Griffin Hosseinzadeh (UC San Diego)

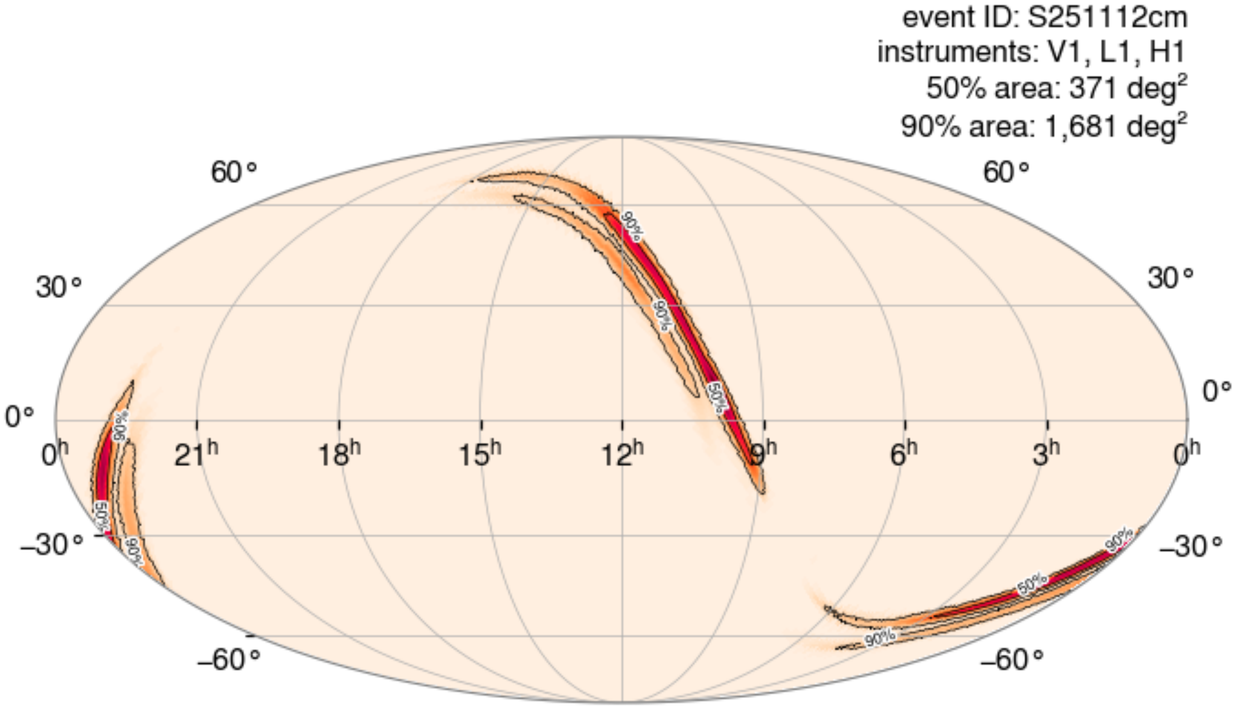
The Multimessenger Treasure TROVE

A Tool for Rapid Object Vetting and Examination

Griffin Hosseinzadeh

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	photoz	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)
AT2025aild	30.4926	-49.3871	60994.09	23.05	0.04	60994.16	21.84	0.04	-	transient-like (c)
AT2024aeuy	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)
AT2025aimi	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)
AT2025aile	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)
AT2025ailh	11.1327	-37.4762	60996.11	21.03	0.01	60994.15	20.78	0.01	0.251	transient-like (b)
AT2025aili	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)
AT2025ailo	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.	22.	0.04	60994.	22.	0.06	0.111	transient-like (c,d)

Current Multimessenger Follow-up Procedure

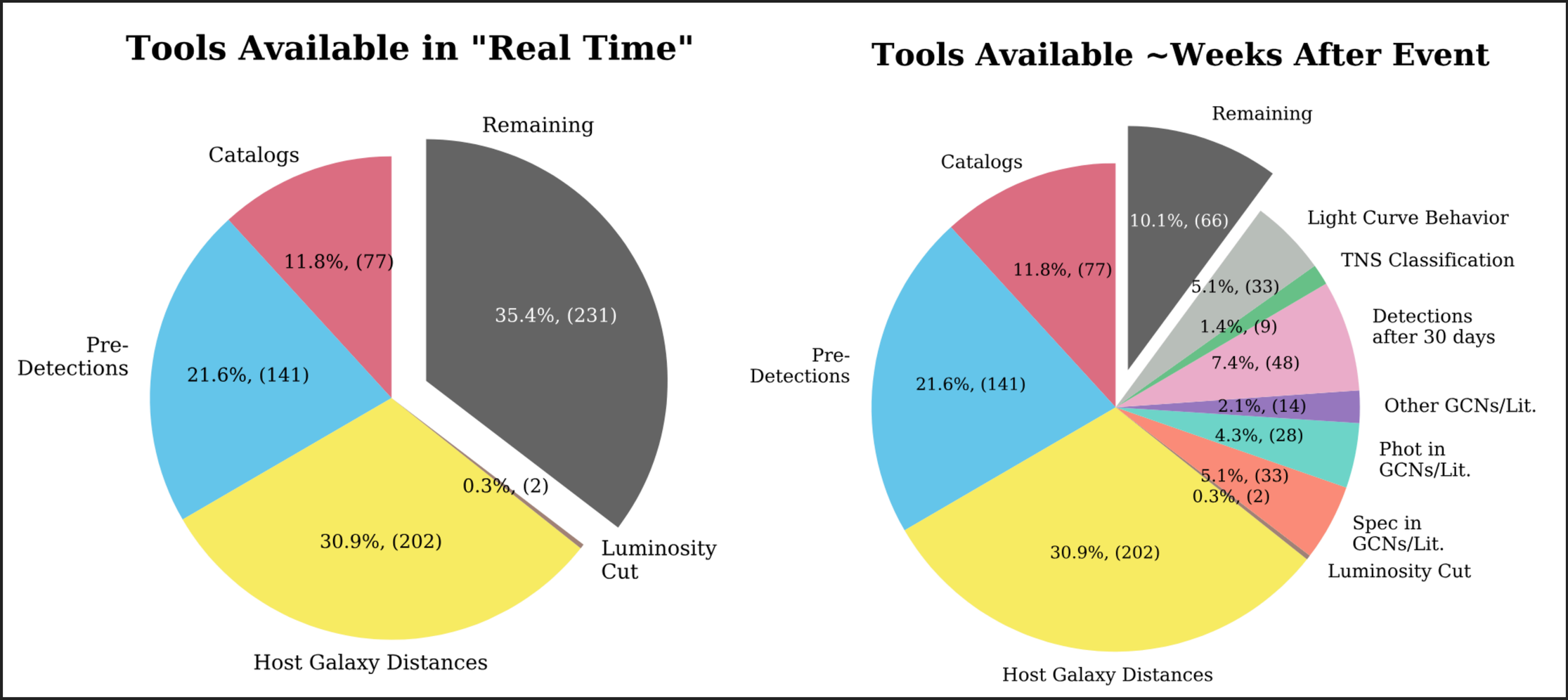
- *Big surveys:* Tile the localization region and report hundreds of candidates via GCN circular and/or TNS reports
- *Everyone:* Wait for someone to highlight 1-2 viable candidates via GCN circular
- *Dozens of groups:* Get an epoch of photometry and report it via GCN circular
- *Papers:* "we find that 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)

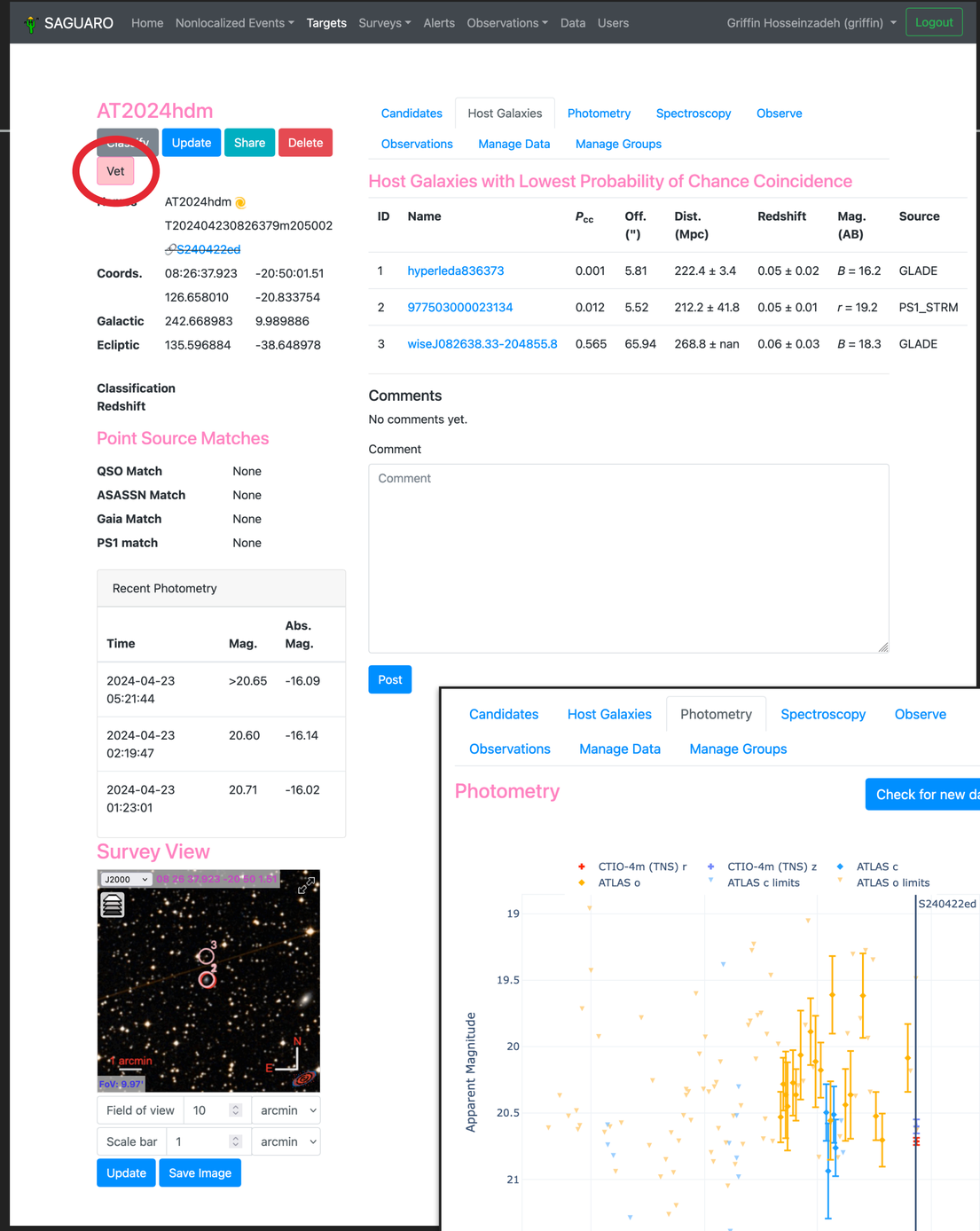
What do I mean by candidate vetting?

Rastinejad et al. (2022)



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 ✅



Hosseinzadeh et al. (2024)

Griffin Hosseinzadeh

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

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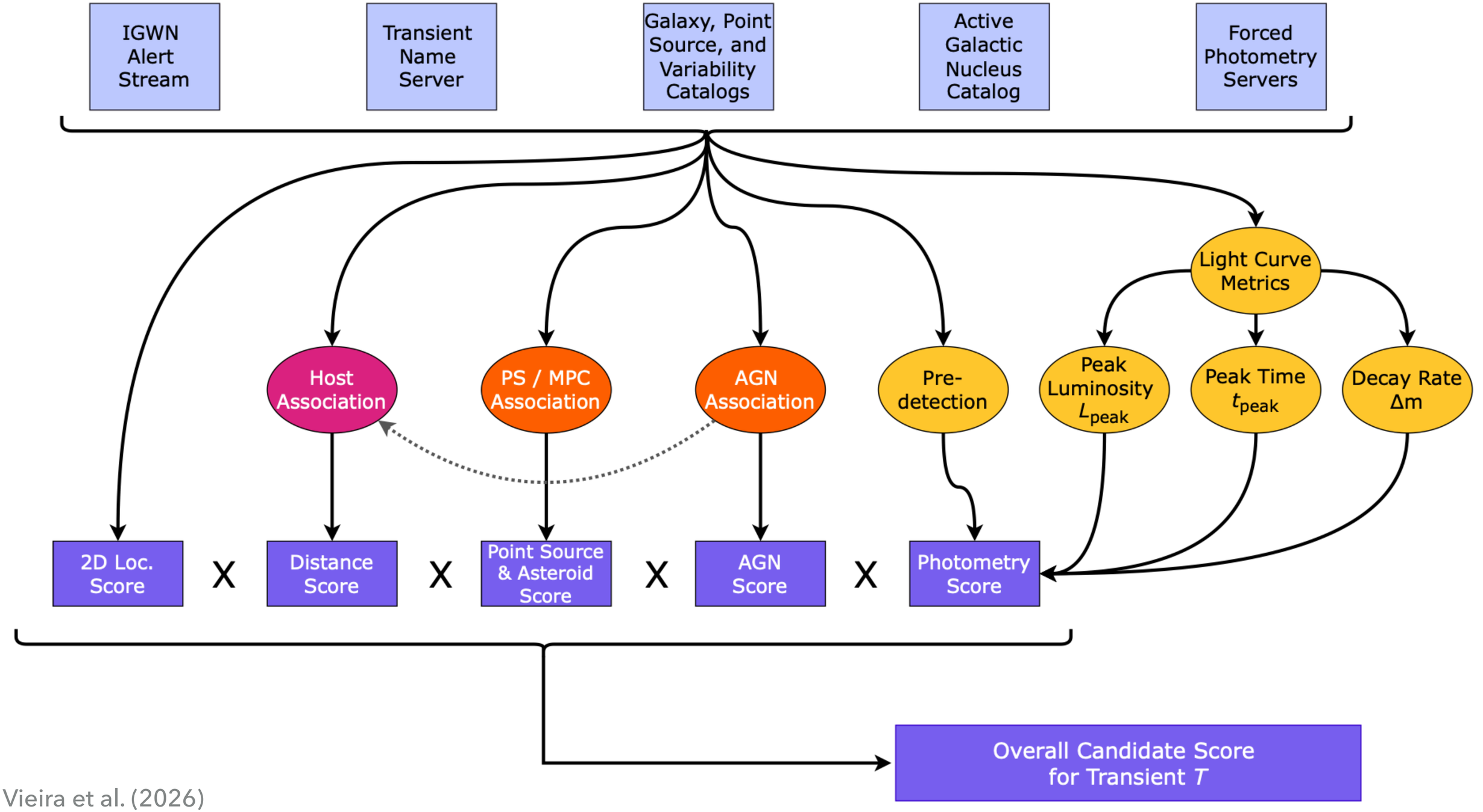
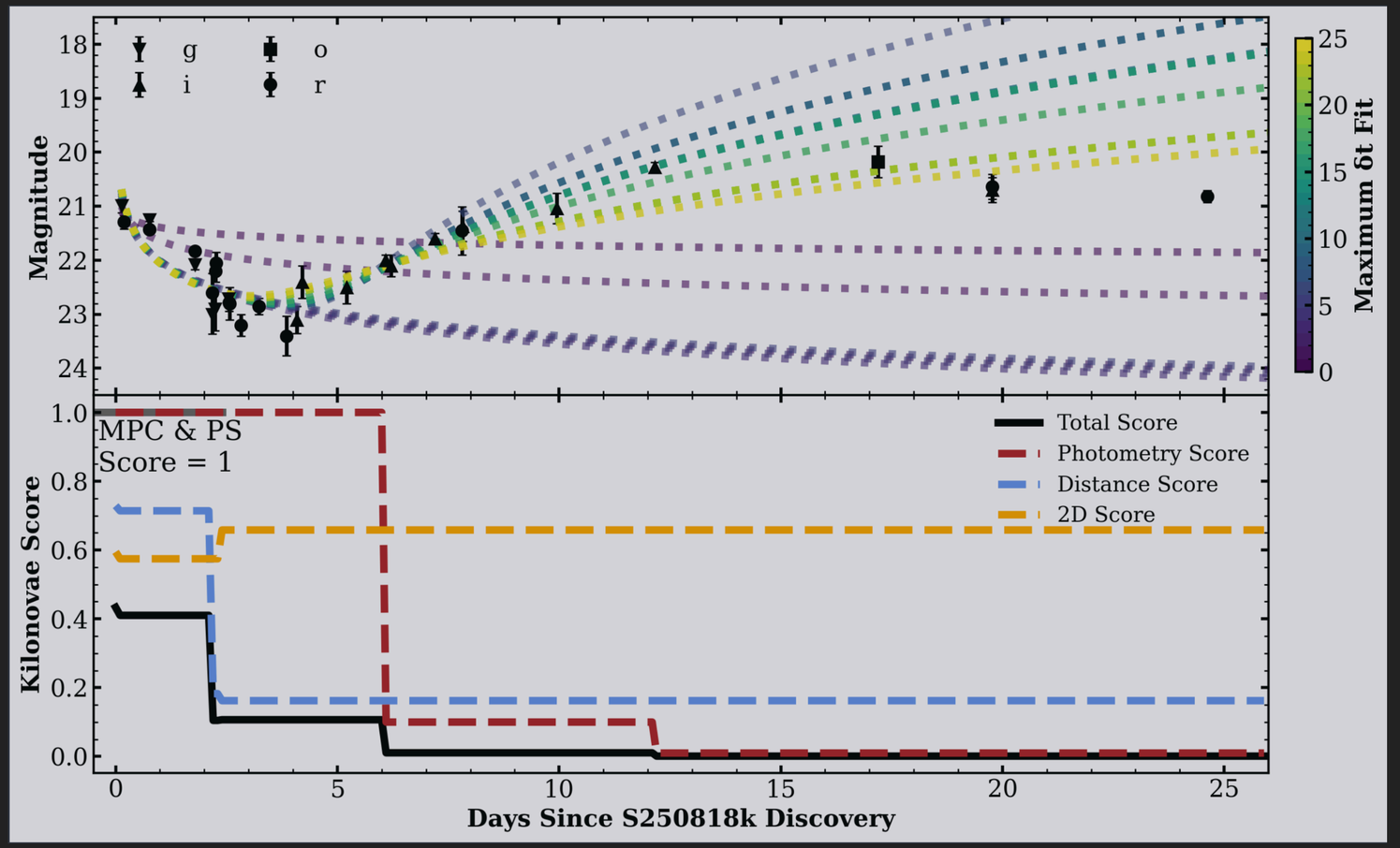


Vieira et al. (2026)

Case Study: S250818k & SN 2025ulz

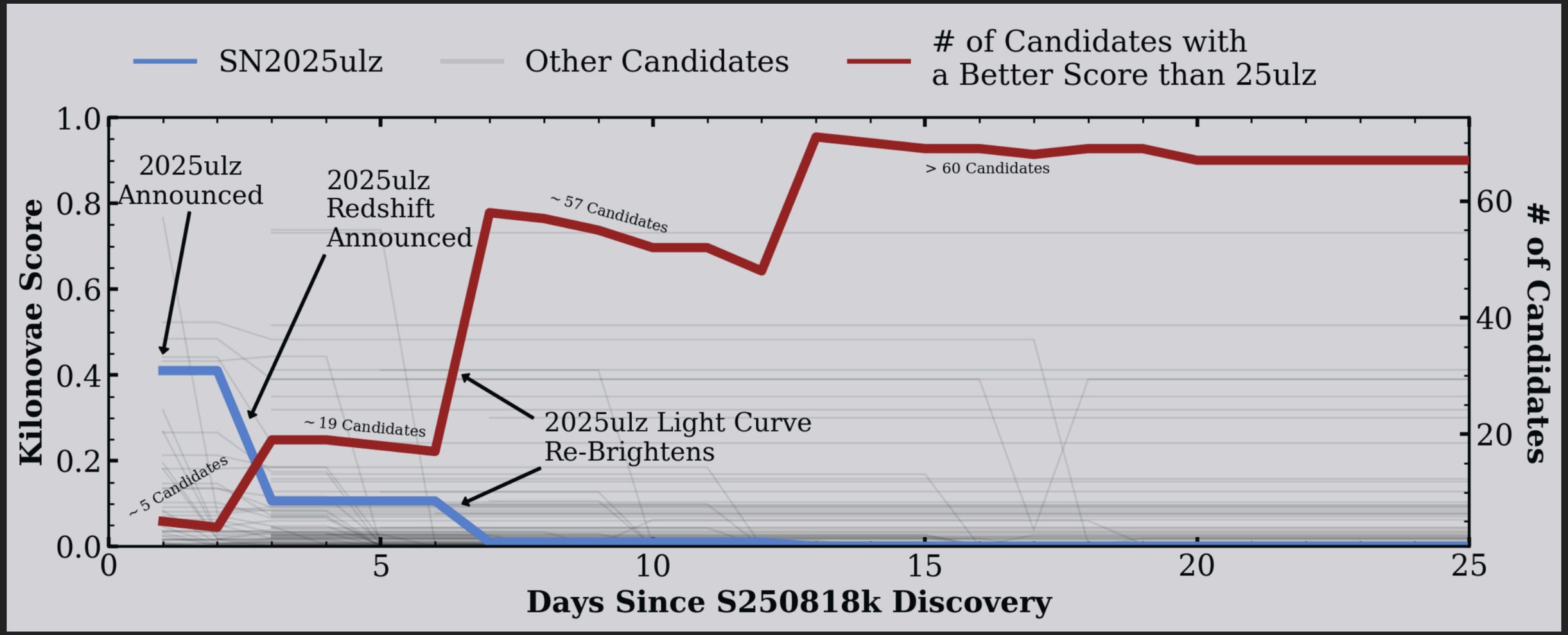
- AT 2025ulz was initially a good candidate for its fast decline rate
- At day ~2.6, a redshift measurement put it at the edge of the 3D localization
- At day ~6, a rebrightening made its light curve inconsistent with a kilonova

Franz et al. (2025)



Other candidates were ignored!

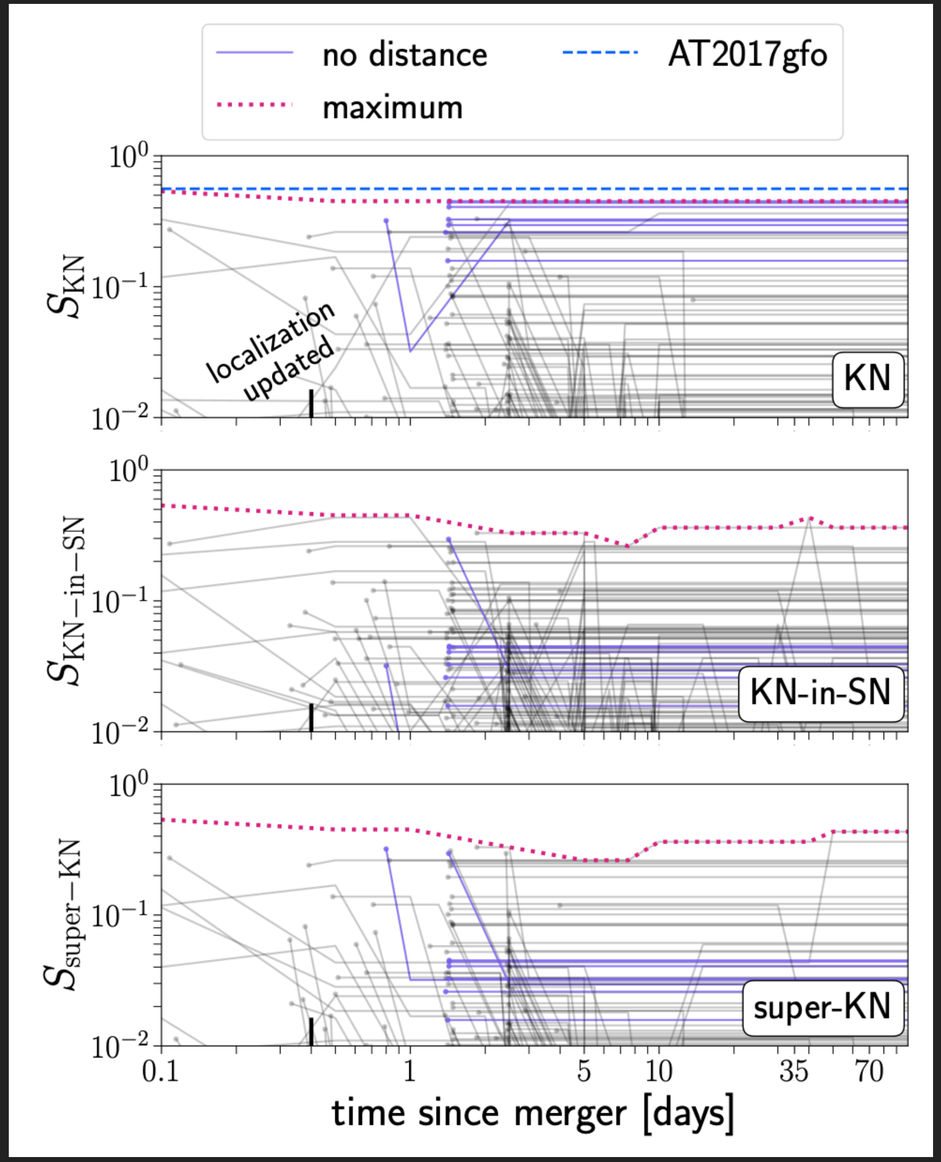
Franz et al. (2025)



General Purpose Multimessenger Tool

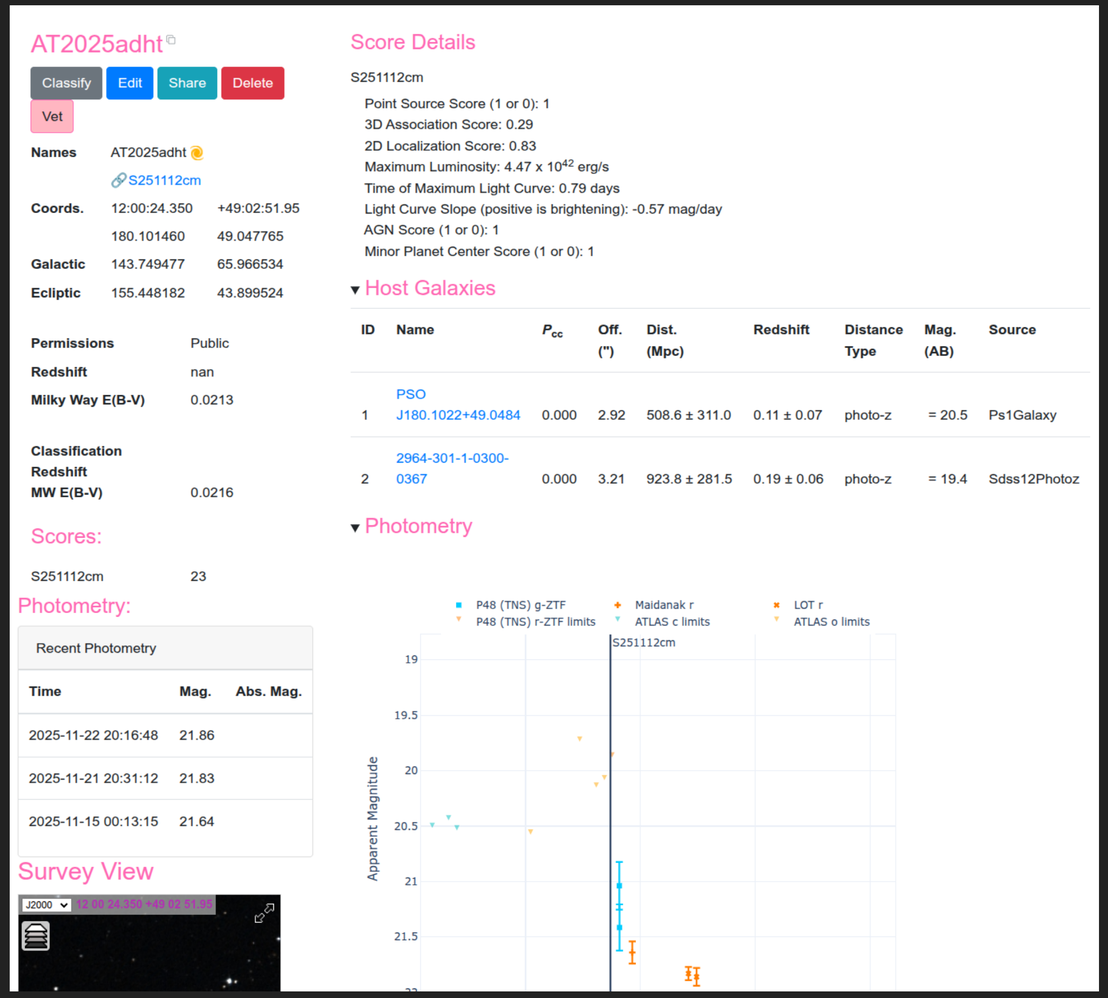
- Can design a score for any counterpart model
  - for subsolar-mass GW event S251112cm: KN, KN-in-SN, super-KN, merger in AGN disk
- Can be applied to any poorly localized event
  - GWs, neutrinos, GRBs, FRBs, x-ray flares, high-energy particles, etc.

Vieira et al. (2026)



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



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!

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- 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