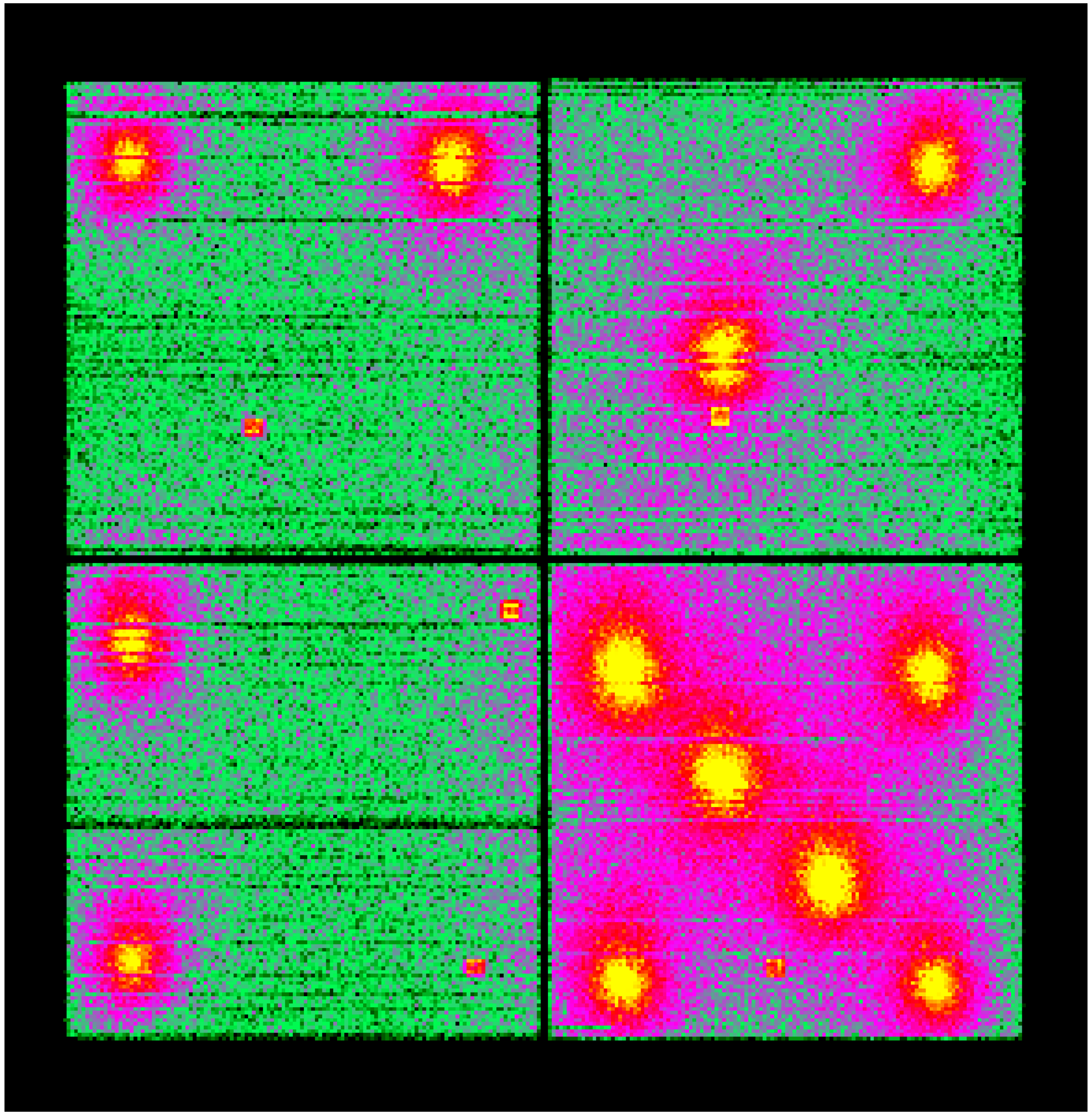
Chandra Calibration Status

CUC - Oct. 8, 2024

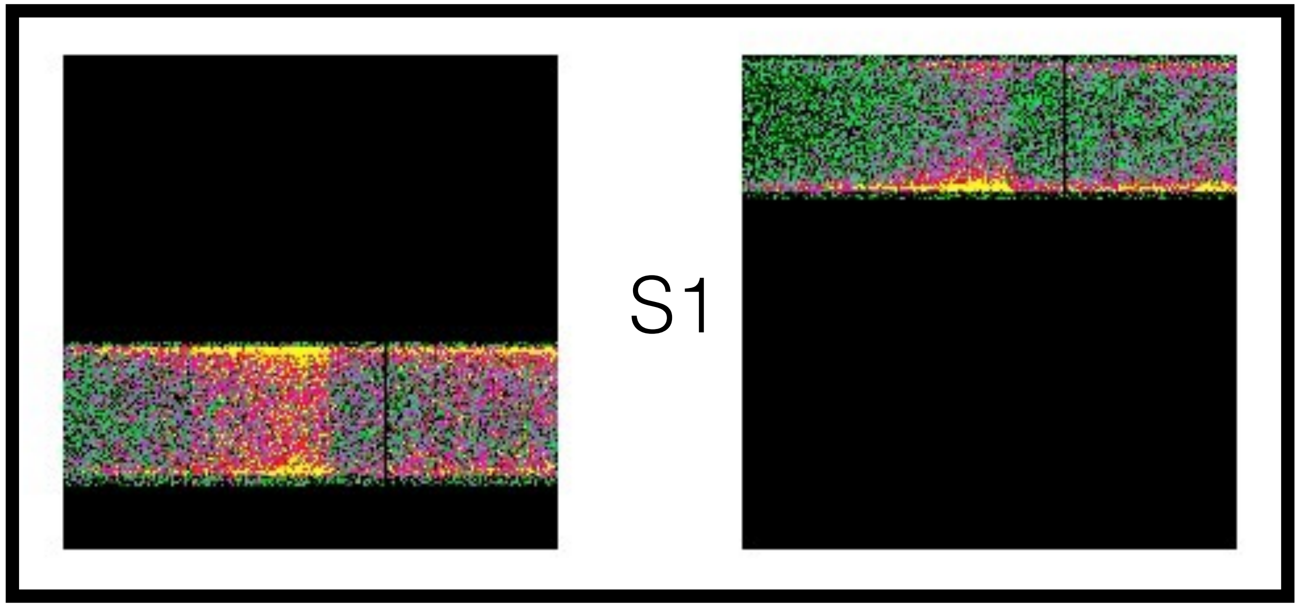
Monitoring the ACIS Contamination

A1795 Raster Scan on ACIS-I

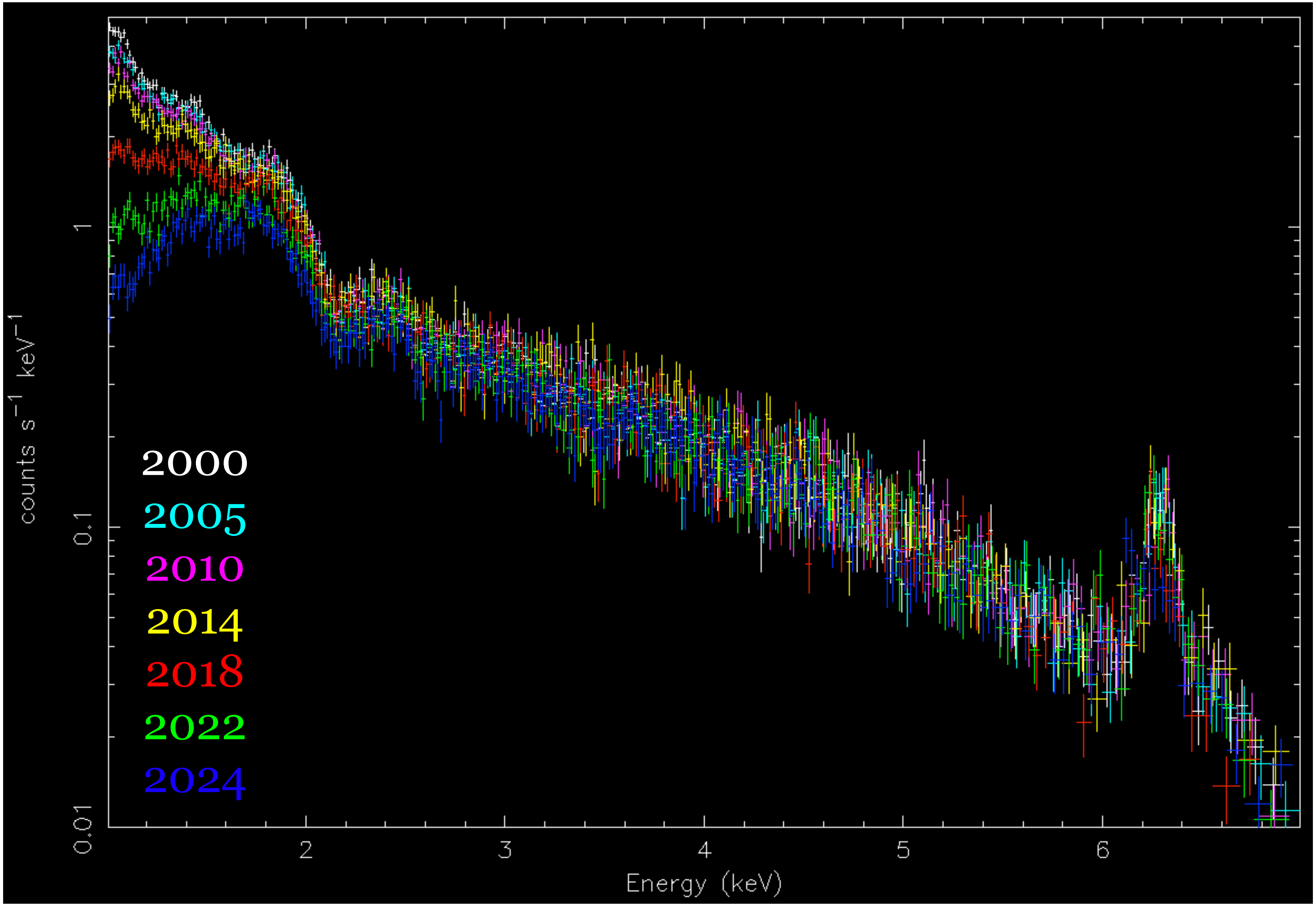


E0102-72

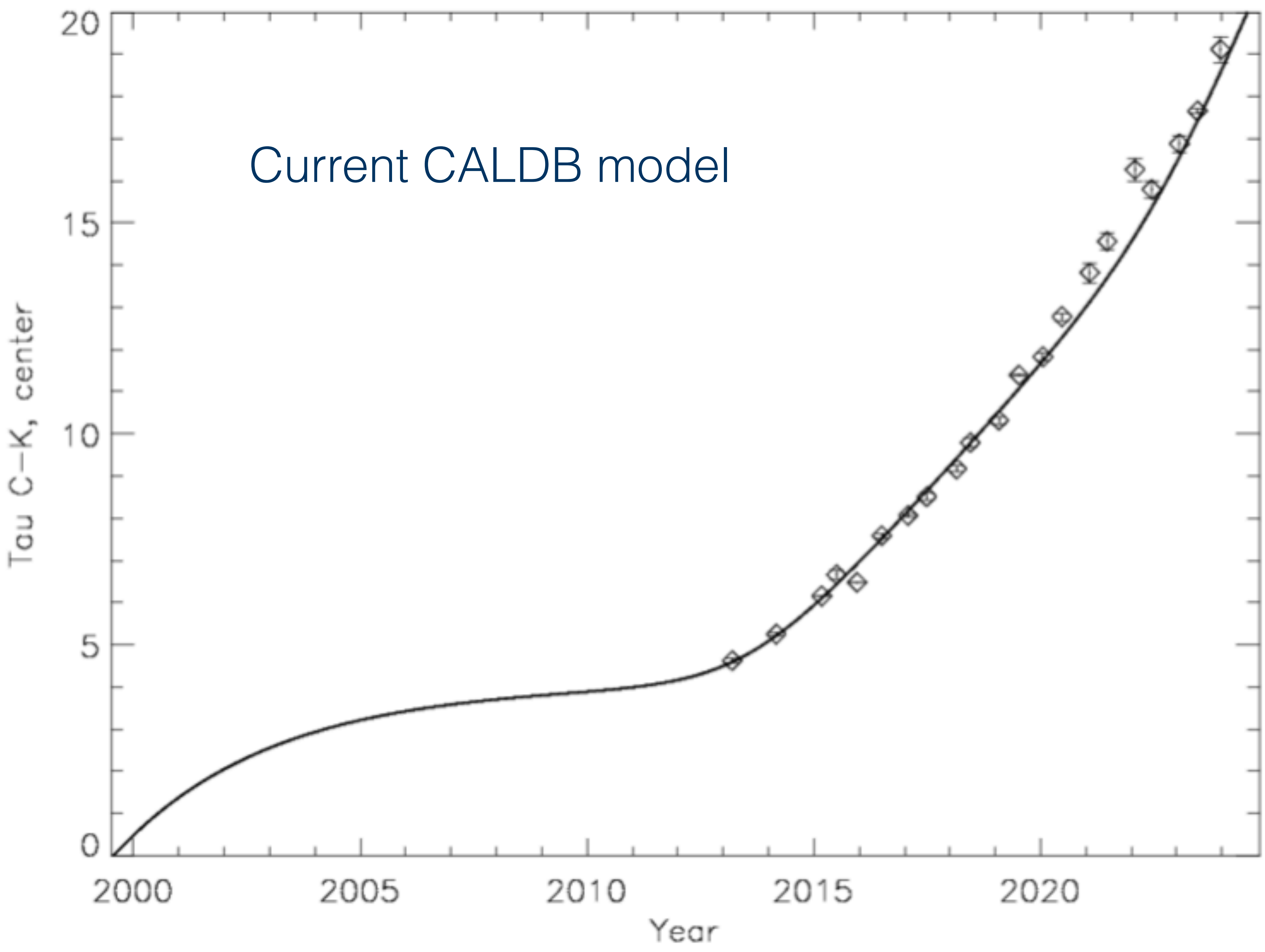
Big Dither LETG/ACIS-S observations of Mkn 421 - measures the optical depth at the K shell edges of C, O, and F



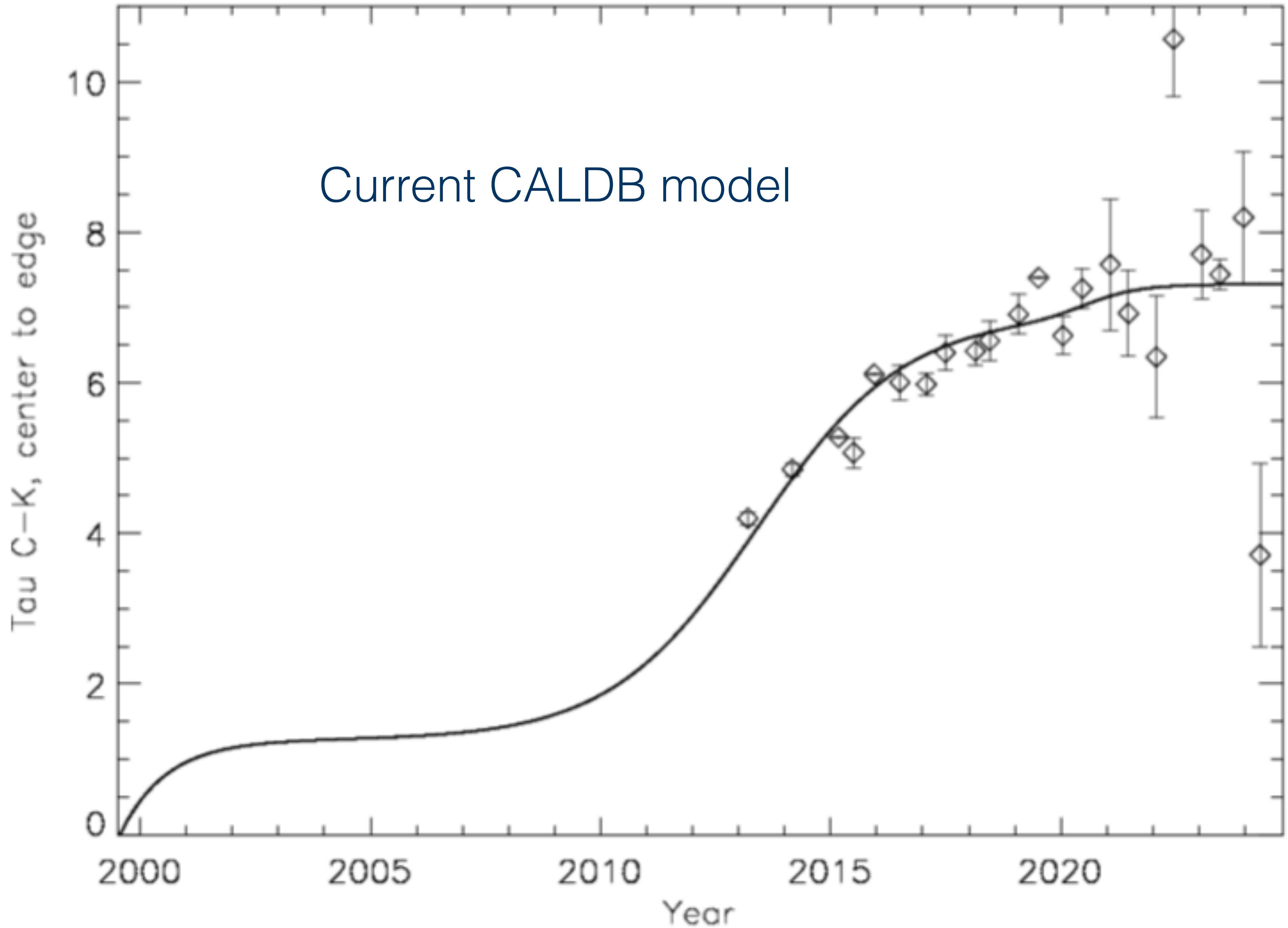
ACIS-S spectra of A1795



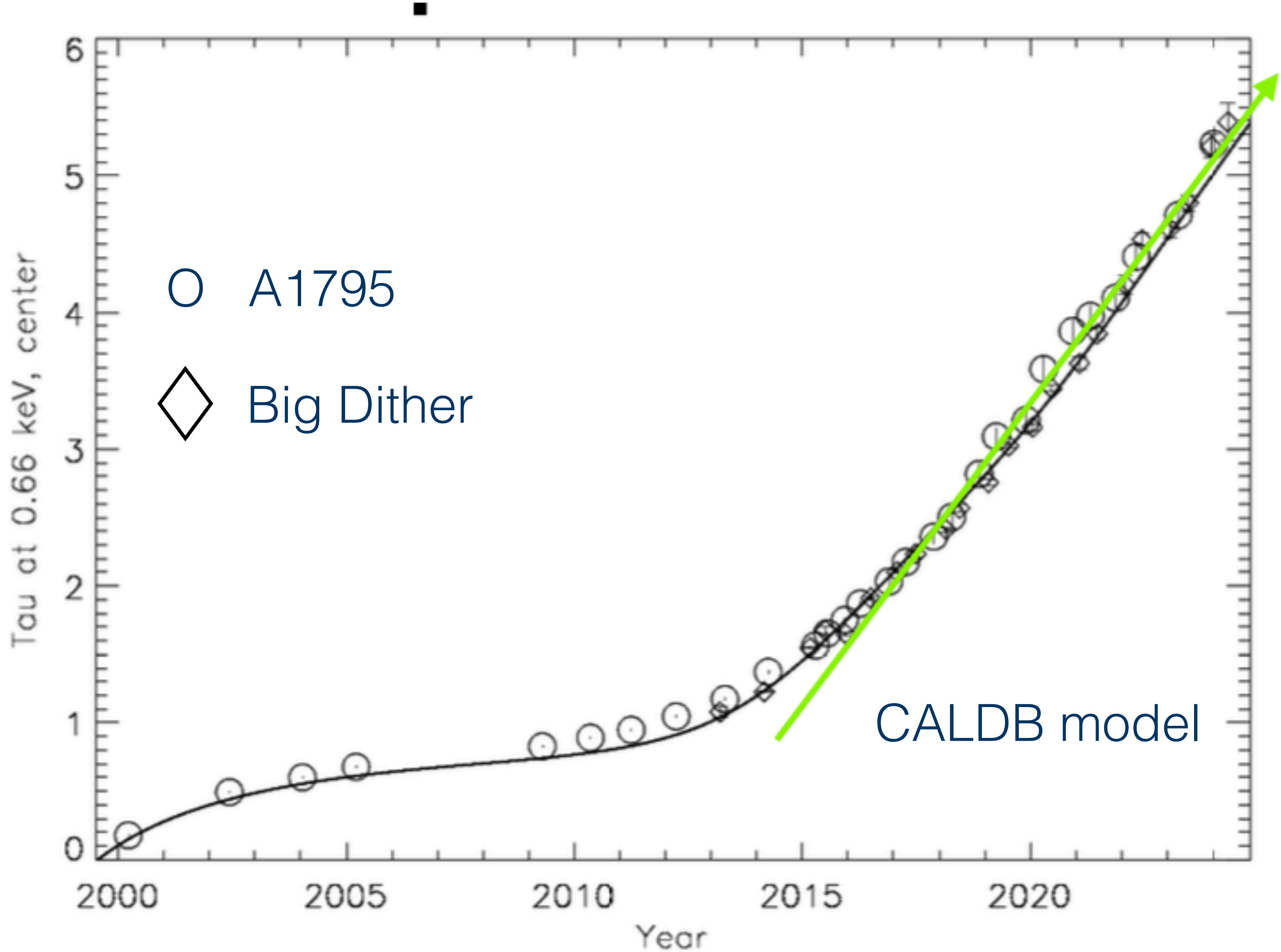
Optical Depth at the C-K edge on the ACIS-S array from the LETG/ACIS-S Big Dither Observations of Mkn421



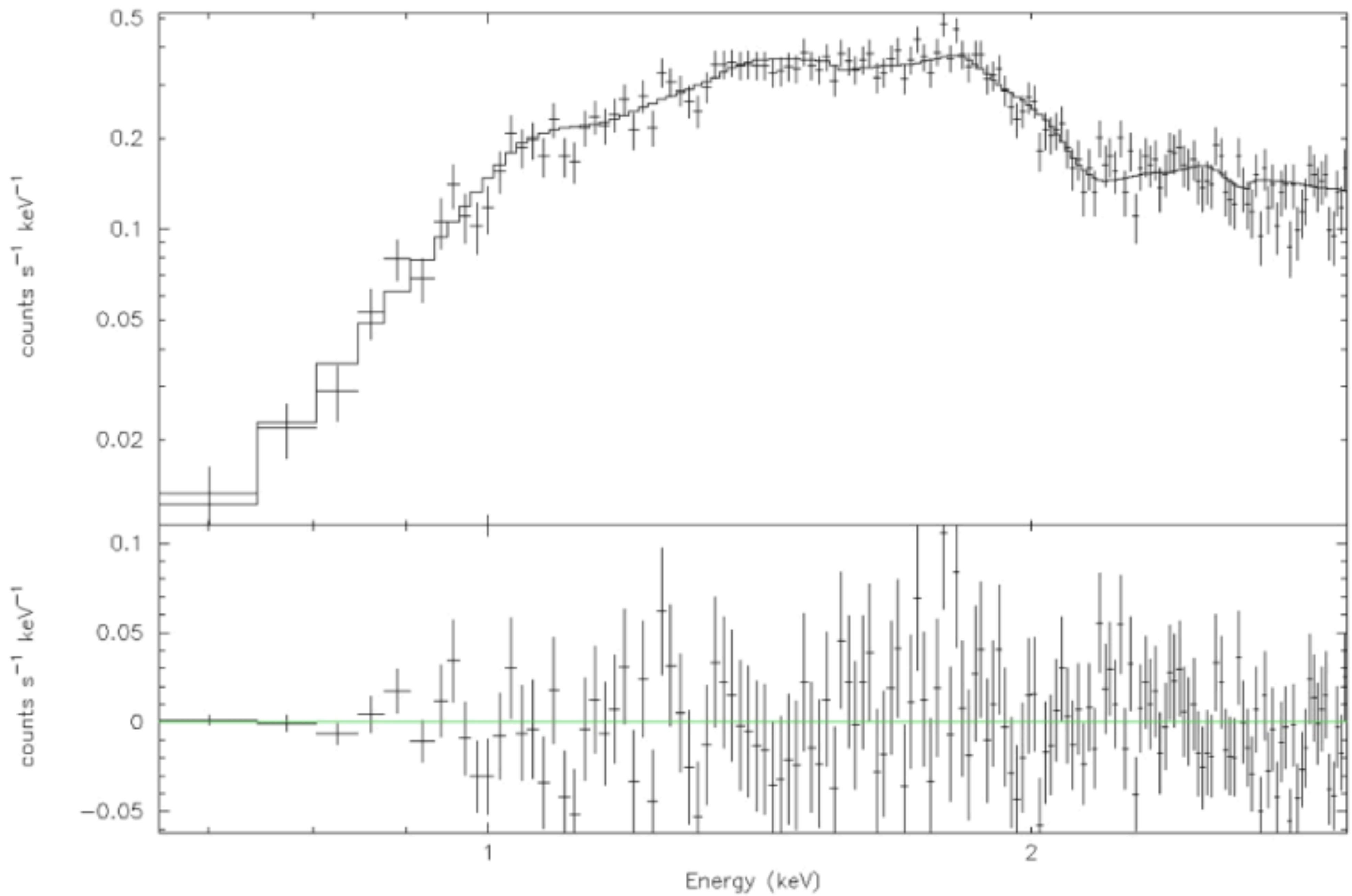
Difference in Optical Depth at the C-K edge between the bottom and middle of the ACIS-S array from the Big Dither Observations



Comparison between the Optical Depth at the C-K edge between the A1795 and Big Dither observations

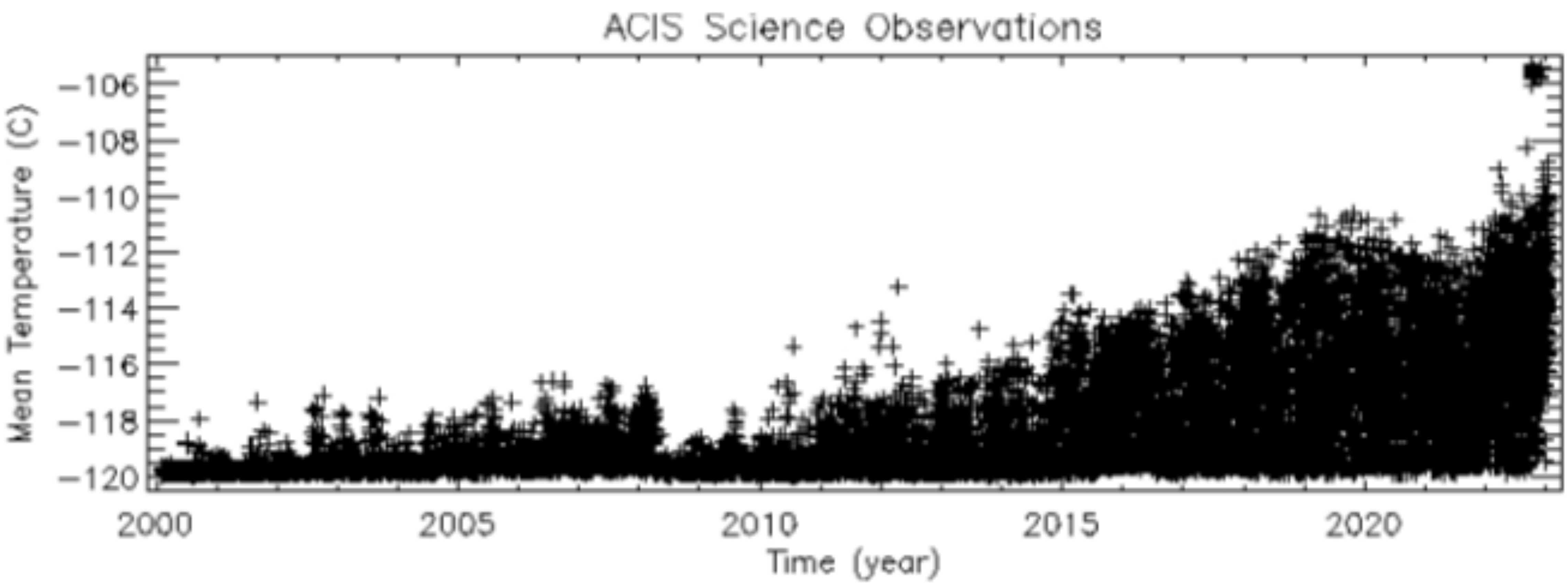


A1795 spectrum from a recent observation near the bottom of S3 shown with the best fit model to an early observation of A1795 using the CALDB version of the contamination model



Conclusion: No update to the ACIS contamination model is needed at the present time

Improving the ACIS CTI Correction at Warm Focal Plane Temperatures



Charge Transfer Inefficiency (CTI) increases with temperature which affects the detector gain and energy resolution

The ACIS CTI Correction Procedure

CTI correction ~ (temperature)(energy)(spatial)
All chips are calibrated separately

1) Temperature-dependence: Calibrated using the Mn line in the ECS data

Old Method: Uses a linear function of temperature.
New Method: Uses a quadratic function of temperature

2) Energy-dependence: Initially calibrated with ECS data.

Old Method: Uses a single power-law for the energy-dependence at all temperatures (i.e. $\Delta Q \sim PHA^a$).
New Method: Uses different power-law indices at different temperatures (i.e., $a=f(T)$).

3) Spatial-dependence: Based on trap maps generated from ECS data

Old Method: Applies the same trap map at all temperatures.
New Method: Applies different trap maps at different temperatures.

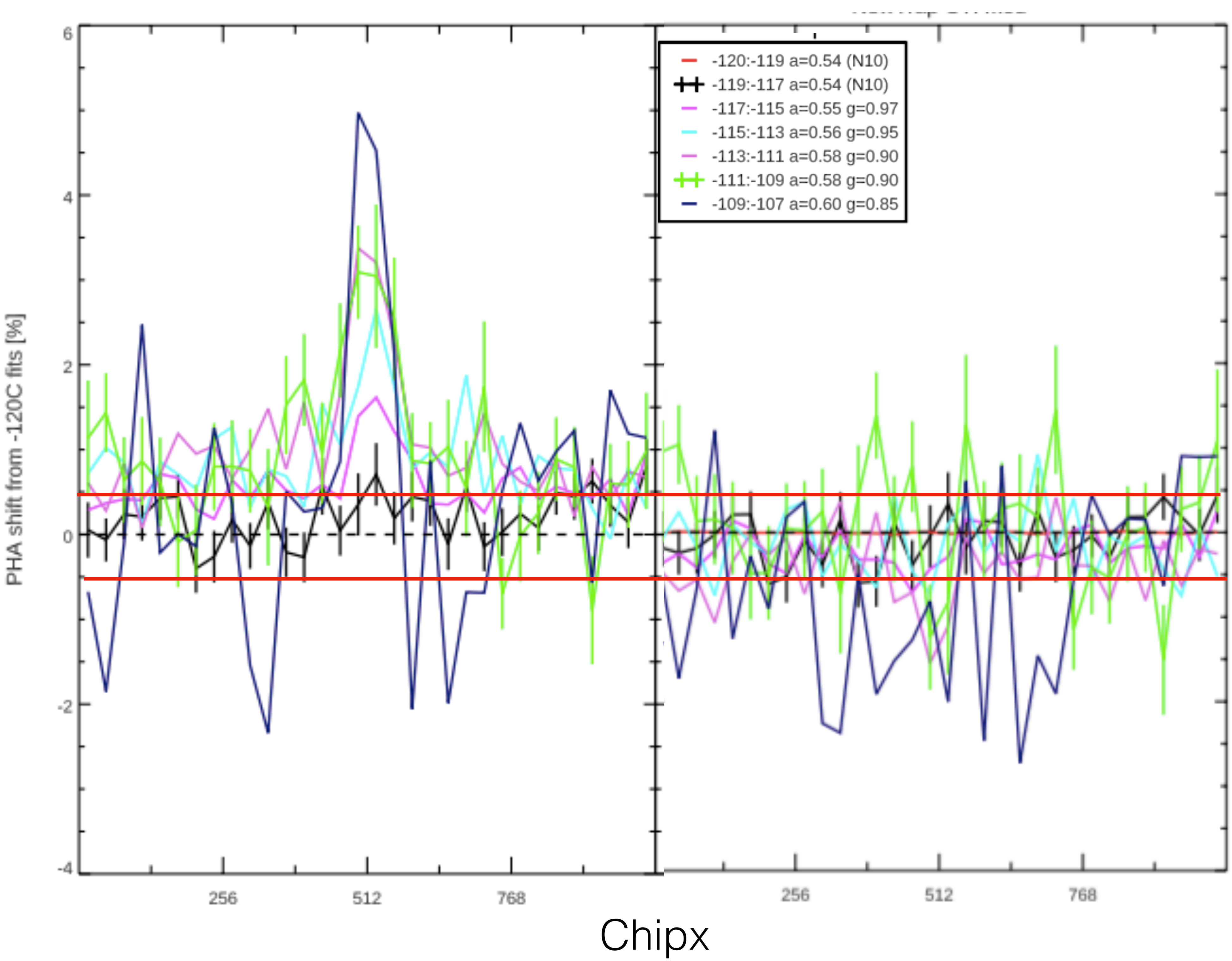
Note: New temperature-dependent CTI calibration products for ACIS-I, S2, and S3 were released in Jan. 2024

CTI Correction for I3

I3 at Al-Ka and chipy=769:1024

Old CALDB

New CALDB

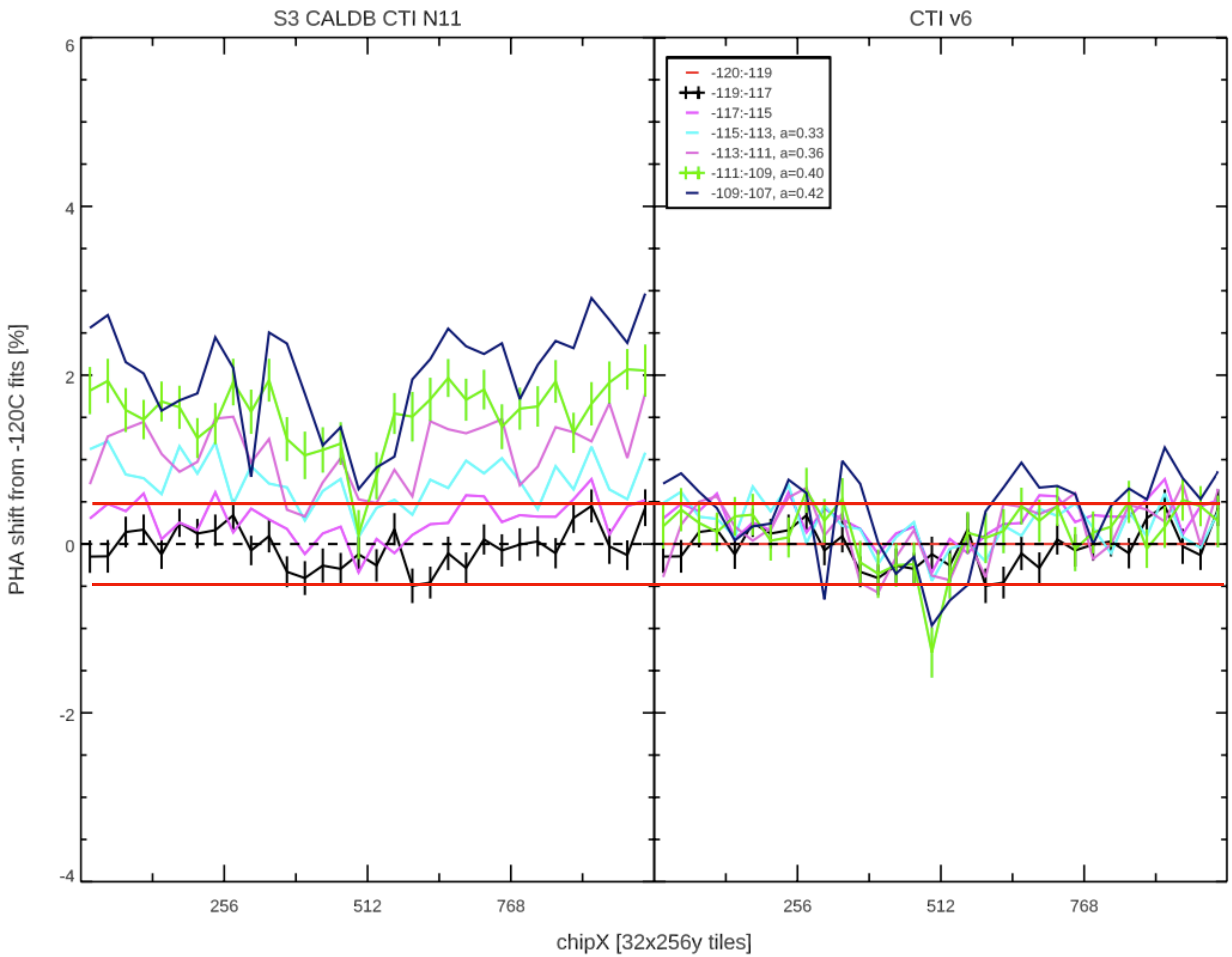


+- 0.5%

CTI Correction for S3

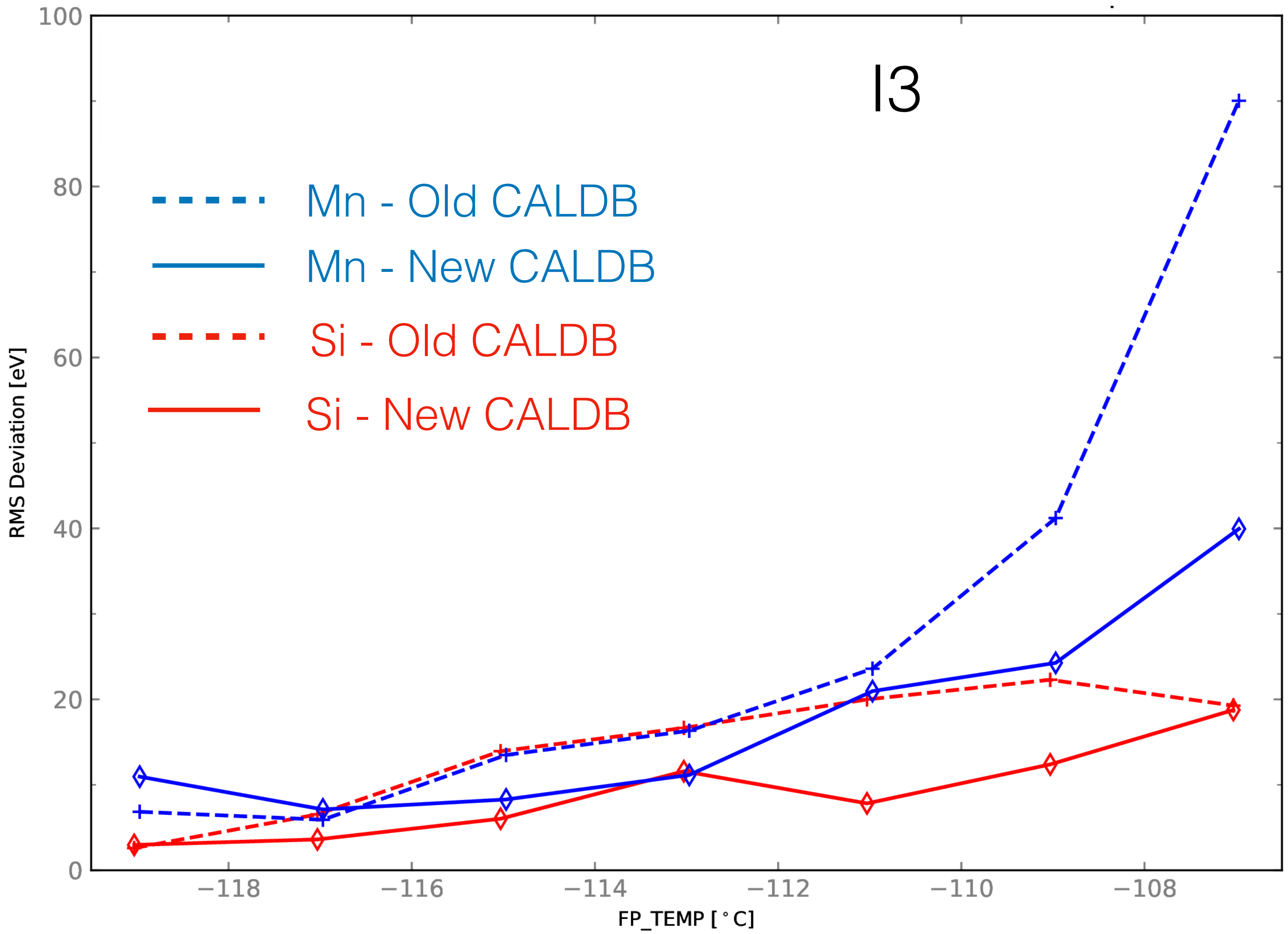
S3 at Al-Ka and chipy=769:1024

Old CALDB | New CALDB



+- 0.5%

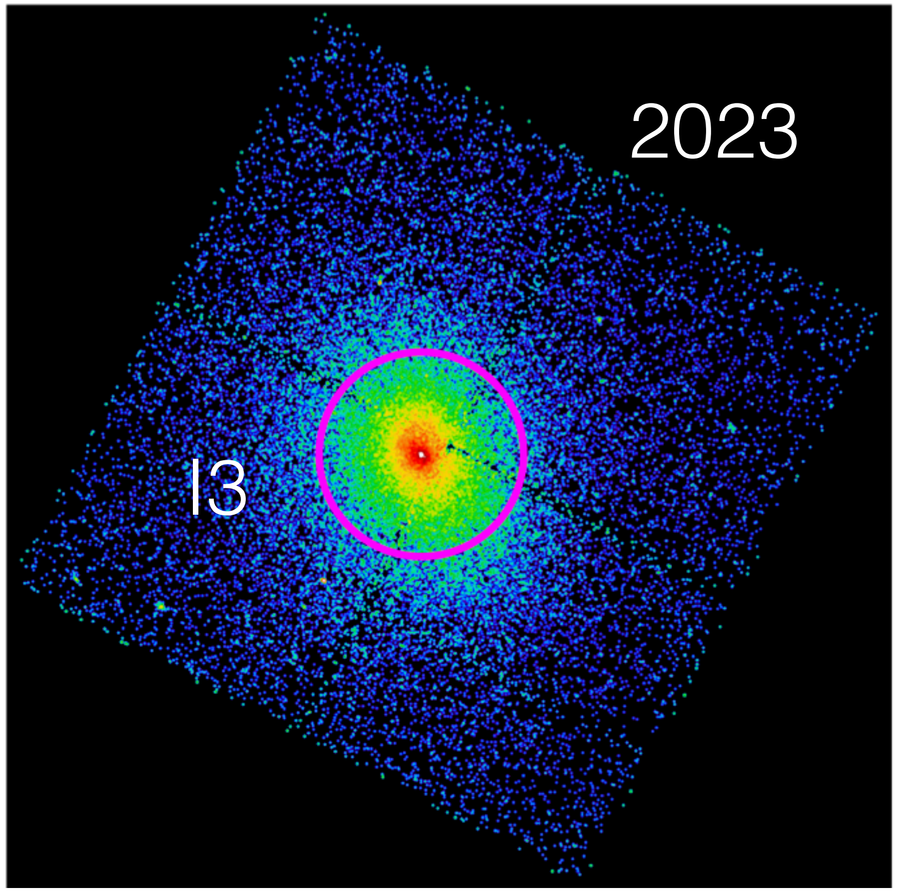
Gain Uncertainties vs. FP Temperature

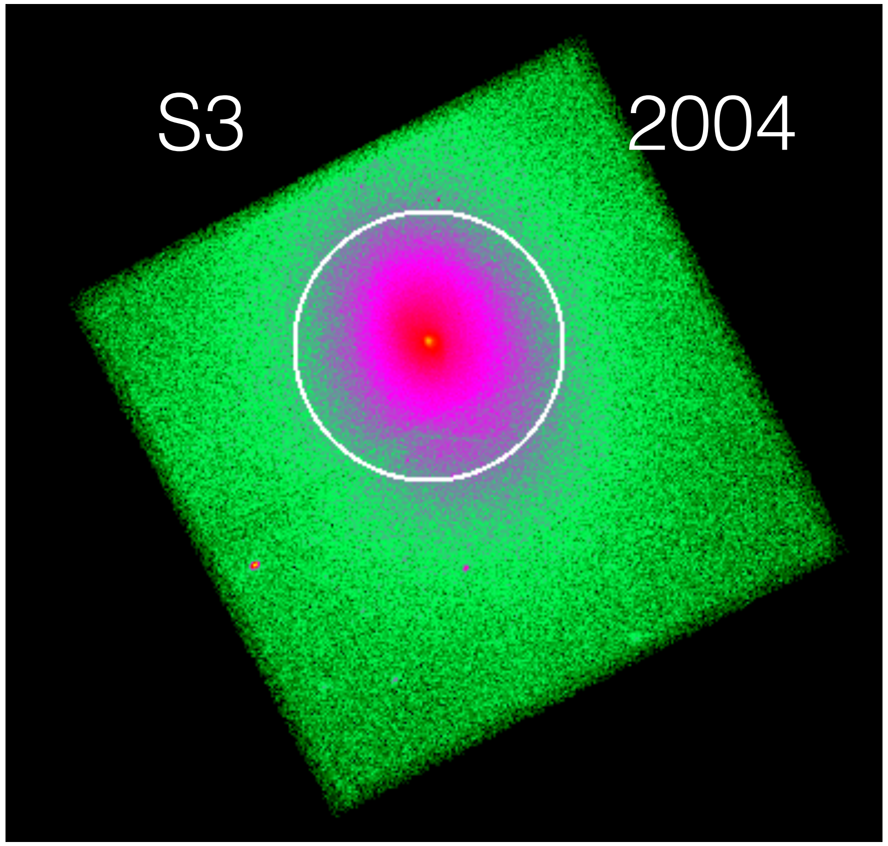


Temp(C)	I3(%)	S3(%)
-111	0.6	0.3
-109	0.8	0.5
-107	1.3	1.0

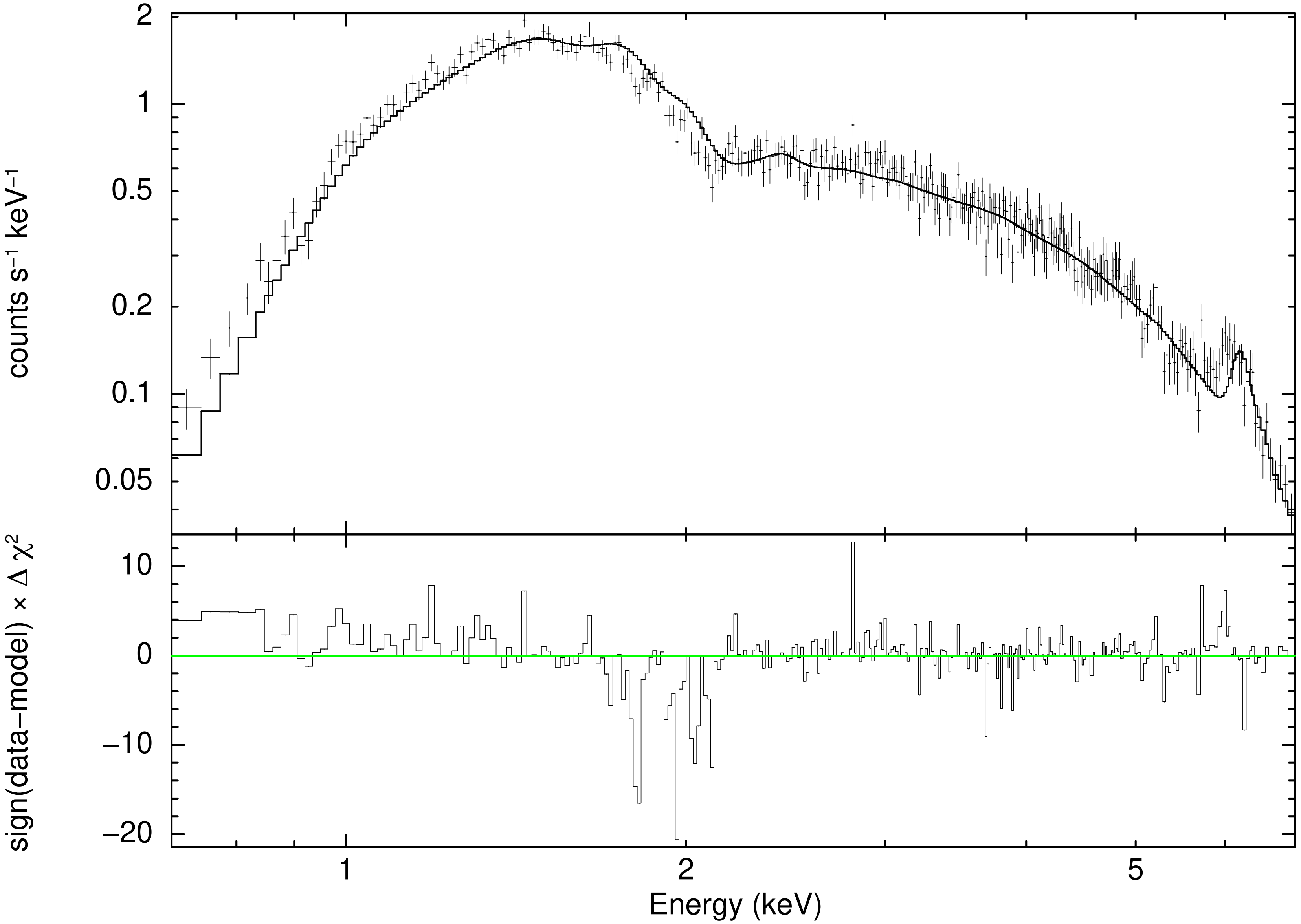
Note: The temperature-dependent CTI correction was calibrated with ECS data taken primarily in the 2010 - 2012 timeframe and tested with ECS data taken up to 2022, at which point the ECS was too faint for a proper calibration.

Gain Issue with Recent ACIS-I Observations of Abell 2029

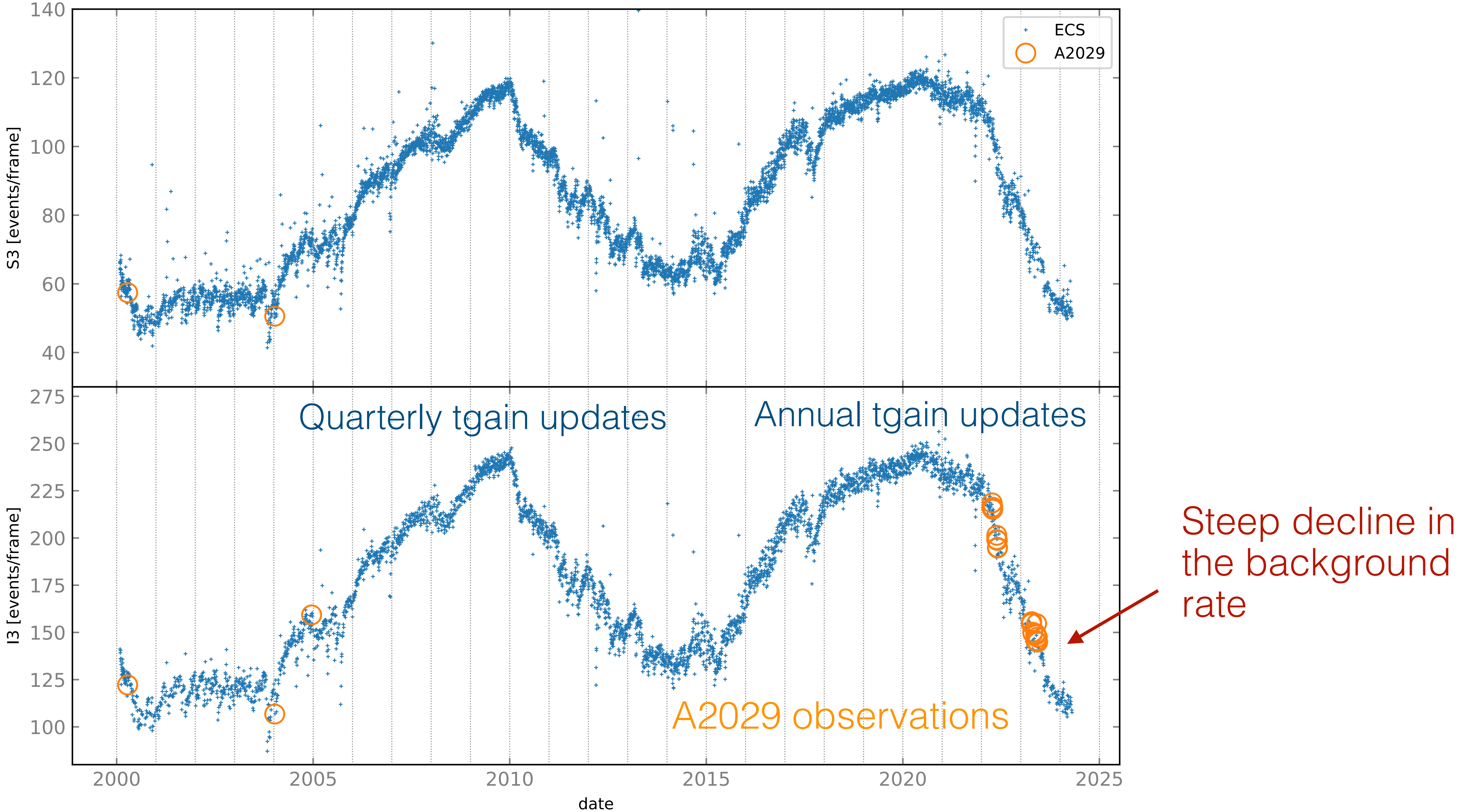




Best fit model to the early ACIS-S model shown with recent ACIS-I data

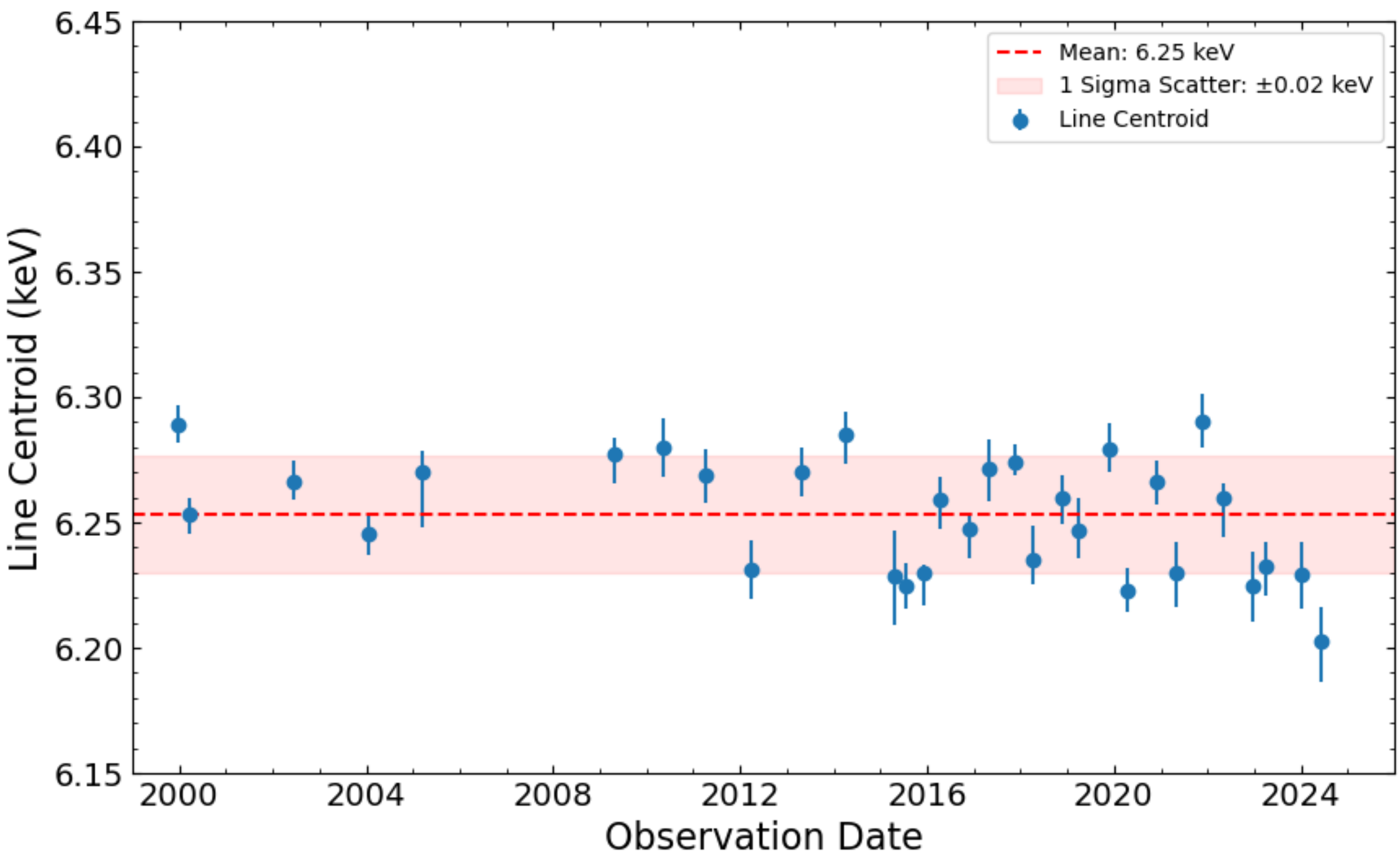


ACIS Background Rates



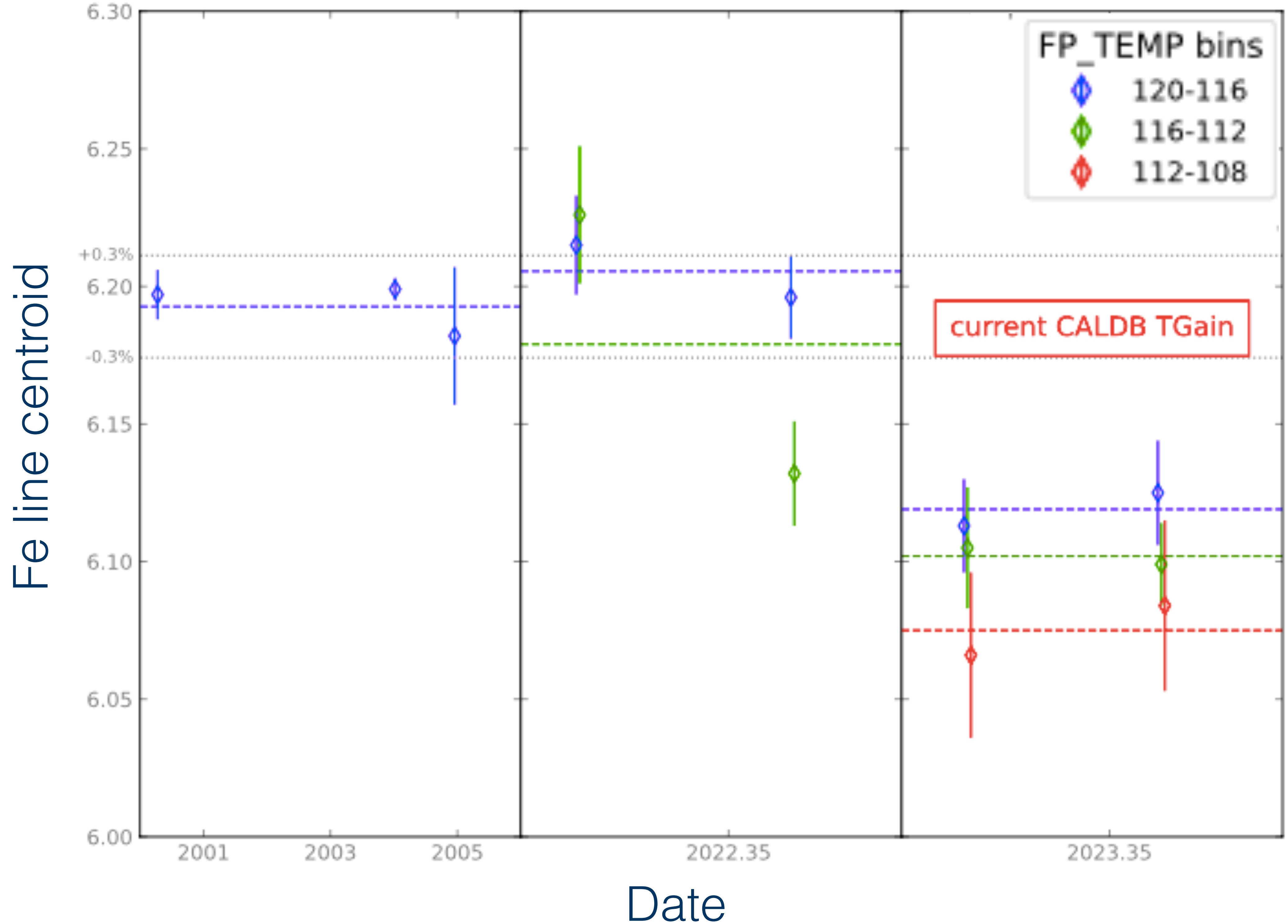
High background rates fill in the radiation-induced traps, reducing the CTI, and increasing the gain. Low background rates have the opposite effect. Time-dependent ACIS gain corrections are calibrated in the tgain CALDB file. CIAO performs a linear extrapolation from the last tgain file to correct the data.

Fe Line Centroid in A1795 Observations on S3

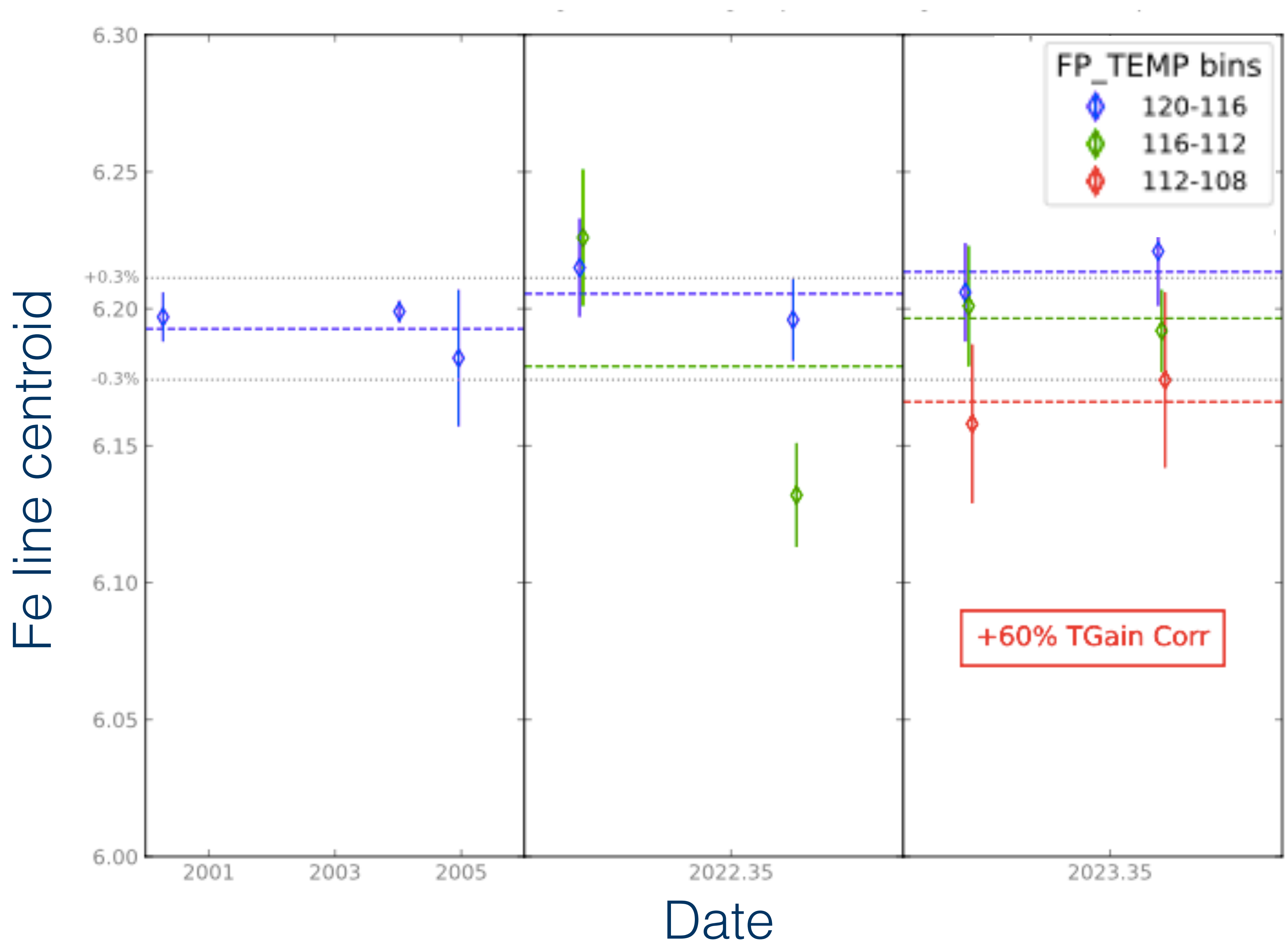


Note: Smaller gain shift on S3 due to the lower CTI on BI chips compared to FI chips

A2029 Fe line centroid using the CALDB tgain file



A2029 Fe line centroid using test version of tgain file



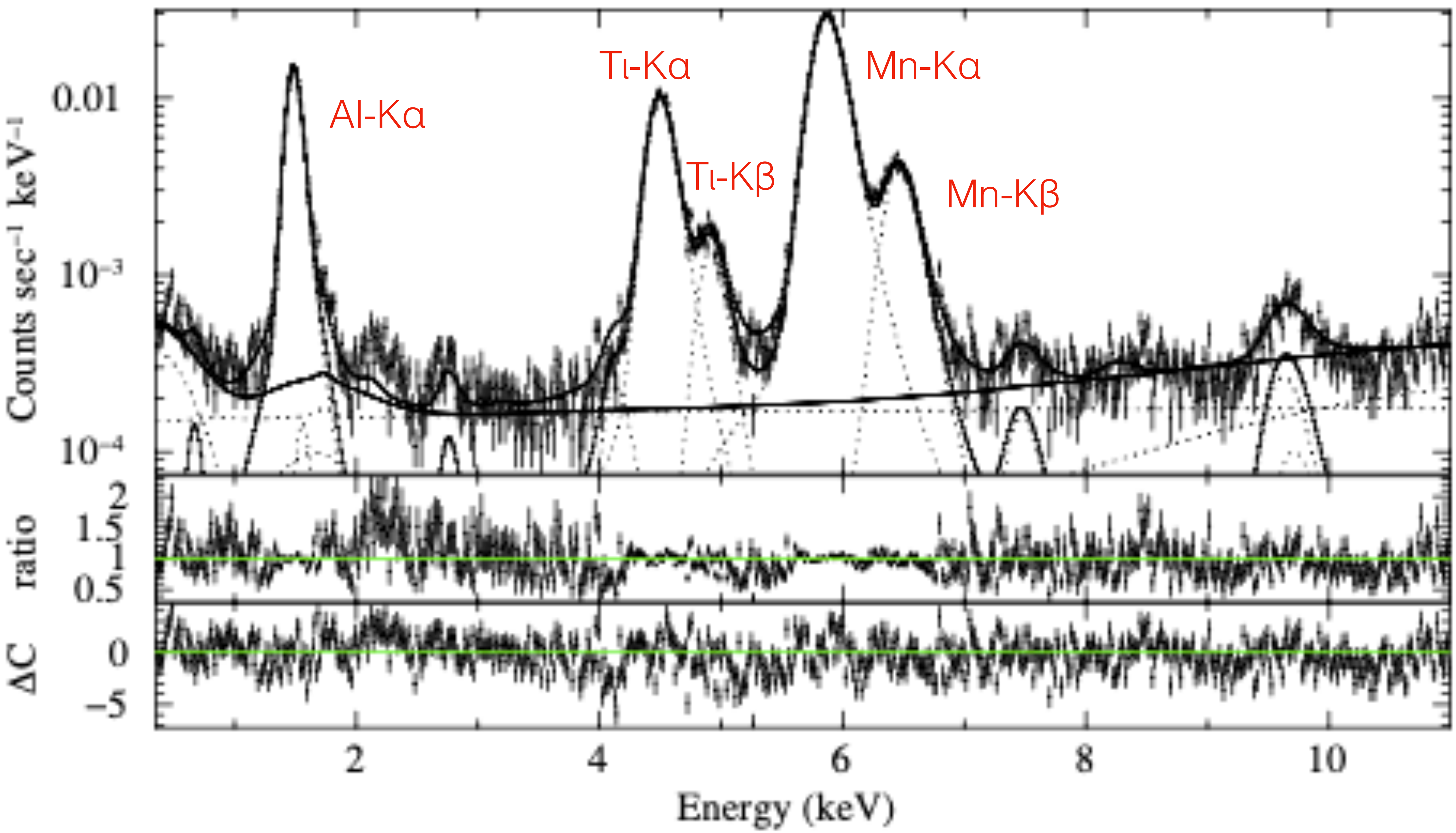
Note: A test version of the CALDB is being generated that incudes the new tgain file and will be tested with Cas A, Perseus, and A1795 calibration data.

RMFs at warmer Focal Plane Temperatures

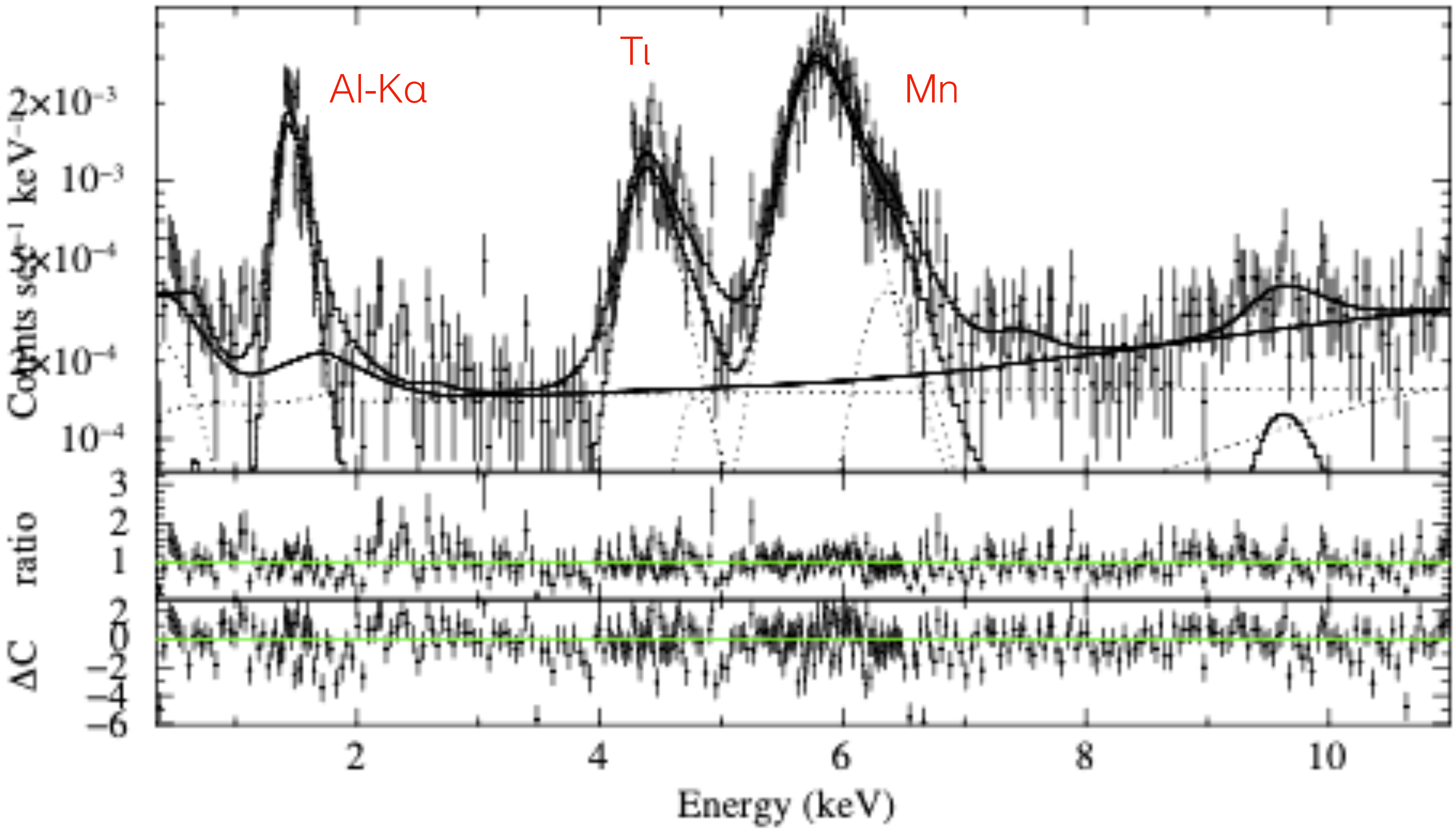
Procedure

- Co-add ECS data from epochs 40-91 (approximately 13 years of data)
- Divide ECS data into 7 FP temperature intervals between -120 and -107 C
- Bin data into 32 by 32 pixel regions
- Fit widths of Al, Ti, and Mn lines in each spatial region and temperature bin

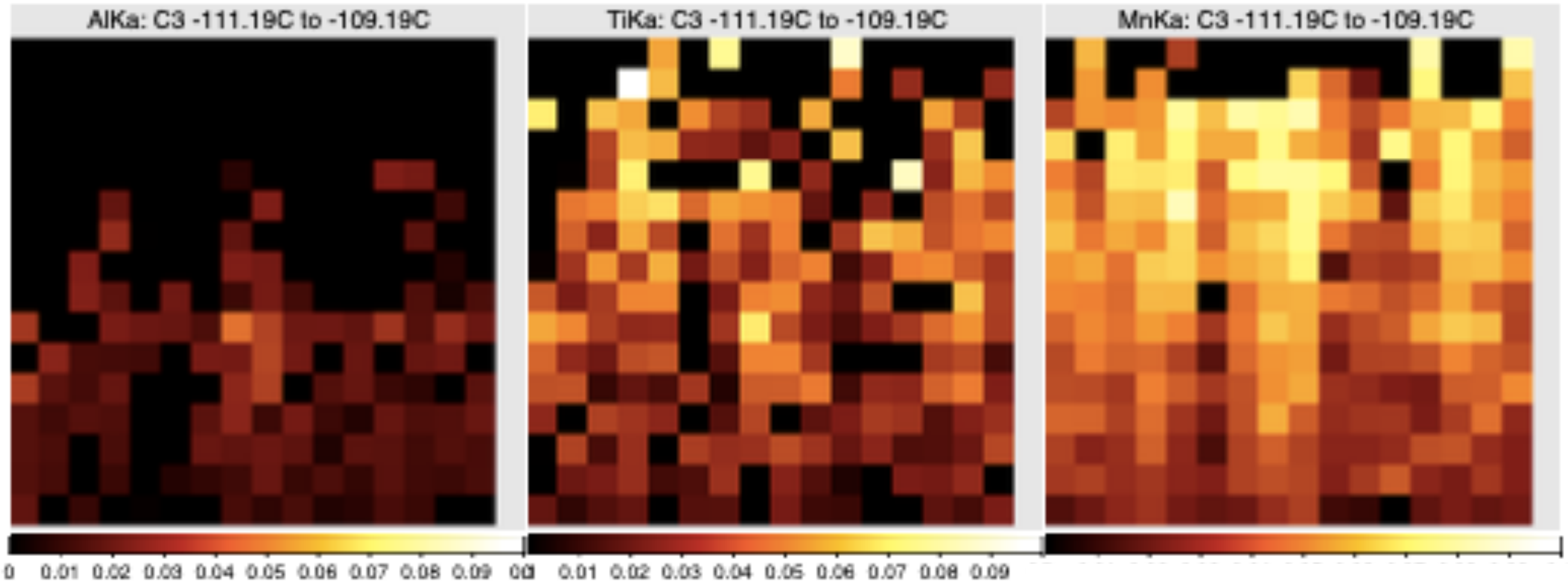
Cold ECS data (FP Temps -120:-119 C) at the I3 aim-point



Warm ECS data (FP Temps -111:-109 C) at the I3 aim-point



Residuals in the FWHM (FP Temps -111:-109 C)

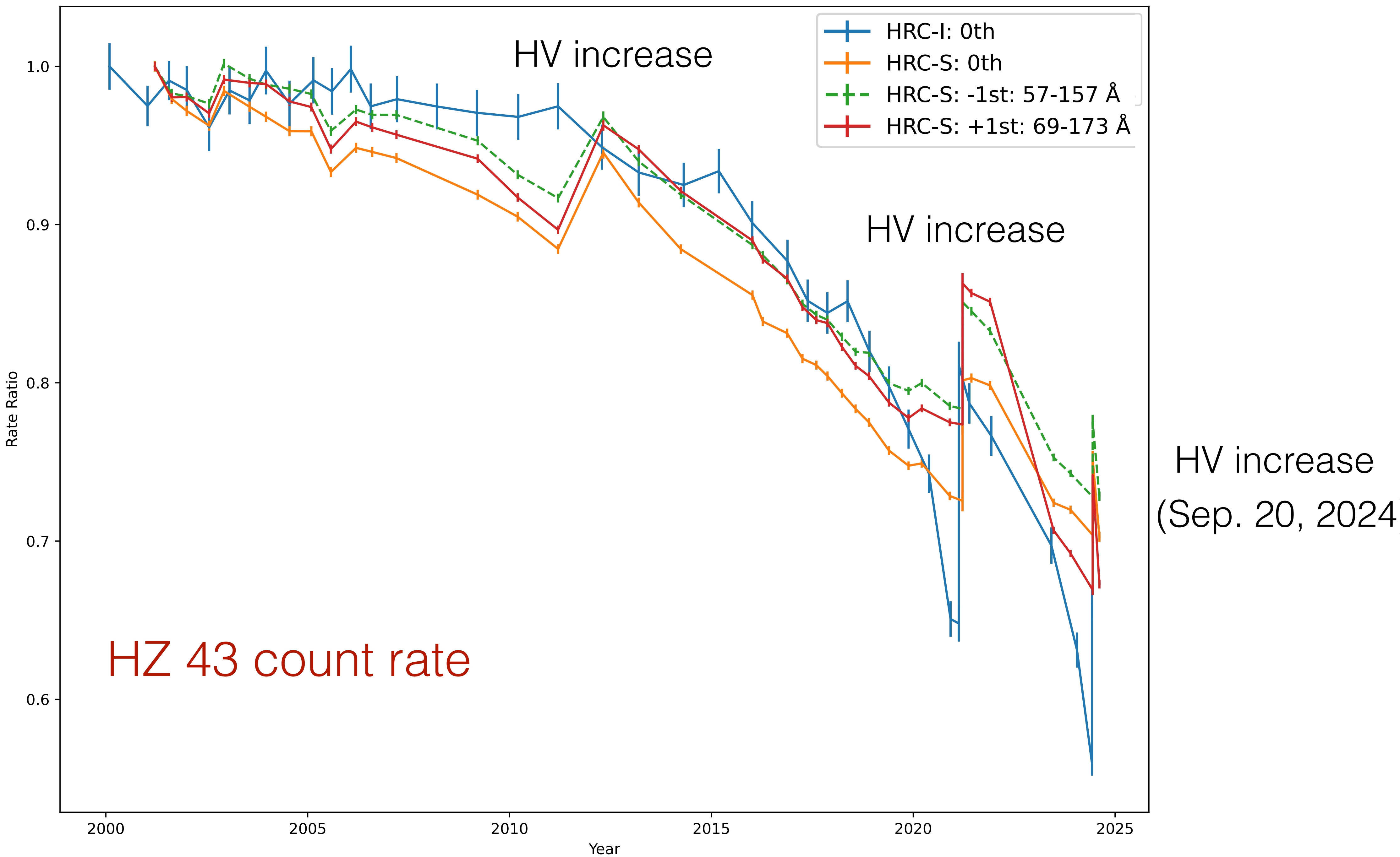


Line	max σ	σ/E_{line}
Al$K\alpha$	44 [eV]	3.0%
Ti$K\alpha$	97 [eV]	2.1%
Mn$K\alpha$	83 [eV]	1.4%

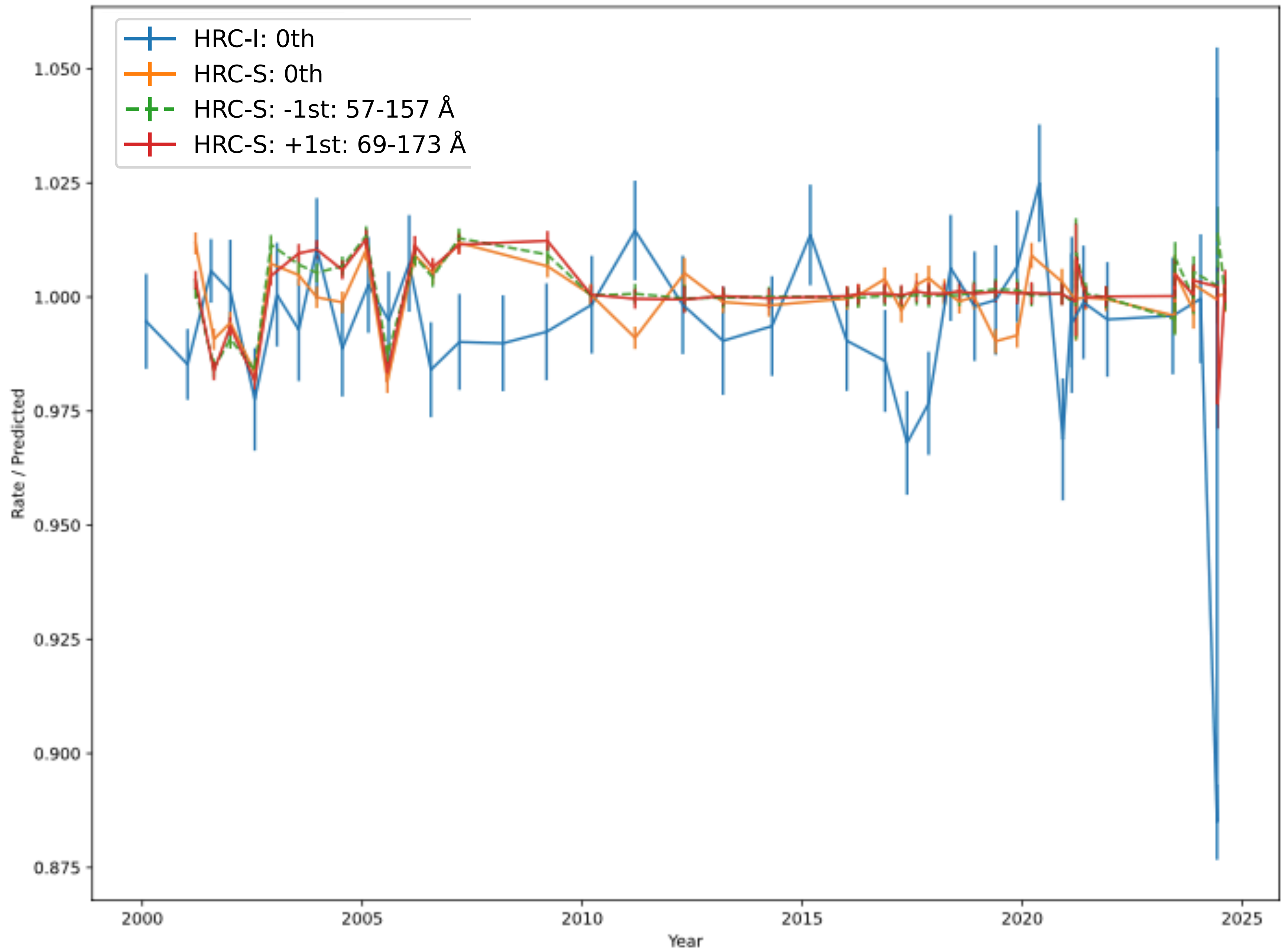
Note: A test version of the CALDB is being generated with the new rmf calibration products and will be tested with Cas A, Perseus, and A1795 calibration data.

Low Energy Response of the HRC

LETG observations of HZ43 with the HRC-I and HRC-S have been performed annually over the course of the mission.

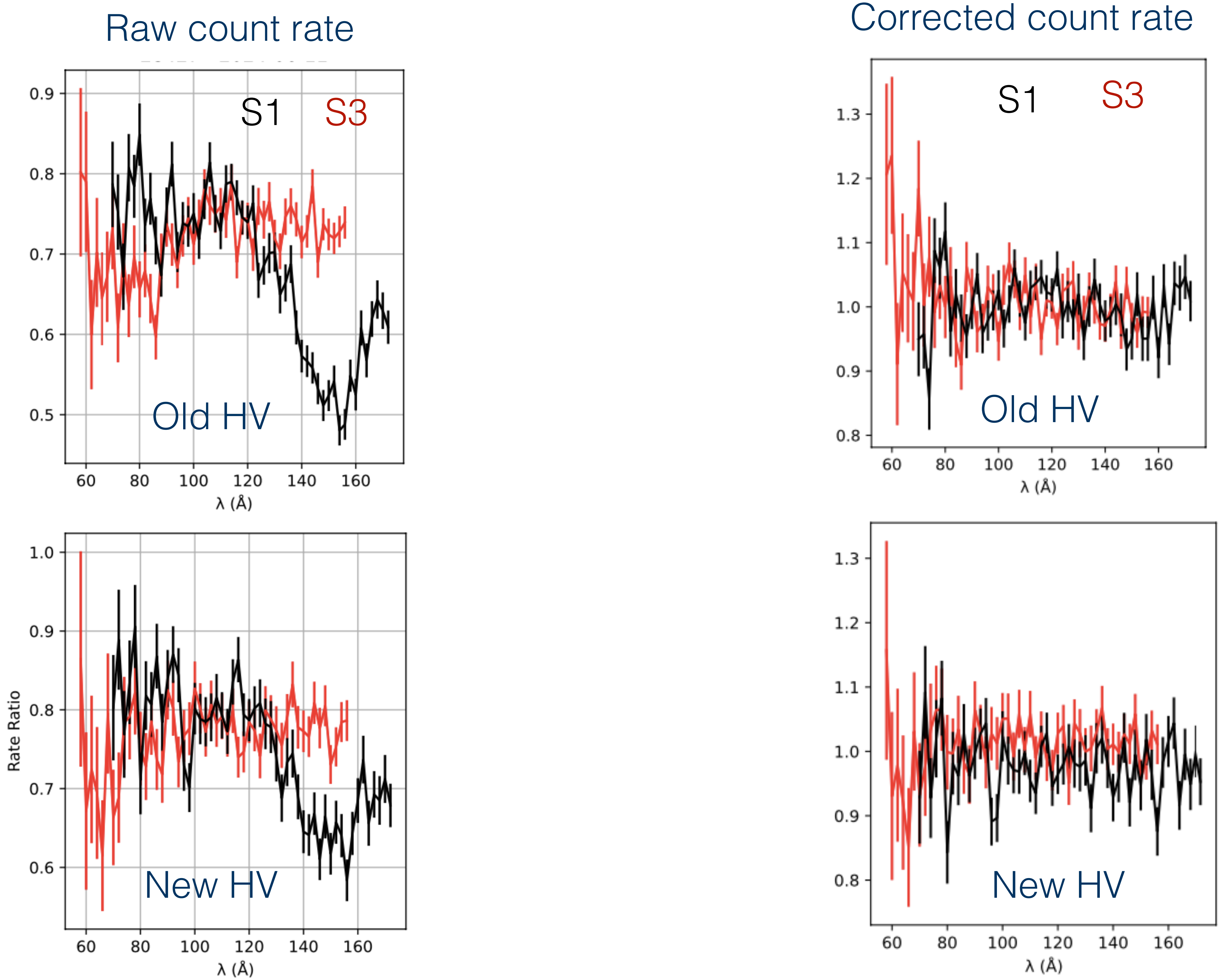


Corrected HRC Count Rates Using Latest HRC-S QEU

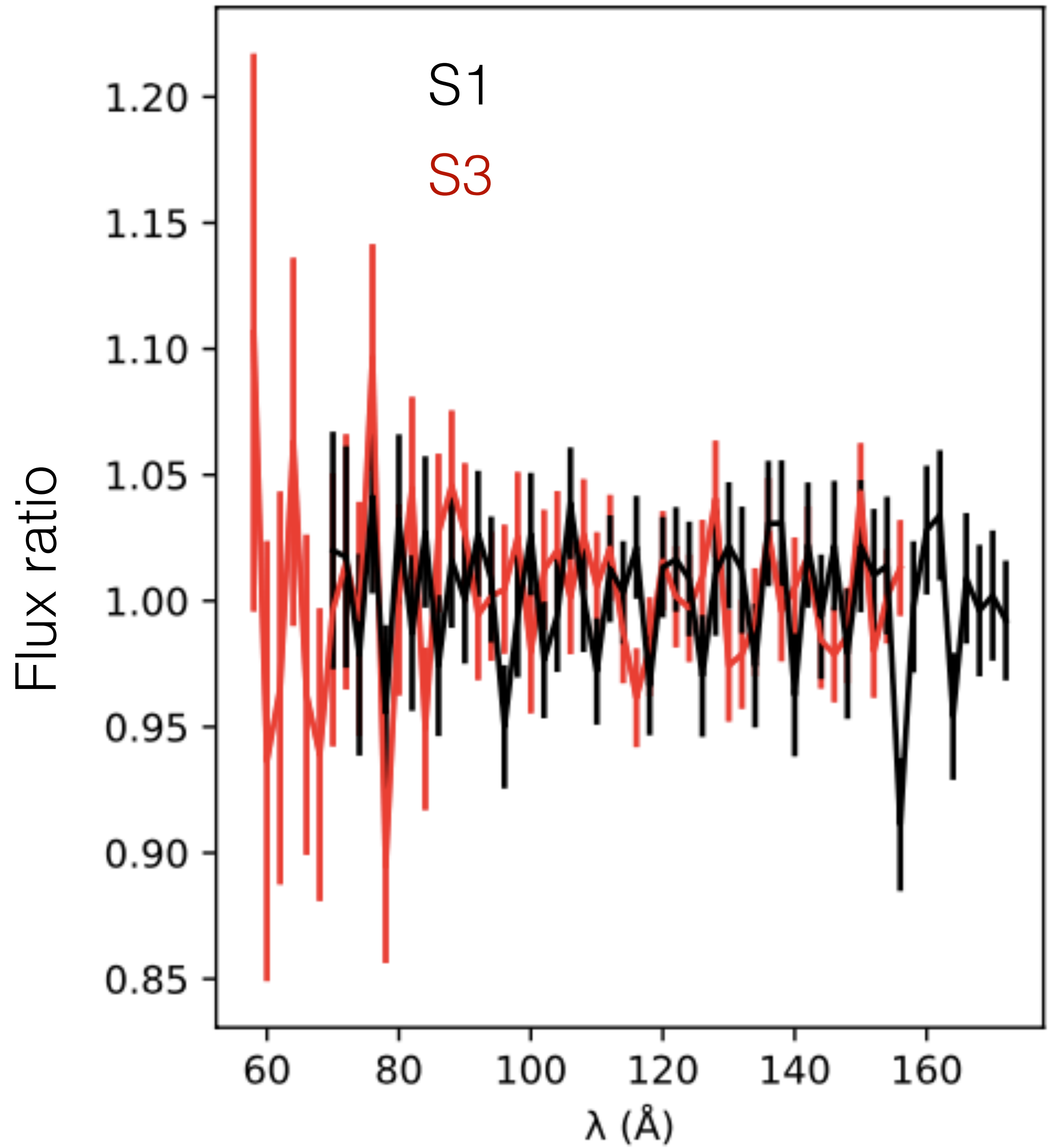


- An updated HRC-S QEU file that accounts for the latest HV increase will be released in the CALDB within the next couple of weeks
- An updated HRC-I QE is currently under development - that is why the HRC-I point at 2024 is so low.

Dispersed LETG spectra of HZ43 on the outer plates of the HRC-S

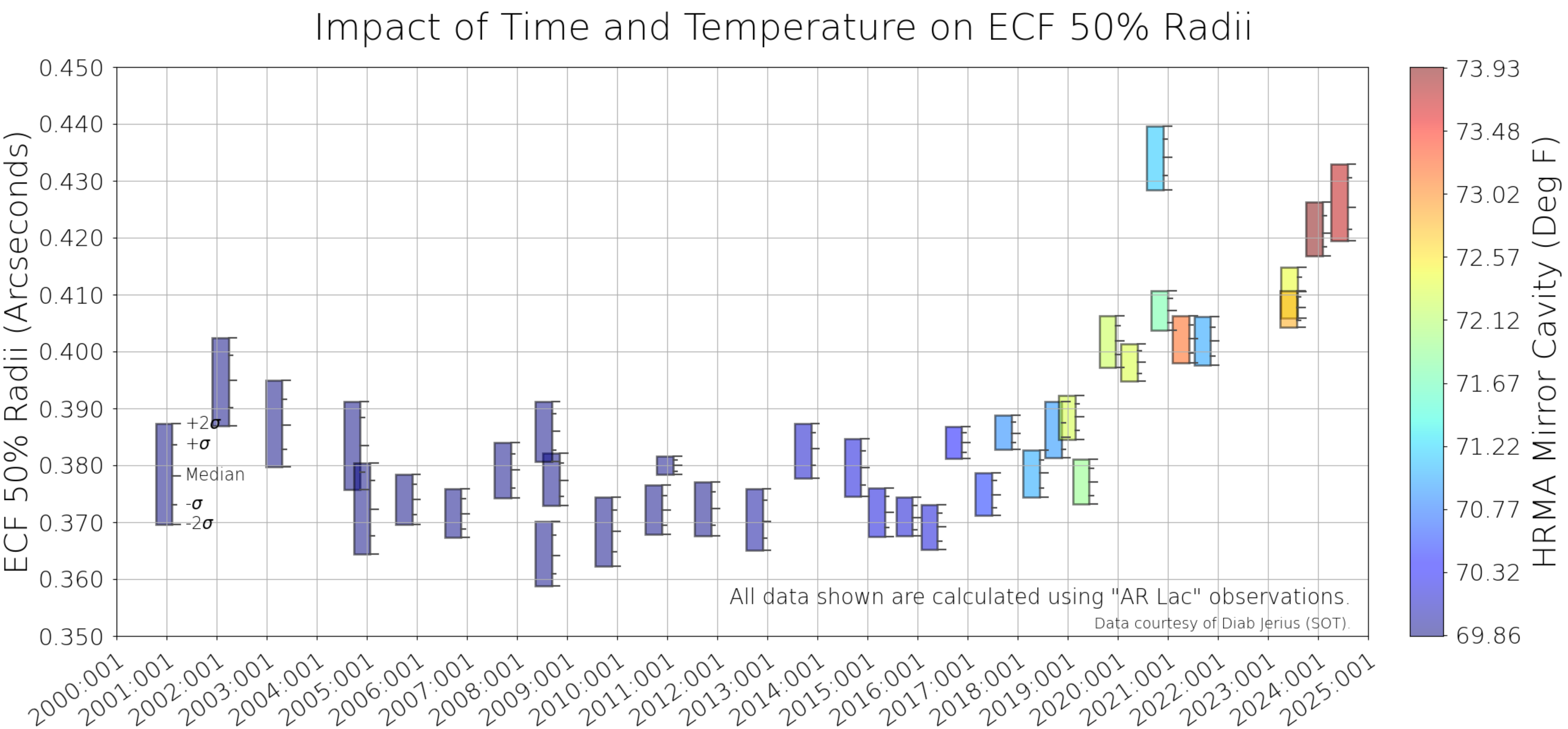


Fluxed LETG spectra of HZ43 on the outer plates of the HRC-S with the newly released HRC-S QEU file (CALDB 4.10.7)



HRMA PSF Monitoring

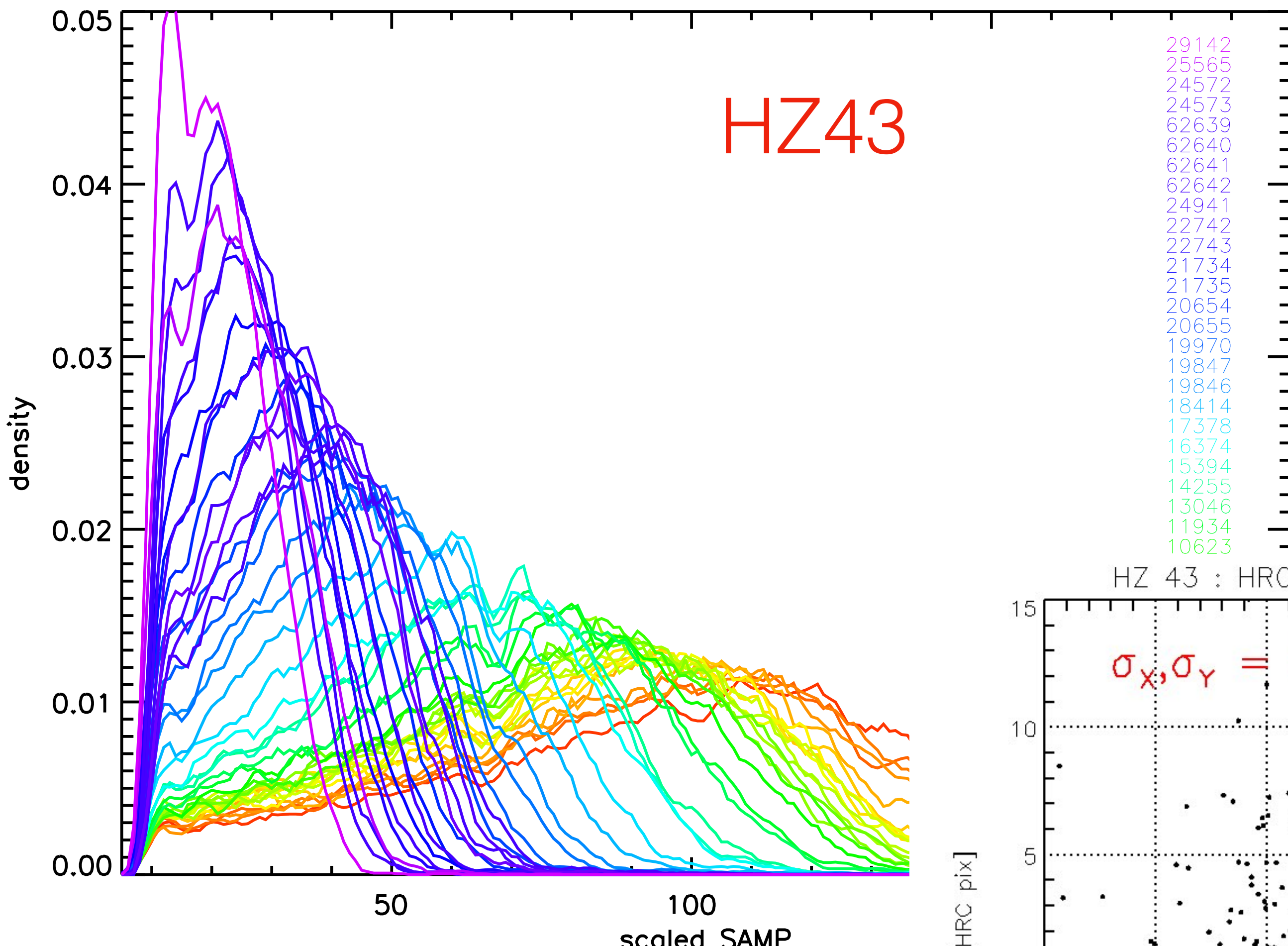
AR Lac has been observed at least once per year on-axis with the HRC-I since launch.



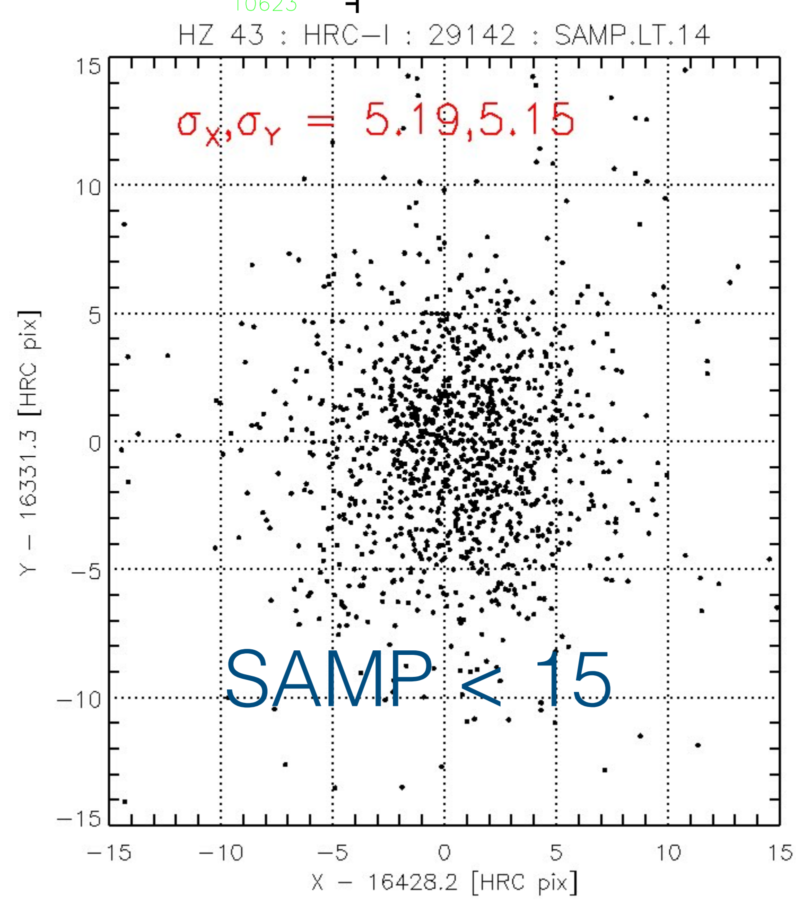
A slight increase of 0.01” per year over the past four years.

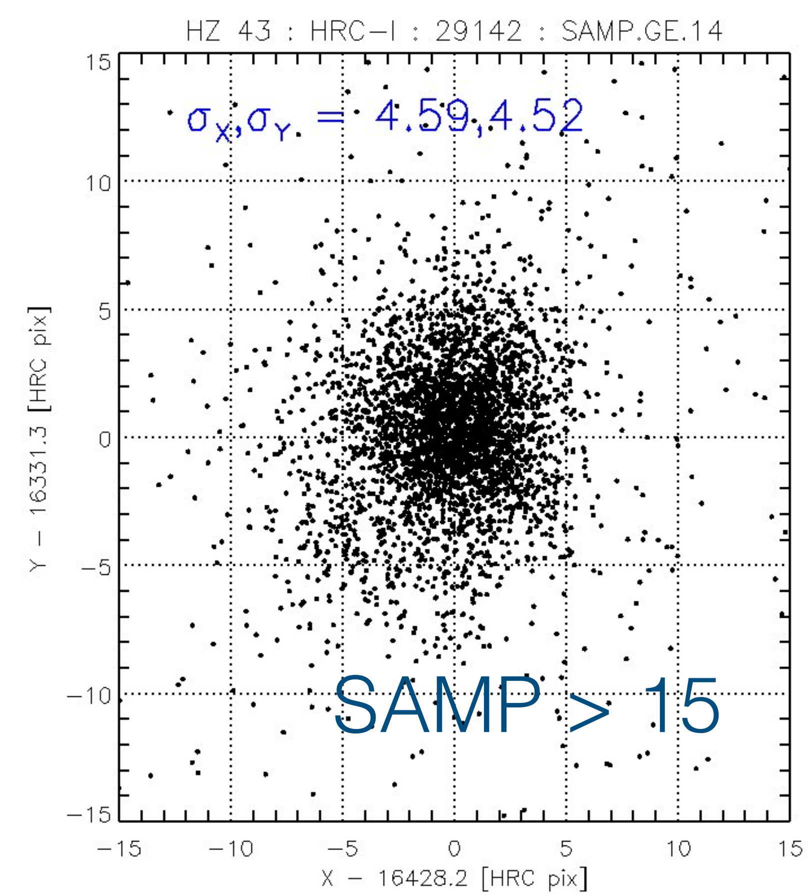
Broadening of the PSF due to low Pulse Height Events

- Steady decline in the mean SAMP with time
- Recent observations show a low SAMP peak



Low SAMP events have a broader PSF





Note: This work indicates that the declining HRC gain is partially responsible for the broadening of the PSF.

Future Calibration Plans

ACIS

- Release an updated tgain file for data taken in the 2023-2024 timeframe.
- Finish testing the set of temperature-dependent rmfs for ACIS data up to a focal plane temperature of -107 C and release the new calibration products.
- Continue to monitor the accumulation of contamination on the ACIS filters.
- Generate a stet of ACIS blank sky observations by co-adding data accumulated over the past four years.

HRC

- Continue to Monitor the QE and gain of the HRC-I and HRC-S
- Release updated QE files for the HRC-I and HRC-S appropriate for the new HV setting.

Optics

- Continue to monitor the PSF