Updates on the Multi-messenger Observation Database & Viewer

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Summary

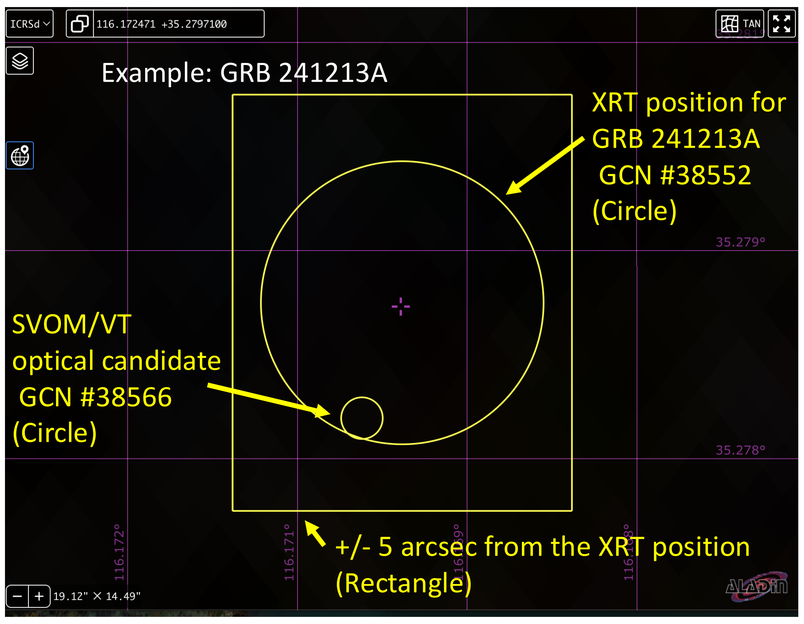
Multi-messenger astronomy requires rapid access to and integration of alerts from various observatories detecting gravitational waves, neutrinos, gamma rays, and X-rays. To address this need, we have been developing the Multi-Messenger observation DataBase & Viewer (MMDB & MMV), which collects, stores, and visualizes alerts in a unified framework. In this poster, we present recent updates to MMV, including a feature for placing user-defined circular and rectangular regions on skymaps, the addition of MAXI light curves, and a new optical lightcurve panel. We also report preliminary applications of MMDB to follow-up observations of multi-messenger events using local optical telescopes at Aoyama Gakuin University to evaluate its potential usefulness. These updates enhance the role of MMDB & MMV as community tools for multi-messenger astronomy, and we discuss future prospects for integrating additional alert streams and expanding their use across observational facilities.

New Features in MMDB & MMV (http://mma.phys.aoyama.ac.jp/)

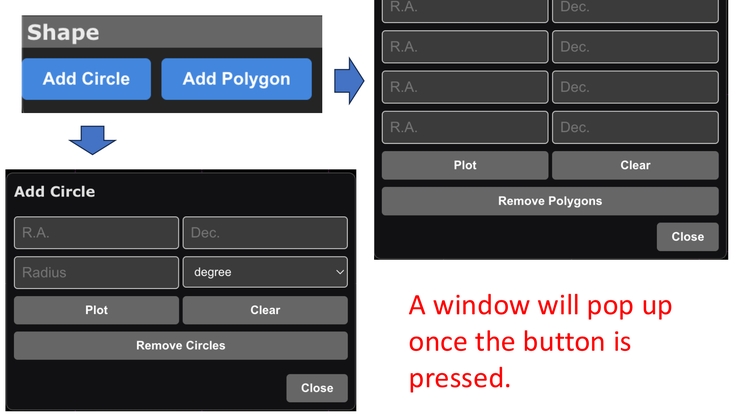
The Multi-Messenger observation DataBase & Viewer (MMDB & MMV) was developed to collect and visualize data from a wide range of multi-messenger observatories and telescopes, offering rapid access to information that supports the planning of future observations and analyses.

• Overlay Shapes on the sky map

A capability to overlay circular or rectangular regions at user-defined positions on the skymap.



The bottom-left corner of the viewer

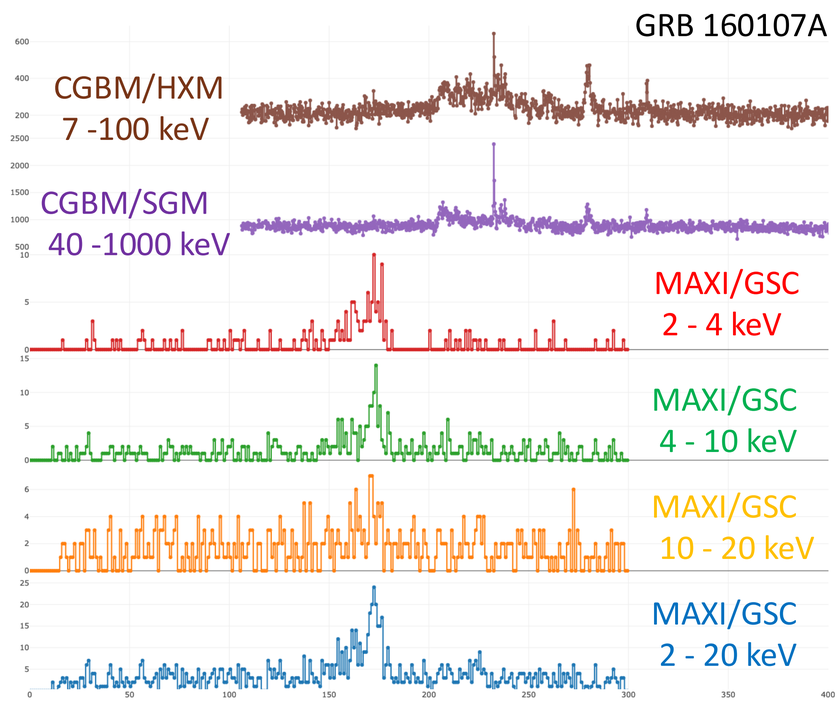


A window will pop up once the button is pressed.

"Plot" button draws a circle or rectangle at the input position.
"Clear" button resets the values in the input fields.
"Remove Circles/Polygons" button removes all circles/rectangles.

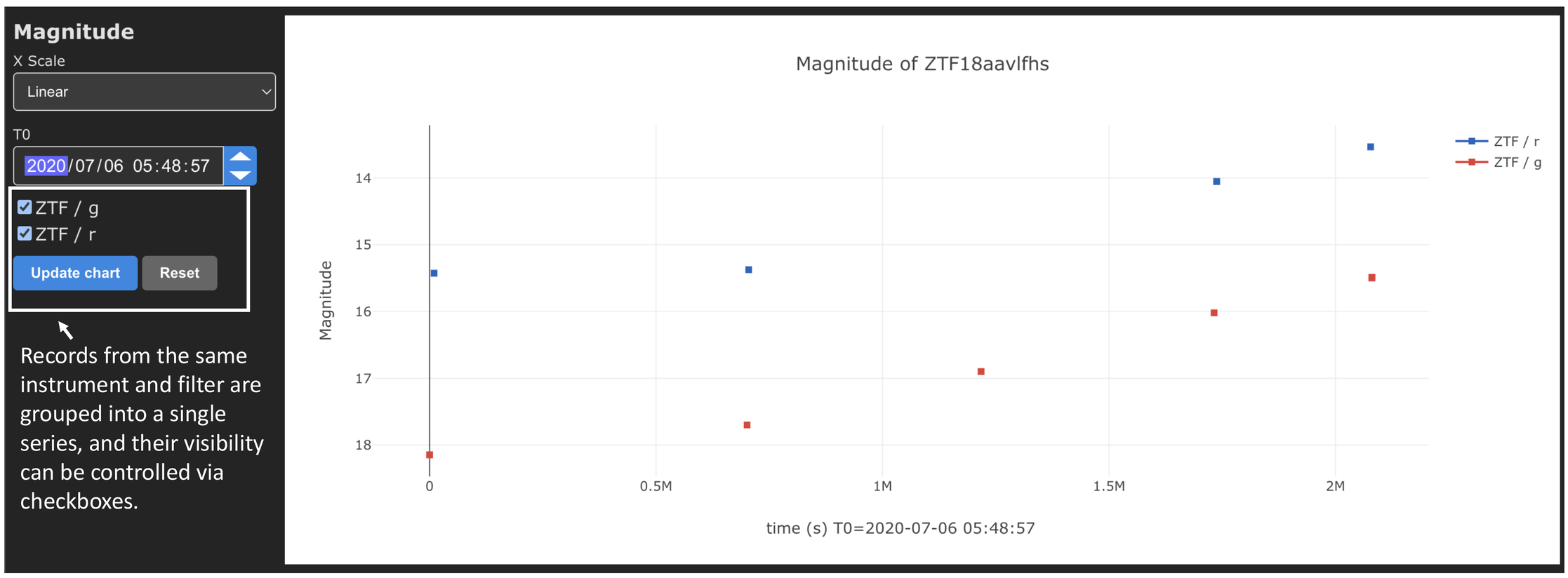
• MAXI light curves for GRBs

Observation records and light curves of MAXI-detected GRBs are stored in the database and are available on the object information page (from GRB 090831 to GRB 250721A).



• Optical light curve panel

To support follow-up observations of neutrino events and X-ray transients detected by *Einstein Probe* (*EP*), we added a panel for visualizing optical light curves.
When observation records are registered in MMDB, their light curves are automatically displayed, as illustrated below.



Evaluating MMDB for Follow-Up with Local Telescopes

MMDB has the potential to prioritize multi-messenger events and send optimized observation coordinates to telescopes, taking into account telescope FoVs and the sizes of target error regions.
We are currently testing these capabilities using local telescopes at Aoyama Gakuin University:

- AROMA-N: AGU Robotic Optical Monitor for Astrophysical object – Narrow field
- TARGET: The AGU Robotic Gravitational-wave Electromagnetic Telescope

	AROMA-N	TARGET
Aperture	356 mm	200 mm
Focal length	2500 mm	600 mm
Field of view	17 arcmin x 17 arcmin	2 deg. x 3 deg.
limiting magnitude	15 mag (R, 60 s)	14 mag (R, 60 s)

Both telescopes are operated through the Astronomer's Control Panel (ACP).

AROMA-N: MMDB sends the reported positions as VOEvents.
(*EP*/WXT, *Swift*/BAT, *SVOM*/ECLAIRs)

TARGET: MMDB computes and sends the central positions of mosaic observations as VOEvents.
(LVK, IceCube, *EP*/WXT, *Swift*/BAT, *SVOM*/ECLAIRs, MAXI/GSC)

Both TARGET and AROMA-N successfully received the VOEvents sent from MMDB.
Test observations will follow.

Other updates

FoV filter:
- *Swift*/BAT fields of view
- *SVOM*/ECLAIRs events

Catalog:
- PS1-STRM (z_phot <= 0.2)
  Beck et al. 2020; Flewelling et al. 2016; https://archive.stsci.edu/hlsp/ps1-strm

Mapping:
- Trigger ID (FoV Filter) -> Object / Event names (Object information)

Future works

- Web interface for accessing and adding records to the database
- Implementation of customized alerts using database records
- Fully automation of registering observation records and light curves (MAXI/GSC, *Swift*/BAT, *Fermi*/GBM, Optical).
- Addition of a reference tab to the web interface.