

NASA Athena Project Independent Programmatic and Cost Review

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Purpose

- **This review was held in response to the June 2020 NASA HQs charter for the Advanced Telescope for High-Energy Astrophysics (ATHENA) Independent Cost Review.**
 - *The goal is to help ensure that the current plans for the NASA contributions to ATHENA are consistent with the (capped) development costs and the Life-Cycle Cost (LCC) estimate.*
 - *The Review Team met with the Project Team for five full afternoons to discuss the activities.*
 - Followup questions were answered quickly by the Project, and clarification discussions were held where necessary.
- **Review activity summary**
 - *Assess NASA's project cost assessment for all of the US contributions to ESA's ATHENA mission.*
 - *Identify any underlying risks that may threaten the cost boundaries.*
 - *Provide an estimate of the cost-capped activities (and compare to the cost cap).*
 - *Provide an estimate of the LCC (and compare to current estimates).*

Overview - NASA Contributions

- **The NASA contributions to ATHENA include a set of activities spanning Phase A through Phase D.**
 - *This is a mix of hardware, test support, algorithms, and specific labor support.*
 - *These activities are cost capped at “\$100M - \$150M.”*
- **In addition, there is a Science Support activity that extends From Phase B to Phase E.**
 - *These activities are not cost capped, but are evaluated as a part of the LCC of the ATHENA contribution.*

Purpose

■ Review topics

– *Deliverables from pre-Phase A through Phase D (cost capped):*

- X-IFU technology, ground support equipment (GSE), and testing hardware and software
- X-IFU Technology Development Plan
- WFI Background Module algorithms and software development/testing
- WFI ASIC design development consultation, testing, and implementation support
- Moog vibration isolation system procurement and delivery
- XRCF services for the demonstration mirror modules including the flight mirror
- XRCF services for characterization of the demonstration, qualification, and flight mirrors
- XRCF services for the flight mirror calibration
- Project management

– *Science support from Phase B through Phase E (part of LCC):*

- NASA Athena Study/Science Team
- NASA Athena Data Center
- Guest Investigator Program

Review Team

- Edward Cheng/Conceptual Analytics (chair)
- Mark Goans/GSFC
- George Helou/Caltech
- Steve Holt/Olin
- Markus Loose/Markury Scientific
- Gary Matthews/ATA
- Dan McCammon/Univ. of Wisconsin
- Gary Rawitscher/Consultant
- Jackie Townsend/GSFC
- Justin Yoshida/Aerospace Corp.

Review Timeline

- **NASA HQs chartered the Advanced Telescope for High-Energy Astrophysics (ATHENA) Independent Cost Review in June/July 2020.**
 - *NASA is providing several contributions to this ESA mission.*
 - *The goal is to help ensure that the (capped) development costs and the Life-Cycle Cost (LCC) for the ATHENA contributions are consistent with current plans.*
- **The Program Office assembled the Review Team in July/August.**
 - *An internal kickoff meeting for the Review Team was held on August 26.*
- **The Review Team held five meetings in September/October with the ATHENA Program and Project Team, addressing the topics defined in the charter.**
- **The Review Team held a caucus meeting on November 6 to start assembling the final report.**
- **The Review Team held a second caucus meeting on December 18 to finalize the report.**
- **The final report was formally delivered to the Program Office on January 15, 2021.**

Executive Summary Summary Graphic

Topic	Technical	Cost	Schedule	Contractual	Comments
Management	C				Manage commitment scope.
WFI Background Module	A	A	A	A	Assume later transfer to science budget.
WFI ASIC	A	B	A	B	Ensure this is a LOE activity. Delays likely.
Vibration Isolation System	A	A	B	B	Long duration between EM and FM.
XRCF Mirror Testing	B	C	C	C	Test requirements maturity and GSE.
X-IFU Components	B	C	C	A	Complex interfaces.
Science Support	A	B	A	B	Need SGS procurement decision early.
Mission Cost Cap	D				Projection exceeds cost cap (and LCC budget).

Legend:	
Execution should be manageable with normal processes	A
Some execution aspects will require extra diligence - there are potential risks that can be avoided	B
Some execution aspects require near-term attention - these are risks ready to realize	C
Immediate attention required - the current situation may be violating stated assumptions	D

- The Management and Mission Cost Cap topics are assessed overall and not separated into the four (column) categories.
- BOE for individual topics is well understood.
- Risk of scope increase and/or schedule slips drives the overall mission cost cap risk.

General Observations

- The NASA contributions to ATHENA draw upon unique skills and capabilities in the US community, and are key to mission success.
- The NASA contributions consist of multiple disparate deliverables that span multiple disciplines with many potential interfaces.
 - *Managing and enforcing the lines of authority and change control will be especially important for successful execution.*
- There is a natural continuous tension between “cost capped” NASA contributions and overall “mission success” that needs to be closely monitored and managed.
- The most serious cost risks derive from immature requirements (leading to future requirements creep to ensure mission success) and ESA schedule slips (which the Review Team believes are almost inevitable, and will result in cost growth from at least the marching army). These risks are largely not under the control of the development team, and it is to their credit that the many aspects that are under their control are being skillfully managed.
- When these factors are considered, in order to maintain the cost cap on the hardware development activity at \$150M, a significant level of reserves would need to be maintained today. Thus, the costed contributions would necessarily need to be significantly less than \$150M to allow for reserves to protect the development cost cap.
 - *However, the probabilistic cost assessment completed as a part of this review shows that the currently in-scope activities **already will exceed** the cost cap and the life-cycle cost budget.*
 - *This is the result of a purely cost- and risk-based analysis. Future planning needs to carefully consider impacts to mission success from any changes.*
- **The review team verified the project’s estimate of the life cycle cost before risks are taken into account. A reasonable reserve posture assuming a ~2033 launch leads to a total hardware cost within the ~150M cap**

Major Risks Summary (2)

- **These specific risks are included in the cost estimate analysis.**
 - *ESA-01: ATHENA Schedule Delays Impacts NASA Contribution*
 - *X_IFU-02: Delays in X-IFU EM Development*
 - *X_IFU-01: NASA Develops X-IFU Cryogenic Harness*
 - *X_IFU-04: Extended X-IFU Support Thru Phase D*
 - *XRCF-02: Mirror Environmental Test at GSFC*
 - *XRCF-03: Metrology and Shutter System for XRCF*
 - *BAM-02: Extended BAM Support to WFI*
 - *XRCF-05: XRCF STE/MGSE Underscoped*
 - *A_PO-01: Addition Project Office Staffing*
 - *ASIC-02: Extended ASIC Analysis Support to WFI*
 - *SOFT-1: Soft Ride Cost Growth*
 - *X_IFU-06: Delays in X-IFU FM Development*