Project Update

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NASA Project Manager
Highlights Since Last FST Meeting (Feb. 2008)

- **Mission Configuration Studies with single telescope for IXO**
  - Conducted trade of mirror size, mass, and focal length
  - Investigated mission options for deployable metering structure
  - Defined strawman parameters and payload for July Mission Design Lab study
  - XMS study in Instrument Design Lab (week of May 19)
  - Initiated Flight Mirror Assembly concept study
  - Developed error budget and plans for 5 arcsec angular resolution
  - Conducted MDL study (week of July 28) for observatory concept definition

- **Technology Development**
  - **Mirror**
    - Mirror segment fabrication and metrology consistent with 15 arcsec requirement; improving toward 5 arcsec
    - Good progress on alignment of segments into housing
  - **Microcalorimeter**
    - Demonstrated spectral resolution for inner array pixels in 8 x 8 arrays; multiplexing of 32 pixels
    - Initiated development of read-out for larger (32 x 32) arrays
IXO Mission Study

- Mission Design Lab (MDL) study was conducted at GSFC during week of July 28, 2008

- Effort to define concept includes extensive “pre-work”, including definition of strawman payload and accommodation parameters, observatory requirements, parameters, and overall lay-out.

- This particular study was limited to:
  - 20 m focal length
  - 3.3 m diameter flight mirror assembly (slumped glass mirror technology)
  - Instrument complement consisting of X-ray Microcalorimeter Spectrometer, Wide Field Imager (WFI), Hard X-ray Imager (HXI), X-ray Grating Spectrometer
  - Atlas V 551 launch vehicle

- Overall, from studies performed to date, mission concept appears viable with positive margins
  - Provides “proof-of-concept” for extensible bench mission configuration

- Work on this configuration is continuing
Strawman Payload Summary

Single Flight Mirror Assembly (FMA)
- Grazing incidence, highly nested mirrors
- 20 m focal length

Four instruments
- X-ray Microcalorimeter Spectrometer (XMS)
  - Covers 0.6 to 10 keV with high spectral resolution
- Wide Field Imager (WFI)
  - Covers 0.1 to 15 keV with large FOV
- Hard X-ray Image (HXI)* extends the WFI bandpass to 40 keV
  - Assumed detector head within WFI envelope
- X-ray Grating Spectrometer (XGS)
  - Dispersive from 0.3 to 1 keV
  - Two grating arrays mount to aft of FMA
  - CCD camera for readout on fixed instrument platform

Note:
* Response by the FMA for this particular design (without multilayers) does not meet desired level for high energies.
Mission Effective Area

- **Flight Mirror Assembly**
  - 3.3 m overall outer diameter (3.2 m largest diameter on optical surface)
  - 20 m focal length
Single Mirror IXO Configuration

- **Instruments**
  - X-ray Microcalorimeter Spectrometer
  - Wide Field X-ray Imager
  - Hard X-ray Imager
  - X-ray Grating Spectrometer

**Diagram Elements**
- Deployable Metering Structure w/Shroud
- Fixed Isogrid Structure
- Flight Mirror Assembly
- Spacecraft Bus Module
- Solar Array
Instrument Module

- Sunshade
- XMS
- Radiators
- WFI/HXI
- Fixed Instrument Platform
- X-ray Grating Spectrometer CCD
- Movable Instrument Platform
- Deployed Shroud
## Launch Configuration and Mass Summary

### Payload

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimate (kg)</th>
<th>Cont. Allocation (%)</th>
<th>Allocation (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Mirror Assembly</td>
<td>1775</td>
<td>30%</td>
<td>2308</td>
</tr>
<tr>
<td>XMS</td>
<td>258</td>
<td>30%</td>
<td>336</td>
</tr>
<tr>
<td>WFI</td>
<td>80</td>
<td>30%</td>
<td>104</td>
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<tr>
<td>XGS</td>
<td>62</td>
<td>30%</td>
<td>81</td>
</tr>
<tr>
<td>HXI</td>
<td>24</td>
<td>30%</td>
<td>31</td>
</tr>
<tr>
<td>Misc. Payload Accom</td>
<td>51</td>
<td>30%</td>
<td>66</td>
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<tr>
<td><strong>Payload Total</strong></td>
<td><strong>2250</strong></td>
<td><strong>30%</strong></td>
<td><strong>2924</strong></td>
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### Bus

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<tr>
<th>Component</th>
<th>Estimate (kg)</th>
<th>Cont. Allocation (%)</th>
<th>Allocation (kg)</th>
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<tbody>
<tr>
<td>Avionics</td>
<td>66</td>
<td>30%</td>
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<tr>
<td>Communications</td>
<td>36</td>
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<td>47</td>
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<tr>
<td>Attitude Control</td>
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<tr>
<td>Structure and Mechanisms</td>
<td>1188</td>
<td>30%</td>
<td>1545</td>
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<tr>
<td>Power</td>
<td>108</td>
<td>30%</td>
<td>141</td>
</tr>
<tr>
<td>Propulsion (dry)</td>
<td>48</td>
<td>30%</td>
<td>63</td>
</tr>
<tr>
<td>Thermal</td>
<td>239</td>
<td>30%</td>
<td>311</td>
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<tr>
<td>Harness</td>
<td>274</td>
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<td>357</td>
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<td><strong>Bus Total</strong></td>
<td><strong>2033</strong></td>
<td><strong>30%</strong></td>
<td><strong>2643</strong></td>
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### Observatory

<table>
<thead>
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<th>Component</th>
<th>Estimate (kg)</th>
<th>Cont. Allocation (%)</th>
<th>Allocation (kg)</th>
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<tbody>
<tr>
<td>Observatory On Orbit Dry Mass</td>
<td>4282</td>
<td>30%</td>
<td>5567</td>
</tr>
<tr>
<td>Separation System LV Side</td>
<td>227</td>
<td>6%</td>
<td>241</td>
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<tr>
<td>Propellant Mass (10 yrs)</td>
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<td>308</td>
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<tr>
<td><strong>Observatory Wet Launch Mass</strong></td>
<td><strong>6116</strong></td>
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### Margins

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimate (kg)</th>
<th>Cont. Allocation (%)</th>
<th>Allocation (kg)</th>
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<tr>
<td>Atlas V 551 Throw Mass (C3=-0.5)</td>
<td>6425</td>
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<td>Project Manager’s Margin</td>
<td></td>
<td></td>
<td>309</td>
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5% margin
Preparations for Decadal Review

- Input required for Decadal likely to be similar to what was required for recent National Research Council (NRC) Beyond Einstein Program Assessment Committee (BEPAC) review, which required the following information:
  - Science
    - Mission science objectives and flowdown to measurement requirements and performance requirements
    - Science reach compared other existing/planned missions
  - Instrumentation
    - Approach and rationale for selection
    - Performance requirements
    - Technical maturity and schedule/plans to achieve Technology Readiness Level (TRL) 6
    - Flight operations modes, complexity and software
    - Data and data analysis plans
Preparations for Decadal Review (cont.)

- Observatory
  - Spacecraft characteristics, requirements, drawings/diagrams
  - Launch options
  - Key trades performed and planned
  - Spacecraft technologies TRL status, open issues
  - S/C subsystem characteristics and requirements
  - Flight heritage of S/C systems
  - Accommodations of instrumentation
- Mission operations and ground system
- Risks and mitigation plans (top 3 for each instrumentation, spacecraft bus, overall mission)
- Mission descope options and associated performance and cost impacts
- Schedules for instrumentation, spacecraft, overall mission
- Organizational structure and responsibilities
- Cost Estimate and profile
  - 70% confidence
  - Basis of estimate and validation

- NRC will independently determine 70% confidence cost estimate
Project Lifecycle

Phase A
Preliminary Analysis
- Mission Definition
  - 2 years
  - Fabrication
  - I&T
  - Deployment
  - 4 years 6 months

Phase B
Definition
- Preliminary Design
  - 2 years
  - Launch 12/2020
  - Transition To Operational 4/2021

Phase C
Design
- Final Design
  - 12 months
  - Phase D-1 Subsystem Development and Observatory Integration and Test
  - Cruise & Orbit Insertion
  - Deployment
  - 4 months

Phase D-2
Launch & Checkout

Phase E/F
Operations
- End of Primary Mission 4/2026
- Mission Ops

Project Lifecycle Timeline:
- Project Start 6/2011
- End of Primary Mission 4/2026
Nominal Plan to prepare for Decadal

- Target for initial submittals to Decadal as early as February 2009
- Finalize Science measurement requirements and performance requirements
  - Facility Science Team meeting (Aug 2008), IXO Workshop and Coordination Group Meeting (Sept 2008)
- Mission and Instrument Concept Update
  - XMS Instrument Design Lab (IDL) study — May 2008 ✔Complete
  - Observatory Mission Design Lab — Jul 2008 ✔Complete
  - SXT Flight Mirror Assembly (FMA) — Jul thru Oct 2008
  - Mission study in ESA CDF — Oct/Nov 2008
  - Conduct supporting technical analyses, refinement, etc. — Sept thru Dec 2008
  - Update/complete all information for decadal (risk assessment operations, etc.) — Dec 2008-Jan 2009
- Schedule
  - Update FMA Schedule (mission development critical path) — Oct thru Dec 2008
  - Update instrument, S/C, and overall mission schedules — Oct 2008 thru Jan 2009
- Costs
  - Generate 70% confidence cost estimates — Aug 2008 thru Jan 2009
- Technology Demo’s
  - Define plans/schedule to achieve required mission performance — Oct thru Dec 2008
  - Complete demonstrations – December 2008 thru June 2009