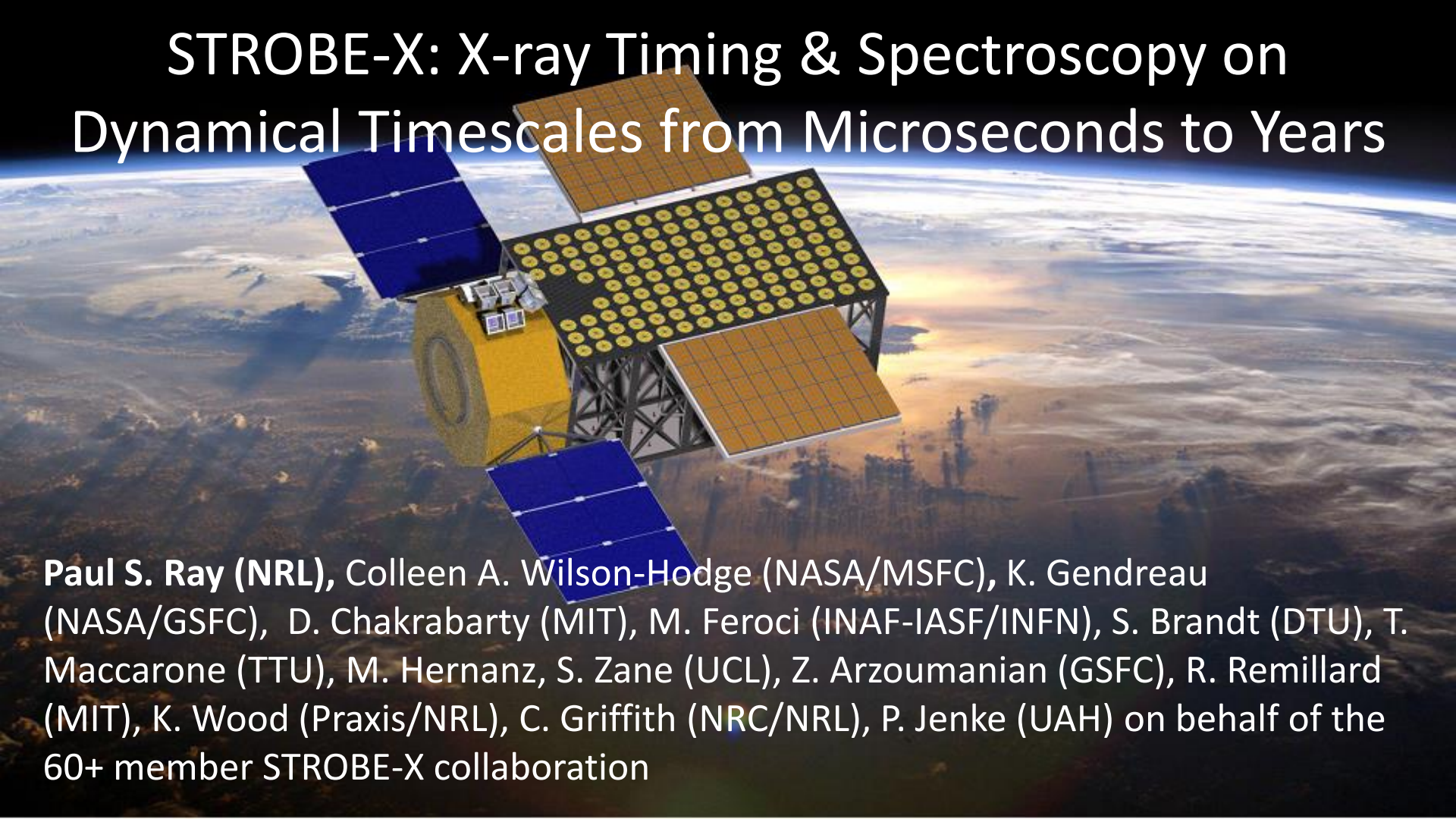
STROBE-X: X-ray Timing & Spectroscopy on Dynamical Timescales from Microseconds to Years



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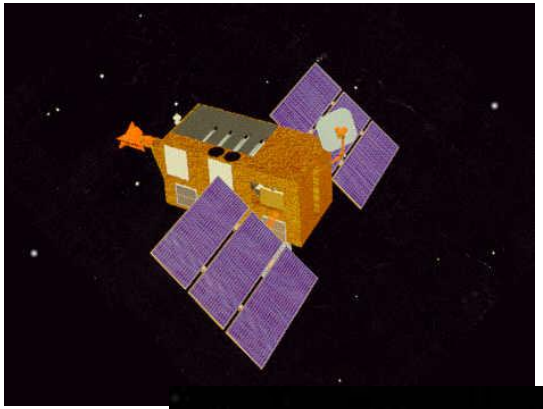
Why a Flexible, High-Throughput Observatory?

- 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

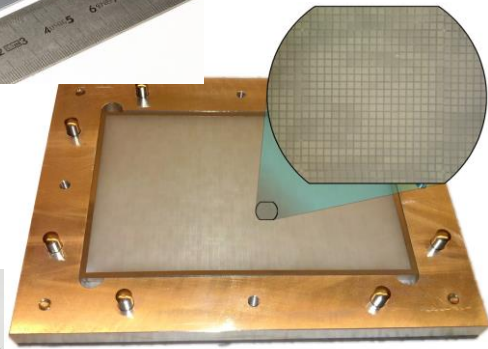
- RXTE combined a scanning sky monitor with large area hard X-ray timing, but it ended in 2012
- Swift provides hard X-ray monitoring and a versatile, but small, X-ray telescope with limited timing capabilities
- XMM-Newton's EPIC-pn provides soft X-ray timing but very constrained scheduling
- NICER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



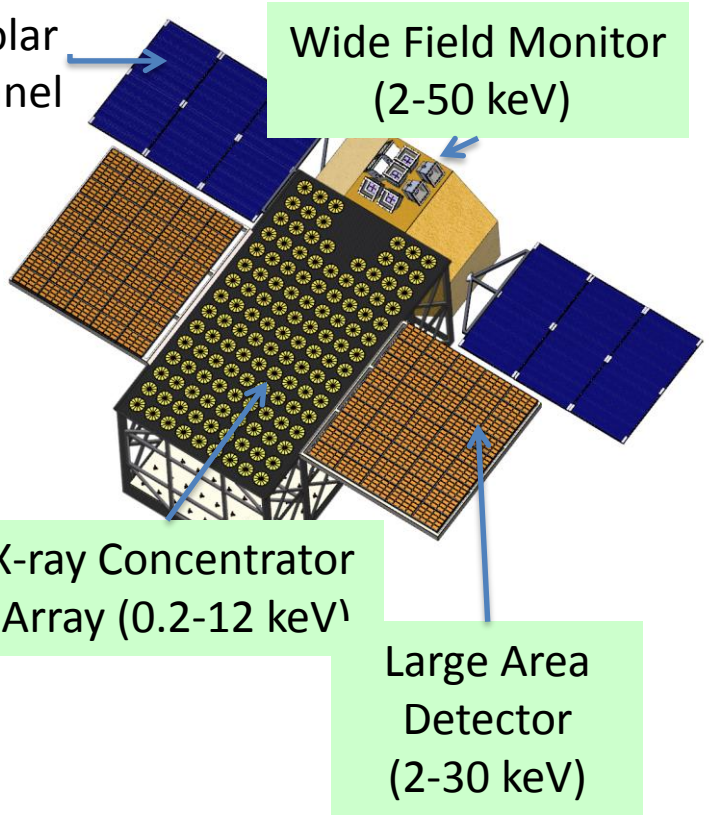
But what will come next?

Technical Context from LOFT and NICER

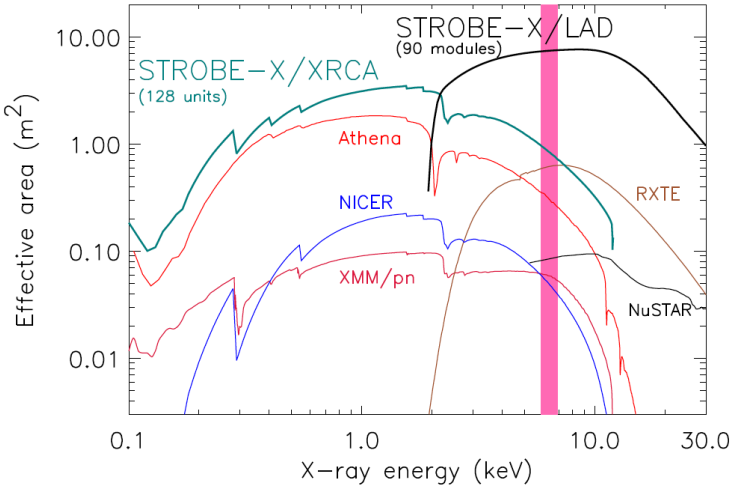
- Solid state detectors like Silicon Drift Detectors can provide high time resolution with low dead time and CCD-like spectroscopy
- Thin, light micropore collimators a much lower mass and volume than traditional X-ray collimators, enabling large missions and modest cost
- Lightweight, inexpensive foil 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 ~10m² @ 6 keV

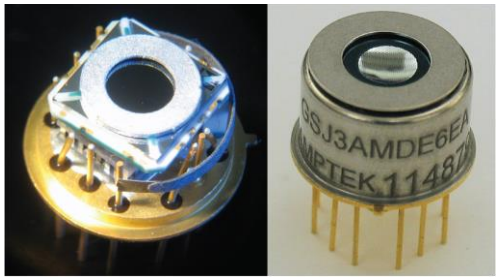


STROBE-X combines the strengths of NICER and LOFT: High throughput X-ray timing with good spectroscopy

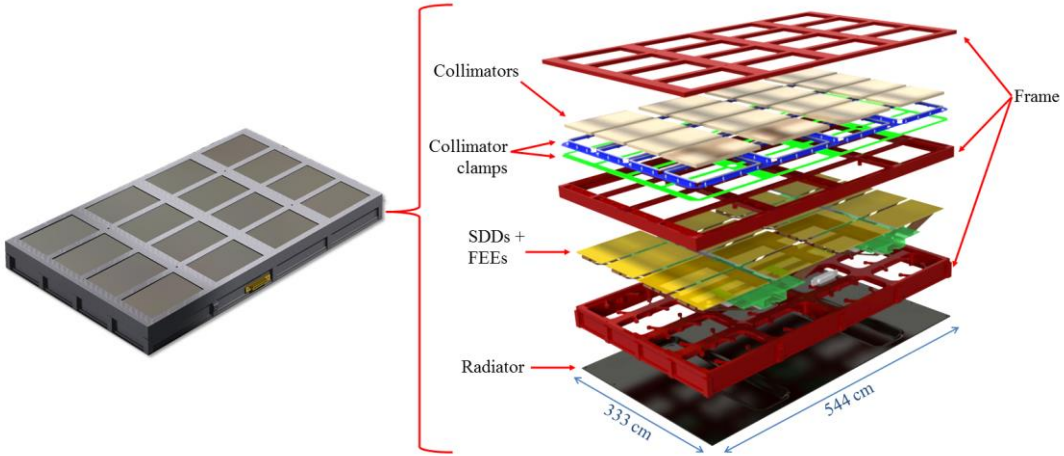
Proposed to NASA's 2016 Call for Astrophysics Probe Mission Concept Studies PI P. Ray (NRL)

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

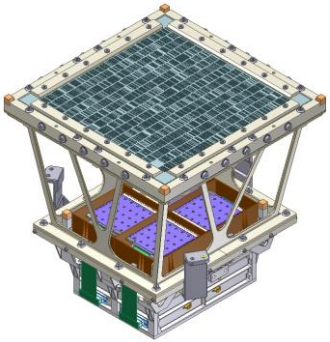


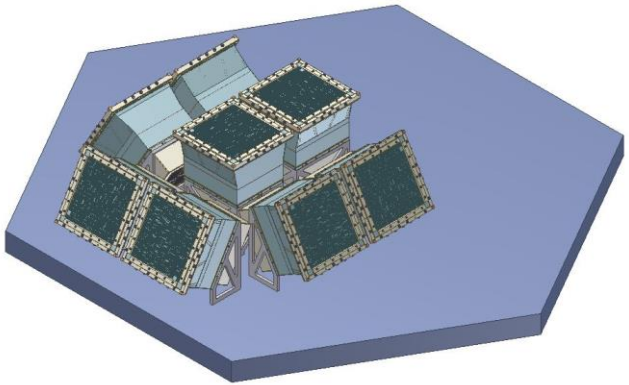
Large Area Detector



- 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

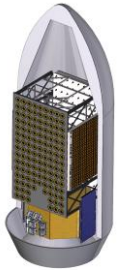




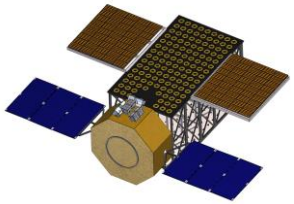
- Wide-field coded-mask imager
- Instantaneous FoV: >1/3 of sky; 50% of sky accessible to LAD
- Sensitive to transients from milliseconds to years
- LOFT SDDs and mask
- Energy resolution: 300 eV FWHM
- Identifies new transients and source states for main instruments, while monitoring long-term source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

STROBE-X Key Science Goals

- Probing stationary spacetimes near black holes (BHs) to explore the effects of strong-field general relativity and measure the masses and spins of BHs.
  - Access spins via continuum fitting, reflection spectra, and HFQPOs
- X-ray reverberation mapping of the geometry of BH accretion flows across all mass scales, from stellar-mass BHs in our Galaxy to supermassive BHs in active galactic nuclei.
  - Observe changes on short timescales and across spectral states
- Fully determining the ultradense matter equation of state by measuring the neutron star mass-radius relation using >20 pulsars over an extended mass range.
- Exploring cosmic chemical evolution by measuring bulk metallicity for ~100 high-redshift ($z>2$) galaxy clusters
- Continuously surveying the dynamic X-ray sky with large duty cycle and high spectral and time resolution to characterize source behavior over a vast range of time scales, and to enable multi-wavelength and multi-messenger studies through cross-correlation with high cadence surveys at other wavelengths and in gravitational waves and neutrinos.



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
  - Specific configuration to be worked out during design study over the next year
- STROBE-X is based on existing technology and builds on experience with NICER and LOFT.
- 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