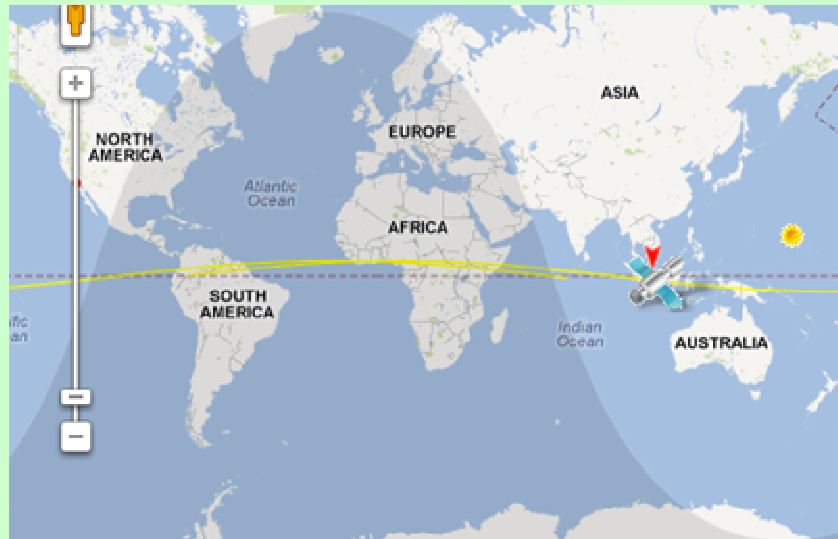
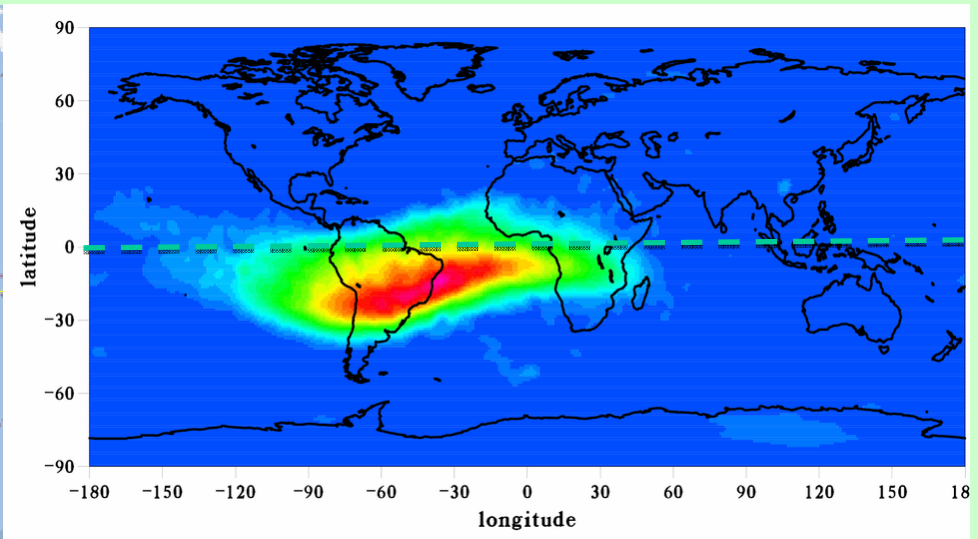


# Orbit

NuSTAR orbit



South Atlantic anomaly



**637 X 623, 6.0 DEG INCLINATION  
LIFETIME ~ 10 YEARS  
SAA PASSAGES: NOT QUITE EVERY ORBIT,  
NEVER THROUGH HIGHEST INTENSITY**

## 1 Ms Sensitivity

$3.2 \times 10^{-15}$  erg/cm<sup>2</sup>/s (6 - 10 keV)

$1.4 \times 10^{-14}$  (10 - 30 keV)

## Timing

relative 100 microsec

absolute 3 msec

## Imaging

HPD 58"

FWHM 16"

Localization 2" (1-sigma)

## Spectral response

energy range 3-79 keV

threshold 2.0 keV

$\Delta E$  @ 6 keV 0.4 keV FWHM

$\Delta E$  @ 60 keV 1.0 keV FWHM

## Field of View

FWZI 12.5' x 12.5'

FWHI 10' @ 10 keV

8' @ 40 keV

6' @ 68 keV

## Target of Opportunity

response <24 hr (reqmt)

typical 6-8 hours

80% sky accessibility

# KEY SCIENCE PROGRAMS

Key science goal	Observations	Time (weeks)
Locate massive black holes	Deep and wide-field extragalactic surveys (ECDFS, COSMOS, BAT-shallow)	23
Study the population of compact objects in our Galaxy	Survey Galactic Center and other fields of varied ages (spiral arms, bulge)	20
Explosion dynamics and nucleosynthesis in core collapse and 1a SNe	Pointed observations of young ( $\tau < 500$ yr) remnants – Cas A, SN1987A, GX1+9 ToO observations of nearby SN1a	22
Understanding relativistic jets in supermassive black holes	Contemporaneous multiwavelength observations of GeV/TeV blazars	6
Other Objectives	Observations	Time
Varied		33

# KEY COORDINATED PROGRAMS

## JOINT WITH XMM

**BLACK HOLE SPIN (AND MUCH MORE) IN BRIGHT AGN  
(860 KSEC!)**

**MCG-6-30-15, ARK 120, 3C 120, SWIFT J2127**

**ULTRALUMINOUS X-RAY SOURCES (200 KSEC)**

**IC 342, HOLMBERG IX X-1, NGC 1313, NGC 1365, NGC 5205**

## JOINT WITH CHANDRA

**STARBURST GALAXY NGC 253**

**FLARES FROM SGR A\***

**EXTENDED COSMOS SURVEY**

## JOINT WITH SUZAKU

**NGC4151, IC4329A**

**HOLMBERG IX X-1**

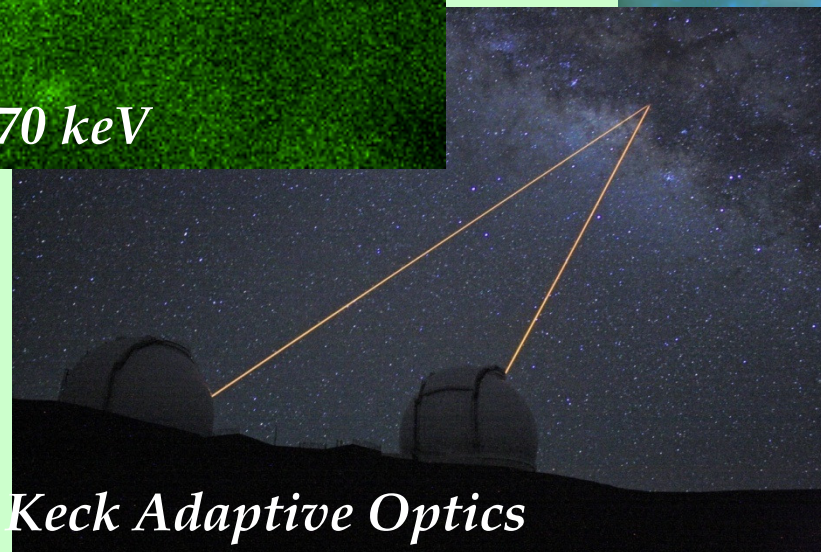
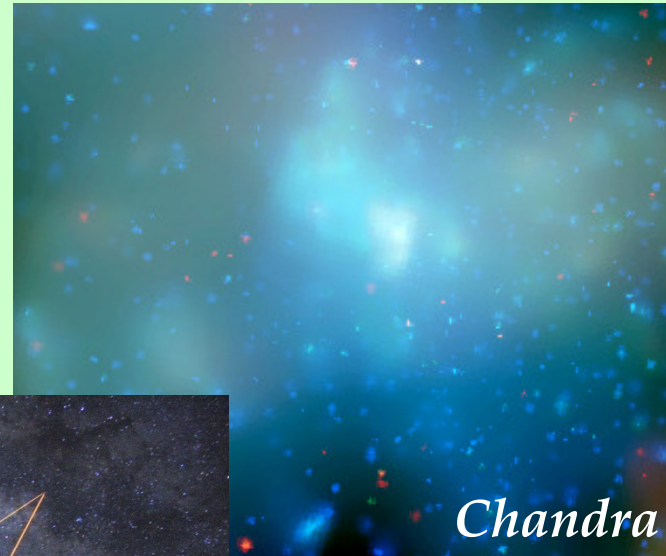
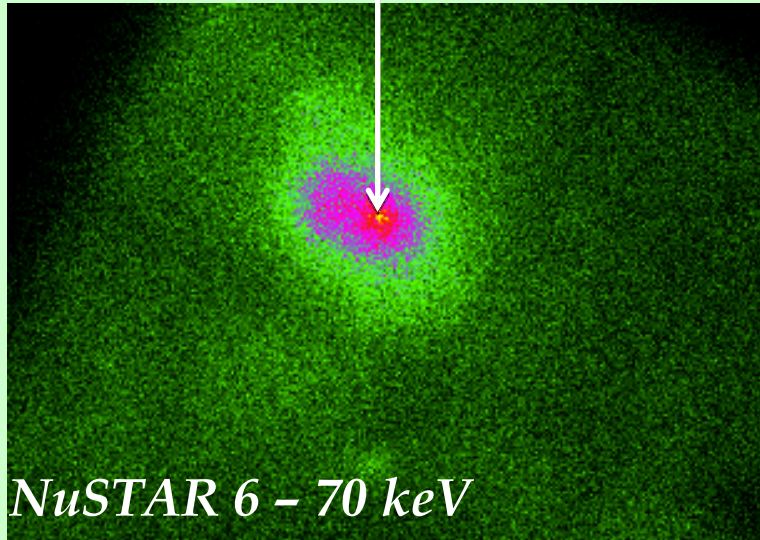
**CYG X-1, HER X-1**

# BASELINE MISSION SCIENCE

Science Group	Working Group Chair
Galactic Surveys, Galactic Center	Chuck Hailey
Supernovae and ToOs	Steve Boggs
Supernova remnants and Pulsar Wind Nebulae	Fiona Harrison
Magnetars and Rotation Powered Pulsars	Vicky Kaspi
Galactic Binaries	John Tomsick
Ultraluminous X-ray Sources	Fiona Harrison
Extragalactic Surveys	Daniel Stern
Blazars and Radio Galaxies	Greg Madejski, Paolo Giommi
Obscured AGN	Daniel Stern
AGN Physics	Giorgio Matt
Galaxy Clusters	Allan Hornstrup, Silvano Molendi
Starburst Galaxies	Ann Hornschemeier
Solar Physics	David Smith

# SGR A\* JULY 19

Sgr A\*

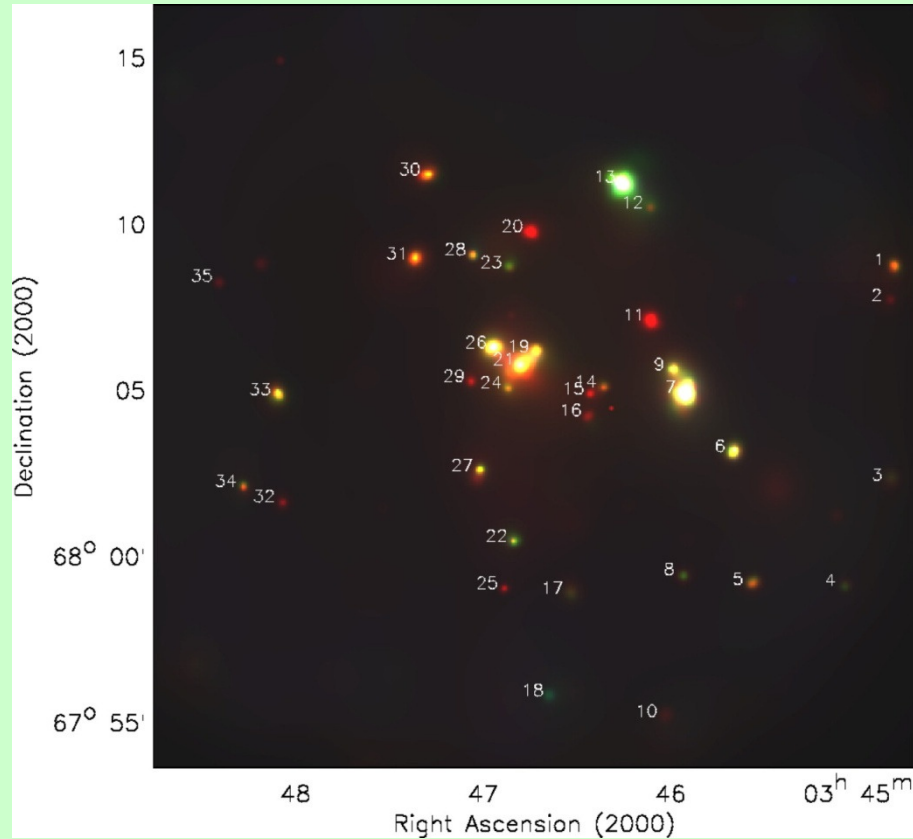


Joint campaign with Chandra and Keck



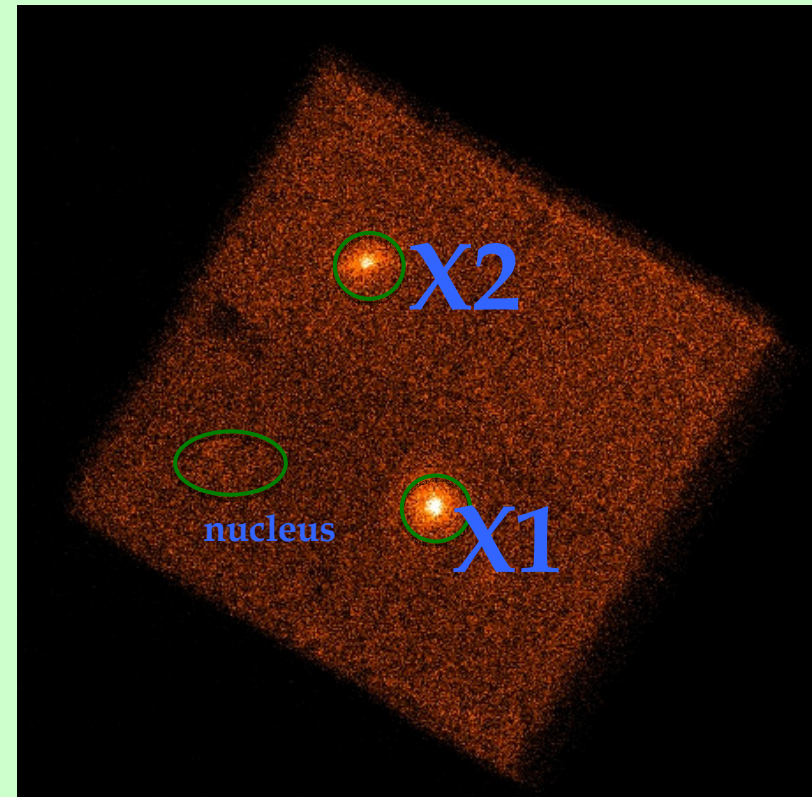


# ULX with XMM



## IC 342 - XMM

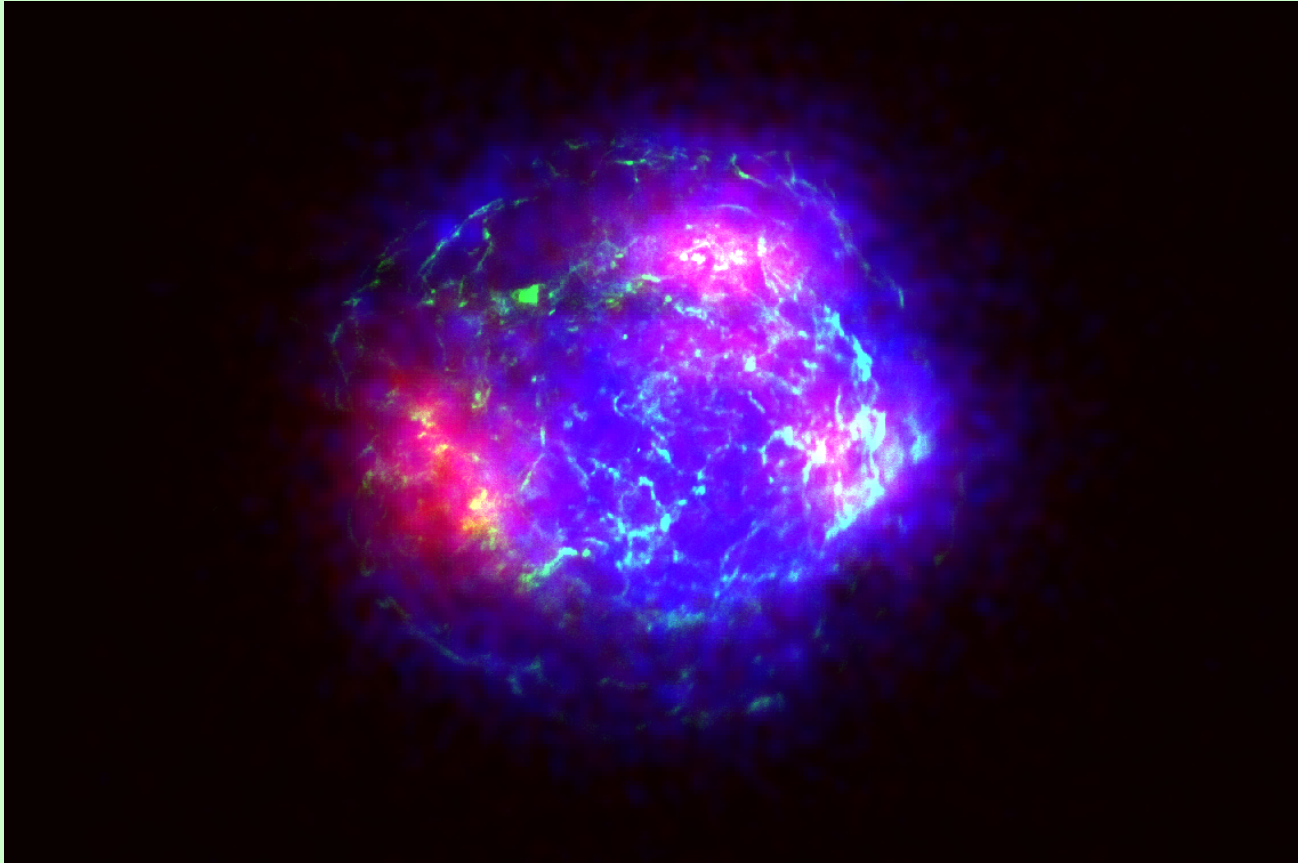
Bauer, Brandt & Lehmer, 2003, ApJ, 126, 2797



## NuSTAR 10-70 keV

1 telescope, first visit

# CASSIOPEIA A



**One telescope, Gaussian smoothed.**

**Red: NuSTAR Fe  
Green: Chandra 4-6 keV  
Blue: NuSTAR 10-25 keV**

# **CONCLUSIONS ON NUSTAR**

**NUSTAR IS PERFORMING WELL ON ORBIT  
AND MEETING SPECIFICATIONS**

**SCIENCE OBSERVATIONS ARE  
UNDERWAY - OFFICIAL SCIENCE PHASE  
BEGAN MID-AUGUST**

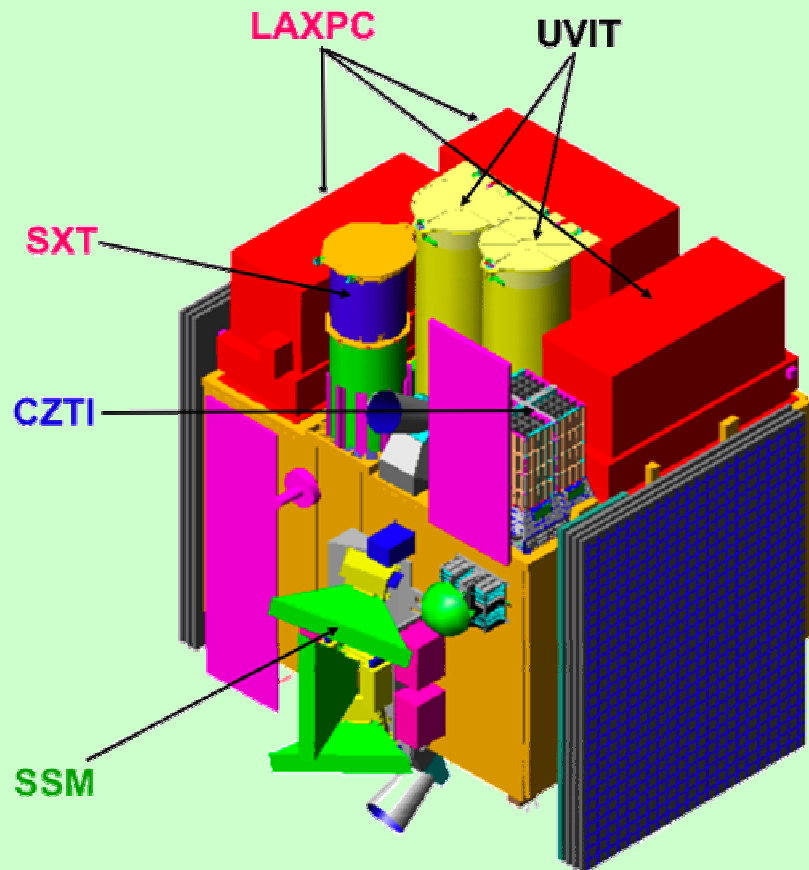
**LONG ORBIT LIFE - EXPECT A GO  
PROGRAM IN TWO YEARS**

# ASTROSAT (2013)



ASTROSAT WILL CARRY FIVE ASTRONOMY PAYLOADS FOR SIMULTANEOUS MULTI-BAND OBSERVATIONS:

- TWIN 40-CM **ULTRAVIOLET IMAGING TELESCOPES (UVIT)** COVERING FAR-UV TO OPTICAL BANDS
- THREE UNITS OF **LARGE AREA XENON PROPORTIONAL COUNTERS (LAXPC)** COVERING MEDIUM ENERGY X-RAYS FROM 3 TO 80 KEV WITH AN EFFECTIVE AREA OF 6000 SQ.CM. AT 10 KEV
- A **SOFT X-RAY TELESCOPE (SXT)** WITH CONICAL FOIL MIRRORS AND **X-RAY CCD DETECTOR**, COVERING THE ENERGY RANGE 0.3-8 KEV. THE EFFECTIVE AREA WILL BE ABOUT 200 SQ.CM. AT 1 KEV
- A CADMIUM-ZINC-TELLURIDE **CODED-MASK IMAGER (CZTI)**, COVERING HARD X-RAYS FROM 10 TO 150 KEV, WITH ABOUT 10 DEG FIELD OF VIEW AND 1000 SQ.CM. EFFECTIVE AREA
  - A **SCANNING SKY MONITOR (SSM)** CONSISTING OF THREE ONE-DIMENSIONAL POSITION-SENSITIVE PROPORTIONAL COUNTERS WITH CODED MASKS. THE ASSEMBLY WILL BE PLACED ON A ROTATING PLATFORM TO SCAN THE AVAILABLE SKY ONCE EVERY SIX HOURS IN ORDER TO LOCATE TRANSIENT X-RAY SOURCES.



	UVIT/OPT	SXT	LAXPC	CZTI	SSM
<b>Detector</b>	UV: photon counting CCD Opt: CCD photometer	X-ray CCD (at the focal plane)	Proportional Counter	CdZnTe detector array	Position-sensitive proportional counter
<b>Imaging property</b>	imaging	imaging	non-imaging	imaging (< 100 keV)	imaging
<b>Optics</b>	Twin Ritchey-Chretien 2 mirror system	Conical foil (~Wolter-I) mirrors	Collimator	2-D coded mask	1-D coded mask
<b>Bandwidth</b>	130-320 nm	0.3-8 keV	3-100 keV	10-150 keV	2-10 keV
<b>Geometric Area (cm<sup>2</sup>)</b>	1250	250	10800	1000	180
<b>Effective Area (cm<sup>2</sup>)</b>	60 (depends on filter)	125@0.5 keV 200@1-2 keV 25@6 keV	6000@5-30 keV	500 (<100 keV) 1000 (>100 keV)	~40@2 keV 90@5 keV (Xe gas)
<b>Field of View</b>	0.50° dia	0.35° (FWHM)	1° x 1°	6° x 6° (< 100 keV) 17° x 17° (> 100 keV)	
<b>Energy Resolution</b>	<100 nm (depends on filter)	2%@6 keV	9%@22 keV	5%@10 keV	19%@6 keV
<b>Angular Resolution</b>	1.8 arcsec	3-4 arcmin (HPD)	1-5 arcmin in scan mode only	8 arcmin	~10 arcmin
<b>Time resolution</b>	10 ms	2.6s, 0.3s, 1ms	10 microsec	1 ms	1 ms
<b>Typical obs. time per target</b>	30 min	0.5 - 1 day	1 - 2 days	2 days	5 min
<b>Sensitivity (Obs. Time)</b>	21 <sup>st</sup> magnitude (5σ) (1800s)	10 microCrab (5σ) (10000s)	0.1 milliCrab (3σ) (1000s)	0.5 milliCrab (3σ) (1000s)	~30 milliCrab (3σ) (300s)

#### Announcement of Opportunity

Proposal opportunity for observing with ASTROSAT will be announced shortly after launch and initial verification of instrument performance. Proposals will be peer-reviewed and the final decision on time allocation will be made by the Astrosat Time Allocation Committee (ATAC). Observations for AO Cycle 1 will begin one year after the launch of ASTROSAT. The observing time will be divided in the following manner:

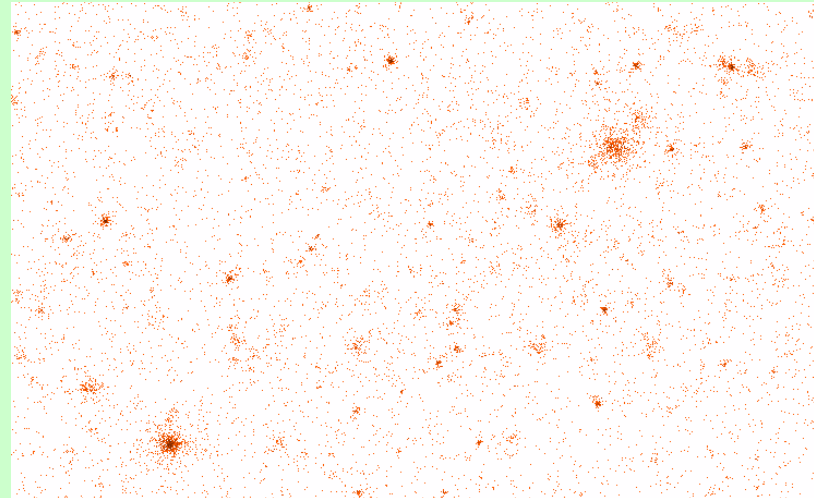
0-6 months: PV (Performance Verification)      6-12 months: GTO (Guaranteed Time)

Year 2:	AO (India) 35%		GTO 50%
Year 3:	AO (India) 45%	AO (World) 10%	GTO 30%
Year 4:	AO (India) 65%	AO (World) 20%	

Reserved time: CSA 5%, UoL 3%, TOO 5%, Calibration 2% throughout the mission

# eROSITA (2014)

**SEVEN IDENTICAL WOLTER-1 MIRROR MODULES, WITH CCD DETECTORS. 0.5-10 KEV ENERGY RANGE. ANGULAR RESOLUTION OF 15" ON-AXIS, UP TO 30". F.O.V. 1 DEG. IN DIAMETER. EFF. AREA 1500 CM<sup>2</sup>@1 KEV**



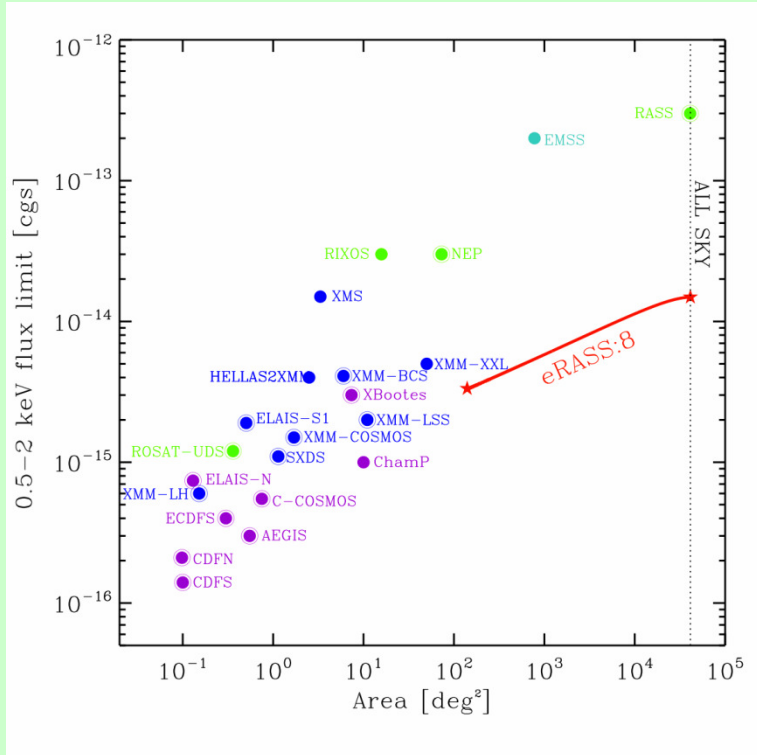
**3 ks pointing**

**COMPLEMENTED BY ART-XC, CODED MASKED TELESCOPES WITH ANGULAR RESOLUTION OF ABOUT 1', F.O.V. OF 30', 6-30 KEV ENERGY RANGE.**

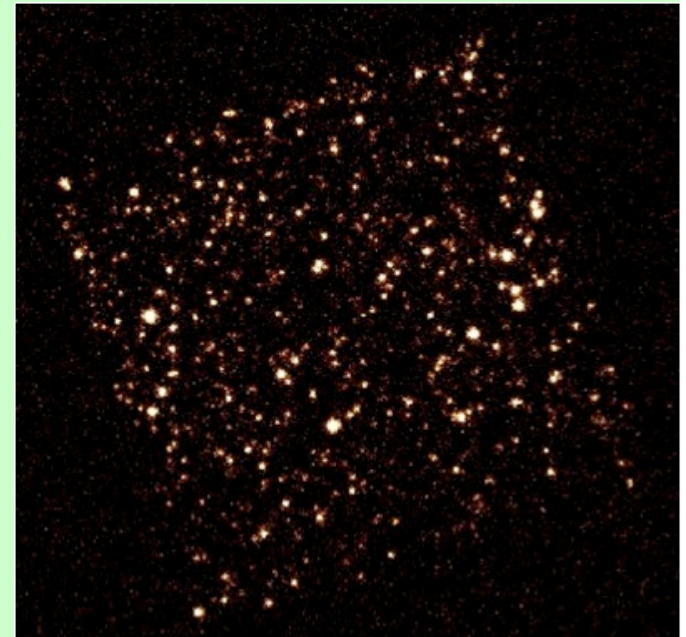
# eROSITA

ALL SKY SURVEY (2-3 KS PER FIELD)  
DEEP SURVEYS (200 DEG<sup>2</sup>, 20-30 KS)

MAIN GOAL: LARGE SCALE STRUCTURE  
AND DARK ENERGY WITH CLUSTERS  
OF GALAXIES



COSMOS FIELD



EXPECTED # OF AGN (0.5-2 KEV)	1.76 X 10 <sup>6</sup> (ASS)	60000 (DS)
EXPECTED # OF AGN (2-10 KEV)	130000 (ASS)	15000 (DS)

# ASTRO-H (2014)

**THIRD JAPANESE MISSION WITH MICROCALORIMETER - FIRST TWO FAILED, BUT THE MICROCALORIMETER WAS TESTED SUCCESSFULLY IN SUZAKU. ENERGY RESOLUTION OF ABOUT 5 EV. IT WILL REVOLUTIONIZE THE IRON LINE STUDIES.**

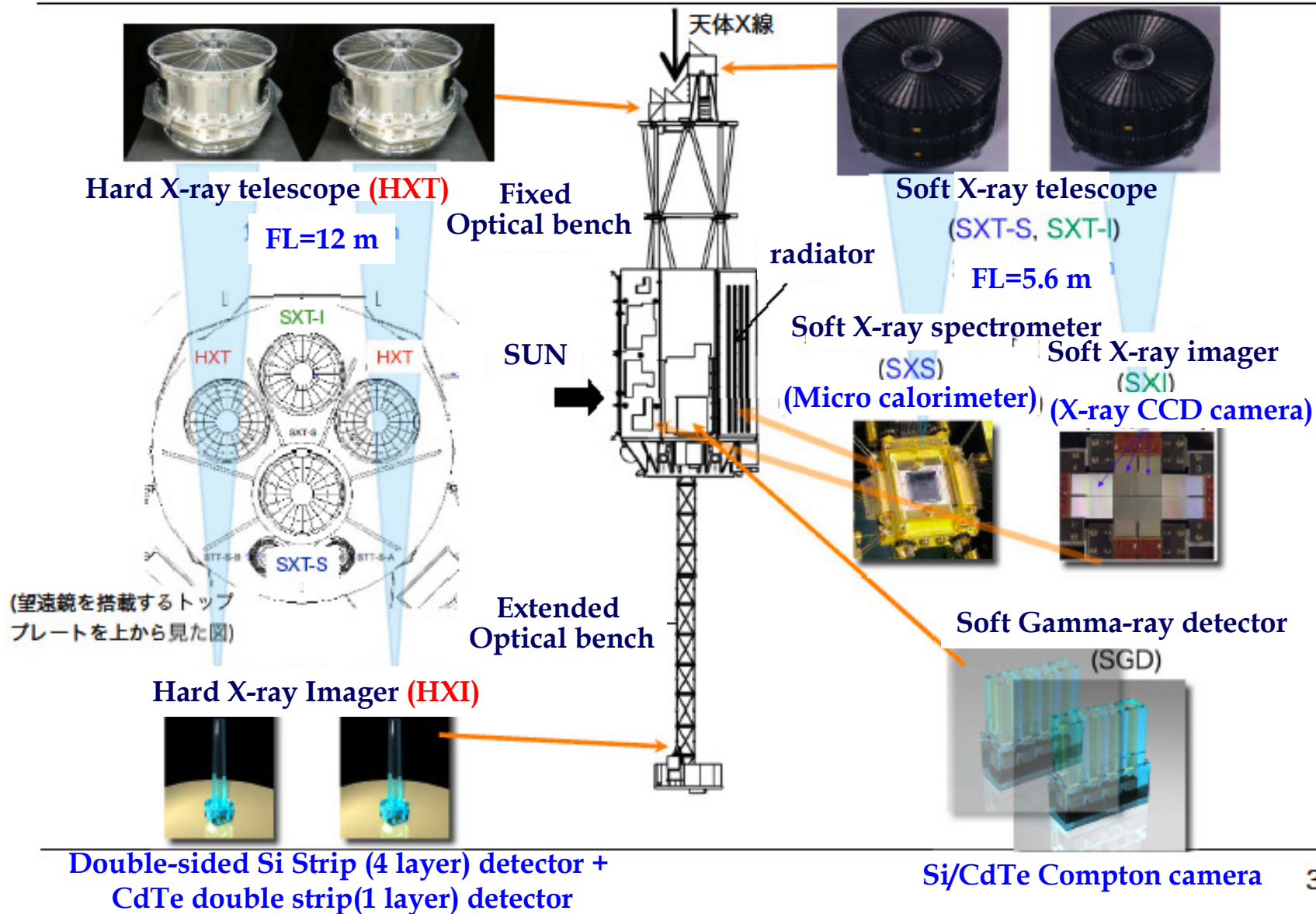
**MANY INSTRUMENTS AND TELESCOPES, COVERING OVERALL THE 0.3-600 KEV BAND (0.3-80 KEV WITH FOCUSING TELESCOPES, SPATIAL RESOLUTION OF ABOUT 90'')**

**SIMILARLY TO ASCA AND SUZAKU, A FRACTION OF OBSERVING TIME WILL BE AVAILABLE TO ESA MEMBER STATES VIA GO PROGRAM.**





# ASTRO-H INSTRUMENTS



**ASTRO-H WILL COVER THE BANDPASS BETWEEN 0.3 KEV TO 600 KEV.**