

Chandra Calibration Status



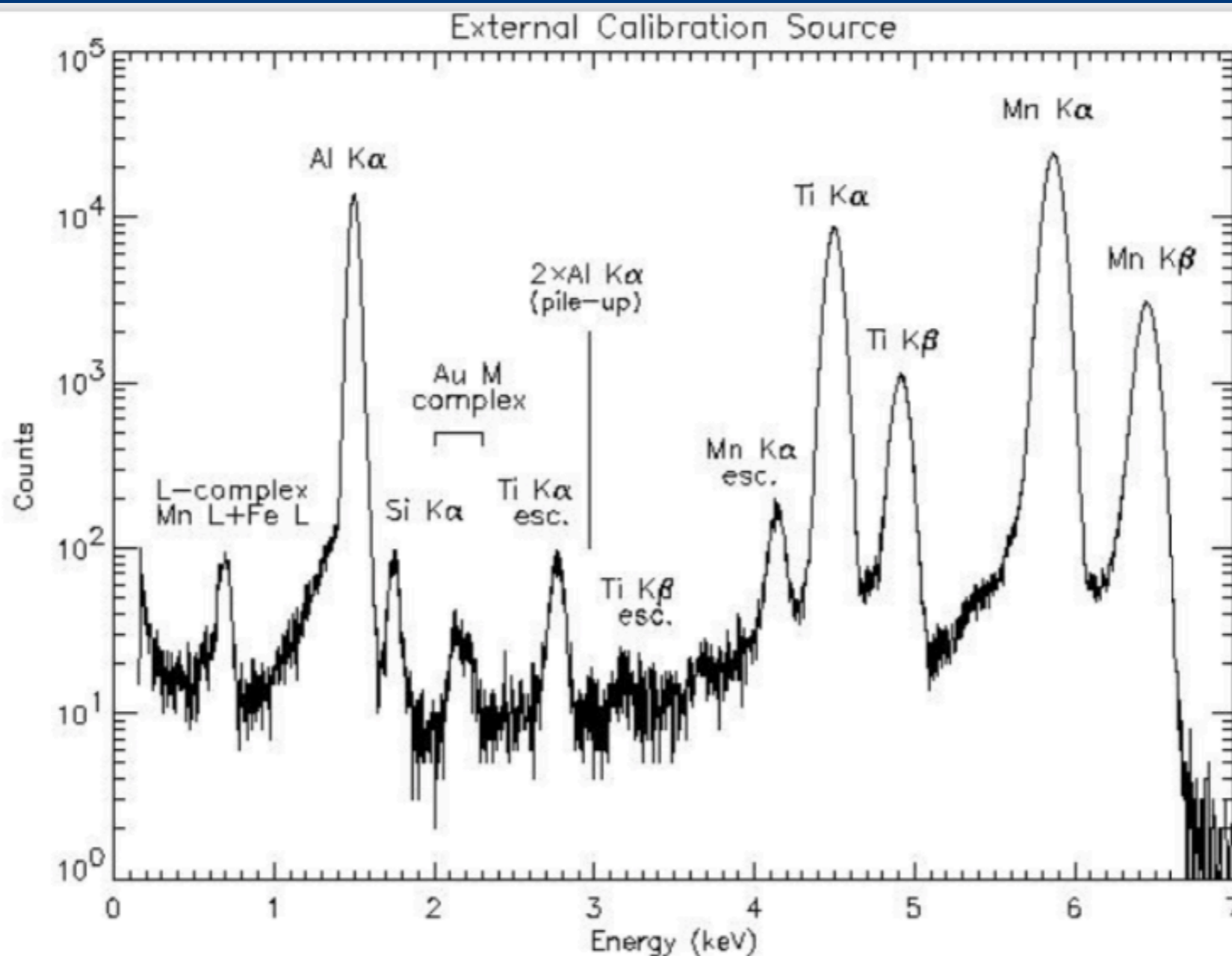
CUC Meeting - Oct. 14, 2020

CUC Recommendations from Previous Meeting:

- Continue to provide regular calibration status report updates (this presentation)
- Continue to play an active role in IACHEC
 - **The 2020 IACHEC meeting was first postponed and then canceled.**
 - **CXC scientists have participated in several remote working group meetings over the past year**
 - **The 2021 IACHEC Meeting will be held remotely**

ACIS External Calibration Source (ECS) Spectrum

- Calibrate ACIS Gain
- Generate ACIS QE Maps
- Monitor contamination Build-up
- Calibrate spectral resolution



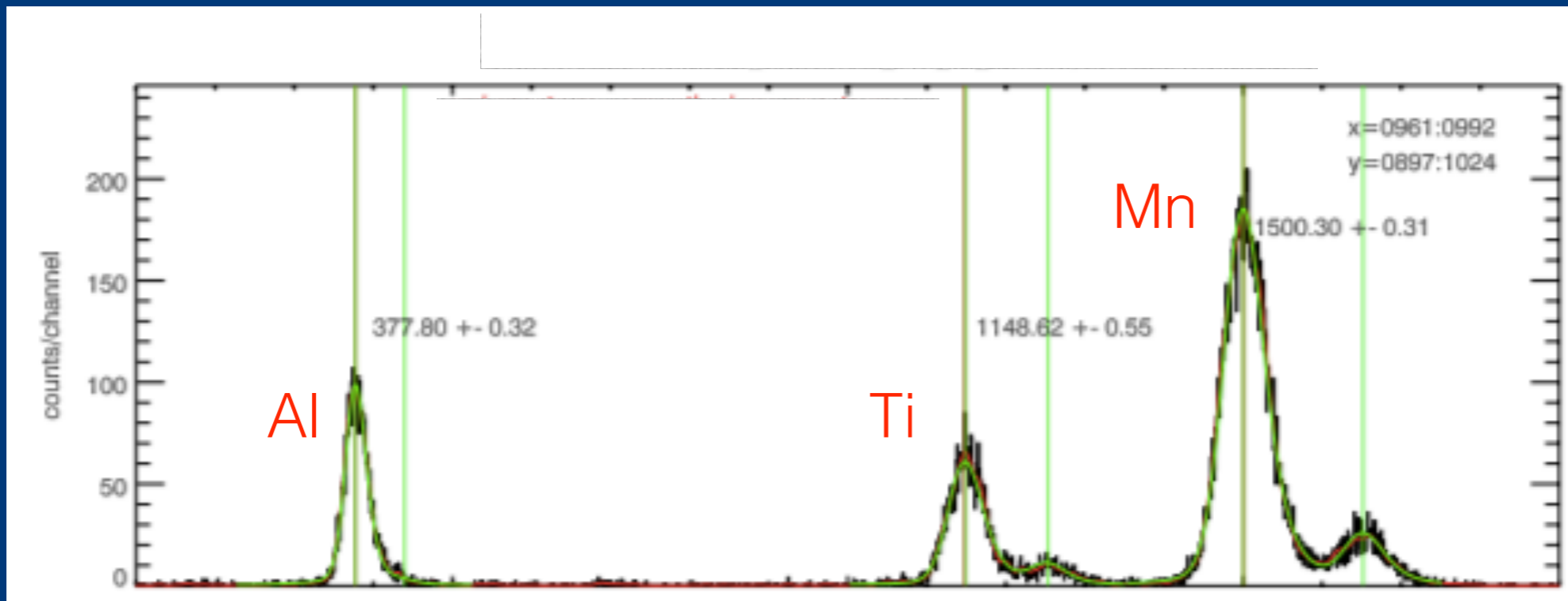
$\tau = 2.71$ yr

Adjustments to how the ACIS Gain is Calibrated

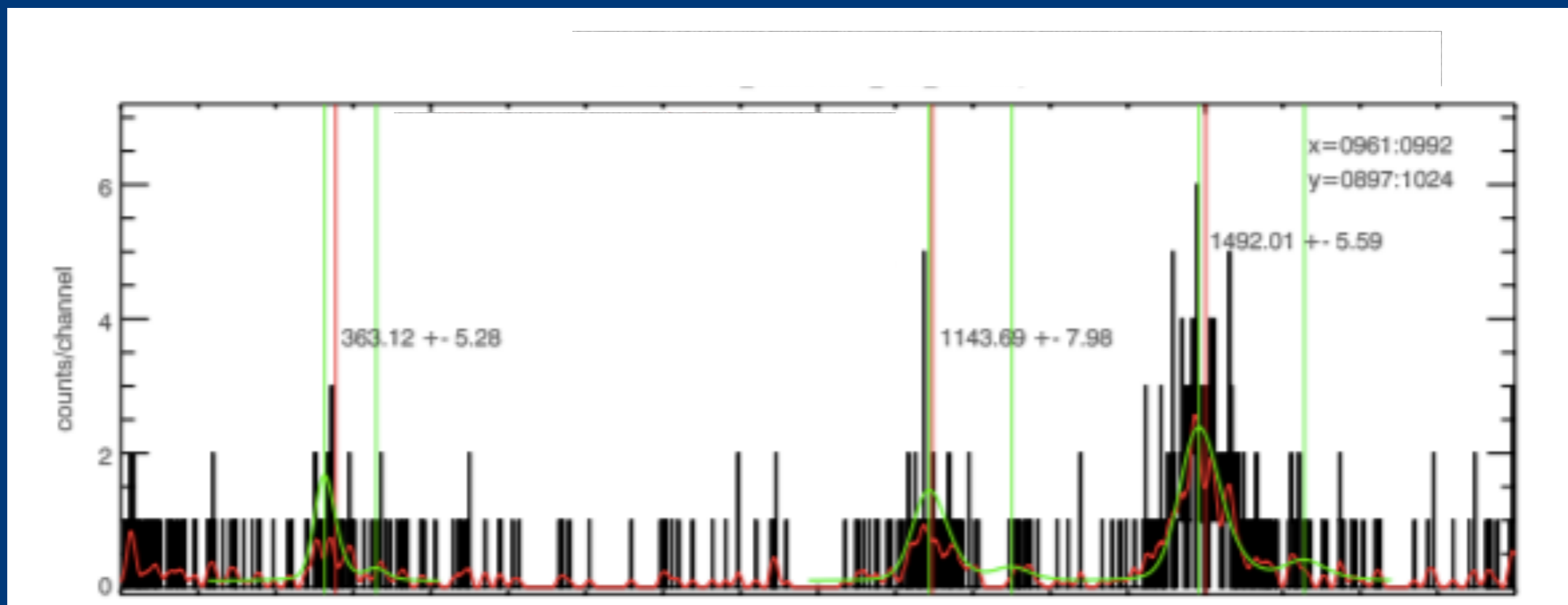
- **Initially calibrated on 32 x 32 pixel regions every three months**
- **Calibrated on 64 by 64 regions every three months**
- **Calibrated on 64 x 64 pixel regions every six months**
- **Calibrated on 32 x 128 (chipx by chipy) regions every six months**

The Future - Cas A(?)

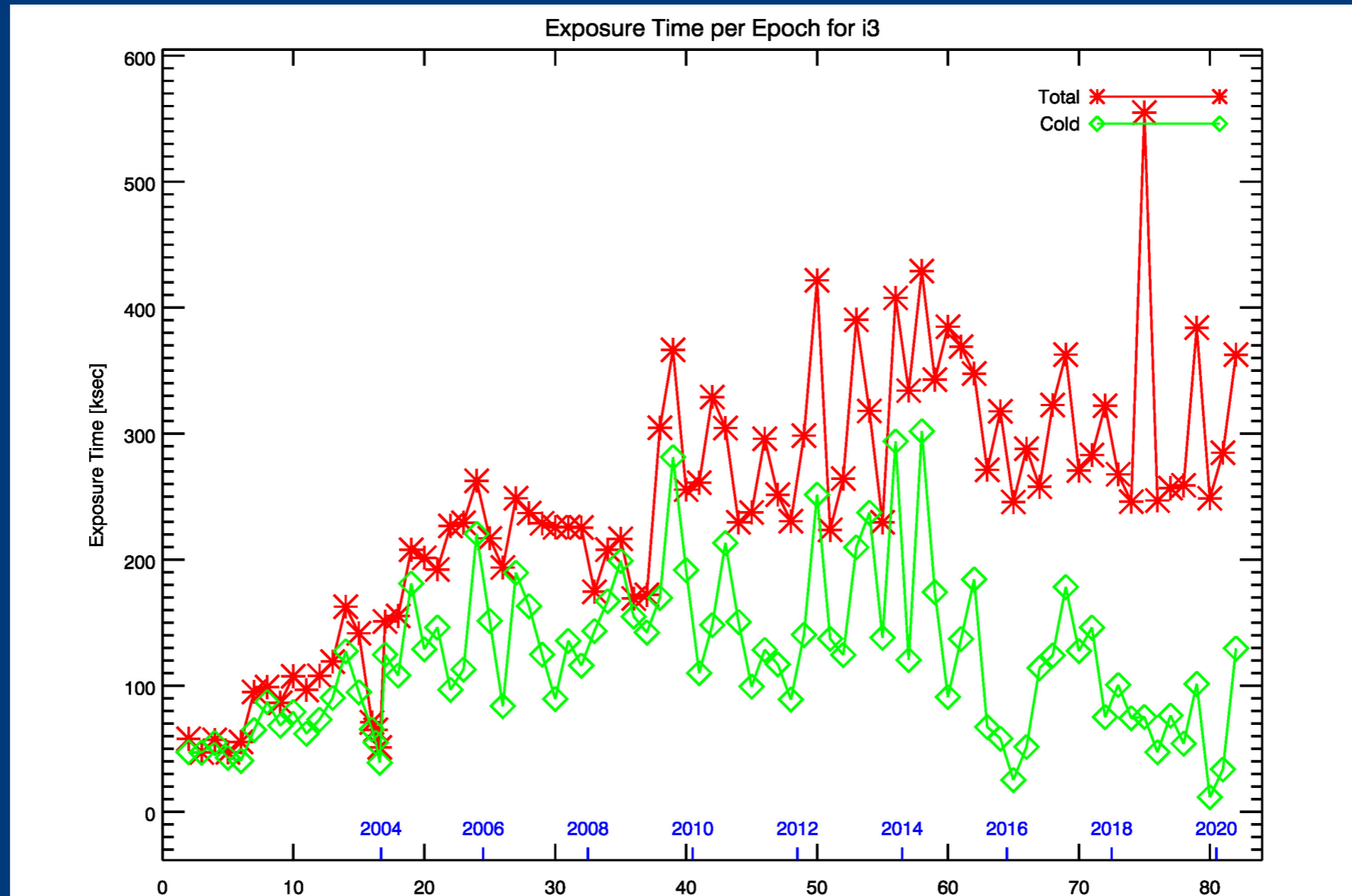
Epoch 1 (32 x 32 pixels - three months)



Epochs 79+80 (32 x 128 pixels - six months)



Decreasing Fraction of Cold (-119.2C to -120C) ECS Time

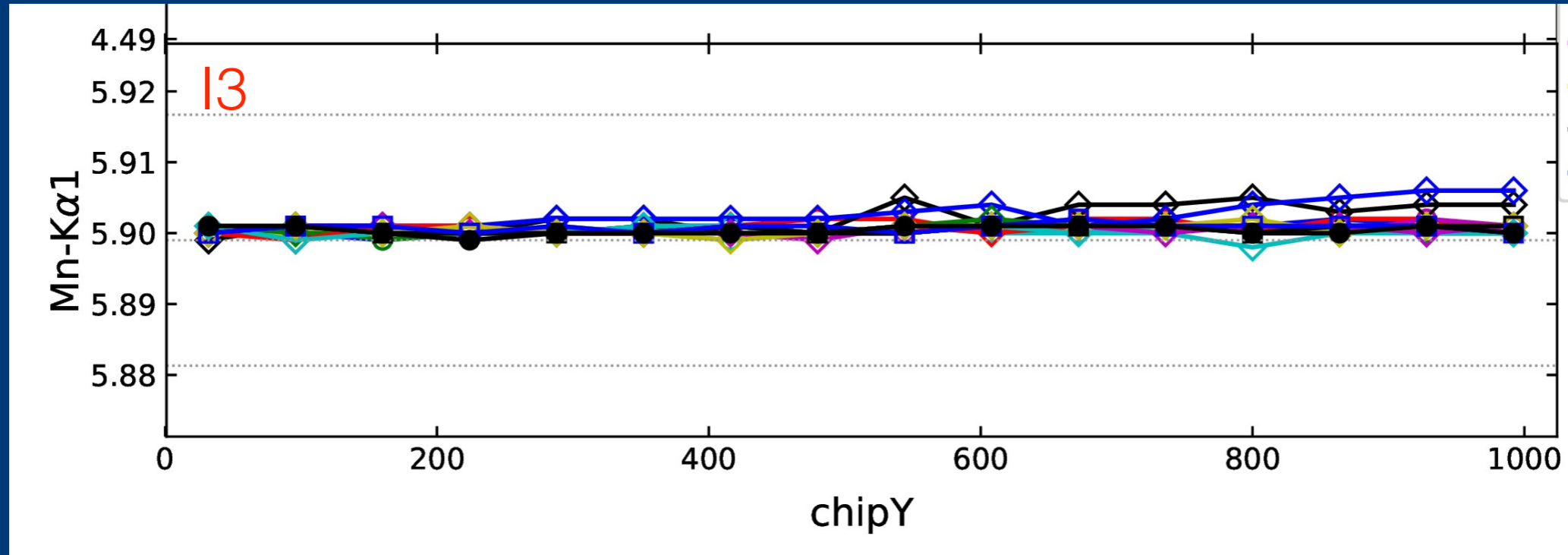


Cold ECS data has always been the fiducial point for ACIS calibration

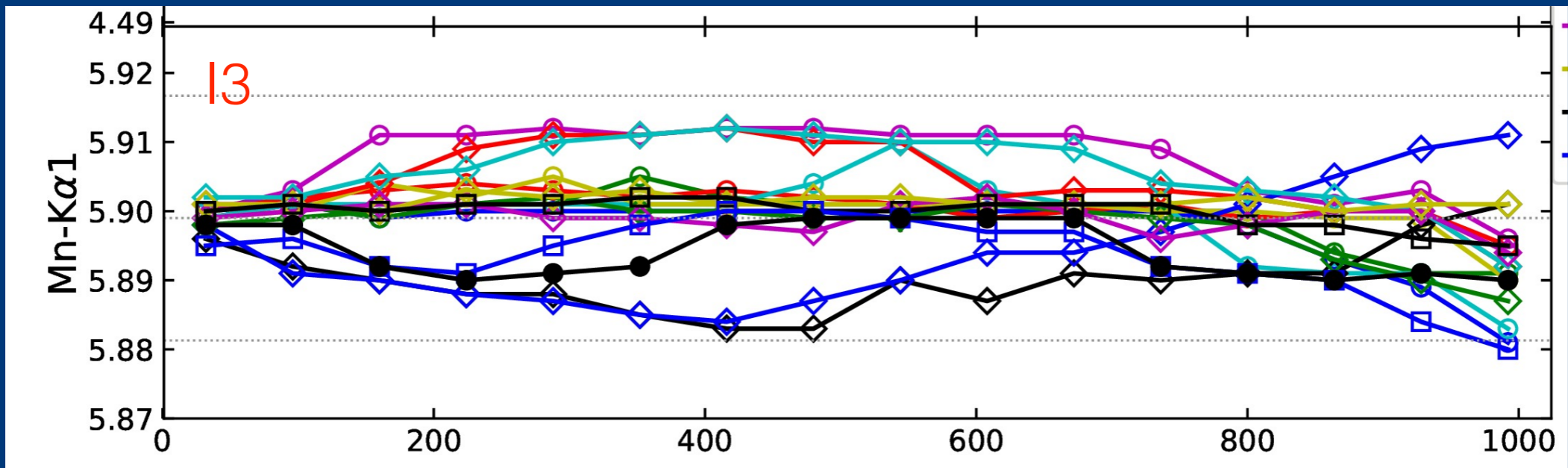
The Calibration team requested an additional 60 ksec of cold ECS time to be taken during science operations in the January-July 2020 time frame and an additional 60 ksec in the August-December 2020 time frame to satisfy our calibration requirements.

Requirement for Gain Calibration is 0.3% (1000 km/s)

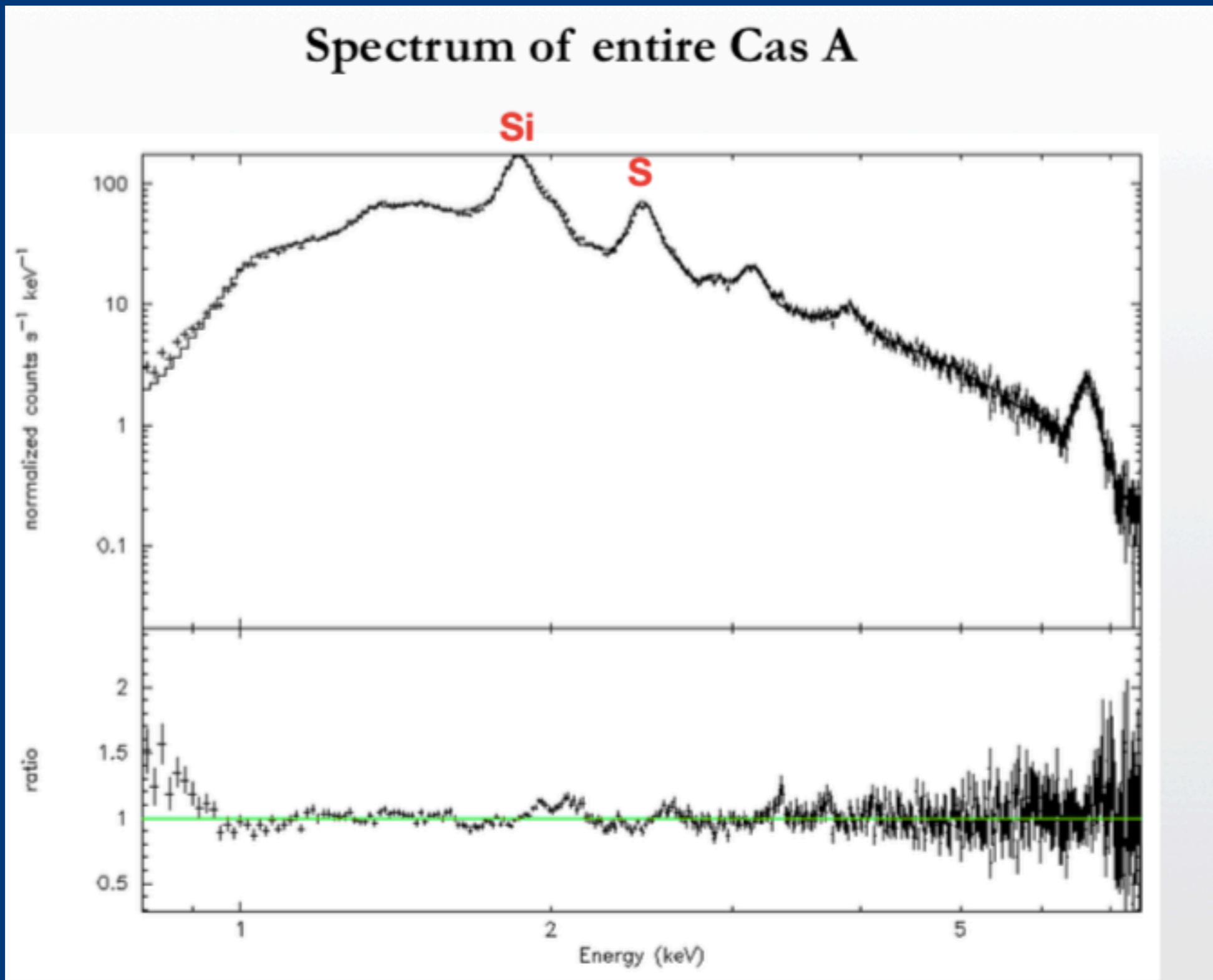
Epoch 1 Gain Calibration



Epoch 79+80 Gain Calibration



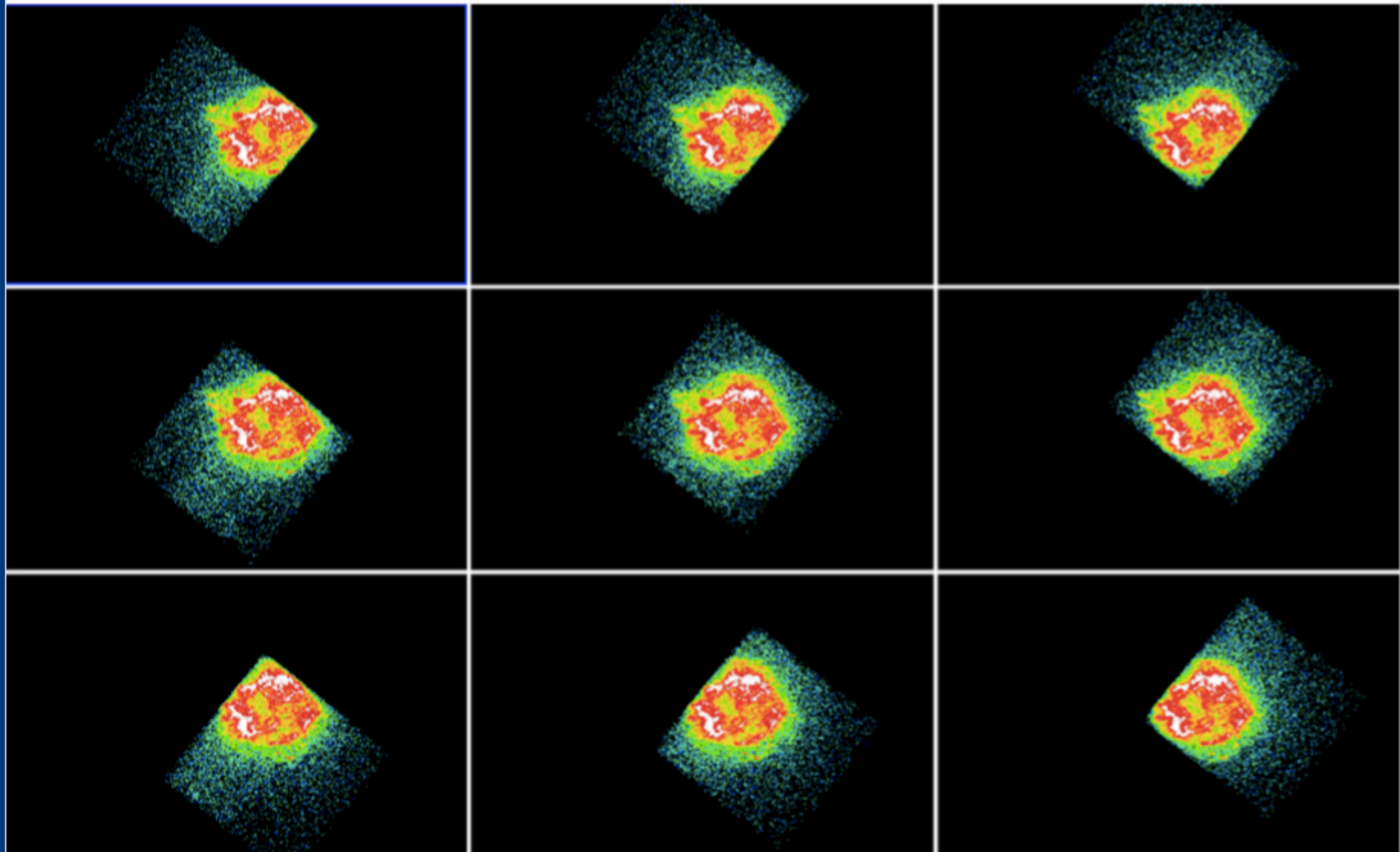
Cas A as a Possible Target for Calibrating the ACIS Gain



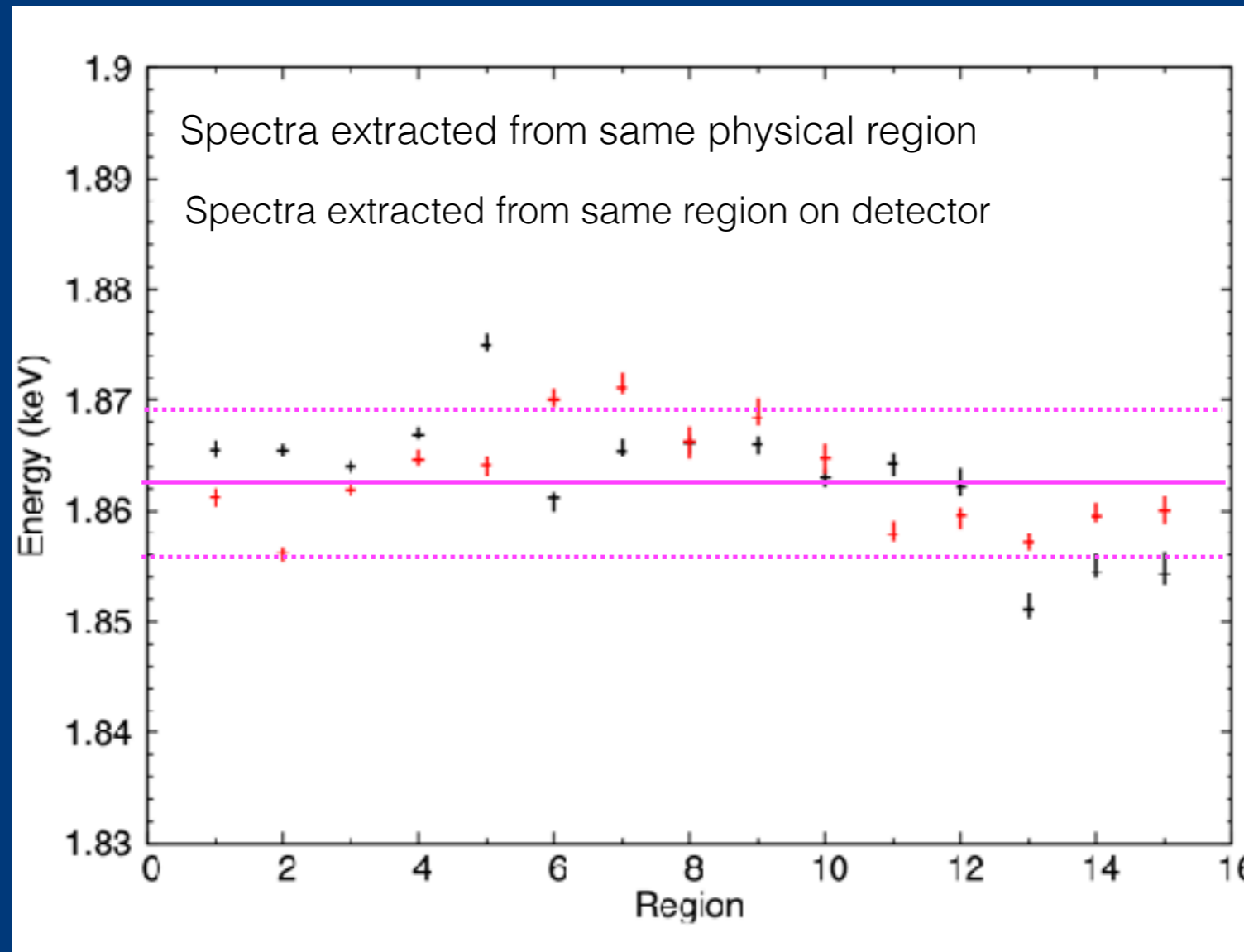
A raster scan (3 x 3) of Cas A was completed on I3 in July

Each exposure was 2 ksec.

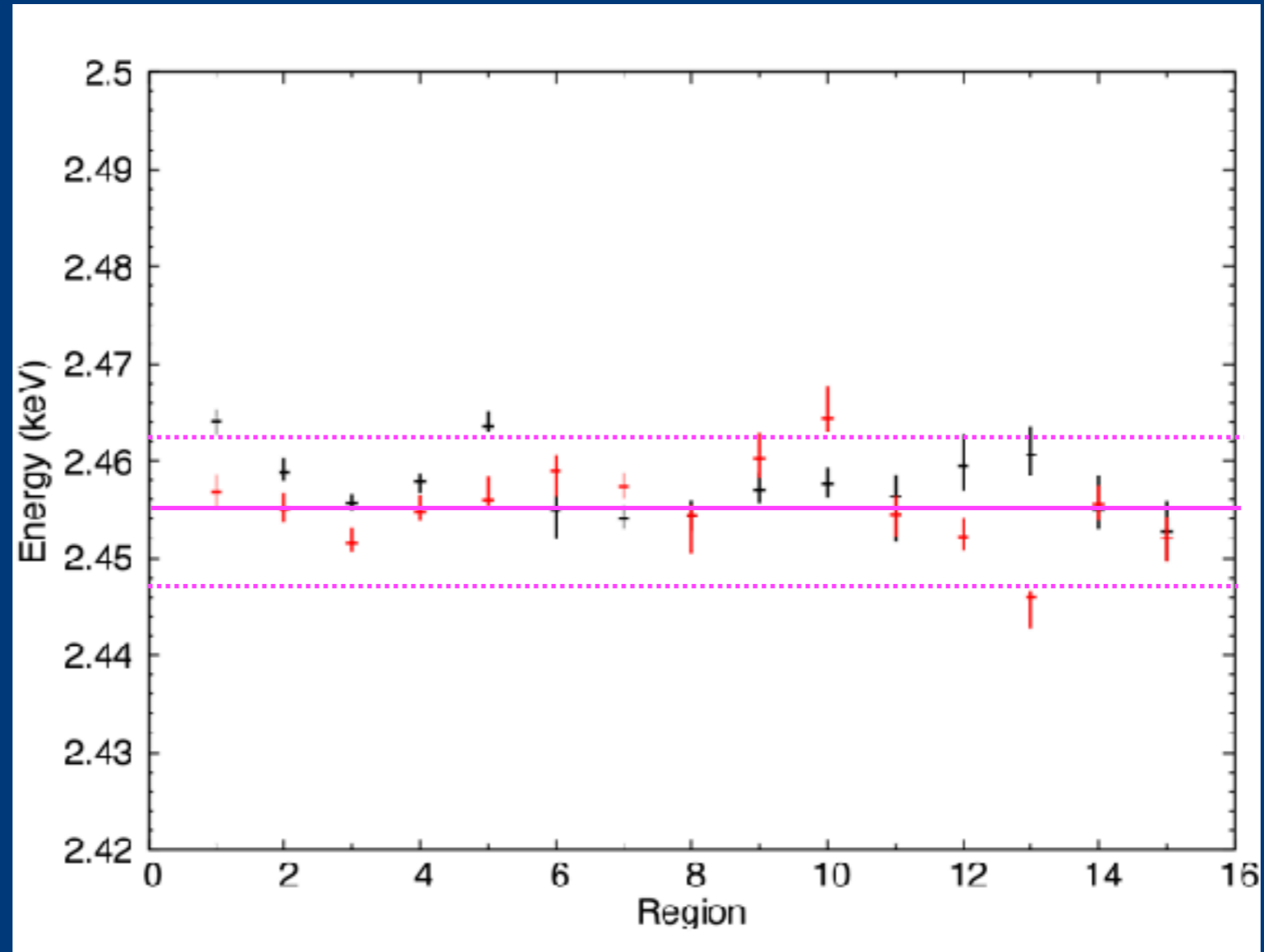
0.5-2 keV band images of Cas A grid



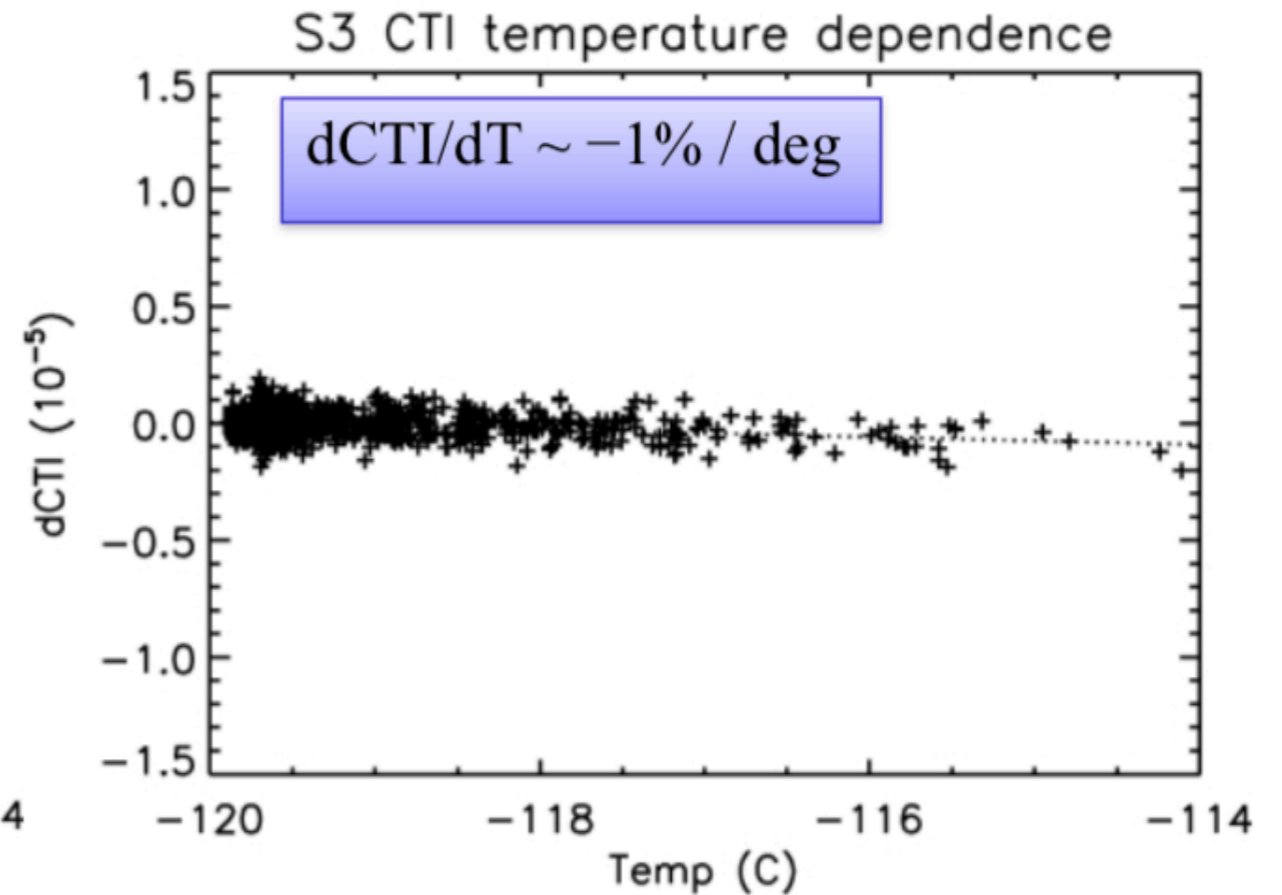
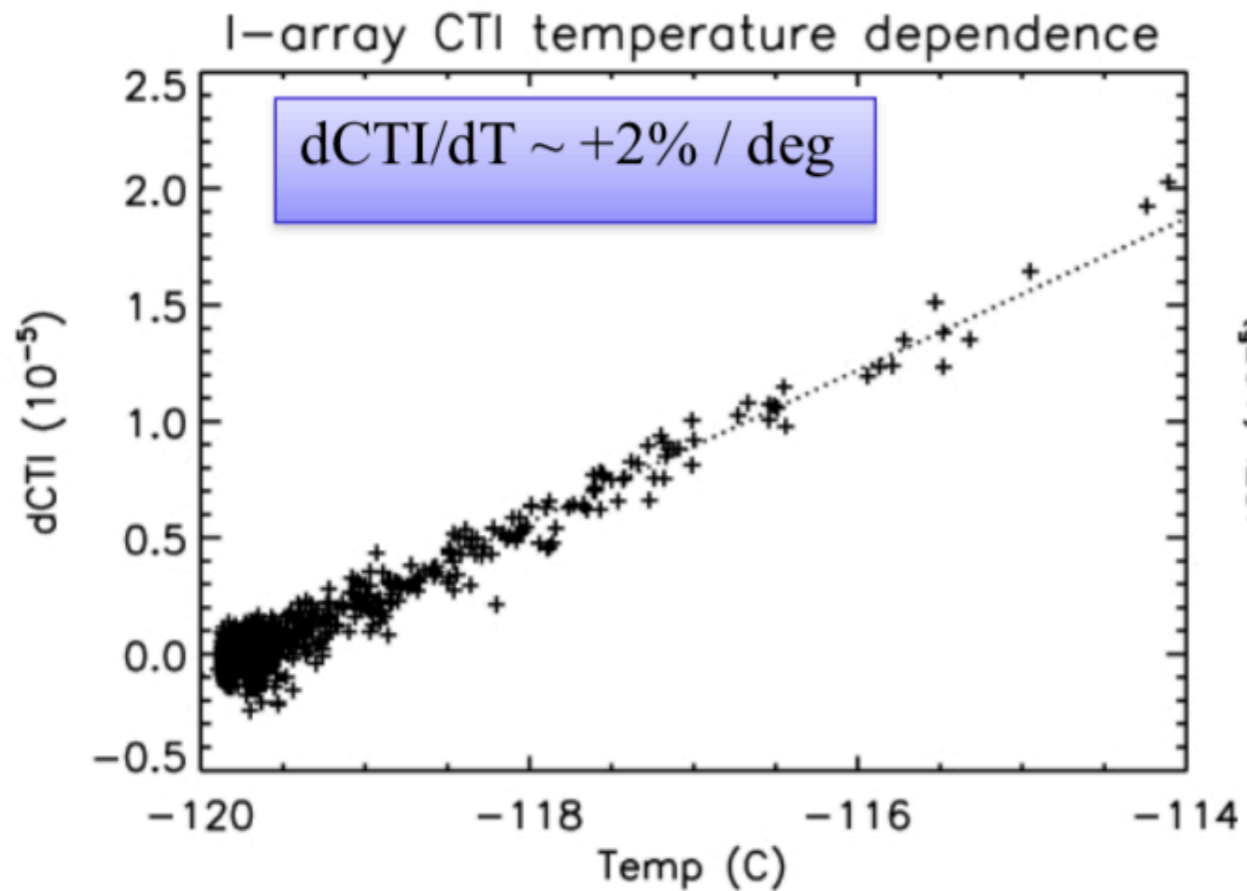
Cas A - Si Line



Cas A - S Line

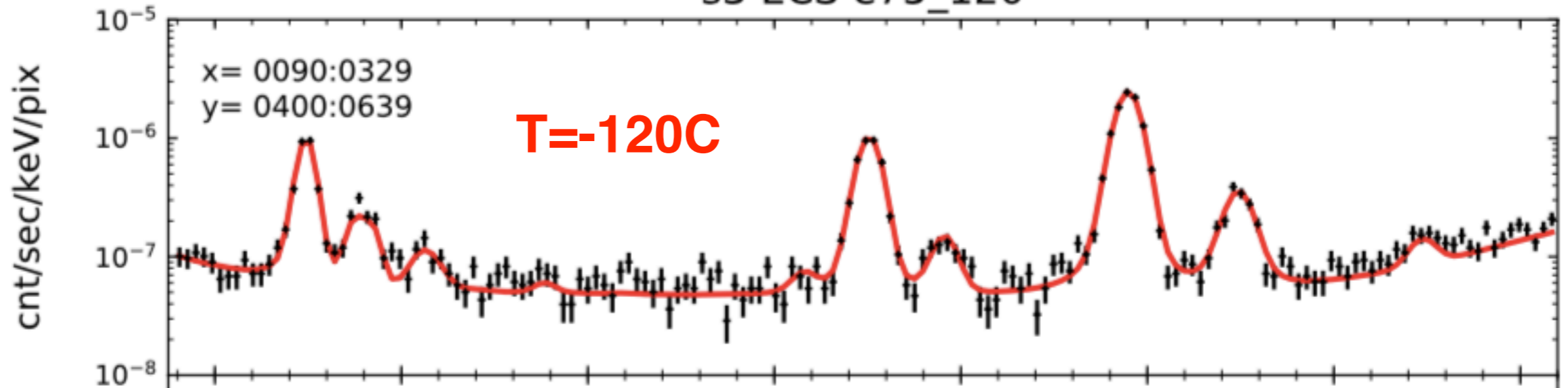


ACIS Temperature-Dependent Calibration

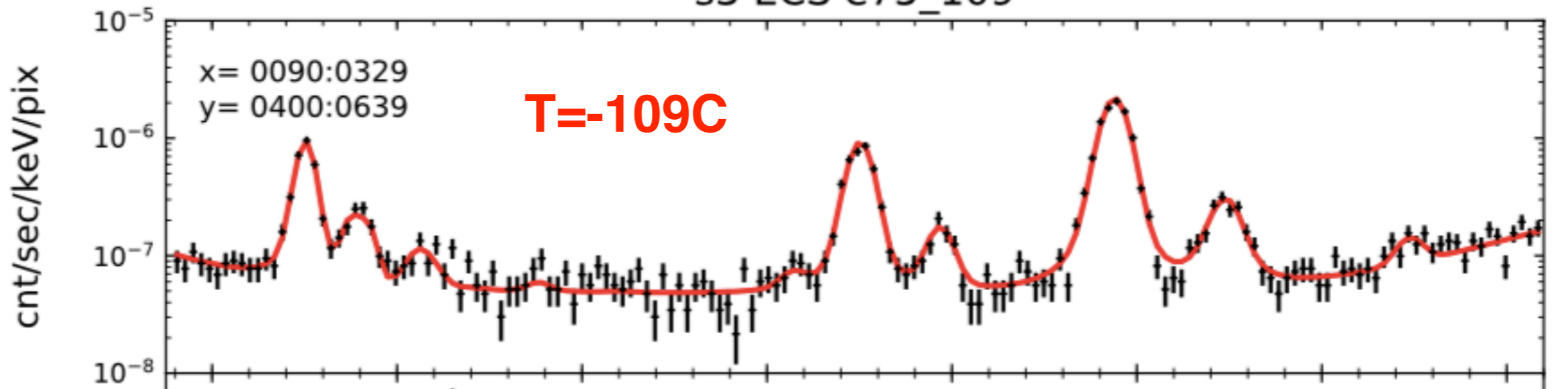


S3-aimpoint Spectral Resolution vs. Temperature

s3 ECS e75_120

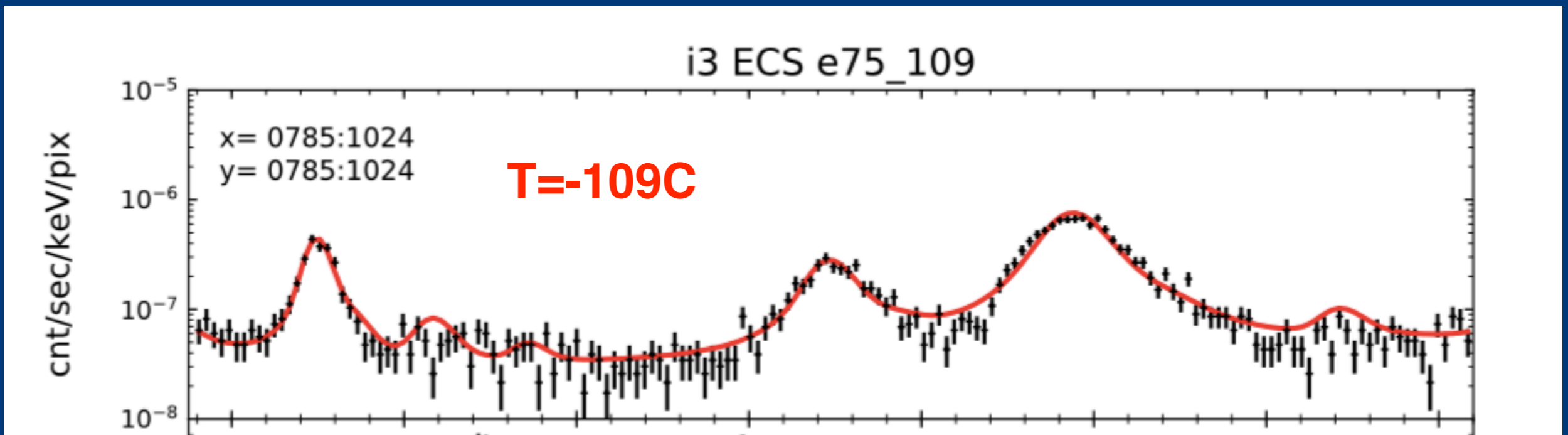
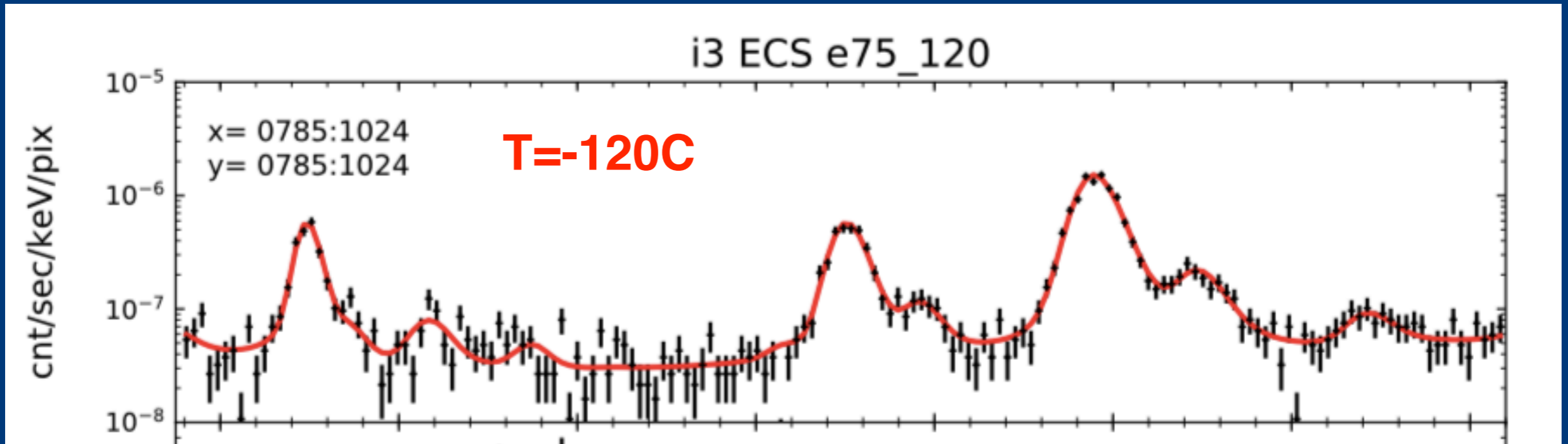


s3 ECS e75_109



The Calibration team has given approval for S3 only observations up to -109C

I3-aimpoint Spectral Resolution vs. Temperature



The thermal limit for FI observations remains at -112C

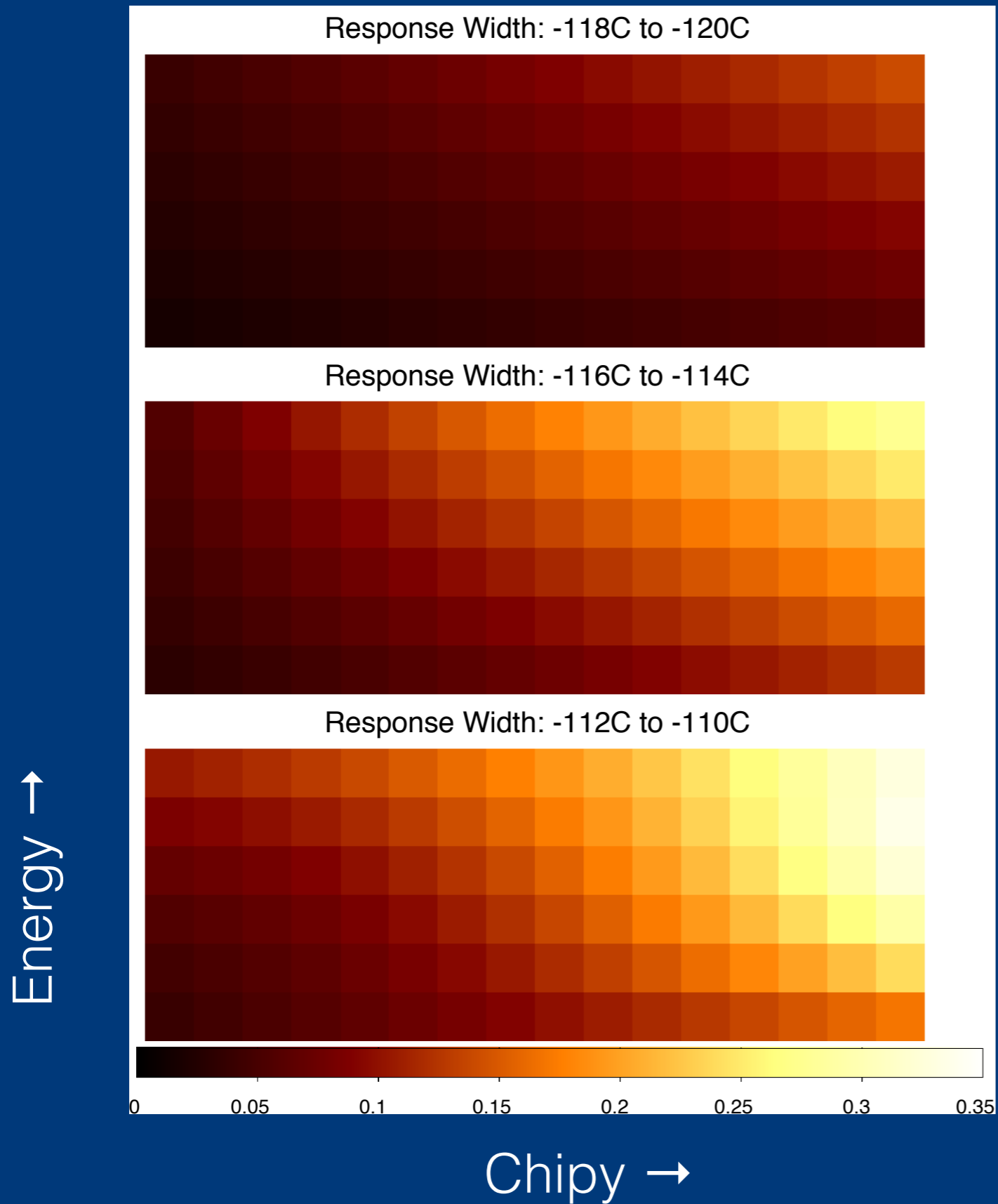
ACIS Temperature-Dependent Calibration

- **Generate scatter matrices in a grid of temperature bins**
- **Generate QE maps in a grid of temperature bins**
- **Improve the temperature-dependent CTI correction**

Preliminary results of fitting ECS line widths on I3 vs. temperature

- **Co-add ECS data from epochs 75-80**
- **Bin data into 2C temperature intervals**
- **Bin data into 64 x 64 pixel regions**
- **Fit Al-K α , Ti-K α , Ti-K β , Mn-K α , Mn-K β , Au-La lines**

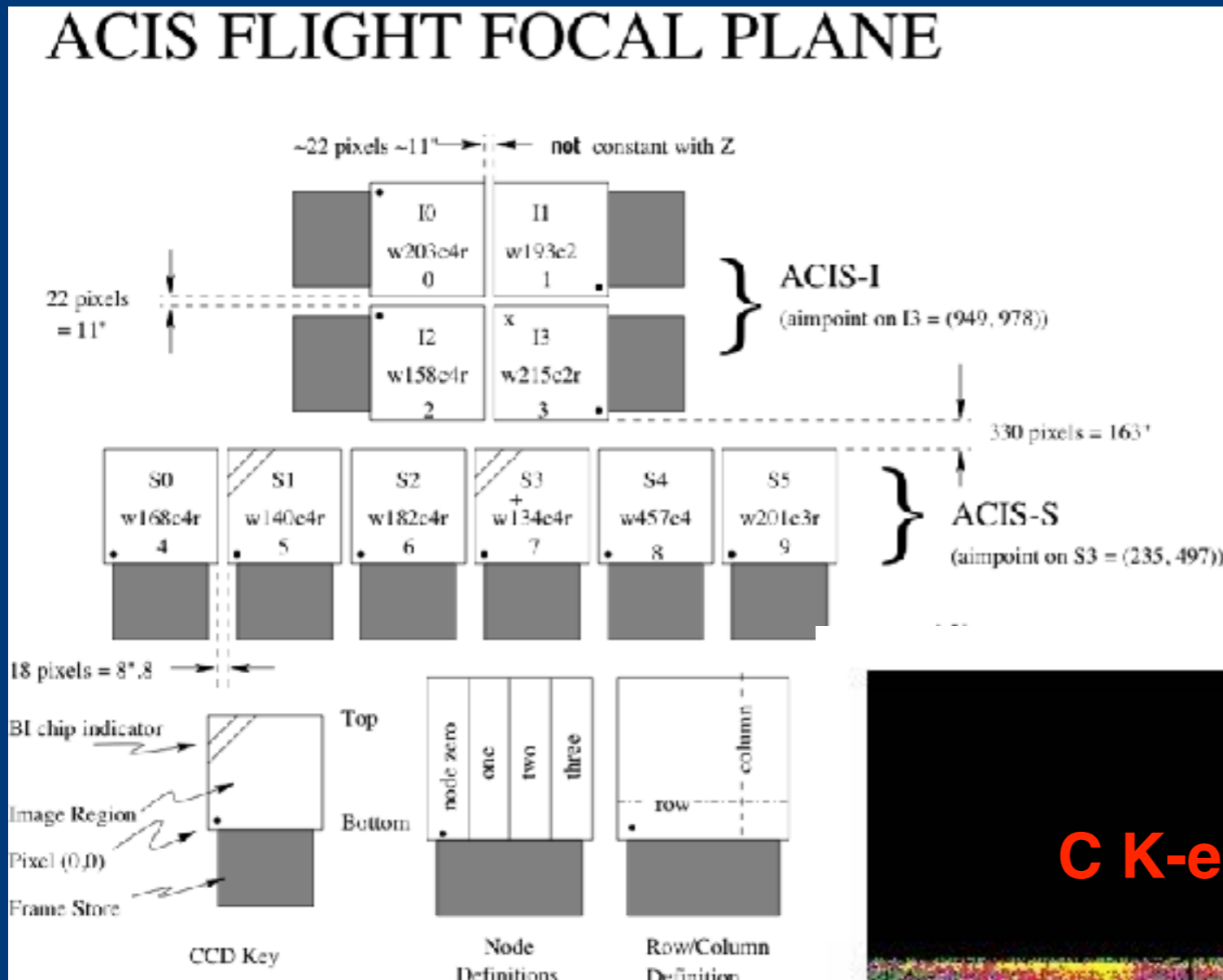
Fitted Line widths vs Temperature on I3



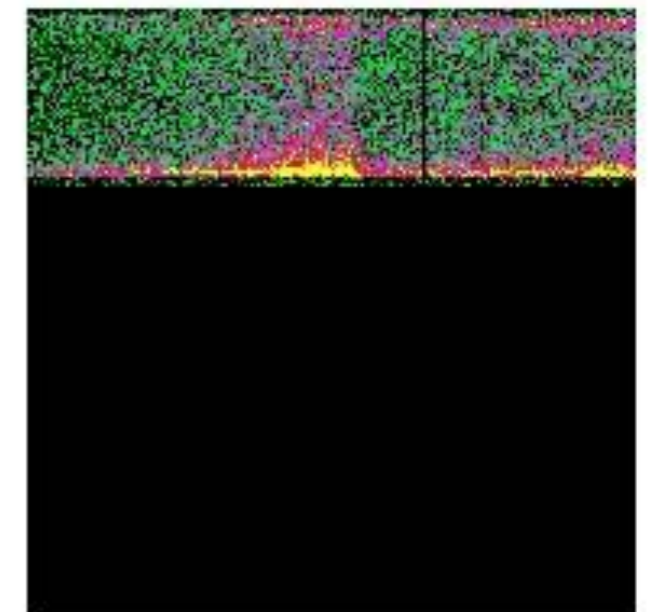
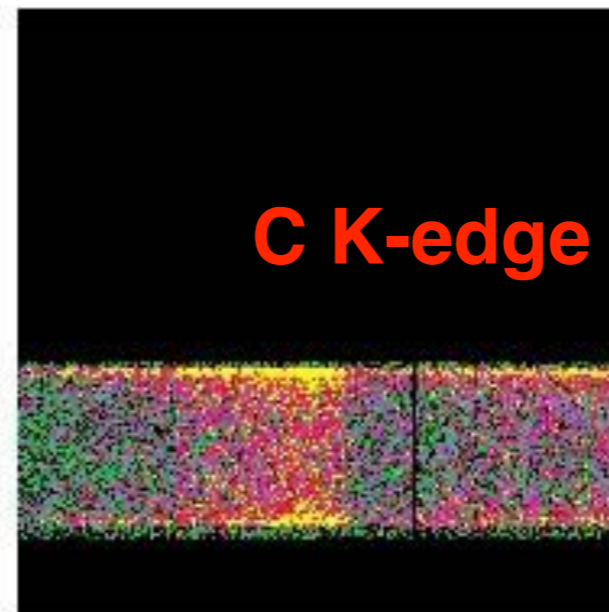
**Color scale corresponds to
line width**

ACIS Effective Area - Monitoring the Contamination

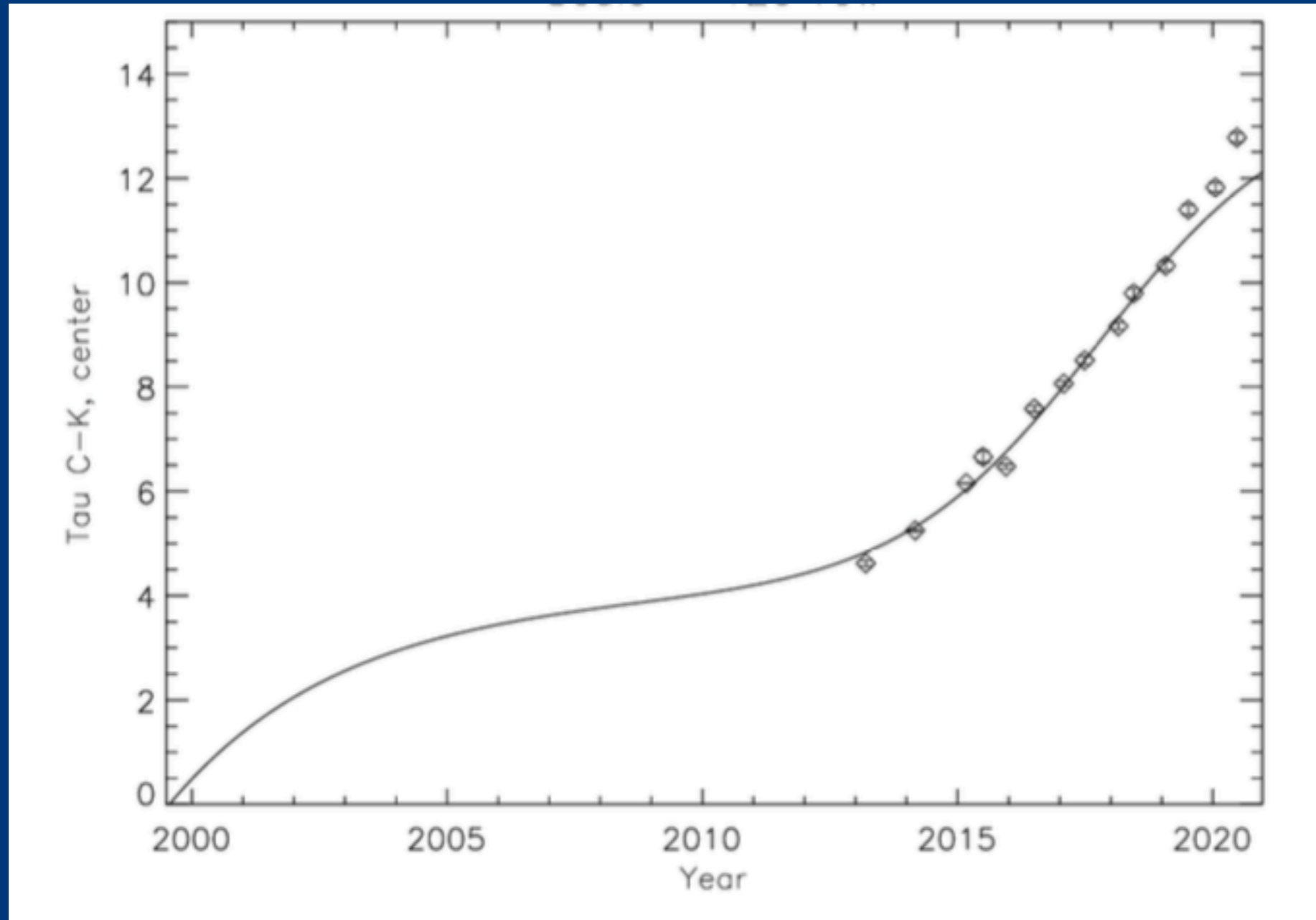
Big Dither LETG/ACIS-S Observations of Mkn 421



ACIS-S1



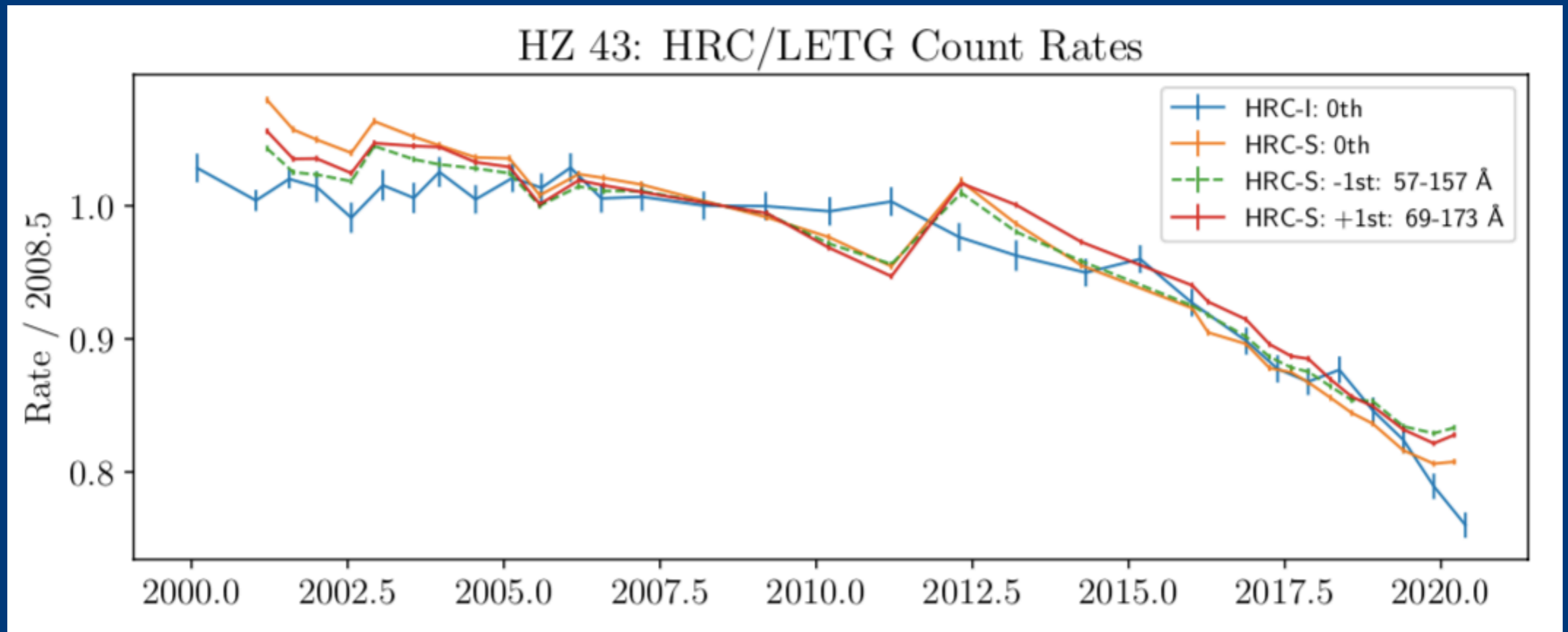
C-K optical depth at S3 Aimpoint



The current CALDB model of the ACIS contamination underestimates the depth of the contaminant. An updated model will be released in the Dec. 15th CALDB release.

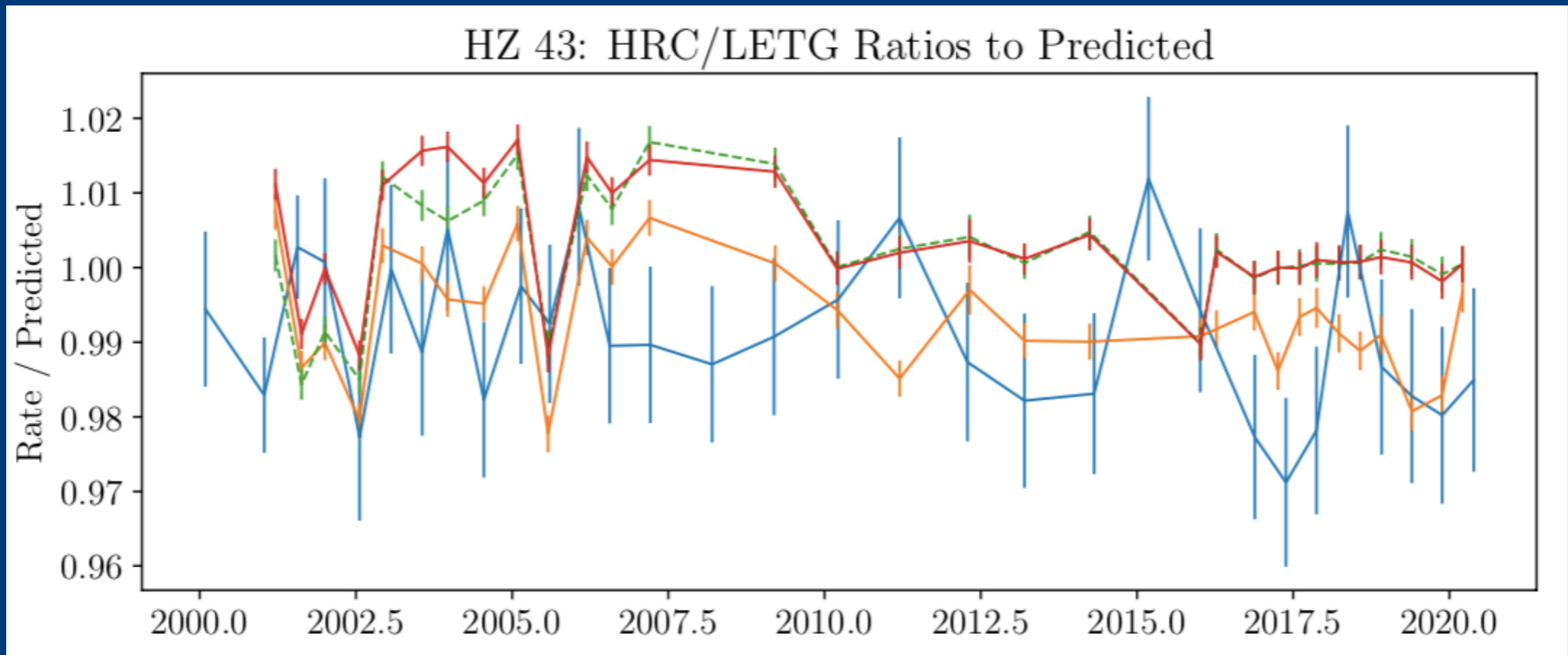
HRC/LETG Calibration

HZ43 is observed annually with the HRC-I/LETG and HRC-S/LETG to monitor the HRC gain and QE



These observations are used to generate annual updates to the HRC-I and HRC-S QE

HRC/LETG Calibration



Time-Dependence of the HRC -S Gain

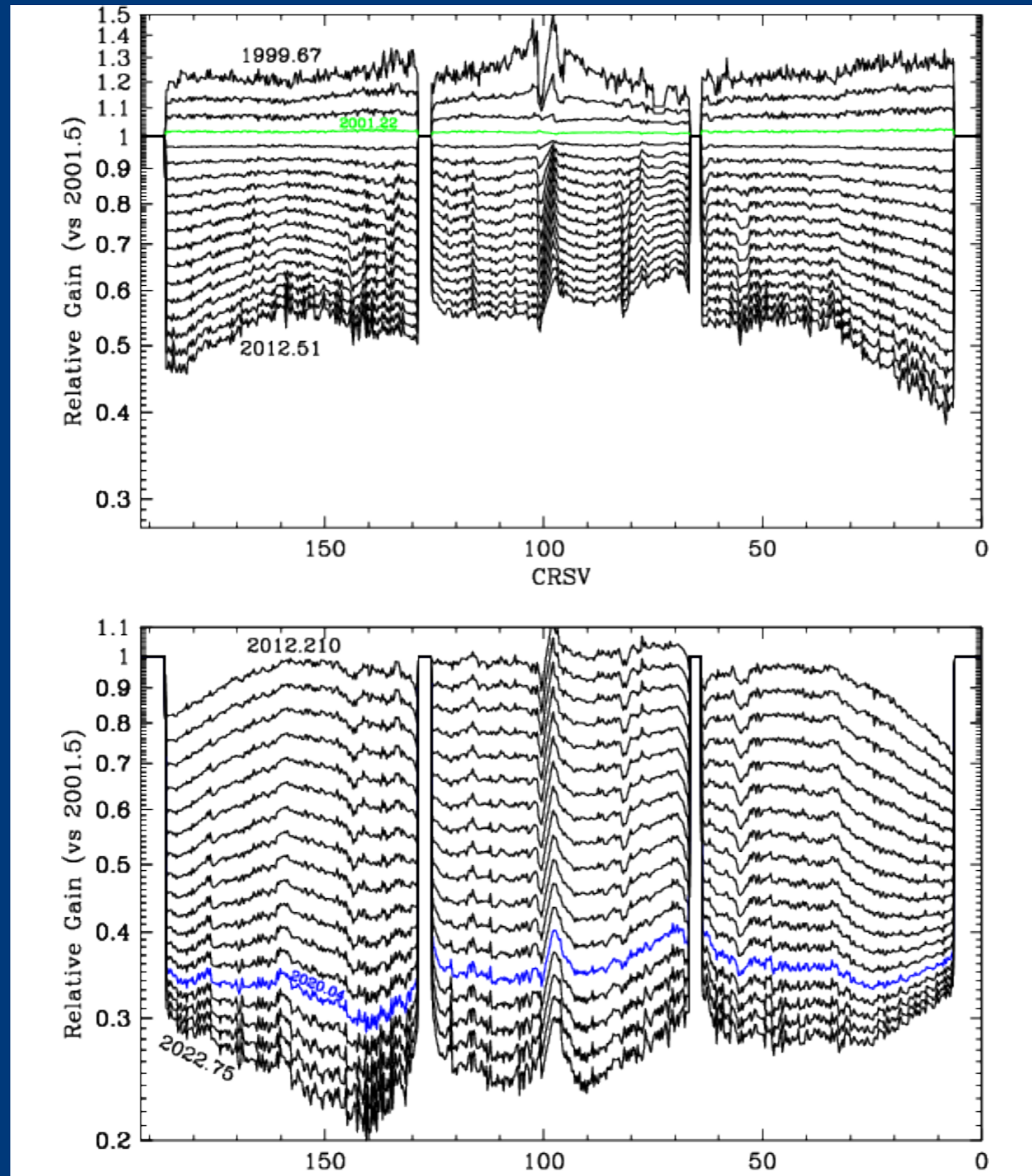
1999

2012

2012
post HV
increase

2020

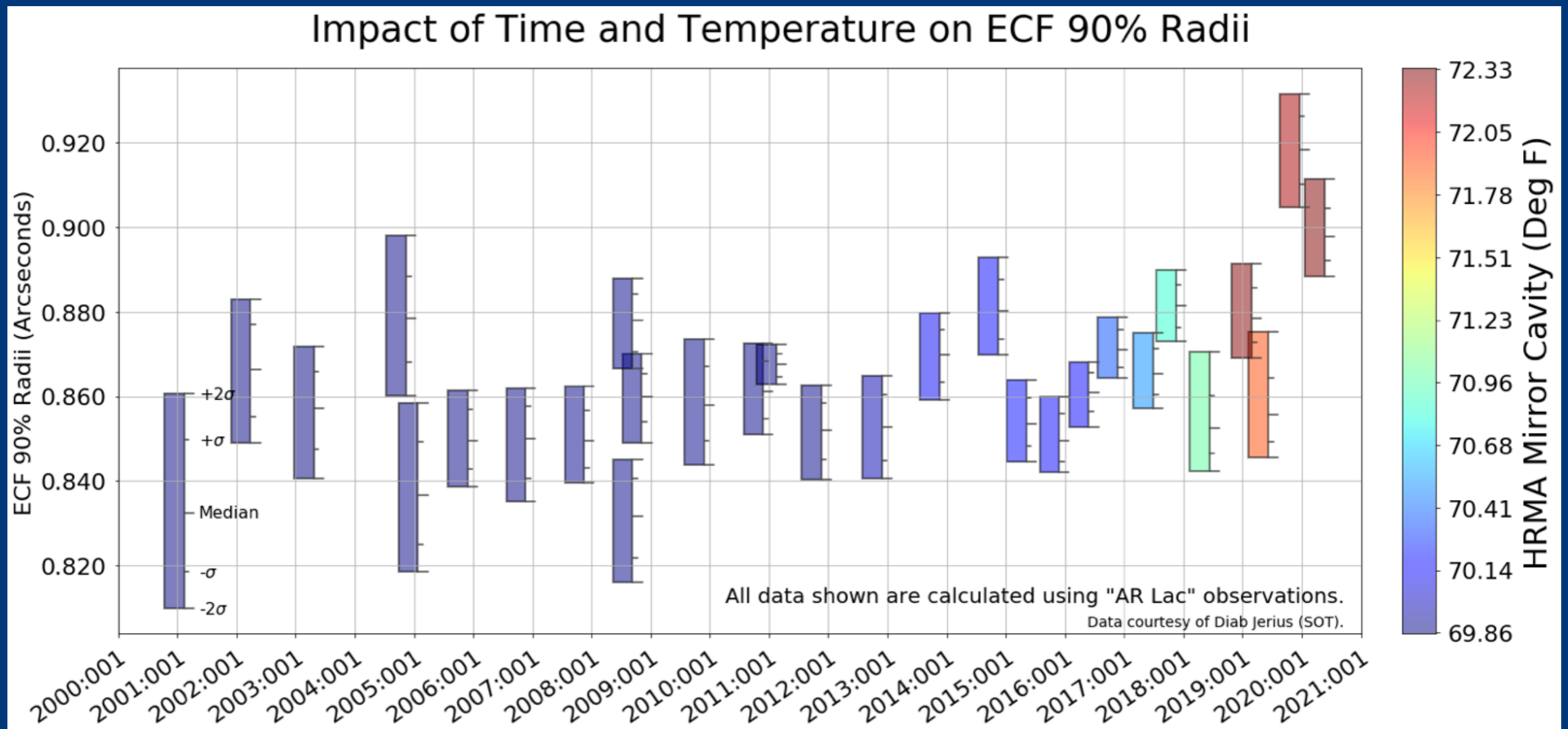
2022



The HRC HV will likely be increased in the spring of 2021

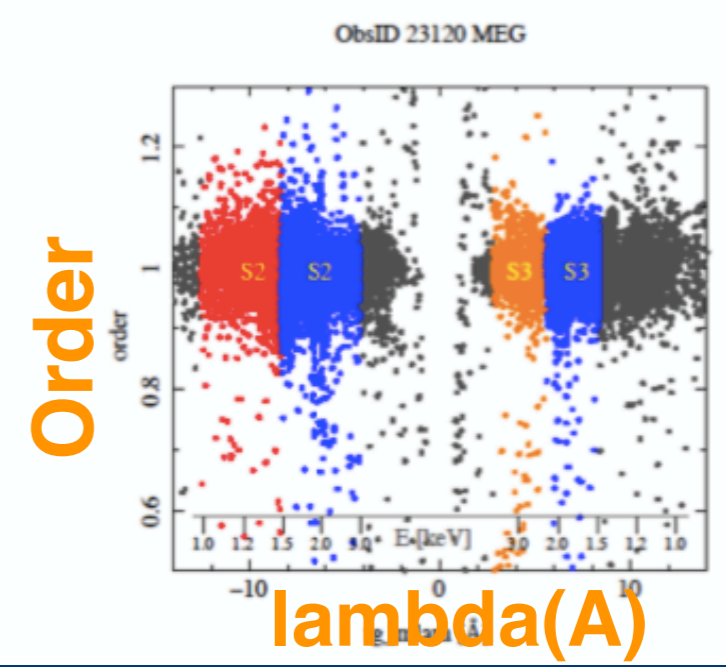
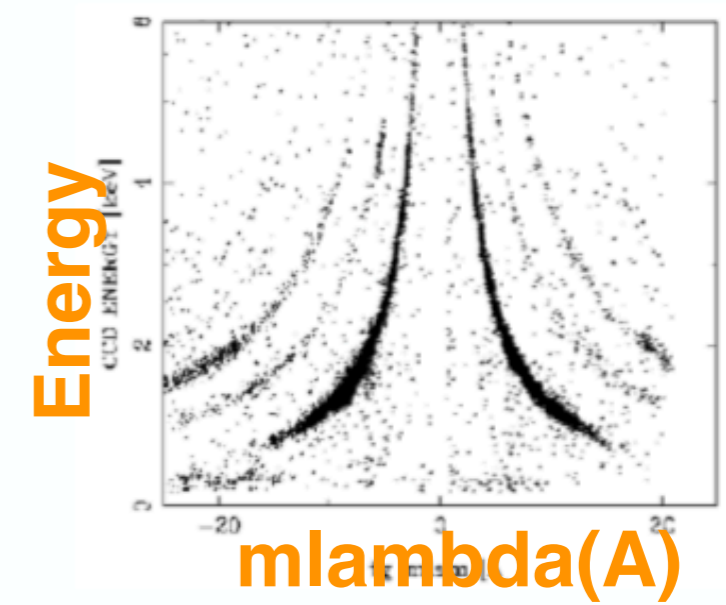
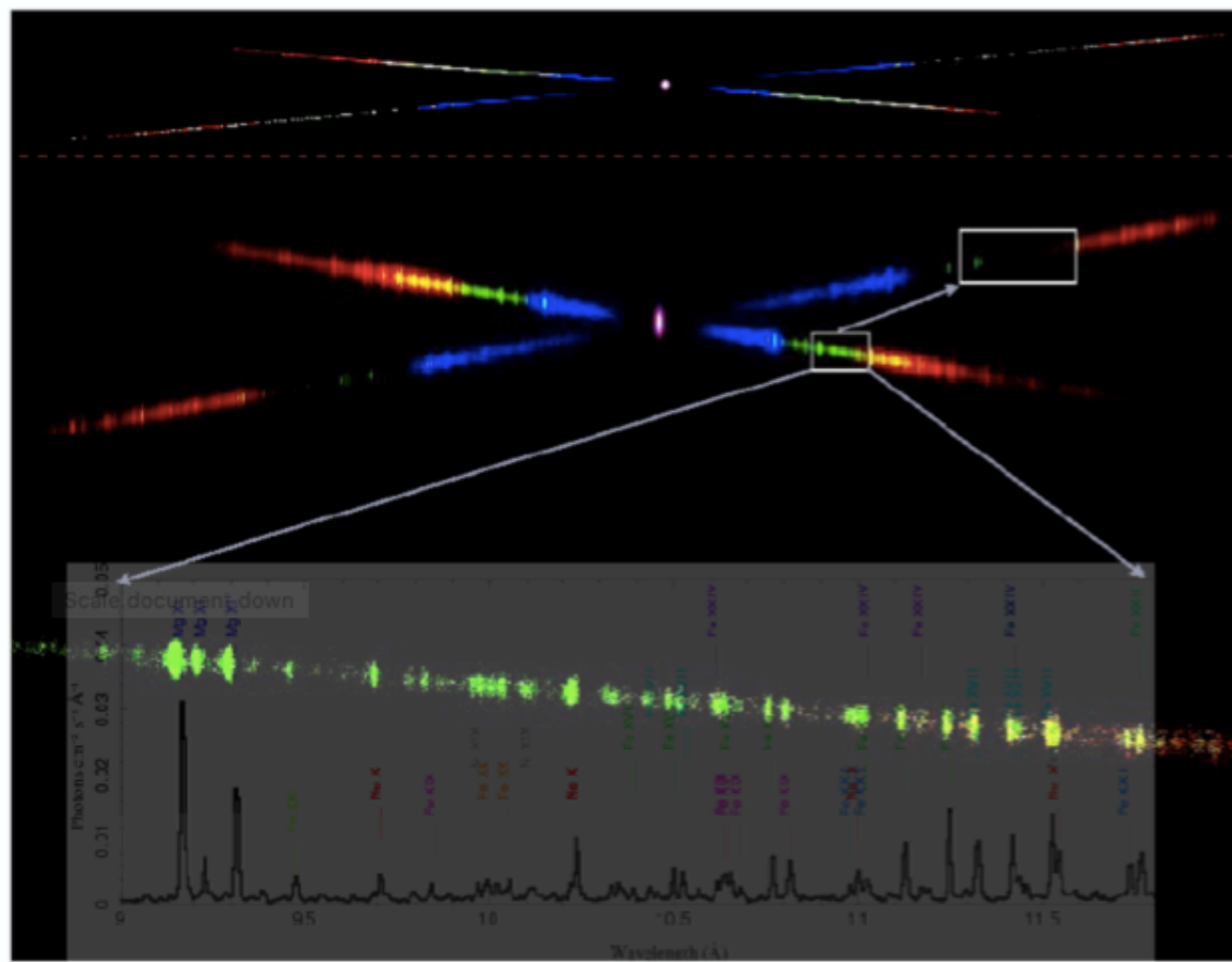
HRC-I PSF Monitoring with AR Lac

AR Lac is observed with the HRC-I every six months to monitor the PSF



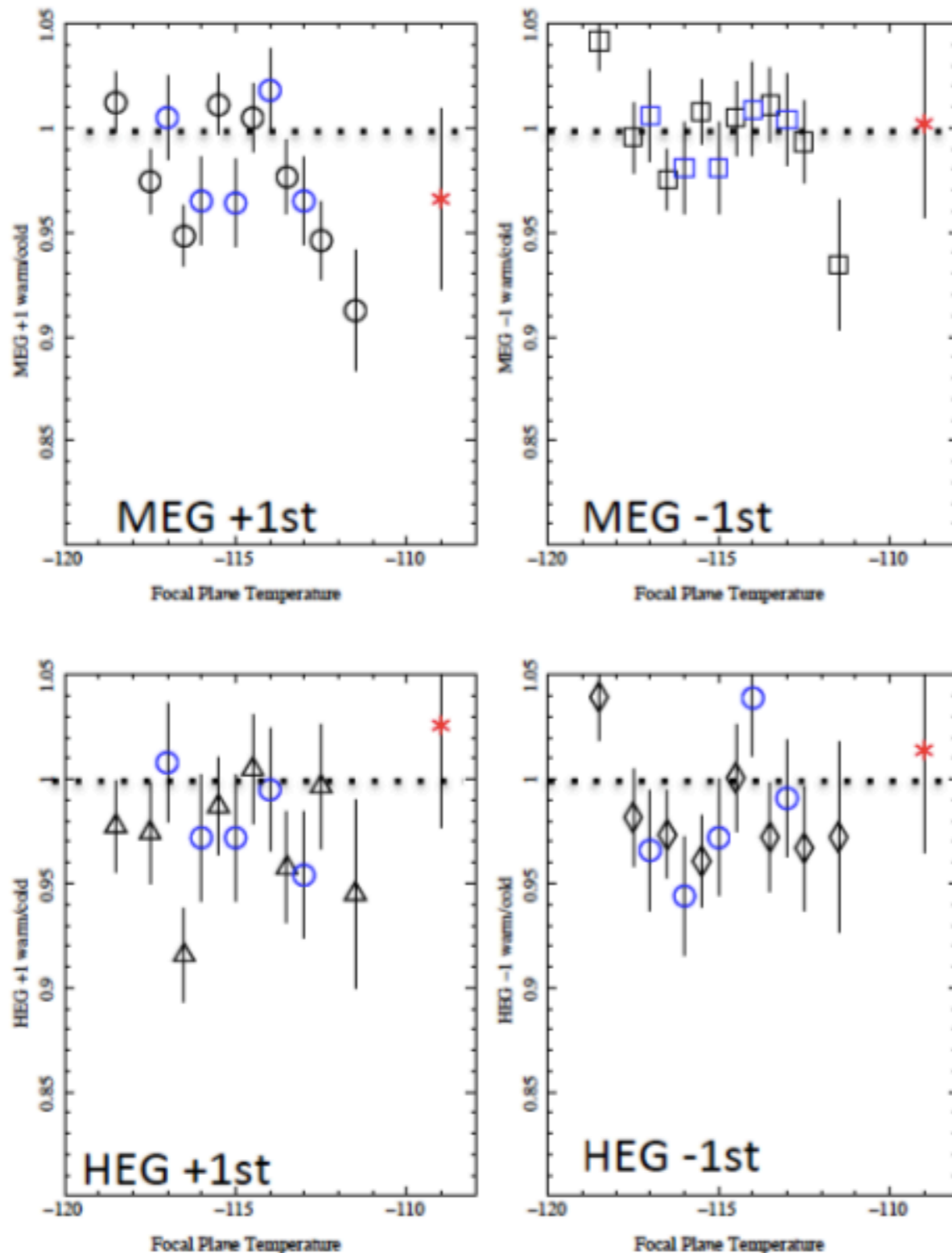
Order Sorting

θ^1 ORI C



Warm HETG/ACIS-S Data

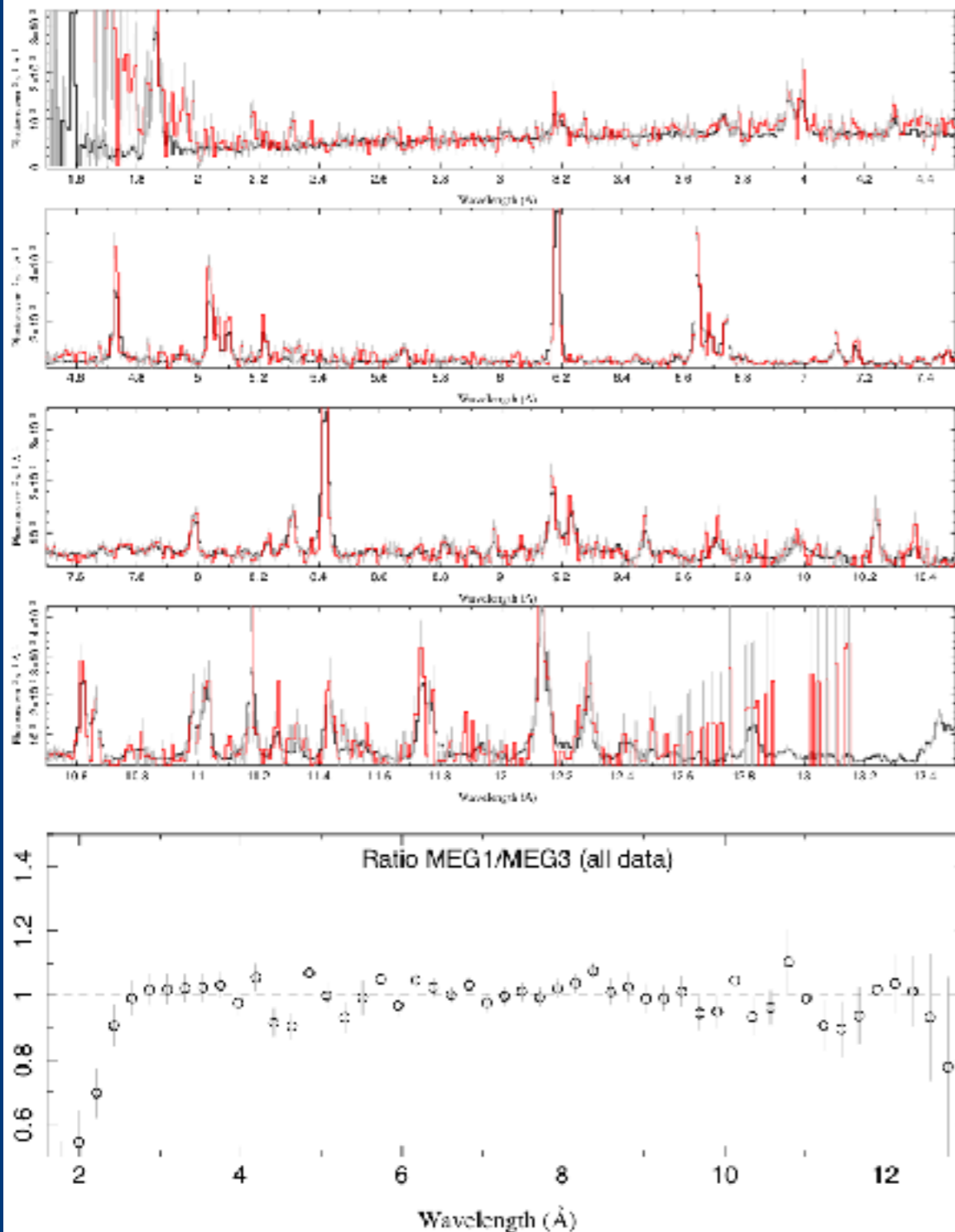
Θ^1 ORI C



Conclusion - overall less than 1% of events are lost due to order sorting and QE effects in HETG/ACIS-S data with ACIS temperatures up to -109C

HETG Higher Order Cross-Calibration

1.2 Ms of Orion Theta1 Ori C:
MEG 1st order (black), MEG 3rd order (red)



MEG 1st and 3rd fluxes
agree to within 3%

Present and Near Future Calibration Work

ACIS

- Monitor contamination and release updates as required
- Develop a set of temperature-dependent calibration products
 - Line Widths vs. energy and vs. temperature
 - QE maps in a range of temperature bins
 - Improve temperature-dependent CTI correction

HRC and HRC/LETG

- Analyze side b electronics check-out and calibration data
- Continue to monitor HRC gain and QE
- Prepare for HV increase in spring 2021
- Compile a post HV increase calibration plan

HETG

- Cross-calibrate between first order and higher orders.

HRMA

- Monitor the PSF
- Update the memo on the imaging effects of EDSEER
- Finish memo on the empirical ACIS PSF