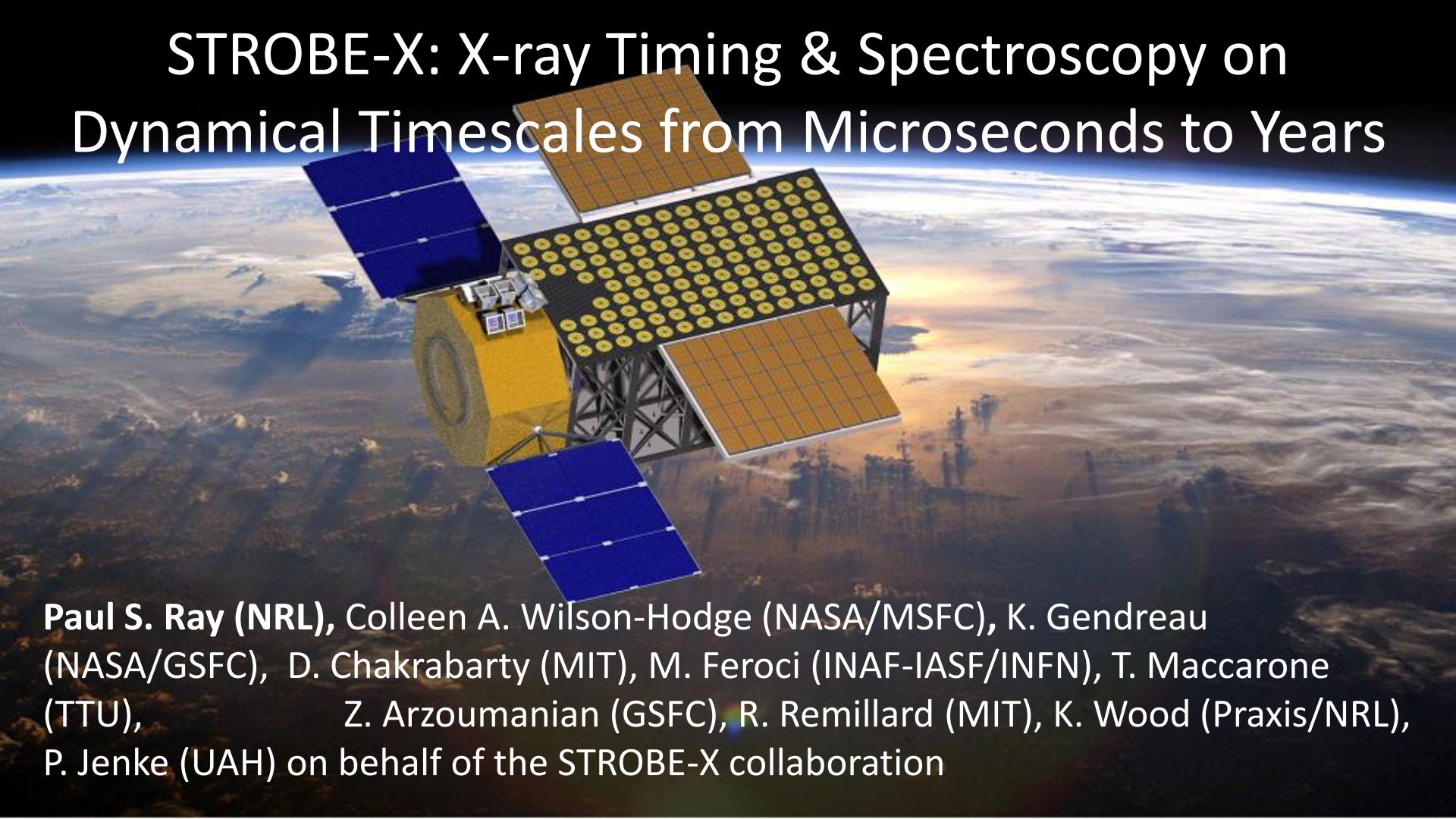
STROBE-X: X-ray Timing & Spectroscopy on Dynamical Timescales from Microseconds to Years



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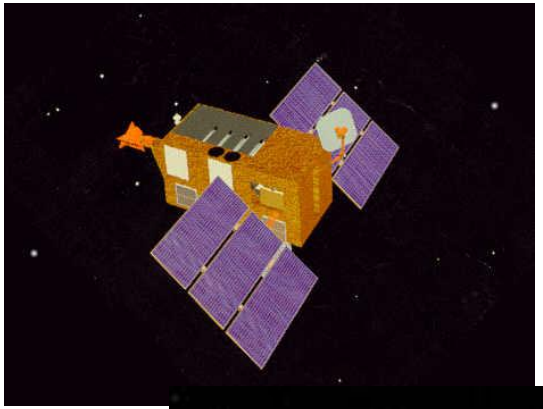
Why a Flexible, High-Throughput Observatory?

- The high-energy sky is highly dynamic –requires catching the right source at the right time
  - Necessitates both wide field monitoring and the ability to repoint quickly (as RXTE and Swift have demonstrated)
- Large areas with low dead time access the shortest timescales
- Both soft and hard X-ray bands are needed to accurately measure the continuum spectral shape, constrain absorption, and understand the relationship between thermal and non-thermal components

Programmatic Context

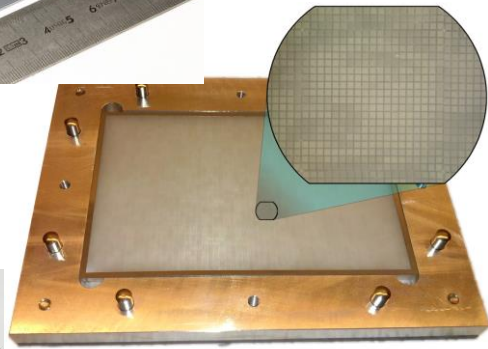
- RXTE combined a scanning sky monitor with large area hard X-ray timing, but it ended in 2012
- Swift provides hard X-ray monitoring and a versatile, but small, X-ray telescope with limited timing capabilities
- XMM-Newton's EPIC-pn provides soft X-ray timing but very constrained scheduling
- NICER will break new ground in soft X-ray timing with extremely high precision and 2x EPIC-pn area



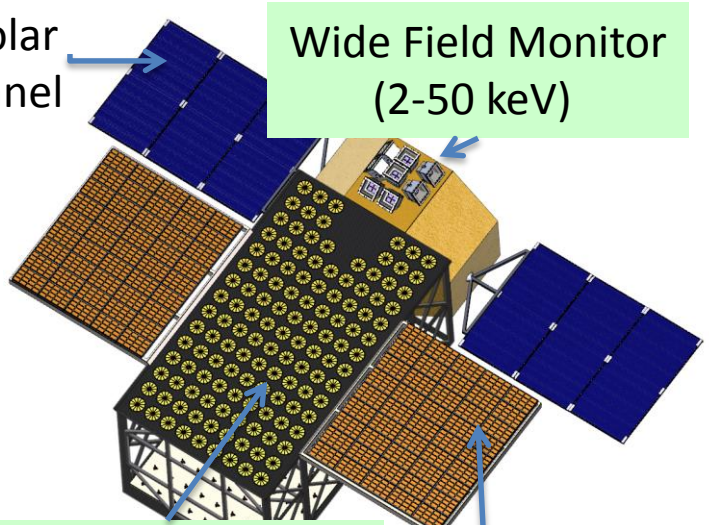
But what will come next?

Technical Context from LOFT and NICER

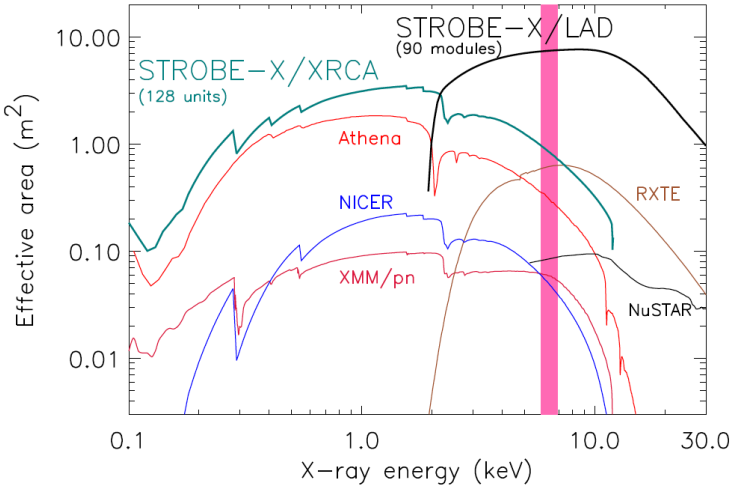
- Solid state detectors like Silicon Drift Detectors can provide high time resolution with low dead time and CCD-like spectroscopy
- Thin, light micropore collimators a much lower mass and volume than traditional X-ray collimators, enabling large missions and modest cost
- Lightweight, inexpensive foil optics can provide large collecting area with low background at low cost



Spectroscopic Time-Resolving Observatory for Broadband Energy X-rays (STROBE-X)



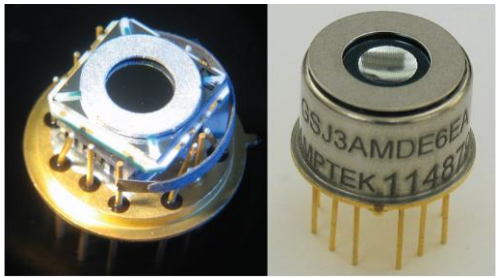
Large effective area ~8 m² @ 6 keV



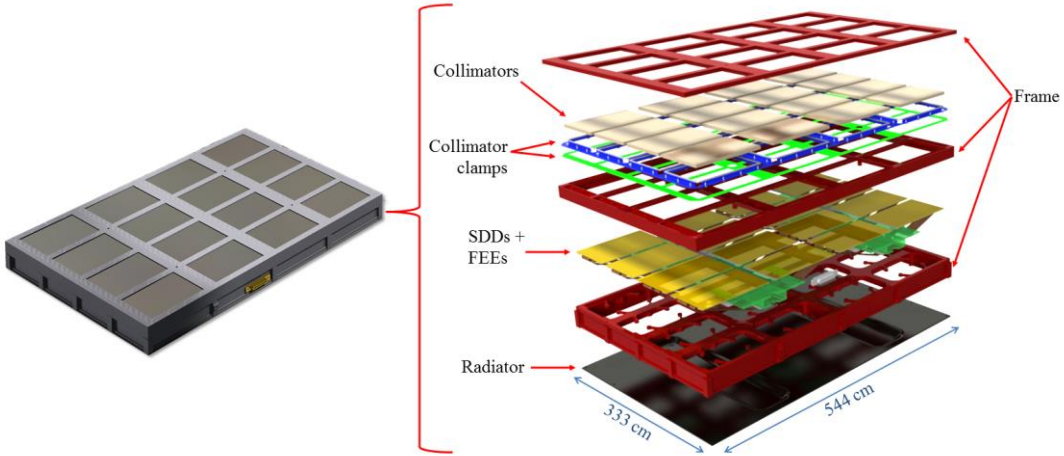
STROBE-X combines the strengths of NICER and LOFT: High throughput X-ray timing with good spectroscopy

X-ray Concentrator Array

- Low background, high throughput
- Enables high time resolution observations of the faintest sources, both extragalactic and galactic
- Sensitive timing and spectroscopy to thermal emission and iron lines
- Scaled up version of NICER concentrators with NICER SDDs
  - Focal length of 3 m and 2’ focal spots for enhanced throughput >2.5 keV
  - Inexpensive Foil optics: large areas w/ low background
  - Energy resolution: 85-175 eV FWHM
  - Effective area @ 1.5 keV: 3.4 m^2

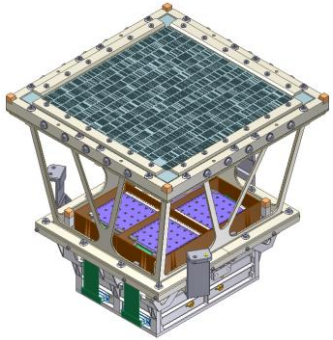


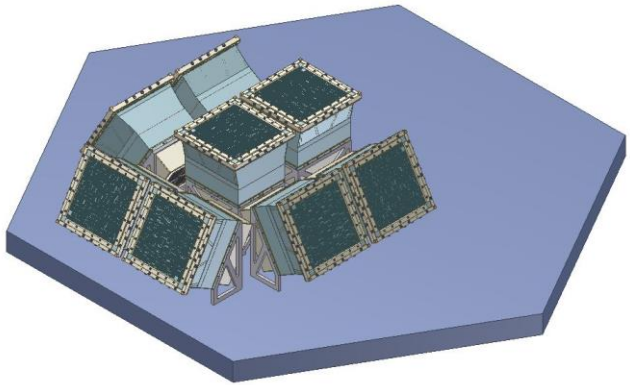
Large Area Detector



- High time resolution and CCD quality energy resolution over the 2-30 keV range
  - Best sensitivity to QPOs; most prominent in harder X-rays
  - Sensitive to non-thermal emission and Compton hump
- SDDs and lightweight microcapillary plate collimators developed for ESA's LOFT M3 & M4.
  - Energy resolution: 200-240 eV FWHM (CCD quality)
  - Effective Area @ 10 keV 7.6 m^2

Wide Field Monitor

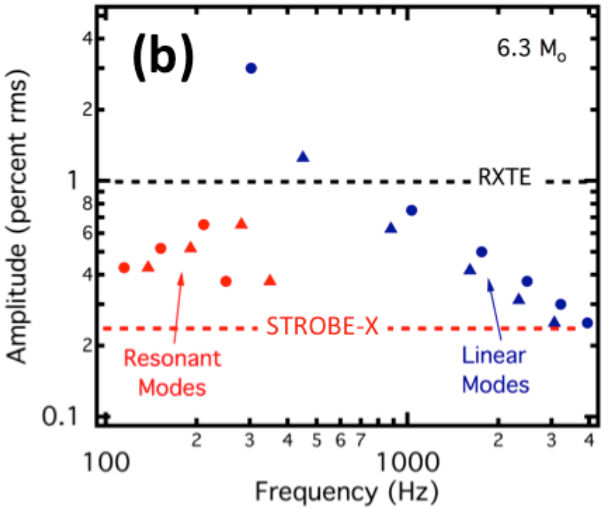


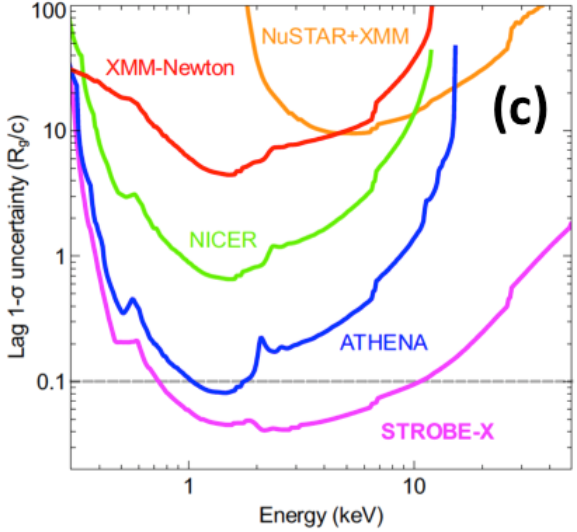


- Wide-field coded-mask imager
- Instantaneous FoV: >1/3 of sky; 50% of sky accessible to LAD
- Sensitive to transients from milliseconds to years
- LOFT SDDs and mask
- Energy resolution: 300 eV FWHM
- Identifies new transients and source states for main instruments, while monitoring long-term source behavior for a large fraction of the sky.

Black Holes on All Mass Scales

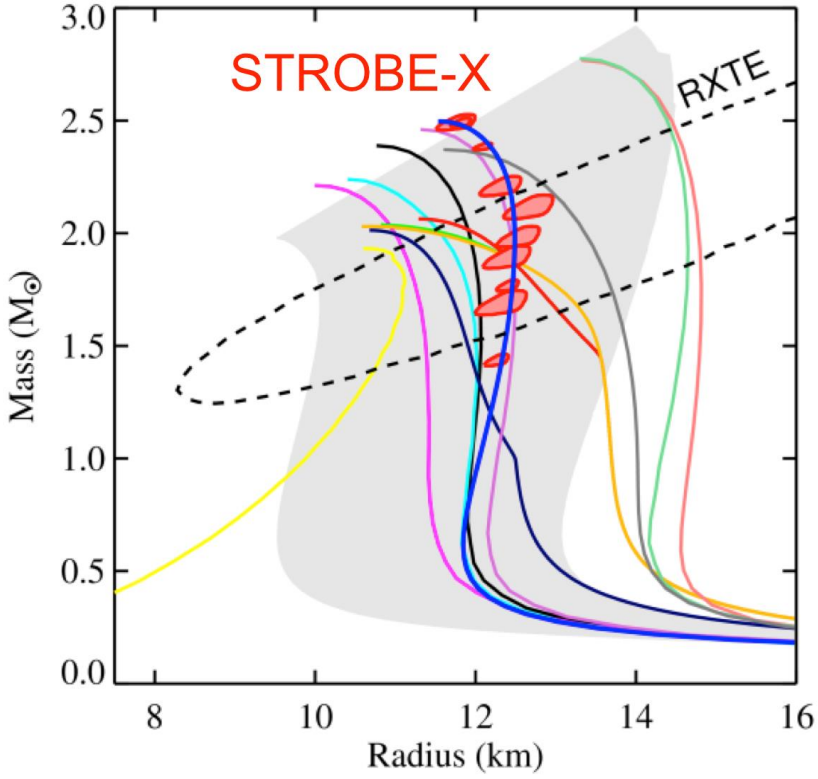
- Three complementary approaches to measuring black hole spin: HFQPOs, continuum fitting and reflection fitting all accessible with STROBE-X
  - Critical for understanding systematics of each technique
- X-ray reverberation probes geometry for both stellar mass BH and AGN
  - Limiting factor usually photon count, so STROBE-X will probe changes in accretion geometry on timescales shorter than the dynamical timescale of AGN
  - Stellar mass BH will be mapped through all spectral states and LAD will measure lags associated with Compton hump
- Also, disk winds, QPOs, state changes, disk-jet connection and more!





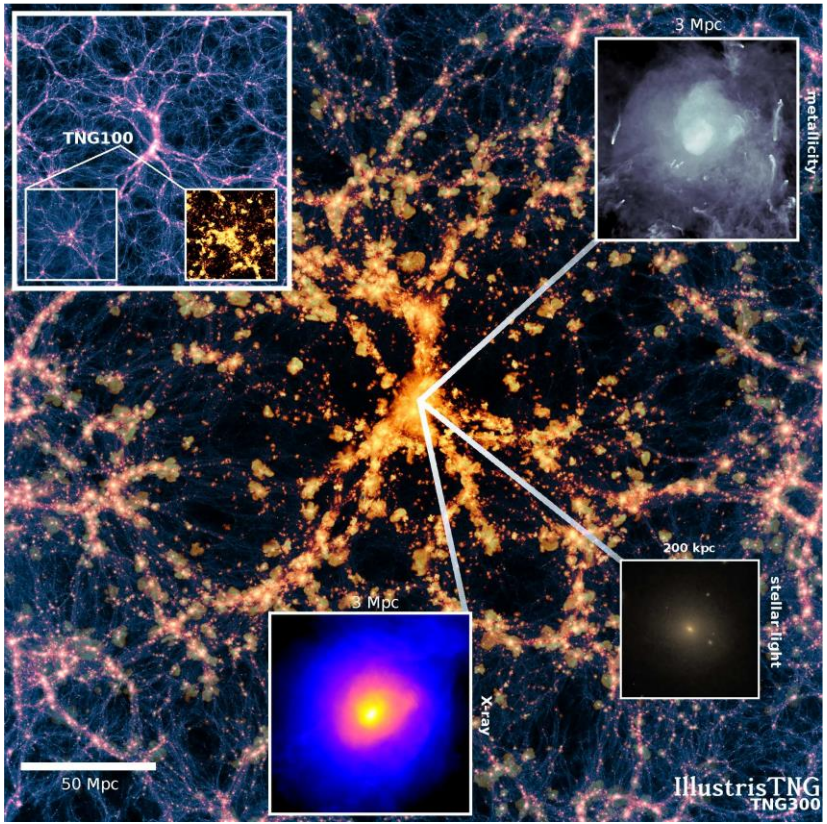
Neutron Stars

- Fully determine the ultradense matter equation of state by measuring the neutron star mass-radius relation using >20 pulsars
  - Measurements spanning low to high masses are critical to nail down the precise EOS
- Both burst oscillations and thermal surface emission will be accessible
- Also could contribute to PTA detection of gravitational waves, etc…



Spectroscopy of the Extragalactic Universe

- Measure the bulk metallicity of diffuse intracluster gas 30x faster than XMM
  - Survey 100 clusters discovered by eROSITA and SPT-3G including at z>2
  - Study the WHIM in cluster outskirts at z>0.2
- WFM survey will be highly sensitive to Compton-thick AGN



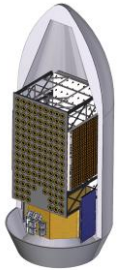
Rapid and Extreme Explosions

- Gamma-ray bursts and X-ray flashes
- LIGO EM counterparts
- TDEs
- Supernova shock breakouts
- Stellar flares
- Much more…

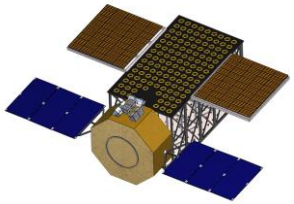
- Arcmin localization allows optical follow up with single pointing
- Large instantaneous FOV probes rare events
- 300 eV spectral resolution sensitive to lines

Study Status

- Over 100 members of Science Working Group
  - Weekly science telecons have begun
  - Response matrices for performance simulations distributed
- Science Requirements Meeting Sep 18–20 at Texas Tech
- Instrument Leads Meeting Sep 21–22 at GSFC
- IDL run November 2017
- MDL run April 2018
- Final report September 2018



Summary



- STROBE-X is a probe class (<$1B) observatory concept designed for X-ray timing and spectroscopy in the 0.2-30 keV band
- STROBE-X has huge collecting area, fast timing, and good spectral resolution
- STROBE-X is based on existing technology and builds on experience with NICER and LOFT.
  - Highly modular design allows easy scaling
- STROBE-X will serve a large community in a decade of time-domain astronomy with complementary capabilities to the large high spectral and spatial resolution missions

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