



# SCIMMA: REAL-TIME ORCHESTRATION OF MULTI-MESSENGER ASTROPHYSICAL OBSERVATIONS

**GAUTHAM NARAYAN**

On behalf of the SCIMMA team:

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and a long list of collaborators and affiliates

OAC-1841625  
OAC-1934752  
OAC-2311355



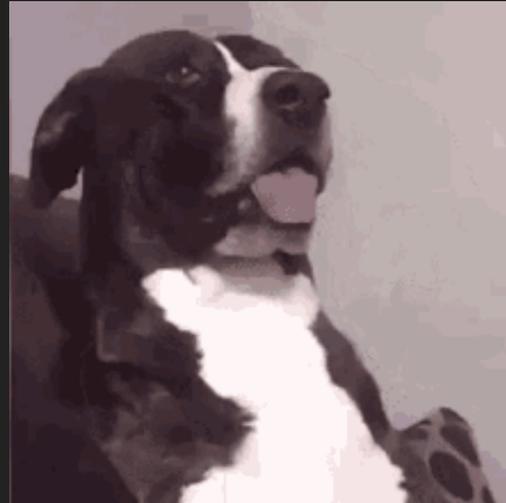
# HOW MMA FOLLOWUP WORKED FOR GW170817

skymap <https://gracedb.ligo.org/api/superevents/S231017bj/files/bayestar.muliorder.fits,0>

gracedb <https://gracedb.ligo.org/superevents/S231017bj/view/>

**EVENT KEYPAIRS**

Key	Value
far	0.00000526891153640463
time	2023-10-17T13:28:29.537Z
group	CBC



1. Receive text alert/kafka message

2. What?!?

3. Trigger approved resources by filling out Phase II forms

Telescope Schedule

2019A telescope schedule

Select schedule for: Barn Tels Year: 2019 Month: January Day: 03

DOW	Date	Dark	Tel#	Principal	Observers	Location	Inst/ACC	Institution	OA	SA	NA	ProjCode
Tue	Jan-01	80	1	Masters	Masters (CIT), J. Cohen (CIT), Hornbush (CIT), Stanford (UCB)	CITA/CB	LRS-ADC(9)	NASA	JA	ARoc		N044
Tue	Jan-01	80	2	G. Fuller	K. Rubin (UCSD), Col. (UCSD) Vaught, (UCSD), Burchett, (UCSD)	UCSD/UCSC	KCWI(8)	UCSD	JR	LR		J090
Wed	Jan-02	88	1	Crystal, Marlin	Crystal, Marlin (UCSB)	UCSB	LRS-ADC(1)	UCSB	JACW	JW	SJ	J156
Wed	Jan-02	88	2	G. Fuller	K. Rubin (UCSD), Col. (UCSD) Vaught, (UCSD), Burchett, (UCSD)	UCSD/UCSC	KCWI(8)	UCSD	JR	LRoc		J090
Thu	Jan-03	98	1	S. Kulkarni	Burdge	HQ	LRS-ADC(2)	CIT	CW	JW	SJ	G293
Thu	Jan-03	98	2	J. Cohen	J. Cohen (CIT), Hernitschek (CIT)	CIT	ES(1)	CIT	JRUP	RG	SJ	G293
Fri	Jan-04	100	1	Pinnao/Ravi	Burdge/Burdge	HQ	LRS-ADC(3)	CIT	CW	JW	SJ	G292C/327
Fri	Jan-04	100	2	J. Cohen	J. Cohen (CIT), Hernitschek (CIT)	CIT	ES(1)	CIT	JP	RToc	SJ	G293
Sat	Jan-05	100	1	J. Cooke	Franz (Swan), Fitchard, Meech, J. Cooke, S. Webb	Swan/HQ	LRS-ADC(4)	Swan/Ime	CW	JW	SJ/JP	W247
Sat	Jan-05	100	2	Fassnacht	Fassnacht (UCD), G. Chen (UCD)	UCD	ES(2)	UCD	JP	JL	SJ/JP	J122
Sun	Jan-06	98	1	Drossing	Isaacson (UCB), Poligino (CIT)	UCB/CIT	HIRES(1)	UCB	CW/TR/AAAR	GO	JLP	J096
Sun	Jan-06	98	2	Oro	Oro, Bah	HQ	DEIMOS(1)	Subaru	JP	AR	JLP	S347
Mon	Jan-07	80	1	Drossing	Isaacson (UCB), Poligino (CIT)	UCB/CIT	HIRES(1)	UCB	TR (AAAR)	GOoc	JLP/TKC	J096
Mon	Jan-07	80	2	Hu	Hu, L. Cowie	HQ	DEIMOS(3)	UH	JP/H	AR	JLP/TKC	H239
Tue	Jan-08	80	1	Redfield	Farrin, Swin, Redfield	HQ	HIRES(7)	NASA	TR (AAAR)	GO	JLP/TKC	N152
Tue	Jan-08	80	2	MawesiHu	Mawesi (CIT), Schewert, (CIT), S. Rappaport, L. Cowie	CITA/HQ	NRES/PAO-NGS+HIRES-DEIMOS(5)	CITA/H	H/AAH	CA	JLP/TKC	G315A-230
Wed	Jan-09	78	1	M. White	Khee Gan, Lee, Ah	HQ	LRS-ADC(8)	UCB	TR (AAAR)	CA	TKC	J096
Wed	Jan-09	78	2	Stamer/Hilbrand	Sallum, (UCSD)/Hilbrand, Okopko	UCSD/HQ	NIR2-NRES(9)/NIRSPEC(1)	UCSD/CIT	H (AH)	CA	TKC	J128C/272
Thu	Jan-10	60	1	S. Valenti/M. White	Boatman, (UCD)/Oee-Gun, Lee, Ah	UCD/HQ	LRS-ADC(8)	UCD/UCB	TR/CJ (AAAR)	JW	TKC	J096/096
Thu	Jan-10	60	2	Stamer/M. Cooper	Sallum, (UCSD)/M. Cooper (UCB), Filmingam, (UCD), Winberry, (UCD), Bester, (UCD)	UCSD/UCI	NIR2-NRES(9)/DEIMOS(8)	UCSD/UCI	H (AH)	CA	TKC	J128U/053

```

////////////////////////////////////
TITLE: GCN CIRCULAR
NUMBER: 21538
SUBJECT: LIGO/Virgo G298048: Las Cumbres Observatory Detection of The Possible Optical Counterpart in NGC 4993
DATE: 17/08/18 04:06:31 GMT
FROM: Iair Arcavi at LCOGT <iarcavi@lcogt.net>

I. Arcavi, D. A. Howell, C. McCully, G. Hosseinzadeh, S. Vasylyev (UCSB/Las Cumbres Obs), M. Zalzman, D. Poznanski (TAU), L.P. Singer (NASA/GSFC), S. Valenti (UC Davis), T. Piran (HUJI), D. Kasen, J. Barnes (UC Berkeley) and W.-f. Fong (UA) report an independent detection of the possible optical counterpart reported by Coulter et al. (LVC GCN 21529), Chornock et al. (LVC GCN 21530), Valenti et al. (LVC GCN 21531) and Melandri et al. (LVC GCN 21532).

In the course of Las Cumbres Observatory galaxy-targeted LIGO followup we observed NGC 4993 from one of our 1-meter telescopes at the Cerro Tololo Inter-American Observatory in Chile. An imaging 5-minute exposure starting at 2017-08-18 00:15:23 UT in the w (=g+r+i) filter clearly shows the candidate.

Analysis of the image is ongoing and followup is planned when the field becomes visible to our Siding Spring telescopes starting at 2017-08-18 08:32 UT.
    
```

4. Look up other resources available. Beg, plead, cajole for time. Form collaborations. Gather information from dozens of sources.

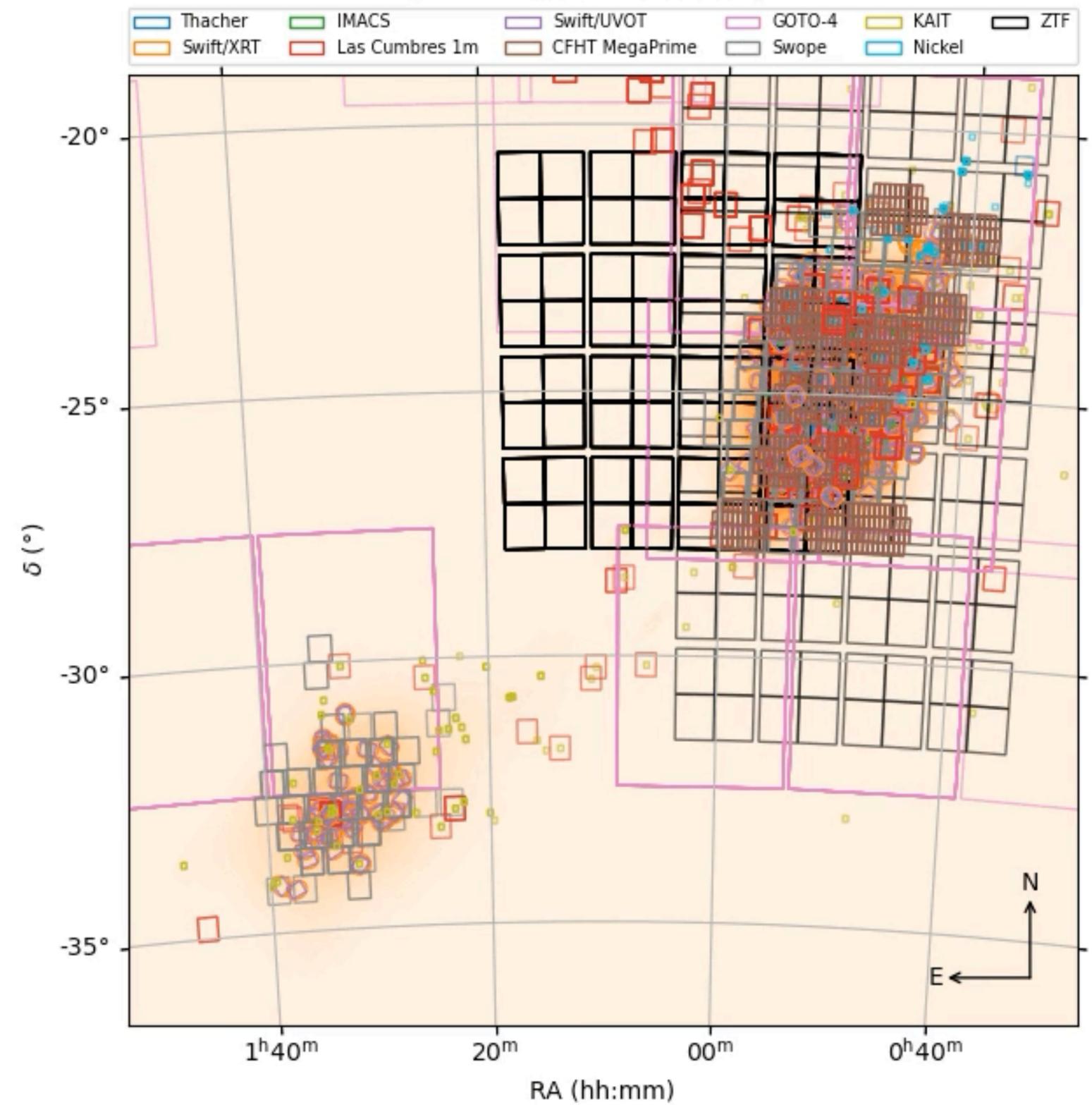
5. Download data from different archives and reduce it.

6. Communicate information to the community, via text

Slide Credit: Andy Howell (LCO/SCIMMA)

# GW190814 Followup

MJD 58713.65 T+3.77 days



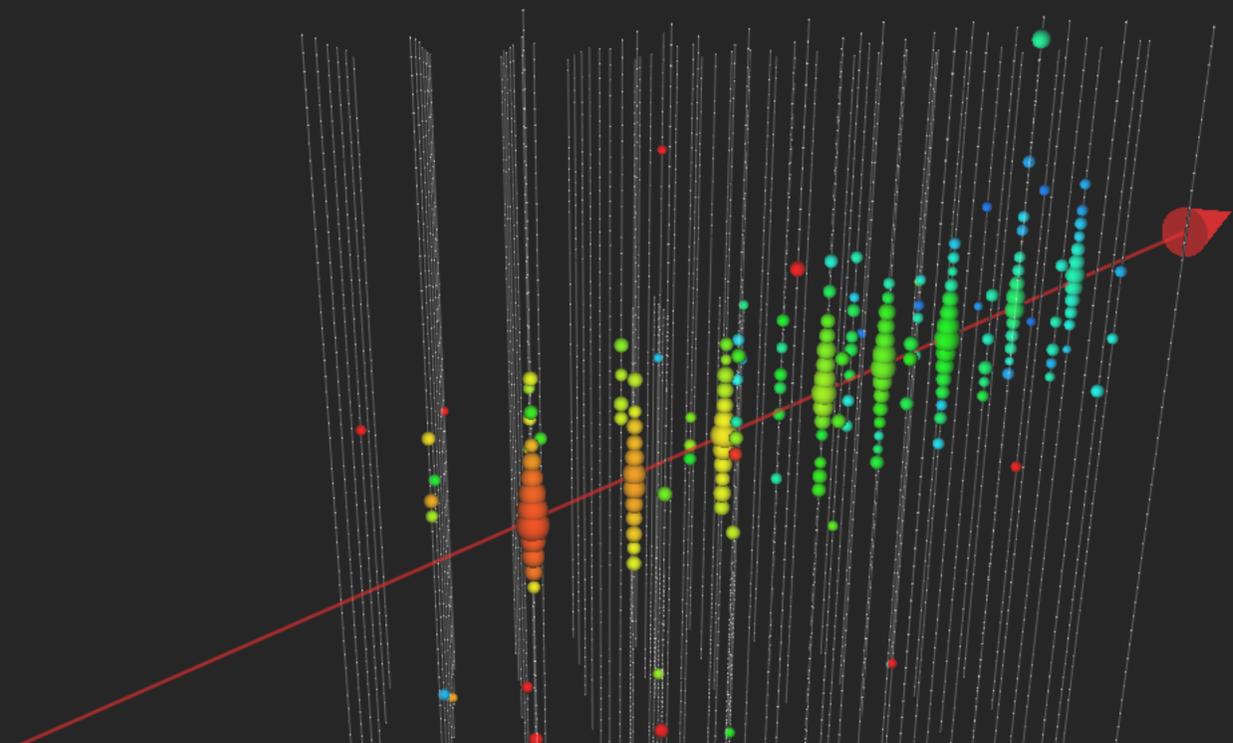
**A FAILURE TO COMMUNICATE COSTS SCIENCE**

# SCIMMA ENABLES CROSS-SURVEY MESSAGING

4

- ▶ **Hopskotch** is an pub-sub system - use your own institutional sign-in (or ORCiD) to sign up: <https://hop.scimma.org/>
- ▶ Public “topics” on our Kafka server: LVK O4 alerts, AMON, GCN (over Kafka!), IceCube, SNEWS or your own private topics - **no charge to your survey!**
- ▶ An easy-to-use **python client** to connect directly to your pipelines - all open source, sets up in 5 min (or less if you type faster than me!)
- ▶ **HERMES** is an easy-to-use web front-end for sending messages on discoveries over Hopskotch

```
{'id': '13882146175426', 'revision': 0,  
'nevents': 1, 'time': '2024-01-05  
12:27:42.573790', 'ra': 1.272221495108027,  
'dec': 0.19768033850355576, 'err90':  
0.0089608185517883, 'err50':  
0.003490658503988659, 'signalness':  
0.30116542756385534, 'energy':  
109512.31832053047, 'far':  
2.6436806145047225, 'run_id': 138821,  
'event_id': 46175426, 'description':  
!Report of IceCube Bronze Neutrino Track
```





Scimma-Alert-Bot APP 4:19 AM

Alert Type: EARLYWARNING

Superevent ID: S230918aq

Group: CBC

Event Time: 2023-09-18T11:19:41.162Z

Alert Time: 2023-09-18T11:19:36Z

FAR [1/yr]: 1.7098958325494311

Detectors: ['H1', 'L1']

Terrestrial : 0.209

BNS: 0.791

NSBH: 0.000

BBH: 0.000

Has NS: 1.000

Has Remnant: 1.000

Has Mass Gap: 0.000

Distance (Mean): 118.825 +/- 45.273 Mpc

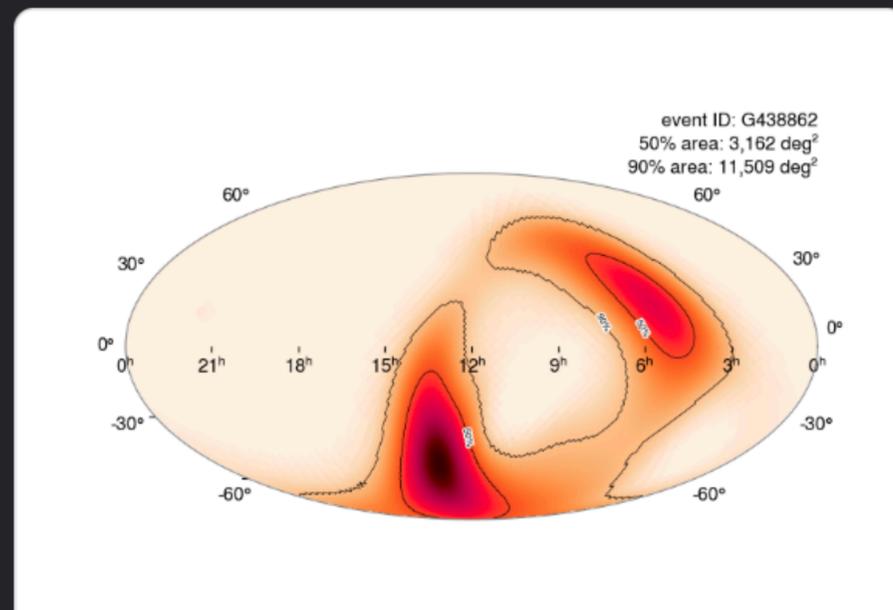
Distance modulus: 35.375

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Join related channel: [#s230918aq](#)

[Skymap Link](#) | [Grace DB](#)

(114 kB) ▾



# BUILDING YOUR OWN PIPELINES AROUND HOPSKOTCH - A SIMPLE EXAMPLE

<https://github.com/scimma/hop-slack-app>

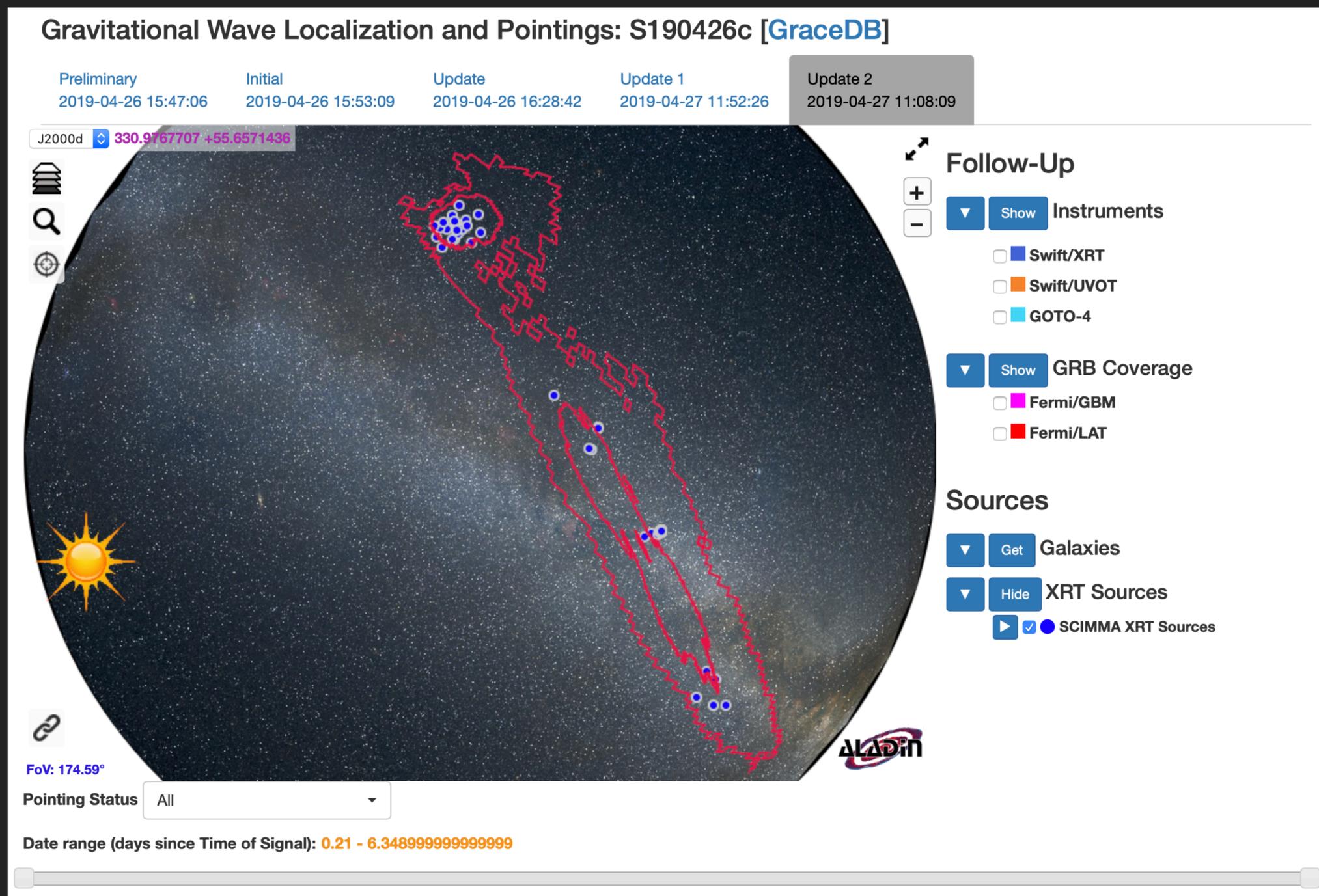
- ▶ It's now possible to listen to Kafka messages with Hopskotch (e.g. LVK)
- ▶ Trigger the LCO TOM Toolkit to get more photometry
- ▶ Report your followup observations to TNS, GCN and again as Kafka message on Hopskotch/HERMES
- ▶ Your colleague can listen to your messages, and trigger spectroscopic followup on Gemini
- ▶ All without a human in the loop!

**See Adam Brazier's Poster - 456.20**

# TREASURE MAP – HOPSKOTCH INTEGRATION

Wyatt et al. 2020, ApJ, 894, 127

<https://treasuremap.space/>



- ▶ X-ray sources are reported by Swift in GCN notices.
- ▶ When a GCN notice is carried through Hopskotch, the X-ray sources are extracted into a database
- ▶ Treasure map queries this database via API to report X-ray sources.
- ▶ Building the connections with TOM Toolkit and AEON automagically means we can keep Treasuremap updated in real-time.

igwn.gwalert ✕

Search Terms

◆TIMESTAMP	TOPIC	◆TITLE	◆SUBMITTER
2 days ago	igwn.gwalert	S240104bl - UPDATE	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104bl - INITIAL	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104bl - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104bl - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ao - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ao - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ah - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ah - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ae - PRELIMINARY	cody.messick-30d512c8
2 days ago	igwn.gwalert	S240104ae - PRELIMINARY	cody.messick-30d512c8

« &lt; 1 2 3 4 ... &gt; »

Show: 10 ▾

## S240104bl - INITIAL

Message ID: [c6f1cc7a](#) Superevent Messages: [S240104bl](#)

### URLS KEYPAIRS ≡

Key	Value
skymap	<a href="https://gracedb.ligo.org/api/superevents/S240104bl/files/bayestar.multiorder.fits,1">https://gracedb.ligo.org/api/superevents/S240104bl/files/bayestar.multiorder.fits,1</a>
gracedb	<a href="https://gracedb.ligo.org/superevents/S240104bl/view/">https://gracedb.ligo.org/superevents/S240104bl/view/</a>

### EVENT KEYPAIRS ≡

Key	Value
far	3.554967487258808e-17

# See Curtis McCully's Talk - 449.04

Submission Form [API View](#) [Text View](#)

SUBMIT TO TNS AND GCN - 1 stop shop

Title:

Topic:

Event ID:

Authors:

Submit to TNS  
 Submit to GCN

Targets 📄 ⬆️ 🔗

DATA IS VALIDATED!

	Name	RA	Dec	New Discovery	
0	AT2024argh	230.15	<input type="text" value="-95.34"/>	<input type="checkbox"/>	<span>+</span> <span>🗑️</span>

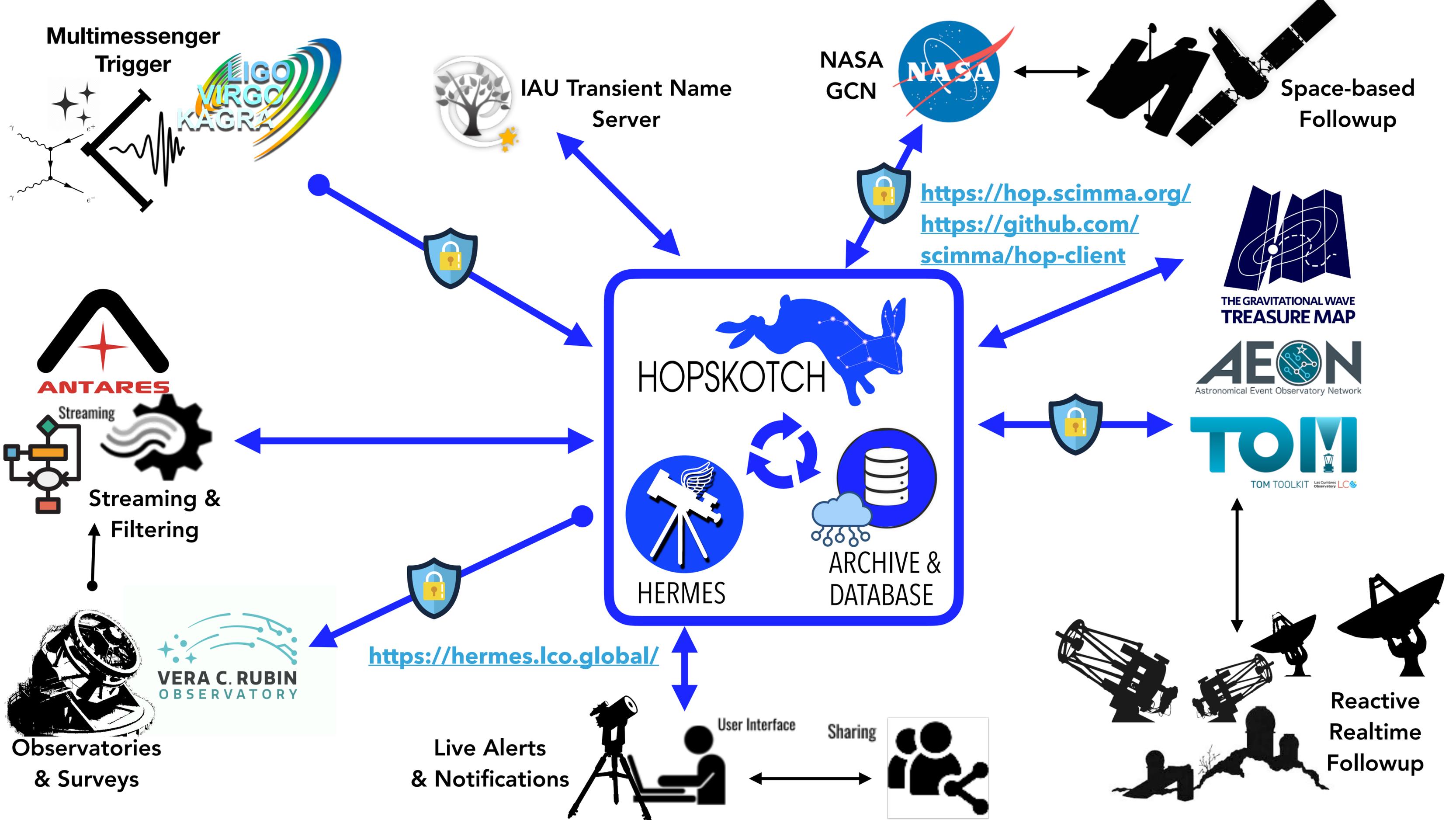
Photometry 📄 ⬆️ 🔗

	Target	Observation Date	Telescope	Instrument	Band	Brightness	Units	Error	
0	AT2024argh	01/05/2024	CTIO 4m	DECam	r	21.3	AB mag	0.2	<span>+</span> <span>🗑️</span>

UPLOAD CSV FILES WITH DATA



**5 min tutorial to get started with Hopskotch & HERMES**



# TAKEAWAYS

- ▶ Hopskotch can carry ANY message - not just science data - e.g. observatory status for your robotic telescope
- ▶ High availability, scalable, pub-sub active with **LVK, IceCube, AMON, SNEWS, GCN** now!
- ▶ Easy to connect to your existing difference imaging analysis/GW/neutrino/high-energy particle pipeline and **start serving alerts to the community with archiving (FOR FREE).**
- ▶ HERMES gives you an easy way to **report** discoveries/lookup fast to the community, including TNS and GCN
- ▶ Several SCIMMA members at AAS - come talk with us!

