On-orbit calibration of the gamma-ray detector KGD on the KOYOH satellite

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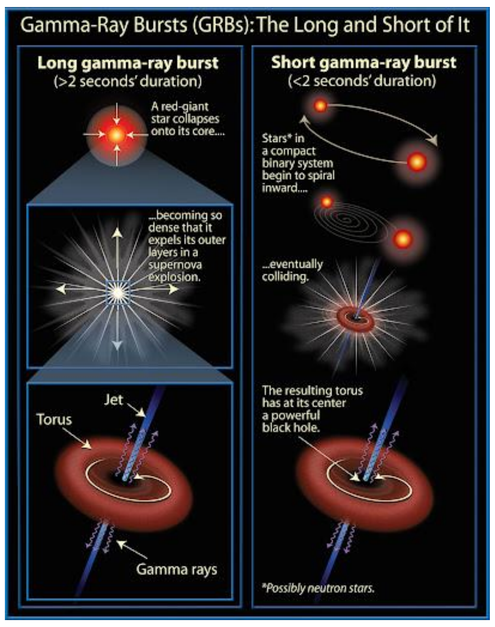
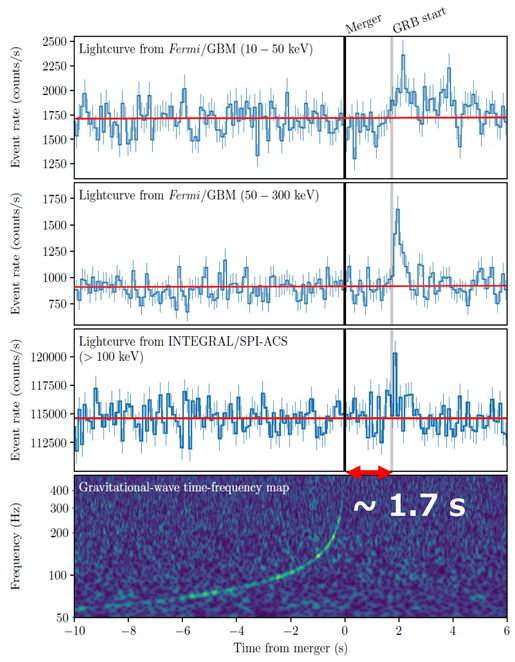
1.Gamma-Ray Burst and Gravitational Wave



From encyclopedia of science



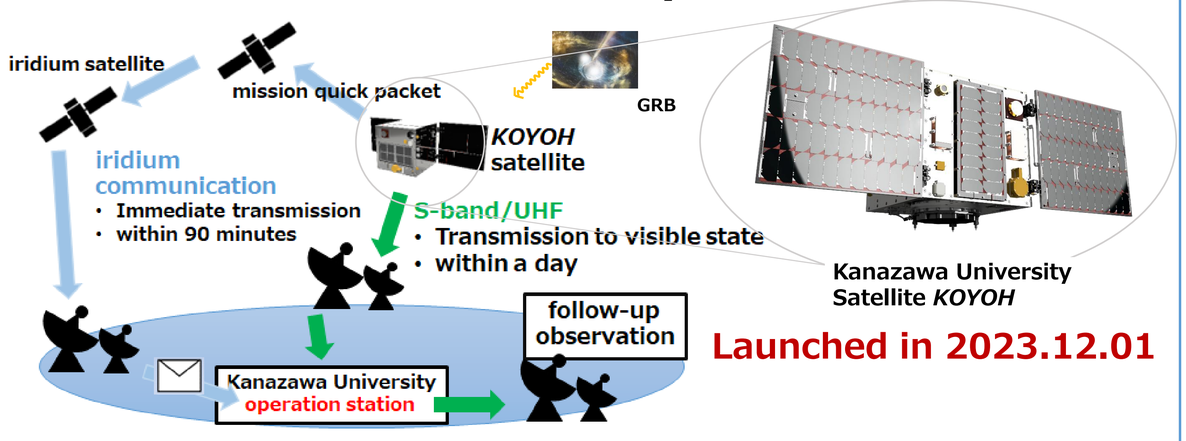
B. P. Abbot, et.al. 2017

Gamma-Ray Bursts (GRBs) are the most violent phenomena (10^{52-54} erg), emitting X-ray and Gamma-ray within ~ 10 ms to ~100 s.

These bursts are classified into two categories based on the duration, Long GRB : > 2 seconds, Short GRB : < 2 seconds.

Short GRBs are believed to originate from binary mergers of density and compact celestial objects such as neutron stars or black holes.

2.The Kanazawa University Satellite *KOYOH*



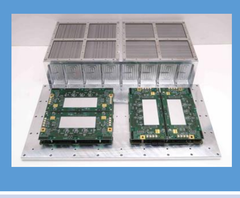
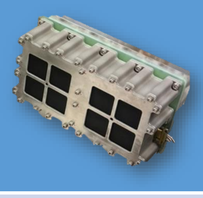
Launched in 2023.12.01

The Kanazawa University satellite *KOYOYH* is equipped with two GRB detectors, namely **T-LEX** and **KGD**.

Mission

- Automatically detecting GRB
- Localizing GRB and Alerting them to the ground immediately
- Observing the energy spectrum of GRB

3.Mission Instruments

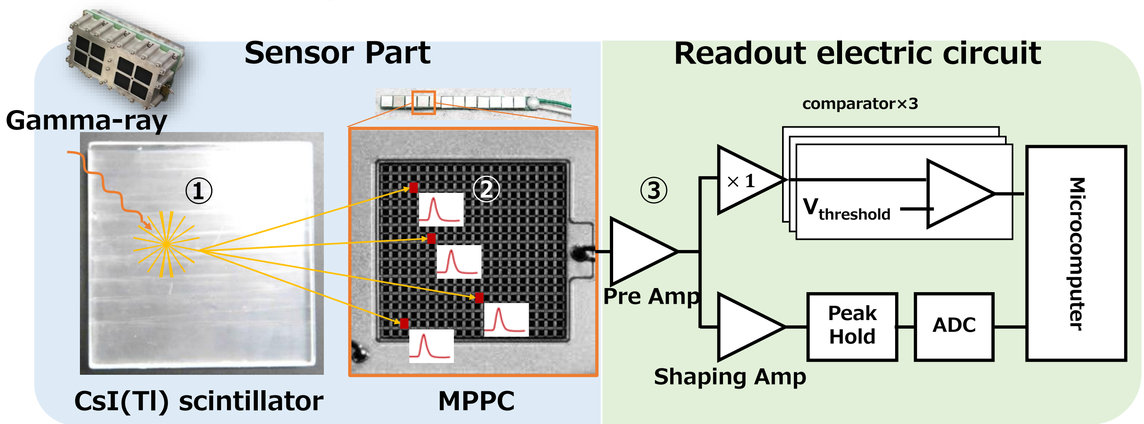
KOYOH GRB Detectors	Transient Localization EXperiment 	Kanazawa Gamma-ray Detector 
Localize Position	Localize GRB Position 15 arcmin	—
Observation Band	4 – 20 keV	20 – 300 keV
field of view	≳ 1 str	~ 3 str
Time resolution	8 ms	8 ms

Gamma-ray Detector KGD

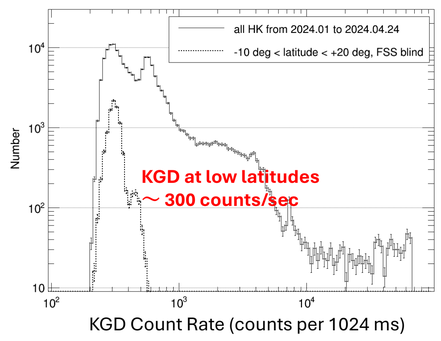
① Emit lights with intensity proportional to gamma-ray energy in scintillator

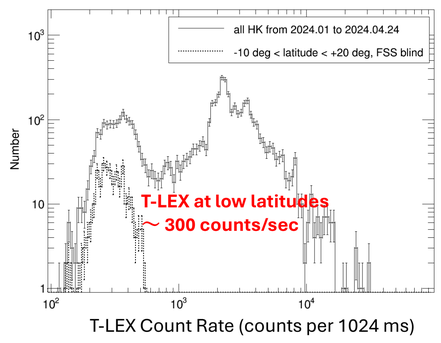
② Count the visible light photons and multiply electric charge in SiPM

③ Read out as voltage → ADC (Gamma-ray Energy), Measurement Light Curve and Spectra



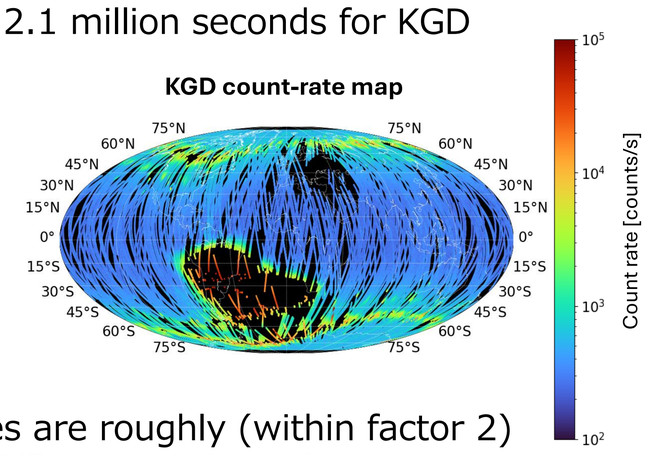
4.Background count rate





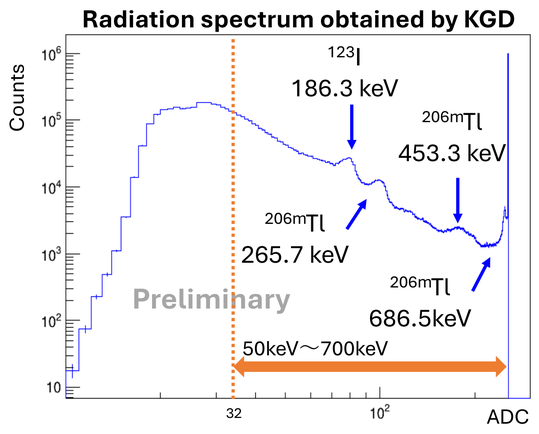
The regular observation runs started on April 25, 2024.

As of November 15, 2024, the operational times for the mission subsystems are,
54,000 seconds for T-LEX
2.1 million seconds for KGD



Found that both count rates are roughly (within factor 2) consistent with expected CXB photons in orbit.

5.Spectral Analysis of KGD



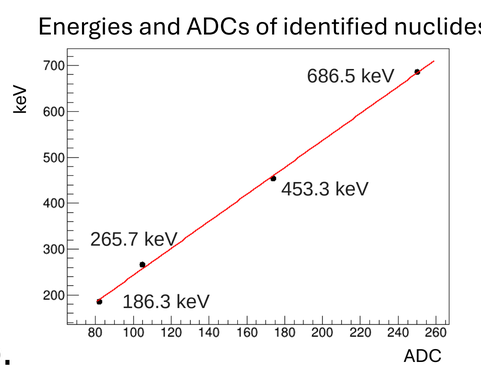
On February 10, 2024, spectrum was measured using KGD during 10 orbits on the nightside at low latitudes.

Observed nuclear gamma rays due to scintillator activation.

Found that the Lower Discrimination Threshold is less than 50 keV based on line gamma rays.

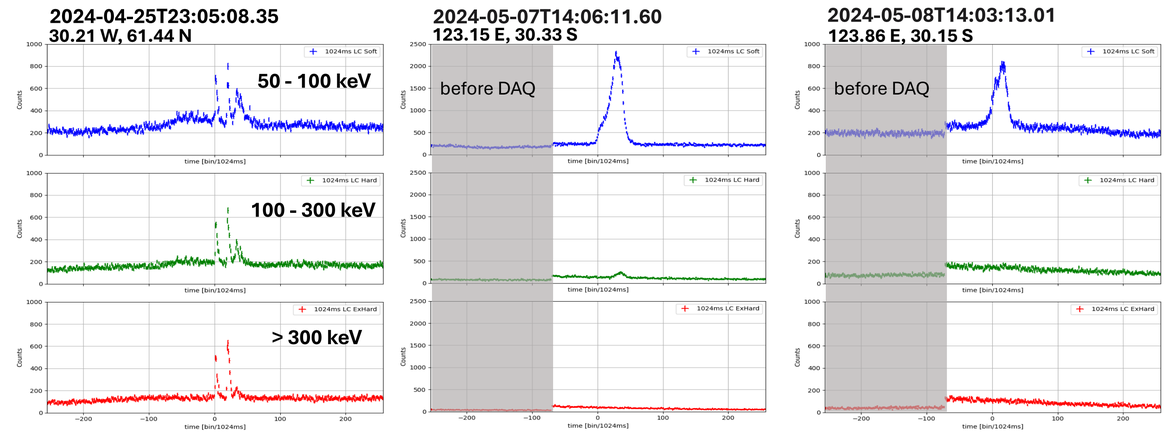
The current Energy band of KGD is tentative and needs to be determined precisely.

The energy band can be determined by analyzing the spectrum and using the calibration curve.



- ☐ Can determine the hardness ratio.
- ☐ Can test whether the event is likely from celestial origin or not.

6.Examples of triggered events by KGD



- Since the start of observations with KGD, a total of 273 bursts have been detected (including experimental observations at high latitudes).
- Two left-side triggers on the upper figure detected at low latitudes.
- The first one was trigger at high latitudes and not GRB-like (but a particle event).

7.Conclusion・Future work

- ☐ Developed the Kanazawa University satellite *KOYOH* equipped with two detectors for GRB observation.
- ☐ Experimental observation runs with the instruments were conducted from January to April 2024, followed by the commencement of regular observations on April 25, 2024.
- ☐ Currently undergoing detailed spectrum analysis using Geant4
- ☐ Determine the energy band and the hardness ratio to find out if the source is from a celestial object or not.