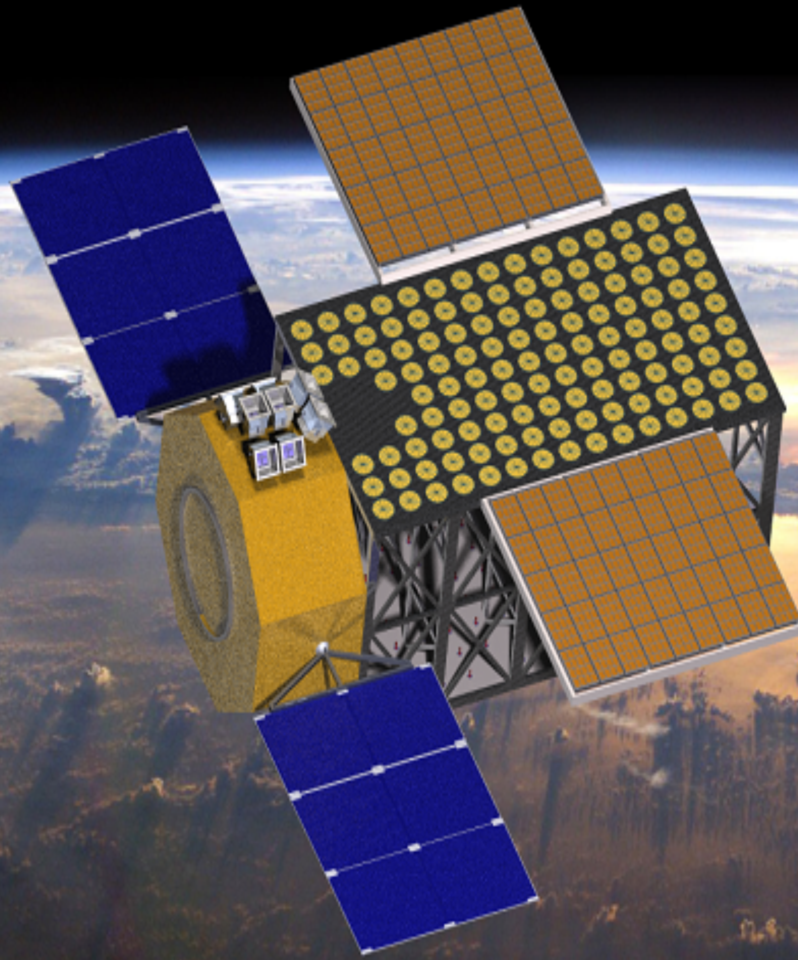
STROBE-X: Hardware Baseline and Study Trades



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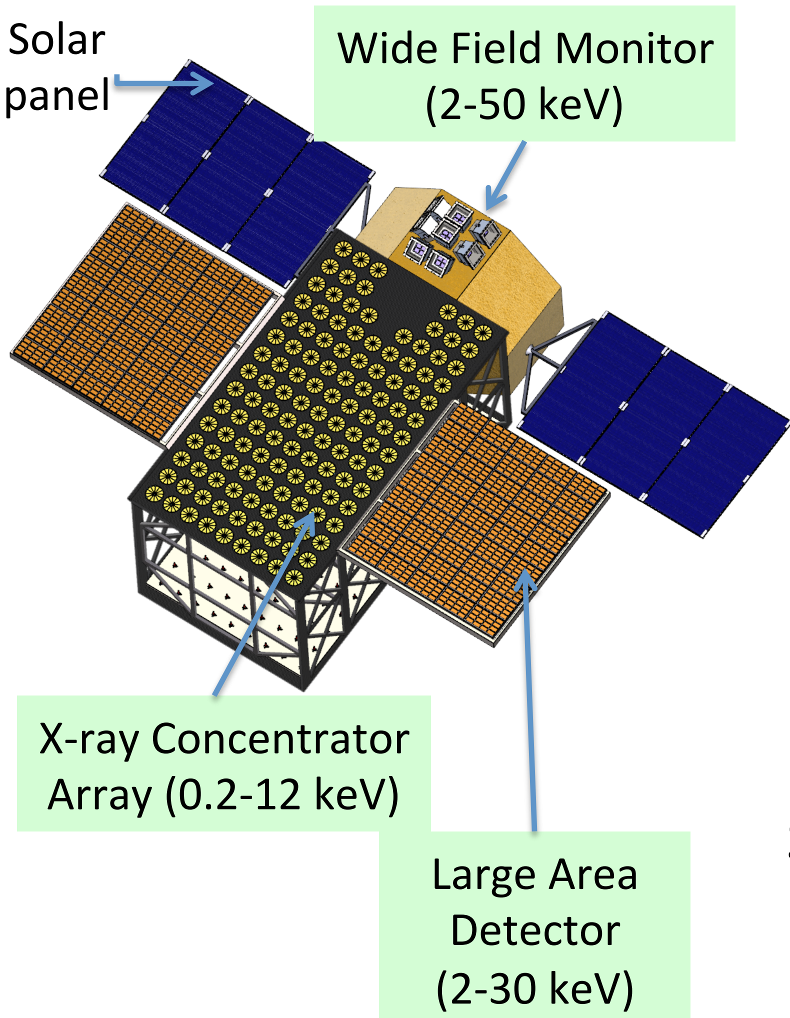
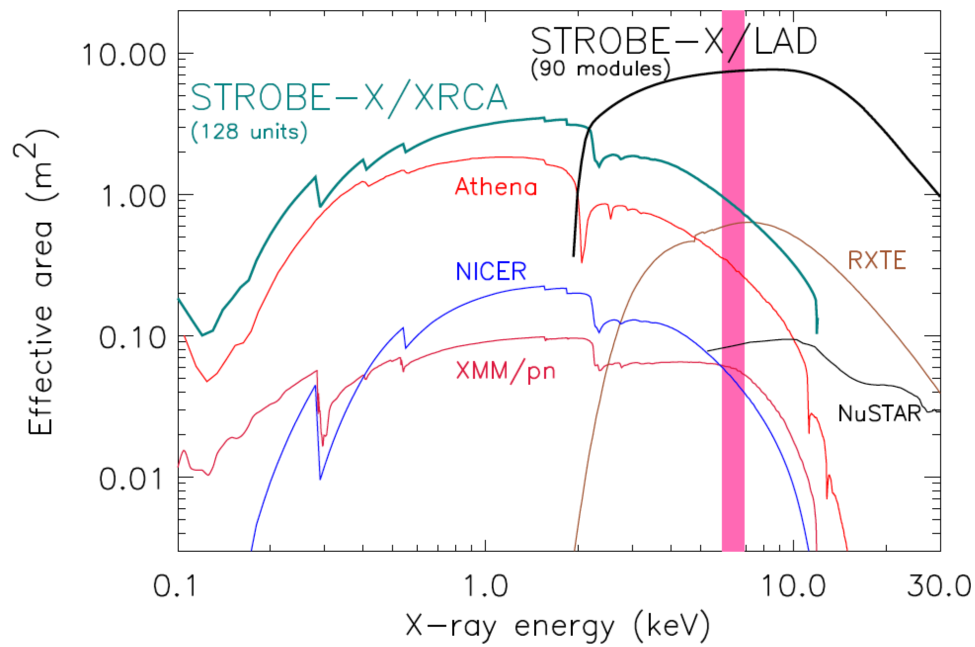
Spectroscopic Time-Resolving Observatory for Broadband Energy X-rays (STROBE-X)



Large effective area ~$10m^2$ @ 6 keV

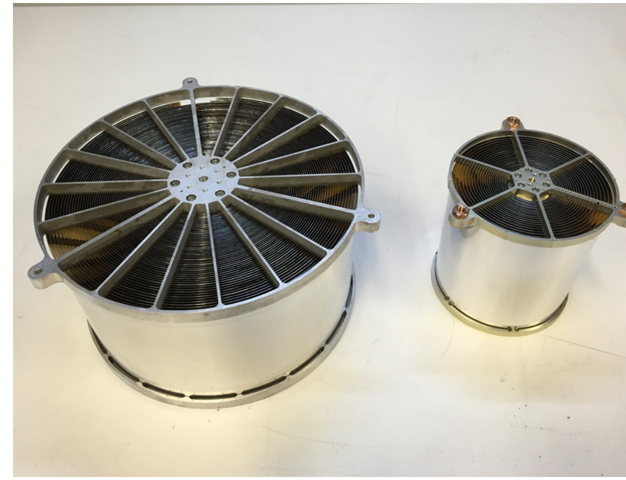


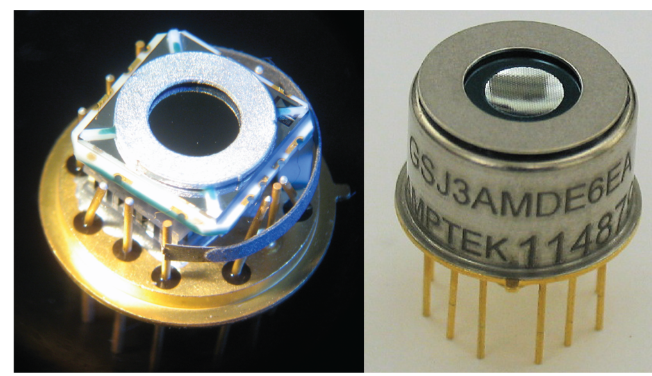
STROBE-X combines the strengths of NICER and LOFT: High throughput X-ray timing with good spectroscopy

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

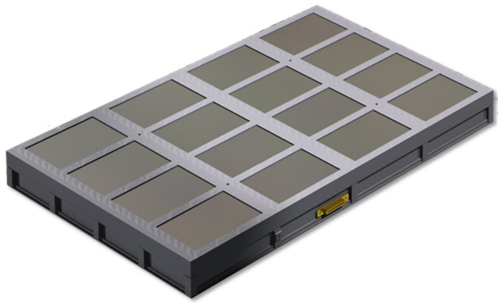
X-ray Concentrator Array

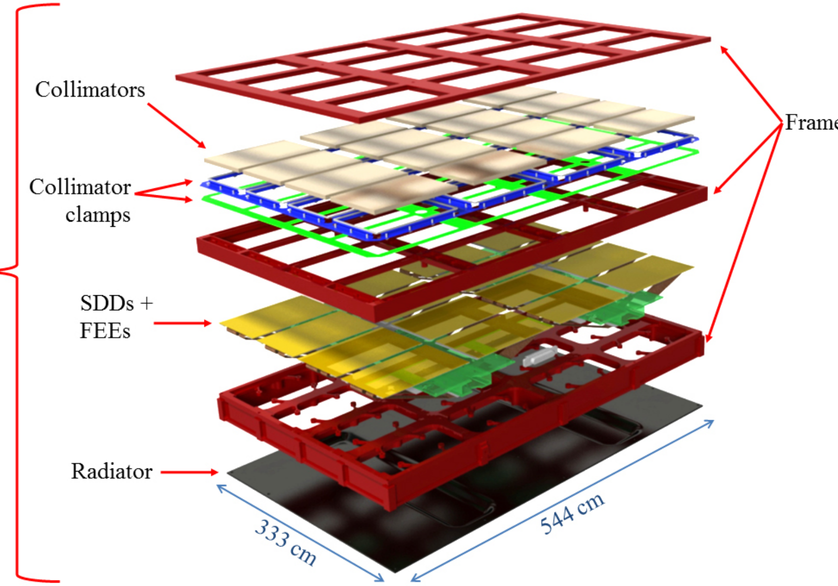
- Low background, high throughput
- Enables high time resolution (100 ns) observations of the faintest sources, both extragalactic and galactic
- Sensitive timing and spectroscopy to thermal emission and iron lines
- Scaled up version of NICER concentrators with NICER SDDs
  - Energy range: 0.2-12 keV
  - 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
- Modular: 128 X-ray concentrator units





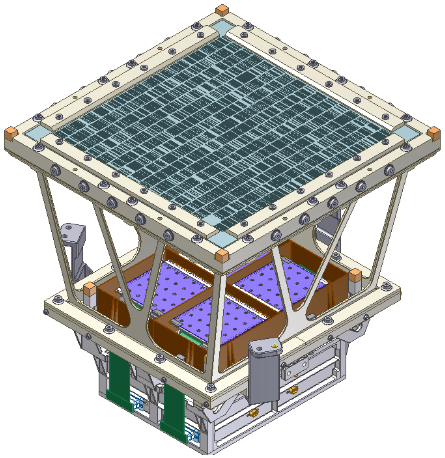
Large Area Detector

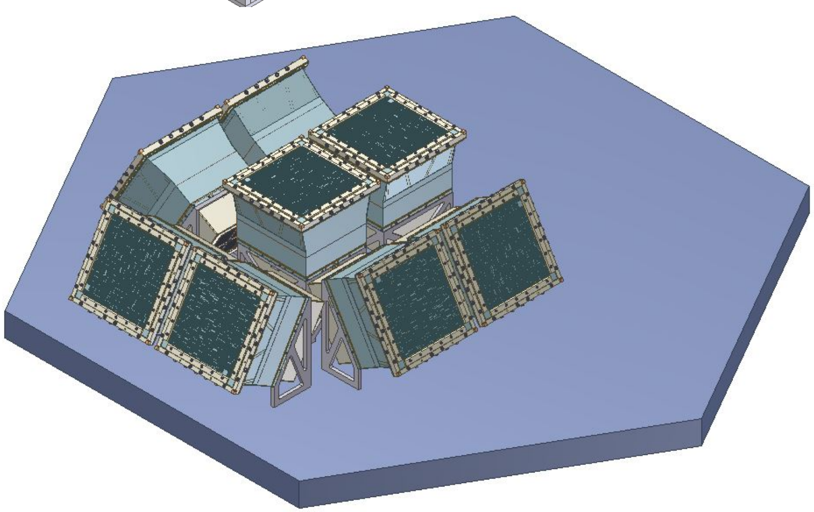




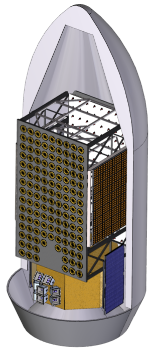
- High time resolution (10 µs) and CCD quality energy resolution over the 2-30 keV range
  - Best sensitivity to QPOs; most prominent in harder X-rays
  - Sensitive to non-thermal emission and Compton hump
- SDDs and lightweight microcapillary plate collimators developed for ESA's LOFT M3 & M4.
  - Energy resolution: 200-240 eV FWHM (CCD quality)
  - Effective Area @ 10 keV 7.6 m^2
- Modular: 90 LAD modules

Wide Field Monitor





- Wide-field coded-mask imager
- Sensitive to transients from milliseconds to years
- LOFT SDDs and mask
- Instantaneous FoV: >1/3 of sky
- Energy range: 2-50 keV
- Energy resolution: 300 eV FWHM @6 keV
- Effective area: 364 cm^2 per camera pair
- Position accuracy: 1 arcmin
- Time resolution: 10 μs



Launch Vehicle Capabilities

Required by study:

- Launch from KSC/CCAFS
- Falcon 9 launcher

Table 1: Separated Spacecraft Mass for 600 km Circular O

Orbit Inclination	Falcon 9 Drone Ship Recovery	Falcon 9 Expendable First Stage
15 deg	5630 kg	7730 kg
10 deg	3470 kg	5130 kg
5 deg	1680 kg	3020 kg
3 deg	1050 kg	2275 kg

Current estimate for STROBE-X mass
5820 kg

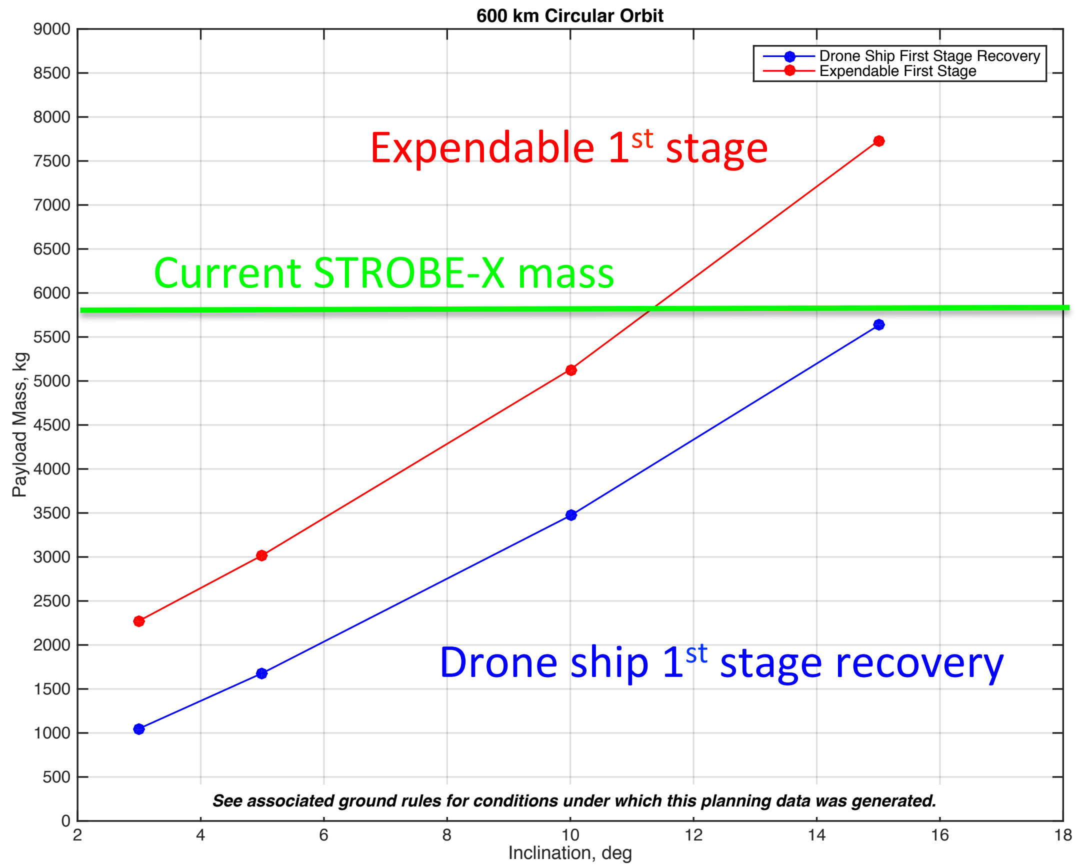


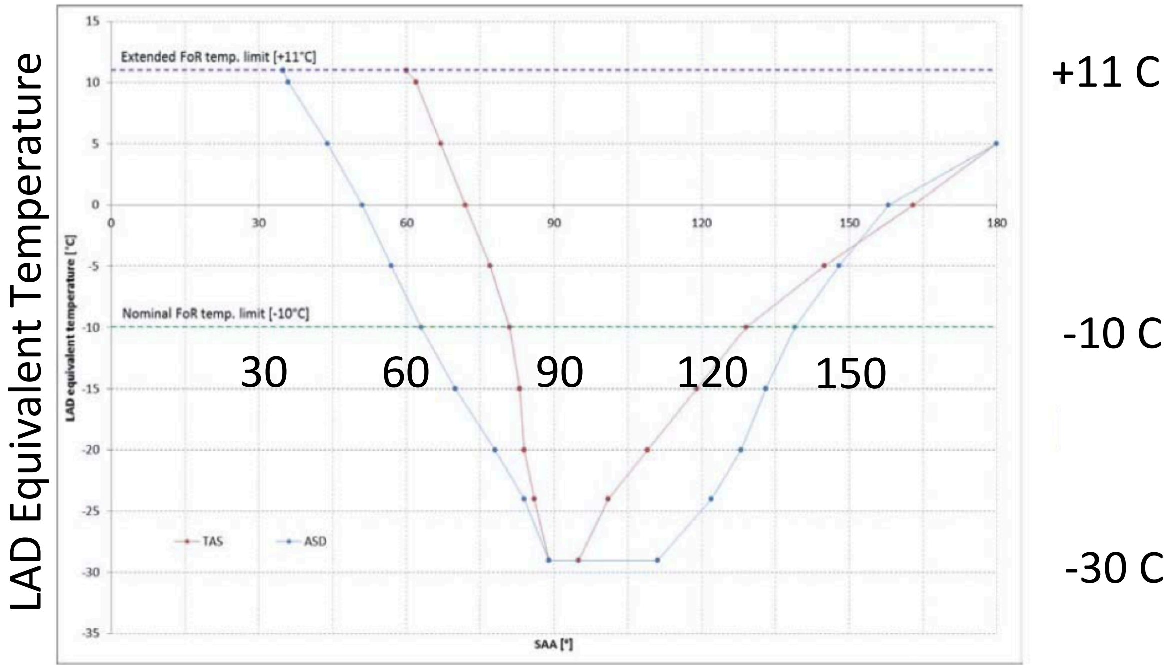
Figure 1: Falcon 9 Performance Planning Curve

Issue to be studied: Energy resolution for LAD detectors (1)

- The noise and energy resolution for the LAD and WFM SDDs depend on leakage current.
- The leakage current increases rapidly with orbital inclination due to radiation damage with exposure to SAA
  - LOFT selected a <2.5 deg inclination to mitigate this.
  - STROBE-X will be at an inclination of 10-15 deg.
- Operating temperature mitigates this effect
  - I_{leak} halves every 7 deg C

Issue to be studied: Energy resolution for LAD detectors (2)

LOFT M3 Field of Regard



Solar Aspect Angle

- @20° inclination operating temperature -30 C to keep energy resolution below 300 eV
- Smaller field of regard = lower temperture
- Cooling?
- SDD design improvements
- More detailed study to come. Need to know the energy resolution required for the science

Key Trades

- Effective Area of XRCA vs Effective area of LAD
  - Where do we need the effective area to do the best science?
- Orbital inclination vs launch mass
  - Trade between energy resolution and effective area
- LAD Field of regard vs energy resolution
  - Trade of how much of sky is accessible vs energy resolution for LAD
- Design of XRCA optical bench
  - Also support structure for deployment of LAD panels
  - Optimize number, diameter, & focal length for concentrator mirrors
- Slewing agility
  - How quickly do we need to be able to repoint?
  - How often can we repoint?
  - Can we repoint during Earth occultations?
  - Onboard automated repoint capability?
- Telemetry – event by event data for all instruments.

What instrument parameters are driven by your science?

- Effective area – in which energy range?
- Energy resolution – what is good enough?
- How much of the sky do you need to be accessible at a given time?
- Low/high energy coverage
- Other considerations?