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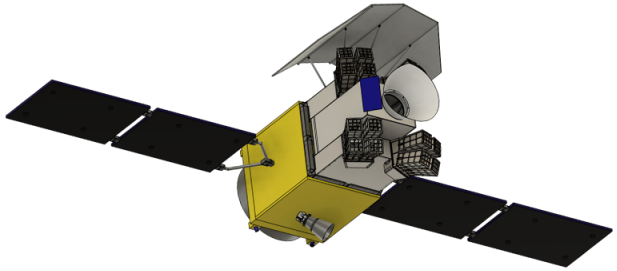
“Multimessenger Astrophysics” @Hotel Matsunoi Minakami
19 Nov 2024, 17:15

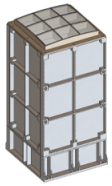
Present Status of On-board Software for HiZ-GUNDAM

Takumi Togashi[a], Shuichi Gunji[a], Keito Watanabe[a], Haruaki Niinuma[a], Daisuke Yonetoku[b], Hiroshi Akitaya[c], Akihiro Doi[d], Yusuke Kono[e], Hideo Matsuhara[d], Tatehiro Mihara[f], Takanori Sakamoto[g], Tatsuya Sawano[b], Mutsumi Sugizaki[b], Seiya Suzuki[g], Hiroshi Tomida[d], and HiZ-GUNDAM team

[a]Yamagata University, [b]Kanazawa University, [c]Chiba Institute of Technology, [d]ISAS/JAXA, [e]NAOJ, [f]RIKEN, [g]Aoyama Gakuin University

The role of the MPU in high-z GRB observations





WFXM

Accuracy ~3 arcmin

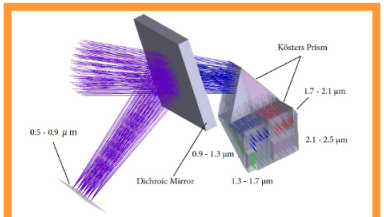
On-board Software

Analyze data from the detectors

Launch commands to mission instruments

MPU

Mission data Processing Unit



NIRT

Accuracy ~3 arcsec

Attitude System

Alert System

Ground Station

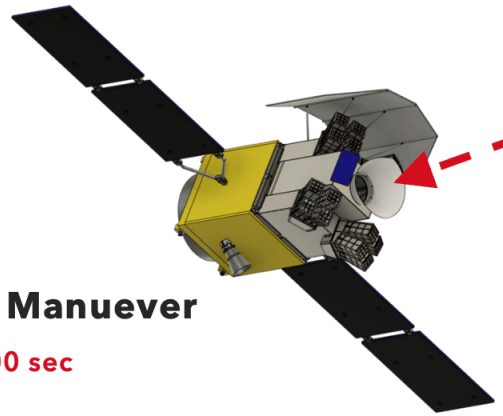
The role of the MPU in high-z GRB observations

Discovered by **WFXM**

t = 0 sec

Transient Source

t: Time since source discovery

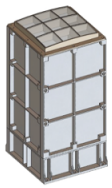


Observed by **NIRT**

10 min (2 min exposure × 5 times)

Automatic Manuever

t < 300 sec



WFXM

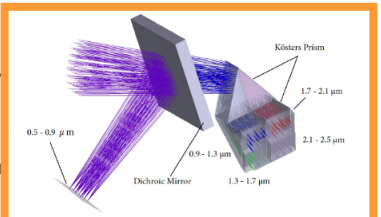
Accuracy ~3 arcmin

Determine the source **Position** ~3 arcmin

Determine the source **Position** ~3 arcsec + **Distance**

MPU

Mission data Processing Unit



NIRT

Accuracy ~3 arcsec

Attitude Change Request

X-ray Alert

t < 1 min

Near Infrared Alert

t < 30 min

t < 1 hour

Attitude System

Alert System

Ground Station

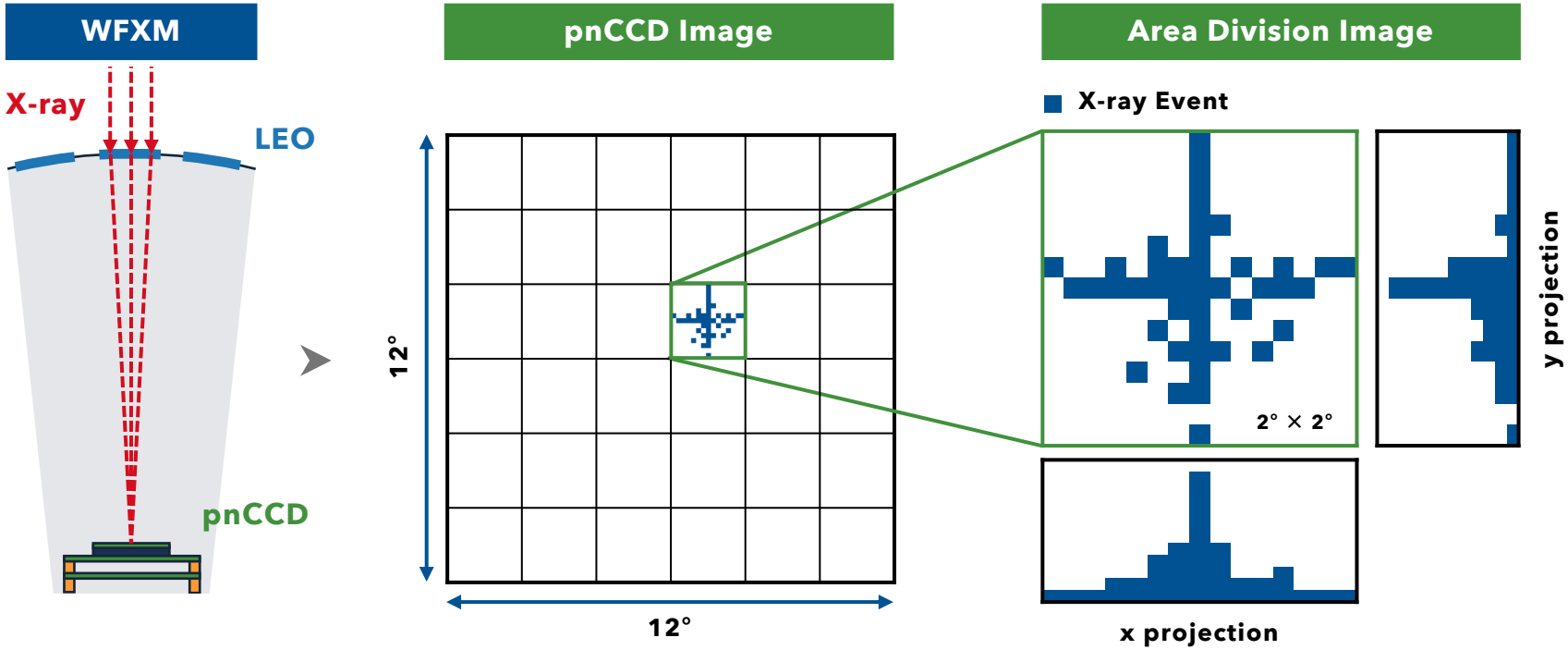
1 | X-ray Data Analysis

Triggered from the WFXM

When X-rays enter the WFXM, a cross-shaped image is produced on the pnCCD.

The pixel data is divided into several regions.

In each region, two projected histograms are generated.

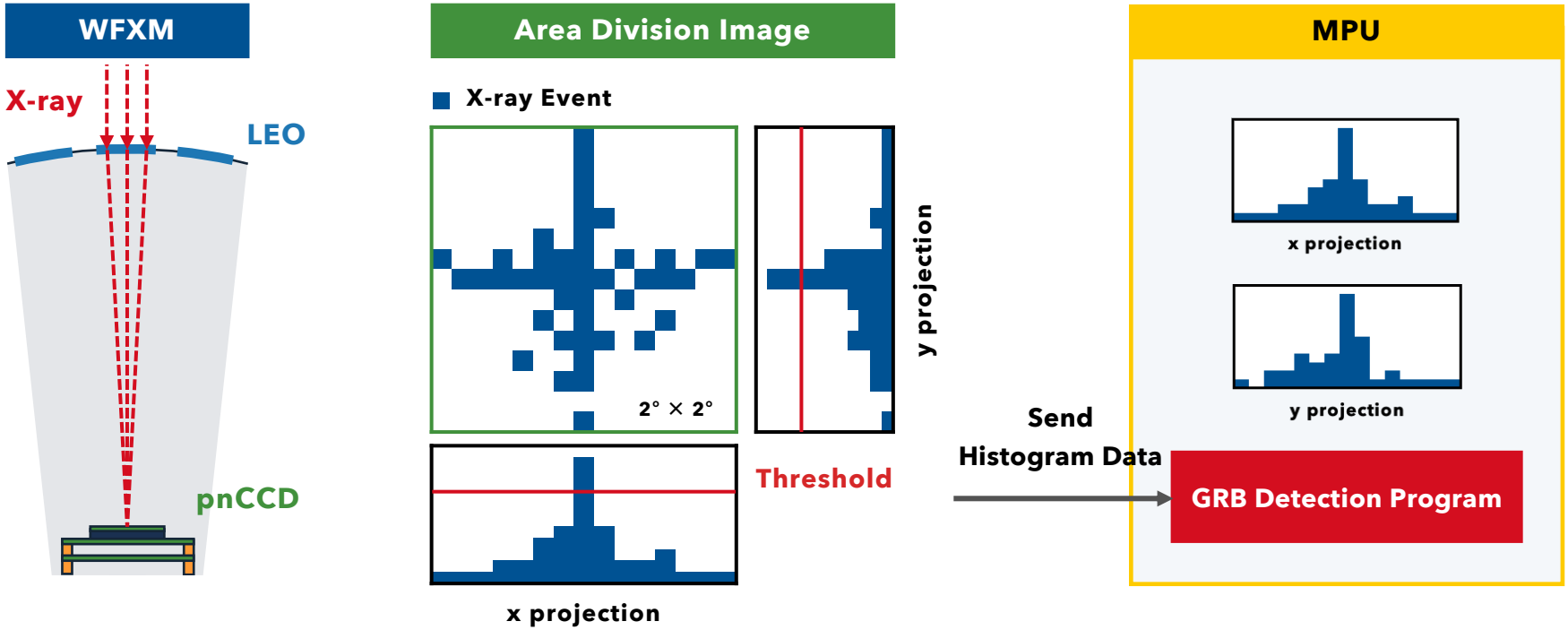


1 | X-ray Data Analysis

Triggered from the WFXM

After generating 1-D histograms, the WFXM performs a threshold determination.

If the below trigger condition is satisfied, the histogram data are sent from the WFXM to the MPU.

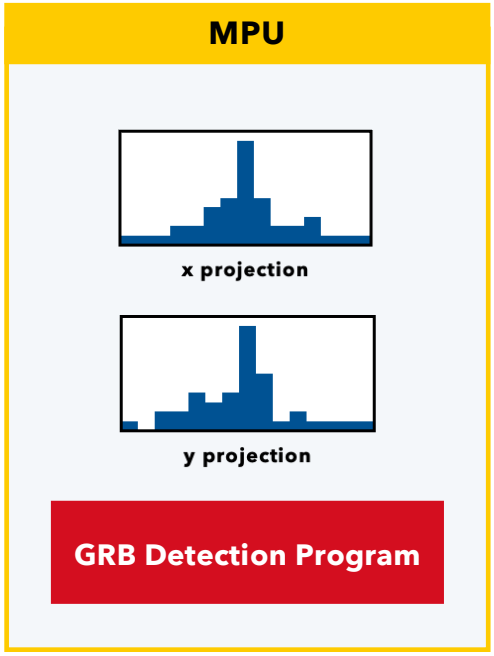


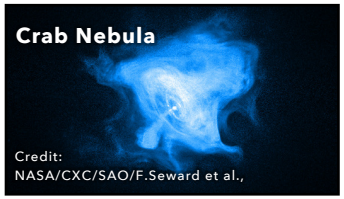
1 | X-ray Data Analysis

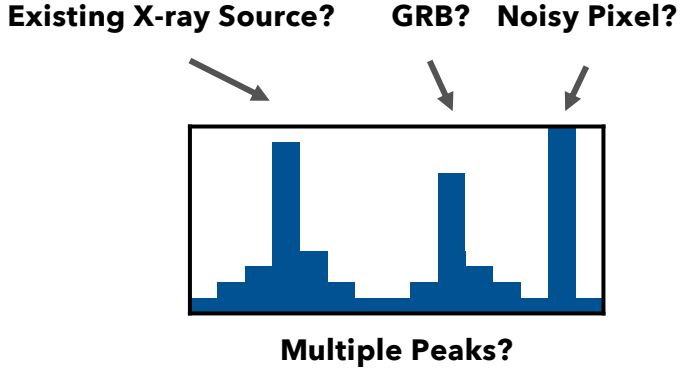
Triggered from the WFXM

The data sent from the WFXM might not be due to a GRB.

Moreover, both GRBs and sources such as the Crab Nebula can be contained in the data.







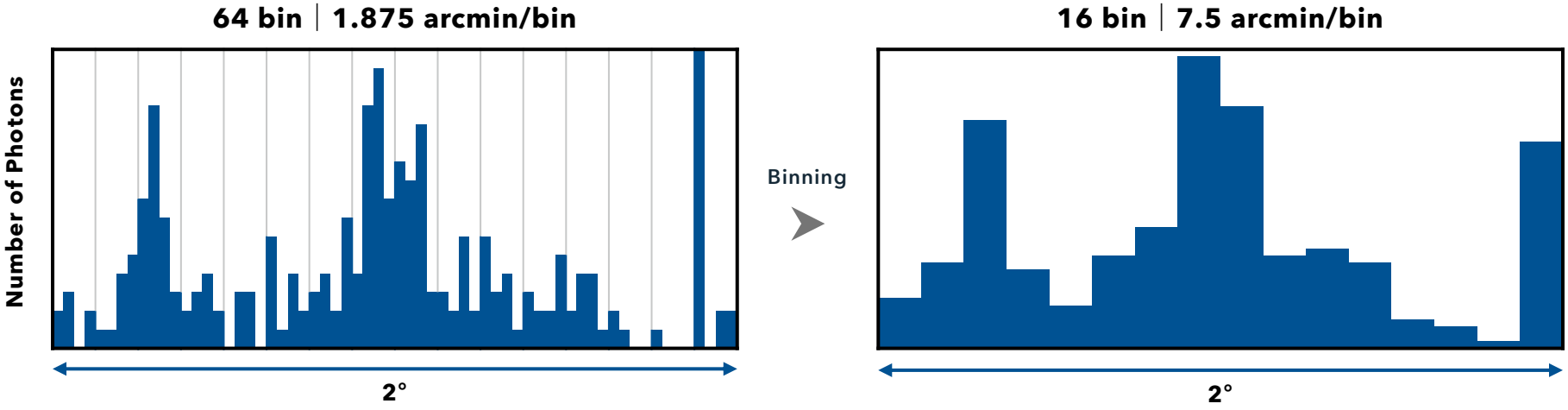
So, the more analysis in the MPU is necessary to determine the GRB location.

1 | X-ray Data Analysis

① Determination of the Centroid for Histograms

According to the following steps, the two projected histograms are analyzed to determine the location of the GRB.

Step 1 | Binning



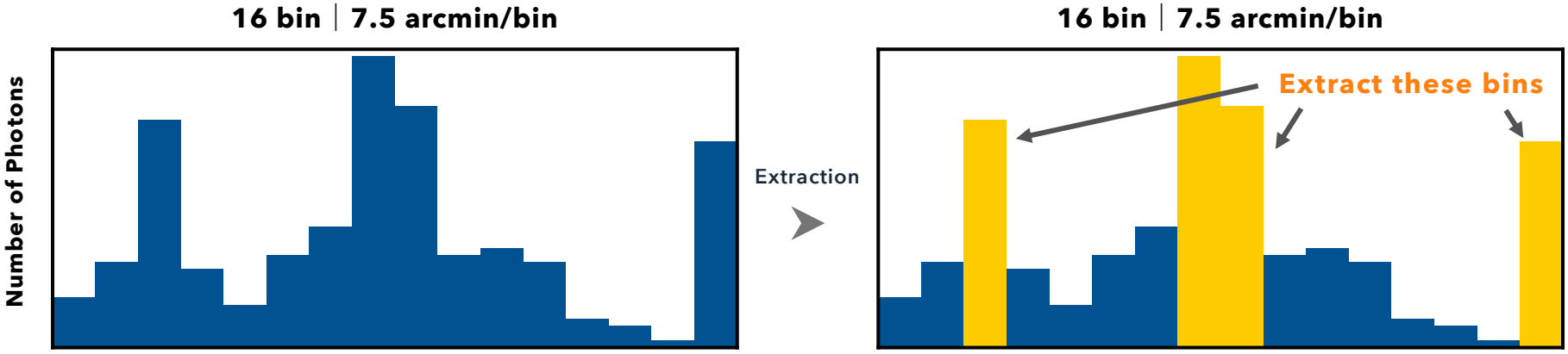
The width of the bin assumes the width of a cross arm (1σ ~8 arcmin).

1 | X-ray Data Analysis

① Determination of the Centroid for Histograms

According to the following steps, the two projected histograms are analyzed to determine the location of the GRB.

Step 2 | Finding Coarse Peaks



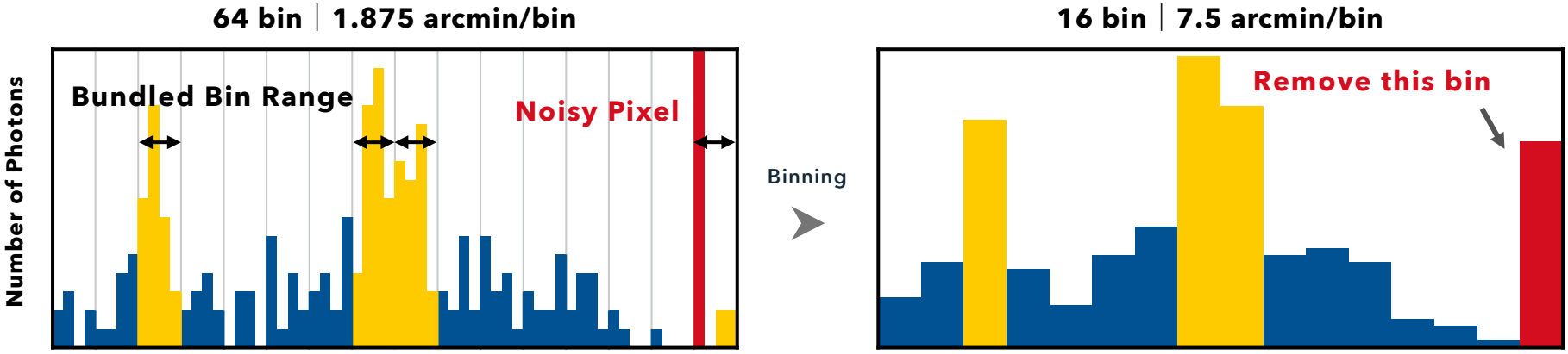
If bins above a certain threshold are found, the information on the bins are saved as the peak candidates.

1 | X-ray Data Analysis

① Determination of the Centroid for Histograms

According to the following steps, the two projected histograms are analyzed to determine the location of the GRB.

Step 3 | Removing Noisy Pixels



Restoring the bundled bin back into the original four bins, and the bin with the abnormally high value are searched.

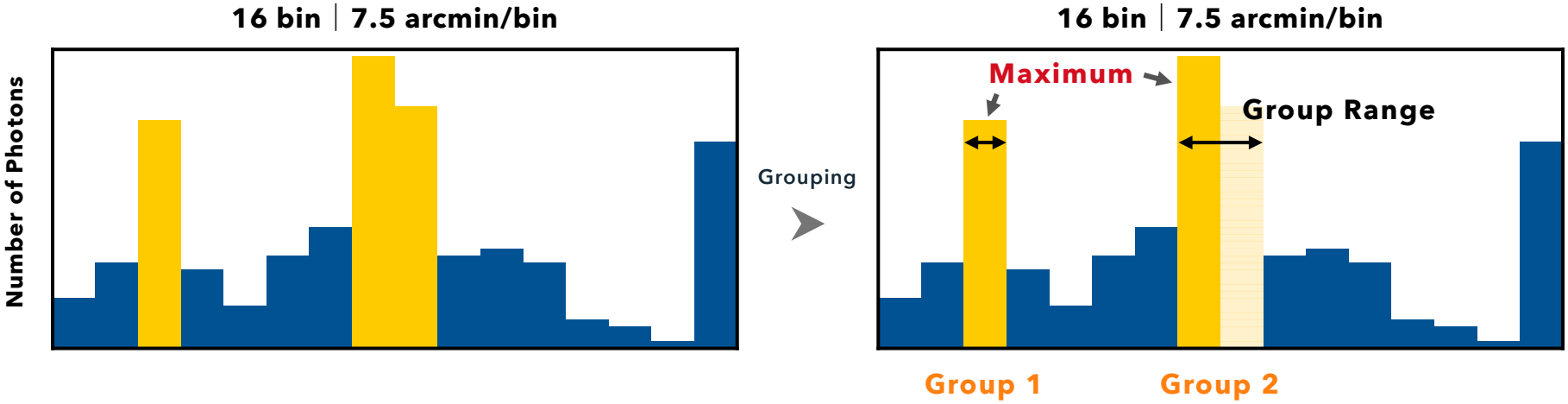
Since these must be noisy pixels, the bundled bins are removed.

1 | X-ray Data Analysis

① Determination of the Centroid for Histograms

According to the following steps, the two projected histograms are analyzed to determine the location of the GRB.

Step 4 | Grouping



Bins adjacent to each other in the extracted histograms are considered as a group.

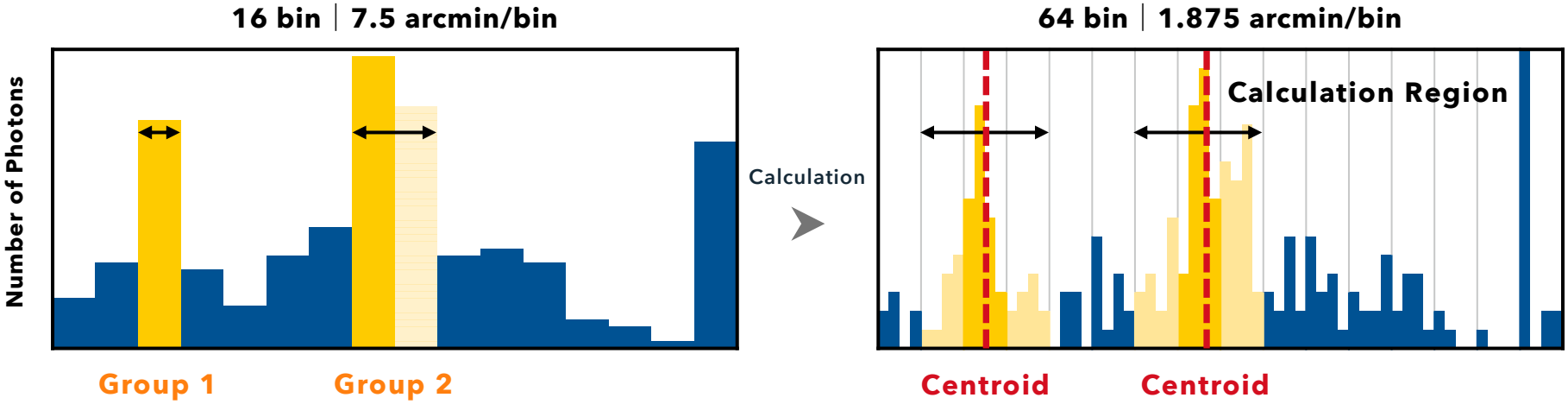
Then find the bin with the maximum value within each group.

1 | X-ray Data Analysis

① Determination of the Centroid for Histograms

According to the following steps, the two projected histograms are analyzed to determine the location of the GRB.

Step 5 | Calculating the Center Position of the Cross



Calculating the centroid in a 3σ region centered on the bin with the maximum value.

Perform this operation in both the x- and y-directions.

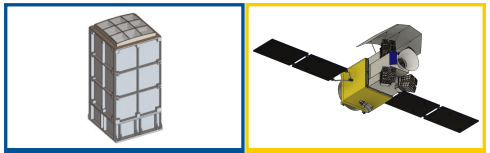
This algorithm is one candidate for analysis.

② Matching with Catalog of Known Stellar Objects

After determining the center position of the cross, the position is converted to the celestial coordinates using the satellite attitude data.

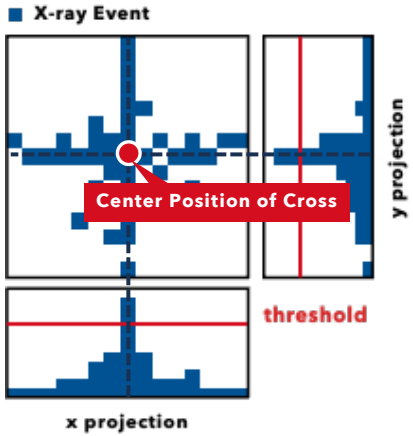
The direction of a GRB candidate is compared by the MPU with a catalog of known stellar objects.

Conversion Factors

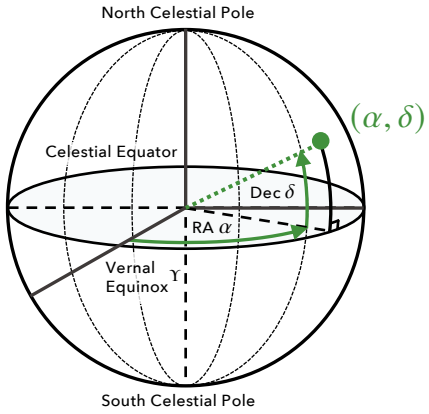


Catalog of Known Stellar Objects

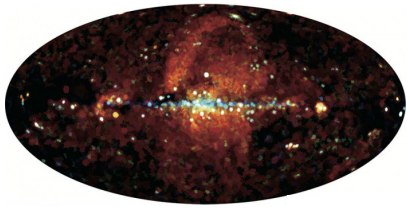
Existing Celestial Bodies	RA	Dec
Crab; M1	83.63	22.01
Vela X-1	135.53	-40.55
Sco X-1	244.98	-15.64
⋮	⋮	⋮



Conversion



Matching



Credit: 2020 RIKEN, JAXA, MAXI team

If not an existing object, the event is regarded as a GRB

① Center Position of Cross | ② Celestial Coordinates | ③ GRB Determination

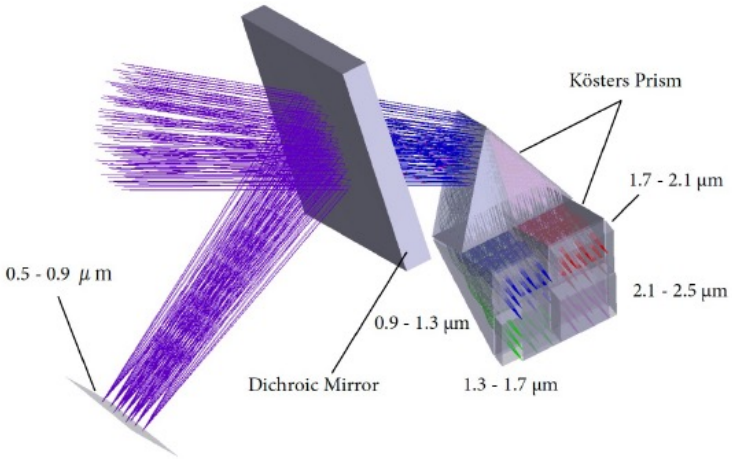
If not an existing object, the event is regarded as a GRB by the MPU.

2 | Near Infrared Data Analysis

Analysis of 25 images

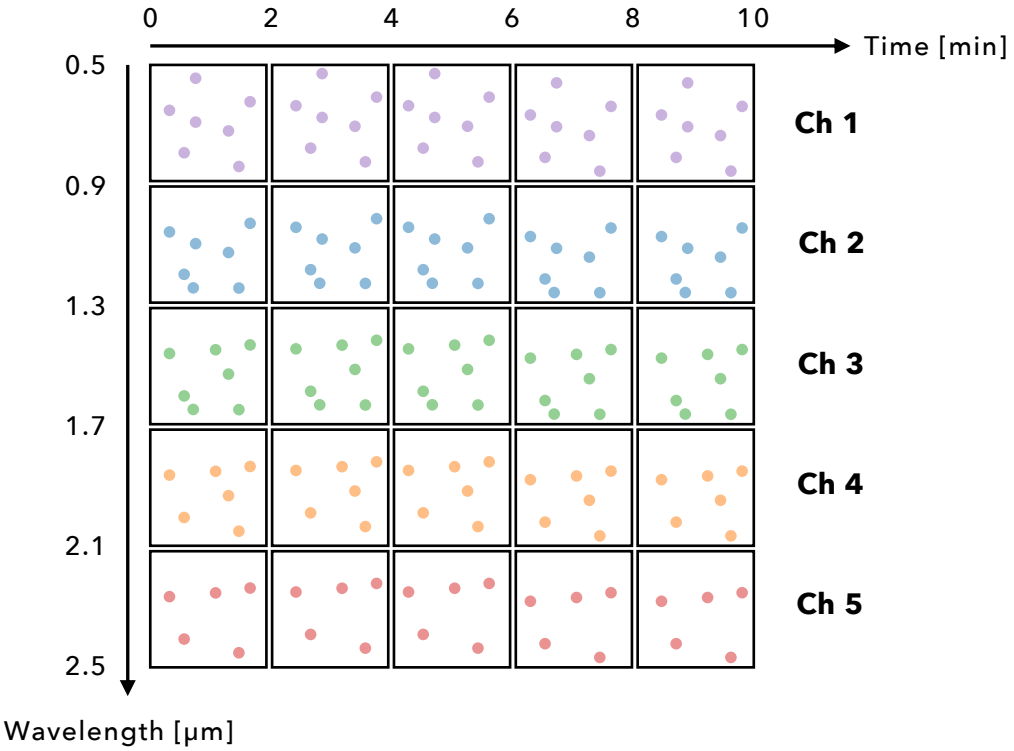
NIRT observes the same part of the sky with the telescope pointing a slightly different.

By image registration and band merging, the MPU process 25 images.



5-band Simultaneous Measurement

10 min (2 min exposure × 5 times)



➡ See **Haruaki Niimuma**'s Poster

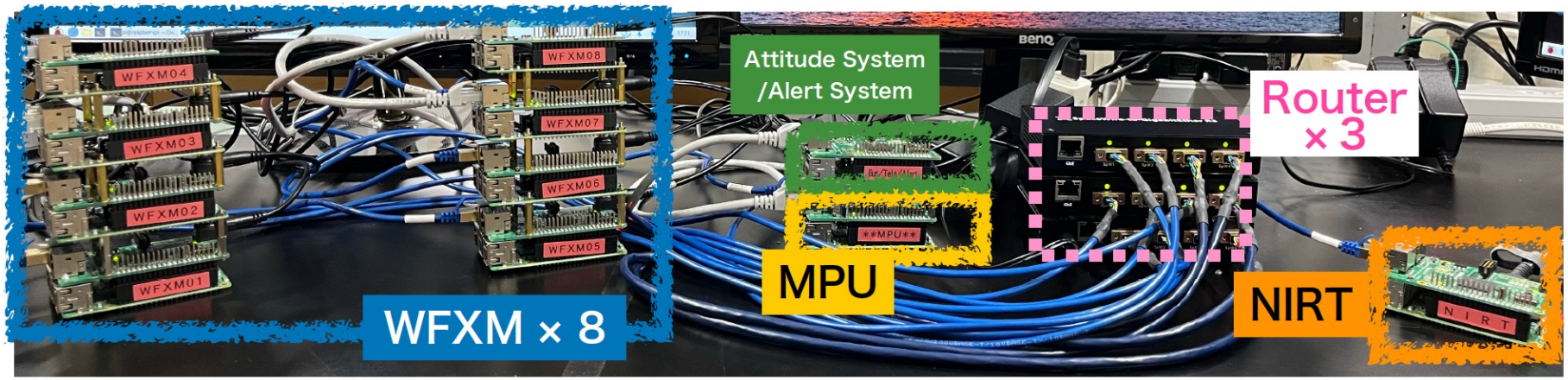
8_2: Development of analysis program for data sent from the Near Infrared Telescope

3 | Hardware

Dummy Network

To test the basic GRB observation sequence based on SpaceWire standards,

we have developed a dummy network system using Raspberry Pi and Space Pi.



Time Synchronize Test

We have also started a time synchronize test.

➡ See **Keito Watanabe**'s Poster

8_1: Developmet of a SpaceWire-Based Dummy Network for HiZ-GUNDAM

Future Work

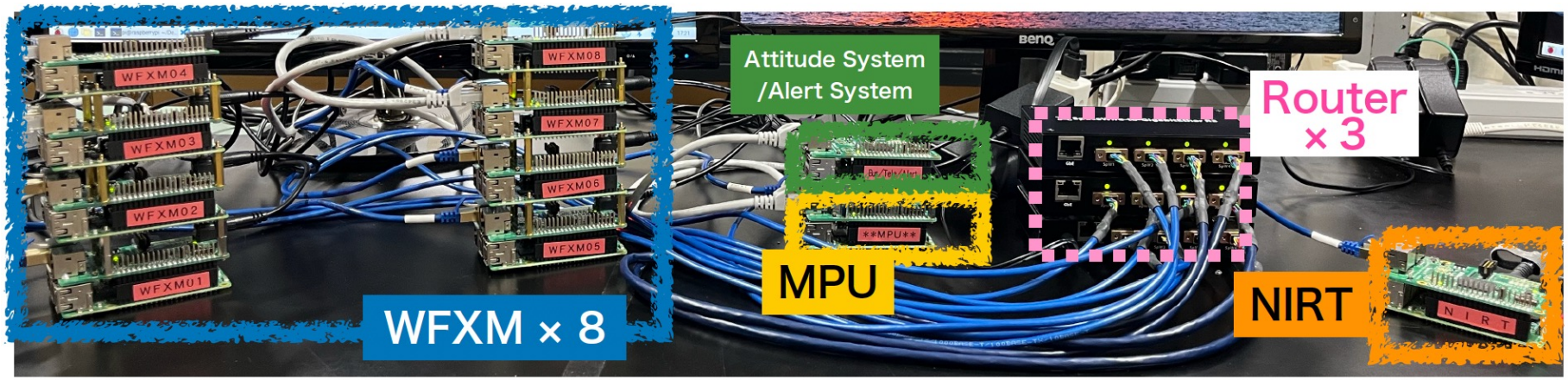
Dummy HiZ-GUNDAM Simulator

We have the ambition to build the dummy HiZ-GUNDAM simulator with SpaceWire network and dummy modules by the year after next.

WFXM Simulator

SpaceWire Network Test
by K. Watanabe (Yamagata Univ.)

➡ See Poster



WFXM Analysis Program
by T. Togashi (Yamagata Univ.)

NIRT Analysis Program
by H. Niinuma (Yamagata Univ.)
& H. Akitaya (Chiba Inst. Tech.)

➡ See Poster

NIRT Simulator

Nov 3 2024, #ISASopen 2024

We made an introductory video. It is available on YouTube “JAXA相模原チャンネル”.

“JAXA相模原キャンパス・オンライン特別公開2024” @YouTube 5:27:40

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