The Proposed STAR-X Mission: Studying the Fast, Furious and Forming Universe

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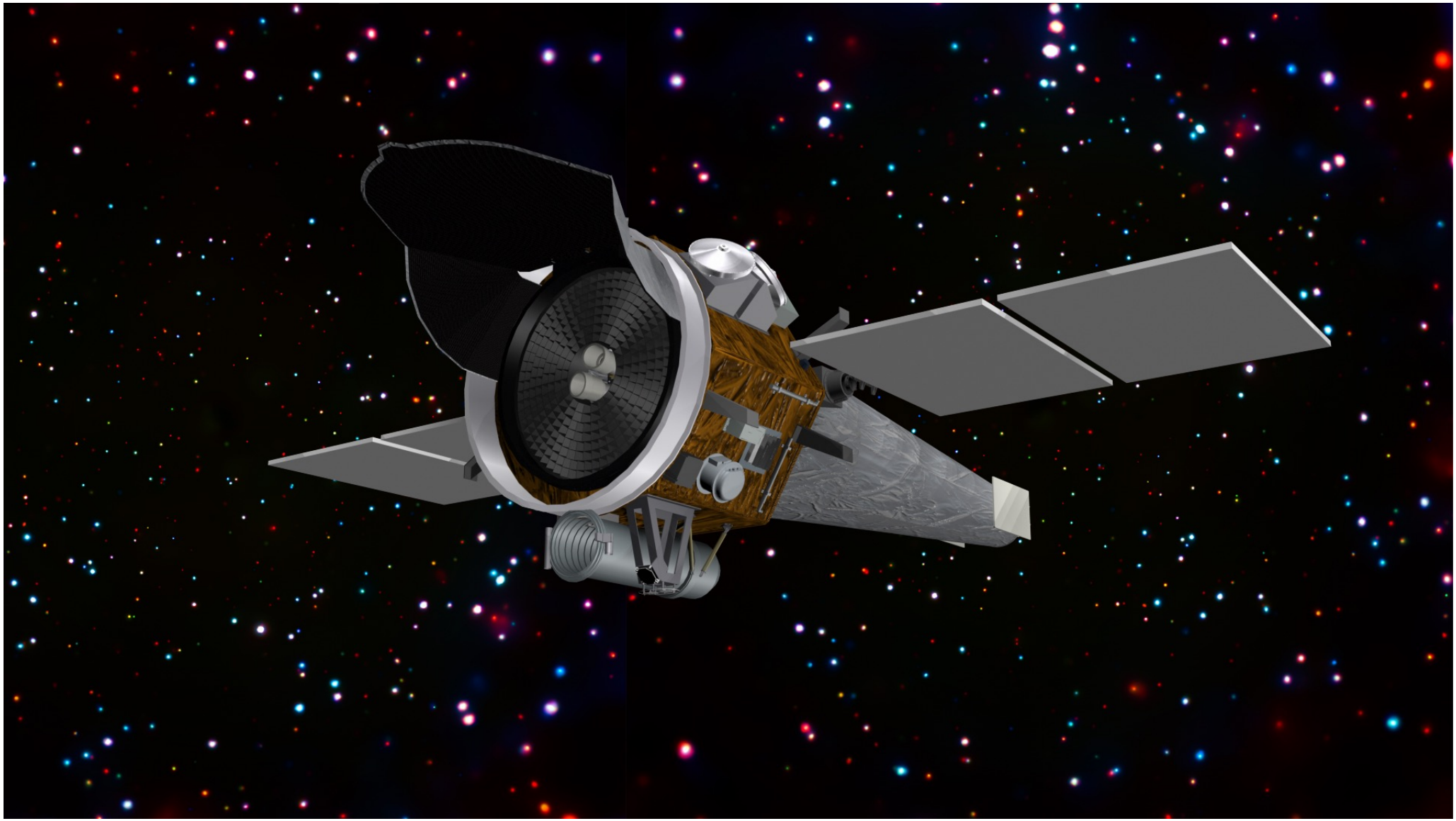
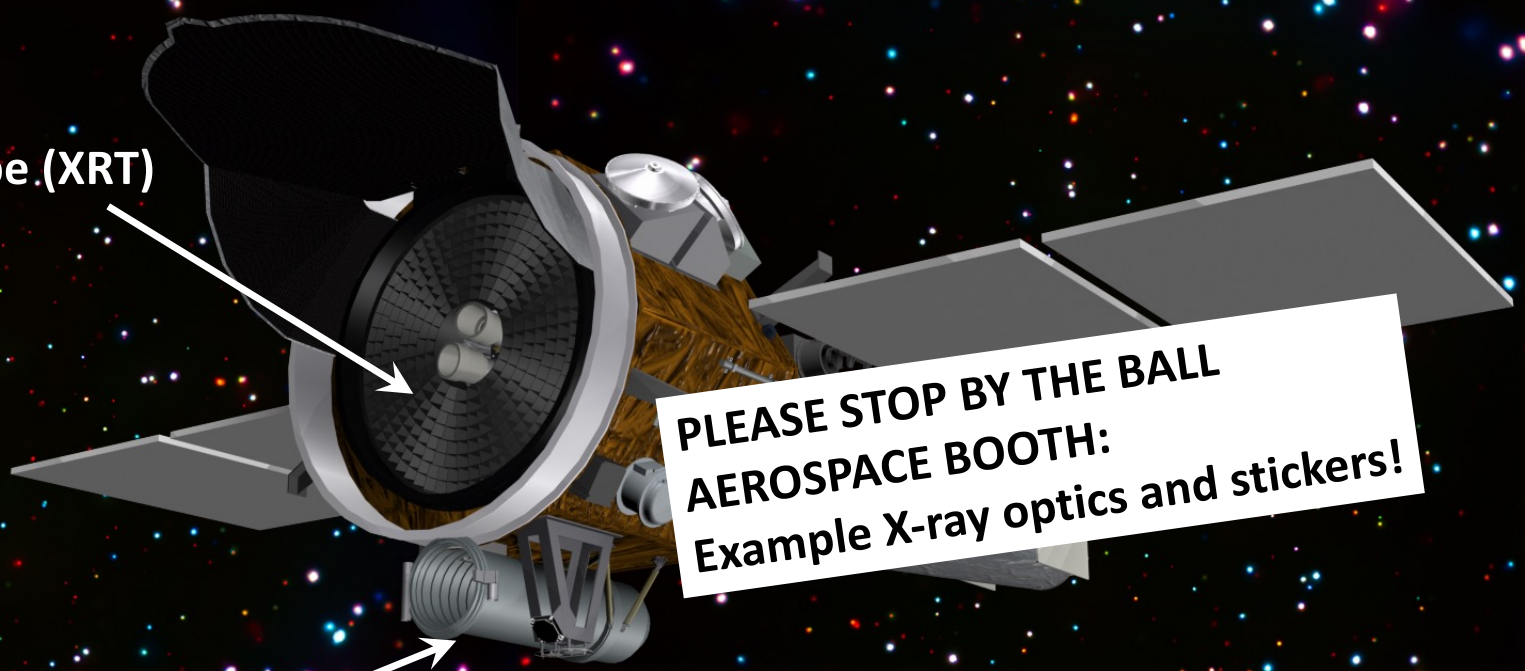
http://star-x.xraydeep.org/



STAR-X: Ready for launch in 2028



PLEASE STOP BY THE BALL AEROSPACE BOOTH:
Example X-ray optics and stickers!

NASA Goddard SPACE FLIGHT CENTER | Ball | MIT KAVLI INSTITUTE | CU LASP Laboratory for Atmospheric and Space Physics University of Colorado Boulder

STAR-X Science Team

Survey and Time-domain Astrophysical Research eXplorer

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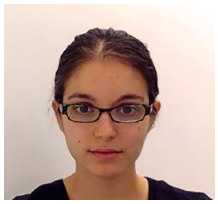
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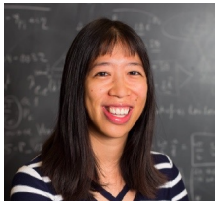
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Takashi Okajima

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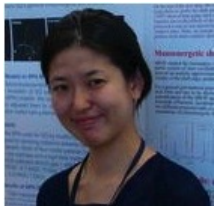
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Andreas Zezas

STAR-X

Survey and Time-domain Astrophysical Research eXplorer

Exploring the Fast, Furious, and Forming Universe

The STAR-X Science Story

The FAST: Locally rare, brief events have an outsized impact on the Universe.

Supernova Explosion

The heavy elements needed for life are synthesized in and dispersed by supernovae and neutron star mergers. Similarly, a single stellar superflare can evaporate an ocean or catalyze prebiotic pathways. The STAR-X wide field UV/X-ray design and fast and flexible operations captures these events.

The FURIOUS: Black holes grow extremely rapidly at early times in the Universe and are critical to galaxy evolution.

Tidal Disruption Event (TDE)

STAR-X will uniquely probe the physics of rapid accretion that allowed massive black holes to grow so quickly in the early Universe. STAR-X will catch transient, extreme black hole feeding events, such as TDEs, where entire stars are disrupted.

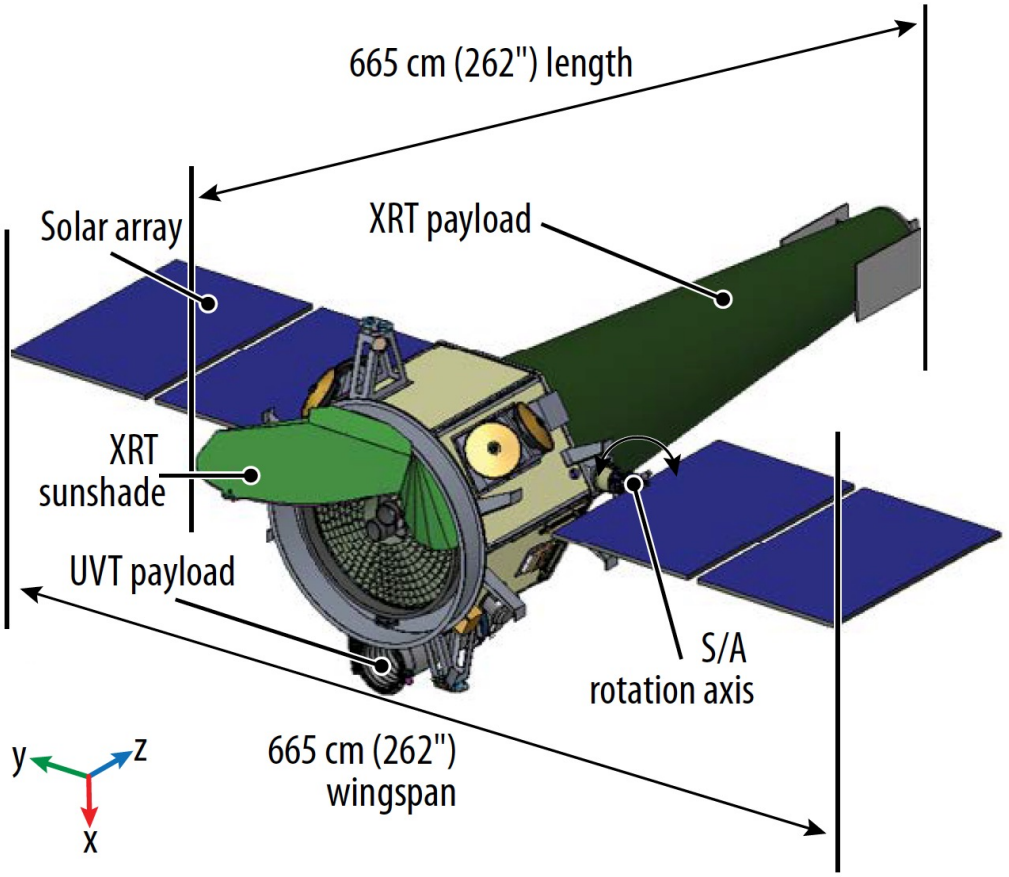
The FORMING: Distant galaxy clusters provide maximal leverage in evolutionary studies of structure formation and chemical enrichment.

Clusters of Galaxies

STAR-X will conduct deep surveys and discover the elusive diffuse emission from the largest bound objects in the Universe (clusters of galaxies), shortly after their birth. STAR-X's combination of excellent imaging and low particle background (due to orbit choice) makes this possible in a way that no other mission can.

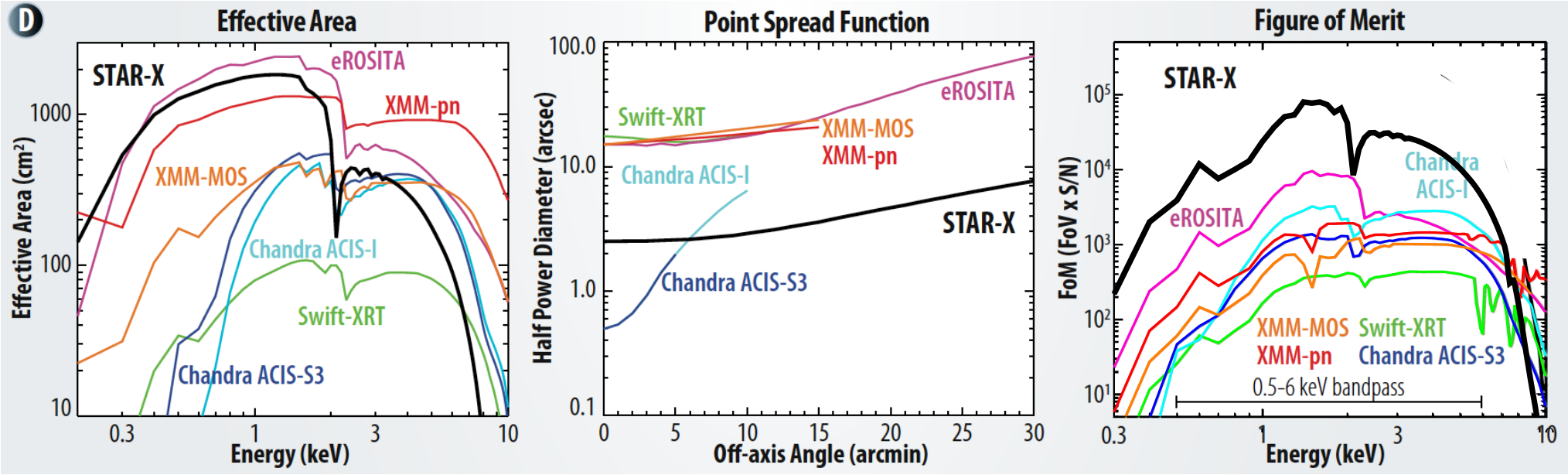
What is STAR-X?

- Three largely independent subsystems: XRT, UVT, and SC
- Each independently built and qualified
  - XRT by GSFC+MIT
  - UVT by Univ. of Colorado
  - SC by Ball Aerospace
- Easy integration and testing: "plug and play"
  - Obs. Integration and testing by Ball Aerospace

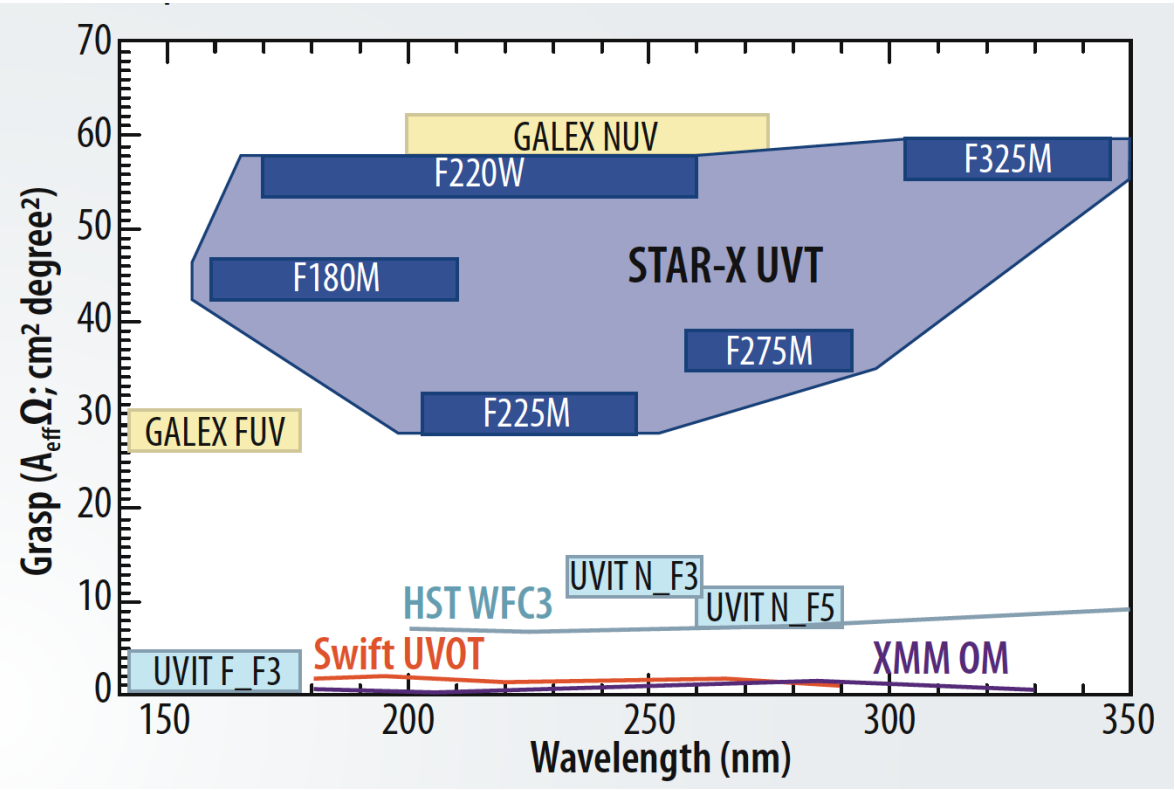


Key Features of the X-ray Telescope

- Excellent PSF: 2.5" on-axis, 8" 0.5-deg off-axis.
- Large FOV: 1 deg^2.
- Large effective area: >1,800 cm^2 at 1 keV.
- Low particle background.



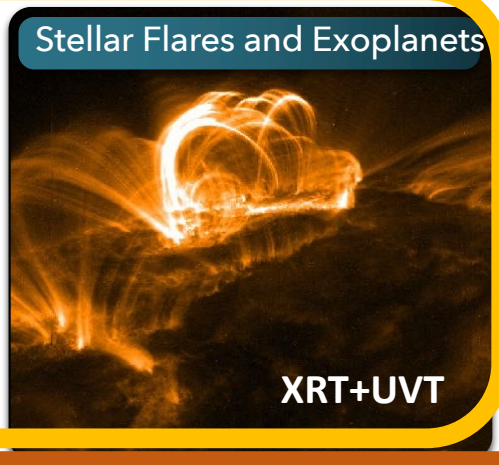
Key Features of the UV Telescope

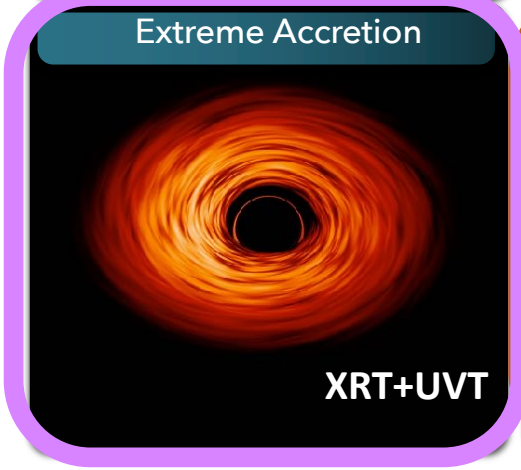


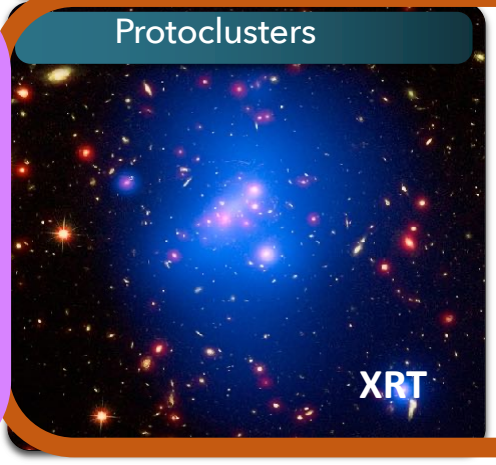
- Excellent PSF: 4" on- and off-axis.
- Large FOV: 1.0 deg^2.
- Good effective area: 25 – 55 cm^2.
- Five filters
  - 180 nm
  - 220 nm
  - 225 nm
  - 275 nm
  - 325 nm

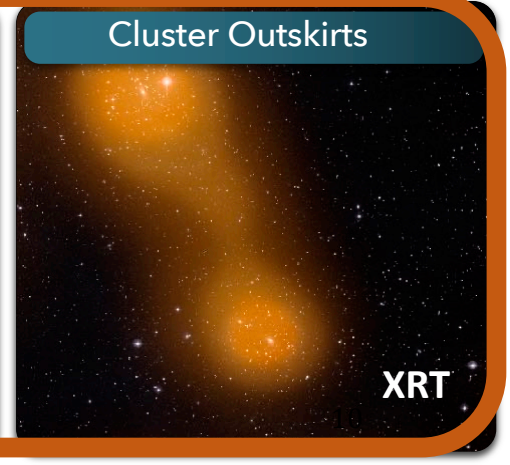
STAR-X Science: Eight science objectives

Survey and Time-domain Astrophysical Research eXplorer



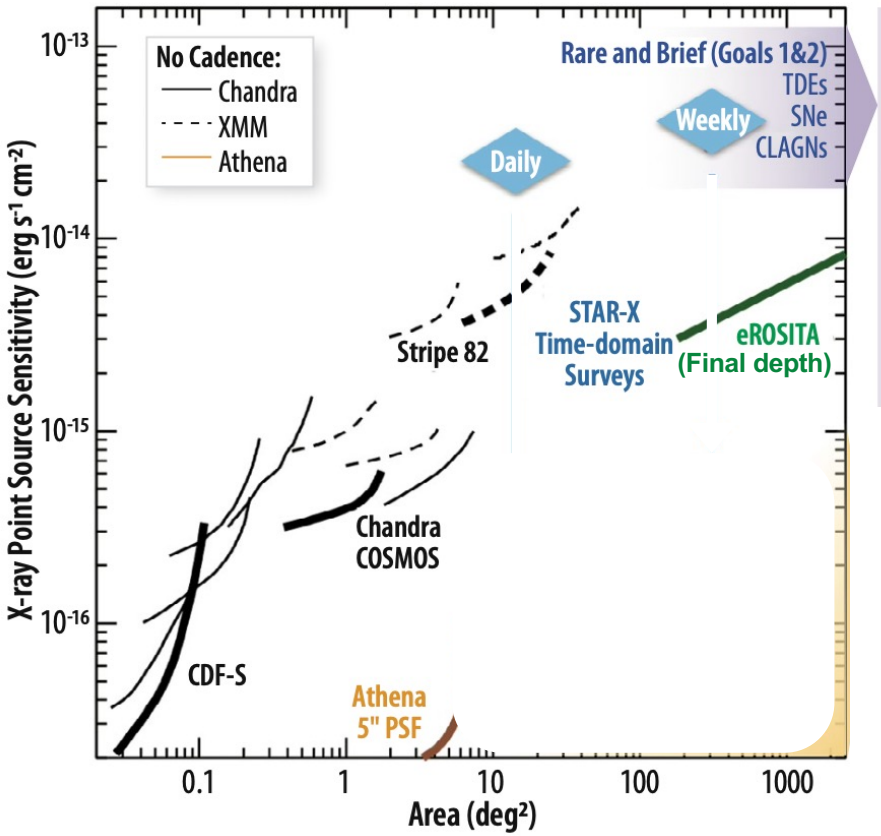


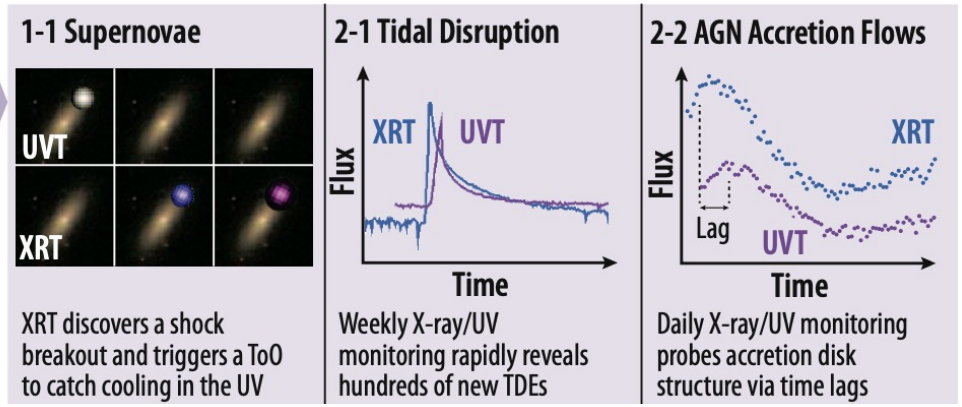




Survey Strategy

Survey and Time-domain Astrophysical Research eXplorer

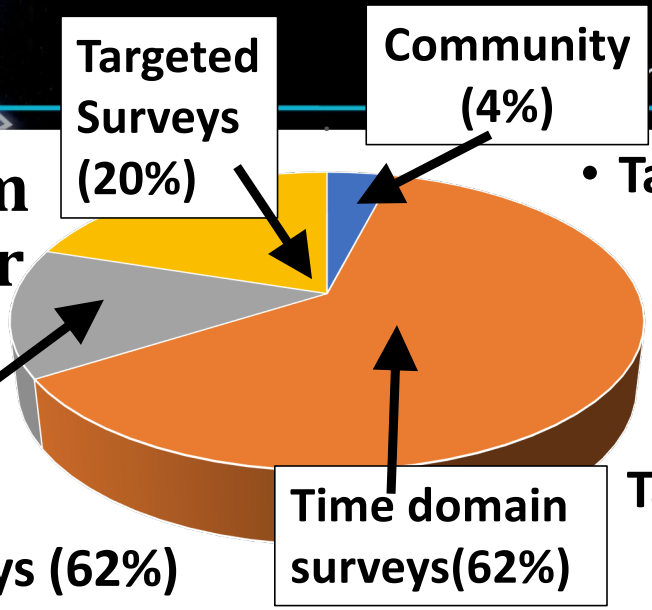




STAR-X finds rare and brief events and rare and faint high-z objects

Final depths: MEDIUM: 3×10^{-16} cgs over 300 deg^2 (~100 Chandra COSMOS fields),
DEEP: 7×10^{-17} cgs over 12 deg^2

Science Program for the Two Year Prime Mission



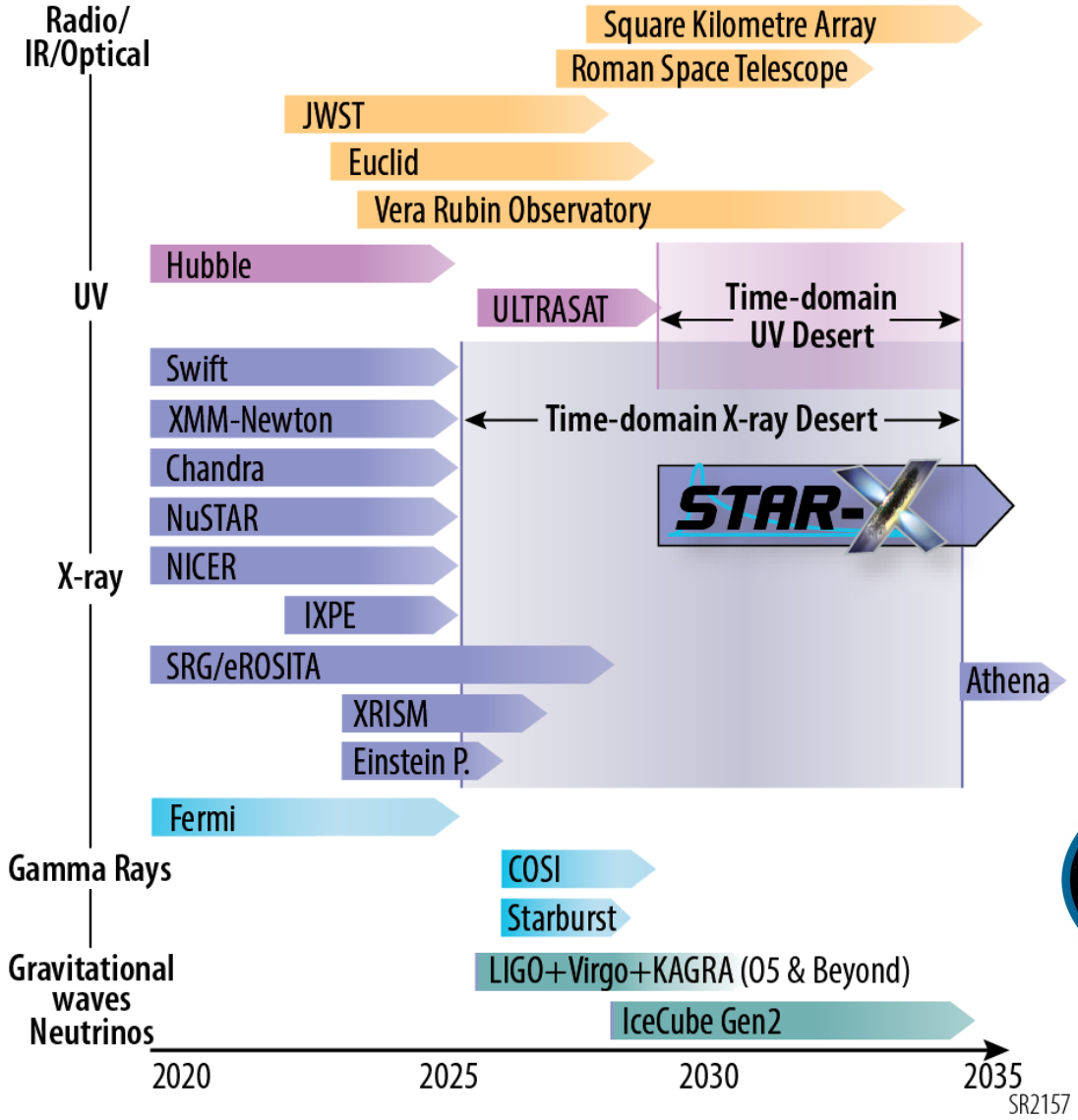
- **Time Domain Surveys (62%)**
  - Deep survey: Rubin deep drilling fields
    - 12 deg^2, **Daily Cadence,** 1500 s
    - Optimized for rapid transients and AGN variability
    - 1x10^{-14}cgs (X-ray) and 22.2 mag (UV, F180M) and 23.3 mag (UV, F275M)
  - Medium survey: Stripe 82 + Subaru fields, & Rubin deep drilling fields
    - 300 deg^2, **Weekly Cadence**, 500 s
    - Optimized for TDEs
    - 3x10^{-14}cgs (X-ray) and 21.9 mag (UV, F180M)

- **Targets of Opportunity (14%)**
  - Young supernovae
  - GW X-ray/UV counterparts
  - GW source late-time follow-up
  - Tidal-disruption events

Targeted Surveys (20%)

- 10 nearby galaxies
- 9 low-mass, planet-bearing stars
- 20 high-z SZ-detected clusters
- 20 nearby clusters

- **Community Program (4%, 1.8 Ms)**
  - Impromptu requests from the broad community



Why STAR-X and Why Now?

STAR-X fills the gap in X-ray and UV time-domain coverage in the late 2020s, providing simultaneous X-ray and UV observations that complement optical, infrared, and gravitational wave facilities.

ALSO Under "Events" on website:
STAR-X Special COMMUNITY Session at HEAD
(March 27-30, 2023, Hawaii)

For more details, see these iPosters !

http://star-x.xraydeep.org/events
(see website for iPoster links!)

107.05, **9-10AM Monday,** January 9, "*The Fast:" Discovering and Characterizing Transients in the X-ray and UV with STAR-X*", **Daryl Haggard et al.**

360.13, **5.30-6.30pm, Wednesday,** January 11, "*Studying 'the Furious', Growing Black Holes with STAR-X in the X-ray and UV*", **Francesca Civano et al.**

461.01, **1-2 PM Thursday**, January 12, "*The Proposed STAR-X MIDEX Mission: Studying The Fast, Furious and Forming Universe in the X-ray and UV*", **William Zhang**

461.02, **1-2 PM Thursday**, January 12, "*The STAR-X Science Case: Exploring the Fast, Furious and Forming Universe in X-rays and UV*", **Edmund Hodges-Kluck et al.**

460.25, **1-2 PM Thursday**, January 12, "*Studying "the Forming" Clusters of Galaxies over Cosmic time in the X-ray and UV with STAR-X*", **Eric Miller et al.**