SCIMMA

Scalable Cyberinfrastructure for Multimessenger Astrophysics

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Las Cumbres Observatory

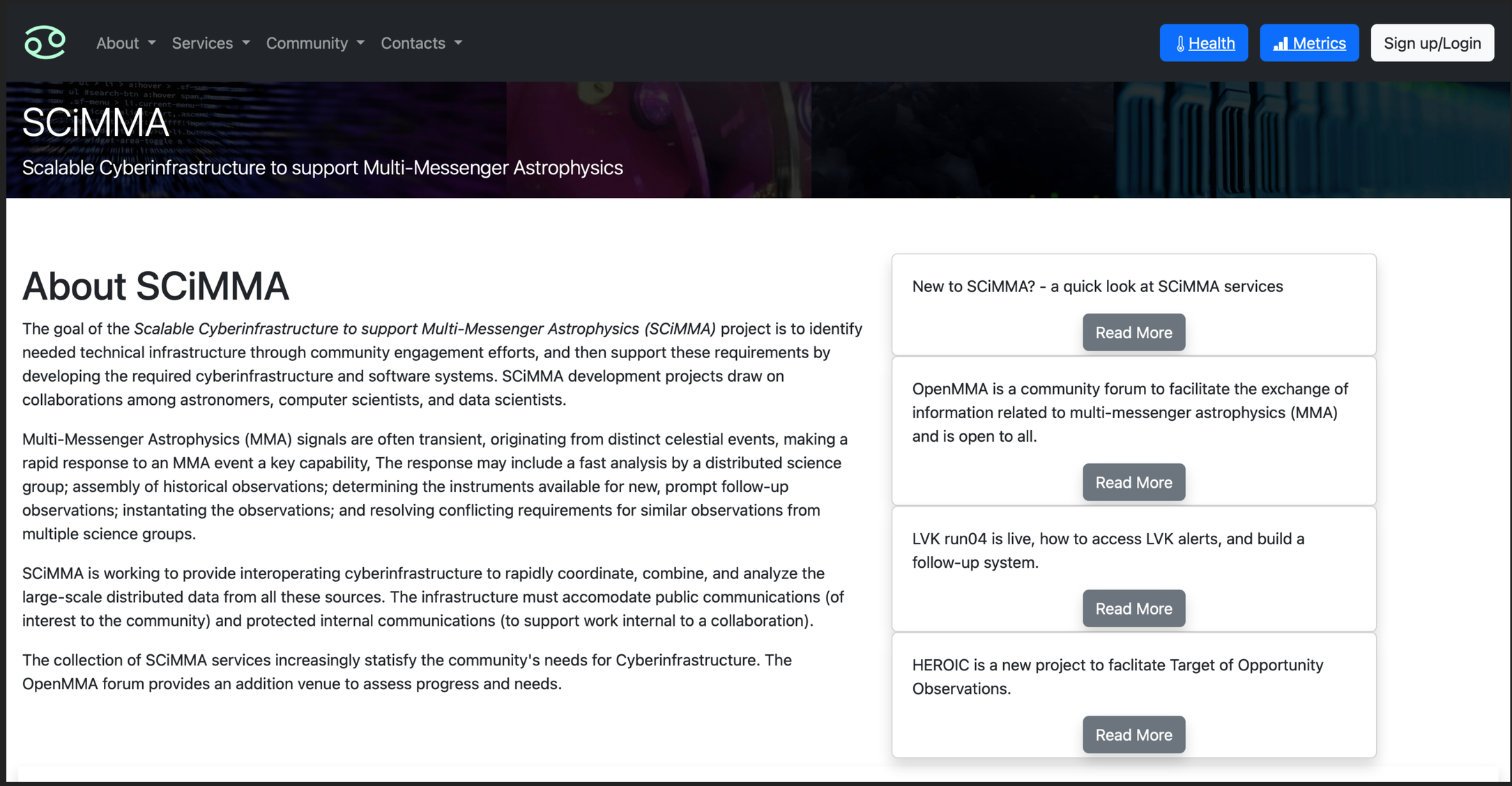
University of California, Santa Barbara

+ SCIMMA, especially Jon Nation (LCO) & Curtis McCully (LCO)

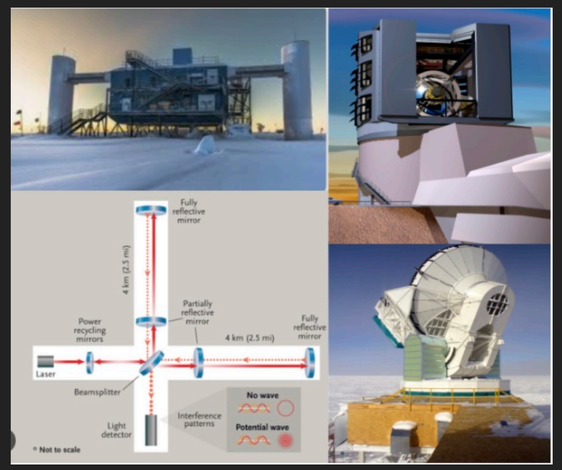
SCIMMA

Scalable Cyberinfrastructure for Multimessenger Astrophysics – scimma.org

NSF-sponsored group to study / build cyberinfrastructure for MMA, including stakeholders from LIGO, IceCube, computing centers, astronomers.



SCIMMA PRODUCTS



Open MMA
Community information

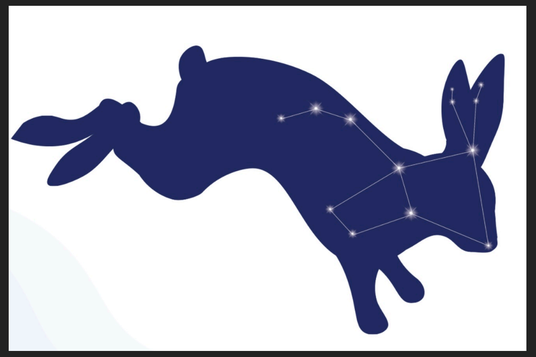
JSON | Avro

alert_type	`{EARLYWARNING, PRELIMINARY, INITIAL, UPDATE, RETRACTION}`
time_created	Time notice was created (UTC, ISO-8601) `2018-11-01T22:34:20Z`
superevent_id	GraceDB ID: `[{T,M}]SYYMMDDabc`. Example: `MS181101abc`
event	
time	Time of event (UTC, ISO-8601), e.g. `2018-11-01T22:22:46.654Z`
far	Estimated FAR in Hz

IGWN alerts
Gravitational wave alerts

Blast

Blast
Host galaxy information

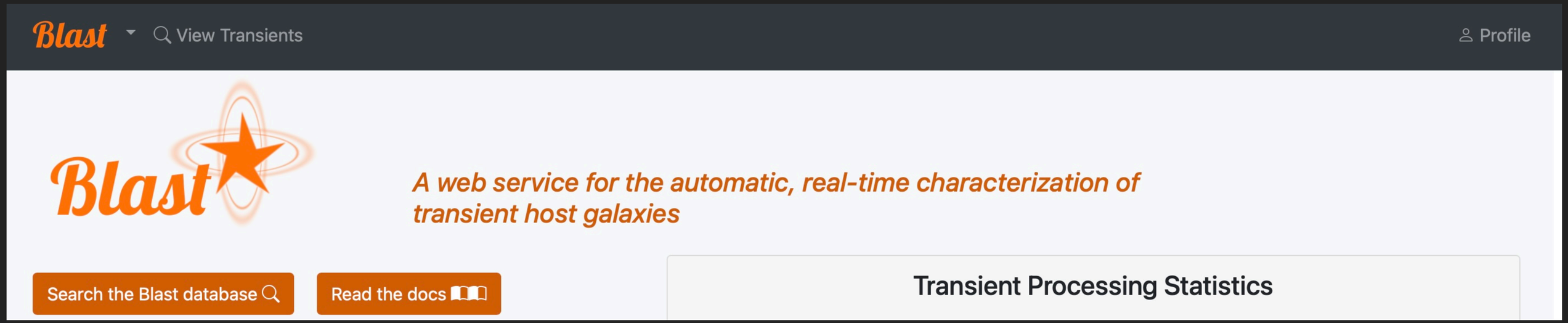


Hopskotch/HERMES
Messaging

HEROIC

HEROIC
Telescope & instrument availability

BLAST



Blast: a Web Application for Characterizing the Host Galaxies of Astrophysical Transients

D. O. Jones [1,*] P. McGill [2,3,*] T. A. Manning [4] A. Gagliano [5,6,7] B. Wang (王冰洁) [8,9,10] D. A. Coulter [11] R. J. Foley [2] G. Narayan [12,13] V. A. Villar [6,5] L. Braff,[2] A. W. Engel [14] D. Farias [15] Z. Lai [16] K. Loertscher,[2] J. Kutcka [2] S. Thorp [17] and J. Vazquez [12]

BLAST

Blast ▾ View Transients Login

2025absa

Download data

Information

Transient

Name: AT2025absa
Right ascension: 9h29m15.21s
Declination: -20d22m34.73s
Discovery Date: Oct. 26, 2025, 5:42 p.m.
Classification: None
Redshift: None
MW E(B-V): 0.046

Host

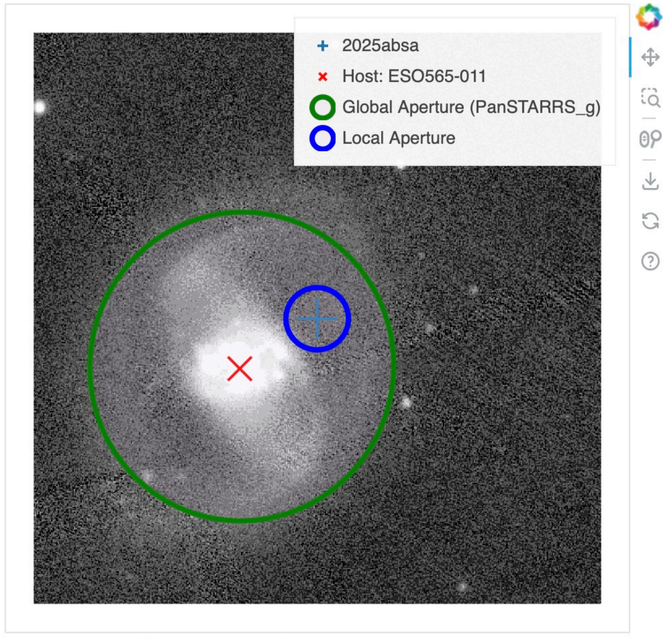
Name: ESO565-011
Right ascension: 9h29m16.42s
Declination: -20d22m45.45s
Redshift: 0.014484
Photometric Redshift:

Processing Status

Cutout download
processed

Imaging data

PanSTARRS_g



Choose cutout Get Cutout

Aperture Photometry

Global | Local

Aperture details

RA, DEC (J2000) = 9h29m16.39s, -20d22m44.99s
semi major axis, semi minor axis (arcsec) = 33.64, 32.86
angle (degrees, anti-clockwise from east) = -12.23

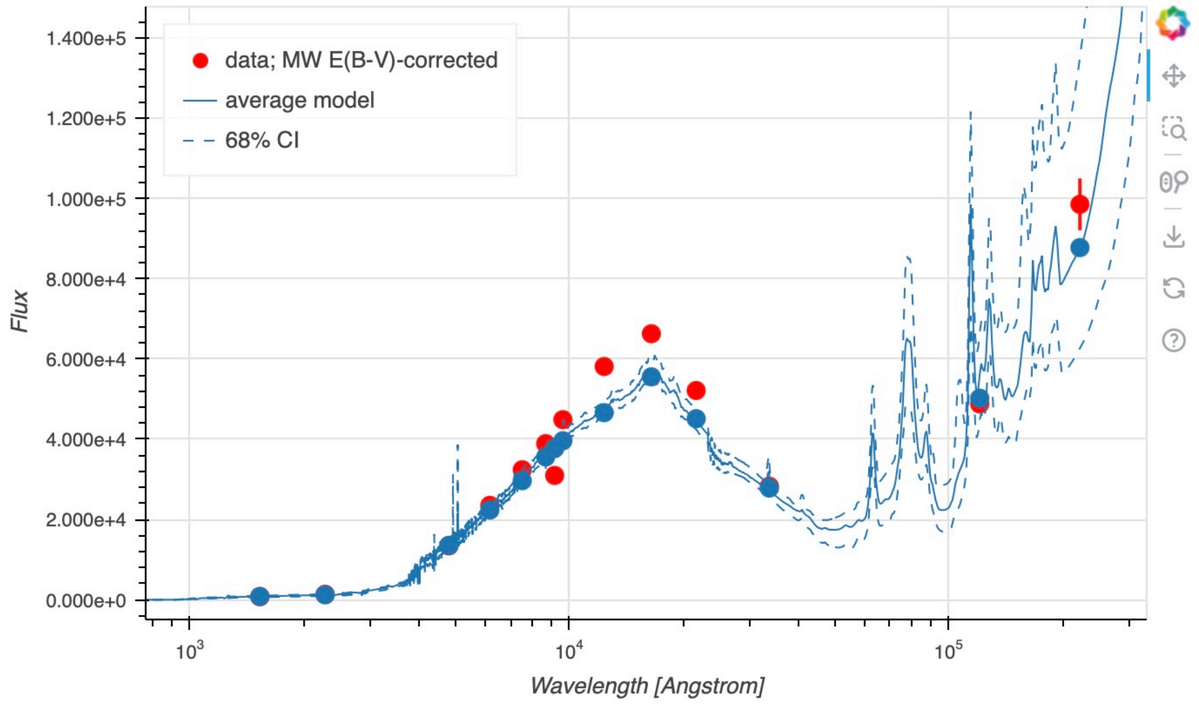
Filter	Flux (μJy)	Flux error (μJy)	Mag	Mag error	Mag sys
GALEX_FUV	549.65	18.15	17.050	0.036	AB
GALEX_NUV	905.88	15.32	16.507	0.018	AB
PanSTARRS_g	11495.13	13.13	13.749	0.001	AB
PanSTARRS_r	21060.75	18.79	13.091	0.001	AB
PanSTARRS_i	29860.67	22.75	12.712	0.001	AB
PanSTARRS_z	36491.76	32.05	12.495	0.001	AB
DES_z	29218.61	80.14	12.736	0.003	AB
PanSTARRS_y	42539.06	65.52	12.328	0.002	AB
2MASS_J	56137.9	855.6	11.132	0.017	Vega
2MASS_H	64853.72	1061.07	10.503	0.018	Vega
2MASS_K	51369.05	1732.01	10.285	0.037	Vega
WISE_W1	28028.55	550.89	10.082	0.021	Vega
WISE_W3	48681.76	1300.33	7.008	0.029	Vega
WISE_W4	98412.99	6369.32	4.797	0.070	Vega

BLAST

Spectral Energy Distribution

Global | Local

Download Best-Fit Model



Host SED inference

Global | Local

Global parameter details

Documentation

Download Chains | Download Percentiles

Parameter	Lower (16%)	Median (50%)	Upper (84%)
$\log_{10}(M_*/M_\odot)$	10.497	10.594	10.701
$\log_{10}(\mathrm{SFR})$	-0.251	0.186	0.513
$\log_{10}(\mathrm{sSFR})$	-10.832	-10.384	-10.026
stellar age	6.962	7.993	11.079

Metallicity parameters

Parameter	Lower (16%)	Med
$\log_{10}(Z_*/Z_\odot)$	-1.437	
$\log_{10}(Z_{gas}/Z_\odot)$	-1.870	

Dust parameters

Parameter	Lower (16%)	Median (5
τ_2	0.479	0
δ	-0.012	0
τ_1/τ_2	0.441	0
Q_{PAH}	0.211	0
U_{min}	2.177	6
$\log_{10}(\gamma_e)$	-3.760	-3

AGN parameters

Parameter	Lower (16%)	Median (50%)	Upper (84%)
$\log_{10}(f_{AGN})$	-2.777	-1.720	-1.327
$\log_{10}(\tau_{AGN})$	1.028	1.272	1.594

Binned star formation history

Lookback time	Lower (16%)	Median (50%)	Upper (84%)
0.00-0.03 Gyr	-1.626	-0.241	0.263
0.03-0.10 Gyr	-0.428	0.235	0.637
0.10-0.33 Gyr	-0.639	0.157	0.557
0.33-1.10 Gyr	-1.426	-0.039	0.384
1.10-3.63 Gyr	-1.347	0.167	0.645
3.63-12.03 Gyr	0.117	0.677	0.851
12.03-13.36 Gyr	0.148	0.889	1.663

RESOURCE AVAILABILITY

- Example: you want to make an observation of a transient immediately. Which facilities can you use?
- What is my target's observability at each facility.
- This information has not been centralized - it is distributed across hundreds of web sites with no common protocol.

Mauna Kea at Mon Jan 11 16:01:06 2021

Gratings currently available in GMOS-N today...

mirror

B600+_G5307

R831+_G5302

R400+_G5305

Slits currently available in GMOS-N today...

IFU-2

0.5arcsec

0.75arcsec

1.0arcsec

1.5arcsec

2.0arcsec

5.0arcsec

NS0.75arcsec

NS1.0arcsec

0.25arcsec

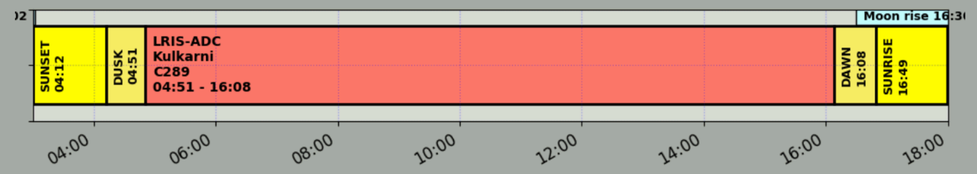
Monday January 11, 2021 HST

Keck 1

Observing Assistant: John Support Astronomer: JoshW Night Attendant: Nick

Oncall Support: Kyle (swoc)

Time (UT)	Instrument	Account	PI	Institution	PROGID	Observers (Location)
04:51 - 16:08	LRIS-ADC	lris5	Kulkarni	CIT	C289	Yao (Other), Sharma (Other)

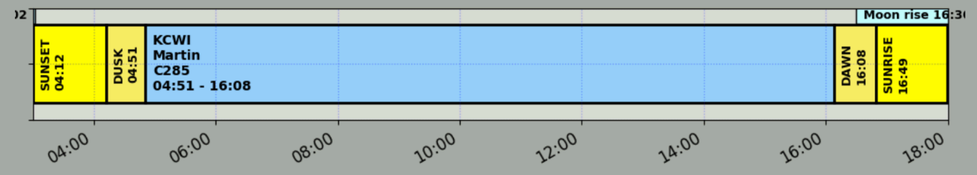


Keck 2

Observing Assistant: Heather Support Astronomer: Sherry Night Attendant: Nick

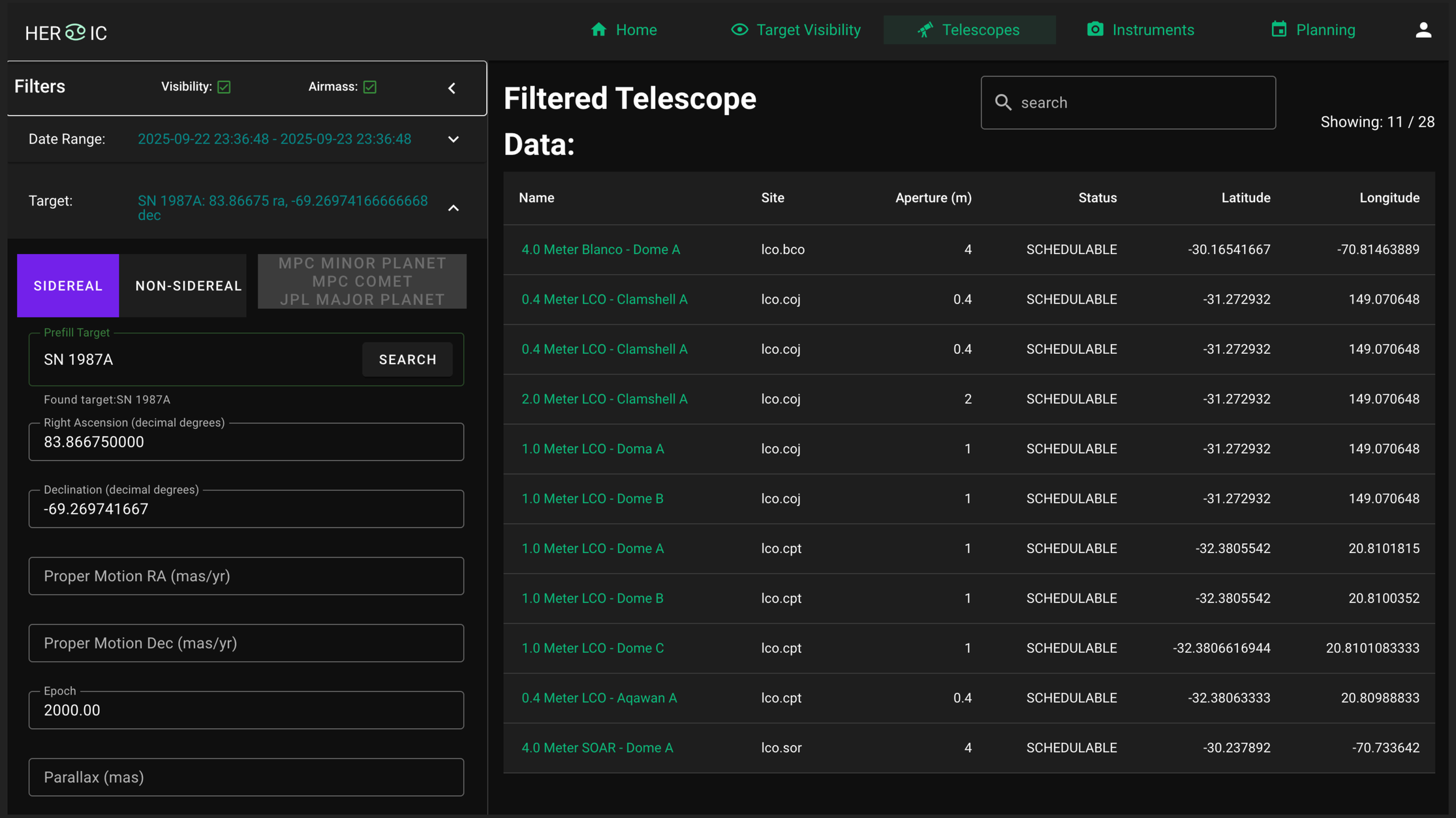
Oncall Support: Kyle (swoc)

Time (UT)	Instrument	Account	PI	Institution	PROGID	Observers (Location)
04:51 - 16:08	KCWI	kcwi6	Martin	CIT	C285	Martin (Other), Lin (Other)



HEROIC – RESOURCE AVAILABILITY

https://heroic.scimma.org



Name	Site	Aperture (m)	Status	Latitude	Longitude
4.0 Meter Blanco - Dome A	lco.bco	4	SCHEDULABLE	-30.16541667	-70.81463889
0.4 Meter LCO - Clamshell A	lco.coj	0.4	SCHEDULABLE	-31.272932	149.070648
0.4 Meter LCO - Clamshell A	lco.coj	0.4	SCHEDULABLE	-31.272932	149.070648
2.0 Meter LCO - Clamshell A	lco.coj	2	SCHEDULABLE	-31.272932	149.070648
1.0 Meter LCO - Doma A	lco.coj	1	SCHEDULABLE	-31.272932	149.070648
1.0 Meter LCO - Dome B	lco.coj	1	SCHEDULABLE	-31.272932	149.070648
1.0 Meter LCO - Dome A	lco.cpt	1	SCHEDULABLE	-32.3805542	20.8101815
1.0 Meter LCO - Dome B	lco.cpt	1	SCHEDULABLE	-32.3805542	20.8100352
1.0 Meter LCO - Dome C	lco.cpt	1	SCHEDULABLE	-32.3806616944	20.8101083333
0.4 Meter LCO - Aqawan A	lco.cpt	0.4	SCHEDULABLE	-32.38063333	20.80988833
4.0 Meter SOAR - Dome A	lco.sor	4	SCHEDULABLE	-30.237892	-70.733642

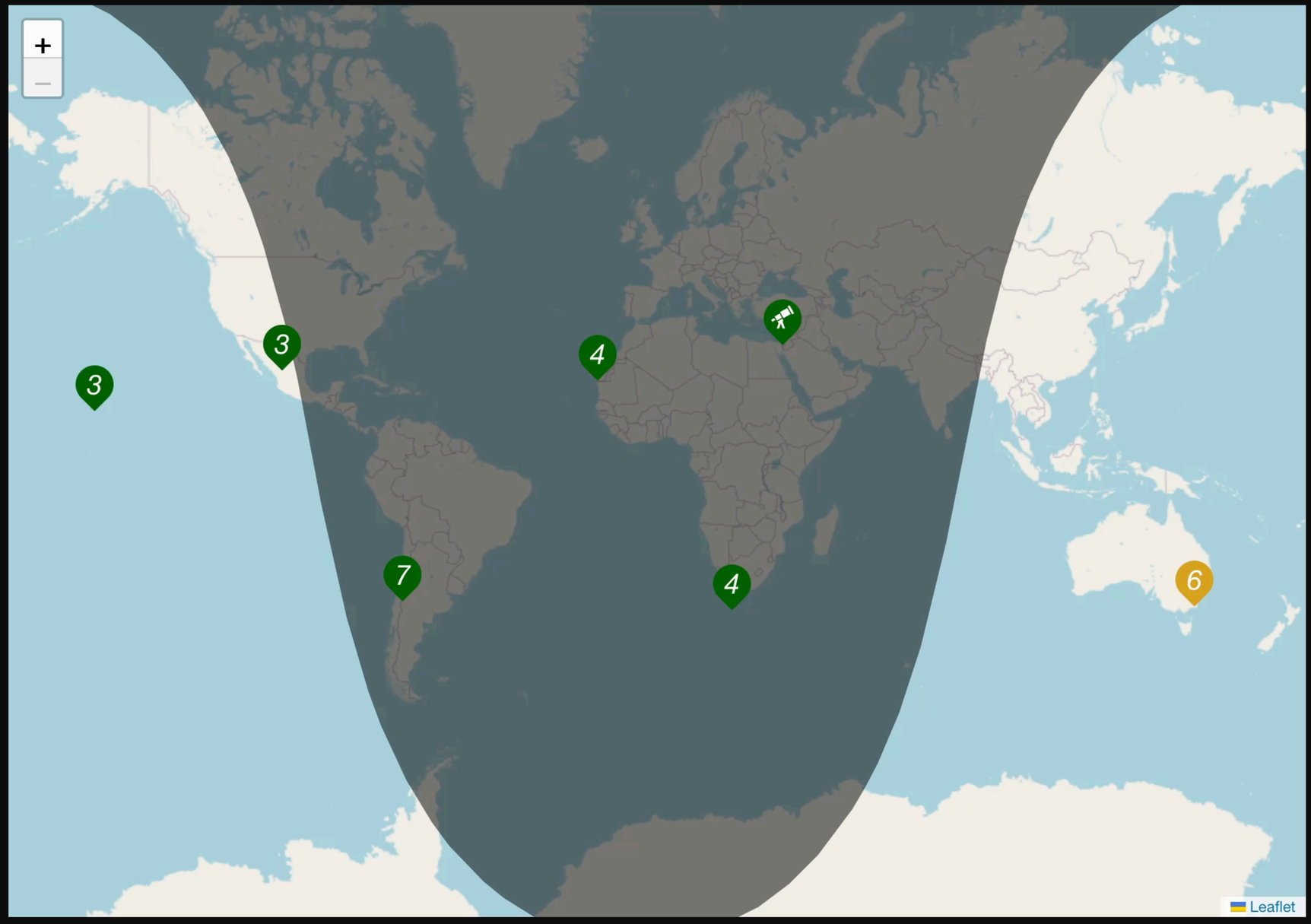
Filters Visibility: ☐ Airmass: ☐

Date Range:

Target: No target specified

Constraints: 2.0 airmass; 1.0 lunar phase

Telescopes: All Telescopes

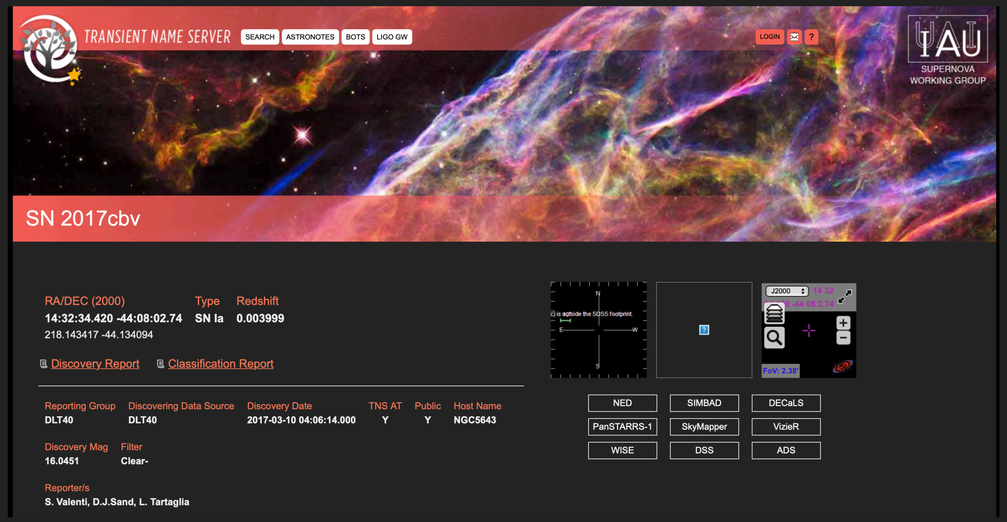


PREEXISTING MESSAGING SYSTEMS

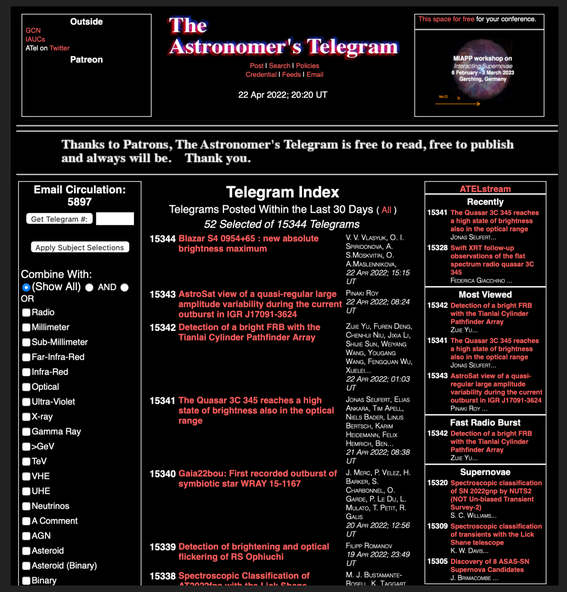
GCN Circulars Used for GRBs & GW events. Free text, not machine readable.

GCN Notices Machine readable, but only used by some NASA missions, no real free text.

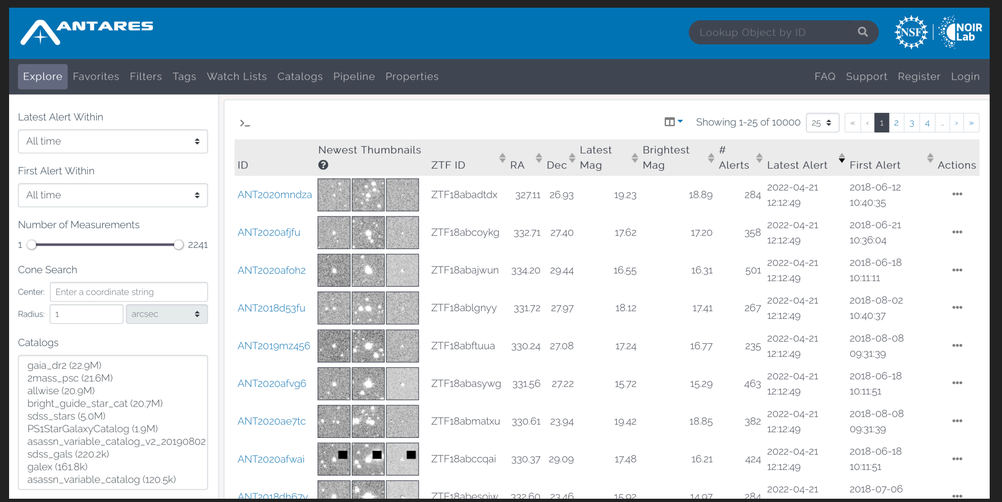
```
////////////////////////////////////////////////////////////////////////
TITLE:   GCN CIRCULAR
NUMBER:  21505
SUBJECT: LIGO/Virgo G298048: Fermi GBM trigger 524666471/170817529: LIGO/Virgo Ide
DATE:    17/08/17 13:21:42 GMT
FROM:    Reed Clasey Essick at MIT  <ressick@mit.edu>

The LIGO Scientific Collaboration and the Virgo Collaboration report:

The online CBC pipeline (gstlal) has made a preliminary
identification of a GW candidate associated with the time
 of Fermi GBM trigger 524666471/170817529 at gps time 1187008884.47
 (Thu Aug 17 12:41:06 GMT 2017) with RA=186.62deg Dec=-48.84deg and an error radiu

The candidate is consistent with a neutron star binary coalescence with
False Alarm Rate of ~1/10,000 years.

An offline analysis is ongoing. Any significant updates will be provided
by a new Circular.

[GCN OPS NOTE(17aug17): Per author's request, the LIGO/VIRGO ID
was added to the beginning of the Subject-line.]
```



Transient Name Server (TNS) Report a new discovery to get an official IAU name and classification. Can send classification spectra. Works well for specific, functions, but not used for sharing arbitrary information.



Astronomer's Telegrams (ATels) Not machine readable. Largely abandoned by transient community.



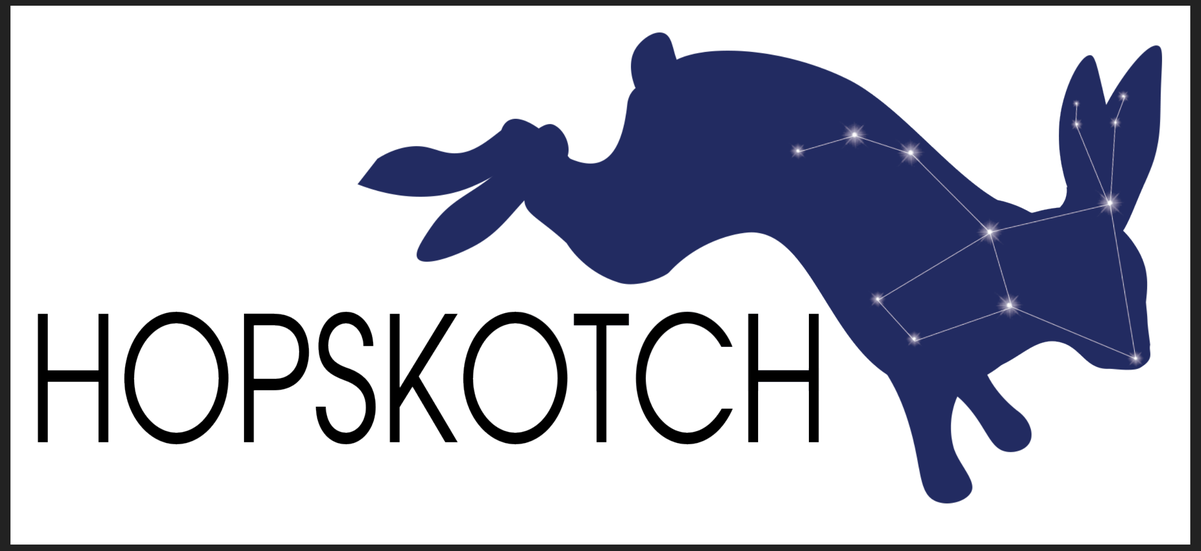
Brokers Designed for high alert volume, e.g. ZTF, LSST. Can use filters. No easy way as yet for users to report additional information.

HOPSKOTCH

- New messaging system being built by SCIMMA (Scalable Cyberinfrastructure for Multimessenger Astrophysics) funded by the NSF - see scimma.org
- Pub-sub model - only subscribe to the information you want. This allows carrying much more information.
- Will carry existing existing astronomical messages, e.g. GCN Circulars and Notices, possibly Transient Name Server messages, Astronomer's Telegrams.
- Goal is to increase machine readable information.
- Can ultimately support other types of messages, e.g. sending images, spectra, data points, observation plans, instrument availability.

- Based on Kafka – will scale to LSST era.
- Cloud-based. Hosted by Amazon Web Services
- Integrated with Identity and Access Management system (CILogon & KeyCloak).

DIFFERENCE BETWEEN HOPSKOTCH AND HERMES



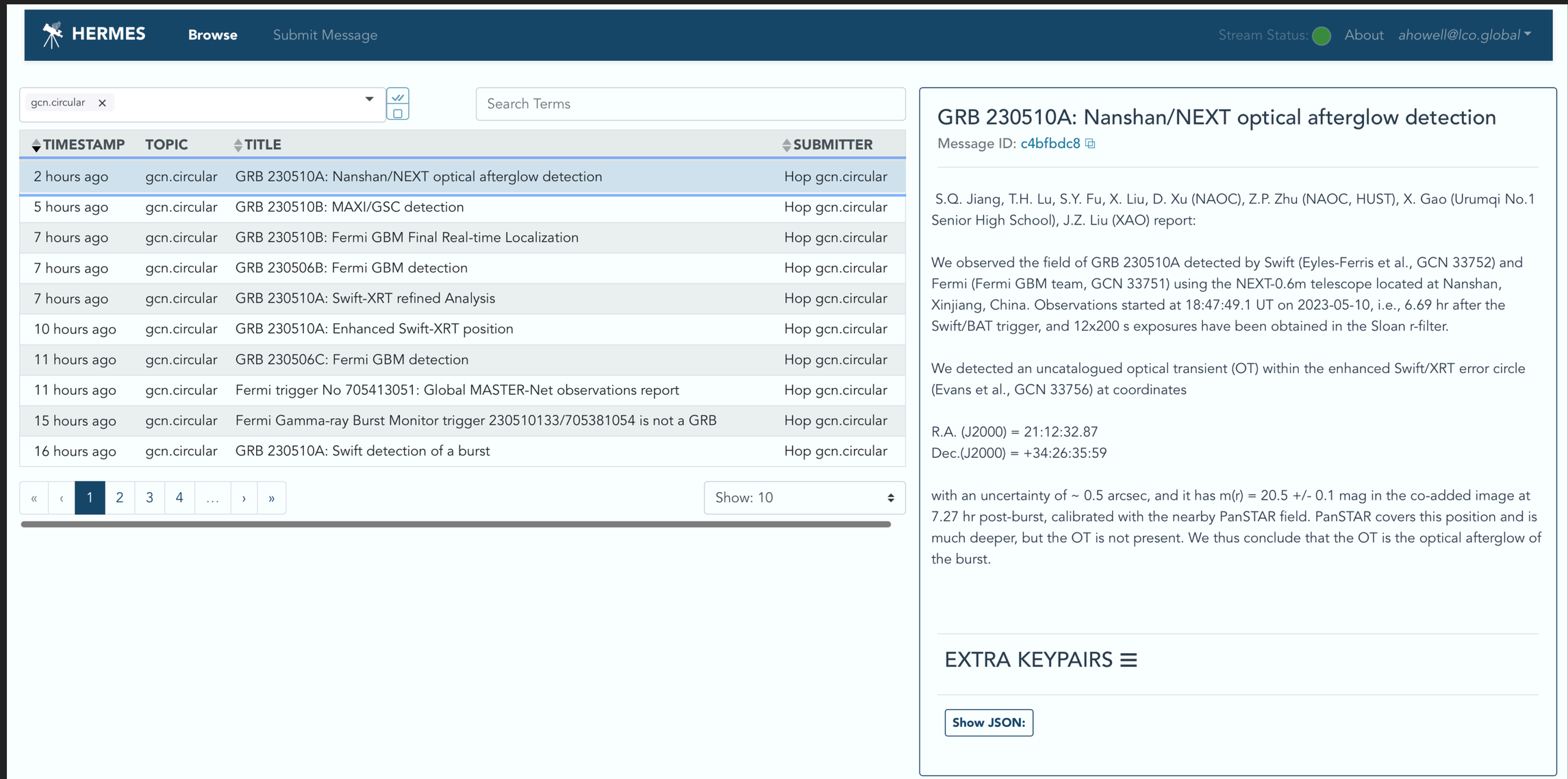
- Kafka + Libraries
- Identity and Access Management
- Topic creation, permissions
- Can carry any message type (e.g. GCNs, TNS, something new) – no schema
- Archive

- Built on HOPSKOTCH
- Reader and GUI
- API for submitting certain well-defined message types
- Machine-readable protocol

HERMES https://hermes.lco.global

HERMES: Hopscotch Enabled Rapid Message Exchange Service

Adds a message browser, GUI, API, message schema to HOPSKOTCH



Filter by Topic

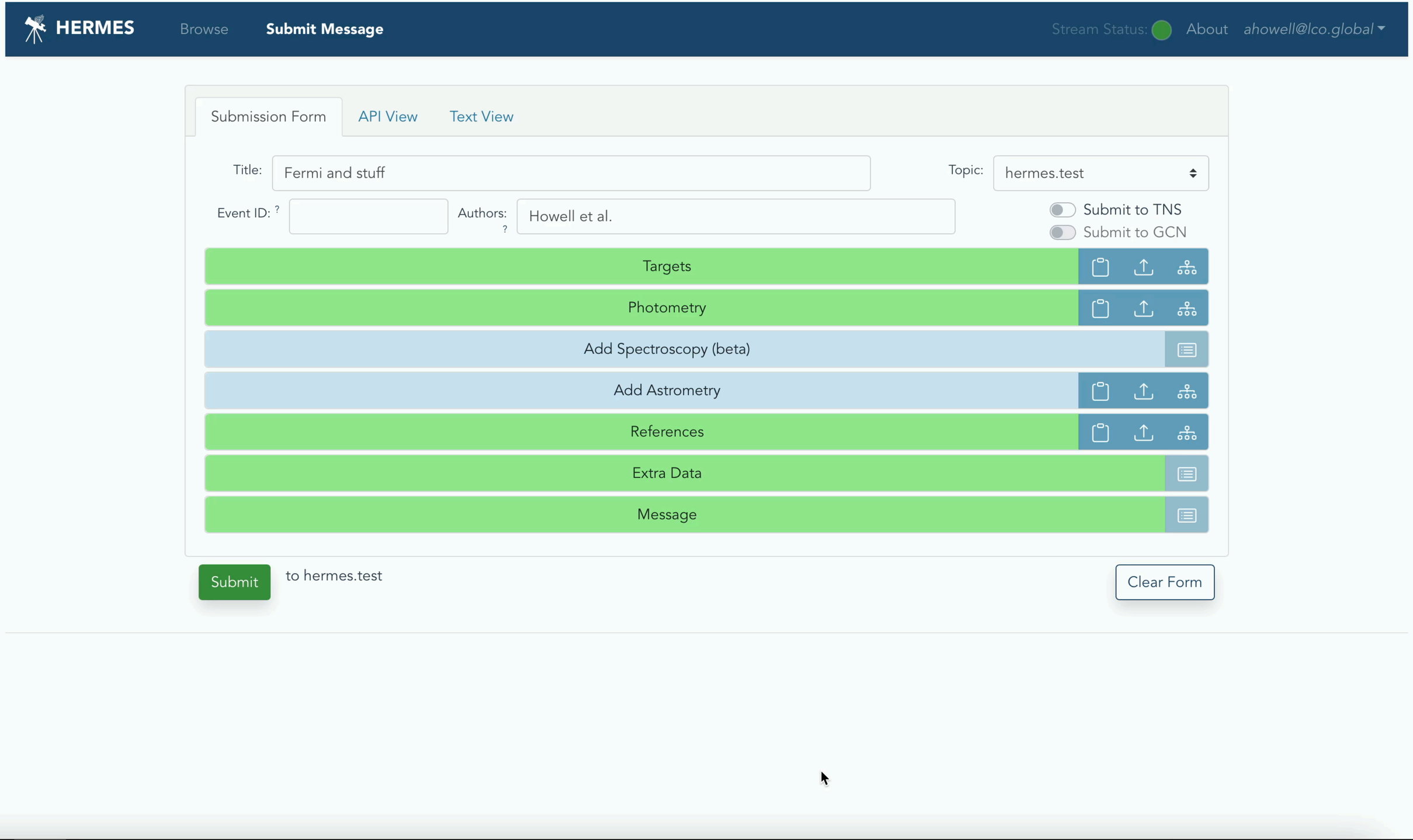
Search Terms

TIMESTAMP	TOPIC	TITLE	SUBMITTER
11 minutes ago	igwn.gwalert	MS230511f - RETRACTION	cody.messick-30d512c8
16 minutes ago	igwn.gwalert	MS230511f - PRELIMINARY	cody.messick-30d512c8
21 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
2 hours ago	igwn.gwalert	MS230511d - PRELIMINARY	cody.messick-30d512c8
3 hours ago	gcn.circular	GRB 230510A: Nanshan/NEXT optical afterglow detection	Hop gcn.circular

« ‹ 1 2 3 4 … › »

Show: 10

HERMES is a Message Exchange Service for Multi-Messenger Astronomy applications that allow users to both send and review messages related to a variety of events and targets of interest.


HERMES
Browse
Submit Message
Stream Status:
About
ahowell@lco.global
Submission Form
API View
Text View
Title:
Fermi and stuff
Topic:
hermes.test
Event ID:
Authors:
Howell et al.
Submit to TNS
Submit to GCN
Targets
Photometry
Add Spectroscopy (beta)
Add Astrometry
References
Extra Data
Message
Submit
to hermes.test
Clear Form

SN 2022wpy

SN Ia z= 0.0152

04:46:28.004 -04:47:23.68
71.6167 -4.7899

Known as:

AT 2022wpy
SN 2022wpy
ATLAS22bhuw

Add a new name

Science Interests:

Classification
Ia
Nearby SNe
Young SNe

Select Science Tags

Interested Persons:

J. Craig Wheeler
Or Graur

I'm Interested

Add to Interesting Targets

Data Used In:

First name of first author

Last name of first author

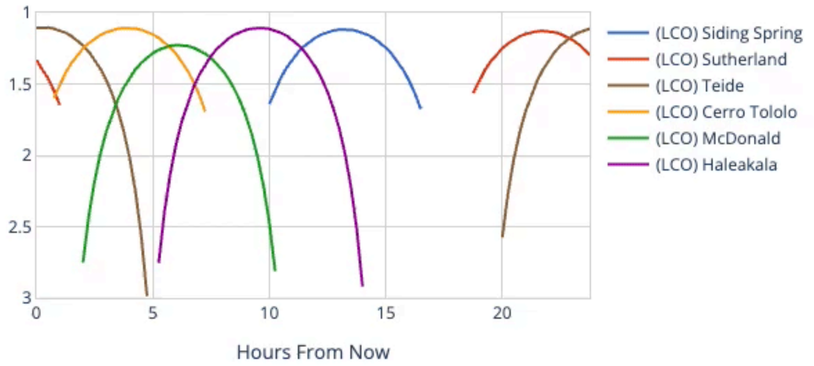
Brief description of contents of this paper, i.e. "All photometry and

Latest Comments

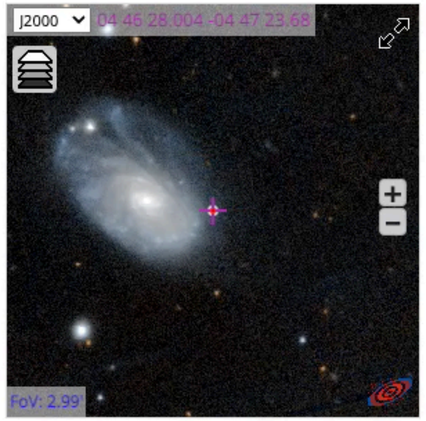
Craig Pellegrino on 2022-10-03
In NGC 1659 (64.3 Mpc, dm=34.04), discovered at 19.0 with a 1 day nondetection at 19.6

Add a comment

Latest Visibility at LCO

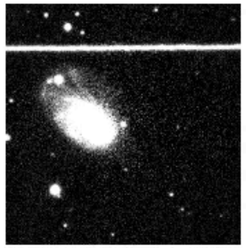


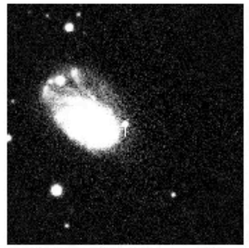
Aladin Viewer

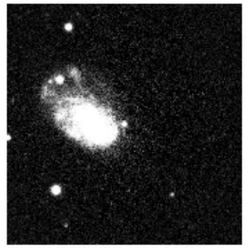


Recent LCO Images

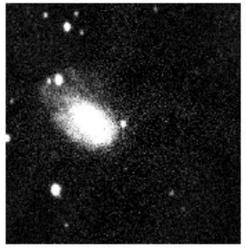
12/01/2022 TFN 1m0 rp 120s

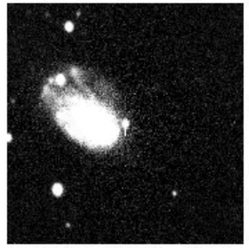

12/01/2022 TFN 1m0 ip 120s

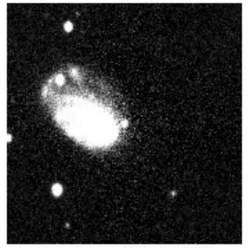

12/01/2022 TFN 1m0 gp 200s


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

MODERN MESSAGING IS HERE

Low latency

Robust

Machine and human readable

1

One stop shop

Pub-sub: can distribute any message

EXTRA SLIDES

HERMES Browse Submit Message Stream Status: About HERMES Guest

Filter by Topic

Search Terms

TIMESTAMP	TOPIC	TITLE	SUBMITTER
9 minutes ago	igwn.gwalert	MS230511f - RETRACTION	cody.messick-30d512c8
14 minutes ago	igwn.gwalert	MS230511f - PRELIMINARY	cody.messick-30d512c8
18 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
2 hours ago	igwn.gwalert	MS230511d - PRELIMINARY	cody.messick-30d512c8
3 hours ago	gcn.circular	GRB 230510A: Nanshan/NEXT optical afterglow detection	Hop gcn.circular

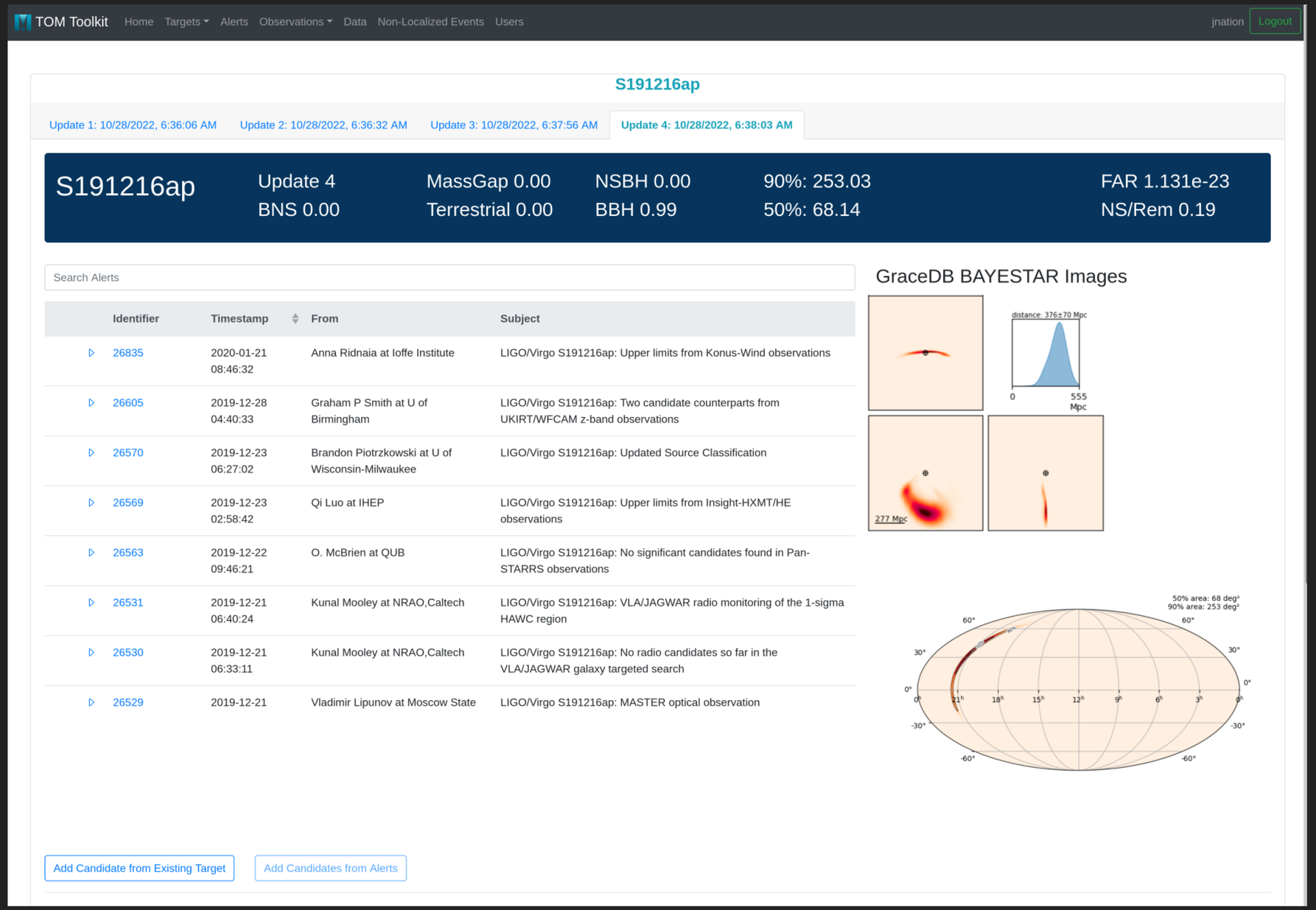
« ‹ 1 2 3 4 … › »

Show: 10

HERMES is a Message Exchange Service for Multi-Messenger Astronomy applications that allow users to both send and review messages related to a variety of events and targets of interest.

NONLOCALIZED EVENT PAGE IN A TOM, CREATED FROM HERMES MESSAGE

- Nonlocalized event (e.g. coordinates not well known like in a GW error region) workflow added to TOM Toolkit
- Your TOM can monitor HERMES and create a page for a GW event automatically thanks to machine readability.
- Can keep track of viable and non-viable candidates



welcome to SNEx 2.0

the SupernovaExchange (2.0)

Search by name or coordinates

Authorship Information

Latest Comments

Noshin Yesmin about at2023dtc on 2023-05-10

I ran SNID on both the first spectrum (2023-03-28) and on the latest (till today) (2023-04-26). For the first spectrum, top 10 type match was Type Ic and top 10 subtype match was Ic-norm. For the other spectrum, top 11 type

Latest Targets

ID	Created
grb230506c	2023-05-07
grb230506b	2023-05-07
sn 2023bhz	2023-05-05
at 2023hnl	2023-05-02
sn 2023hlf	2023-05-01
at 2023gss	2023-04-25
at2023ghq	2023-04-24
at 2023gft	2023-04-20
ztf18aaxeoqk	2023-04-20
at2023gfo	2023-04-20

HERMES – READING

Topic (can read multiple topics simultaneously).

Message text

Selected message

HERMES | Submit New Non-localized Event | Submit Candidates | Submit Non-Detections | Submit Search Pointings | Report Photometry | Report Spectroscopy | Report Observatory Availability | *User*

‹ 1 2 3 4 5 … 27 › Topics: gcn.circular

	TIMESTAMP	TITLE	SUBMITTER
1	2022/06/13	GRB 220608B: Detection by VZLUSAT-2	Jakub Ripa at Masaryk University <ripa.jakub@mail.muni.cz>
2	2022/06/12	Swift GRB 220611A: Global MASTER-Net observations report	Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>
3	2022/06/12	GRB 220611A: Swift-XRT refined Analysis	Phil Evans at U of Leicester <pae9@leicester.ac.uk>
4	2022/06/12	GRB 220610B: AstroSat CZTI detection	Gaurav Waratkar at IIT,Bombay <gauravwaratkar@iitb.ac.in>
⇒ 5	2022/06/11	GRB 220611A: Enhanced Swift-XRT position	Phil Evans at U of Leicester <pae9@leicester.ac.uk>
6	2022/06/11	GRB 220611A: Swift detection of a burst	David Palmer at LANL <palmer@lanl.gov>
7	2022/06/11	IPN triangulation of GRB 220609B	Anna Ridnaia at Ioffe Institute <ridnaia@mail.ioffe.ru>
8	2022/06/11	Fermi GRB 220610A: Global MASTER-Net observations report	Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>
9	2022/06/10	GRB 220610A: Fermi GBM Final Real-time Localization	Fermi GBM Team at MSFC/Fermi-GBM <do_not_reply@GIOC.nsstc.nasa.gov>
10	2022/06/10	Fermi trigger No 676537486: Global MASTER-Net observations report	Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>

GRB 220611A: Enhanced Swift-XRT position

Phil Evans at U of Leicester <pae9@leicester.ac.uk>

M.R. Goad, J.P. Osborne, A.P. Beardmore and P.A. Evans (U. Leicester) report on behalf of the Swift-XRT team.

Using 496 s of XRT Photon Counting mode data and 1 UVOT images for GRB 220611A, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 66.51464, -37.26019 which is equivalent to:

RA (J2000): 04h 26m 3.51s
Dec (J2000): -37d 15' 36.7"

with an uncertainty of 2.4 arcsec (radius, 90% confidence).

This position may be improved as more data are received. The latest position can be viewed at http://www.swift.ac.uk/xrt_positions. Position enhancement is described by Goad et al. (2007, A&A, 476, 1401) and Evans et al. (2009, MNRAS, 397, 1177).

This circular was automatically generated, and is an official product of the Swift-XRT team.

JSON / data

ADDITIONAL DATA TABLE ☰

Show JSON:

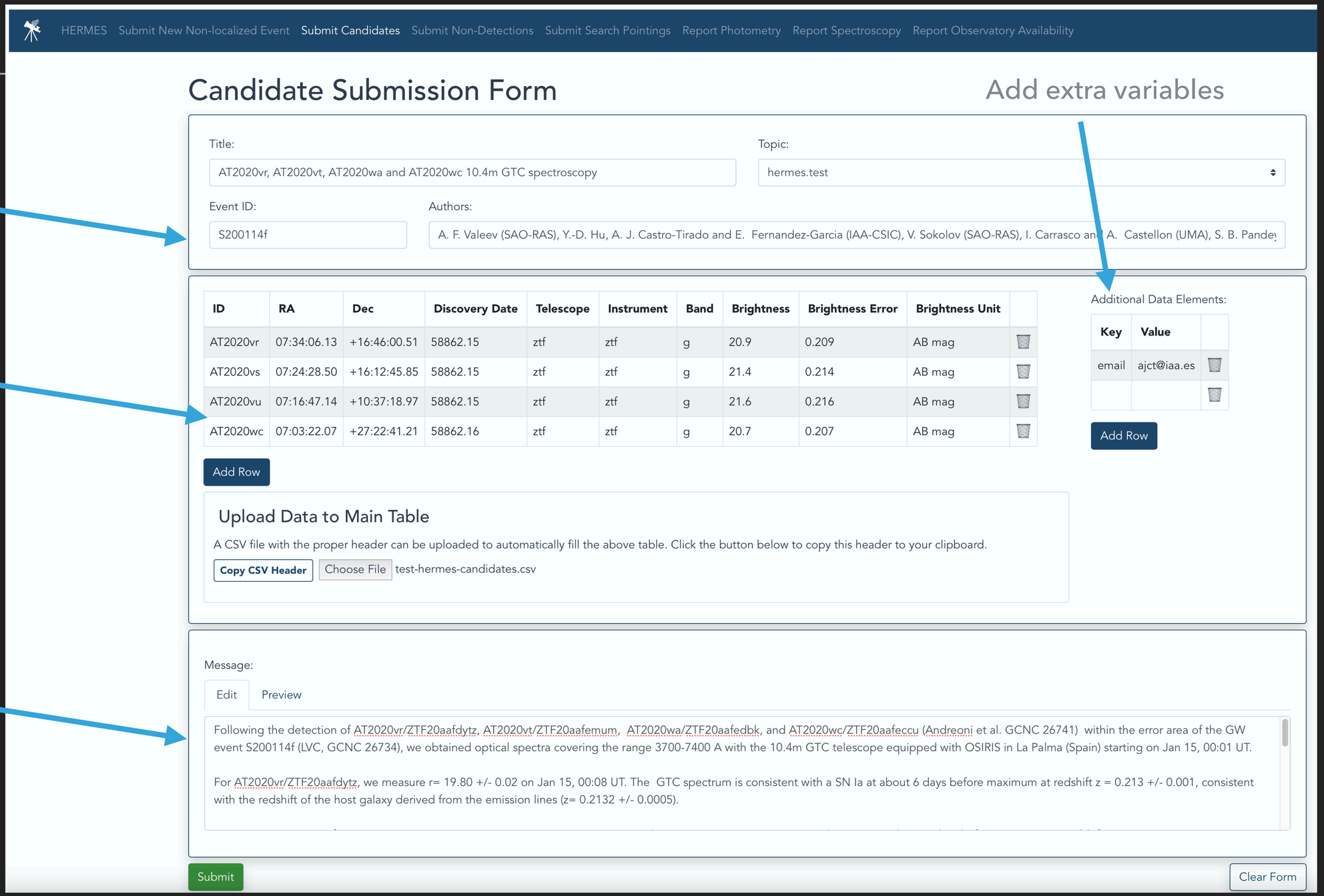
HERMES

Associate a message with a gravitational wave event.

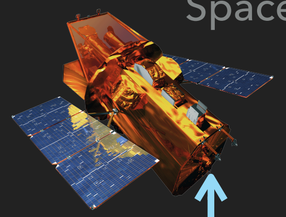
Manually type or upload a data table.

There is built-in error checking.

Compose a text message, and refer to items in the table.



Multimessenger trigger



Space Observatories

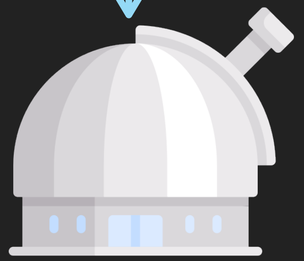
New Kafka tools

Coordinate, visualize follow-up

Broker

Target & Observation Manager

Survey facility



Observatory

A NEW SOCIOLOGY?

- Right now we have either data that is fully public or fully private.
- This leads to duplication of data and inefficient use of resources because people don't know what others have found.
- We are disincentivized from sharing in real time because someone else can publish our data without us if we make it public.
- We need something in-between, a way for people to share preliminary data publicly, but still get credit.

- **Proposed solution:** a license when you share data that explains how it can be used, like software licenses. For example, "you can use this data for planning purposes and inferences, but if you want to publish it you have to ask me." This could be a flag sent with the data.

SUMMARY

- We need new communication infrastructure and software tools to fully realize the potential of LIGO-Virgo-Kagra, Vera Rubin Observatory, and other new facilities
- We are making improvements in nearly every step of this process, especially AEON for streamlining triggering, Treasure Map for finding targets, HEROIC for resource availability, the TOM Toolkit for data reduction, analysis, telescope triggering, and HOPSKOTCH & HERMES for messaging. Many of these were built to work together but can also work on their own.
- Some problems are still unsolved, especially data lakes and archive compatibility
- MMA is a useful driver because it has some of the most stringent requirements, but these tools should be useful for many other areas of transient astronomy.