



# FINK tools for amateur follow-up of SSO

Roman Le Montagner, Julien Peloton (IJCLab)  
25/11/2023



# Fink: cloud-based broker

Brokers are software serving the scientific community by **ingesting**, classifying, filtering, and **redistributing** alerts from telescopes and surveys.

60+ members, 15+ scientific topics covered

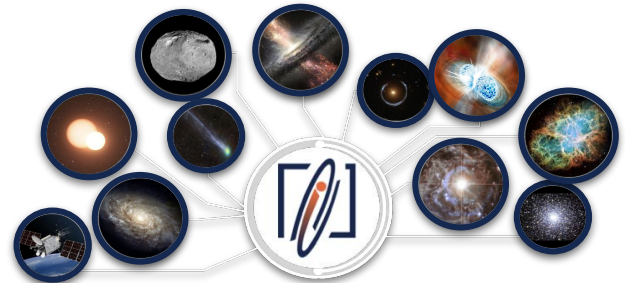
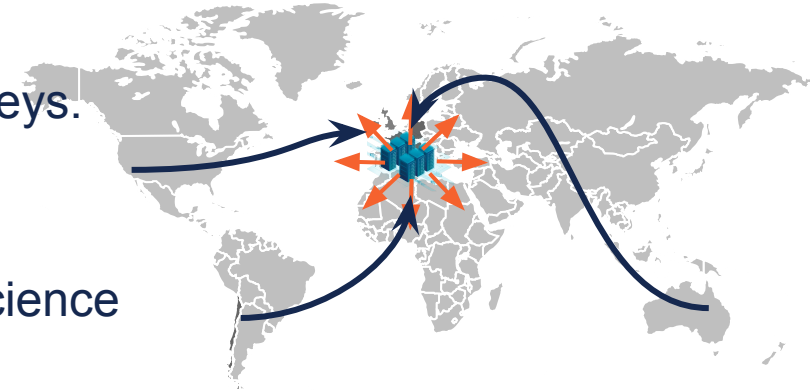
- Solar system, galactic and extragalactic science

Services deployed on large **OpenStack clouds** (UPSaclay & CC-IN2P3)

- Scalable to millions of alerts per night

Operating 24/7 since 2019, serving 100+ unique users per day (**scientists, follow-up facilities & amateurs\***)

*\*e.g. In GRANDMA*

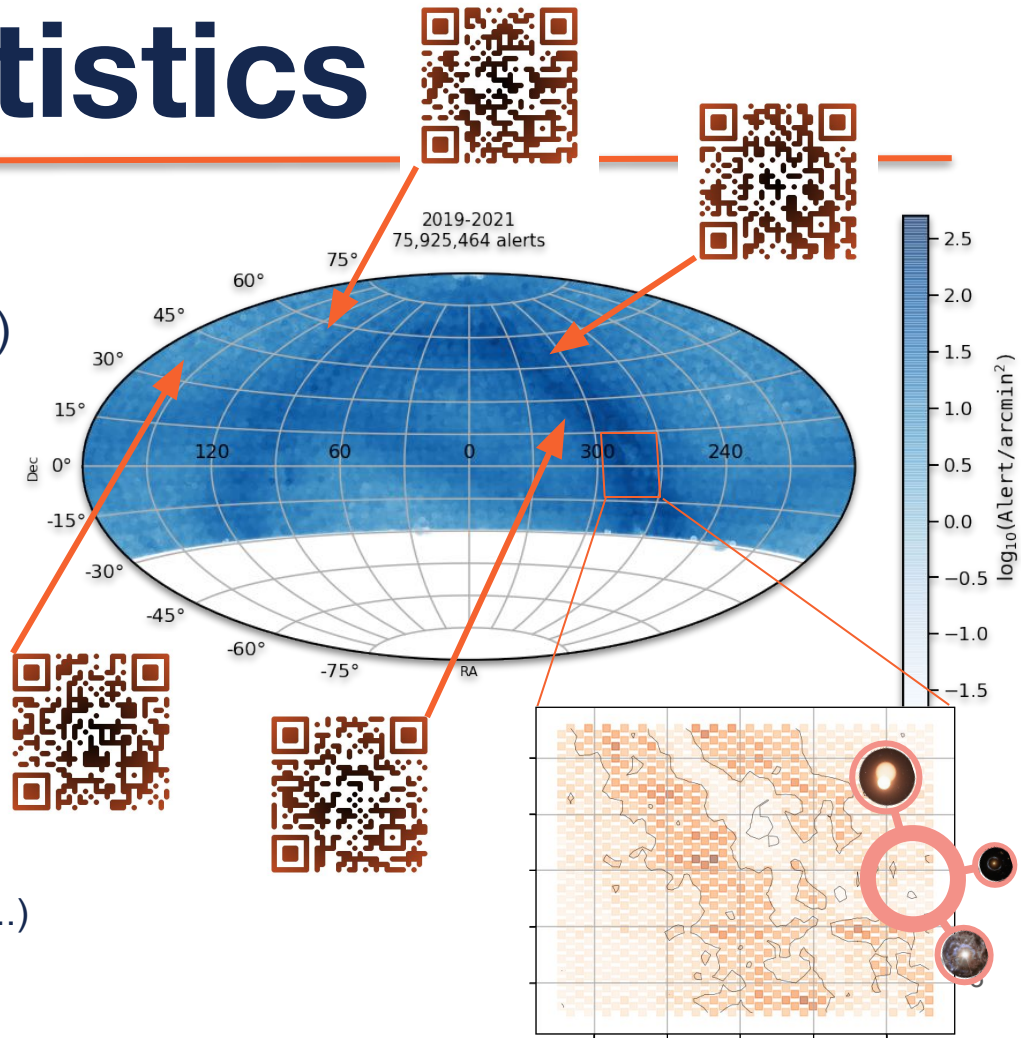


# ZTF/Fink statistics

210 million alerts received, 143 million processed (<https://fink-portal.org/stats>)

Typical nightly rates (200,000 alerts):

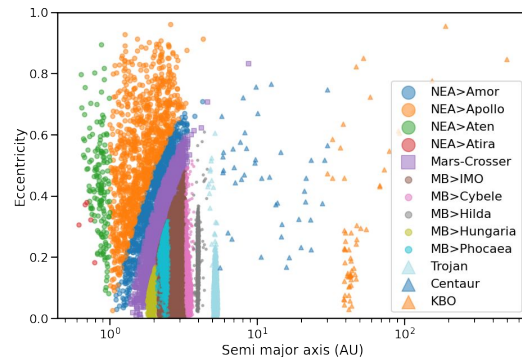
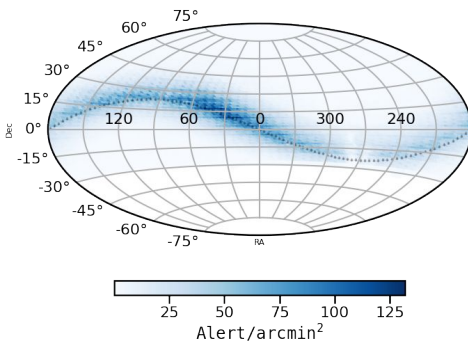
- ~75,000 known variable stars
- ~25,000 known SSO
- ~100 new SSO candidates
- ~100 new supernovae & core-collapse candidates
- ~50 (known+new) AGN
- ~10 (un)identified satellite glints
- ~5 new SN Ia candidates
- ~1 fast transient candidate (KN, GRB, CV ...)
- ~1 new microlensing candidate
- ~1 anomaly



# Solar System: what we know

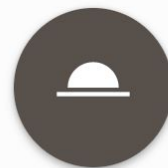
We can already capitalise on the huge data set in Fink from the MPC database

- 16M solar system alerts, which is about 500,000 unique objects



One of the difficulty is to get auxiliary data at this scale.

- <https://ssp.imcce.fr/webservices>
- Ephemerides: Miriade
- ID & properties: SsODNet



SsODNet

Information system



Miriade

Ephemeris generator



SkyBoT

Data mining



M4AST

Modeling for asteroids

# How to retrieve data

<https://fink-portal.org>

The screenshot shows the Fink portal search interface. A search bar contains the number '1922'. Above the search bar are several filters: 'objectId', 'Conesearch', 'Date Search', 'Class Search', 'SSO' (selected), and 'Trakklet'. Below the search bar are tabs for 'Info', 'Table', and 'Sky map'. A 'Table options' dropdown is visible, and a 'Preview' button is on the right. A table of search results is displayed with columns for 'objectId', 'RA (deg)', 'Dec (deg)', 'Last alert', 'Classification', and 'Number of me'. The first row is highlighted in red and circled with a red '3'. The 'SSO' filter and the search bar are circled with a red '2'. The 'SSO' filter is also circled with a red '1'.

objectId	RA (deg)	Dec (deg)	Last alert	Classification	Number of me
ZTF23abrlrvn	110.122921	-12.4440115	2023-11-15 11:07:10.001	Solar System MPC	1
ZTF23abrkkkn	110.1255761	-12.4376392	2023-11-15 10:02:57.002	Solar System MPC	1
ZTF23abqmgcs	110.2708611	-12.0141923	2023-11-12 11:29:07.999	Solar System MPC	1
ZTF23abpnbsj	110.4337895	-11.2870218	2023-11-07 12:20:52.999	Solar System MPC	1
ZTF23abpavoe	110.4718856	-10.9787321	2023-11-05 10:22:12.999	Solar System MPC	1
ZTF23aboncxj	110.4913558	-10.6857829	2023-11-03 11:03:11.002	Solar System MPC	1
ZTF23abninhj	110.3854494	-9.3463909	2023-10-25 11:24:05.996	Solar System MPC	1
ZTF23abmrmbp	110.2408126	-8.7568859	2023-10-21 12:02:40.004	Solar System MPC	1
ZTF23ablugyw	110.1432455	-8.4523052	2023-10-19 10:29:56.000	Solar System MPC	1
ZTF23abipqtg	109.2912147	-6.7304975	2023-10-07 12:02:55.003	Solar System MPC	1

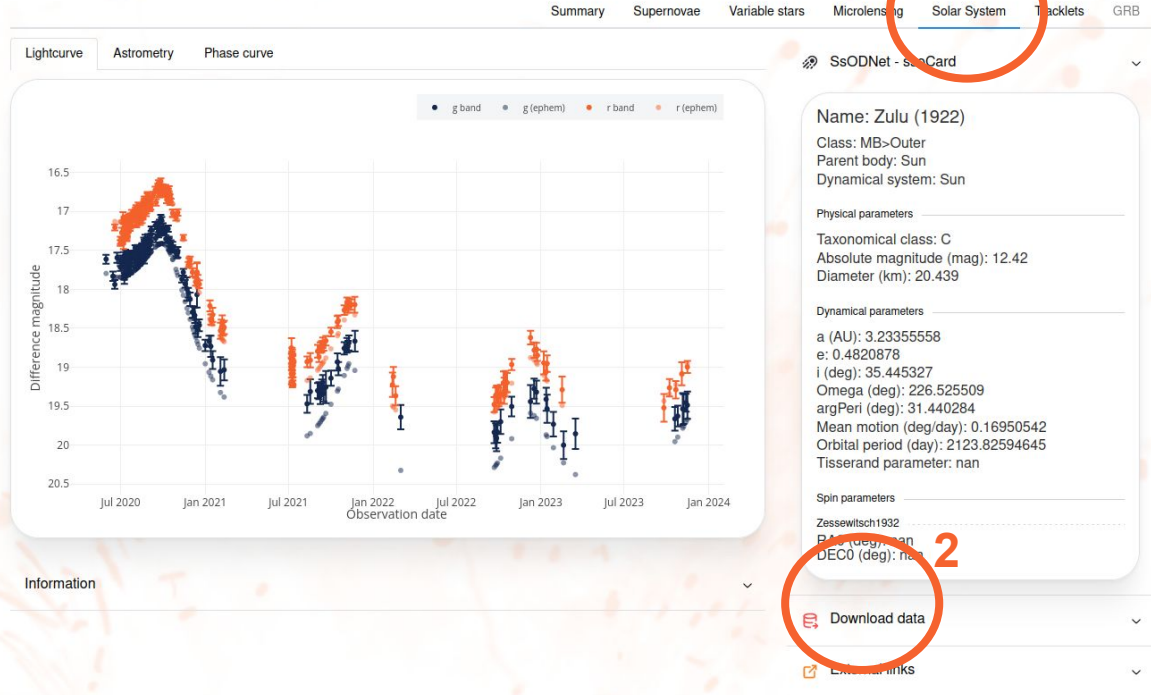
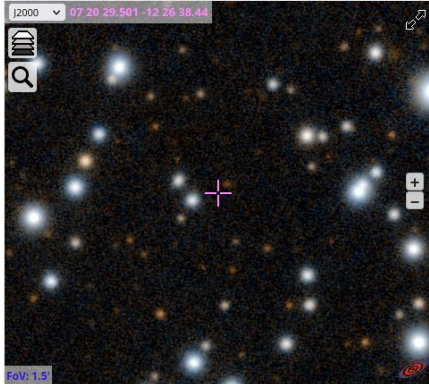
# How to retrieve data



ZTF23abrlrvn

SOLAR SYSTEM MPC

Discovery date: 2023-11-15 11:07:10.001  
Last detection: 2023-11-15 11:07:10.001  
Number of detections: 1  
Number of low quality alerts: 0  
Number of upper limits: 18



# Fink-Asteroids Tracker

---

Fink-FAT aka Fink Asteroids Tracker based on ArXiv:2305.01123

Challenge: Tracking systems over thousands (up to millions) of alerts leads to a very large combinatorial number.

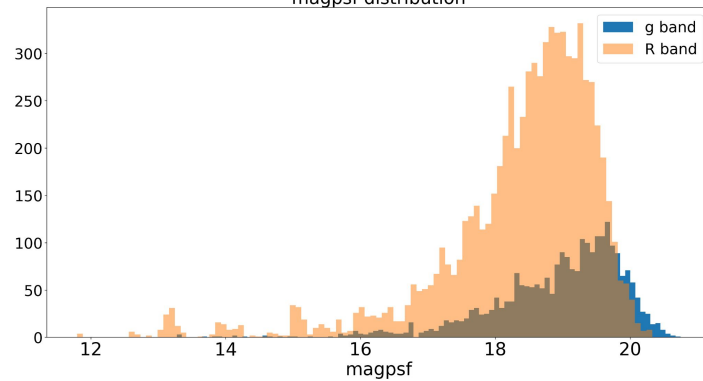
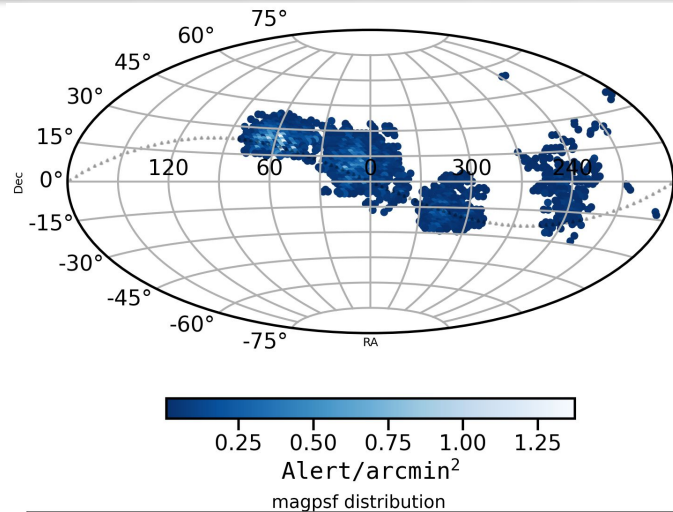
- **Filtering** (FINK alone)
  - reduce the number of alerts for the linking step
  - return a sample of independent asteroid candidate alerts
- **Linking** (FINK-FAT)
  - create a set of trajectory (linked alerts) from the asteroid candidates
- **Fitting** (FINK-FAT)
  - Find the orbital parameters of the trajectories

# Candidate Results

Tested between 2019-11-01 and 2023-11-24 (975 observing nights):

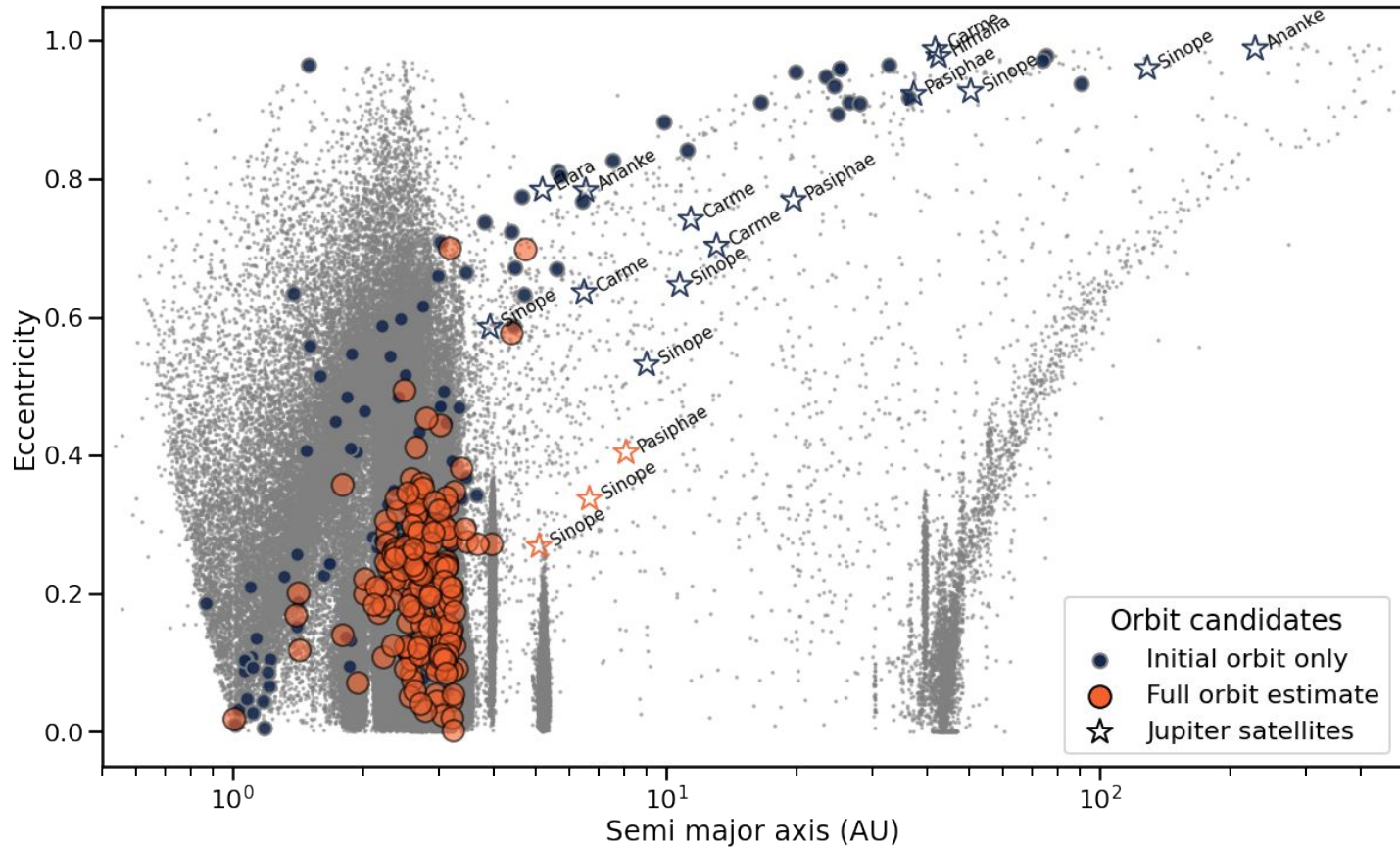
- **Input:** 596,107 alert candidates
- **Output:** 1,855 trajectories  
including **818 orbits with error estimation**

Most of trajectories have six measurements (~20 days), so they are very preliminary!

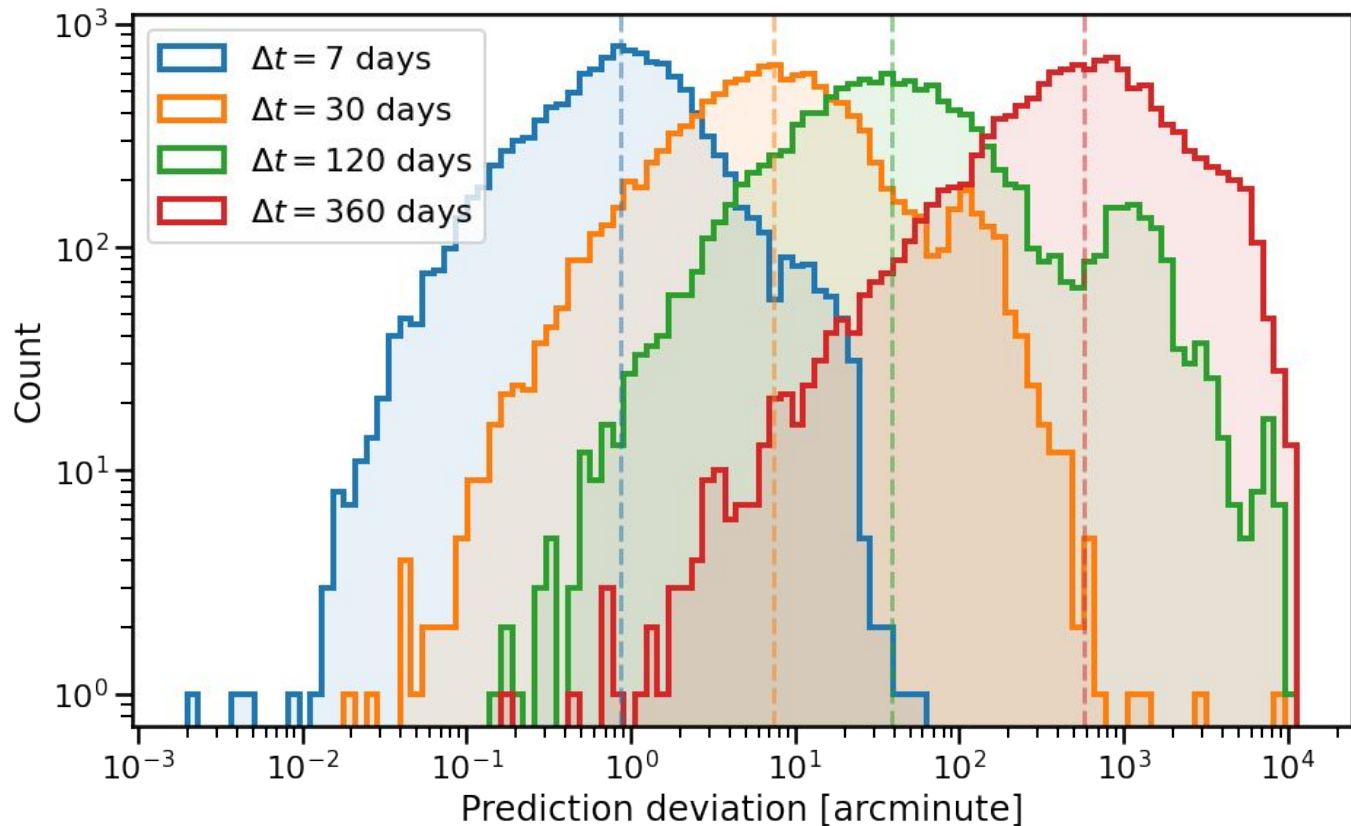




# Follow-up



# Follow-Up



# Fink-FAT Open Questions

---

- How do we interact together?
  - Observation campaign (trajectories mainly during Autumn)
  - How do we know that an amateur follows a trajectory?
  - What are the tools/services you would like to see in Fink?

# Useful links

---

Fink website: <https://fink-broker.org>

Fink Science Portal: <https://fink-portal.org>

Fink-FAT: <https://github.com/FusRoman/fink-fat>

Documentation: <https://fink-broker.readthedocs.io>

Tutorials (notebooks): <https://github.com/astrolabsoftware/fink-tutorials>