

COMMUNITY COORDINATION TO MAXIMIZE SCIENCE RETURN FOR MULTI-MESSENGER ASTROPHYSICS

AN ECOSYSTEM OF SERVICES



Presenter: R. Street,
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In collaboration with SCIMMA



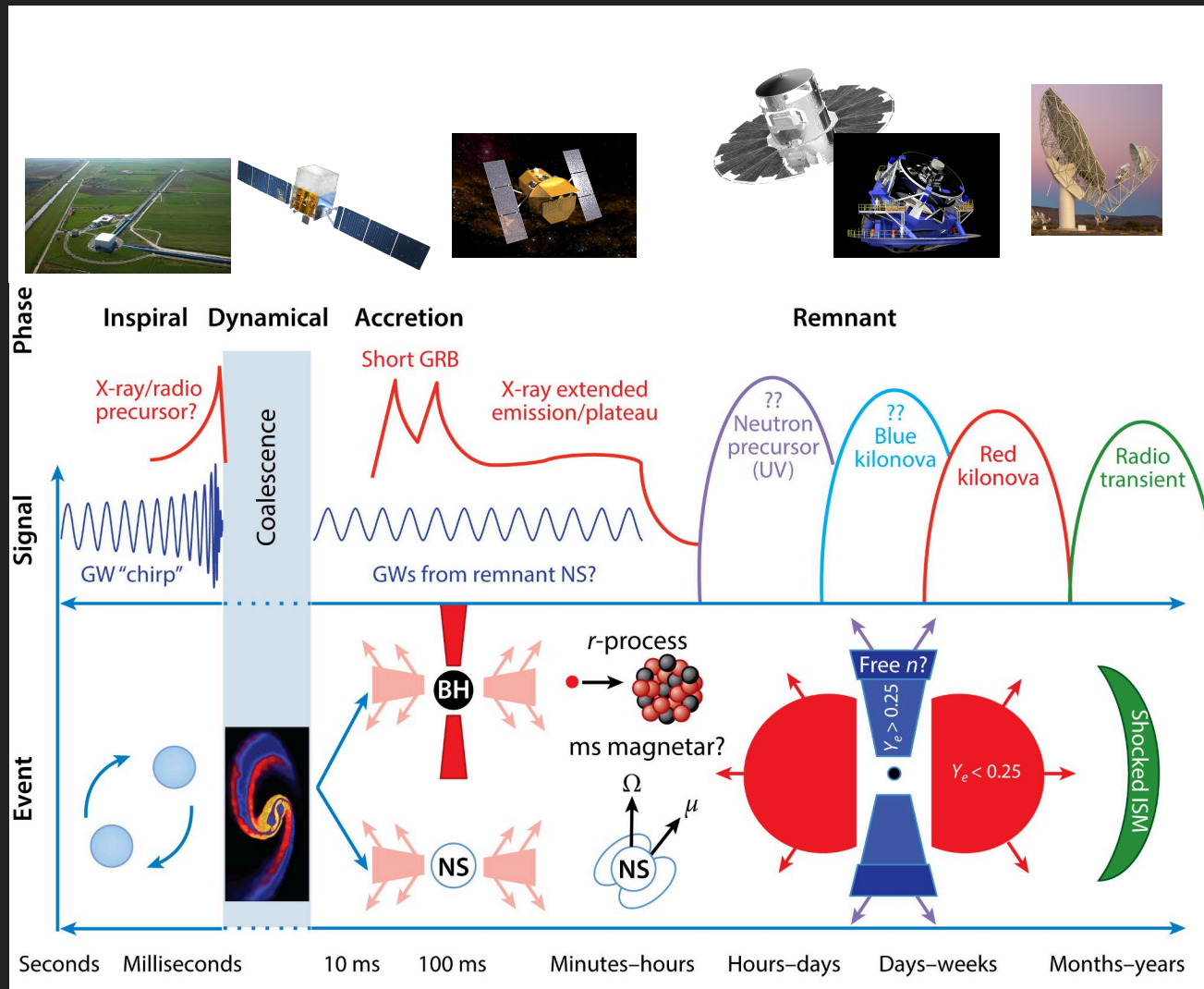
This material is based upon work supported by the National Science Foundation under Grant No. 2209852

INFORMATION SHARING IS KEY

Detection is not the same as understanding

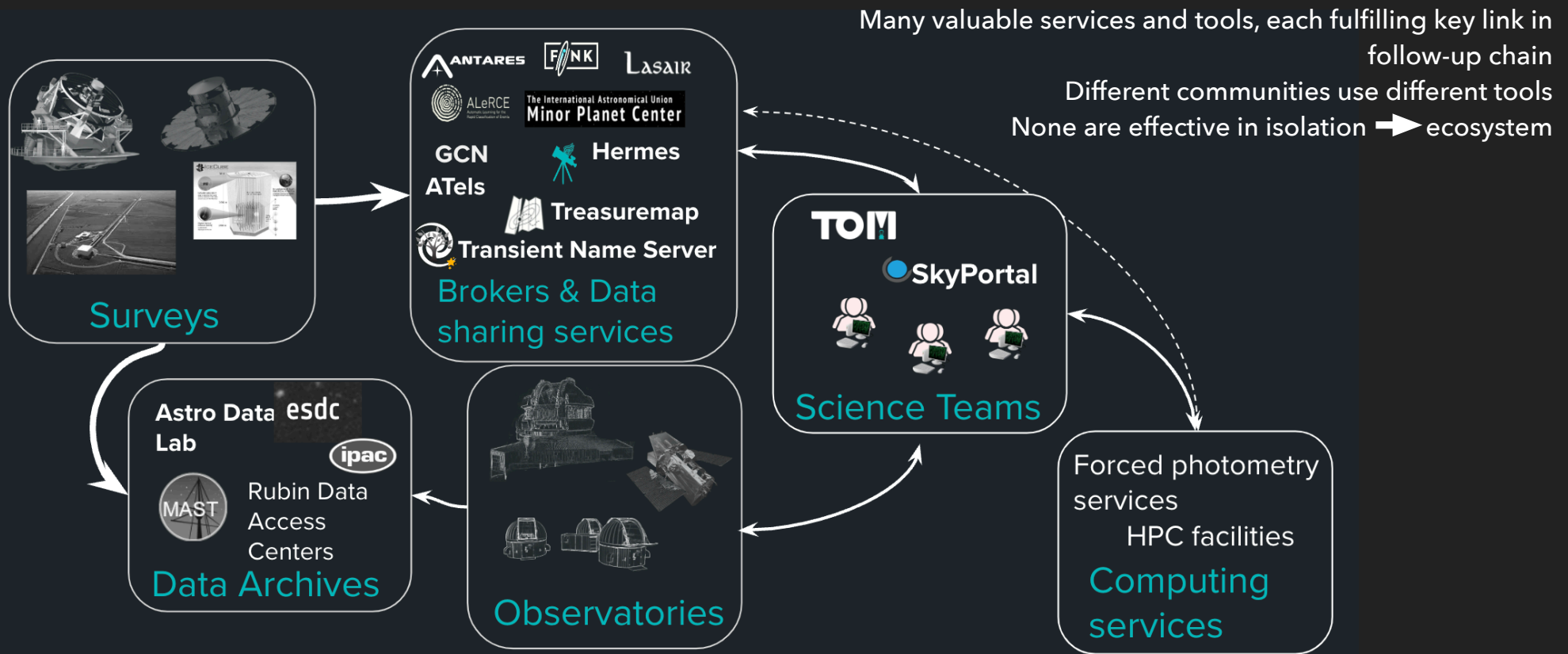
Time-domain astrophysics requires the synthesis of information from multiple wavelengths and messengers

...often in real-time.
Lots of information.



Credit: Fernández & Metzger, 2016, LIGO/Virgo/Kagra, NASA Swift, Fermi, Gaia, Rubin Obs., MeerKat

TIME DOMAIN SCIENCE DEPENDS ON A NETWORK OF SOFTWARE SERVICES



Just a sample of the services & tools available



Image credits: Rubin Obs/AURA, Gaia/ESA, LIGO/Virgo/Kagra, IceCube, ANTARES, Alerce, Fink, Lasair, MPC, Gemini, LCO, NASA/Swift

HERMES [Submit New Non-localized Event](#) [Submit Candidates](#) [Submit Non-Detections](#) [Submit Search Pointings](#) [Report Photometry](#) [Report Spectroscopy](#) [Report Observatory Availability](#)

Candidate Submission Form

Title: Topic:

Event ID: Authors:

ID	RA	Dec	Discovery Date	Telescope	Instrument	Band	Brightness	Brightness Error	Brightness Unit	
AT2020vr	07:34:06.13	+16:46:00.51	58862.15	ztf	ztf	g	20.9	0.209	AB mag	
AT2020vs	07:24:28.50	+16:12:45.85	58862.15	ztf	ztf	g	21.4	0.214	AB mag	
AT2020vu	07:16:47.14	+10:37:18.97	58862.15	ztf	ztf	g	21.6	0.216	AB mag	
AT2020wc	07:03:22.07	+27:22:41.21	58862.16	ztf	ztf	g	20.7	0.207	AB mag	

[Add Row](#)

Additional Data Elements:

Key	Value	
email	ajct@iaa.es	

[Add Row](#)

Upload Data to Main Table

A CSV file with the proper header can be uploaded to automatically fill the above table. Click the button below to copy this header to your clipboard.

[Copy CSV Header](#) [Choose File](#) test-hermes-candidates.csv

Message:

[Edit](#) [Preview](#)

Following the detection of [AT2020vr/ZTF20aafdztz](#), [AT2020vt/ZTF20aafemum](#), [AT2020wa/ZTF20aafedbk](#), and [AT2020wc/ZTF20aafeccu](#) (Andreoni et al. GCNC 26741) within the error area of the GW event S200114f (LVC, GCNC 26734), we obtained optical spectra covering the range 3700-7400 Å with the 10.4m GTC telescope equipped with OSIRIS in La Palma (Spain) starting on Jan 15, 00:01 UT.

For [AT2020vr/ZTF20aafdztz](#), we measure $m = 19.80 \pm 0.02$ on Jan 15, 00:08 UT. The GTC spectrum is consistent with a SN Ia at about 6 days before maximum at redshift $z = 0.213 \pm 0.001$, consistent with the redshift of the host galaxy derived from the emission lines ($z = 0.2132 \pm 0.0005$).

[Submit](#) [Clear Form](#)



Scalable Kafka-based streaming service for MMA developed by SCIMMA.org in collaboration with LCO



Flexible new message service where users can share almost any data

Machine readable

GUI + API submission

CI/Logon Identity and Access Management

Supports submission to GCN Classic over Kafka via email

Filter by Topic

Search Terms

⌵ TIMESTAMP	TOPIC	⌵ TITLE	⌵ SUBMITTER
a few seconds ago	hermes.test	A new test message	ahowell@lco.global
3 minutes ago	gcn.circular	GRB 230510A: CALET Gamma-Ray Burst Monitor detection	Hop gcn.circular
19 minutes ago	igwn.gwalert	MS230511f - RETRACTION	cody.messick-30d512c8
24 minutes ago	igwn.gwalert	MS230511f - PRELIMINARY	cody.messick-30d512c8
29 minutes ago	igwn.gwalert	MS230511f - PRELIMINARY	cody.messick-30d512c8
an hour ago	igwn.gwalert	MS230511e - RETRACTION	cody.messick-30d512c8
an hour ago	igwn.gwalert	MS230511e - PRELIMINARY	cody.messick-30d512c8
an hour ago	igwn.gwalert	MS230511e - PRELIMINARY	cody.messick-30d512c8
2 hours ago	igwn.gwalert	MS230511d - RETRACTION	cody.messick-30d512c8
2 hours ago	igwn.gwalert	MS230511d - PRELIMINARY	cody.messick-30d512c8

« < 1 2 3 4 ... > »

Show: 10

A new test message

Message ID: 96920b4e

I observed SN 2023bee at RA = 134.048461

TARGETS TABLE

PHOTOMETRY TABLE

REFERENCES TABLE

EXTRA KEYPAIRS

[Show JSON:](#)

TARGET AND OBSERVATION MANAGER SYSTEMS (TOMS)

The screenshot shows the BHTOM web interface. On the left, the target details for 'Gaia22awa' are listed:

Names	Gaia22awa
Target Type	SIDEREAL
Right Ascension	286.21651
Declination	19:04:51.962
Epoch	-8.56685
Galactic Longitude	-08:34:0.660
Galactic Latitude	2000.0
gaia_alert_name	26.793101608219274
calib_server_name	-6.860884191924089
ztf_alert_name	Gaia22awa
aavso_name	ivo://Gaia22awa
gaiadr2_id	
TNS_ID	AT2022eii
classification	microlensing event candidate
tweet	False
jdlastobs	2460108.59446759
maglast	15.11
priority	0.0

The main panel shows a 'Photometry' plot with a legend on the right. The legend includes filters: i(APASS), V(APASS), i(PS1), r(APASS), B(APASS), r(PS1), g(APASS), g(PS1), G_Gaia, B(GaiaSP), z(PS1), J(ZMASS), i(GaiaSP), g(GaiaSP), r(GaiaSP), I(GaiaSP), and V(GaiaSP). The plot shows a light curve with a significant dip in magnitude around 2022.5. Below the plot is a 'Download photometry data' button.

Software to manage all aspects of science programs

Interface directly with services inc. telescopes, alert brokers and archives

Open-source packages:

 **TOM Toolkit**

 **SkyPortal**

Black Hole TOM system by Maja Jobłowska, Łukasz Wyrzykowski, Poland
Built with TOM Toolkit



TOM TOOLKIT – NEW TOOLS FOR MMA

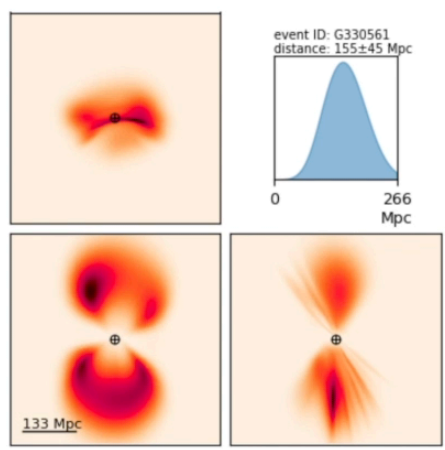
- ▶ **tom_alertstreams**: New app to enable TOM to listen to Kafka streams
- ▶ **tom_classifications**: Tool for comparing and visualizing alert classifications from brokers By Brendan Mills, UCSB
- ▶ **tom_nonlocalized_events**: New app for GW, neutrino detections

S190425z **Update 2** **MassGap 0.00** **NSBH 0.00** **90%: 7460.74** **FAR 4.538e-13**

BNS 0.99 **Terrestrial 0.00** **BBH 0.00** **50%: 1377.65** **NS/Rem 1.00**

Identifier	Timestamp	From	Subject
▶ 24767	2019-06-06 05:47:28	Paul Kuin at MSSL	LIGO/Virgo S190425z: Swift UVOT - no new sources identified, and a summary of the Swift UVOT processing of GW triggers.
▶ 24673	2019-05-28 05:21:03	Bruce Gendre at UVI	LIGO/Virgo S190425z: No counterpart candidate in Zadko-GRANDMA observations.
▶ 24459	2019-05-10 02:16:15	Alexander Kann at IAA-CSIC	LIGO/Virgo S190425z: CAHA-GRANDMA Observation of the Swift UVOT Source
▶ 24417	2019-05-07 06:24:07	Dmitry Svinkin at Ioffe Institute	LIGO/Virgo S190425z: Konus-Wind observations
▶ 24367	2019-05-02 08:57:30	Jozsef Vinko at Konkoly Observatory	LIGO/Virgo S190425z: Konkoly imaging of target galaxies
▶ 24366	2019-05-02 08:22:02	Zuzanna Kostrzewa-Rutkowska at SRON	LIGO/Virgo S190425z: Gaia Photometric Alerts transient candidates

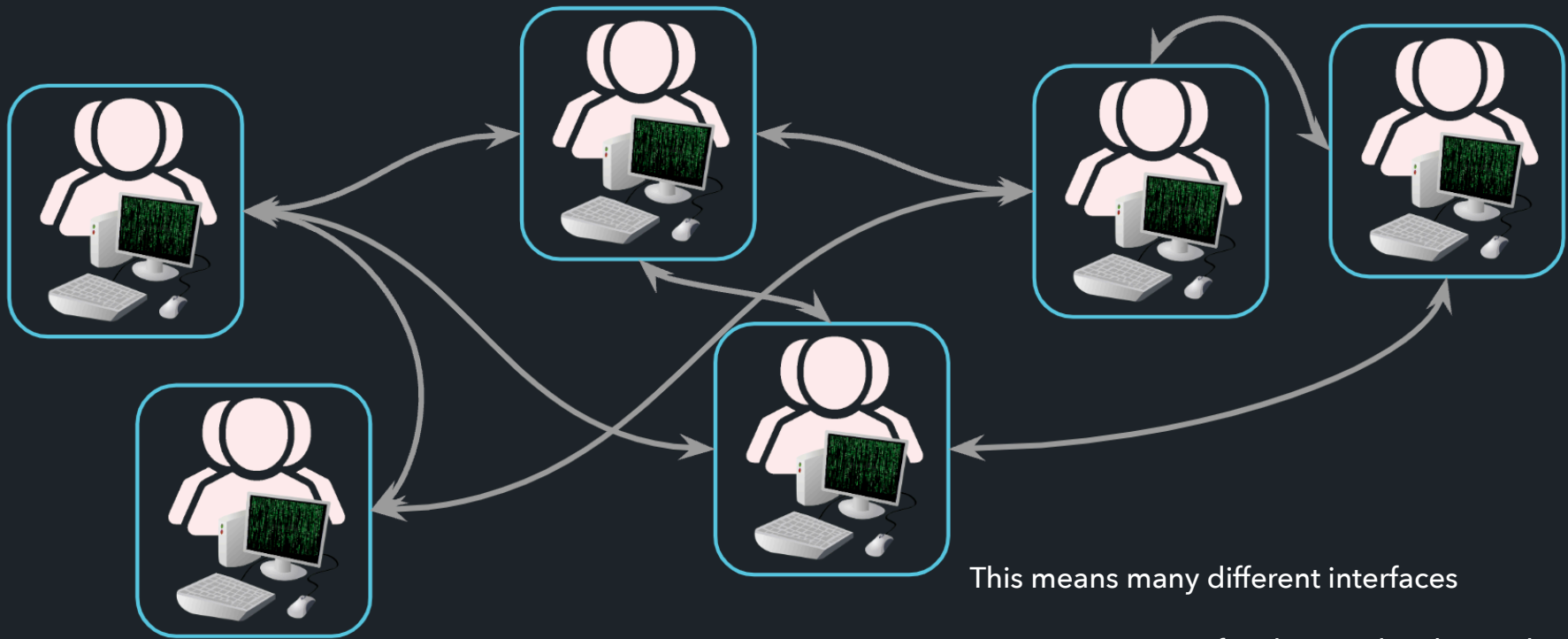
GraceDB BAYESTAR Images



DATA SHARING BETWEEN TEAMS

Independent research teams want to share results and coordinate

Different teams run independent systems - TOMs/SkyPortal/own software



This means many different interfaces

Common services for sharing data lower the barrier for coordination

TOM sharing data via Hermes

TNSEx 2.0 Home Targets Alerts Scheduling Data Users TNS Targets Search by name or coord Curtis McCully Logout

SN 2022wpy SN Ia $z = 0.0152$ 04:46:28.004 -04:47:23.68
71.6167 -4.7899

Overview Details Observations Manage Data Observing Runs Images Photometry Spectroscopy

Known as:

- AT 2022wpy
- SN 2022wpy
- ATLAS22bhuv

Add a new name

Science Interests:

- Classification
- la
- Nearby SNe
- Young SNe

Select Science Tags

Interested Persons:

J. Craig Wheeler
Or Graur


Data Used In:

First name of first author

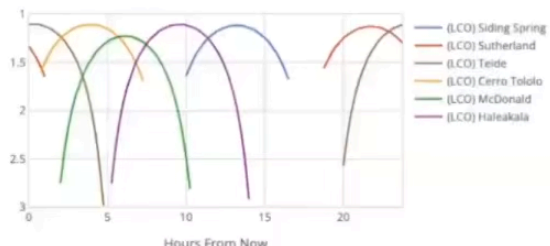
Last name of first author

Brief description of contents of this paper, i.e. "All photometry and

Latest Comments

 Craig Pellegrino on 2022-10-03
In NGC 1659 (64.3 Mpc, dm=34.04), discovered at 19.0 with a 1 day nondetection at 19.6


Latest Visibility at LCO



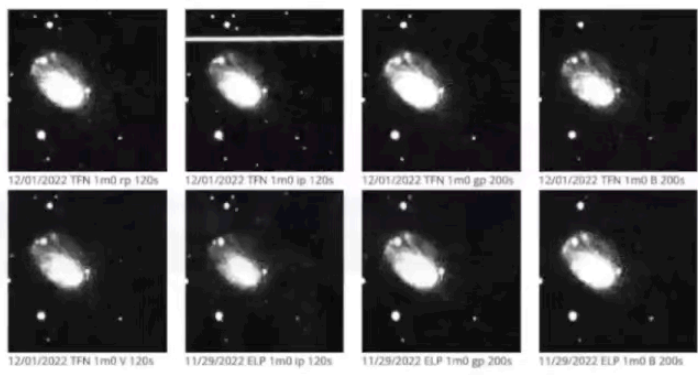
Hours From Now

- (LCO) Siding Spring
- (LCO) Sutherland
- (LCO) Teide
- (LCO) Cerro Tololo
- (LCO) McDonald
- (LCO) Haleakala

Aladin Viewer



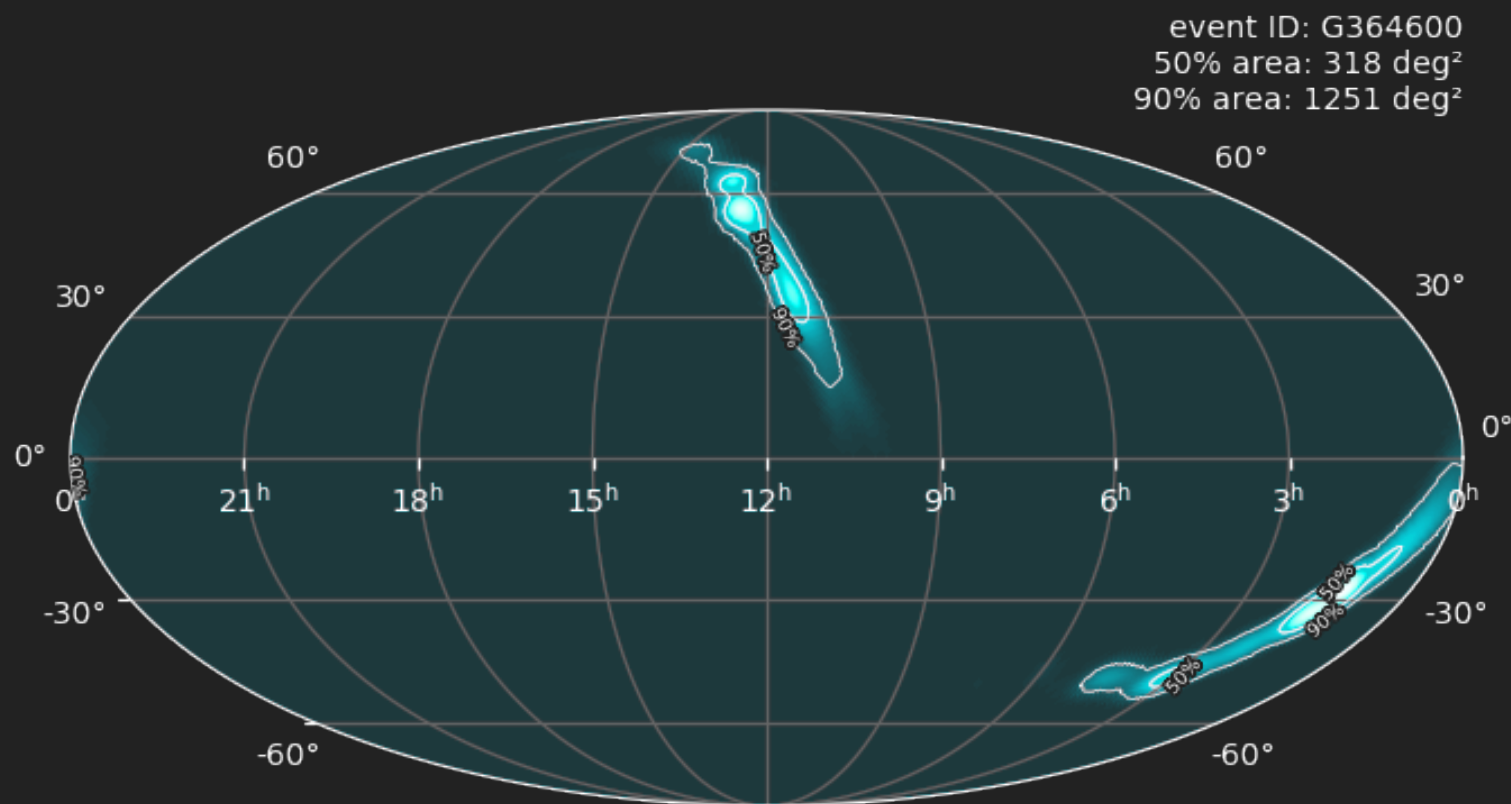
Recent LCO Images



12/01/2022 TFN 1m0 v 120s 12/01/2022 TFN 1m0 ip 120s 12/01/2022 TFN 1m0 gp 200s 12/01/2022 TFN 1m0 B 200s
12/01/2022 TFN 1m0 V 120s 11/29/2022 ELP 1m0 ip 120s 11/29/2022 ELP 1m0 gp 200s 11/29/2022 ELP 1m0 B 200s



COORDINATING OBSERVATIONS



Localization regions often include many candidates

Many teams observing those candidates can duplicate observations of some candidates while neglecting others

Sharing observations helps to ensure a more thorough search for counterparts

If you are using our API, you must update your base URL to 'https'.

Gravitational Wave Treasure Map

Welcome! The Treasure Map is designed to help coordinate electromagnetic followup of gravitational-wave (GW) events. It allows observers to easily report their planned and executed observations in search of counterparts to GW events, and to query the reports of other observers, in a programatic way. The goal is to enable coordination between observatories in order to minimize unnecessary overlap in these searches, and find the counterpart as quickly and as efficiently as possible.

Please [register](#) for an account, so that you can programatically query the Treasure Map. For more details on how to use the Treasure Map see our [User Guide](#).

Please direct any general inquiries to [lair Arcavi](#). If you use the Treasure Map in your research, please cite the [Treasure Map paper](#) in addition to the circulars and/or papers of the teams whose pointing information you use.



Visualization

- Visualize GW alert contours
- Submit your follow-up pointings
- Collaborate with the counterpart search community
- Analyze follow-up

Images from [GW190814](#)

Explore all GW alerts [here](#)



COORDINATING OBSERVATIONS

VOObsLocTAP protocol

ESA's TOBY service

<http://integral.esa.int/toby>

TOOL FOR OBSERVATION VISIBILITY AND SCHEDULE

Source name: M31

Coordinates (RA, DEC) in degrees: 10.6847168, 41.2687524

Start and End (UTC): 2023-06-14T20:0, 2023-12-14T21:0

Start and End (MJD): 60109.83855324, 60292.880219907

Visibility

Instrument	Visibility Period (2023)
INTEGRAL	Continuous observation from July to September
GAIA	Observation windows in July and August
Chandra	Observation windows in July and August
Insight-HXMT	Continuous observation from July to December
XMM-Newton	Observation windows in July and August
NOT	Continuous observation from July to December
Swift	Continuous observation from July to December

Schedule

Instrument	Schedule (2023)
INTEGRAL	Observation windows in July and August
Chandra	Observation windows in July and August, including MKN42, G35 Sngc, WOLF 4, [GH9], NGC 13, LUT 1, 202 SNR, G3, bell 2, A2319, A2319, 70 OPH, V750 A, QSO J, m31, NGC 2, SXDSF, SXDSF, WISEA, AT202 SN 202, 202, NGC 3, AT201, AT202
NuSTAR	Observation windows in July and August
XMM-Newton	Observation windows in July and August



SUMMARY

- ▶ Many excellent tools and services for MMA
- ▶ Maximize science (and lower barriers to entry) if they work as an ecosystem
- ▶ Questions
 - ▶ Community feedback to brokers
 - ▶ IAM
 - ▶ Managing on-demand services
 - ▶ More responsive follow-up facilities
 - ▶ ...