

Alert brokers, discovery and classification in the LSST era

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lasair.lsst.ac.uk



Starting points :

<https://www.lsst.org>

<https://www.lsst.ac.uk>

<https://lsst-uk.atlassian.net>

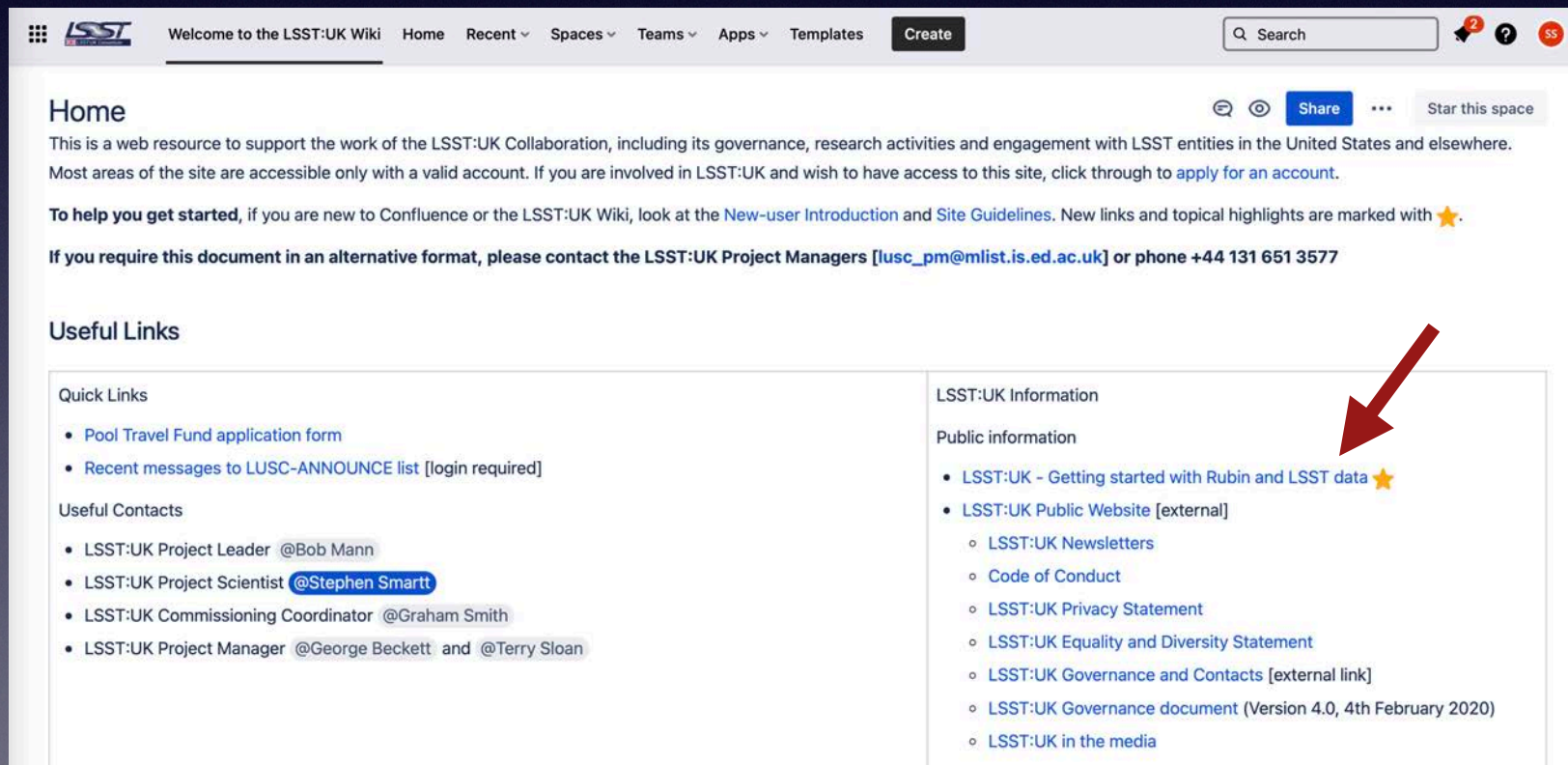
Legacy Survey of Space and Time (LSST)

LSST:UK consortium

Stephen Smartt (University of Oxford and Queen's University Belfast)

Project Lead : Bob Mann (University of Edinburgh)

Slides reviewed and last updated : 8 February 2023 <https://lsst-uk.atlassian.net>



The screenshot shows the home page of the LSST:UK Wiki on Atlassian Confluence. The page has a navigation bar at the top with the LSST logo, a welcome message, and various menu items like Home, Recent, Spaces, Teams, Apps, and Templates. A search bar is also present. The main content area is titled 'Home' and contains introductory text about the wiki's purpose and access requirements. Below this, there are sections for 'Useful Links' and 'Useful Contacts'. The 'Useful Links' section is divided into 'Quick Links' and 'LSST:UK Information'. A red arrow points to the link 'LSST:UK - Getting started with Rubin and LSST data' in the 'Public information' list.

Welcome to the LSST:UK Wiki

Home Recent Spaces Teams Apps Templates Create

Search

Home

This is a web resource to support the work of the LSST:UK Collaboration, including its governance, research activities and engagement with LSST entities in the United States and elsewhere. Most areas of the site are accessible only with a valid account. If you are involved in LSST:UK and wish to have access to this site, click through to [apply for an account](#).

To help you get started, if you are new to Confluence or the LSST:UK Wiki, look at the [New-user Introduction](#) and [Site Guidelines](#). New links and topical highlights are marked with ★.

If you require this document in an alternative format, please contact the LSST:UK Project Managers [lusc_pm@mlist.is.ed.ac.uk] or phone +44 131 651 3577

Useful Links

Quick Links	LSST:UK Information
<ul style="list-style-type: none">Pool Travel Fund application formRecent messages to LUSC-ANNOUNCE list [login required]	<p>Public information</p> <ul style="list-style-type: none">LSST:UK - Getting started with Rubin and LSST data ★LSST:UK Public Website [external]<ul style="list-style-type: none">LSST:UK NewslettersCode of ConductLSST:UK Privacy StatementLSST:UK Equality and Diversity StatementLSST:UK Governance and Contacts [external link]LSST:UK Governance document (Version 4.0, 4th February 2020)LSST:UK in the media

Useful Contacts

- LSST:UK Project Leader [@Bob Mann](#)
- LSST:UK Project Scientist [@Stephen Smartt](#)
- LSST:UK Commissioning Coordinator [@Graham Smith](#)
- LSST:UK Project Manager [@George Beckett](#) and [@Terry Sloan](#)

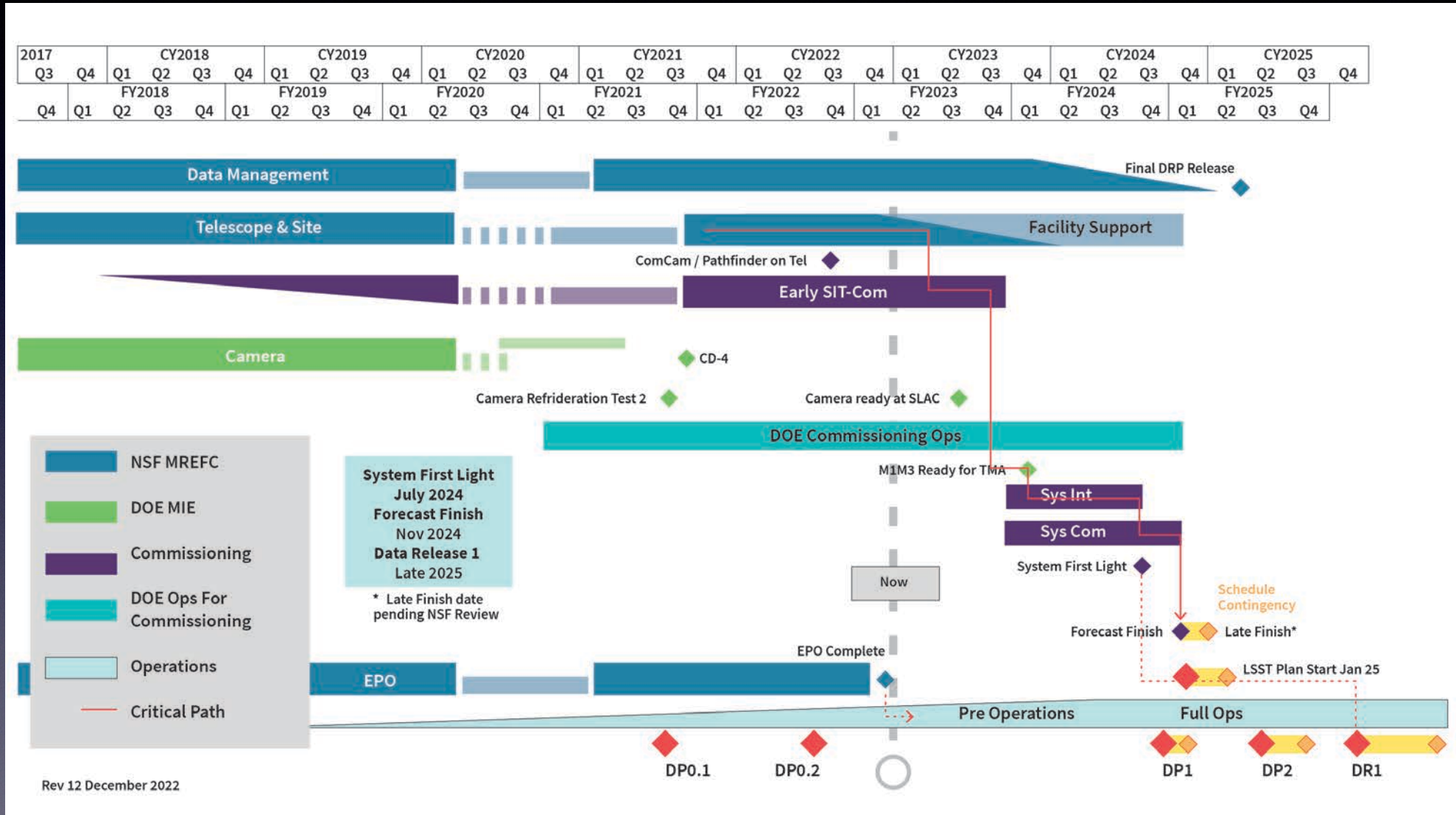
Construction progress : as of Feb 2023



Image
Credit:
Rubin
Obs.

Rubin schedule

Projected science operation start January 2025



Monthly updates (including diagram updates) :
<https://www.lsst.org/about/project-status>

When will science data arrive ?

Two useful Rubin documents which are continually updated :

Release Scenarios for Rubin - LSST
Commissioning and Survey data
Marshall et al. RDO-11

<https://docushare.lsstcorp.org/docushare/dsweb/Get/RDO-11>

Rubin Observatory Plans for an Early
Science Program

Guy et al. RTN-11

<https://rtn-011.lsst.io/>

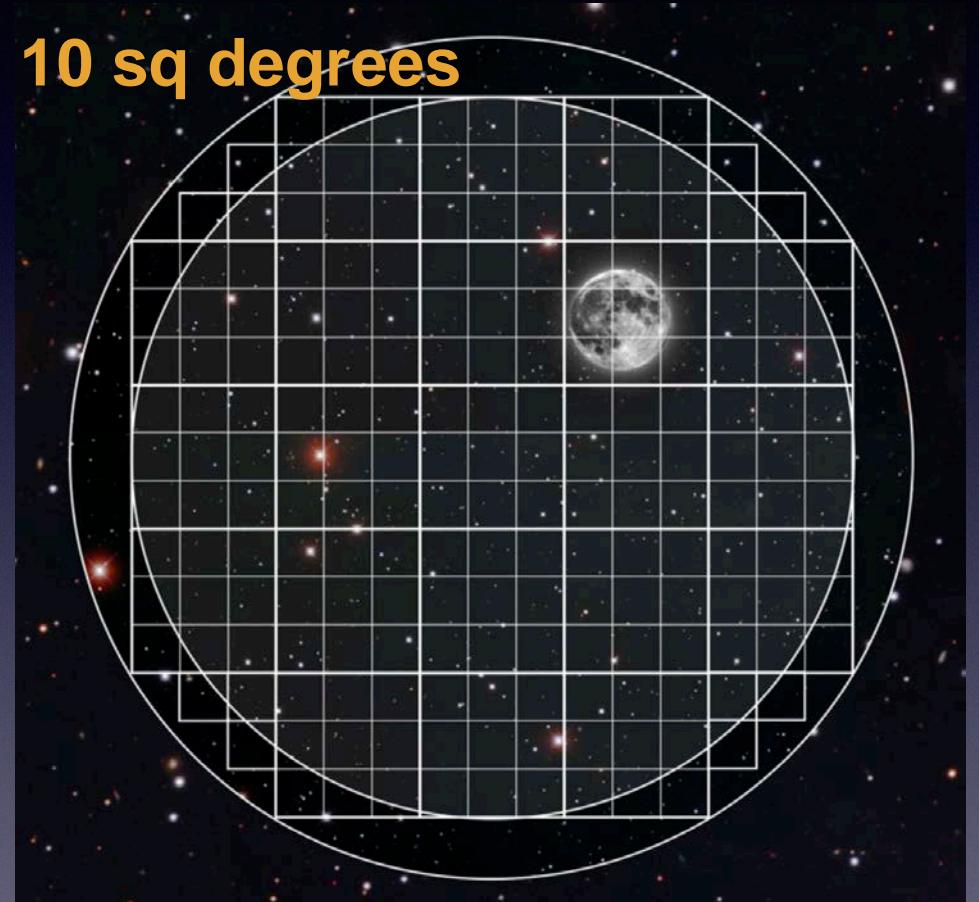
Guy et al. Table 1

Rubin Early Data Release Scenario	Jun 2021	Jun 2022	Jun 2023 - Sep 2023	Sep 2024 - Oct 2024	May 2025 - Aug 2025	Nov 2025 - Apr 2026	Nov 2026 - Apr 2027	Nov 2027 - Feb 2028	Nov 2028 - Feb 2029
	DP0.1	DP0.2	DP0.3	DP1	DP2	DR1	DR2	DR3	DR4
Data Product	DC2 Simulated Sky Survey	Reprocessed DC2 Survey	Solar System PPDB Simulation	First Light LSSTCam Data	LSSTCam Science Validation Data	LSST First 6 Months Data	LSST Year 1 Data	LSST Year 2 Data	LSST Year 3 Data
Raw images	✓	✓	□	✓	✓	✓	✓	✓	✓
DRP Processed Visit Images and Visit Catalogs	✓	✓	□	✓	✓	✓	✓	✓	✓
DRP Coadded Images	✓	✓	□	✓	✓	✓	✓	✓	✓
DRP Object and ForcedSource Catalogs	✓	✓	□	✓	✓	✓	✓	✓	✓
DRP Difference Images and DIASources	□	✓	□	✓	✓	✓	✓	✓	✓
DRP ForcedSource Catalogs including DIA outputs	□	✓	□	✓	✓	✓	✓	✓	✓
PP Processed Visit Images	□	□	□	□	□	✓	✓	✓	✓
PP Difference Images	□	□	□	□	□	✓	✓	✓	✓
PP Catalogs (DIASources, DIAObjects, DIAForcedSources)	□	□	□	□	✓	✓	✓	✓	✓
PP SSP Catalogs	□	□	✓	□	✓	✓	✓	✓	✓
DRP SSP Catalogs	□	□	□	□	□	✓	✓	✓	✓

Where to point and when ?

- Rubin Observatory
 - 8m telescope (6.5 m clear aperture) on Cerro Pachon, Chile
 - 3.5 gigapixel camera, impressive detector quality
 - Real time alert stream and multi-colour deep image of the sky
- **Science Requirements**
 - 18,000 square degrees observed 825 times over 10 yrs
 - Multi-Colour deep image of southern sky
 - Parallax and proper motion precision requirements
 - Rapid revisit timescale requirements

10 sq degrees



Cadence problem in a nutshell:

Can do all southern, visible sky once per night : but we need 2 visits and we have 6 filters

Average return time (in same filter)⁶ would be $2 \times 6 = 12$ days

Multi-colour and deep

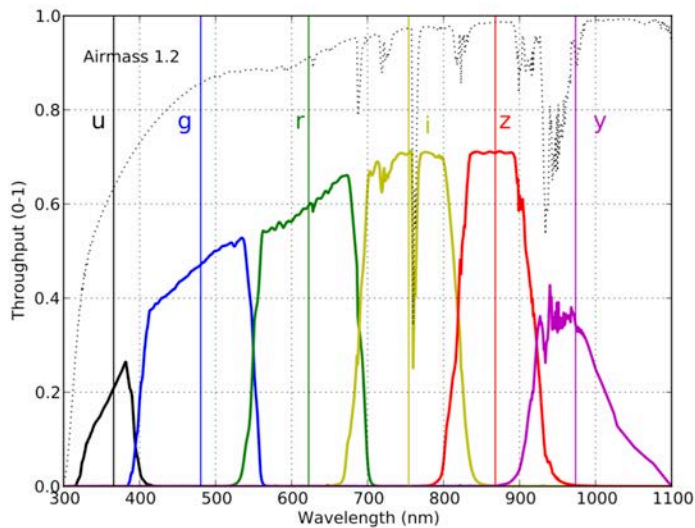


Figure 4. The LSST bandpasses. The vertical axis shows the total throughput. The computation includes the atmospheric transmission (assuming an airmass of 1.2, dotted line), optics, and the detector sensitivity.

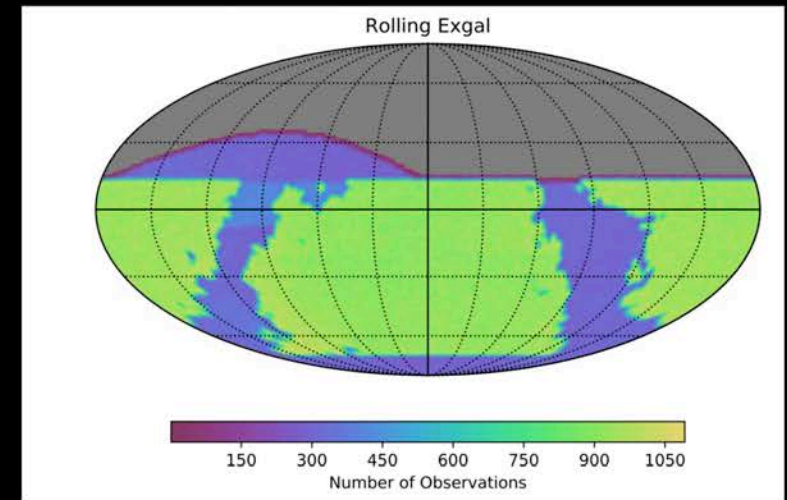
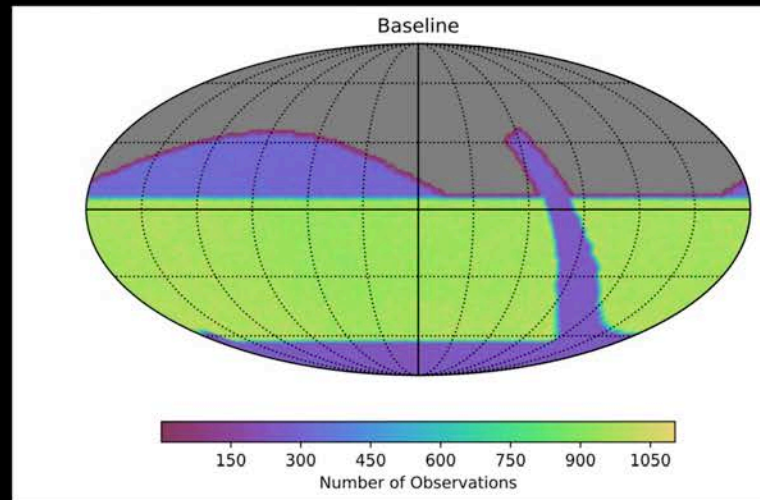
	5 σ single visit	10 yr depth
<i>u</i>	23.9	26.1
<i>g</i>	25.0	27.4
<i>r</i>	24.7	27.5
<i>i</i>	24.0	26.8
<i>z</i>	23.3	26.1
<i>y</i>	22.1	24.9

2 example strategies

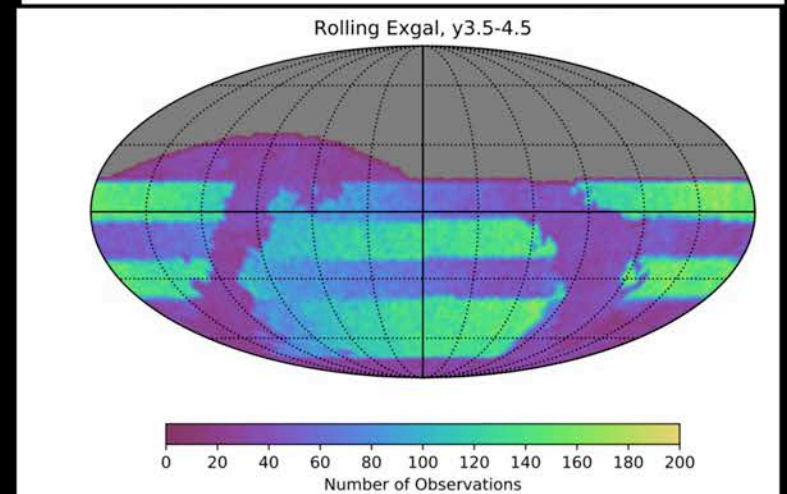
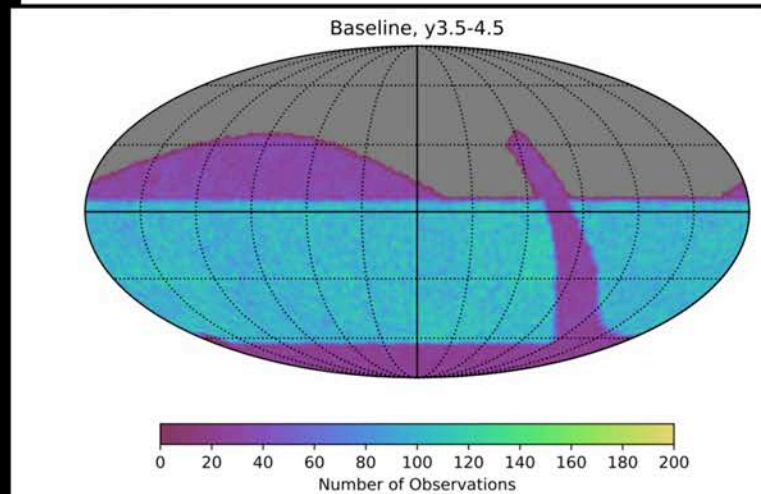
Baseline

Exgal sky and rolling

Number of
observations after 10
years (DDF visits
removed)



Year 3.5-4.5



LSST Observing sequence and cadence

- Observe a camera footprint with 2x15 second exposures, taken back-to-back (they are called “snaps”. They will be co-added automatically to make a 30 second image, allowing cosmic ray mitigation
- Come back on the same night, about 30mins later, and observe exactly the same footprint. Still to be decided if the 2nd visit will be in the same filter as the 1st or a suitable different pair (e.g. **g+r**, **i+z** **u** and **y** would not be paired of course)

When does LSST revisit this footprint again ?

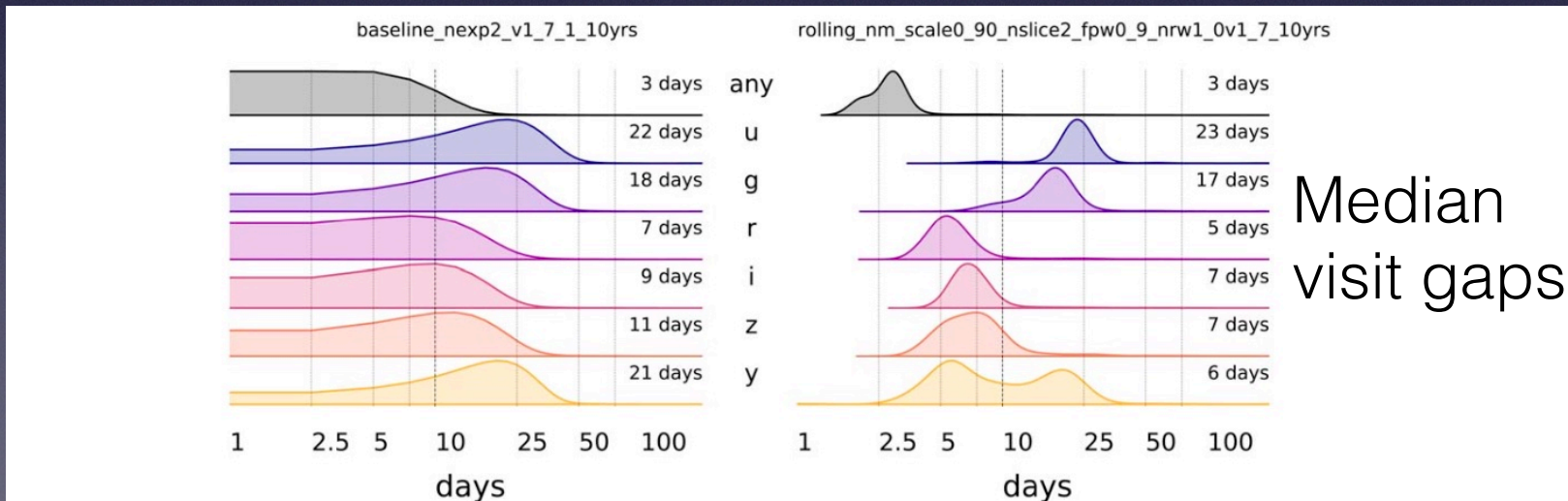


Figure 2. Distribution of median internight visit gaps (the time elapsed between visits to the same field in different nights) at a given location in the sky for two simulated LSST OpSim strategies: `baseline_nexp2_v1.7.1_10yrs` (left) and `rolling_nm_scale0.90_nslice2_fpw0.9_nrwl.0v1.7_10yrs`

LSST Alerts - Key numbers

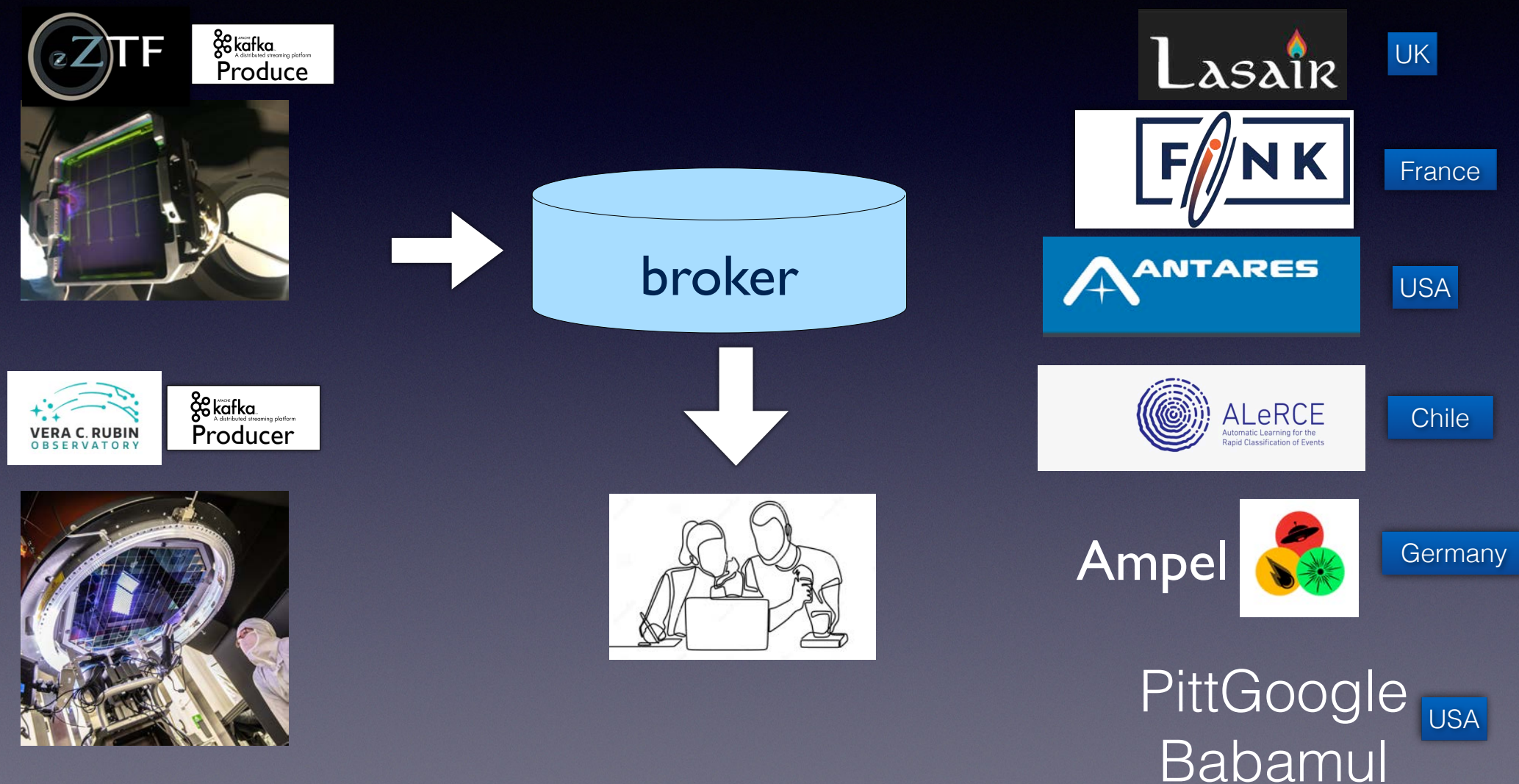
Goal is 60 seconds to send an alert. Every 60 seconds the following tables give an idea of number of alerts and their types that will be released.

Alert numbers : per visit

Type	Extragalactic (80% of sky)	Galactic (20% of sky)
Movers	3000	3000
Stars	1800	30000
AGN	70	70
Supernovae and extragalactic transients	200	200

	5 σ single visit	10 yr depth
<i>u</i>	23.9	26.1
<i>g</i>	25.0	27.4
<i>r</i>	24.7	27.5
<i>i</i>	24.0	26.8
<i>z</i>	23.3	26.1
<i>y</i>	22.1	24.9

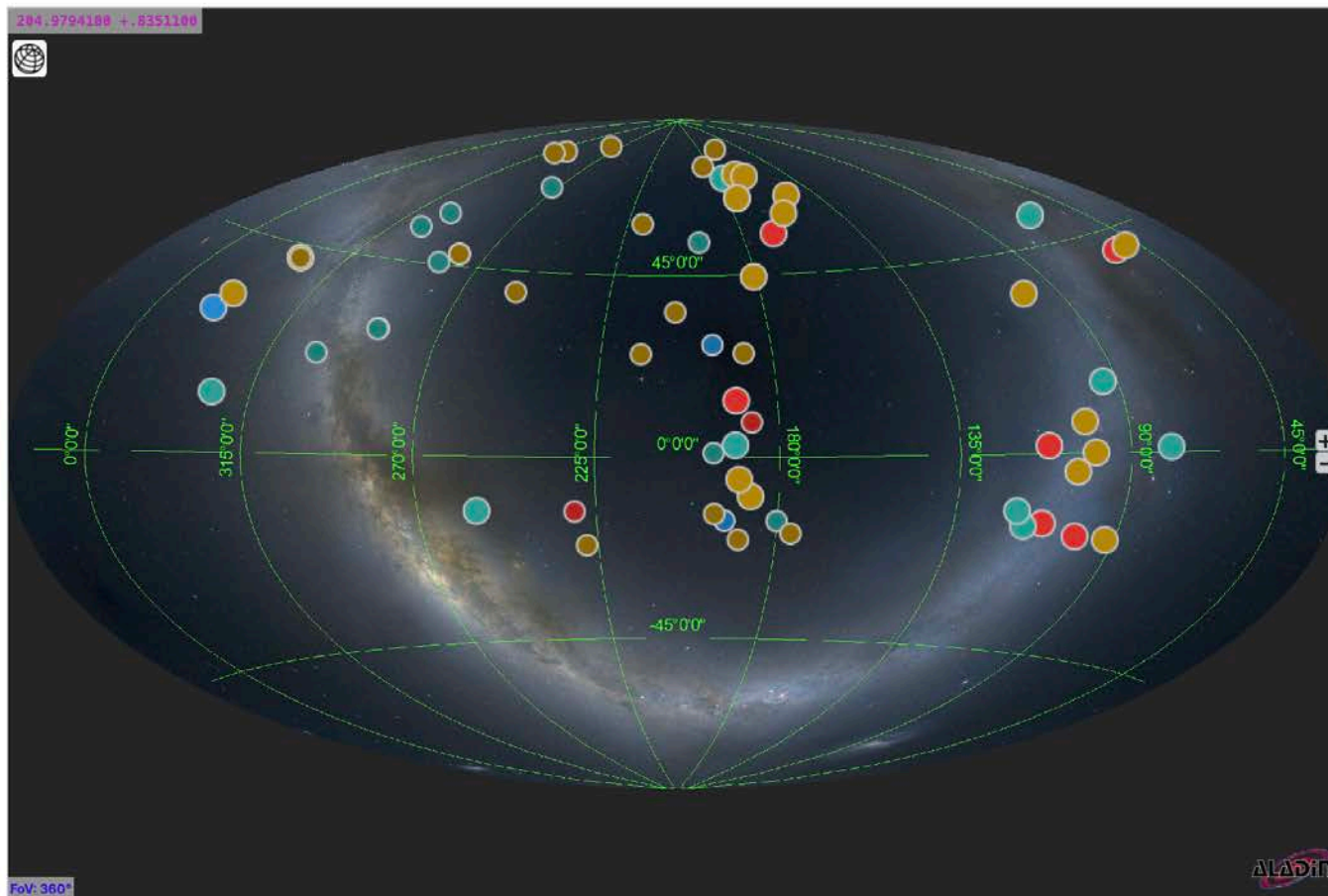
The broker landscape






Latest ZTF Transient Alerts Map

This skymap shows the most recent, bright (<17 Mag) ZTF transient detections, coloured by their predicted type. The longer ago the transient was last detected, the smaller and fainter its marker. Click on a markers for information about an object, and then on the 'ZTF' transient ID for full information.




● Possible Supernova ● Nuclear Transient ● Cataclysmic Variable ● Active Galaxy


What do brokers do ?



- Filters ⓘ
- Watchlists ⓘ
- Watchmaps ⓘ
- Annotators ⓘ
- Status >
- Quick Start
- About
- FAQ
- Schema Browser ⓘ
- Contact

Search

sjsmartt  435

'SN-like candidates in last 14 days' filter results 

SN-like candidates (Sherlock classifications SN, NT and orphans). Rejects Pan-STARRS star matches The filter is **streamed via kafka** with the topic name `lasair_242SN-likecandidatesinlast14days`. ⓘ

Run Filter

Edit Filter

Duplicate

History

Settings

Show Query

Filter Results

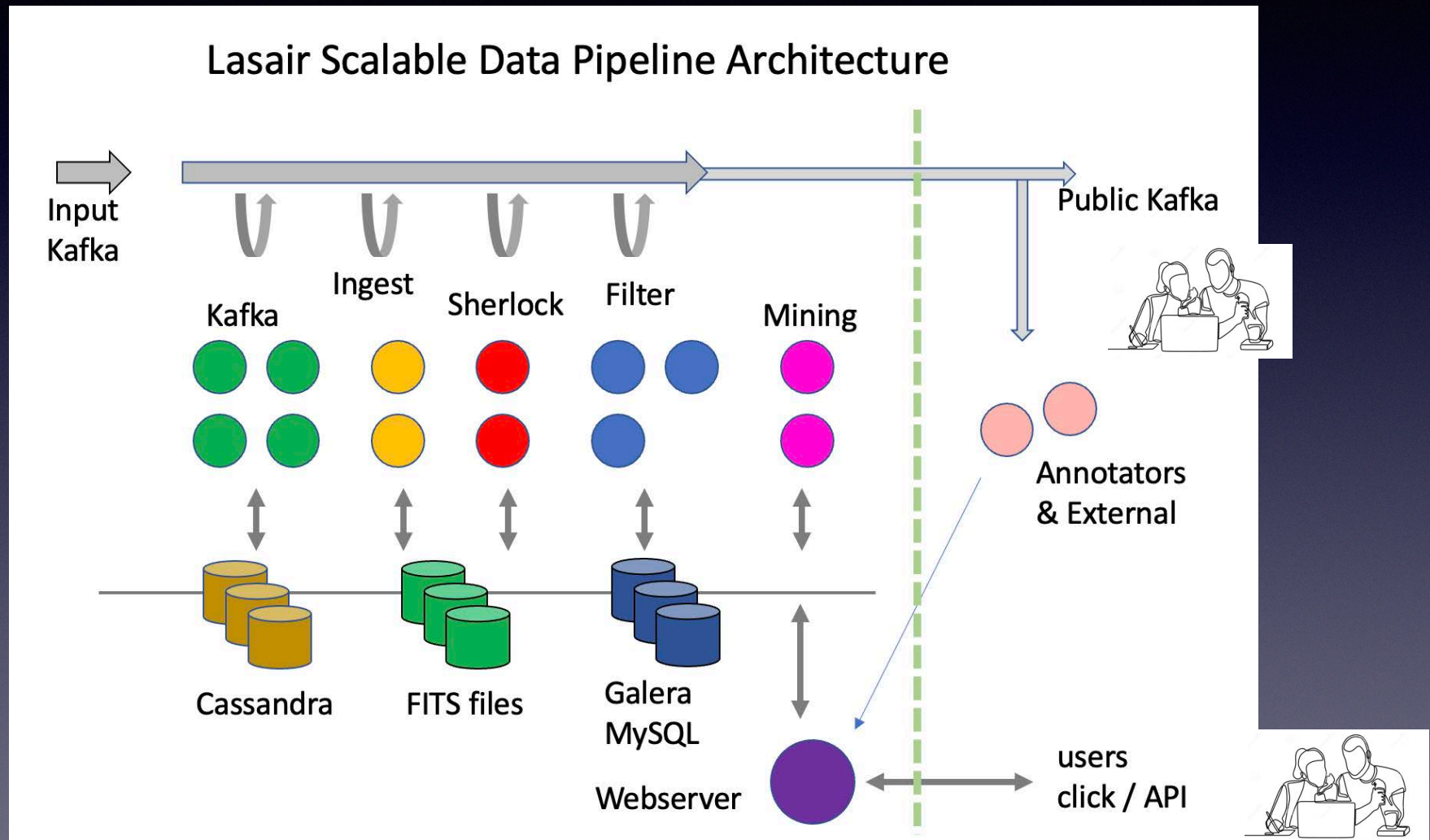
Export

A list of objects passing the 'SN-like candidates in last 14 days' filter.

Search table...

objectId	ramean	decmean	mjdmin	mjdmax	magrmin	rmag	classification	score
ZTF23aadqduf	268.99920	23.877823	60016.4907	60021.5125	19.639	19.639	SN	Not Near PS1 star
ZTF23aadqcvj	264.48923	22.562881	60016.4897	60021.4948	19.193	19.482	SN	Not Near PS1 star
ZTF23aadqcax	230.25042	55.953445	60016.4051	60021.4520	19.335	19.335	NT	Not Near PS1 star
ZTF23aadmhxe	71.55626	71.485326	60013.2388	60021.2037	19.264	19.264	SN	Not Near PS1 star
ZTF23aadjrbt	249.06923	18.392791	60016.4878	60021.3467	19.759	19.759	SN	Not Near PS1 star
ZTF23aadjnac	214.94754	57.938523	60016.3881	60020.4881	19.544	19.560	SN	Not Near PS1 star
ZTF23aadjjse	190.86160	8.206266	59996.4075	60020.3615	20.178	20.250	SN	Not Near PS1 star
ZTF23aadfrnv	121.50831	-10.232411	60020.1916	60021.1927	19.760	19.760	SN	Not Near PS1 star
ZTF23aadedhp	192.17960	-8.584071	60016.3214	60021.3817	18.919	19.008	SN	Not Near PS1 star
ZTF23aadcvce	122.26069	55.947170	60013.3183	60021.2022	19.177	19.177	NT	Not Near PS1 star

Lasair scalable architecture





ZTF23aabtfo
183.680902, 19.168134



Discovery Date: 2023-02-04
08:25:23 UTC
Discovery MJD: 59979.35
Disc g-Mag: 18.15±0.08

Latest Date: 2023-03-17 05:18:03
UTC
Latest MJD: 60020.22
Latest g-Mag: 18.67±0.08



Transient Name Server ⓘ
SN Ia SN2023bhb

The transient was discovered on *4th February 2023* at *08:25:26* (MJD 59979.35) by ZTF as ZTF23aabtfo with a discovery magnitude of $g = 18.15$. It was subsequently classified as a *SN Ia* at $z = 0.028$.

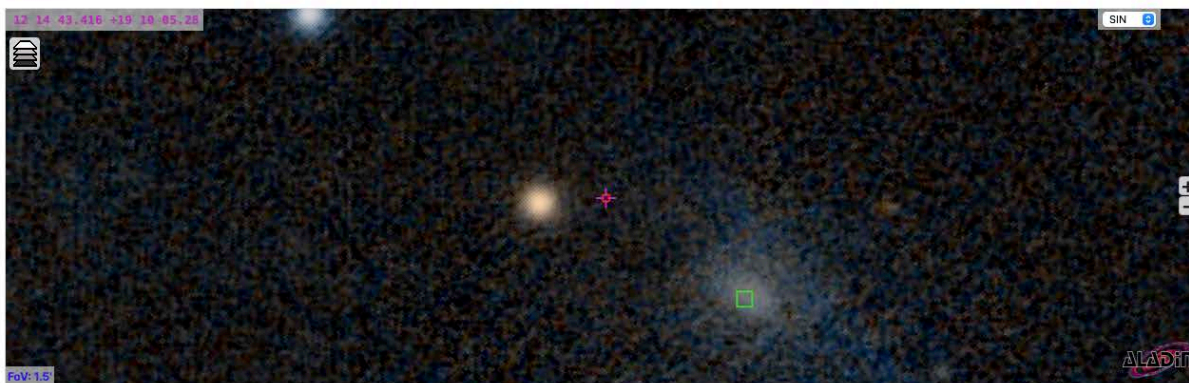


Sherlock Contextual Classification ⓘ
Prediction: **Supernova**

The transient is possibly associated with [SDSSJ121442.63%2B190957.6](#); an $r=17.75$ mag galaxy found in the NED/SDSS catalogues. Its located 7.57" N, 11.00" E (7.5 Kpc) from the galaxy centre. A host $z=0.028$ implies a $m - M = 35.44$.



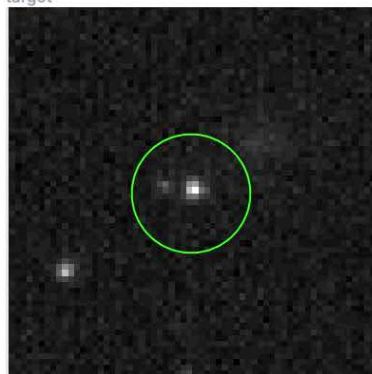
Context Map ⓘ



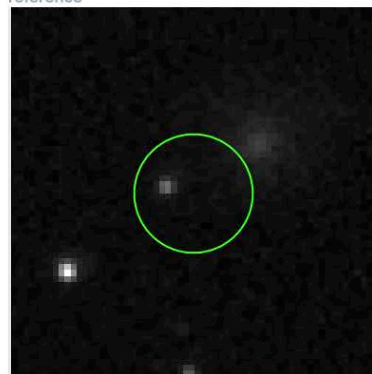
Recent Image Stamps ⓘ



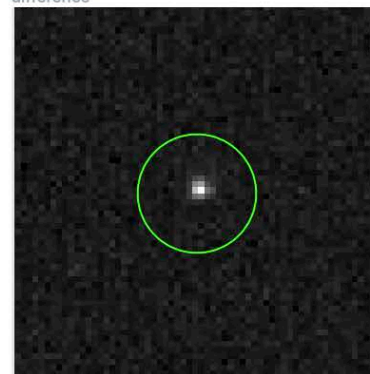
target



reference



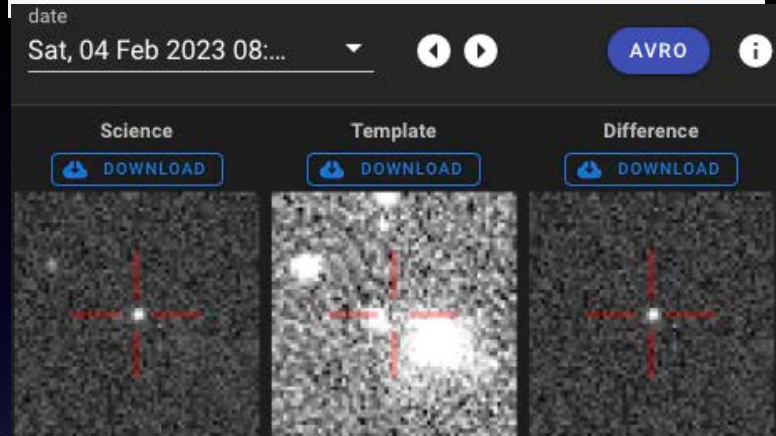
difference





ALeRCE

Automatic Learning for the
Rapid Classification of Events



ZTF23aabtfho

SN CANDIDATE

UNKNOWN

Discovery date: 2023-02-04 08:25:23.998

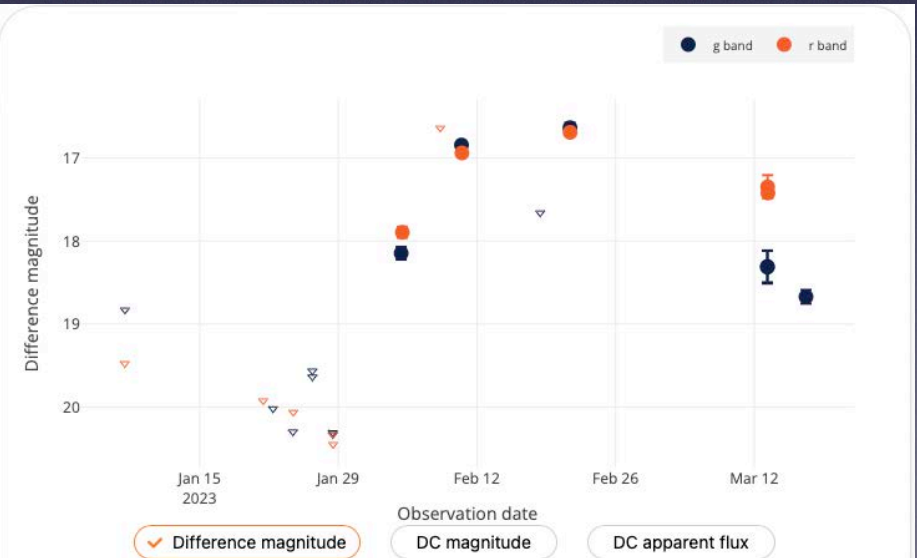
Last detection: 2023-03-17 05:18:03.997

Number of detections: 11

Number of low quality alerts: 0

Number of upper limits: 14

SN candidate: 91% Unknown: 9%



ZTF23aabtfho ICRS: 12:14:43.42 19:10:5.24 Gal: 254.3613 78.4074
183.6809 19.1681



ZTF23aabtfho

Num. Alerts: 25

Num. Mag. Values: 11

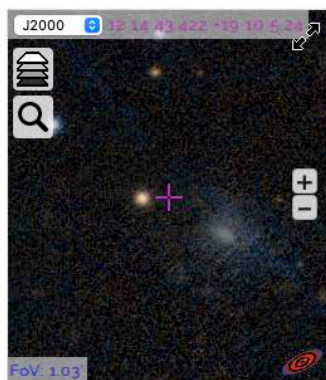
Associated Tags:

nova_test
high_amplitude_transient_candi...
refitt_newsources_snrcut
lc_feature_extractor

Alert Brokers: ALeRCE, MARS

External Services: IPAC, NED,
SIMBAD, SNAD, TNS, VizieR

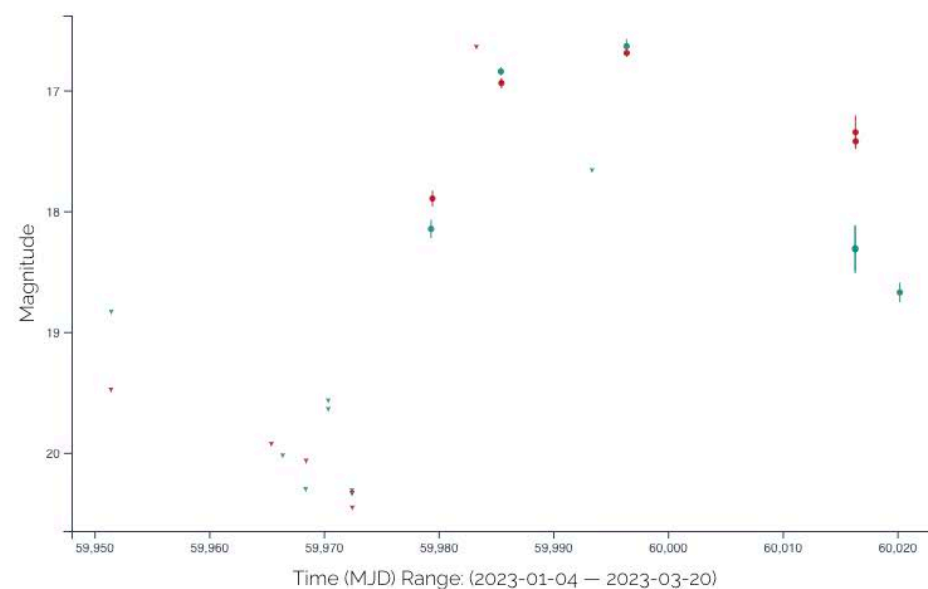
Finder Chart



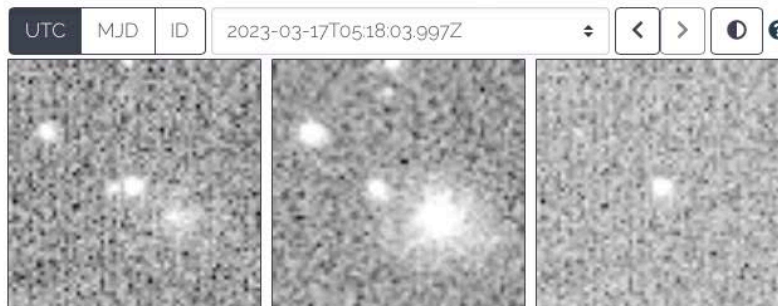
Lightcurve

passband: g R rcid: 35 46 type: mag ulim llim

errors:

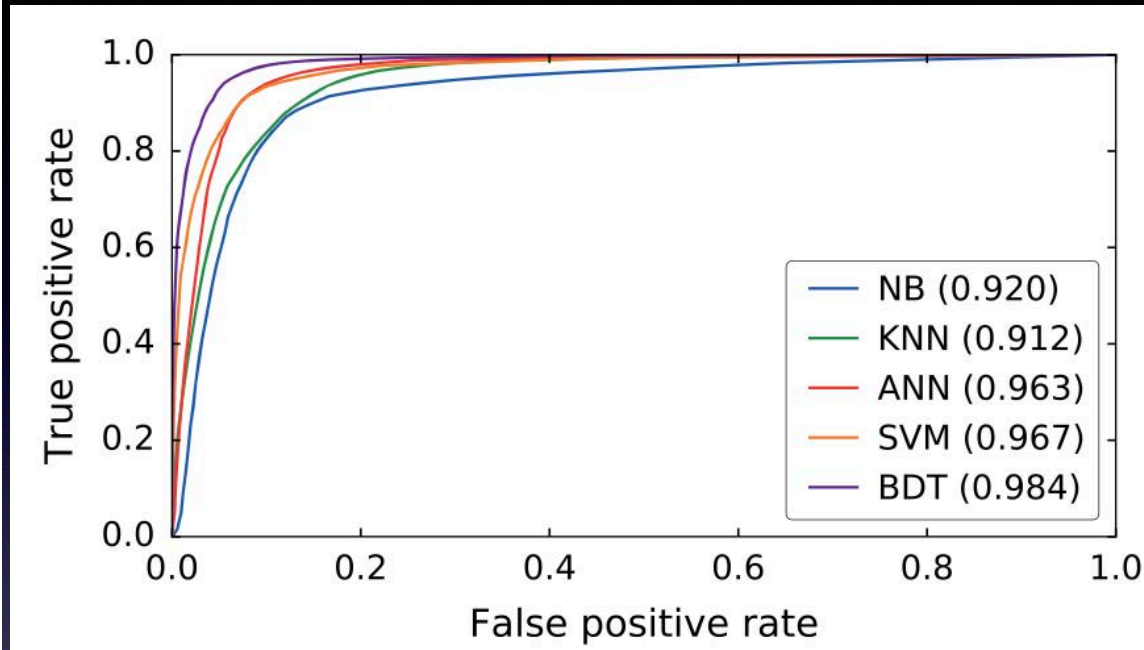


Alert Thumbnails

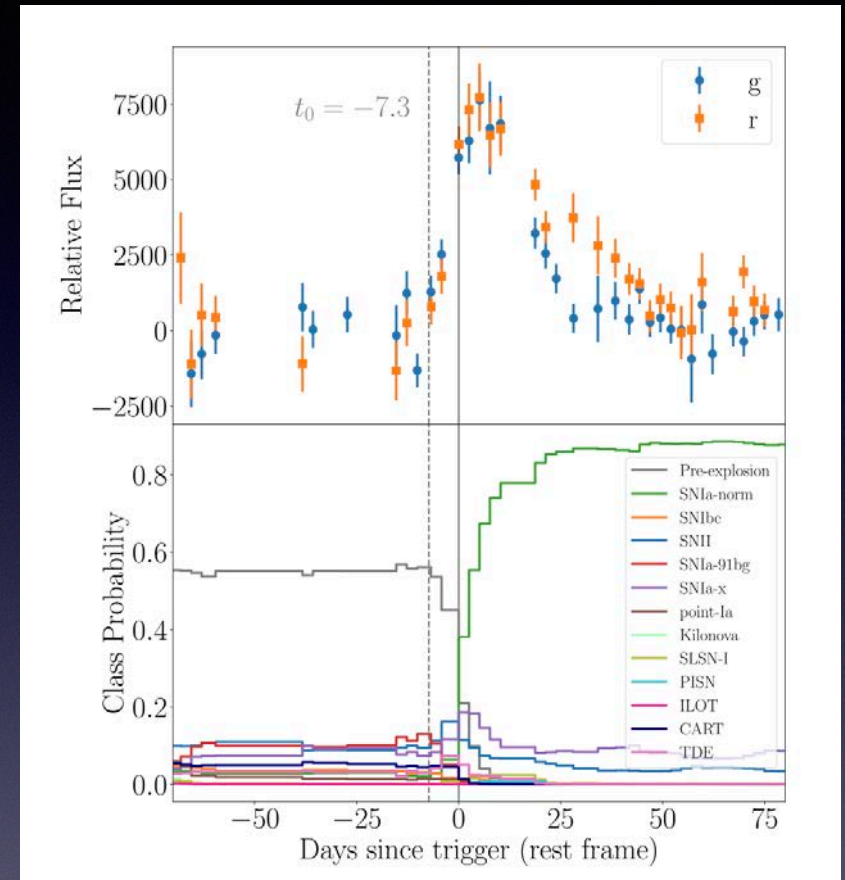


Alerts

ML classification



Lochner et al. 2016

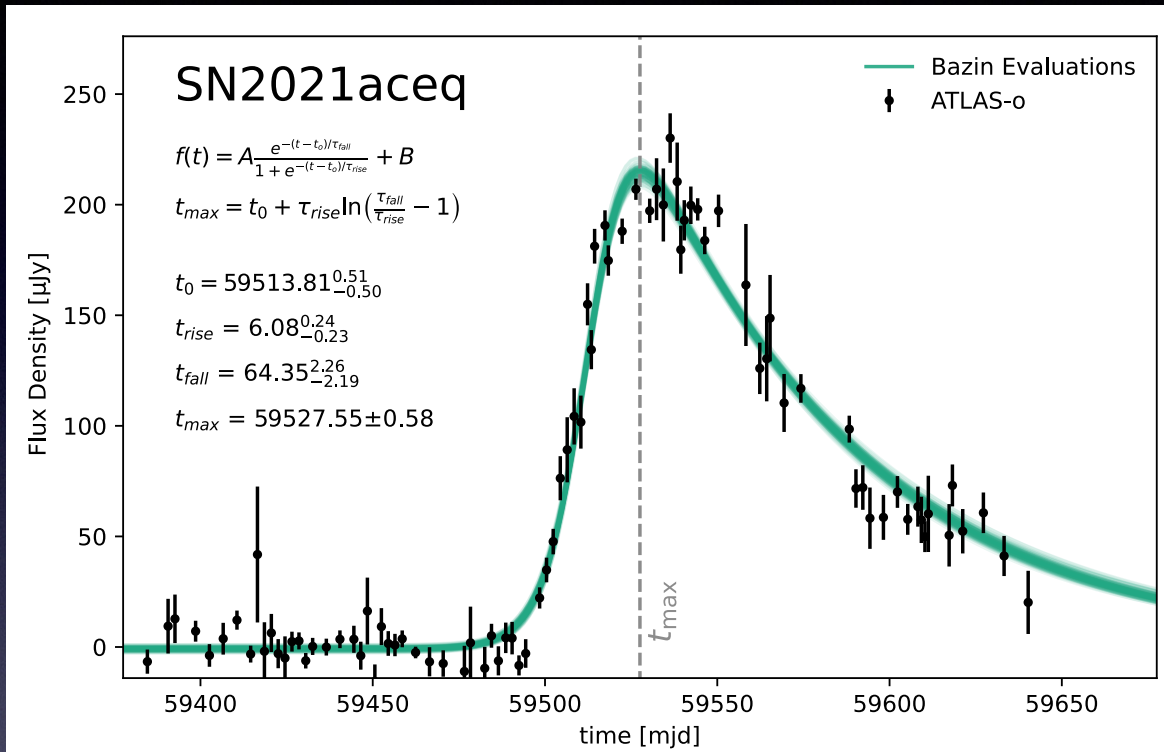


Muthukrishna et al. 2019

Potential for major advances

- Improved ML methods
- Better training, with data and models
- Large and expert community - rapidly changing field

Lasair and lightcurve fitting



$$f(t) = A \frac{e^{-(t-t_0)/\tau_{fall}}}{1 + e^{-(t-t_0)/\tau_{rise}}} + B$$

Lasair focus

- Mover/star/galaxy separations (galaxy offset or nuclear transient or AGN)
- Provide trustworthy measurements and values
- Host galaxy match and redshift
- Trust in the data values
- User decides
- Can work with Lasair team on “Annotator”

Lasair watchlists



Filters ⓘ

Watchlists ⓘ

Watchmaps ⓘ

Annotators ⓘ

Status >

Quick Start

About

FAQ

Schema Browser ⓘ

Contact



Public Gallery

Watchlists submitted to the public gallery by other Lasair users. You can view matches or copy individual watchlists into your own collection.

Name	Owner	Description	Count	Created
TNS	Roy Williams	All the sources in the IAU Transient Name Server https://www ... more	113,233	2023-03-14 14:18:26
BL Lac for TeV	Roy Williams	BL Lac candidates for TeV observations (Massaro+, 2013)	42	2023-03-14 14:18:26
AM CVn	Roy Williams	These are 56 very close binaries of compact objects, from " ... more	55	2023-03-14 14:18:26
AM Her	Gavin Ramsay	Magnetic CVs (B>10MG). some go into prolonged low states. se ... more	101	2023-03-14 14:18:26
Milliquas_1000000	Roy Williams	million	999,998	2023-03-14 14:18:26
E+A galaxies	Matt Nicholl	French & Zabludoff 2018	51,907	2023-03-14 14:18:26
Gaia DR2 white dwarfs	Roy Williams	Gaia DR2 white dwarf candidates (Gentile Fusillo+, 2019) MNR ... more	486,641	2023-03-14 14:18:26

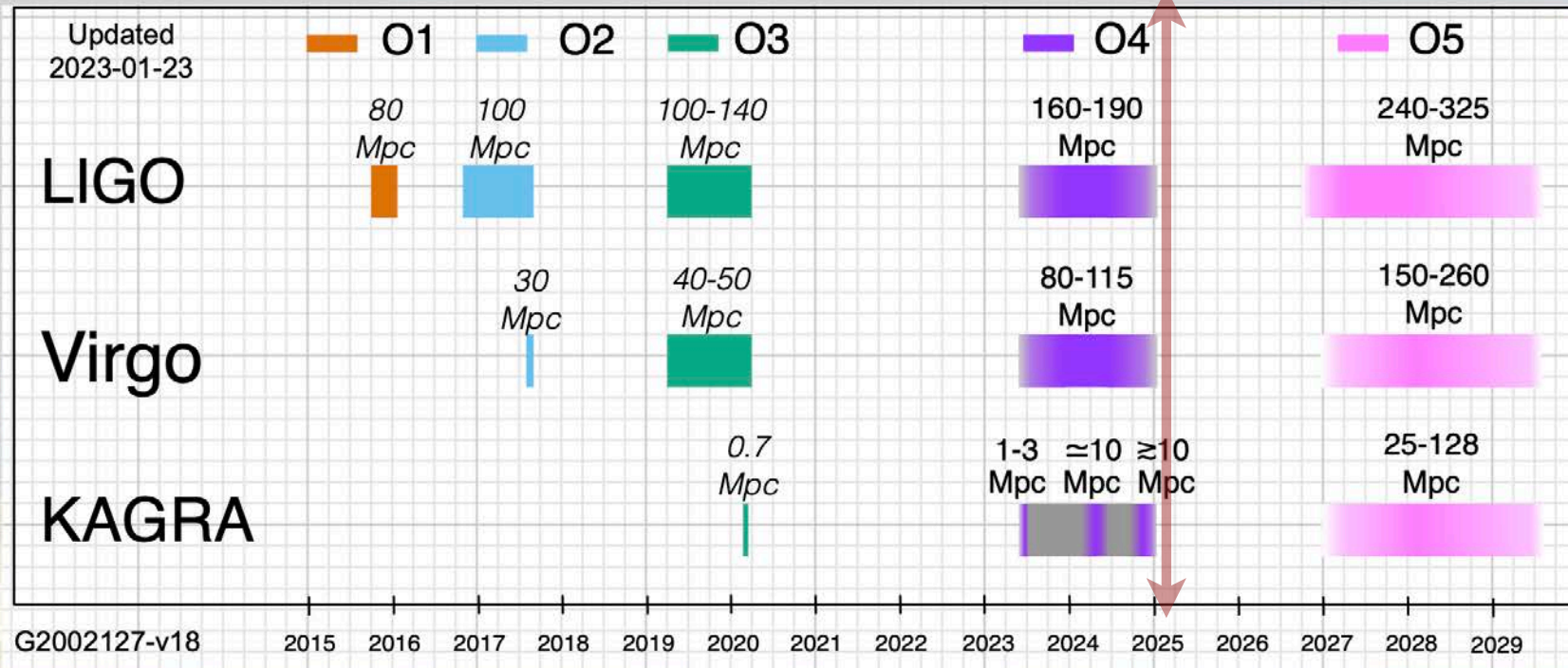
Help

Lasair

 Contact

 Help

Landscape now to 2030



<https://observing.docs.ligo.org/plan/>

Discussion points

1. Are we taking the right approach with Lasair ?
2. Can we facilitate your science, and what extra can we do ?
3. A UK strategy for time domain real-time data federation, classification and curation

Roy
Williams



Ken
Smith



Dave
Young



Gareth
Francis



All very helpful!

Finally the last word

the latest on alerts from LSST

7th Feb 2023

The LSST Survey start: 4-7 months after System First Light. Some “near-live” alerts are planned around the time of the LSST Survey start, and then alert production is planned to increase smoothly to “live” during the early months of the LSST Survey, covering more regions over time as the static-sky templates are built up.

Monthly updates (including diagram updates) :

<https://www.lsst.org/about/project-status>

<https://lsst-uk.atlassian.net>

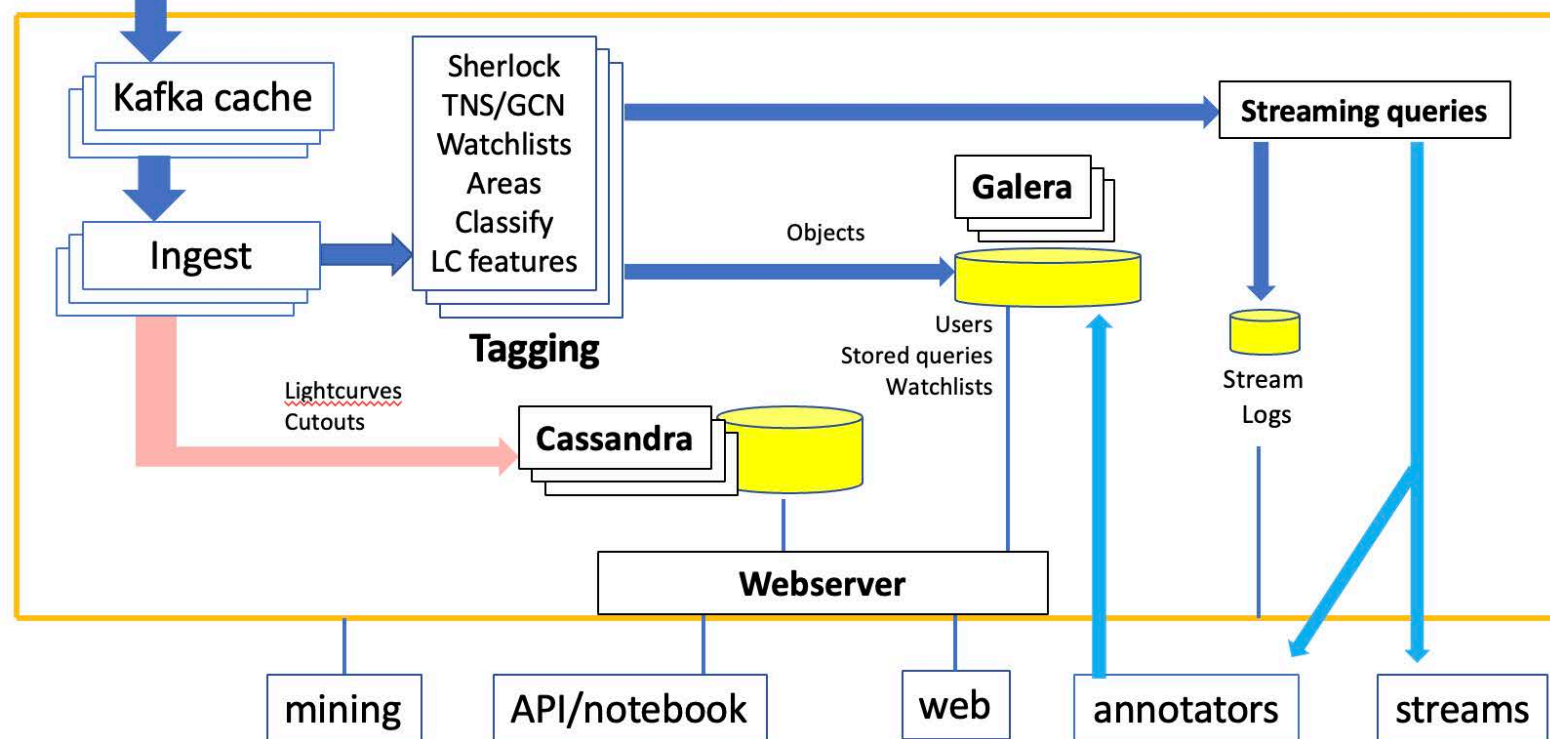
Fin

NSF
Vera C. Rubin
Observatory



internal
public

Openstack cloud "Somerville"



Galera = MySQL++
Cassandra = NOSQL