## CUC Report Sep 28, 2023

### CUC Members

**In-person**
Kristin Madsen (Chair)
Anjali Gupta
Silas Laycock
Dave Pooley
Takanori Sakamoto
Tea Temim
Chris Fryer
Brian Williams
Marcella Brusa

**Remote**
Tesla Jeltema

Link to slides: Presentation Slides
Link to summaries: Summaries of Presentations

# Meeting Summary

The Chandra Users Committee (CUC) meeting was held in-person at the Chandra X-ray Center (CXC) at SAO on September 28 and 29 (half day), 2023. Nine of the committee members were in person and one remote. The agenda was as follows on the 28th, with the talk by Mark Clampin as given in-person, and on the 29th the CUC discussed what was presented and deliberated on the recommendations.

Schedule:
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09:00 Introduction *Antonella Fruscione*
09:05 Chandra Status Report *Mark Weber*
09:55 Proposal Cycle and Future Plans *Rudy Montez*

10:30 Morning Break

11:00 NASA HQ Update *Mark Clampin [closed session for CUC only]*
11:45 Director's Report *Pat Slane*

12:30 Lunch

13:30 Mission Planning Update *Ewan O'Sullivan*
14:10 Calibration: Goals, Priorities, and Plans *Larry David*
14:50 CIAO Update *Jonathan McDowell*

15:30 Afternoon break

16:00 HRC Update *Dan Patnaude*
16:20 ACIS Update *Paul Plucinsky*
16:40 Chandra Source Catalog & Data Systems Initiatives *Rafael Galarza*
17:15 SDSS-V and NHFP Project Update *Paul Green*

# Top level summary of concerns and recommendations

The presentations delivered by the CXC to the CUC made it clear that Chandra operations are at a very critical juncture in time. The spacecraft and instruments are healthy and the GO program as vibrant (and oversubscribed) as ever, but the expected cuts in the NASA budget are now at a level where they will begin to affect the operations adversely. Prior to the CUC meeting, the CUC wrote a letter of support for the CXC, highlighting how such cuts are going to affect our community, and advocating for maintaining the funding at the minimum level as was requested in the Senior Review 2022. Unfortunately, the CXC will not be receiving funding at the level requested, and the Astrophysics Division Director of the Science Mission Directorate at NASA Headquarters, Mark Clampin, came in person to explain to the CUC how NASA has been forced to prioritize their funding strategy and have seen it necessary to reduce funding to existing large missions in their extended phase.

As a consequence of these cuts, the CXC must review how to balance the operation of the observatory against GO funding. It is not the CUC's role or responsibility to direct this effort, but the CUC has chosen to present a list of priorities and recommendations from the community's standpoint.

The list of priorities and recommendations are as follows:

1. The top priority is to ensure operational safety and health of the mission.
2. The CUC recommends that if the Legacy program for very long observations over multiple years is enacted, it should only be funded by other sources, not by the GO program. Since the amount of time available for Chandra observations is fixed and the Legacy program will reduce the available amount of time for other GO observations, this will necessitate a reduction of funding for the GO program overall. However, the "dollars per ksec" awarded will not be decreased.
3. Further reductions of the GO program are likely inevitable, but the CUC recommends reducing some efforts across the CXC as well:
    - Minimize community support and only do essential software updates for maintaining current capabilities of CIAO and sherpa
        - DS9 could be funded and maintained by another source, like STScI.
        - Complete the CSC v2.1 and pause efforts on future versions and enhancements.
    - Minimize calibration effort to essential updates.

- Move the Chandra Archive data funding to come out of ADAP and Theory out of ATP.

Despite the sober budget outlook and the issues it will cause in years to come, the CUC advocates to continue moving forward with the Legacy program effort under the caveat that it will not be funded out of the GO program. The Legacy program may help alleviate the pressure on the GO funding should the Legacy time allocation be increased (up from 6 Ms), as this will decrease the amount of GO time available per cycle and possibly allow the CXC to maintain grant funding for selected proposals. The CUC had some concerns that the Legacy program might be too limited in its current scope and potentially limit the types and scope of ideas submitted. The CUC therefore recommends removing the 6Ms cap and reevaluating the 2 year limitation. The CUC further recommends having a defined set of guidelines as done for the Treasury HST program, as well as including an evaluation on a tiered-risk strategy (component of discovery space and guaranteed scientific returns) and for enabling science for future X-ray flagships or Probes. An idea is to form a panel which, based on the white paper input, comes up with the observing plan for the Legacy program.

# Detailed summaries and reports on presentations

### Chandra Status Report *Mark Weber*

The funding Contract runs through Sep 2024 with a 3-year extension option in the contract for FY 25--27. Work on an extension will begin in 2024 for a proposal effort toward a contract continuation of science observations that would pick up in FY28 and go from there. The current contract has an option for a 3-year closeout starting in FY28 if there were to be no extension of observations past that point.

The funding for FY23 was adequate to maintain capabilities and included the hire of 2 engineers, but none of the augmentations of Senior Review 2022 were implemented. The budget for FY24 has not yet been settled, but recent information indicated that it will be well below 2023 PPBE guidelines. FY25 is even more uncertain and new guidelines will likely not be provided for several months yet. The strategy to decide where to put resources is driven by the guiding principle: “for the use of the funded overguide should be to maximize the science returns for the community by preserving mission infrastructure while maximizing the General Observer program funding.” With the current funding outlook, it is very possible there will be reductions in staff and to the GO funding.

The observatory remains healthy, but a fine sun sensor (A) was lost and operations switched to the redundant sensor (B). 700 km of science time was lost due to the recovery from FFSA. If sensor B is lost as well the observatory can fall back on the coarse sun sensors with more restricted angles.

Among notable accomplishments, the Aspect Camera Assembly (ACA) got a FORTH (code) patch, and has returned to an operational efficiency of 8 years ago in its ability to track faint stars. The patch helps to keep the ACA cooler and enables faster recovery after safe mode.

### Proposal Cycle and Future Plans  Rudy Montez

The major activities in the past year in the Chandra Director's Office included having a booth at the winter and summer AAS and HEAD meeting, sending out Fall and Spring Newsletter, conducting the Cycle 25 Peer Review, hosting the High Res X-ray spectroscopy conference, and the Hubble Fellowship symposium.
For the Cycle 25 Peer Review, 408 proposals were submitted, oversubscription by time is steady (4.7 times). Four LPs (oversubscription of 9!) and one VLP were approved. Archive was oversubscribed by 4.1 and Theory 3.6.

The Schedule for Cycle 26 is

- 14 Dec call for proposals
- 14 March proposal deadline
- Peer review June 2024

They will continue with 4 Ms in the Big project panel and keep requirements for 1 MS awarded to 1 VLP. HEL time will be limited but not as severely as it was in Cycle 25. Joint Partner Observations will have an allocation of HEL time and Resource Consts (no evidence for exceeding these limits in Cycle 25). There were only a few joint proposals with JWST,  37 hours requested (34 approved) out of 150 hours available, so a stronger advertisement will be made for the Cycle 26 CfP.

### Director's Report Summary  *Pat Slane*

The telescope is functioning nominally.  A software patch was uplinked to the on-board star tracker which drastically improves performance and effectively erases eight years of thermal degradation.  Half of all DDT proposals were approved.  Those DDT proposals that first contacted the Chandra team to determine feasibility tended to be more successful than proposals without this guidance.  A new Chandra cool target proposal call was anticipated by the end of 2023 but this deadline will likely be delayed by efforts on budget planning.  There will also be a Chandra Legacy proposal call to seek proposals supporting a broad science discovery space.  Although the final NASA budget has not been released, federal budget cuts will impact Chandra and plans for mitigation of budget shortfalls are underway, including an impact on GO funding.

### Mission Planning Update  Ewan O'Sullivan

The overall temperature increase as Chandra ages continues to limit the length of observations at any given pitch angle, owing to the thermal limits of the various spacecraft subsystems. This complicates construction of the long term schedule and weekly planning, but we continue to work to mitigate the impact of heating through proactive software, procedure and policy

changes. In the past year these have included: (i) the release of a tool to allow proposers to determine whether their target field has sufficient guide stars for observation, (ii) the introduction of new thermal models for the HRC after its return to operations, (iii) investigation of the impact of high ecliptic latitude time on LTS building, (iv) initial development of assistive scheduling tools to speed up weekly planning, and (v) prototyping of resource-cost-like scoring for target-of-opportunity proposals. In addition, The ability to operate ACIS up to -105C has opened up a range of pitch angles (around 130 to 140) in which longer uninterrupted observations (~100 ks) can be accomplished.

Despite the increasing difficulty of scheduling, observing metrics remain favorable, with observing efficiency, TOO/DDT response, and science constraint compliance on par with mission history.

### **Calibration: Goals, Priorities, and Plans** Larry David

Based on the comparison of the ACIS contamination model with observed trends, there is currently no need to update the ACIS contamination model. There is a new method for correcting for the charge transfer inefficiency (CTI) in the ACIS CCDs at warmer focus plane temperatures that includes a quadratic function of temperature, different power-law indices at different temperatures, and different trap maps at different temperatures. The new method produces a good agreement at warmer temperatures. Future plans include finishing testing and release updated CTI correction products for ACIS-I data taken up to -107 C, developing and releasing new CTI corrections for ACIS-S data up to -107 C, developing CTI corrections for Cas A data at -105 C and appending the new CTI corrections with additional temperature bins from -107 to -105, finishing work on temperature-dependent RMFs for data up to -107 C, developing a tgain file for Cas A and Perseus data for 2023, and continuing to to monitor the accumulation of contamination on the ACIS filters.

### **CIAO Update** Jonathan McDowell

Usage of CIAO remains steady, with the number of downloads as a function of time being approximately flat. CIAO development continues, with a number of new features, some contributed scripts, and continued patches and bug fixes. Improvements to Sherpa and DS9 continue as well, with better handling of data grouping and filtering in Sherpa and new modes available in DS9. The CIAO workshop that was planned for the January 2023 AAS meeting was canceled due to low registration. However, the CUC considers this to be a byproduct of the outstanding CIAO threads available online rather than a lack of interest by the community. The steady download rate for CIAO supports this conclusion. Future CIAO versions remain in development, with v4.15 out now and v4.16 coming out in December. The CUC is supportive of continuing to maintain this valuable community resource, however, given the budgetary environment and the need to reduce costs, we recommend going forward that updates be limited to essential functionality and that community support be minimized.

## **HRC Update** Dan Patnaude

After over one year of study and planning, including the development of a thermal model for the HRC central electronics box power supplies and new mission planning constraints and guidelines, the HRC was returned to operations beginning in the week of April 10, 2023. Since that time, over 100 HRC observations have been performed, at a cadence of several observations per week. When not observing, the HRC remains in a low power state with only the 5V power supply on.

In the coming year, with the flight operations team, work will continue on the development of a voltage and temperature safing monitor which will run autonomously while the HRC is operating.

## **ACIS Update** Paul Plucinsky

The ACIS instrument continues to produce spectacular results, despite the challenges of continuing buildup of contaminants on the detector and the increasing thermal constraints on the observatory as a whole.

The MIT ACIS team developed a new version of the flight SW that corrected a bug in alternating exposure mode and changed the behavior of the flight SW in three cases in which an unexpected condition is encountered. The ACIS Operations team worked with the FOT to develop the command loads and procedures to uplink the new version to the spacecraft. The procedure was successfully executed on 19 September 2023 and had been operating without incident since that time. A moratorium had been placed on GO observations that use alternating exposure mode; this moratorium has been lifted since the successful activation of the new software.

The ACIS FP and electronics temperatures have been on average lower over the past year for science observations due to the longer allowed dwell times at pitch angles around 90 degrees. Currently, there are 3 focal plane temperature limits at -109, -111, and -112 C, with the majority of observations taking place at <-112 C. The majority of a GO observation will be executed at temperatures below these limits providing the GO with higher quality data. For example, the FP temperature of 101.6 ks observation (OBSID 27175) was -119.7 C for almost the entire observation. Typically it is only the beginning or end of an observation that is close to the temperature limit given that the ACIS FP temperature is almost always rising or falling. The calibration team has determined that HETG observations with SIM Z offsets of -6.0 mm or more negative can be executed with a FP temperature of -105 C with negligible impact on the quality of the data. The ACIS Operations team is working with the FOT to implement this new, fourth temperature limit for ACIS observations.

The radiation environment has become more challenging as the Sun approaches the peak of Solar Cycle 25. The ACIS Operations team has recommended three manual shutdowns in the past year. There have been no autonomous shutdowns based on the ACIS txings radiation monitor this year. ACIS txings is now the only radiation monitor onboard Chandra and it is not as effective a radiation monitor as the EPHIN instrument was at the beginning of the mission. The fluence of low energy protons on ACIS is approaching the mission high levels encountered in the first years of the mission when the Solar cycle was stronger.

**Chandra Source Catalog & Data Systems Initiatives** Rafael Galarza

The release of the Chandra Source Catalog version 2.1 is now expected in January 2024 to coincide with the AAS meeting (a 6 month delay from the last estimate provided to the CUC in Nov 2022). This delay stems from the uncertainty in the original estimate. That uncertainty was driven mostly by the amount of required Manual Quality Assurance (QA), science checks for statistical consistency with CSC 2.0, and some unexpected trends identified in the most recent data. The schedule is now mostly driven by compute-intensive tasks, including estimating source properties for three incomplete ensembles, including the Galactic Center region, and completing the remaining data migrations. Source properties for all other regions of the sky (93% of all stacks) are already available to the users via the CSC interfaces.

CSC2.1 contains 390,000 unique sources, 70,000 more than 2.0, and a 40% increase in sky coverage. All ACIS and HRC available on 12/31/2021 are included.
The 3 sky regions still being worked on are SgrA*, M82, EO102, these being unusually “heavy” in terms of number of ObsIDs, # of point sources, and extended emission. For example the SgrA* stack is projected to take 8 weeks computation-time alone to generate the products. Improvements over CSC 2.0 summarized: Photometry algorithms, source position fitting, multiple catalog interfaces (CSCView, WorldWideTelescope, VO–python, pyvo, Jupyterr notebooks). New data added to previous stacks has increased depth. Uniform production enables data-mining at scale, in turn enabling machine learning. CUC cautions that beginning a machine learning project may be inconsistent with mission priorities.

45 data product types include: Light Curves, Spectra, Bayesian blocks, totalling >22 TB compressed. Statistical comparison between 2.0 and 2.1 shows superb consistency. 2.1 includes additional tail of low count fluxes due to improved MC sampler. Absolute astrometry has dramatically improved, with tying the catalog to the Gaia catalog, and sophisticated position fitting algorithms. Position uncertainty at 95% confidence has shrunk from 0.7 arcsec to 0.29 arcsec.

One artifact discovered is an upward drift in fluxes in the ultrasoft band (only) over the mission. Due to the ACIS contamination causing a drift in the effective-area. This could be corrected in a future iteration, however the CUS recommends not investing this additional effort.

Community engagement sessions have been popular at AAS, HEAD, APS. Jupyter Notebook tutorials are reaching new generation of scientists who prefer to interact with the data products in this way,

DOIs are generated for each ObsID, each major version of CSC, and Stack. Custom DOIs can be generated upon request by CXC for collections of data products (e.g. used in a particular study or paper). ADS shows hundreds of papers per year cite CSC. Careful checking reveals 50 papers per year are based on CSC data products.

**SDSS-V and NHFP Project Update** Paul Green

SAO joined SDSS-V as a full member and in turn CSC sources are targeted.
The CXC has provided targets for spectroscopy in the ongoing SDSS-V all-sky spectroscopic campaign on the basis of a preliminary version of CSC2.1p (with cuts in magnitude to match SDSS spectroscopic sensitivity). This constituted an updated list of 188k optical and IR counterparts to Chandra X-ray sources (wrt a previous one of 148k based on previous versions of CSC catalogs), out of about 387k X-ray sources from the CSC 2.1. There are about 16k IR-only sources with H<14 and R>20-21. Targeting simulations expect 40k spectra (wrt 300k for eROSITA) by the end of the survey. So far 10k new spectra have been obtained (Figure of spatial distribution of the targets in the slides).

We have also matched CSC2.1p to the full OIR catalogs, finding about 229k counterparts and about 17k existing public SDSS spectra and good quality spectra (ZWARNING =0), with fluxes, magnitudes, redshifts and spectroscopic classifications now available to the public. When also the newly obtained SDSS-V spectra are included, the number of spectra increases to about 23000.

Updates on the NASA Hubble Fellowship Program selection results and 2023 symposium have also been presented. The last call provided 24 fellowships and the oversubscription remained very high (>15). The deadline for the 2024 call of the NASA Hubble Fellowship Program will be November 2 2023. To mitigate COVID effects the eligibility criteria has been extended to 4 years post PHD. The selection review will be virtual. The process is not dual anonymous. A large number of recommendations from the NASA review have already been implemented. Also a new program has been started: Astronomy Mentoring Program for Upcoming Postdocs, a series of workshops to help them apply, with examples of successful applications etc.

At the 2023 NHFP symposium 60 talks were presented covering all topics in astrophysics, and all delivered by very good presenters. The symposium also featured 4 non science sessions (e.g. focused on grants and benefits, careers, open mic)