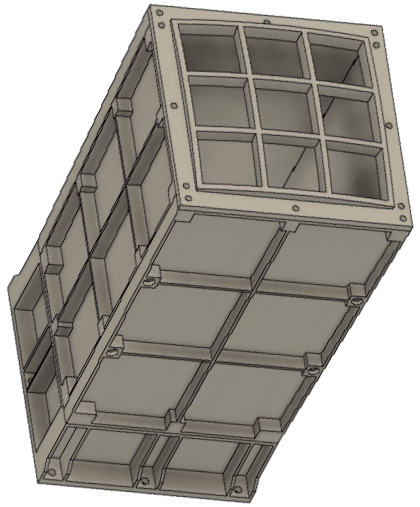
B02: HiZ-GUNDAM

Recent progress in the Development of EAGLE, the Wide-Field X-ray Monitor onboard HiZ-GUNDAM

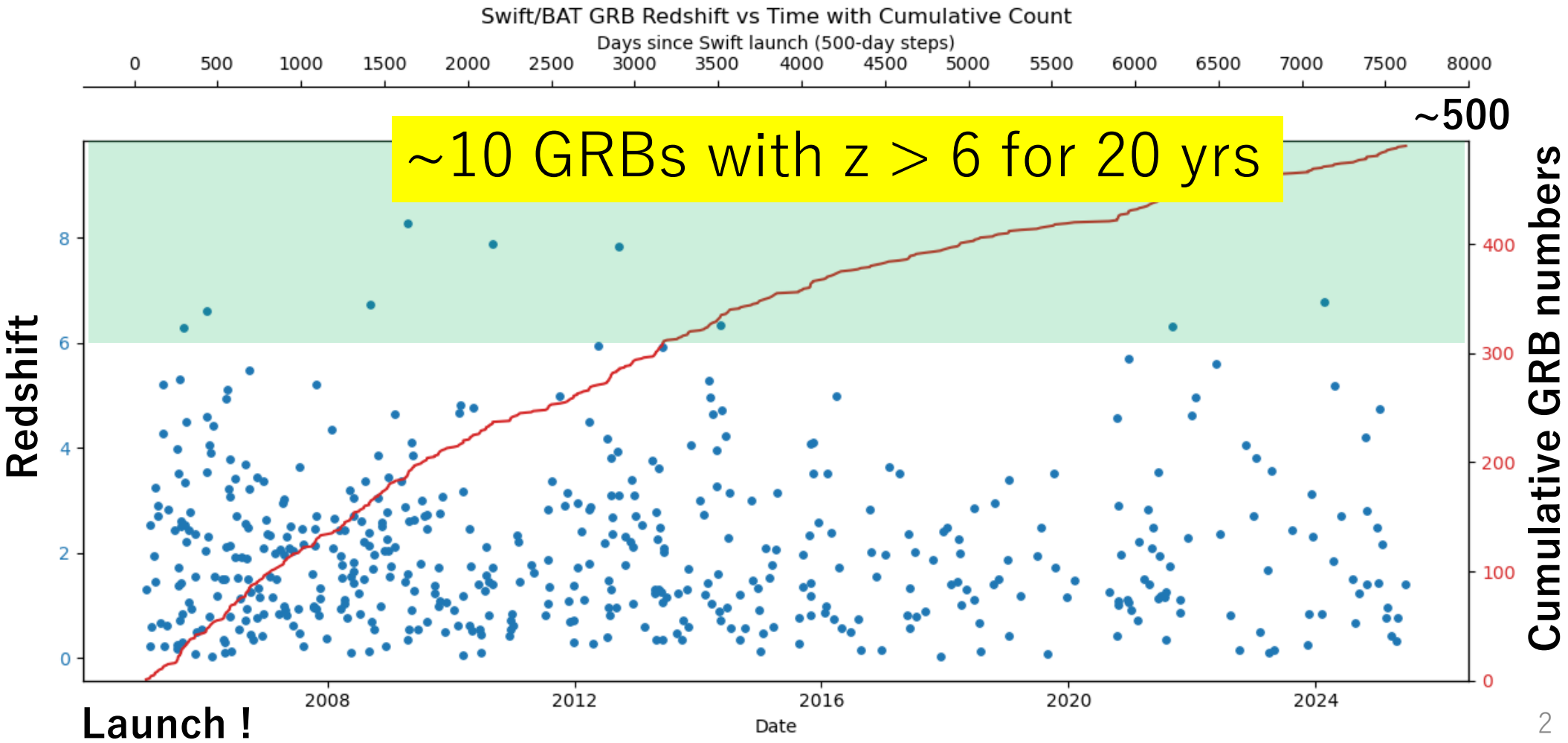
Makoto ARIMOTO (Kanazawa University)
on behalf of the HiZ-GUNDAM Collaboration

HiZ-GUNDAM



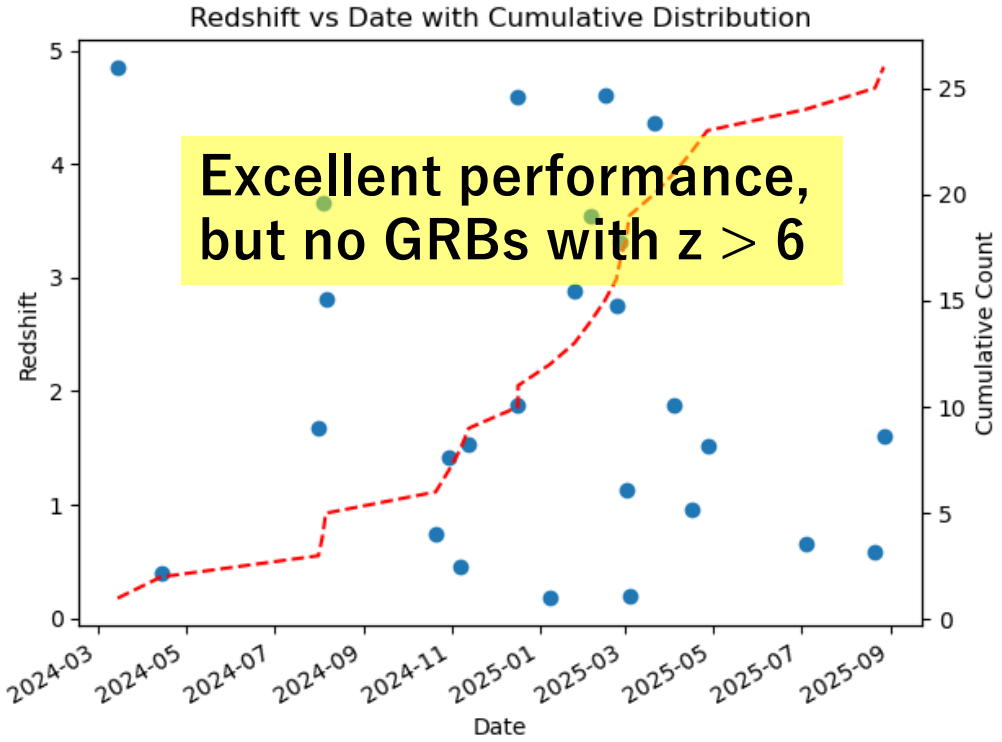
EAGLE

History of GRB detection by Swift (2004 - Now)

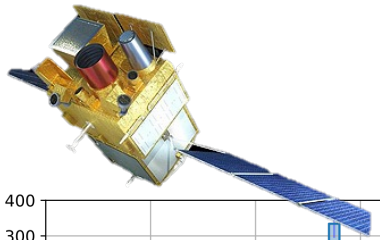


EP & SVOM

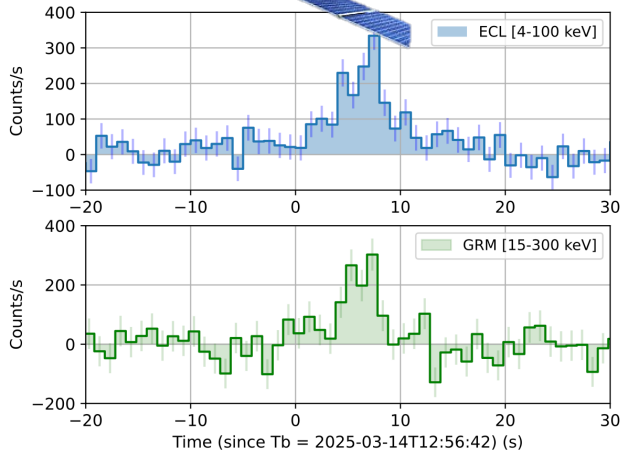
Einstein Probe (~1.5 yr)

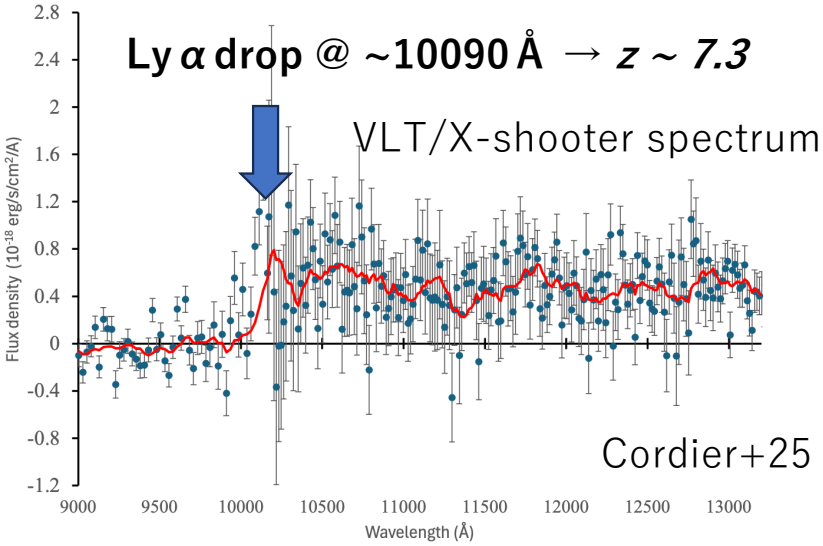


Reproduced from O'Connor+25

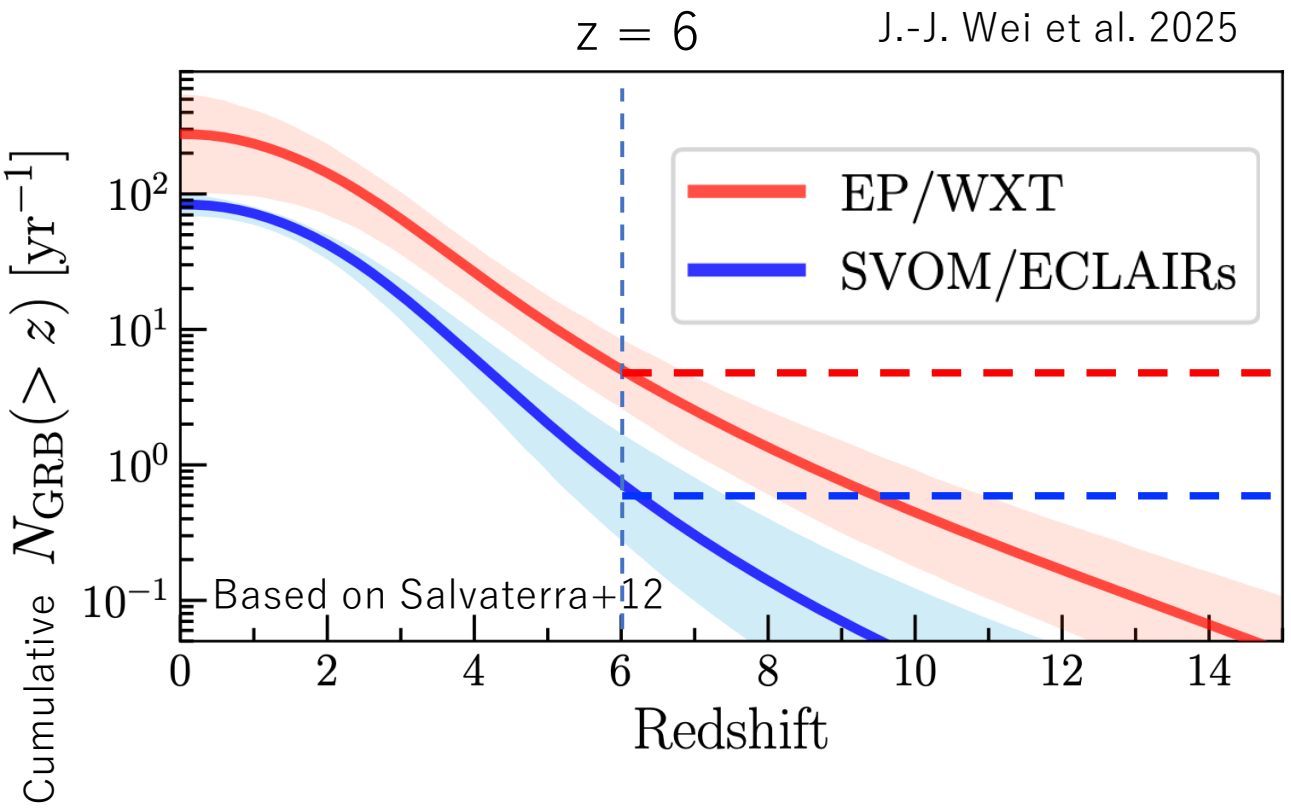


SVOM (~1 yr)





Expectation from Einstein Probe & SVOM



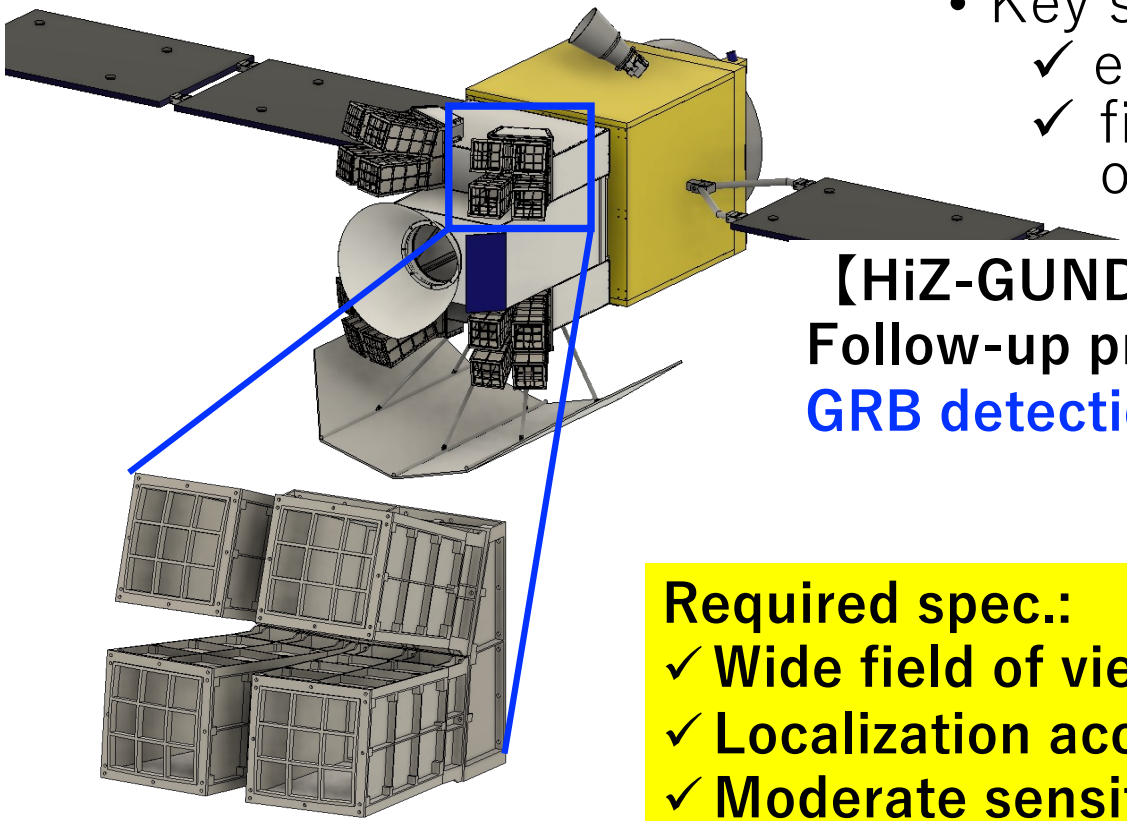
Opt. follow-up efficiency

$5.1^{+3.4}_{-2.4}$ x ~30%

$0.7^{+1.0}_{-0.4}$ x ~100%

~1 GRB/yr at z > 6

HiZ-GUNDAM: **Hi**gh-**z** **G**amma-ray bursts for **Un**raveling the **D**ark **A**ges **M**ission



- Launch: Early 2030s
- Key sciences via GRBs
  - ✓ exploring **early universe at z > 6**
  - ✓ finding electromagnetic counterparts of **GW events**

【HiZ-GUNDAM Goal】

Follow-up probability: ~100%

GRB detection rate: >10 GRBs/3yr at z > 6

→ >3 GRBs/yr at z > 6

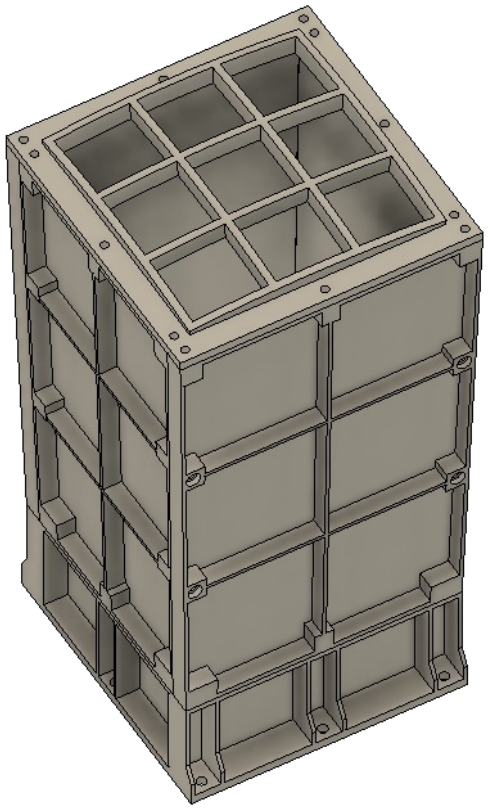
Required spec.:

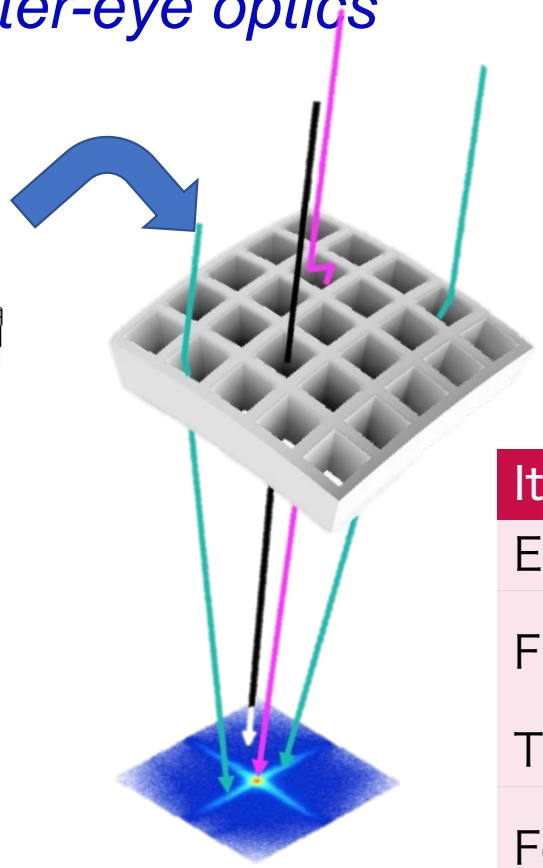
- ✓ **Wide field of view: ~ 0.5 sr**
- ✓ **Localization accuracy: 1.5 arcmin (1 σ)**
- ✓ **Moderate sensitivity: ~ a few 10^{-10} erg/cm^2/s (100 s)**

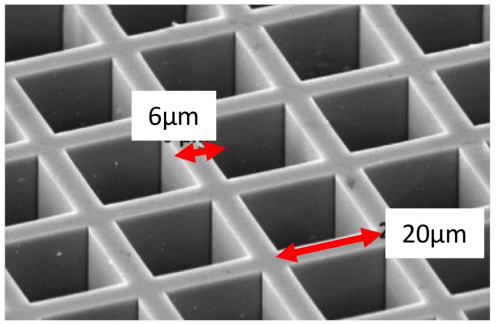
Exploration of Ancient GRBs with Lobster Eye *EAGLE*

(previously known as *WFXM*)

Lobster-eye optics



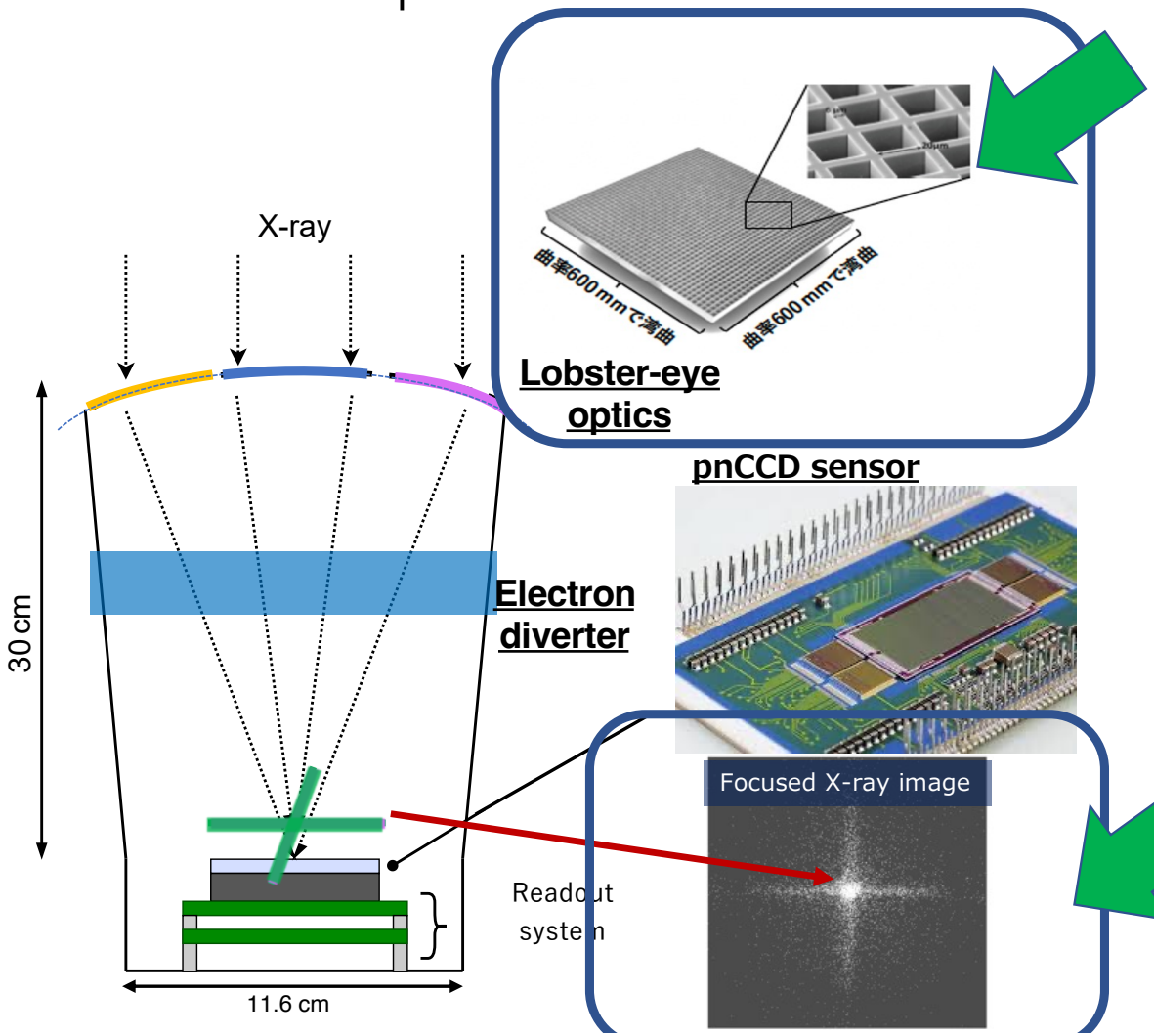




- **Focusing type**
- **Wide field of view**

Items	Parameters
Energy range	0.4 – 4 keV
Field of view	~0.5 str for 16 units (1.5 arcmin accuracy, 1 σ)
Time resolution	< 0.1 s
Focal imager	Total area: 55 x 55 mm^2, pixel size: ~100 um

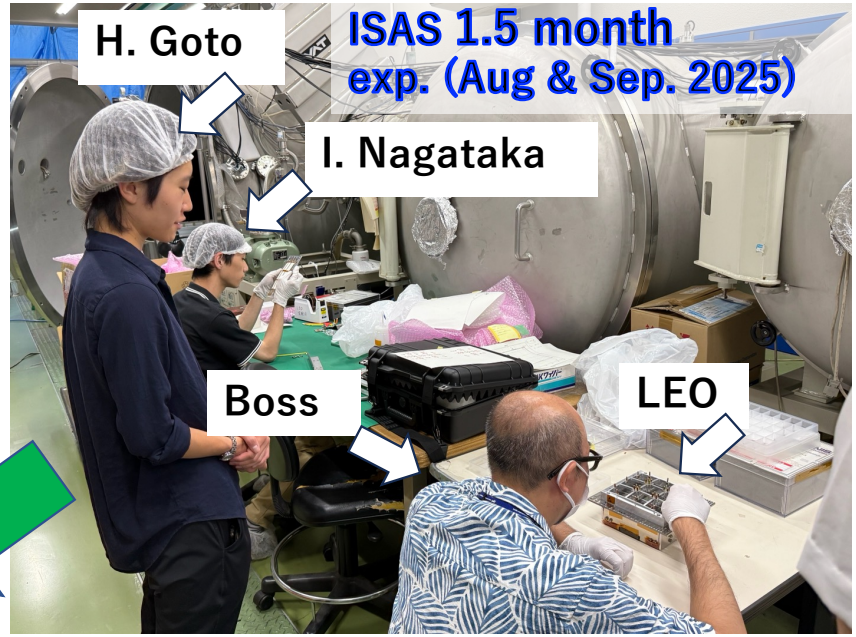
Development items



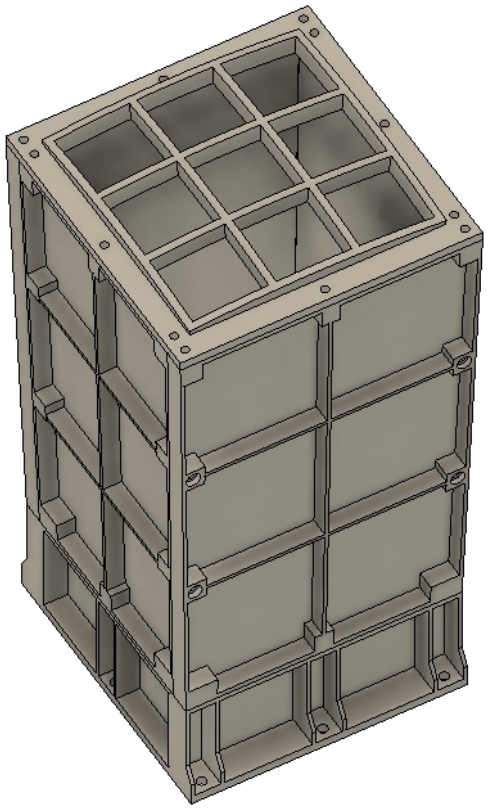
Lobster-eye optics

Localize X-ray source within 1.5 arcmin (1 σ)

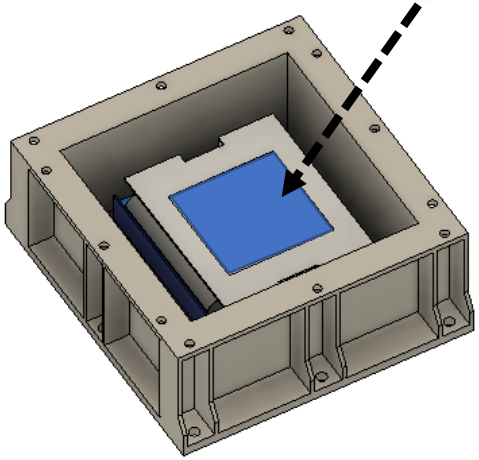
- LEO alignment
  → *I. Nagataka's poster*
- Performance evaluation
  → *H. Goto's talk (next)*

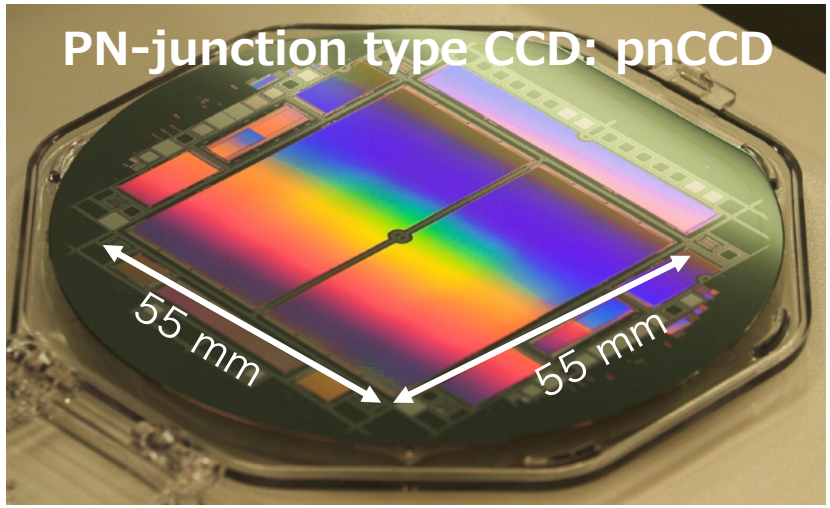


Exploration of Ancient GRBs with Lobster Eye *EAGLE*



Focal X-ray imager





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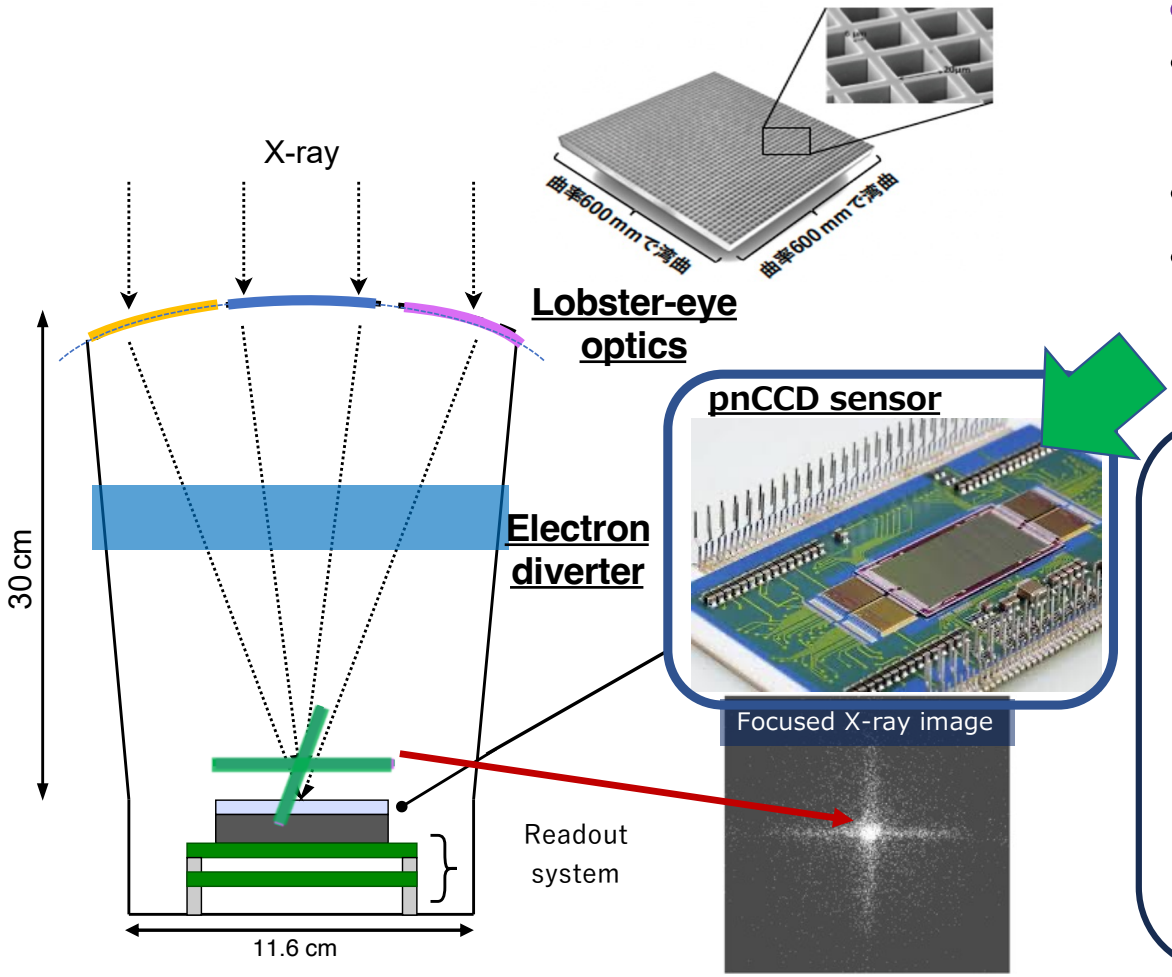
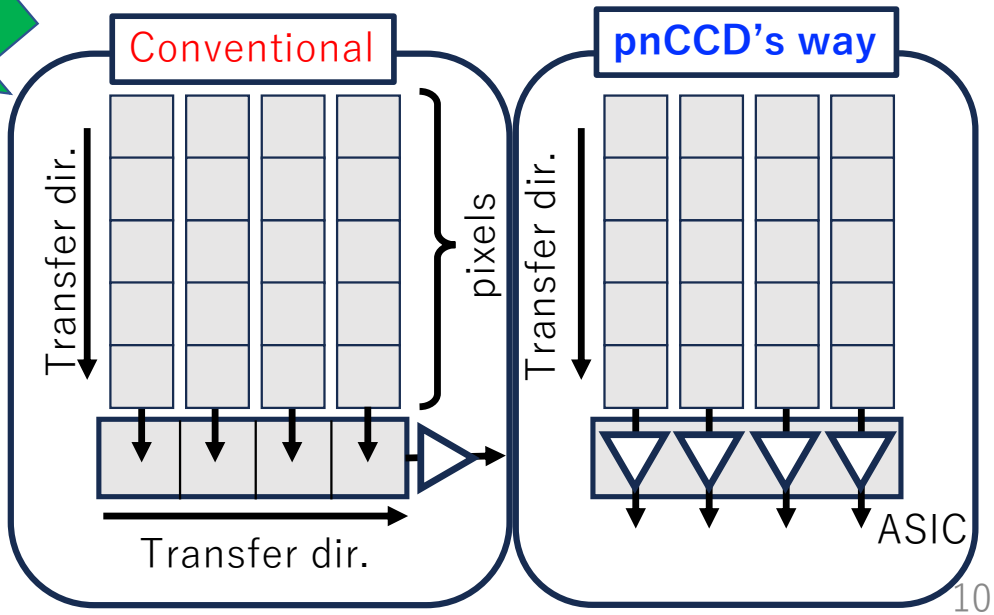


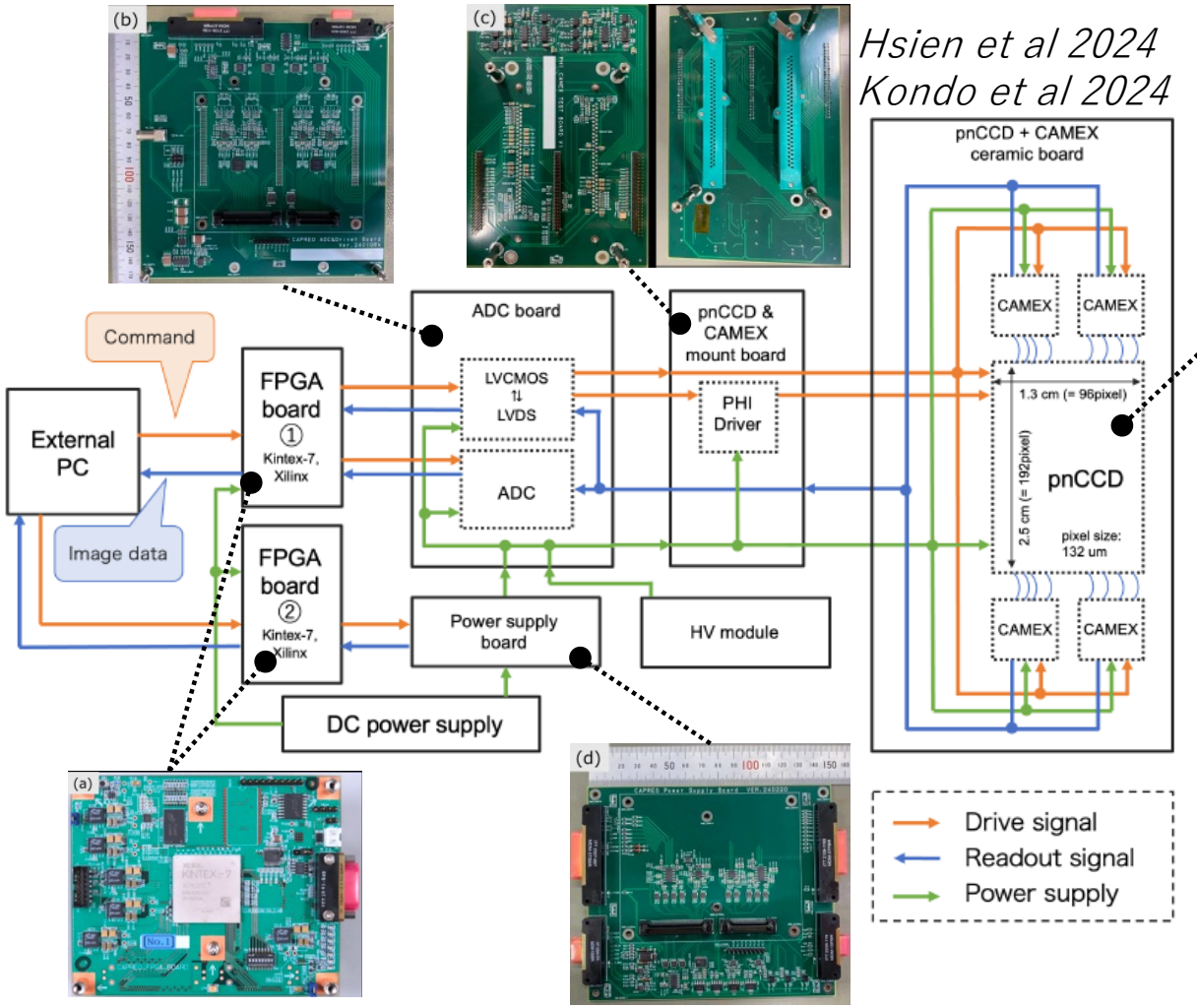
Focal X-ray pixel sensor pnCCD

Detect X-ray photons over a large area quickly

- Development of dedicated onboard electronics
- A large-area pnCCD
- Design of the radiator cooling system (-40degC or lower)

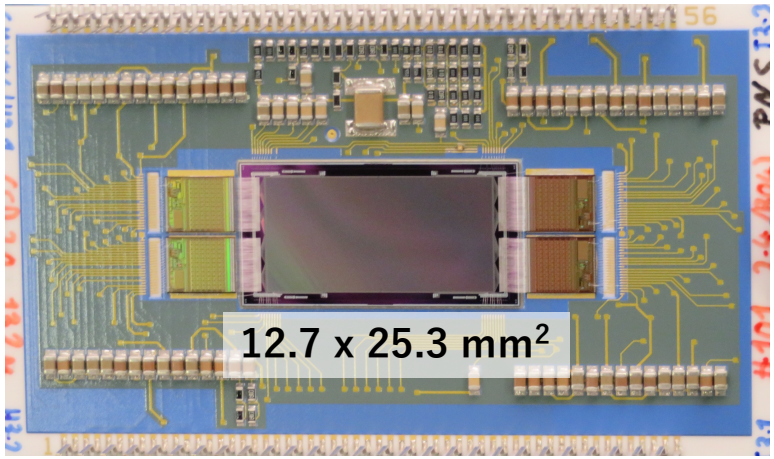


pnCCD and its *in-house* readout system



Hsien et al 2024
Kondo et al 2024

A small pnCCD for demonstration



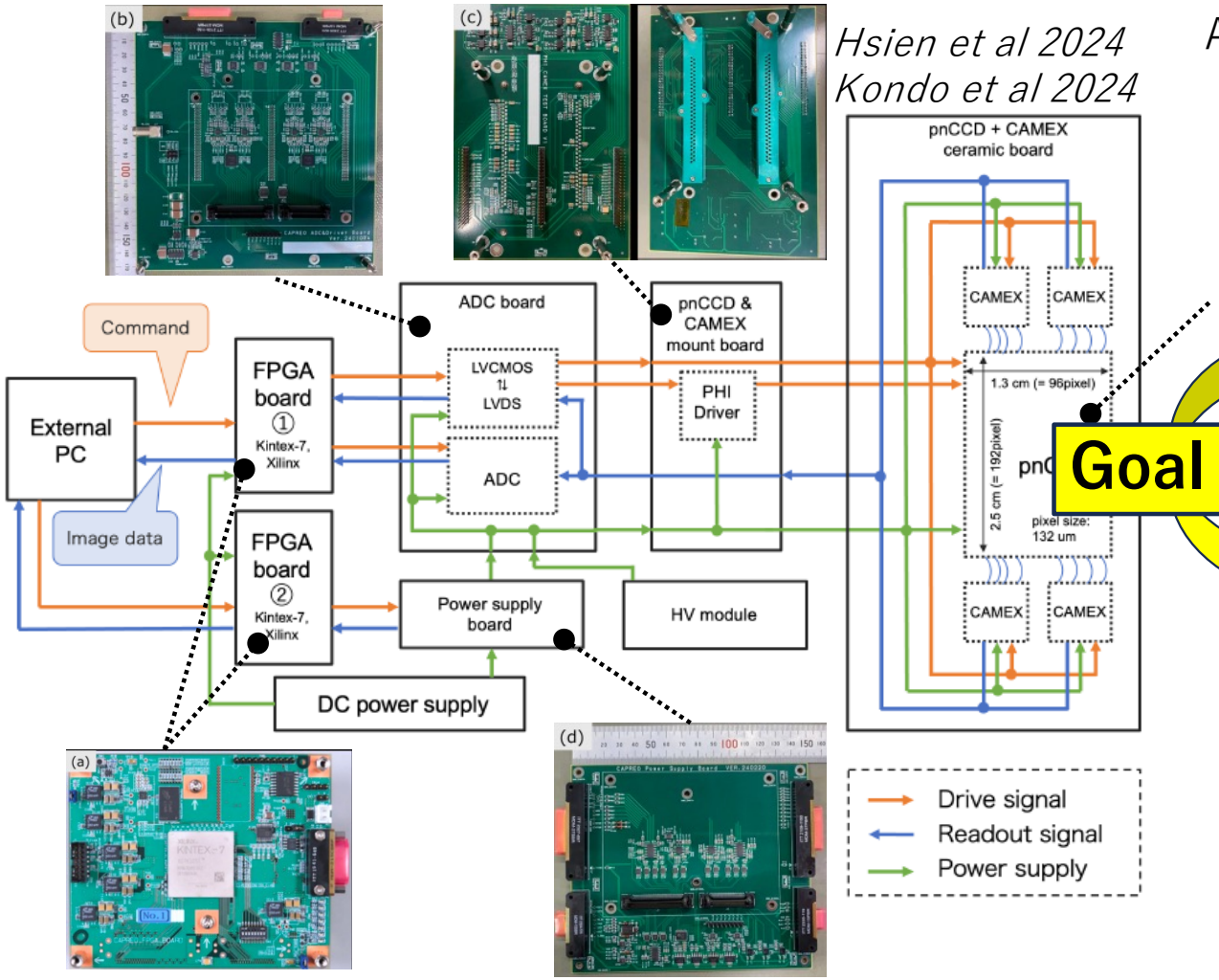
- ✓ **Thickness: 450 um**
- ✓ **Pixel size: 132 um**


K. Sei


R. Kondo


T. Kanenaga

pnCCD and its *in-house* readout system



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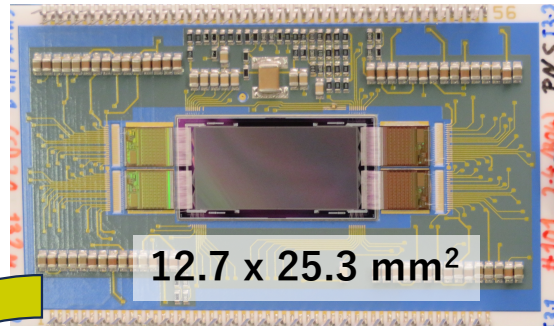
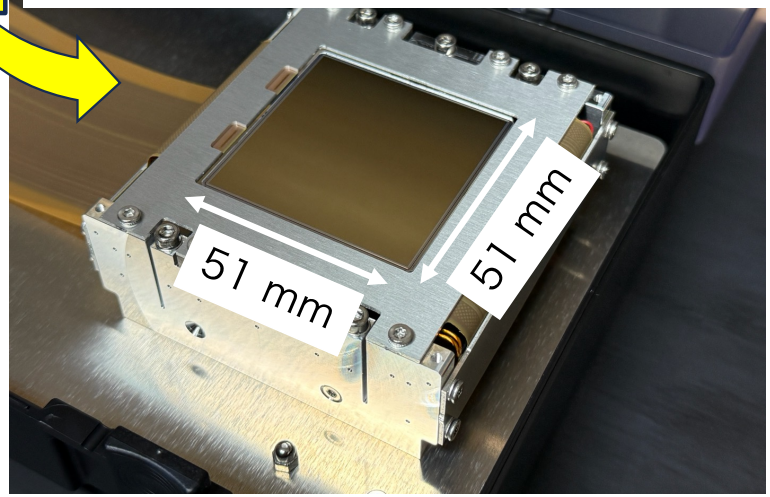
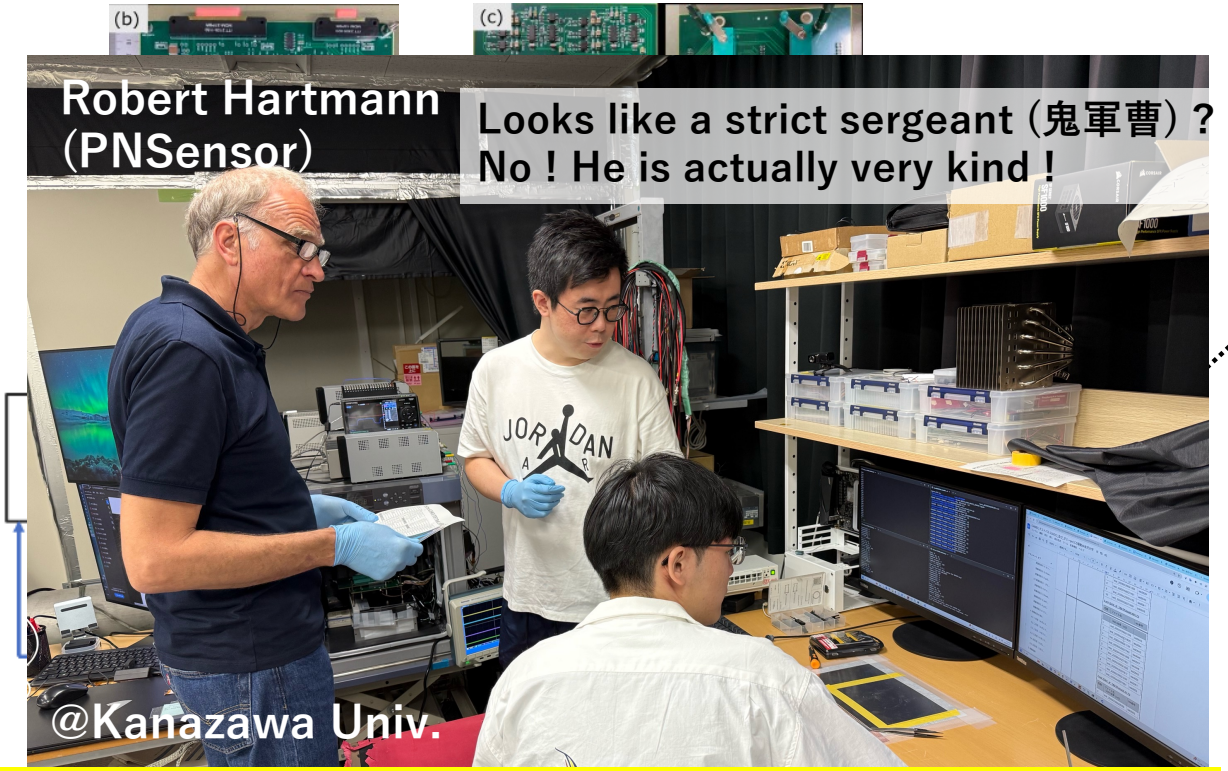


Goal

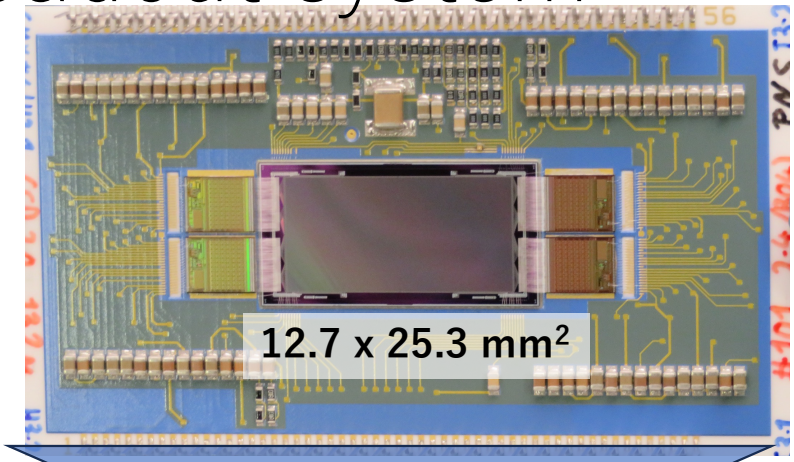
A new large pnCCD (PreEM pnCCD)

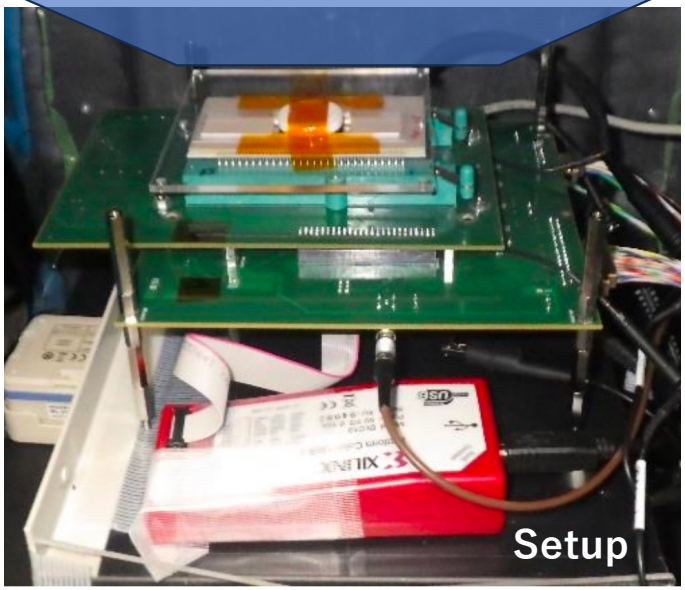


pnCCD and its *in-house* readout system



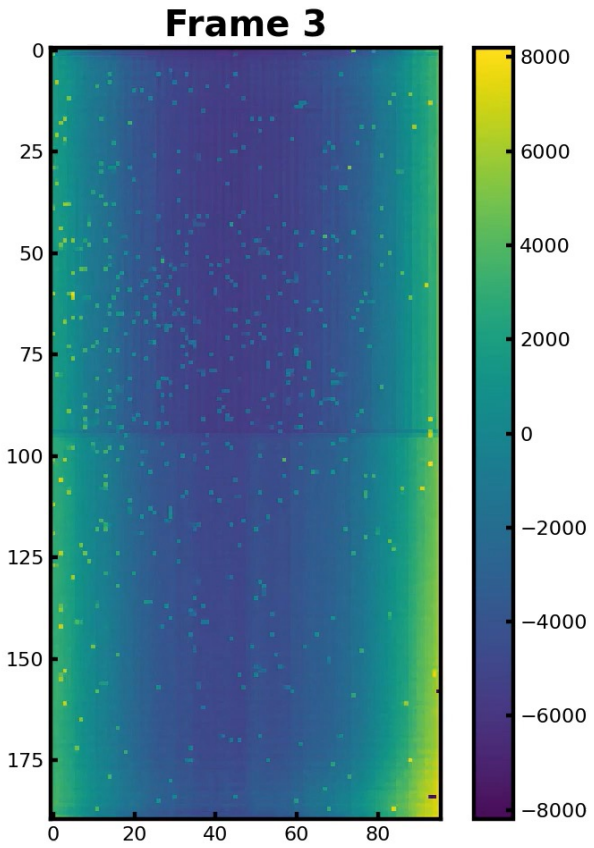
1-week bootcamp for driving pnCCD
2025 May 26 ~ May 30 @ Kanazawa U.



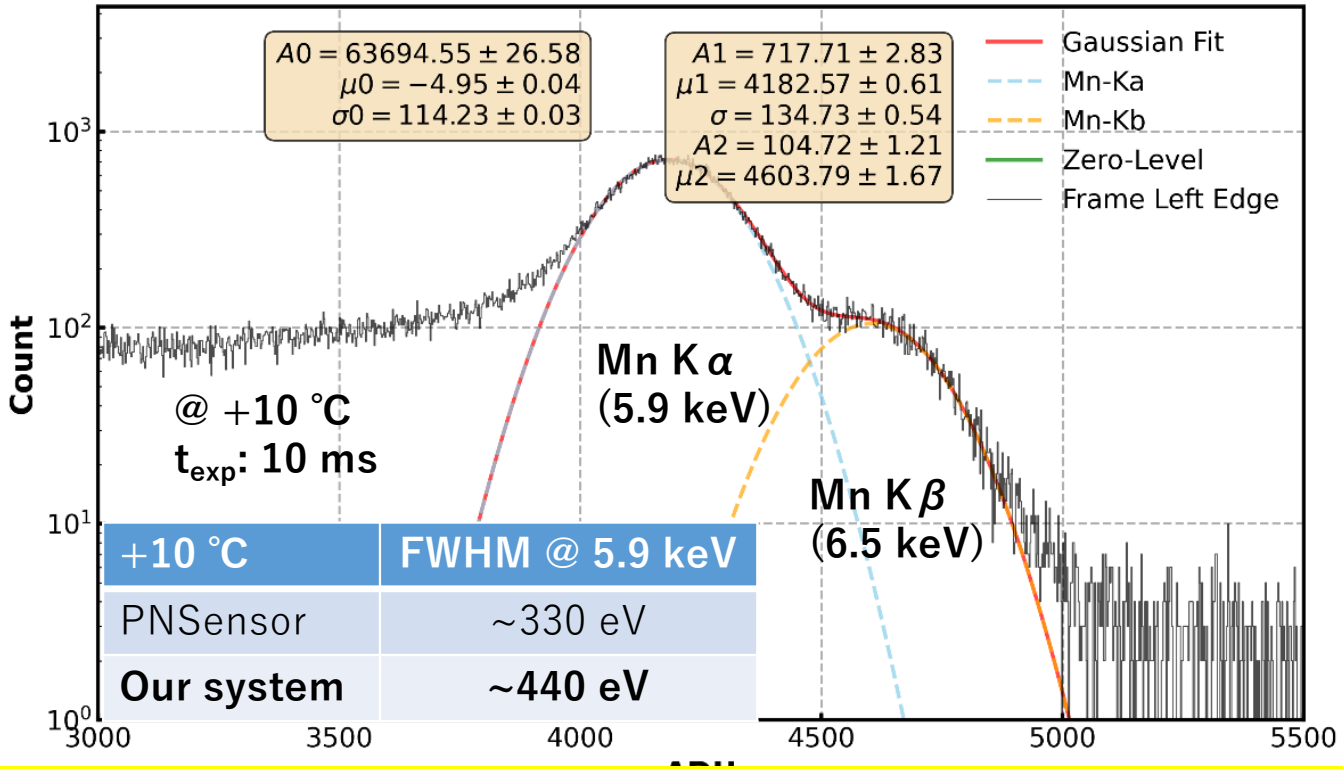


First demonstration of X-ray detection !!

Succeeded in X-ray detection from Fe-55



After dark subtraction & gain adjustment

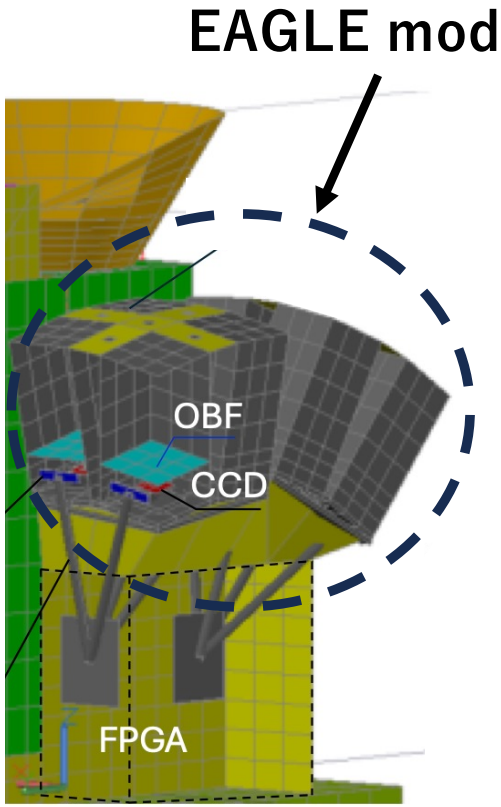


+10 ℃	FWHM @ 5.9 keV
PNSensor	~330 eV
Our system	**~440 eV**

Nice spectrum !
but slight room for improvement (e.g., noise reduction)
For more details, see T. Kanenaga poster !

Thermal design & a large pnCCD

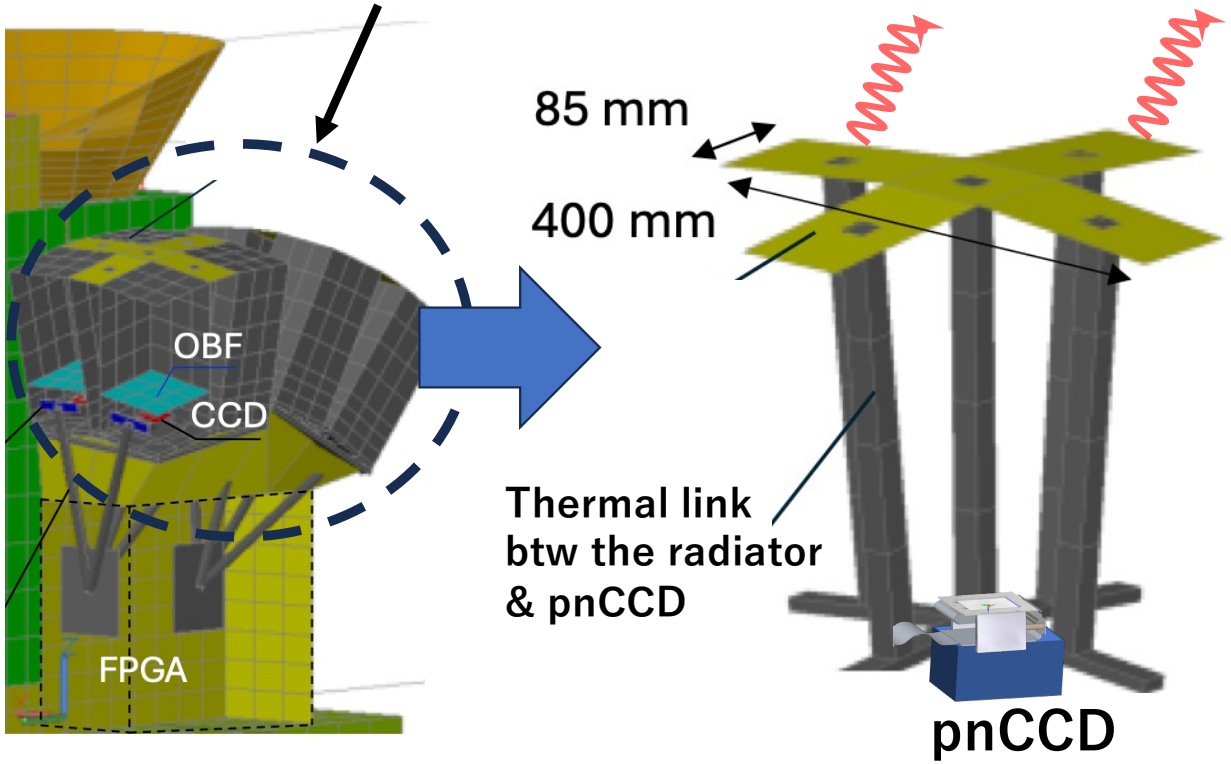
✓ **Op. temp.: -40 degC or lower to suppress the degradation**



Thermal design & a large pnCCD

✓ **Op. temp.: -40 degC or lower to suppress the degradation**

Current design:
Propeller-shaped radiator

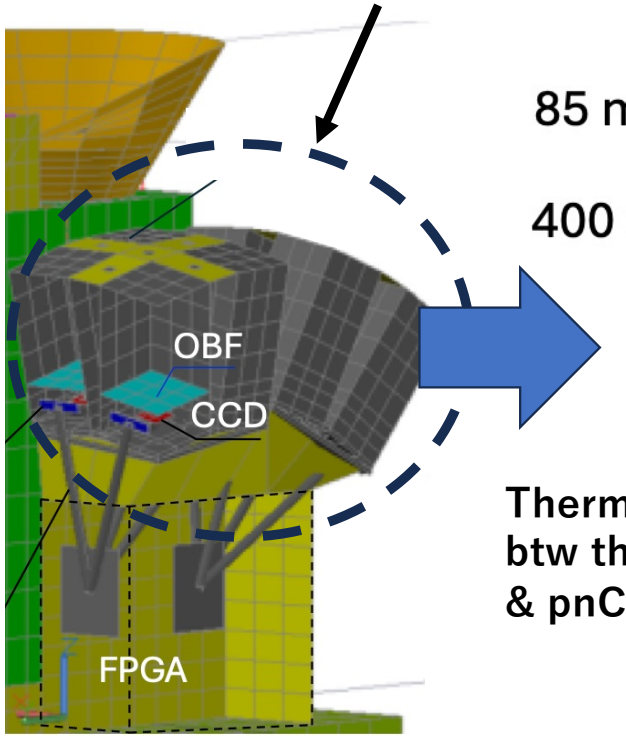


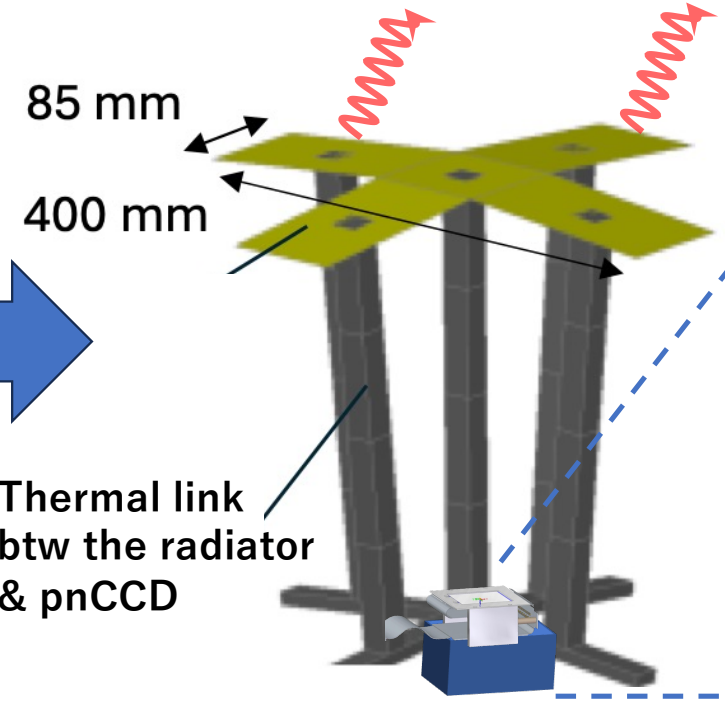
Thermal design & a large pnCCD

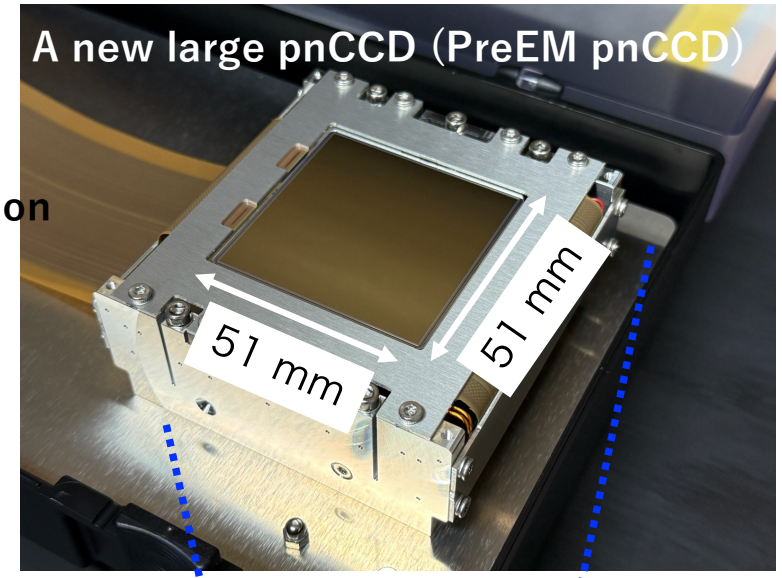
✓ **Op. temp.: -40 degC or lower to suppress the degradation**

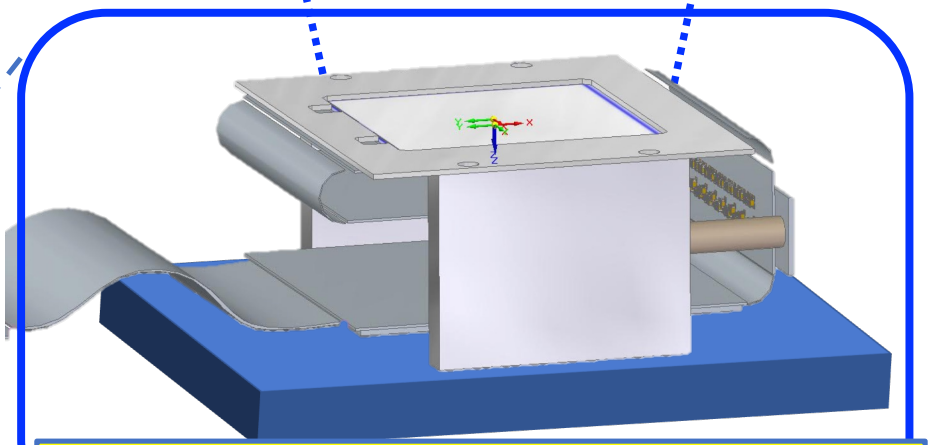
Current design: Propeller-shaped radiator

EAGLE modules









The demonstration test of the thermal design will be done.

Our EAGLE Team has become stronger !!

A small but elite team (少数精鋭？)
well… actually, we're just terribly understaffed.

New members with expertise in the XRISM and Hitomi X-ray satellites !

S. Ueda,

T. Tanaka

H. Uchida

D. Ishi

S. Kobayashi, M. Nobukawa,
K. Nobukawa, H. Murakami,
H. Nakajima, S. Sugita,
T. Yoneyama and more

Summary

- **Development of the wide-field X-ray monitor *EAGLE* is in progress**
  - **Lobster-eye optics (LEO): see the next talk and poster**
  - **Electron diverter:** quantitative analysis by the simulator
  - **Focal X-ray pixel sensor pnCCD**
    - ✓First demonstration of X-ray events with our dedicated electronics
    - ✓A large pnCCD similar to the flight model has been fabricated, and we will test it.
    - ✓Design of the radiator cooling system and the thermal demonstration test will be planned.
  - Downselection in ISAS will be planned next FY (maybe)
  - The development will continue in a steady and methodical manner.