

Griffin Hosseinzadeh (UC San Diego)

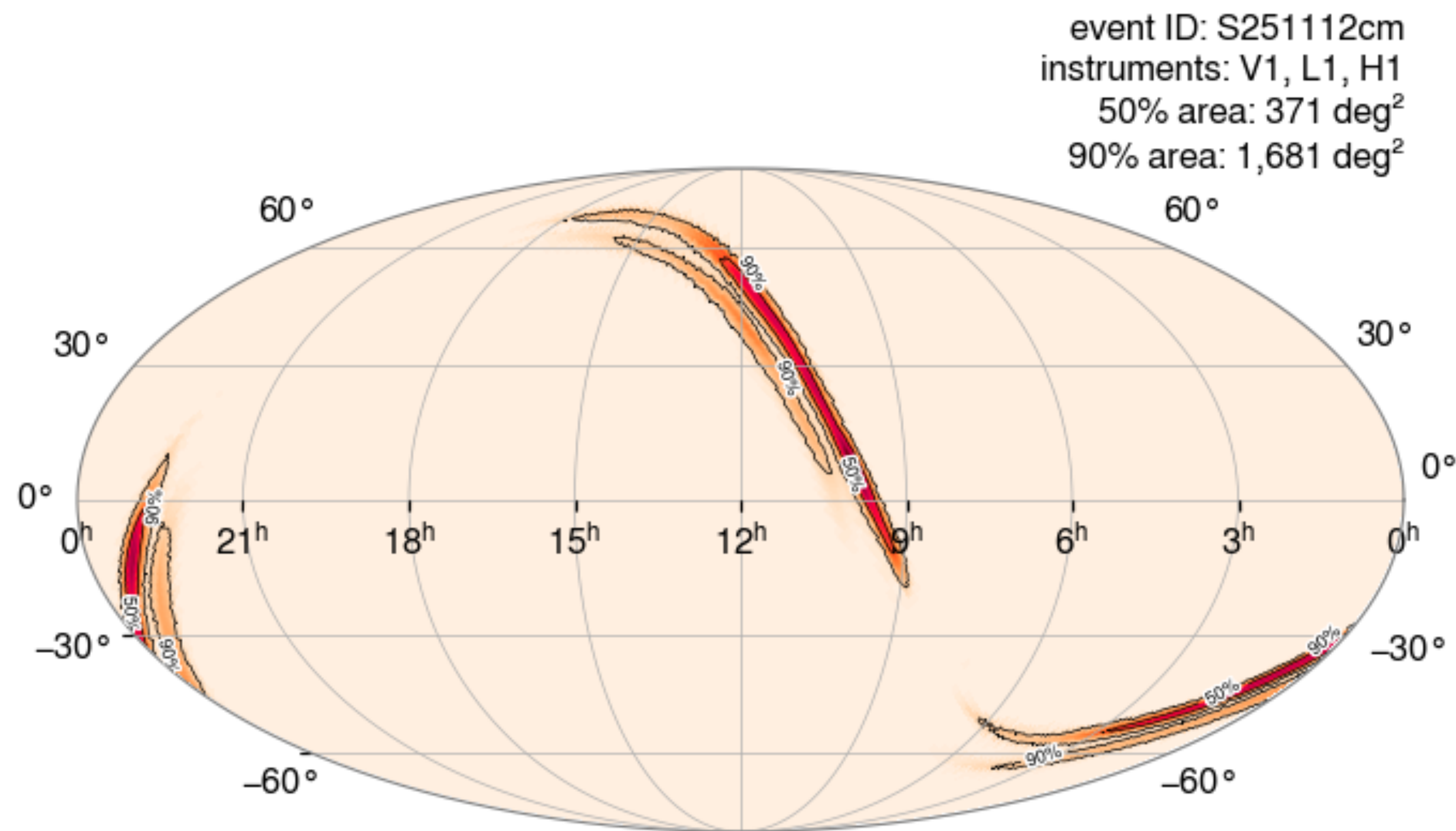


The Multimessenger Treasure TROVE

A Tool for Rapid Object Vetting and Examination

HAS THIS EVER HAPPENED TO YOU?

▶ 1,681 deg², 248 optical optical transients



LVK (GCN 42690)
Anand+ (GCN 43257)

tnsName	ra	dec	mjd_g	g	unc_g	mjd_i	i	unc_i	phot_oz	notes
AT2025aill	38.7231	-57.9901	60994.10	23.88	0.09	60994.16	22.12	0.05	-	transient-like (c)
AT2025aimp	35.2965	-52.4648	60994.10	22.55	0.03	60994.16	21.58	0.03	-	transient-like (b)
AT2025ailld	30.4926	-49.3871	60994.09	23.05	0.04	60994.16	21.84	0.04	-	transient-like (c)
AT2024aey	4.5991	-44.9641	60994.06	22.47	0.05	60994.14	21.05	0.02	0.163	transient-like (c,d)
AT2025aimx	6.9966	-45.6209	60994.07	22.23	0.05	60994.14	21.59	0.04	0.294	transient-like (c)
AT2025aimj	5.0418	-43.5832	60994.06	22.03	0.03	60994.14	21.15	0.02	0.179	transient-like (c)
AT2025adil	4.9861	-42.849	60994.06	20.26	0.01	61001.14	20.51	0.02	0.145	transient-like (b,d)
AT2025aimj	13.1101	-40.5702	60994.09	22.24	0.03	60994.15	22.18	0.05	0.130	transient-like; nuclear (a,b)
AT2025aims	14.8886	-41.2259	60994.09	21.11	0.01	60994.15	20.99	0.02	-	transient-like (c)
AT2025aill	6.4582	-39.459	60994.08	23.58	0.07	60994.14	21.96	0.04	0.220	transient-like (c)
AT2025adkm	7.7313	-39.6507	60994.06	22.53	0.07	60994.14	20.52	0.01	0.090	transient-like (c,d)
AT2025aillh	11.1327	-37.4762	60996.11	21.03	0.01	60994.15	20.78	0.01	0.251	transient-like (b)
AT2025ailli	352.8751	-25.2769	60994.12	22.94	0.05	60994.18	21.88	0.06	-	transient-like (c)
AT2025aimo	350.4845	-21.584	60994.12	22.87	0.04	60999.11	22.69	0.09	-	transient-like (c)
AT2025aill	352.6156	-21.3053	60994.12	23.33	0.06	60994.18	22.47	0.09	-	transient-like (c)
AT2025aimm	351.7215	-21.3579	60994.12	22.97	0.05	60994.18	22.53	0.09	-	transient-like (b)
AT2025xhb	352.3902	-20.988	60994.12	22.51	0.04	60994.18	21.35	0.03	-	transient-like (c,d)
AT2025aazc	351.2951	-21.0291	60994.12	20.0	0.01	60994.18	19.45	0.01	-	transient-like (c,d)
AT2025aimr	342.8701	-14.1804	60994.11	21.39	0.02	60994.17	21.23	0.04	-	transient-like; variable? (c)
AT2025vof	352.01	-13.69	60994.12	22.0	0.04	60994.18	22.0	0.06	0.111	transient-like (c,d)

Current Multimessenger Follow-up Procedure

- ▶ *Big surveys:* Tile the localization region and report hundreds of candidates via GCN circular and/or TNS reports
- ▶ *Everyone:* Wait for someone to highlight 1-2 viable candidates via GCN circular
- ▶ *Dozens of groups:* Get an epoch of photometry and report it via GCN circular
- ▶ *Papers:* “we find that none of these potential transients appear to be an unambiguous electromagnetic counterpart associated with [event]—although some simply do not have enough publicly available photometry to draw any conclusions.” (Franz et al. 2025)

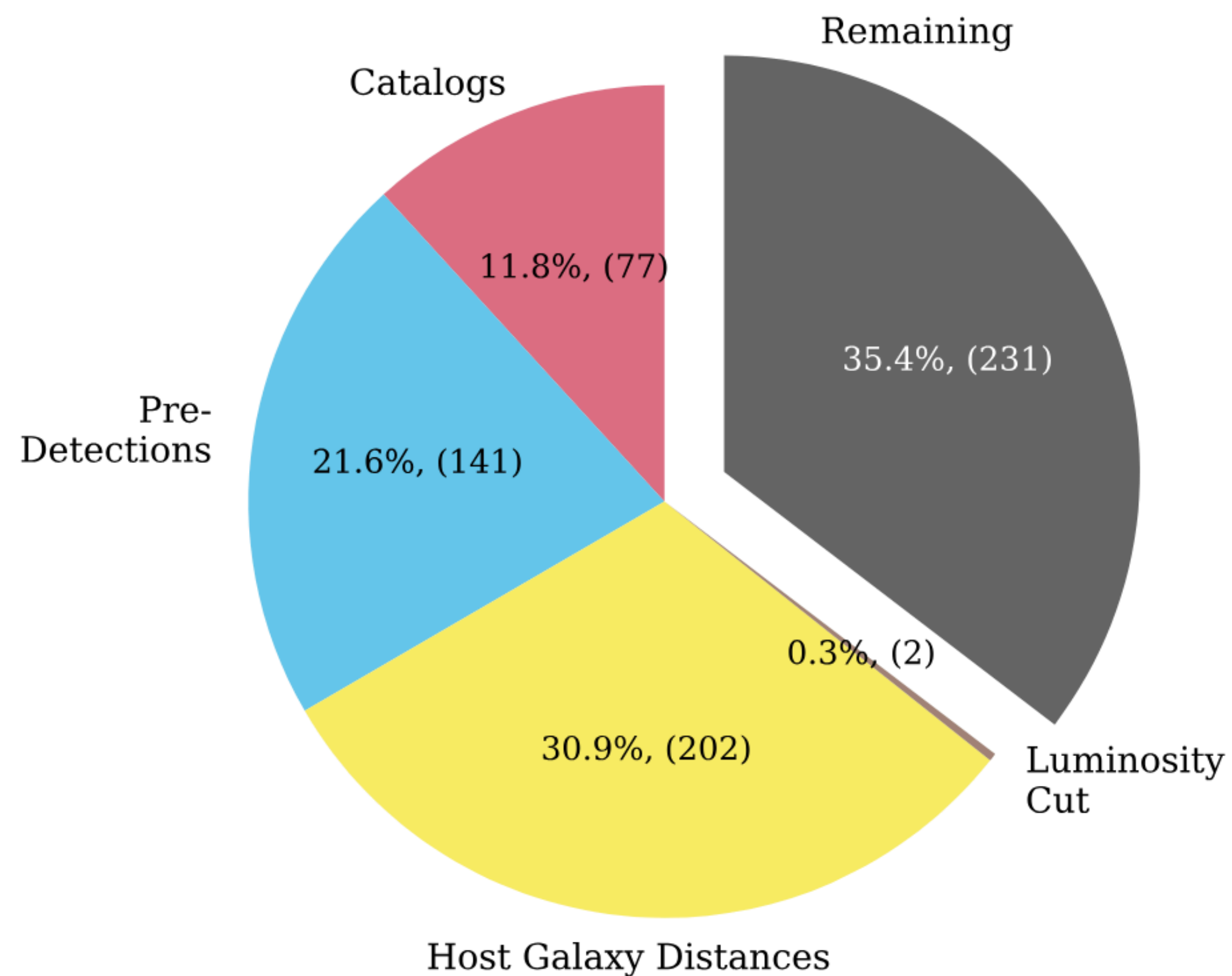
Future Multimessenger Follow-up Procedure

- ▶ *Big surveys*: Tile the localization region and report hundreds of candidates via GCN circular and/or TNS reports
- ▶ *Everyone*: Visit a web portal to see a ranked list of candidates given publicly available information and start picking them off one by one
- ▶ *Dozens of groups*: Get an epoch of photometry and report it back to this portal so the ranking can be updated
- ▶ *Papers (hopefully)*: “we found the second kilonova!” (Franz et al. 2025)

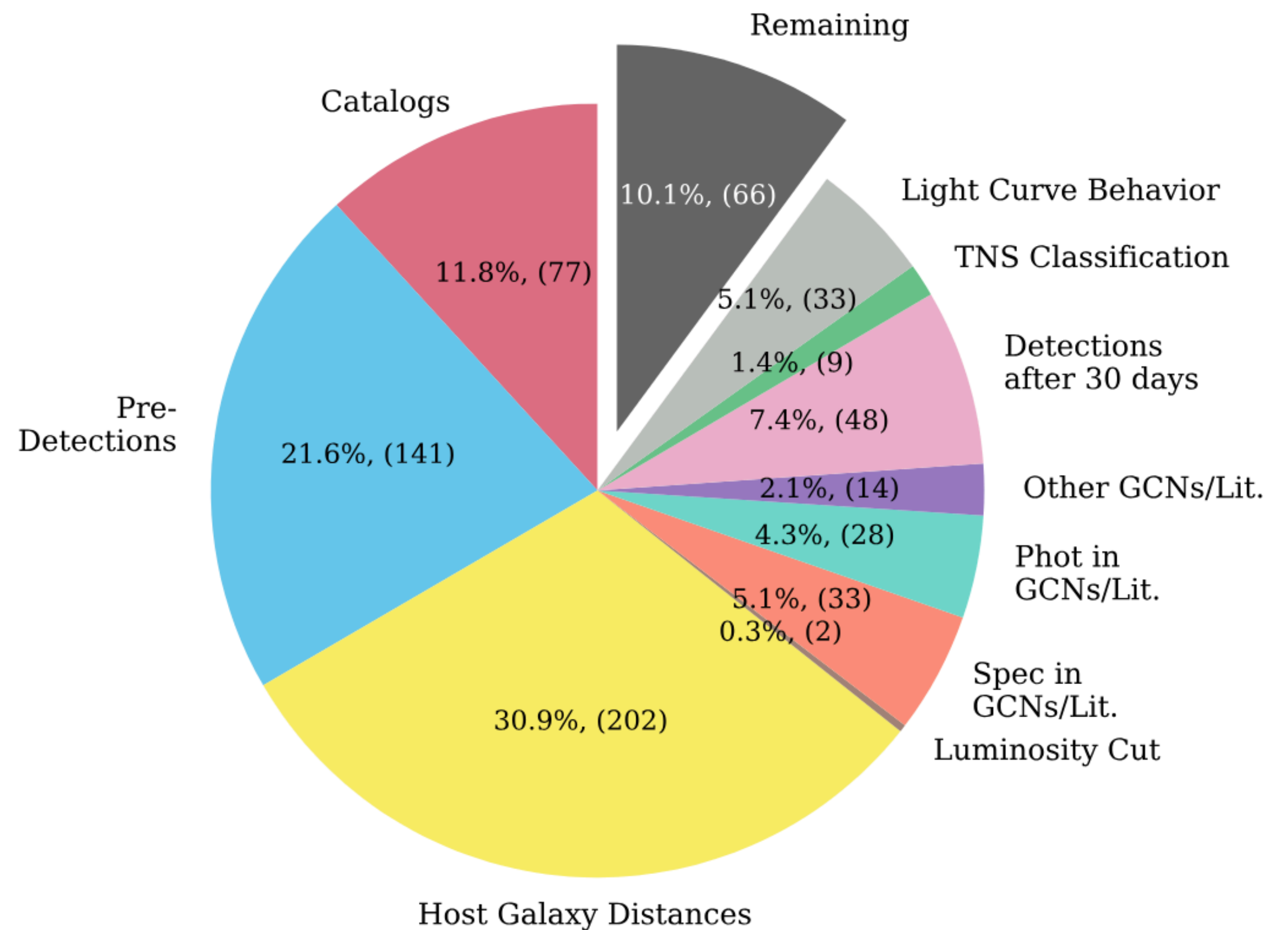
What do I mean by candidate vetting?

Rastinejad et al. (2022)

Tools Available in "Real Time"



Tools Available ~Weeks After Event



SAGUARO Target & Observation Manager

- ▶ One clicks run all “kilonova vetting” tools (Rastinejad et al. 2022):
 - ▶ point-source (quasar, variable star) crossmatch
 - ▶ host-galaxy identification
 - ▶ public photometry (ATLAS, TNS, ZTF) aggregation
- ▶ Code is public but requires local copies of all relevant databases
- ▶ We have proposed to expand this into a community service



AT2024hdm

[Classify](#) [Update](#) [Share](#) [Delete](#)

Vet

AT2024hdm
T202404230826379m205002
[S240422ed](#)

Coords. 08:26:37.923 -20:50:01.51
126.658010 -20.833754

Galactic 242.668983 9.989886

Ecliptic 135.596884 -38.648978

Classification
Redshift

Point Source Matches

QSO Match None
ASASSN Match None
Gaia Match None
PS1 match None

Recent Photometry

Time	Mag.	Abs. Mag.
2024-04-23 05:21:44	>20.65	-16.09
2024-04-23 02:19:47	20.60	-16.14
2024-04-23 01:23:01	20.71	-16.02

Survey View

J2000 [S240422ed](#)

Field of view 10 arcmin
Scale bar 1 arcmin

[Update](#) [Save Image](#)

Host Galaxies with Lowest Probability of Chance Coincidence

ID	Name	P_{cc}	Off. (")	Dist. (Mpc)	Redshift	Mag. (AB)	Source
1	hyperleda836373	0.001	5.81	222.4 ± 3.4	0.05 ± 0.02	$B = 16.2$	GLADE
2	977503000023134	0.012	5.52	212.2 ± 41.8	0.05 ± 0.01	$r = 19.2$	PS1_STRM
3	wiseJ082638.33-204855.8	0.565	65.94	268.8 ± nan	0.06 ± 0.03	$B = 18.3$	GLADE

Comments
No comments yet.

Comment

[Post](#)

Photometry [Check for new data](#)

CTIO-4m (TNS) r CTIO-4m (TNS) z ATLAS c ATLAS o ATLAS c limits ATLAS o limits

Apparent Magnitude

Absolute Magnitude

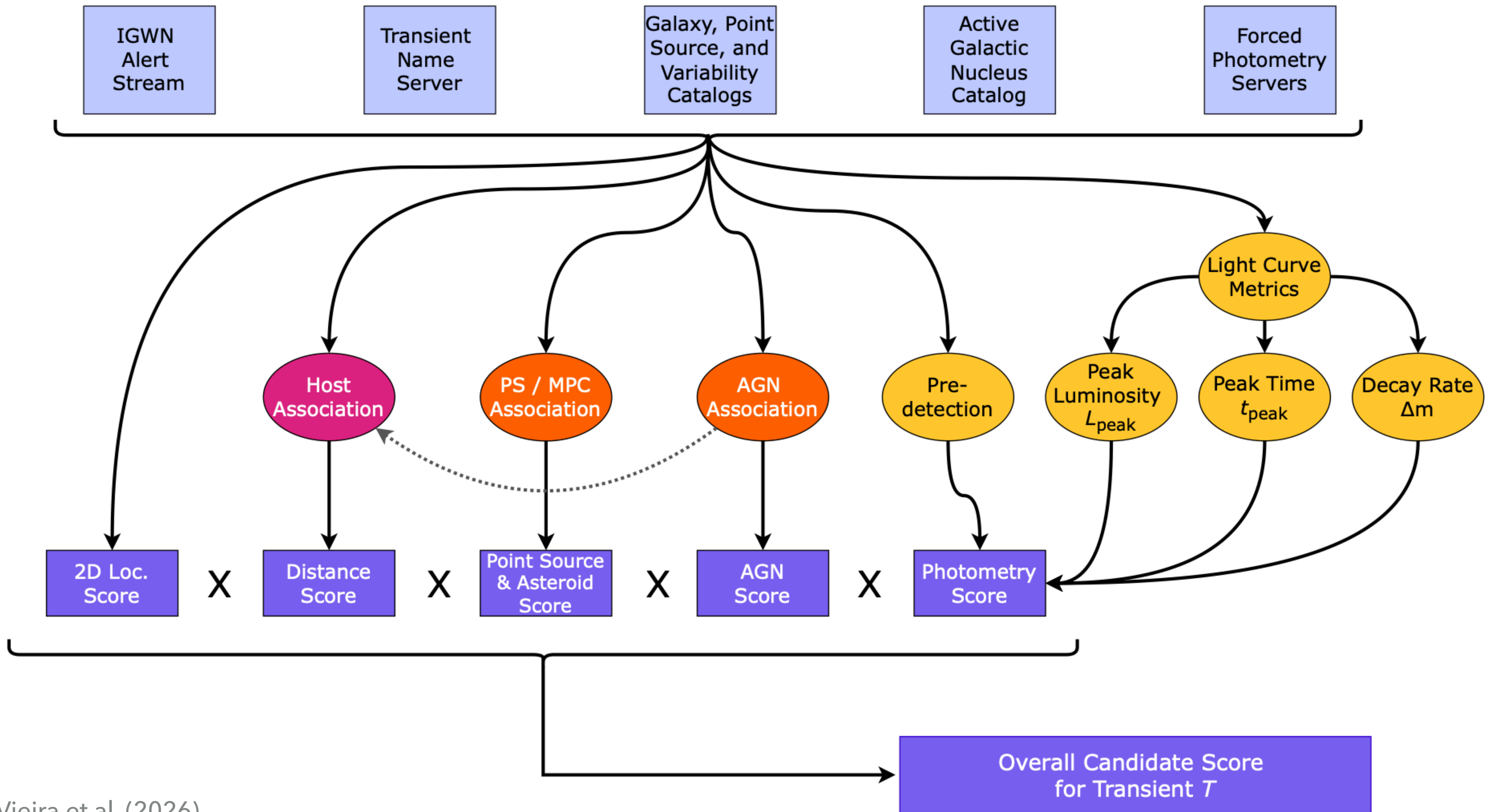
S240422ed

Nov 2023 Jan 2024 Mar 2024 May 2024

Multimessenger Treasure TROVE: A Tool for Rapid Object Vetting & Examination

- ▶ NSF-funded cyberinfrastructure project to coordinate multimessenger follow-up
- ▶ Web interface based on the TOM Toolkit
 - ▶ run SAGUARO vetting tools as a service
- ▶ Calculate a score for each candidate and update in response to new information

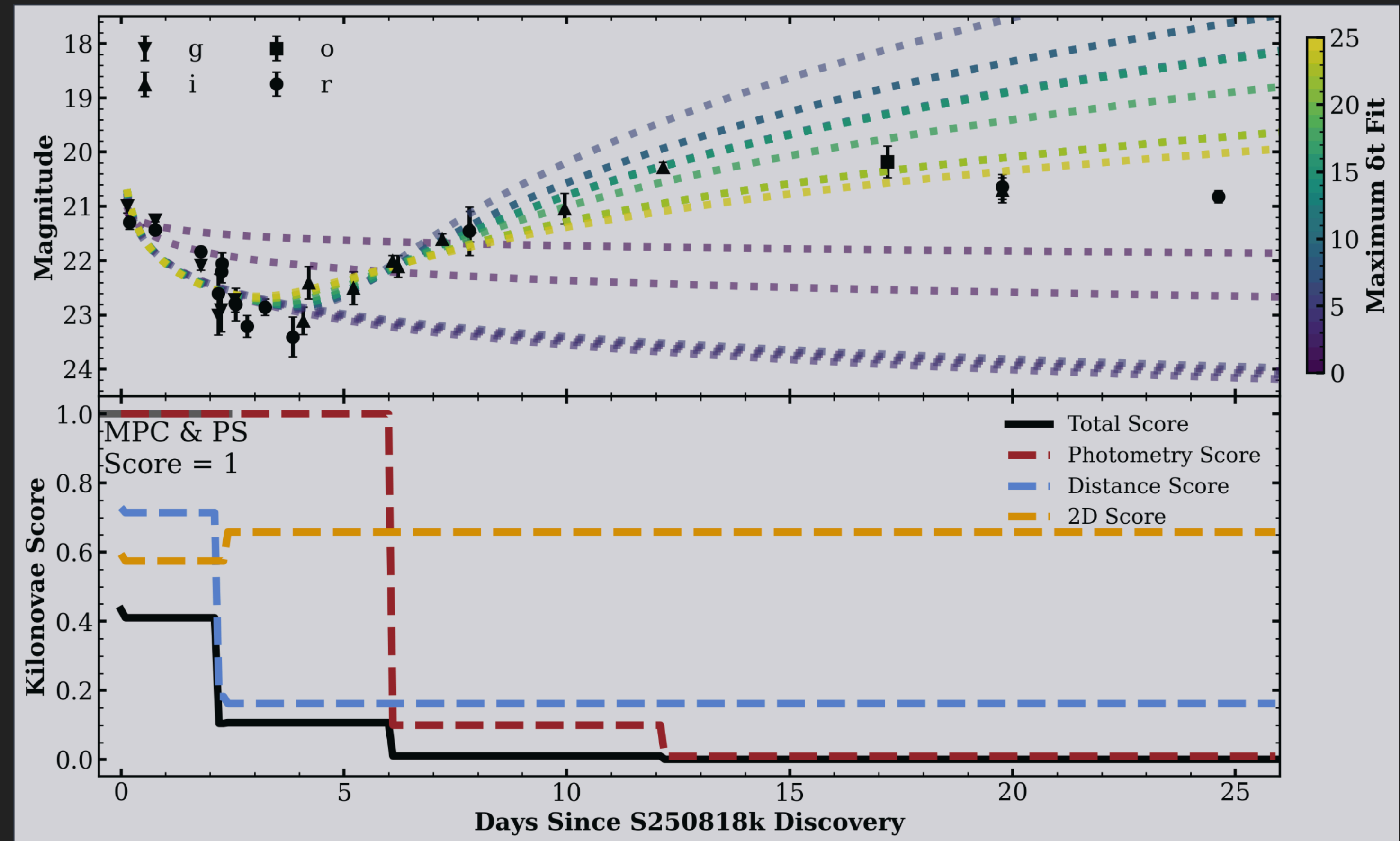




Case Study: S250818k & SN 2025ulz

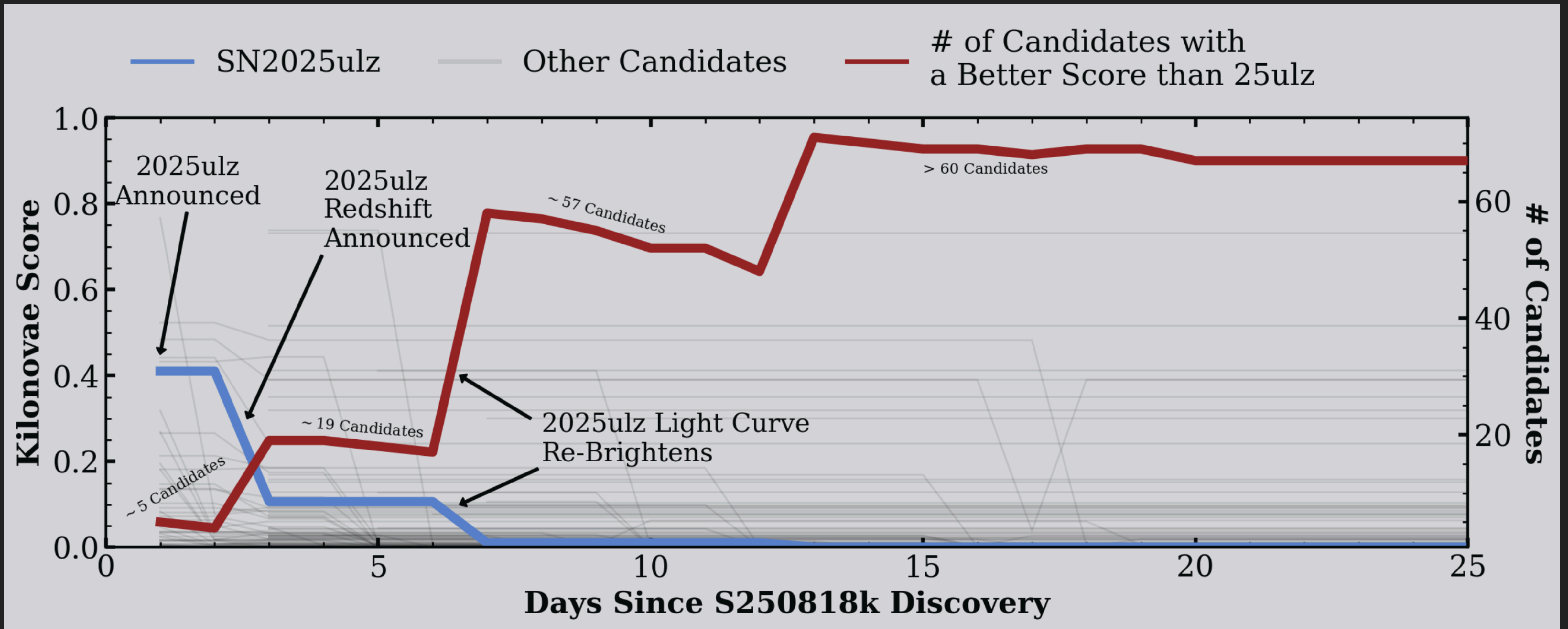
Franz et al. (2025)

- ▶ AT 2025ulz was initially a good candidate for its fast decline rate
- ▶ At day ~ 2.6 , a redshift measurement put it at the edge of the 3D localization
- ▶ At day ~ 6 , a rebrightening made its light curve inconsistent with a kilonova



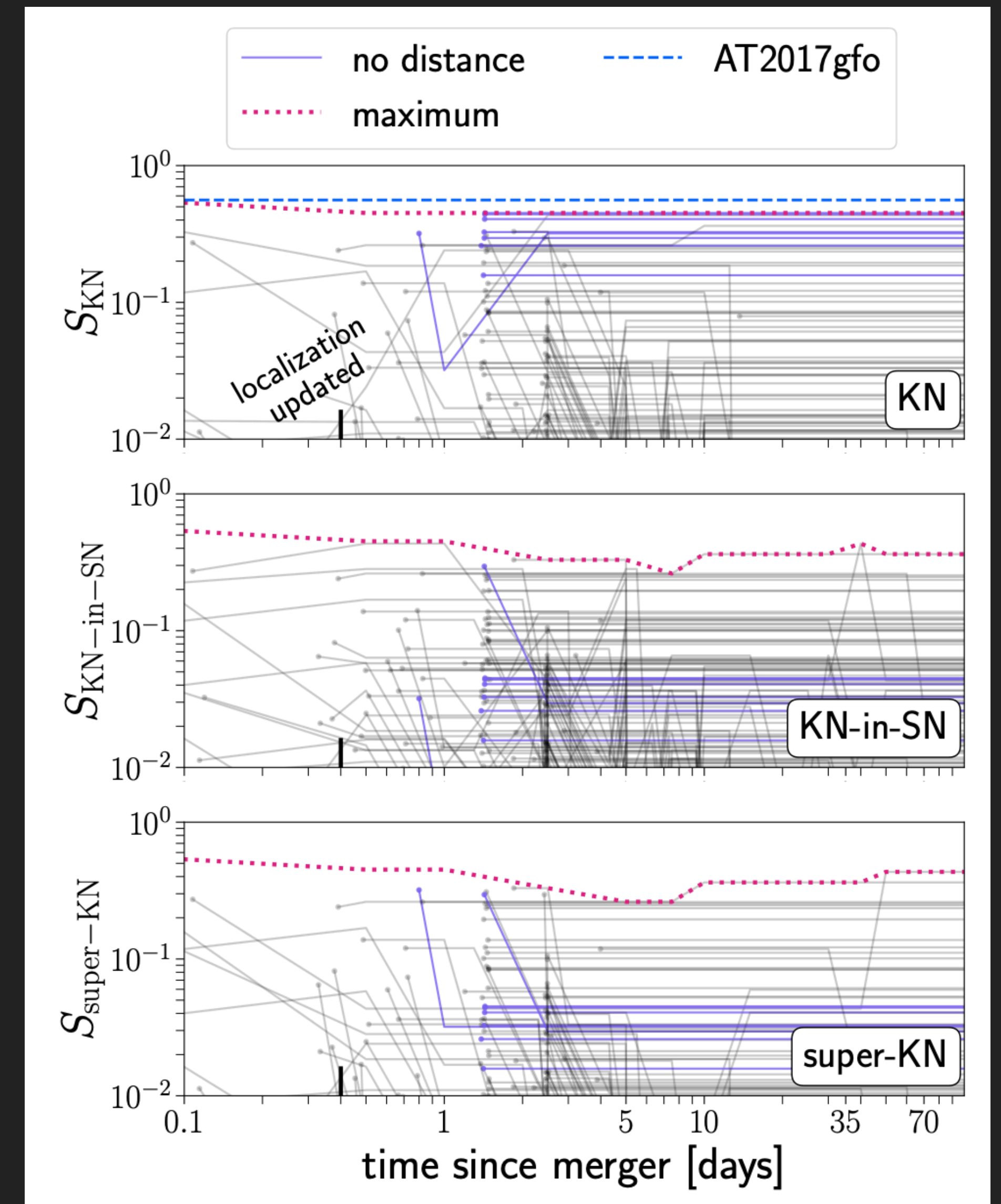
Other candidates were ignored!

Franz et al. (2025)



General Purpose Multimessenger Tool

- ▶ Can design a score for any counterpart model
 - ▶ for subsolar-mass GW event S251112cm:
 - KN, KN-in-SN, super-KN, merger in AGN disk
- ▶ Can be applied to any poorly localized event
 - ▶ GWs, neutrinos, GRBs, FRBs, x-ray flares, high-energy particles, etc.



What can you expect in the coming year?

- ▶ We have an “alpha” site running now
 - ▶ API development in progress
 - ▶ documentation & tutorials to write
- ▶ Will solicit feedback on a “beta” this summer
 - ▶ workshops at conferences
 - ▶ community Slack workspace
- ▶ TROVE v1.0 due before the fall GW run

AT2025adht

Classify Edit Share Delete

Vet

Names AT2025adht [S251112cm](#)

Coords. 12:00:24.350 +49:02:51.95
180.101460 49.047765

Galactic 143.749477 65.966534

Ecliptic 155.448182 43.899524

Permissions Public

Redshift nan

Milky Way E(B-V) 0.0213

Classification

Redshift

MW E(B-V) 0.0216

Scores:

S251112cm 23

Photometry:

Time	Mag.	Abs. Mag.
2025-11-22 20:16:48	21.86	
2025-11-21 20:31:12	21.83	
2025-11-15 00:13:15	21.64	

Survey View

Score Details

S251112cm

Point Source Score (1 or 0): 1
3D Association Score: 0.29
2D Localization Score: 0.83
Maximum Luminosity: 4.47×10^{42} erg/s
Time of Maximum Light Curve: 0.79 days
Light Curve Slope (positive is brightening): -0.57 mag/day
AGN Score (1 or 0): 1
Minor Planet Center Score (1 or 0): 1

Host Galaxies

ID	Name	P_{cc}	Off. (")	Dist. (Mpc)	Redshift	Distance Type	Mag. (AB)	Source
1	PSO J180.1022+49.0484	0.000	2.92	508.6 ± 311.0	0.11 ± 0.07	photo-z	= 20.5	Ps1Galaxy
2	2964-301-1-0300-0367	0.000	3.21	923.8 ± 281.5	0.19 ± 0.06	photo-z	= 19.4	Sdss12Photoz

Photometry

What do we need from you?

- ▶ Community participation
 - ▶ feedback on scoring algorithms, GUI, API
 - ▶ open to adding your favorite class of multimessenger transient
- ▶ Collaboration with broker teams
 - ▶ help us ingest all transients in the (changing) localization region
- ▶ Report your transients and photometry in a machine readable way
 - ▶ the TROVE is only as good as the data it can ingest!

Multimessenger Treasure TROVE: A Tool for Rapid Object Vetting & Examination

- ▶ Papers by the SAGUARO/TROVE team:
 - ▶ Rastinejad et al. 2022, ApJ, 927, 50
 - ▶ Hosseinzadeh et al. 2024, ApJ, 964, 35
 - ▶ Franz et al. 2025, ApJL, 994, L45
 - ▶ Vieira et al. 2026, arXiv:2603.17009
- ▶ See astro-trove.github.io for (a tiny bit) more info
- ▶ Follow up on Slack or ghosseinzadeh@ucsd.edu

