BEYOND EINSTEIN: From the Big Bang to Black Holes

Mission Status Update

Nicholas White

Project Scientist

NASA GSFC

2006 HEAD Meeting

October 4 - 7

San Francisco, CA

Overall Mission Status

Constellation-X is an approved mission, currently pre-phase A

- **Pre-phase A activities**
  - Documentation of science requirements and goals**, flow down to measurement requirements and mission implementation**
  - Technology development **in TRL3-6 range**
  - Mission architecture studies **that realize the science requirements, while minimizing the cost and technical risk**

- **Launch date is currently driven by budget constraints and programmatic considerations, not technology or schedule**
  - Decision pending whether Con-X, LISA or JDEM proceeds as next major Astrophysics observatory, and mission ordering there after…

- **National Academy Review will determine which Beyond Einstein mission goes first**
  - Report due in September 2007
  - Con-X Team busy preparing for this activity

National Academy Review

NASA and DOE funded National Academy of Science Study with the following charge to the Space Studies Board:

1. Assess the five proposed Beyond Einstein missions and recommend which should be developed and launched first using the following criteria
   - Potential scientific impact within the context of other existing and planed space-based and ground-based missions
   - Realism of preliminary technology and management plans, and cost estimates
2. Assess the remaining four missions sufficiently so that they can act as input to the decadal survey on the ordering of the remaining missions
   - Assist NASA investment strategy for Beyond Einstein prior to the decadal

Deadline for report September 8, 2007 (so as to impact FY 2009 budget)

- *Input from missions is not yet specified*
- *Timeline of events unknown*

Con-X Science Enhancement Package

- The Science Enhancement Packages (SEP) extends the basic performance so as to achieve the full Con-X science objectives:
  - Provide increased spectral resolution at low energies (< 0.6 keV) to maintain a resolving power of R > 300, and/or additional coverage at high energies (>10 keV)
  - A maximum of 100kg and $100M have nominally been allocated
  - SEP concepts can involve both new instrumentation, or modifications to the existing XMS and/or the SXT mirror designs
  - New instrumentation must fit within the available envelope
  - Concepts must assume 4 SXT is the reference configuration, but also should address how the concept would be modified if the 3 SXT design were adopted

- The project may use one or more SEP concepts as part of the planning and development of this single Atlas V launch vehicle approach as a new mission reference design

SEP: Design Options

SEP concepts may include, but are not limited to the following:

- Extend High Energy Capabilities (>10 keV):
  - Multi-layer SXT inner mirror shells
  - Restore some HXT modules
  - Extend the XMS bandpass to higher energies
  - Use hybrid XMS for High Energy response

- Extend Low Energy/High Resolution Capabilities (<1 keV):
  - Use hybrid XMS for High Resolution at Low Energies
  - Implement multiple detectors in focal plane
  - Include a simplified grating/detector system

SEP RFI Timetable

- RFI will be released on October 12th
  - responses by 4pm November 17, 2006
  - No funding is available for this phase of the SEP study
  - Submissions must be limited to no more than 10 pages (8.5 x 11 inch) single sided. Figures, tables and other supplementary material must be included within the page limit
  - Do not include any information that is restricted or limited
- Facility Science Team Meeting at GSFC to discuss new Atlas V configuration and the SEP proposals: Dec 18-20
  - One day workshop Dec 18 at GSFC, where each SEP team are invited to present their concept

SEP Request for Information

Responses should address SEP concepts that provide high energy coverage and/or high spectral resolution at low energies. Papers should include the following elements:

Science

Description of the SEP science capabilities and how it augments the capabilities provided by the basic payload to achieve the Con-X science objectives

Technical

Description of the overall SEP concept, the associated technology, and how it would interface with or modify the basic payload or mission concept

Estimated mass, power and dollar cost as they relate to the maximums given above.

Brief discussion of any significant impact on the SEP if the payload is 3 SXT instead of 4 SXT

Performance

Estimated performance including the bandpass, efficiency, spectral resolution, and angular resolution

Any estimated reduction in capability of the basic payload

Technology Readiness

Status of the technology (including Technology Readiness Level, or TRL) needed to implement the SEP concept

Overview of major steps required to achieve TRL 6 for the proposed SEP

Important Addresses and Contacts

- The RFI and information on the Con-X observatory configuration and estimated capabilities for the Single Atlas V launch will be found at

  https://conxproj.gsfc.nasa.gov

- Submission Information: **Lorrie.L.Eakin@nasa.gov** (reference 210S-GBG-06-001)
- Technical questions: Dr Jean Cottam at **jcottam@milkyway.gsfc.nasa.gov**
- FST (Dec 18-20, 2006) at GSFC

  Meeting information: Sandy Barnes at **sbarnes@lheapop.gsfc.nasa.gov**

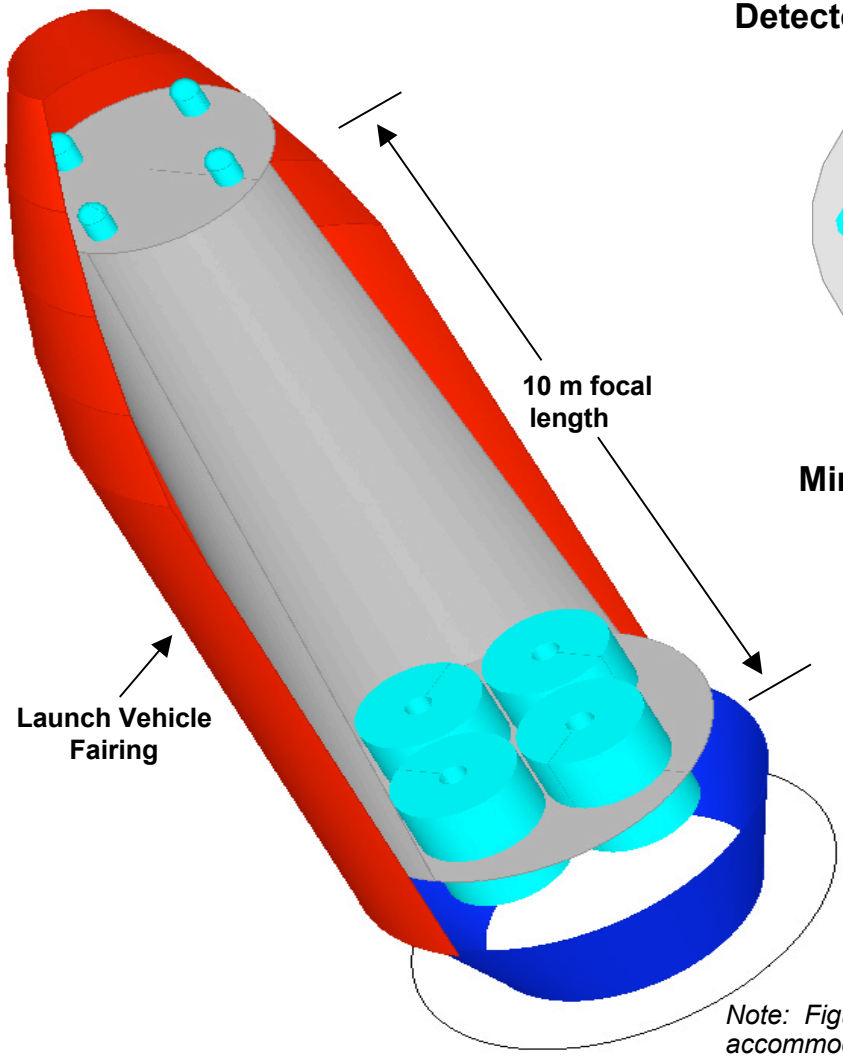
  – **Those attending the FST must contact Sandy Barnes by email (or at the HEAD registration desk) as soon as possible to ensure badges are processed in time:**
    - **Non-US citizens: 6 weeks (before November 6, 2006)**
    - **US Citizens: 1 week (before December 11, 2006)**
    - **The sooner the better! And do it even if your not sure that you will be coming!!!**

Summary

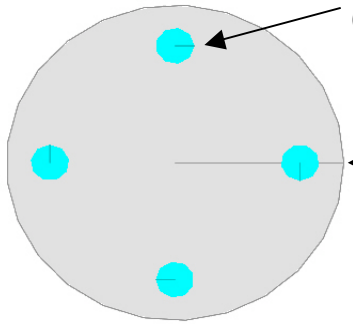
- Academy study over next year to determine which BE mission goes first, *Constellation-X is well placed to take the first slot*
- A single launch, single satellite Atlas V approach is now under study as the reference mission to present to the NAS review
- Response for Information (RFI) for a Science Enhancement Package to complete the Atlas V configuration approach
- Community input on the SEP and assistance with the science case is welcome (contact Ann Hornschemeier and Mike Garcia)
- Facility Science Team (FST) at GSFC Dec 18-20, 2006: all are welcome and encouraged to attend

Con-X Atlas V 551 Single Launch 4 SXT Configuration

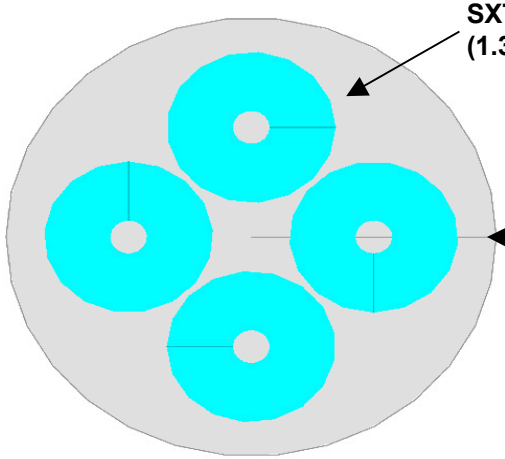
ATLAS V 551



Detector Bench View

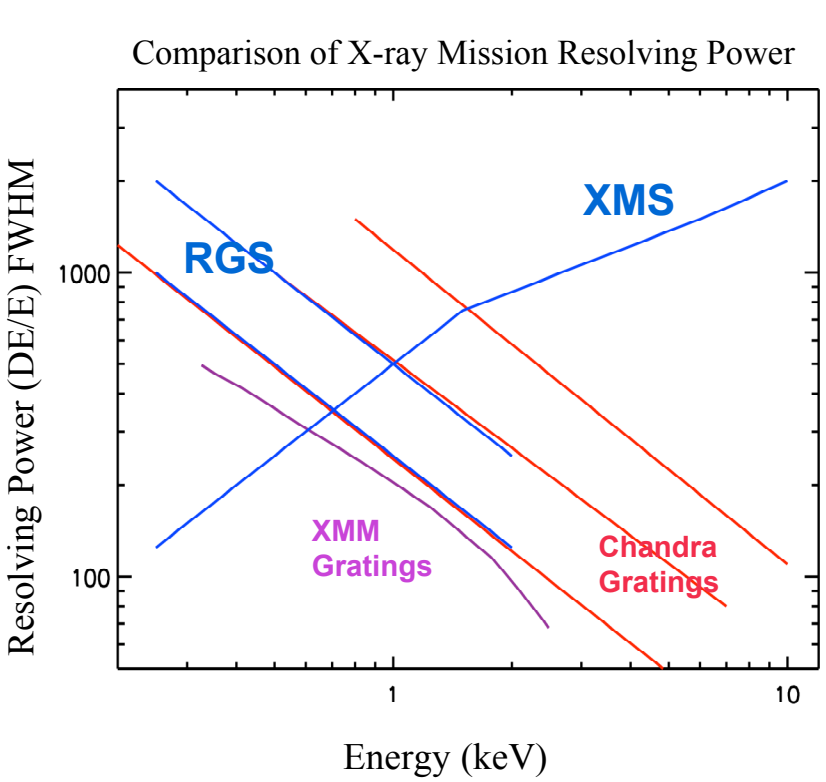


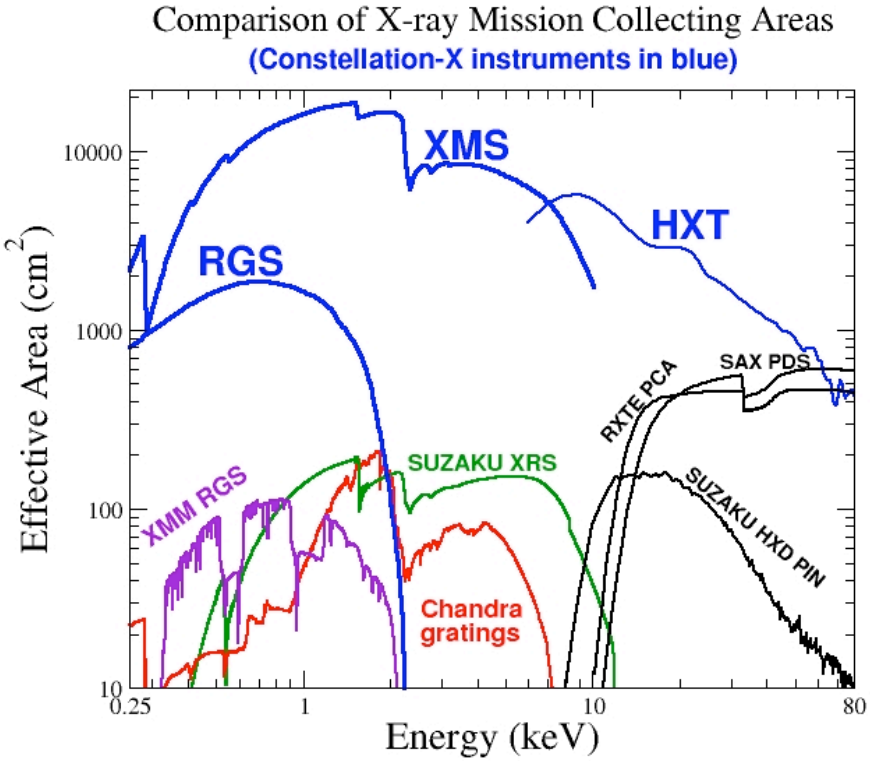
Mirror Bench View



Note: Figure provides notion of potentially available volume for accommodation of SEP and spacecraft subsystem hardware. Optical path between XMS detectors and SXT FMA's must remain unobstructed.

Con-X Delta IVH Reference Mission Capabilities



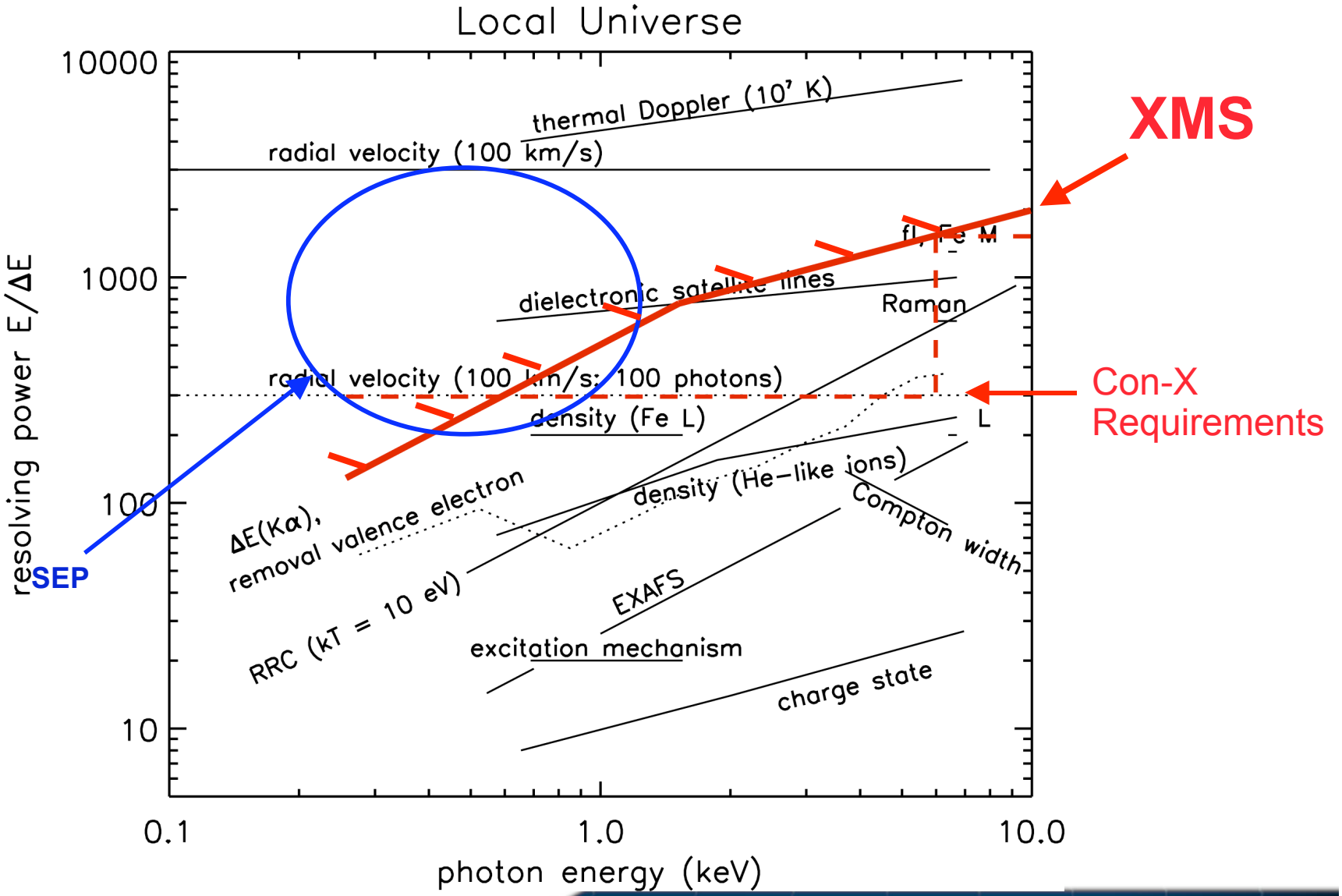


SEP concepts should provide increased spectral resolution at low energies (< 0.6 keV) to replace RGS so as to maintain a resolving power of R > 300, and/or additional coverage at high energies (>10 keV) to replace the HXT

Con-X Performance Requirements

Parameter	Con-X Reference Requirements	Con-X Atlas V Projected Basic Payload Capability
Effective Area:		
0.25-10.0 keV	1,000 cm^2	≥ 1,000 cm^2
1.25 keV	15,000 cm^2	15,000 cm^2
6.0 keV	6,000 cm^2	6,000 cm^2
10.0 - 15.0 keV	1,500 cm^2	1,000 to 175 cm^2
15.0 - 40.0 keV	1,500 cm^2	≤ 175 cm^2
Resolving Power (FWHM):		
0.25-0.6 keV	300	125 to 300
0.6 - 6.0 keV	300	300 to 1500
6.0 - 10.0 keV	1500	1500 to 2500
10.0 – 15.0 keV	10	> 1000
15.0 - 40.0 keV	10	---
Angular Resolution (HPD):		
0.25 - 10.0 keV	15.0 arcsec	15.0 arcsec
FOV:		
0.25 - 10.0 keV	2.5 arcmin	2.5 arcmin

Constellation-X Spectral Requirements



Constellation-X Hard X-ray Requirements

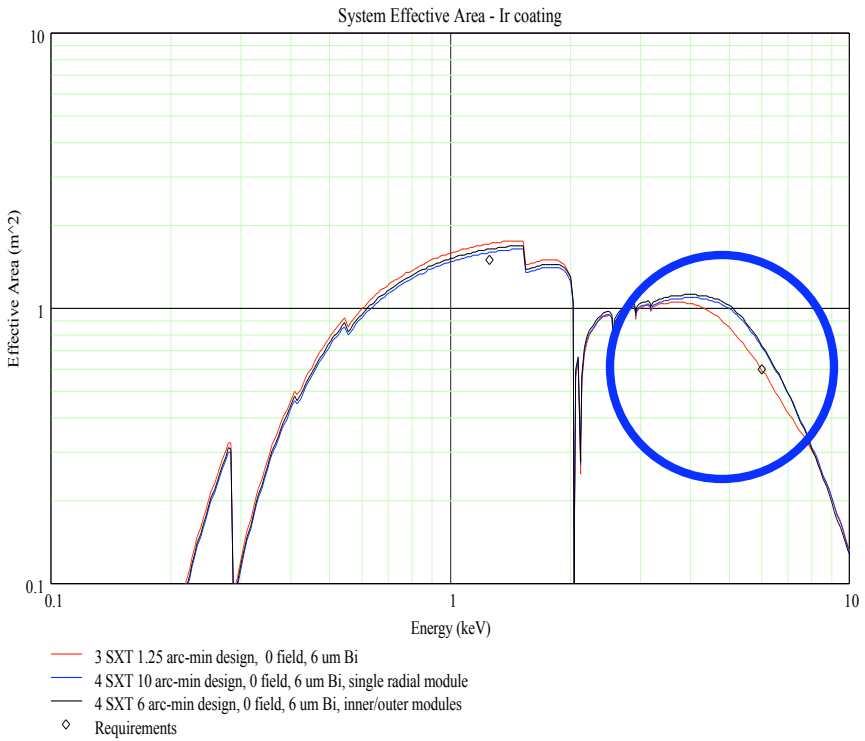
- Current requirements is driven by the need to meet a sensitivity comparable to that of the Spectroscopy X-ray Telescope for a typical AGN:
  - a collecting area of 1500 cm^2 at 40 keV
  - Angular resolution of 1 arc min

- SEP proposals are encouraged to reformulate this requirement taking into account the latest results from Suzaku, Chandra, XMM-Newton, combined with the latest technology developments

3 SXT v 4 SXT: A Trade Study

- Top level issue:
  - 4 SXT: Maximize the science performance of the SXT+XMS at 6 keV
  - 3 SXT: Minimize cost and mission mass

- The project approach is to maximize the science performance and has **adopted 4 SXT as the reference**
  - Provides maximum performance margin on the overall mission parameters



Iridium will be adopted as the mirror coating for the reference mission, again to maximize mission performance and also leverage Chandra experience

Significant Mission Study Events the Past Year

- **Study in 2005 of single satellite and single launch options**
  - Delta IVH shown to be feasible and saves $100M ($2.6B to $2.5B)
  - Adopted as new reference mission in Spring 2006
- **Budget cut by 50% in February 2006, half way through the fiscal year prompted a radical restructuring of the project**
  - Project office staffing cut back to bare minimum
  - Technology programs curtailed to focus on optics and calorimeters
- **To substantially reduce mission cost and risk, the Con-X project is studying a streamlined mission design that can be launched on a single Atlas V 551 launch vehicle**
  - Potential cost saving of $600M (to $1.9B), and also a major reduction in mission risk
  - Appropriate response to much tighter NASA budget environment