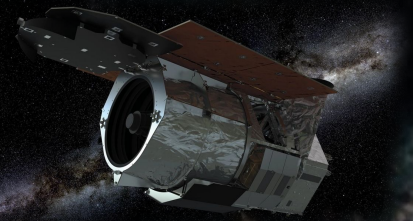
NANCY GRACE ROMAN SPACE TELESCOPE



Enabling RAPID Time Domain Science with the Roman Space Telescope

Ryan Lau (IPAC)

February 17, 2026
Ready, Set, ROMAN Training Series

Mansi Kasliwal (PI; Caltech)
Ben Rusholme (Pipeline Development Lead; IPAC)
Schuyler Van Dyk (Science Definition Lead; IPAC)
Roberta Paladini (Galactic transients, Inclusion Lead; IPAC)
Lin Yan (Testing and Validation Lead; Caltech)
Ashish Mahabal (Machine Learning Lead; Caltech)
Joe Masiero (Solar System Objects Lead; IPAC)
Russ Laher (Applications Developer; IPAC)
Jacob Jencson (Testing and Validation Scientist; IPAC)
Amalia Rivera (Database Administrator; IPAC)
Ryan Lau (Coordination Scientist; IPAC)

ipac Caltech

How do we enable prompt transient discoveries with Roman?

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What is RAPID? (**R**oman **A**lerts **P**romptly from **I**mage **D**ifferencing)

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RAPID is…

…a Project Infrastructure Team for the Roman Space Telescope

What is RAPID? (Roman Alerts Promptly from Image Differencing)

RAPID is…

…a Project Infrastructure Team for the Roman Space Telescope

RAPID *will deliver…*

- ***Rapid image-differencing*** of every new Roman image
- A ***prompt public alert stream*** of all transient and variable candidates in difference images
- Source match-files recording ***candidate light curves***
- ***Forced photometry tool*** to investigate a precise photometric history

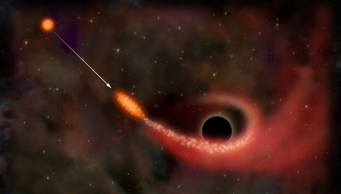
Science Enabled by RAPID

IR Time-domain Science with Roman

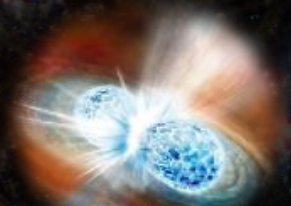
Roman will find transients and variables associated with…

- *High opacity from heavy element synthesis*
- *Self-enshrouding by dust*
- *High attenuation by Milky Way extinction*
- *Stellar variability, YSO outbursts, CVs*
- *Obscuration from host galaxy*

Supernovae



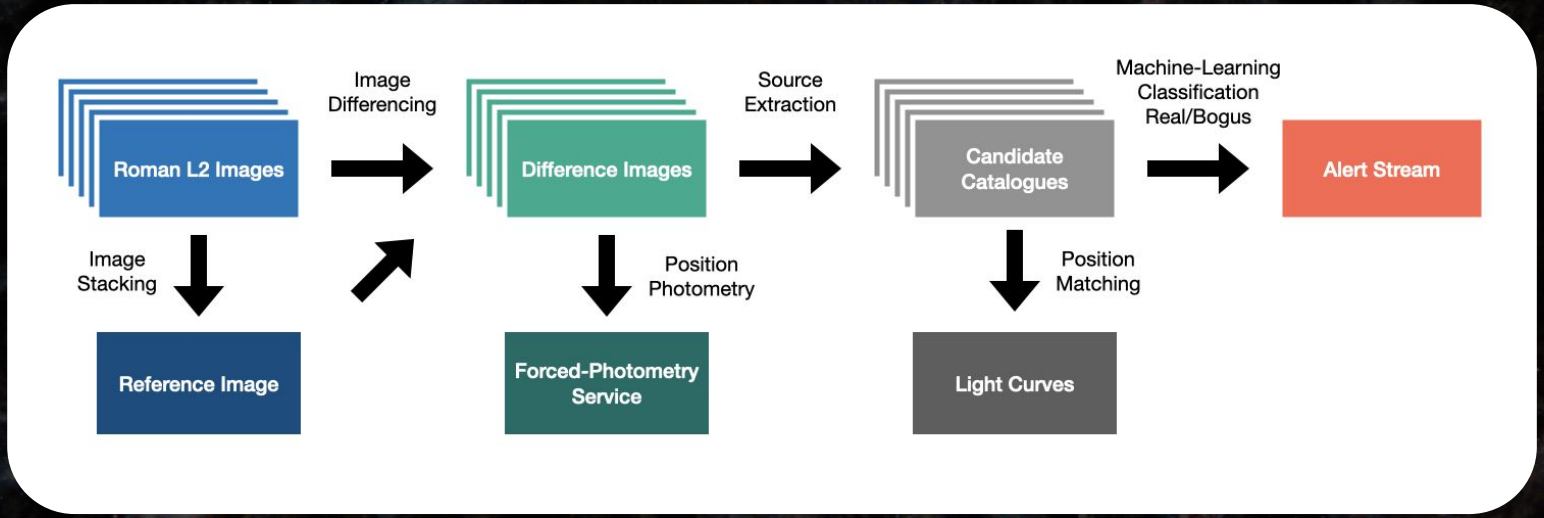
Tidal Disruption Events



NS Mergers (Kilonovae)

Stellar Mergers

A Quick Tour of the RAPID pipeline

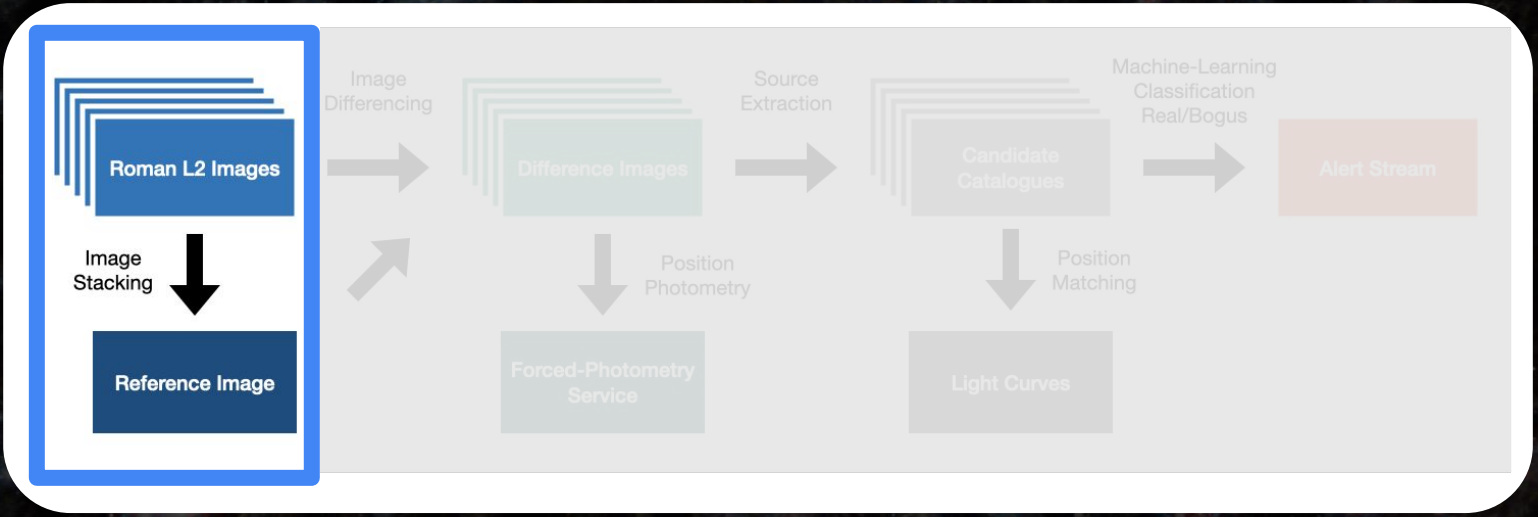


On-going development – feedback is welcome!

RAPID Github - https://github.com/Caltech-IPAC/rapid
RAPID Pipeline Docs - https://caltech-ipac-rapid.readthedocs.io/en/latest/

A Quick Tour of the RAPID pipeline

Roman Images and Reference Building



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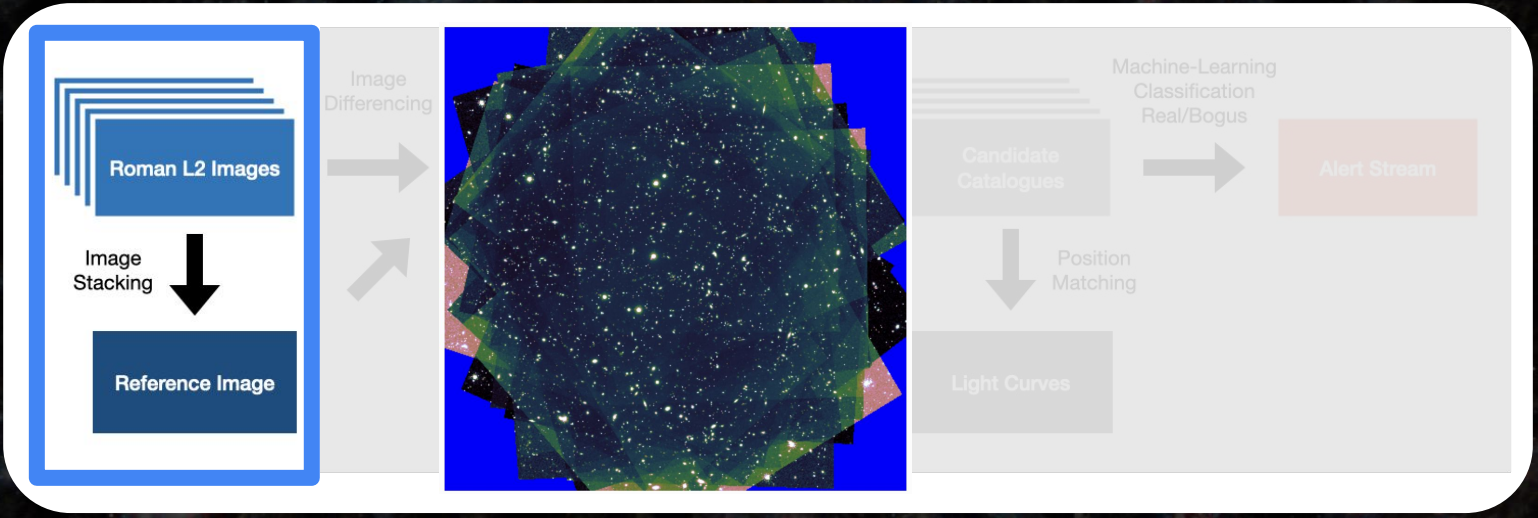
Roman Images and Reference Building

RAPID pipeline will run on every new Roman/WFI Image!



Simulated reference mosaic of 100 frames
(Roman sims from ***OpenUniverse2024***)

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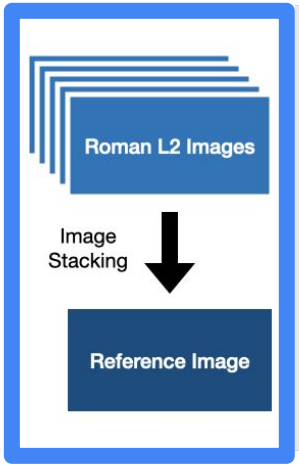
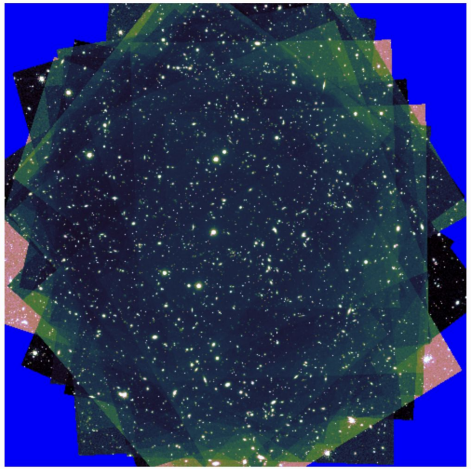


Image Differencing



Low latency is the top priority

➔ We will obtain calibrated WFI exposures within the **< 48 hour** turnaround requirement (*but will likely be faster!*)

Reference Image Building Strategy

- First epoch becomes reference
- Second epoch, subtractions begin
- Trigger regeneration when certain depth threshold is reached

Simulated reference mosaic of 100 frames
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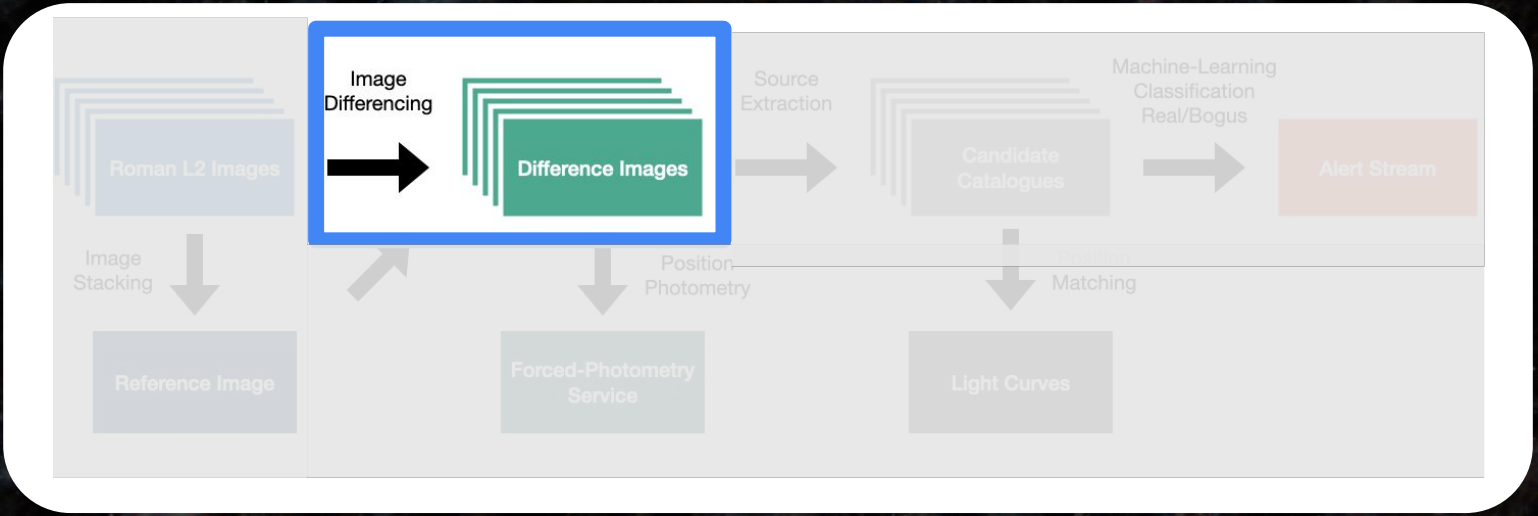

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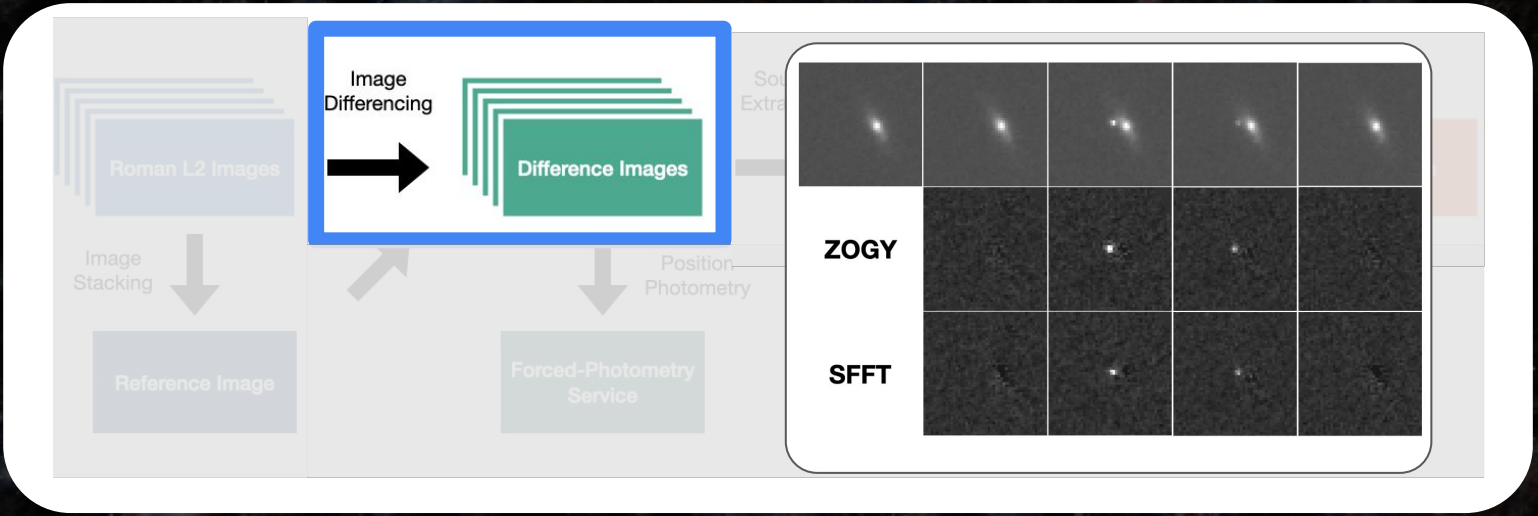
Image Differencing

Image differencing tests on simulated data



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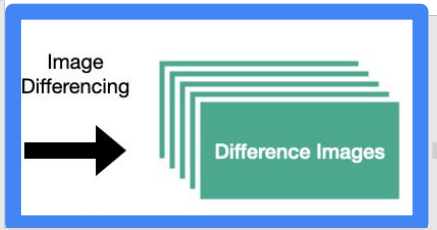
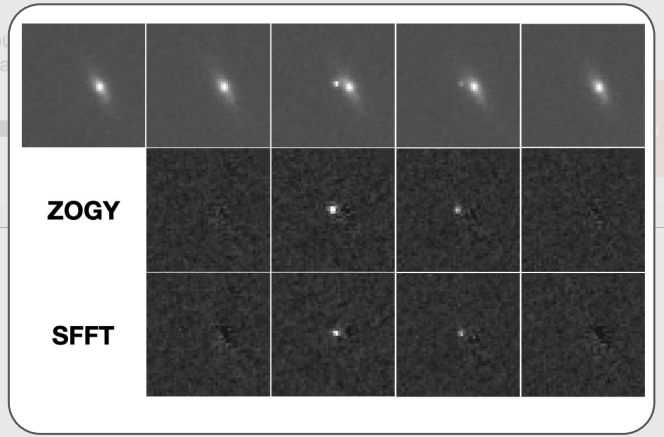


- Considering **ZOGY** (Zackay, Ofek & Gal-Yam 2016) and **SFFT** (Hu+ 2022), or hybrid model (e.g., Hu+2024)
- Able to recover injected sources with both ZOGY and SFFT in sparse fields
- Both algorithms performing similarly well (and better than naive A-B)

Image differencing tests on simulated data



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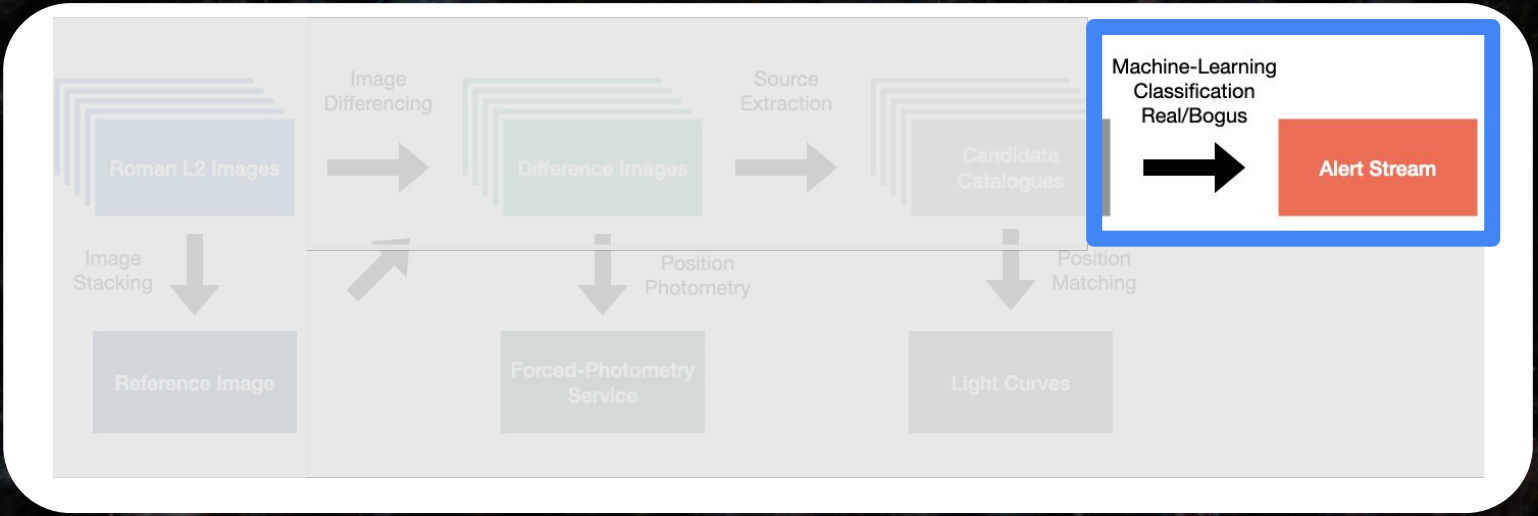
Alerts and Machine Learning



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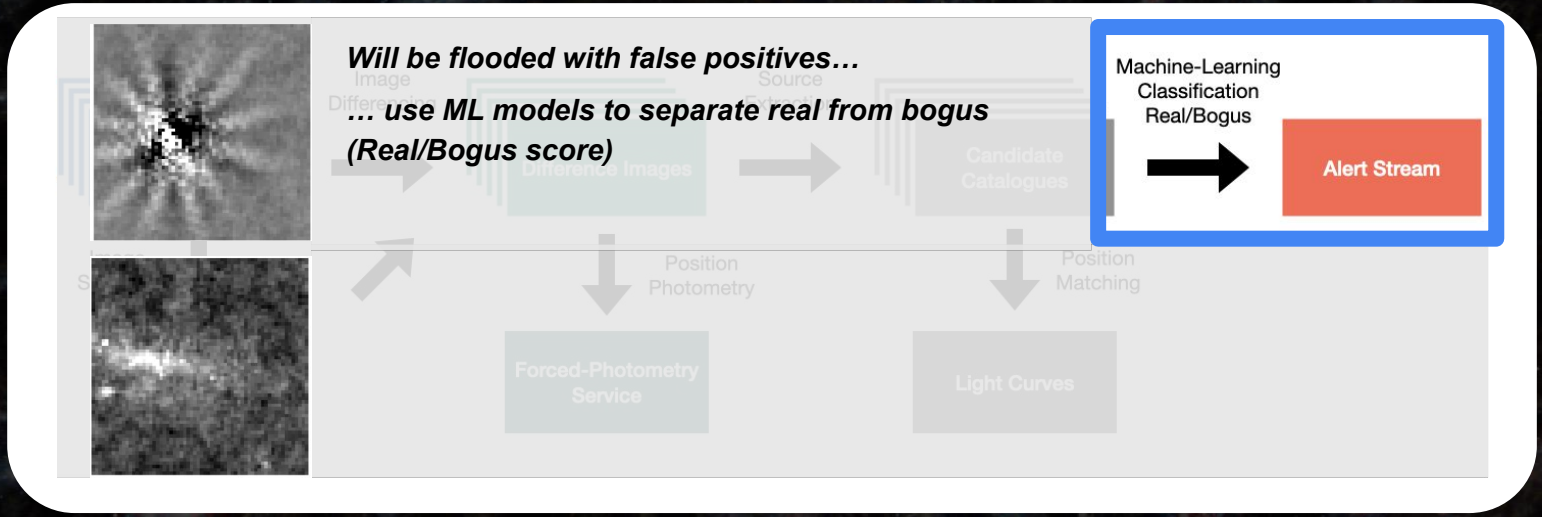

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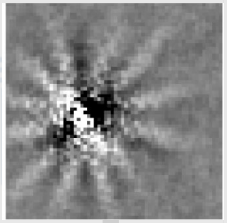
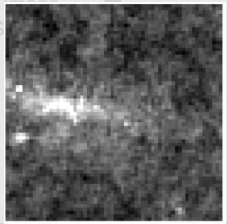
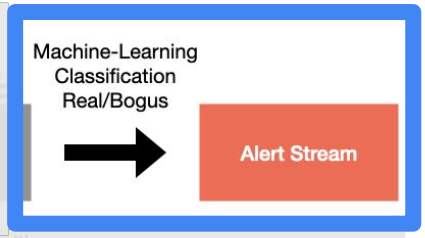


Will be flooded with false positives…

… use ML models to separate real from bogus (Real/Bogus score)



Stream alerts containing data for on time-variable source (e.g. cutouts, photometry, real/bogus score) and distributed to alert brokers like ALeRCE, Fink, ANTARES, Lasair, etc. where they can be ***analyzed by the community for rapid follow up***



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RAPID Products and Tools

Product	Format	Location	Availability	Expected size per product	Data Volume	Example
Difference Images	Advanced Science Data Format (ASDF)	MAST (TBC)	Monthly	~70 MB (per SCA)	>10M over 5-year mission	See https://caltech-ipac-rapid.readthedocs.io/en/latest/prod/products.html
Reference Images	Advanced Science Data Format (ASDF)	MAST	Monthly	~70 MB (per SCA)	TBD	See https://caltech-ipac-rapid.readthedocs.io/en/latest/prod/products.html
Alerts	Apache Avro via Apache Kafka	Streamed to Brokers* (*and available on request)	Within 1 hr of receipt of calibrated L2 images (<48 hr)	<100 KB	>260M “raw” alerts over 5-year HLTDS	https://github.com/Caltech-IPAC/rapid/tree/main/alerts
Light Curves	HATS-partitioned Apache Parquet	MAST	Monthly	TBD	TBD	-
Forced Photometry On-Demand	Under development	Under discussion	TBD	-	-	-
RAPID Pipeline	Python / C	RAPID github	Publicly available now	< ~1 MB	-	https://github.com/Caltech-IPAC/rapid

RAPID Product Use Case Examples

Difference Images

Alerts

Source-Matched Light Curves

On-demand Forced Photometry

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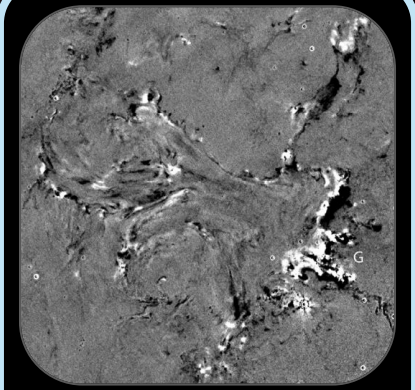

- Infrared light echos
- Moving objects
- Reproduce difference photometry

Besel & Krause (2012)

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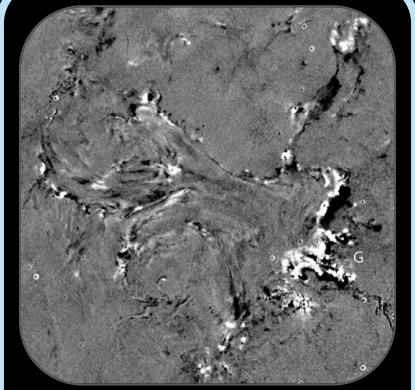

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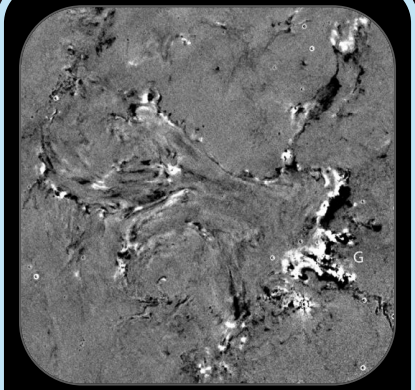

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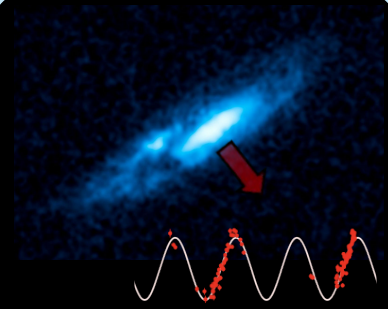

- Identifying periodic variability from obscured binaries
- YSOs, symbiotic stars, late-type giants

Mauerhan et al. (2015), Lau et al. 2021)

On-demand Forced Photometry

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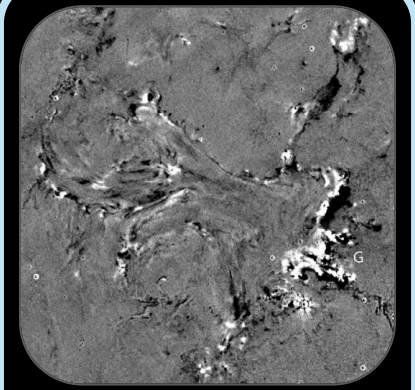

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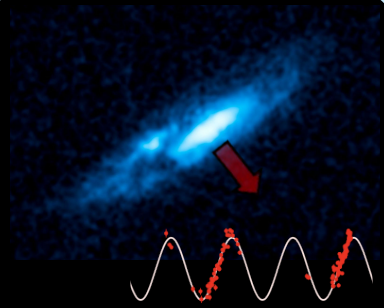

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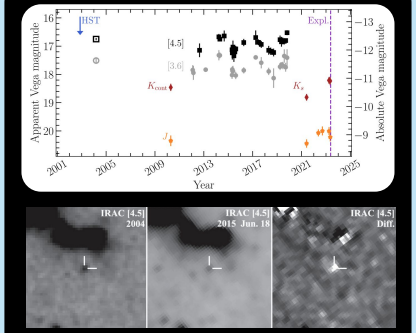

- Investigating progenitor variability from core-collapse SNe (e.g. SN 2023ixf)

Jencson et al. (2023)

RAPID Community Engagement

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RAPID Response: Hot-wiring the Next Generation of Time-Domain Science

---

Dates: March 23 - 27, 2026

Detailed schedule now available and registration is still open!

Website:
https://conference.ipac.caltech.edu/rapid-hotwiring2026

Location: Pasadena, CA (Caltech campus)

Engage in discussions on RAPID deliverables (and beyond!)

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STRIDE: Strategic Time-domain Research and Infrastructure Development for Roman Exploration

Working group for open communications across PITs, SOC, SSC, and other teams

Chairs: Ashish Mahabal (RAPID) and Tyler Pritchard (SN-PIT)

Monthly meetings:
10 AM PT First Fridays

Contact:
ROMANTDAWG@MAILLIST.STSCI.EDU

Summary and keeping up with RAPID

Roman will be launching soon and has tremendous potential for prompt Multi-messenger and Time-domain astronomy…

… and *RAPID will fully realize this potential by delivering:*

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Email Us!

rapid@ipac.caltech.edu

Visit the RAPID Website!

Join the RAPID Slack!

Sign up for a Roman Science Collaboration!