



Gaia Photometric Science Alerts Data Flow

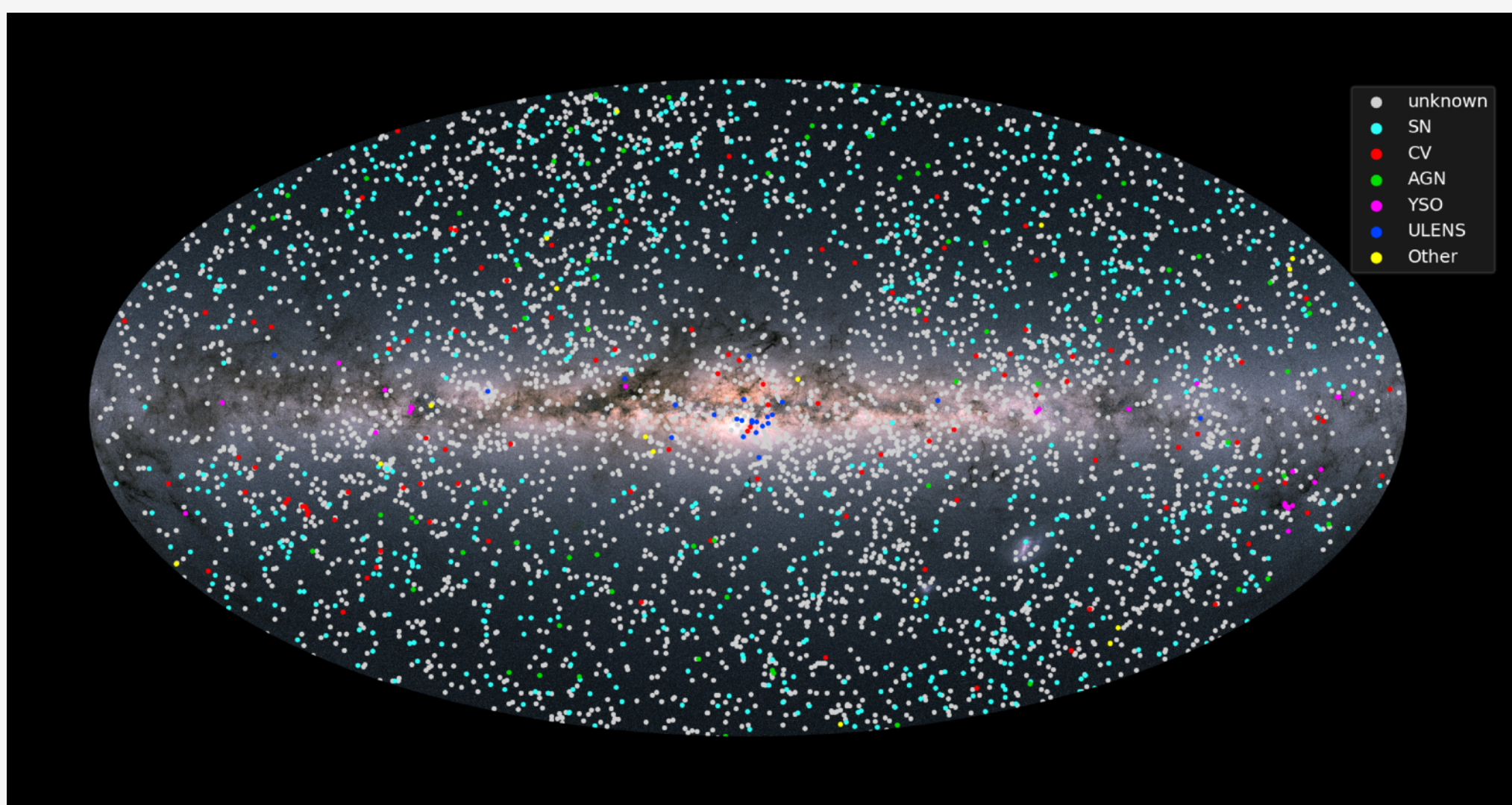
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Gaia Science Alerts Workflow



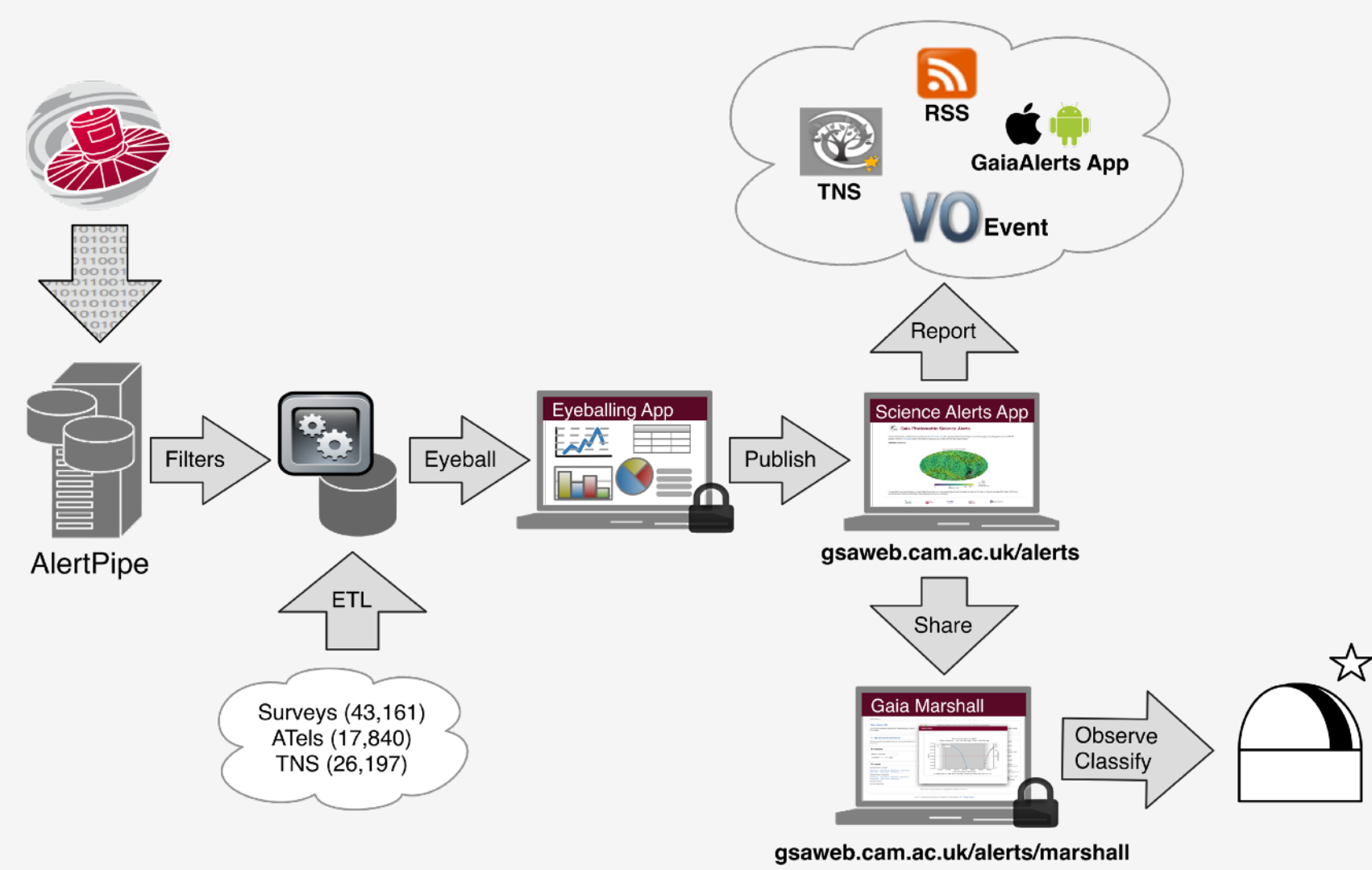
Gaia all-sky colour map ©ESA/Gaia/DPAC with Gaia alerts superposed.

The Gaia Photometric Science Alerts project started operations in 2014 with the goal of discovering transient events in the Gaia mission data, and since then more than 6000 transients have been discovered or confirmed by Gaia Science Alerts.

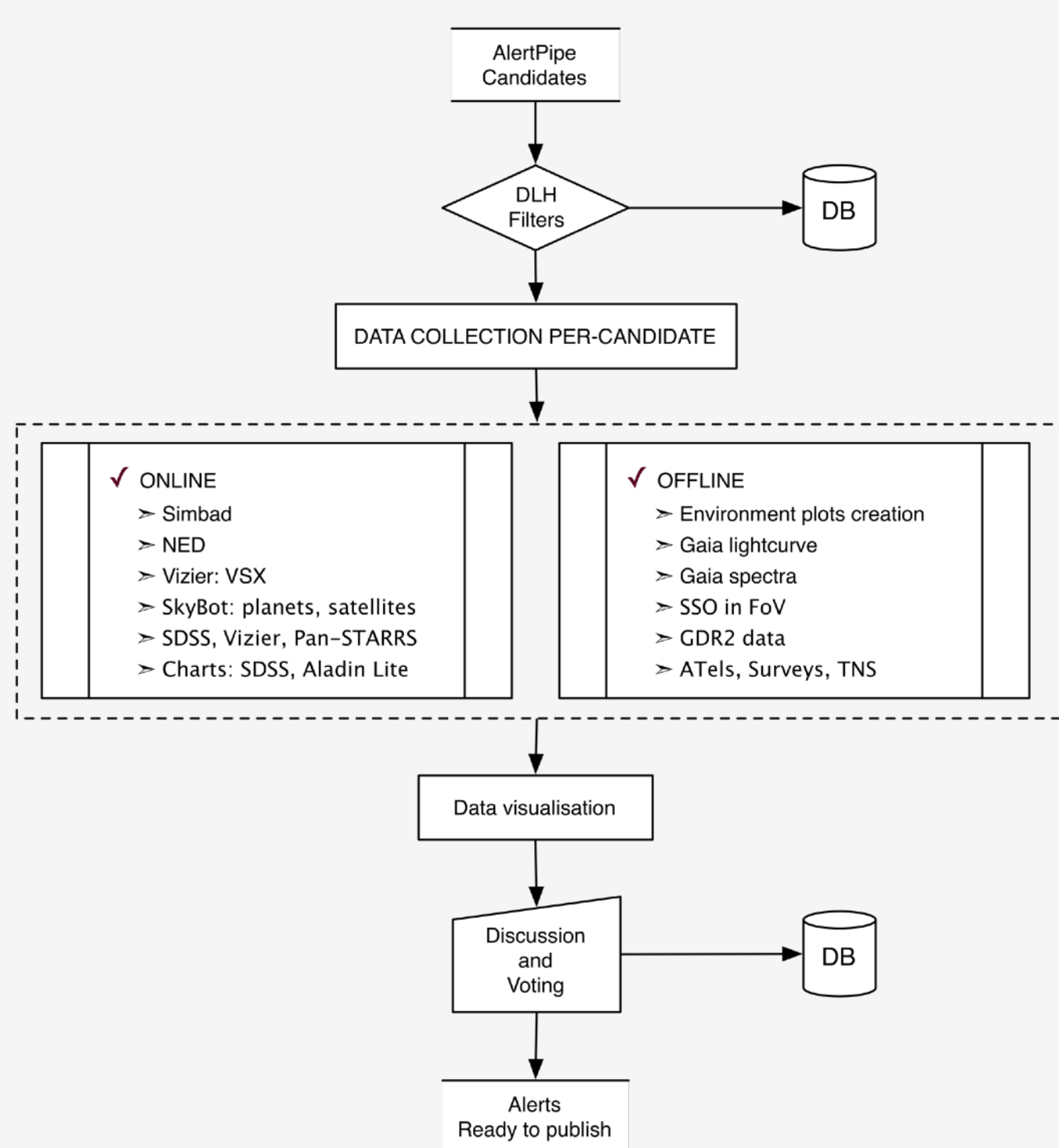
Data is transmitted daily from the spacecraft, and received and processed by the Gaia Photometric Science Alerts System at the Institute of Astronomy (Cambridge, UK). After data processing and filtering, the surviving transient event candidates (alerts) are visually inspected using a web application, known as the Eyeballing App, which displays the Gaia data as well as ancillary information on each candidate. This enables the final decision on whether an alert should be made publicly available to the wider astronomical community or not. If published, the alert data and associated information is made available online in multiple formats.

To support the interaction between astronomers, and to prioritise and optimise the follow-up of the alerts, the Gaia Marshall web application provides contextual data for the alerts. The Marshall acts as a place to exchange information and improve the classifications.

In this poster we present an outline of the Gaia alerts data flow, from the alert candidate extraction to the follow-up.



Alerts candidates: discovery and selection



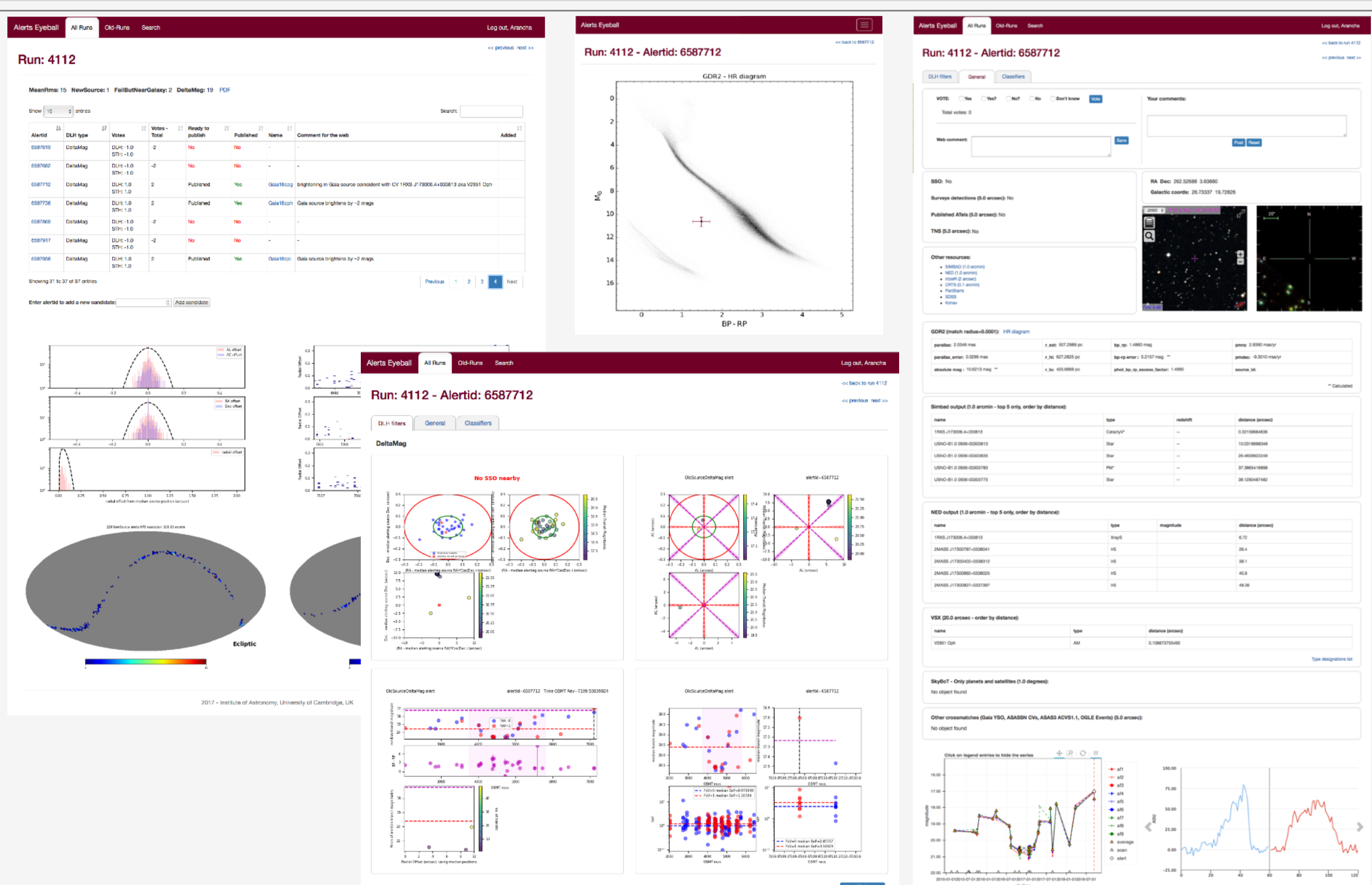
The Gaia Photometric Alerts pipeline, AlertPipe, processes the data received daily and extracts potential new sources and objects increasing or decreasing in brightness.

The Eyeballing App web application allows the final assessment of the publishability of the alerts by collecting and displaying data available from Gaia and other resources. The use of this tool is restricted to the Gaia Alerts team.

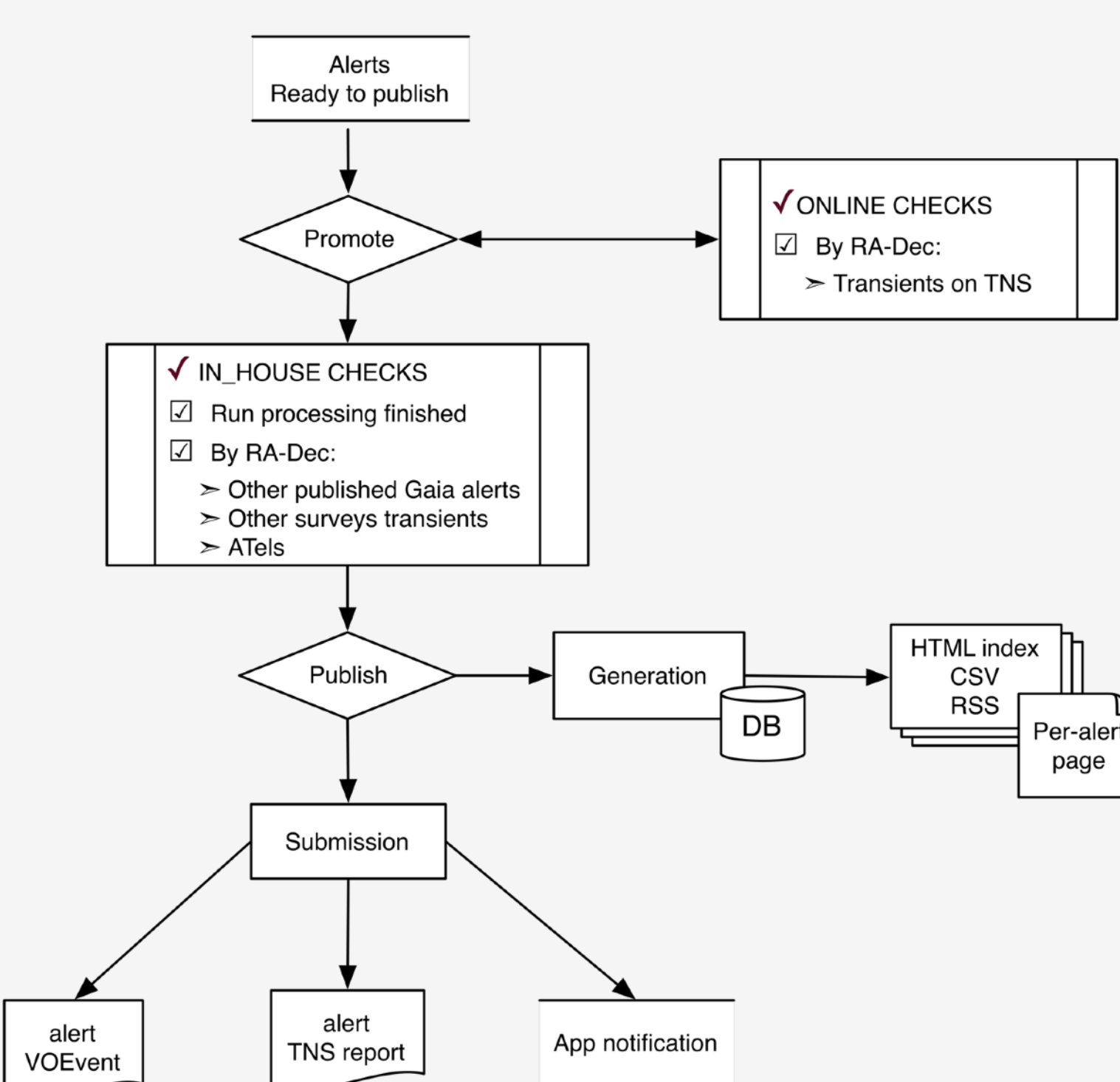
For every alert, the Eyeballing App shows the data available from Gaia; the lightcurve, spectra, DR2 parameters, if available, and environment plots.

Additionally, to allow a visual inspection of the alert's location, the Eyeballing App shows the Aladin Lite and SDSS finding charts. It also connects to Simbad and NED to learn more about the candidate's location, checks Vizier VSX catalogue to discover whether it is already a known transient or variable object, and acquires information from SkyBot¹ to allow the user to reject spurious transients due to data affected by the close proximity of planets and their satellites. Note that the probability of other Solar System objects crossing the field of view at the time of the alerting transit is evaluated by AlertPipe, and this information is displayed within the Eyeballing App. Also shown in the App, are the results of the cross-match between the alert position and with data assembled from the hourly parsing of other transient surveys, Astronomer's Telegrams² and the Transient Name Server³ website.

The Eyeballing App allows each user to vote and comment on each alert. When an alert reaches the voting threshold for publication, a link to publish the alert is enabled.



Alerts candidates: publication



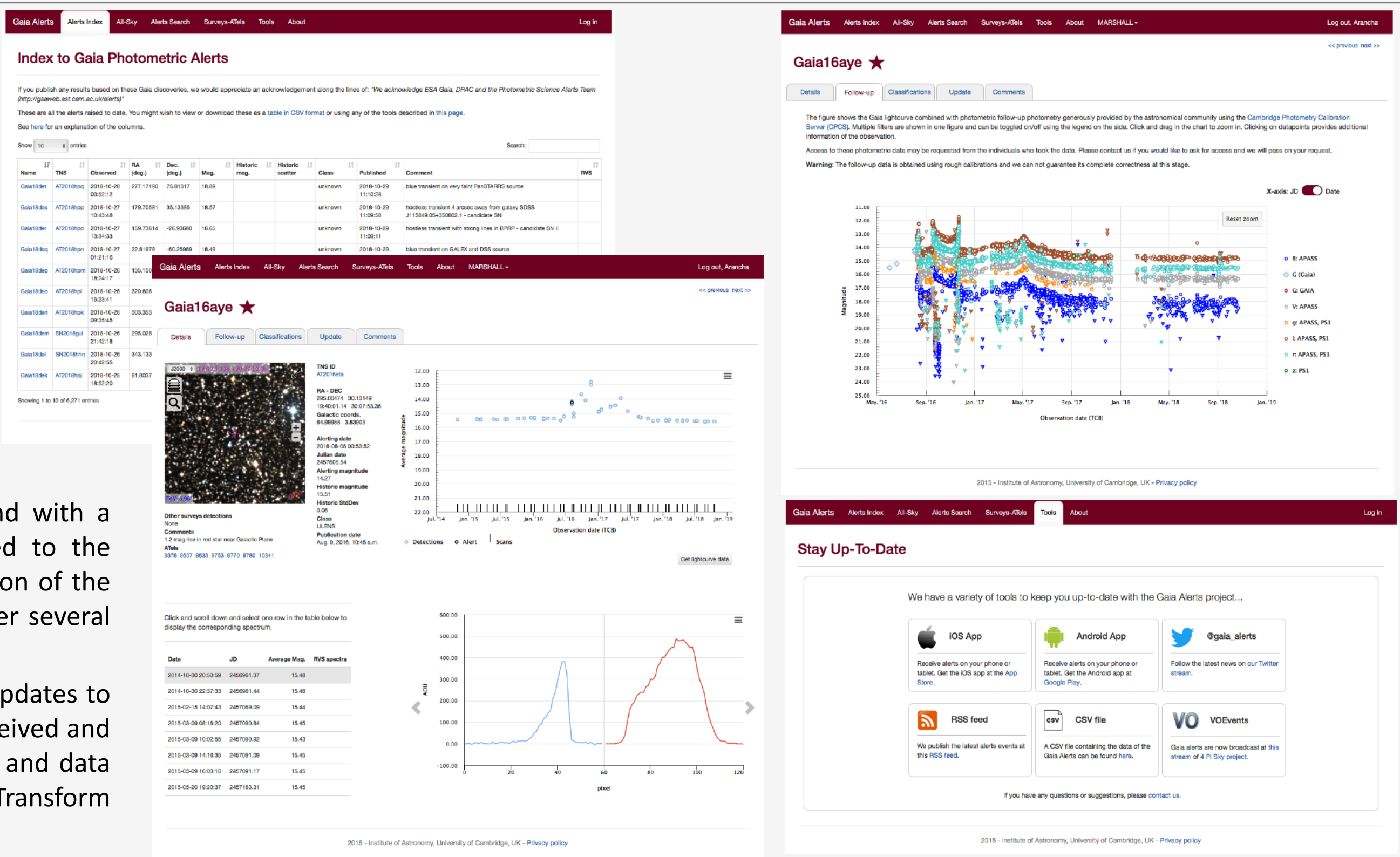
After the inspection of the alerts data and the selection of the candidates, the findings are made publicly available in multiple formats:

- Through a dedicated website (<http://gsaweb.ast.cam.ac.uk/alerts>) in CSV, HTML and RSS formats.
- Reported to IAU-Transient Name Server.
- Broadcast as VEvents⁴.
- Notifications to GaiaAlerts mobile apps (iOS and Android).
- Providing data to Gaia in the UK site (<https://gaia.ac.uk>).

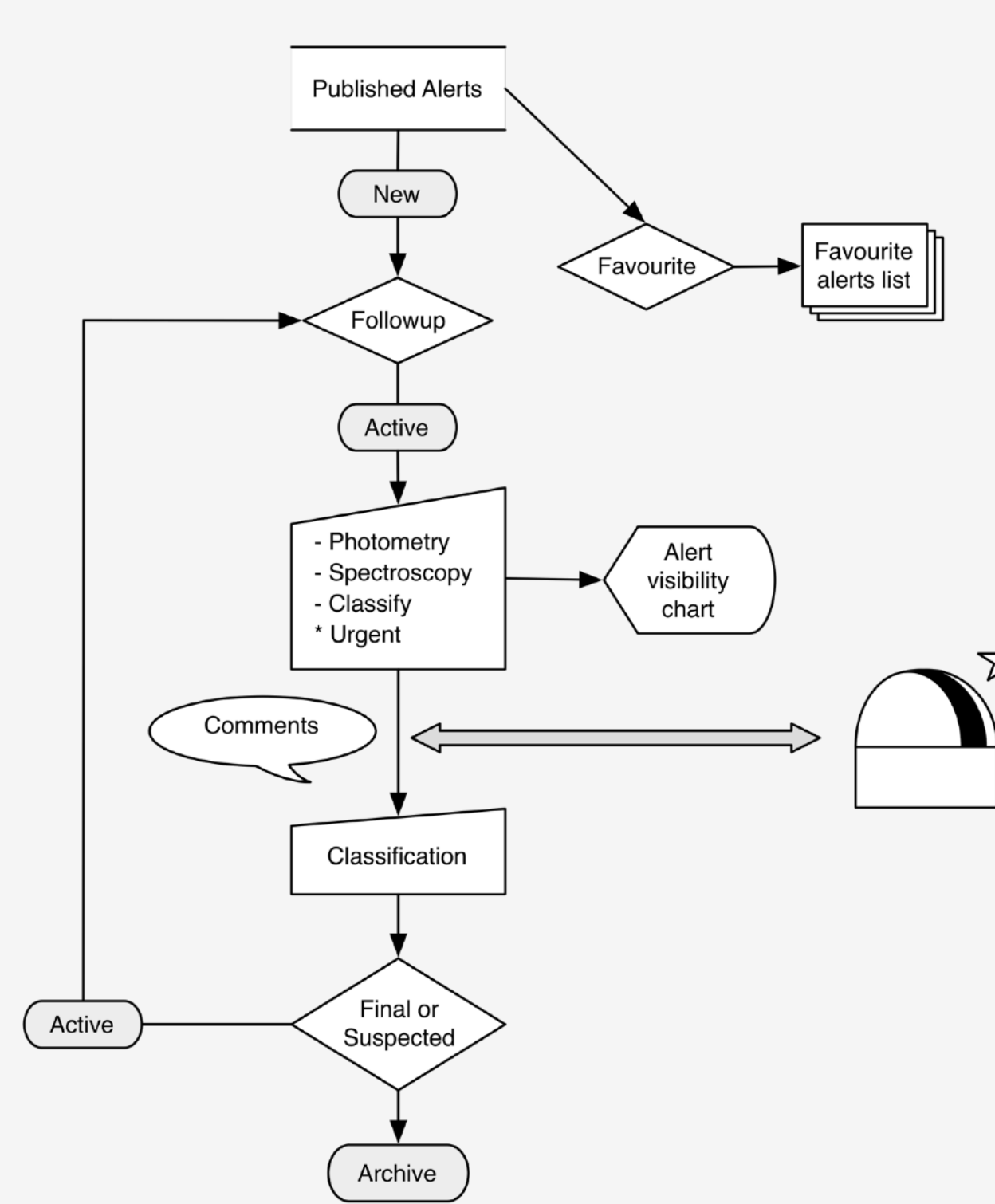
On average, the rate of candidates to be eyeballed is 30/day of which 6/day are published.

The Gaia Photometric Science Alerts web application has a front end with a public area where all the information about the alerts is published to the astronomical community, and a restricted area where the administration of the application and the publication of the alert candidates takes place after several online and internal checks.

The back end of the Photometric Science Alerts system manages the updates to the published alerts with the latest data from Gaia once it has been received and processed. Cron jobs handle the collection of Astronomer's Telegrams and data from various transient surveys available on the Web using ETL (Extract Transform Load) techniques.



Gaia Photometric Alerts community: Gaia Marshall



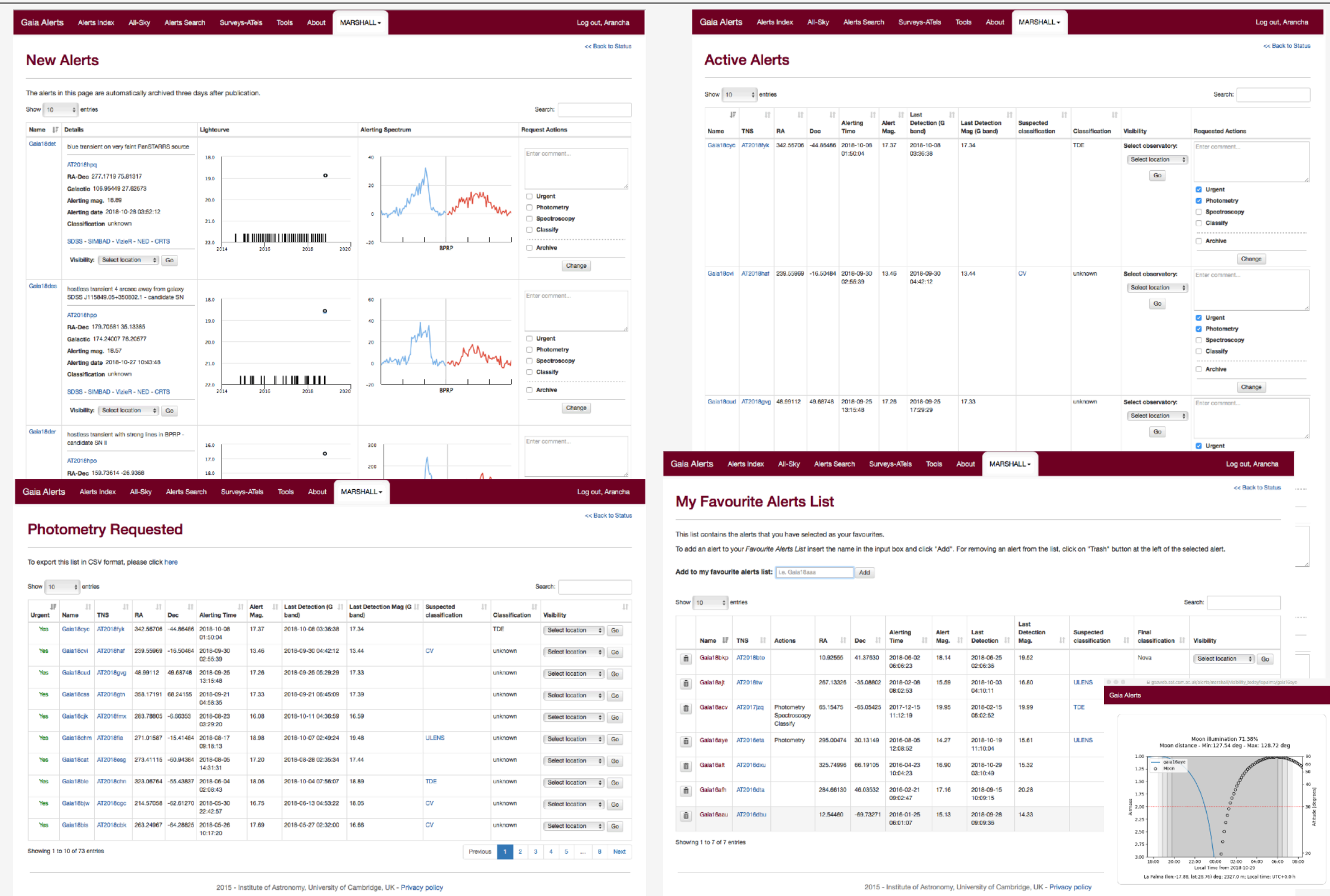
The Gaia Marshall is part of the Gaia Photometric Science Alerts web application but access requires authentication. The credentials are granted per user and the access level depends on their assigned group.

The Marshall provides contextual data for the alerts and acts as a place to exchange information and improve the classifications. This web application comprises the follow-up information, including the data added through the Cambridge Photometric Calibration Server⁵ and the collected data for every alert. It also contains per-alert message boards which support the interaction between astronomers allowing them to prioritise and optimise the follow-up and classification.

Each alert has a lifecycle that flows through various states, from New to Active and finally to Archive (if it does not require further follow-up). While an alert is Active, the Marshall users can request actions as Photometry, Spectroscopy or Classify, tagging them as Urgent if that is the case. There are web pages displaying lists of alerts, per-status and per-action, and some of them have counterpart machine-readable files to allow the automation of observations with robotic telescopes. The Status page gives an overview of the Gaia alerts follow-up.

The Marshall has other features, including visibility charts in local and UTC times for the alert, at a range of observatory locations. We have also added a personalised Favourites List, to which an alert can be added and deleted (via the per-alert page or from the Favourites List).

The classifications can be entered as suspected or final. The complete history of the alerts are kept and shown to the users to aid in the decision of the final classification, which is only propagated to the public Alerts website and mobile apps when the proposed final classification is accepted by Gaia Alerts team. The follow-up of an alert can continue when the object is classified. The classification rate is ~20% of the published alerts.



References

- Berthier et al., *SkyBot, a new VO service to identify solar system objects*. ADASS XV. (2006ASPC..351..367B)
- Astronomer's Telegrams - <http://www.astronomerstelegram.org>
- Transient Name Server - <https://wis-tns.weizmann.ac.il>
- 4 Pi Sky VEvents - <https://4pisky.org/voevents/>
- Cambridge Photometry Calibration Server - <http://gsaweb.ast.cam.ac.uk/followup/>



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

Acknowledgements

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