

# Development of the Multi-Messenger Observation Database and Viewer

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**Summary:** In the past two decades, multi-wavelength observations of astronomical objects and phenomena using electromagnetic waves have become commonplace. Furthermore, multi-messenger astronomy, which includes messengers beyond electromagnetic waves, such as gravitational waves and neutrinos, is emerging as the new standard. The Multi-Messenger Observation Database and Viewer compile and visualize various types of observation data, enhancing the ability to identify potential targets for multi-messenger astronomy. In particular, the viewer quickly provides information to assist in deciding whether to follow up on transients. We will introduce the Multi-Messenger Observation Database and Viewer and provide a development status.

**FoV Filter can display reported events or FoV information registered in the Database.**

**A survey image can be displayed as the background image (Digitized Sky Survey, Lasker et al.).**

URL: <http://mma.phys.aoyama.ac.jp>

## What is the purpose?

- The Database collects & archives various data from multi-messenger observations.
- The Viewer provides information for us to schedule follow-up observations by visualizing observational data overlaid.
- Overlaid data may give us inspirations of potential targets for multi-messenger observations.

## Contents of the Viewer

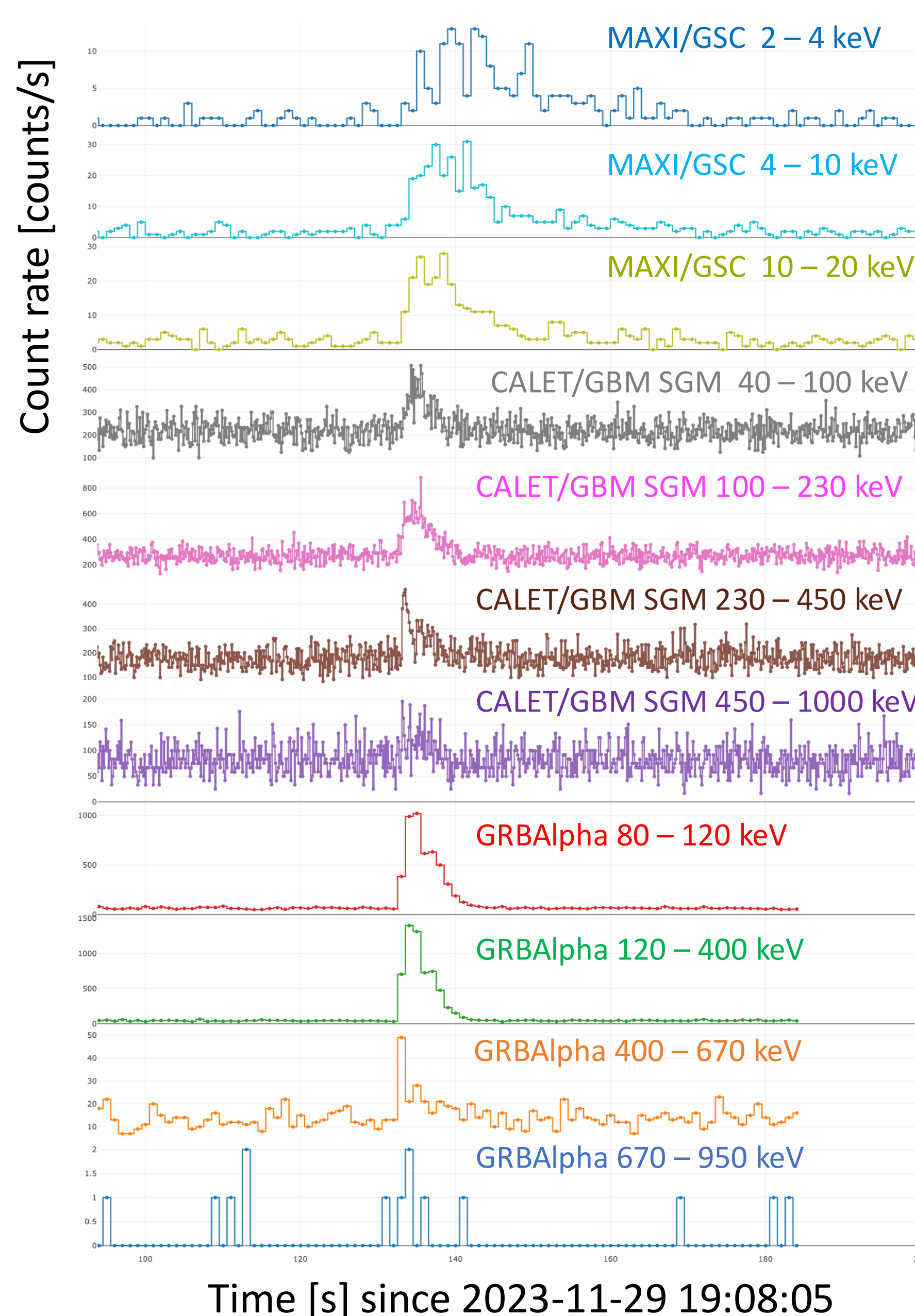
- Survey**
  - Publicly available survey images
- FoV Filter**
  - Reported events or FoV
- Gravitational Wave Filter**
  - GW events from LIGO/Virgo/KAGRA
- Status**
  - Sharing observation status (TBD)

## Search

- Go to the Object search
- Catalog**
  - Publicly available catalogs can be overlaid on the Viewer.
  - We can put shortcuts for catalogs manually created or frequently used.

## Object Search & Object Information

object	instrument	tstart	tstop	ra	dec
GRB 231129C	MAXI GSC	2023-11-29T19:08:05	2023-11-29T19:13:05	11.91	-81.636
GRB 231129C	CALET CGBM	2023-11-29T19:08:34.975000	2023-11-29T19:15:14.980000		
GRB 231129C	GRBAAlpha	2023-11-29T19:09:28.539022	2023-11-29T19:11:09.539003		
GRB 231129C	Optical	2023-11-29T19:11:48	2023-11-29T19:11:49	11.1582	-81.9969
GRB 231129C	swift XRT	2023-11-30T04:47:22	2023-11-30T04:56:22	11.1769	-81.9936



- The "Object Search" can search for "Object Information" recorded in the Database.
- The "Object information" can include below:
  - light curve (count, flux)
  - time (start, stop)
  - R.A., Dec.
  - link to spectrum
  - link to image
  - link to source
- Light curves obtained by each detector can be displayed.
- We are adding light curves of missions below to the Database: MAXI/GSC, CALET/GBM, Swift/BAT, Fermi/GBM, GRBAAlpha, VZLUSAT-2.

## Development status

- AstroArts has already developed the main system.
  - <https://www.astroarts.co.jp/official/corporate/index-j.shtml>
- We manage servers for the Database and Viewer at Aoyama Gakuin University.
- The data collection systems are under development for increasing data in the Database

## Future works

- Enrichment of existing contents
  - Catalogs
  - FoV filter
  - light curves
- Customized alerts
  - Once the server receives alerts, the server distributes customized alerts considering the data in the Database e.g., list of galaxies in the MAXI's error box for GRBs