



Chandra Users' Committee Meeting

September 28, 2023

CXC Manager's Status Report

Mark Weber, CXC Manager

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- High Level Overview
- Program Management
- Mission Operations
- Science Community Support
- Public Communication and Outreach



- **Spacecraft and instruments are performing well, despite challenges**
 - With the primary exceptions of low-energy ACIS quantum efficiency and the restrictions imposed by the HRC power supply anomaly, Chandra continues to meet or exceed all other Level 1 requirements.
 - The pre-launch AXAF Level 1 requirements specify performance for a minimum of 3 years of mission operations. The Program has considerably exceeded that span.
 - HRC has returned to science operations with new thermal and scheduling constraints.
 - Increasing spacecraft temperature and the low perigee altitude make mission planning and operations more complex, thereby increasing staff effort.
- **Senior Review 2022**
 - The Senior Review Chandra Panel rated Chandra '**Excellent**' overall, its highest rating.
 - The Astrophysics Advisory Committee ranked Chandra '**Tier 1**'.
 - The Panel and Subcommittee urged NASA to fully fund our recommended overguide budget to maintain the observatory's and program's capabilities.



- **Budget**

- FY23 expenditures are in line with the FY23 Operating Plan, as updated in the NASA 2022 PPBE (Planning, Programming, Budgeting & Execution) cycle.
- The FY23 budget included the overguide funding recommendation from Senior Review to fully maintain capabilities.
- The FY24 budget is still not settled with NASA, but recent information indicates that it might be well below 2023 PPBE guidelines.
- The FY25 budget is very uncertain, and new guidelines likely will not be provided to CXC for several months yet.

- **COVID-19**

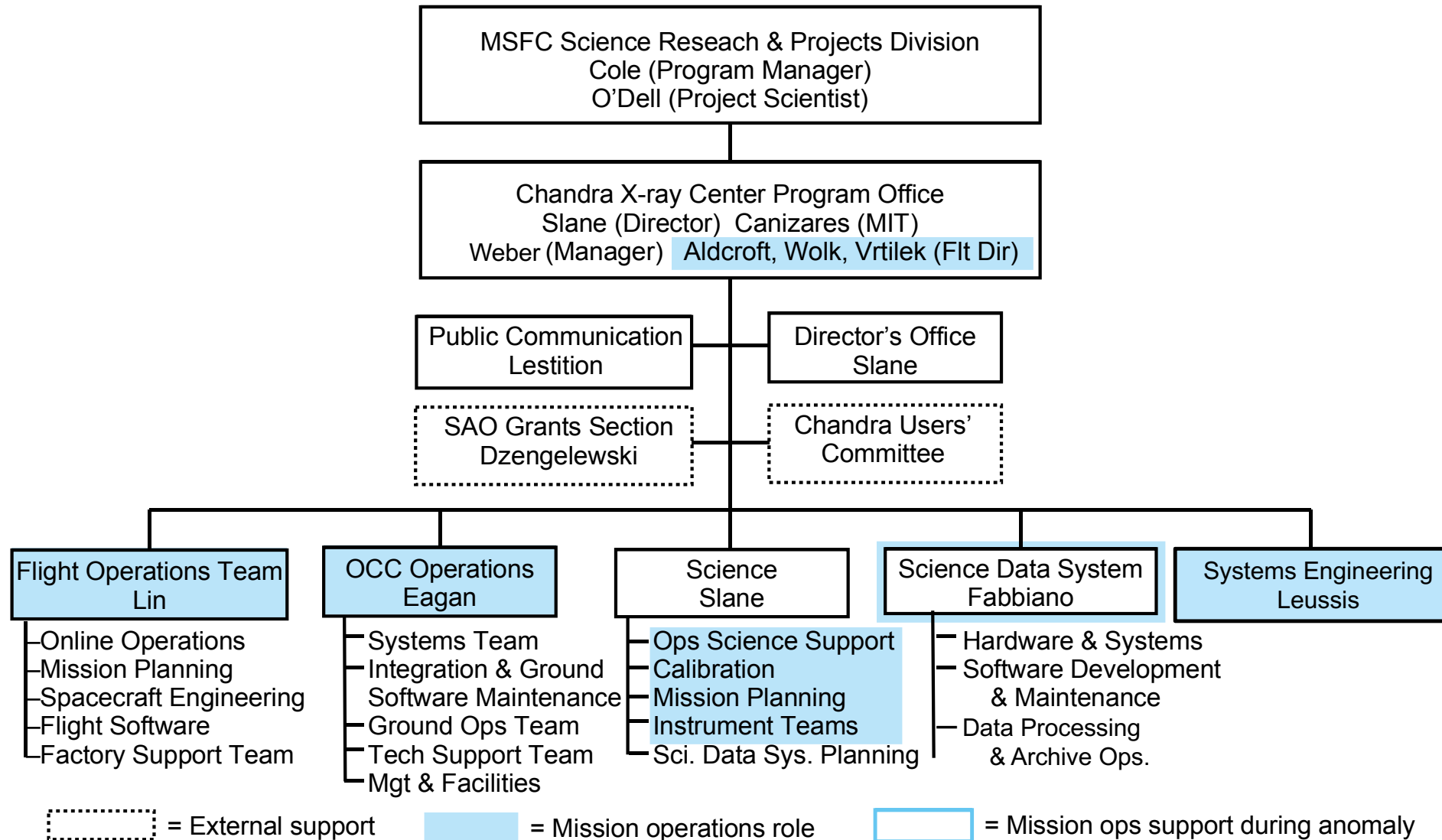
- Operations have proceeded without significant impact.
- As part of the Smithsonian Institution, organizational response to any potential upswing will be driven by alert levels issued by public health authorities.
- It has been demonstrated that science and mission operations can successfully adapt to potential resurgences.



- Changes in Leadership Personnel
 - MSFC Chandra Deputy Project Manager:
 - **Andrew Schnell** came on in May 2023.



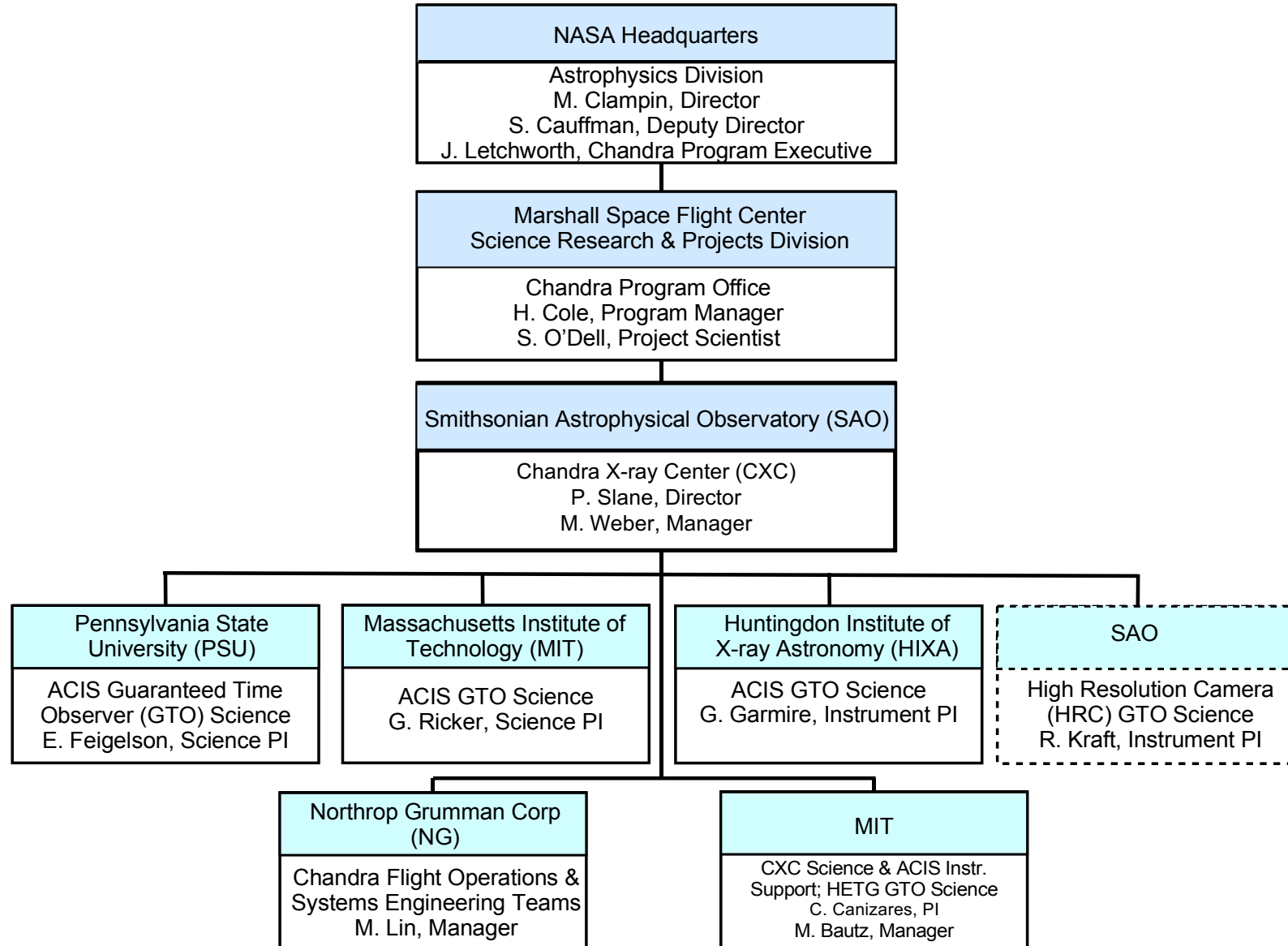
Program Management (1/10)





Program Management (2/10)

CXC



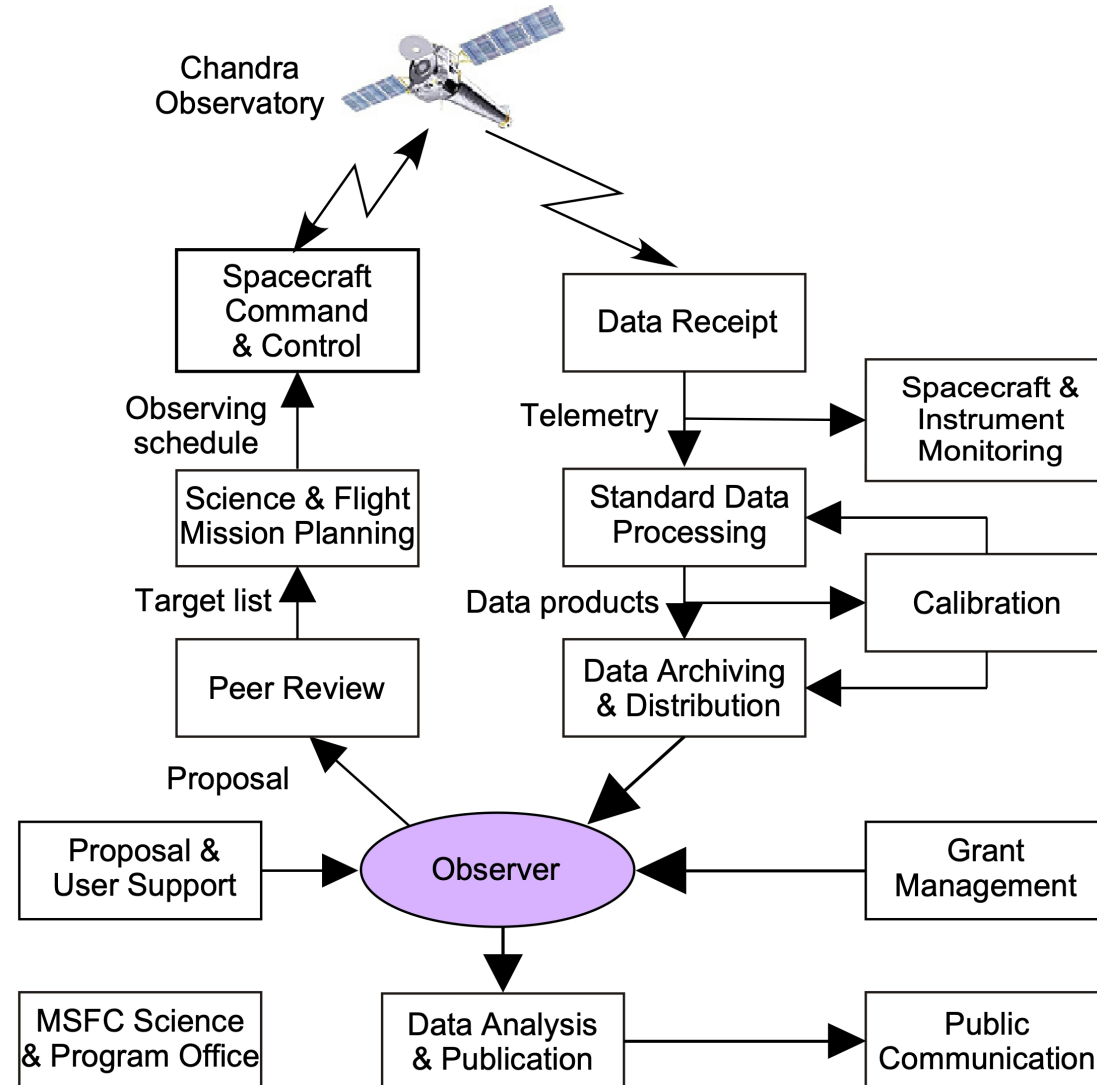


Program Management (3/10)

Chandra Task Thread

MSFC and the Chandra X-ray Center conduct all aspects of the Chandra X-ray Observatory program

- Science
- Spacecraft operations
- Data processing, archiving, & distribution
- General observer grants management
- Public communication





- **CXC-organized Reviews and Conferences**
 - Cycle 25 Dual Anonymous Peer Review
 - Was held 20–29 June 2023 (conducted remotely)
 - Science workshop: "High Resolution X-ray Spectroscopy"
 - Was held 1–3 August 2023 (conducted in-person and remotely)
 - Science conference: "25 Years of Chandra Symposium"
 - Scheduled for 2–6 December 2024, Boston
- **Programmatic Meetings**
 - Quarterly #55
 - "Quarterlies" are the semi-annual, in-depth, technical oversight meetings with NASA.
 - This event was held at the OCC on May 16 (conducted in-person and remotely).



- **Current CXC Contract**
 - Current contract carries mission ops through Sep-2024.
 - Contract option for extending mission ops through Sep-2027.
 - Contract option for a 3-year closeout period follows the end of mission operations.
- **Current Funding**
 - Current CXC funding runs to 15-Dec-2023.
 - The Einstein program is funded through 2025.
- **FY23 Budget**
 - FY23 expenditures are in line with the FY23 Operating Plan, and both are in accord with the FY23 budget, as updated in the NASA 2022 PPBE cycle.



- **Budget Background: 2021**

- In 2021, the Chandra budget was insufficient to meet all costs. This was due to a number of things, but two were particularly important:
 - 1) The NASA budget for Chandra had been nominally flat (i.e., the same dollar value every year) for multiple years. Cost-of-living increases and advancement/promotions required more funding to maintain level capability for the program (staff, purchases, grants).
 - 2) COVID effects.
- Chandra requested more funds to cover this in 2021, but got only half of that difference. As a result, we had to have a reduction in staff in 2022.

- **Budget Background: 2022**

- In 2022, Chandra submitted the Senior Review proposal. It included a budget request for two additional FOT engineers to support increasing complexity of the spacecraft, and for yearly increases to account for inflation, cost-of-living, and advancement/promotion projections. The request also included some other “augmentations”.
- Chandra received the highest scores in the Senior Review, and in the subsequent budget (PPBE) process was awarded an amount that covered the engineers and rising costs, but not the augmentations.
- However, for FY24 and beyond, while the guidelines included increases each year, they were not the full amount to maintain FY23 capability. NASA advised us to request in the 2023 budget cycle for the difference to be made up.



- **Budget Background: 2023**

- In the 2023 PPBE process, the guidelines for FY24 carried over from the previous year, i.e., they showed a nominal increase over FY23, but not an amount sufficient to maintain “level capability”.
- Chandra submitted an overguide request in the 2023 PPBE to be funded at level capability in FY24 and beyond.
- The budgeting process between the White House and Congress resulted in delays and reductions to the Federal budget. It now appears that NASA’s FY24 budget will be cut by ~ 5–6%.
- CXC has yet to receive a settled budget number for FY24, but discussions indicate that it might be well below the initial guidelines provided last year.
- No updates or confirmation on FY25 guidelines have been given. Discussions suggest that FY25 is highly uncertain, and it appears likely that NASA will not make decisions about FY25 budget guidelines for several months yet.



- Addressing the FY24 budget situation

Memorandum from Paul Hertz, 5 August 2022: NASA Response to the 2022 Astrophysics Senior Review of Operating Missions:

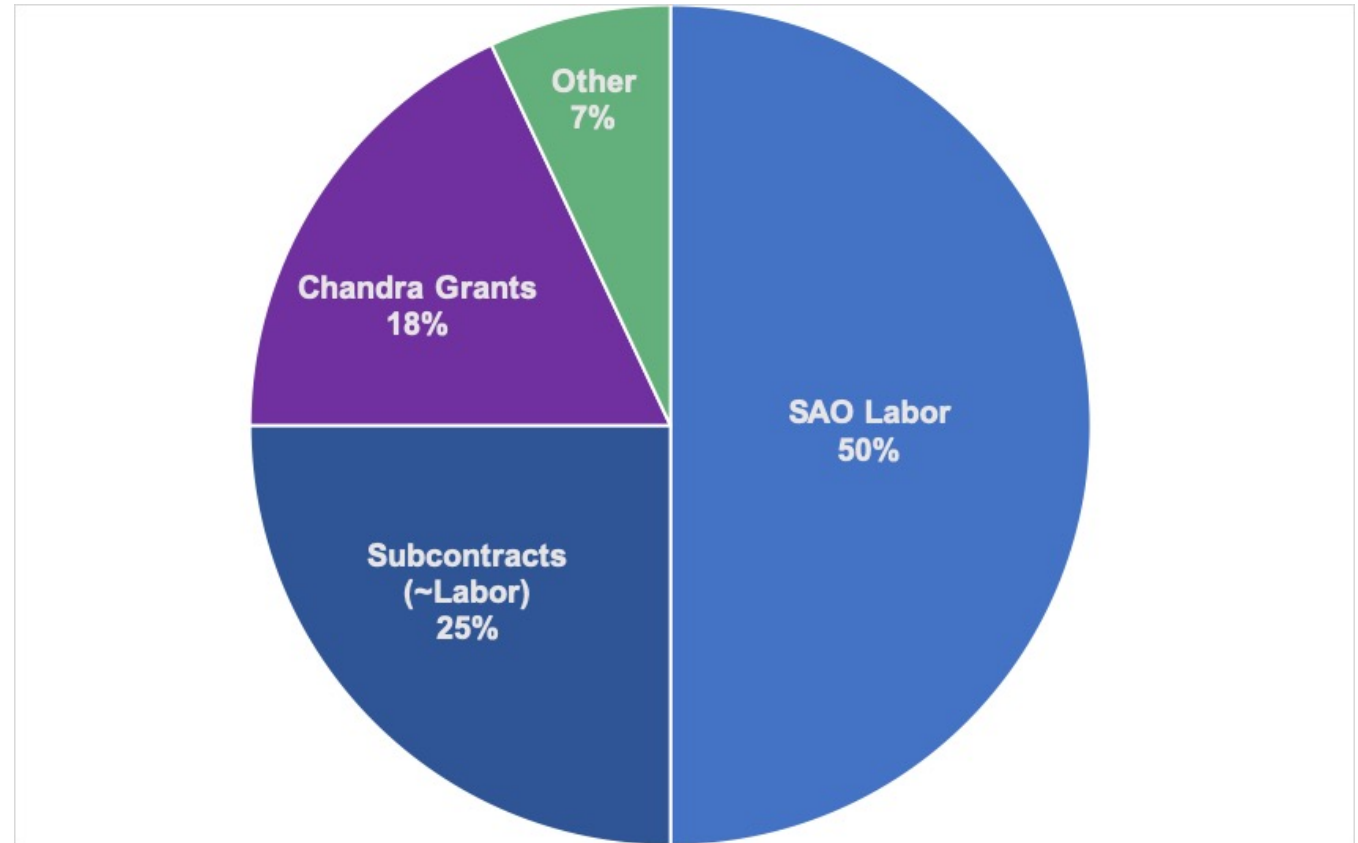
“The Chandra mission is provided additional funding to preserve operational capabilities and enhance Chandra’s ability to support time-domain science within the budget provided. **The guiding principle for the use of the funded overguide should be to maximize the science returns for the community by preserving mission infrastructure while maximizing General Observer program funding.**”

- CXC management has been working with MSFC and NASA HQ to advocate for minimizing cuts to the project, but have also been investigating a variety of mitigation plans under scenarios of various levels of cuts.
- The uncertainty about FY25 is an important factor — ideally, mitigation strategies for FY24 would incorporate the outlook for the subsequent year.
- To prepare a budget strategy, CXC management with MSFC are both (a) pursuing the possibility of additional available funds and (b) reviewing all aspects of the program for cost saving measures. Such considerations include (but are not limited to) deferring or reducing procurements and travel, limiting promotions and bonuses, non-replacement of staff, **reductions in staff, and reductions in GO funding.**



FY23 CXC Budget Structure

The CXC budget is dominated by labor and Chandra grants.





- Addressing a possible Federal shutdown
 - *There is a strong likelihood of a Federal shutdown starting next week. How does that affect Chandra?*
 - There is only one Federal person on CXC staff, and none in the SAO Contracts & Procurement department. Effectively all SAO and subcontractor staff can continue working as long as we have funds. SAO can continue to fund, and work with, subcontractors.
 - MSFC Chandra project staff that are necessary for operation approvals and anomaly responses will be available as needed, so no impact to operations.
 - However, MSFC will not be able to issue funds.
 - CXC is currently funded to Dec 15.
 - **If a shutdown begins next week, CXC will halt the funding of grants as an immediate measure to extend funds. This is a precedented action.**
 - In the case that the shutdown continues into November, CXC has the option to seek emergency funds from SI. There is precedent for that action. But there is also elevated risk this year because SI itself faces potentially large budget cuts in FY24.



- **Spacecraft — Overall status**

- **The spacecraft continues to operate extremely well.**
- Temperature control is a continuing and increasing challenge to mission planning.
- Low perigee during 2022–24 continues to require extra mission planning effort to mitigate a variety of effects, including high gravity gradients and ionizing radiation near perigee.
- Fine Sun Sensor (FSS) A has failed ⇒ no redundancy for FSS-B anomaly.
- FSS-B performance has degraded (max sun pitch angle reduced from 135 deg to 125 deg) ⇒ minor impact to planning flexibility.

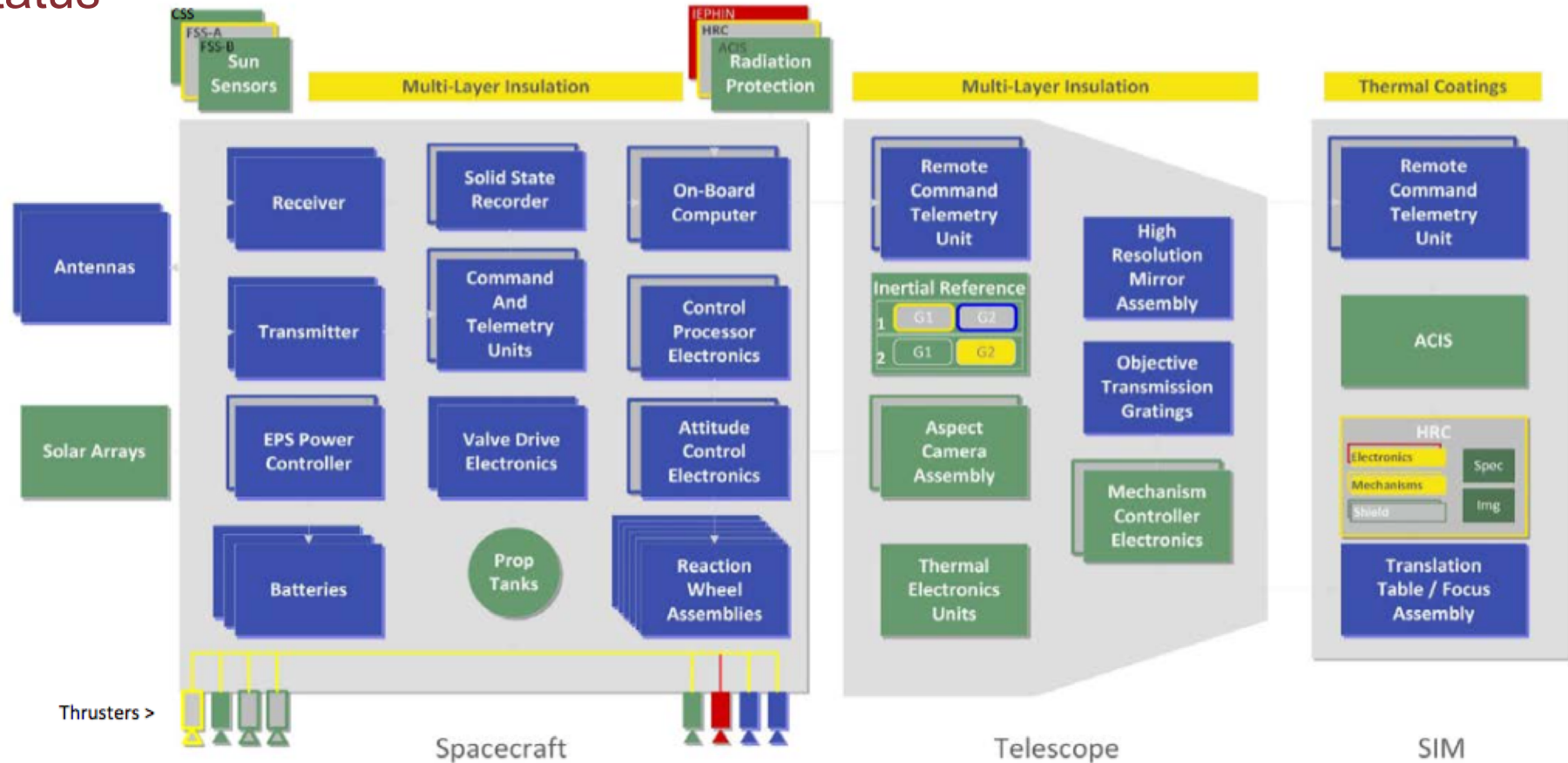
- **Science Operations**

- **ACIS continues to operate well.**
 - A new ACIS flight software version was developed and uplinked on 19 September 2023.
 - ACIS FP and electronics temperatures have been lower (on average) due to longer dwelltimes at pitch angles around 90 degrees.
- **HRC returned to regular science observations in Apr-2023.**
 - HRC has functioned nominally since the restart.



Mission Operations (2/9)

- Vehicle Status

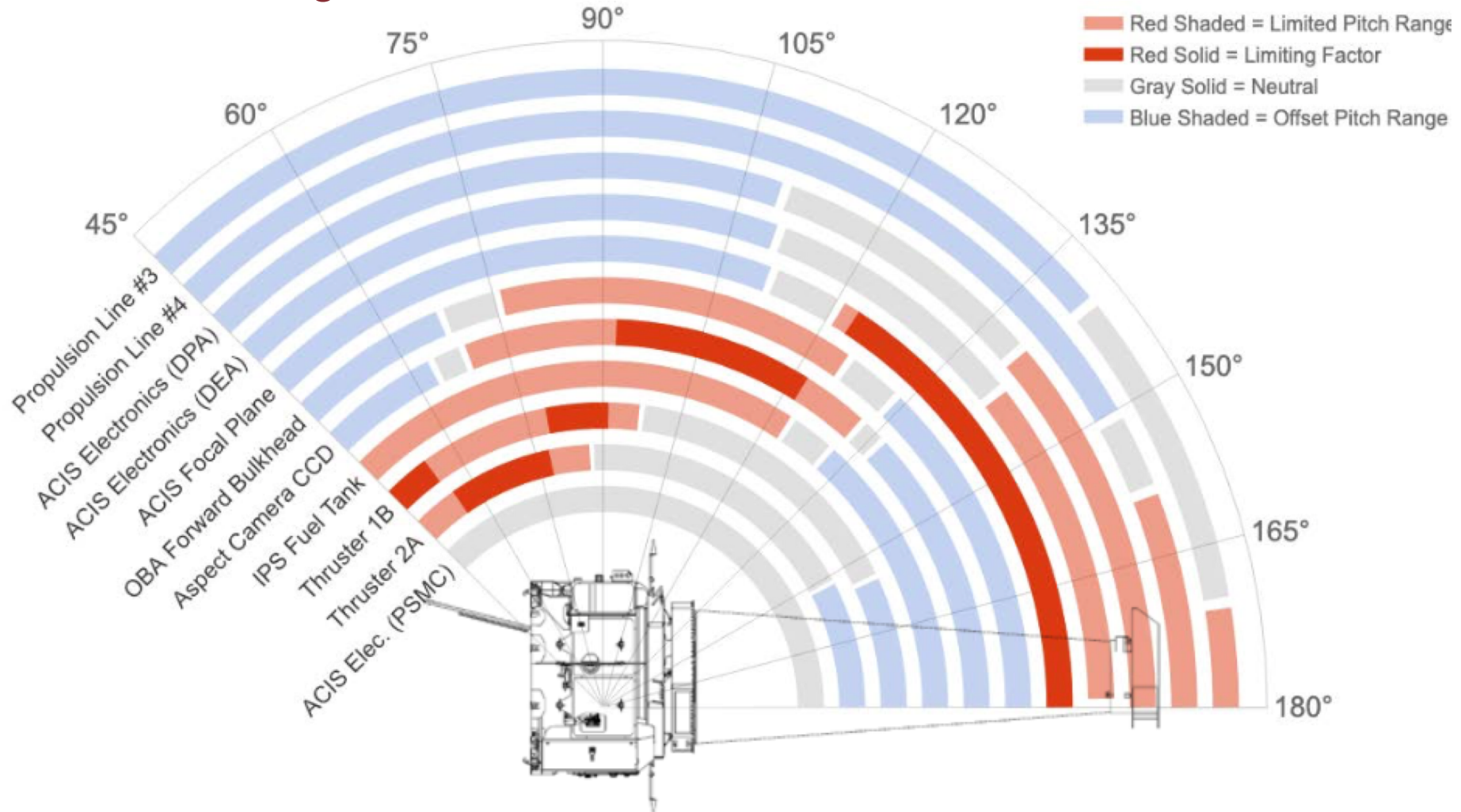


Key: **blue** = fully functional; **green** = minor problem but meeting all requirements; **yellow** = partially mitigated performance impacts; **red** = major problem affecting performance; **gray** = backup unit, border represents status when last powered on



Mission Operations (3/9)

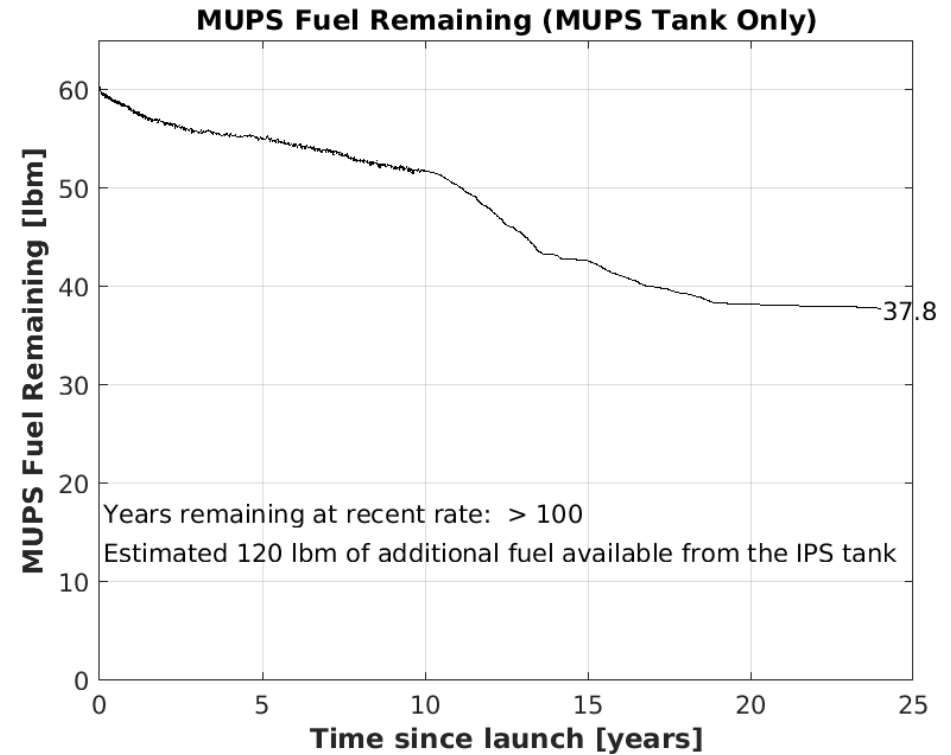
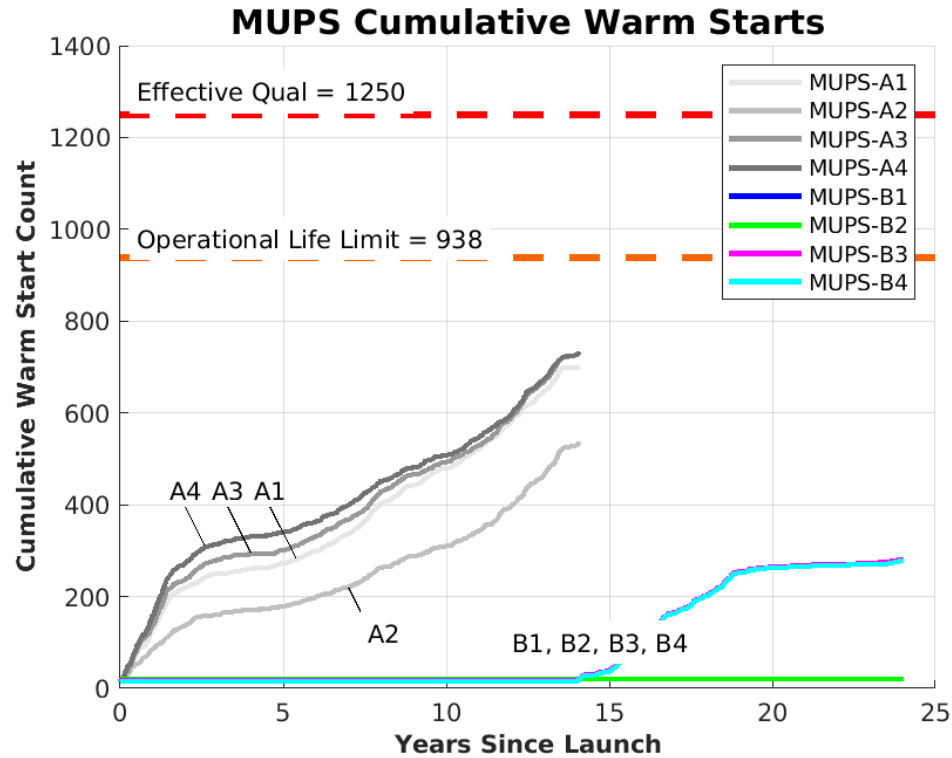
- Spacecraft — Heating versus Pitch





Mission Operations (4/9)

- Spacecraft — Trends on Resources





- Major Operational Improvements

- Two additional FOT engineers were hired and are currently in training.
 - ➔ **Increases staff availability, as well as operational flexibility & robustness.**
- A dynamic background algorithm patch for the Aspect Camera Assembly (ACA) was uplinked May 18 as the culmination of many years of effort, not only developing and testing the patch, but writing an entire Forth SDK for the ACA.
 - ➔ **Updated code working as expected, and ACA guide star tracking now resembles performance from 8 years ago.**
- A setpoint adjustment was made to the Telescope Forward Thermal Enclosure Heater.
 - ➔ **Removed unnecessary heating, reversing ~1.5 years of thermal degradation.**
- A patch has been developed to allow Normal Sun Mode (NSM) offset pitches of 130° or 160°.
 - NSM is a safing attitude control mode following certain anomalies or during recovery from Safe Mode.
 - ACA heating at Normal Sun pitch hinders finding stars with the ACA to establish spacecraft fine attitude ⇒ significant operational challenge in recent Safe Mode anomalies.
 - Patch and associated usage products are undergoing final review prior to seeking program approval for operational use.
 - ➔ **Keeps ACA cooler, enabling faster recoveries from some Safe Mode anomalies and mitigating thermal risks.**



- Major Operational Improvements (continued)

- MAUDE — a realtime and archive telemetry distribution system using HTTPS — was formally promoted for operational use.
 - Agile capabilities and accessible interface make MAUDE widely used across operations .
 - ➔ “[Q]uickly and easily provid[es] secure access to telemetry data to users on their device of choice and with minimal coding required by client developers.”
- Fine Sun Sensor B (FSS-B) has been returned to service for normal science operations (with a slightly smaller field of view) and established for use in Safe Mode due to FSS-A failure.
 - ➔ **The Sun Position Monitor is now fully enabled, increasing spacecraft safety margins.**
- MUPS-B (momentum thruster set) returned to service.
 - An unplanned auto-unload in Oct-2022 resulted in dry-firing of a thruster.
 - After extensive analysis and careful checkout activities, the MUPS-B was certified for normal operational use in Mar-2023.
 - ➔ **Normal momentum unloading is now available again.**
- **The HRC return to science!**



- Spacecraft — Interruptive events

- (Feb 13) Safe Mode transition

- Root cause was a trip of the Sun Position Monitor due to faulty data from the Fine Sun Sensor (FSS) near the edge of the FSS field of view.
 - Recovery to science operations was extremely challenging due to a perfect storm of DSN down-time, high temperatures impacting multiple systems, and rapid momentum accumulation due to low perigee.
 - Science time lost: 700 ks

- (Feb 27) “SCS 107” event

- This is a manually triggered interruption as a mitigation response to high radiation background.
 - Science time lost = 118 ks.

- (Mar 15) “SCS 107” event

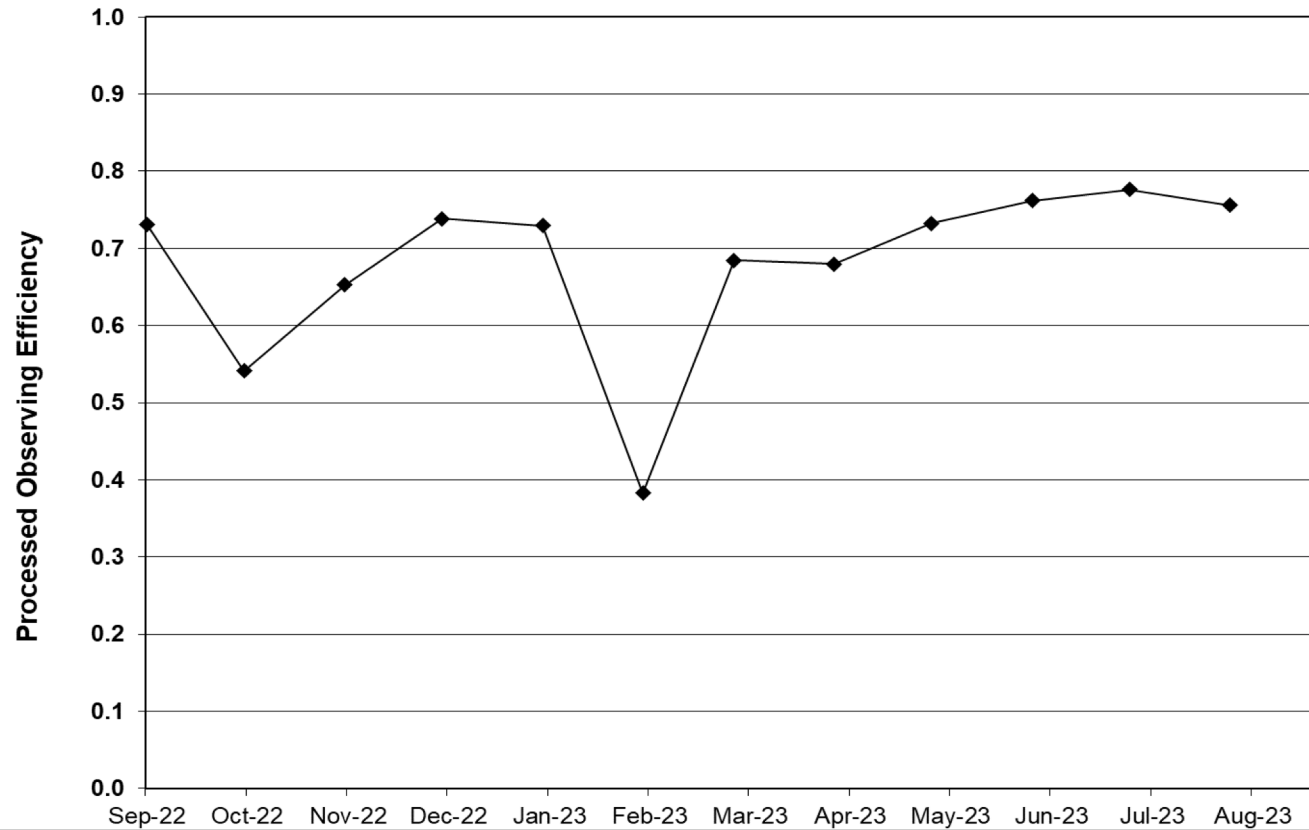
- Science time lost = 89 ks.

- (Apr 23) “SCS 107” event

- Science time lost = 72 ks.



- Observation Efficiency





- **Operations Control Center (OCC)**
 - The OCC has maintained smooth operations.
 - COVID-19 protocols have sustained spacecraft and personnel health & safety. On 10 April 2023, President Biden signed a congressional resolution ending the national emergency.
 - Started hardware refresh for systems purchased in 2017–18. Transitioned to new NetApp equipment at Wayside and CDP. Replacement of COG and EHS servers continues.
 - Migration of off-line system (OFLS 13) to new GUI builder continued, with delivery expected in October.
 - Migration of on-line system (ONLS 4.2) to new GUI builder delivered four beta releases for dry run test. ONLS 4.2 includes automation API and new telemetry display client.
 - The Backup OCC is fully capable to support science operations.
- **Science Data Systems**
 - Software development and deliveries have stayed on schedule.
 - Standard data processing and archive operations are proceeding smoothly.
 - Chandra Source Catalog v2.1 processing almost complete (~ end of 2023, estd.).
 - The Archive Operations and DS Operations teams have been consolidated into a single team.



- **Data Delivery**

- We continue to deliver data to observers within ~1.5 days of observation.

- **Grant Issuance**

- We continue to issue grants typically within 2–3 weeks of initial observation.
- Grants $< \$30k$ are issued for total award amount.
- Grants $\geq \$30k$ and $< \$100k$ are initially issued for 50% of total award; remaining amount is awarded when 75% of initial award has been invoiced.
- Grants $\geq \$100k$ are initially issued for 33% of total award; remaining amount is awarded in multiple increments when 75% of previously awarded funds have been invoiced.



- **General Observer Program**

- The Observing Cycle 25 Call for Proposals was issued 15-Dec-2022.
- There were 408 proposals submitted (336 general observer, 22 theory, 49 archive).
- Total time available: ~17.1Ms.
- Oversubscription in time: 4.65x.
- Dual anonymous peer review was held remotely, Jun 20–29.

- **Einstein Fellows Program**

- NASA Hubble Fellowship Program (NHFP, administered by STScI) retains Hubble, Einstein, and Sagan science-based categories and their lead project scientists.
- Current fellows class had 457 applications, with 34 offers made, yielding 24 new fellows.
- P. Green (SAO) continues to provide scientific and policy leadership to Einstein fellows.
- SAO hosted the NHFP Symposium in Cambridge, on 18–22 Sep 2023.



Public Communication and Outreach (1/3)

CXC

- **Overview**

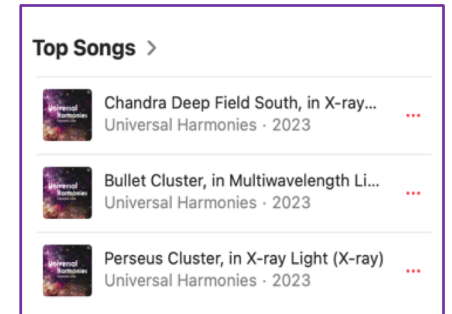
- The Chandra Public Communications team remains very highly productive and influential.
- Recognized by NASA with a group achievement award in Aug 2023.

- **Accessibility**

- Leading the field with projects to present science by sound and touch (e.g., sonifications, 3D printable models).
 - Highly successful sonification program included at SXSW 2023, and featured on Apple Music, Spotify, & numerous podcasts.
 - Visual description & 3D printing programs successfully incorporated into Chandra's release pipeline for maximum inclusion.

- **Informal Learning**

- Sonification coding app (NASA's Space Jam) released Nov 22, ranked as #1 Hour of Code activity, primarily responsible for highest month of traffic on Chandra public server.
- Virtual field trips served ~9k learners: 37% learners from underrepresented groups; 34% female-identifying learners (above typical averages for computer science (CS) learners).
- Highly positive evaluations showing students being more interested in CS after the event than they were before. *“Students enjoyed seeing the images of space and hearing about astronauts. I had several girls who really were happy to listen to a female shuttle commander.”*

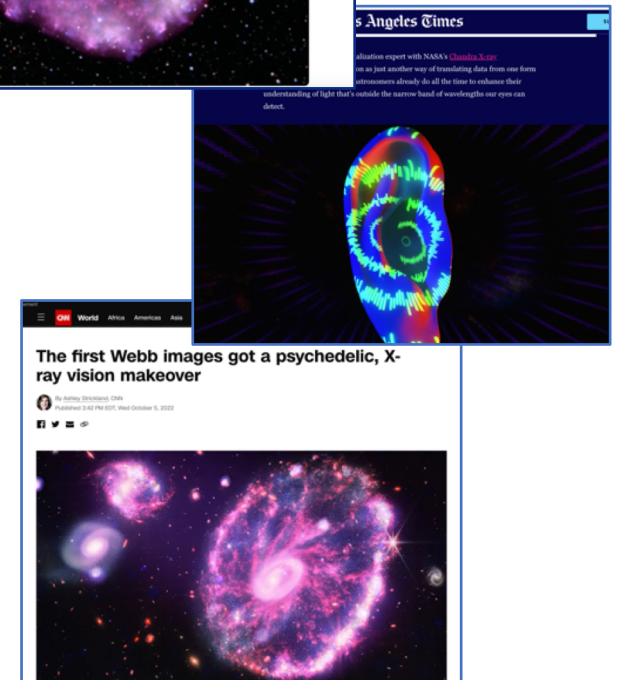




Public Communication and Outreach (2/3)

- **Press Releases October 2022 – October 2023**
 - 11 science press releases.
 - 16 image features; 3 with sonification, 4 including James Webb (JWST) data, and 6 including IXPE data.
- **Press Results**
 - Since October 1, 2022, Chandra has been mentioned in, or been featured in, > 2,300 popular news articles.
 - In this period, Chandra & stories about its science appeared in > 50 articles in top* media outlets such as The New York Times, Los Angeles Times, CNN, Fox News, National Public Radio, The Miami Herald, & others.

* “Top” outlets defined by media monitoring service Meltwater as top 10% reach in US news, English language





Public Communication and Outreach (3/3)

CXC

- **Public website**

- The Chandra public website attracted an average of ~16 M hits per month since Oct 2022.
- Largest month of traffic recorded with 37 M hits in Dec 2022 from sonification coding app.
- Posted 28 videos in 2 series, and 31 blog posts.

- **Social media growth across all platforms**

- YouTube: > 1.1 million video views.
- X (Twitter): 370k → 407k followers -- yearly increase of 10%.
 - Oct 2022 Sonification-based TwitterSpace (TS) had one of highest total listens for a NASA HQ TS event in 2022.
 - May 2023 Black Hole TS event was most-listened-to TS for NASA HQ, with >3 times the listeners of 2nd most popular TS for HQ.
- Instagram: 1.2 million → 1.4 million follower increase; highly active follower engagement.
 - SNR E0102 post reached > 1 million non-followers.
- Facebook: Reached > 3.1 million users.





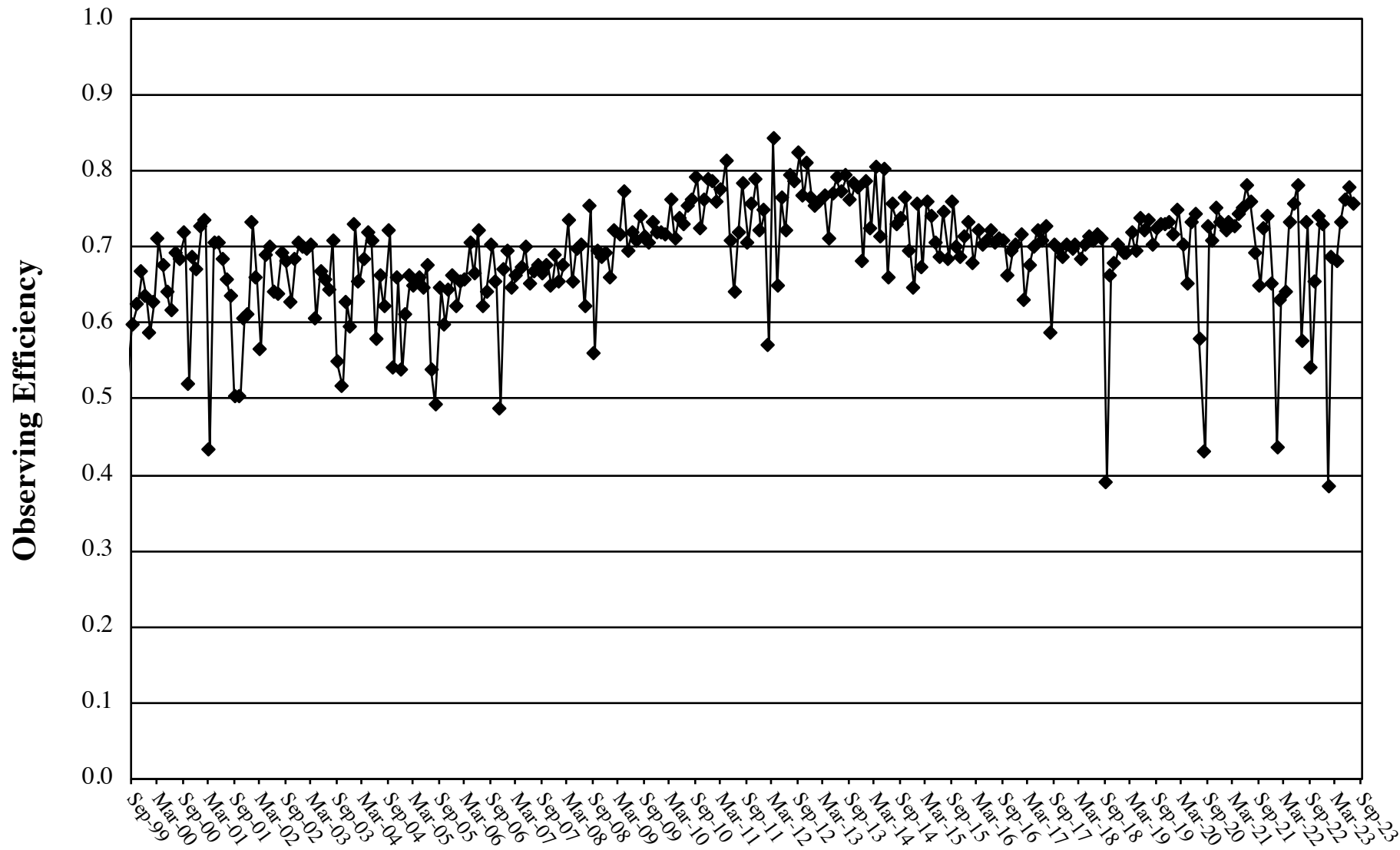
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Supplementary Information

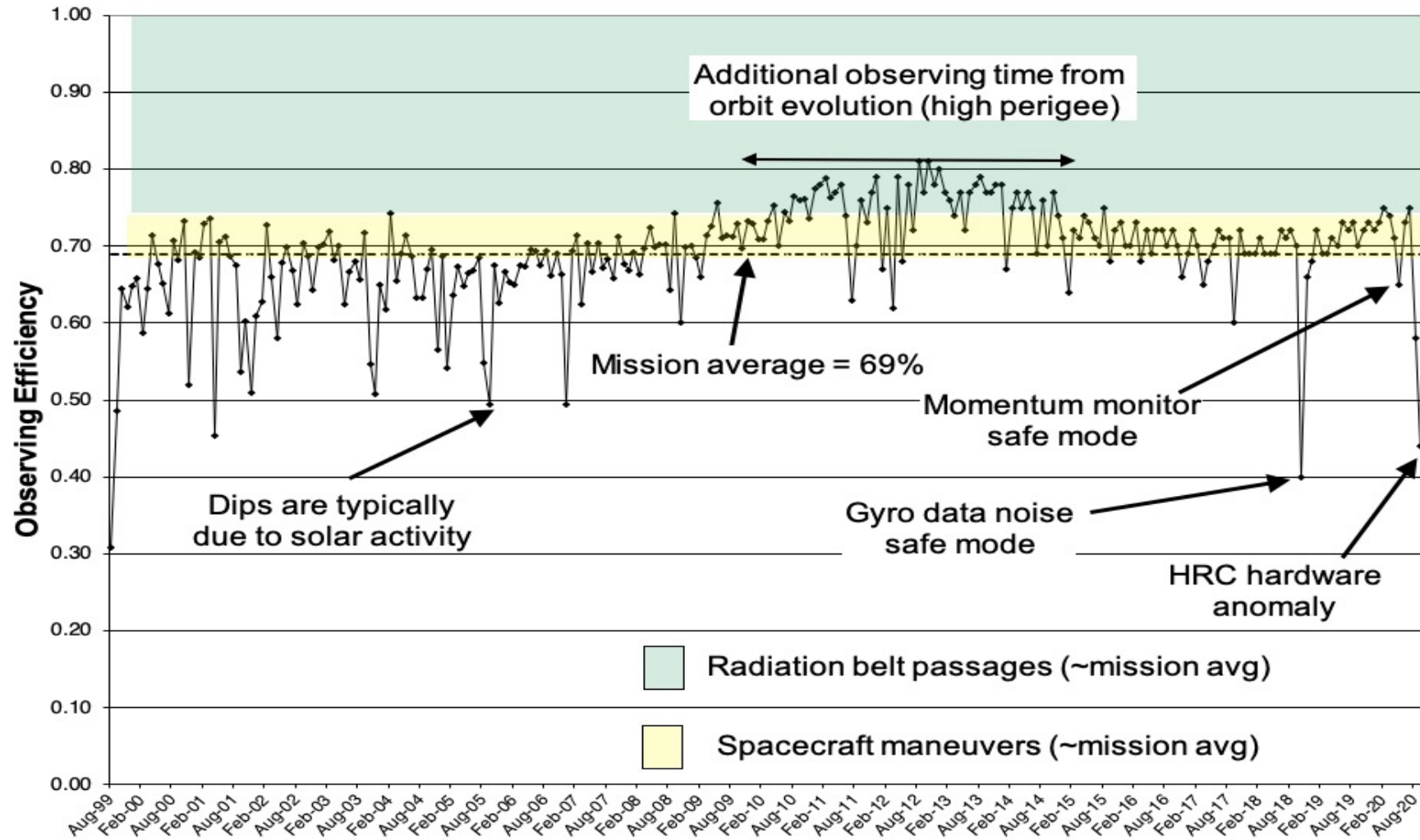


Observing Efficiency — Launch through Aug-2023





Observing Efficiency — Launch to Aug-2020





Mission Metric: Data Delivery Effectiveness

As of middle of following month					As of 9/6/23				
<u>Month</u>	<u>Number of Obs</u>	<u>Days to Data Delivery</u>			<u>Number Deliv</u>	<u>Number Outstanding</u>	<u>Number Deliv</u>	<u>Number Outstanding</u>	<u>Comments</u>
		<u>Min</u>	<u>Avg</u>	<u>Max</u>					
Sep-22	125	0.2	1.1	7	124	1	125	0	
Oct-22	94	0.1	1.4	8	94	0	94	0	
Nov-22	105	0.2	1.6	9	105	0	105	0	
Dec-22	110	0.2	1.4	18	110	0	110	0	
Jan-23	115	0.2	1.2	12	115	0	115	0	
Feb-23	53	0.2	1.2	8	53	0	53	0	
Mar-23	114	0.2	1.1	10	114	0	114	0	
Apr-23	98	0.2	1.5	7	98	0	98	0	
May-23	106	0.2	1.6	9	105	1	106	0	
Jun-23	101	0.3	1.3	6	97	4	101	0	
Jul-23	106	0.2	1.1	7	106	0	106	0	
Aug-23	105	0.2	0.9	9	105	0	105	0	



Mission Metric: Science Observation Summary

	Total Mission through 8/31/23	
	No. ObsIDs	Total Msec
Cal ER	1,362	N/A
Cal	3,267	26.8
DDT	804	16.6
GO	14,978	387.4
GTO	3,095	64.1
TOO	1010	25.1
CCT	406	5.6
Total	24,922	525.6
Time since first light (Ms)		758.4
Mission average efficiency		69.3%



- **Senior Review 2022**

- SR22 proposal was submitted to NASA Feb 11. Virtual site visit by SR panel was Apr 4.
- Chandra received highest achievable marks:
 - The Chandra Panel rated Chandra **'Excellent' overall**.
 - The Astrophysics Advisory Committee (APAC) ranked Chandra **'Tier 1'**.
- We proposed an Overguide budget and augmentations.
 - The Overguide budget maintains current capabilities:
 - Compensates for inflation
 - Funds 2 additional Flight Operations engineers to meet rising challenges of planning and operations
 - Augmentations:
 - Diversity, Equity, and Inclusion: CFaSt Minority Internship Initiative
 - Time domain science: enhance data processing pipelines to identify varying targets
 - Chandra grants: increase funding for added observing time in FY23–25 and to restore purchasing power lost to inflation during mission
- The SR22 APAC report recommended the following ranking of funding priorities:
 - 1) Completely fund the Overguide, reducing GO (General Observer) funds if necessary
 - 2) Time-domain science
 - 3) Increase GO program funding