# 1. ACIS Calibration: Planned Updates & Future Issues

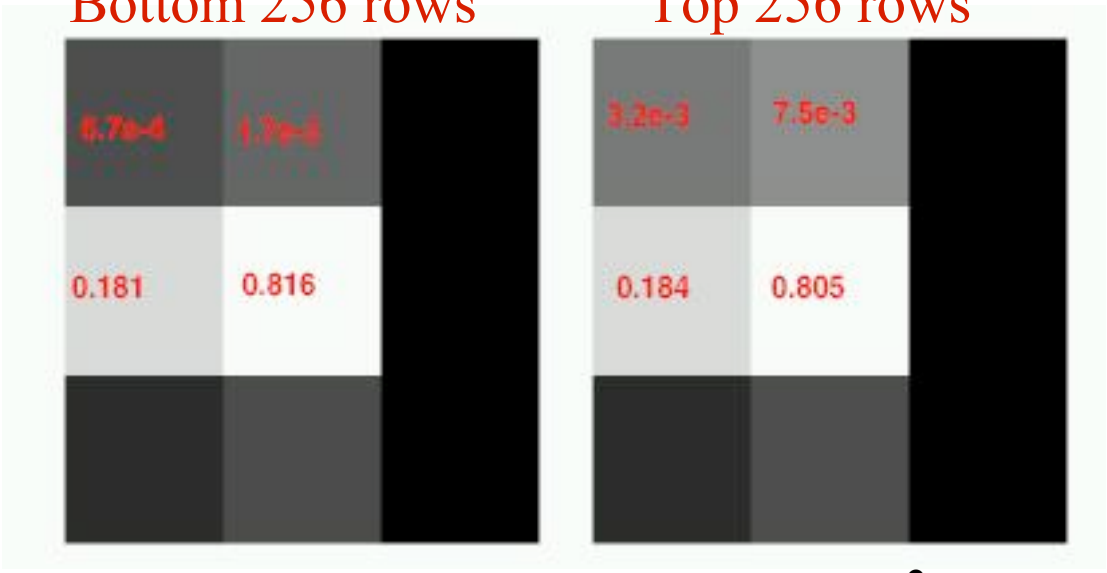
# 2. ACIS Operations: Controlling the ACIS FP Temperature

Paul Plucinsky & The ACIS Ops and Cal Teams

## Planned Update: CTI Correction for Graded Mode for FI CCDs

- Timed Exposure (TE) Faint mode CTI correction adjusts the PH of each pixel in the 3x3 event island
- In TE Graded mode, only have x, y position of event, grade, and summed PH
- Use grade and summed PH to determine the most likely charge distribution based on ``average'' images
- Use this information in an Graded mode CTI correction

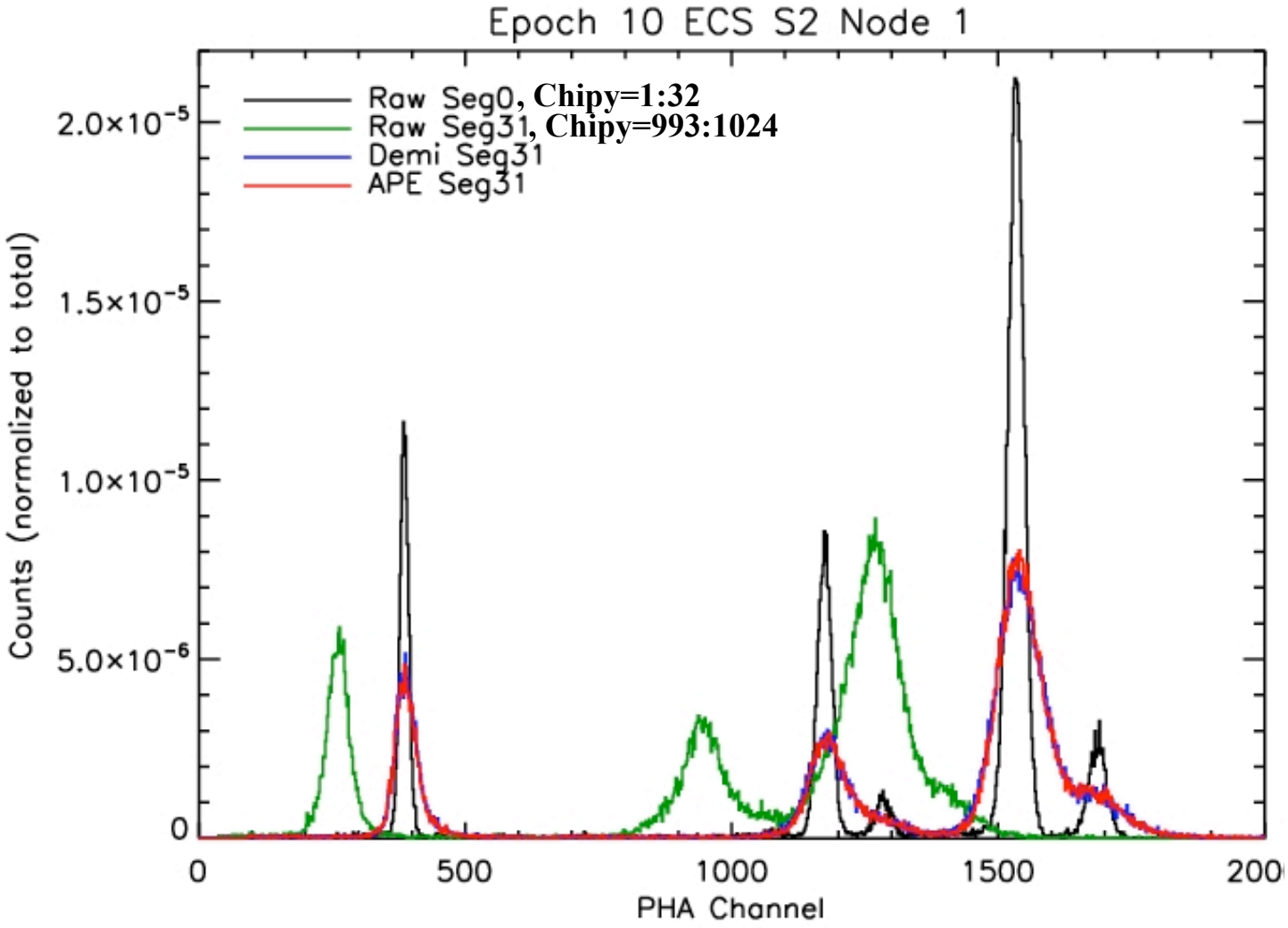
**Mn-K flight grade 8 (left split) for S2**




Vikhlinin (SAO)

**For FI CCDs only !**

# Comparison of Graded Mode and Faint Mode CTI Correction



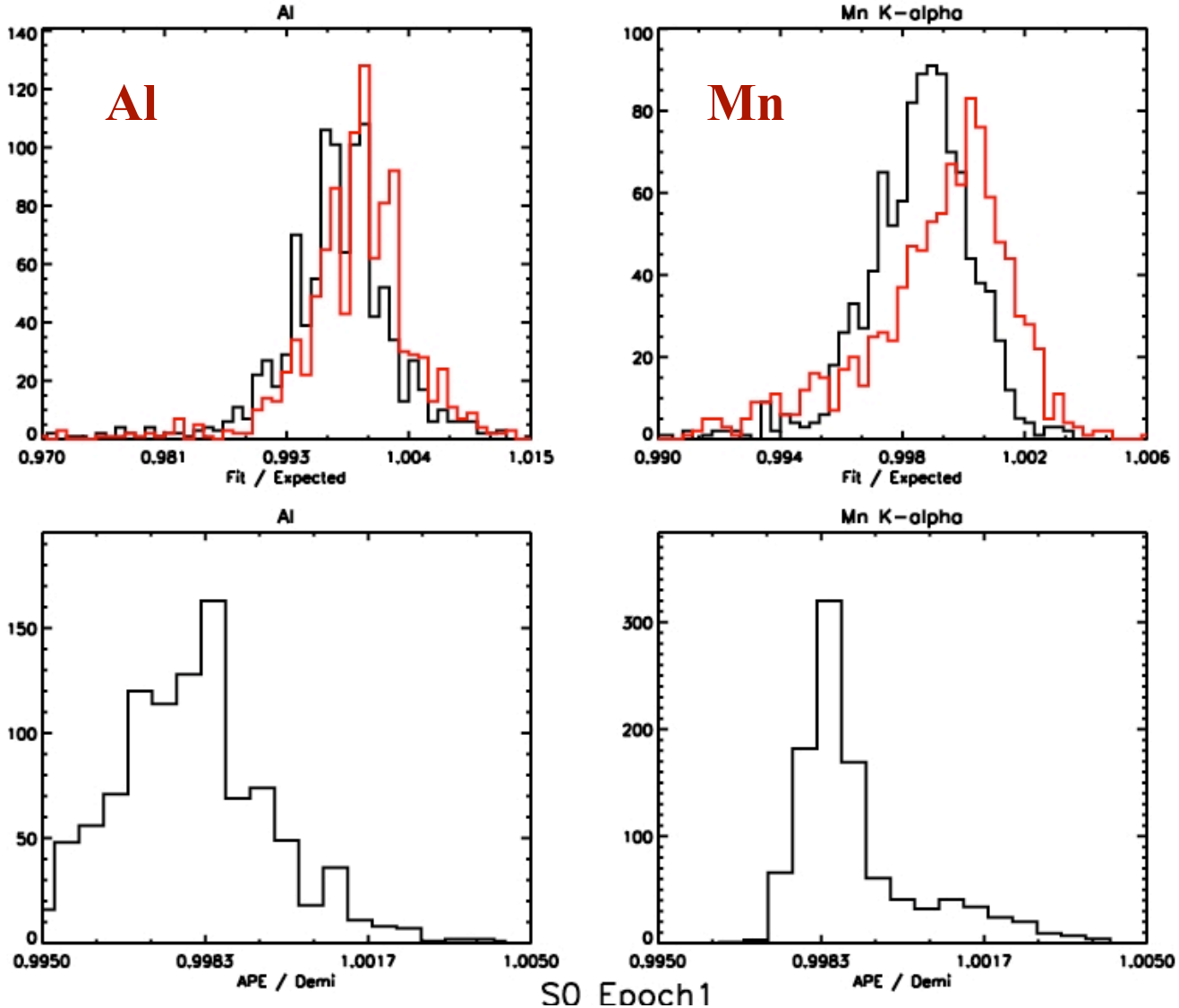

**Posson-Brown**

**(SAO)**

**Graded mode CTI correction provides most of the benefit of the Faint mode correction**

**For FI CCDs only !**

## Comparison of Graded Mode and Faint Mode Gain Calibration



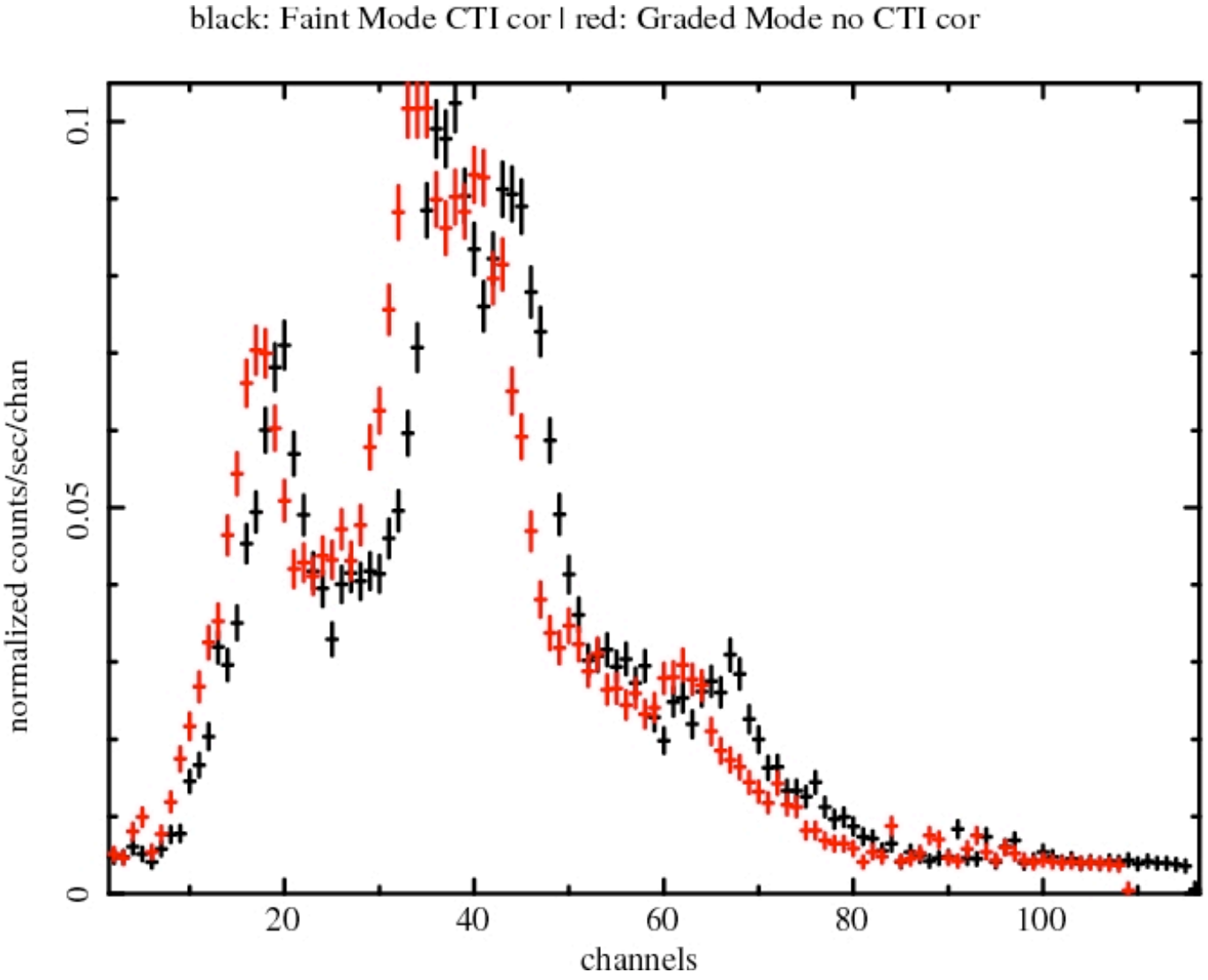

Posson-Brown (SAO)

Red: Graded
Black: Faint
Fit spectra from 1024 regions

Small gain shift between Faint and Graded mode, typically less than 0.3%, Graded > Faint

**For FI CCDs only !**

# Comparison of Graded Mode and Faint Mode CTI Correction



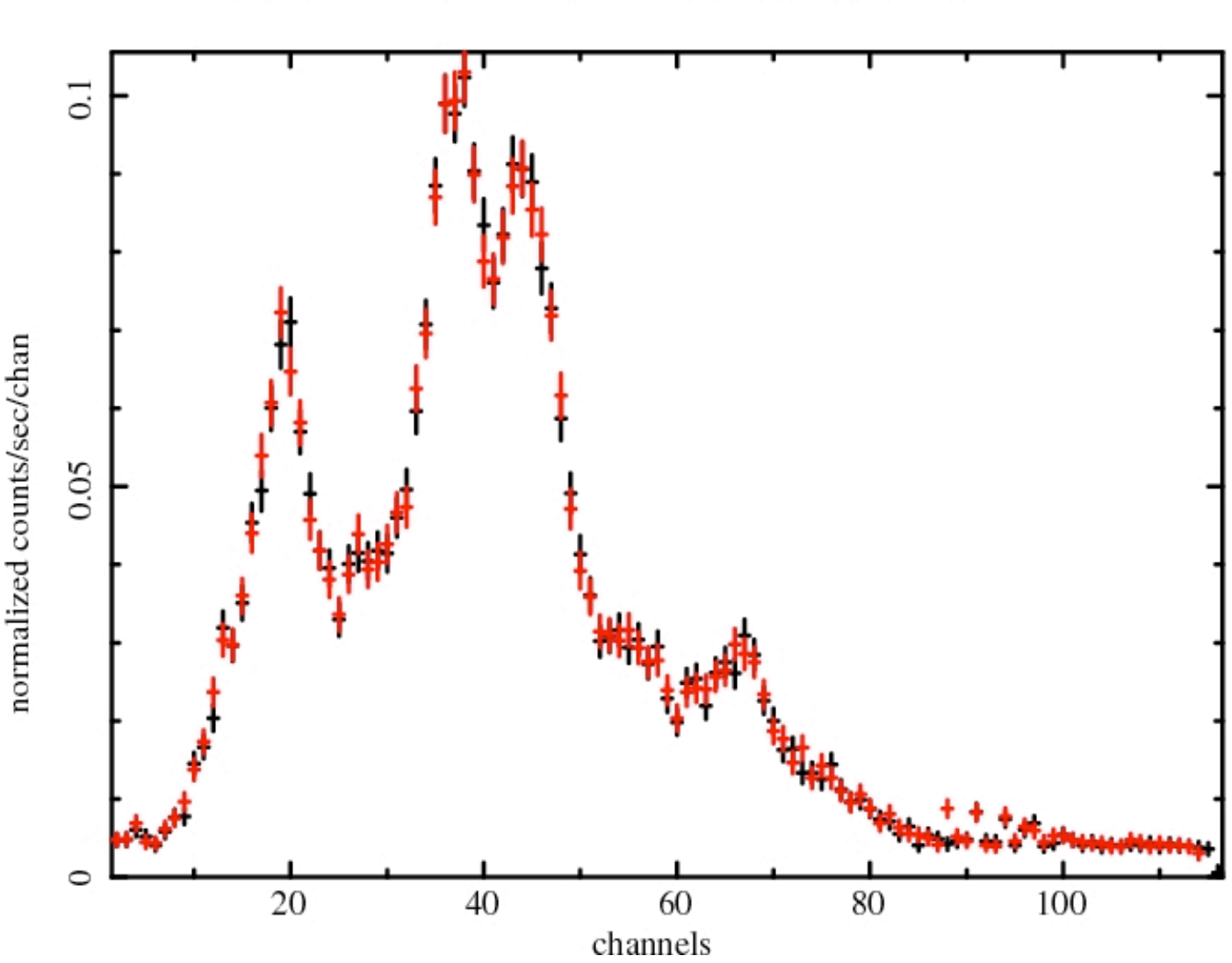

DePasquale

(SAO)

**E0102 provides a test at low energies**

**For FI CCDs only !**

## Comparison of Graded Mode and Faint Mode CTI Correction




DePasquale

(SAO)

**Graded mode CTI correction provides most of the benefit of the Faint mode correction**

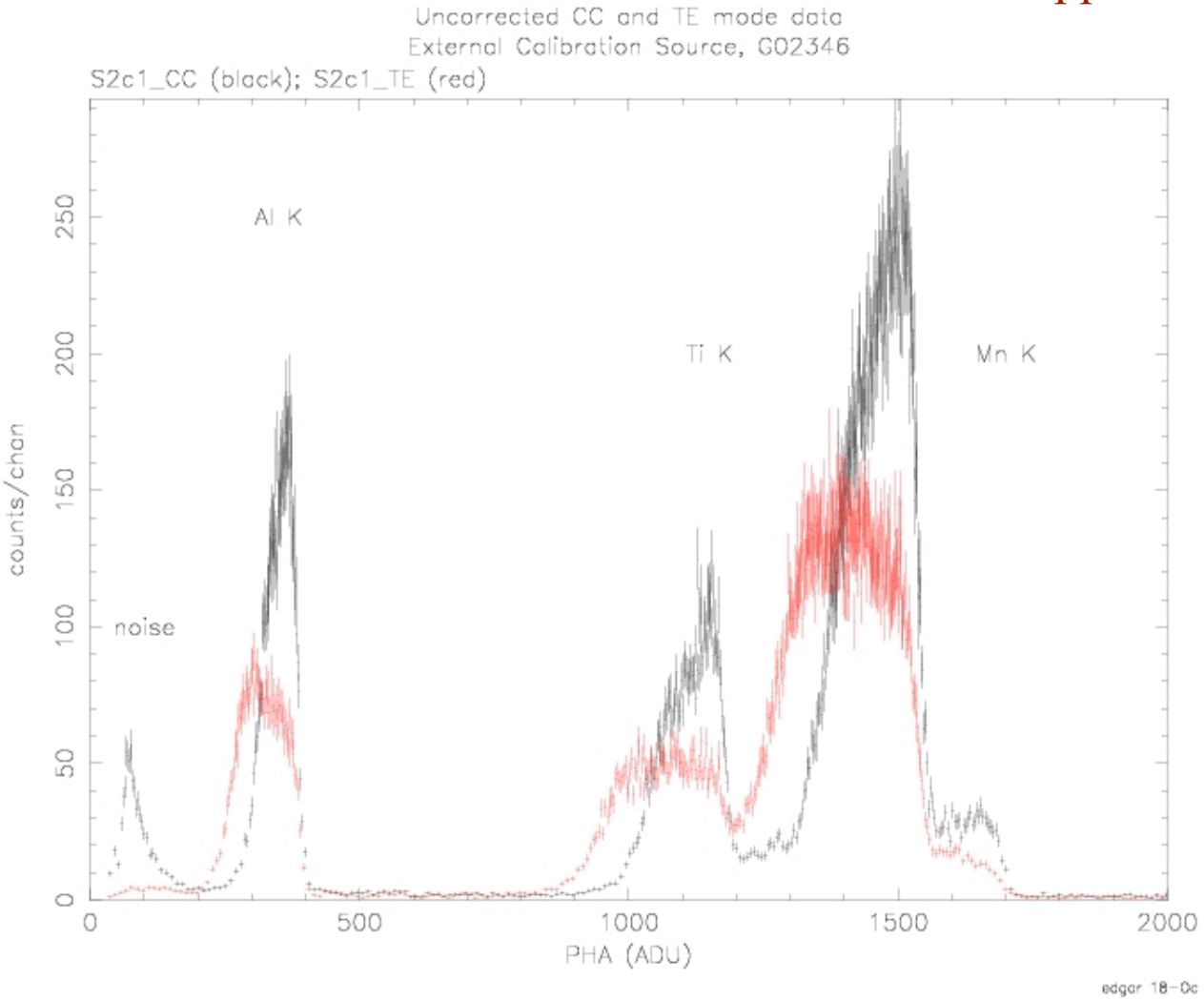
**For FI CCDs only !**

## Plan for Implementation

- approved by calibration group for development in next *CIAO* release
- requires a change to **`acis_process_events`**
- will need to be tested again after **`CIAO`** implementation
- it is expected to use all other TE Faint mode products, ie: gain, QE, QE uniformity, spectral redistribution function, etc.

# Continuous Clocking vs. Timed Exposure Mode

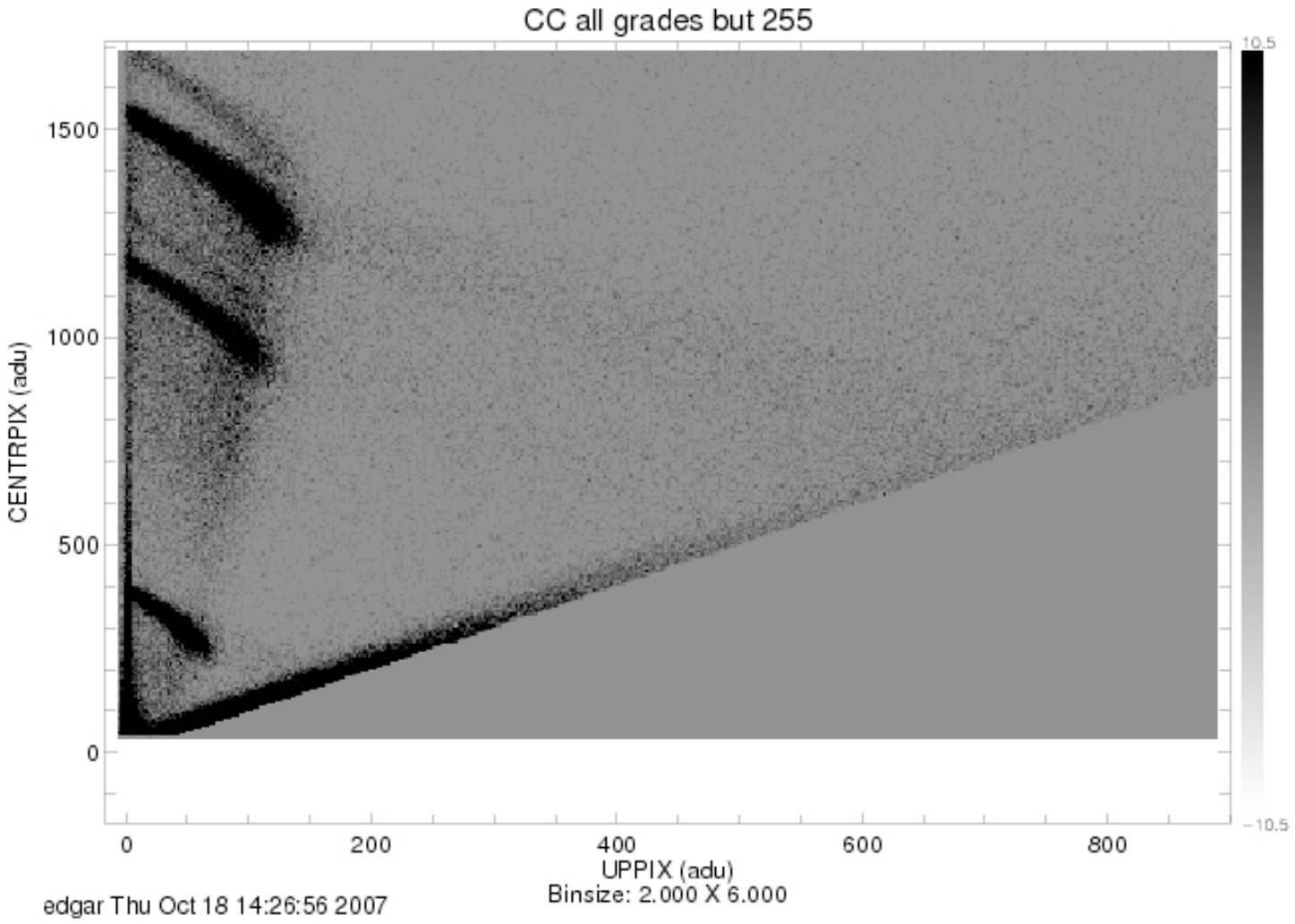
External Calibration Source: No CTI correction applied




**Edgar (SAO)**

In CC mode:
- row-to-row transfer time is different so the effects of CTI are different (2.85ms vs. 40us)
-- resulting spectra are clearly different between the two modes
-- don't know the y position of the events, but for some observations you know the y position of the source

# Continuous Clocking Mode Charge Distributions




**Edgar (SAO)**

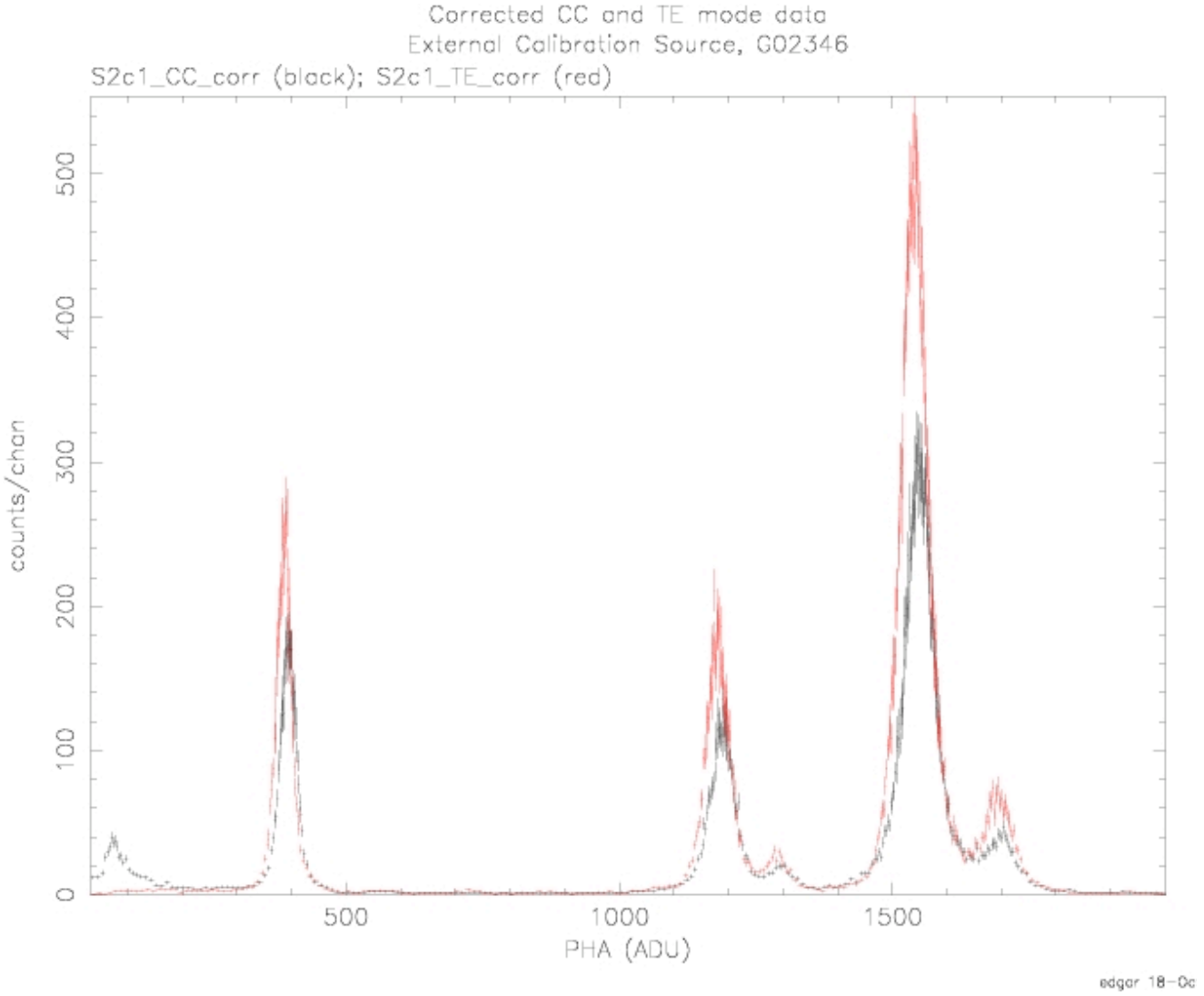
In CC mode:
-- significantly more charge in the pixel trailing the center of the event
-- some of the traps are re-emitting a large fraction of the charge within 2.85 ms

# Continuous Clocking Mode CTI Correction Algorithm

## Edgar (SAO)

- use the charge in the trailing pixel to estimate how much charge has been lost to CTI
- estimate that for every 1.0 ADUs of charge in trailing pixel that 2.2 ADUs should be added back into the central pixel and 1.0 ADU removed from the trailing pixel
- replace charge up to the maximum of the charge loss (determined by envelope of maximum charge in upper pixel)
- if the trailing pixel is within central pixel - 2X spilt threshold (26 ADUs) apply no correction
- CC mode has many more flight grade 64 events (vertical splits) and grade 66 events (3 pixels in vertical split)

# Continuous Clocking vs. Timed Exposure Mode



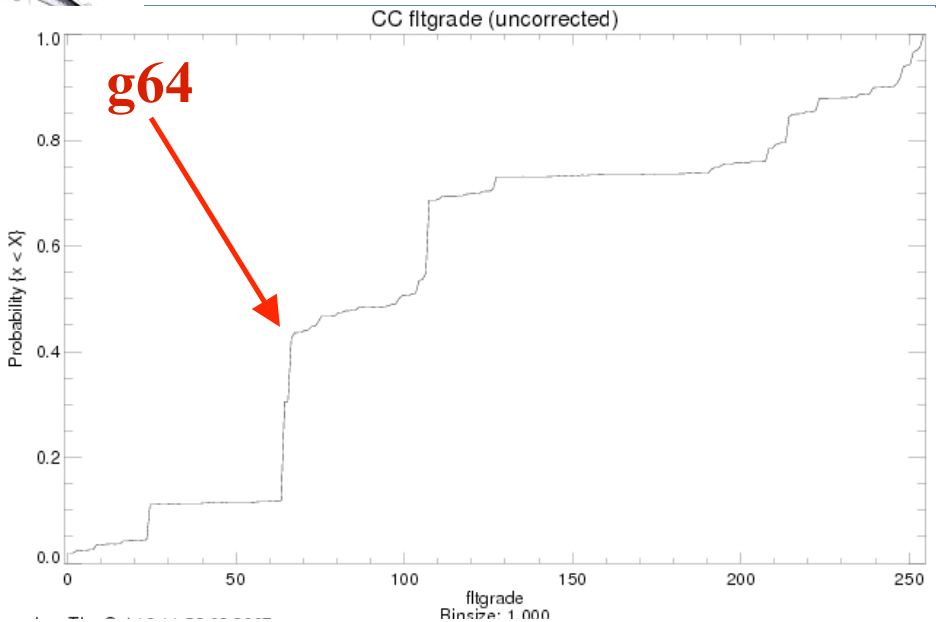

**Edgar (SAO)**

Black - CC mode with CTI correction

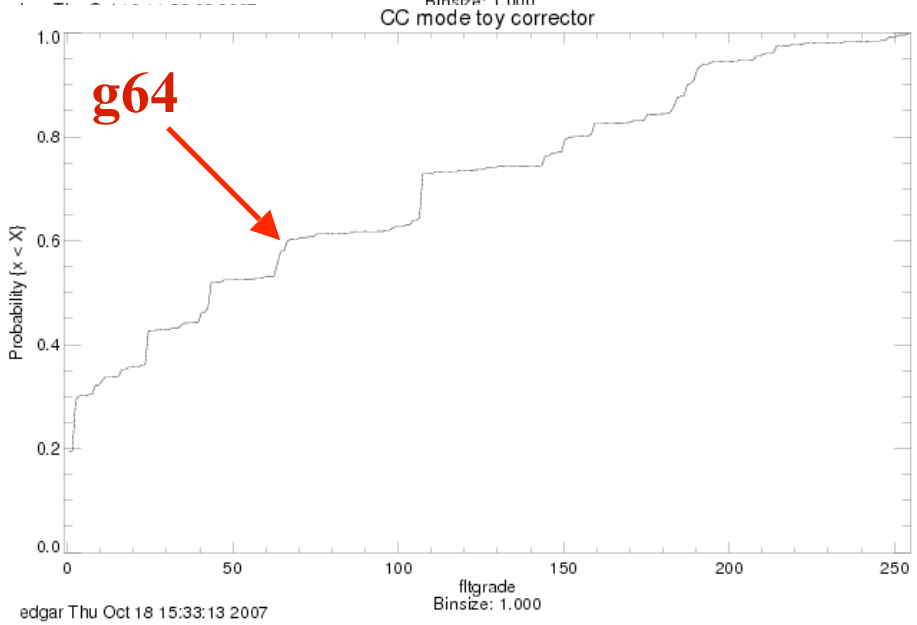
Red - TE mode

-- small gain shift, CC > TE

-- resolution looks comparable




CC Mode - Uncorrected, Large percentage in g64 events




CC Mode - CTI corrected, Grade distribution more similar to TE mode

**Grade Distributions in CC Mode**

Edgar (SAO)

## Continuous Clocking Mode Calibration

**Open Questions:**

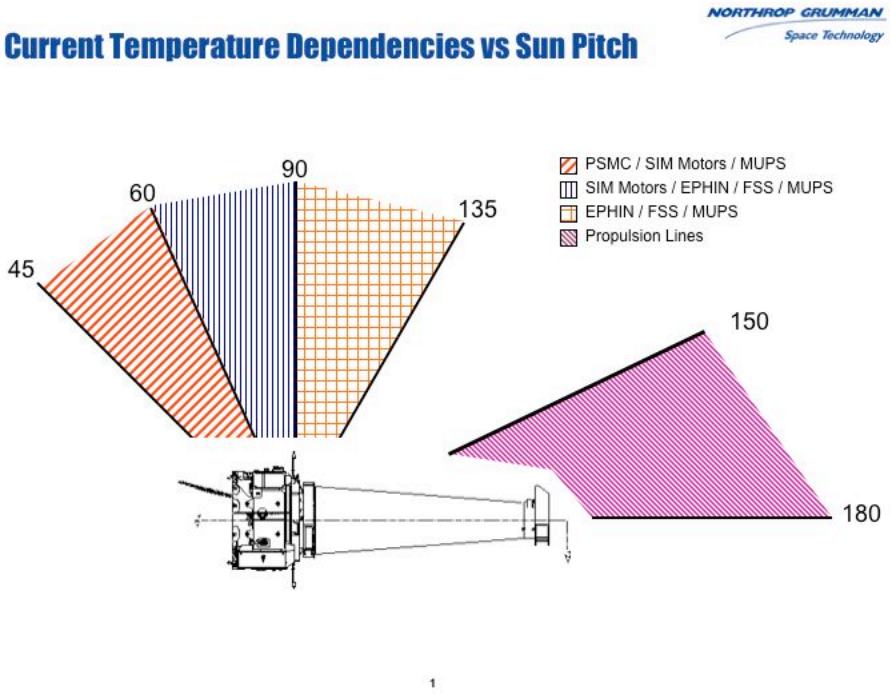
- **spectral redistribution function, looks similar to TE mode**
- **gain, small shift needs to be calibrated**
- **QE and QE uniformity**
- **some real X-ray events end up in g66 events which are currently rejected on-board**
- **some "bad" events transform into "good" events**
- **for gratings observations, make use of chipy information from dispersed arms**

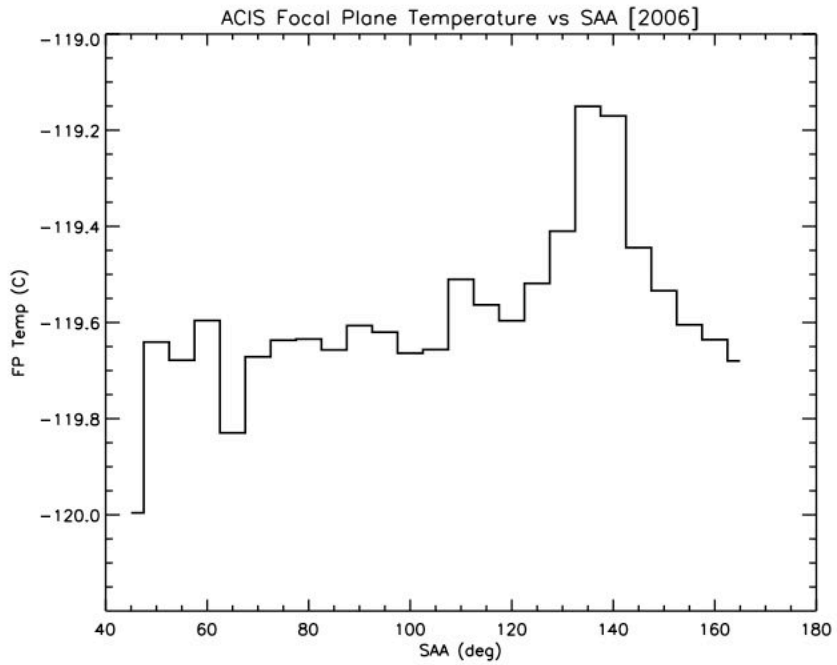
## Census of ACIS Modes and CTI Correction

| Mode | Corrections/Calibrations | |
|---|---|---|
| TE Faint | CTI correction for all 10 CCD | **Most commonly used modes** |
| TE Very Faint | CTI correction for all 10 CCD | |
| TE Graded | Prototype CTI correction for 8 FI CCDs<br>BI CCDs use spatial gain correction | **Used with gratings mostly** |
| CC Faint | Prototype CTI correction for 8 FI CCDs<br>?? BI CCDs ?? | **Timing mode & with gratings** |
| CC Graded | ?? Hybrid approach of Vikhlinin graded mode correction and Edgar CC CTI ?? | **Used with gratings mostly** |

## Focal Plane Operating Temperature

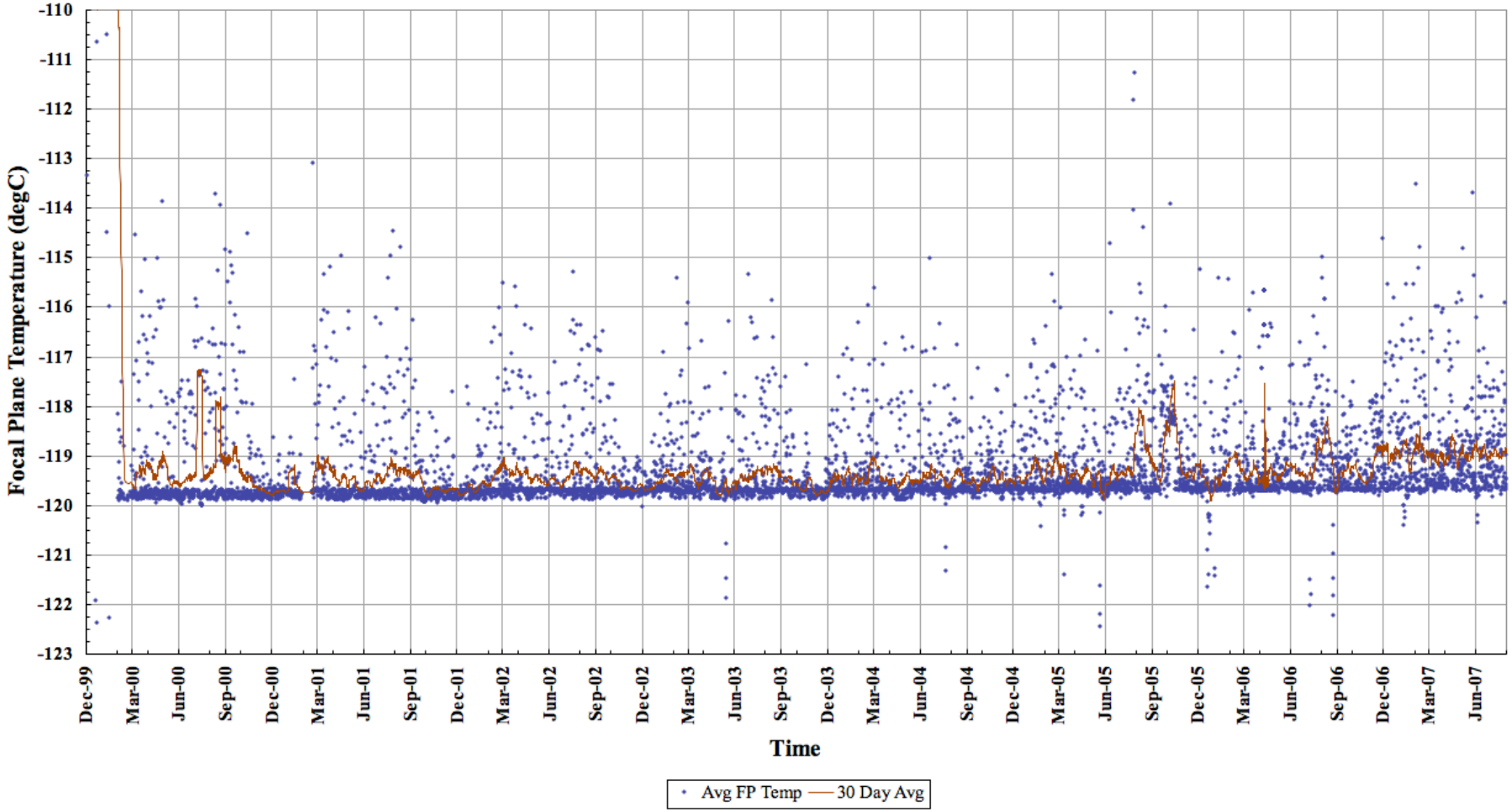
- current operating temperature is -119.7 C
- as the mission has progressed, the frequency and magnitude of deviations from the desired temperature have increased
- it might become necessary to operate at a higher temperature, significant impact for the FI CCDs



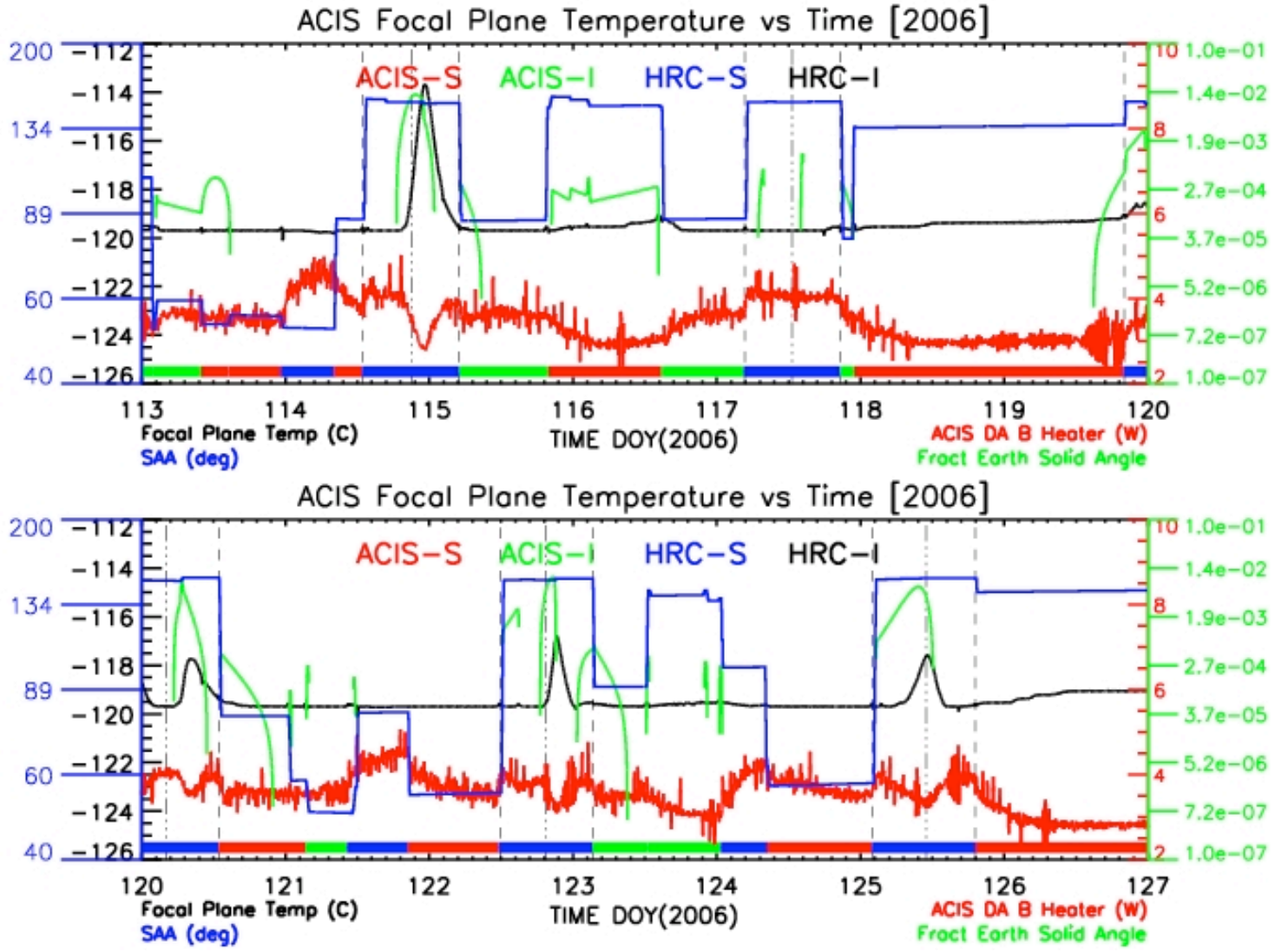



# Focal Plane Temperature Over the Course of the Mission

**Blue: 8 hr averages  Red 30 day running average  Bissell (NGST)**



## Focal Plane Temperature and Spacecraft Orientation




DePasquale (SAO)

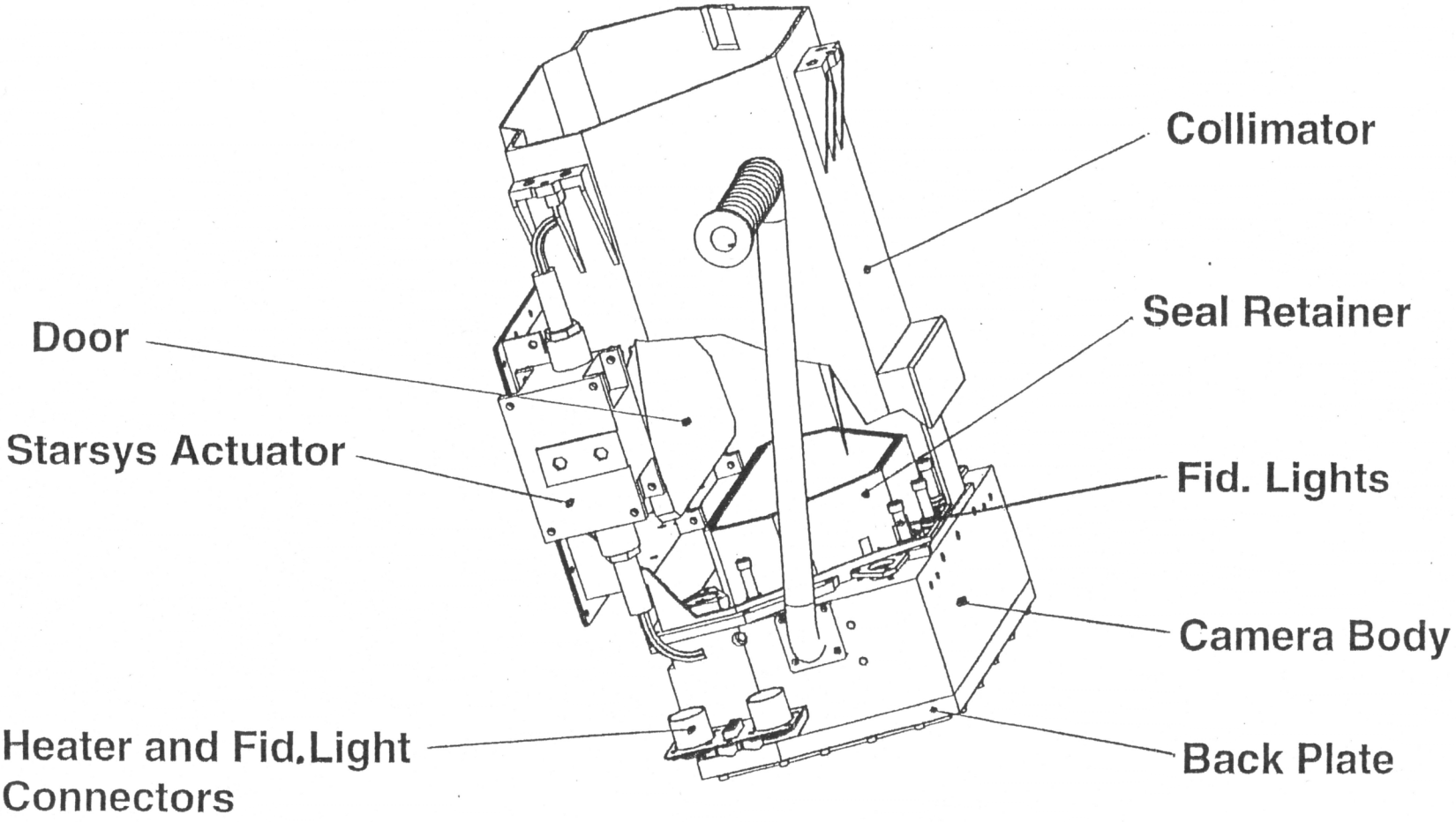
Blue: pitch angle

Black: FP temperature

Green: Earth solid angle

Red: ACIS DH heater power

## ACIS Detector Housing and Camera Body

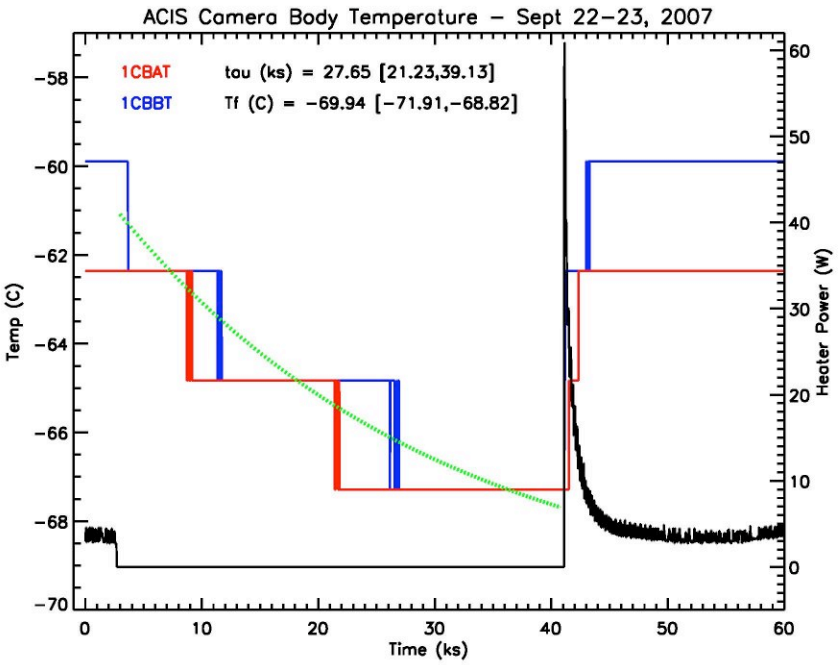


# DH Cooling Tests: Test #1

**Red: side A Camera Body T**

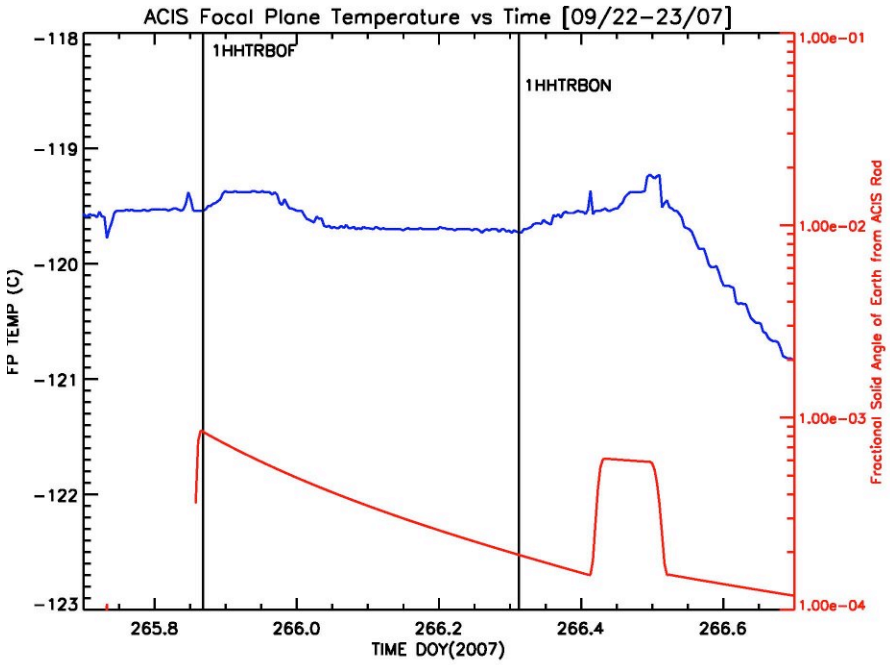
**Blue: side B Camea Body T**

**Black heater power**




**Red: Earth Solid Angle**

**Blue: FP Temperature**

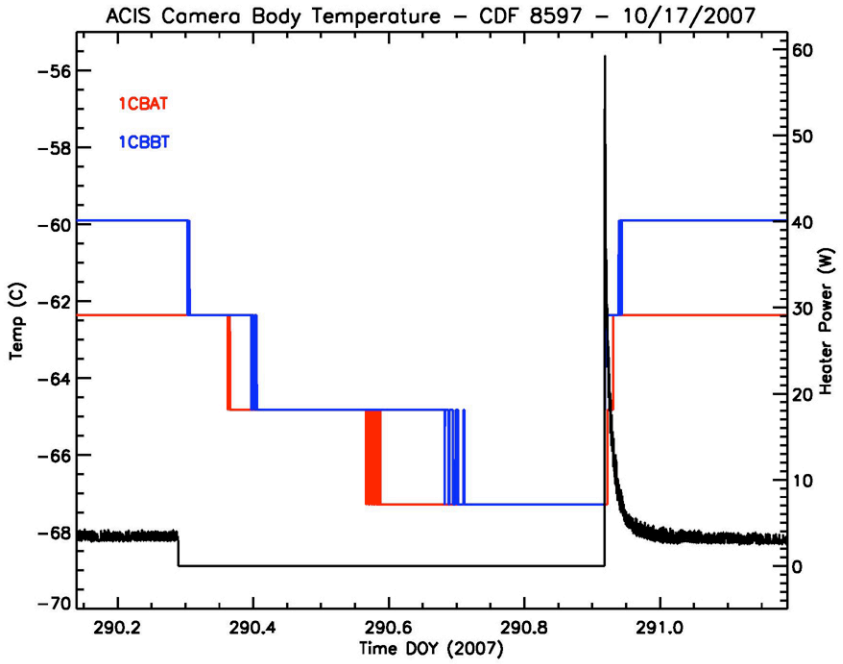


# DH Cooling Tests: Test #2

**Red: side A Camera Body T**

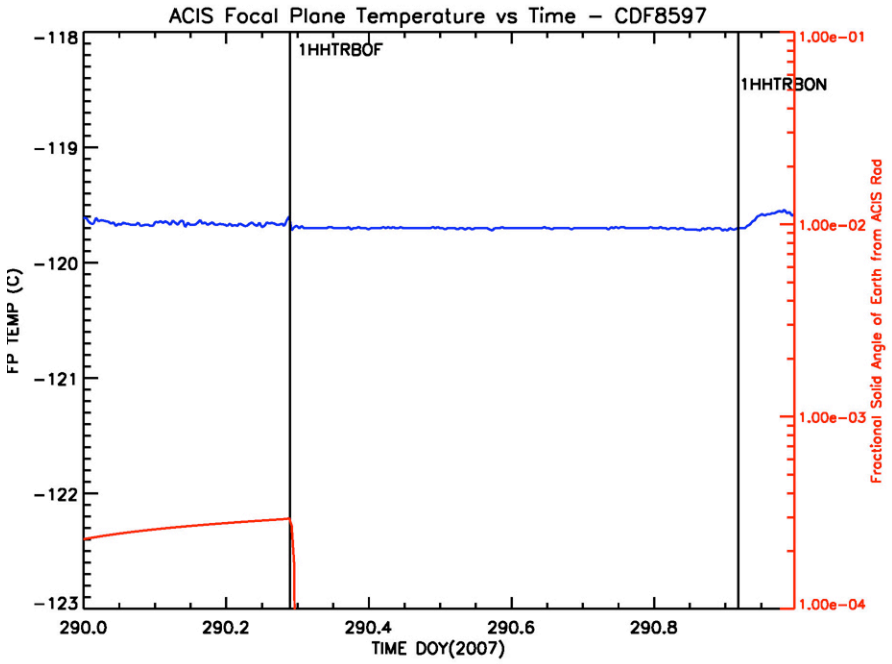
**Blue: side B Camea Body T**

**Black heater power**




**Red: Earth Solid Angle**

**Blue: FP Temperature**



# Motion of Fidiucial Lights as the Camera Body T Changes

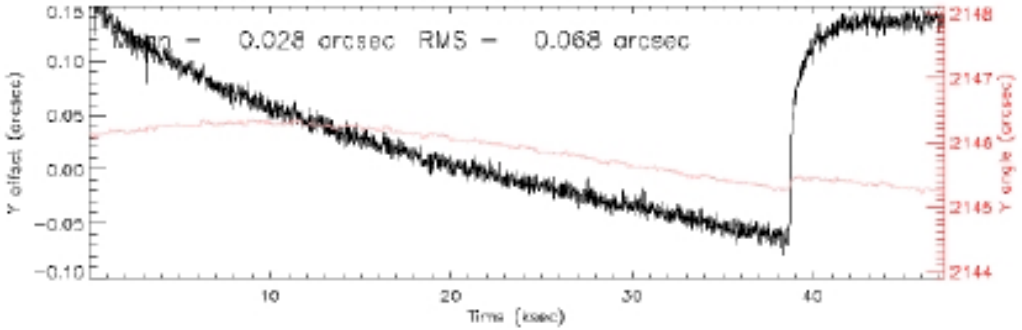
**Aldcroft (SAO)**

**Black - residuals from common motion**

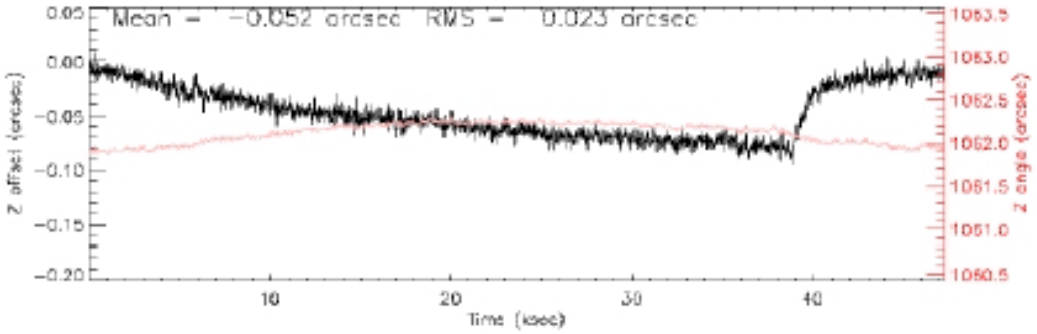
**Red - image centroids**

***Fid Light brightness is the most sensitive thermometer !***

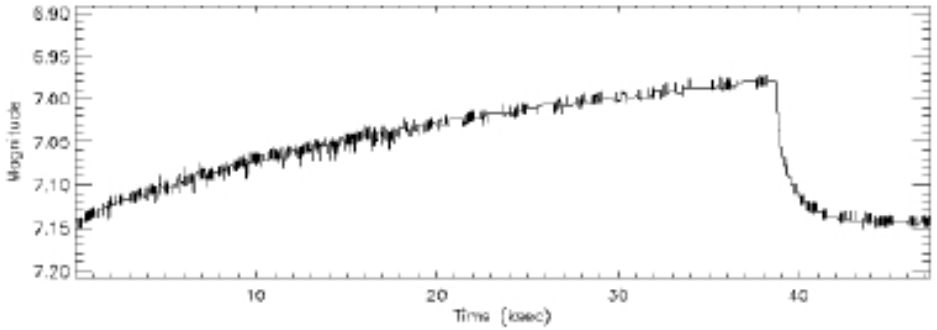
**Y motion**




**Z motion**




**Brightness**



## Focal Plane Operating Temperature: Future Plans

- develop an aspect correction which accounts for motion of Fid Lights during an observation
- implement this correction in the **CIAO** pipelines
- conduct longer tests in colder orientations to determine that the survival heaters turn on as expected and keep ACIS and the Fid Lights in a safe temperaure range
- turn off the DH heater for the rest of the mission
- hopefully this will provide many years of a cold (-119.7 C) and stable FP temperature