Initial jitter analysis of Lynx, a proposed Future Large Astrophysics Facility

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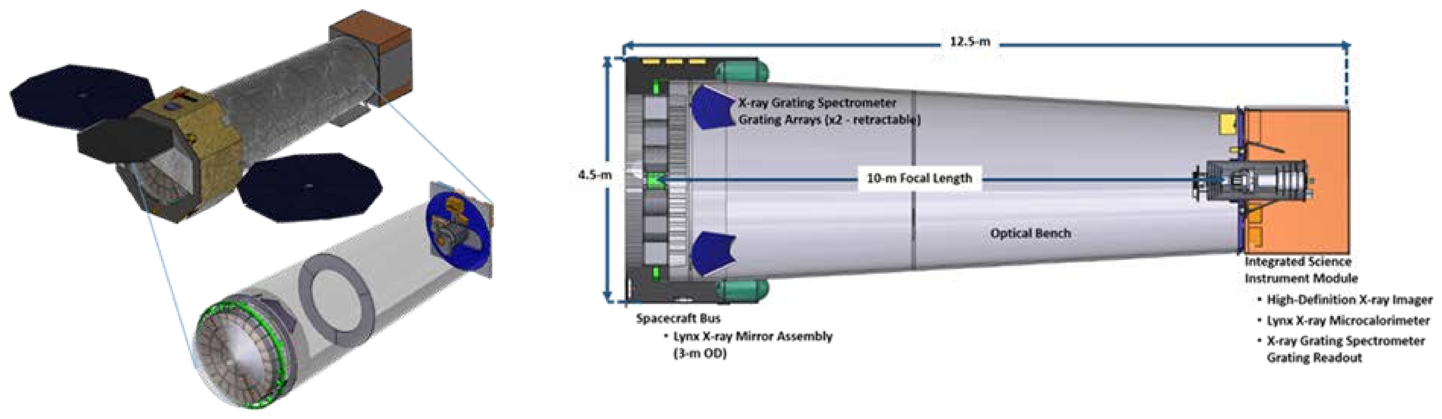
INTRODUCTION

Lynx is an X-Ray telescope large-mission concept for consideration in NASA's 2020 Astrophysics Decadal Survey. A conceptual structural design is evolving that leverages the success and lessons learned from Chandra and that takes into account unique needs of Lynx.



Space optics systems require extreme stability. Any motion in-service (thermal effects, structural dynamics, etc.) impacts performance. An initial analysis was performed to predict the first-cut dynamic responses, jitter, at two selected points on the Lynx observatory. One point is on the Lynx X-ray Mirror Assembly (LMA) and the other, on the focal plane Integrated Science Instrument Module (ISIM). Relative motion between these two points was predicted along with vibration spectra. This information will be used in upcoming analyses of the LMA and the ISIM.

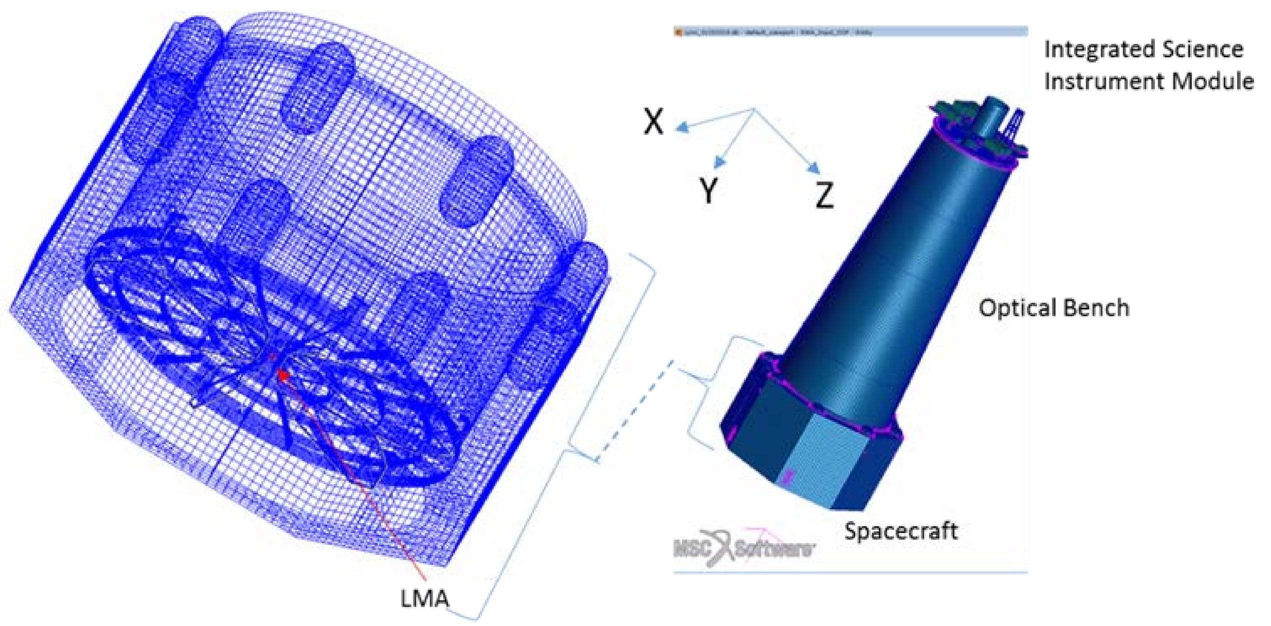
At the feasibility level, the goal is to identify global design decisions that could impact jitter and in doing so drive performance and/or costs.

Possible Impacts to the Lynx Design Concept:

1. Global material selection
2. Load paths
3. Location and arrangement of disturbance sources such as Reaction Wheel Assemblies (RWA)
4. Vibration mitigation devices

DYNAMIC ANALYSIS

A structural dynamic Finite Element Analysis (FEA) was performed to predict the global relative motion between the LMA and the center of the focal plane (which approximates the ISIM base). A detailed representation of the LMA and science instruments are not included in the model so local effects are not yet included in results.



Damping was assumed to be 1.0%. Applied external loads were the Chandra RWA vibration limit specification (frequency dependent axial & radial forces as well as moments). Results (displacements and accelerations) were output at 10 Hz intervals from 0 to 500 Hz as well as at each predicted mode.

An overall Uncertainty Factor (UF) of 2.0 was applied to results and multiple analysis assumptions were conservative. The combination of the scalar UF with the analysis assumptions are considered an overall reasonable UF for this fidelity of a design/analysis. Results presented are effectively factored 2.5-3.0 times above raw predictions.

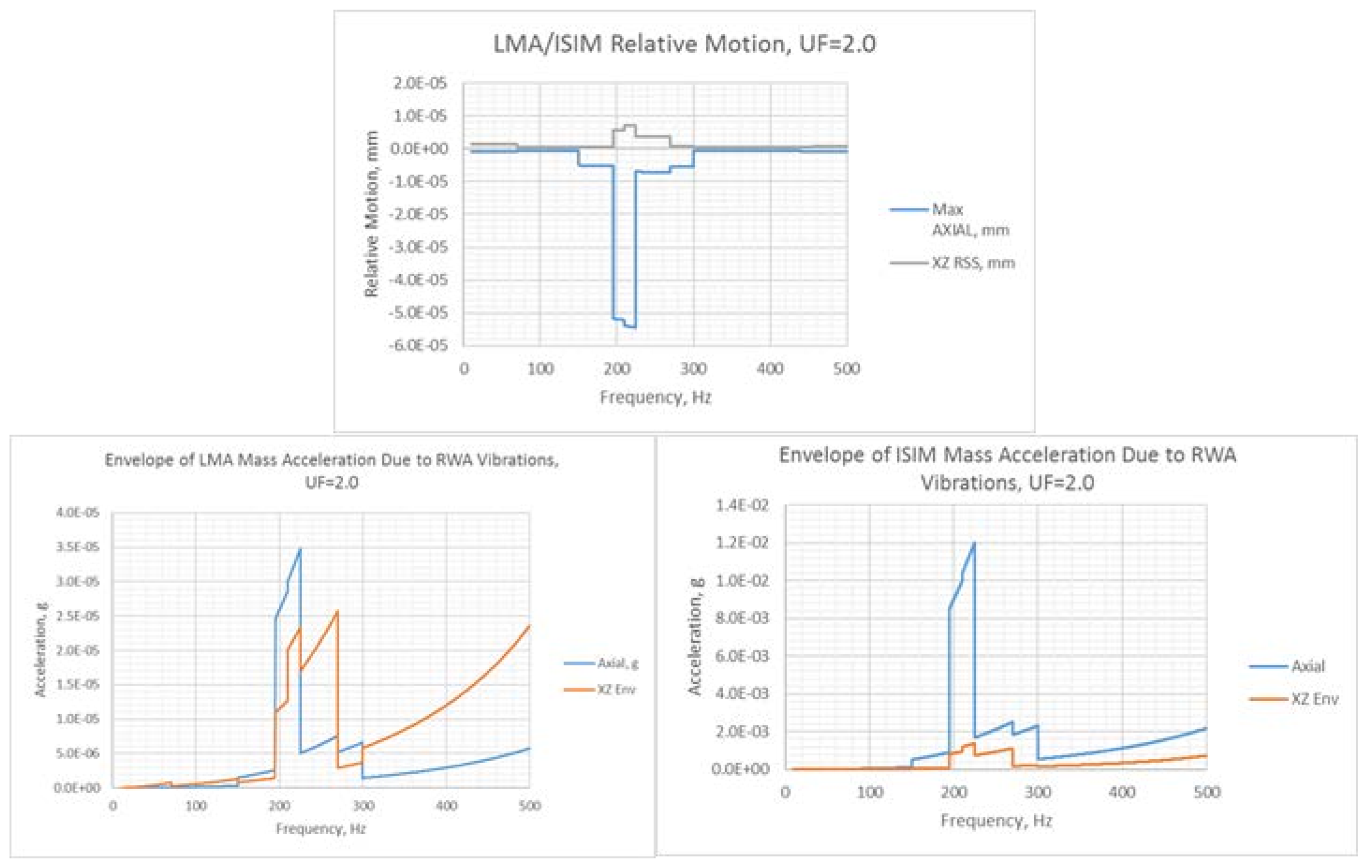
Analyses have been performed that initiate assessments of global design parameters relative to jitter and, therefore, to Lynx performance predictions.

RESULTS

Results include Relative Displacements (RD) in 3 orthogonal directions between the LMA and the ISIM as well as accelerations at the center of those two structures.

- **Relative Displacements are one metric of mechanical stability/performance**
- **Acceleration spectra will be used as input in future analyses with detailed models of the LMA and the ISIM**

A negative RD is indicative of the LMA and ISIM base moving away from one another.



DISCUSSION

Models and analyses are evolving to assess the Lynx performance relative to structural dynamics/jitter. Predicted RDs will be compared to allowable levels once the initial system error budget has been finalized.

Among other things, future analyses will predict:

i. Jitter at the instrument interfaces and of the LMA shells
ii. Transient vibration time associated with moving and re-pointing the telescope

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