X-RAY OBSERVATORY LYNX

Lynx: SIMPLY DESIGNED FOR MAXIMUM SCIENCE RETURN

J. Gaskin. NASA MSFC

Presented on behalf of the Lynx Team

THE PEOPLE BEHIND LYNX

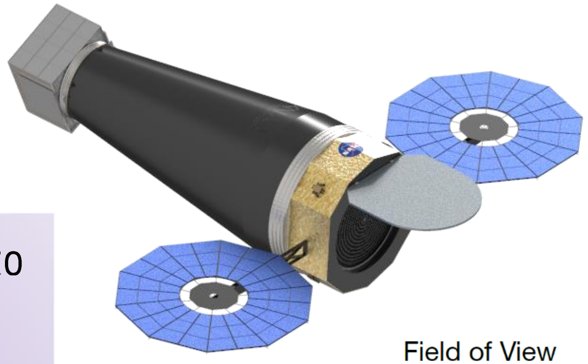
Over 300 total members!

- 22 STDT Members
- 8 Science Working Groups
- Ex-officio International Members
- Instrument Working Group
- Communications Working Group
- Lynx Calibration Working Group
- Optics Working Group

Orgs.	**Effort**
GSFC	HDXI IDL runs LXM IDL & costing contributed effort MDL (Partial)
JPL (ExEP) + X-ray Optics Community	Optics Trade Study facilitation & Evaluation Contributed effort (>35 Volunteers)
X-Ray Grating Spectrometer Team	XGS Trade Study Team (>10 Volunteers)
CAN Study Partners >50% overall contributed	Creare: LXM cryocooler study Hypres: superconducting ADC study Luxel: blocking filter fab. & test Lockheed Martin: LXM cryo-system Northrop Grumman (w/Ball & Harris): Observatory design & analysis
UAH	MBSE modeling of interfaces, requirements & Observatory error budget
Interim Report Red Team	Chair: C. Kouveliotou (GWU) Contributed effort

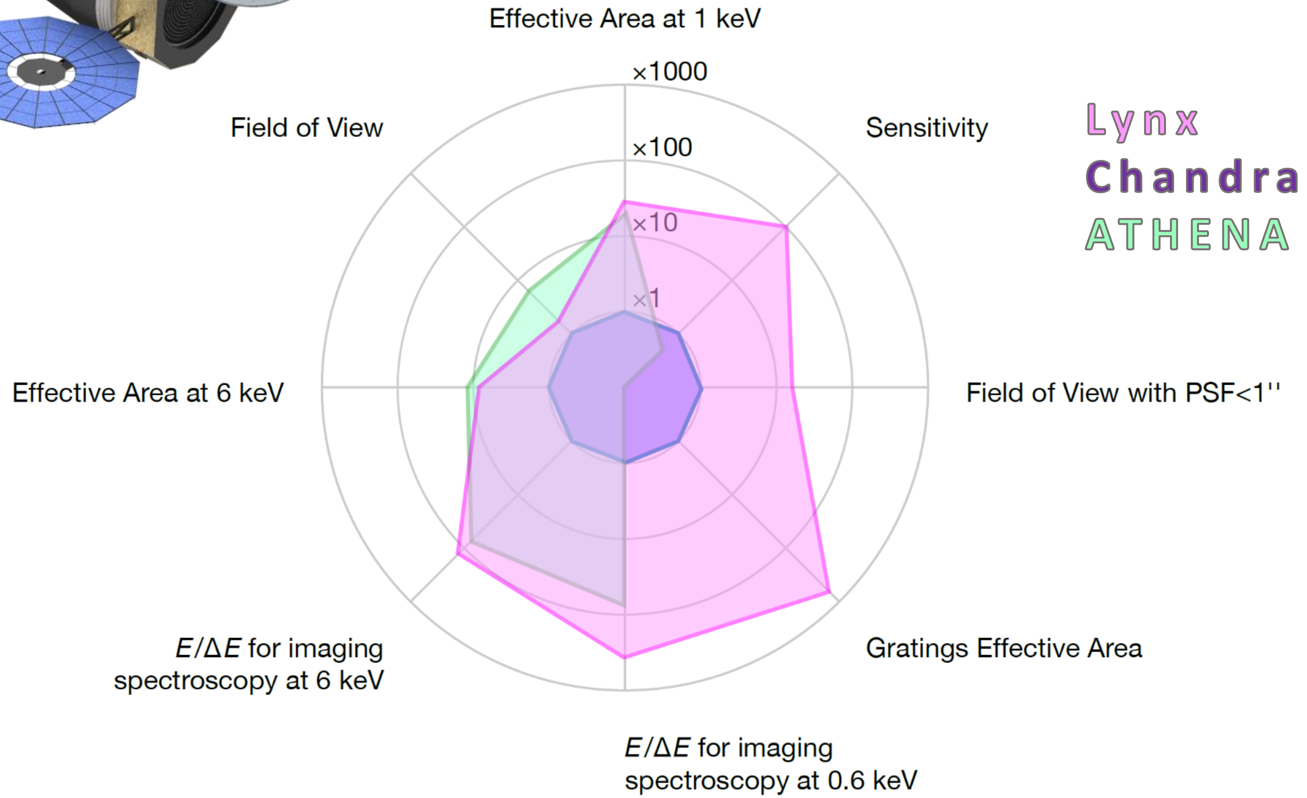
MEET LYNX!

Of the 4 large missions under study for the 2020 Astrophysics Decadal, Lynx is the only observatory that will be capable of directly observing the high-energy events that drive the formation and evolution of our Universe.



Lynx will provide unprecedented X-ray vision into the "Invisible" Universe with leaps in capability over Chandra and ATHENA:

- **Orders of magnitude gain in sensitivity** over Chandra and Athena, via high throughput with high angular resolution
- **Increased field of view** for arcsecond or better imaging
- **Significantly higher spectral resolution** for point-like and extended sources



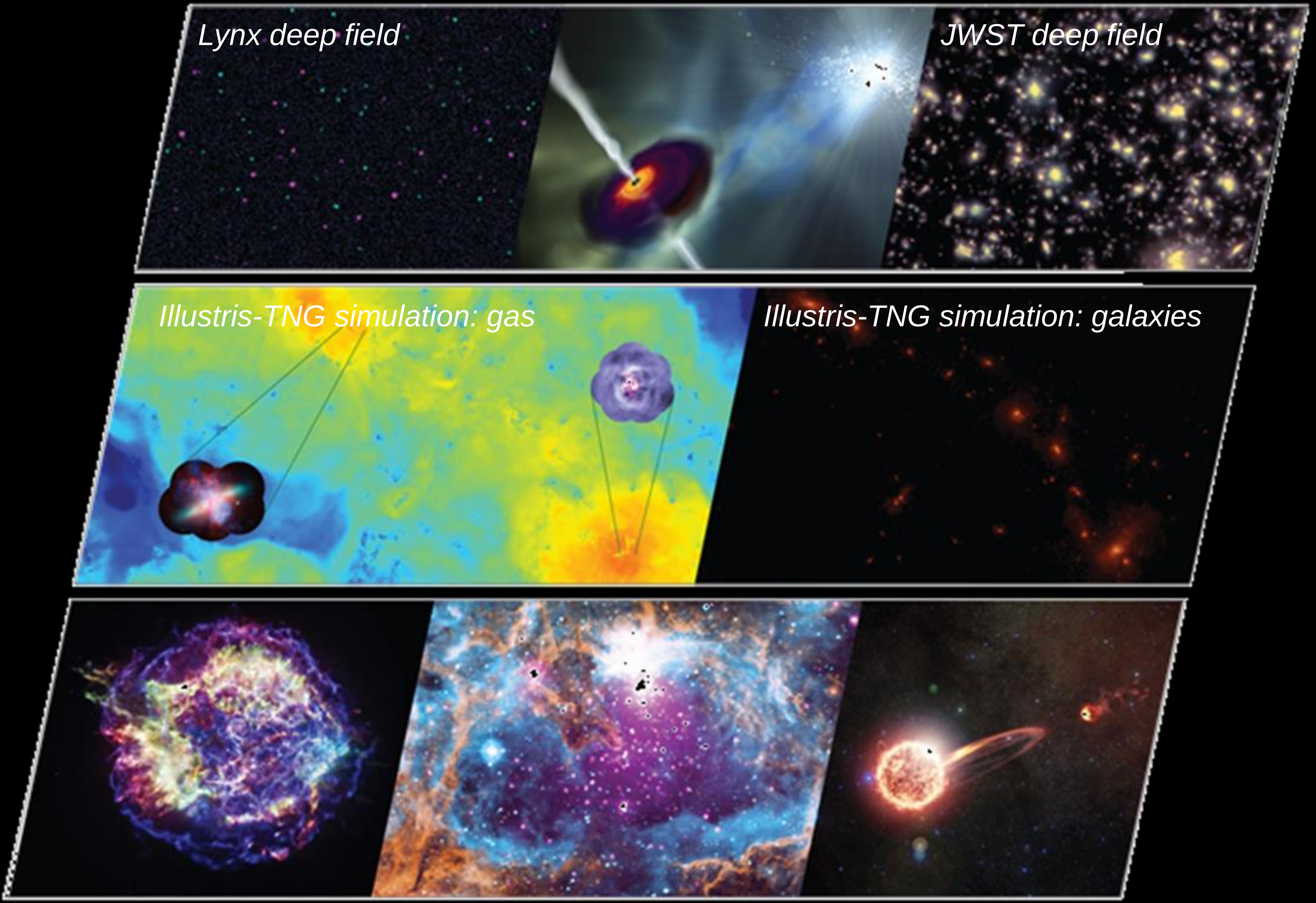
SCIENCE OF LYNX

Through a GO Program, *Lynx* will contribute to nearly every area of astrophysics and provide synergistic observations with future-generation ground-based and space-based observatories, including gravitational wave detectors.

The Dawn of Black Holes

The Invisible Drivers of Galaxy and Structure Formation

The Energetic Side of Stellar Evolution and Stellar Ecosystems



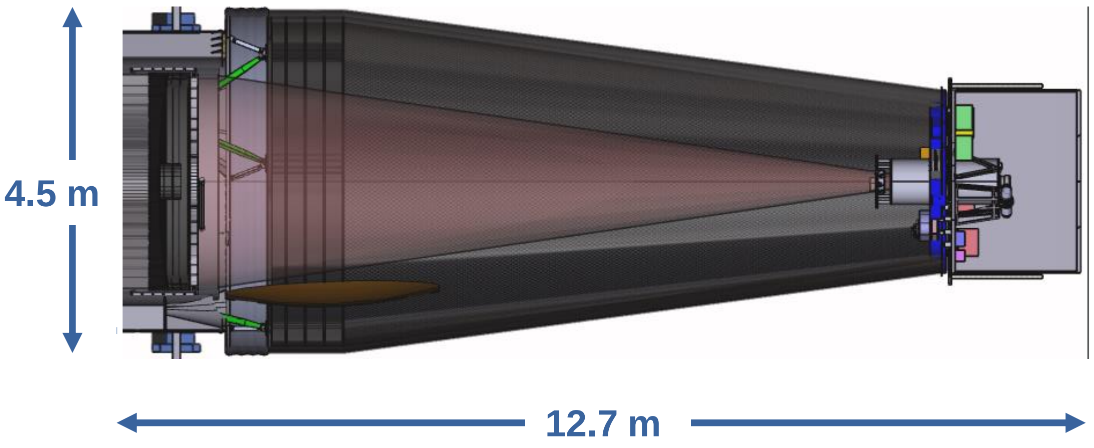
Endpoints of stellar evolution

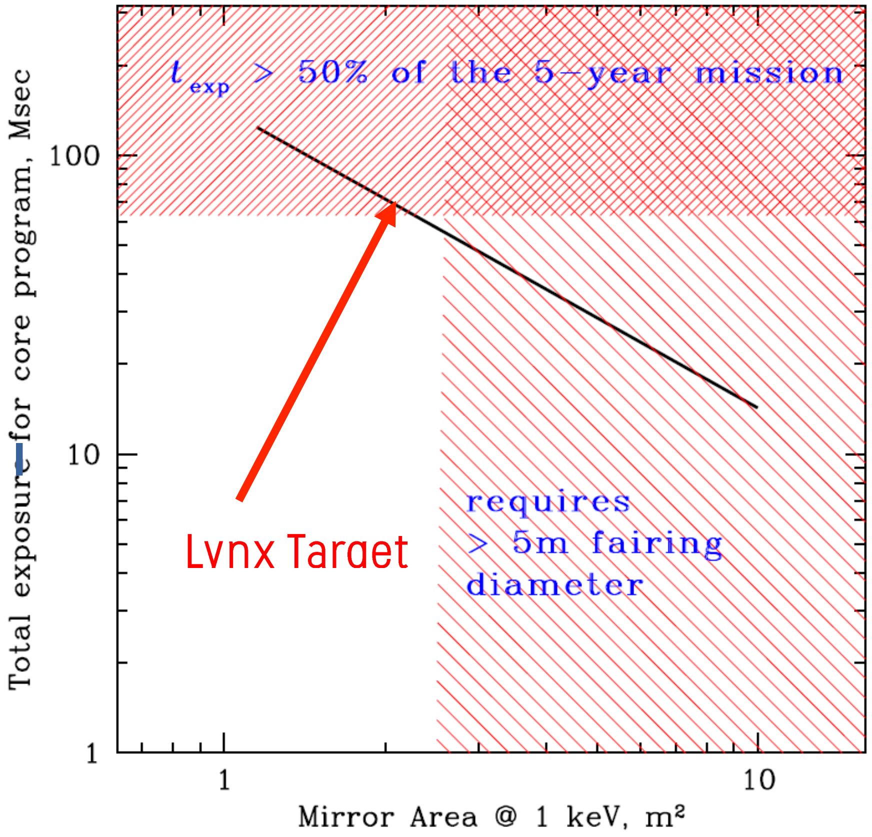
Stellar birth, coronal physics, feedback

Impact of stellar activity on habitability of planets

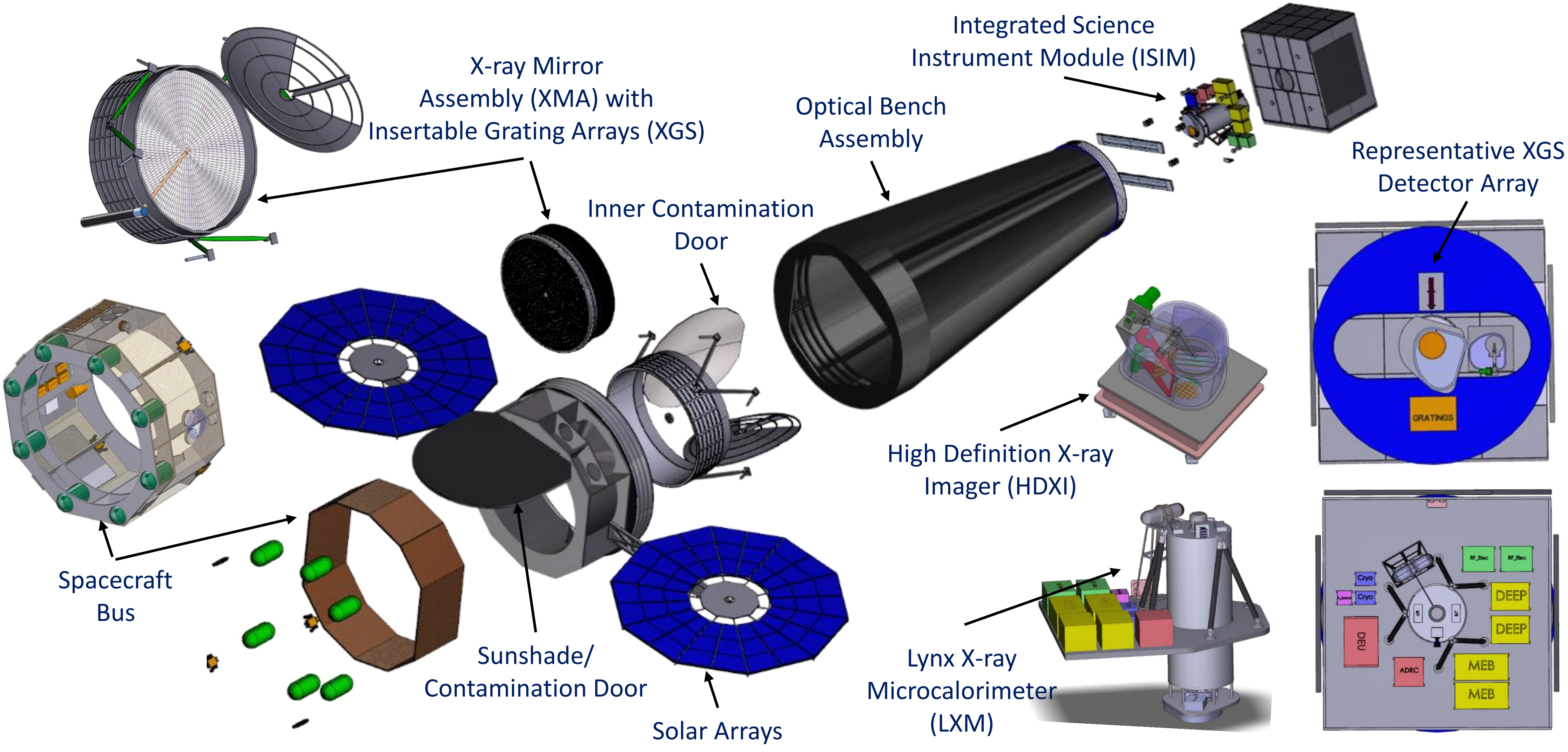
SCIENCE DRIVEN TELESCOPE CONFIGURATION

- 2 m^2 of effective area at E = 1 keV is required to execute the three science pillars in ~50% of the 5-yr mission baseline lifetime.
- This is achieved with an outer diameter of 3-m with a focal length of 10-m.





LYNX OBSERVATORY CONFIGURATION



Enabling Technologies TRL Assessment Summary

At Decadal Studies Management Team request, the ExEP, PCOS, and COR Program Offices and the Aerospace Corp assessed the TRL of tech gaps submitted by the teams as of Dec. 2016. Assessment was presented June 2017.

ID	Technology Gap	TRL
1	High-Resolution 'Lightweight' Optics	~~2~~ 3
2	Non-deforming X-ray Reflecting Coatings	3
3	Megapixel X-ray Imaging Detectors (HDXI)	3
4	X-ray Grating Arrays (XGS)	4
5	Large-Format, High Spectral Resolution X-ray Detectors (LXM)	3

Multiple Technologies 3-4+ by mid-2020

Multiple Technologies

Multiple Technologies

Subsystem Heritage

LYNX MISSION DESIGN

Mission Risk Class A

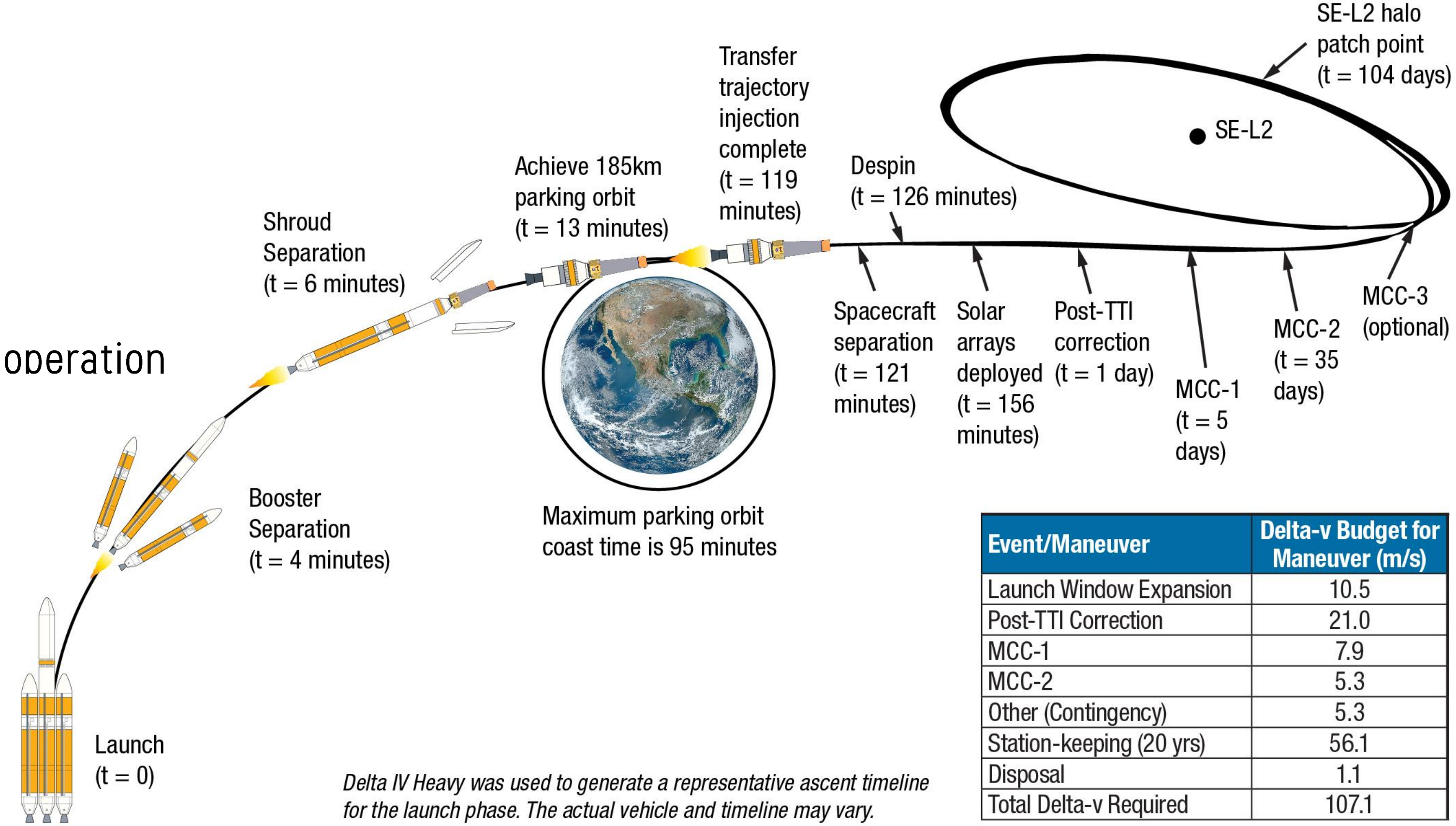
Launch Vehicle:
- Heavy class, 5-m fairing
- SLS co-manifested payload study underway

Mission Life:
- 5 years, extendable to 20 years
- >20 years with power management and modified operation
- Designed for No-to-Minimal In-Space Servicing

Orbit:
- Halo around SE-L2

Communication:
- Up to 3 x per day via DSN
- Maximum of 240 Gbits/day
- Downlink Rate 22.2 Mb

Mission Operations:
- Chandra-like
- Primarily General Observer Program



Delta IV Heavy was used to generate a representative ascent timeline for the launch phase. The actual vehicle and timeline may vary.

Event/Maneuver	Delta-v Budget for Maneuver (m/s)
Launch Window Expansion	10.5
Post-TTI Correction	21.0
MCC-1	7.9
MCC-2	5.3
Other (Contingency)	5.3
Station-keeping (20 yrs)	56.1
Disposal	1.1
Total Delta-v Required	107.1

Ascent timeline provided by NASA LSP for a Delta-IV Heavy.

JATIS Special Section & Lynx Website

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Scope

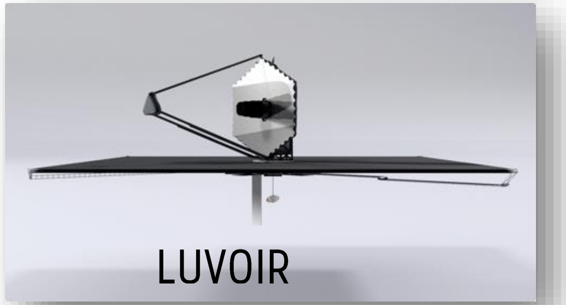
The Lynx X-Ray Observatory will radically change the way we see the universe [illegible] answ[illegible] me of the most persistent questions of our time: How and when did the first supe[illegible]massive b[illegible] for[illegible] and how do they co-evolve with their host galaxies? What processes drive [illegible] formatio[illegible] [illegible]ution of the largest structures in the universe? What high-energy processes pla[illegible] oles in t[illegible] irth and death of stars, and how do they influence planet habitability?

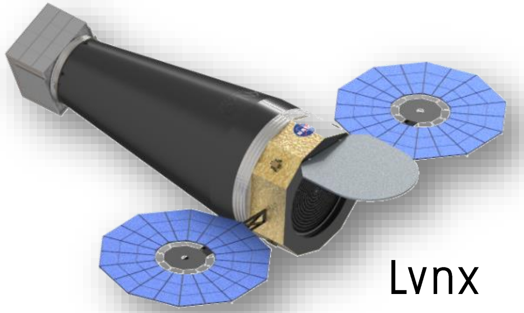
The ability to answer these questions is mad[illegible] ynx payload design. Currently in concept phase, Lynx is design[illegible] o ha[illegible] ps[illegible] capa[illegible] ty over NASA's existing flagship Chandra and the European Space Age[illegible] s ([illegible]) [illegible] a mission. More specificall[illegible] ynx will have a 50-fold increase in se[illegible] vity via th[illegible] up[illegible] of su[illegible] o angular resolution with high thr[illegible] put, 16× larger field of view with arc[illegible] et[illegible] ma[illegible] g, and 10 to 20 times higher s[illegible] solu[illegible] for both point-like and extend[illegible] ou[illegible]. T[illegible] rim[illegible] y purpose of this special s[illegible] n is [illegible] deta[illegible] f the Lynx obser[illegible] ry a[illegible] exp[illegible] n-orbit performance. Related to[illegible] interest inc[illegible] e, but are not limited to:

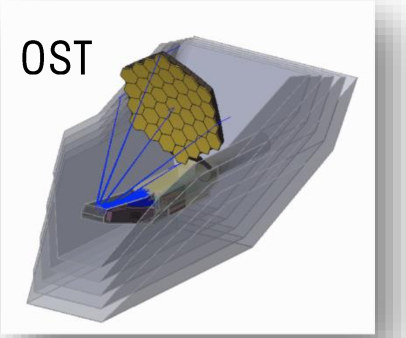
- [illegible] and x-ray optics descriptio[illegible] yst[illegible] and [illegible] syste[illegible]
- [illegible] ctural, thermal, and optical per[illegible] ma[illegible]
- [illegible] n-flight performance predictions and mo[illegible] ng
- data analysis algorithm[illegible]
- instrument-relat[illegible] oft[illegible] stems
- spacecraft [illegible] ms[illegible] t performance
- sy[illegible] gi[illegible] ing [illegible]
- [illegible] ied le[illegible] ns [illegible] rned from previous missions
- [illegible] pla[illegible] ng for the 2030s.

This special section focuses on technical aspects of the Lynx mission and instrumentation. Purely science discussions are to be published elsewhere. All submissions will be peer reviewed. Peer review will commence immediately upon manuscript submission, with a goal of making a first decision within 6 weeks of manuscript submission. Special sections are opened online once a minimum of four papers have been accepted. Each paper is published as soon as the copyedited and typeset proofs are approved by the author. Submissions should follow the **guidelines of JATIS**. Manuscripts should be submitted online at **http://JATIS.msubmit.net**. A cover letter indicating that the submission is intended for this special section should be included.

To be published in Spring 2019!







“One builds large missions not because they can do what a small mission can do better. The large missions can do what a small mission can’t do at all.”

– Dr. Megan Donahue.

Professor Michigan State University
President American Astronomical Society
Lynx STDT Member

CREDITS

Lynx IWG Leadership:

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Ralf Heilmann (MIT)

<u>High-Definition X-ray Imager</u>
Mark Bautz (MIT)
Ralph Kraft (SAO)
Abe Falcone (PSU)

<u>Lynx X-ray Microcalorimeter</u>
Simon Bandler (GSFC)
Tali Figueroa (Northwestern)

Lynx Optics Leadership:

<u>Silicon Metashell Optics</u>
Will Zhang (GSFC)

<u>Full Shell Optics</u>
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Kiranmayee Kilaru (USRA/MSFC)

<u>Adjustable Optics</u>
Paul Reid (SAO)

MSFC Advanced Concepts Office:

Alexandra Dominguez & the ACO team

GSFC Instrument Design Laboratory:

MDL & IDL teams

Lynx MSFC-SAO Study Office

Lynx Websites:

https://wwwastro.msfc.nasa.gov/lynx/

https://www.lynxobservatory.com/#home-section