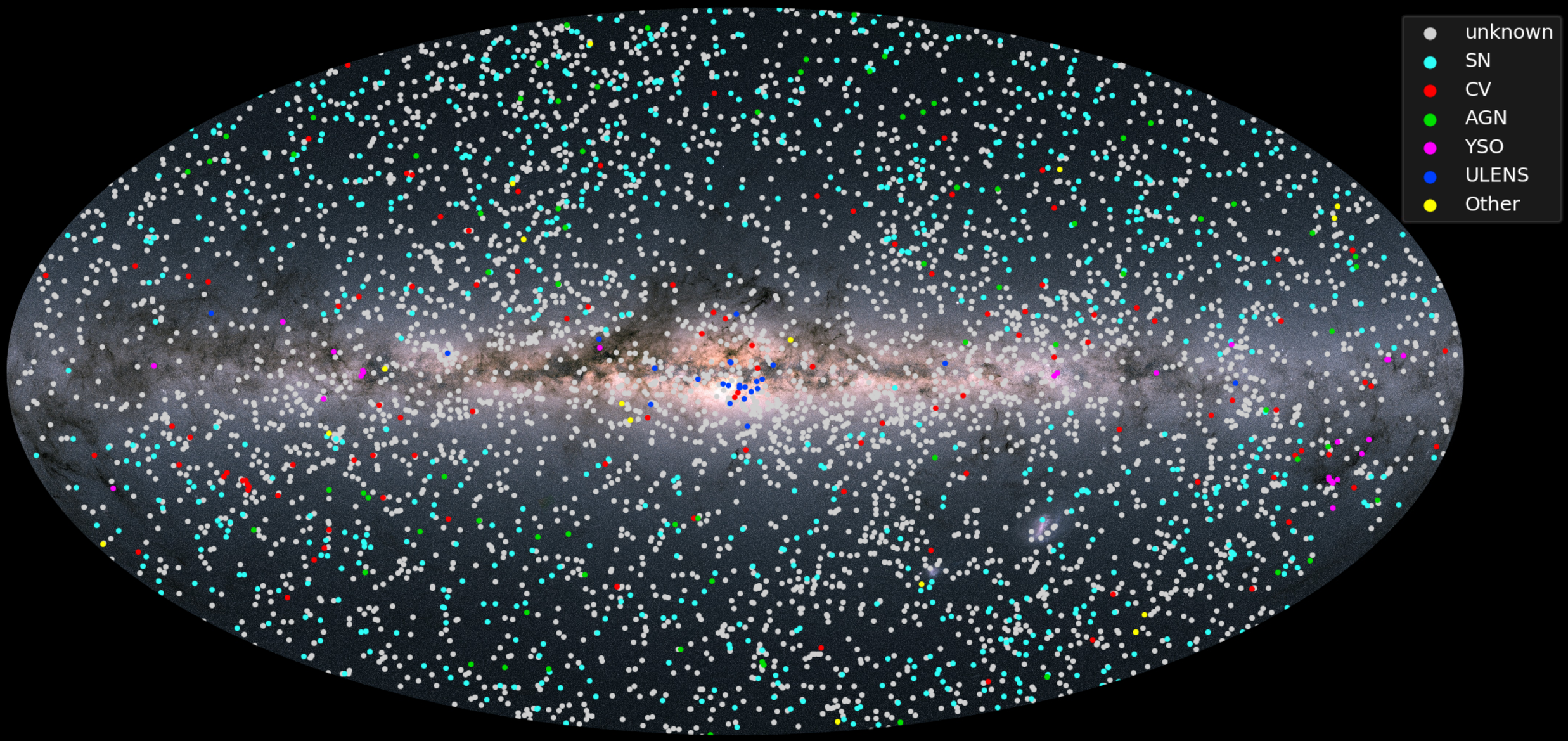
Gaia Photometric Science Alerts



Simon Hodgkin, Diana Harrison, Guy Rixon, Abdullah Yoldas, Zuzanna Kostrzewa-Rutkowska, Lukasz Wyrzykowski, Elmé Breedt, Thomas Wevers, Goska van Leeuwen, Floor van Leeuwen, Dafydd Wyn Evans

@SpacemanSimon
@gaia_alerts

http://gsaweb.ast.cam.ac.uk/alerts

WHERE ARE WE?

	Q1	Q2	Q3	Q4
2013				Launch
2014			Science Operations	Start Alerts
2015			Validation	Development
2016	Restart Alerts			
2017				
2018				
2019				
2020				Actual Mission End?
2021				Actual Mission End?
2022				Actual Mission End?
2023				Actual Mission End?
2024				Actual Mission End?
2025				

Personnel

Simon Hodgkin 0.4

Diana Harrison 0.3

Guy Rixon 0.15

Abdullah Yoldas 0.7

With additional contributions from Elme Breedt (IoA), Thomas Wevers (IoA), Katarzyna Kruszynska (Warsaw), Nada Ihanec (Warsaw), Krzysztof Rybicki (Warsaw), Lukasz Wyrzykowski (Warsaw), Zuzanna Kostrzewa-Rutkowska (Leiden), Deepak Eappachen (SRON), Peter Jonker (SRON), Gabor Marton (Konkoly)

New Since Vipava meeting

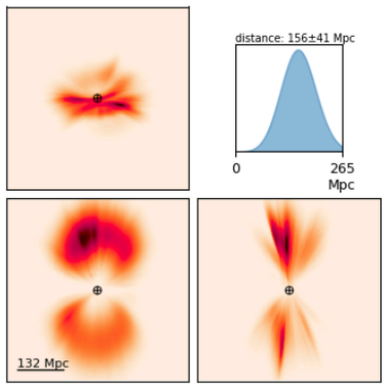
- Gravitational Wave Classifier
- Skew Von Neumann Detector
- Improved Filtering (Miras, Planets, Bright Stars)

Gravitational Waves

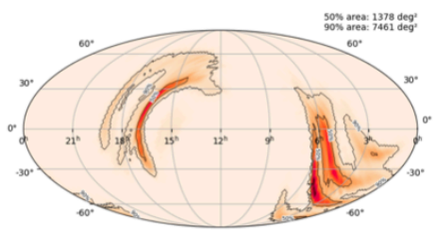
- In collaboration with the team from SRON (Zuzanna Kostrzewa-Rutkowska, Deepak Eappachen, Peter Jonker) we designed a classifier to identify GaiaAlerts which fall in the confidence regions of LIGO/Virgo Gravitational Wave events.
- Motivations:
    - improved astrometry
    - observe targets relatively close to the Sun
- Implemented April 2019
- 24 GCN (Gamma-ray Coordinates Network) notices issued so far (50 Gaia Transients for 15 GW events), led by ZKR, DE

S190425z

Parameter Estimation



Volume rendering of LALInference.fits LALInference.volume.png. Submitted by Gregory Ashton on Apr 26, 2019 10:17:04 UTC

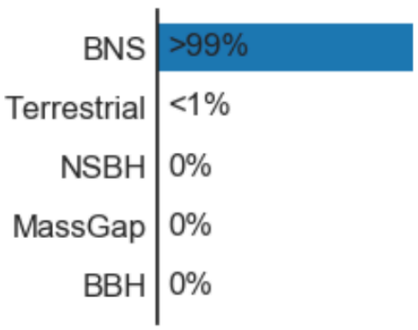


Mollweide projection of LALInference.fits LALInference.png. Submitted by Gregory Ashton on Apr 26, 2019 10:48:17 UTC

UTC

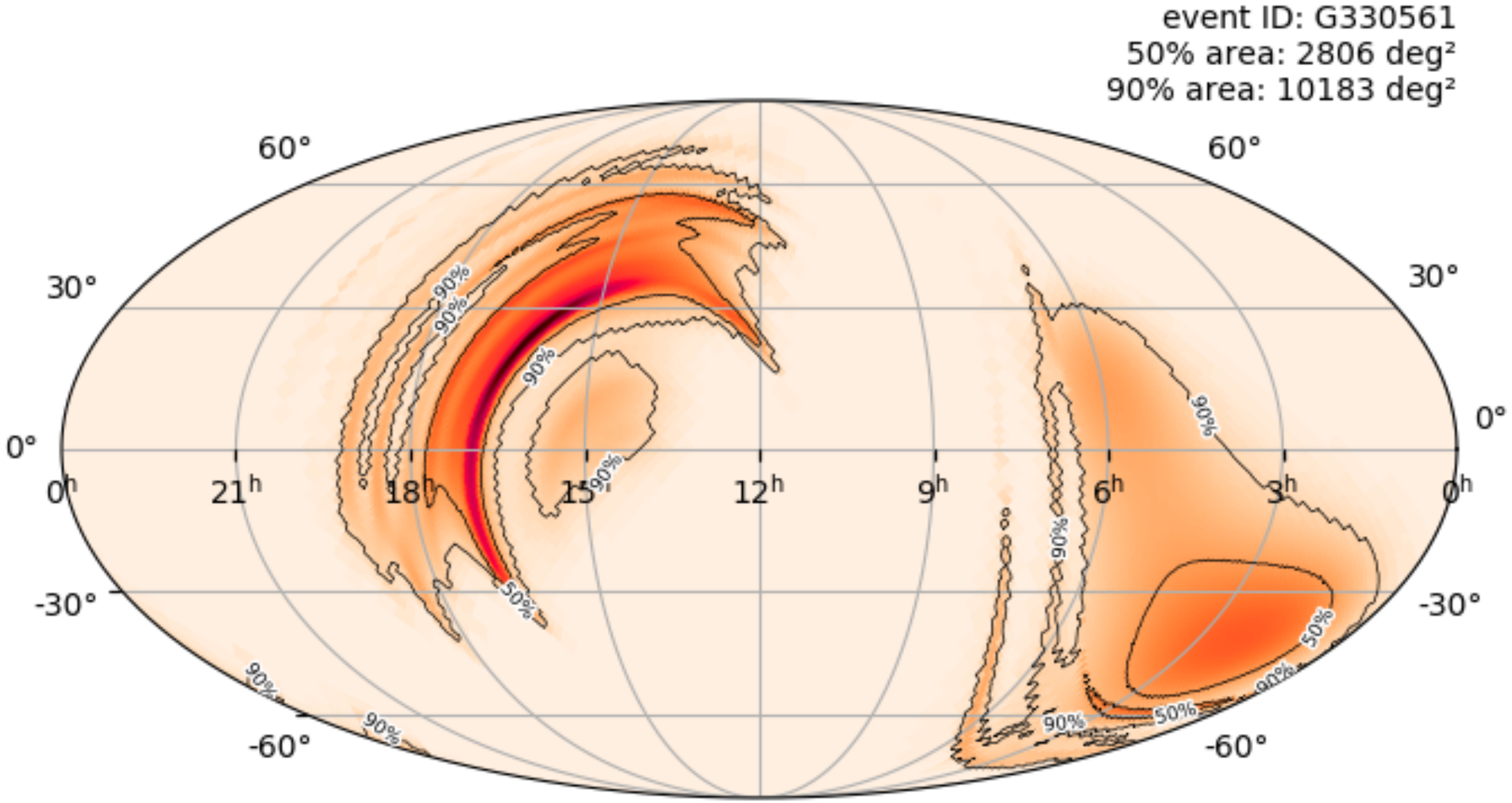
Log Entry Created	Submitter	Comment
Apr 26, 2019 14:03:14 UTC	LIGO/Virgo EM Follow-Up	FITS headers for LALInference.fits LALInference.html
Apr 26, 2019 13:55:33 UTC	LIGO/Virgo EM Follow-Up	Flattened from multiresolution file LALInference.fits LALInference.fits.gz
Apr 26, 2019 10:31:45 UTC	Gregory Ashton	LALInference FITS sky map LALInference.fits

EM Followup



Source classification visualization from p_astro.json p_astro.png. Submitted by LIGO/Virgo EM Follow-Up on Apr 25, 2019 08:22:05 UTC

S190425z

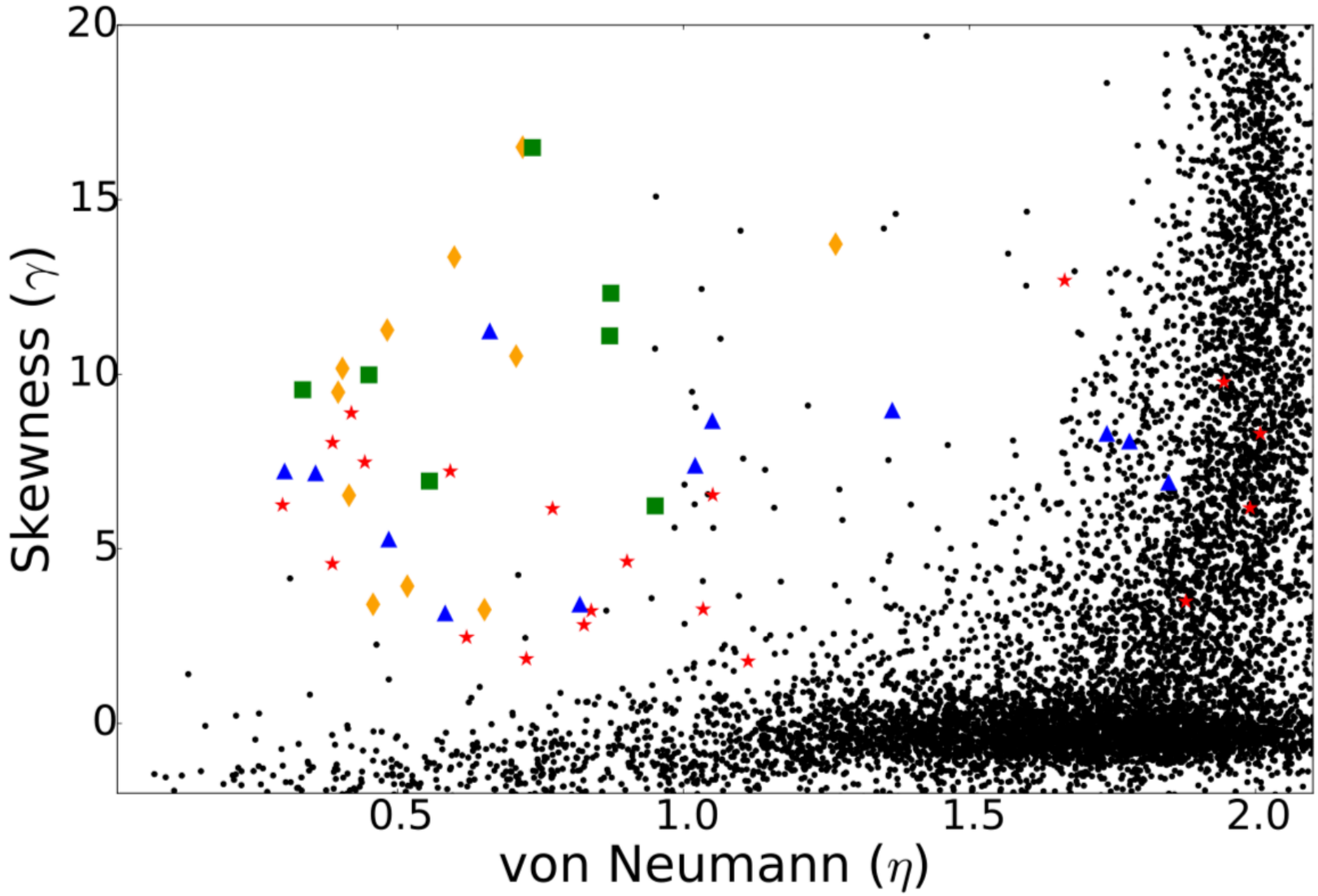

event ID: G330561
50% area: 2806 deg²
90% area: 10183 deg²
60°
30°
0°
-30°
-60°
0h
21h
18h
15h
12h
9h
6h
3h
0h
90%
50%

Skew Von Neumann

Simulations from Wevers et al. 2018

η is small when there is strong positive serial correlation between successive data points.

single outliers tend to η=2

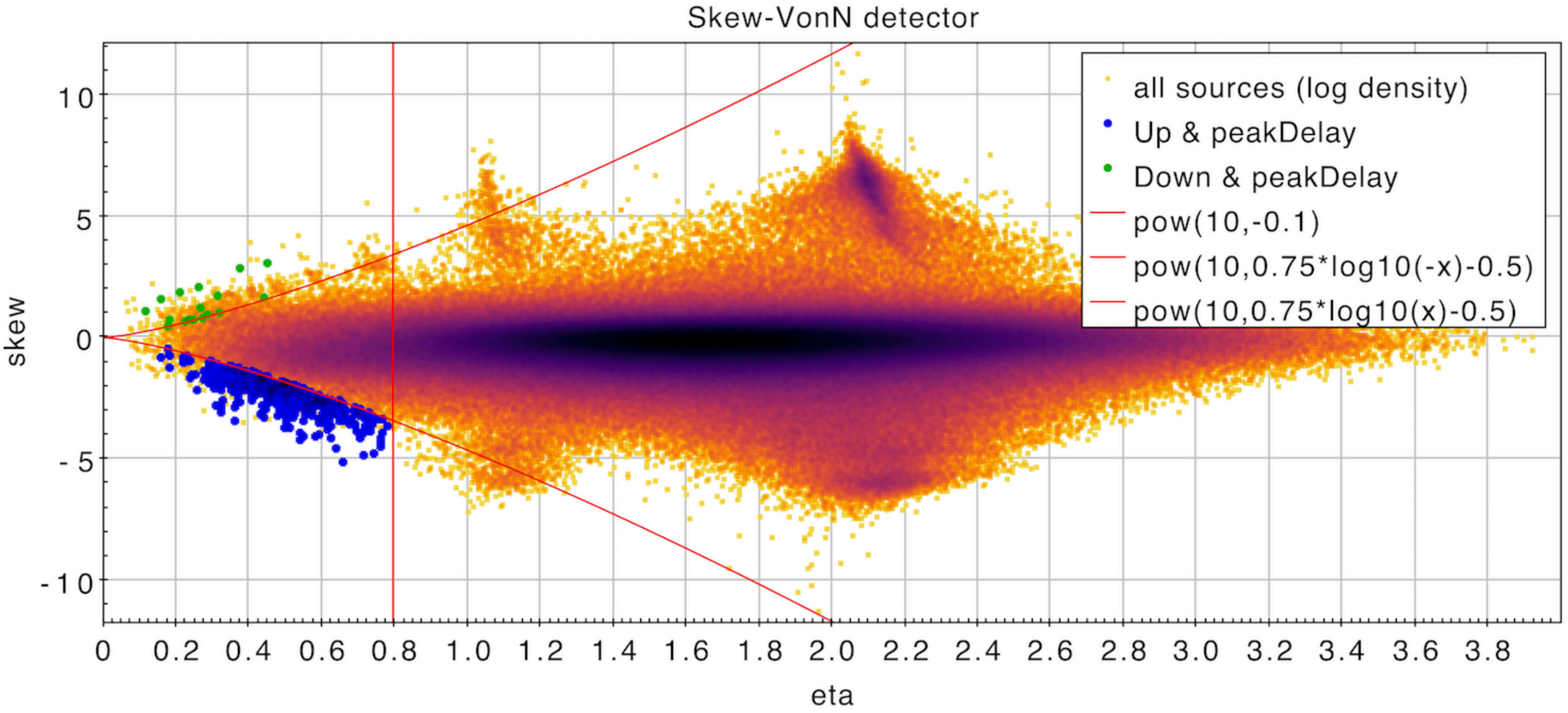


$$\gamma = \frac{\frac{1}{n}\sum_{i=1}^{n-1}(x_i - \bar{x})^3}{s^3}$$

$$\eta = \frac{\frac{1}{n-1}\sum_{i=1}^{n-1}(x_{i+1} - x_i)^2}{s^2}$$

Artificial transients in (γ, η) space. Different markers indicate the amplitude of the transients, ranging from 1.5 mag (red stars), between 1.5 and 2 mag (blue triangles), between 2 and 2.5 mag (orange diamonds) up to 2.5 mag (green squares)

Skew Von Neumann

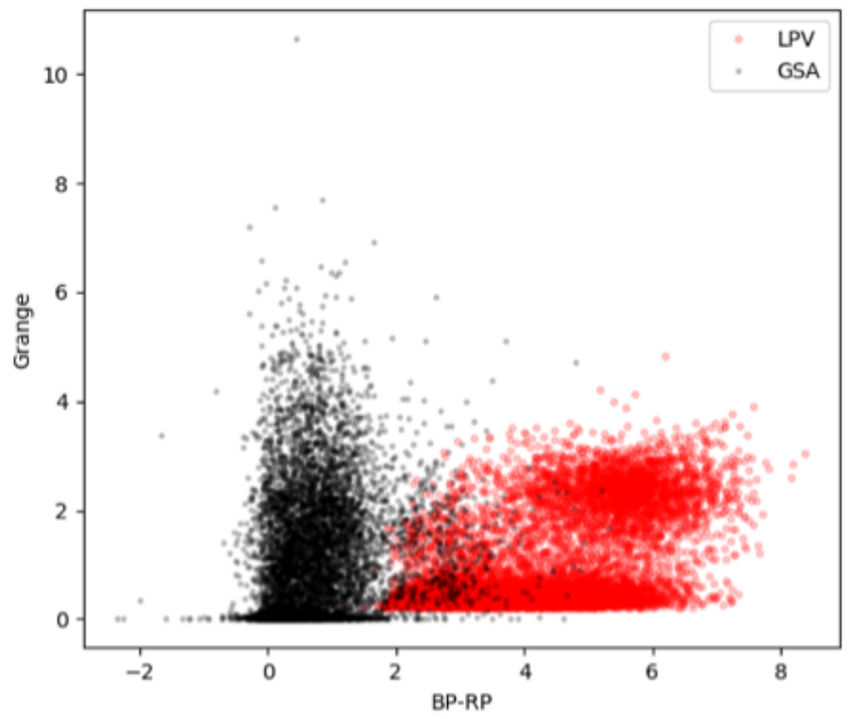


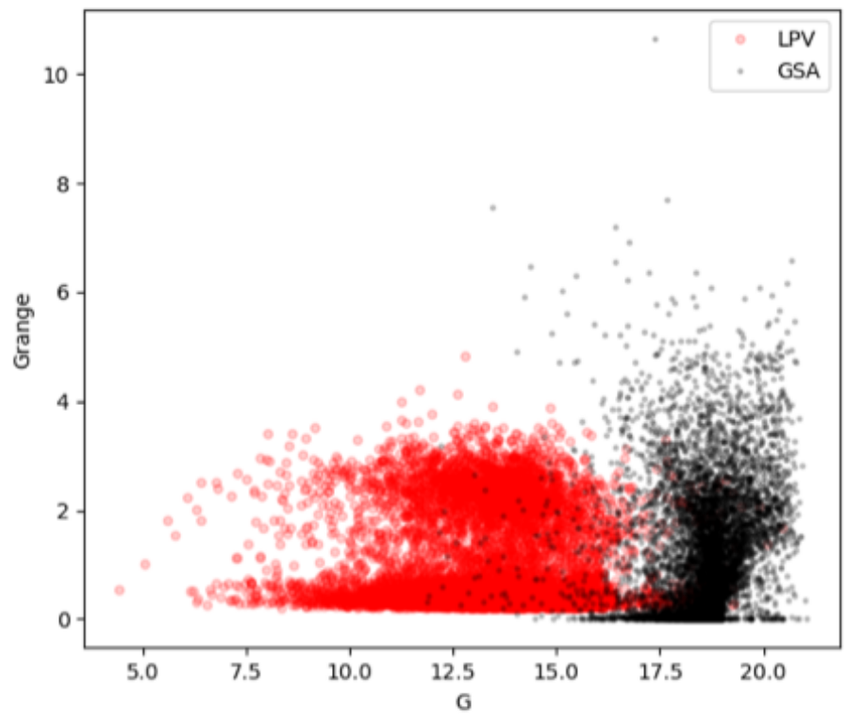
$$\gamma = \frac{\frac{1}{n}\sum_{i=1}^{n-1}(x_i - \bar{x})^3}{s^3}$$

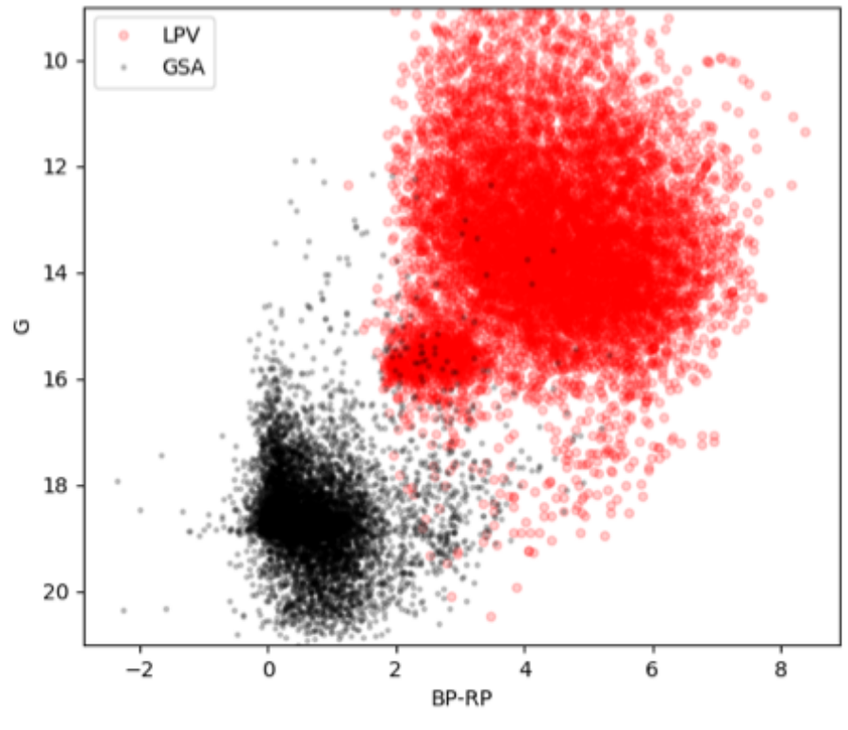
$$\eta = \frac{\frac{1}{n-1}\sum_{i=1}^{n-1}(x_{i+1} - x_i)^2}{s^2}$$

For slowly changing transients such as microlensing events and AGN activity which the other OldSource detectors tend to miss. Further tuned to improve YSO detection rates (thanks to Konkoly - Peter Abraham, Gabor Marton). Implemented in May 2019.

Too Many Miras







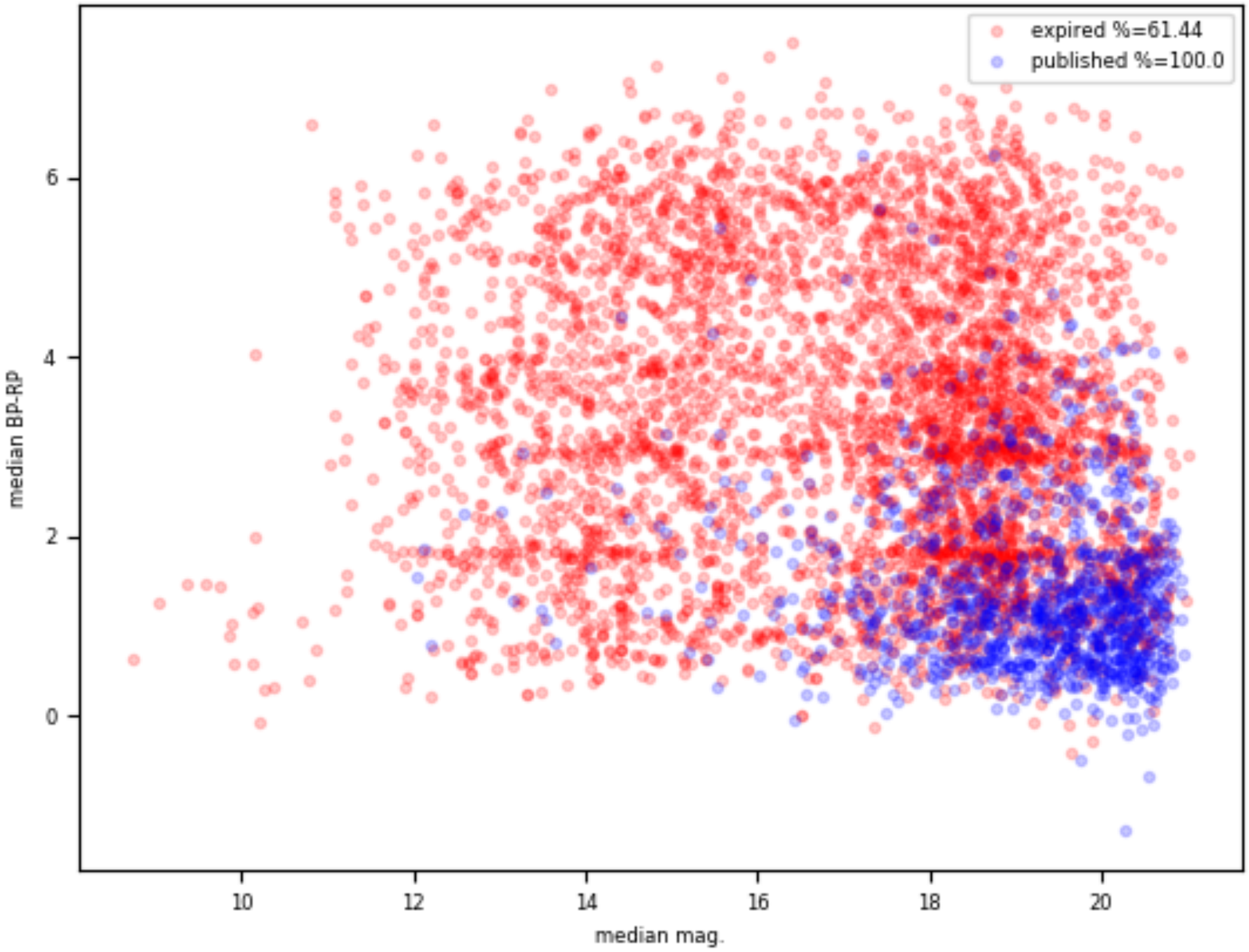
Too Many Miras

filter on:

- BP-RP
- LC MAD
- LC kurtosis

Preserves 100% of published alerts

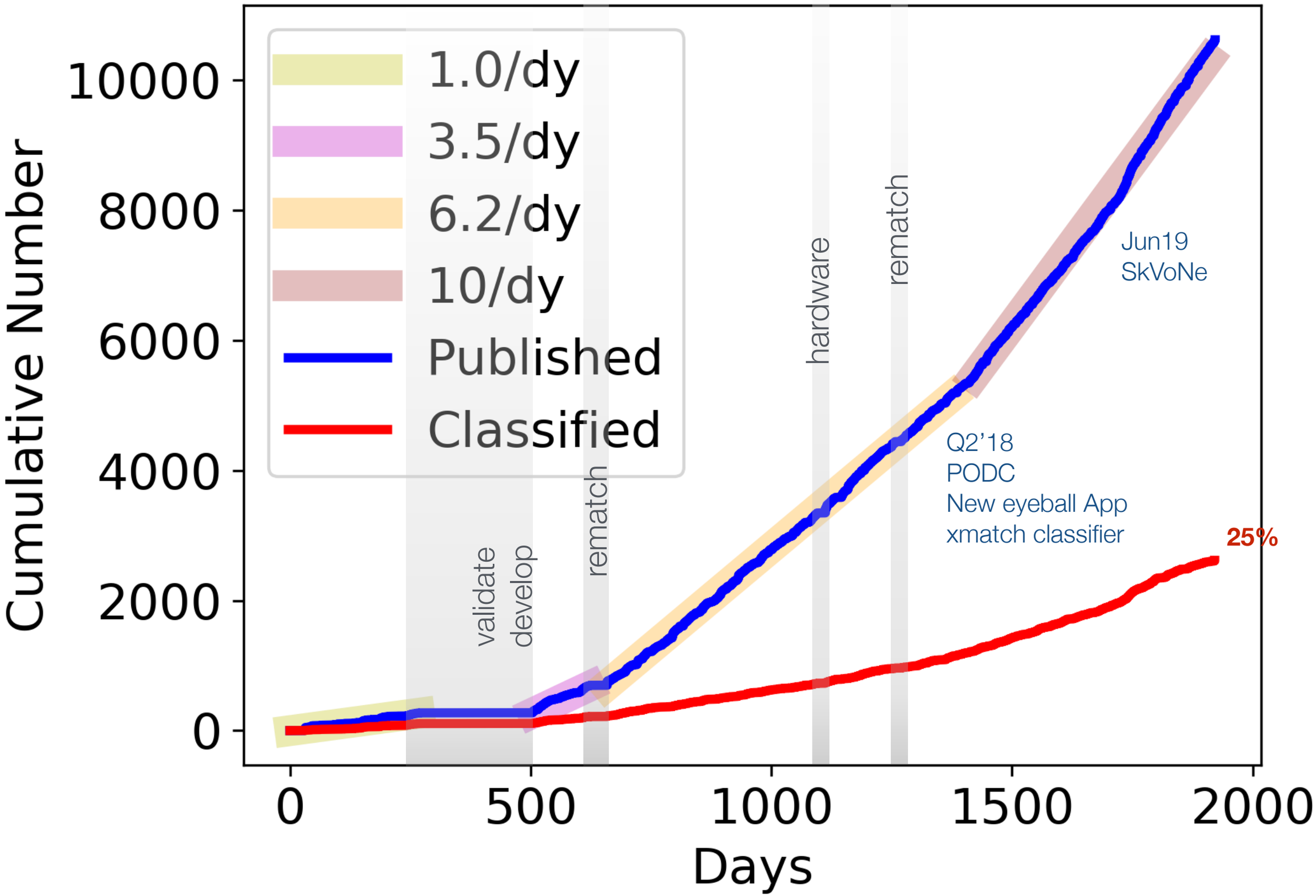
Rejects 40% of candidates which historically fail eyeballing

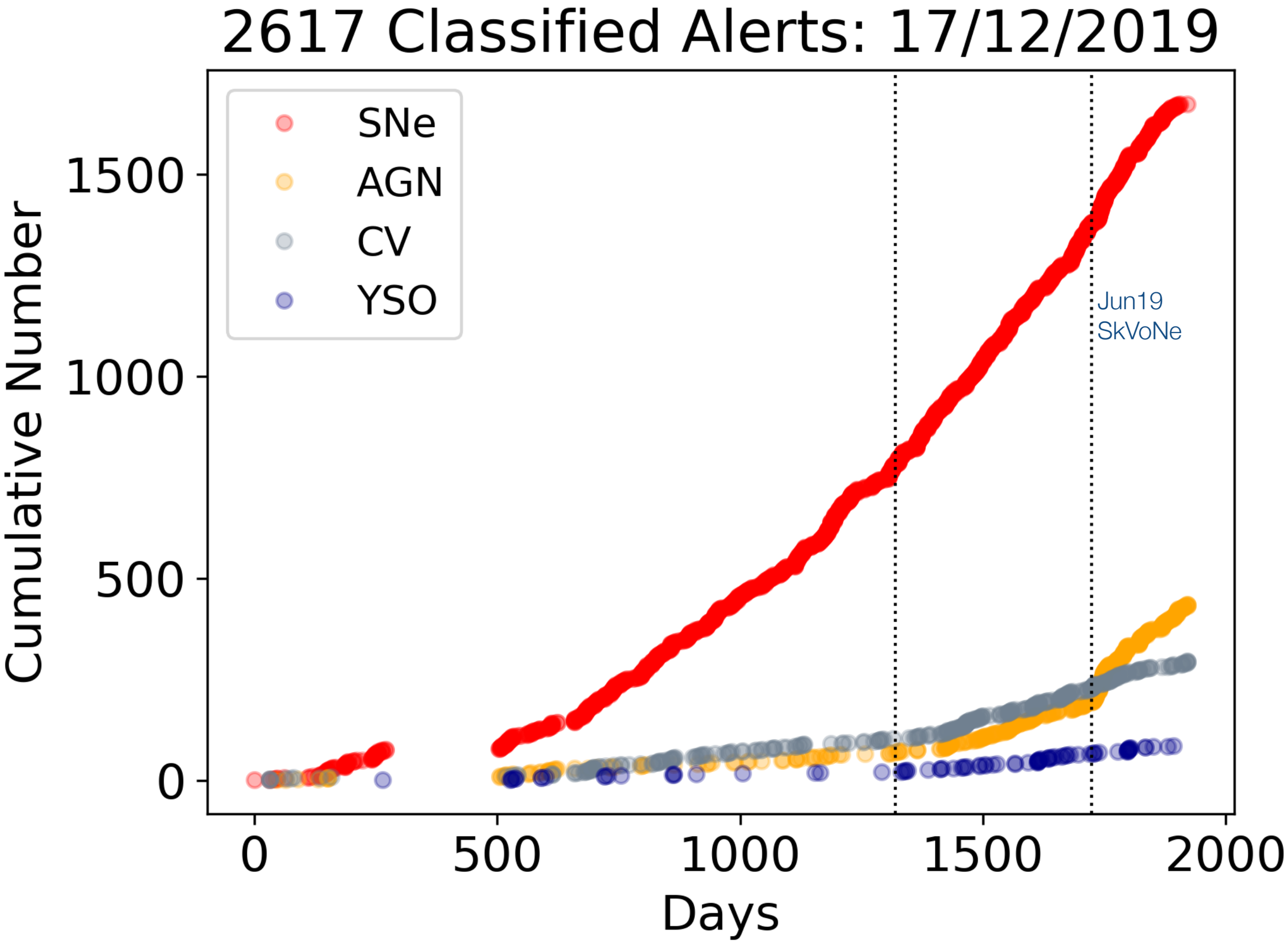


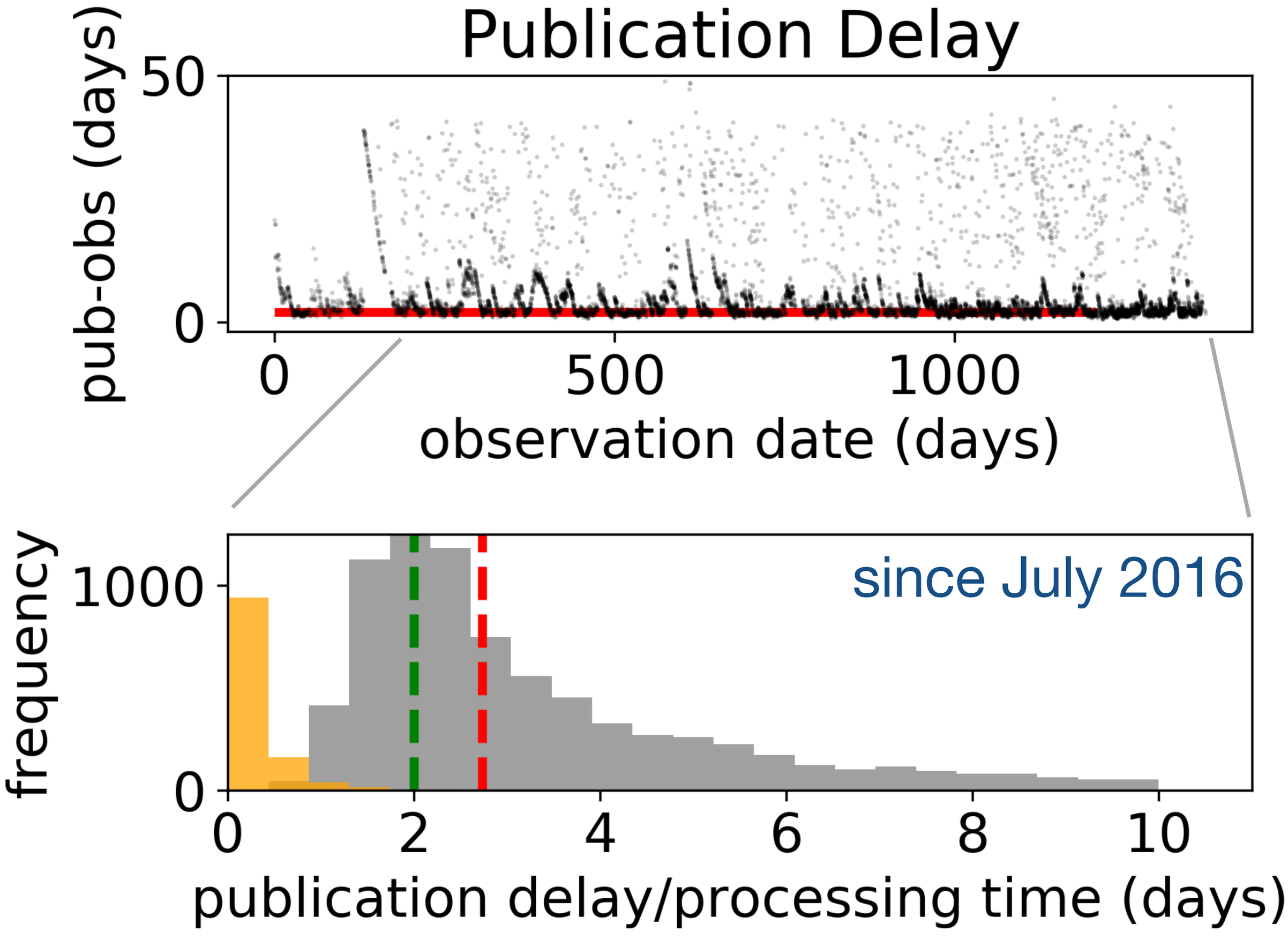
Operations

- >10619 published Alerts
- Publication rate ~10 alerts/day
- The median time to publish (last 365 days) is 2.3 days

10619 Published Alerts: 17/12/2019




2617 Classified Alerts: 17/12/2019
SNe
AGN
CV
YSO
Jun19
SkVoNe
Cumulative Number
0
500
1000
1500
0
500
1000
1500
2000
Days


Publication Delay
pub-obs (days)
50
0
0
500
1000
observation date (days)
since July 2016
frequency
1000
0
0
2
4
6
8
10
publication delay/processing time (days)

Looking Ahead

Rematch coming

- IDT will update it's catalogue for Cycle3 (the same catalogue that will be used for DR3) - expectation is end of January 2020

- We expect about a 10% churn in our database (splitting and merging sourceIds).

- Published alerts will also have their lightcurves corrected to fill in the gaps (using mix-in sources).

- We have to implement the update as soon as IDT swap.

- There will be small delay (2 weeks) while we rematch and catch up.

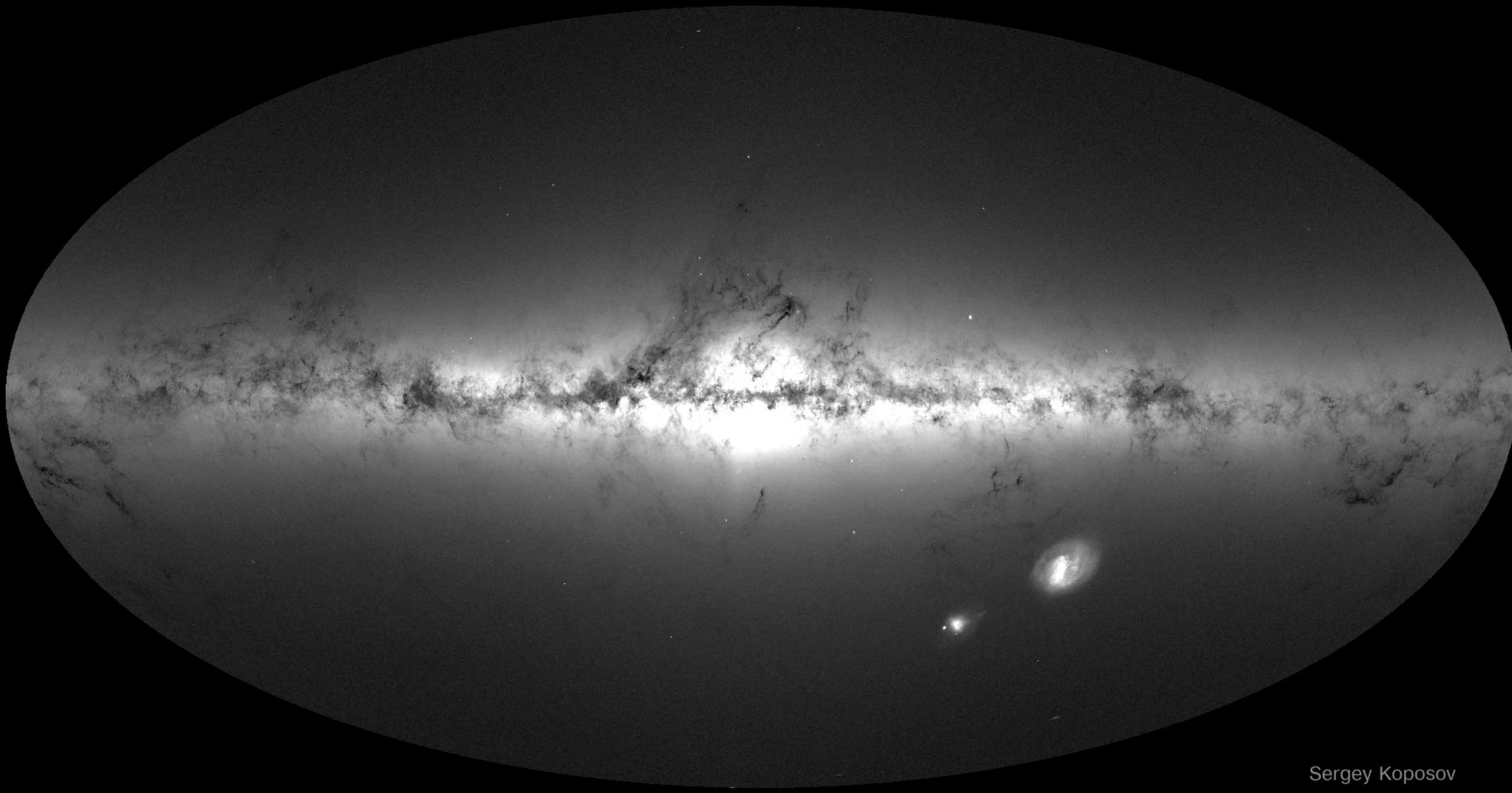
Science Alerts in GDR3

- We include in data releases only the minimal information additional to the web page. For each alert:
    - The name of the alert, e.g. Gaia18abc.
    - The identifier of the alerting transit.
    - The identifier of the primary source, in the GDR catalogue of choice.
    - The identifiers of any secondary Gaia sources that GSA considers to be part of the astrophysical source.

Science Alerts in GDR3

- We are making three tables, all of them defined already in recent MDB data-models:
  - MDB/CU5/ScienceAlerts/Alert : all the above information
  - MDB/CU5/ScienceAlerts/InputDataUsed : provenance tracking
  - MDB/CU5/WhiteListedDetection : transits of the light curves of the alerts, to prevent them being dropped from the MDB

Year 2014.500



Sergey Koposov

WITH THANKS TO

- DPAC
- Francesca De Angeli
- Giuseppe Altavilla
- Vasily Belokurov
- Nadejda Blagorodnova
- Josh Bloom
- Elme Breedt
- Anthony Brown
- Jos de Bruijne
- Patrick Burgess
- Ross Burgon
- Giorgia Busso
- Heather Campbell
- Gisella Clementini
- Chris Copperwheat
- Sue Cowell
- Michel Dennefeld
- Andrew Drake
- Dafydd Wyn Evans
- Laurent Eyer
- Morgan Fraser
- Gerry Gilmore
- GREAT
- Liam Hardy
- Jorge Fernandez Hernandez
- Greg Holland
- Anna Hourihane
- Peter Jonker
- Uli Kolb
- Zuzanna Kostrzewa-Rutkowska
- Sergey Koposov
- Stuart Littlefair
- Ashish Mahabal
- Francois Mignard
- Paul Osborne
- Lovro Palaversa
- Andrzej Pigulski
- Timo Prusti
- Marco Riello
- Guy Rixon
- Iain Steele
- Rachel Street
- Frank Suess
- Lina Tomasella (and team),
- Manuel Torres
- Yiannis Tsapras
- Massimo Turatto
- Sjoert van Velzen
- Nic Walton
- Thomas Wevers
- Patricia Whitelock
- Roy Williams
- Lukasz Wyrzykowski
- all co-I's on our numerous proposals.