Development of Multi-Messenger Observation Database & Viewer

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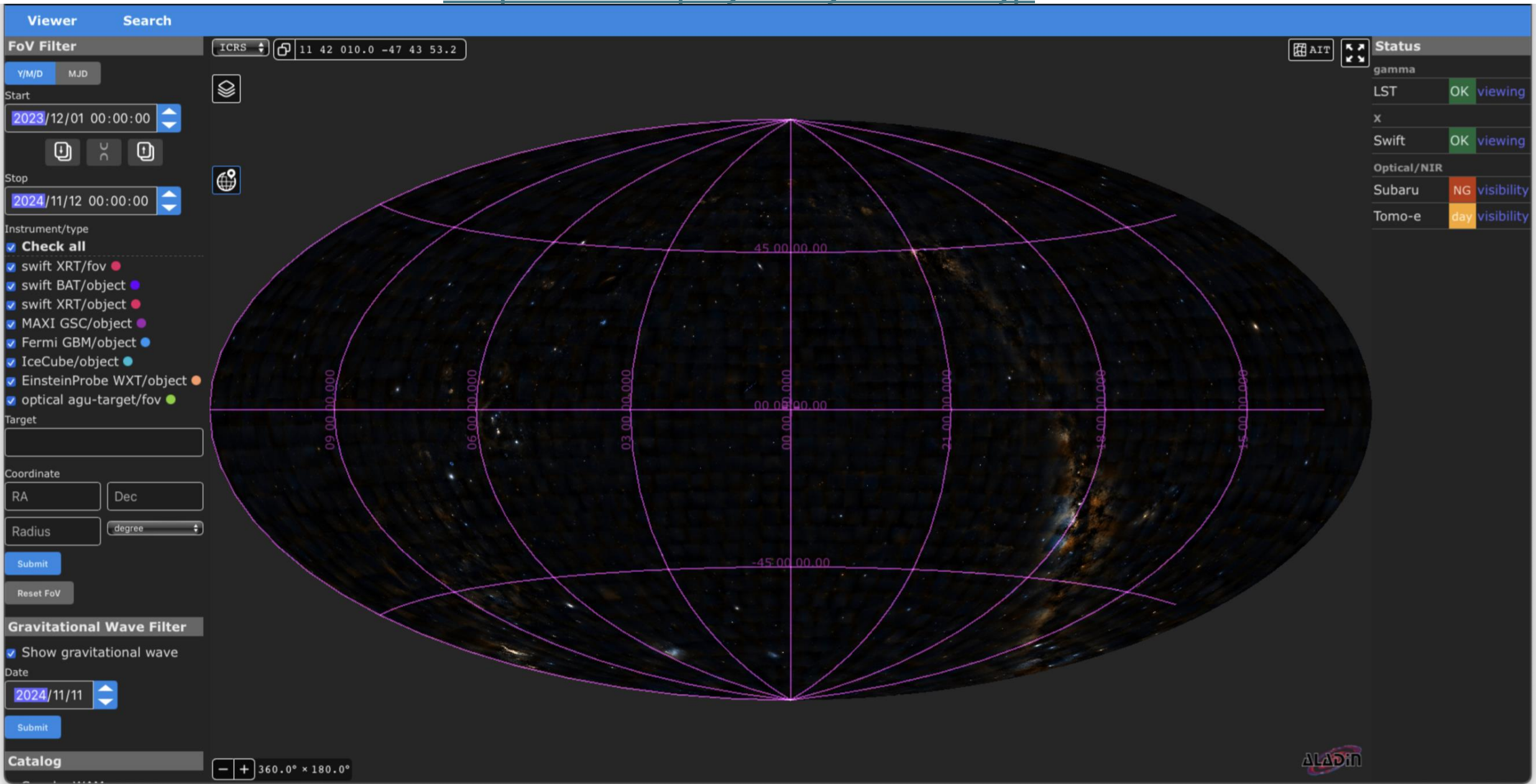
The second annual conference, Nov. 18-20, 2024

Multi-messenger observation Database & Viewer

http://mma.phys.aoyama.ac.jp



Aims of Database and Viewer

- The multi-messenger observation **Database collects and archives data from various observatories and telescopes**.
- **Viewer visualizes the observational data, providing helpful information for devising strategies** for future observations and analyses.
- The **Viewer may inspire us to potential targets for multi-messenger** astronomy by **overlaying observational data**.

Development of Database and Viewer

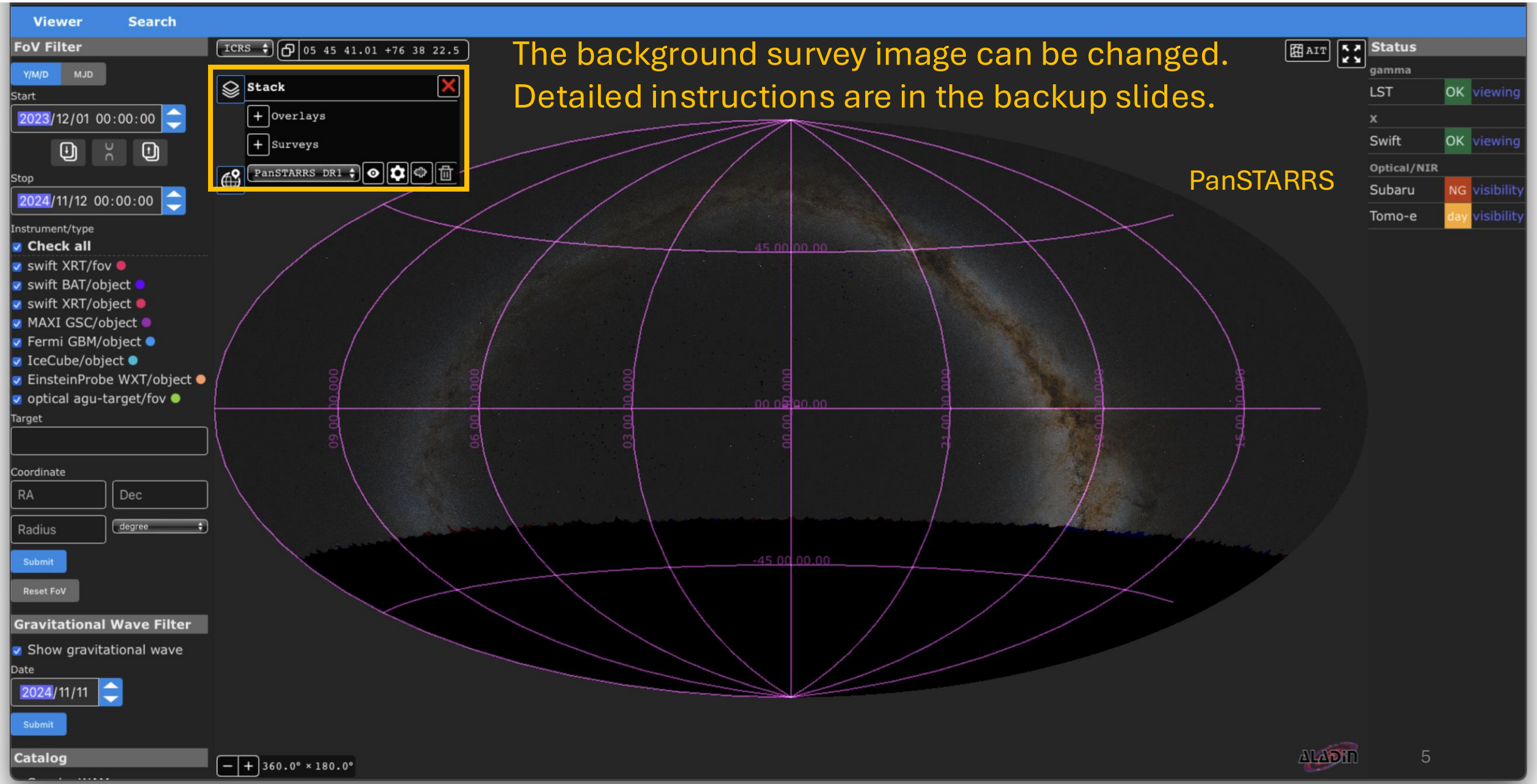
- The development of the main system was outsourced to AstroArts.
  - https://www.astroarts.co.jp/official/corporate/index-j.shtml
- We manage the servers and develop the data collection system for the Database at Aoyam

- Database
  - Ubunts 22.04 LTS
  - PostgreSQL

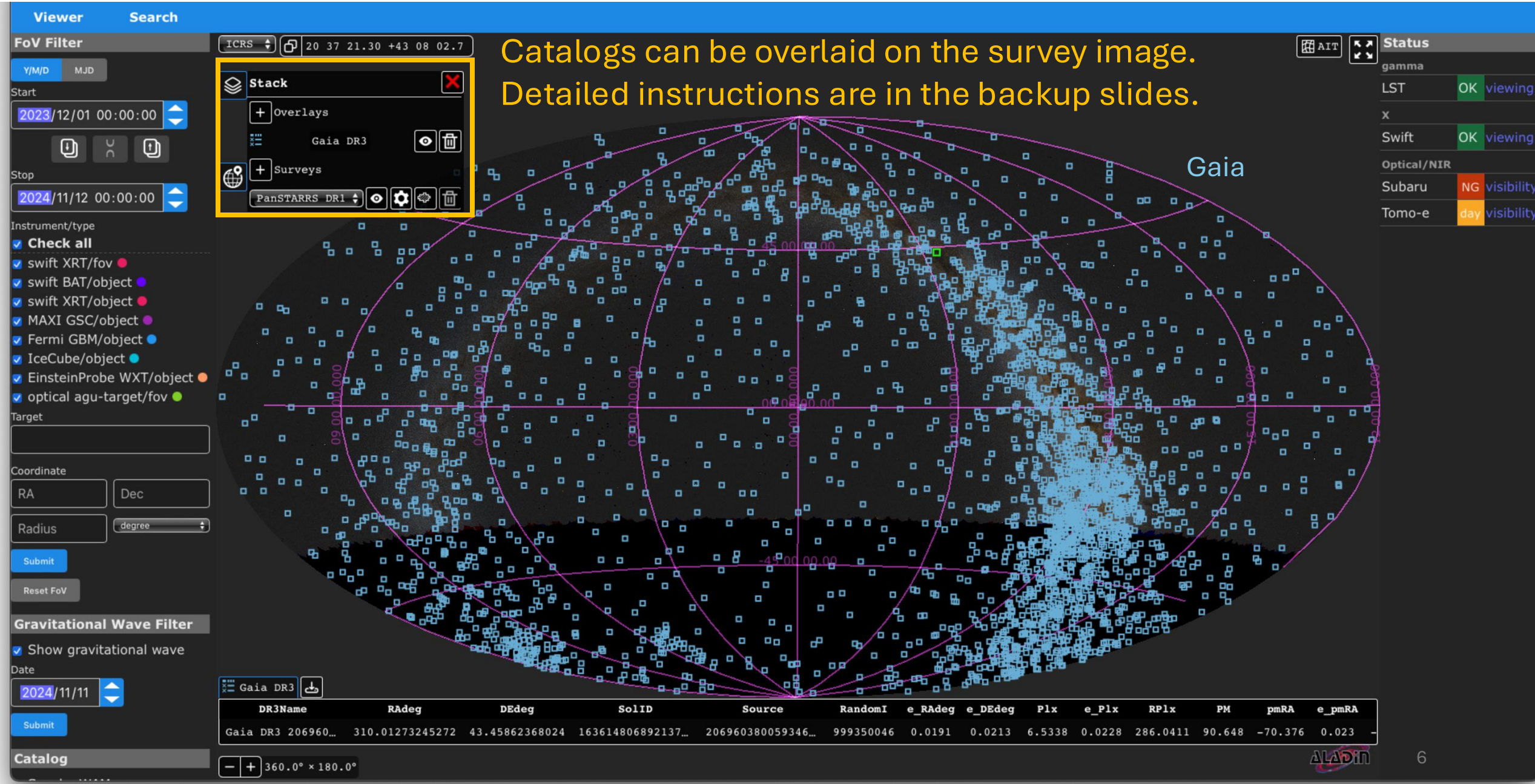
```
                    List of relations
 Schema |            Name             |   Type   |  Owner
--------+-----------------------------+----------+----------
 public | gravitational_wave          | table    | postgres
 public | gravitational_wave_id_seq   | sequence | postgres
 public | obj                         | table    | postgres
 public | obj_id_seq                  | sequence | postgres
 public | observation                 | table    | postgres
 public | observation_id_seq          | sequence | postgres
```

- Viewer (+ Object Search)
  - Ubunts 22.04 LTS
  - HTTP server: nginx
  - Aladin Lite (https://aladin.cds.unistra.fr)
  - © Centre de Données astronomiques de Strasbourg.

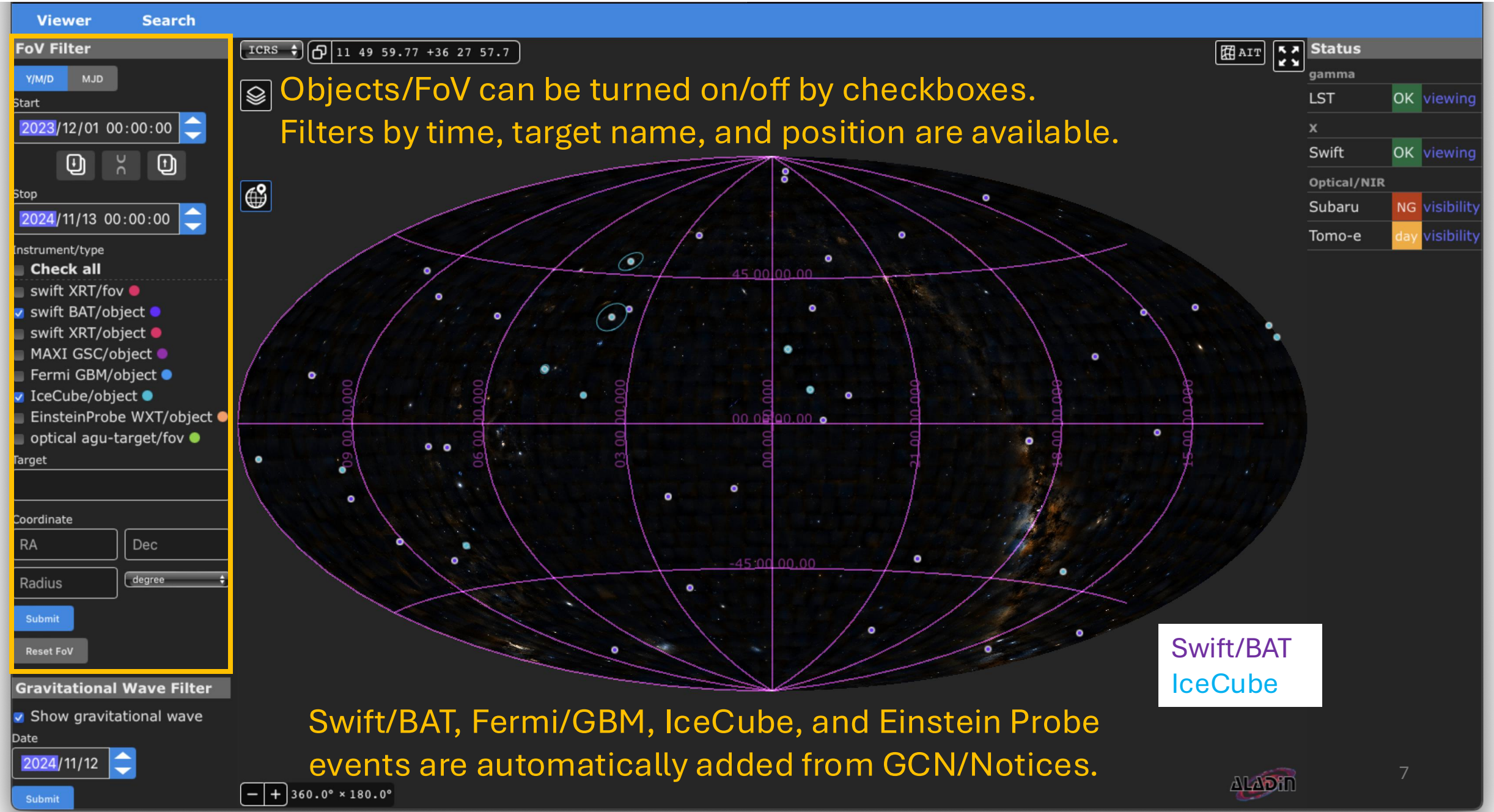
Viewer: Survey



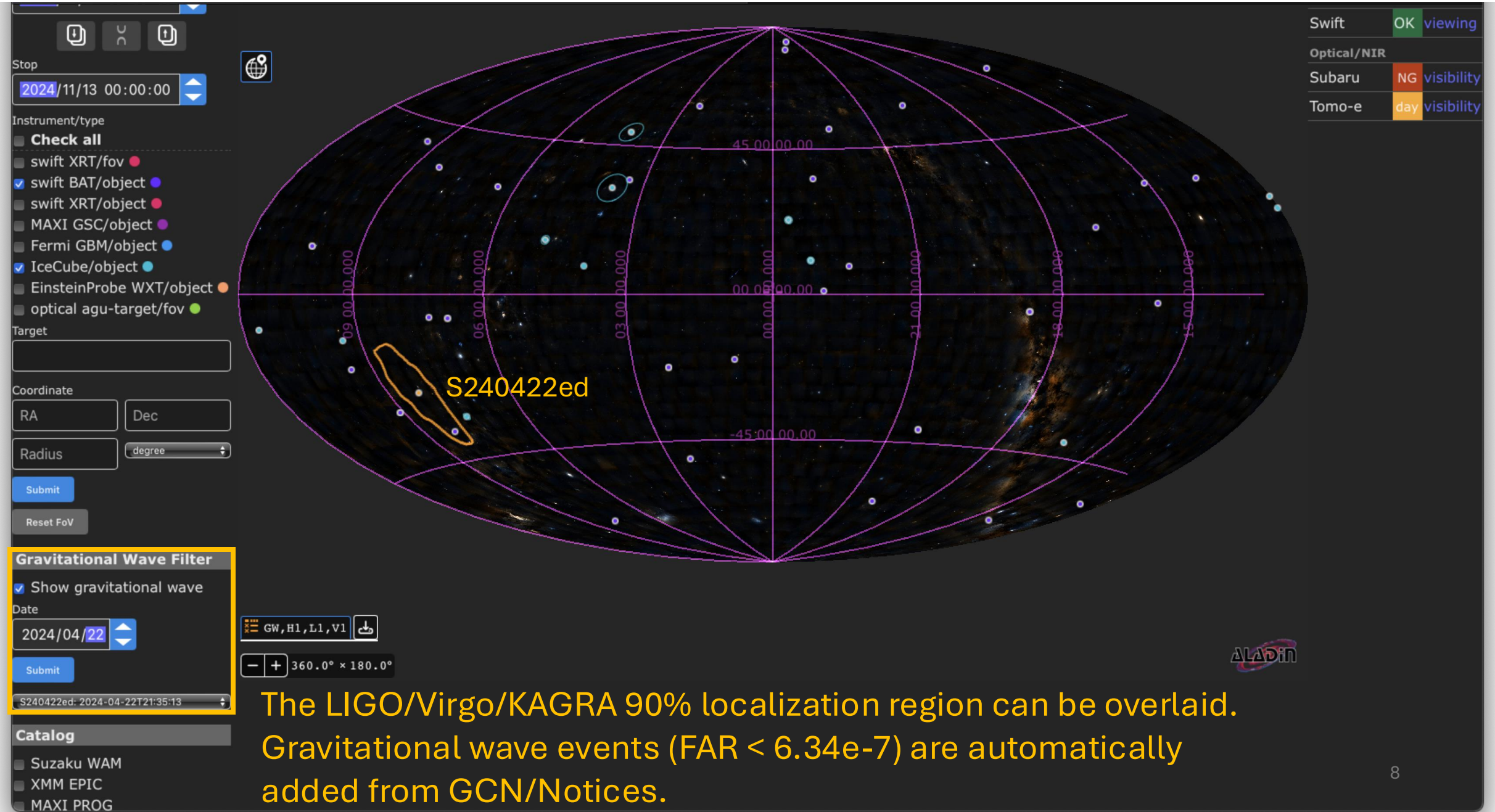
Viewer: Catalog



Viewer: FoV Filter

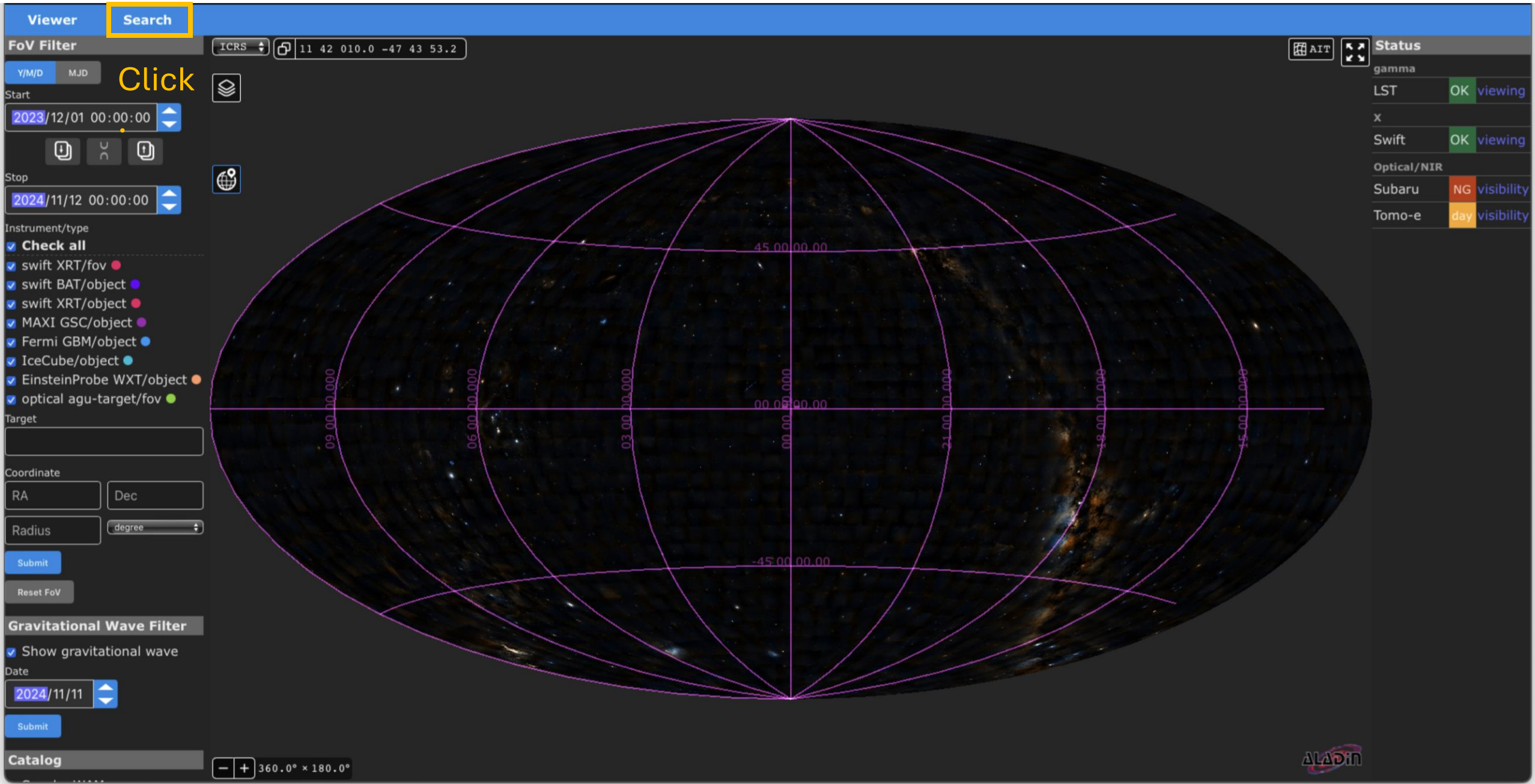


Viewer: Gravitational Wave Filter

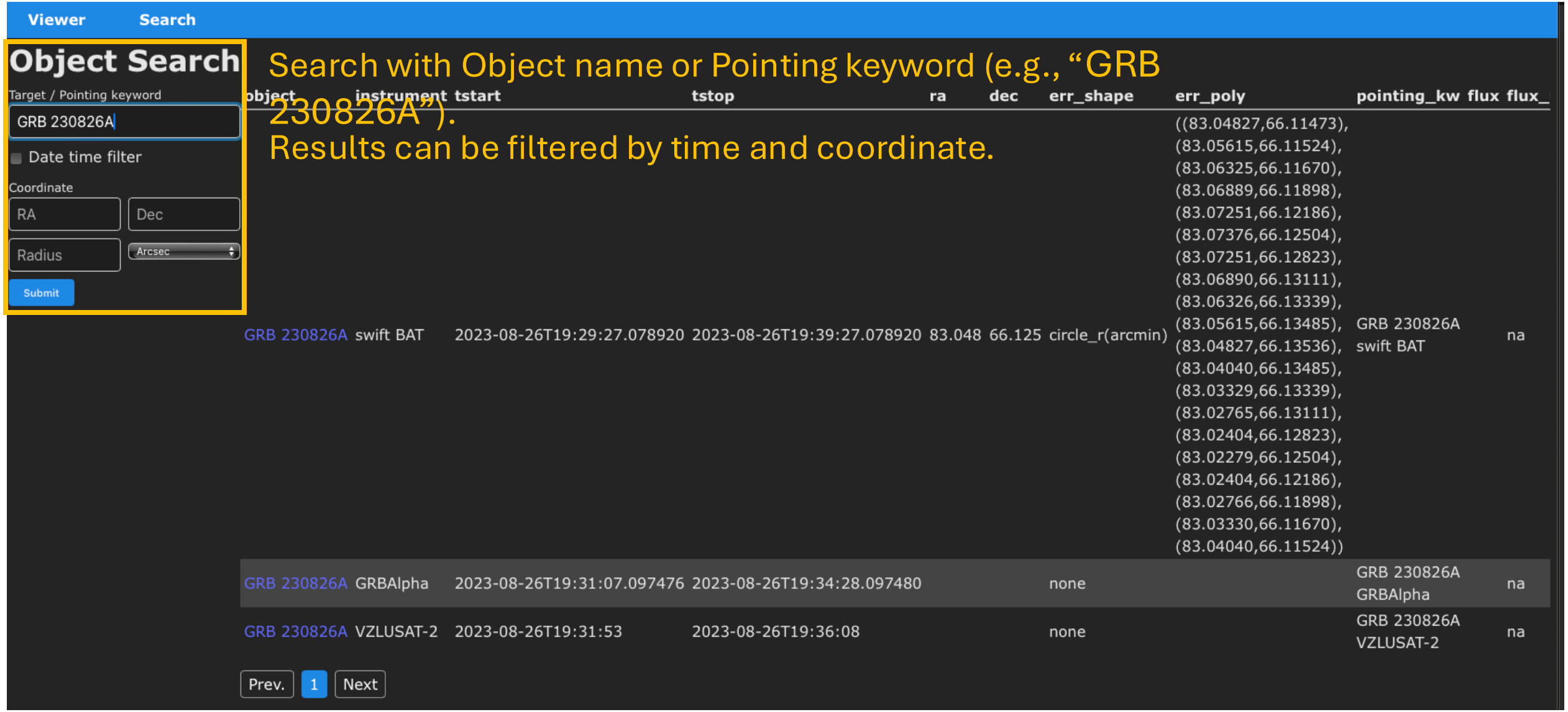


The LIGO/Virgo/KAGRA 90% localization region can be overlaid.
Gravitational wave events (FAR < 6.34e-7) are automatically added from GCN/Notices.

Object Search



Object Search

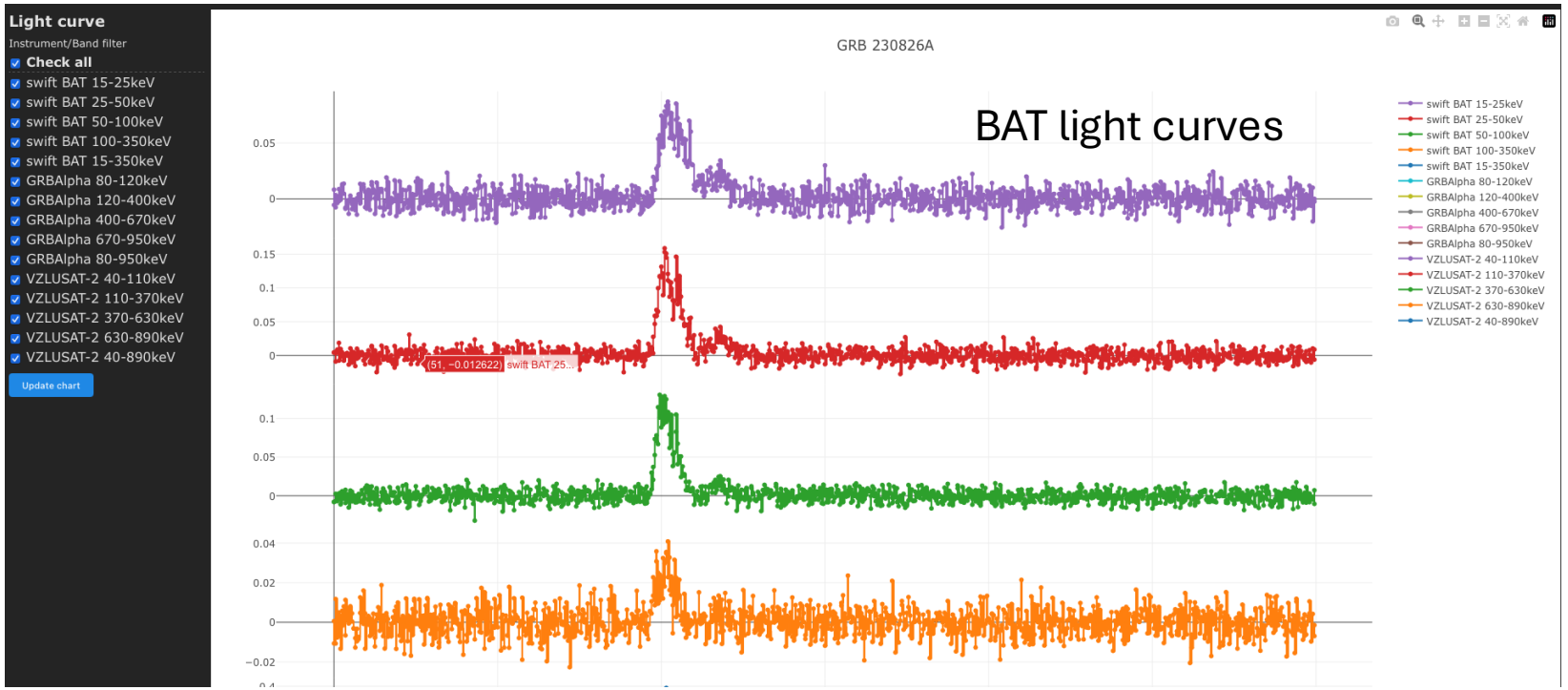


Object Search: GRB 230826A

Viewer Search

GRB 230826A

viewer	object	instrument	tstart	tstop	ra	dec	pointing_kw	flux	flux_unit	flux_com	upper_limit	lc_
viewer	GRB 230826A	swift BAT	2023-08-26T19:29:27.078920	2023-08-26T19:39:27.078920	83.048	66.125	GRB 230826A swift BAT		na			file
viewer	GRB 230826A	GRBAlpha	2023-08-26T19:31:07.097476	2023-08-26T19:34:28.097480			GRB 230826A GRBAlpha		na			file
viewer	GRB 230826A	VZLUSAT-2	2023-08-26T19:31:53	2023-08-26T19:36:08			GRB 230826A VZLUSAT-2		na			file



Light curve (Count)

Implemented:

- GRBALpha
- VZLUSAT-2

In Progress:

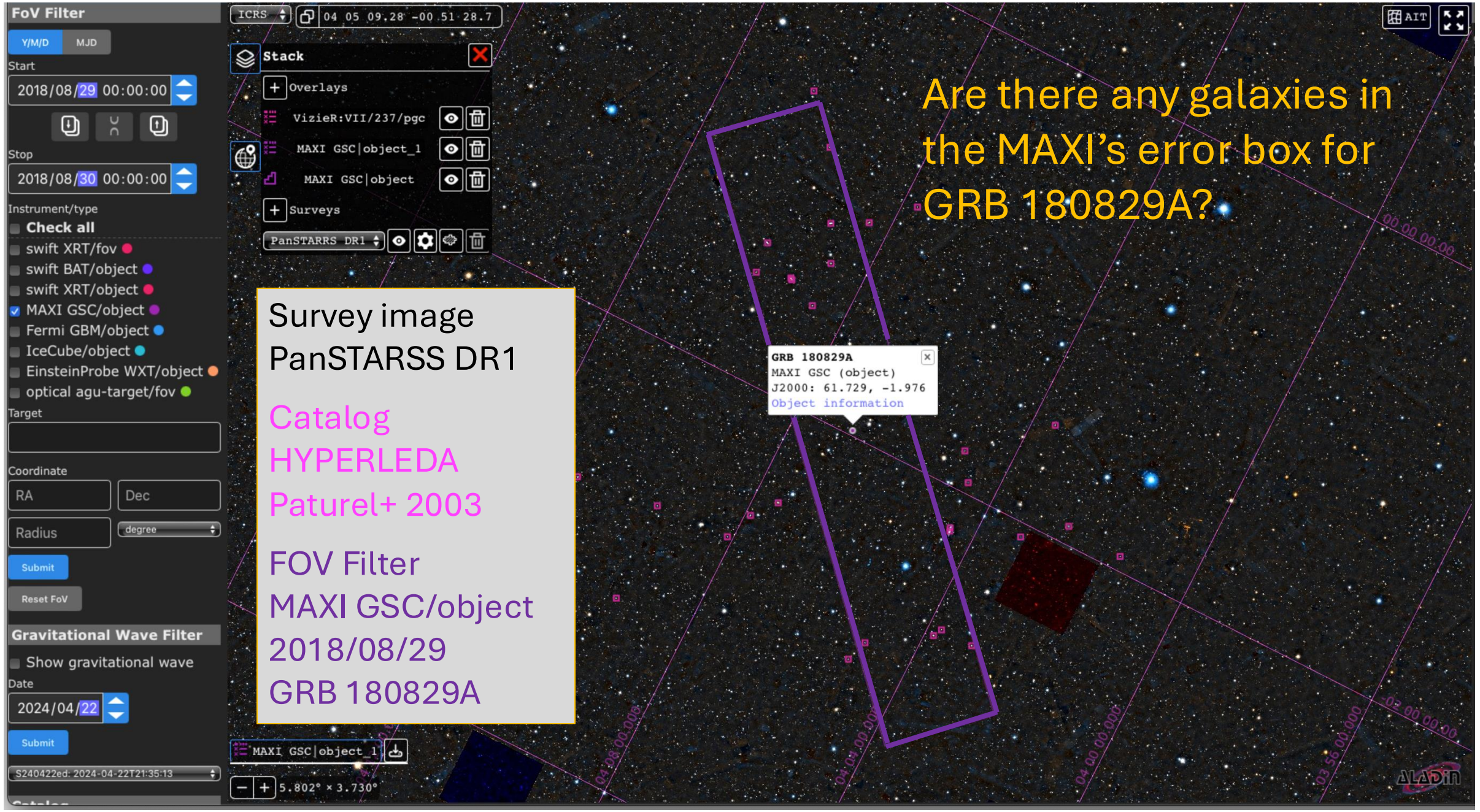
- Swift/BAT
- MAXI/GSC
- Fermi/GBM
- CALET/GBM

Light curve (Flux)

Pending:

- Swift/XRT
- MAXI/GSC
- Optical

Use example: GRB180829A



Ongoing and future tasks

Enrichment of existing contents

- Catalogs
- Status
- Light curves
- Reported events (FoV Filter)

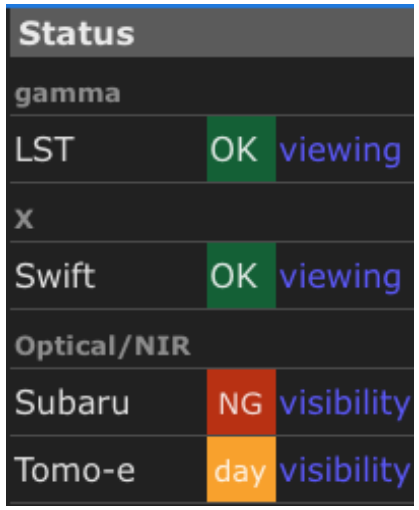
Ongoing
Pending
Under Review

The “Catalog” section can have non-public catalogs.

What catalog should be listed here?

Outsourcing to AstroArts

- Improvement of UI
  - More convenient search
  - Link from the trigger ID to the object/event name
- Major revision (if needed, the next fiscal year)



The ”Status” section was prepared to share observation status of each mission.

What information can/should be shared here?

Sub-threshold events

Promoting more collaborative observations

- MAXI sub-threshold
- Swift-BAT sub-threshold

API to access data in the Database

Anticipating future automatic analysis

Summary

- The multi-messenger observation Database and Viewer are under development.
- **The beta version is available on the web.**
  http://mma.phys.aoyama.ac.jp
- We are working on the enrichment of existing content.
  - **Light curves**
  - **Reported events (FOV Filter)**
- We need inputs to proceed with the development below:
  - **Catalog**
  - **Status**
  - **Major revision (if needed, the next fiscal year)**
- **The user's manual is available in backup slides.**

Backup

Implementation Items

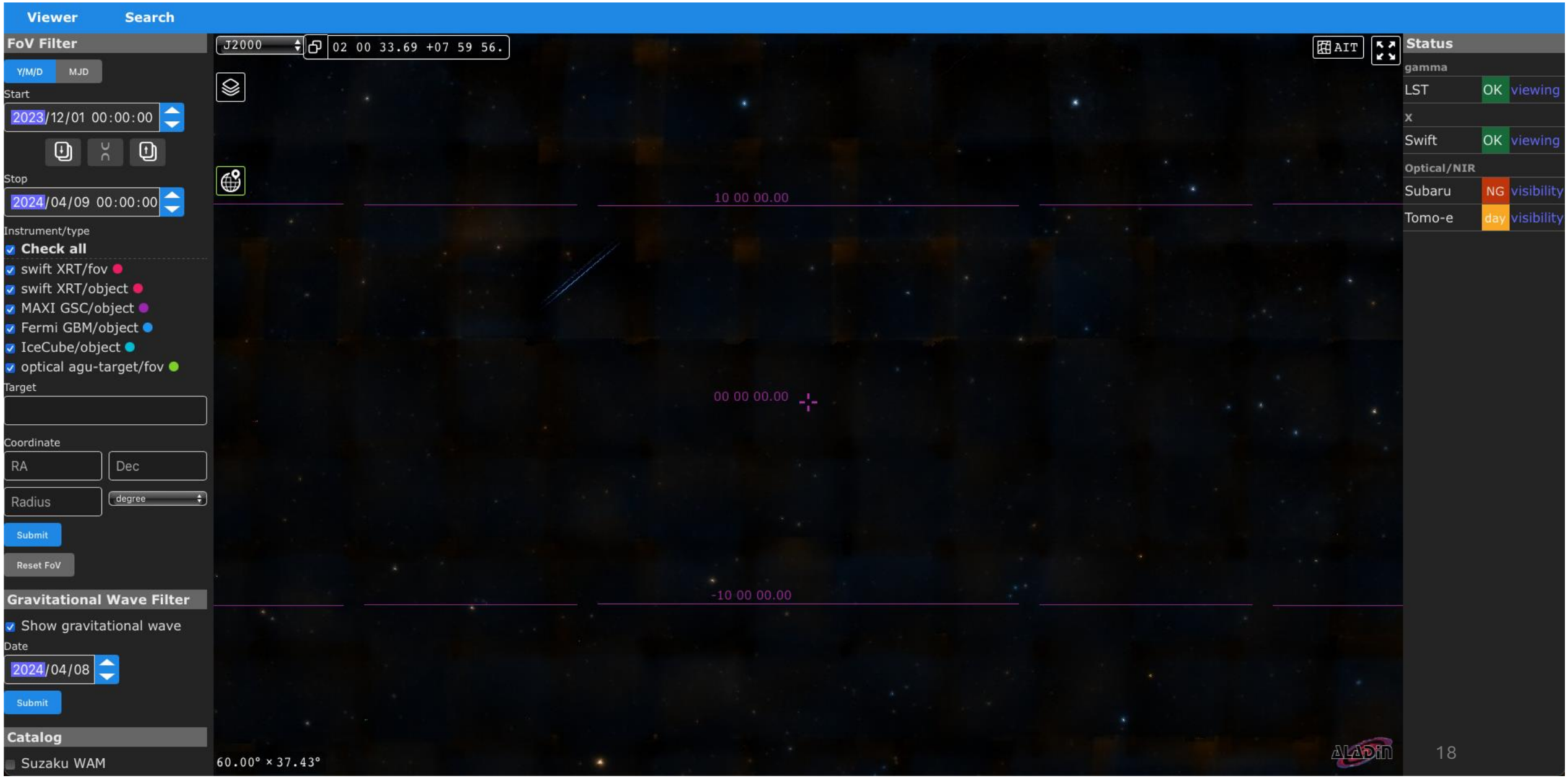
Implemented
Implementing
Pending
Under Review
Temporal

- FOV Filter
  - MAXI GSC/object
  - Swift XRT/fov
  - Swift BAT/object
  - Fermi GBM/object
  - IceCube/object
  - EinsteinProbe WXT/object
  - MAXI/GSC sub-threshold
  - Swift/BAT sub-threshold
  - GCN Circular events
  - Transient Name Server
  - Swift XRT/object
  - optical agu-target/fov
  - others
- Status
  - LST
  - Swift
  - Subaru
  - Tomo-e
  - others
- Gravitational Wave Filter
  - LVK GCN Notice
- Light curve (count rate)
  - GRBAlpha
  - VZLUSAT-2
  - Swift/BAT
  - Fermi/GBM
  - MAXI/GSC
  - CALET/GBM
  - others
- Catalog
  - Suzaku WAM
  - XMM EPIC
  - MAXI PROG
  - Swift BAT
  - Chandra CSC2
  - Swift XRT
- Light curve (flux)
  - MAXI/GSC
  - Swift/XRT
  - others

Multi-messenger Observation Database & Viewer User's manual ver. 241117

Yuta Kawakubo (Aoyama Gakuin University)

Top page (Viewer): http://mma.phys.aoyama.ac.jp

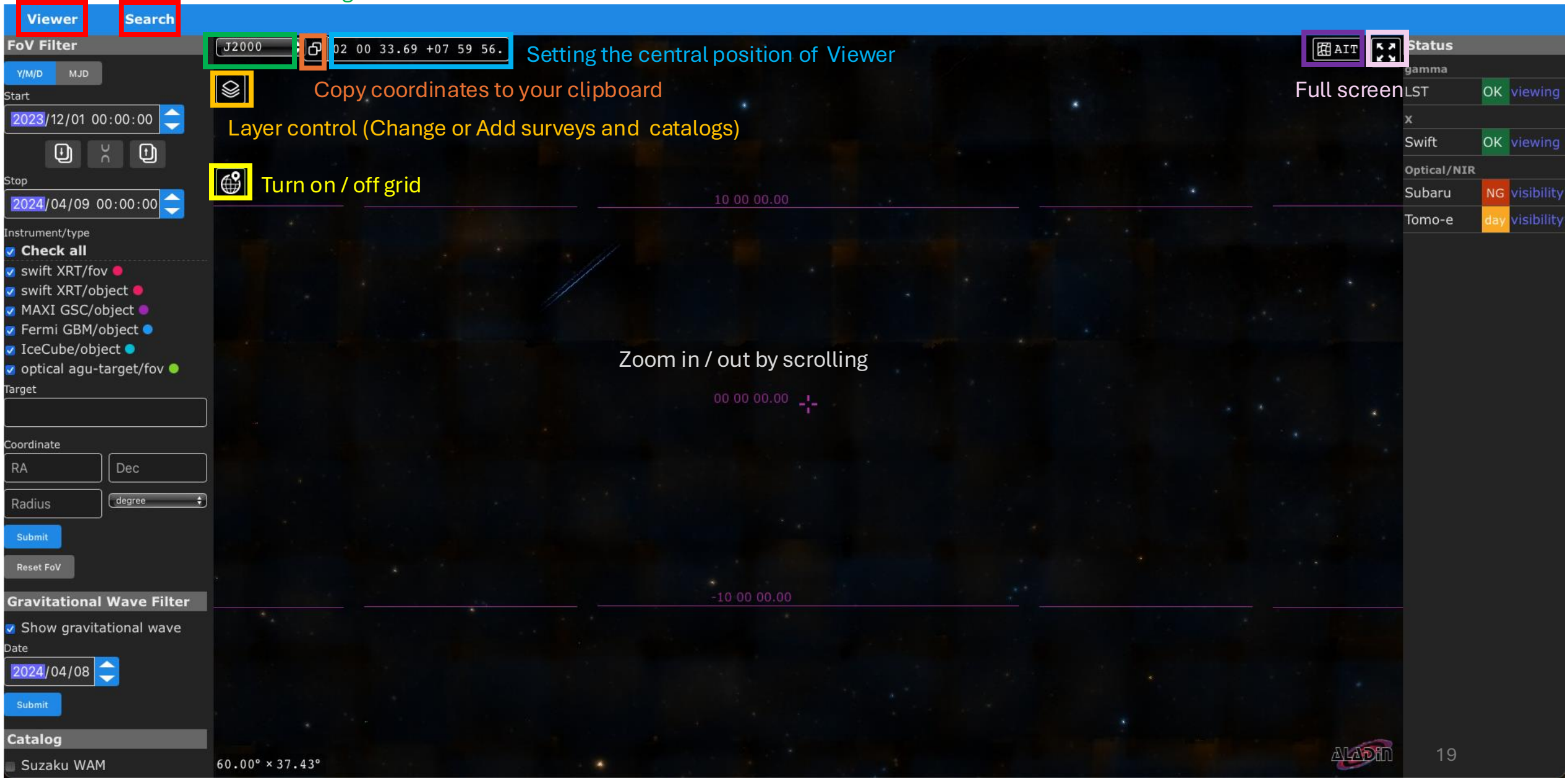


Button Usage

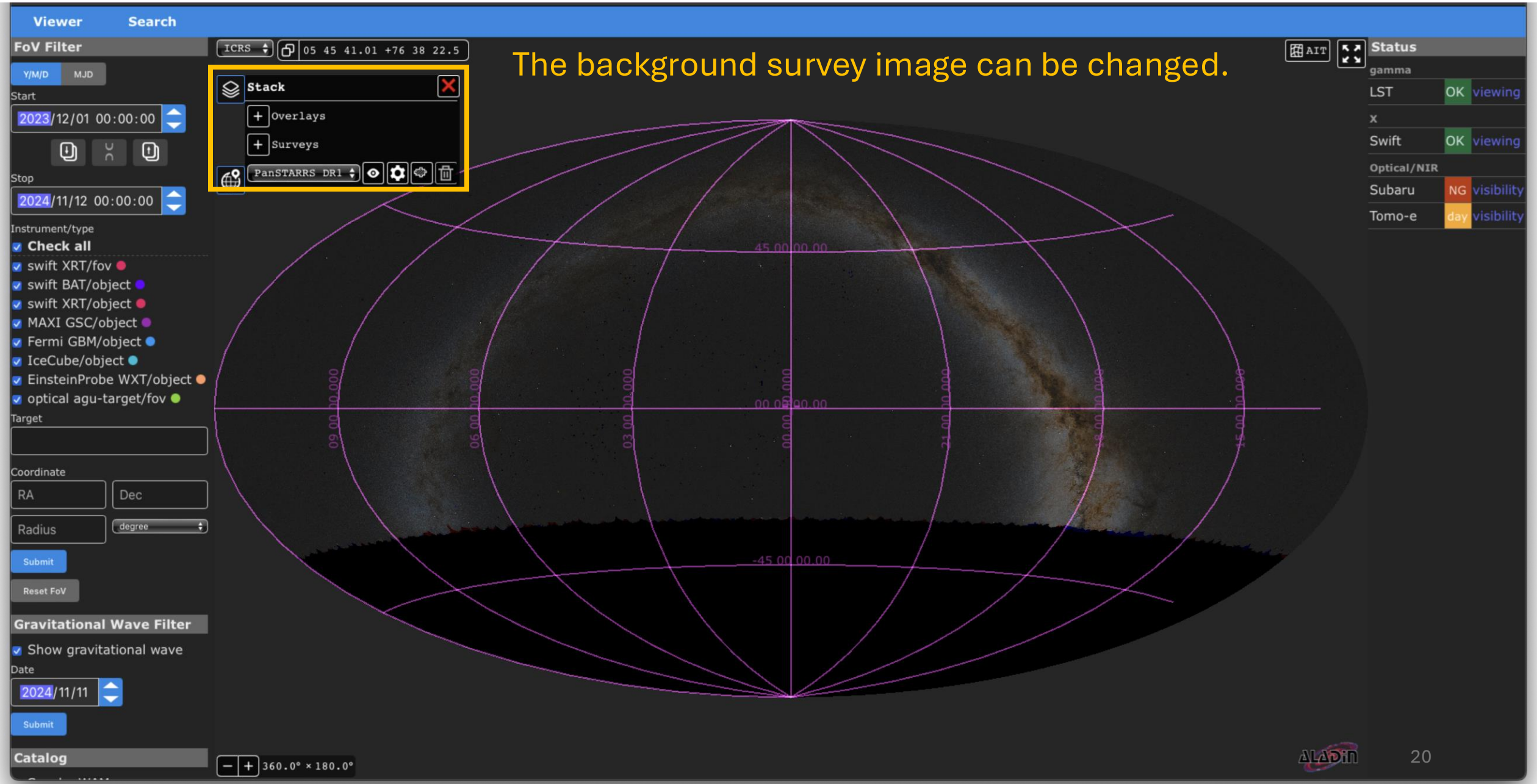
Switching between Viewer & Object Search

Switching coordinates

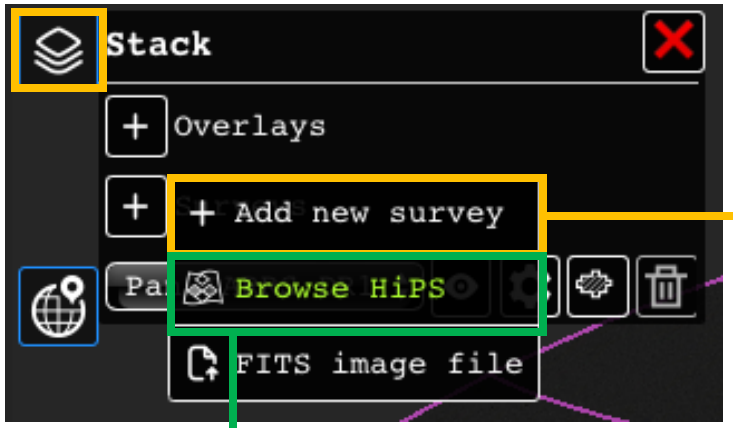
Switching Projection



Viewer: Survey

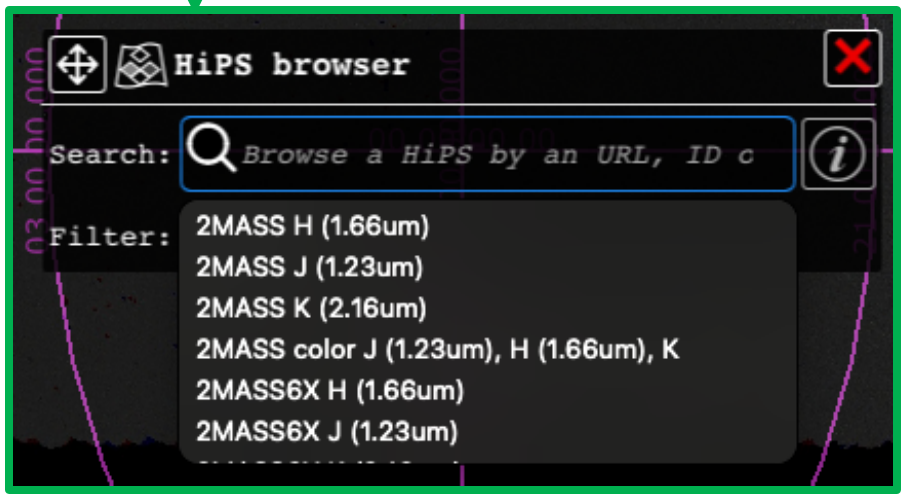


Display survey image

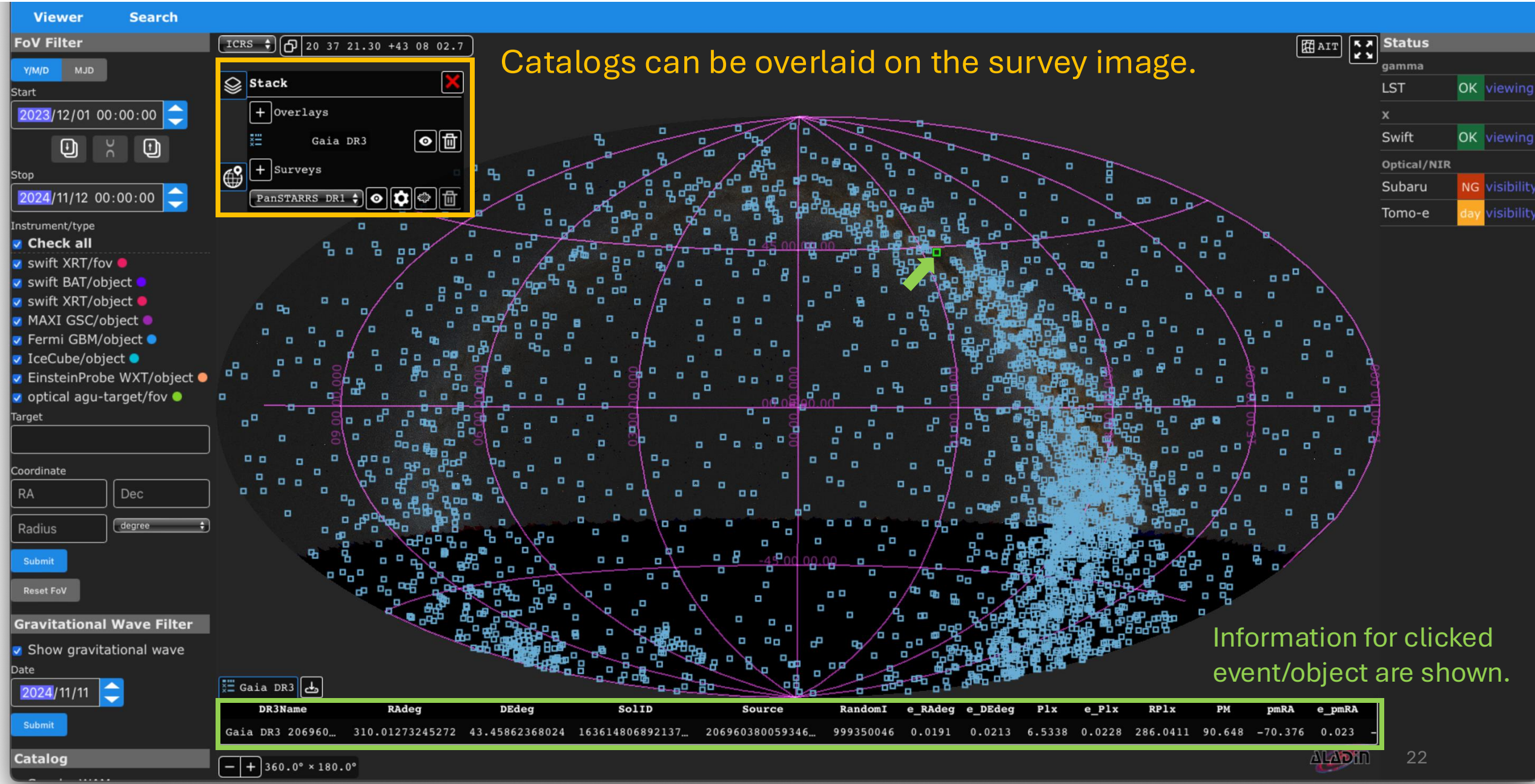


2MASS colored
AllWISE color
DECaPS DR2 color
DSS colored
DSS2 Red (F+R)
Density map for Gaia EDR3 (I/350/gaiedr3)
Fermi color
GALEXGR6_7 NUV
Halpha
IRAC color I1,I2,I4 - (GLIMPSE, SAGE, SAGE-SMC, SINGS)
IRIS colored
Mellinger colored
✓ PanSTARRS DR1 color
PanSTARRS DR1 g
SDSS9 band-g
SDSS9 colored
VTSS-Ha
XMM PN colored
PanSTARRS DR1 color

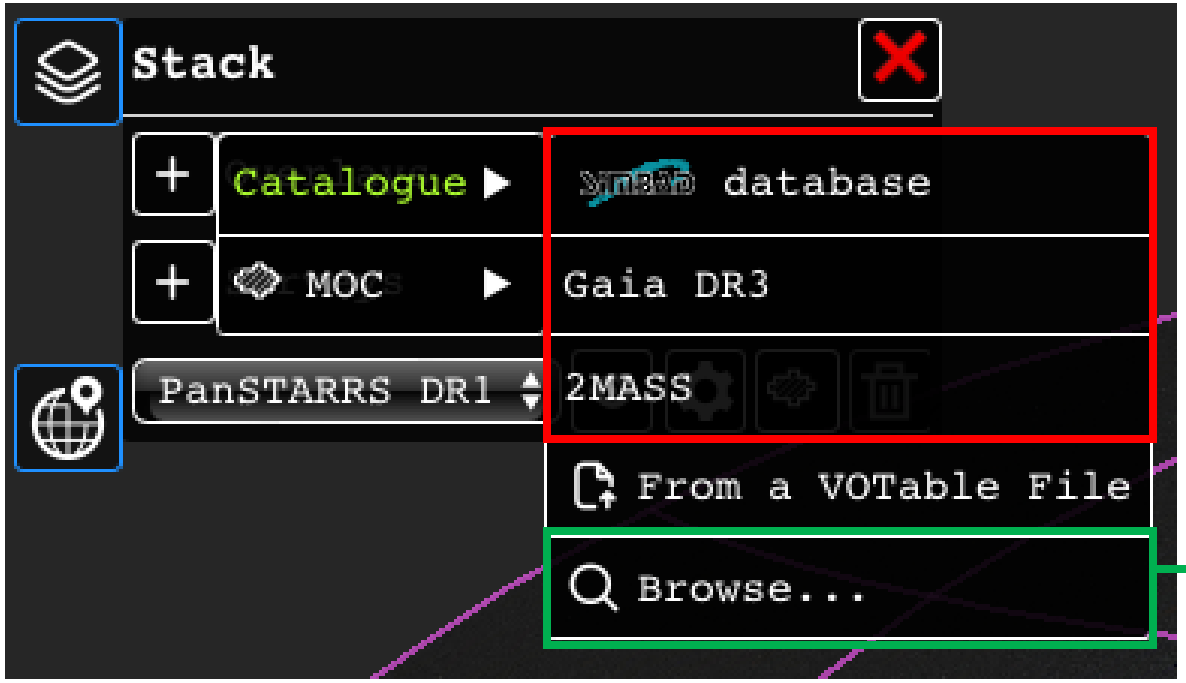
More selections:
https://aladin.cds.unistra.fr/hips/list

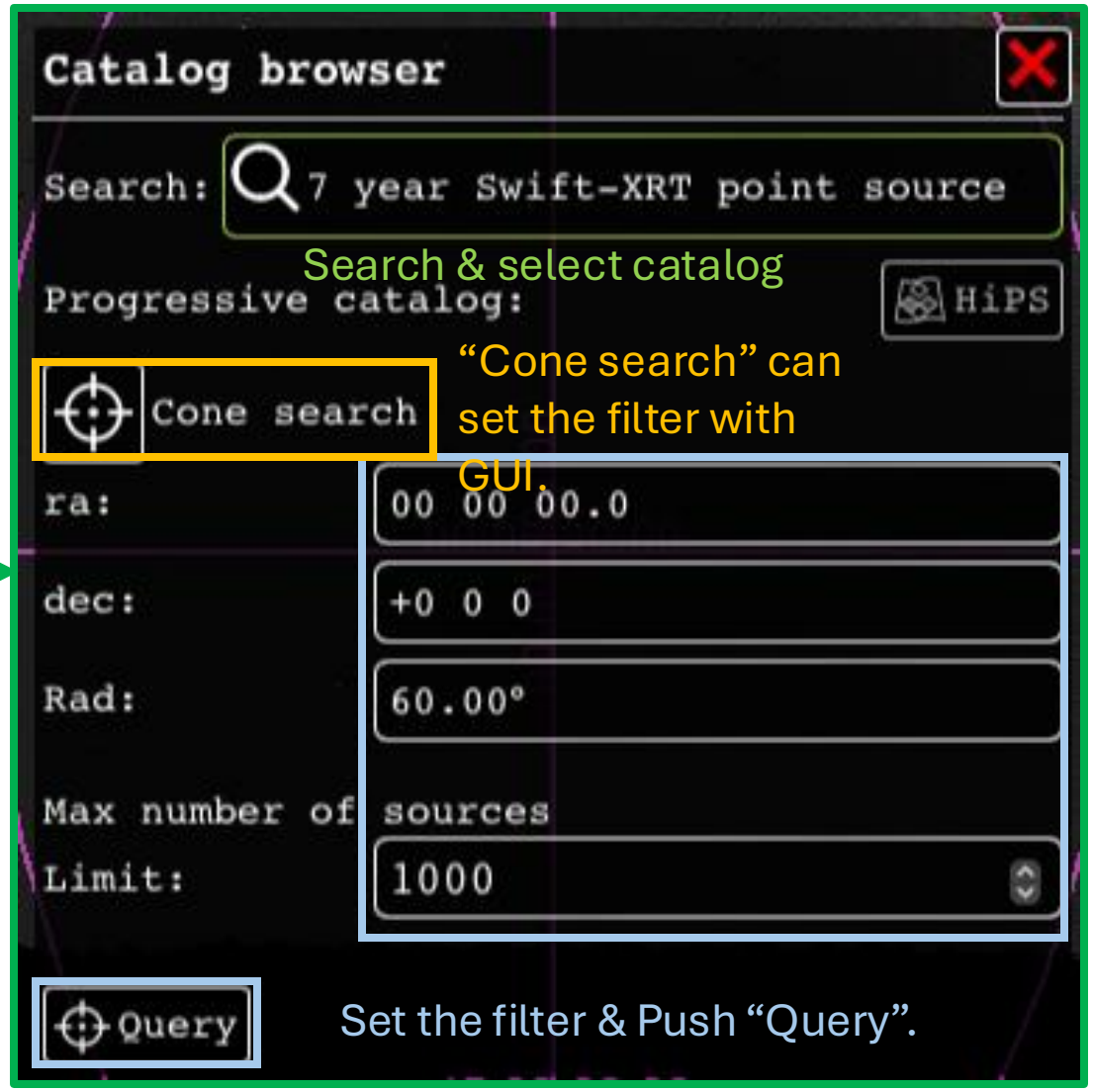


Viewer: Catalog



Display catalogs

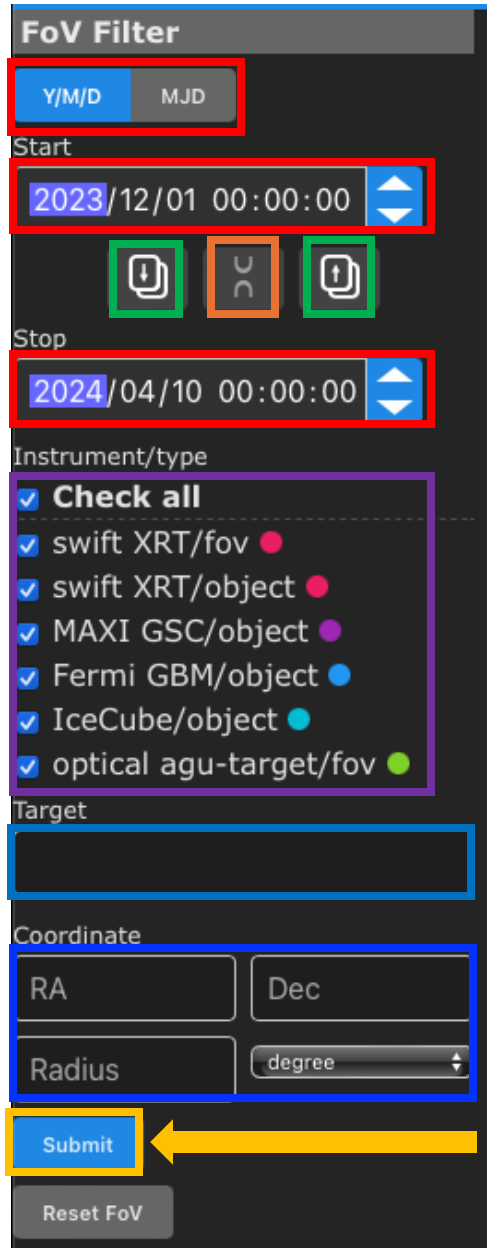




Unavailable catalogs can be added to the "Catalog" section.

The current catalogs listed are temporal for testing.

Viewer: FoV Filter



Objects/FoV can be filtered by time. "Y/M/D" and "MJD" can be switched by the button.

Upward (downward) arrow copy Stop (Start) time to Start (Stop) time.

Start and Stop times increase/decrease independently.

Start and Stop times increase/decrease synchronized.

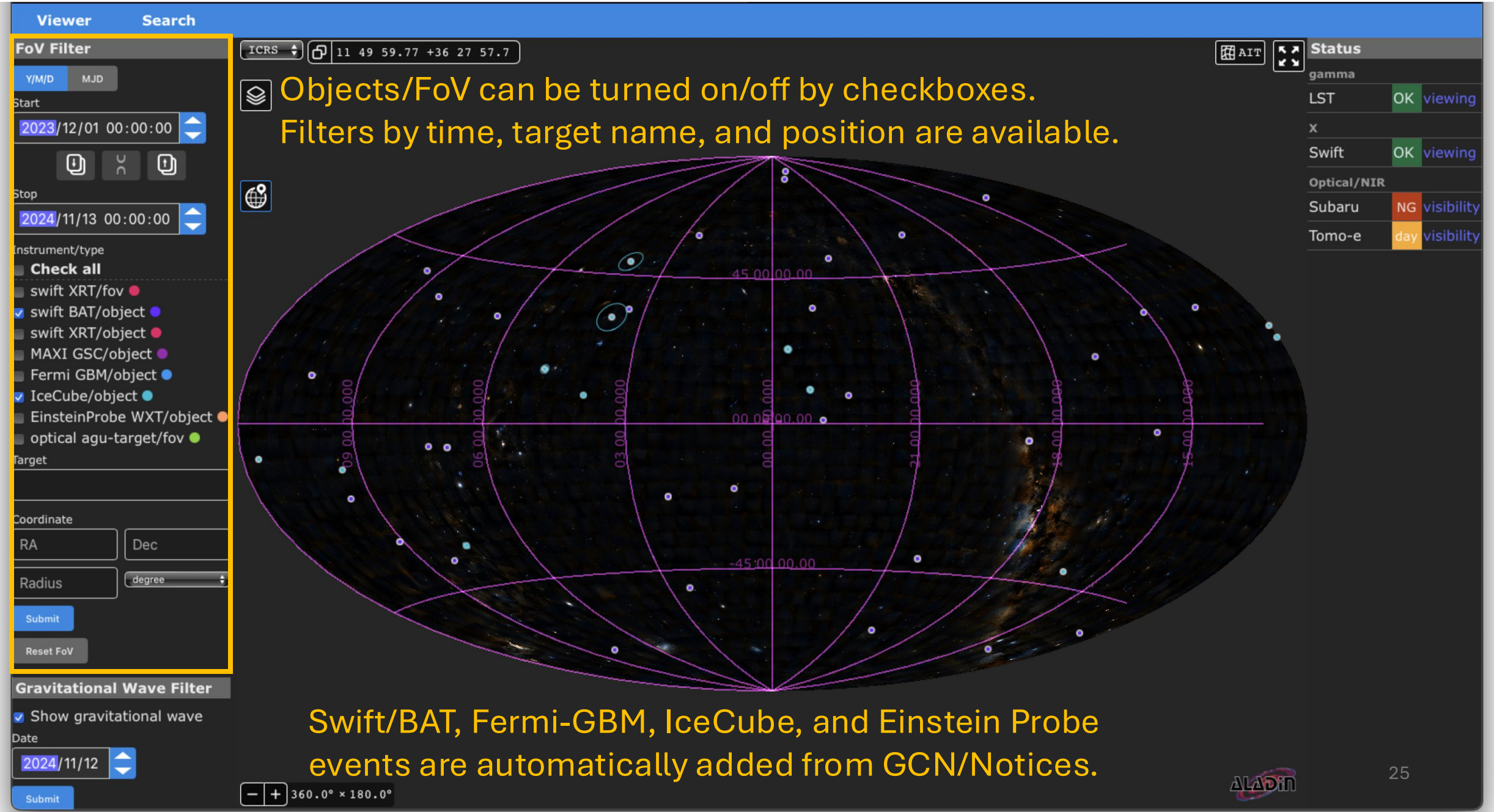
Checkboxes can turn each item on/off.

Events/objects can be filtered by the name.

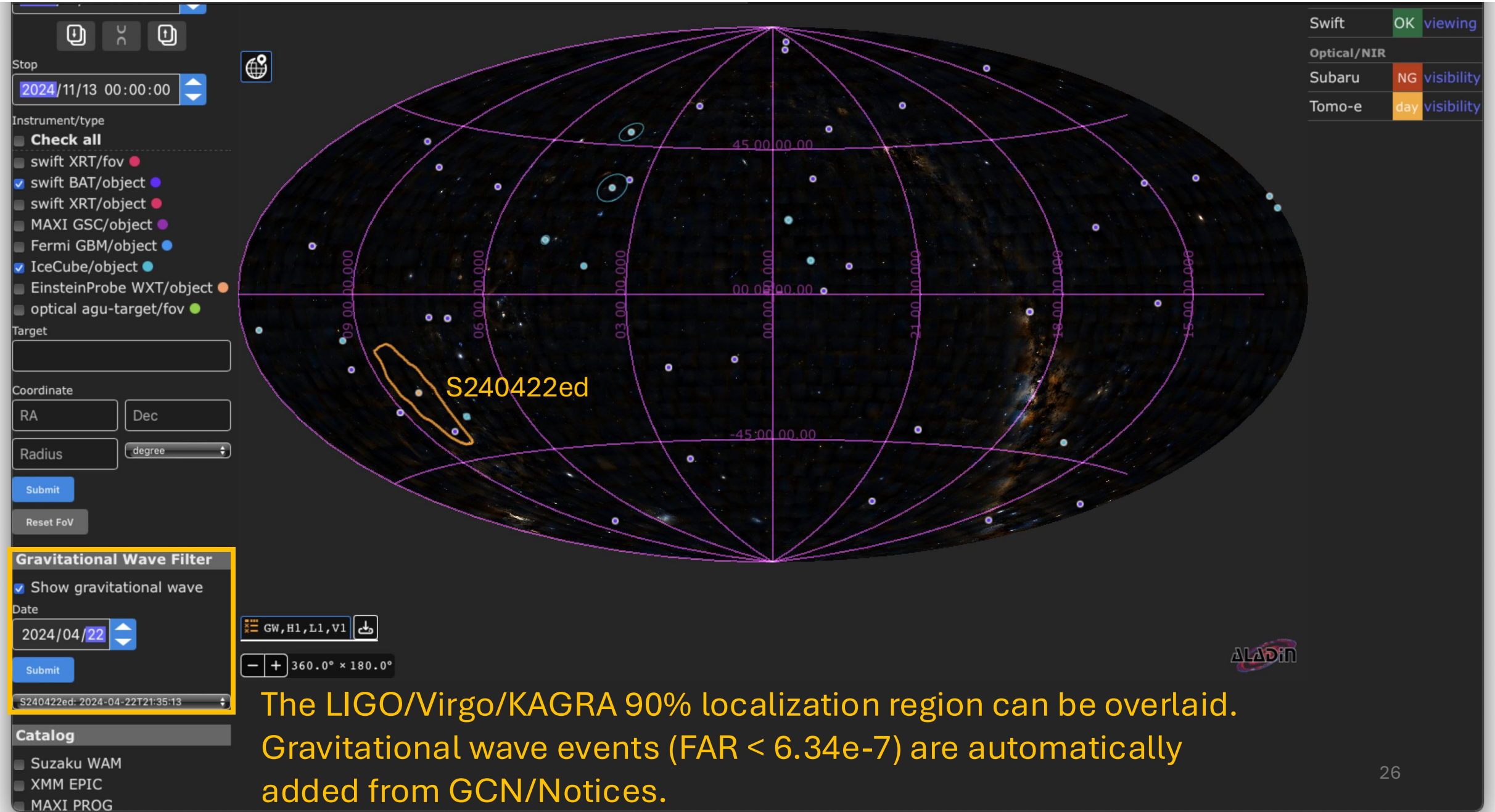
If you input central position (equatorial coordinates) and radius (degrees, arcmin, arcsec), Objects/FoV can be filtered by the circle.

"Submit" applies the settings above.

Viewer: FoV Filter

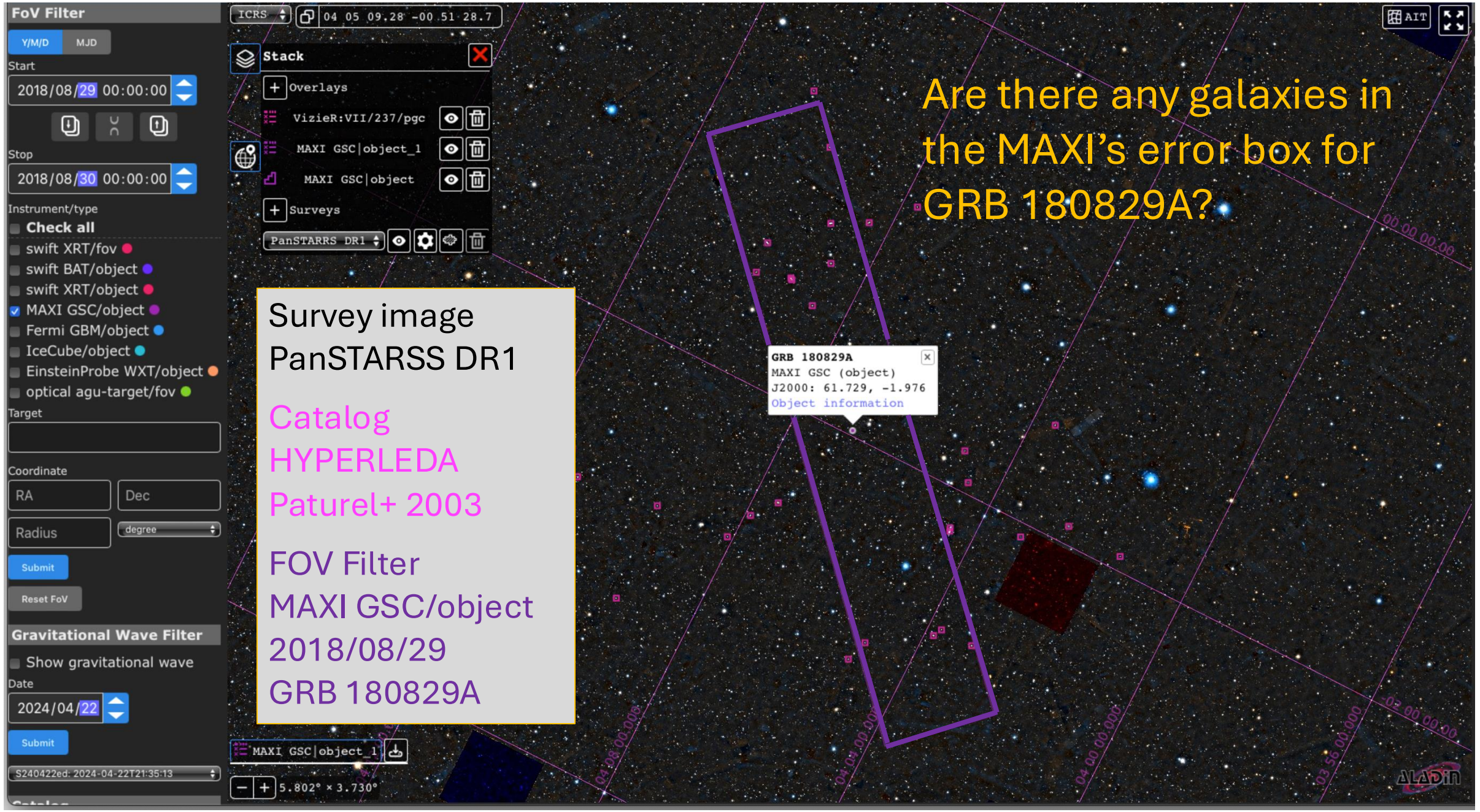


Viewer: Gravitational Wave Filter

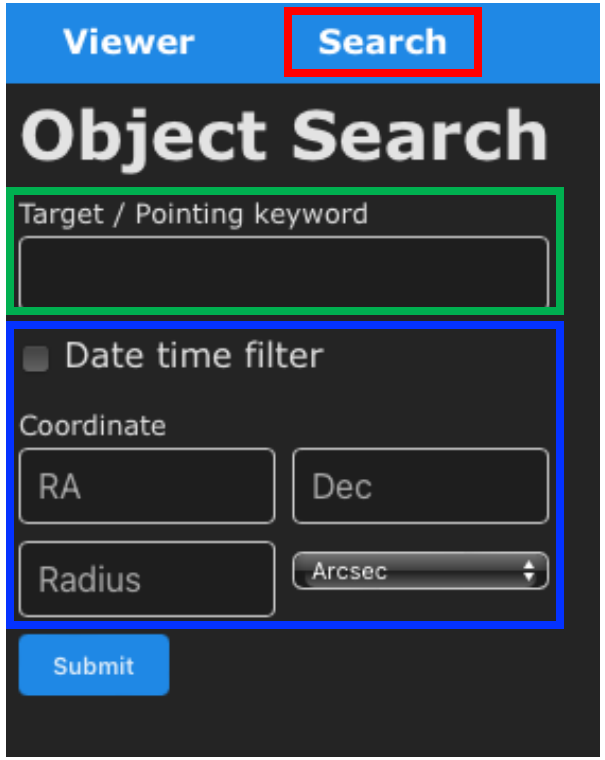


The LIGO/Virgo/KAGRA 90% localization region can be overlaid.
Gravitational wave events (FAR < 6.34e-7) are automatically added from GCN/Notices.

Use example: GRB180829A



Object Search

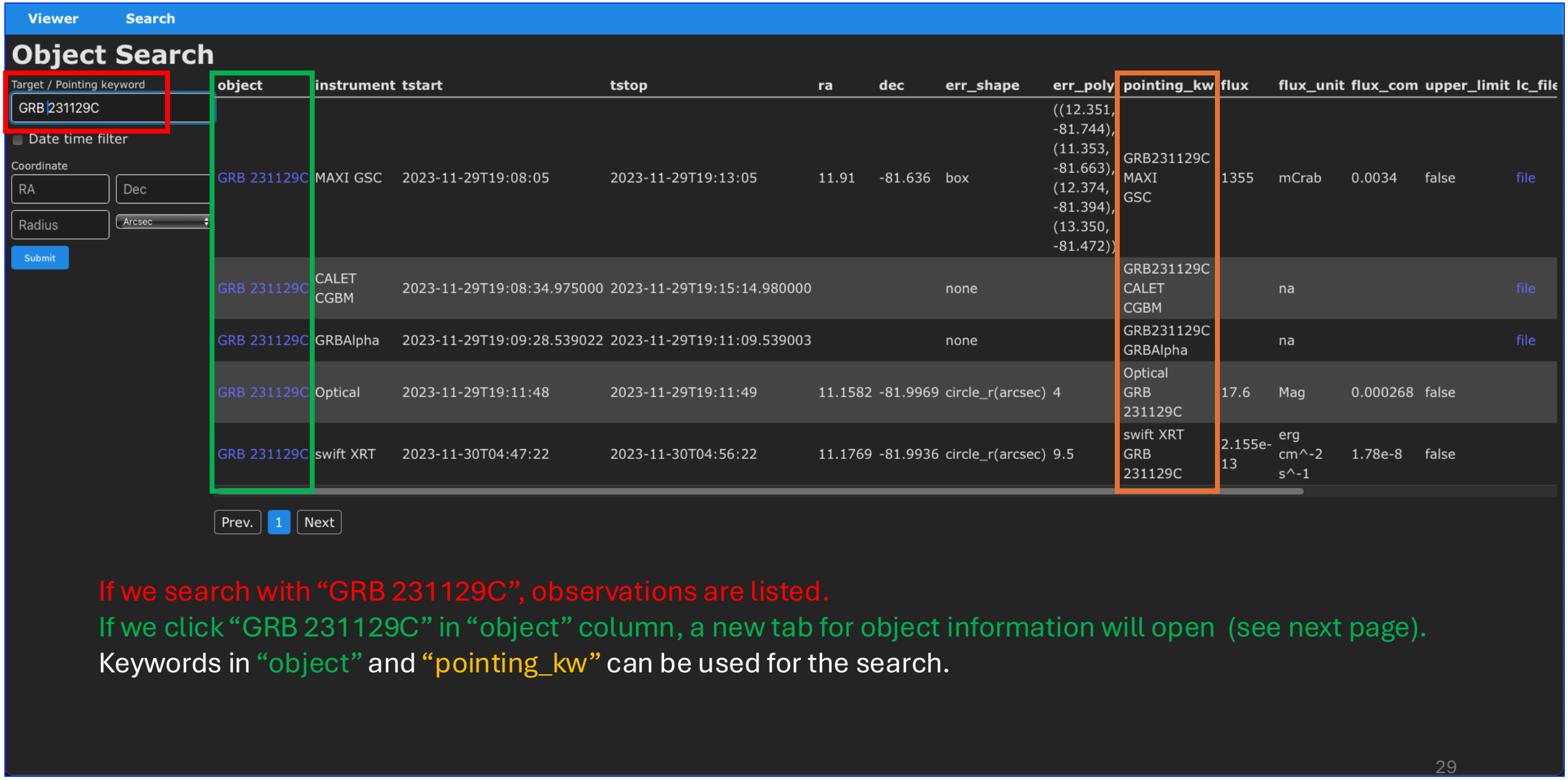


Click “Search” to switch to object search.

Search with Target (Object) / Pointing keyword.
The exact match is only available (a partial match will be available in the future).

The filters by time and coordinate are also available in the same way as the Viewer.

Object Search (GRB 231129C)



object	instrument	tstart	tstop	ra	dec	err_shape	err_poly	pointing_kw	flux	flux_unit	flux_com	upper_limit	lc_file
GRB 231129C	MAXI GSC	2023-11-29T19:08:05	2023-11-29T19:13:05	11.91	-81.636	box	((12.351, -81.744), (11.353, -81.663), (12.374, -81.394), (13.350, -81.472))	GRB231129C MAXI GSC	1355	mCrab	0.0034	false	file
GRB 231129C	CALET CGBM	2023-11-29T19:08:34.975000	2023-11-29T19:15:14.980000			none		GRB231129C CALET CGBM		na			file
GRB 231129C	GRBAlpha	2023-11-29T19:09:28.539022	2023-11-29T19:11:09.539003			none		GRB231129C GRBAlpha		na			file
GRB 231129C	Optical	2023-11-29T19:11:48	2023-11-29T19:11:49	11.1582	-81.9969	circle_r(arcsec)	4	Optical GRB 231129C	17.6	Mag	0.000268	false	
GRB 231129C	swift XRT	2023-11-30T04:47:22	2023-11-30T04:56:22	11.1769	-81.9936	circle_r(arcsec)	9.5	swift XRT GRB 231129C	2.155e-13	erg cm^-2 s^-1	1.78e-8	false	

If we search with “GRB 231129C”, observations are listed.

If we click “GRB 231129C” in “object” column, a new tab for object information will open (see next page).

Keywords in “object” and “pointing_kw” can be used for the search.

Object Search (GRB 231129C)

GRB 231129C

viewer	object	instrument	tstart	tstop	ra	dec	pointing_kw	flux	flux_unit	flux_com	upper_limit	lc_file	spec_url	image_url	source_url	filter
viewer	GRB 231129C	MAXI GSC	2023-11-29T19:08:05	2023-11-29T19:13:05	11.91	-81.636	GRB231129C MAXI GSC	1355	mCrab	0.0034	false	file			source	2-20keV
viewer	GRB 231129C	CALET CGBM	2023-11-29T19:08:34.975000	2023-11-29T19:15:14.980000			GRB231129C CALET CGBM		na			file			source	40-1000keV
viewer	GRB 231129C	GRBAlpha	2023-11-29T19:09:28.539022	2023-11-29T19:11:09.539003			GRB231129C GRBAlpha		na			file			source	80-950keV
viewer	GRB 231129C	Optical	2023-11-29T19:11:48	2023-11-29T19:11:49	11.1582	-81.9969	Optical GRB 231129C	17.6	Mag	0.000268	false				source	unfiltered
viewer	GRB 231129C	swift XRT	2023-11-30T04:47:22	2023-11-30T04:56:22	11.1769	-81.9936	swift XRT GRB 231129C	2.155e-13	erg cm^-2 s^-1	1.78e-8	false		spec	image	source	0.3-10 keV

Flux

X Scale

Linear

Switch the x-axis scale (Linear/Log)

T0

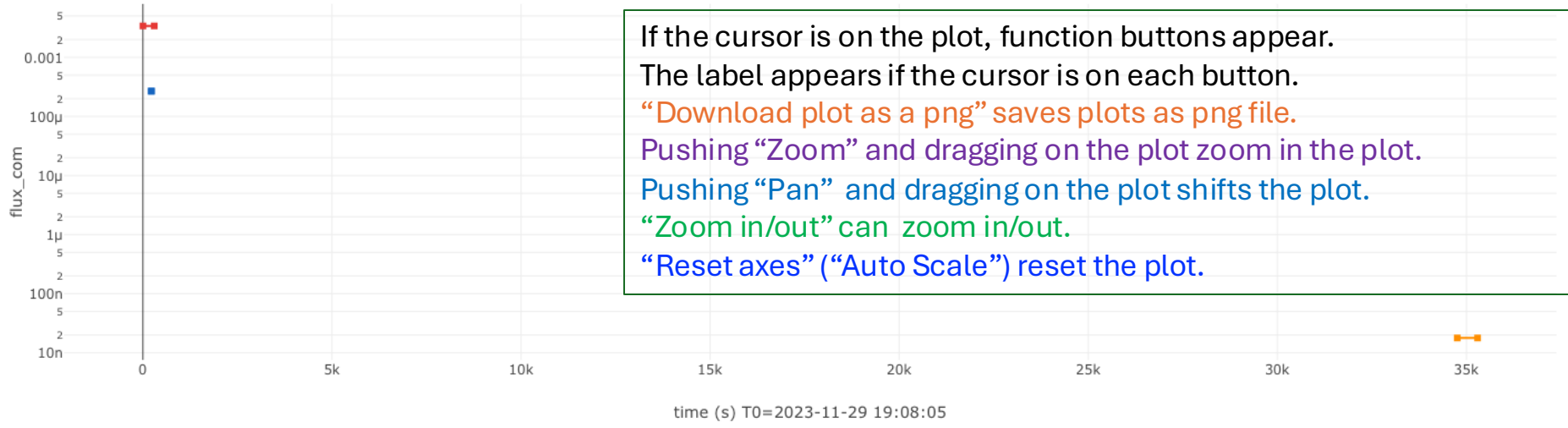
2023/11/29 19:08:05

Update chart | Reset

Change offset time (T0)

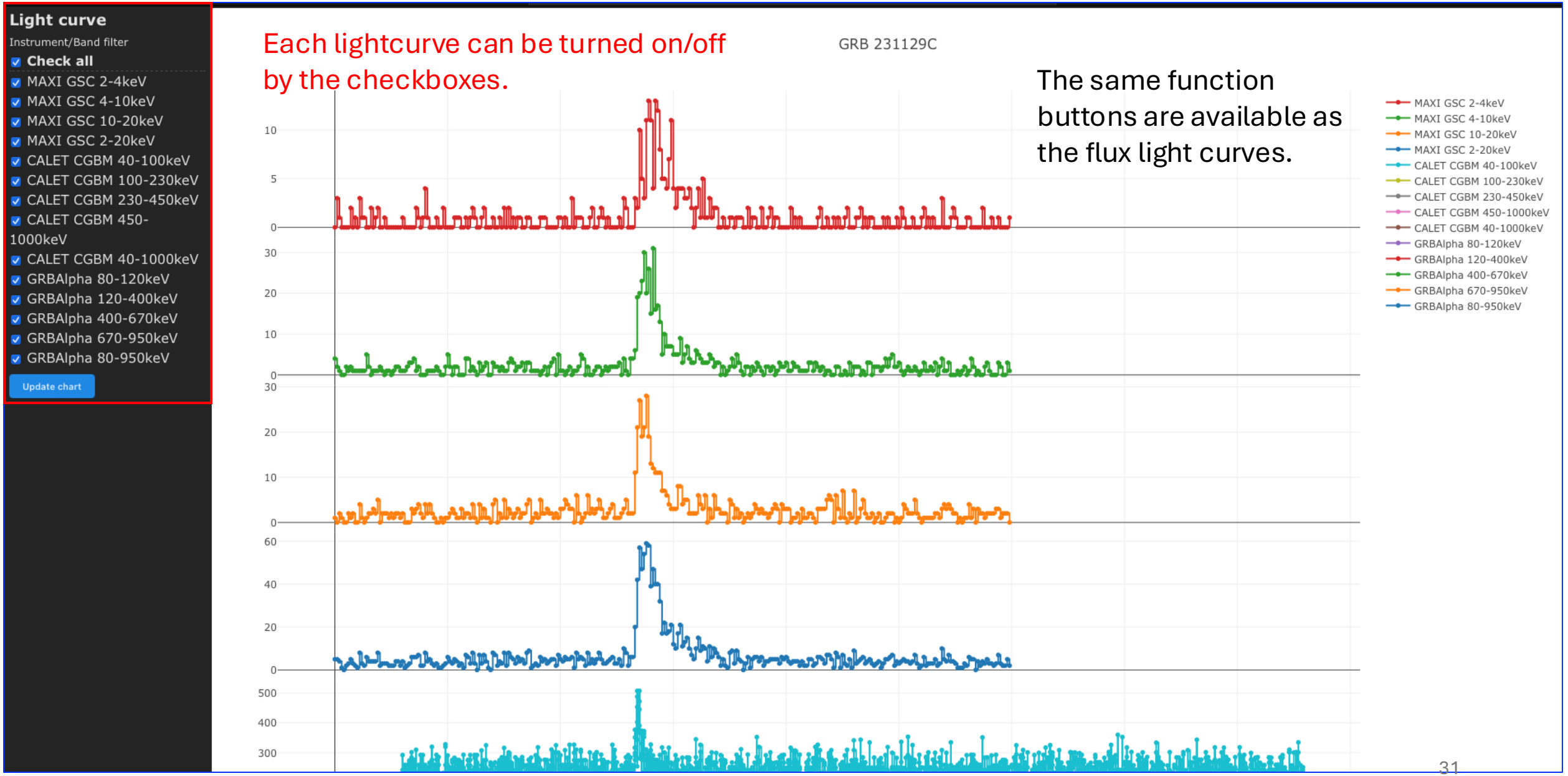
"update chart" apply settings changed.

Flux of GRB 231129C

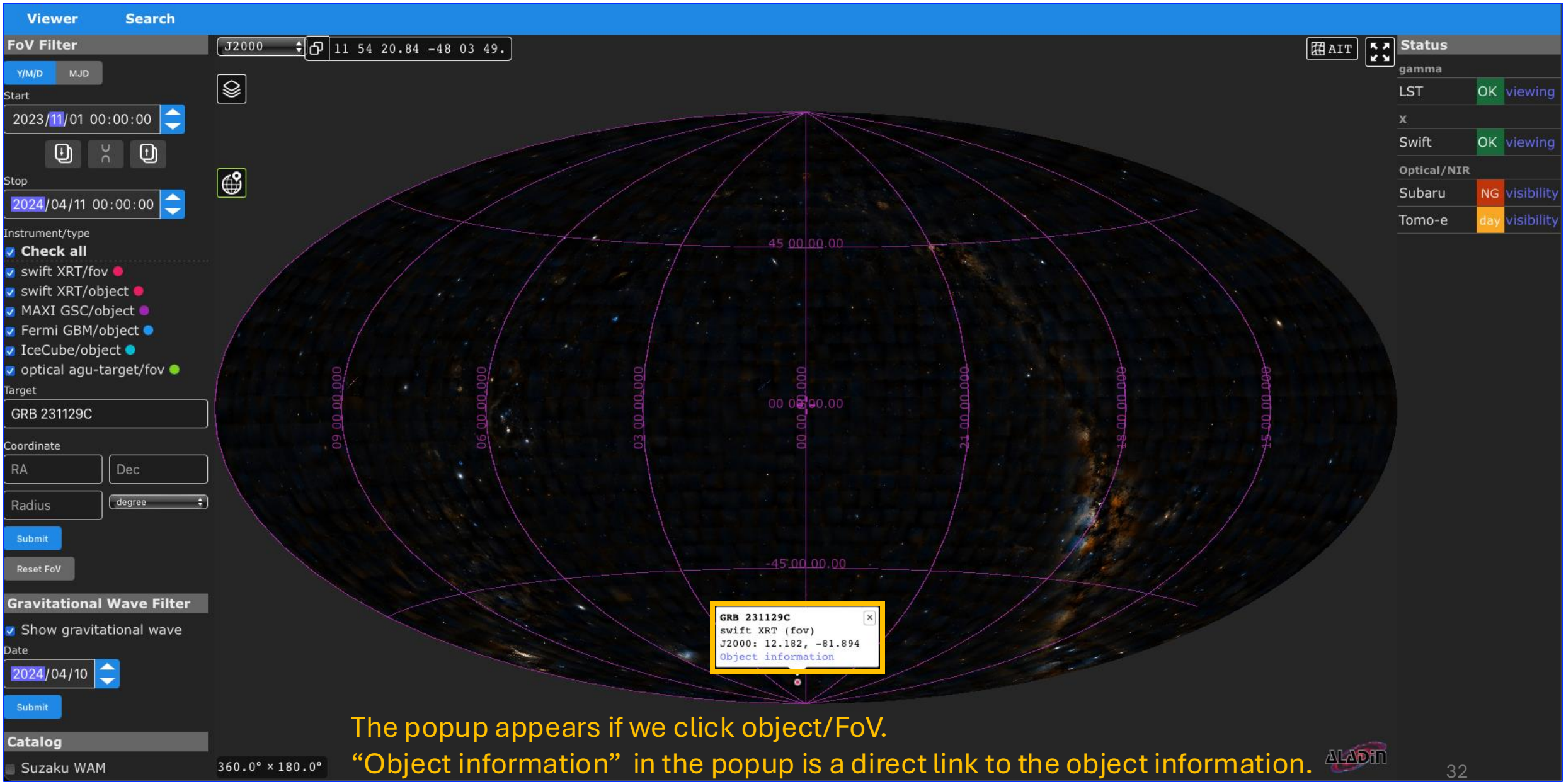


If the cursor is on the plot, function buttons appear.
The label appears if the cursor is on each button.
"Download plot as a png" saves plots as png file.
Pushing "Zoom" and dragging on the plot zoom in the plot.
Pushing "Pan" and dragging on the plot shifts the plot.
"Zoom in/out" can zoom in/out.
"Reset axes" ("Auto Scale") reset the plot.

Object Search (GRB 231129C)



Link from Viewer to Object information



The popup appears if we click object/FoV.
“Object information” in the popup is a direct link to the object information.

Registered data (2024/11/14)

- Swift XRT/fov
  - observation history (once / day)
- Swift BAT/object
  - every GCN/Notice (near real-time)
- MAX GSC/object
  - MAXI GRBs (manual)
- Fermi-GBM/object
  - every GCN/Notice (near real-time)
- IceCube/object
  - ICECAT-1 (Gold & Bronze, 2011-2023) https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/SCRUCD
  - every GCN/Notice (near real-time)
- optical agu-target/fov (temporary)
  - S230927ba (for testing)

Gravitational wave filter

- GW150914
- GW170817
- O4b (FAR < 6.34e-7)
  - every GCN/Notice (near real-time)

Light curves (count)

- GRB 241129C (for testing)
  - MAXI/GSC
  - CALET/GBM
  - GRBAlpha
- GRBAlpha GRBs
- VZLUSAT-2 GRBs
- Swift/BAT GRBs (~ 2023)

Light curves (flux)

- GRB 241129C (for testing)
  - MAXI/GSC
  - Swift/XRT
  - Optical