Systematic analysis on trigger event data of the gamma-ray detector KGD on the KOYOH satellite

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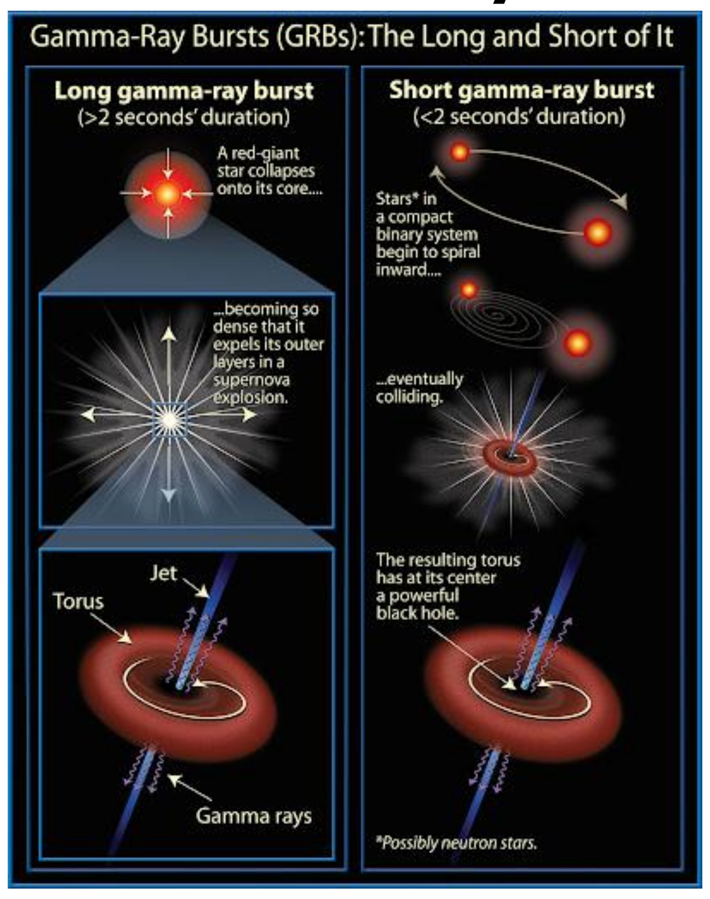
1.Gamma-Ray Burst and Gravitational Wave



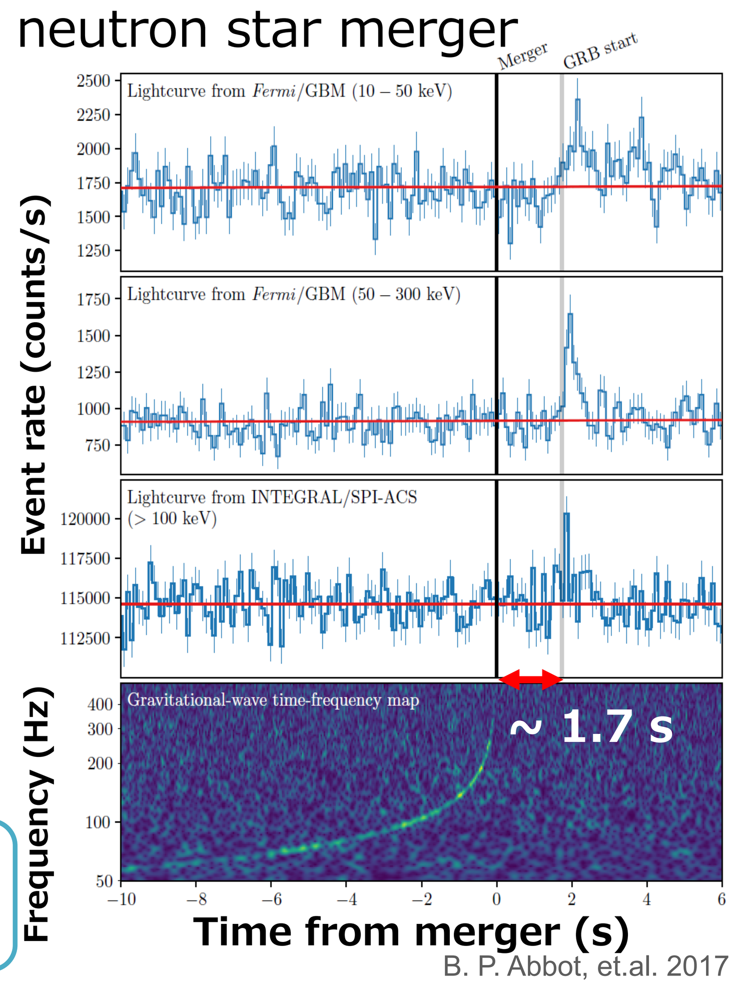
From encyclopedia of science

➢ Gamma-Ray Burst (GRB)

- the most violent phenomena ($10^{52\text{-}54}$ 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 →Binary neutron star merger

➢ Gravitational wave

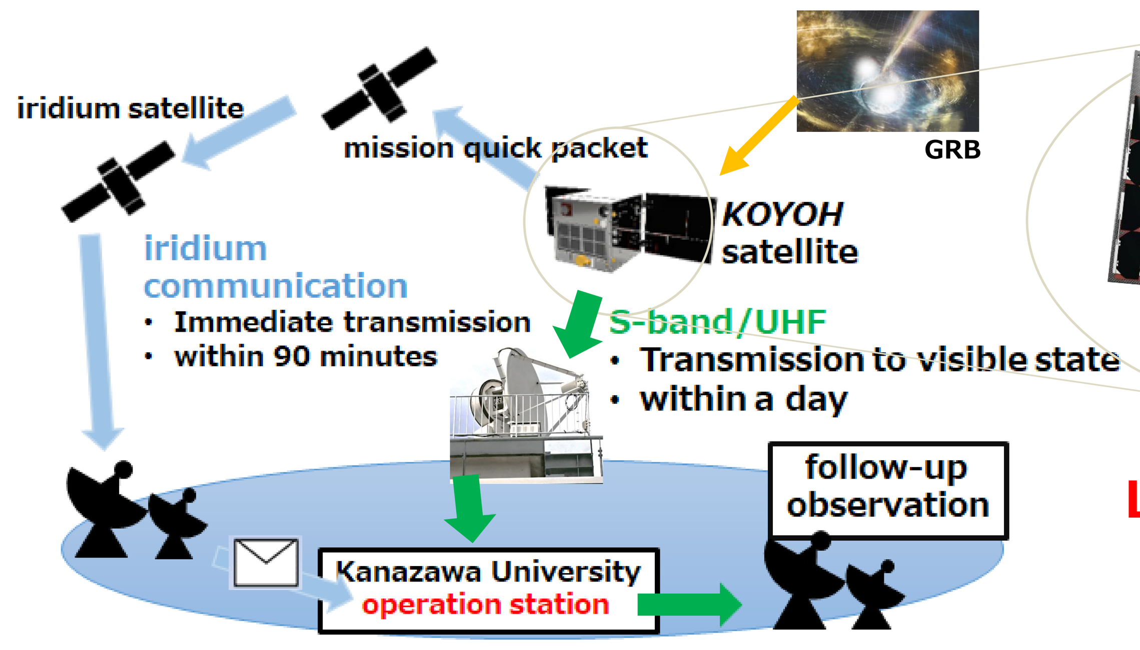
- As neutron star binaries merge, distortions in spacetime propagate as waves
- On August 17, 2017, Gravitational waves (**GW 170817**) were detected →Observation of **GRB 170817A** from the same direction



B. P. Abbot, et.al. 2017

Only one case of simultaneous observation
→ **More observations are needed**

2.The Kanazawa University Satellite *KOYOH*




Kanazawa University Satellite *KOYOH*

Launched on 2023.12.01 (UTC)

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

➢ Mission

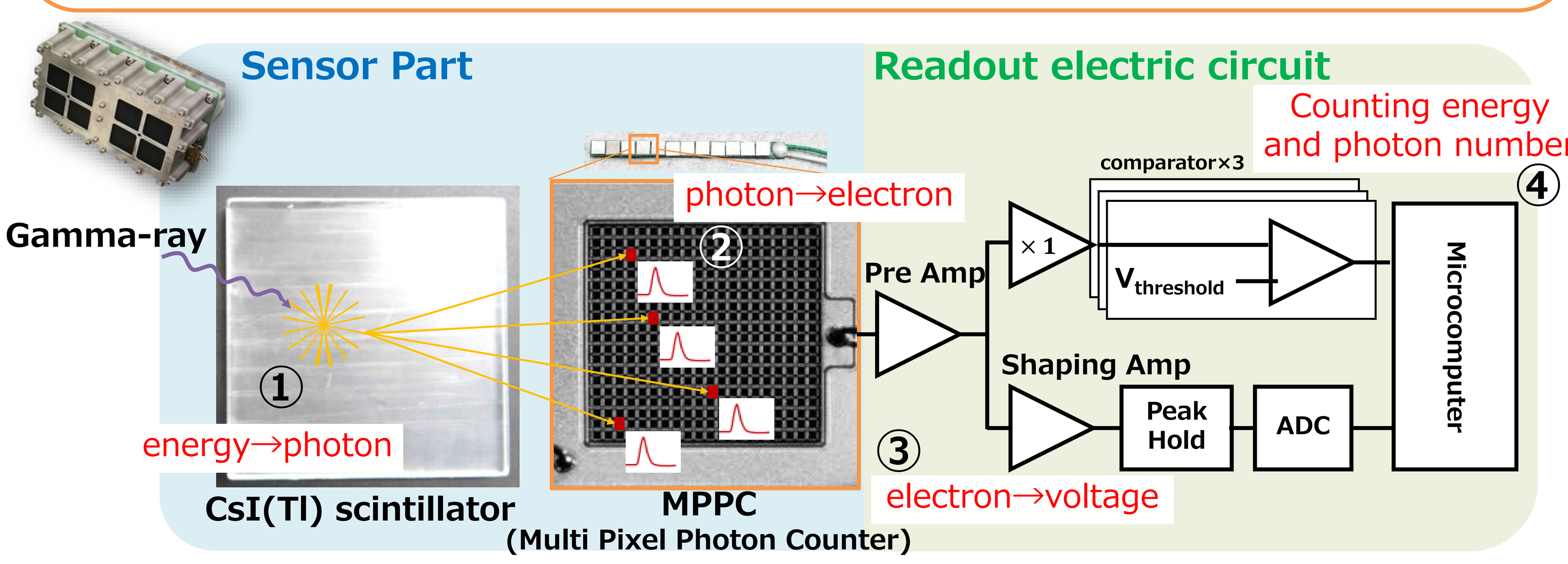
- Automatically detecting GRB
- Localizing GRB and Alerting them to the ground immediately
- Observing the energy spectrum of GRB

3.Mission Instruments

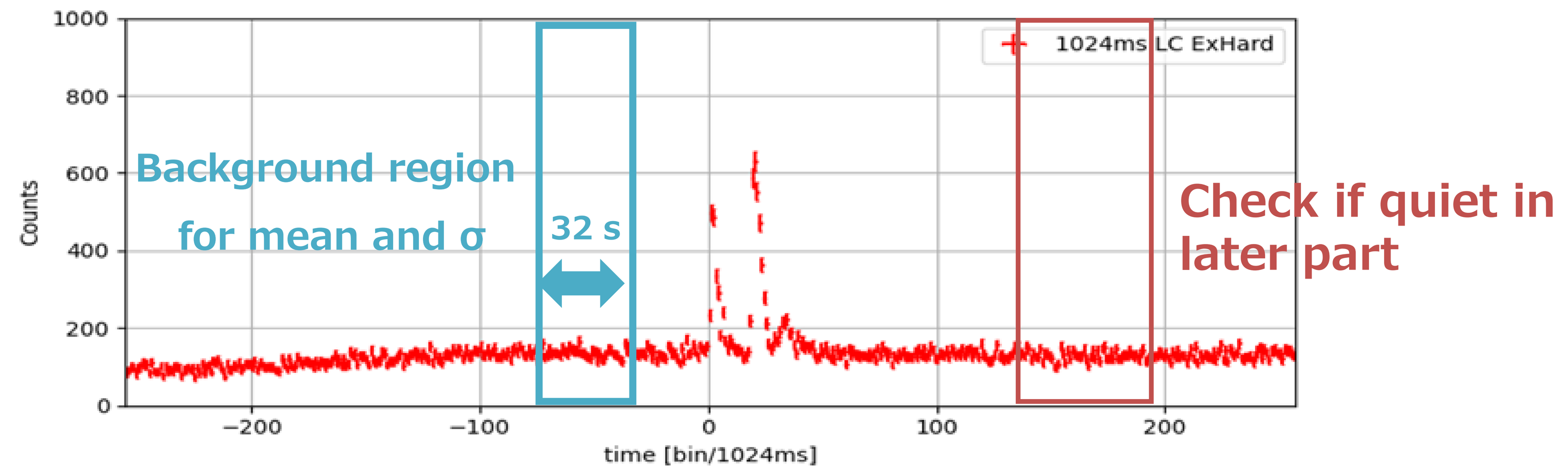
KOYOH GRB Detectors	**T**ransient **L**ocalization **E**xperiment (**T-LEX**) 	**K**anazawa **G**amma-ray **D**etector (**KGD**) 
Localize Position	Localize GRB Position 15 arcmin	–
Observation Band	4 – 20 keV	20 – 600 keV
field of view	≳ 1 str	~ 3 str
Time resolution	8 ms	8 ms

➢ Gamma-ray Detection Principle of KGD

①Emit lights with intensity proportional to gamma-ray energy in scintillator
②Count the visible light photons and multiply electric charge in SiPM
③Read out as voltage → ADC (Gamma-ray Energy)
④Measurement Light curve (Low/Mid/High) and spectra



4.Event selection

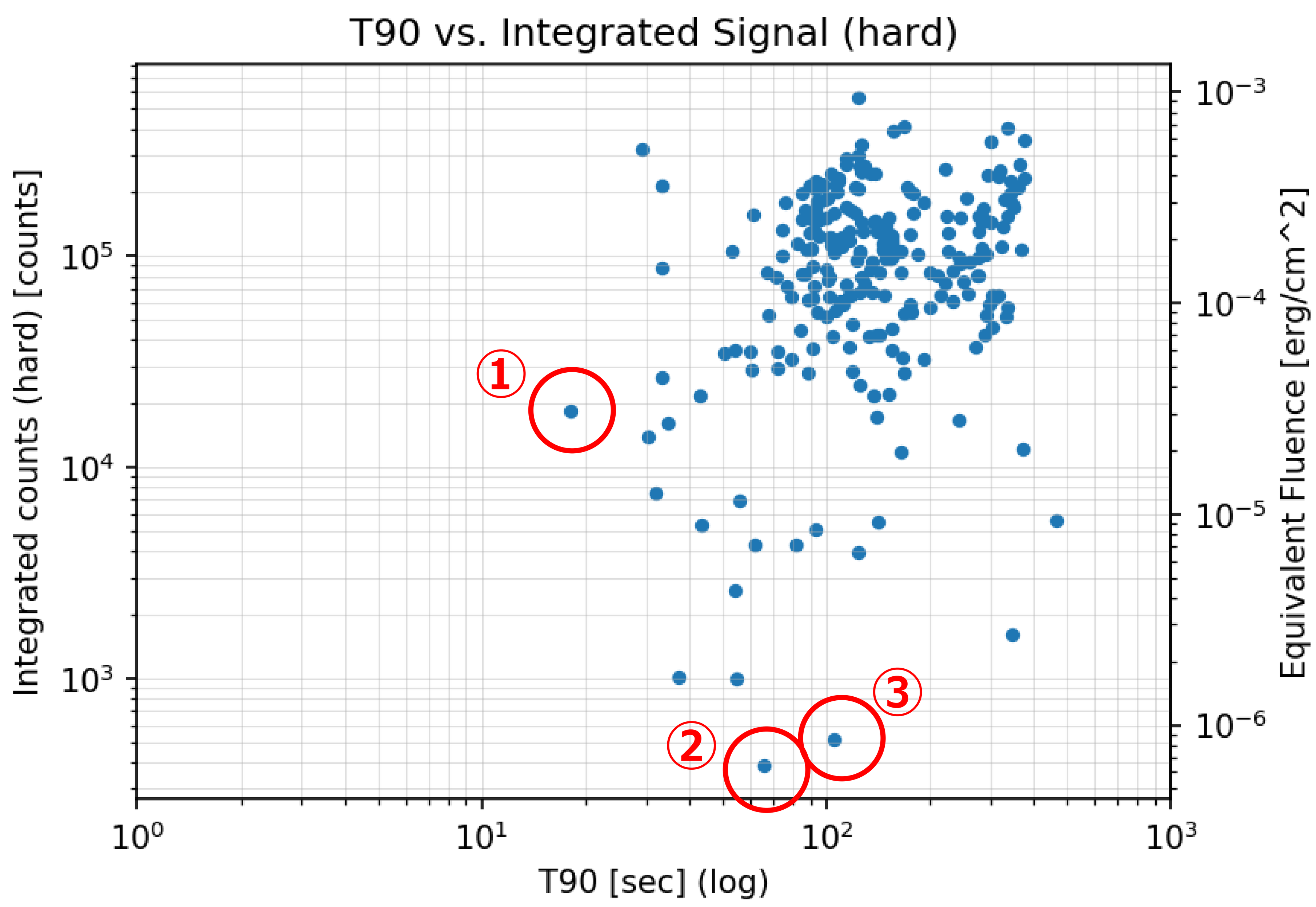


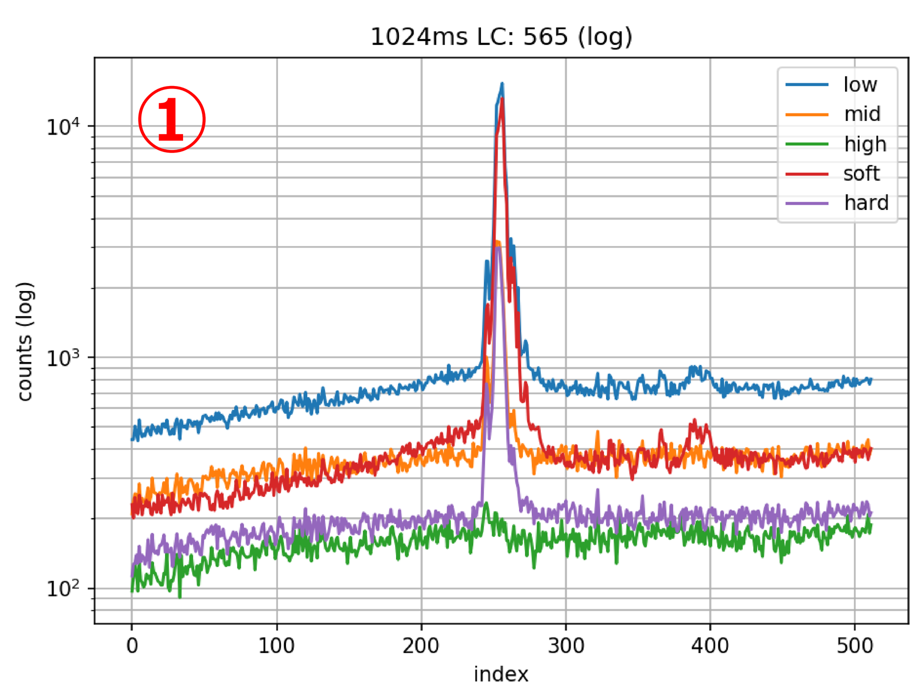
- Background: 32 s before trigger, with s < 1.8 √m (Poisson-like)
- Late 1024 ms background < 20 % of pre-trigger mean
- **729 bursts downlinked (by Jan 30 2025); 253 passed criteria**
- T_{90} and integrated counts (between low/mid and high thresholds) computed

→Distribution examined for auroral region events

5.Result

- T_{90} of auroral-region bursts is distributed **between 100–300 s**
- **Assuming 600 counts ≈ 10^{-6} erg cm^{-2}** (mid–high threshold range), auroral-region events correspond to **~10^{-4} erg cm^{-2} in fluence**

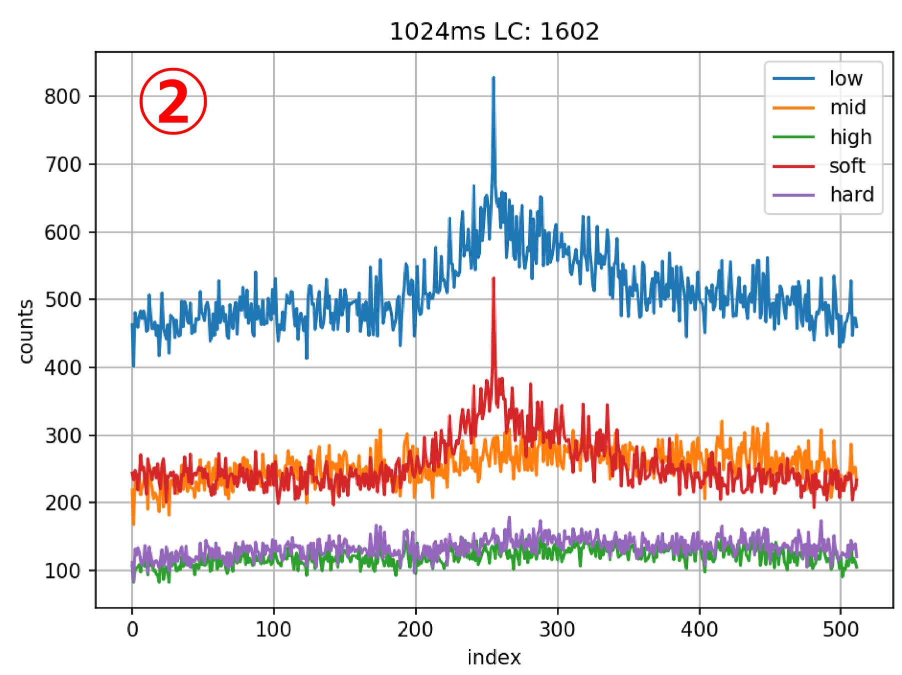


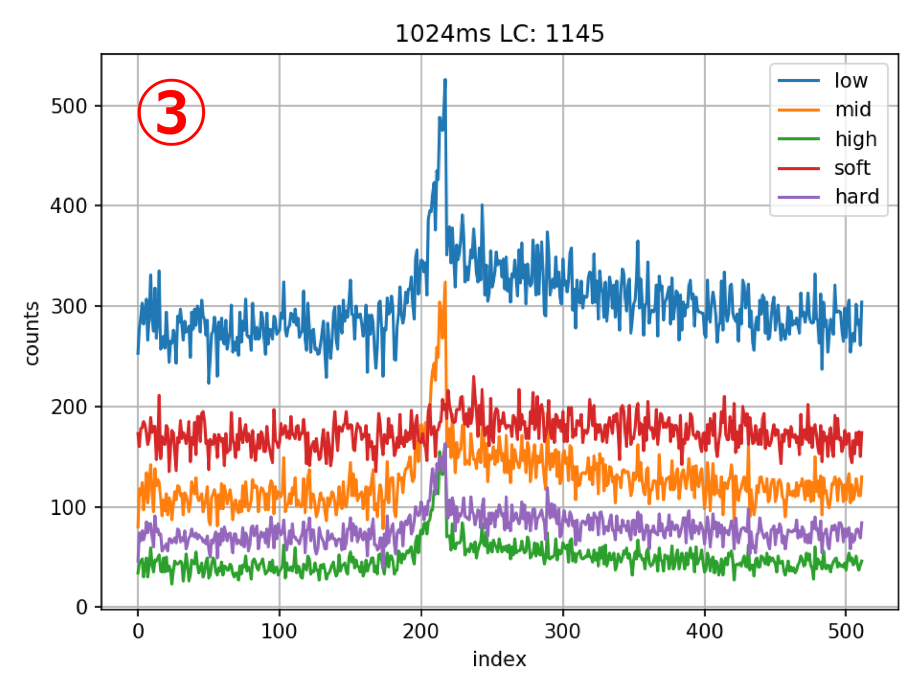


➢ Details of Outliers

Three outlier events were identified:
- ① **T_{90} < 20 s**
- ②–③ **Fluence < 10^{-6} erg cm^{-2}**

All occurred while the satellite was passing through the auroral region





6. Summary and Future Work

✓ 700+ bursts downlinked; auroral events show T_{90} = 100–300 s, fluence ≈10^{-6} erg cm^{-2}

☐ Need to separate them from GRBs; next, study hardness ratio in auroral region

The third annual conference, November 18-20, 2025, Naruko Kanko Hotel, Miyagi, Japan