

An Extensible TOM for the Time-Domain Era: SAGUARO as a Scalable Discovery Platform

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University of Arizona
On behalf of SAGUARO collaboration

March 27, 2026
RAPID Response: Hot-wiring the Next Generation
of Time-Domain Science
Pasadena, CA

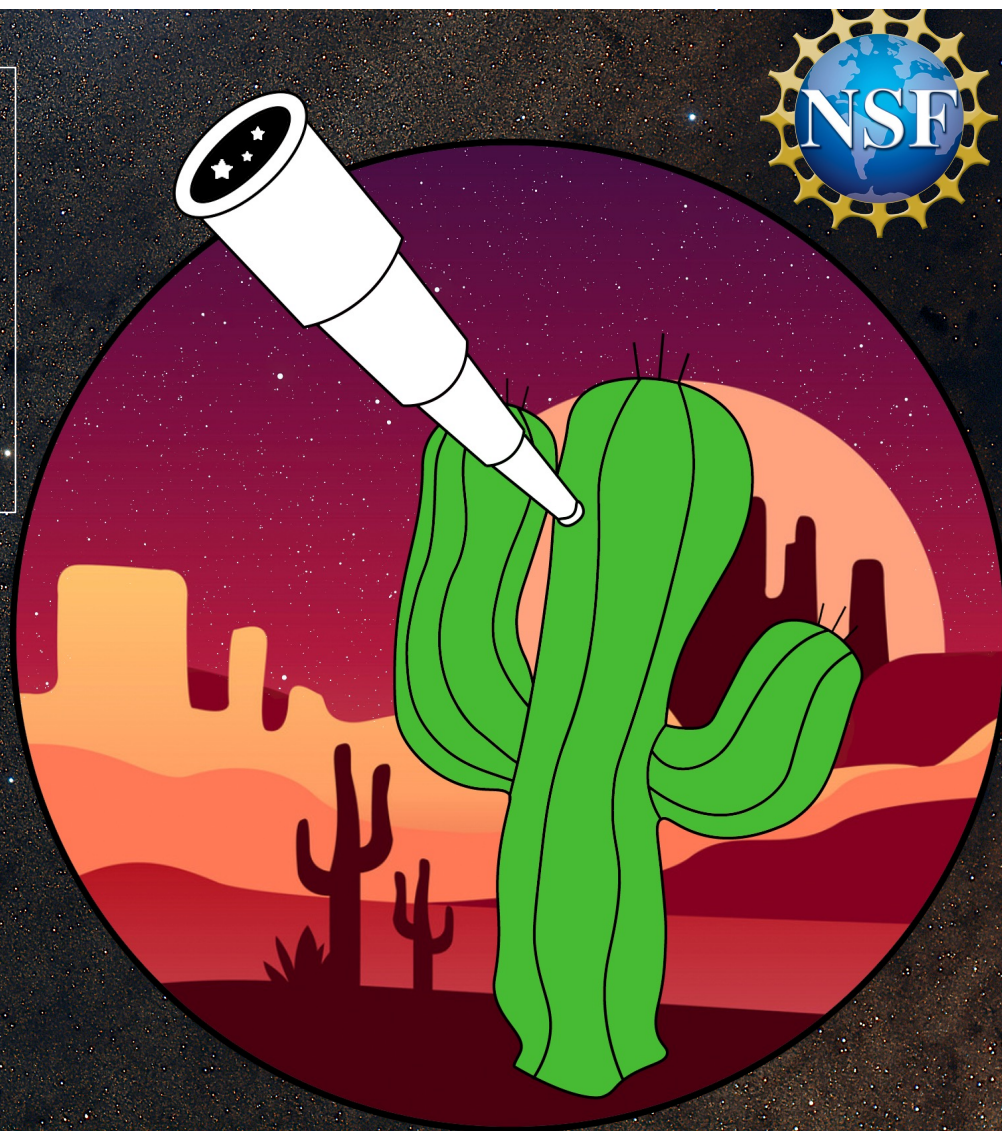


Image credits: Stu Parker, Parkdale Observatory

Huge shout out to SAGUARO collaboration!



David Sand



Wen-fai Fong



Griffin Hosseinzadeh



Manisha Shrestha



Kate Alexander



Charlie Kilpatrick



Azalee Bostrom



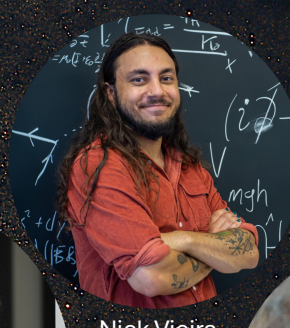
Mike Lundquist



Noah Franz



Phil Daly



Nick Vieira



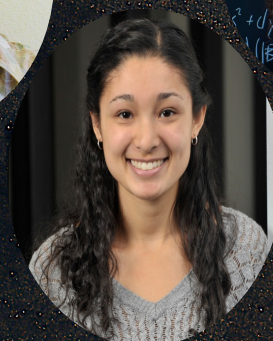
Felipe Darc



Bhagya Subrayan



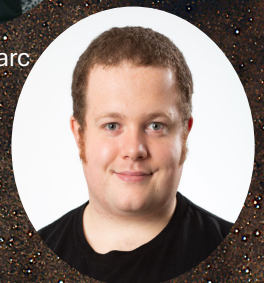
Kerry Paterson



Jillian Rastinejad



Phillip Noel



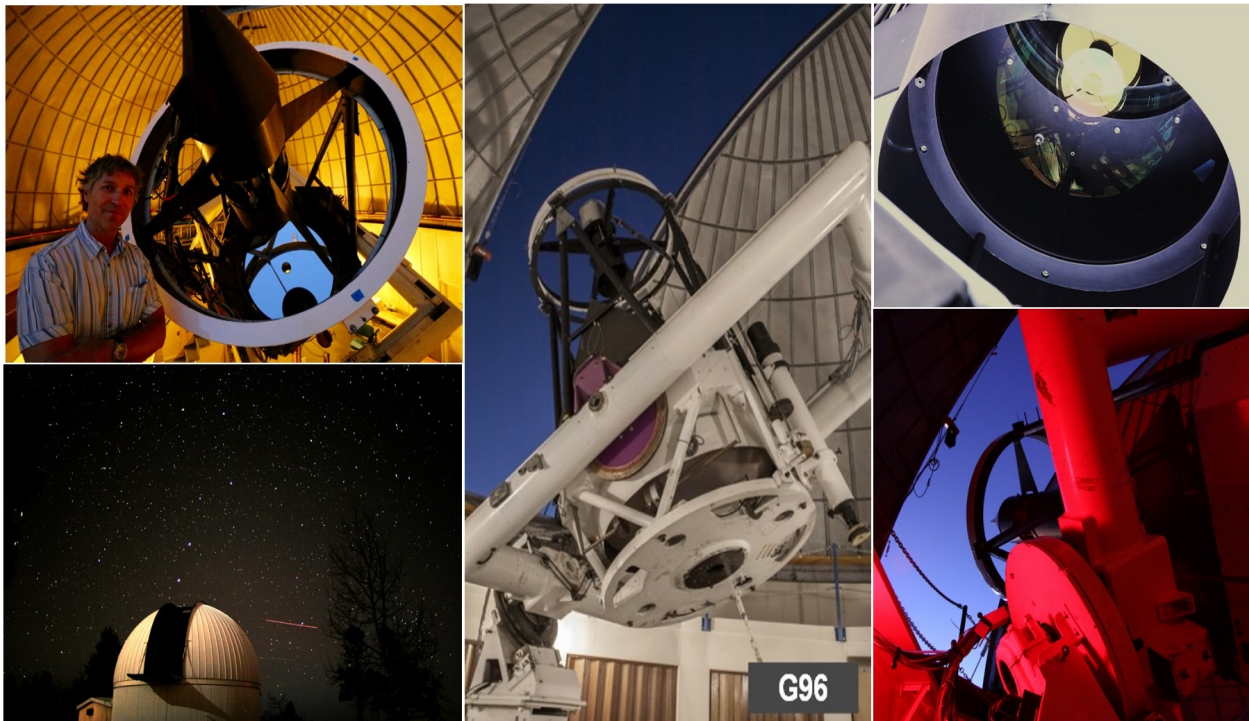
Conor Ransome

What is **SAGUARO**?

Searches **A**fter **G**ravitational waves **U**sing **AR**izona **O**bservatories



The Catalina Sky Survey (CSS) Leveraging Wide Field Area Surveys for GW Follow-up



- 5 deg² field of view, 21.5 mag depth
- Designed to discover and track Near- Earth Objects (NEO)
- They provide calibrated images
- We perform image subtraction and search for transients
- For promising BNS/NSBH events, we can override their survey with a ranked list of fields

What is **SAGUARO** (from a hot-wiring point of view)? A Target and Observation Manager (TOM)



- A Django Web Application
(recall GOATS, Dan Avner's talk, BHTOM/infrastructure talks in next session)
- Integrates all of our tools for

- receiving GW alerts
- planning surveys
- scanning survey candidates
- vetting KNe candidates
- scheduling follow up
- visualizing data
- reporting results

Lundquist+2019
Paterson+2021
Hosseinzadeh+2024

Congratulations!! Welcome to SAGUARO!



SAGUARO

Latest Comments
No comments yet.

Latest Targets	
ID	Created
AT2026hje	2026-03-26
AT2026hjf	2026-03-26
AT2026hjd	2026-03-26
AT2026hja	2026-03-26
AT2026hjb	2026-03-26
AT2026hjc	2026-03-26
AT2026hix	2026-03-26
AT2026hiy	2026-03-26
AT2026hiz	2026-03-26
AT2026hiu	2026-03-26

From GW alerts to triggering follow-up

An end-to-end workflow and case studies

1. GW Slack Alerts (ingest Kafka with SCIMMA Hopskotch)

Search SAGUARO

alerts-ns Significant alerts with BNS > 1%, NSBH > 1%, or HasNS > 1%



GW Alerts APP 18:21

@channel

NSBH INITIAL v3

S240422ed (significant)

2024-04-22T21:35:13.417Z

1/FAR = 102 kyr

Distance = 214 ± 64 Mpc

50% Area = 103 deg²

90% Area = 403 deg²

Has NS = 100%

Has Mass Gap = 46%

Has Remnant = 100%

BNS = 0%

NSBH = 100%

BBH = 0%

Terrestrial = 0%

SAGUARO Hermes GraceDB Treasure Map



GW Alerts APP 9:04 AM

SSM UPDATE v4

S251112cm (significant)

2025-11-12T15:18:45.362Z

1/FAR = 6.2 yr

Distance = 93 ± 27 Mpc

50% Area = 371 deg²

90% Area = 1681 deg²

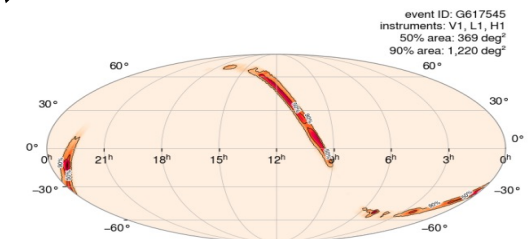
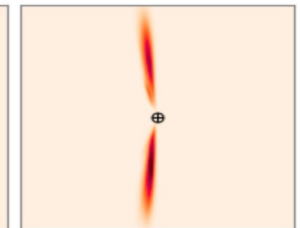
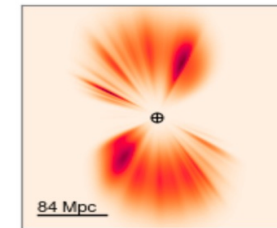
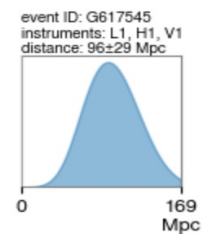
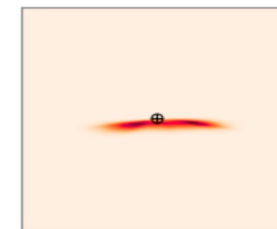
Has NS = 0%

Has Mass Gap = 0%

Has SSM = 100%

SAGUARO Hermes GraceDB Treasure Map

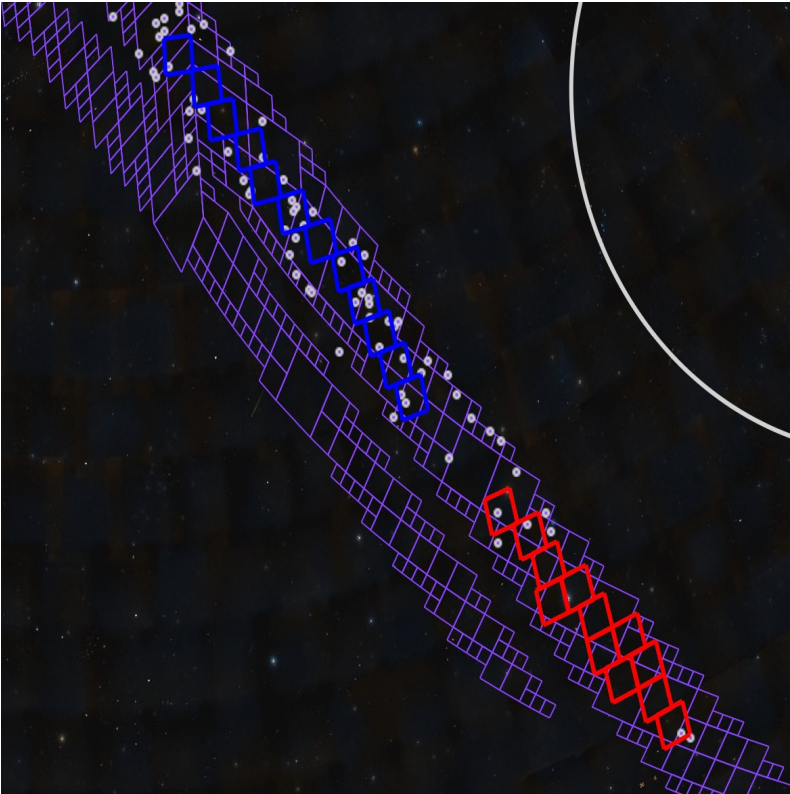
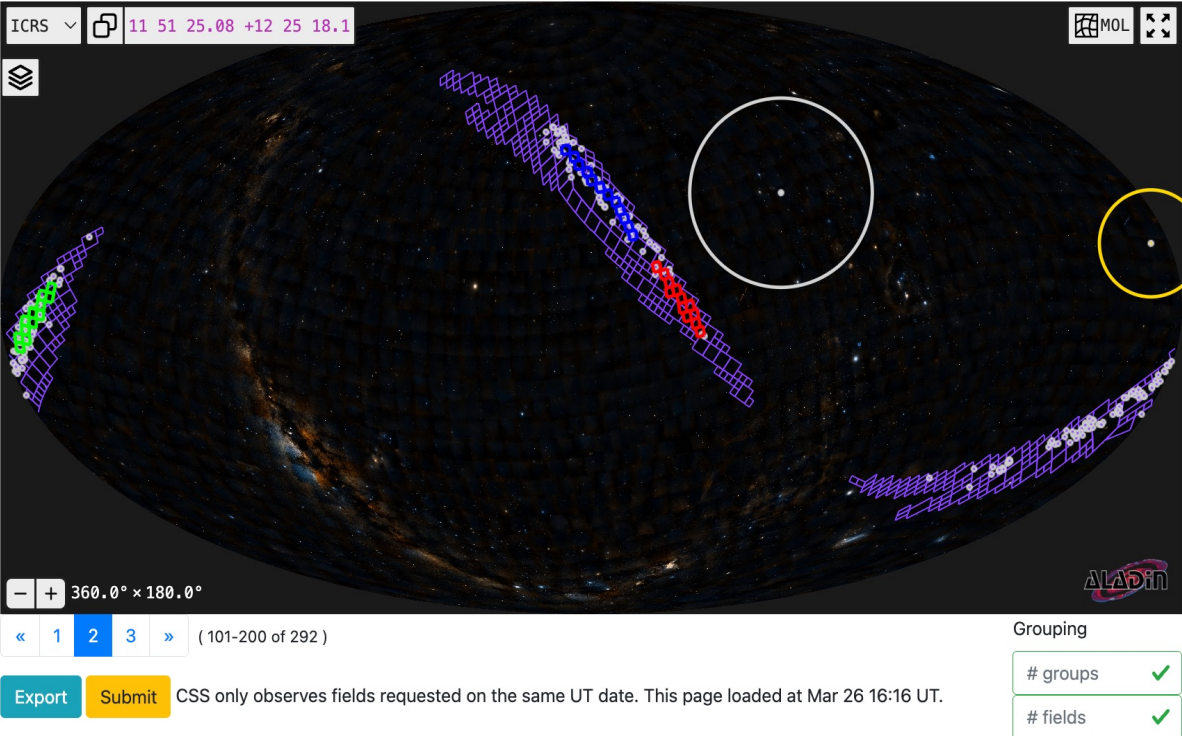
GraceDB BAYESTAR Images



Survey Plans for S251112cm Update 4

Event Type	GW CBC	1/FAR	6.2 yr
Instrument	H1+L1+V1	Distance	93 ± 27 Mpc
50% Area	371 deg²	HasNS	0%
90% Area	1681 deg²	HasSSM	100%
		HasMassGap	0%
		HasRemnant	0%

From GW alerts to triggering follow-up
An end-to-end workflow and case study
2. Survey Plans in GW localization



Just a click and it submits the plans to CSS scheduler!

Candidates for S251112cm

Event Type	GW CBC	1/FAR	6.2 yr
Instrument	H1+L1+V1	Distance	93 ± 27 Mpc
50% Area	371 deg ²	HasNS	0%
90% Area	1681 deg ²	HasSSM	100%
		HasMassGap	0%
		HasRemnant	0%

From GW alerts to triggering follow-up
An end-to-end workflow and case study
3. Transient Candidates and Vetting

ICRS 12 57 23.39 +51 19 38.2

Target	Field	Obs. Date	Mag.	FW HM	S/N	# Det.	ML Old	ML Real	ML Bog.	Image	Reference	Difference	S _{corr}
J11042938 +3433492 S251112cm	N34064	11-14	19.5	2.8	7.9	10	0.84	0.49	0.02				
J11122393+3325198 S251112cm	N34064	11-14	18.9	1.4	14.7	18	0.84	0.49	0.02				

134.9° × 67.45°

From GW alerts to triggering follow-up: An end-to-end workflow and case study

3. Transient Candidates and Vetting + Reporting

J23080031-1029563

EditShareDeleteReport

MPCVet

Names J23080031-1029563

[S251112cm](#)

Coords. 23:08:00.314 -10:29:56.29

347.001308 -10.498969

Galactic 62.296124 -60.523722

Ecliptic 343.958823 -4.543049

Classification

Redshift

MW E(B-V) 0.0273

Point Source Matches

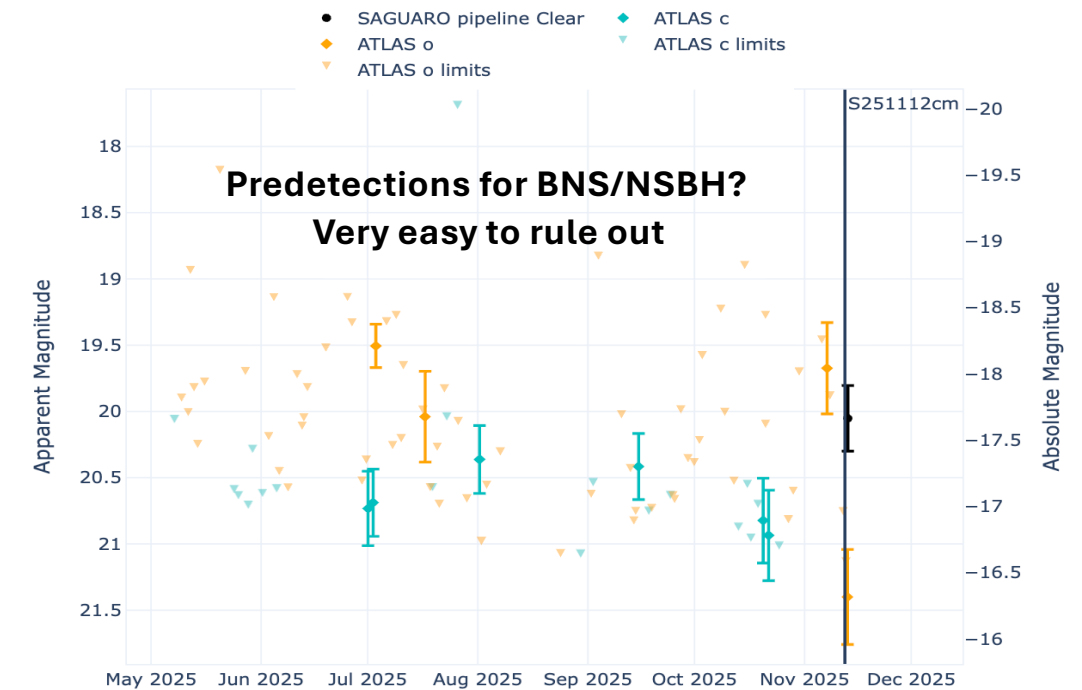
QSO Match	None
ASASSN Match	None
Gaia Match	None
PS1 match	None
Minor Planet Match	None
Minor Planet Date	2025-11-13

CandidatesHost GalaxiesPhotometrySpectroscopyObserve

ObservationsManage DataManage Groups

Photometry

Check for new data



AT2025aebp

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

[MPC](#) [Vet](#)

Names AT2025aebp 
WFST-GW251113xrxq
PS25ikk
[S251112cm](#)

Coords. 10:37:03.154 +23:11:47.05
159.263144 23.196404

Galactic 212.769514 59.428815

Ecliptic 152.089187 13.410379

Classification
Redshift
MW E(B-V) 0.0202

Point Source Matches

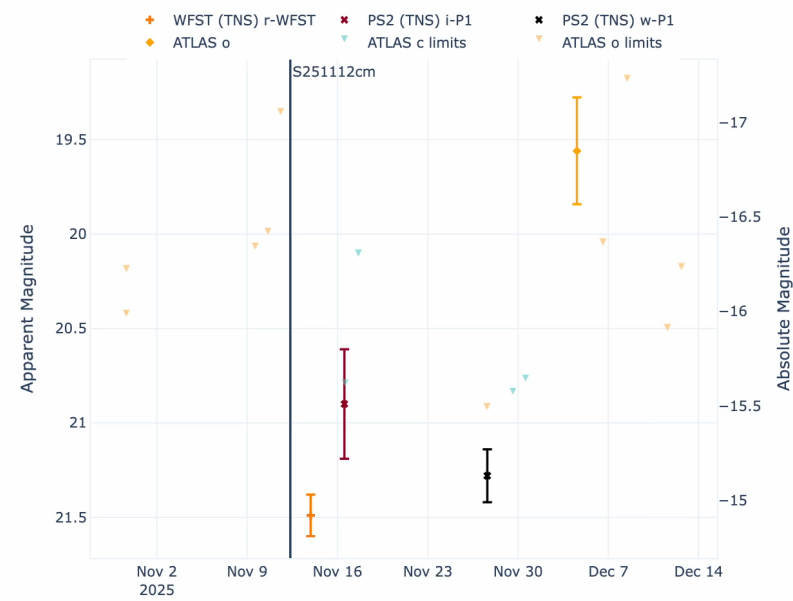
Minor Planet Match None
Minor Planet Date 2025-11-27
ASASSN Match None
Gaia Match None
QSO Match None
PS1 match None

[Candidates](#) [Host Galaxies](#) [Photometry](#) [Spectroscopy](#) [Observe](#)

[Observations](#) [Manage Data](#) [Manage Groups](#)

Photometry

Check for new data



Photometry Data

☐ [Share](#) [Timestamp](#) [Filter](#) [Magnitude](#) [S/N](#) [Source](#)

From GW alerts to triggering follow-up: An end-to-end workflow and case study
4. Community Follow-up and Awareness

Check out pyMMT for ToO observations with MMT (Shrestha+2024)



Treasure TROVE (Griffin's talk)
Rastinejad+2022, Franz+2025, Vieira+2026



SAGUARO in the Rubin Era as an Extensible TOM

We are actively ingesting early LSST alerts!



Transient Alerts APP # alerts

Feb 25th at 11:59 PM

ANT2026a9uldy8izz9q has been updated from the Antares alert stream. (20.4 mag) @channel

The three most likely host galaxies are:

1. 0.155" from 10995203488885893 at 4678.9 Mpc
2. 13.732" from 10995203488885822 at 612.1 Mpc
3. 108.034" from 10995203488884442 at 73.6 Mpc

[SAGUARO SNEx TNS](#)



Transient Alerts APP # alerts

Feb 25th at 11:59 PM

ANT2026m9zv735xtjwk has been updated from the Antares alert stream. (22.8 mag)

The three most likely host galaxies are:

1. 0.097" from 10997406556506868 at 5663.8 Mpc
2. 5.292" from 10997406556506979 at 1700.8 Mpc
3. 2.665" from 10997406556506822 at 4802.6 Mpc

[SAGUARO SNEx TNS](#)



Transient Alerts APP # alerts

Feb 25th at 11:59 PM

ANT2026ourxh905r123 has been updated from the Antares alert stream. (23.1 mag)

The three most likely host galaxies are:

1. 0.096" from 10997405536246166 at 7573.9 Mpc
2. 0.387" from 10997405536246159 at 4987.4 Mpc
3. 10.358" from 10997405536245916 at 1325.6 Mpc

[SAGUARO SNEx TNS](#)

ID	Name	Reps	Class	RA	DEC	Obj. Type	Reporting Group/s	Discovery Date (UT)	Sender
202175	SN 2026ekf	6	1	12:30:49.857	+08:16:26.15	SN Ia	SAGUARO, VHU-TDA, YSE, GOTO, ZTF, BlackGEM	2026-02-25 07:00:10.000	SAGUARO_Bot1
202167	AT 2026ejx	1		10:01:07.335	+02:44:47.74		SAGUARO	2026-02-25 07:00:10.000	SAGUARO_Bot1
202165	AT 2026ejv	1		04:12:42.068	-47:23:31.47		SAGUARO	2026-02-25 07:00:10.000	SAGUARO_Bot1
202159	AT 2026eip	1		04:06:01.044	-48:07:35.90		SAGUARO	2026-02-25 05:01:11.000	SAGUARO_Bot1
202158	AT 2026ejo	1		10:01:40.588	+03:40:57.05		SAGUARO	2026-02-25 05:01:11.000	SAGUARO_Bot1
202156	AT 2026ejm	1		10:01:10.043	+02:24:59.89		SAGUARO	2026-02-25 05:01:11.000	SAGUARO_Bot1
202152	AT 2026eij	2		03:57:40.907	-49:42:53.84		SAGUARO, SGLF	2026-02-25 01:39:57.000	SAGUARO_Bot1
202150	AT 2026eijh	2		03:49:00.055	-49:21:12.37		SAGUARO, VHU-TDA	2026-02-25 01:39:57.000	SAGUARO_Bot1
202137	SN 2026eif	1	1	04:04:37.779	-48:30:07.25	SLSN-I	SAGUARO	2026-02-25 01:39:57.000	SAGUARO_Bot1
202129	AT 2026eiy	2		03:49:41.167	-48:16:09.46		SAGUARO, VHU-TDA	2026-02-25 00:16:57.000	SAGUARO_Bot1

10 Discovery TNS reports on day 1!



SAGUARO in the Rubin Era as an Extensible TOM

We are actively ingesting early LSST alerts!

SN2026ejf

Edit Share Delete Classify
MPC Vet

Names SN2026ejf
313831458352922664
ANT2026ndnbcbb1n5bi
Coords. 04:04:37.779 -48:30:07.25
61.157411 -48.502013
Galactic 256.195304 -47.208012
Ecliptic 36.270549 -66.641755

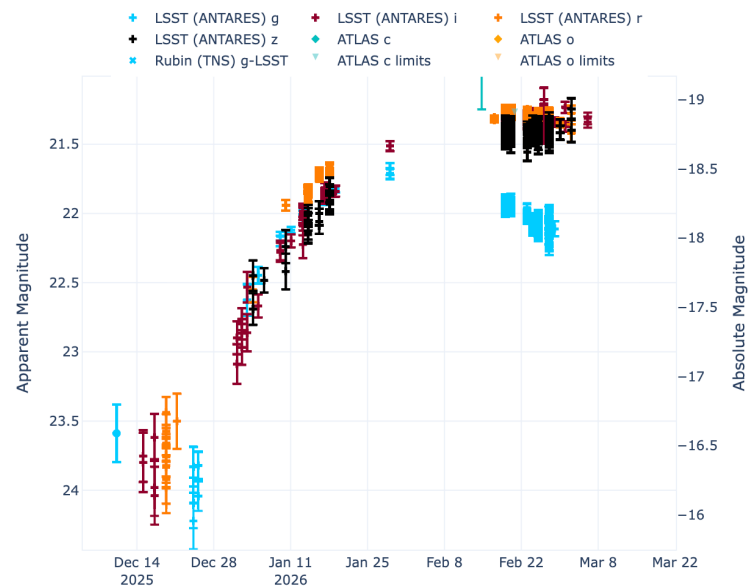
Classification SLSN-I
Redshift 0.96
MW E(B-V) 0.0098

Point Source Matches

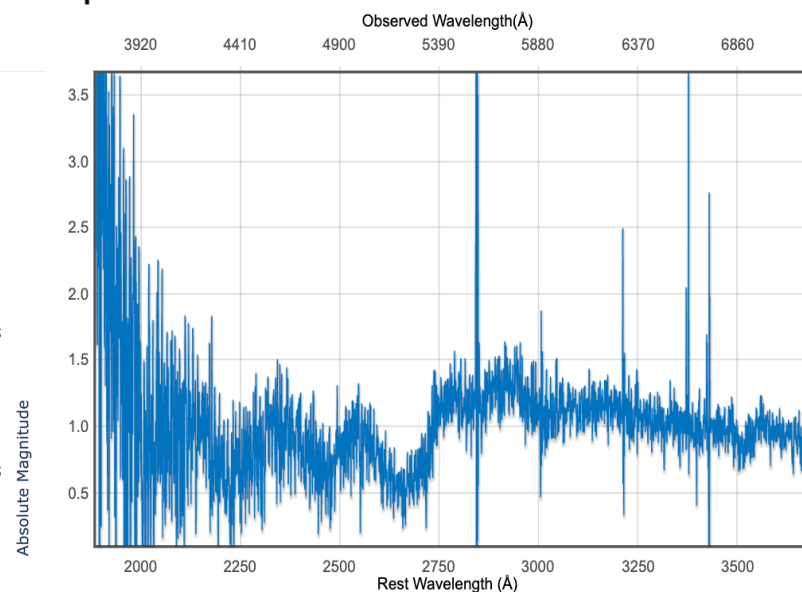
QSO Match None
ASASSN Match None
Gaia Match None
PS1 match None
Minor Planet Match None
Minor Planet Date 2026-03-06

Candidates Host Galaxies Photometry Spectroscopy Observe
Observations Manage Data Manage Groups

Photometry

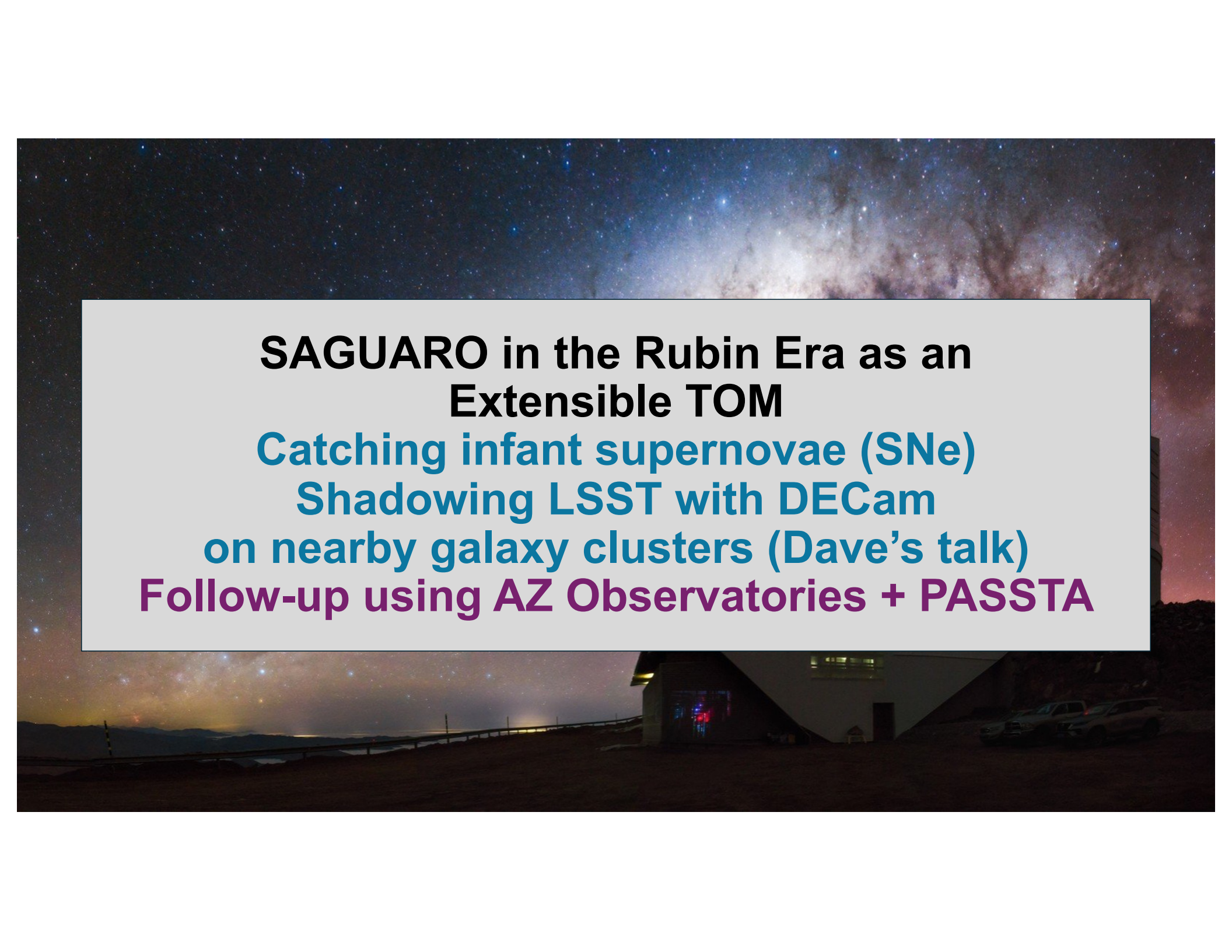


Spectra



**Spectroscopically classified as
SLSN-I at 0.96**

Zoom Full Auto Zoom Binning factor: 1 (rounded to nearest integer >1)
Mouse hovers at WL: 2371.27 (rest), 4647.69 (observed)



**SAGUARO in the Rubin Era as an
Extensible TOM**
Catching infant supernovae (SNe)
Shadowing LSST with DECam
on nearby galaxy clusters (Dave's talk)
Follow-up using AZ Observatories + PASSTA

Congratulations!! Welcome to SAGUARO!



SAGUARO

Latest Comments

No comments yet.

Latest Targets

ID	Created
AT2026hkb	2026-03-27
AT2026hjz	2026-03-27
ANT2020ebis6	2026-03-27
ANT20262lqa2w79oew	2026-03-27
ANT2026ycgilwakjzng	2026-03-27
ANT2026wrgwuh92th2p	2026-03-27
ANT2020aeghmva	2026-03-27
ANT2026l0qukdpthx2e	2026-03-26
ANT2026tf1iwhf31o4f	2026-03-26
ANT2026e5gw3lpictg7	2026-03-26

Key Takeaways:

- **SAGUARO** is a mature, end-to-end framework for rapid transient discovery, vetting, and coordinated follow-up.
- Built for GW counterpart searches, but broadly adaptable to time-domain science.
- The **TOM infrastructure is modular and scalable**, enabling new science programs with minimal re-engineering.

Open Questions:

- What have we learned from existing alert streams and Rubin alerts?
 - Are we ready for alerts from Roman and beyond?
- How do we optimize transient discovery with multi-wavelength and multi-messenger alert streams?