HXMT: the Hard X-ray Modulation Telescope mission

eXTP: the enhanced X-ray Timing and Polarimetry mission

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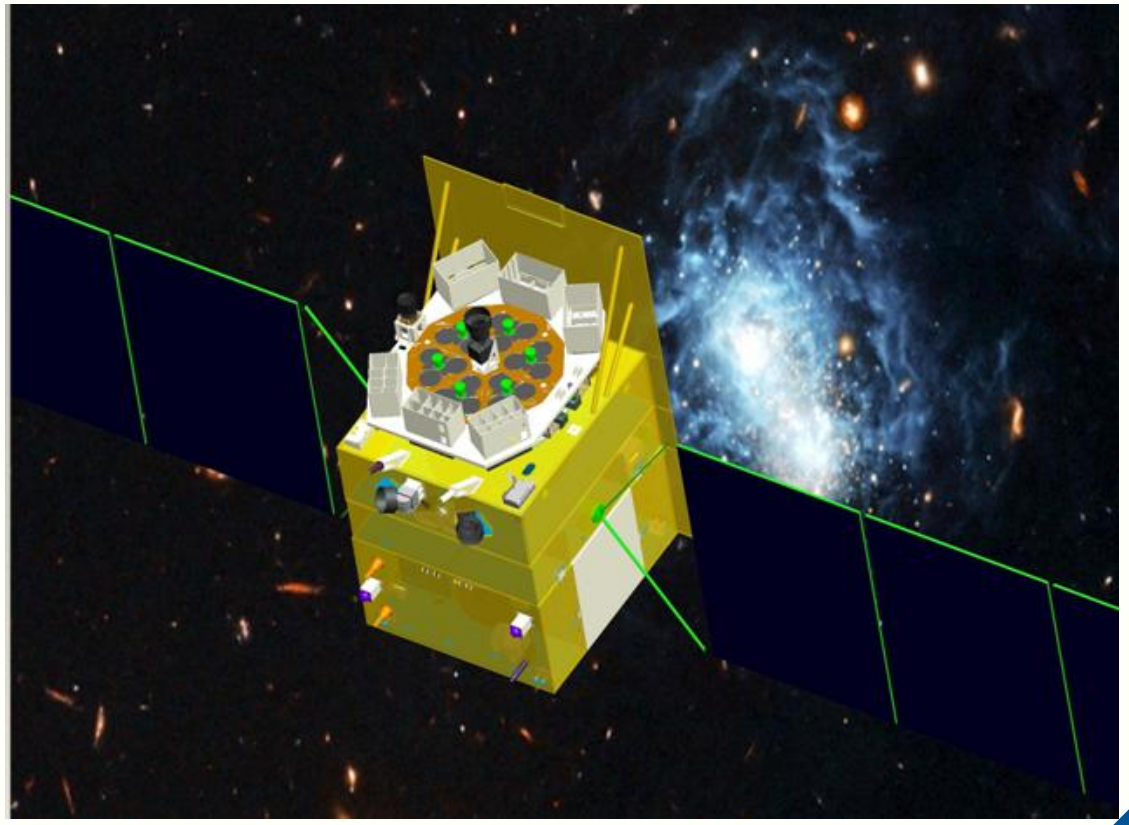
Hard X-ray Modulation Telescope (HXMT) satellite

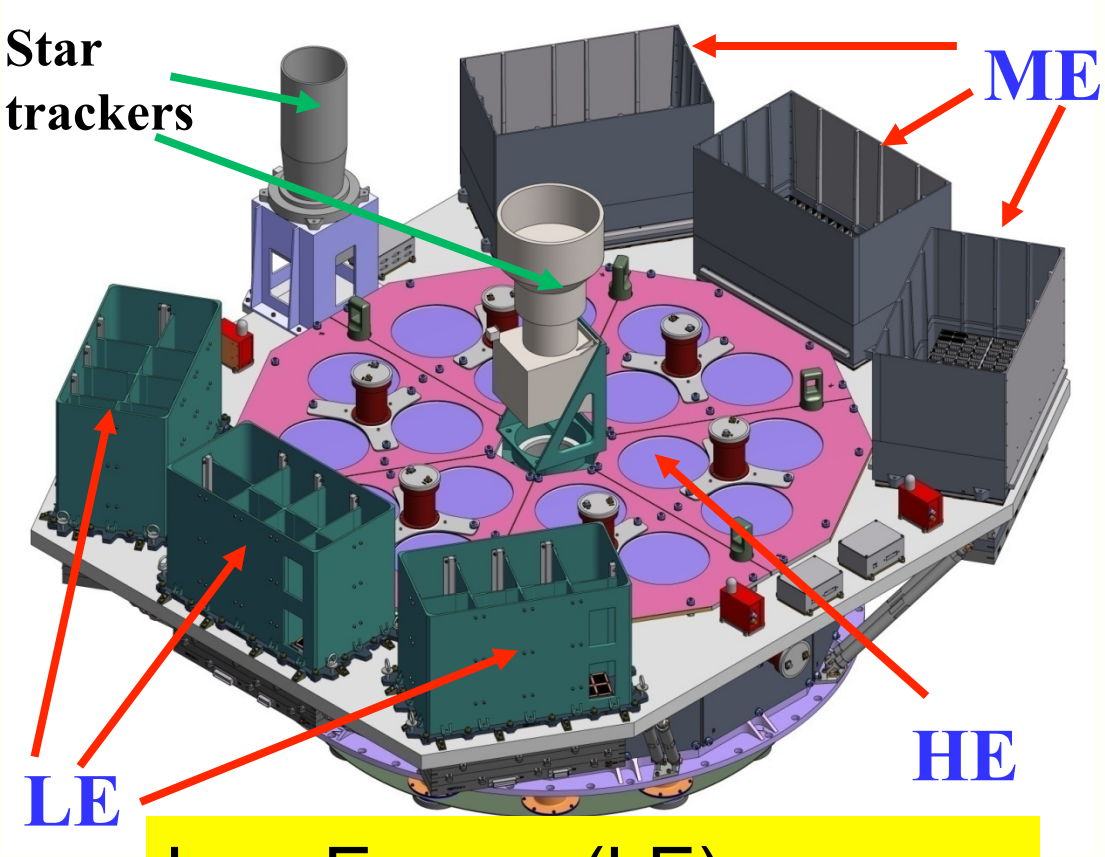
- China's 1st X-ray astronomy satellite
- Selected in 2011
- Total weight ~2500 kg
- Cir. Orbit 550 km, incl. 43°
- Pointed, scanning and GRB modes
- Designed lifetime 4 yrs
- Launch in June 2017



HXMT core sciences

1. Galactic plan scan and monitor survey: finding more weak short transients at hard X-rays
2. Pointed observations: high statistics observations of bright sources and high cadence XRB outbursts
3. GRB observations: up to 3 MeV with large area
4. Multi-wavelength observations

HXMT Payloads



Medium (ME):

Si-PIN,5-30 keV, 952 cm^2

High Energy (HE): Normal Mode

NaI, 20-250 keV, ~5000 cm^2

CsI, 50-700 keV, ~5000 cm^2

High Energy (HE): GRB Mode

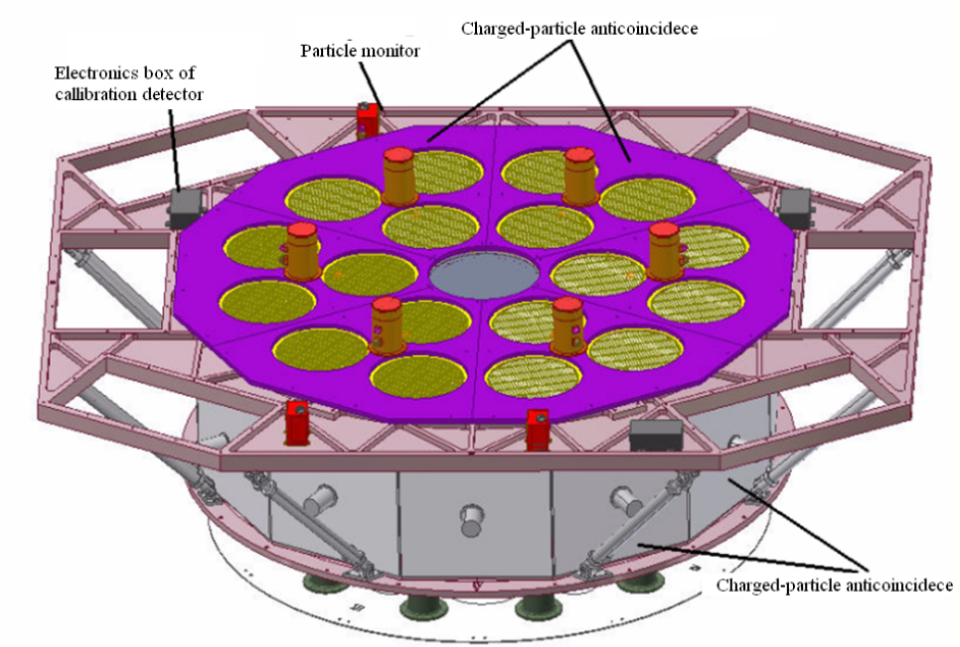
NaI, 100-300 keV, 5000 cm^2

CsI, 250-3000 keV, 5000 cm^2

Low Energy (LE):

SCD,1-15 keV, 384 cm^2

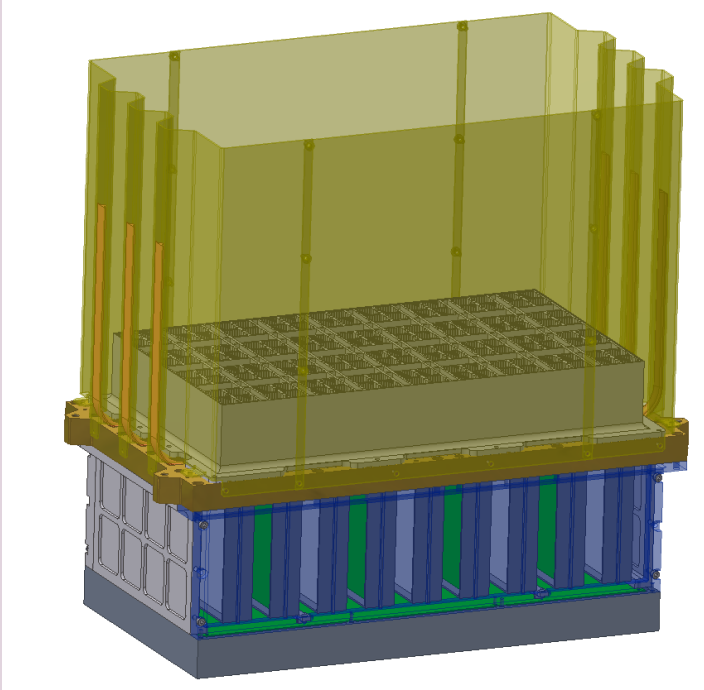
High Energy X-ray Telescope (HE)

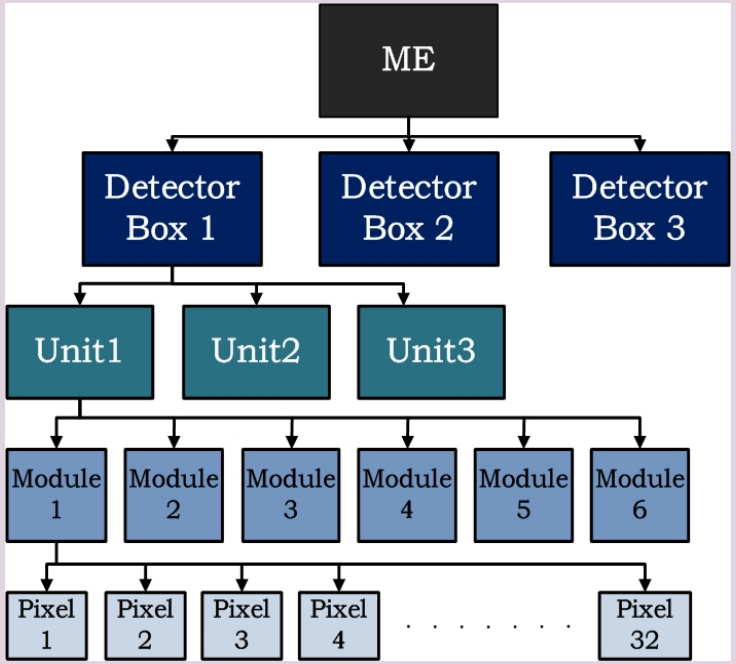


HXMT/HE Components assembly

- 18 main collimated phoswich detectors
- 18 calibration detectors (automatic gain control)
- 18 charged-particle anticoincidence plates (6 top +12 lateral sides)
- 3 particle monitors

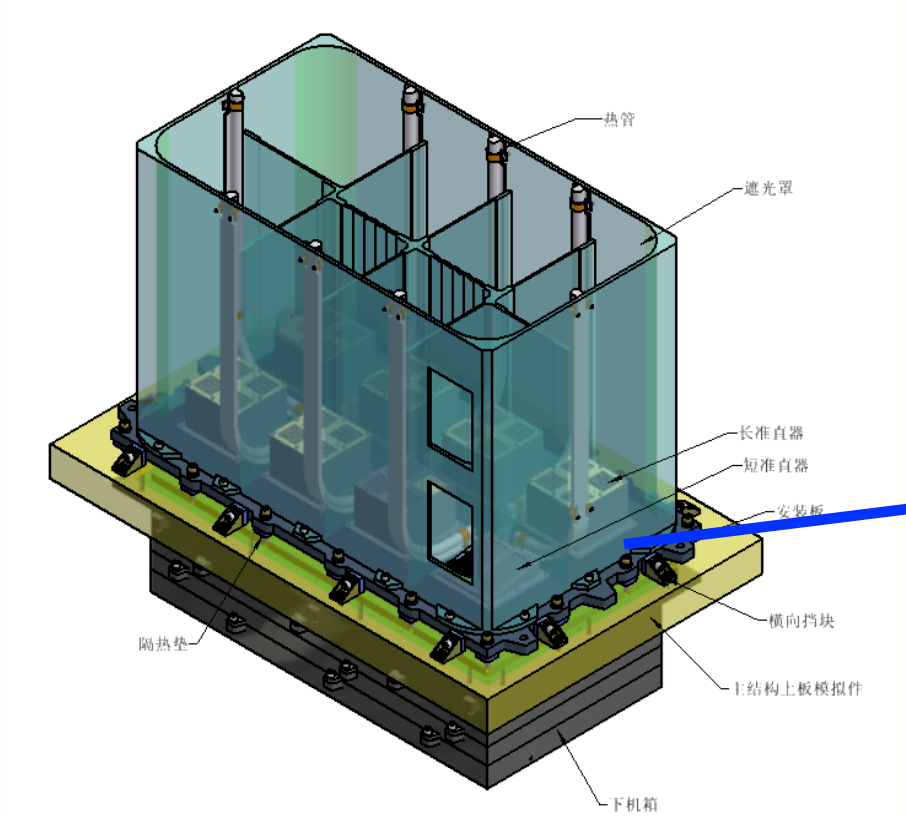
Medium Energy X-ray Telescope (ME)

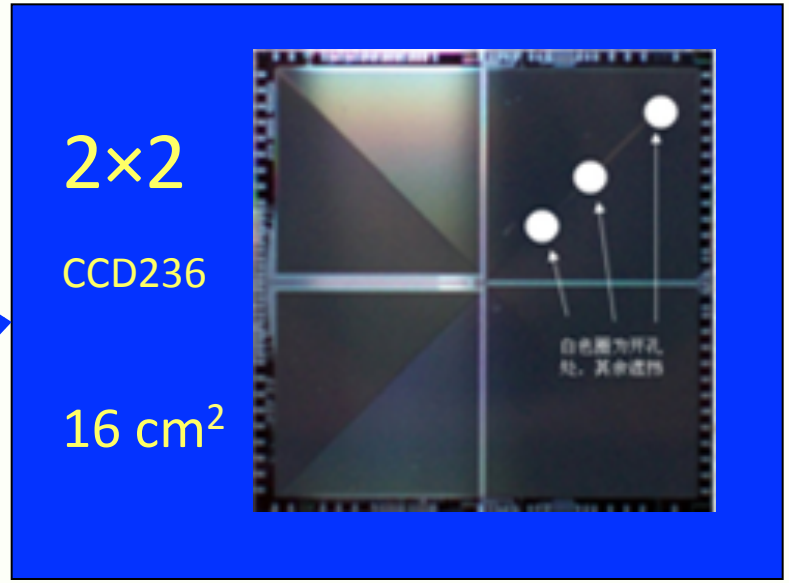




ME uses 1728 Si-PIN detectors read out by 54 ASIC (application specified integrated circuit). The energy coverage of ME is 5-30 keV, and the total detection area is 952 cm^2. The in-orbit working temperature of ME is -40 to -20 ℃

Low Energy X-ray Telescope (LE)



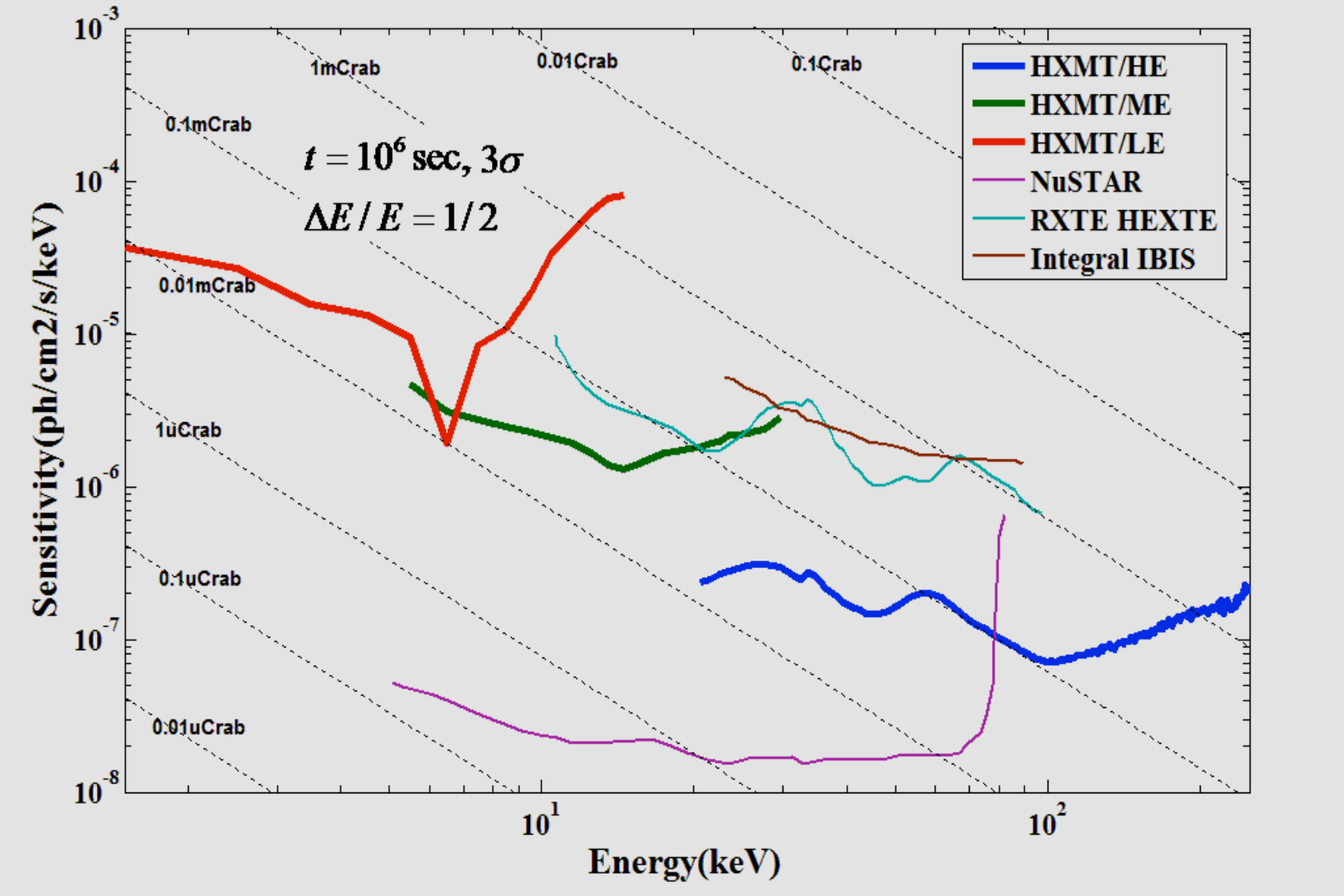


LE consists of 3 detector boxes, and each boxes contains 32 SCD 236 chips, which have a time resolution of 1ms and energy resolution of <140 eV (@6 keV) . The total detection area is 384 cm^2. The in-orbit working temperature is between -80 to -40 °C.

Main characteristics of the HXMT Mission

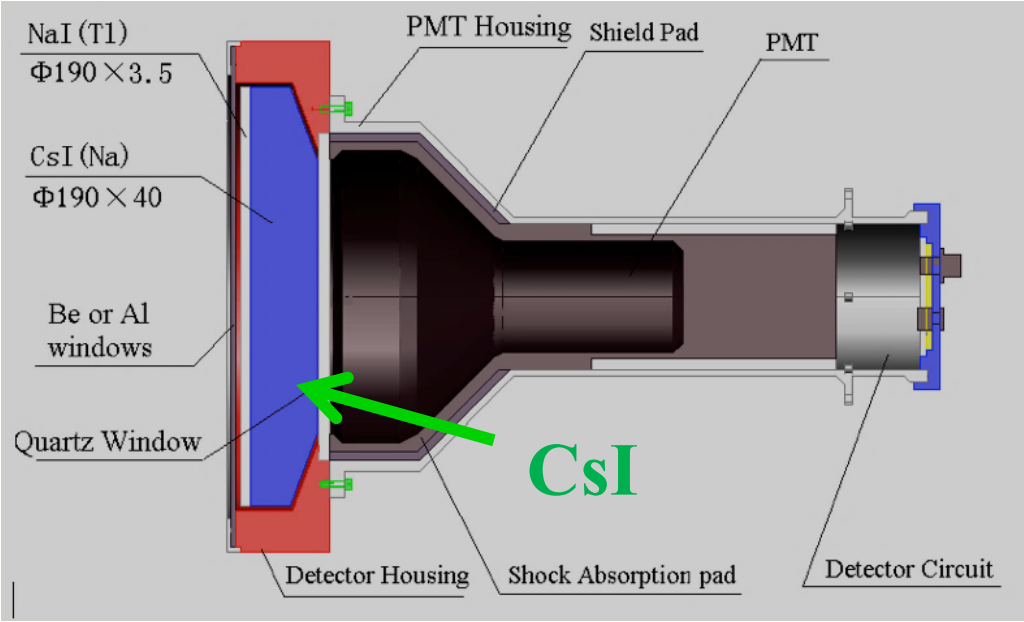
Detectors	LE: SCD, 384 cm^2;ME : Si-PIN, 952 cm^2 HE : NaI/CsI, 5000 cm^2
Energy Range	LE: 1-15 keV;ME: 5-30 keV;HE: 20-250 keV GRB mode：200-3000 keV
Time Resolution	HE: 25μs; ME: 20μs;LE: 1ms
Energy Resolution	LE: 2.5% @ 6 keV ME: 8% @ 17.8 keV HE: 19% @ 60 keV
Field of View of one module	LE: 6°×1.5°; 6°×4°; 60°×3°; blind; ME: 4°×1°; 4°×4°; blind; HE: 5.7°×1.1°; 5.7°×5.7°； blind
Source Location	<1' (20σ source)

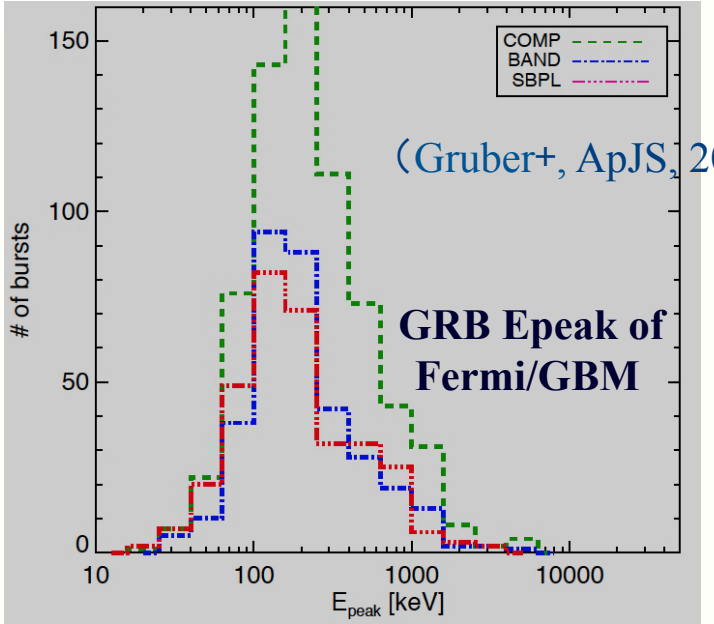
HXMT Sensitivity: pointed observation



Two modes of HXMT/HE

	NaI Energy Range (keV)	CsI Energy Range (keV)	Note
Normal mode	20 – 250	40 – 600	Normal HV
GRB mode	100 – 1250	200 – 3000	Lower HV to reduce gain by 5X And turn-off AGC system



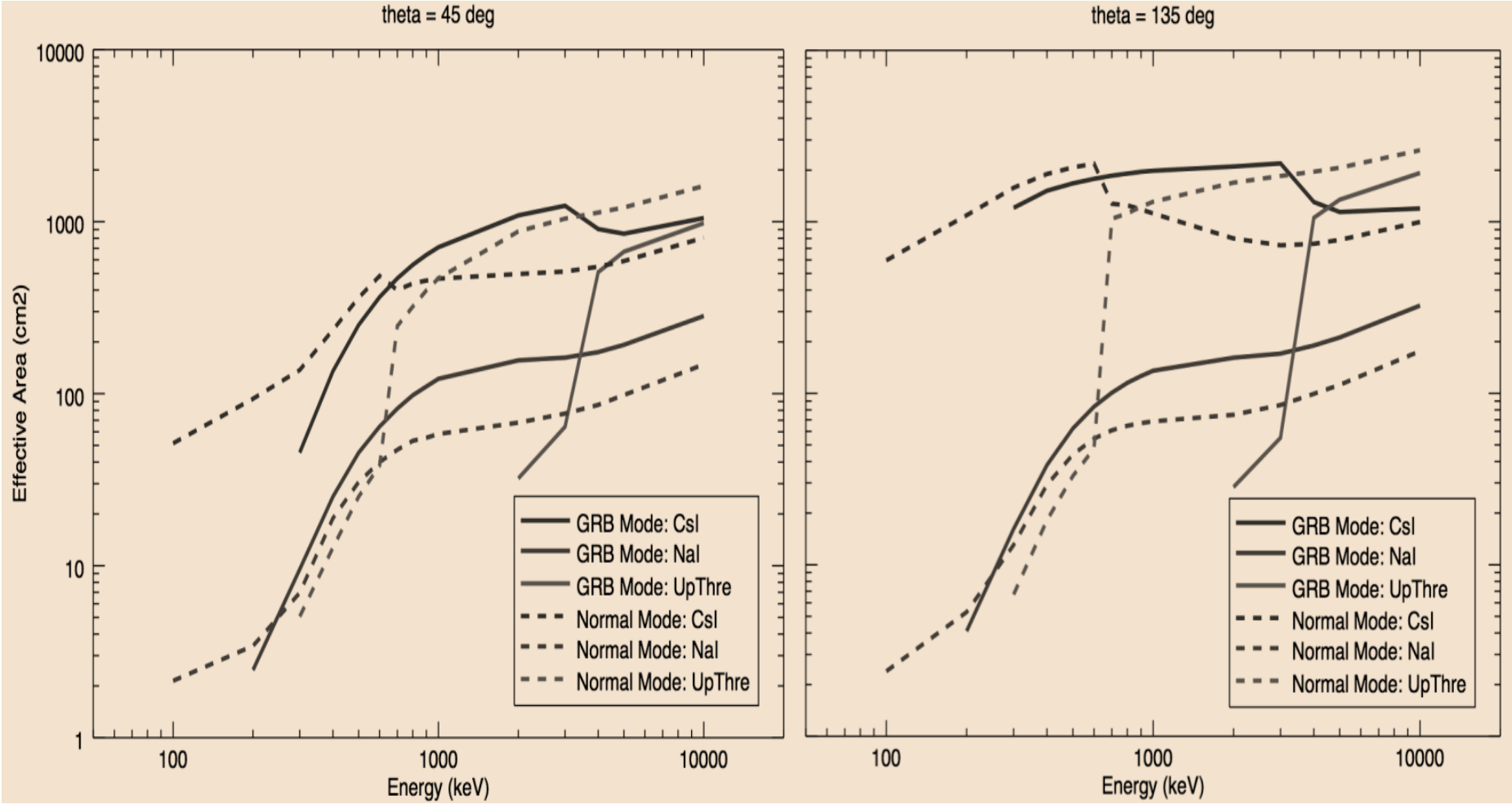


（Gruber+, ApJS, 2014）

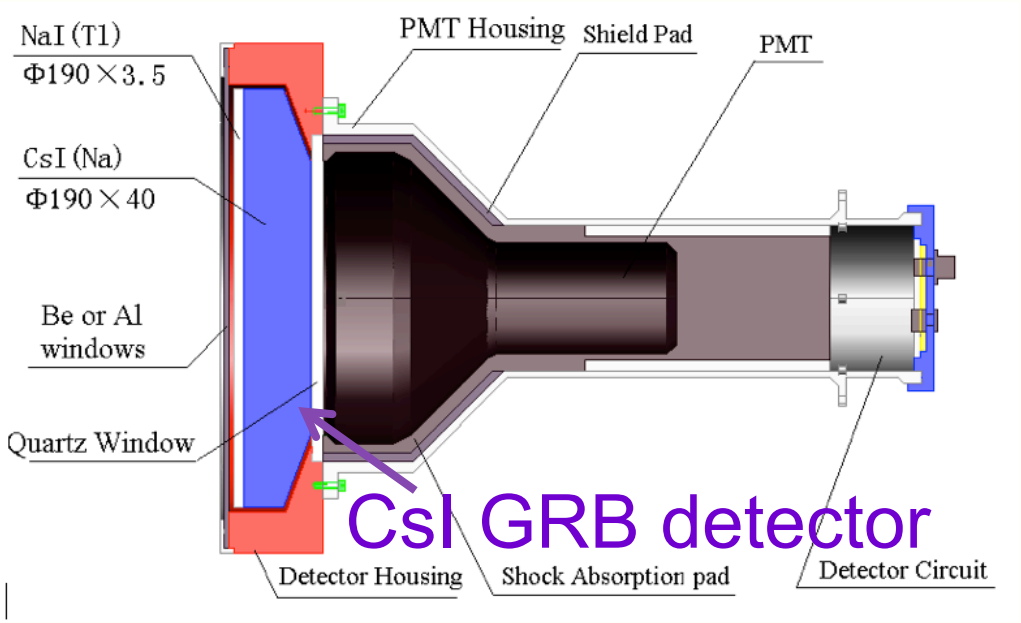
Effective area

Front incident

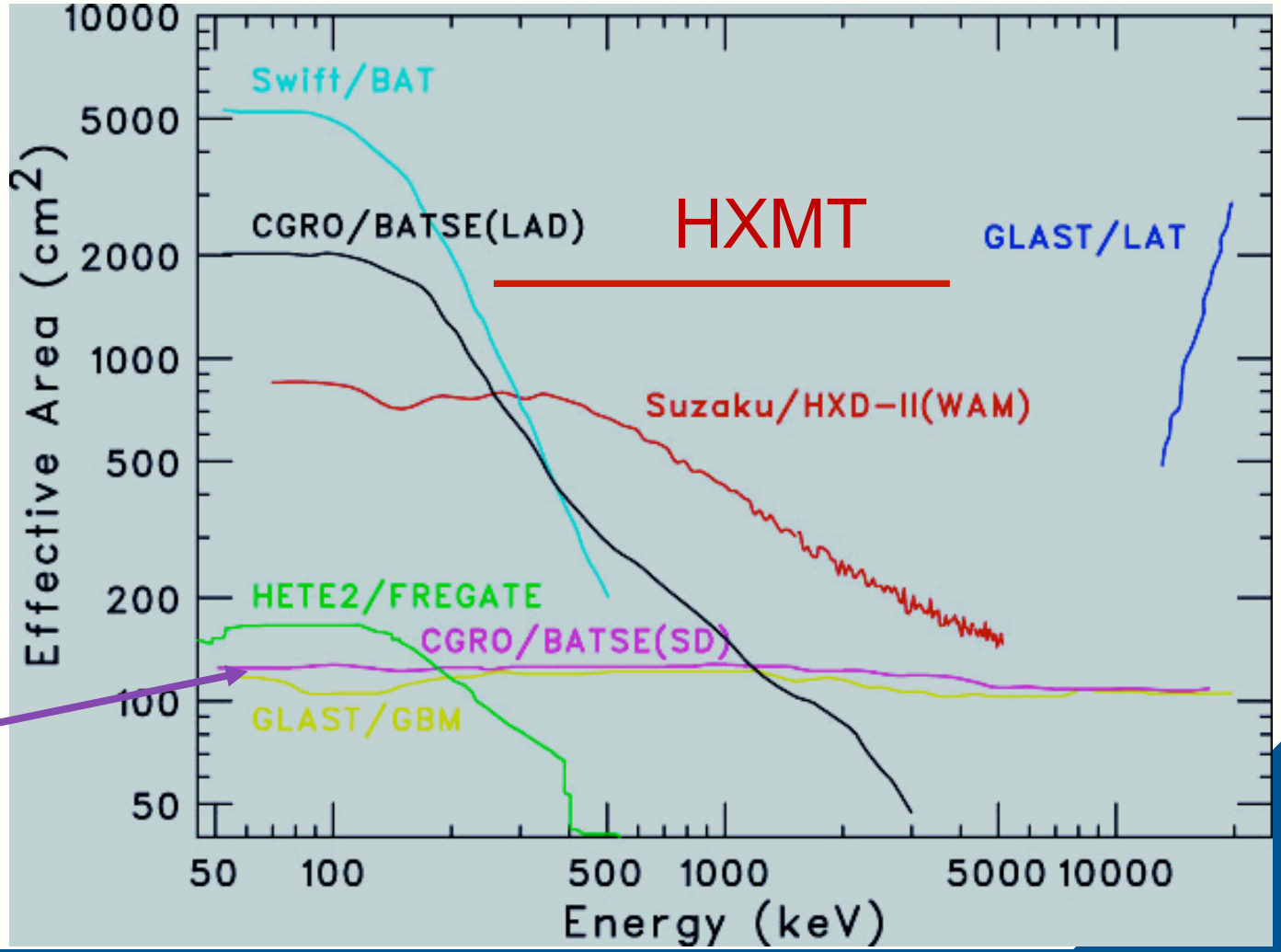
Back incident



HXMT's GRB capability comparison



Quite sensitive in soft gamma-rays (MeV), 10X larger than GBM on-board Fermi satellite.



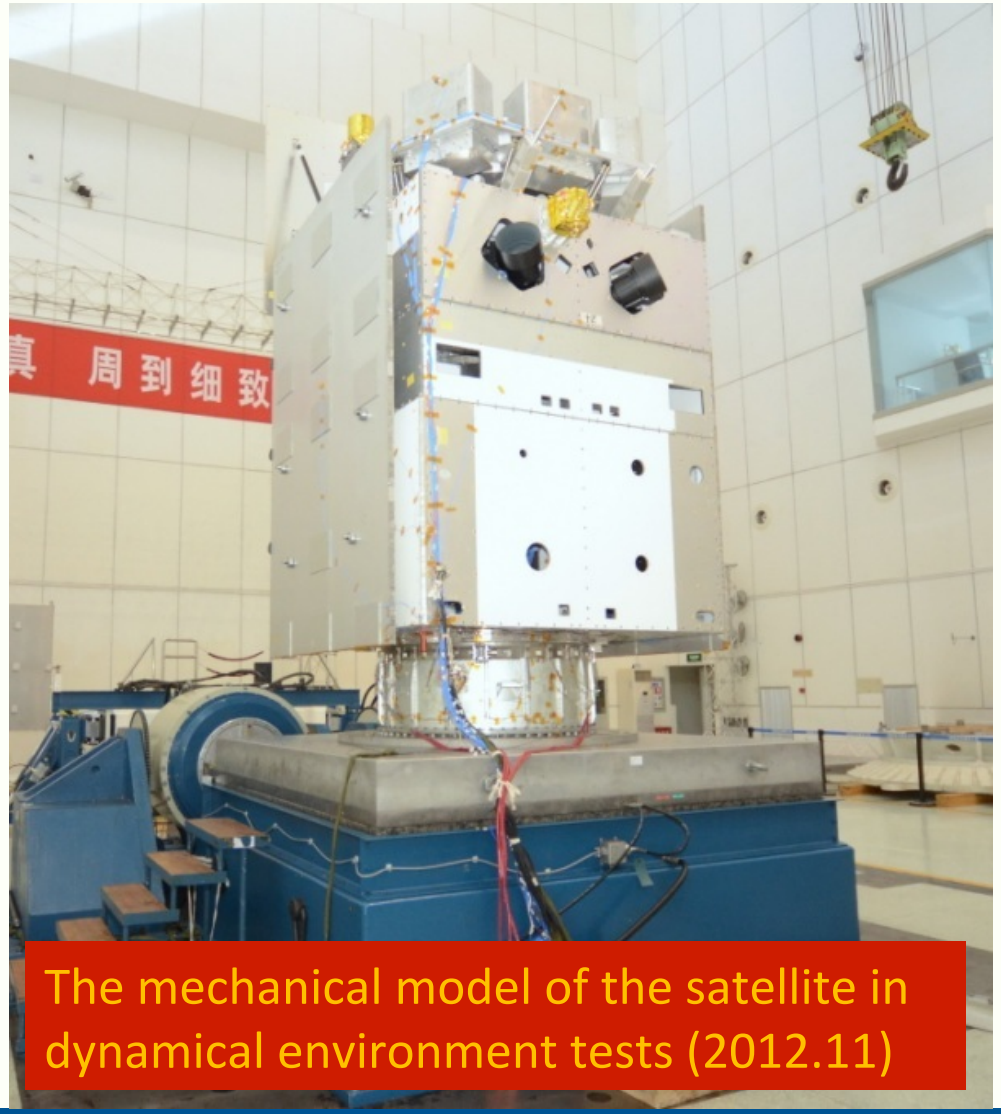
"HXMT: the Hard X-ray Modulation Telescope mission", Shuang-Nan Zhang, Institute of High Energy, Chinese Academy of Sciences

Expected HXMT GRB detection rates

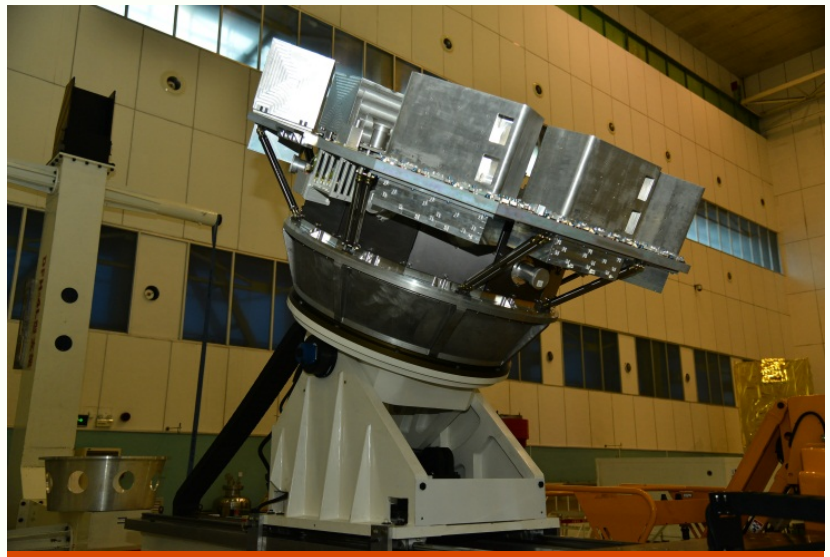
Significance (sigma)	GRB mode (GRBs/year)		Normal mode (GRBs/year)	
	Front	Back	Front	Back
5	70	130	85	145
10	40	110	50	135
20	20	80	25	115

About 200 GRBs per year > 5 sigma

Some milestones



The mechanical model of the satellite in dynamical environment tests (2012.11)



Measuring the weight center and rotation inertia of the telescope (2012.11)

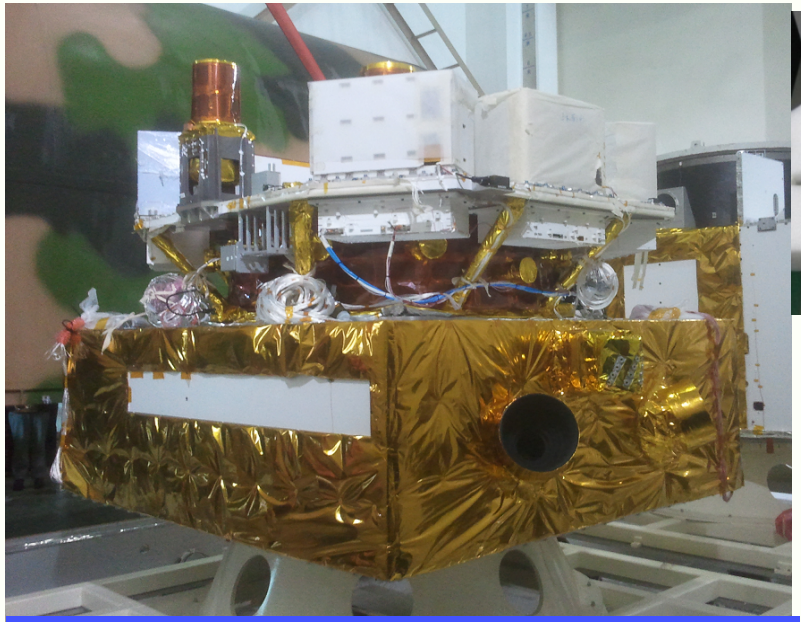
The Mechanical Model of the satellite was finished in 2012. The payloads and platform both passed the dynamical environment tests.

Some milestones

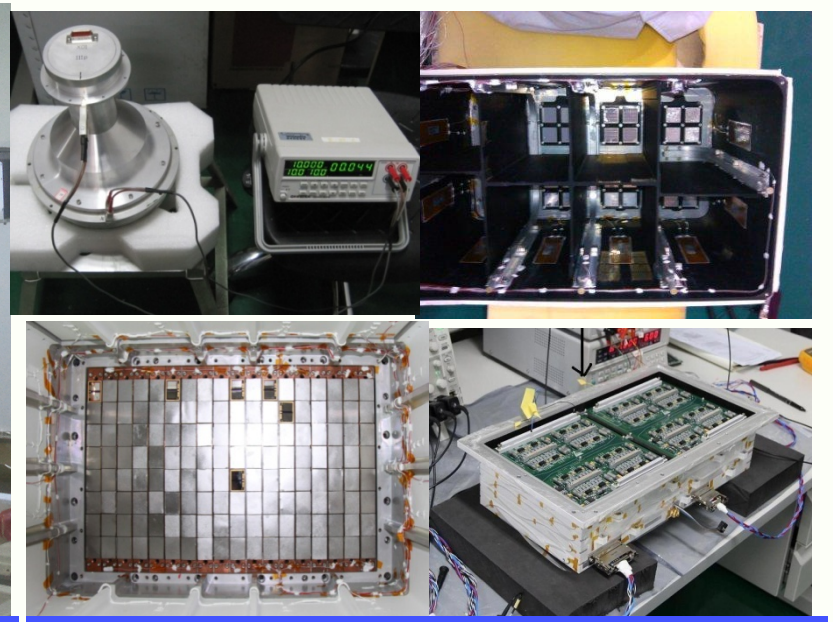
The electric model of HXMT's payloads in assembling and testing (2012.12).

Tests of the electric performance of the payloads were finished in Dec. 2012, and those of the whole satellite were finished in early March of 2013.

Some milestones

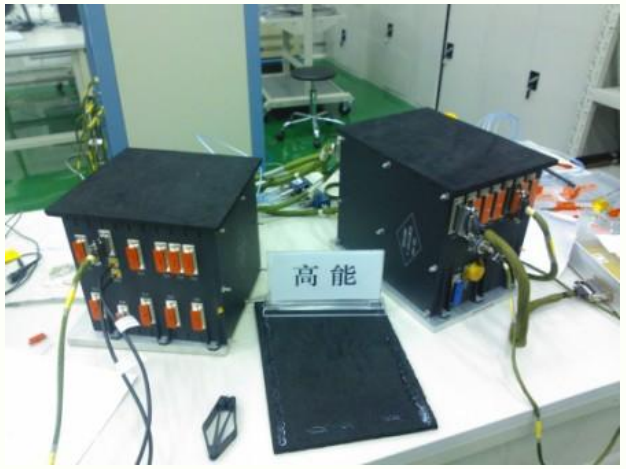


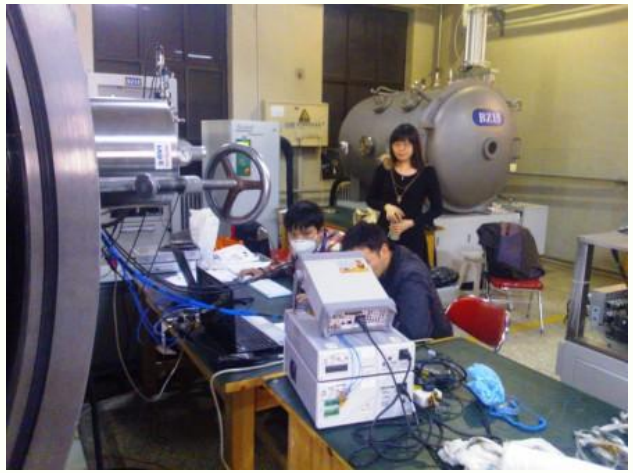
The payloads after thermal control coating



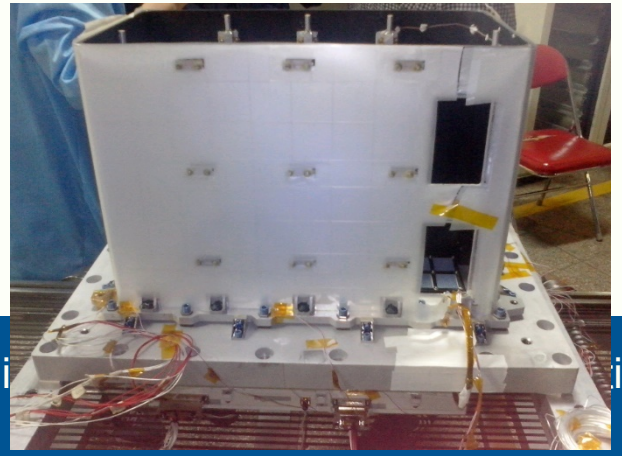
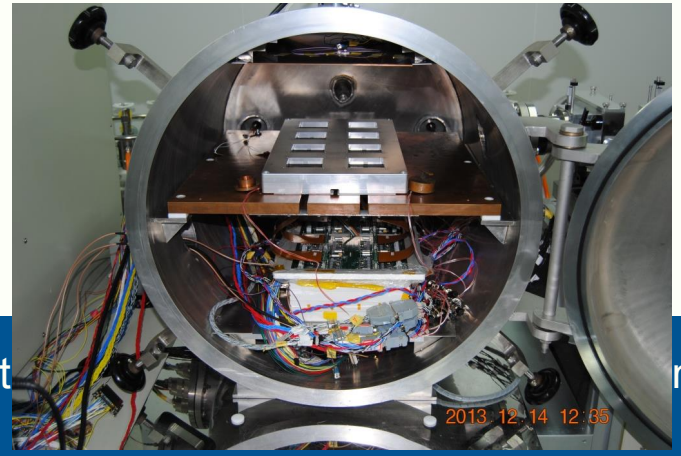
Some of the components jointed the vacuum tests

Vacuum thermal balance tests of the satellite were carried out in Dec, 2012. The quasi-qualification models of all the detectors joined the tests. Those of HE and LE worked well during the tests, but that of ME had some problems with the FPGA, which were fixed and tested later.



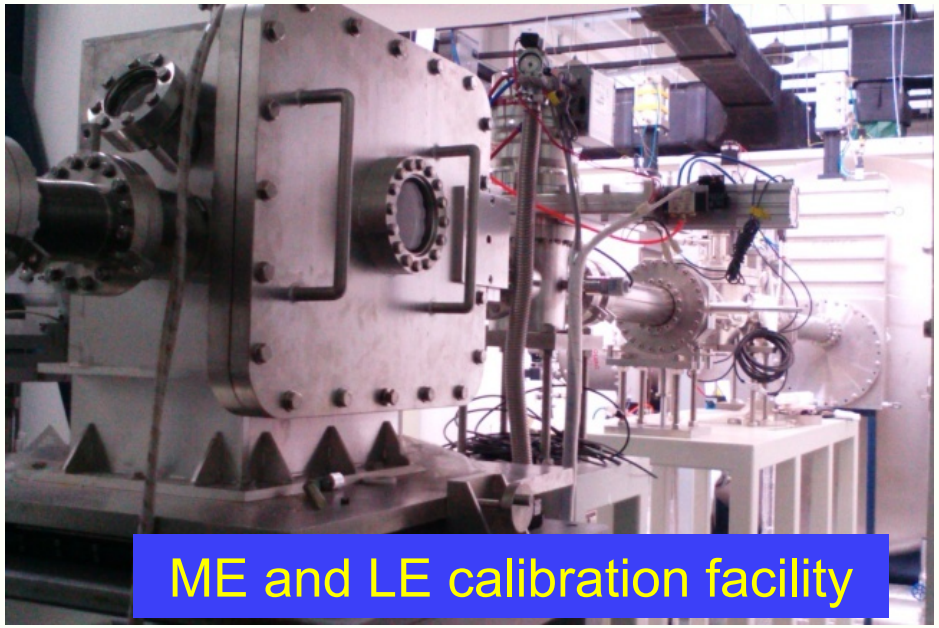




All space qualification models and environmental tests were finished in 2013 and 2014.

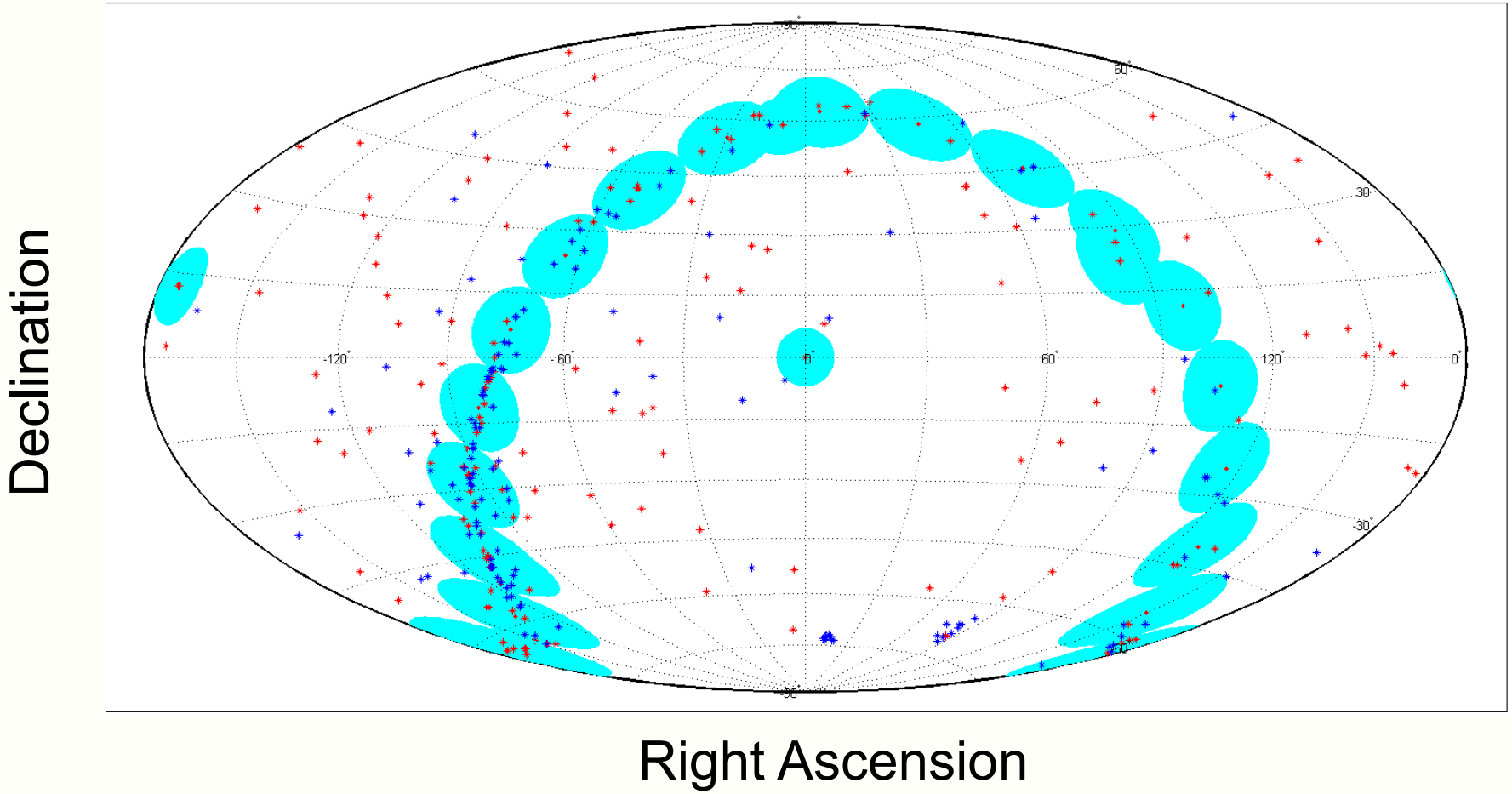
Ground calibration facilities

Finished in May 2014. The energy coverage of the monochromatic beam is 15~150 keV



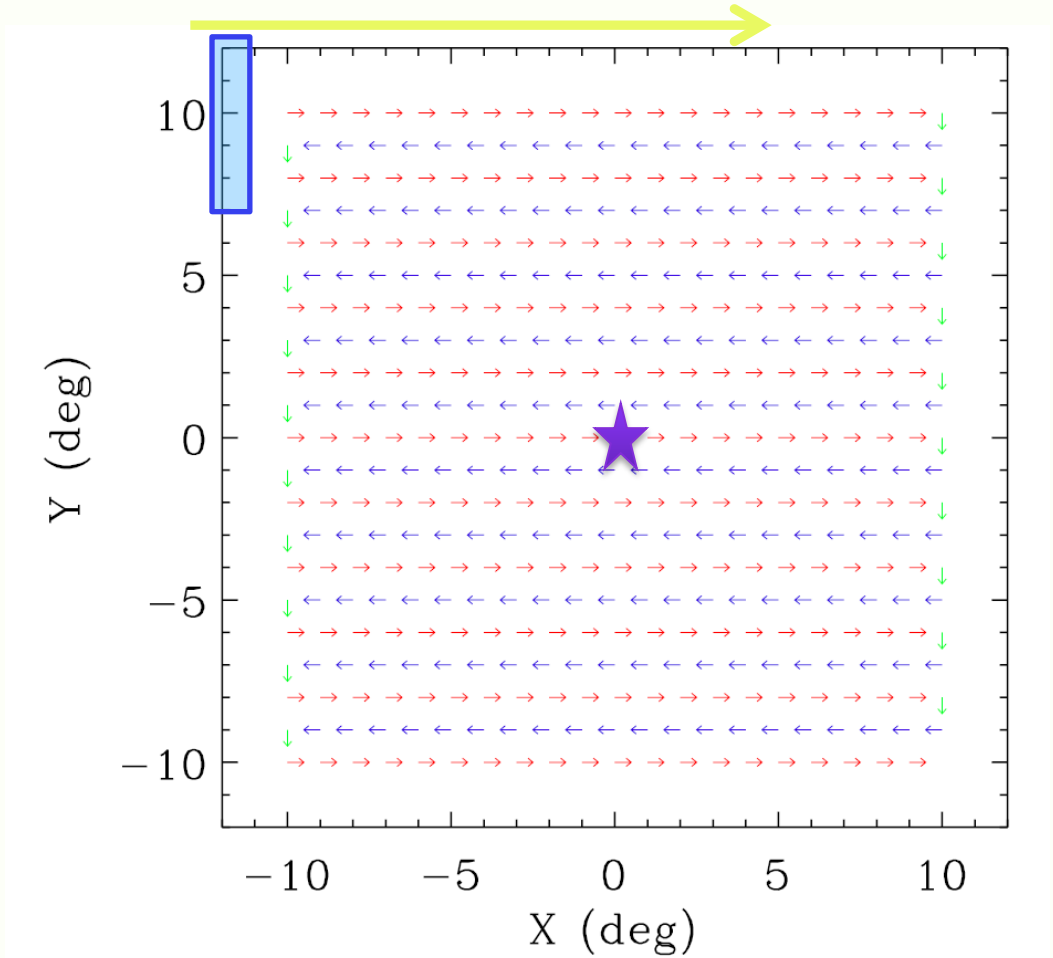
Finished in the end of 2014. The energy coverage of the monochromatic beam is 0.8-30 keV.

1st yr observation program: July, 2017

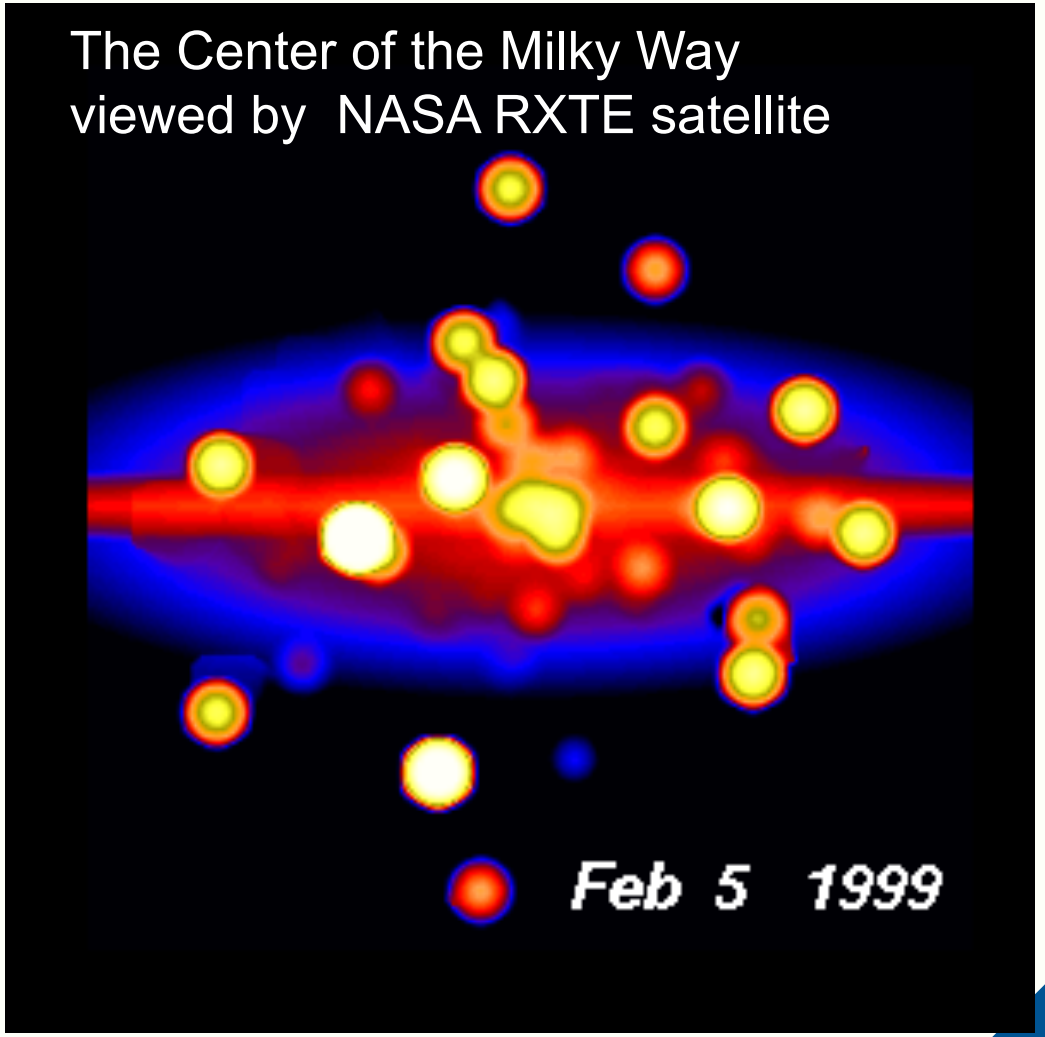


From HXMT AO-1： Regular; ToO; scanning

The Milky Way is highly variable in X-ray eyes!

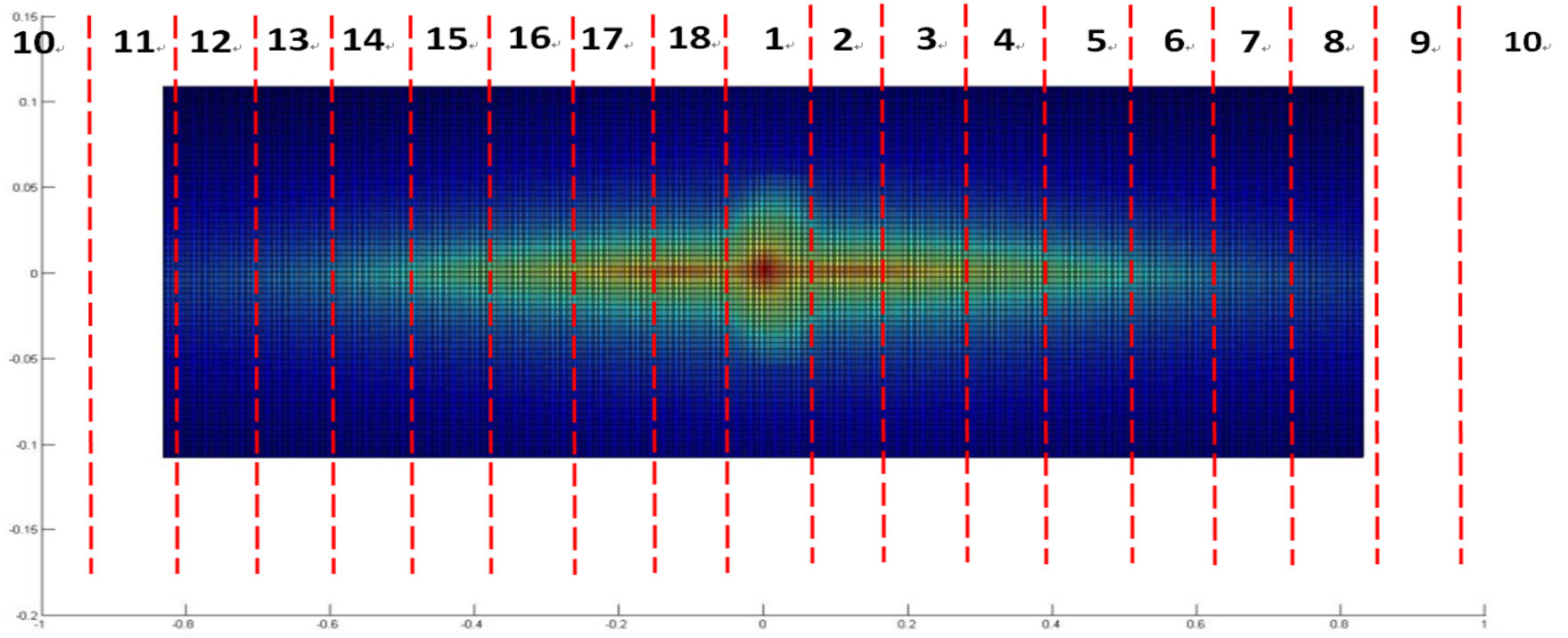


HXMT scan mode

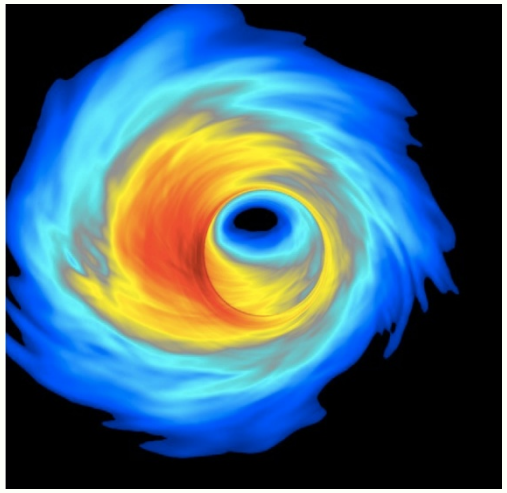


HXMT scanning survey of the Milky Way

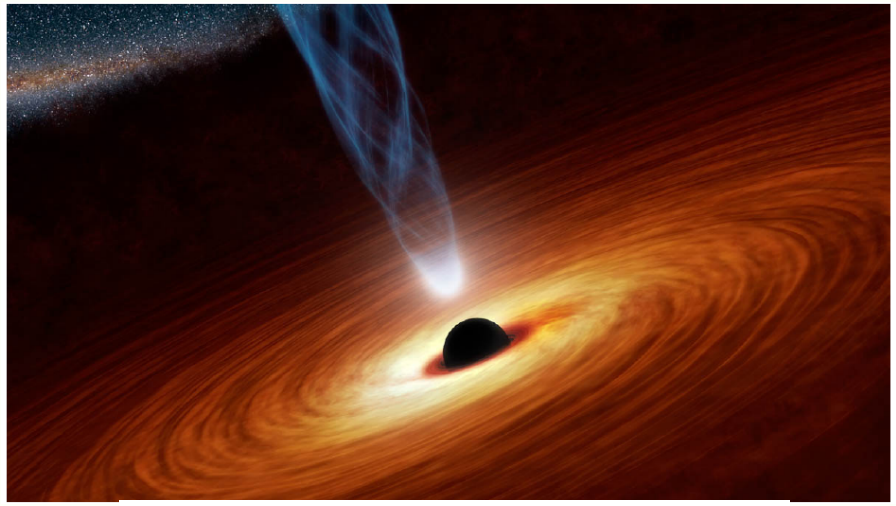
- Repeatedly scanning the whole Milky Way, to discover new variable black holes and neutron stars, and monitor activities of the known X-ray sou

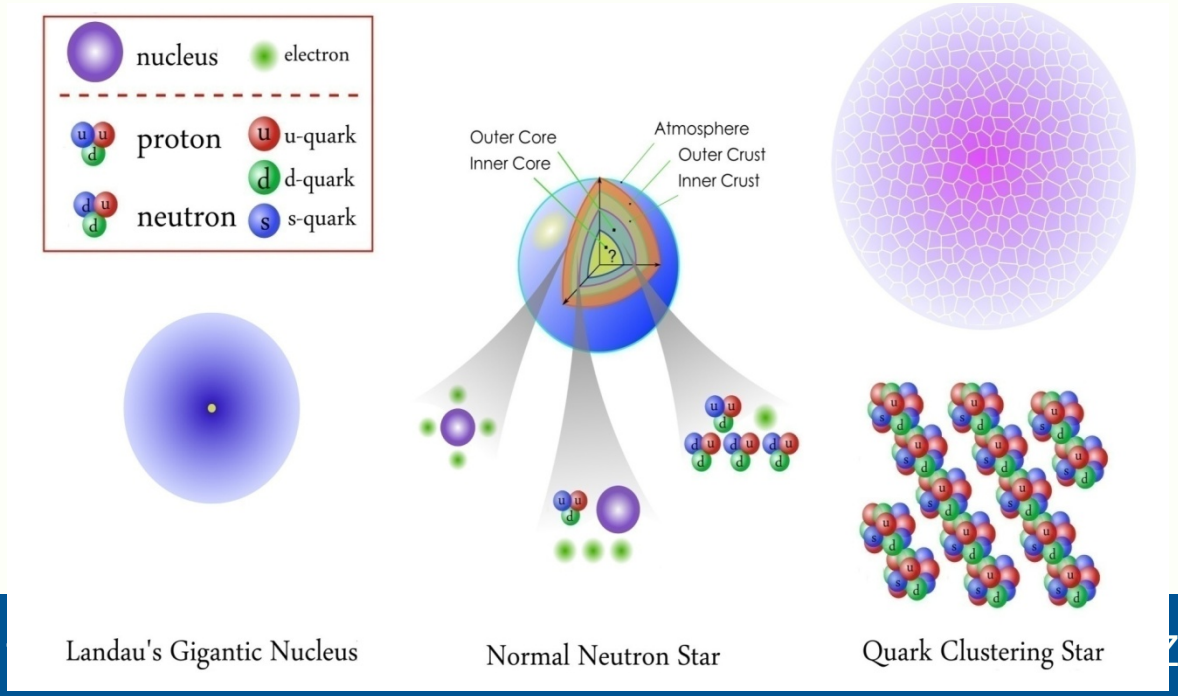


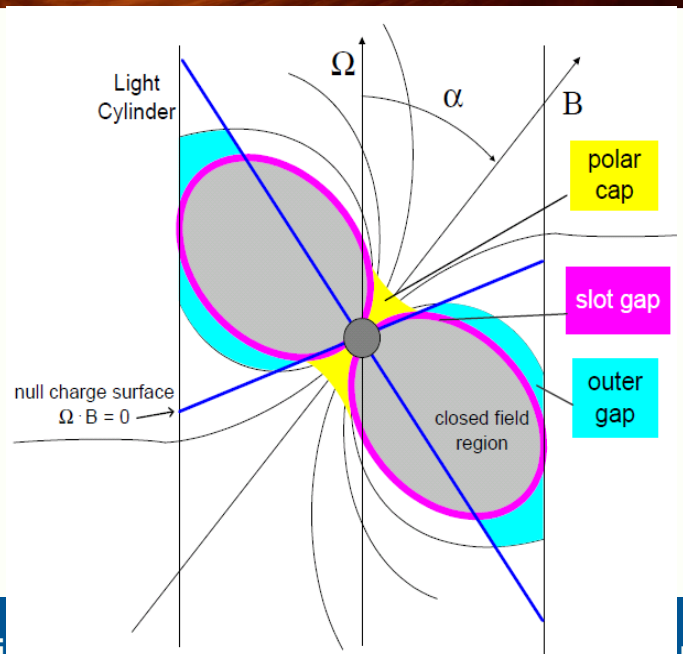
enhanced X-ray Timing and Polarimetry (eXTP) mission



Singularity?
Neutron or
Quark Star?
Extreme gravity
magnetism
density

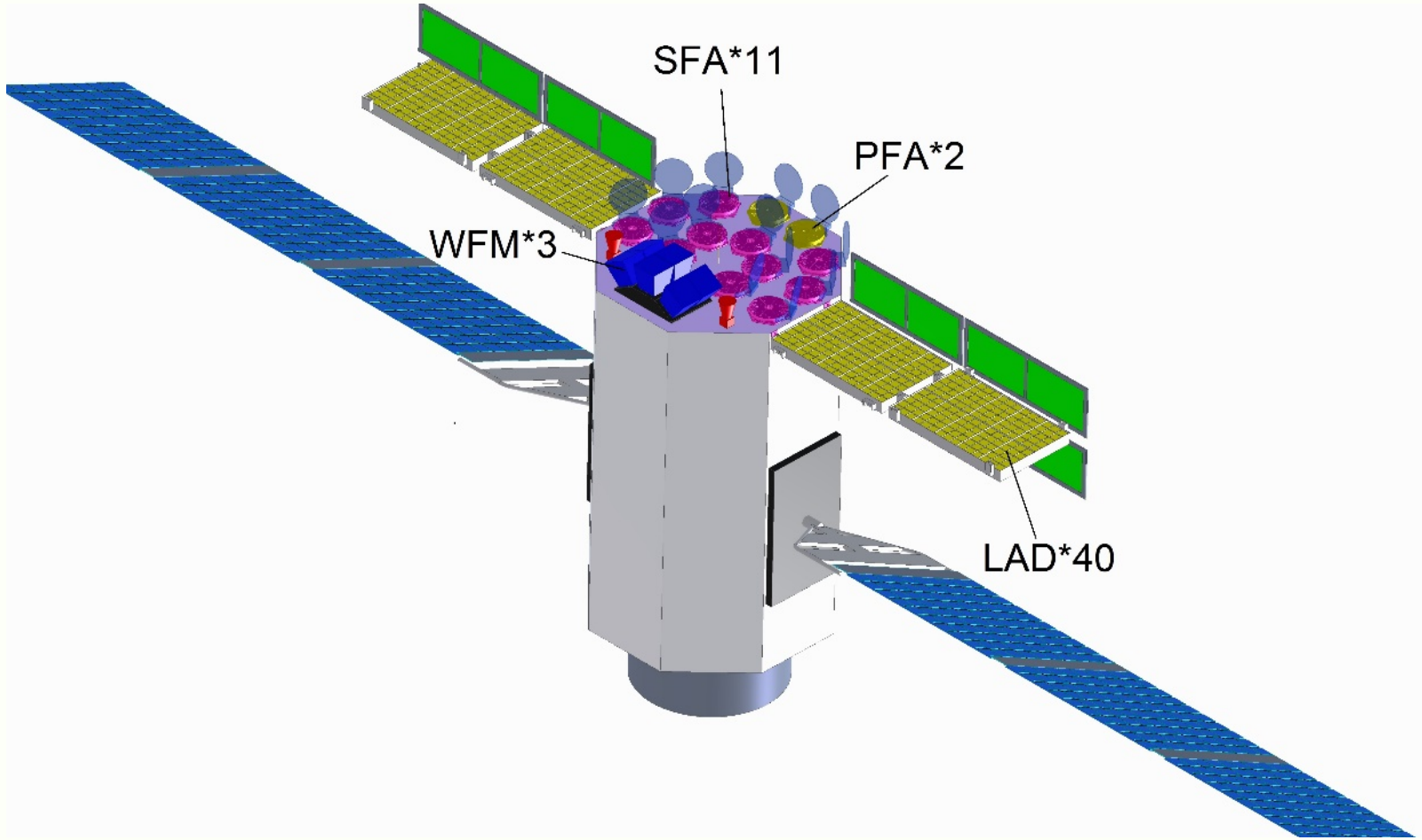




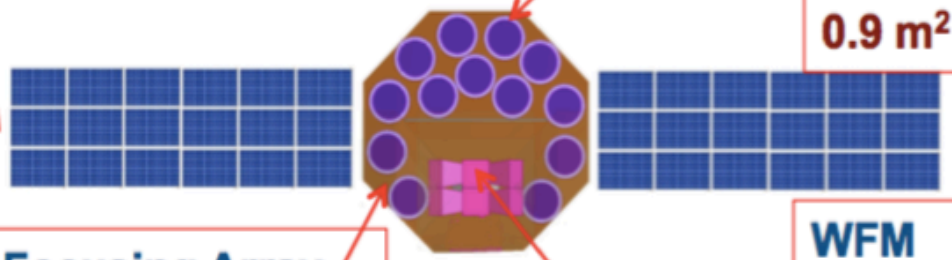


enhanced XTP (eXTP=XTP+LOFT)<2025

13 XTP telescopes (~ 1 m^2)+ 4 LOFT LAD (~ 3 m^2) + 3 LOFT WFM



Payload



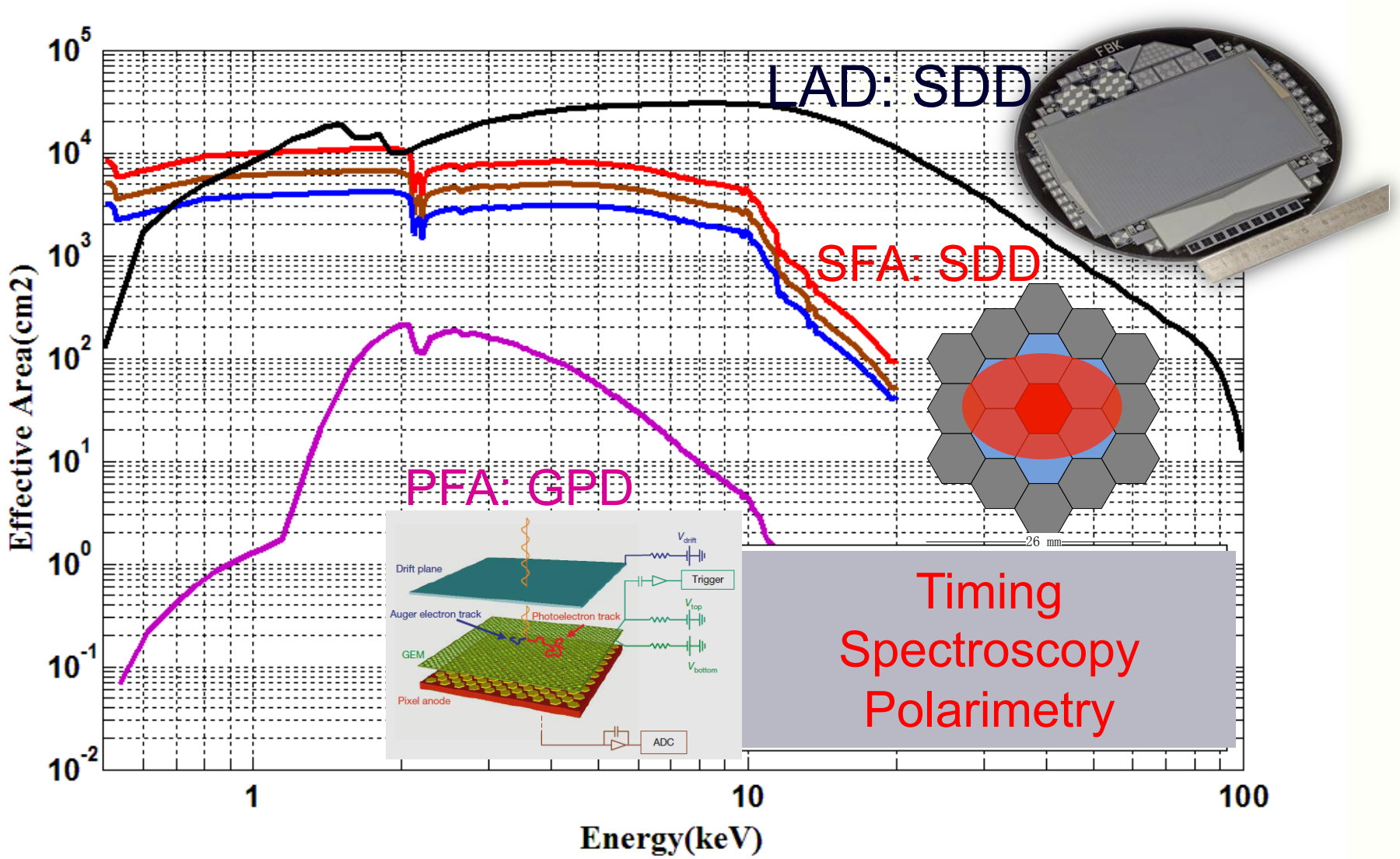
LAD
40 arrays SDD
Energy band：2-50 keV
Collimated FOV 1deg FWHM
Time resolution: 1us
Energy res.: 200eV@ 6keV
Sensitivity：0.01 uCrab（10^4s）
Effective area：3.4m²@6keV

Spectroscopy Focusing Array
11 arrays: focal length 4.5m,
Diameter 450 mm, SDD
Energy band: 0.5-20 keV
FOV：12 arcmin
Time resolution：10 us
Energy res.: 180eV@6keV
Angular resolution: 1 arcmin
Sensitivity：0.16uCrab（10^4s）
Effective area: 6500cm²@6keV
0.9 m² between 1-2 keV

Polarimetry Focusing Array
2 arrays focal length 4.5 m,
diameter 450 mm
Energy band: 2-10 keV
FOV:12 arcmin
Time resolution: 500us
Energy res: 1.8keV@6keV
Angular resolution：15 arcsec
Sensitivity：5 uCrab（10^4s）
Effective area：250cm²@2keV

WFM
3 arrays, SDD
Energy band：2-50 keV
FOV：1.33PI
Time resolution：2 us
Energy resolution：
300eV@6keV
Angular resolution：4.5 arcmin
Sensitivity：3uCrab（2x104s）
Effective area：170cm²@6keV

Effective Area



Summary and outlook

- HXMT is China's 1st X-ray astronomy satellite.
- All HXMT instruments built, calibrated and integrated to the satellite → launch in June 2017!
- HXMT AO-1 made in June 2016 and proposals due in Aug. 2016 → 1st yr observation program available.
  - 1/3 total time in Galactic plane scan and monitoring
  - GRB mode when in Earth shadow or HE not used (~1/2)
- eXTP in development phase → launch < 2025?

We look forward to cooperation with MAXI!