



the UK community broker for LSST
(ZTF now)

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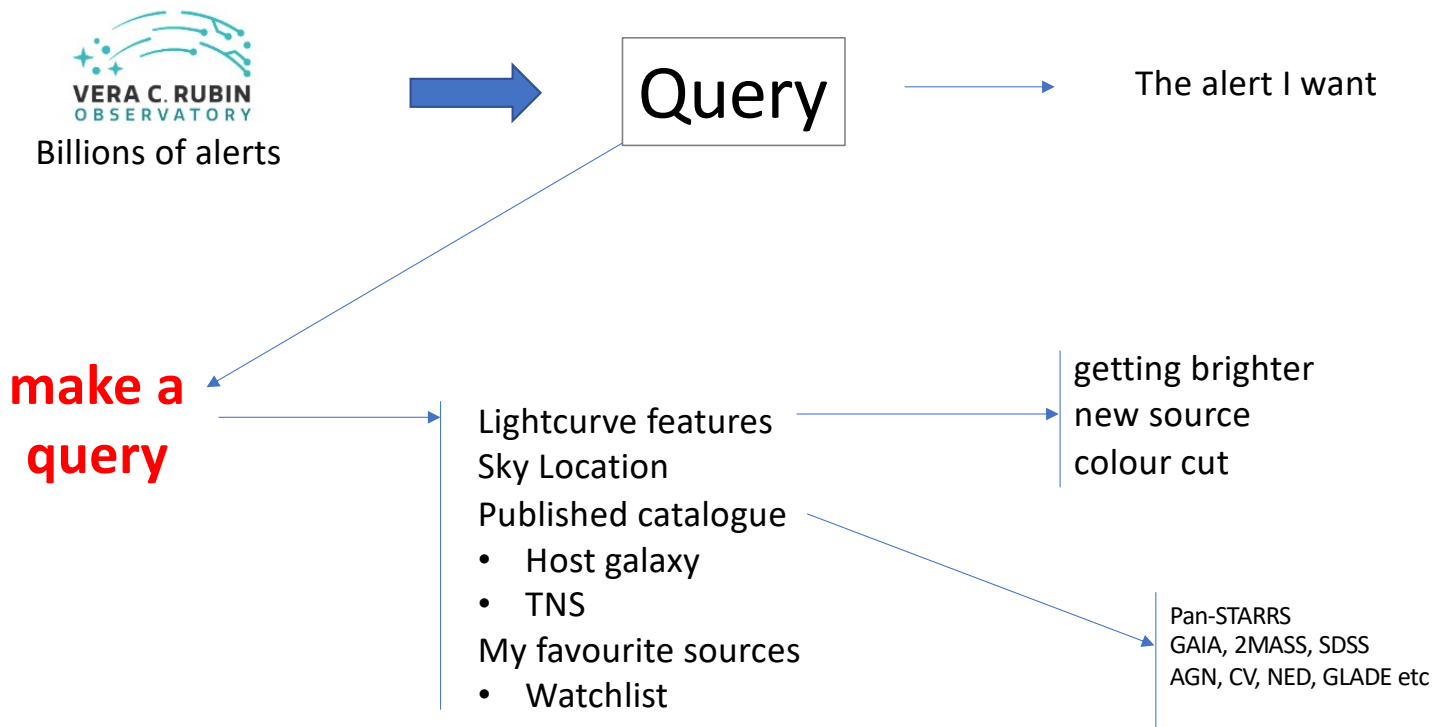
Stephen Smartt, Ken Smith, Dave Young
Queens University Belfast

<https://lasair-ztf.lsst.ac.uk>

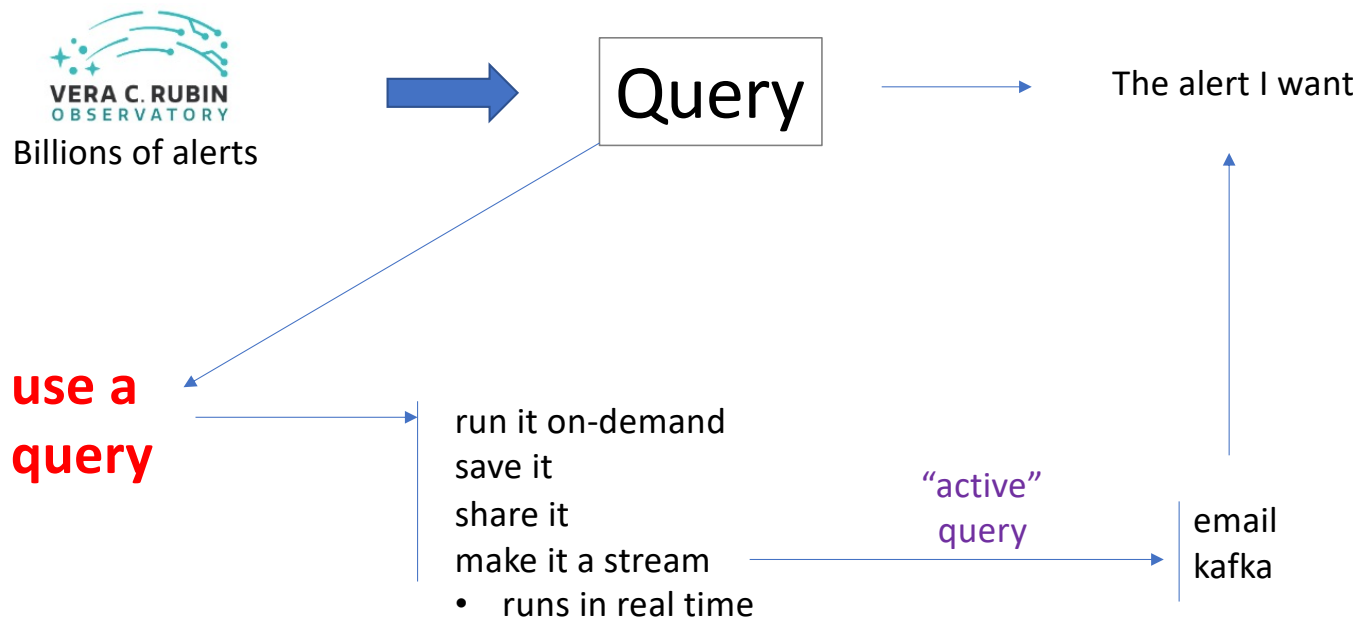
What does Lasair do?



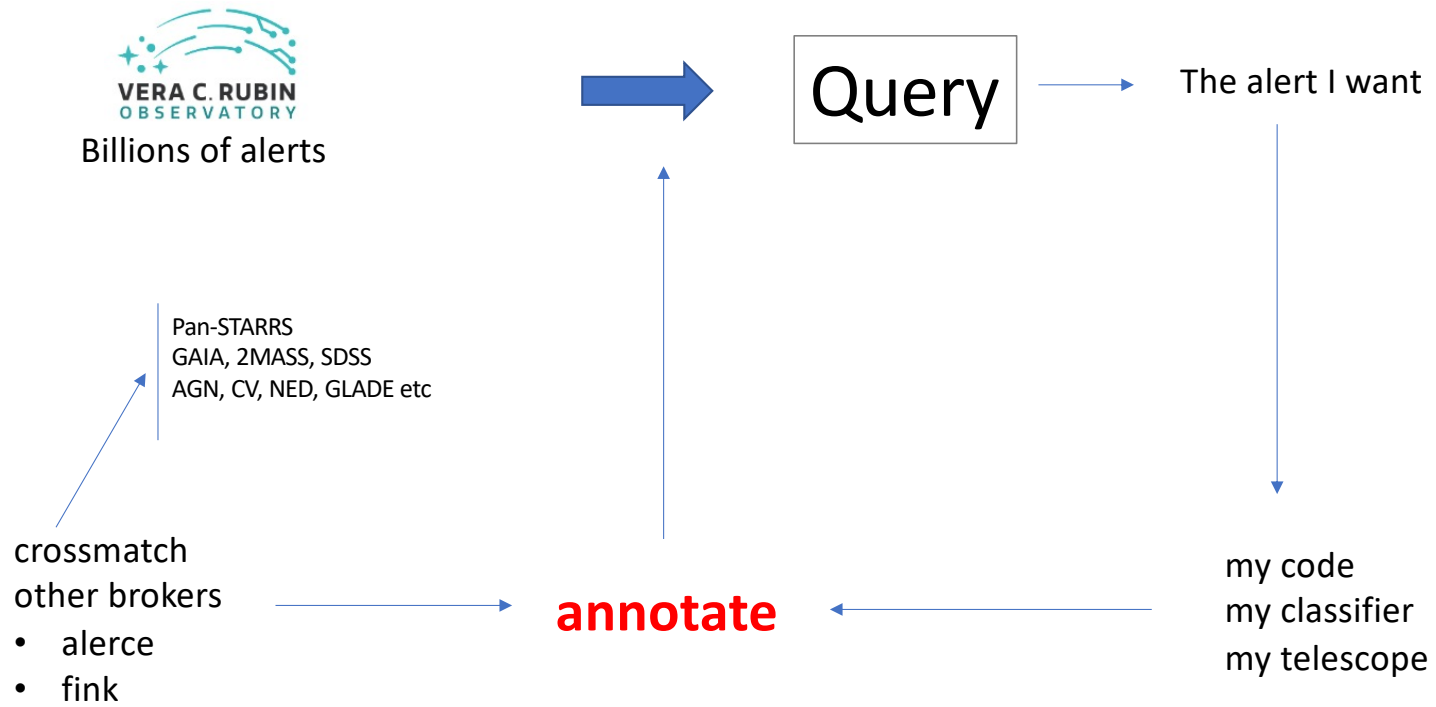
What does Lasair do?



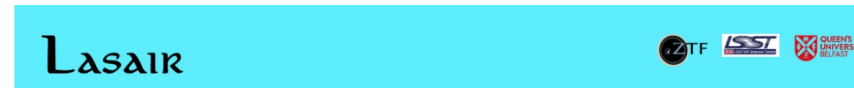
What does Lasair do?



What does Lasair do?



Lasair object view



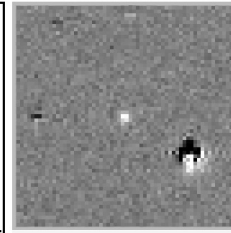
FITS viewer

Linear [download fits](#)

19

Image: 63 x 63 @ [1, 1]
 Min -947.2 @ [49, 41]
 Max 1059.0 @ [49, 43]
 Mean 0.6 StdDev 38.0
 Median 8.0 Sum 2273.1

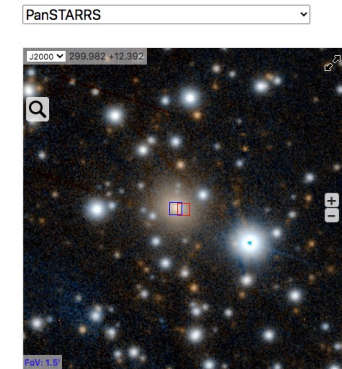
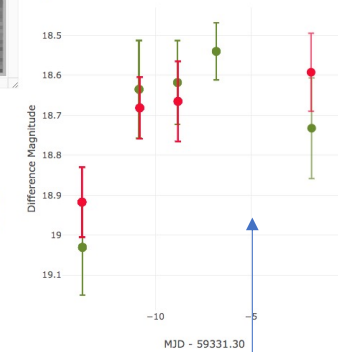
forked from [fitsview](#) by Elwood Downey



logged in as roy (Logout)

Home About Data Documents Status Contact

Object ZTF21aavhswd



Transient position: red square.
 Sherlock source: blue square.

Each detection

Candidates (To sort, click the column headings)

MJD	UTC	Filter	magpsf	status	images
59349.461	2021-05-15 11:03:12	r	19.300 ± 0.115	t	target ref diff
59347.466		r	17.574	non-detection	
59347.452		g	17.850	non-detection	
59345.462	2021-05-11 11:05:42	r	19.337 ± 0.130	t	target ref diff
59345.424		g	20.169	non-detection	
59342.464	2021-05-08 11:07:53	g	19.654 ± 0.126	t	target ref diff

Sherlock

- Classified as SN, at 2.26 arcsec.
- Best crossmatch is galaxy
- The transient is possibly associated with 19595411+1223075; a J=12.57 mag galaxy found in the 2MASS/PS1/GAIA catalogues. Its located 0.06" S, 2.35" W from the galaxy centre.

TNS

- TNS name is SN 2021jwk
- type SN Ia, z=0.061, host is WISEA J195954.11+122307.5
- discovered by ZTF
- discovery magnitude 18.9173

Light Curves

AladinLite

TNS

Sherlock

<https://lasair-ztf.lsst.ac.uk>

Lasair “Watchlist”

- Named “interesting” sources with radius
- If “active”, matching objects are tagged real-time
- Can be public or private
- Query can include watchlist constraint

Lasair About Data Documentation Code Support roy ▾

Name:

Description:

These are 56 very close binaries of compact objects, from "The physical properties of AM CVn stars: new insights from Gaia DR2", Ramsay et al 2018 A&A 620A 141

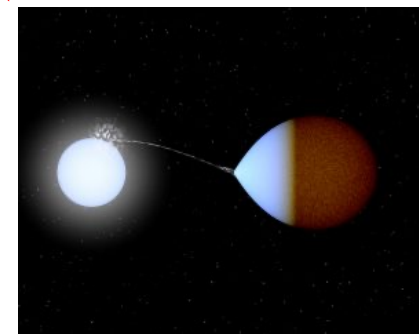
Radius (arcsec):

Active:

Public:

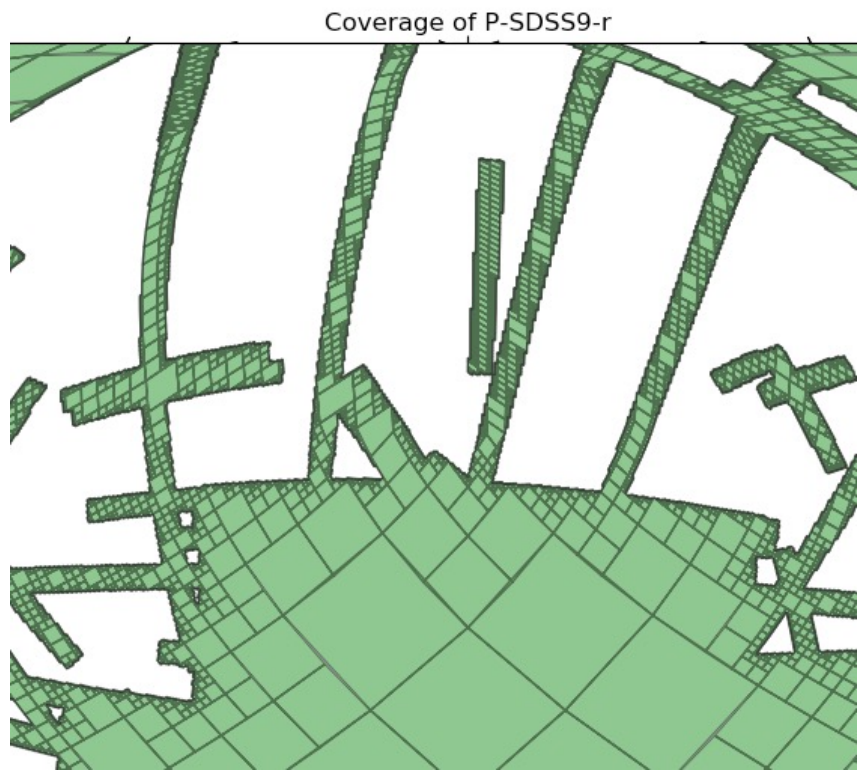
Watchlist			Crossmatch ZTF			
RA	Dec	Name	Radius	objectId	Age (days)	candidates
291.1594	59.6963	KL Dra	1.0	ZTF18aarkcxh	1.0726	16
289.7716	48.2517	PTF1 J1919+4815	1.0	ZTF18aaptcay	2.0027	16
242.8915	63.1422	Gaia14aae	1.0	ZTF18aaplouo	4.0273	2
207.2301	7.9599	CR Boo	1.0	ZTF18adkhuxp	5.1604	9
190.2418	-1.9887	SDSS J1240-0159	1.0	ZTF18acyerom	9.1786	20
334.7920	31.5898	PTF1 J2219+3135	1.0	ZTF18abcqadc	13.9629	17

SDSS Quasar	Main DR9 Quasar catalog with $z < 1.5$ VII/269/dr9	17631	10.0 arcsec	✓	
Cataclysmic Variables	Catalog of Cataclysmic Variables (Downes+ 2001-2006) VizieR V/123A	1830	0.2 arcsec	✓	
WFCAM	J/A+A/573/A/100/WVSC Post annotation WFCAM Variable Star Catalog (Ferreira Lopes+, 2015) ReadMe+ftp2015A&A...573A.100F WFCAM Variable Star Catalog: parts C1 (periodic variables, table4), C2 (no main periodicity, table 6), and C3 (low-amplitude variables table 8) (334 rows)	334	1.0 arcsec	✓	
BL Lac for TeV	BL Lac candidates for TeV observations (Massaro+, 2013)	42	5.0 arcsec	✓	✓
AM CVn	These are 56 very close binaries of compact objects, from "The physical properties of AM CVn stars: new insights from Gaia DR2", Ramsay et al 2018 A&A 620A 141	55	1.0 arcsec	✓	✓
Milliquas_1000000	million	999998	2.0 arcsec	✓	✓
Gaia DR2 white dwarfs	Gaia DR2 white dwarf candidates (Gentile Fusillo+, 2019) MNRAS.482.4570G	486641	5.0 arcsec	✓	✓



<https://lasair-ztf.lsst.ac.uk>

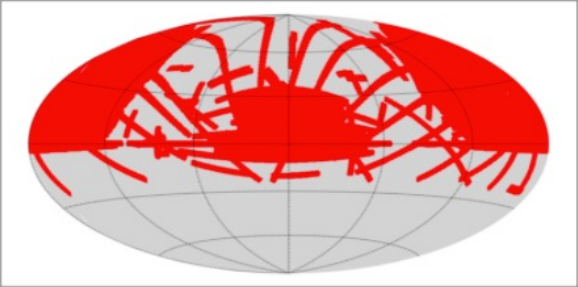
Lasair “Area”



Upload a MOC file

- Objects inside are tagged
- Query can include only these
- Examples
 - Survey footprints
 - GW or other skymap
 - My telescope coverage

Name	SDSS
Description	The area of the SDSS footprint
Active	yes
Public	yes



Area has 786793 objects, shown below.. To see the original input data, click [here](#).

Lasair Design Decisions

- It's a platform not a product
 - Users share queries, watchlists
 - Users contribute classifiers and annotations
- SQL based
 - Astronomers have got used to it
 - Expressive AND can be ring-fenced
 - On-demand AND Streaming
 - Same query for both!
 - Streaming in time order
- Short and long lightcurves
 - features and queries from last month (will be year for LSST)
 - for scalability
 - long LC display/download

Simple Query

(coming soon)

- Form based

- Fill in criteria
- Basic crossmatch
- TNS match
- my watchlists

Lasair About Data Documentation Code Support

Simple Search

Select object characteristics

Show	Column	Constraint	Description
<input type="checkbox"/>	RA		Right Ascension (decimal degrees)
<input type="checkbox"/>	Dec		Declination (decimal degrees)
<input type="checkbox"/>	g mag	< 19	Latest g magnitude
<input type="checkbox"/>	r mag	< 19	Latest r magnitude
<input type="checkbox"/>	number	> 6	Number of points in the light curve
<input type="checkbox"/>	since		Days since most recent observation
<input type="checkbox"/>	dmdt_g		Rate of increase of brightness (dm/dt in g)
<input type="checkbox"/>	dmdt_r		Rate of increase of brightness (dm/dt in r)

Select sky context (optional)

- and in AGN catalogue
- and in CV catalogue
- and has host galaxy
- and in variable star catalog

Select known transients from IAU naming service (TNS) (optional)

- and supernova type Ia
- and supernova type II
- and superluminous supernova
- and CV burst

Use my watchlist of sources (... [more info](#))

- BL Lac for TeV
- AM CVn
- Gaia DR2 white dwarfs
- Strong Lensing

Advanced Query Builder

FROM

First pick your tables: ("objects" is mandatory)

<input checked="" type="checkbox"/> objects	<input checked="" type="checkbox"/> sherlock classifications	<input type="checkbox"/> TNS
<input checked="" type="checkbox"/> Watchlist <input type="checkbox"/> SDSS Quasar, ID=23 <input type="checkbox"/> Cataclysmic Variables, ID=26 <input type="checkbox"/> WFCAM, ID=29 <input type="checkbox"/> BL Lac for TeV, ID=35 <input type="checkbox"/> AM CVn, ID=58 <input type="checkbox"/> AM Her, ID=118 <input type="checkbox"/> Milliquas_1000000, ID=137 <input checked="" type="radio"/> E+A galaxies, ID=139 <input type="checkbox"/> __TNS__, ID=141 <input type="checkbox"/> Gaia DR2 white dwarfs, ID=147	<input type="checkbox"/> Area	

SELECT

SELECT clause here. Which attributes to return? See list at right.

```
objects.objectId,
jdmin - 2400000.5 AS mjdmin,
jdmax - 2400000.5 AS mjdmax,
magrmin, rmag,
sherlock_classifications.classification
```

WHERE

The SQL **WHERE**. Which objects to return. See list at right.

```
sherlock_classifications.classification = "NT"
AND objects.ncandgp > 3
AND objects.maggmean < 20
```

- FROM tables
- SELECT attributes
- WHERE conditions (use GUIDE)
- ACTION save, run, delete, copy

GUIDE

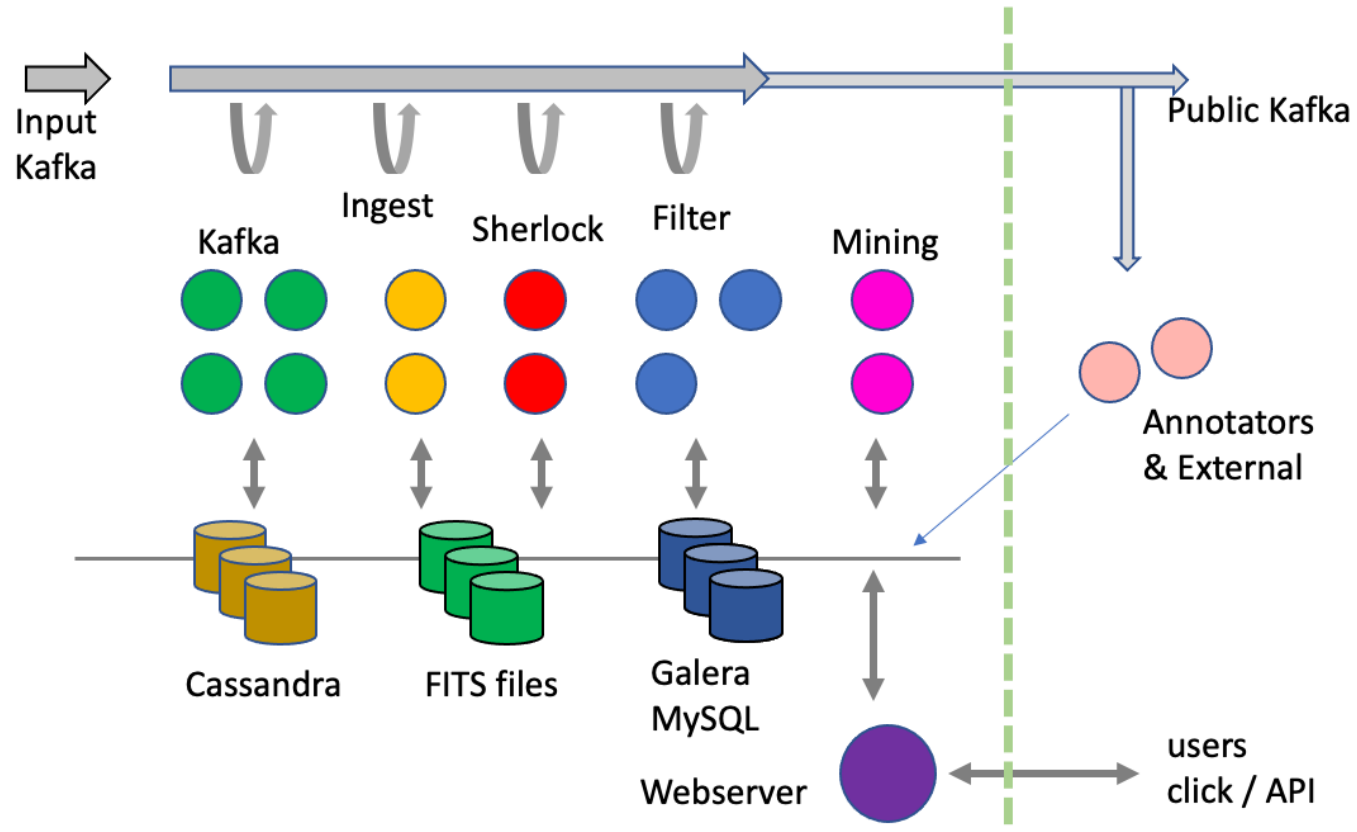
objects.glonmean	Mean galactic longitude in degrees
objects.jdgmmax	Latest Julian Day of g mag candidates
objects.gmag	Latest g magnitude
objects.dmdt_g	most recent increase in g magnitude divided by time difference, (brightening = positive)

<https://lasair-ztf.lsst.ac.uk>

ACTION

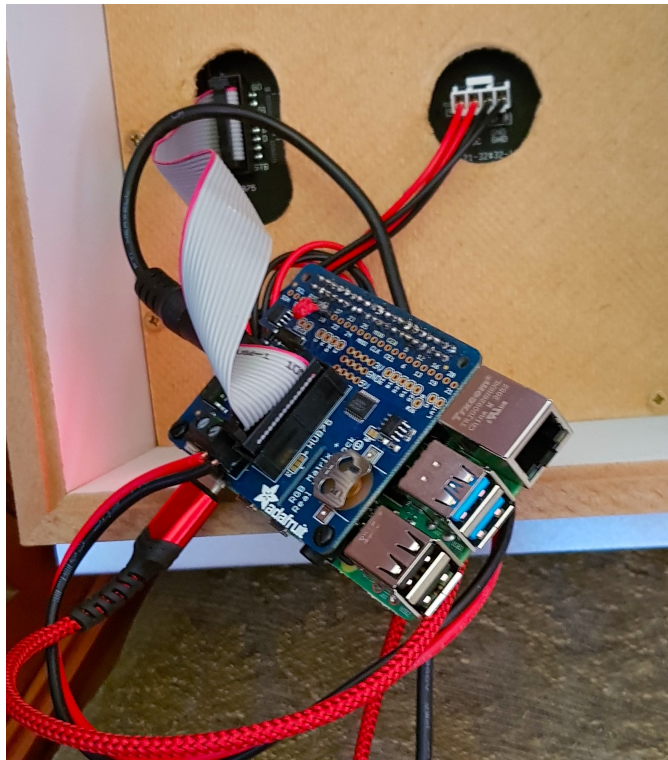
<input type="checkbox"/> Check this box for JSON output
<input type="button" value="Save this Query"/> <input type="button" value="Run this Query"/>
<input type="button" value="Delete this Query"/> <input type="button" value="Copy this Query"/>

Lasair Scalable Data Pipeline Architecture

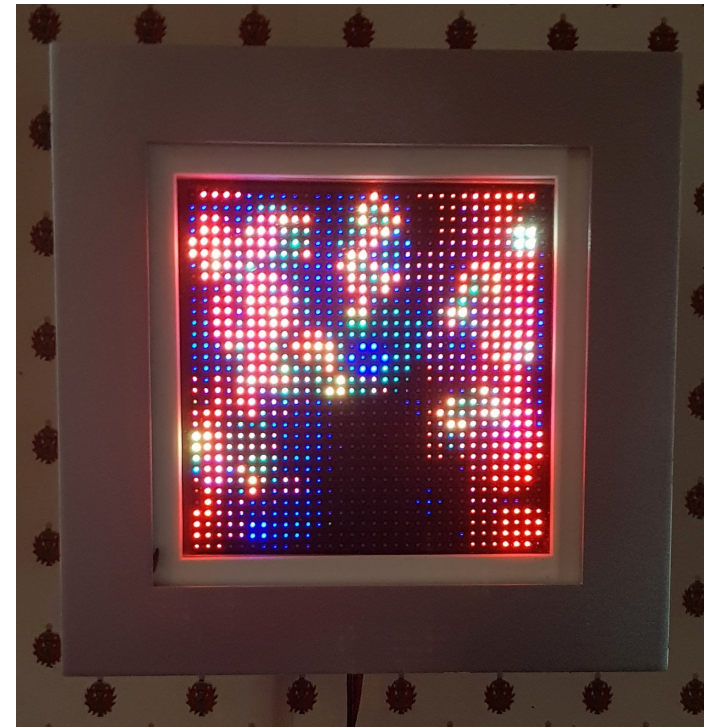


Wall-mounted alert monitor with Lasair public Kafka

Raspberry Pi



32x32 LED array (Adafruit)



<https://lasair-ztf.lsst.ac.uk>

IRIS@Edinburgh “Somerville*” System

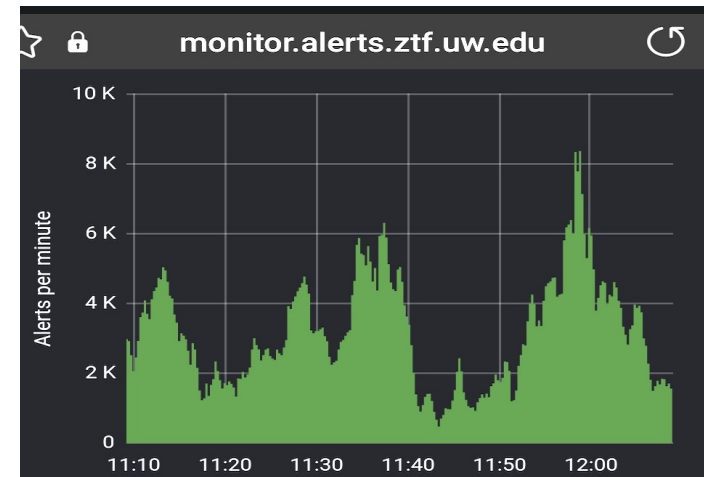
- Support for large-scale, high-performance database applications
 - OpenStack
 - **1600 TB HDD** Ceph file system and object store
 - **100 TB SSD** Ceph file systems
 - **320 cores** (16 GB/ core)
 - **100 Gbps** public network w/ 2×100 Gbps uplink to Internet



* Mary Somerville, polymath Scot for whom the word “Scientist” was coined in 1834 -- she made “man of science” obsolete.

Keeping up!

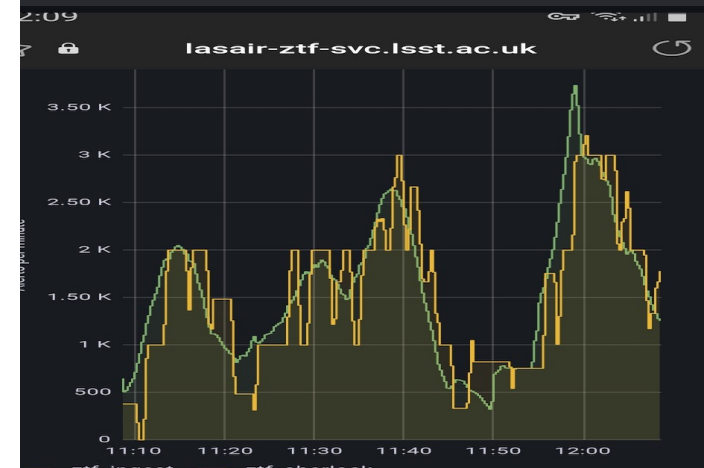
ZTF rates
California



LSST will be ~30 times the rate and volume of ZTF

Work this year has been on making Lasair FAST

Lasair processing
Edinburgh



<https://lasair-ztf.lsst.ac.uk>

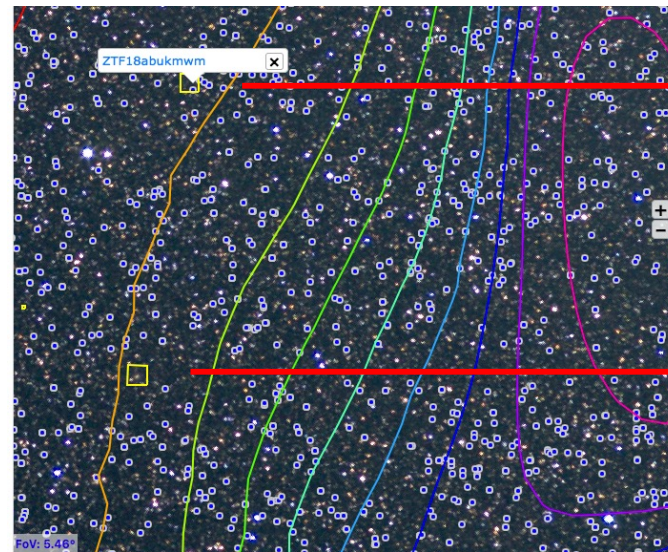
Gravitational Waves

Is one of these the counterpart of a GW event?

position and distance.
Gravitational Wave Skymap: S190518bb

Distance	27.8 ± 15.3 Mpc
ISO Date:	2019-05-18T19:19:21.922921
Julian date:	2458622.305
Percent probability:	BNS=75, NSBH=0, BBH=0 MassGap=0
max prob RA,Dec	327.0, 32.6

- Coverage of ZTF From To
- Show ZTF candidates From To
- Show galaxies from [GLADE](#) *doubleclick a galaxy*



200 most probable galaxies

Name (NED link)	Percent probability	Distance (Mpc)
NGC7217	2.72	20.04
LEDA AGC322487	2.28	22.85
UGC04195	1.57	74.58

<https://lasair-ztf.lsst.ac.uk>



Sherlock Attributes

Smart crossmatch from ~40 catalogues

classification	Top-ranked contextual classification for the transient (NULL, AGN, BS, CV, NT, ORPHAN, SN, UNCLEAR, VS)
classificationReliabil	Reliability of classification
description	Long-form, human-readable summary of the transient's characteristics as inferred from Sherlock's classification
catalogue_object_type	Type of catalogue from which the best crossmatch is made
catalogue_table_name	Name/s of catalogue/s from which the best crossmatch is made
catalogue_object_id	Identifier in the catalogue/s from which the best crossmatch is made
Mag	Magnitude
MagFilter	Magnitude filter
MagErr	Magnitude error
z	Redshift of the top-ranked catalogue source match
photoZ	Redshift of the top-ranked catalogue source match
photoZErr	Redshift of the top-ranked catalogue source match
direct_distance	Determined from a non-redshift related measurement - e.g. Cepheids/standard candle (Mpc)
distance	Luminosity distance -- conversion from the spectral redshift (Mpc)
separationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
northSeparationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
eastSeparationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
physical_separation_kpc	Distance in kilo parsec between transient and top-ranked catalogue source match

<https://lasair-ztf.lsst.ac.uk>

Lasair Lightcurve Features

objectId	ZTF object identifier
ramean	Mean RA in degrees
decmean	Mean Dec in degrees
rastd	Standard deviation of RA in arcseconds
decstd	Standard deviation of Dec in arcseconds
glatmean	Mean galactic latitude in degrees
glonmean	Mean galactic longitude in degrees
jdmin	Earliest Julian Day of candidates that cite this object
jdmax	Maximum of jdgmax and jdrmax
jdrmax	Latest Julian Day of r mag candidates
jdgmax	Latest Julian Day of g mag candidates

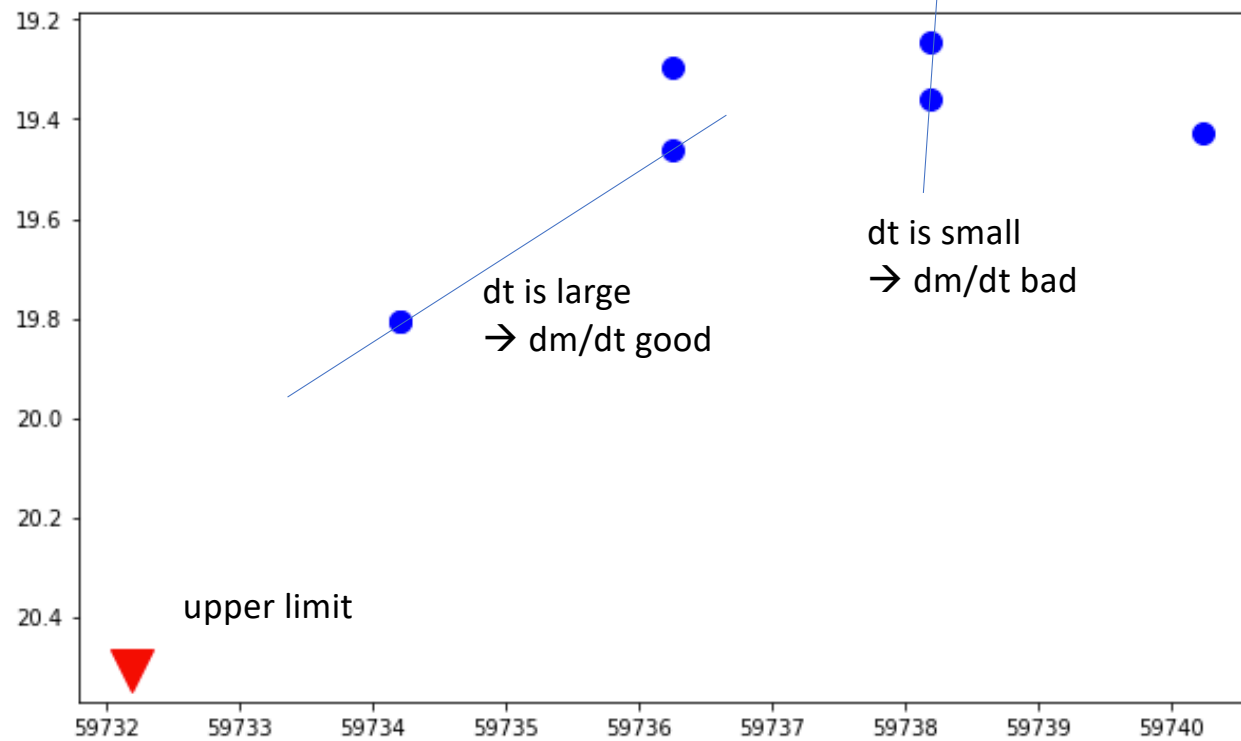
qmag	rmag	latest r magnitude
dmdt_g	dmdt_r	most recent increase in r magnitude divided by time difference, (brightening = positive)
dmdt_g_2	dmdt_r_2	2nd most recent increase in r magnitude divided by time difference
mag_g02	mag_r02	Latest Exponential Moving Average of difference magnitude in r band, with 2-day timescale
mag_g08	mag_r08	Latest Exponential Moving Average of difference magnitude in r band, with 8-day timescale
mag_g28	mag_r28	Latest Exponential Moving Average of difference magnitude in r band, with 28-day timescale
maggmin	magrmin	Minimum r magnitude of light curve (brightest)
maggmean	magrmean	Mean r magnitude of light curve
maggmax	magrmax	Maximum r magnitude of light curve (faintest)

g_minus_r	Value of g-r on most recent night when both were available
jd_g_minus_r	Julian date of most recent g measure on a night when both g and r were available
ncand	Number in light curve
ncandgp	Number in light curve with good quality and brighter than reference
ncandgp_7	Number in light curve with good quality and brighter than reference in last 7 days
ncandgp_14	Number in light curve with good quality and brighter than reference in last 14 days
distpsnr1	Distance of closest source from PS1 catalog; if exists within 30 arcsec [arcsec]
sgscore1	Star/Galaxy score of closest source from PS1 catalog 0 <= sgscore <= 1 where closer to
sgmag1	g-band PSF magnitude of closest source from PS1 catalog; if exists within 30 arcsec
srmag1	r-band PSF magnitude of closest source from PS1 catalog; if exists within 30 arcsec

what else???

Features for Light Curves

<https://lasair-iris.roe.ac.uk/object/ZTF22aamsths/>



<https://lasair-ztf.lsst.ac.uk>

Gaussian Processes for Light Curves

- Removes human-made cadence
- Can handle upper limit
- Derivatives and error
- What about 6 light curves?

**WE ARE LOOKING FOR INPUT
ON LIGHT CURVE FEATURES!!
TALK TO ROY OR STEPHEN!!**

