

# The Large Array Survey Telescope

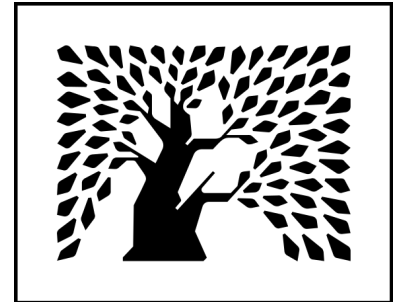


**Ruslan Konno**

On behalf of the LAST collaboration

4<sup>th</sup> Astro-COLIBRI multi-messenger  
astrophysics workshop, Orsay

2025-10-20



[www.weizmann.ac.il/wao](http://www.weizmann.ac.il/wao)

# Designing a cost-effective survey

- Grasp - Volume per unit time in which a standard candle is detectable

$$G \propto A^{3/4} \Omega$$

$\Omega$ ... FoV  
 $A$ ... effective area

[\*Ofek & Ben-Ami 2020\*](#)

- Empirical cost of a telescope

$$C \propto A^n, n > 1$$

→ Survey cost effectiveness

$$G \rightarrow 2 \times G$$

Increase A



$$G : (2^{4/3} A)^{3/4} \Omega = A^{3/4} (2\Omega)$$

$$C : 2^{\frac{4n}{3}} A^n > 2A^n$$



Increase  $\Omega$

# Designing a cost-effective survey

- Several smaller telescopes are more cost-effective
- How small can the telescopes be?
  - Avoid diffraction limit → Aperture > 20-cm
  - Larger FoV requires shorter focal lengths
    - Resolution suffers
    - Need smaller pixels
- Example: a 30-cm f/2 telescope requires 3  $\mu\text{m}$  pixels for 1"  $\text{pix}^{-1}$ 
  - Technology limited, <4  $\mu\text{m}$  only possible since ~2019

# Large Array Survey Telescope (LAST)



- wide-FoV, small-pixel optical survey
  - 28-cm f/2.2, 3.6  $\mu\text{m}$  pixels, 61 Mpix (9600x6400)
    - 1.25"  $\text{pix}^{-1}$ , 7.4  $\text{deg}^2$  FoV
- 4 telescopes per unit
- Diverging pointing  $\sim 30 \text{ deg}^2$  FoV



QHY600

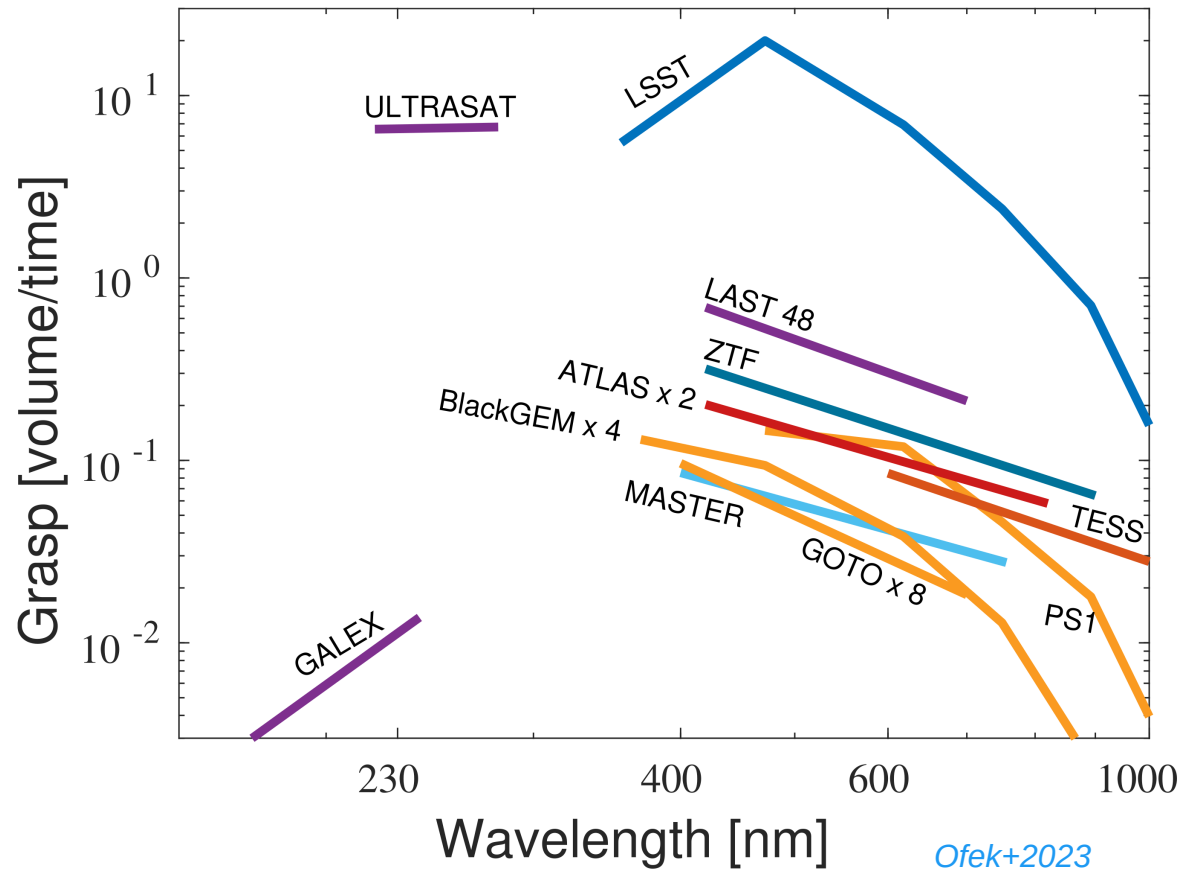


# Large Array Survey Telescope (LAST)

- First node being constructed in Israeli Negev Desert
- Will consist of 72 telescopes (18 units)
  - Total FoV of  $530 \text{ deg}^2$
  - 10 units are deployed and operational
- Total node cost at ~\$1.5M
  - All hardware and construction



# Grasp of survey instruments



# Design advantages and disadvantages

- Modular and scalable
- Off-the-shell components are cheap
- Failure points generally isolated
- Easy to modify (e.g. filters, polarizers)

## But!

- Many failure points
- High data rate
  - ~ 24 000 images per hour
    - 3.3 Gbit/s (large chip, small pixels)
    - Need for highly efficient procedure and pipeline

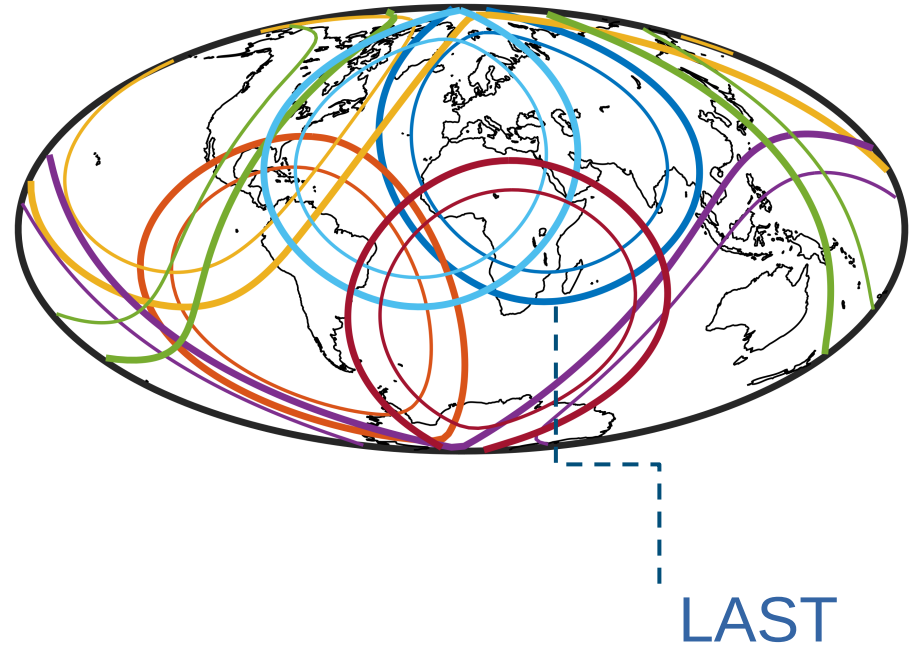
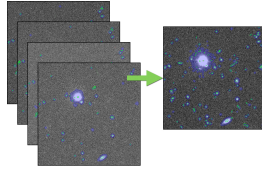


LAST-P; Polarization Survey  
by group of A. Franckowiak

[Barbosa Martins+in prep.](#)

# The LAST survey

- Scan the sky in visits
  - 20x20 s exposures per visit
  - Images are coadded
- 20.8 mag limiting magnitude
  - No filter (clear), AB system
- Cadence of  $\sim 3$  for airmass  $\leq 2$
- Covers the Asiatic gap



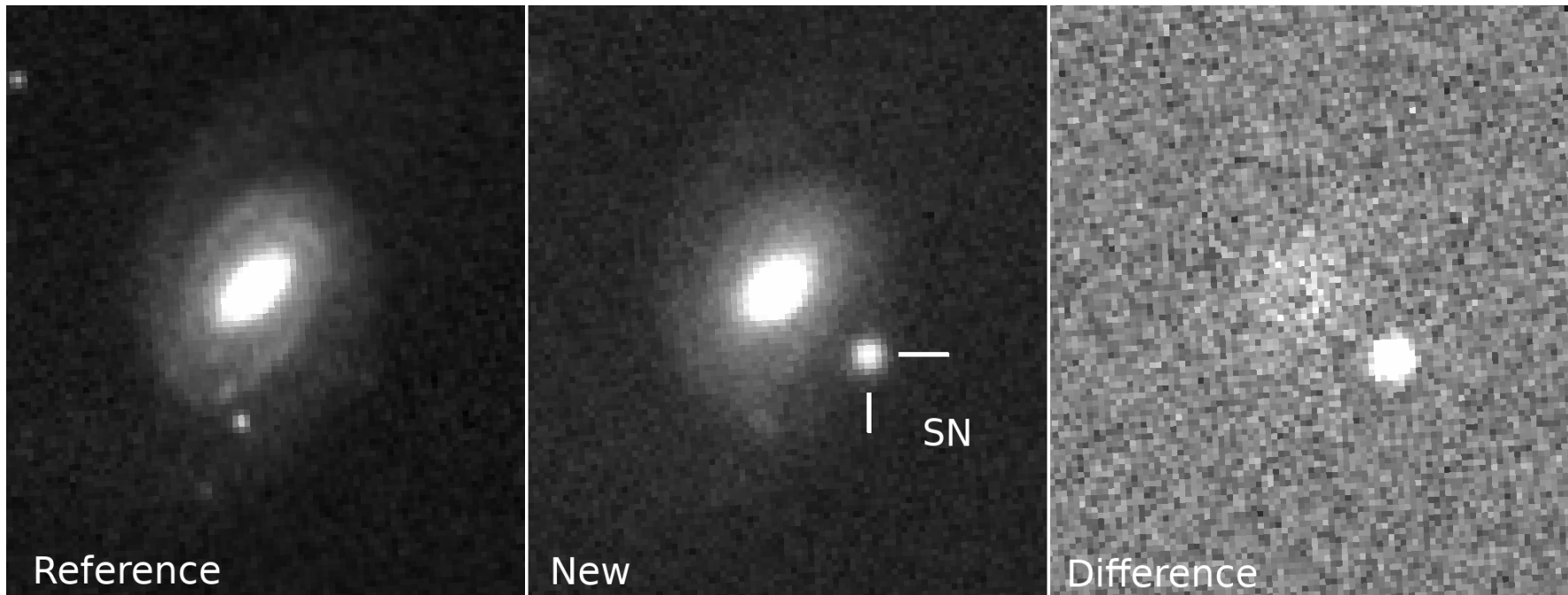
# Science focus

- Primarily transients detection via survey mode
- Follow-up
  - GWs, SNe, GRBs, flares,...
- Cosmology (lensing and time delays)
- Exoplanet, stellar activity, stellar systems
- Solar system, Oort cloud
- Strength: short time scales



# Transients Detection

- Transients search via subtraction (ZOGY) [Zackay, Ofek & Gal-Yam 2016](#)
- Test of new-source hypothesis across difference image



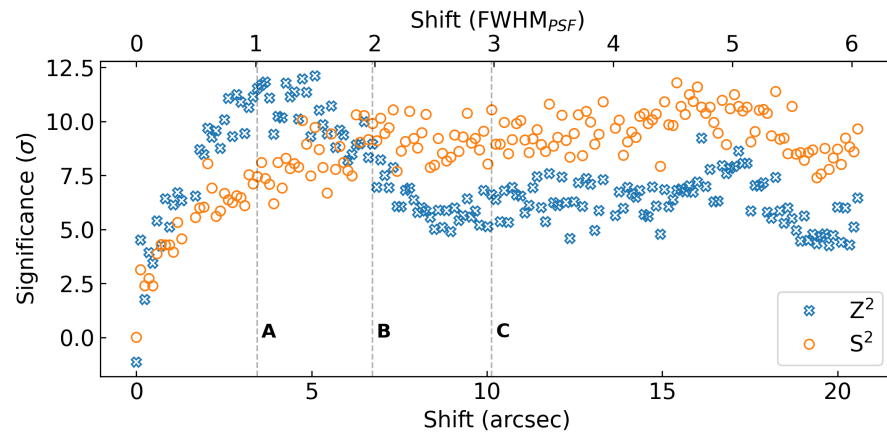
# Transients Detection

- 1.7 million transients candidates per night per telescope
  - >100 million for full 72-telescope array
- Far majority are false positives
- Fully deterministic vetting process
  - Collection of hypothesis & heuristic tests
    - Bad pixels
    - Artifacts
    - PSF shape
    - Registration
    - Known objects
    - ...

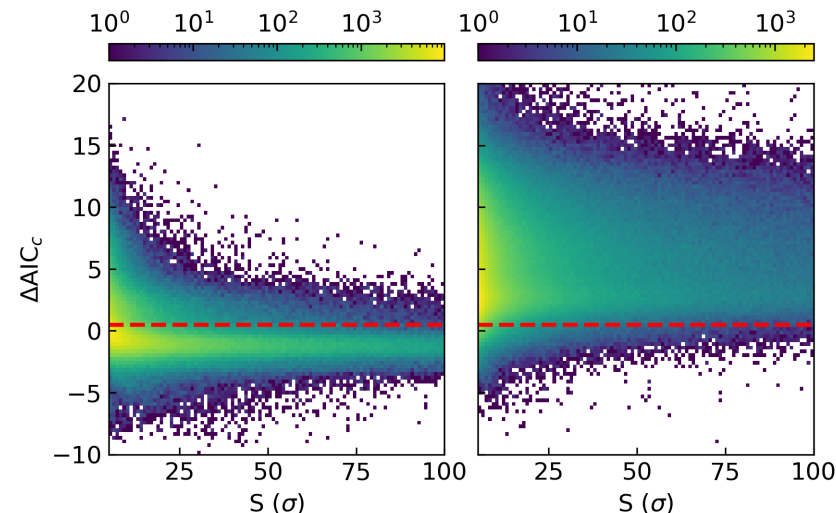
[Konno+in prep.](#)

# Filter example: Transient

- Common source of artifacts; registration errors between New and Ref
- New statistic testing moving-source hypothesis [Springer+2024](#)
- Comparison with ZOGY (=new-source hypothesis) allows distinction



Moving asteroid



Var. stars

Non-var. stars

# Transients reporting

Discovery date (UTC):  
2025-09-22 22:03

Name: [LAST](#)  
[J015250.38+155553.61](#)  
[🔗](#)

IAU name: [2025yhj](#)

Host galaxy:  
[J015250.58+155552.5](#)  
(wiseX)

Distance (Mpc): 168.36

Redshift: 0.036147

Coordinates (RA, DEC):  
28.20990, 15.93156

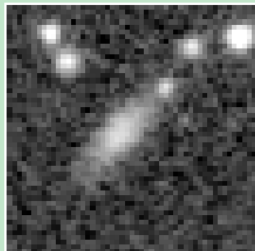
Score: 43.25

mount, camera: 5, 1

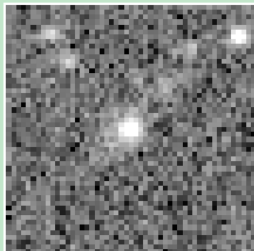
field, subimage: 1075,  
15

Date added: 2025-09-  
23 00:58

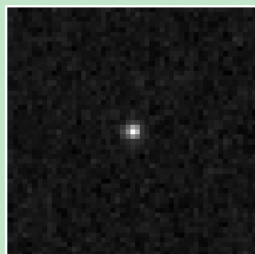
Last alert: 2025-09-29  
04:38



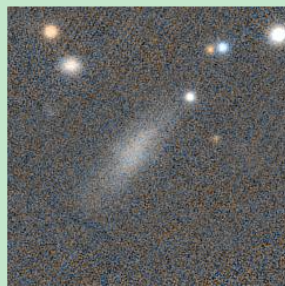
Ref



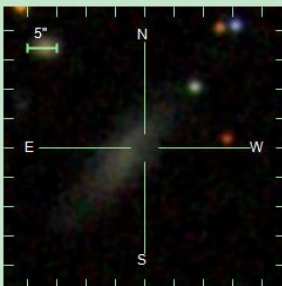
New



Diff



Pan-STARRS



SDSS



TNS  
report →

Real/Bogus:

[Real](#) [Bogus](#) [Reset](#)

Set by:

Ruslan Konno

Classification:

[Stellar](#) [Solar](#) [AGN](#)

[Reset Classification](#)

[Add Target](#)

[Simbad Lookup](#)

[NED Lookup](#)

[Check Horizons](#)

[Reported to TNS](#)

[Days ago](#) [Refresh Atlas](#)

[Days ago](#) [Refresh ZTF](#)

Admin Actions:

[Delete](#)

## AT 2025yhj

RA/DEC (2000) Type Redshift  
01:52:50.346 +15:55:53.53 ---  
28.2097757895 +15.9315363158

[🔗 Discovery Report](#)

Reporting Group	Discovering Data Source	Discovery Date	TNS AT	Public	Discovery Mag
LAST	LAST	2025-09-22 22:03:02.592	Y	Y	18.84

Filter

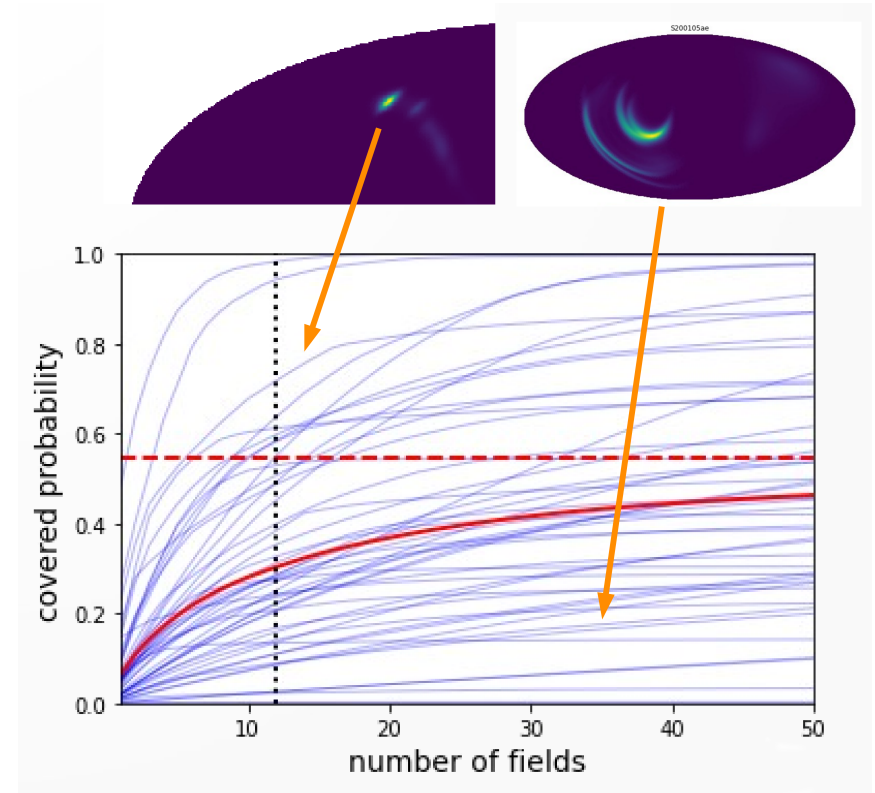
[Clear-](#)

Reporter/s

R. Konno (WIS), E. A. Zimmerman (WIS), A. Horowitz (WIS), S. Garrappa (WIS), E. O. Ofek (WIS), S. Ben-Ami (WIS), D. Polishook (WIS), O. Yaron (WIS), P. Chen (WIS), A. Krassilchikov (WIS), Y. M. Shani (WIS), E. Segre (WIS), A. Gal-Yam (WIS), S. Spitzer (WIS), and K. Rybicki (WIS) on behalf of the LAST Collaboration

# Follow-up of large unc. events (GWs, GRBs, $\nu$ )

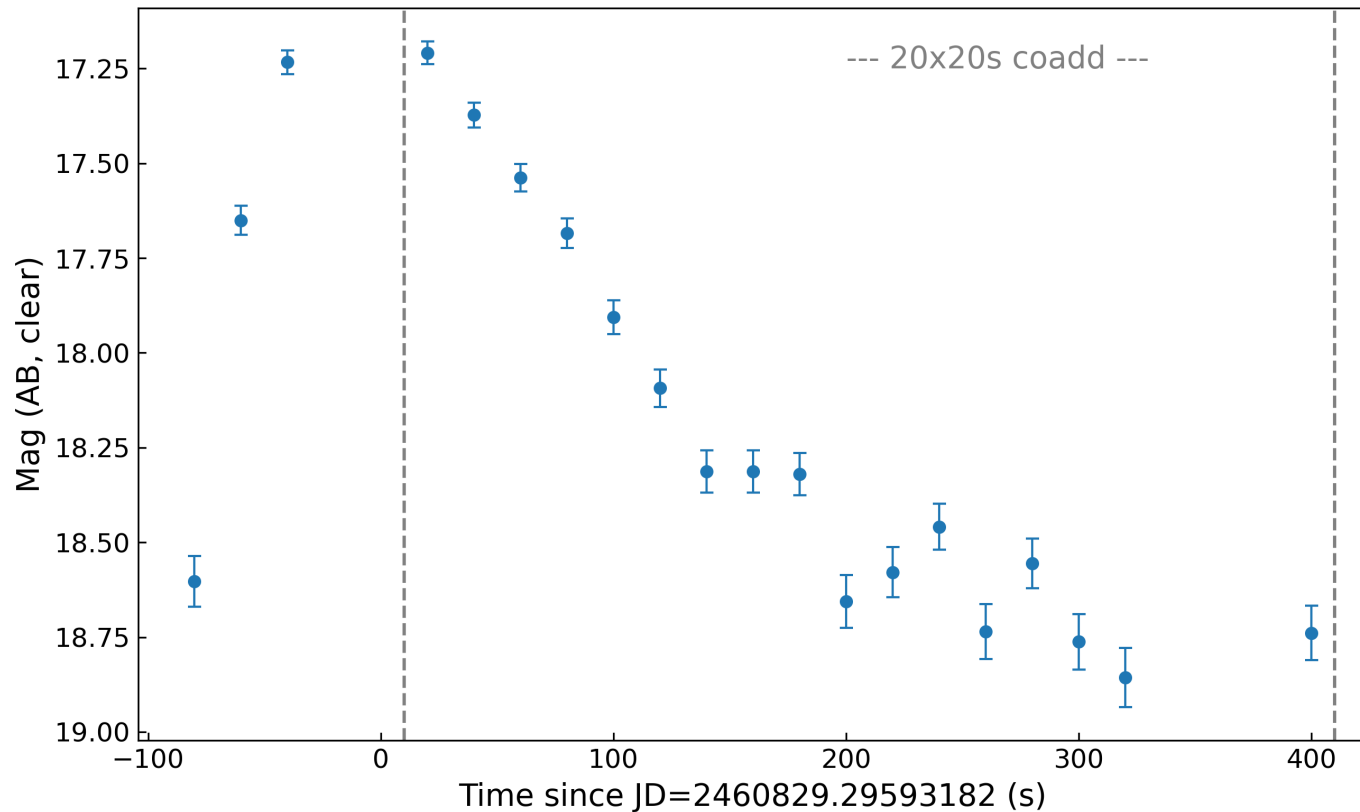
- Tiling study with 12 units
- Error regions of O3 alerts
  - 12 fields correspond to ~55% of observable error region for average alert
- 24 fields: 70%; 36 fields: 78% ...



Credit: Nora Linn Strotjohann

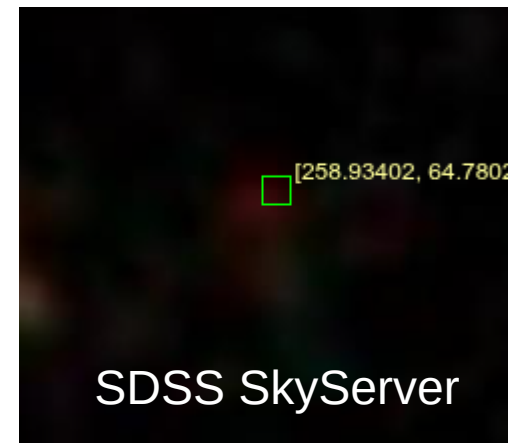


# Sub-visit photometry



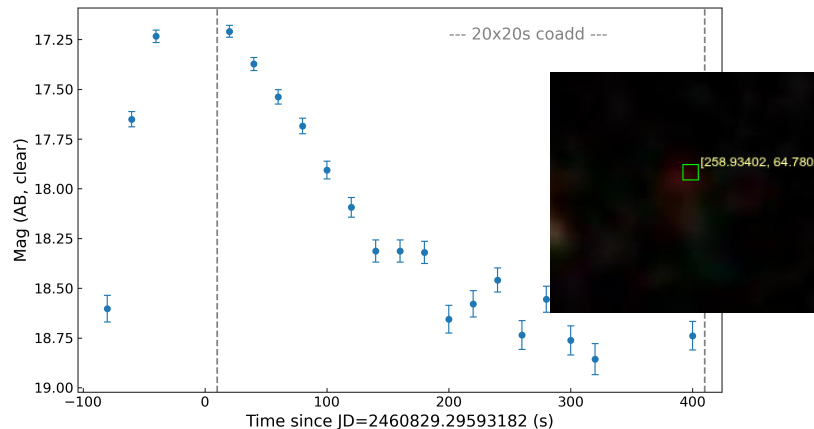
Fast evolving transient in single images

Likely an M-dwarf flare



# Feedback from the community

- What do we (LAST & everyone) do with Galactic transients ?
  - M-dwarf flares, CVS, ...
- Astro-COLIBRI has offered to receive such alerts
  - LAST is adding a Astro-COLIBRI alerts for Galactic transients



# Weizmann Astrophysical Observatory



**LAST**  
Large Array Survey Telescope

18x4x28-cm telescopes

Clear photometric survey



**PAST**  
Pan-chromatic Array for Survey Telescopes

2x4x36-cm telescopes  
2x2 broad-band filters per telescope

Color photometry



**MAST**  
Multi-Aperture Spectroscopic Telescope

20x60-cm telescopes  
1 spectrograph

Spectroscopy







LAST + PAST

An aerial photograph of a fenced-in industrial or research site in a desert environment. The site contains three large buildings and a white dome. The buildings are labeled 'LAST + PAST', 'MAST', and 'MAST'. The 'Current LAST' label is positioned over a building that appears to be under construction or renovation. The site is surrounded by a dirt road and sparse desert vegetation.

Current LAST

MAST

MAST

# Current status

- Finalizing new enclosures for 72 LAST telescopes + PAST & MAST
  - Full array by 2026
- LAST in general running from data taking to alert production.
  - ~ 100 internal alerts per night
  - In 1 year > 1000 TNS reports
  - ToO follow-ups reported via GCNs & AstroNotes



LAST

LARGE ARRAY  
SURVEY  
TELESCOPE



# Summary

- LAST is an under construction cost-effective optical sky survey
- Will study the unexplored phase space of fast transients
  - Wide FoV – up to 530 deg<sup>2</sup>
  - High cadence – up to 3 scans of sky at airmass  $\leq 2$
- Will be part of a larger facility with follow-up instruments; MAST and PAST



LAST

LARGE ARRAY  
SURVEY  
TELESCOPE

