OPCR 2024 – Chandra & HST

Operating Paradigm Change Review

Committee Membership

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Charge to the committee

Present findings of strengths and weaknesses of the options presented by HST and Chandra to meet the budget guidelines

No recommendations are requested, this is not a FACA committee, and unanimity is not required

Evaluation Criteria

- scientific merit
- relevance and responsiveness
- technical capability, management and science productivity given the costs

Review Process

April 20: Submissions by HST and Chandra distributed

May 7: Online meeting of committee

May 8: Presentation by HST (90 min + discussion)

May 9: Presentation by Chandra (90 min + discussion)

May 16: Follow-up meeting of committee

May 20: Summary report presented to NASA HQ

(most of these slides are taken from that report)

Submissions followed a prescribed format (text and budgets) and certain categories of costs could not be reduced.

Panel Background Value Statement

1. Maximize scientific productivity and ability to make groundbreaking discoveries
2. Take reliable scientifically useful data from these observatories and make sure it is appropriately archived for future use, to enable scientific discoveries.
3. Maintain training and expertise in X-ray/UV/optical astronomy, in order to pave the way for future missions such as HWO and Lynx.
4. Nurture community of young users and contribute to equity in the STEM pipeline
5. Maintain US leadership position in astrophysics

Summary of Findings - both

Chandra and HST are Great Observatories serving huge observing communities and producing frequent scientific breakthroughs from observations and archives, with increasing numbers of publications

Both received top marks in Senior Reviews: high return on the dollar

Annual operating cost a few percent of capital cost provides large and guaranteed return on investment

Both are unique: no other equipment now or approved for construction could replace them

Both have new scientific projects in synergy with JWST and time domain multi-messenger astronomy (a top priority in Decadal Survey)

Summary of Findings - both

Both are in good health, operating efficiently, in high demand (oversubscription), archiving and distributing data, and supporting widely used analysis tools. The thermal control issues facing Chandra have not had any impact on its scientific productivity.

Both have limited lifetime, but should run well into next decade

Both have approved end-of-mission plans

Summary of Findings - both

General Observer and Archive program funding ensures observations analyzed completely and published promptly. These programs also provide funds to train the future scientific leaders.

Archives widely used by astronomers around the world, including at small institutions that traditionally have more diverse student bodies.

Operations are highly streamlined and optimized after years of improvements - even small budget cuts require losses of services and capabilities

Operations costs are mostly staff: significant cuts would require RIFs, with legal implications and irreversibility

Ending either of these missions now would be premature and would have a large, permanent impact on science and the astronomical community

HST

For reference the OPCR guideline budgets for FY25-FY29 compared to FY23

FY23	FY25	FY 26	FY27	FY28
105.6M	88.8M	87.5M	87.7M	82.9M

- HST explored reductions in three areas: GO funding, discontinuing instrumentation modes, and reduced (i.e., higher risk) mission operations.
  - Option A (in guide): most savings from reductions in GO funding
  - Option B (in-guide): elimination of instrument modes, less reduction in GO funding
  - Option C (in-guide): reduced mission ops, less reduction in GO funding
  - Option D (over-guide): avoid reduced capabilities, maintain most GO funding

- In addition, all options incorporate several other reductions
  - drop WFC/IR (redundant with JWST) and ACS/WFC (most moves to WFC/UVIS)
  - drop high-level science products and tools except for calibration of data
  - drop finance committee, mid-cycle reviews, in-person TAC
  - drop archival research support (→ ADAP)
  - reduce outreach activities, disseminate more results via NASA outreach
  - GSFC mission operations reductions

Hubble Option A Concept

Budget: in guide
Configuration: UVO (removing overlap with JWST)
Mission ops: continue

GO funding: significant reductions

Hubble Option A Findings

Strengths

- continues most of HST's instrumental functionality. Only redundant and non-unique functionality is dropped.

- consistent with NASA guidelines once carryover is taken into consideration

Weakness

- No GO funding except previous commitments
- Loss of support for high-level science products

Hubble Option B Concept

- Budget: inguide
- Configuration: Minimal (critical only)
- Mission ops: continue
- GO funding: maintain larger levels

Reduction Overview

Instrument Usage

We do not know what science the community will propose with a reduced set of capabilities, as the field evolves, but these shifts are likely

Prime	C29	C30	C31	C32*
WFC3/IR	*10.4%*	*18.6%*	*4.8%*	*9.4%*
ACS/WFC	*8.8%*	*9.2%*	*10.4%*	*11.5%*
WFC3/UVIS	**22.4%**	**35.9%**	**42.8%**	**36.4%**
STIS/CCD	*5.0%*	*3.7%*	*9.4%*	*6.0%*
COS/NUV	*0.5%*	*3.0%*	*4.1%*	*3.2%*
STIS/NUV	**7.4%**	**4.7%**	**7.5%**	**7.3%**
ACS/SBC	*2.3%*	*3.4%*	*0.0%*	*4.3%*
STIS/FUV	**13.0%**	**5.7%**	**6.4%**	**6.0%**
COS/FUV	**30.2%**	**16.0%**	**14.4%**	**15.8%**

*Requested

WFC3/IR & ACS/WFC lost in all options

Most science goes to Webb

Most science goes to WFC3/UVIS

UVO config drops these modes

Nearly all science lost

Some science goes to STIS/NUV

Most science goes to STIS/FUV

Minimal config ***also*** drops these modes

Significant parallel science is lost in all options

Hubble Option B Findings

Strengths

- Maintains most important instrument functionality- which accounts for 75% of HST utilization

- Roughly consistent with NASA cost guidelines

- Includes GO funding at a fraction of current levels

Weaknesses

- Eliminates many instrument modes which likely cannot be restored due to loss of expertise

- Loss of support for high-level science products

Hubble Option C Concept

- Budget: inguide
- Configuration: ~~Minimal (critical only~~) UVO
- Mission ops: risk increase, no longer prepare for failures
- GO funding: $5 M/yr, $5 M/yr, $5 M/yr, $5 M/yr

Hubble Option C Findings

Strengths

- continues most of HST's instrumental functionality. Only redundant and non-unique functionality is dropped.

- Includes GO funding

Weaknesses

- More risky than other options due to loss of flight operations staff in later years and therefore ability to mitigate problems if they arise.

- Loss of support for high-level science products

Hubble Option D Concept and Findings

Budget: overguide ($13M-$22M/yr over-guide)
Configuration: UVO
Mission Ops: continue
GO funding: $22M/22M/22M/22M

Strengths:

- Continues most of HST's instrumental functionality. Only redundant and non-unique functionality is dropped.
-
- Maintaining the GO funding at current levels supports the science community to maximizes scientific discovery

Weakness

- Requires agreements to provide necessary funding.
- Loss of support for high-level science products

HST: General Findings and Remarks

- The three in-guide options illustrate the impacts and trade-offs between absorbing reductions primarily in GO support *vs* available instrument modes *vs* mission operations.

- Other approaches might be to combine elements of Options B and C to further mitigate impacts on GO funding, but such choices are beyond the scope of the OCPR.

- The committee debated the merits and liabilities of reductions to GO funding vs observatory capabilities, but no clear consensus emerged. Severe funding cuts would impact a very large community, on the other hand once an observatory capability is lost it almost certainly won't be recovered. Needs to be addressed at a higher level.

Chandra

For reference the OPCR guideline budgets for FY25-FY29 compared to FY23

FY23	FY25	FY 26	FY27	FY28
68.3M	41.4M	26.6M	26.6M	26.6M

- The Chandra project had a considerably more challenging task, with much deeper cuts in the FY25 PBR
- The only viable in-guide option was to initiate termination of the mission (approved plan already in place). The other three options are over-guide, but with Options II and III entailing major reductions in funding compared to FY23 levels.
- Options:
  - Option I (in-guide): mission closeout
  - Option II (over-guide): "TSL" meaning TDAMM/Synergy/Legacy program elimination of regular GO observing and reduced user support
  - Option III (over-guide): "TSL+" meaning Option B with increased levels of user support
  - Option IV (over-guide): Full capability mission
- As with HST some additional reductions would be made in all options (e.g., elimination of GTO funding, staffing reductions via attrition)

Chandra Option I Findings

The committee notes that Option 1, which is a direct implementation of the NASA approved Chandra close-out plan, only just fits in-guide. This highlights that all options (Options 2-4) which continue science operations will be over-guide.

Strength: meets requested budget profile.

Weaknesses:

- Would stop a fully functioning Great Observatory
- Loss of scientific discoveries at beginning of Time Domain Astronomy and JWST synergy
- Loss of NASA prestige, loss of US leadership
- Irreversible - the observatory and associated expertise would be unrecoverable
- Requires rapid adoption to facilitate downsizing and fairness to employees

Option II: Chandra TDAMM/Synergy/Legacy (TSL) Mission

A reduced science mission with Chandra that approaches FY25 guidelines is feasible with major reductions (~65 FTEs) and restructuring.

Chandra TSL introduces reductions in every area to reach a minimum cost level for science operations with Chandra:

- **Eliminate the Chandra GO program, including funding and standard proposal cycle.**
- Chandra archival research through ADAP only.
- Remove HRC from use. Grating use available only with ACIS.
- Minimize available operating modes for ACIS. No new configurations.
- Place all software into maintenance mode. No new updates/algorithms/functionality to analysis software (ciao, sherpa, MARX, SAOTrace, ds9).
- No new updates to Data System software beyond mission-critical needs.
- Halt any further work on Chandra Source Catalog (frozen at CSC 2.1) and TGCAT.
- Eliminate Chandra conferences/symposia, newsletters, and training workshops.
- Freeze HRC/LETG/HETG calibration. Minimize ACIS calibration.
- Eliminate Uplink Support for observations. Reduce HelpDesk to minimal levels.
- Eliminate V&V task and special processing of observations.
- Minimize monitoring and trending of instruments.
- Eliminate bibliography and other mission statistics tracking.
- Reduce rapid return-to-science support following anomalies.
- **Introduce ≥50% idle time for observing to simplify planning and scheduling, significantly reducing observing efficiency.**

Observations accepted through DDT Requests, Joint Observing Programs with other observatories, and Legacy Program.

- Up to 1 Ms available for DDT requests to support **TDAMM** initiatives.
- Up to 2 Ms available for Chandra **Synergy** observations approved in Joint Programs from JWST, HST, XMM, etc.)
- 5-6 Ms available for annual **Legacy** Program observations.

Full onset of Legacy portion of Chandra TSL would commence after completion of approved Cycle 25 observations.

- Cycle 25 would be extended to accommodate reduced observing efficiency.
- Cycle 26 proposals would not be approved.

Chandra TSL costs exceed the NASA guidelines for FY25 by a modest amount. Adoption would require significant increases for FY26-28.

Chandra TSL Represents a Dramatically Reduced but Scientifically Important Mission

Chandra Option II Findings

The committee agrees that this option presents the mode of operation that minimizes overall cost while maintaining viable science operations. A key aspect of this option is the reduction in observing efficiency. CXC presented a paradigm for the allocation of the reduced observing time that serves NASA focus on TDAMM as well as the Chandra Legacy Program, but other possibilities exist and could be explored.

Strengths:

- minimal but impressive scientific capability. Most widely used instrument is maintained
- cost approximately $20M/yr less than fy2024 NASA budget (30-35% reduction)
- Includes Legacy programs proven to be cost effective with both HST and Spitzer

Weaknesses

- No funding for new GOs which would negatively impact training and retention of early-career researchers
- In order to reduce costs only 50% of current observing time would be used
- Instruments turned off are lost and gone forever
- Does not meet budget guidelines in years 2 and 3, but the committee does not see a way for them to continue to operate under the in-guide budget scenario given

Chandra Option III Concept

Option II with more user support

Chandra Option III Findings

Strength
- includes GO funding (but reduced compared to current levels) related to main themes - TDAMM, Synergy, and Legacy
- continues operations while continuing to provide some funding to conduct the science including training of early-career researchers

See OPTION 2 Slide for further comments.

Weakness - This version is more expensive than Option 2.

Chandra Option IV Concept

Strengths:

- Restoring the nominal observing efficiency will permit double the on-sky exposure, doubling the scientific impact of the observatory.
- Restoring the GO program maximizes discovery space and allows the science program to respond to new developments as effectively as possible.

Weakness - Requires agreements to provide necessary funding.

Chandra: General Findings and Remarks

- After considerable discussion the committee agreed that continuation of a scientifically viable CXO mission was not possible within the funding constraints of the FY25 proposed budget (PBR).
- Option II, though entailing considerable reductions in science and loss of GO observing and funding support, provided a proof of concept that a scientifically viable (and impressive) mission is possible with more modest (but still large) reductions in funding relative to FY24 and those projected in the 2022 Senior Review.
- In common with HST, the options raise serious questions about the relative impacts of reductions to GO funding vs (permanent) reductions in mission capability, which need to be addressed at levels above the OPCR. [RCK: Consideration might be given to whether funding impacts on the two user communities should be handled consistently.]

Acronym List

CXC	Chandra X-ray Center
FACA	Federal Advisory Committee Act
GO	Guest/General Observer
HWO	Habitable Worlds Observatory
OPCR	Operations Paradigm Change Review
TDAMM	Time Domain and Multi Messenger