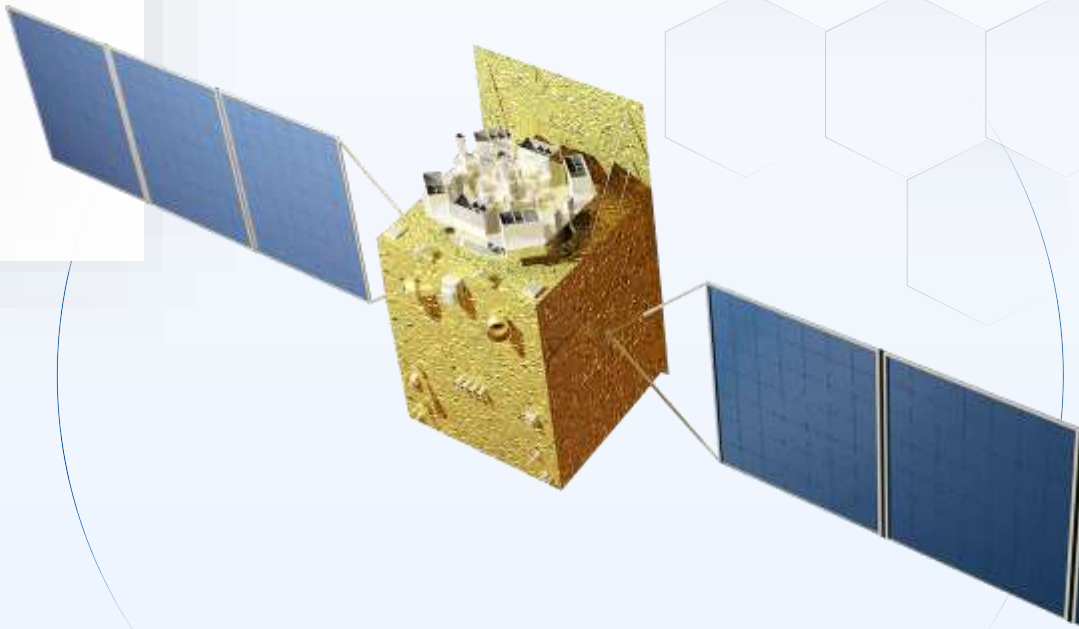
2024 16th IACHEC

Current Status of *Insight*-HXMT



Reporter Xiaobo Li

On behalf of HXMT mission

Parador de La Granja (Spain)

2024-05-13

OUT LINE

01 Introduction of HXMT

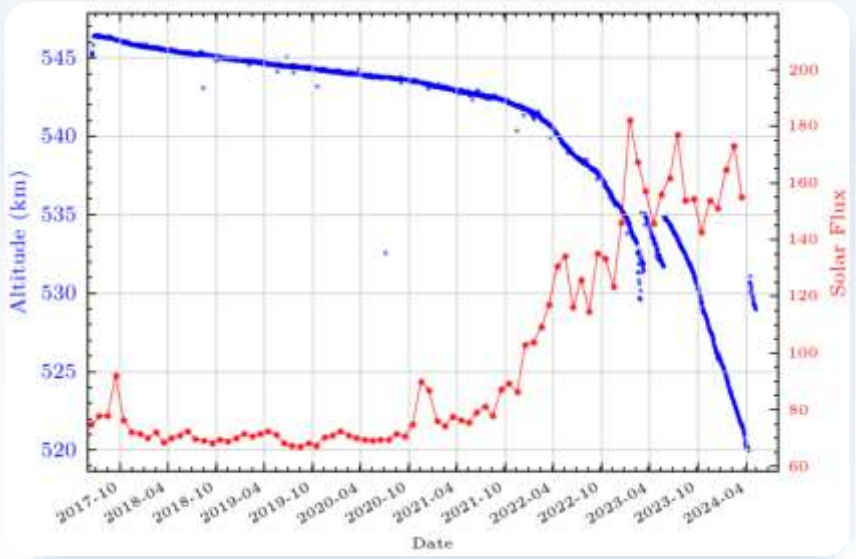
02 Current status of HXMT

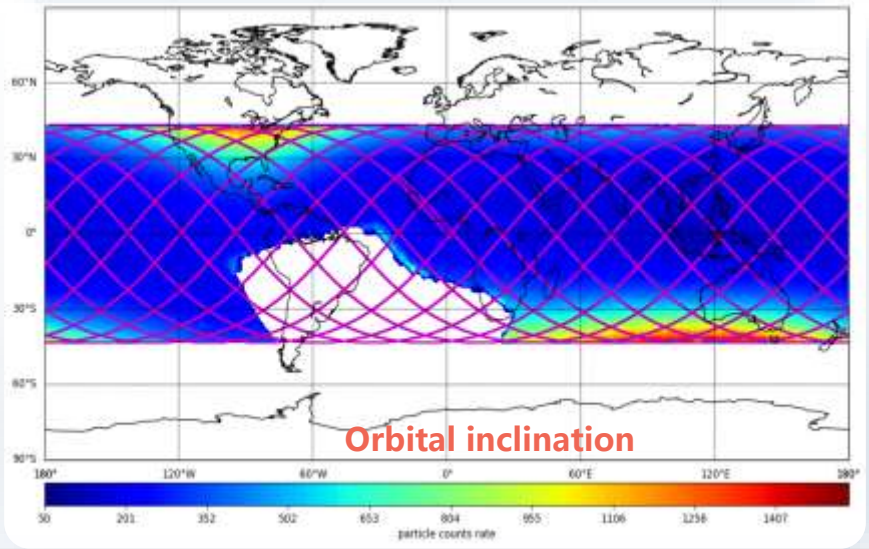
03 Summary

1.1 Hard X-ray Modulation Telescope (HXMT)

1st X-ray Astronomy Satellite in China

Lifetime	~7 years, launched on June 15th, 2017
Altitude	~530 km, raised three times
Inclination	43°
Weight	2500 kg
Mode	Pointed | scanning | GRB modes
Avoidance	Solar avoidance angle is more than 70°



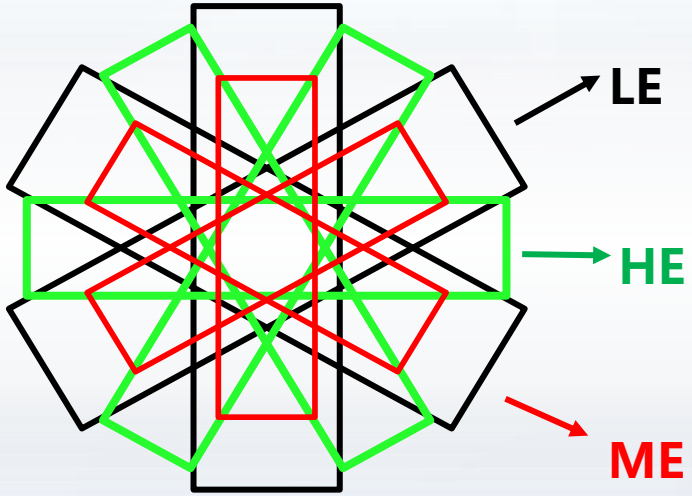


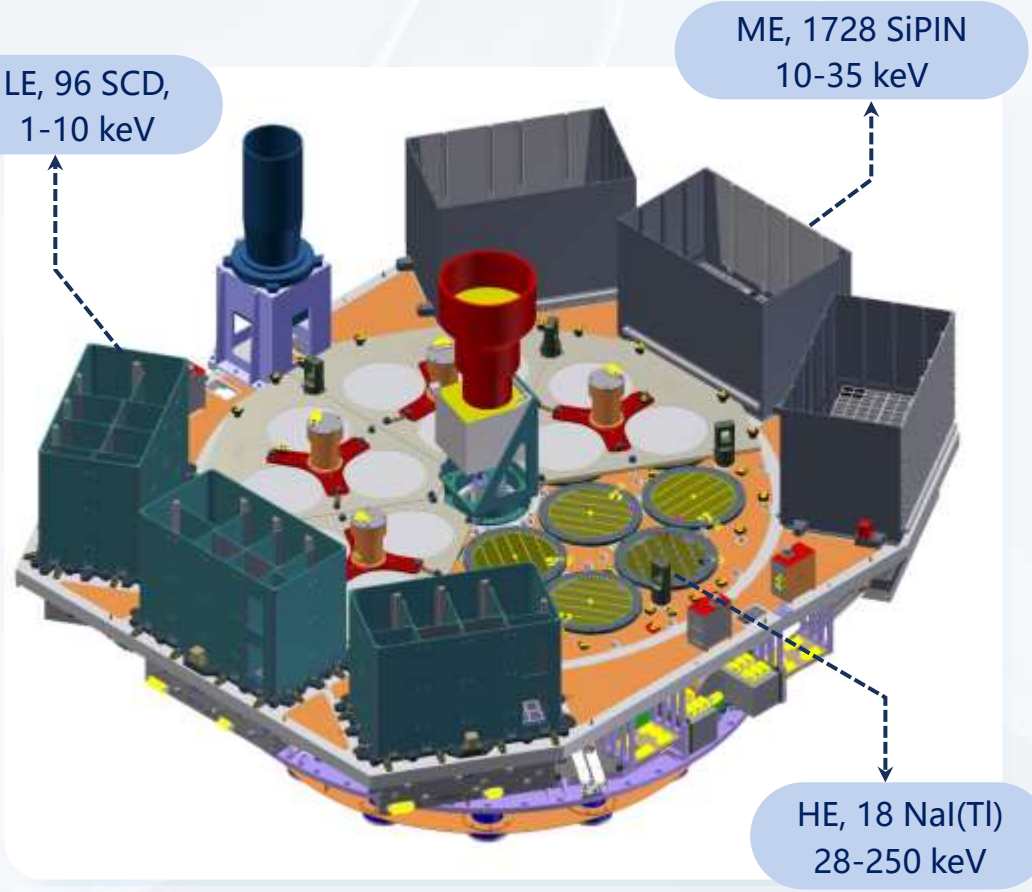
1.2 Hard X-ray Modulation Telescope (HXMT) Payloads

Main properties of HXMT payloads

Characteristic	HE	ME	LE
Energy range (keV)	28-250	10-35	1-10
Energy resolution	18%@60 keV	13.6%@22 keV	1.5%@6.4 keV
Time resolution (us)	2	6.4	10
FOV	1.1° × 5.7°	1° × 4°	1.6° × 6°
	5.7° × 5.7°	4° × 4°	4° × 6°
Detector	NaI(Tl), CsI(Na)	Si-PIN	SCD
Open area (cm^2)	4270	850	300
Operating temperature	18 ± 2 °C	−40 °C∼−10 °C	−75 °C∼−40 °C

Small FoV





1.3 Core Sciences

1. Galactic plane scan

Monitor or survey for weak & short transient sources in very wide energy band (1-250 keV)

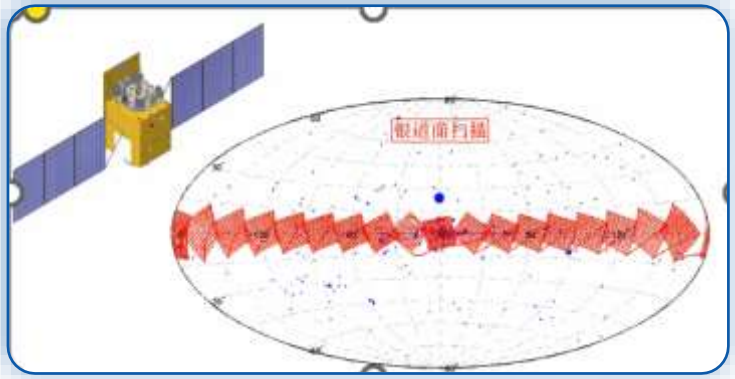
2. Pointed observations

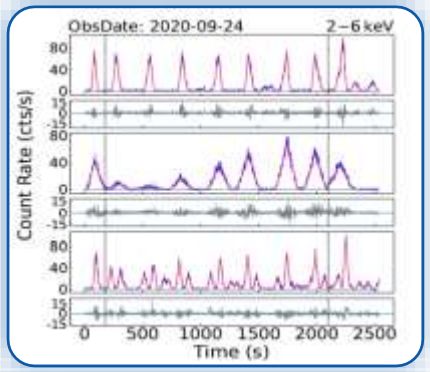
High statistics study of bright sources and long-term high cadence monitoring of XRB outbursts.

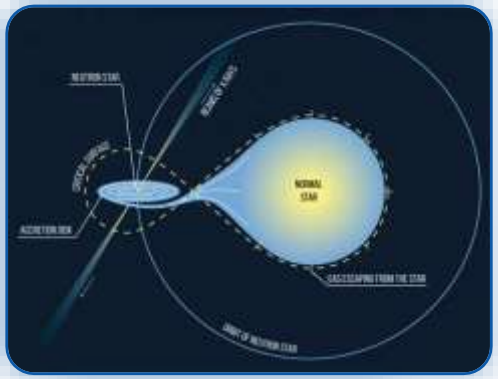
3. High energy bursts

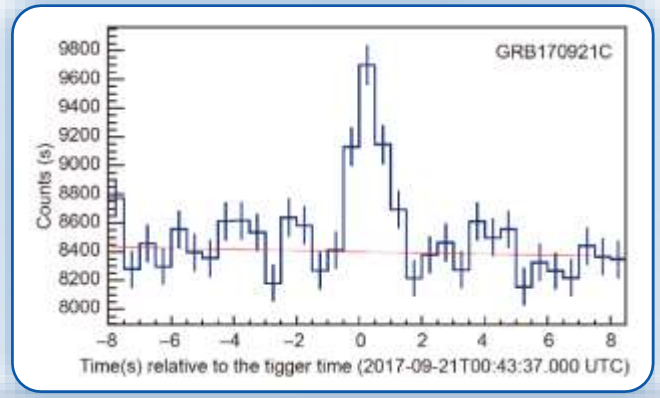
GRBs，especially associated with GW, FRB, HEN, etc.

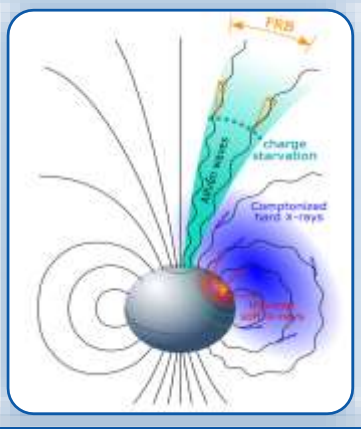
Magnetar bursts











2

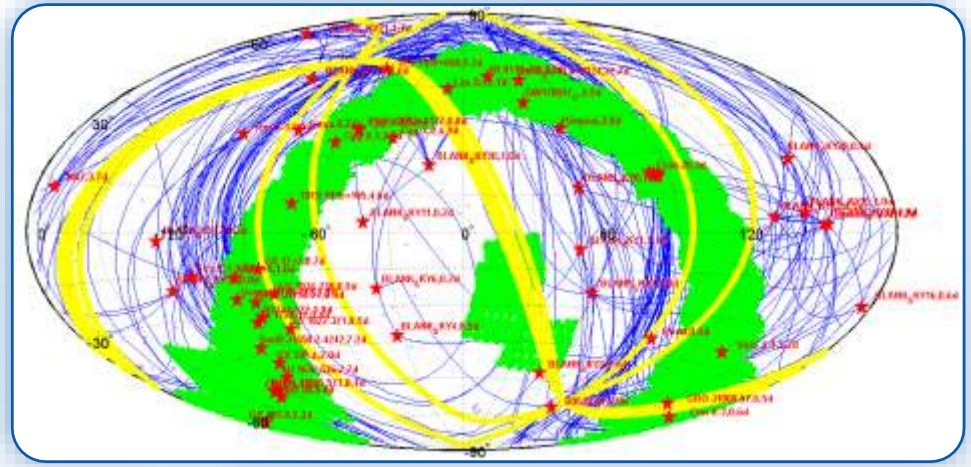
Current status

1. Proposals and observations
2. Data and software
3. Calibration status

2.1 Proposals and observations

Cycle	Submission Period	Proposals Amount	Observation Amount	Observation Period	ToO
AO01	2016.8-9	**90**	517	2017.11-2019.06	**39**
AO02	2019.1-2	**35**	349	2019.07-2020.07	**26**
AO03	2020.4-5	**34**	329	2020.08-2021.07	**16**
AO04	2021.4-5	**33**	333	2021.08-2022.08	**30**
AO05	2022.4-5	**43**	339	2022.09-2023.08	**30**
AO06	2023.4-6	**50**	337	2023.09-2024.08	**/**

http://proposal.ihep.ac.cn;
AO07 is ongoing!



Red stars: Pointed observations **Blue lines:** Tracks of slew
Green regions: Small area scans **Yellow belts:** All sky survey

2.2 Data and Software

Data

Level 1: published to users

- **Data format: FITS**
- **Data release: Pointed Observations**
- **Download: http://archive.hxmt.cn/proposal**

Software

- ***HXMTSOFT:***
  - ***Task Style:*** **FTOOLs style**
- ***Input :*** Level 1 data product & CALDB
- ***Output :*** Response files, background files, event files, spectra, light-curves

2017

2017.07
hxmtsoftv1
CALDBv1

2017.12
hxmtsoftv2
CALDBv2

2018

2018.12
hxmtsoftv2.00
CALDBv2.00

2019

2019.06
hxmtsoftv2.01
CALDBv2.01

2019.12
hxmtsoftv2.02
CALDBv2.02

2020

2020.05
hxmtsoftv2.03
CALDBv2.03

2020.10
CALDBv2.04

2020.11
hxmtsoftv2.04

2021

2021.03
CALDBv2.05

2022

2022.02
hxmtsoftV2.05
CALDBv2.06

2023

2023.10
CALDBv2.07

2023.12
hxmtsoftV2.06

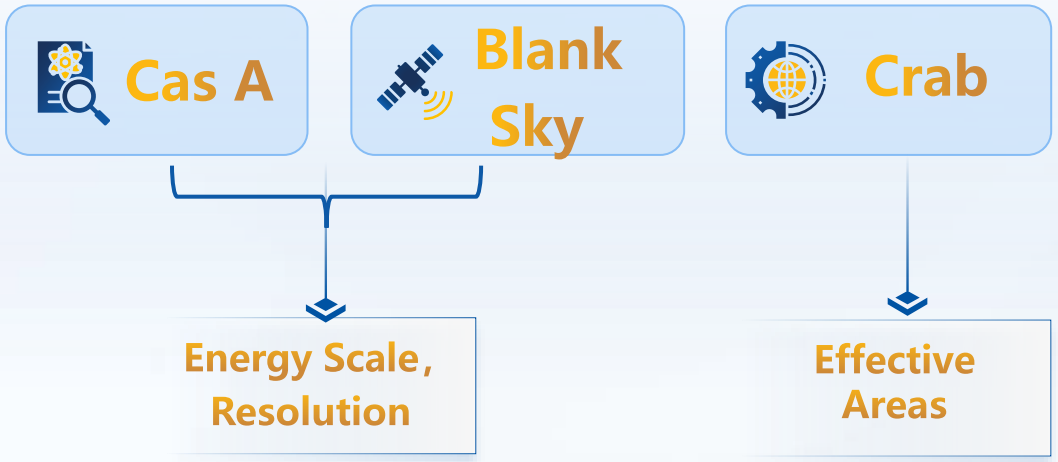
http://hxmtweb.ihep.ac.cn/software.jhtml

2.3 Calibration

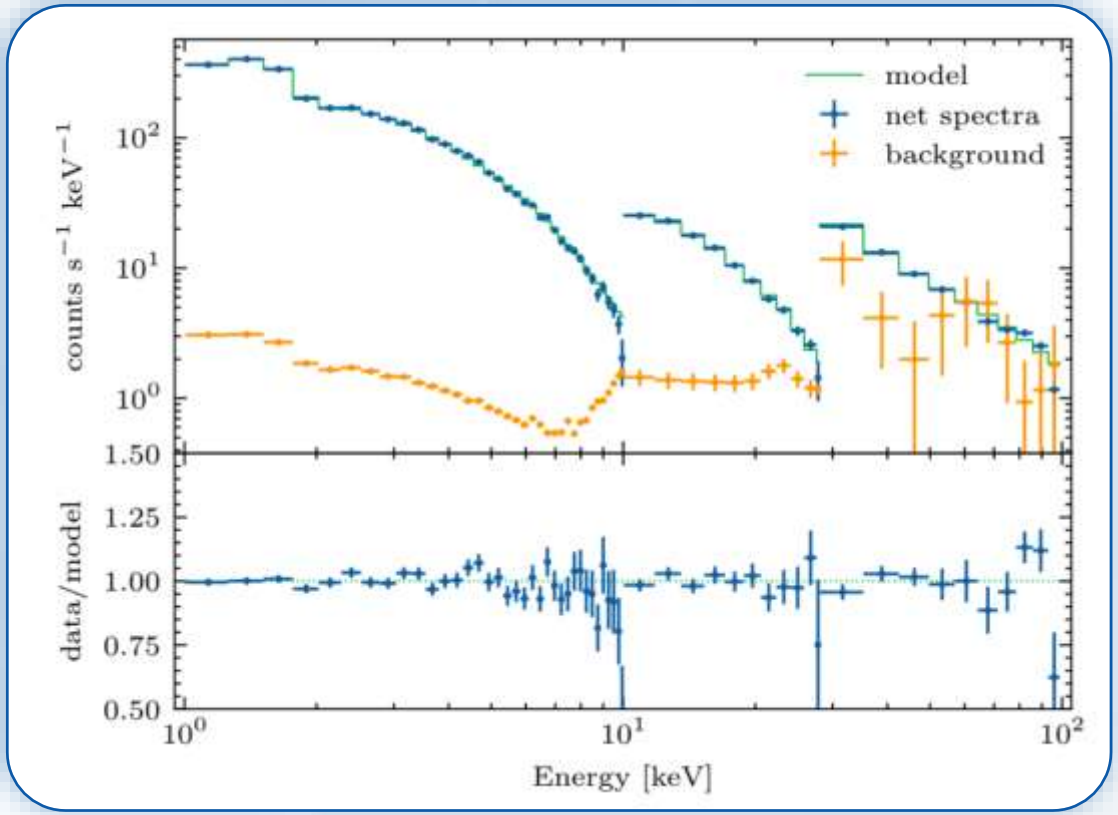
Detected Counts Rate

Payloads	Crab (cts/s) (source +b.k)	Background (cts/s)
HE (28-250 keV)	540+530	530 (~1Crab)
ME (10-35 keV)	200+20	20 (~0.1Crab)
LE (1-10 keV)	760+10	10 (~0.01Crab)

As a **collimated telescope,** HXMT has high background:



Crab spectrum observed by HXMT



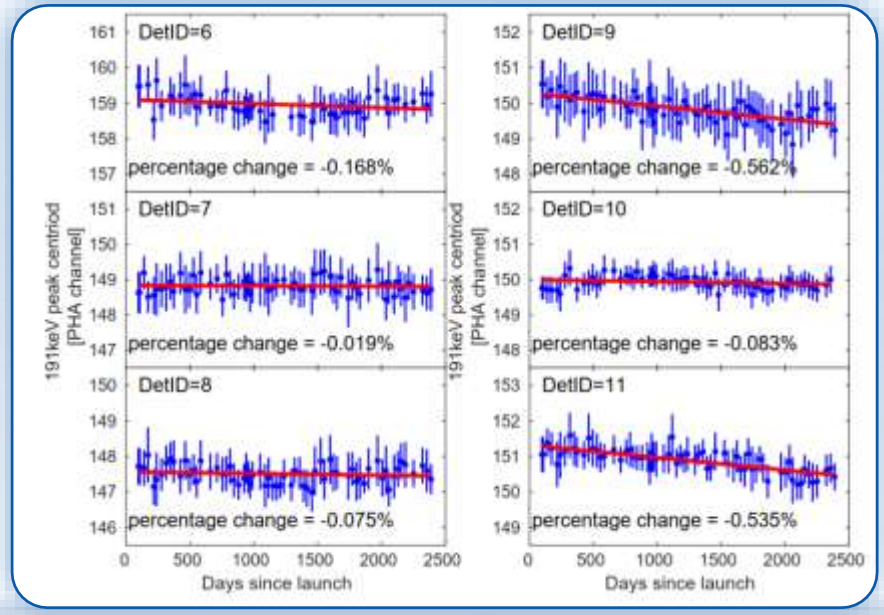
Li et al. 2023, RDTM
Li et al. 2020, JHEAp
Liao et al. 2020, JHEAp

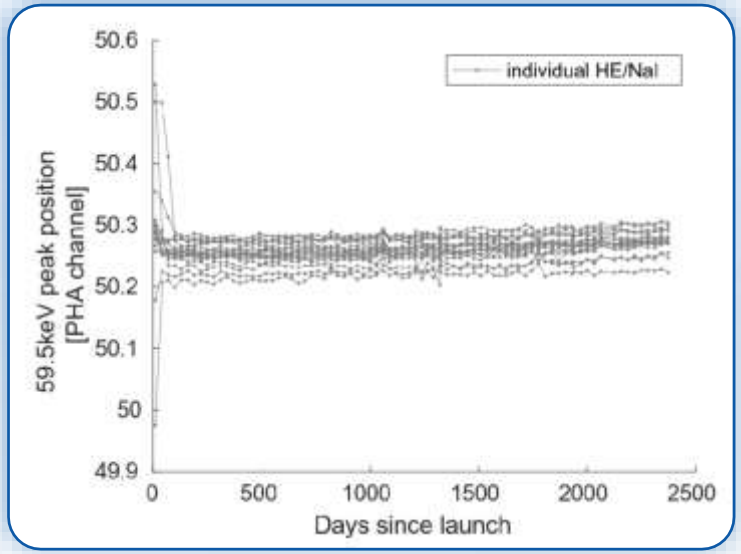
2.3 Calibration---HE

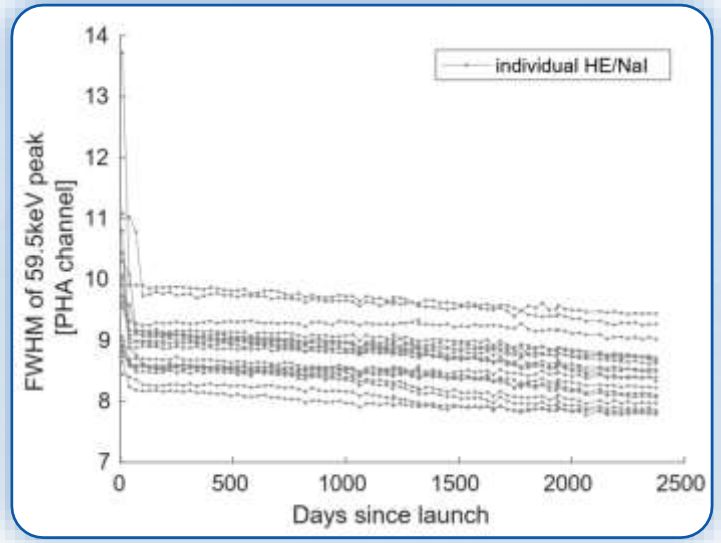
All 18 detectors are working

- Energy Scale: keep stable (<1%) after three month in orbit
- Energy resolution：getting a little better
- Effective areas: keep stable

- ^{241}Am Source
- Automatic Gain Controller
- α and X-ray coincidence



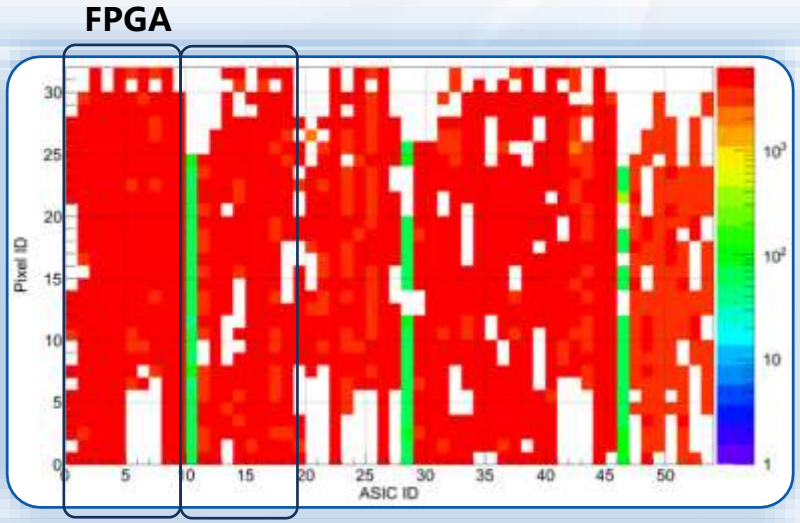


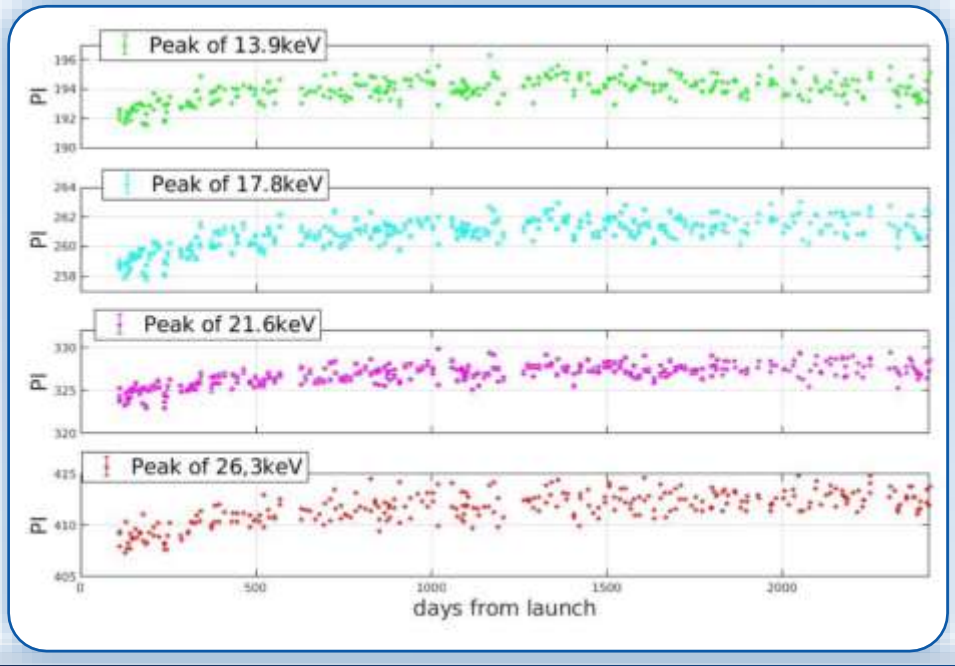


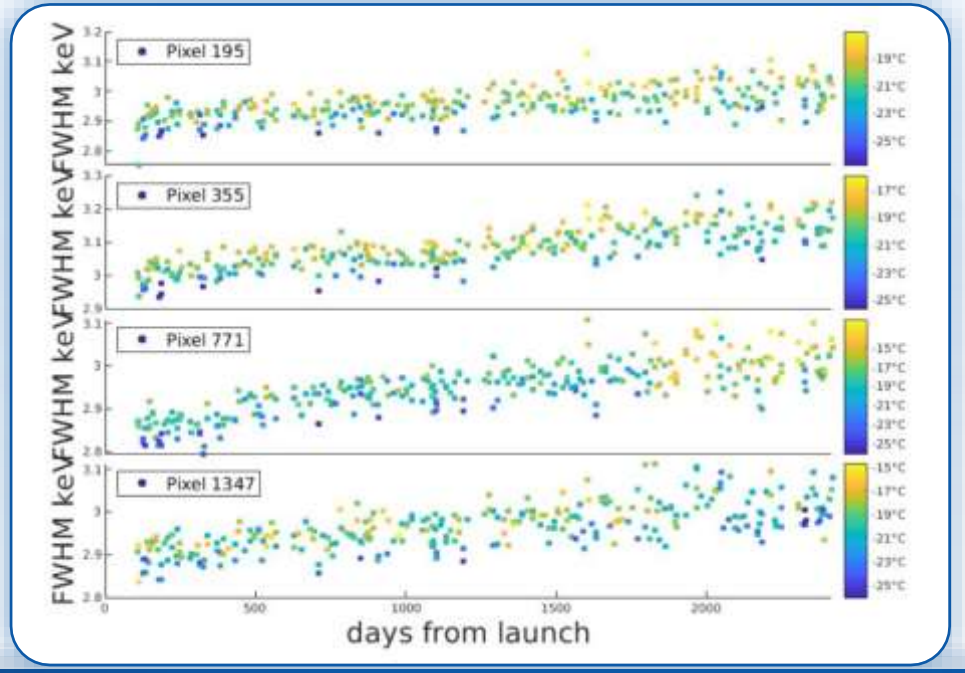
2.3 Calibration---ME

298 SiPINS (17%) turned off

- Energy Scale: keep stable, change is less than 1.5%
- Energy resolution：change less than 3%
- Effective areas: keep almost stable



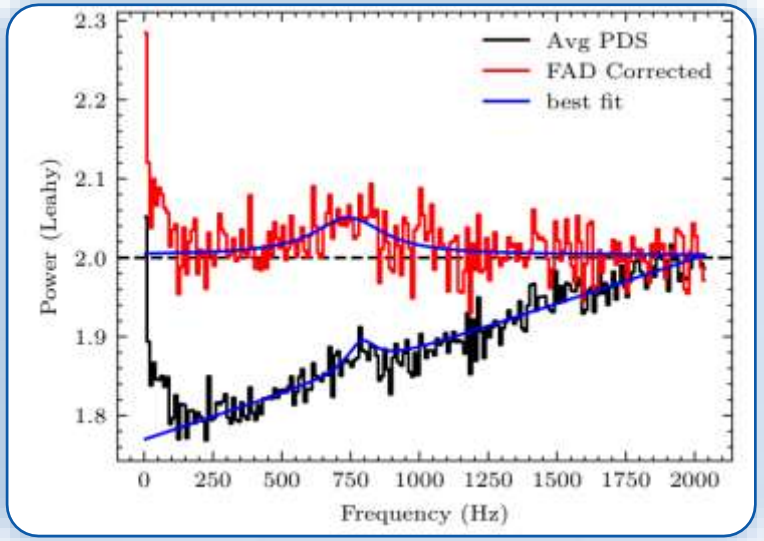


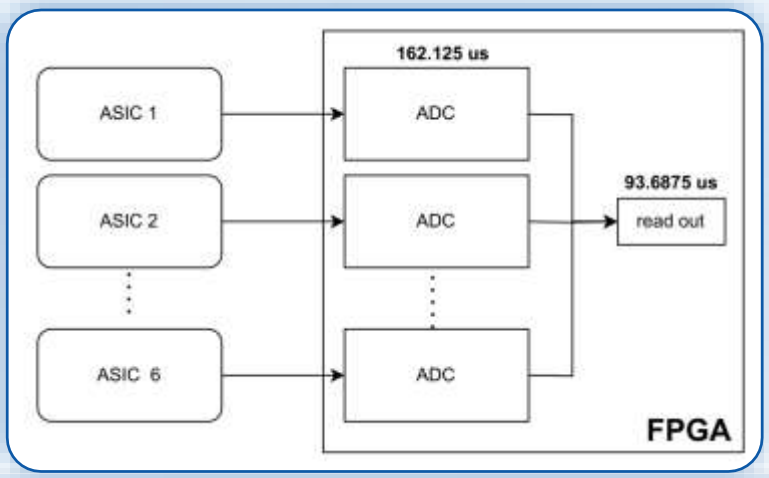


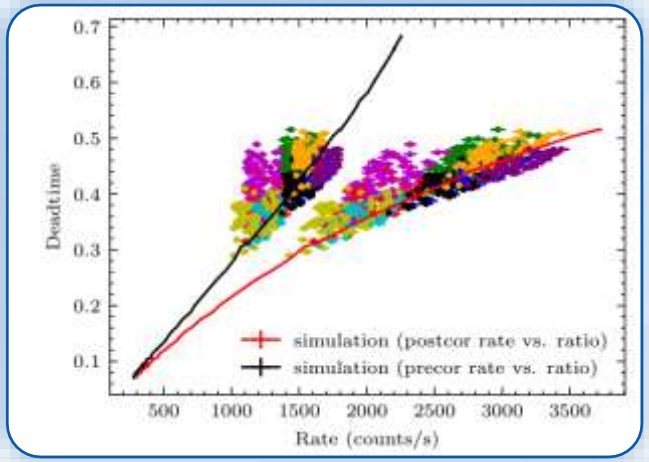
2.3 Calibration---ME

Dead time correction in Power Density Spectrum

- **The Fourier-amplitude-difference (FAD)** method could well recover the intrinsic shape of the observed PDS in the case that the PDS is from **two identical detectors**. *Bachetti & Huppenkothen (2018)*
- We apply FAD on ME, by splitting **the 9 FPGA modules** into two groups. The results indicate that the FAD technique suits the case when two group of detectors are not largely different.
- The recovered PDS enhances the significance of the previously known QPO signal.







obsid	FAD corrected	dead time distorted [a]
P010132801001	5.86σ	5.2σ
P010132801002	5.28σ	4.2σ

[a] cited from Jia et al. (2020)

Tuo et al. 2024

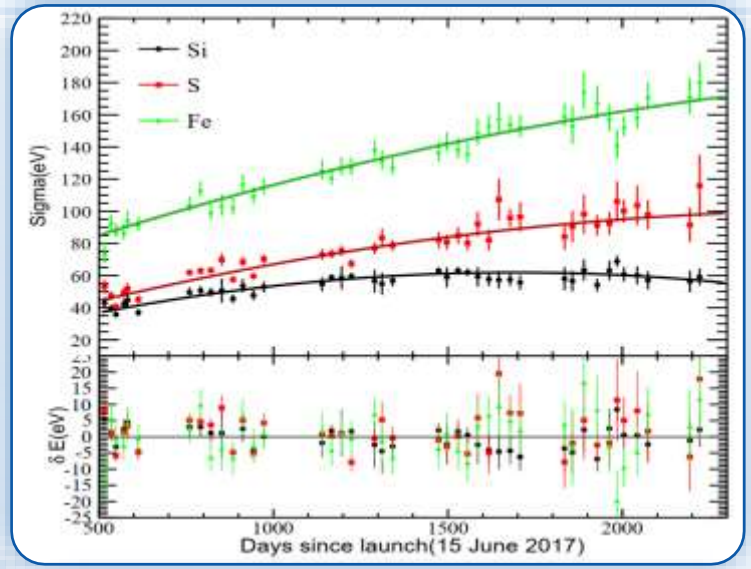
Submitted to MNRAS

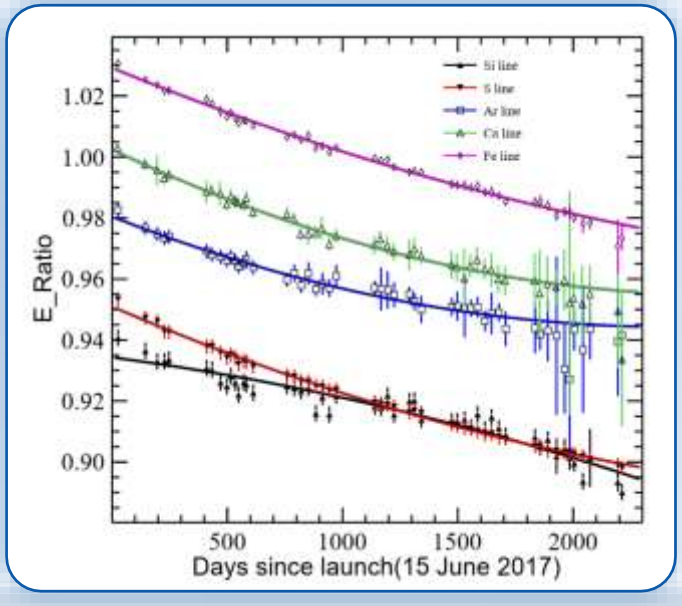
Method is used in hxmtsoft

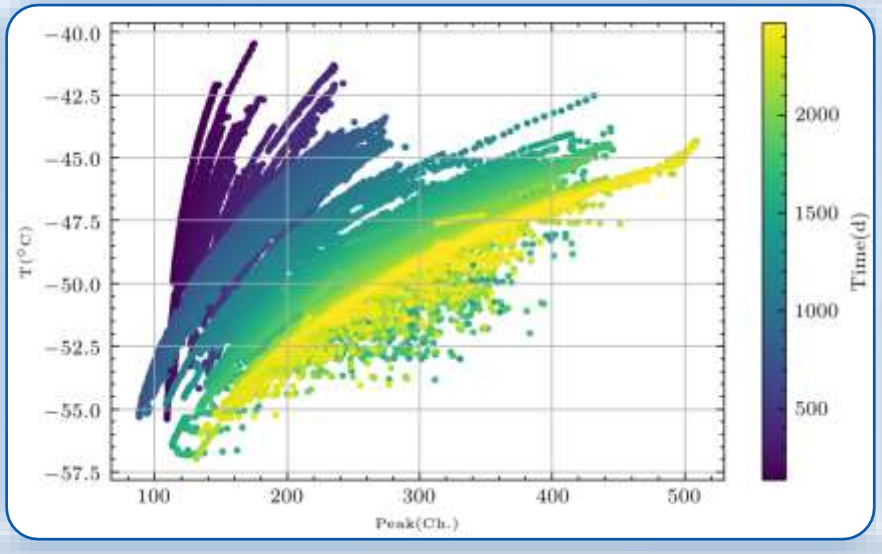
2.3 Calibration---LE

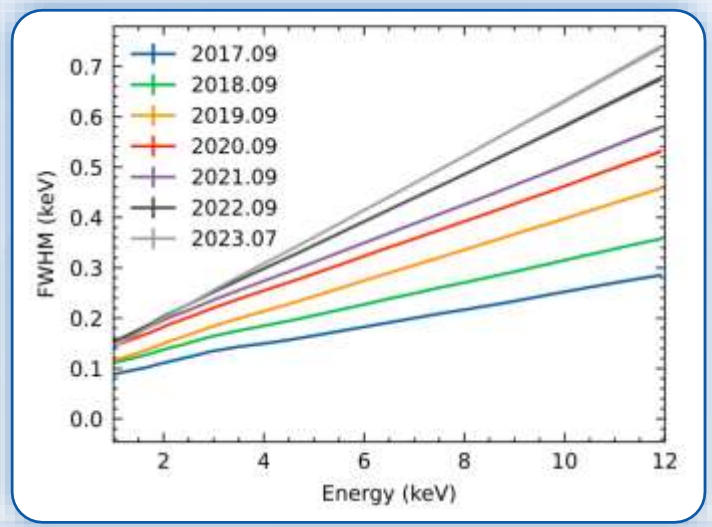
7 CCDs (8%) turned off

- **Energy Gain: decrease month by month due to radiation damage**
- **Energy resolution: getting worse each year**
- **Effective Areas: relatively minor**



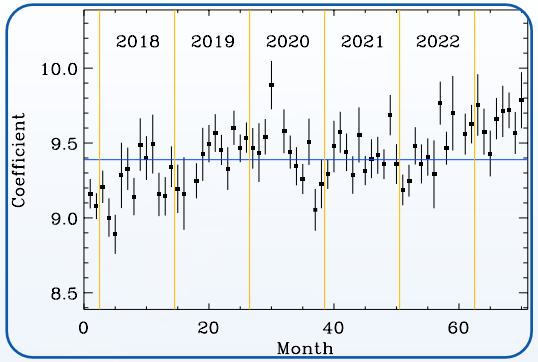


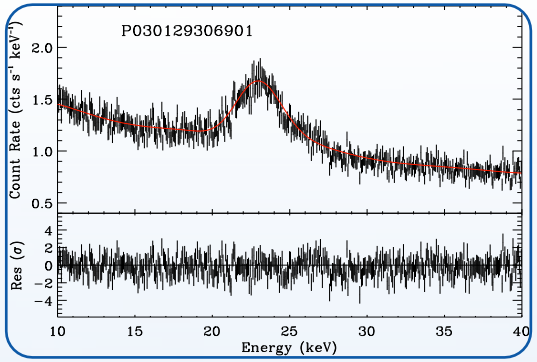


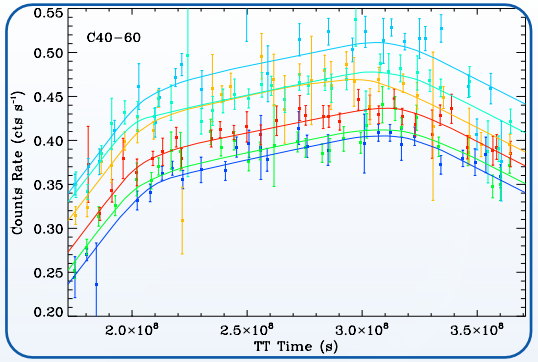


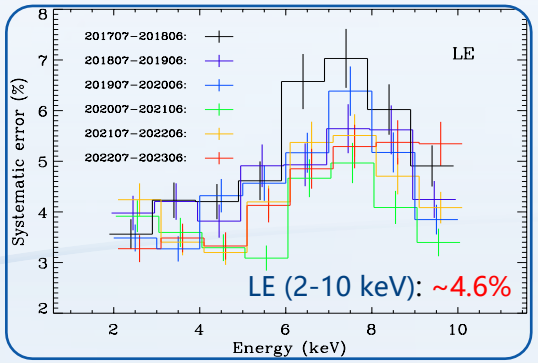
2.3 background model

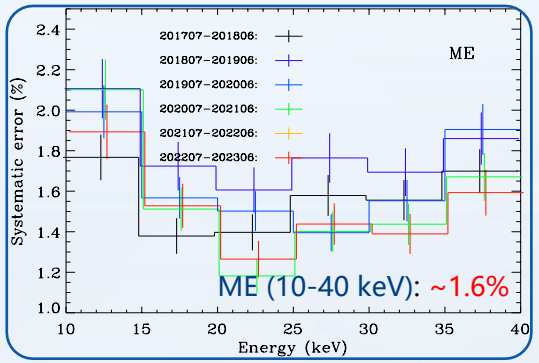
The background model is estimated and verified by blank sky observations and blind detectors.

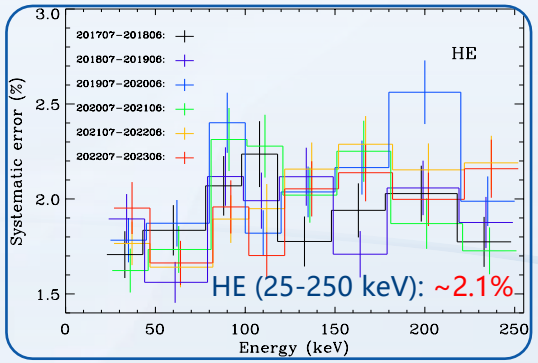












The background models of each payload are reliable

Liao J.Y., et al. 2023, RDTM

3. Summary

1. *Insight*-HXMT has worked smoothly for about 7 years, and all the instruments of HE work well. ME and LE deactivated some detectors but also satisfy the scientific requirements.

2. Six cycles of AO have been collected and the scientific observation targets of the six years have been successfully scheduled. AO07 is ongoing.

3. HXMTSOFT , CALDB and background model are continuously updated. We provide the FAD correction tool implemented in HXMTSOFT for users in the future to better analyse QPO signals.

Thanks!