

Gaia follow-up of the uncatalogued Solar System Objects

Tracking the Gaia SSO detections: Gaia-FUN SSO

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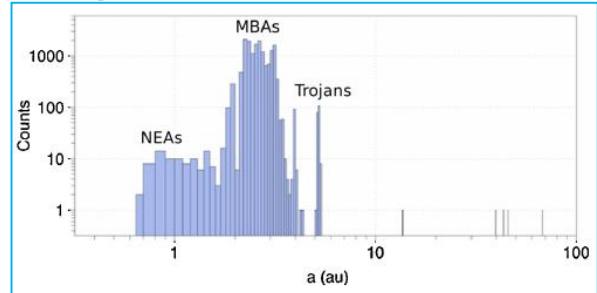
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Gaia and the Solar System Objects

Gaia data on Solar System Objects ?

- DR1: 14 Sept. 2016, no Solar System Objects
- DR2: 25 April 2018 – 14 099 Asteroids (Spoto et al., 2018)
- (E-DR3 3 Dec. 2020) DR3: first half of 2022: a « large set » of asteroids with epoch data <https://www.cosmos.esa.int/web/gaia/release>

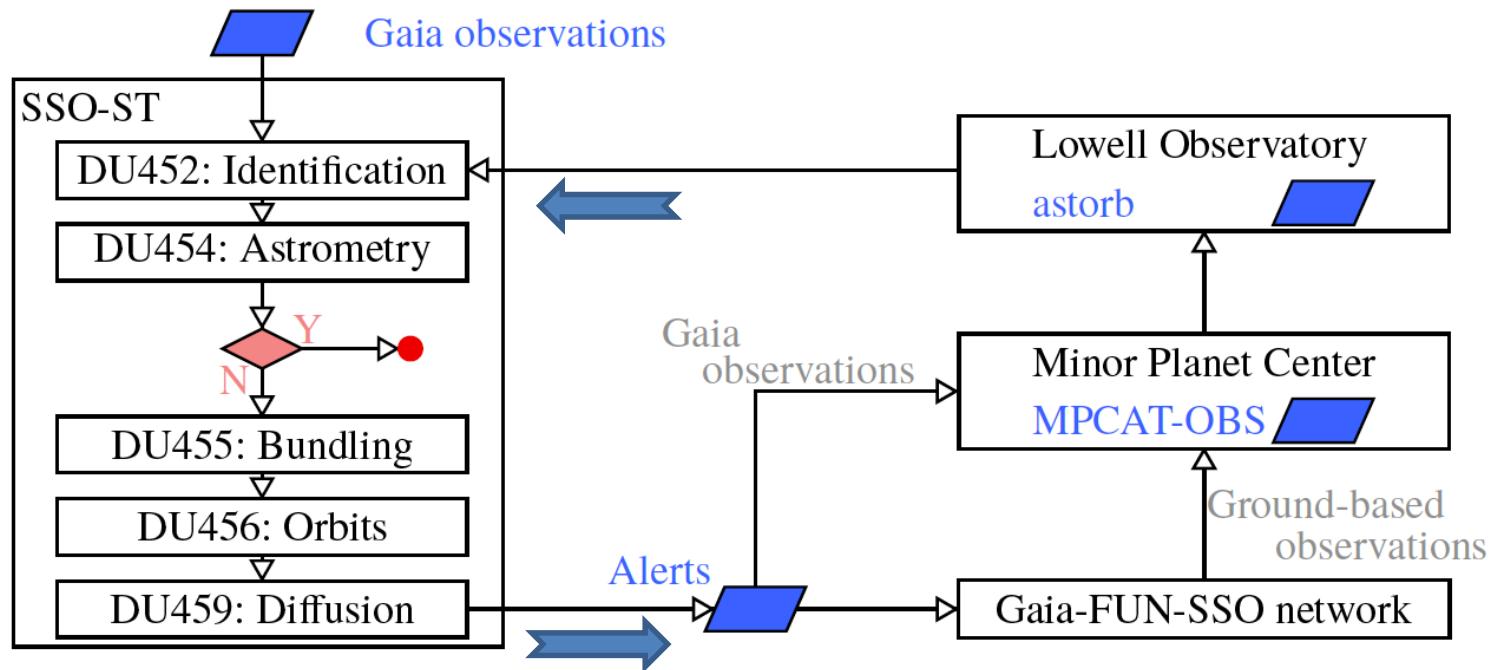


Other data are continuously accessible:

- Gaia alerts after detection of uncatalogued moving objects
- Publicly available
- Need for recovery and follow-up

The SSO-ST daily processing

- SSO-LT Known SSOs => Long Term Processing => Data releases
- SSO-ST Unknown SSOs => Short Term Processing => alerts



Goal and means

- => Validation of the Gaia discoveries of new moving objects (~ 48h)
- => Recovery + astrometry measurement

- Triggering alerts to ground based observations
- Geographical coverage => network of observatories (Gaia-FUN-SSO)
- Observations on alert on the best effort basis
- Loop for feeding the Gaia auxiliary data base for identification

Alerts publicly
release through a
web site:
<https://gaiafunsso.fr>

Gaia Follow-Up Network for Solar System Objects

Goal

The Gaia Follow-Up Network for Solar System Objects (Gaia-FUN-SSO) has been set up in the framework of a task (D449) of the Coordination Unit 4 (Object processing) of the Data Processing and Analysis Consortium (g4pac). Its goal is to coordinate ground-based observations on alert triggered by the data processing system during the mission for the confirmation of newly detected moving objects or for the improvement of orbits of some critical targets. Gaia will scan the sky following a predefined scanning law and such ground-based observations are required to avoid the loss of newly detected Solar System objects and to facilitate their subsequent identification by the probe.

These pages provide an access to the alerts, including the statements to help finding the targets, for the registered members of the Gaia Follow-up network. The network currently consists in about 50 observers in 27 observing sites, spread all over the world (January 2016).



Results and statistics

We are publishing alerts daily since early November 2016. You can find the statistics on the released alerts and on confirmed data discoveries from the ground in the [Results](#) page.

Workshops

Three Gaia-FUN-SSO workshops dedicated to the astrometric follow-up of the Solar System Objects have already been organized in 2010, 2012 and 2014 in Paris Observatory. Discussions has been held about this network and the tasks to be accomplished, the capabilities of the observing sites and the preliminary actions already performed.

- Proceedings of the 2010 workshop have been published and can be freely downloaded [here](#).
- Proceedings of the 2012 workshop have been published and can be freely downloaded [here](#).
- Proceedings of the 2014 workshop have been published and can be freely downloaded [here](#).

Registration

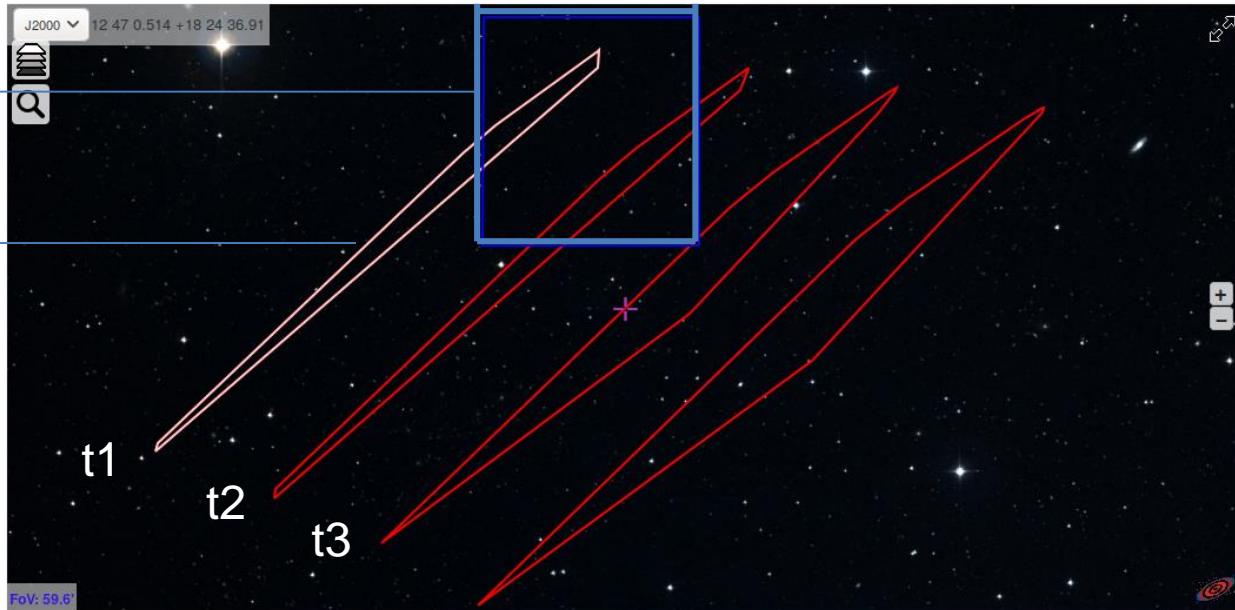
To get a full access to these pages and to share data, you must be registered as active participant of this observing network. For this registration, please use this form. This network needs to have a large geographical coverage. If you are interested, do not hesitate to contact us!

Asteroid recovery: a challenge

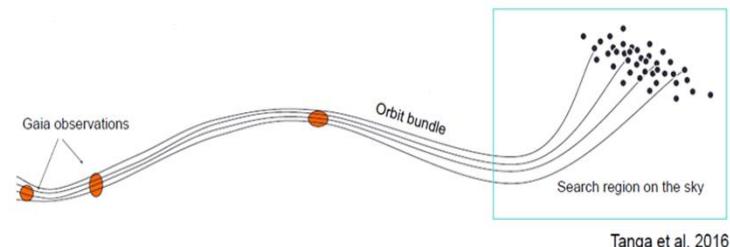
Probable presence

Extended area

<https://gaiafunso.fr>



- On the basis of **short arcs of orbit**
- MCMC method (Oszkiewiczs 2009, Muinonen 2015) => **bundle of orbits**
- Projected on the sky => **areas for recovering**
- « **Ephemerides** » and **sky maps** on the web



Gaia and the Solar System Objects

- Follow-up observations by pro and amateurs were expected
- Workshops 2010 + 2012 + 2014
- Starting in 2016...Most of the alerts in the 20-21 mag range
- Need of telescopes ~1m diameter

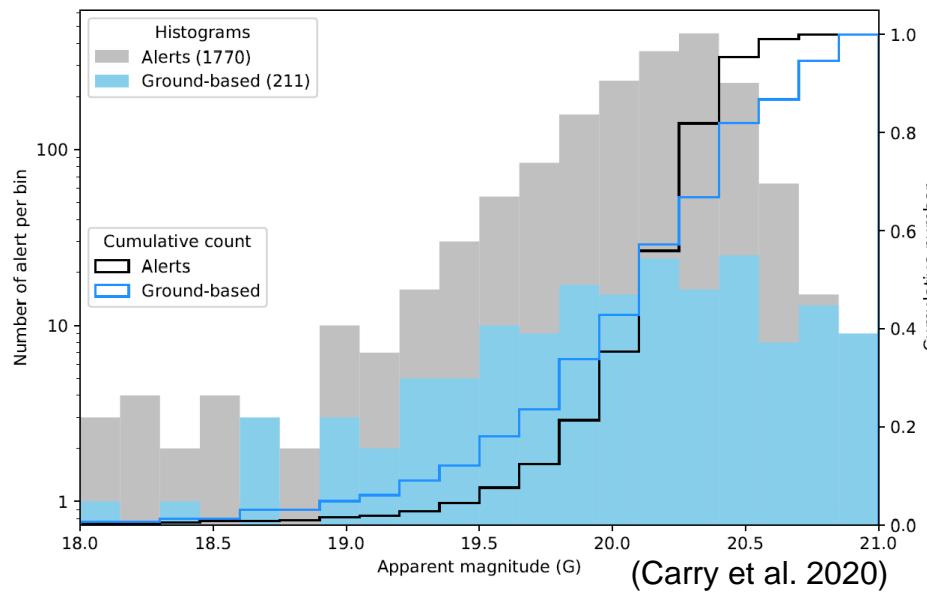


Fig. 6: Distribution of the G magnitude of all alerts and of ground-based observations.

Detailed information on alert

You will find below detailed information on the target and its probable position on the plane of the sky.

Object Information

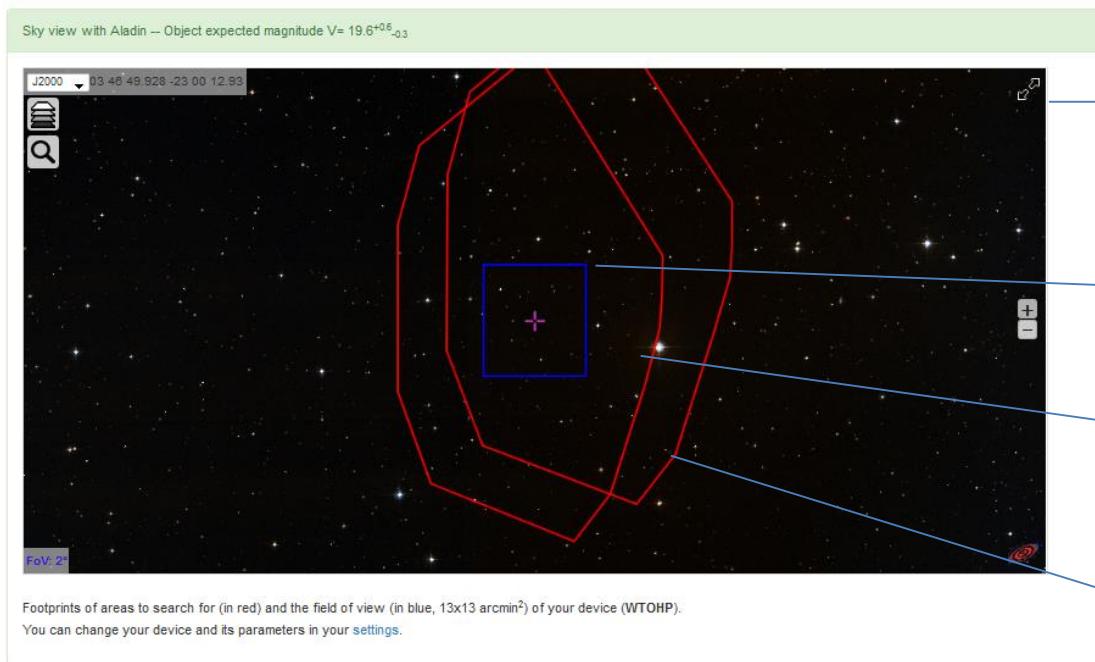
- Gaia ID: -4194967176
- Database ID: 10148
- Name: GAIA120
- Magnitude (V): $19.6^{+0.6}_{-0.3}$
- Date of observation: 11/13/2016

[Report observation](#) [Back to Gaia alerts](#)

Instrument and Field of View		
Field of View	RA	Dec
<input checked="" type="checkbox"/> 13x13 arcmin ²	03:55:02.880	-23:05:05.640

<https://gaiafunsso.imcce.fr>

Information
on the alert
+nb of transits



Sky map

Field of View
Here 12'x12'
Most probable
zone (blue)

Zone to explore
if not in the FoV
(red) on date 1

and on date 2

Available epochs								
Show?	Epoch	RA	Dec	V_{mag}	Rate	Orientation	Area	Polygon
<input checked="" type="checkbox"/>	2019-02-10 15:21:02	10:52:54.816	-22:07:43.320	$20.4^{+0.3}_{-0.2}$	0.36	-51.1	0.04945	
<input type="checkbox"/>	2019-02-11 03:21:02	10:52:40.416	-22:04:13.800	$20.4^{+0.3}_{-0.2}$	0.39	-52.6	0.05296	
<input checked="" type="checkbox"/>	2019-02-11 15:21:02	10:52:26.352	-22:01:58.440	$20.4^{+0.3}_{-0.2}$	0.37	-50.3	0.05711	
<input type="checkbox"/>	2019-02-12 03:21:02	10:52:11.568	-21:58:48.000	$20.4^{+0.3}_{-0.2}$	0.41	-51.7	0.06137	
<input checked="" type="checkbox"/>	2019-02-12 15:21:02	10:51:57.048	-21:56:58.920	$20.4^{+0.3}_{-0.2}$	0.39	-49.5	0.0663	
<input type="checkbox"/>	2019-02-13 03:21:02	10:51:41.856	-21:53:38.400	$20.4^{+0.3}_{-0.2}$	0.43	-50.8	0.07138	
<input type="checkbox"/>	2019-02-13 15:21:02	10:51:27.024	-21:47:02.120	$20.4^{+0.3}_{-0.2}$	0.41	-48.7	0.07724	

Ephemerides
+ Velocity



GFSS0: “Permanent” stations

- **Haute-Provence Observatory (OHP code 511)**

Joint programme GFSS0 + Sc. Alerts (photometry SN, gravi. Lens,...)

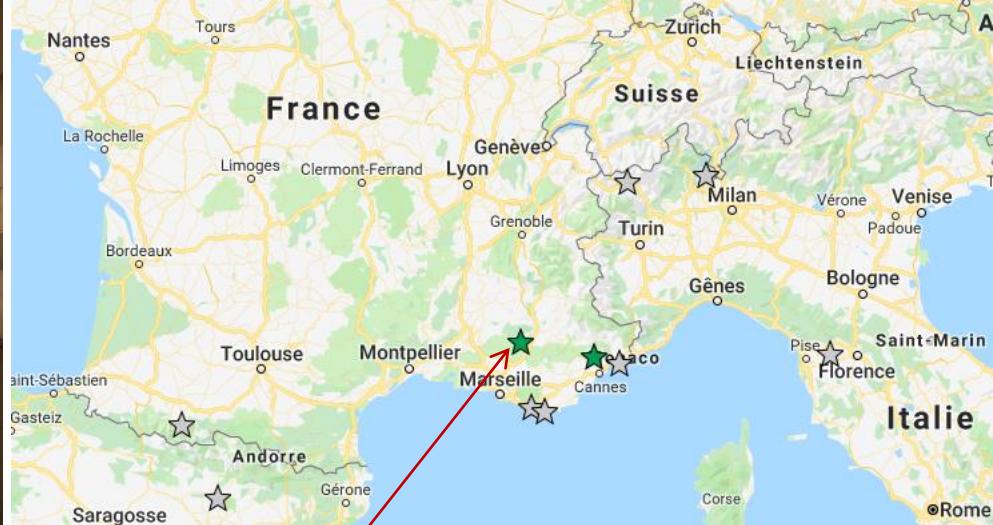
4 nights every 2 months

T 1.2m

« classical observations »



Credits: J. Desmars



OHP (France)
T1.2m

GFSSO: “Permanent” stations

- **Haute-Provence Observatory (OHP code 511)**

Joint programme GFSS0 + Sc. Alerts (photometry SN, gravi. Lens,...)

4 nights every 2 months

T 1.2m

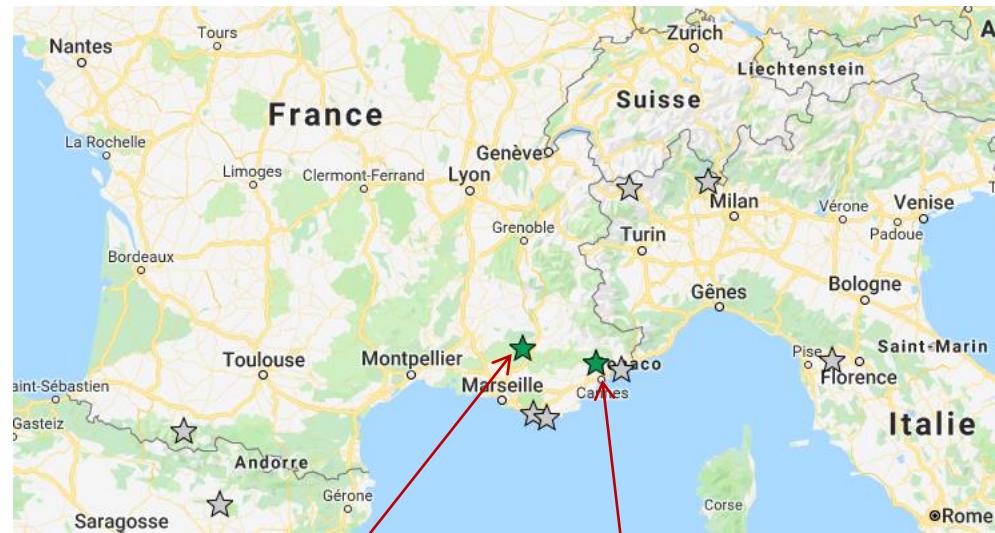
« classical observations »

- **C2PU remote telescope (OCA Calern Code 010)**

Observations in remote
programme GFSS0

4 nights every 2 months

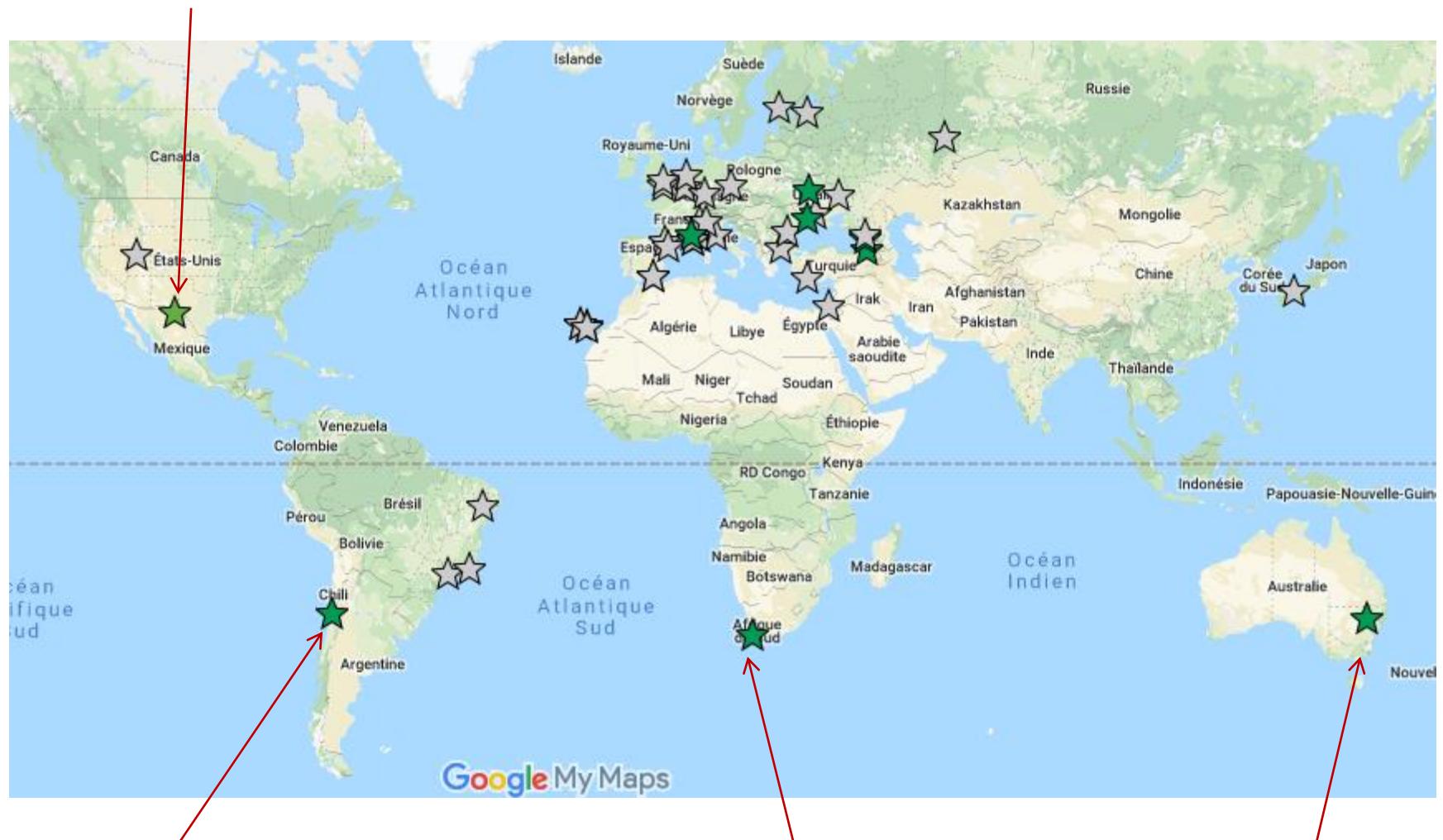
T 1.0m



OHP (France) C2PU (France)
T1.2m T1m

McDonald (USA, TX)
2 xT1m

LCOGT 1m robotic telescopes



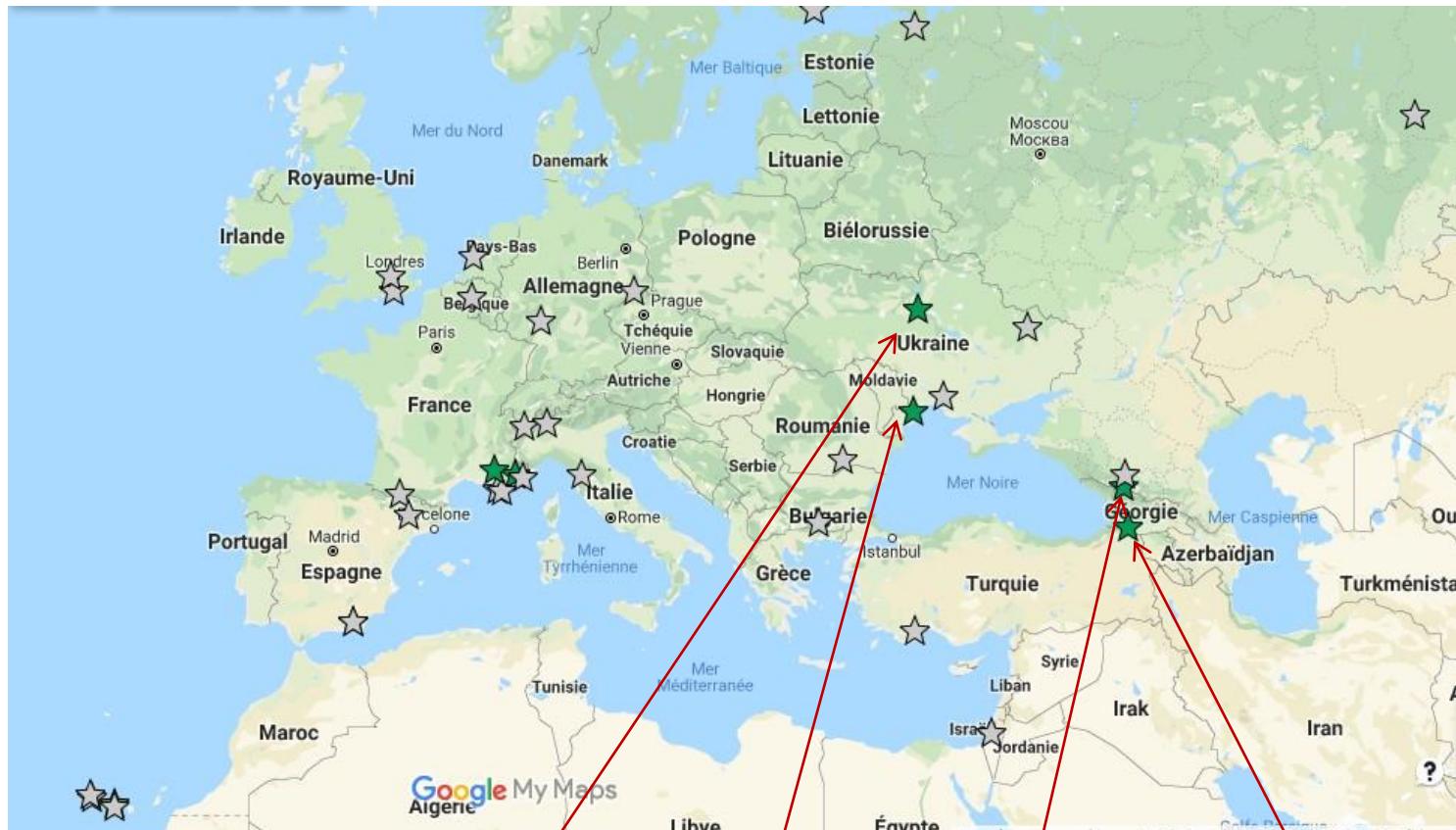
Cerro Tololo (Chile)
3 xT1m

Sutherland (South Afr.)
3 xT1m

Siding Springs (Austr.)
2 xT1m



GFSSO collaborations



Kiyv Comet Station
(Ukr.)

T0.7m

Odessa obs. (Ukr.)
T0.8m

Terskol
(Russia)

T0.8m

Abastumani
(Georgia)

T1.2m & T0.7m

The results (end 2020)

- More than 250 objects detected on alert
- Almost 200 designations assigned by MPC
- Most of the objects were lost or badly known (uncatalogued)
- 6 objects assigned to Gaia

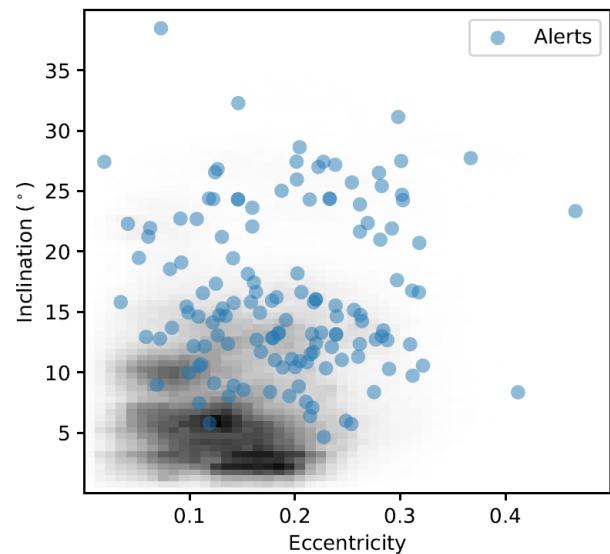
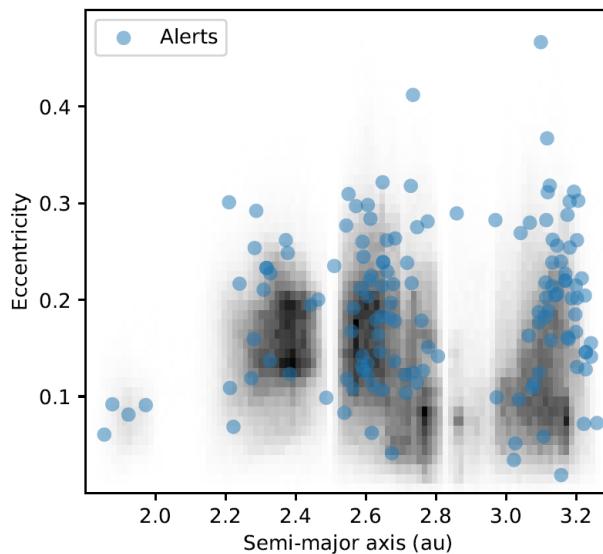
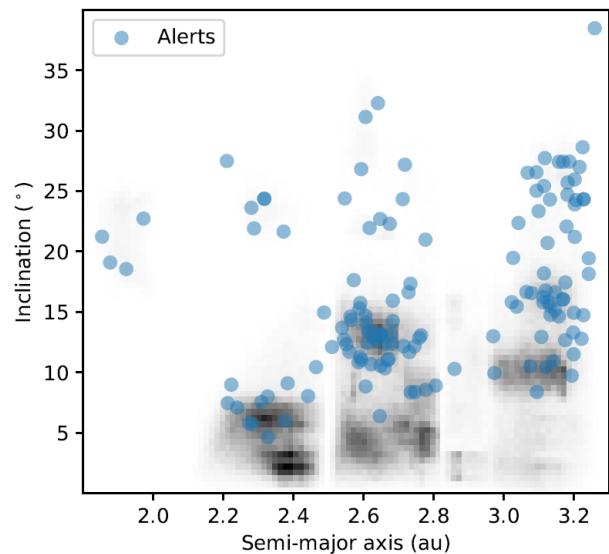
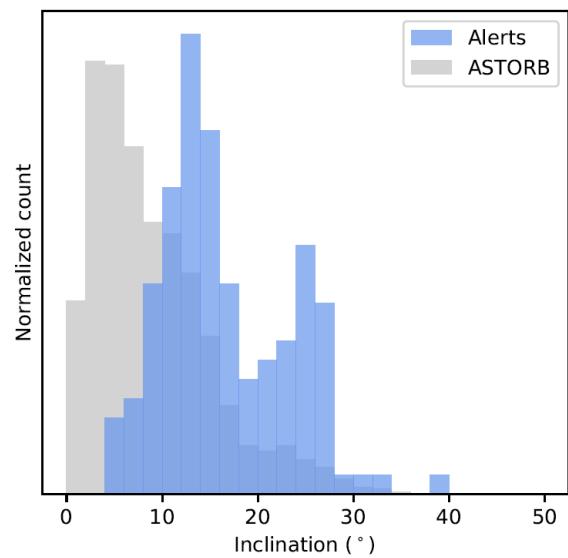
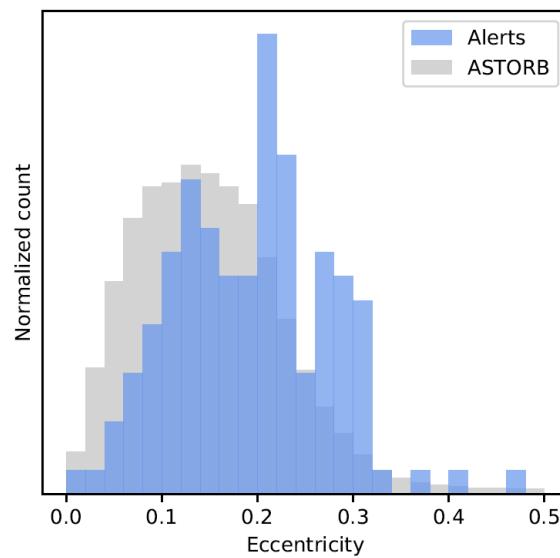
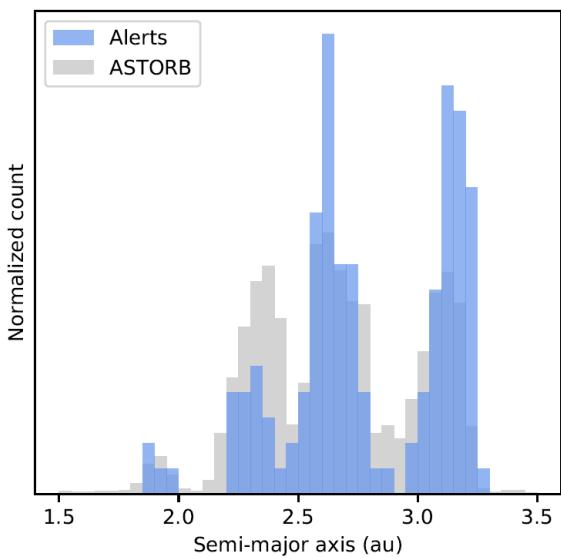
Table 1: Most-participating observatories of the network, with their numbers of detection (up to July 2020).

Observatory	Code	Country	Apert.(m)	Detections
Observatoire de Haute Provence (OHP)	511	France	1.2	44
C2PU, Observatoire de la Côte d'Azur)	010	France	1.0	23
Terskol Observatory	B18	Ukraine	0.6 & 2.0	27
Kyiv Comet station	585	Ukraine	0.7	21
Odessa Mayaki Observatory	583	Ukraine	0.8	18
Abastumani Observatory, Tbilisi	119	Georgia	0.7	
	V37	USA	1.0	
	V39	USA	1.0	
	W85	Chile	1.0	
	W86	Chile	1.0	
	W87	Chile	1.0	
Las Cumbres Observatory Global Telescope Network	Q63	Australia	1.0	
	Q64	Australia	1.0	
	K91	South Africa	1.0	
	K92	South Africa	1.0	
	K93	South Africa	1.0	

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The results (end 2020)

(Carry et al. 2020)



Summary

- Alerts triggered since Nov. 2016
- SST works well (up to 10 to 15 days after Gaia detection)
- More than 250 detections of « new » asteroids (end 2020)
- Few Gaia discoveries + many re-discoveries
- Soon Gaia alerts systematically sent to MPC
- Bias to high inclinations + outer main belt : poorly known population of asteroids

Carry et al. : article submitted to A&A accessible at

<https://arxiv.org/abs/2010.02553>