Progress on Constellation-X Design Reference Mission

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Current top-level requirements

- Bandpass – 0.25 to 40 keV (goal 60 keV)
- Min. Resolving power 0.25–10 keV = 300
- Wavelength accuracy <20% (goal <10%)
- Minimum effective area @ 1.25 keV = 15,000 cm^2
- Photometric accuracy <10% (<5 % goal)
- Relative flux accuracy <5% (<2% goal)
- Angular resolution 15 arcsec HPD below 10 keV
- Minimum f.o.v of 2.5 arcmin (goal 5 arcmin)
- Timing accuracy 100 microsec (goal of 50 microsec)
- Celestial location accuracy of 5 arcsec
- Slew times less than 1 hour

Discussed later

The purpose of the DRM

- To describe a scenario for the expected usage of Constellation-X for GO science.
- From this scenario we can derive slew rates, downlink volume, data storage requirements, power requirements, etc.
- DRM will be used by industry to evaluate the satellite design. Contractors can use DRM scenarios to show that their design satisfies our needs.
- Help us examine alternate requirements and pinpoint needed science trade-off studies.

DRM Proposals received so far:

lheawww.gsfc.nasa.gov/users/kweaver/Constellation-X_DRM.htm

- OB stars in the Magellanic Clouds: The dependence of hot star X-ray emission on metal abundances
- Low Mass Stars in Tr 10 and the Vela OB2 Association
- X-rays from Class I T Tauri Stars
- Circumstellar absorption in the V471 Tau system
- TOO observations of SNIa
- Kinematics of the Fe-rich ejecta in the SNR DEM 71
- The Effects of Extreme Gravity: Iron K line reverberation studies
- Multiwavelength Observations of the Black Hole XTE J1118+480 in Quiescence
- The Photosphere of Neutron Stars
- The interaction between the hot gas and radio plasma in Cyg A
- Dark Matter Distribution in the spiral galaxy NGC 891

Critical Science not yet covered

- Missing Baryons in the Intergalactic Medium
- Abundances in Galactic Halos
- Cluster Cooling Flows
- Star Formation History in the Universe
- Composition of interstellar medium
- Heavily Absorbed AGN and the X-ray Background
- The High Redshift Universe
- Solar System X-rays
- Cataclysmic Variables
- Extragalactic Populations

Example proposal (McClintock et al.)

1. Title of Investigation:

Multiwavelength Observations of the Black Hole XTE J1118+480 in Quiescence

2. Science Category:

Galactic X-ray binary with black-hole primary

3. Abstract:

We propose to (1) assemble the best possible optical to X-ray spectrum of a quiescent black hole, (2) constrain the radius of the inner edge of the accretion disk, (3) determine if the UV/optical emission is due to the accretion disk or to an advection-dominated flow, (4) acquire key data on the extreme faintness of black holes relative to neutron stars, and (5) test models proposed to explain the faintness of quiescent black holes.

5. Objects:

XTE J1118+480

6. Technical Feasibility Discussion:

Please describe any feasibility issues, especially with respect to the baseline mission.

XTE J1118+480 is a faint, isolated, point source. I do not expect that there are any feasibility issues. We require a very good flux calibration at low energies (E ~ 0.3 keV) in order to scrutinize the spectrum there (NH = 1.3×10^{20} cm^2).

7. **Energy Range** *For calibration purposes, what energy range is most important for this observation (in keV):* __0.3 - 7.0_____

8. Count Rates (counts per second): CHANDRA ACIS-S COUNTRATE = 0.0018

8a. SXT/Calorimeter: Peak (per pixel):_____ Average over the detector:_____

8b. SXT/Grating: Peak in the strongest line:_____

8c. What is the zeroth order count rate for the grating/CCD?_____

8d. HXT: Peak (per pixel):_____Average over the detector:_____

Probably too faint to be detected, even though the 1-10 keV spectrum is a power-law with photon index ~ 2.

9. What is the required signal to noise in the primary instrument? REQUIRE ~10^4 COUNTS IN THE SXT/CALORIMETER

10. Variability and Timing Issues:

10a. Is this a variable source? _Yes__ If yes, approximately how much does the source vary? _~X3; ~X10__

10b. Do you require monitoring observations? (Yes/No) _Yes_ If yes, fill in table 2 (below).

10c. Is there a preferred sequence for the observations? (Yes/No) _Yes_

10d. Do you require precision timing? (Yes/No) _Yes___If yes, at which of the following levels (in absolute UT)? 100 microsec, 500 microsec, 1 millisecond: ____~1 millisecond_____

11. Extended Sources/Crowded Fields:

11a. Is the source in a crowded field (ie., confusing X-ray source within 20") (Yes/No) __No_

If yes, please answer Questions 12a.

11b. Is this an extended source? (Yes/No) _____No___

If yes, please answer Questions 12b.

12. Observing strategy, Pointing Issues:

12a. Do you require a roll angle constraint? (Yes/No) _No___

If yes, specify the angle and acceptable tolerance in Table 1 below.

12b. If extended, do you require a raster scan? (Yes/No):__No____

If yes, list offsets and exposures times per offset in Table 2 below.

13. Target of Opportunity (TOO):

13a. Is this observation a TOO? (Yes/No)_No_____

13b. If yes what response time is required? (hours) _____

14. Target Coordinates

Please specify target coordinates in J2000 including known proper motions. The exposure time should be the total time for each pointing. If raster scans, or multiple observations are required (ie., monitoring or phase dependent observations) the times for individual exposures should be provided in Table 2.

15. Request for additional information from proposers:

BECAUSE WE REQUIRE A BROADBAND SPECTRUM AND THE SOURCE IS TIME VARIABLE, WE NEED SIMULTANEOUS OBSERVATIONS AT UV, OPTICAL AND IR FREQUENCIES.

15a. After looking at the baseline requirements for this mission, are there observing capabilities that you still require for your science? (e.g., Would a non-square calorimeter array be an advantage for your science?)

15b. Do you have special calibration requirements for your observation (wavelength and intensity, etc.) that are not currently available.

WE REQUIRE A SECURE FLUX CALIBRATION AT LOW ENERGIES AS STATED IN POINT #6 ABOVE.

15c. Do you have special needs for simulation tools and software, and what are they?

Send us proposals!

- What capabilities does your science require?
- This is your chance to provide input to the satellite design.
- Your comments for the DRM will help us asses our spectral resolution, spatial resolution and calibration requirements.

Evaluation steps / projected dates:

- What science should be examined? *(Aug. – Oct. 2002)*
- What are people's wish lists? *(Sept. – Oct. 2002)*
- Provide new tools/matrices for evaluation *(Oct. – Nov. 2002)*
- Perform science trade off studies and new simulations *(Nov. '02 – Feb. '03)*
- Enlist help of FST & panels *(Aug. '02 – Feb. '03)*

DRM inputs to date suggest the following science trade studies to be done:

- Calorimeter: 2 eV vs. 4 eV resolution @ 6 keV
- Extend low energy range to 0.1 keV
- Extend HXT high energy range to 60 keV
- Goal of 5 arcsec HPD spatial resolution for SXT
- Energy resolution of >1000 at low energies
- 30 arcsec HXT spatial resolution (important for spatially separating hot gas emission from the hard AGN core emission in galaxies)

Spectral resolution

Requirement of 2 eV at 6 keV

Change to goal of 2 eV, and requirement of 4 eV?

Original requirement was partly based on assumption of constant ΔE for calorimeter and overlap with gratings

What is the physical criteria that defines 1,000?

Set goal for a minimum of ~1,000 based on *Chandra* and XMM results

Spectral Resolution > 300 to resolve He-like triplets at ~ 1 keV

Detect velocity broadening of the ~1 keV Fe-L X-ray lines

To resolve satellite lines of iron K line, what is really required?

Energy Range

0.25 to 40 keV (goal for upper band of 60 keV)

Increase upper band requirement to 60 keV?

Add goal for lower band of 0.1 keV?

In both cases how do we define an effective area at 0.1 keV and 60 keV?

Spatial Resolution

15 arc sec HPD requirement for SXT (5 arc sec goal)

Chandra deep fields verify this is well matched to source confusion. 5 arc sec goal would be helpful for crowded fields (especially galaxies)