# ACIS Update

*Chandra Users Committee September 28, 2023*

# ACIS Overview



## *ACIS continues to function nominally and produce high quality data*

Steiner (SAO)

- All 10 CCDs are fully functional
- Electronics are nominal, primary units are still in use
- Flight software is nominal, modified 8 times after launch for bug fixes and enhancements
- Over 90% of GO & GTO observations use ACIS

### Cycle 23 GO & GTO Observing Statistics

| Instrument | Grating | # of Obs | % of Obs | Time(ks) | % of Time |
|---|---|---|---|---|---|
| ACIS-I | NONE | 296 | 30.3 | 5700 | 33.4 |
| ACIS-S | NONE | 556 | 57.0 | 9056 | 53.1 |
| ACIS-S | HETG | 75 | 7.7 | 1638 | 9.6 |
| Total | | | 95.0 | | 96.1 |

## Future Challenges:

- ACIS is now the only radiation monitor
- Contamination layer continues to accumulate, further degrading the low energy response
- Warmer electronics temperature limit dwell times and # of active CCDs
- Warmer focal plane temperatures degrade the spectral response

# ACIS Flight SW Update



- Flight SW updated on 19 September 2023, 8th modification since launch
- Four "patch loads" were included in this update:
  1. Alternating Exposure Mode bias computation bug fix → *GO impact*
  2. SW reports that science is idle when all video boards are powered off
  3. SW reports more diagnostic information when the BEP reboots due to a bus error
  4. SW forces a new bias map computation when a FEP has been powered off before the current science run

  } *minimal or no GO impact*

## Alternating Exposure Mode:

- Allows the Observer to specify two different CCD frametimes for an observation
- Typical use is one short frametime and N long frametimes
- **WARNING:** if the short exposure is smaller than the minimum exposure required to read out all selected pixels, there will be **deadtime**
- The bug is a possible infinite loop during the bias computation
- The bug has been present since launch, the observation that triggered the bug had one short exposure and one long exposure
- 165 alternating exposure mode runs have been executed in the mission
- This mode is rarely selected by GOs at this point in the mission due to the **deadtime** issue, two runs in Cycle 15 and only one since Cycle 19
- The CXC put a moratorium on alternating exposure mode runs until the patch was active, the moratorium has now been lifted

# ACIS Flight SW Update

## Chandra OCC: 19 September 2023, 8pm-10pm EDT

# ACIS Flight SW Update


**Gregg Germain (SAO)**

**John ZuHone (SAO)**

**Jack Steiner (SAO)**

**Jim Francis (MIT)**

# ACIS Flight SW Update

**Ken Gage**
**(NGST)**

**Paul Plucinsky**
**(SAO)**

**Mark Bautz**
**(MIT)**

**Catherine Grant**
**(MIT)**

# ACIS Flight SW Update

- Flight SW update execution was smooth
- The entire team (ACIS Ops, MIT flight SW, FOT) put in a lot of preparation to make this smooth execution possible
- But ***most*** of the credit goes to Peter Ford who was on-line supporting the activity remotely
- This patch and all other ACIS patches were developed by Peter and Jim
- The entire Chandra team owes our gratitude to Peter for developing and maintaining the ACIS flight SW for 24 years !!

**THANK YOU PETER !!!!!**

**Peter Ford (MIT) circa Aug 1999**

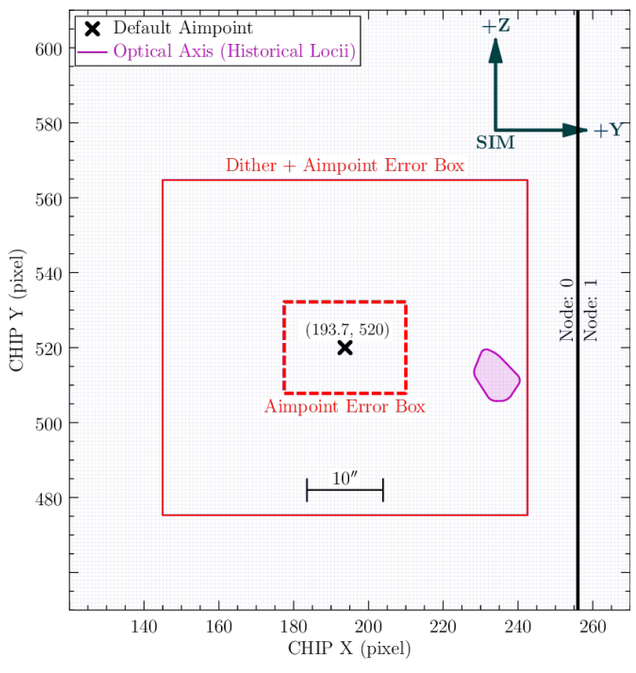
# ACIS Default Dither Parameters

## ACIS default dither has doubled since Oct 2022

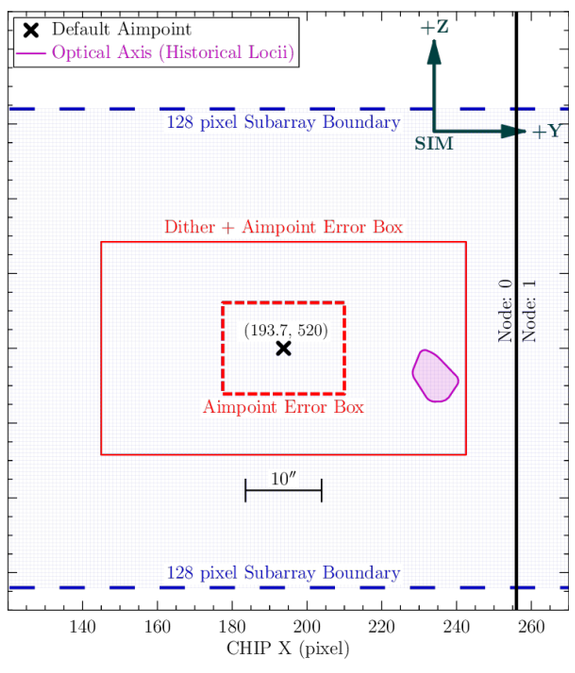
- **Improves ACA performance**
- **Lowers dosing accumulation near aimpoint on ACIS**
- **New dither is 32”x32” full-amplitude for full frame observations or subarray >128pix**
- **Pattern-period has doubled to 2ks and 1.4ks for y and z axes, preserving slew rate**
- **Dither is halved along short-axis for 128pix subarray**
- **No expected impact on GO observations**

**Figures 4.27-4.30 from the Proposers Guide**

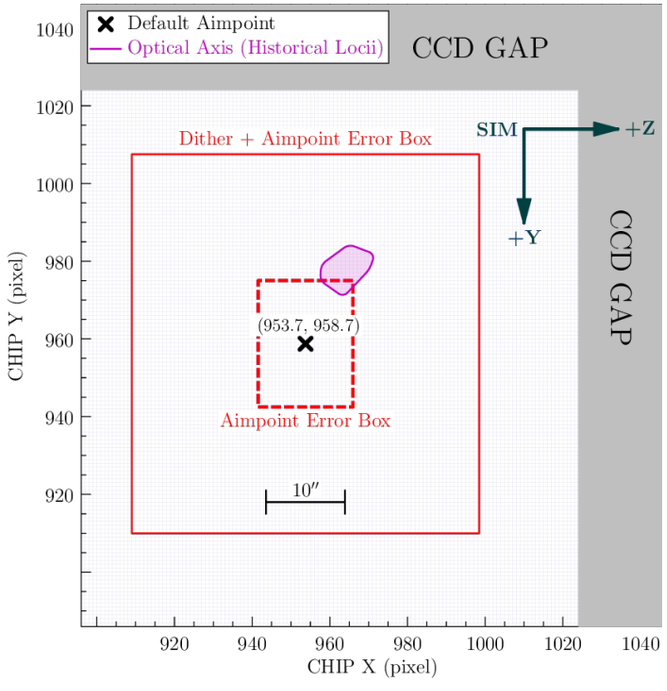
S3: Full Frame



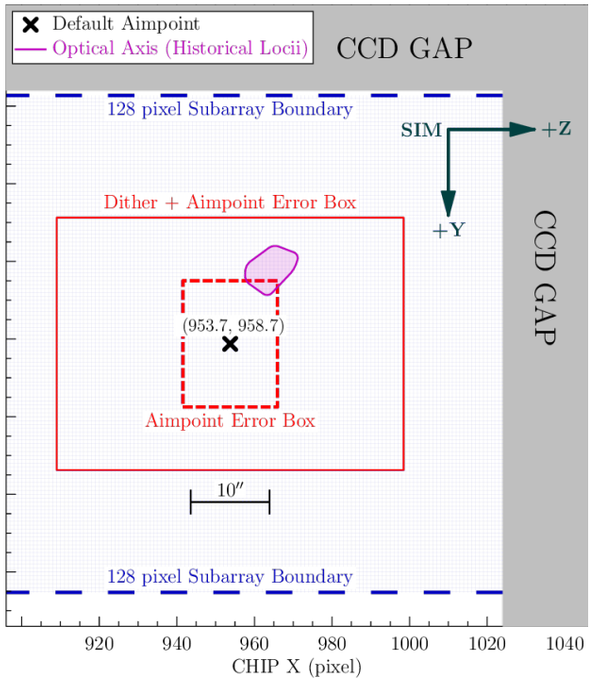

S3: 128pix subarray




I3: Full Frame




I3: 128pix subarray



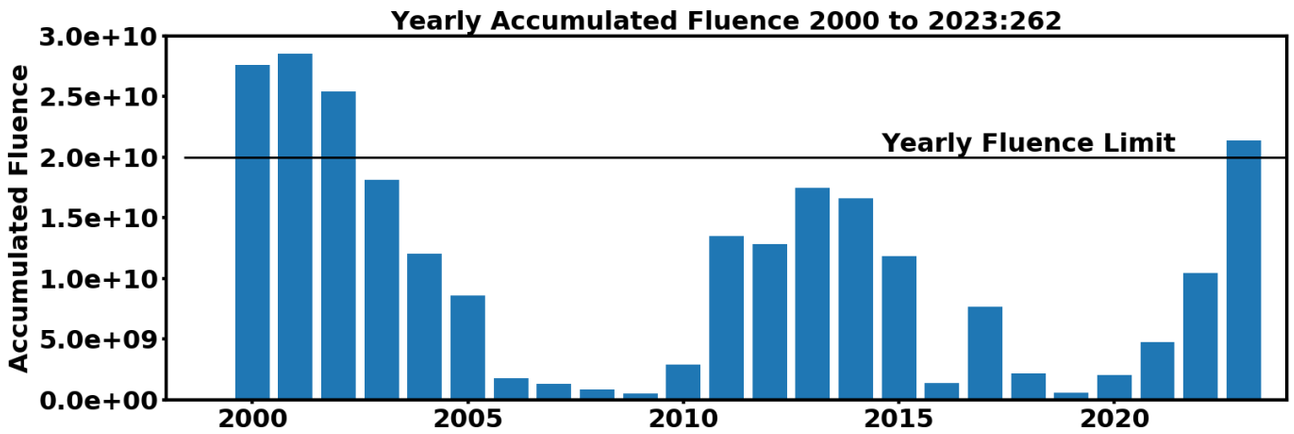
# ACIS Radiation Monitoring

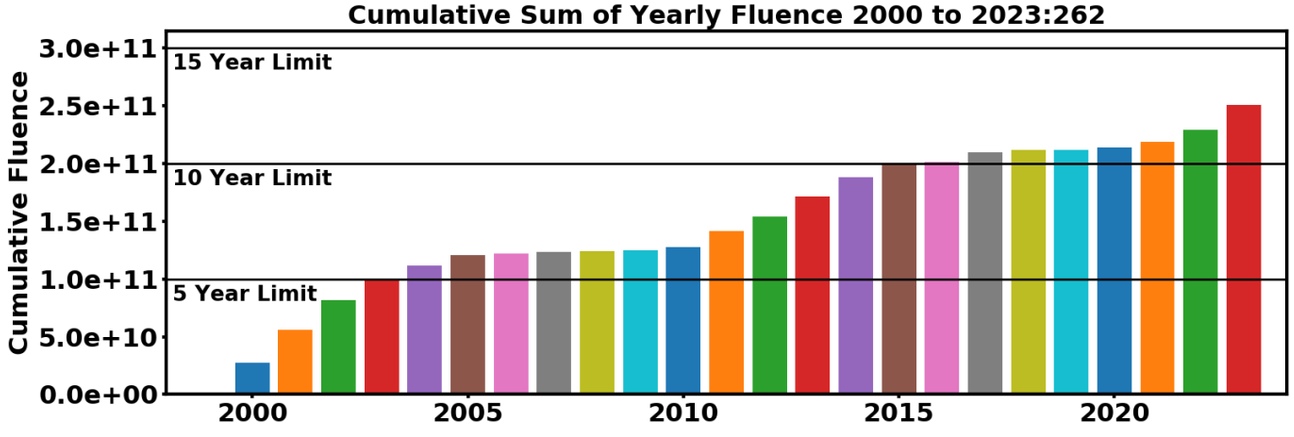
CXC

- ACIS is now the only radiation monitor on Chandra
- Solar Cycle 25 is predicted to peak in late 2024 or early 2025
- There are have been three manual radiation safing actions, and no autonomous safing actions in 2023

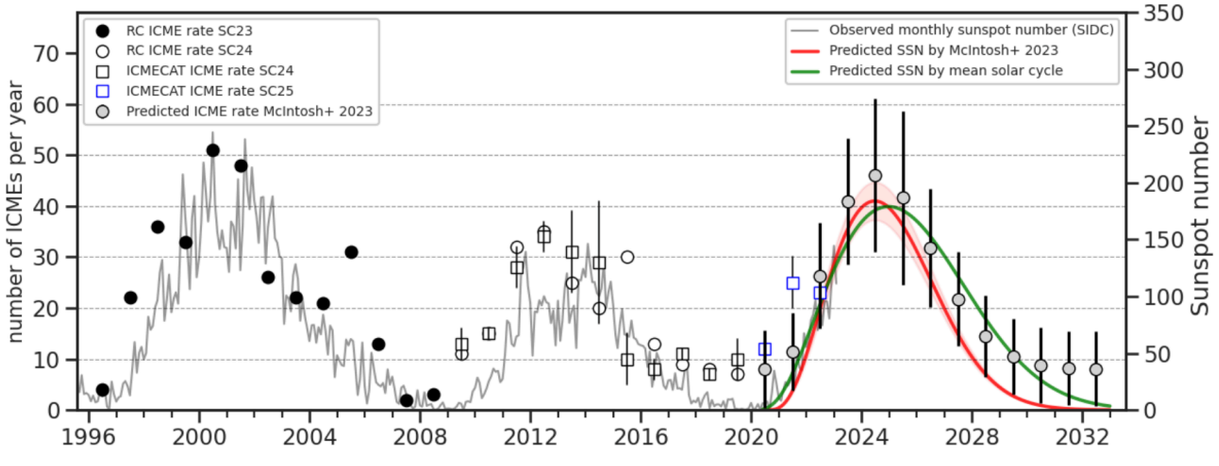
Germain (SAO)

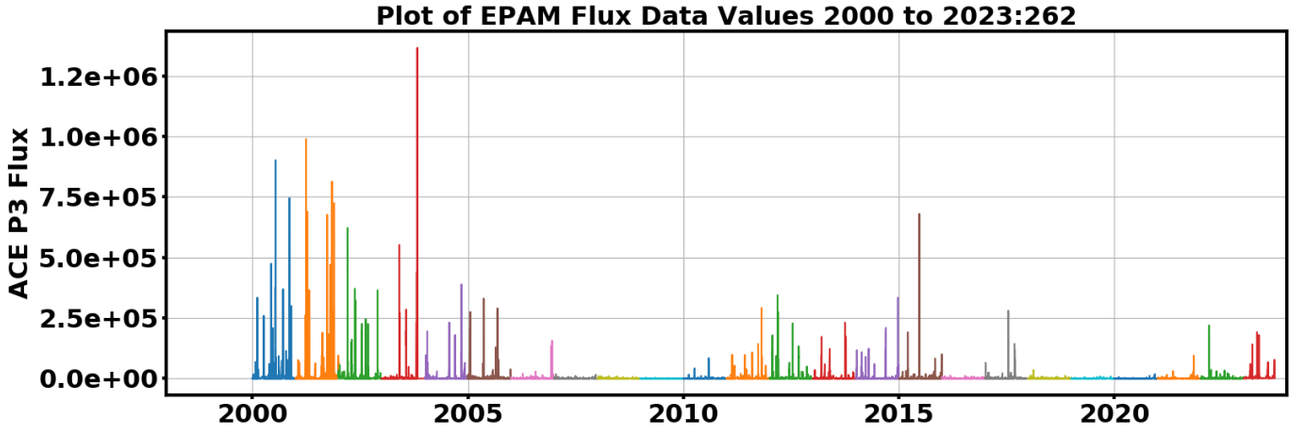
- Fluence on ACIS this year is approaching the highest values seen in previous years
- ACIS can not be as sensitive a radiation monitor as the EPHIN instrument was




https://helioforecast.space/solarcycle



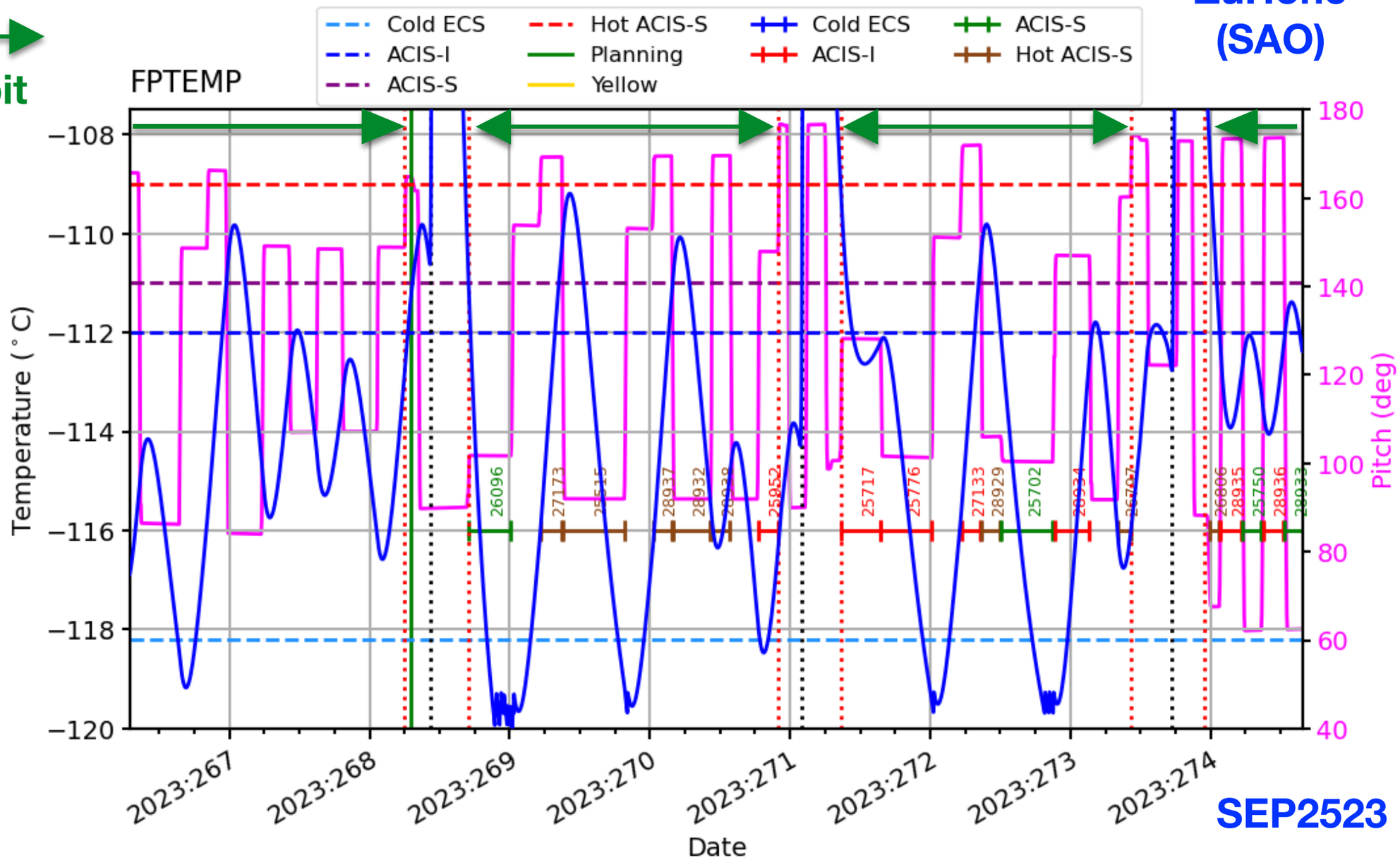
# ACIS FP Temperature Limits

- **-109 C ACIS-S and ACIS-I imaging observations that do not benefit from the most accurate spectral response**
- **-111 C ACIS-S observations that *do* benefit from the most accurate spectral response**
- **-112 C ACIS-I observations that *do* benefit from the most accurate spectral response**
- **-105 C ACIS-S/HETG observations with a SIM Z offset of -6.0 mm or more negative such that the dispersed spectrum is closer to the readout [Not implemented yet]**

**Science Orbit**

- **FP temperature is almost always increasing or decreasing**
- **KEY POINT: almost all of a GO observation will be executed with a FP temperature *less* than the limit**
- **Calibration files account for this variable FP temperature**

**ZuHone (SAO)**

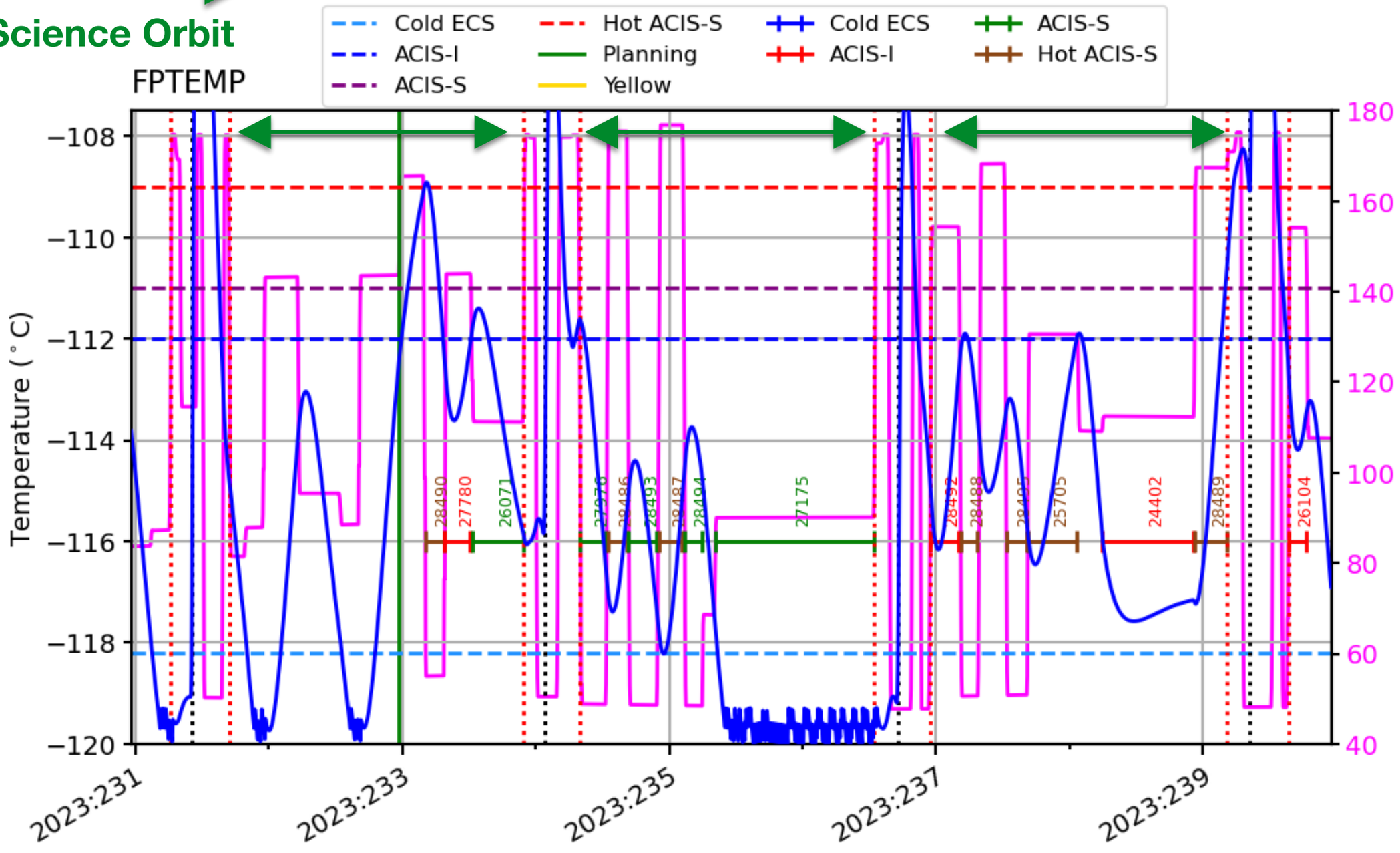



**SEP2523**

# ACIS FP Temperature Limits

- relaxation of ACA temperature limits have allowed longer dwells at pitch angles around 90 degrees which benefits the ACIS FP temperature and electronics temperatures
- OBSID 27175 in the AUG2123 week was a 101.6 ks observation at a pitch angle of ~90 degrees for which the FP temperature was at -119.7 C for almost the entire observation

Science Orbit



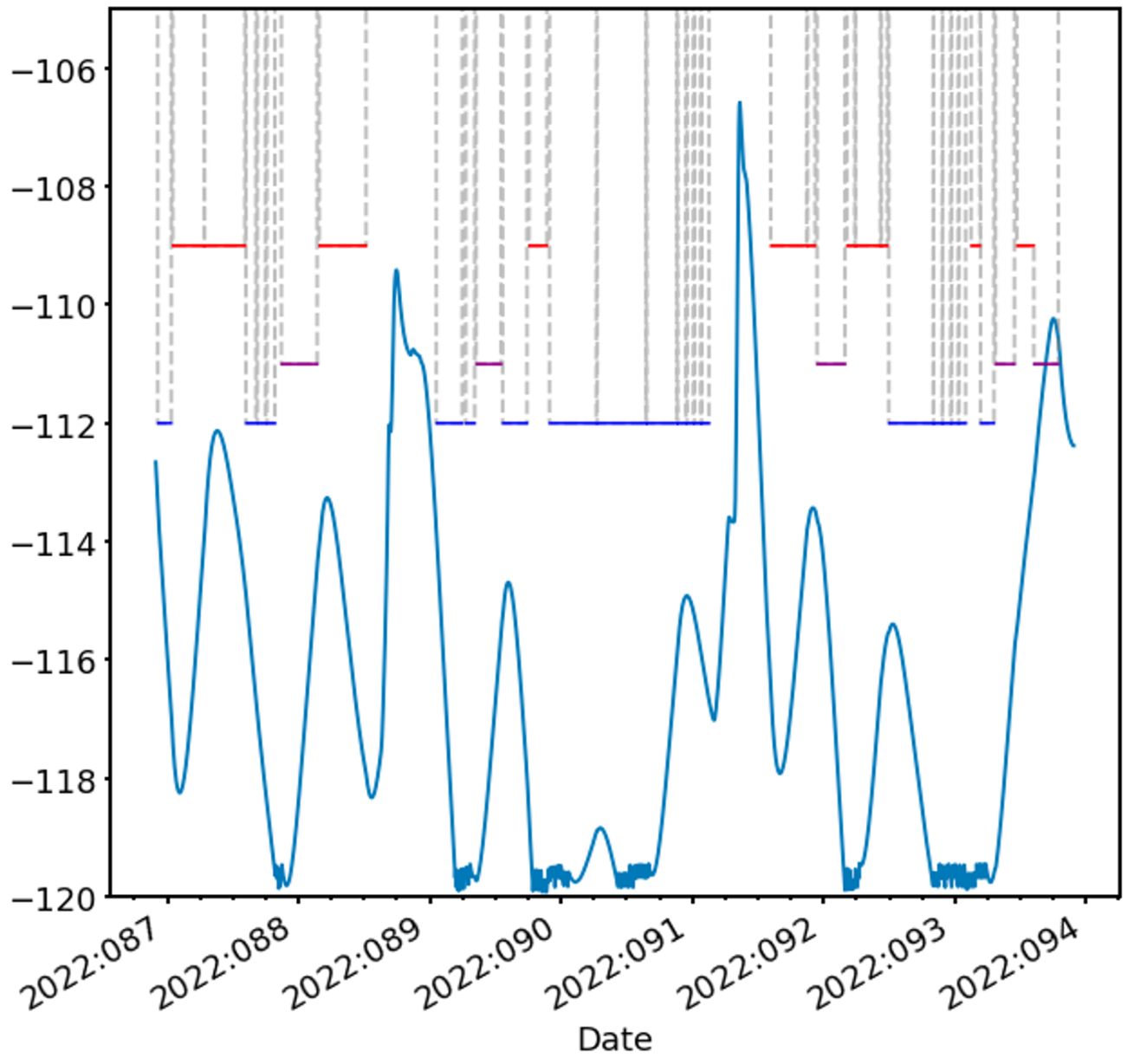

ZuHone (SAO)

AUG2123

# New Temperature Limit Handling Package

- **Thermal limits are becoming more complicated and varied—many are dynamic, changing with spacecraft state**
- **A new limits infrastructure package has been developed, chandra_limits, that provides a simple and unified interface to thermal limits that will be used across the project, in a variety of scenarios and levels of planning**
- **Handles limit plotting, violations checking, etc.**
- **Currently working on interfaces to the SOT program acis_thermal_check and the FOT Matlab tools**

**ZuHone (SAO)**

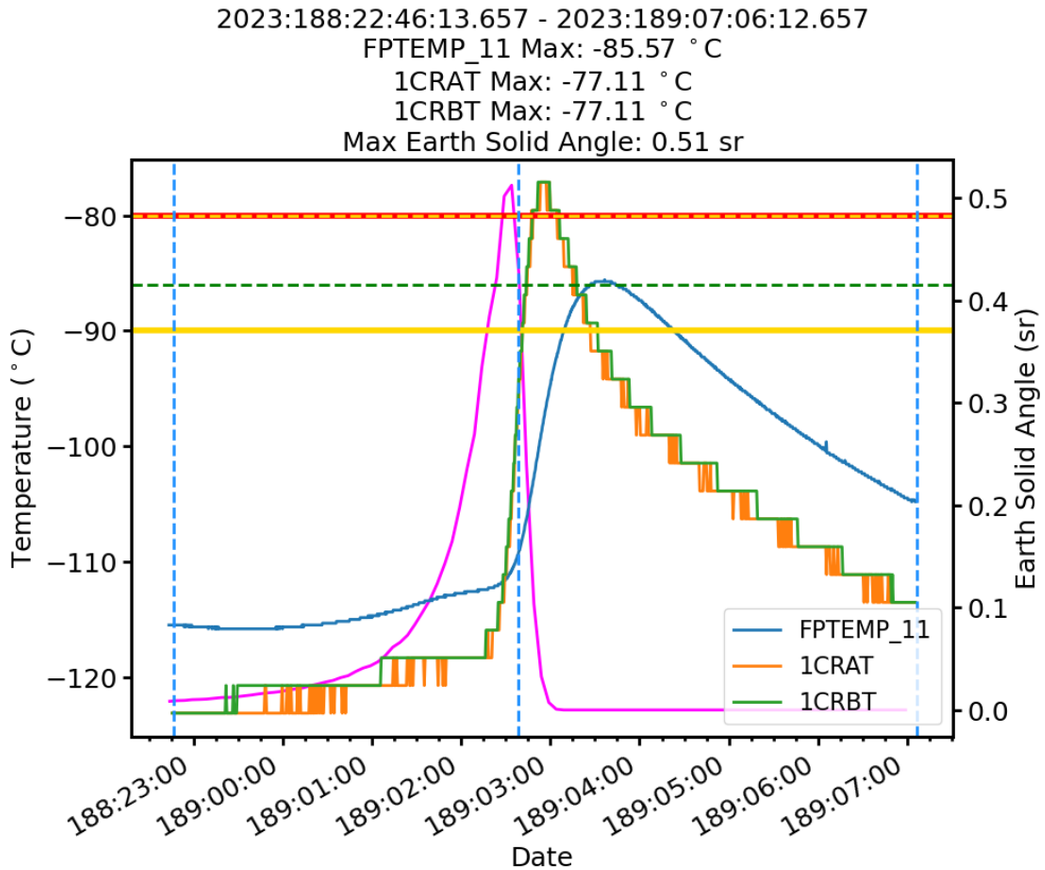


# ACIS FP Temperature During Perigee Passages

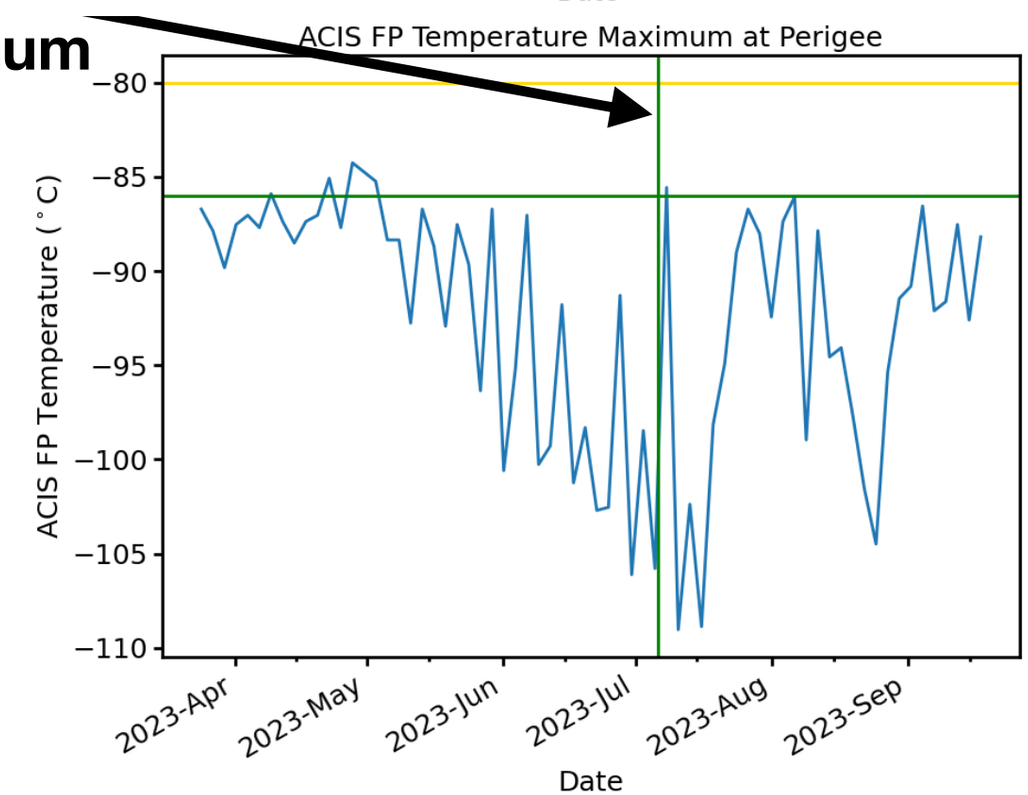
CXC

- **The ACIS FP temperature significantly increases during radzones due to earthshine in the ACIS radiator FOV—this was exacerbated recently as we passed low perigee**
- **We want to keep the ACIS FP temperature below -80 C to avoid increase in CTI**
- **The ACIS FP thermal model has a 6 C buffer against this -80 C limit, and we are running up against this buffer frequently in planning now, but this is successfully keeping us away from -80 C**
- **ACIS Ops continues to monitor the performance of the model and the data at every passage**

**ZuHone (SAO)**




**perigee minimum**



# Low Input Voltages during Perigee Passages

CXC

- **ACIS Input voltages have dropped below their Yellow Low limits during a recent perigee passage**
- **There is long term, slow degradation in the solar array output**
- **In addition, there are short term (~minutes) decreases in solar array output due to heating of the arrays during perigee passages**

**Germain (SAO)**

- **Yellow Low limit = +24.5 V**
- **Red Low limit = +22.0 V**
- **The concern is that the ACIS electronics may not function as expected if the input voltage were to drop below +22.0 V**

**Bissell (NGST)**