

# GAIA SCIENCE ALERTS

## Follow-up and Alerts Verification Brochure



**gaia**

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v. 02 October 2012

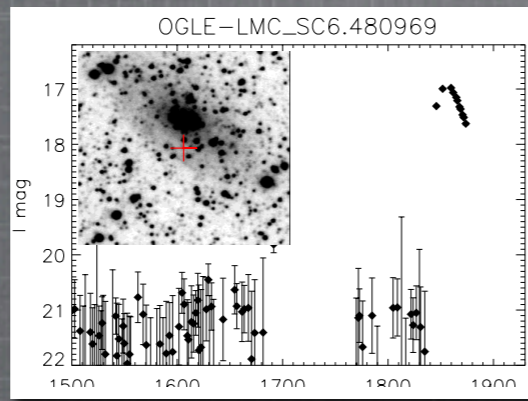
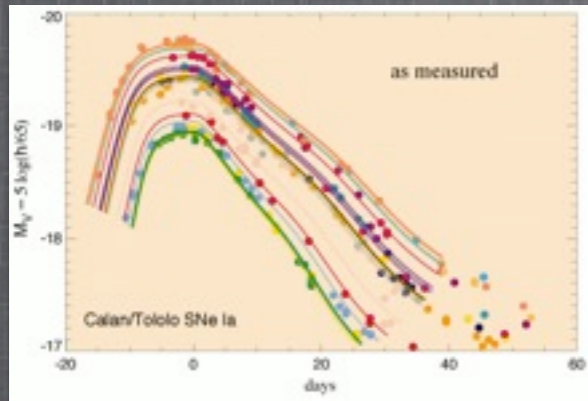
# GAIA ALERS IN A NUTSHELL

- Gaia is the milestone ESA's space mission, to be launched in **late-2013**
- main target: ultra precise astrometry of billion of stars to map the Galaxy
- serendipitous project: **Gaia Science Alerts**
- alerts inform about events, which scientific value will be lost if not followed-up immediately
- uses daily data transmissions to detect **anomalous** and **transient events** from the **whole sky**
- alerts issued usually within **12-48h** after observation
- limiting magnitude: **~20 mag**
- sampling: about **70** observations per object over 5 years (grouped in pairs)
- anomalies detected and classified on **1-2** Gaia data points (photometry and low-res spectroscopy)
- thousands of alerts per day possible (tuneable)

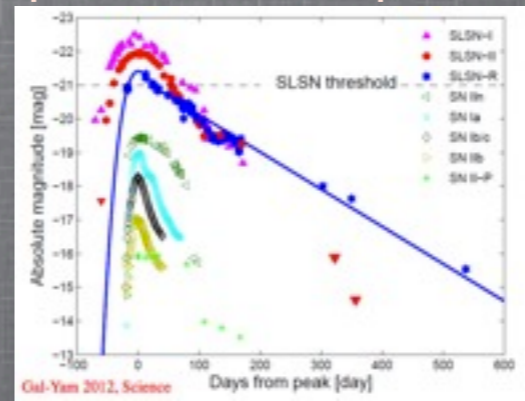
**an extensive ground-based follow-up is needed  
for early verification of alerts, classification  
and characterisation of objects**

# SCIENTIFIC OPPORTUNITIES

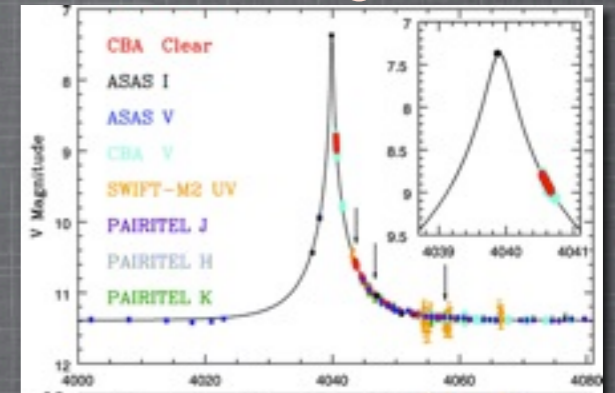
Supernovae



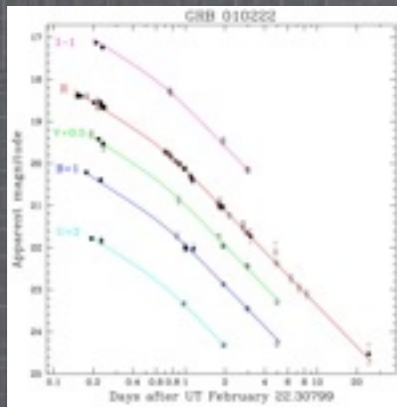
Super-Luminous Supernovae



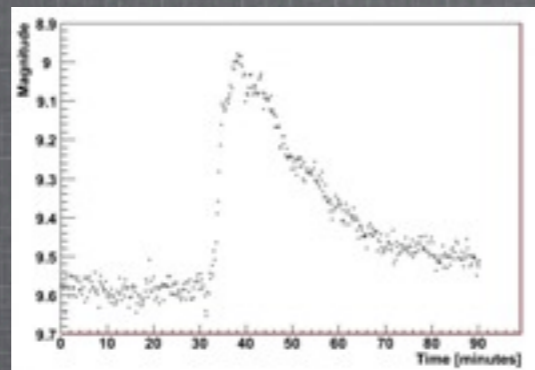
Microlensing events



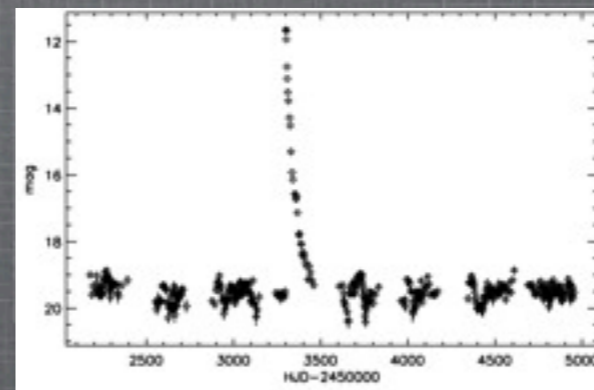
GRBs optical counterparts



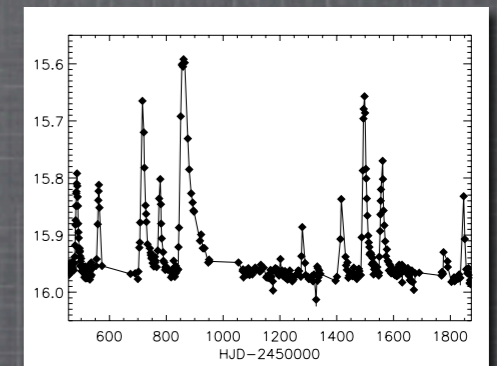
M-dwarf flares



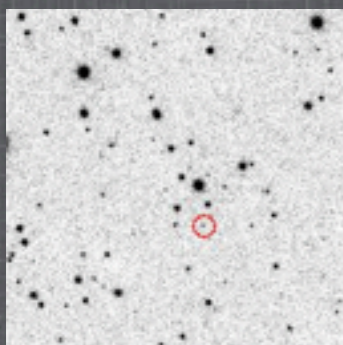
Classical novae



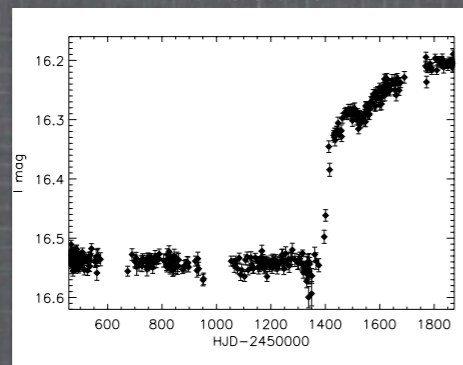
Dwarf novae



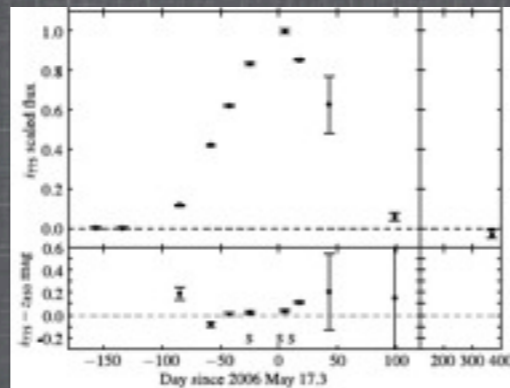
Asteroids



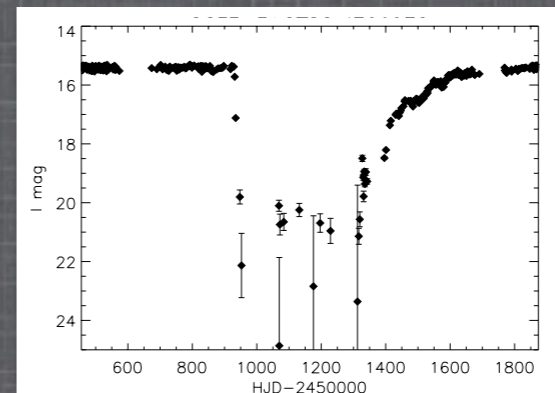
Be stars



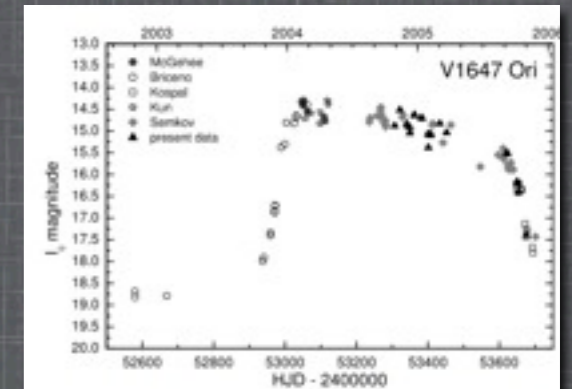
NEW THINGS??



R Coronae Borealis

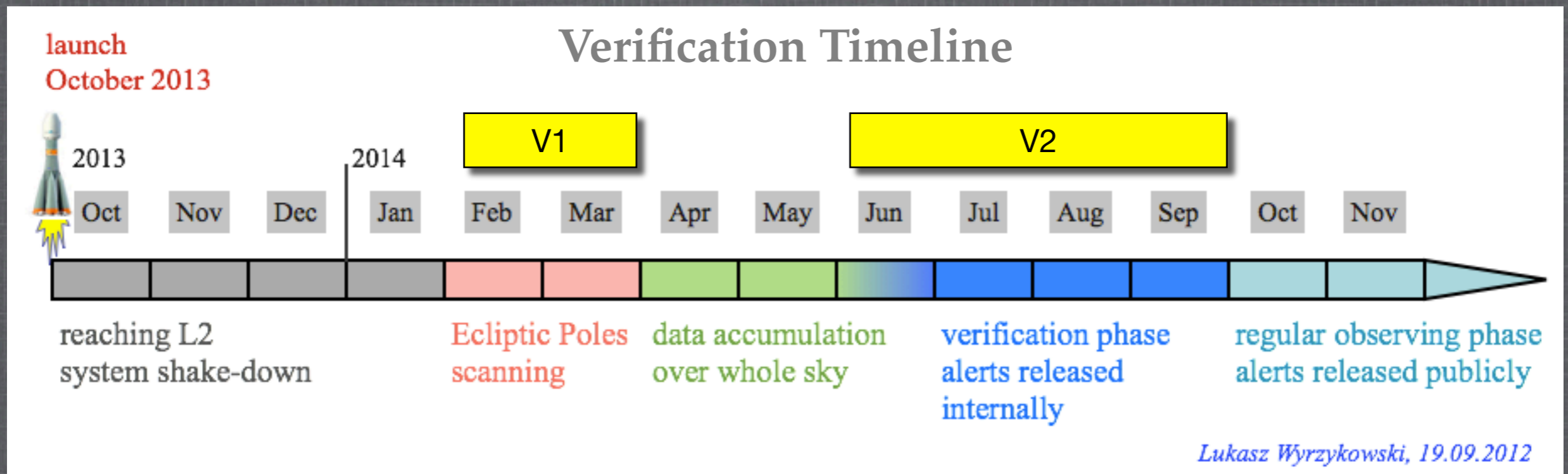


FU Orionis



# VERIFICATION PHASE

- needed to demonstrate if the Gaia detection and classification works
- test and fine-tuning of the detection thresholds
- only during the verification alerts are NOT public and are available only to a dedicated group of follow-up telescopes (Gaia-FUN-TO)
- Two main stages:
  - V1 : during the special scanning mode (Ecliptic Poles)
  - V2 : commences as soon as sufficient sky has been observed enough times to define the baseline catalogue



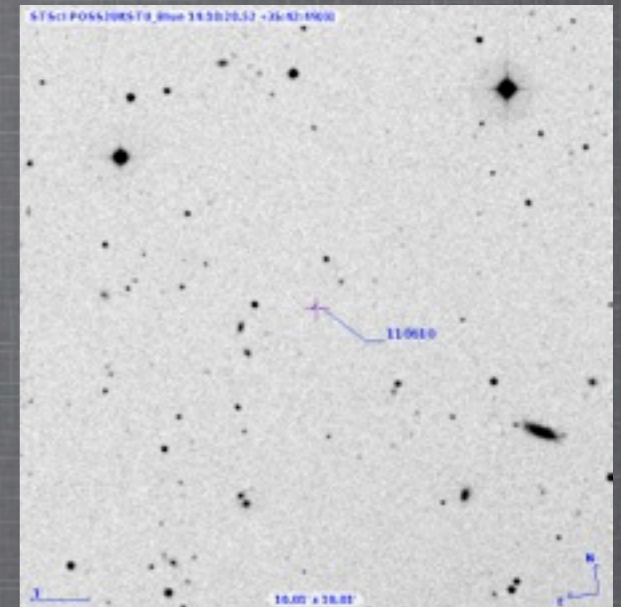
# FOLLOW-UP REQUIREMENTS

## Gaia Follow-Up Network for Transient Objects

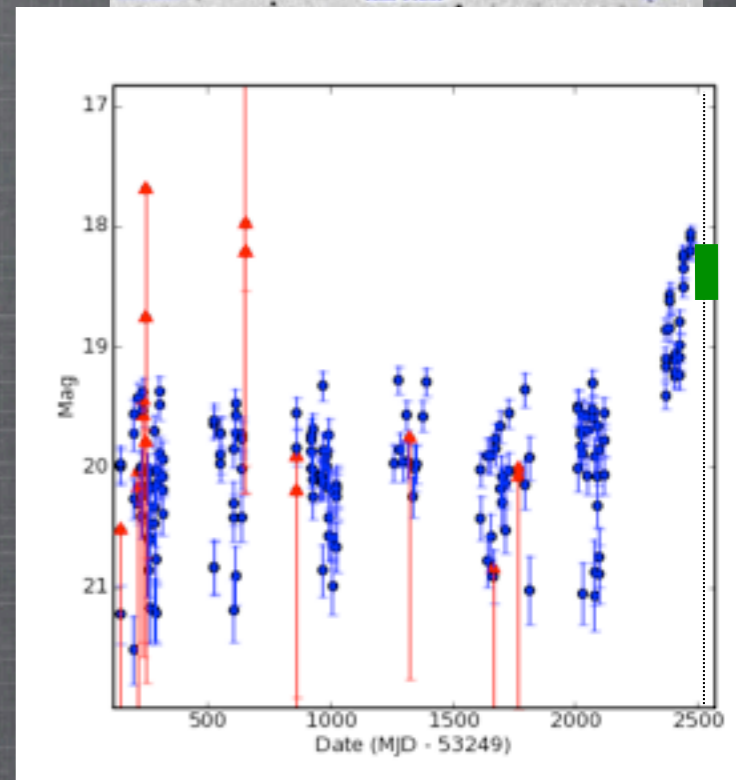
- photometric follow-up (imaging) to confirm an alert
- multi-band photometric monitoring to build a light-curve and classify an alert
- low-, mid-, high-resolution spectroscopy to confirm and refine the classification of an alert based on Gaia data
- >0.5m telescopes on both hemispheres, east and west
- ideally, fully robotised telescopes, easy to schedule with ToO
- human operated telescopes also useful, response time within 24h
- reduced data available within 24h
- unified/standardised observational output, centralised repository of data
- rules on data policy, publications, etc. has to be decided and agreed (via Memoranda of Understanding)

# PRE-LAUNCH TEST PHASE

- to prepare the telescopes and people for Gaia alerts
- using CRTS survey transients as proxy to Gaia
- a potential new partner needs to prove capability to perform the rapid follow-up in order to join the verification
- potential scientific outcomes



- Simple guide for photometry:
1. observe any alert (e.g. from CRTS)
  2. reduce the data *asap*
  3. attach astrometry (WCS)
  4. derive photometry (e.g. with SExtractor)
  5. submit to Calibration Server



follow-up example  
from Giuseppe Altavilla



# FOLLOW-UP CALIBRATION SERVER

for Gaia Science Alerts Photometric Follow-up

GAIA SCIENCE ALERTS  
Cambridge Photometric Calibration Server  
manual



Lukasz Wyrzykowski & Sergey Koposov  
Institute of Astronomy, University of Cambridge, UK  
last update: 30 July 2012

## UPLOADING THE FOLLOW-UP DATA

<http://gaia020.ast.cam.ac.uk:5000> (temporary site)

Gaia Science Alerts Follow-up

gaia020.ast.cam.ac.uk:5000/uploader/

### Follow-up Data Uploading Form

Event ID:

Hash tag:

MJD OBS:

Exposure time:

Filter:

SExtractor catalog:

**Skyalert.org**

Sponsored by the National Science Foundation  
[Browse Event Streams](#) | [Browse Skyalert Feeds](#) | [my Feeds and Alerts](#)

Portfolio: <ivo://nvo.caltech/voeventnet/catot#1111181120424127237>

From the [CRTS](#) stream,  
Catalina Real-time Transient Survey  
Position is 118.19689,12.37233 ± 0.0012  
This portfolio initiated 2011-11-18 05:32:05  
Also available is the [JSON](#) representation of this portfolio.

Your unique access name / pass  
(provided by Cambridge)

## RESULT OF CALIBRATIONS

Hi 536c \*\*\*\*\*

Upload done from IP 131.111.70.231 from hashtag 536 \*\*\*\*\*

EventId : ivo://nvo.caltech/voeventnet/catot#1106101350644123477

Ra : 214.61884

Dec : 35.71373

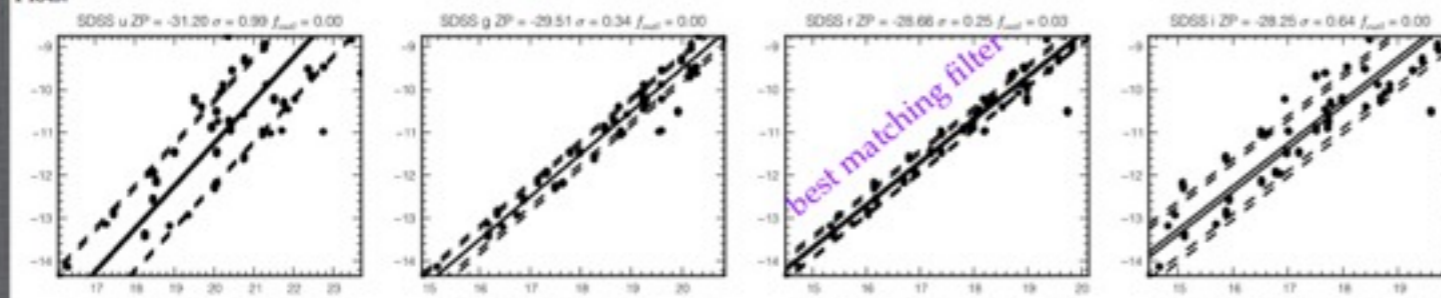
Filter: SDSS / r

Magnitude: 18.1738541917 +/- 0.0142 mag

ZP: -28.6588541917

Scatter: 0.248369741493 mag

Plots:



best matching filter (data will be stored as in this filter)

calibrated magnitude

zero point

Database:

Ra	Dec	N_follow-up
59.71914	1.59959	-
49.69022	21.57691	-

### REQUIRED SExtractor FIELDS:

- # ALPHA\_J2000 Right ascension of `barycenter` (J2000) [deg]
- # DELTA\_J2000 Declination of `barycenter` (J2000) [deg]
- then, either:
- # MAG\_APER Fixed aperture magnitude vector [mag]
- # MAGERR\_APER RMS error vector for fixed aperture mag. [mag]
- or:
- # MAG\_AUTO Automatic aperture magnitude [mag]
- # MAGERR\_AUTO RMS error for automatic aperture mag. [mag]

access can be fully automatised

software developed by Sergey Koposov, IoA

# Now is the time to join!

## Gaia Follow-Up Network for Transient Objects

contact me at  
[wyrzykow@ast.cam.ac.uk](mailto:wyrzykow@ast.cam.ac.uk)  
and  
sign in here:

[www.tinyurl.com/telescopes-for-gaia](http://www.tinyurl.com/telescopes-for-gaia)

<http://www.ast.cam.ac.uk/ioa/research/gsa/wg/>

Telescopes for Gaia

Telescope/observatory name	Location	Longitude (+ for E, - for W)	Latitude (+ for N, - for S)	Altitude [m]	Size [m]	Field-of-view [deg <sup>2</sup> ]	Limit DEC	Limit HA	instruments	CCD size [arcsec/pix]	limiting magnitude (R or equivalent)	filters	spectral range	spectral resolution	time available for alerts follow-up
Besancon Obs	France				2				spectropolarime Coude spectrograph				4000 - 9000 A	10 000	upon request from the GAIA Alerts WG
Ondrejov	Czech Rep.	14.78	49.92	524	2		-20	no							
Asiago	Padova, Italy	11.57	45.84	1362	1.82	8.7x8.7			AFOSC	0.52" (2x2bin)	V-21 at S/N-10 with 10min	UBVRI	370-950	200-5000	7-10 nights per month during the period August to April, upon request from the GAIA Alerts WG pending the internal agreement of 3 participants, Ondrejov, Charles University, Bmo University total quota 90 nights per year.
Darish 154	La Silla, Chile	-70 44 08	-29 15 14	2340	1.54	13.7x13.7 arcmin			DFOSC only camera in use		V-22 in 30min, V-6-7 in 2-3 sec; in spectroscopy V-18 in 30min, V-5-6 in 10sec	18	n/a	n/a	2-3 nights/month ( August 2011-January2012) , 5 nights/months afterwards
Loiano	Bologna, Italy	11.33	44.26	785	1.5	13x12.6	-5	+70 optimal	BFOSC	0.58"		UBVRI, Gunn	370-850	200-2000, 4200 in echelle mode	
Maidanak	Uzbekistan				1.5										
Toppo di Castelgrande	Italy				1.5				photometry/LDS						
Vienna	Austria				1.5										
Belgian Mercator	La Palma, Spain	-17°52'42"	17°52'42"	2303	1.2	6.5x6.5			Merope, Hermes, Maia(soon)	0.19		7 Geneva filters + R + 1 Geneva filters (U,B1,B2,B,V plus RG, ZG (Gunn?), Echelle IC (Cousins)	380 nm to 690 nm (69 orders)	85000	From Geneva: upon request and pending acceptance by Geneva group of Stellar Variability.
Swiss Euler	La Silla, Chile	-70.73	-29.2567	2347	1.2	10x10"		+29 deg (z=2)	Coralie (spectrograph), ECAM CCD	0.3"	CCD: ~197			85000	tentative: upon request and pending internal (Geneva Stellar Variability Group) acceptance.



# CONTACT

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**Sergey Kuposov**: [kuposov@ast.cam.ac.uk](mailto:kuposov@ast.cam.ac.uk)

**Gaia Science Alerts Working Group Wiki:**

WWW: <http://www.ast.cam.ac.uk/ioa/research/gsawg>