FXT Status Update

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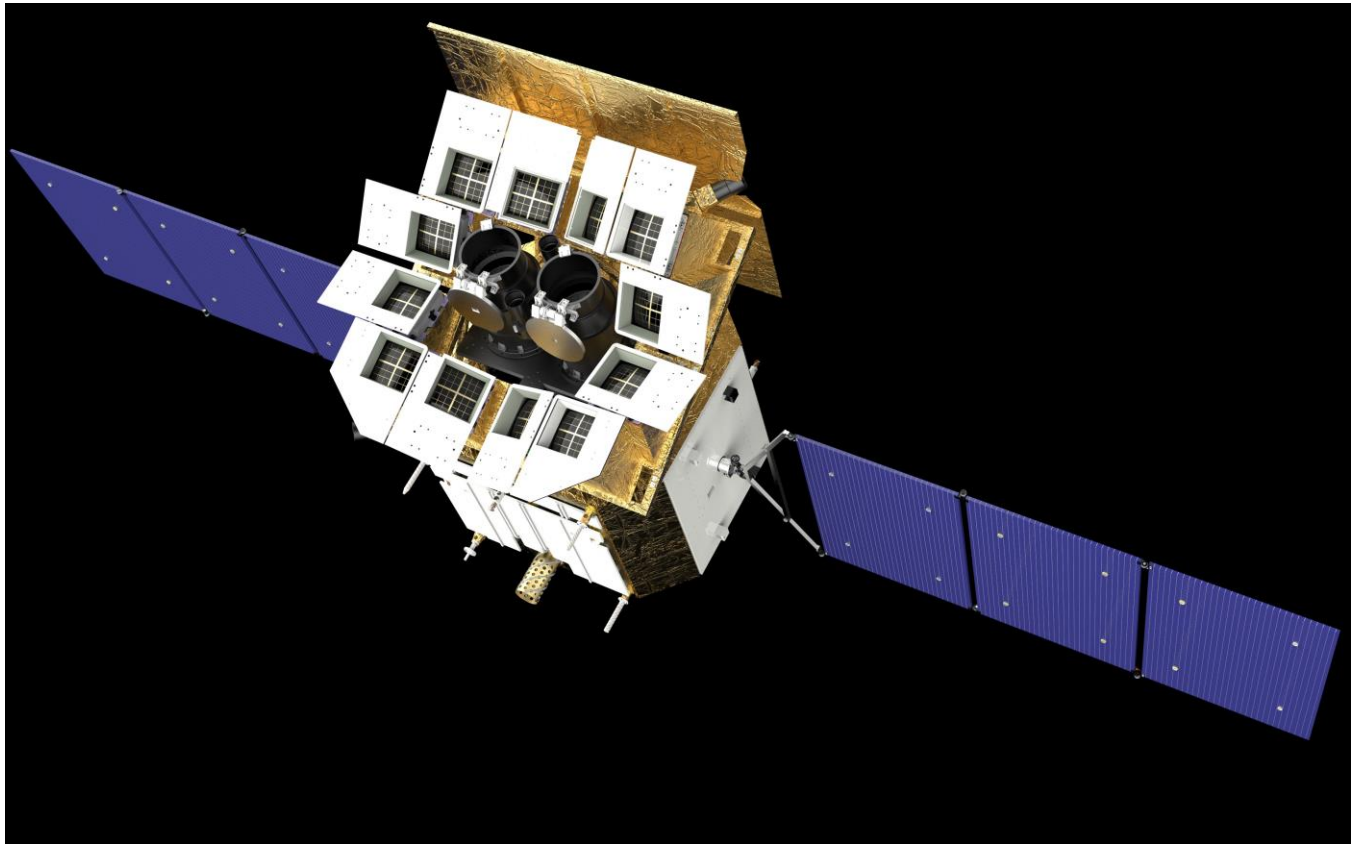
On behalf of FXT team of IHEP
Apr. 24, 2024

Outline

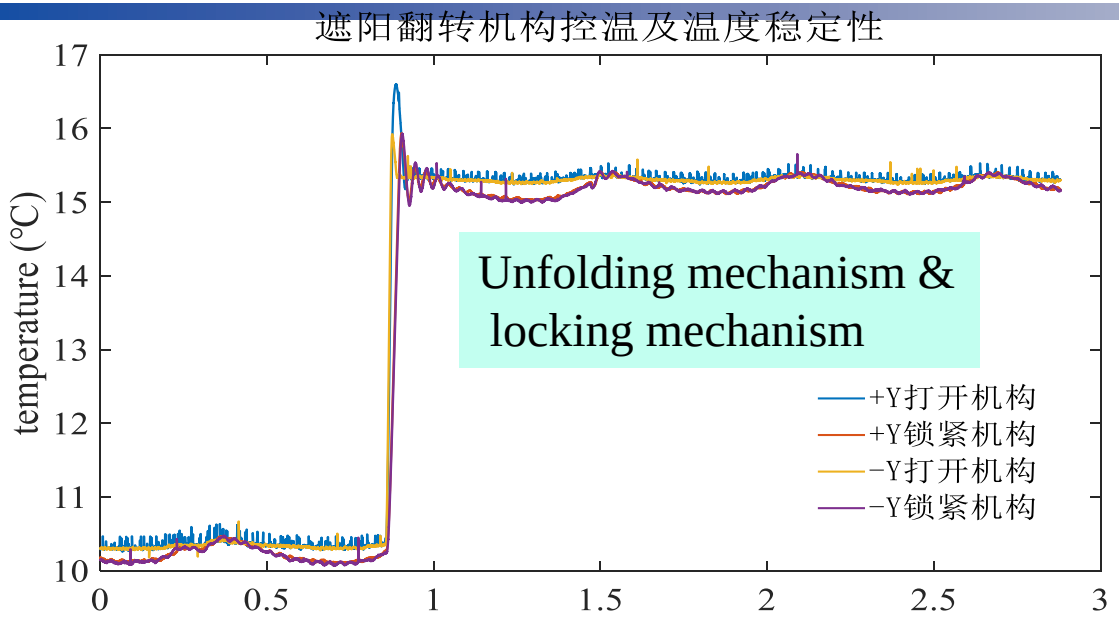
- **FXT on-orbit commission**
- **FXT performance**
- **Summary**

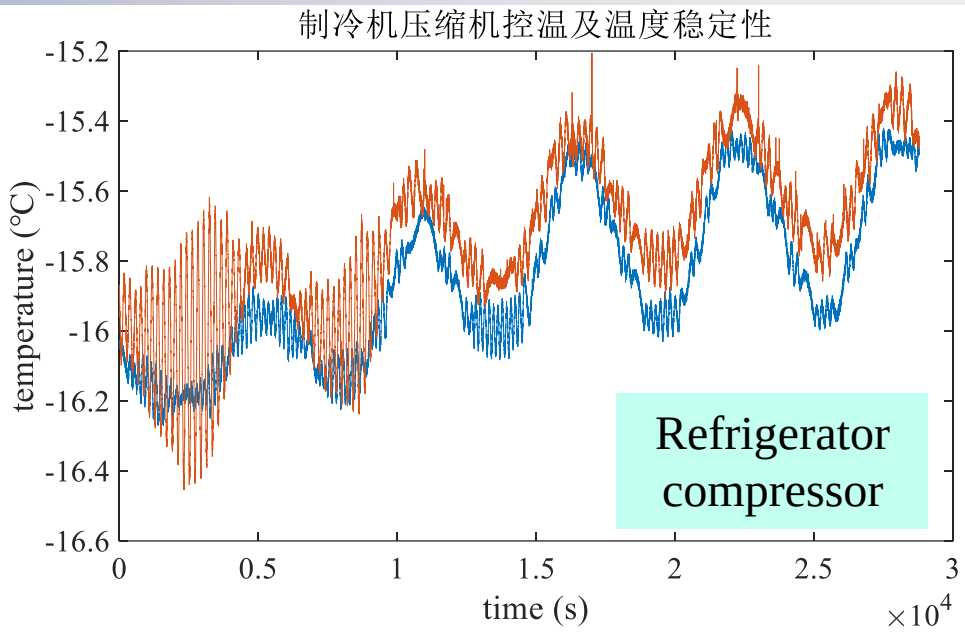


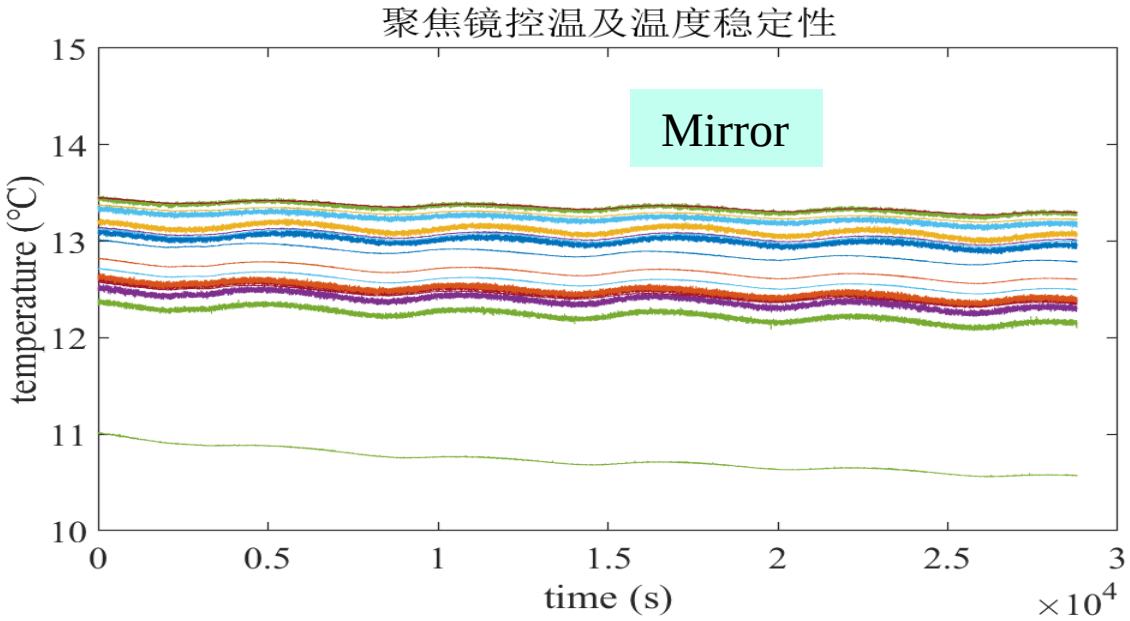
FXT on-orbit commission

- ✓ January 10: Sunshade cover A/B was unlocked and unfolded at a small angle;
- ✓ January 11-24: FXT temperature controller controlled the temperature and completed the FXT baking process;
- ✓ January 25-26: pnCCD-A was powered on for the first time and underwent background and mode testing;
- ✓ February 5: pnCCD A/B were powered on and worked normally;
- ✓ February 22: Cover of FXT-A opened, observing M87;
- ✓ February 28: Cover of FXT-B opened, and both FXT units observed Crab simultaneously;
- ✓ March 5: pnCCD-A radiation source test;
- ✓ April 5: pnCCD-B radiation source test.

FXT thermal control: early in orbit



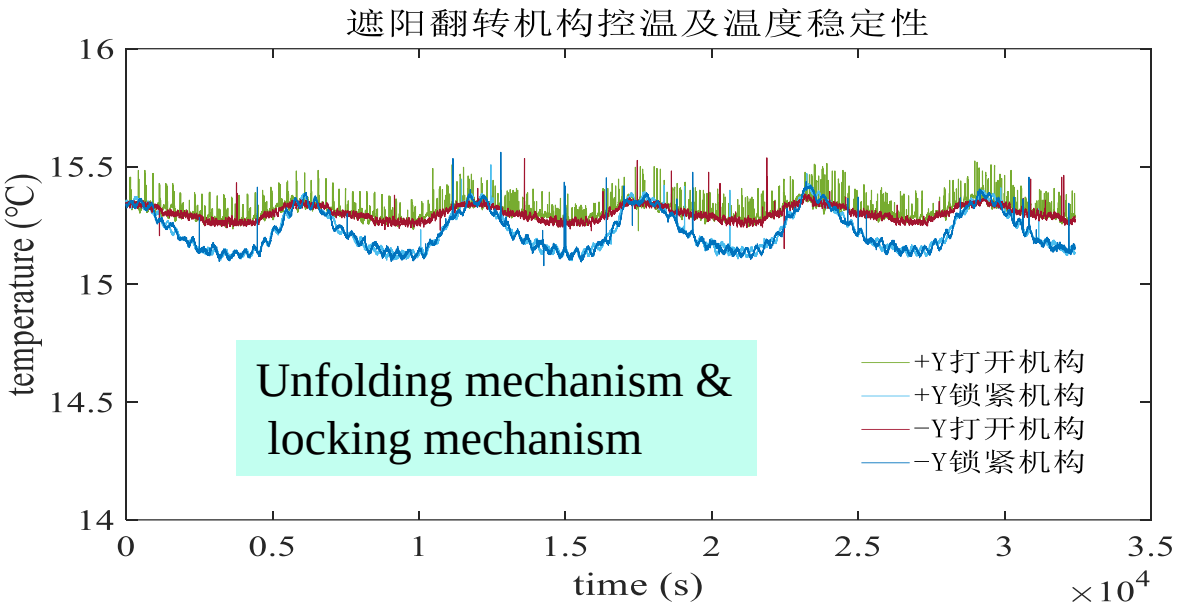


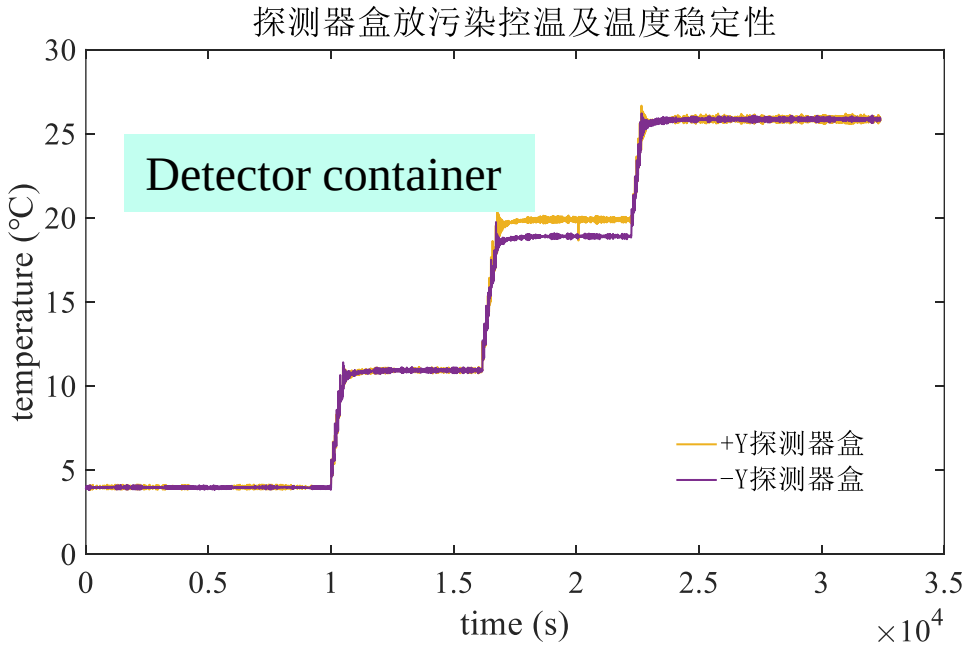


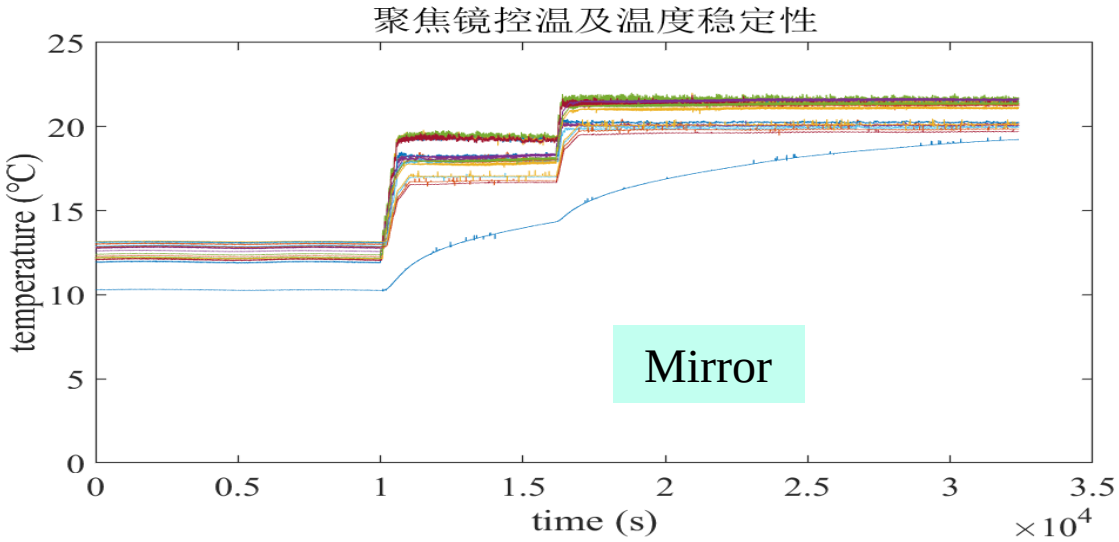
Early in orbit:

- **The temperature of each component meets the storage temperature requirements.**
- **The actual measurement of thermal control is consistent with expectations and meets the requirements.**

FXT thermal control: baking stage



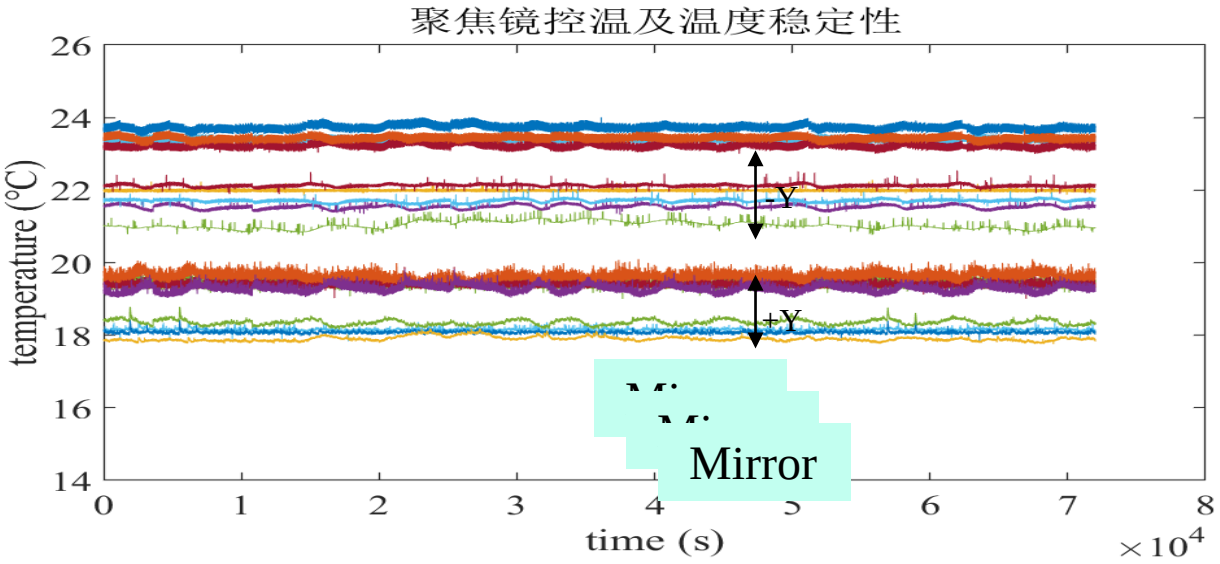


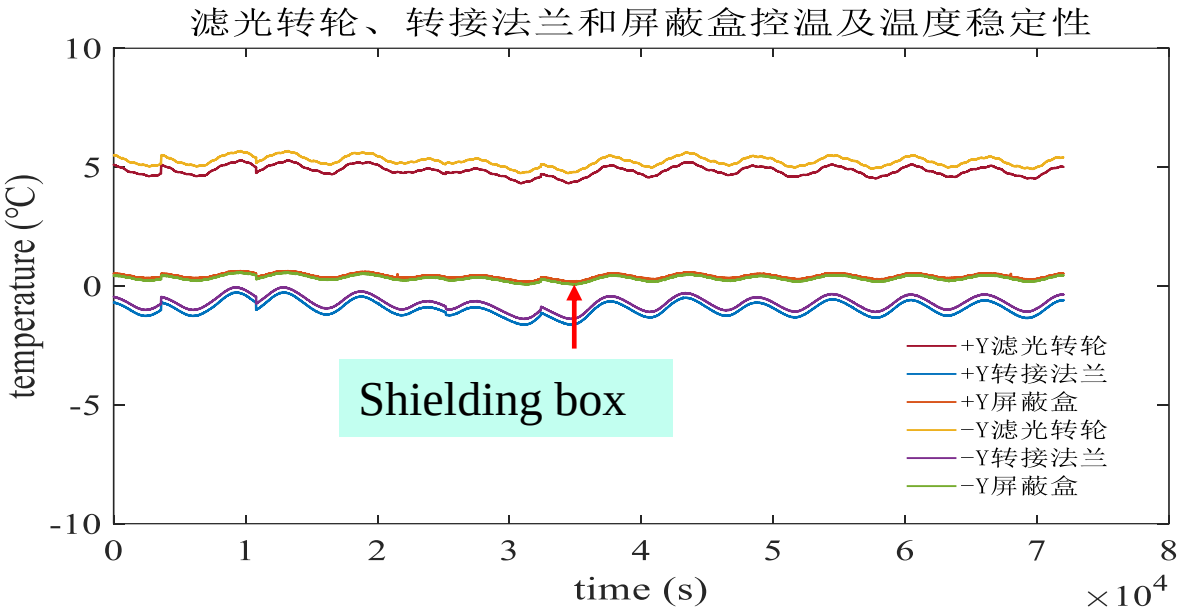


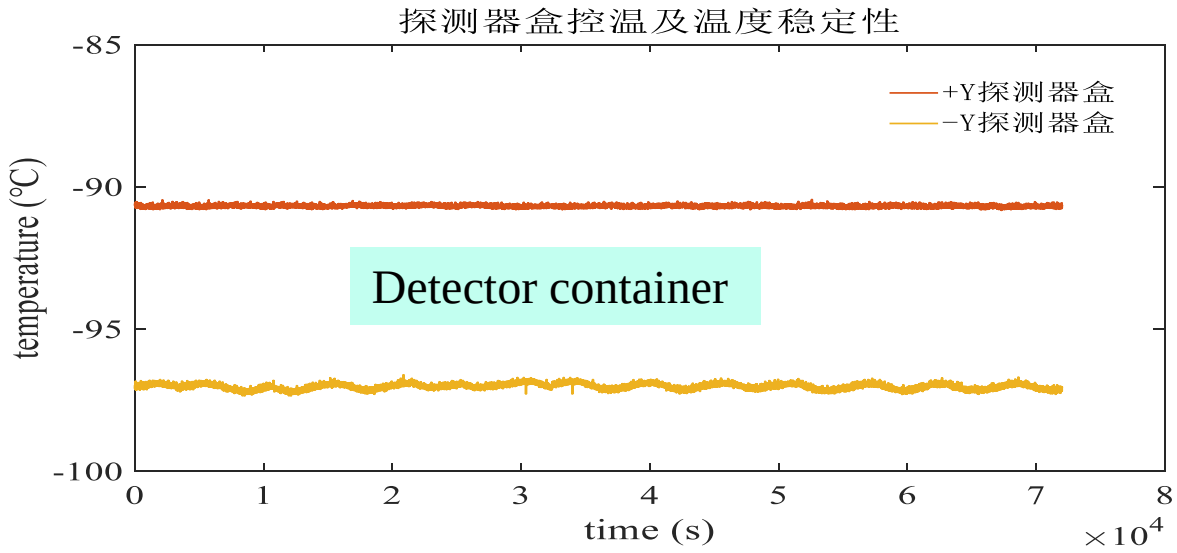
Baking stage:

- **The temperature of each component meets the storage temperature requirements**

FXT thermal control: observations

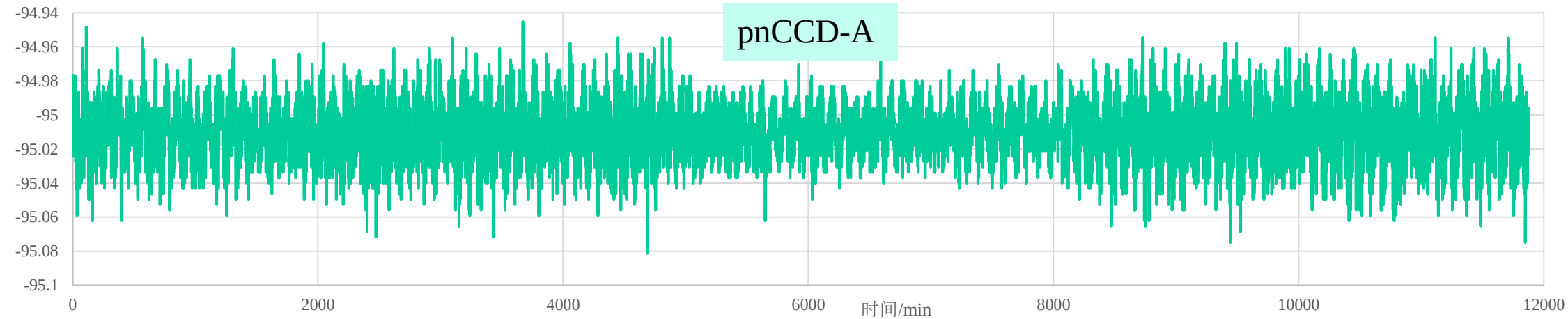


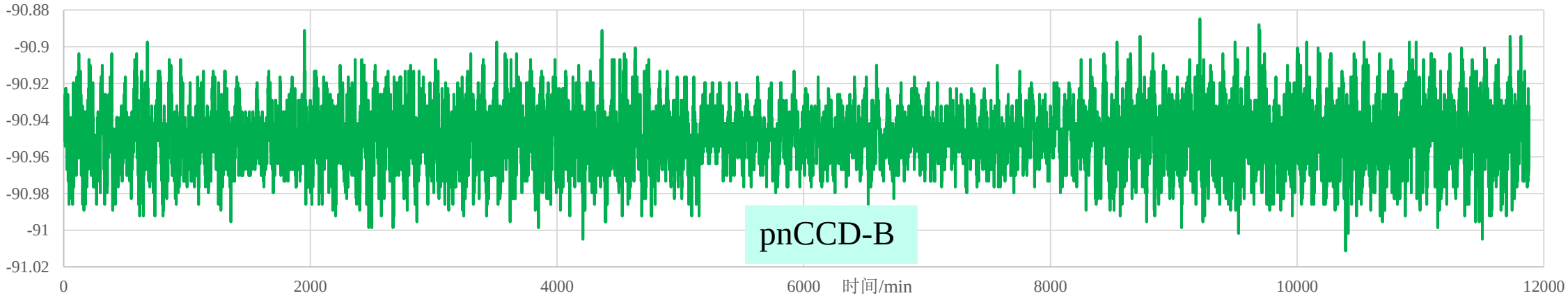




- **The FXT thermal control subsystem is working normally in orbit**
- **The temperature and temperature control stability of each component in the early stage of orbit, baking stage, and normal observation stage all meet the corresponding requirements**
- **The power consumption of the FXT thermal control subsystem is normal**

制冷机性能满足要求



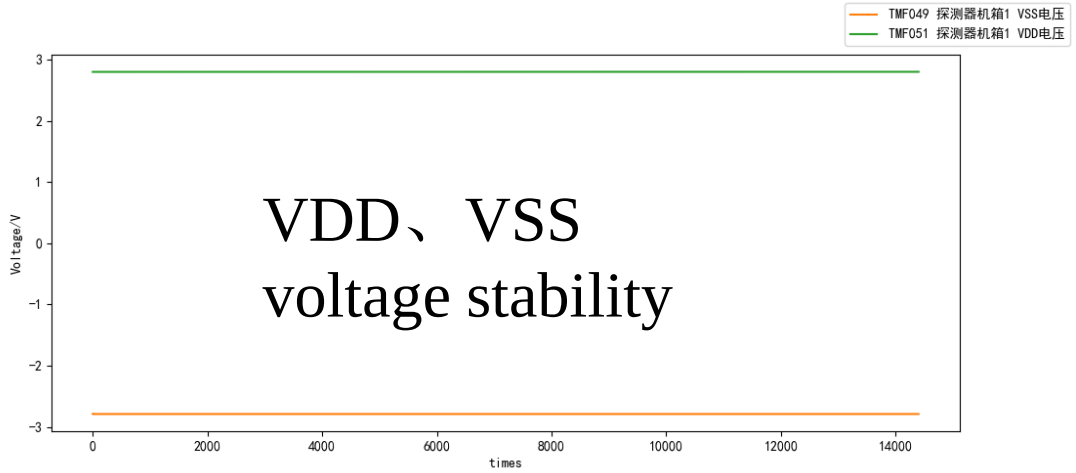


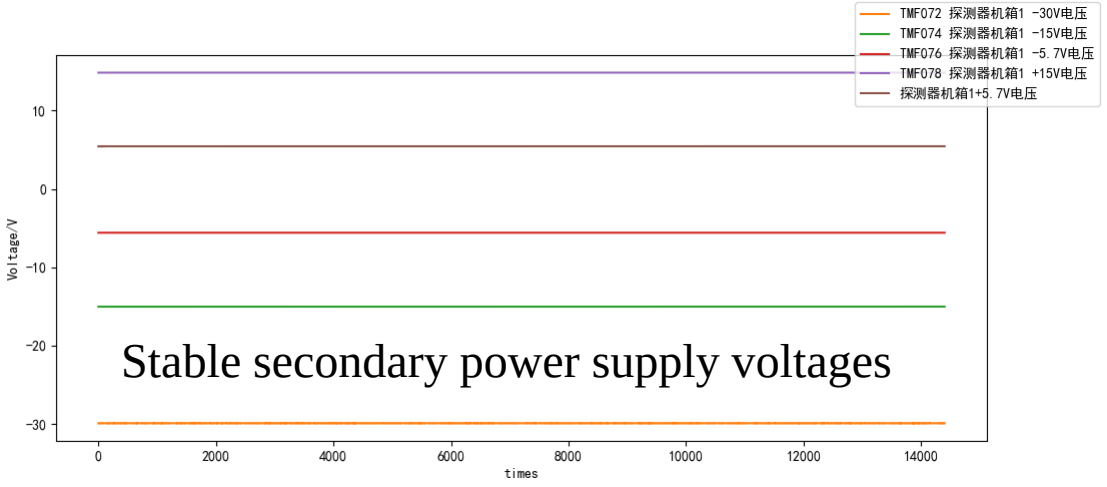
- **The temperature stability meets the technical specifications: the temperature control target point of pnCCD-A is -95 ℃; pnCCD-B is -90.95 ℃, with fluctuations of ± 0.05 ℃ during long-term continuous operation.**
- **Stable output power of refrigeration unit: Refrigerator A has an output power of 16.5 ± 1W; Refrigerator B has an output power of 18.5 ± 1W with a significant cooling margin.**

Electronics units functionality & performance

The two detector boxes are operating normally

- Both detector-boxes have undergone work mode testing and have completed preliminary in orbit
- FXT-A: Full Frame, Partial-window, Timing and Power saving mode
- FXT-B: Full Frame, Partial-window, Timing mode
- Command reception and execution are normal
- Scientific and engineering data are normal
- The pnCCD detector is operating normally and its performance meets expectations

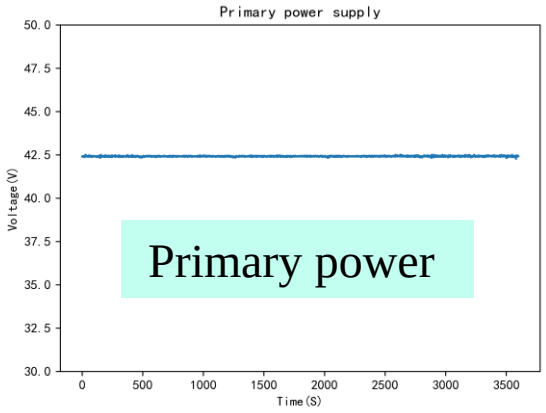


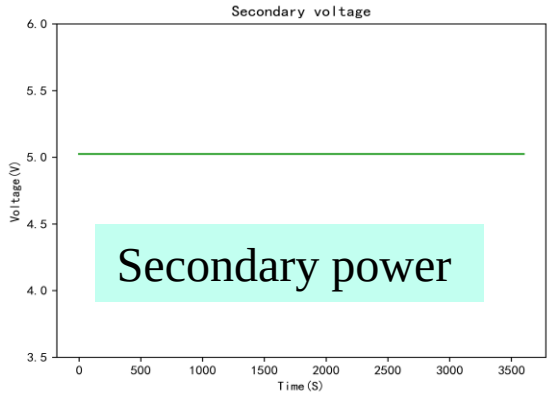


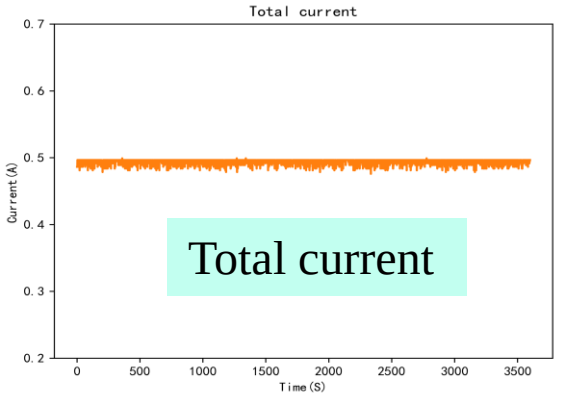
The electronic control box

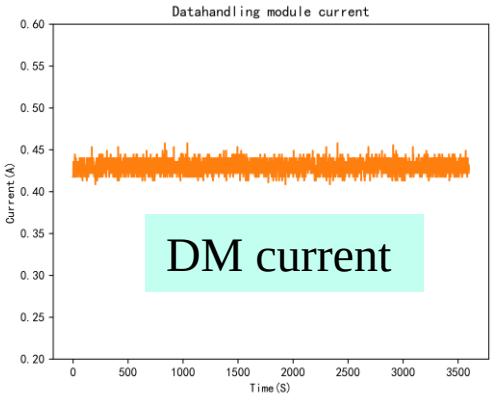
- Function completion status:
- The communication between the electronic control box, satellite platform, and the internal 5 electronic units interfaces of the FXT payload is normal;
- There is no loss or misalignment of scientific data;
- The management strategy on the two detectors is normal.
- The management strategy for the filter wheel (monitoring bright earth and mirror reflection) is normal.

The electronic control box is operating normally.



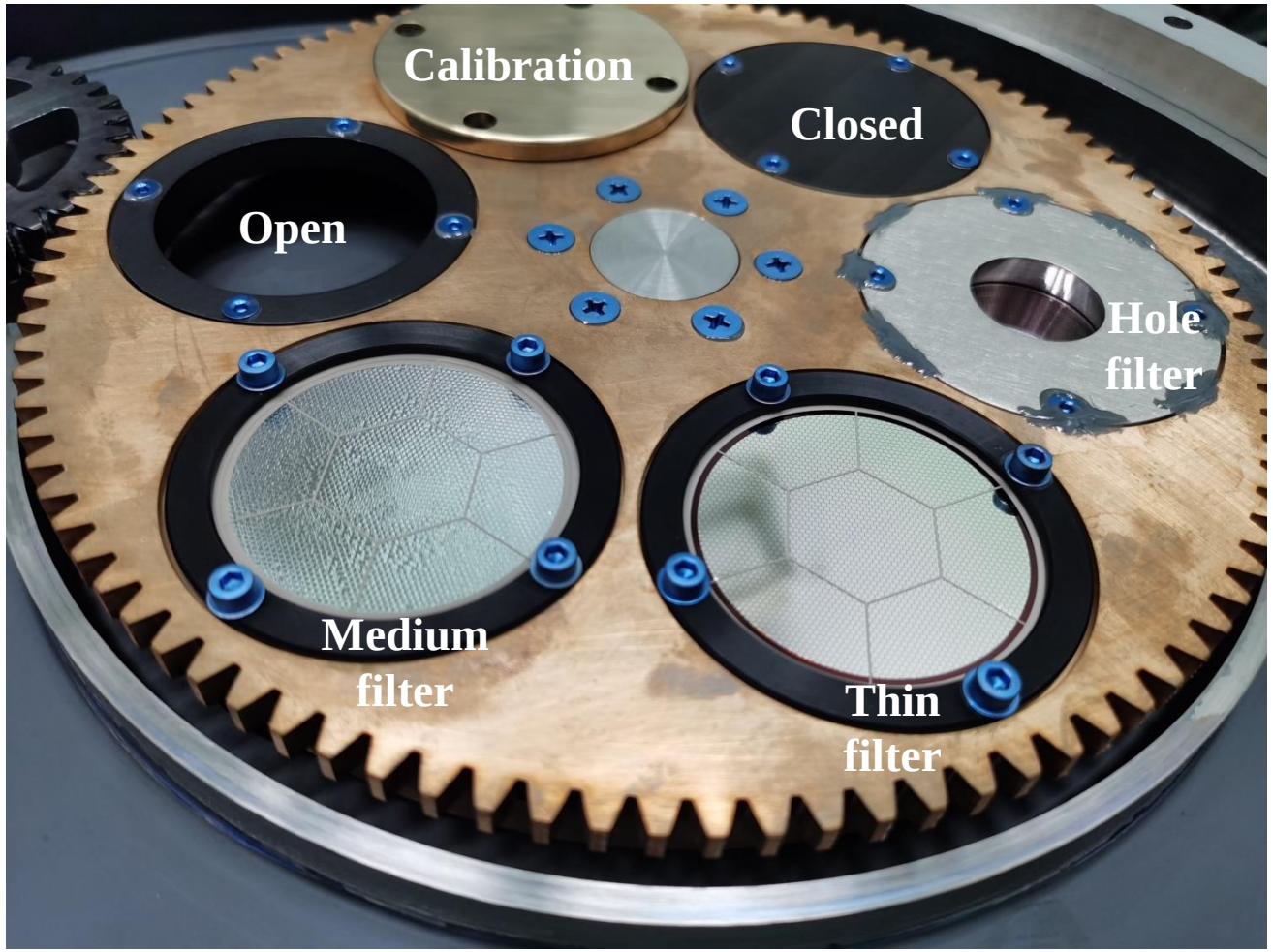






Filter wheel

- Open
- Thin filter（80 nm Al+200 nm PI）
- Medium filter（200 nm Al+400 nm PI）
- Hole filter（hole; 80 nm Al+200 nm PI）
- Closed（2mm-thick Al）
- Calibration（Fe-55）



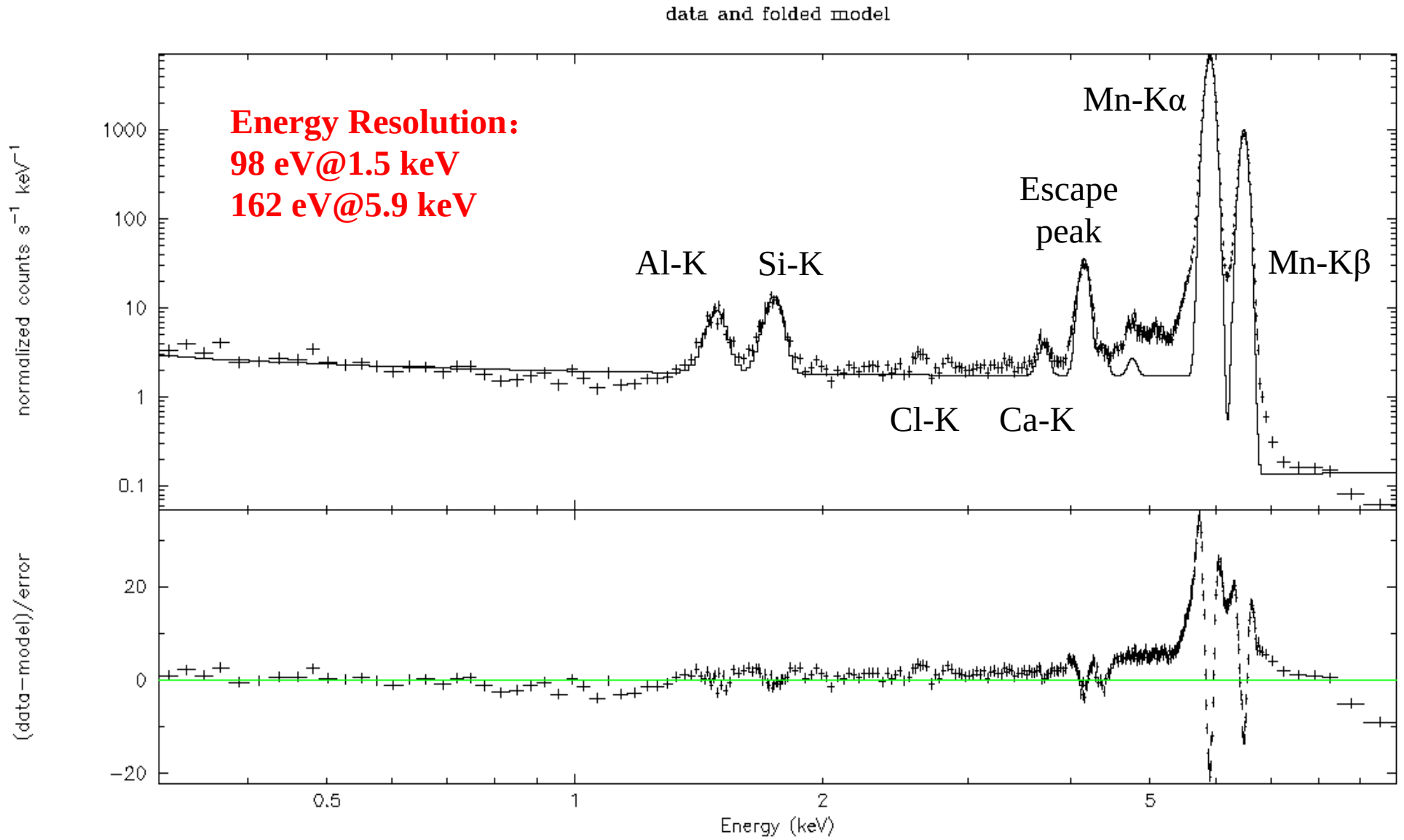
Movement mechanism

- **Sunshade mechanism successfully completed in orbit mission**
- **The filter wheel rotates according to the control strategy**
  - Filter wheel A&B tested for all of the 6 positions/filters
  - Everything is running well
  - All remote measurement status monitoring is normal
- **The motion mechanism controller is working properly**

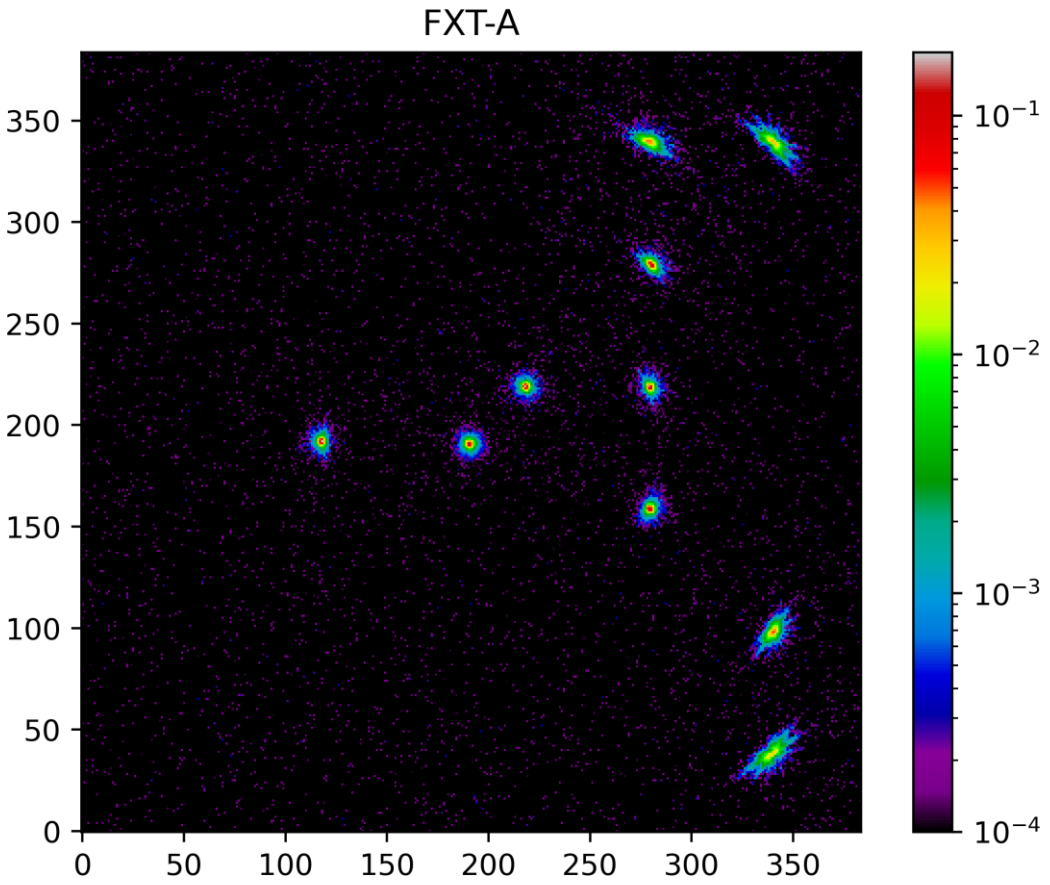
FXT commission

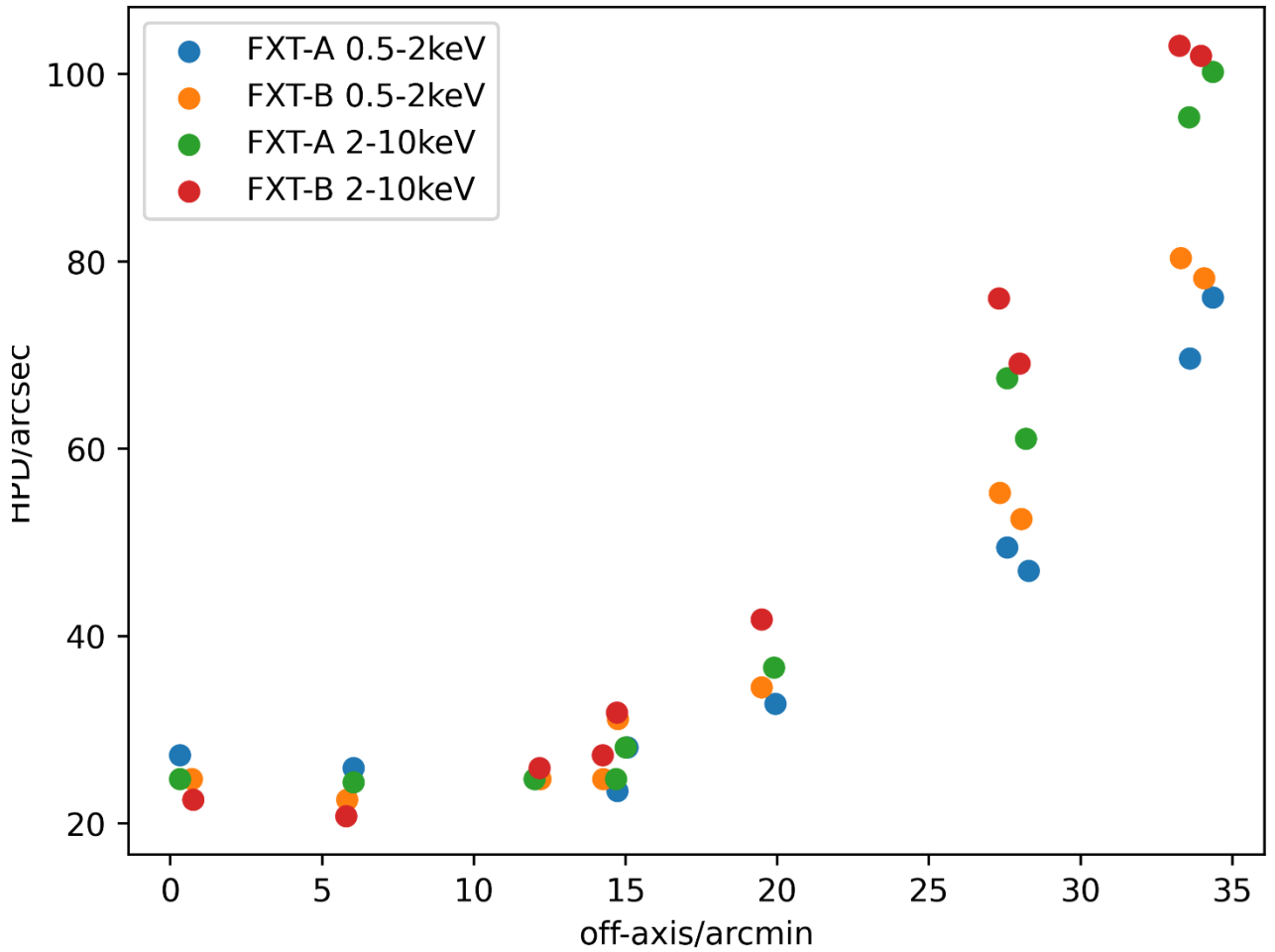
- ✓ March 5-19:
- ✓ NGC 2516: Coordinate Conversion Matrix
- ✓ Crab: Time System
- ✓ Omega Centauri: Coordinate Conversion Matrix
- ✓ 3C 273 and SRGA J144459.2-604207: Angular resolution; optimize the mirror temperature.
- ✓ Vela SNR and M87: Imaging quality, E-C calibration, effective area calibration.
- ✓ The performance meets the requirements, and detailed calibration analysis is needed in the future.

FXT-A on-orbit Fe-55 measurement



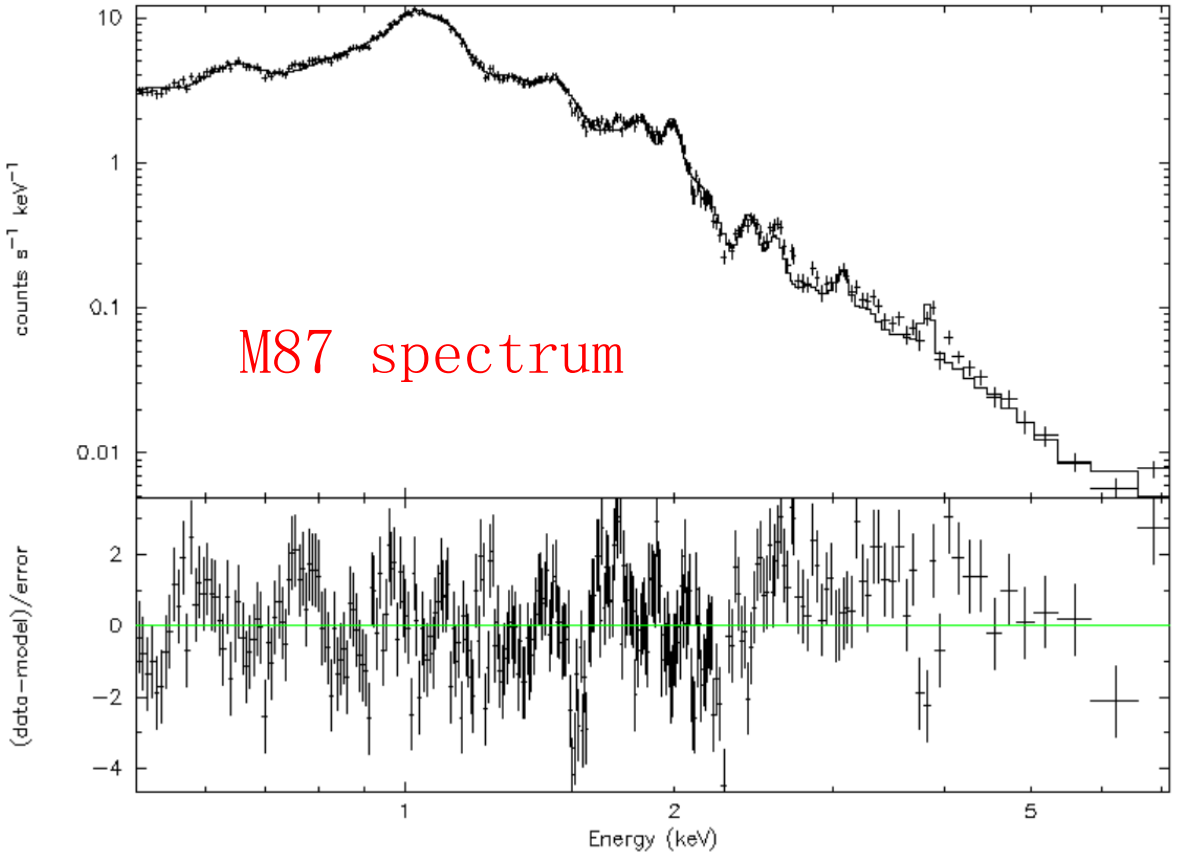
PSF measurements





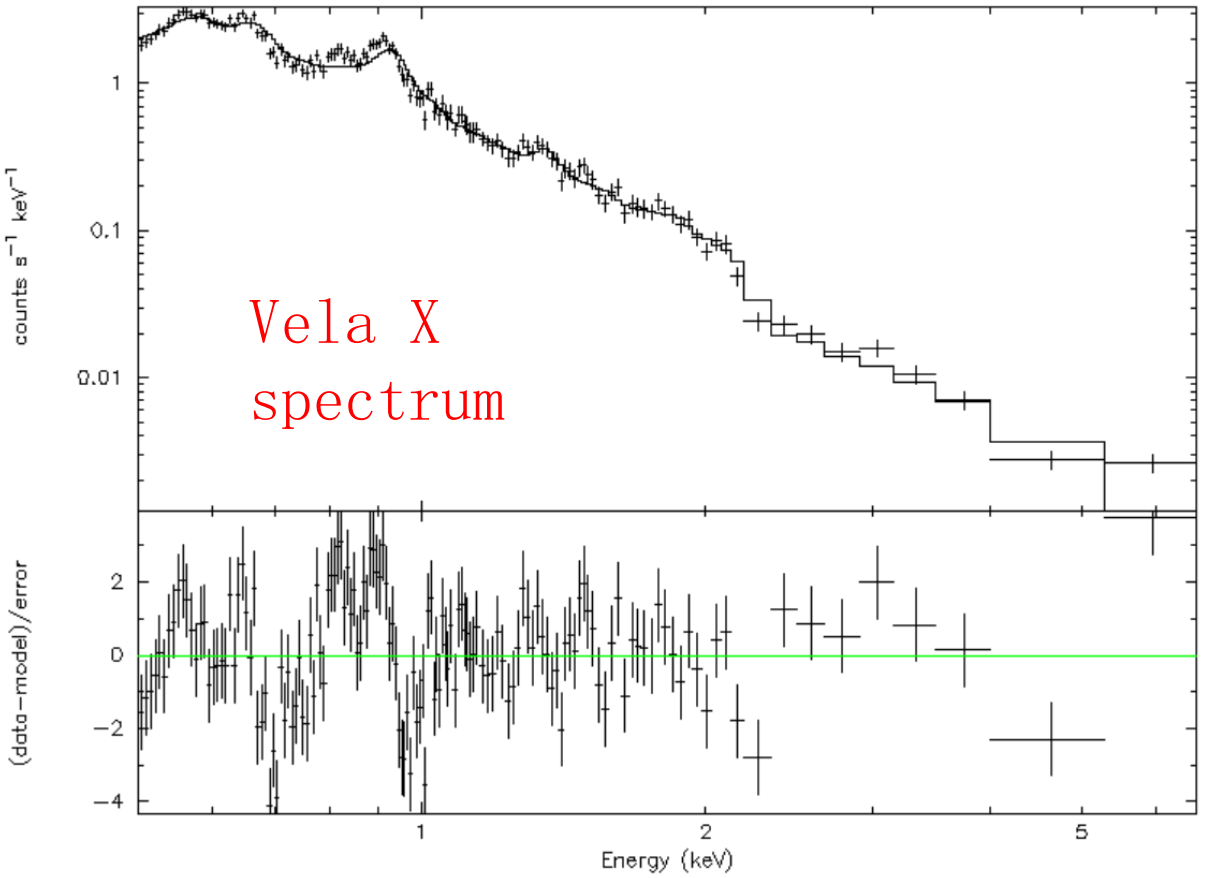
3C273

FXT spectrum



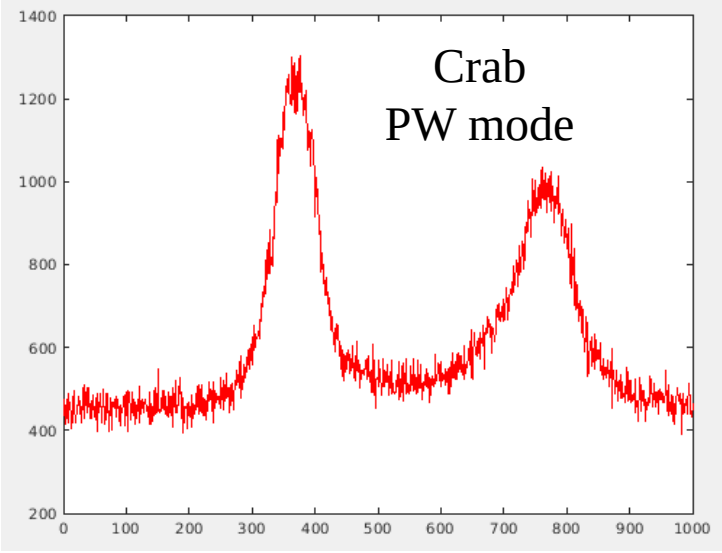
model：tbabs*（vmekal1+vmekal2）

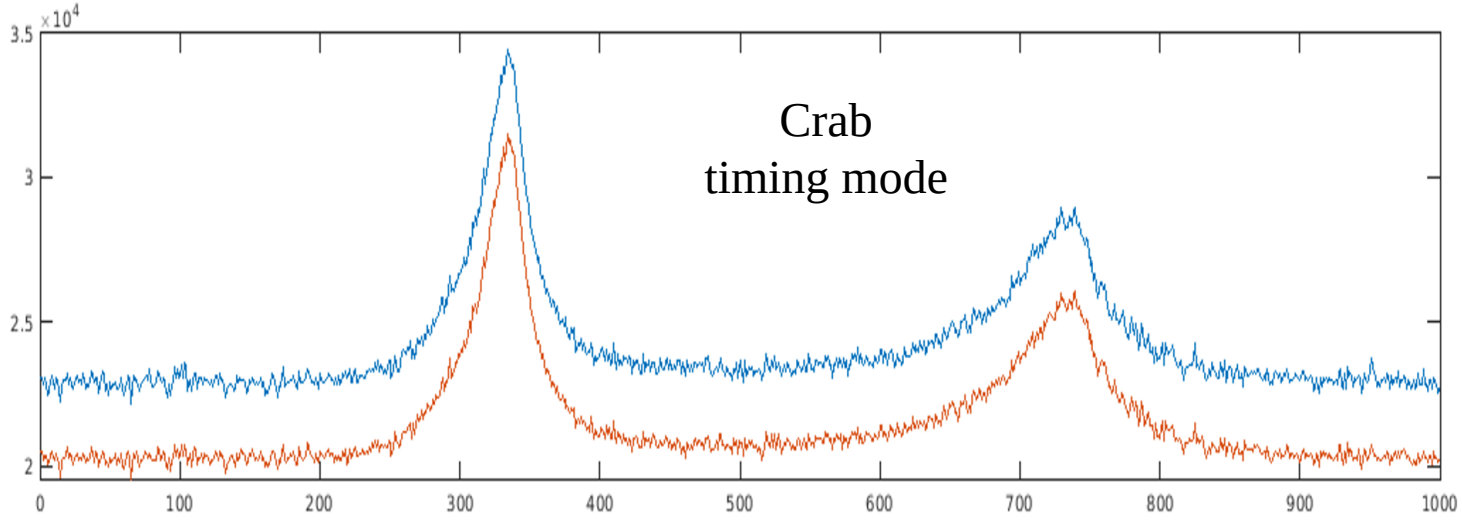
model：tbabs*（vnei+pow）



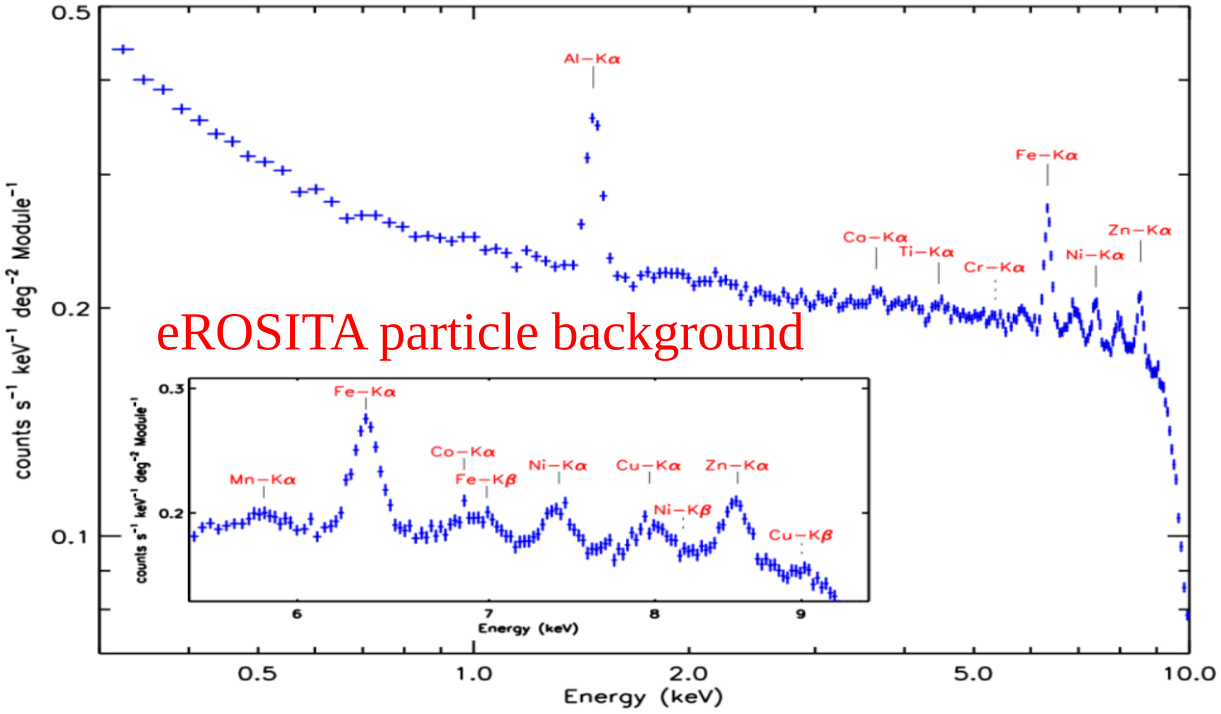
Partial-window mode and timing mode parameter optimization

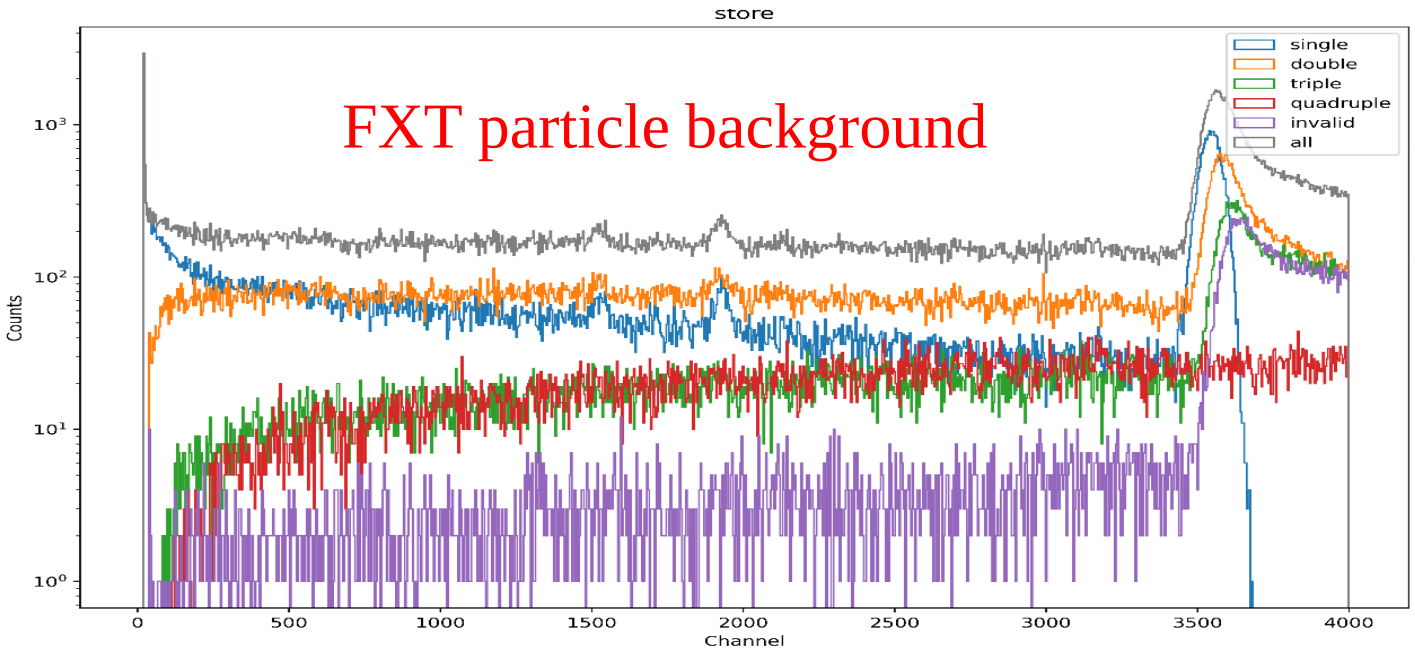
- Partial-window mode and timing mode are newly developed modes compared to eROSITA
- The parameters were optimized in-orbit
- The optimized discharge time is set to 200 microseconds
- Operate stably for observations

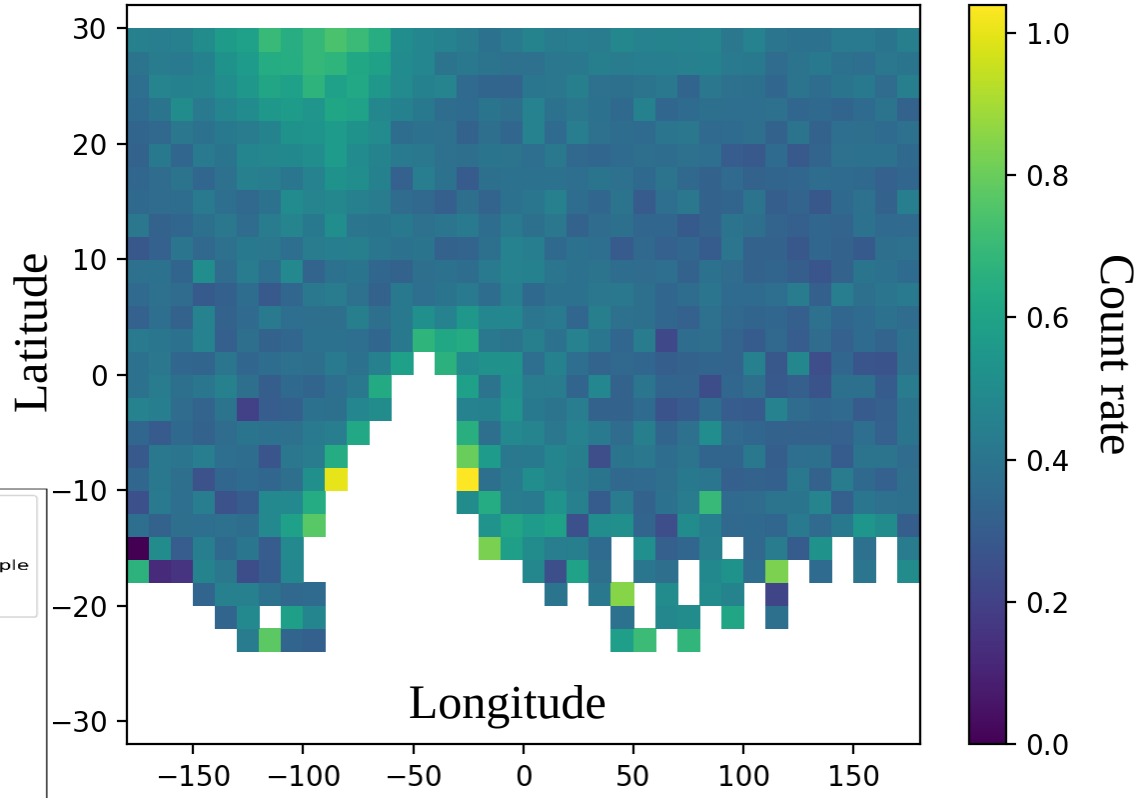




In-orbit particle background



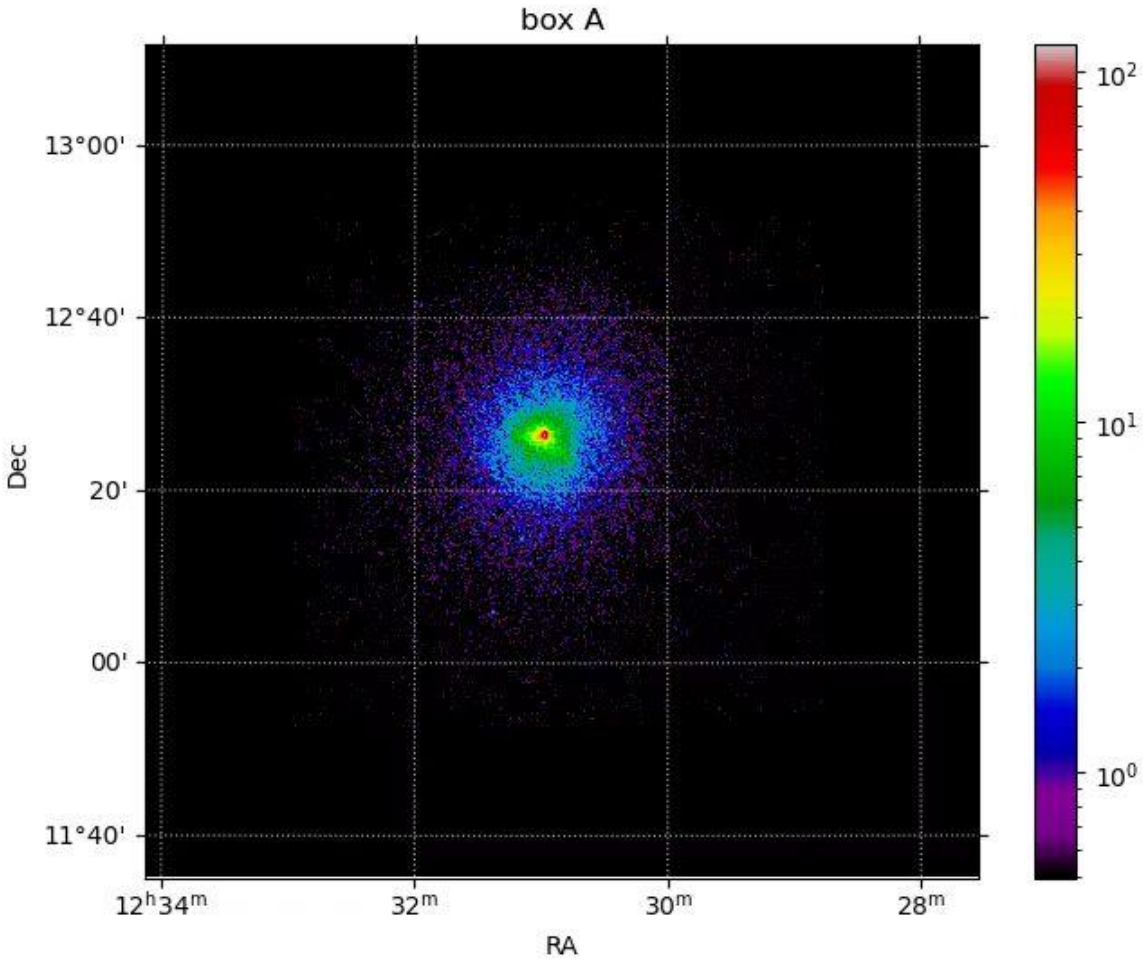


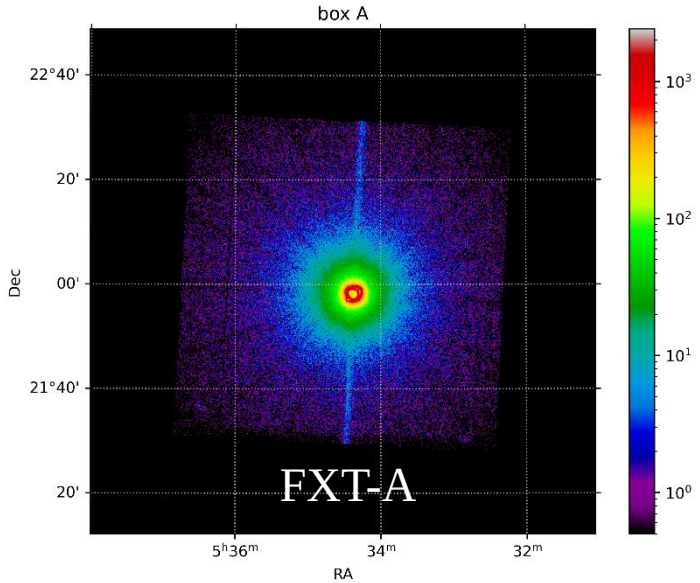


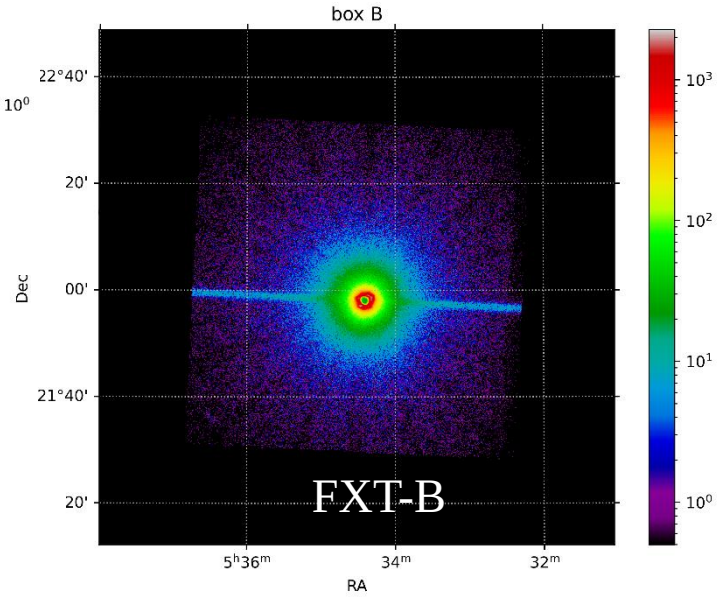
Variation of particle background count rate with orbital position

The particles background of FXT is about 1/5 of that of eROSITA

FXT observation of M87 and Crab



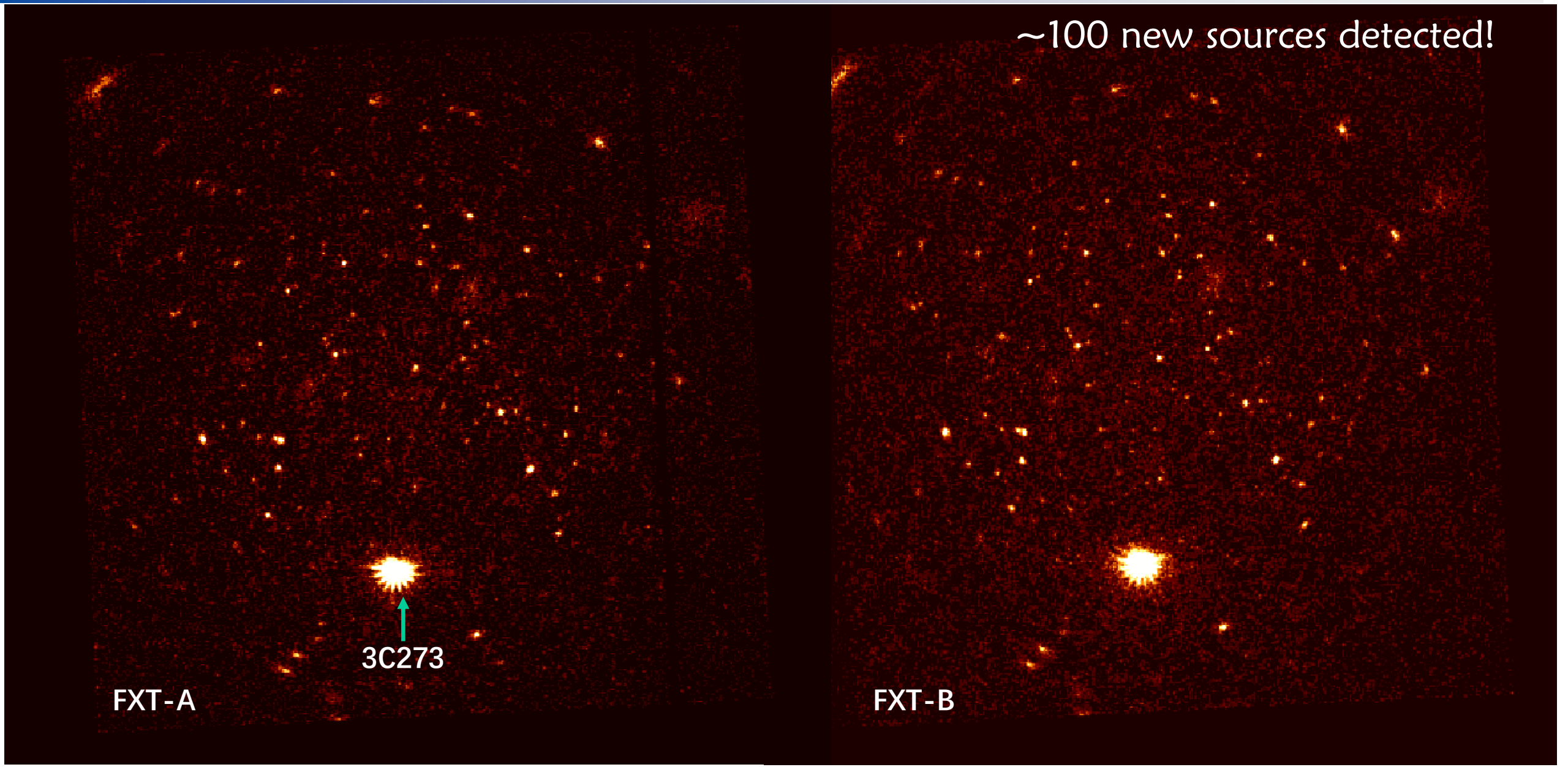




Feb. 22, FXT-A observation of M87

Feb. 28，FXT-A&B observation of Crab

- Medium filter, Full Frame mode, ~40000 s
- 139 sources detected by FXT-A，with 38 cataloged sources (1eRASS，4XMM，2RXS，2SXPS)
- 134 sources by FXT-B，with 44 cataloged sources



Searching for X-ray transients

Source name	Count rate （cts/s）	remarks
EPF_J063443.5+314436	0.080	Counterpart: QSO， z=0.24
EPF_J043532.7-114627	0.10	AGN
EPF_J033546.2+490408	0.10	AGN
EPF_J060543.7+231308	0.10	Star flare

Follow-up observation

Source name	Obs. time	remarks
EPW20240306aa	2024-03-08 09:30:01 2024-03-08 12:35:47	Star flare
EPW20240222aa	2024-03-13 00:10:01 2024-03-13 01:46:43	TDE candidate
EPW20240309aa	2024-03-16 02:00:01 2024-03-16 03:42:41	X-ray binary
EP240315a	2024-03-17 14:10:01 2024-03-17 16:34:28	After glow of γ-ray burst z = 4.9
	2024-03-18 16:00:01 2024-03-18 19:52:30	
EPW20240320aa	2024-03-21 20:00:01 2024-03-21 21:09:53	Star CME (coronal mass ejection)

Test & calibration status

	Test item	Requirements	Test results
1	FXT power on	Normal	normal
2	Unlock, unfold the sunshade cover	Normal	All successful
3	Refrigerator temperature control	PNCCD temperature control to target temperature ± 0.5 ℃ (-95 ℃ ≤ target temperature ≤ -85 ℃)	Temperature stability ≤ 0.5 ℃
4	Detector working mode	Full frame, Partial-window and Timing mode	Working modes are all normal
5		Three working states: normal, offset calibration, and SAA	Working states are all normal
6	X-ray imaging	Energy range：0.5 keV~8 keV	**0.3 keV~10 keV**
7		Effective area：≥100 cm^2@1.25 keV，on axis	**Roughly consistent with ground calibration ~300 cm^2@1.25 keV (Further detailed calibration is needed)**
8		Angular resolution：≤2′ HPD	**A：23.7” ; B： 20.1”; on axis, 20℃**

	item	requirement	Test result
1.	Source location accuracy	< 20″(90% C.L.)，J2000	**< 10” (90% C.L.) J2000 (still optimizing)**

3. Summary

- The FXT instrument is operating normally in orbit
- FXT has good in-orbit performance and meets the requirements
- The particle induced background is very low for FXT
- Preliminary scientific results have been made
- Detailed calibration will be conducted in the next step

Thanks!