree to better than 5%.

M31 Source 6

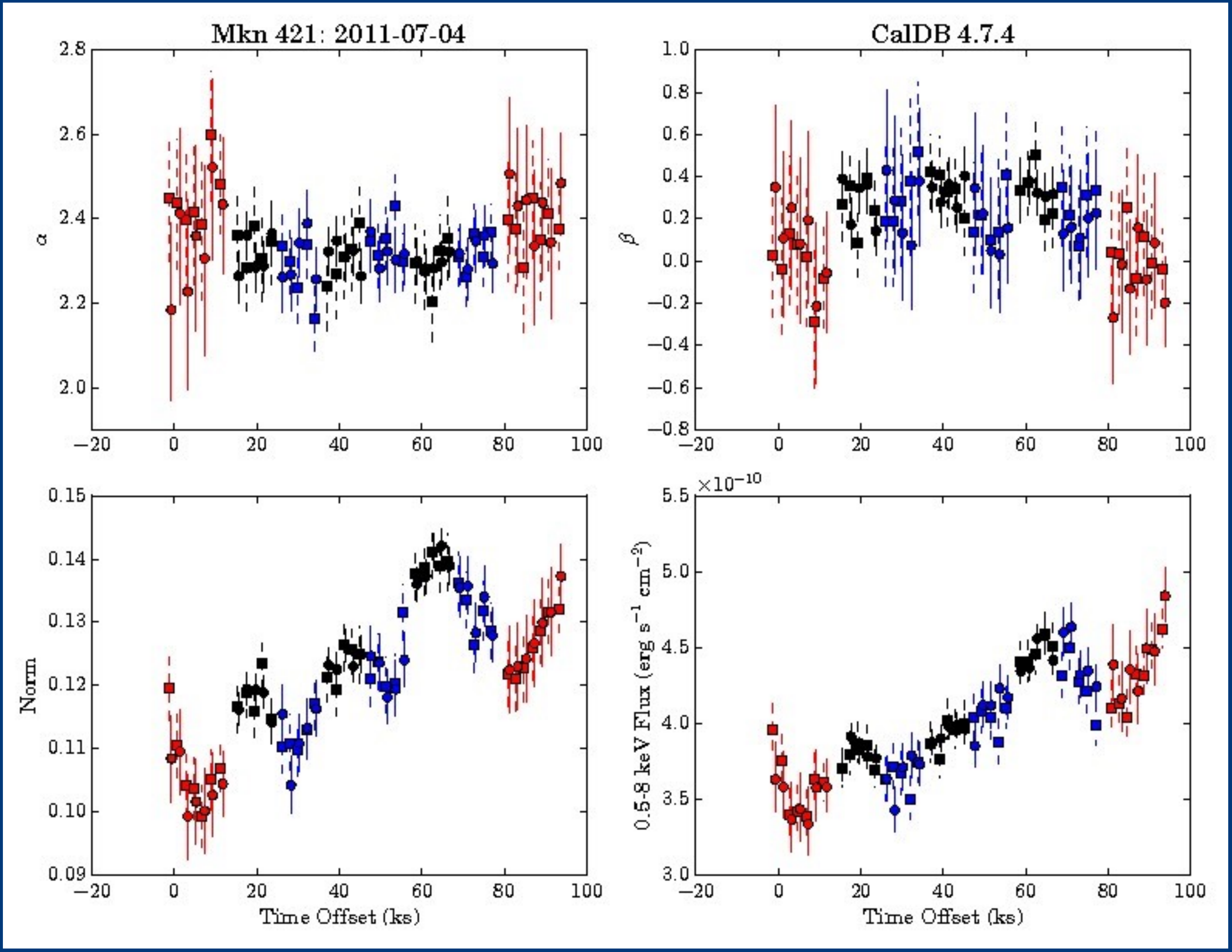


Gratings Cross-Calibration

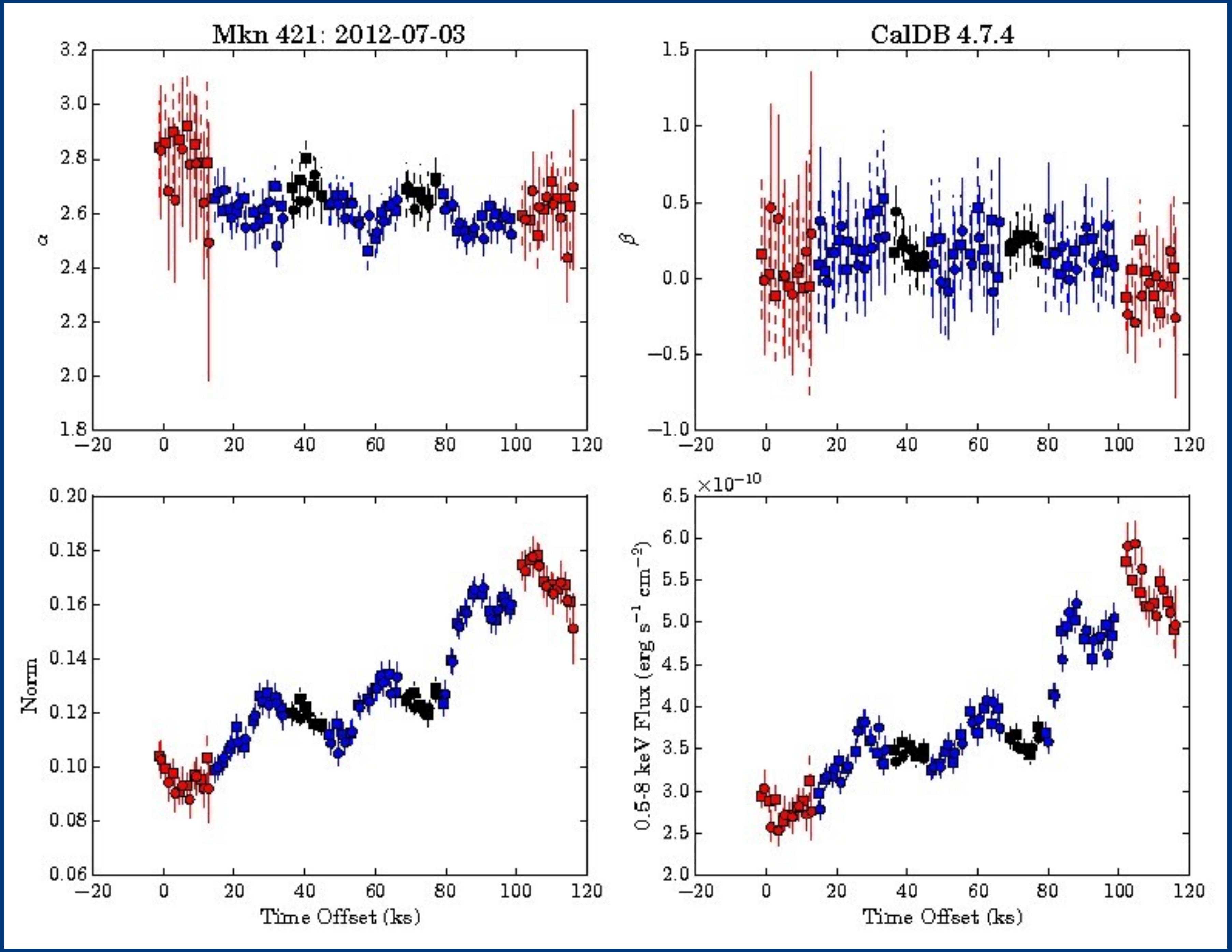


Analysis of annual interleaved grating/detector observations of Mkn 421. All spectra were fit to a xsologpar (log-parabolic) blazar model.

Gratings Cross-Calibration



Gratings Cross-Calibration



This analysis shows that all broad band fluxes agree to within 5%.

Present Calibration Projects

ACIS

- Monitor contamination and release updates as required.
- Develop grid of time- and temperature-dependent rmfs.
- Investigate new gain calibration methods.
- Release a set of QE uniformity maps for the epoch 2012-2016.

HRC

- Monitor QE and gain loss.
- Update HRC-I QE to maintain cross-calibration with HRC-S.
- Update the HRC-I QE map.

HETG

- Determine if the transmission efficiencies of the m/= 1 orders need to be adjusted.

LETG/HRC-S

- Revise HRC-S de-gap map - correct slight off-set between plus/minus orders.
- Release new set of annual HRC-S gain maps.
- Revise higher order portion of QEU map.