

GAIA NUCLEARS - HOW TO

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NUCLEARS AND GAIA

- nuclears: **SNe, TDEs, QSOs**
- offsets from the host galaxy nucleus of **<0.5 arcsec**
- be discovered by the on-board detection of a **new source**
- be discovered by the brightening of a previously known source (**old source**)
- no significant loss of nuclears at close radial distances to the nucleus
- Gaia Alert Pipe - detection process - limiting mag for transient alert; minimum change in magnitude (for old existing sources)
- avoid too many false positives

EXPECTATIONS

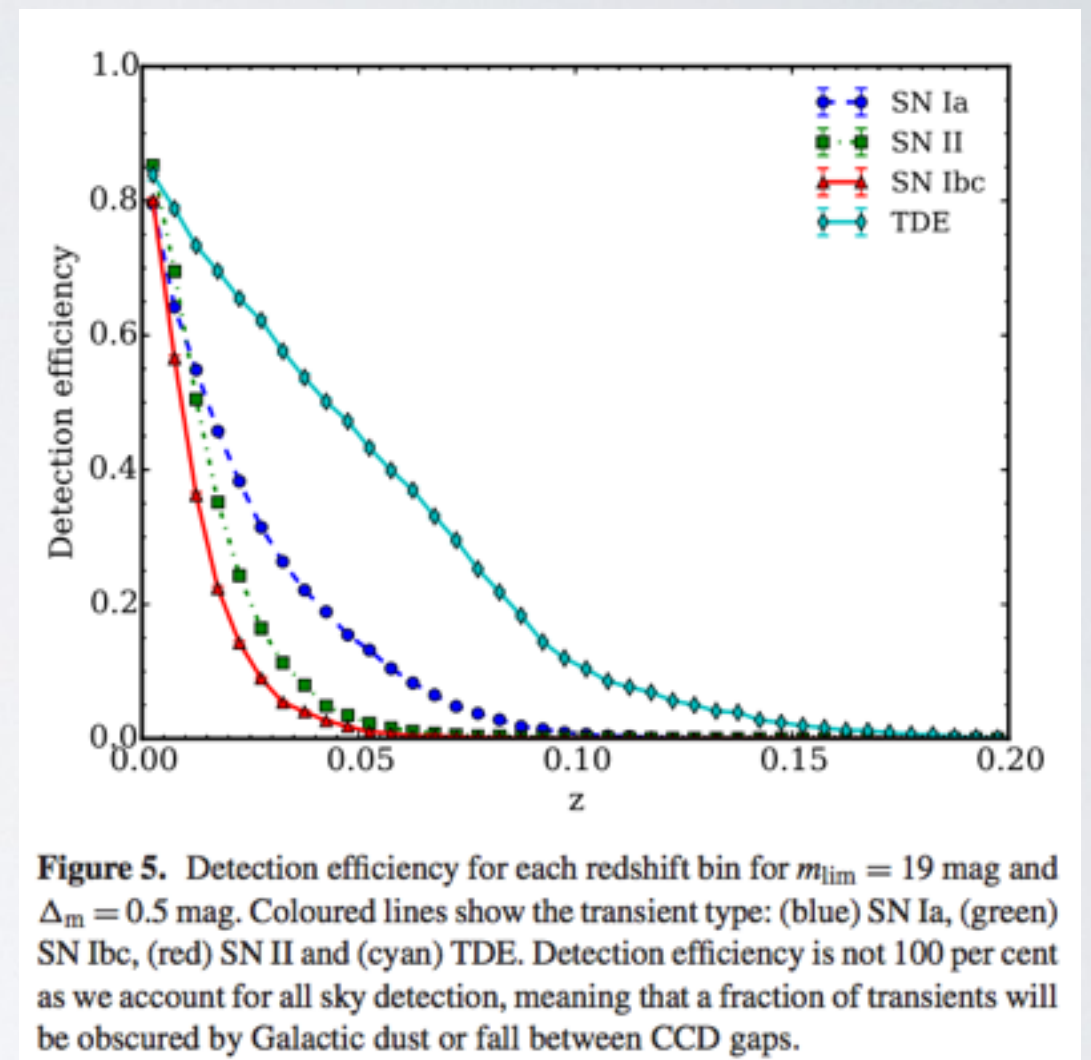
- Blagorodnova et al. 2016

- $G < 19$ mag

- 1300 SNe/yr

- 195 nuclear SNe/yr
(nuclear == offset 1")

- 20 TDEs/yr



215 nuclear transients/yr

threshold 0.3-0.5 mag, at least three historical data points

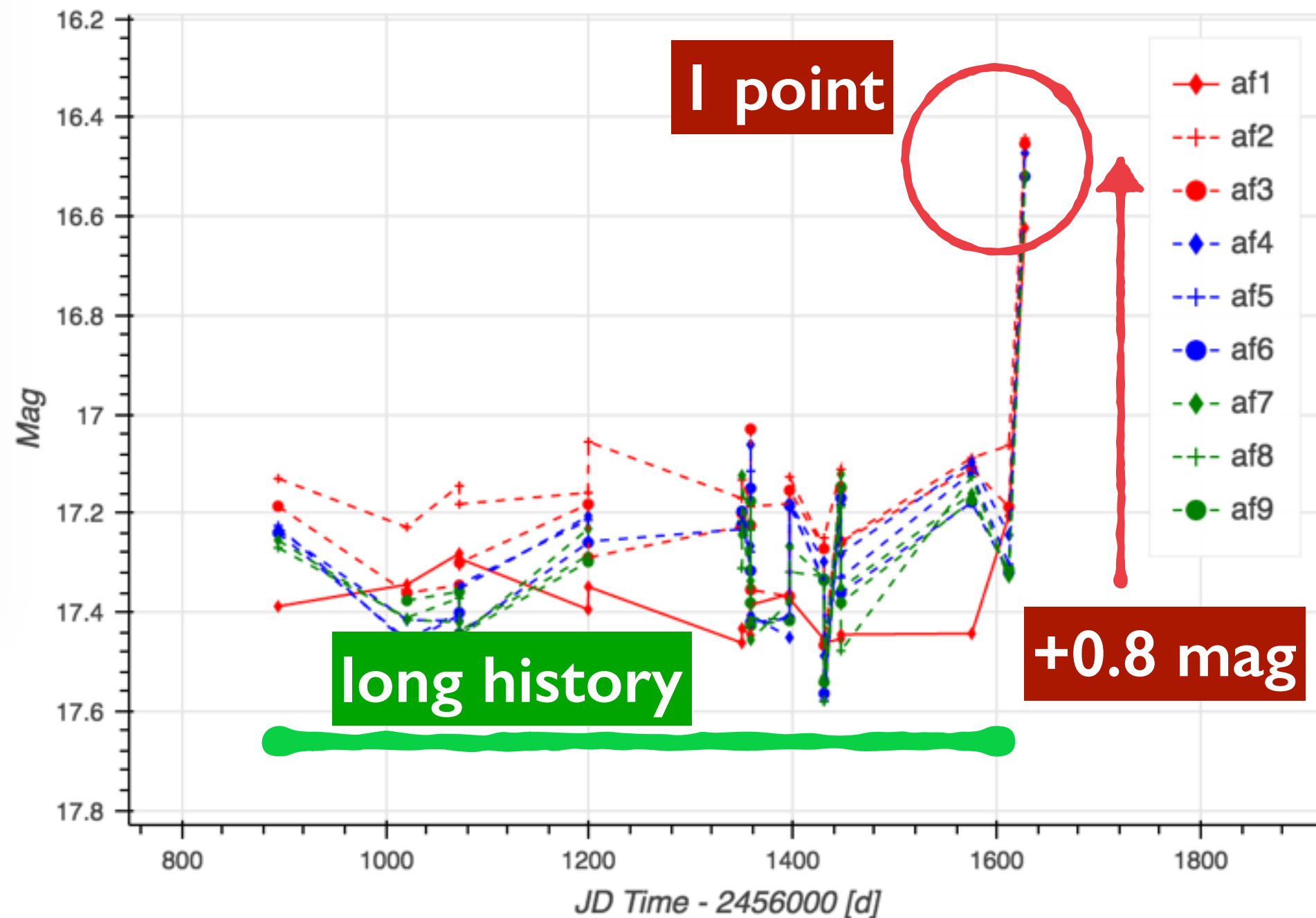
REALITY

- 2016 - 11 months
- transients: 1333 ($G < 19$ mag: 1250)
- SNe $\sim < 900$ $\sim 75\%$; contaminated by misclassification
- nuclears ~ 60 $\sim 30\%$; contaminated by QSOs

1. HOW TO FIND NUCLEAR
TRANSIENTS WITH GAIA?

2. HOW TO CONFIRM THEIR
NUCLEAR ORIGIN?

IPTF 16FNL

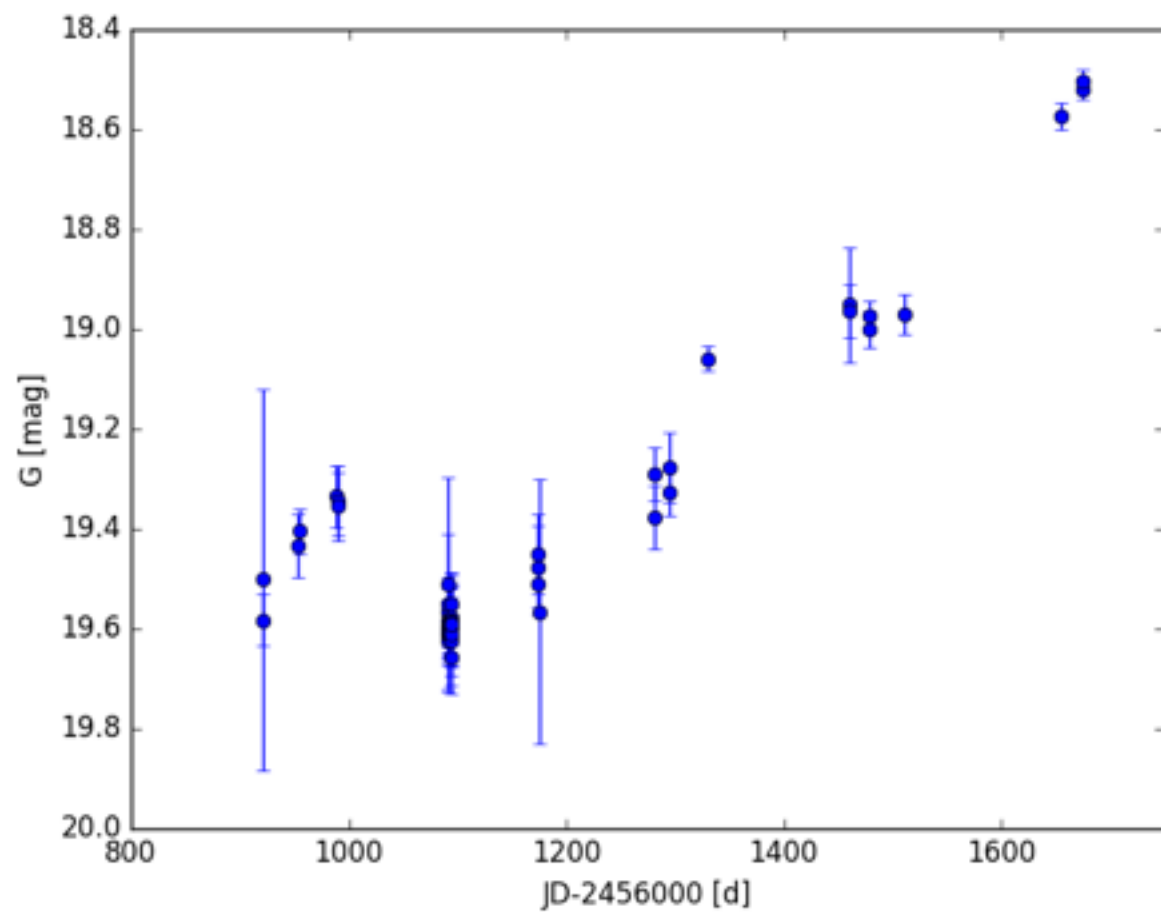
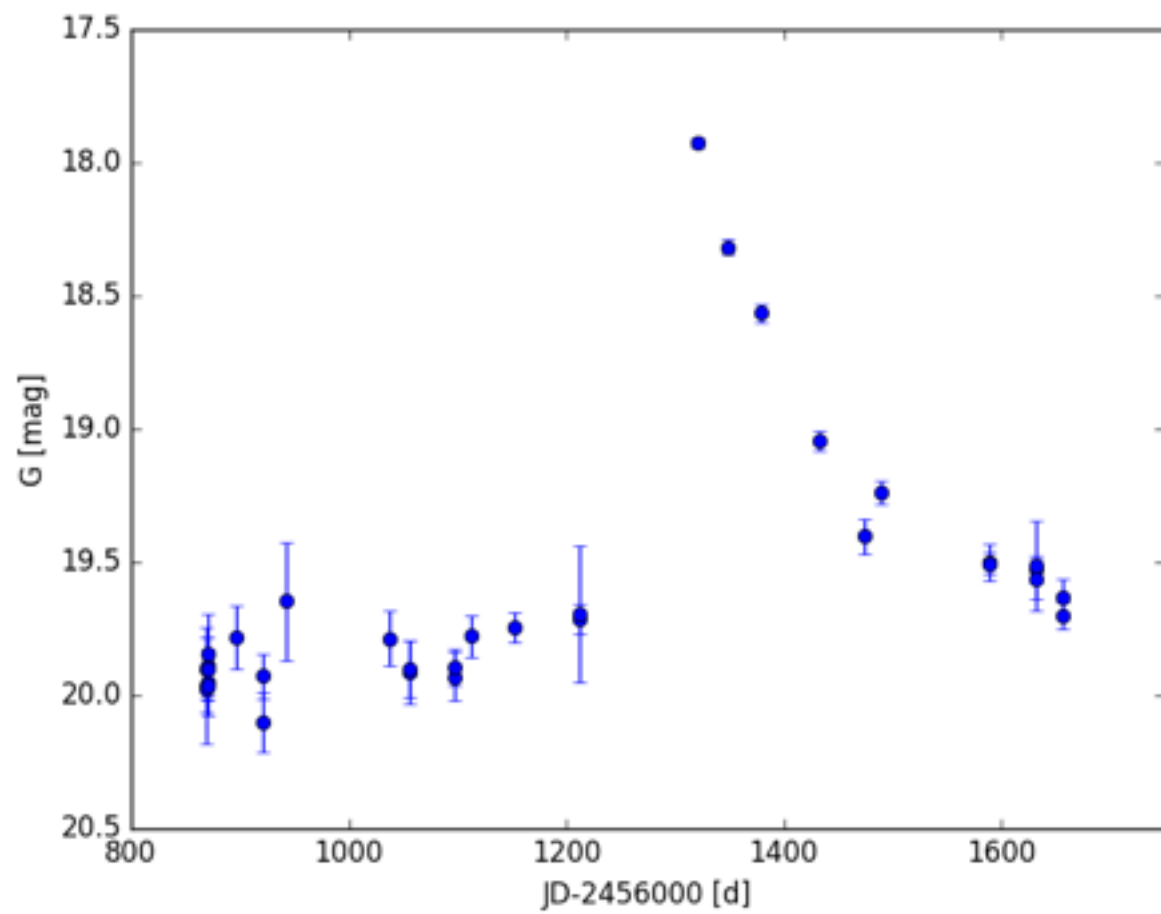


WHAT HAPPENED?

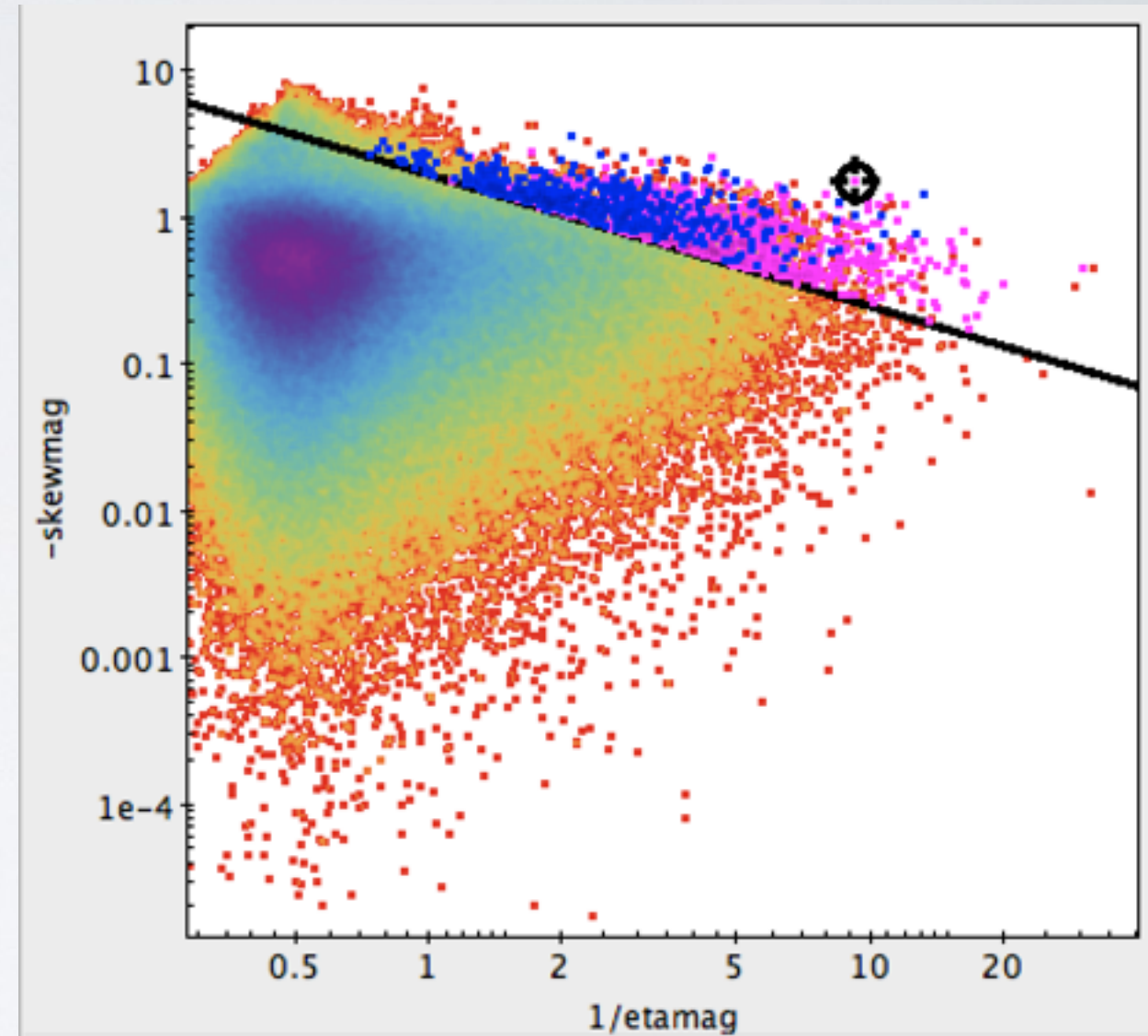
- too conservative threshold up for debate
- too short history no longer a problem
- on-board detection and crossmatch beyond the scope
- TDEs could be fainter need of larger sample
- decay time wrongly estimated need of larger sample

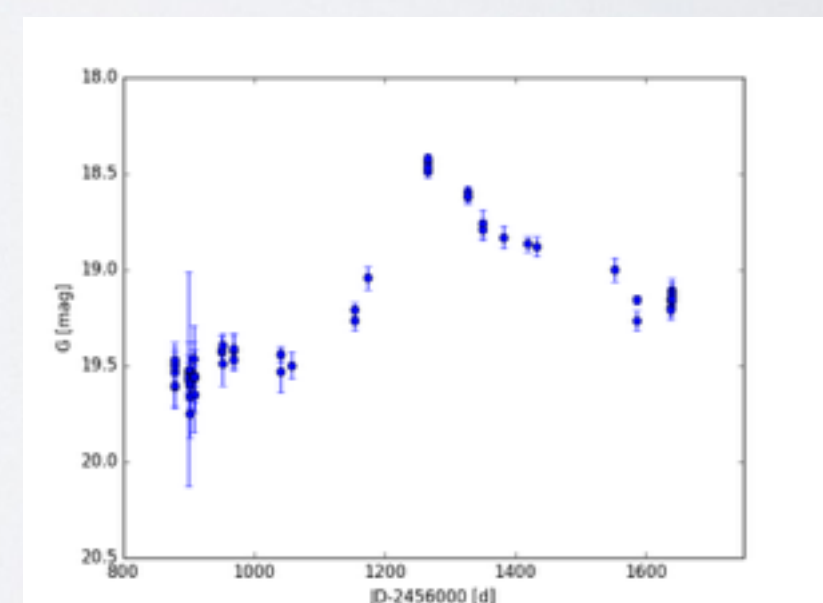
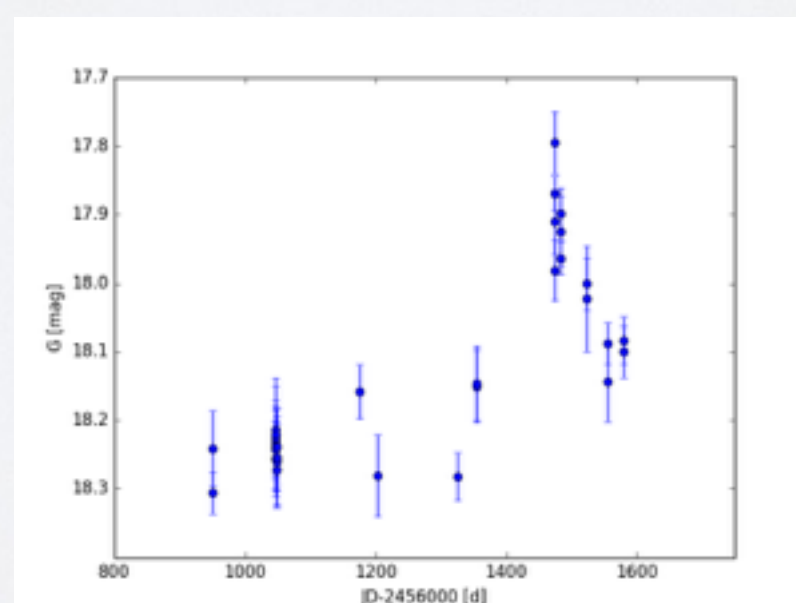
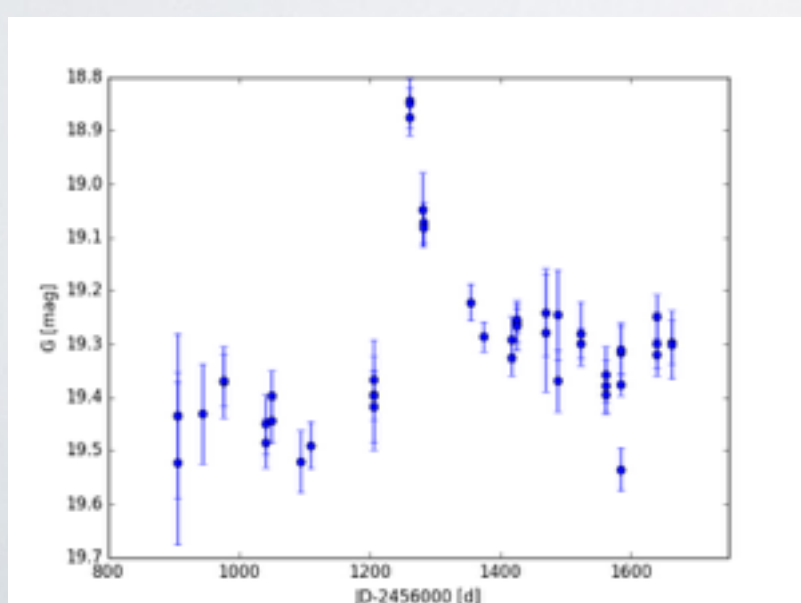
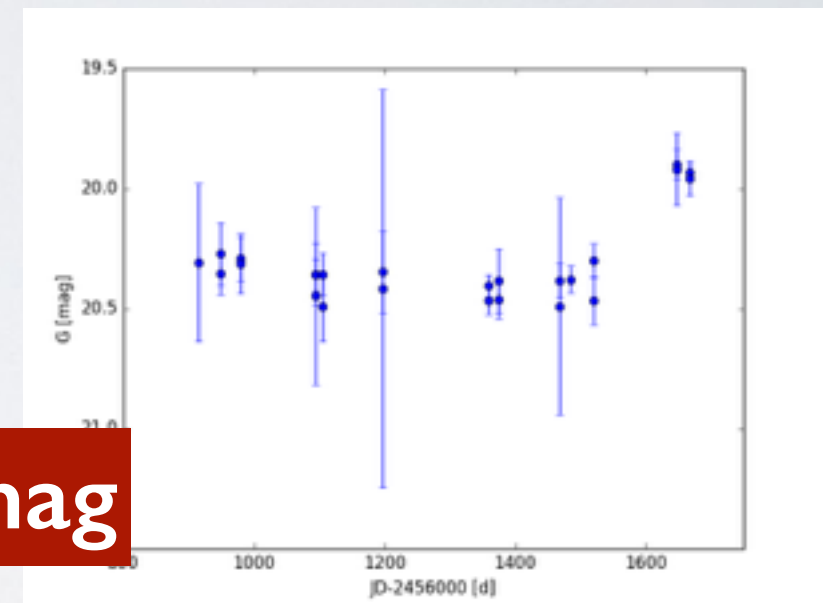
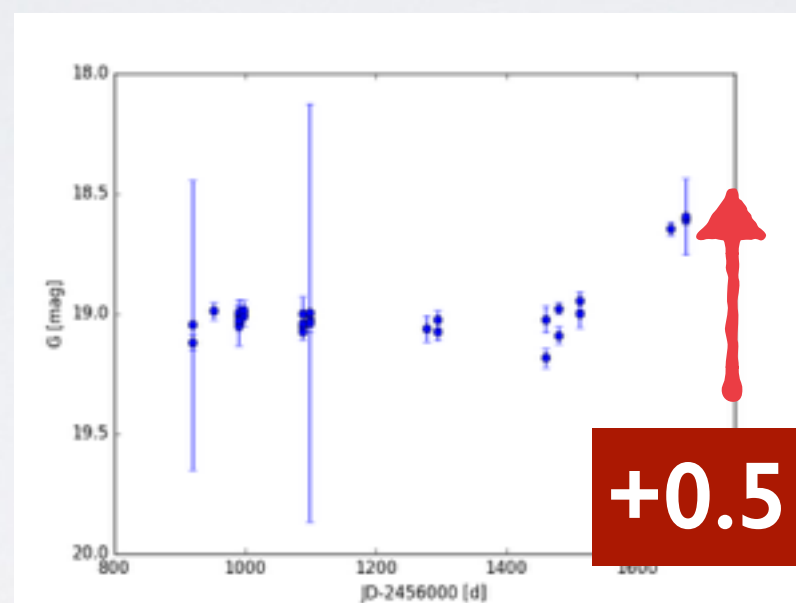
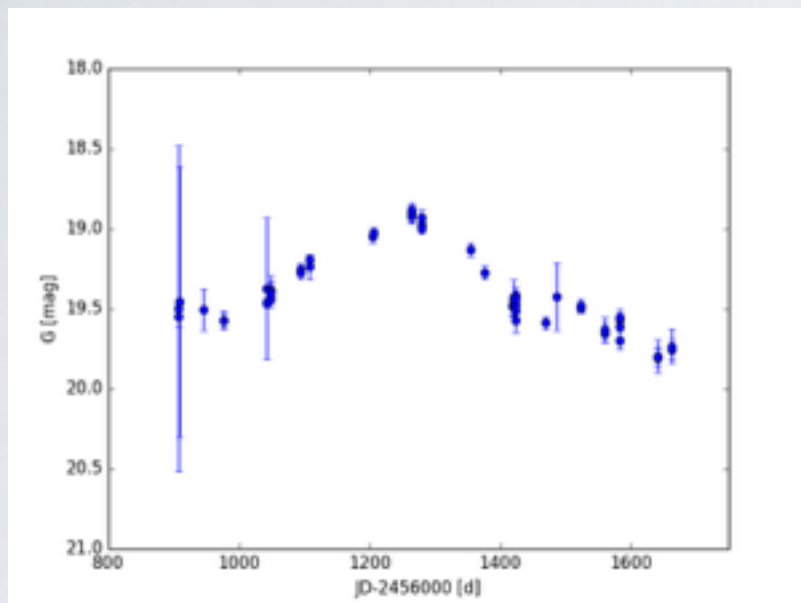
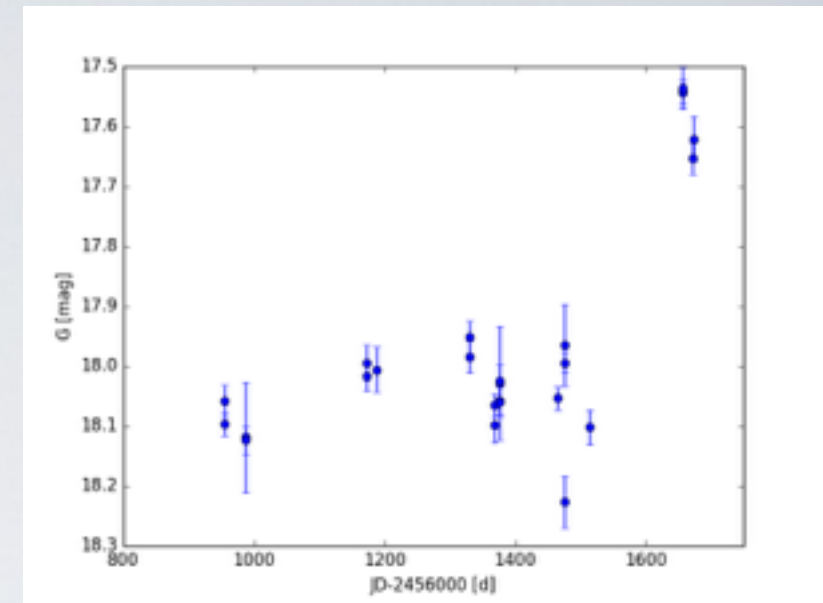
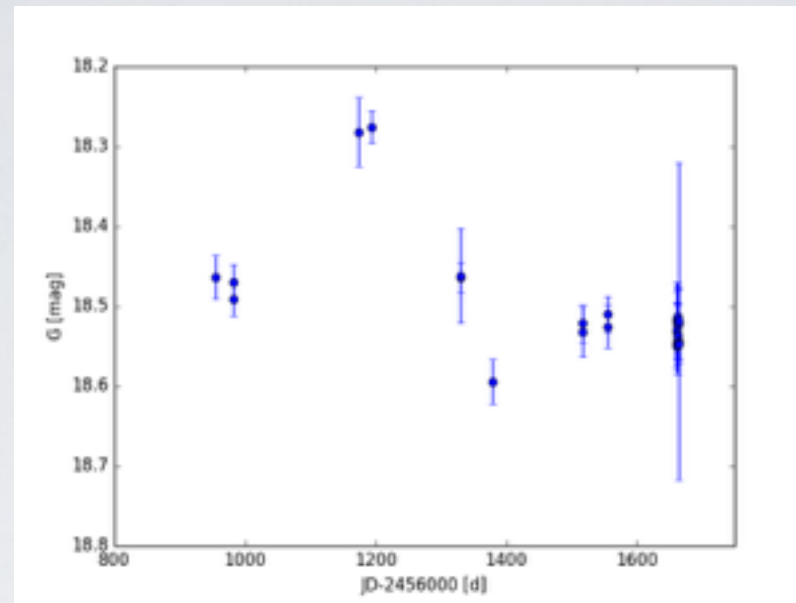
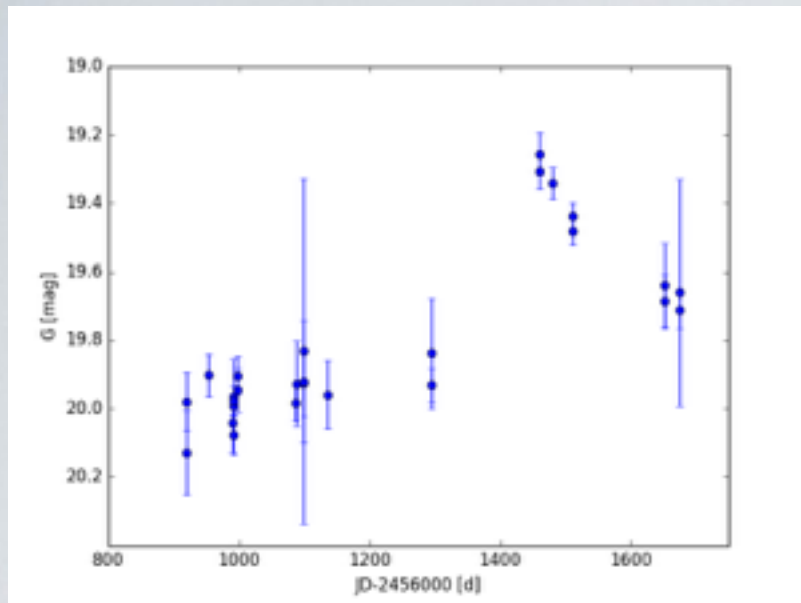
SDSS DR12 GALAXIES QSOS

- 3E6 spectroscopically confirmed QSOs and Galaxies from SDSS DR12
- cross match within 0.5 arcsec with Gaia sources
- sources with > 10 observations
- 2.2E6 - 0 sources (60% with no source < 10 detections, 20% - multiple objects with short history)
- 0.8E6 - 1 source
- 5E4 - multiple objects



von Neumann vs. skewness





IS THE TRANSIENT NUCLEAR?

- astrometry OGA1: uncertainty ~ 100 mas
- 100 mas for $z=0.1 \rightarrow \sim 200$ pc
- OGA2...

IN HOW MANY WAYS CAN YOU DESCRIBE NUCLEARS?

<http://gsaweb.ast.cam.ac.uk/alerts/alertsindex>

Name	Observed	RA (deg.)	Dec. (deg.)	Mag.	Historic mag.	Historic scatter	Class	Published	Comment
Gaia16bzg	2016-11-29 19:08:38	192.61047	-22.67441	18.53			unknown	2016-11-30 19:54:32	candidate SN near 2MASX J12502798-2240245
Gaia16bzf	2016-11-28 22:51:15	53.91629	-38.65898	18.71			unknown	2016-11-30 19:49:04	candidate SN near galaxy APMUKS(BJ) B033349.36-384926.5 GS-TEC predicts SN Ia at t=5
Gaia16bze	2016-11-28 19:07:53	190.14328	-21.22412	18.94			unknown	2016-11-30 19:43:07	hostless blue transient
Gaia16bzd	2016-11-29 16:55:45	339.90953	52.68903	18.39			unknown	2016-11-30 19:34:05	blue hostless transient in Galactic plane
Gaia16bzc	2016-11-29 04:56:27	336.21707	52.09392	17.91			unknown	2016-11-30 19:31:00	candidate CV, declining blue hostless transient
Gaia16bzb	2016-11-29 11:30:57	268.04922	57.41330	18.32			unknown	2016-11-30 19:21:35	candidate CV, blue hostless transient
Gaia16bza	2016-11-28 04:50:42	338.64953	45.86354	18.31	19.04	0.04	unknown	2016-11-30 12:25:54	0.7 mag rise and fast decline in red star
Gaia16byz	2016-11-27 22:08:33	13.81801	12.31972	18.11			unknown	2016-11-30 12:23:26	candidate SN in the outskirts of galaxy MCG+02-03-012
Gaia16byy	2016-11-28 04:53:41	334.50728	47.58773	17.38			unknown	2016-11-30 12:21:34	hostless transient near Galactic plane, GS-TEC predicts SN Ia at t=-3
Gaia16byx	2016-11-27 09:35:46	151.41526	-45.09329	17.36			unknown	2016-11-29 15:20:02	candidate CV, hostless blue transient near Galactic plane

IN HOW MANY WAYS CAN YOU DESCRIBE NUCLEARS?

- transient **near centre**
- candidate SN **close to centre** of galaxy
- I mag increase **in the core** of SDSS galaxy
- slow rise **in** galaxy **near** **centre**
- nuclear SN/AGN **close to centre** of galaxy
- slow rise and colour change **near centre** of a galaxy
- brightening **in the core** of faint compact SDSS galaxy
- candidate SN **close to core** of galaxy

use Gaia
and its astrometry!!!

GAIA I 6AKA



RA - DEC
222.03436 37.23296
14:48:08.25 37:13:58.66

Alerting date
2016-03-31 14:44:52
Julian date
2457479.11

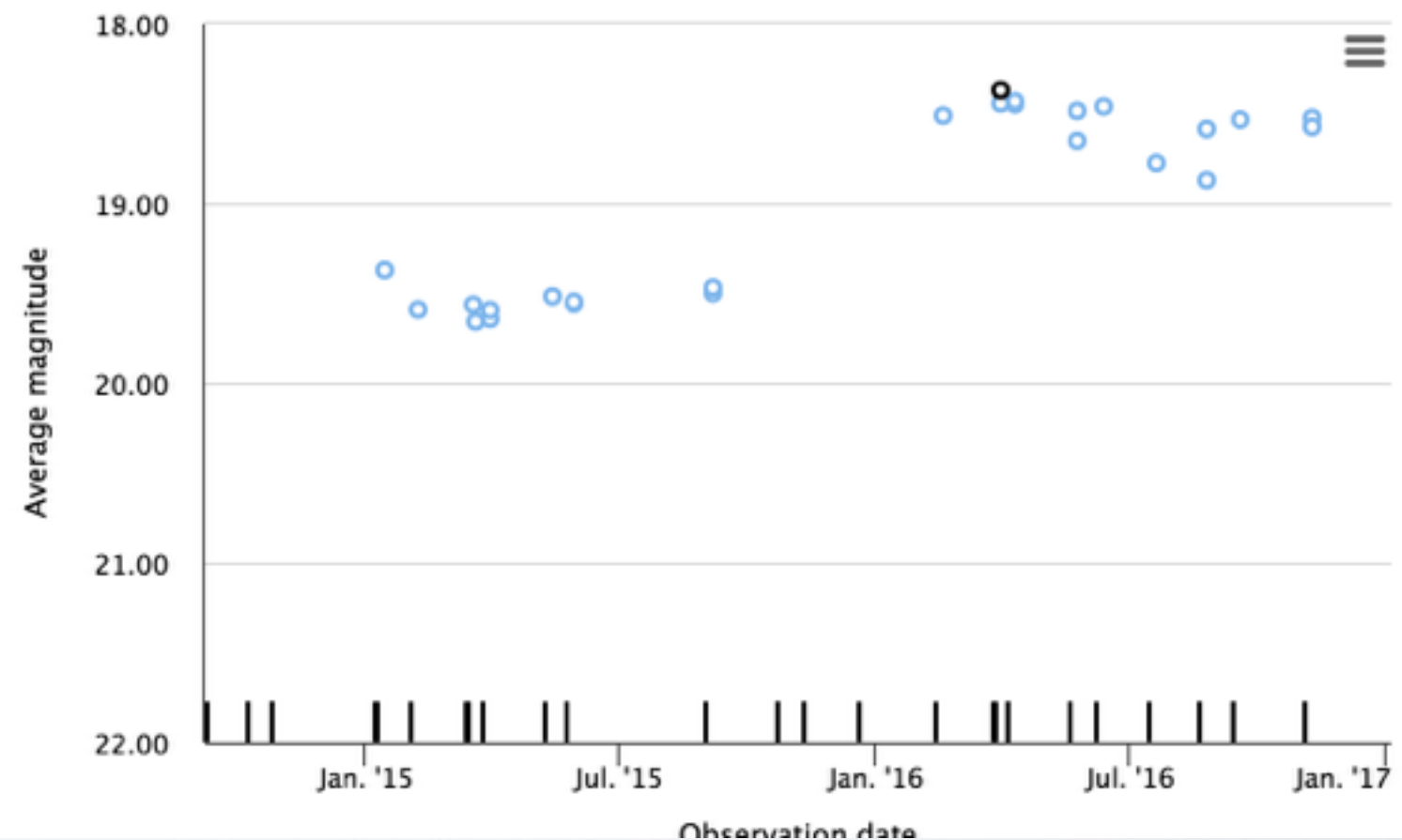
Alerting magnitude
18.37

Historic magnitude
None

Historic StdDev
None

Class
unknown

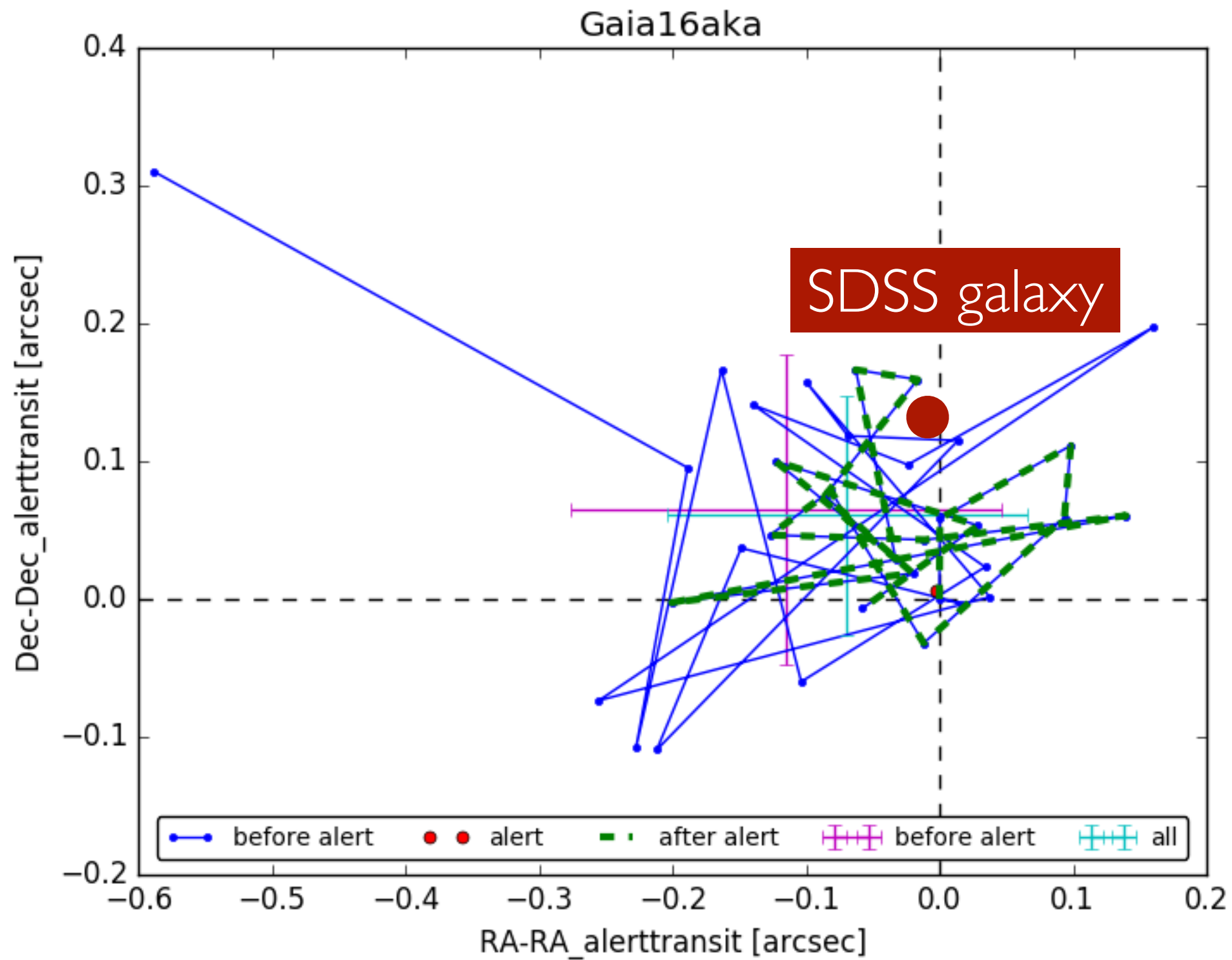
Publication date
April 4, 2016, 11:30 p.m.



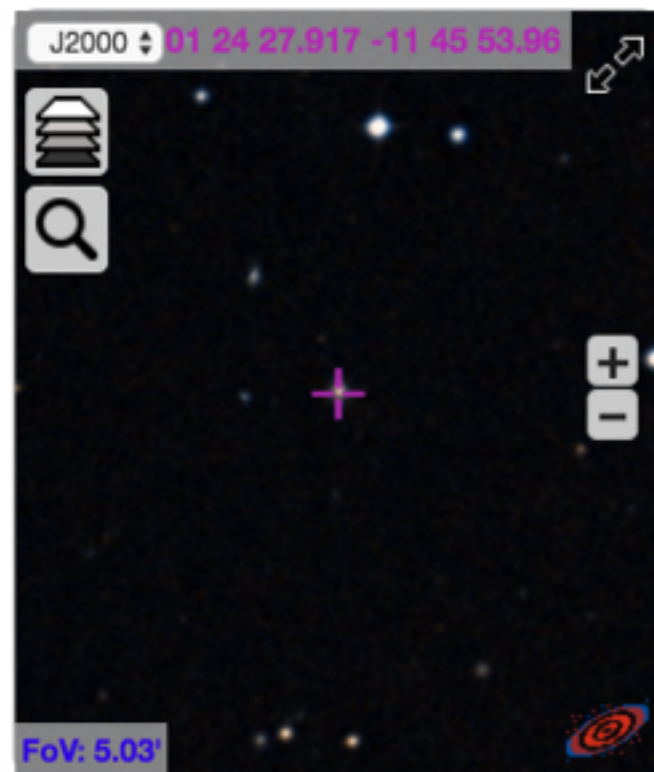
Other surveys detections

1 mag increase at centre of faint SDSS galaxy

GAIA 16AKA



GAIA I 6AQE



RA - DEC
21.11632 -11.76499
01:24:27.92 -11:45:53.96

Alerting date
2016-05-22 17:24:35

Julian date
2457531.23

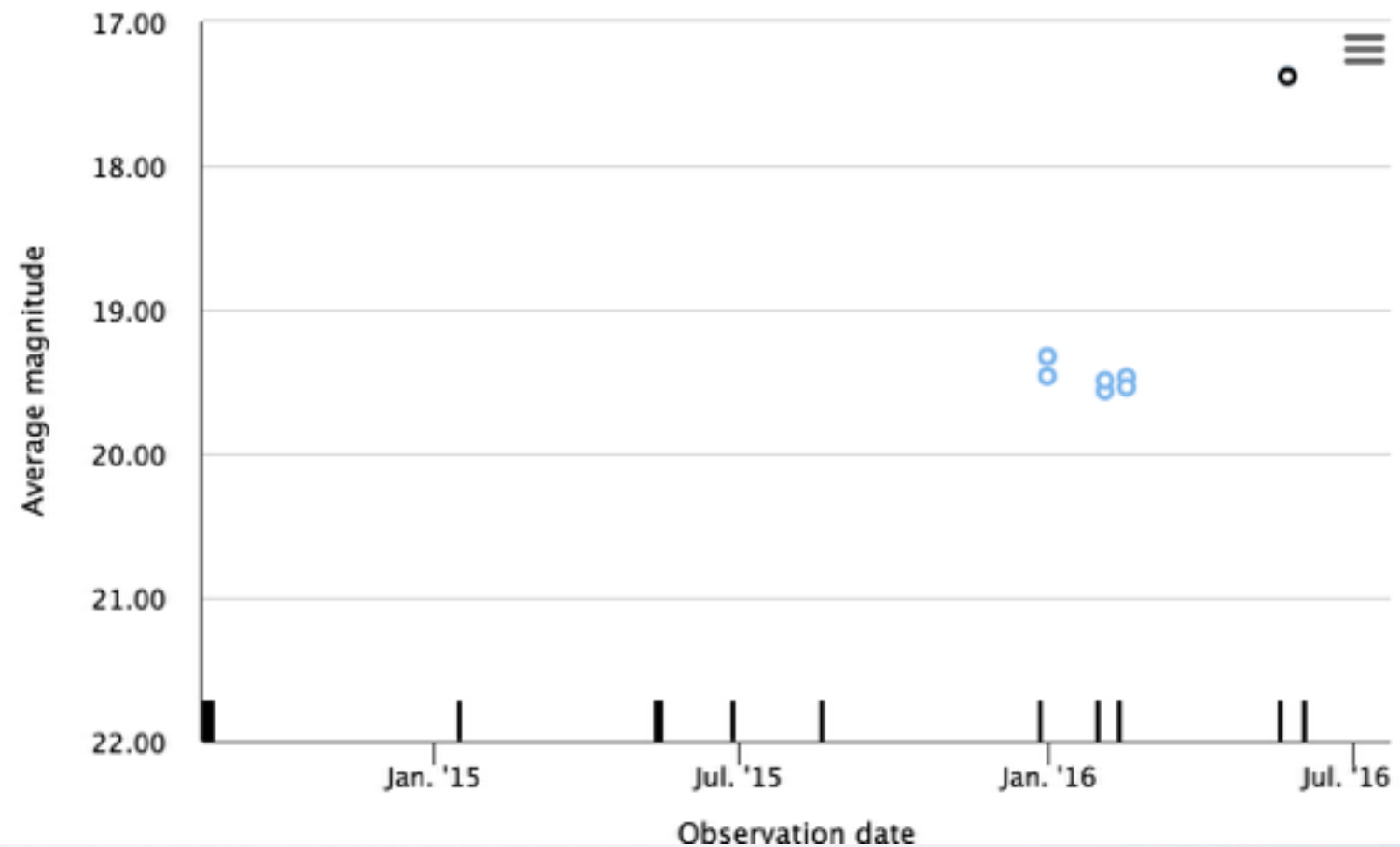
Alerting magnitude
17.38

Historic magnitude
19.58

Historic StdDev
0.11

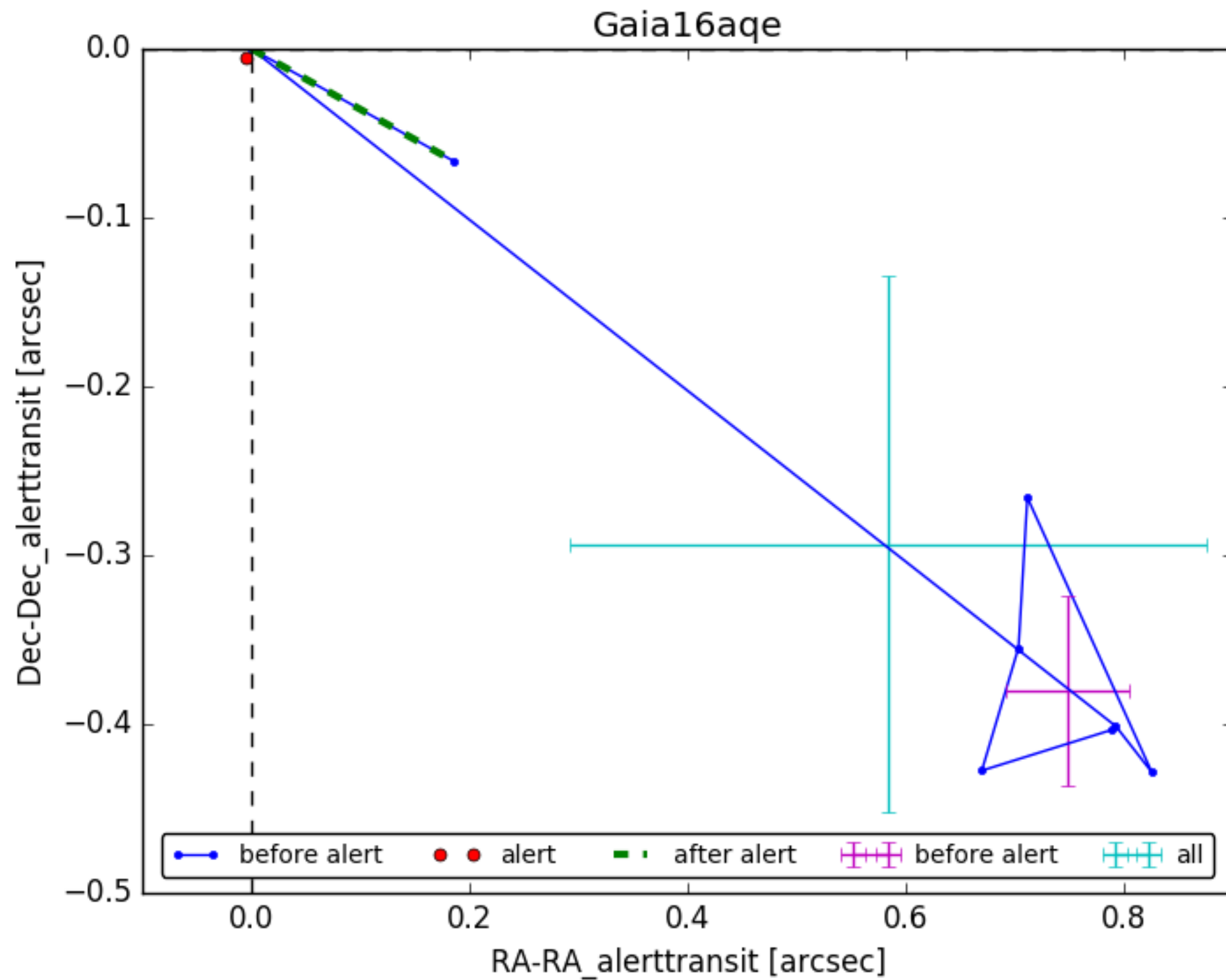
Class
unknown

Publication date
May 27, 2016, 11:48 a.m.

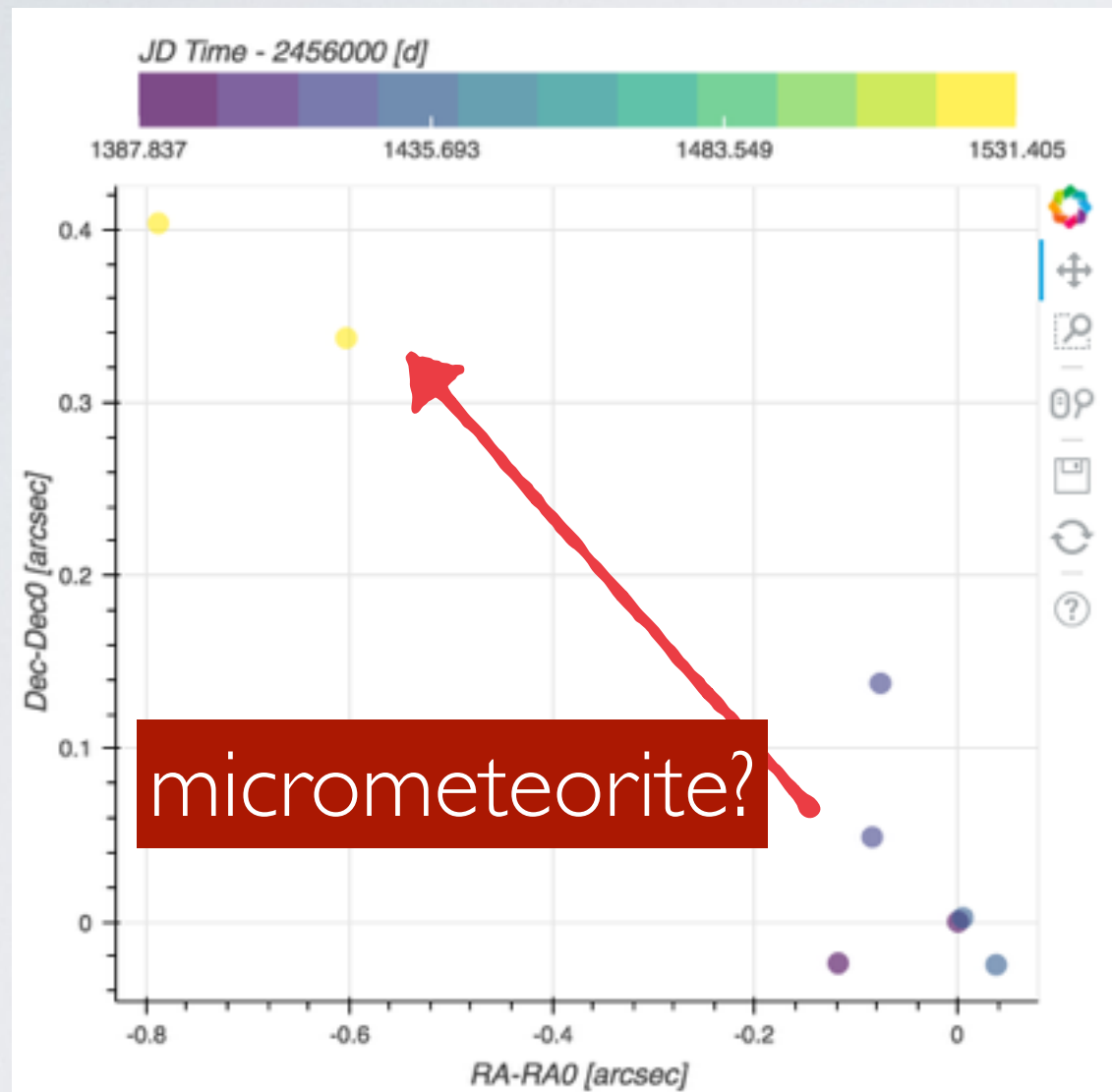


Candidate SN Ia

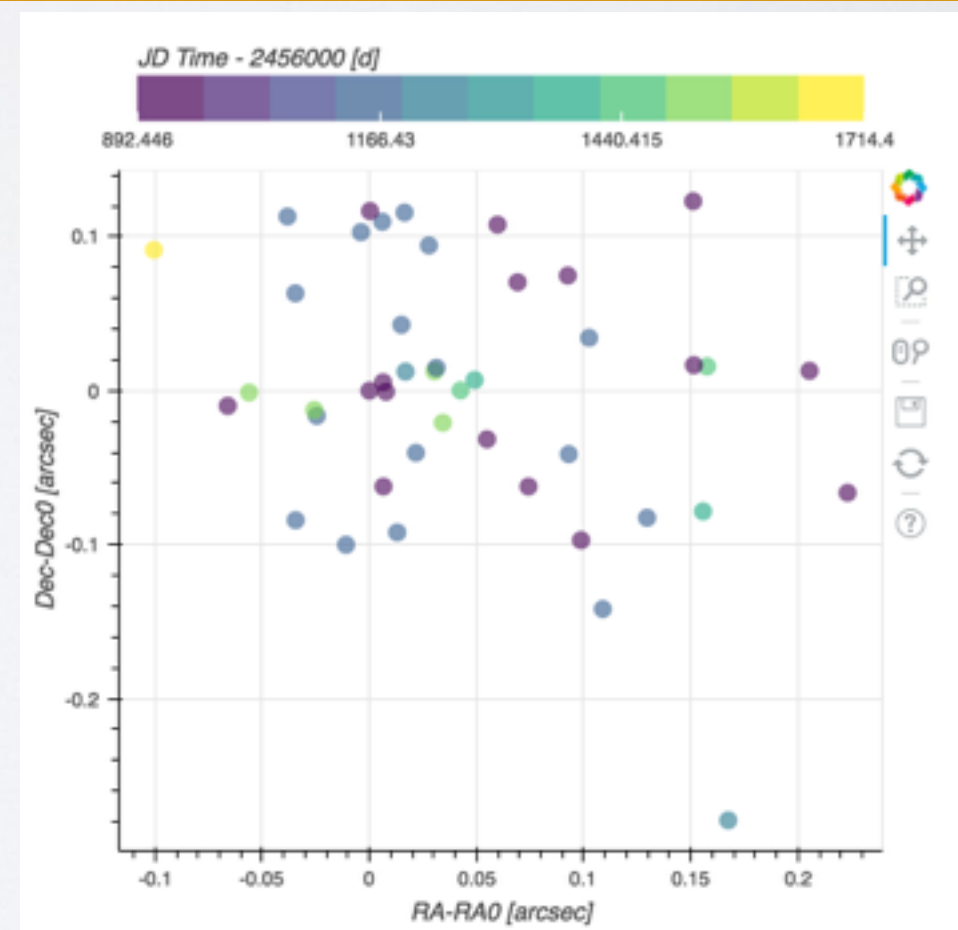
Gaia16AQE



GAIA I 6AQE



sanity check - nearby object



SUMMARY - TO DO

- tune Alert Pipe for nuclear transients
- use a watch list of galaxies
- include OGA2 in Alert Pipe