



Multi messenger astronomy: latest results from the fink broker



IN2P3
Les deux infinis


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15/12/2023

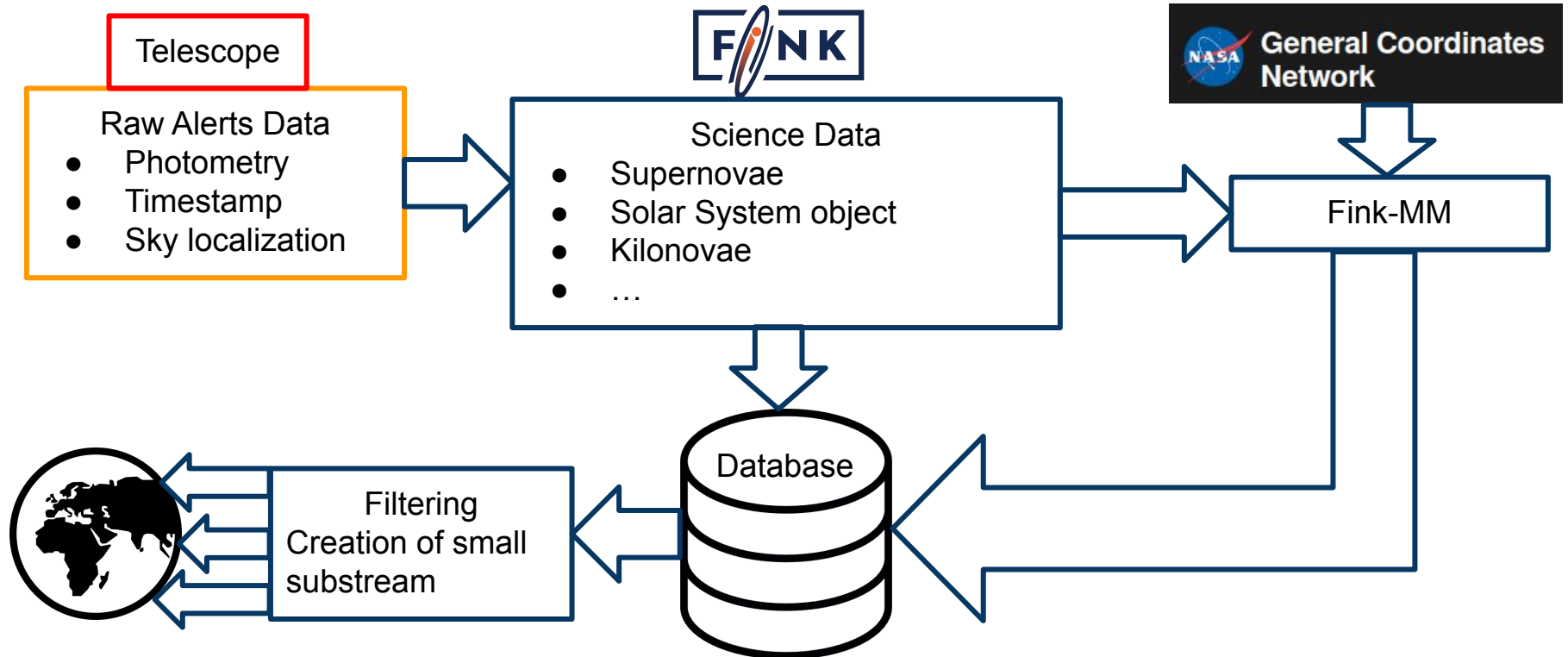


FINK : An Astronomical Alert Broker

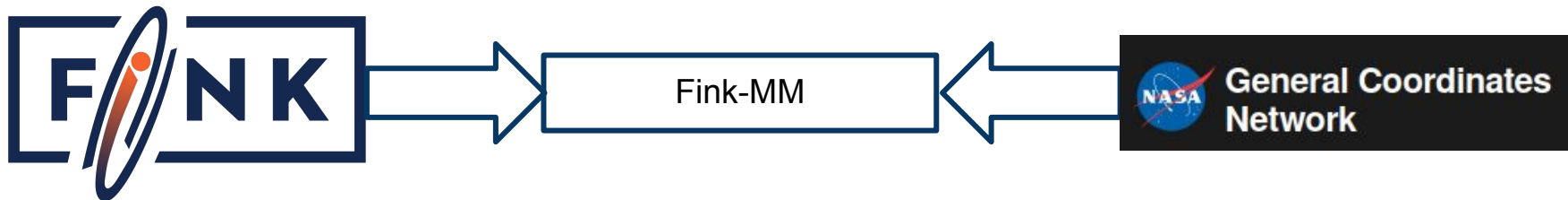
Fink's goals :

- Studying the transient sky as a whole, from solar system to galactic and extra-galactic science
- Enabling real-time science with the large volume of alerts from the Rubin Observatory
- Guaranteeing permanent access to archival data and data analysis tools (all Fink products are **publicly** available)
 - Fink is a community-driven effort, open to anyone (60 scientists world-wide contribute to the project)
-  **Online since 11/2019 using ZTF public alert stream**

Multiwavelength/Multimessenger pipeline



Challenges



- Ruben Observatory will send about **10 million alerts per night over 10 years**
 - ~ 1TB/night: x100-x1000 above current streams
 - current tools do not scale

Rubin brokers were selected to analyze this monster stream.

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

Currently testing on the Zwicky Transient Facility (~200,000 alerts/night)



Challenges



Identify the alerts as potential optical counterparts of multiwavelength/multimessenger (MW/MM) events

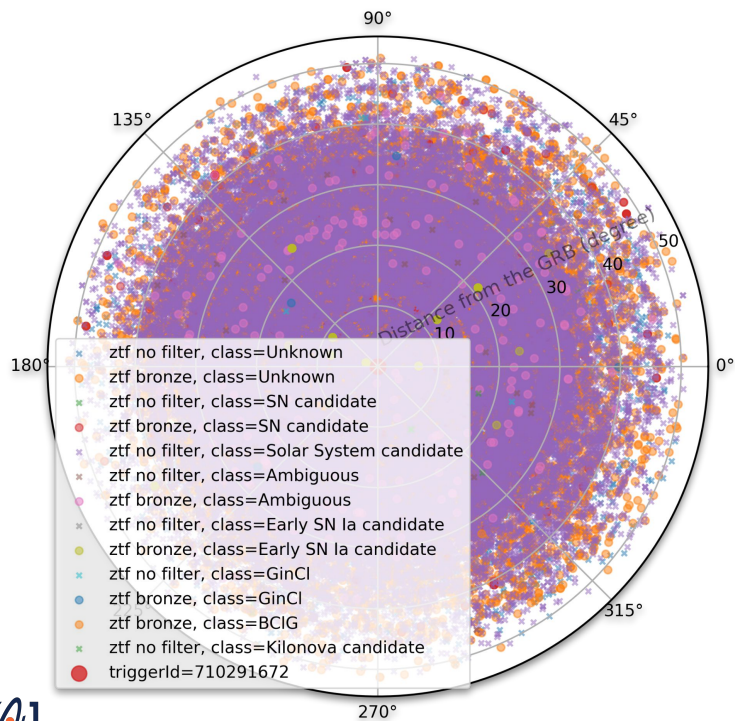
- Current connected instruments: Fermi, Swift, Integral, Icecube, Ligo Virgo Kagra (LVK)

Localization error are very huge (up to several square degree for the worst)

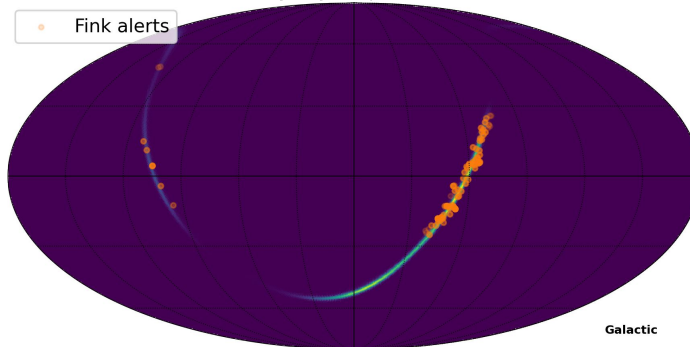


Challenges

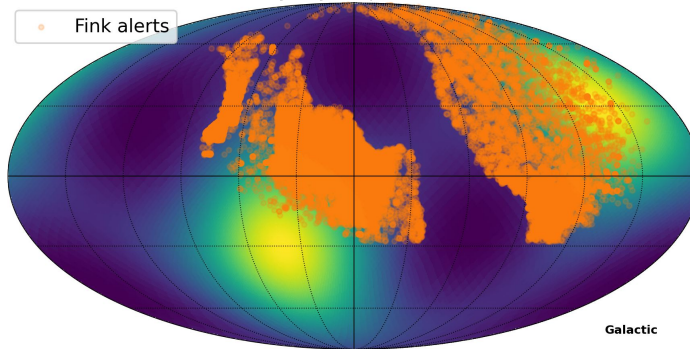
ZTF alert distribution
for the GRB triggerId=710291672



Probability sky maps for G441185



Probability sky maps for G419671



Filtering

Filtering / Distribution

- Bronze
 - $\text{realbogus} \geq 0.7$
 - Only extra-galactic objects or Unknown
- Silver
 - is Bronze
 - GRB association probability above 5 sigma
- Gold
 - is Silver
 - Magnitude rate above 0.3 mag / day
- Online : Real-time cross-match
 - Latency : ZTF > 15 min, LSST > 2 min
- Offline : 20 days time window

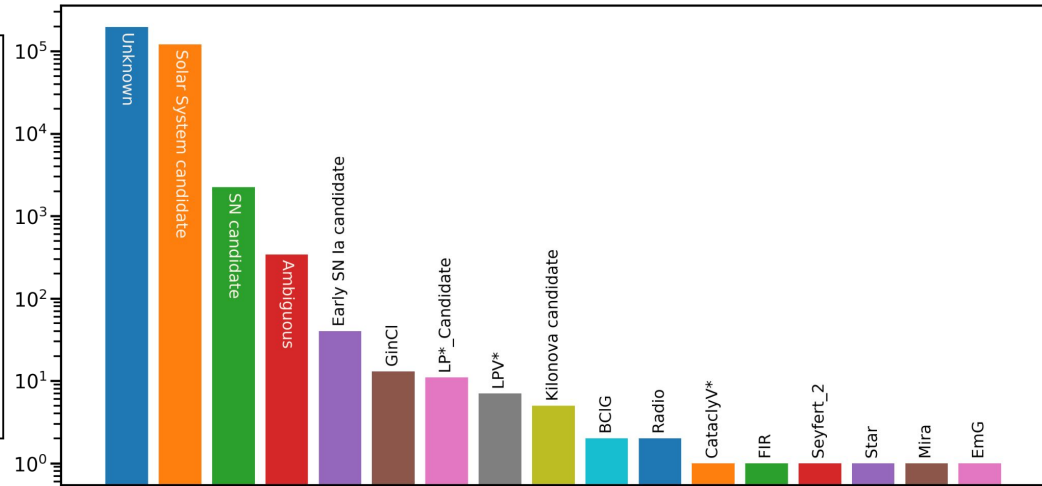
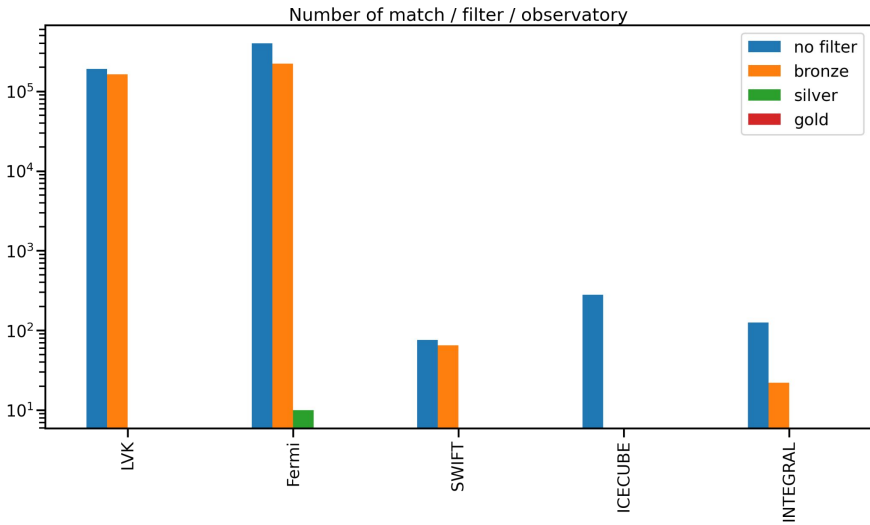


New filters can be easily added



Results

- 333384 matched alerts since 06-2023 (321066 unique ZTF objects)



[Le Montagner et al 2023, A&A](#)



Results

GCN N° 714809315 / GRB230827B

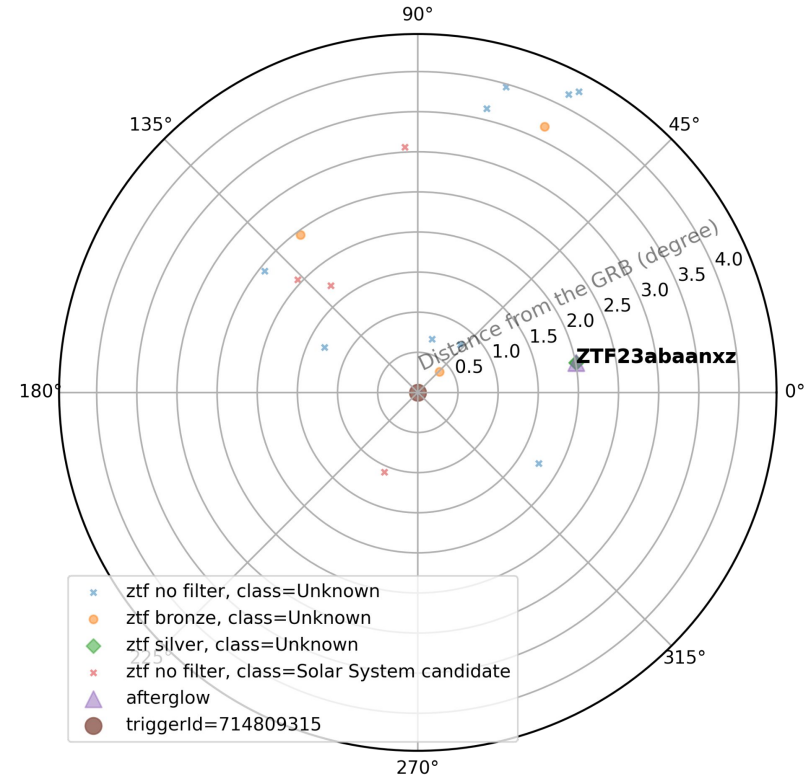
- Fermi GBM
- Long GRB : T90 ~ 11 s (50-300 keV)

2 **silver** match in ZTF alerts:



- [ZTF23abaanxz](#)
- 1.63 hours after triggerTime
- Two measurements in r band, fast fading.
- Afterglow reported by the ZTF team

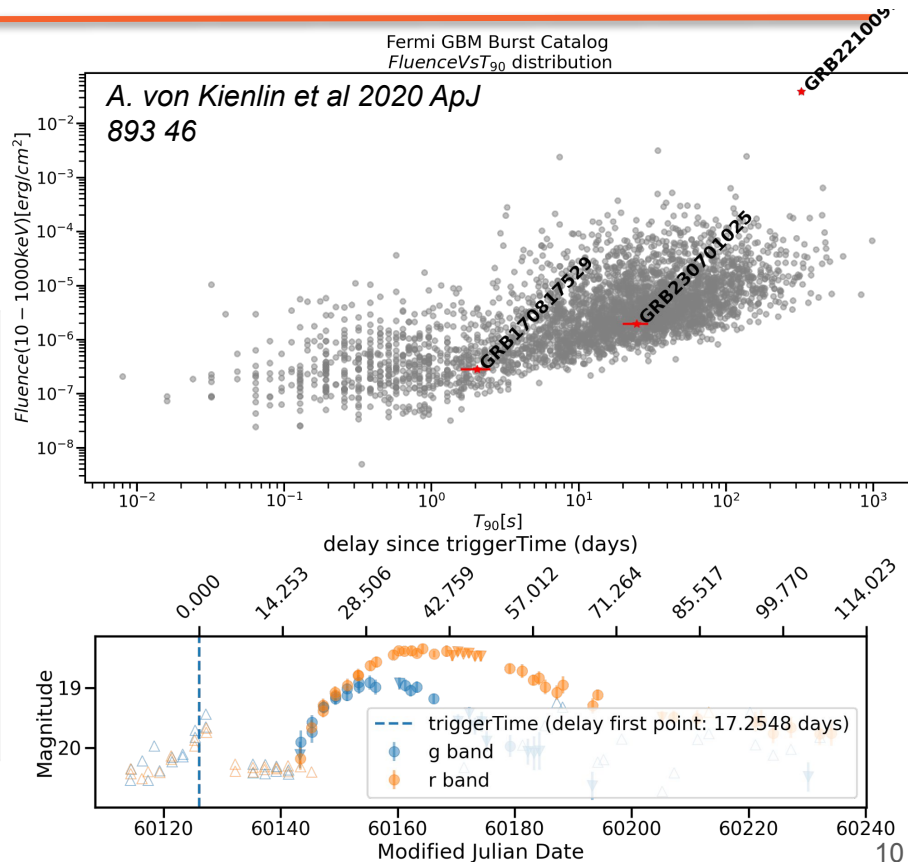
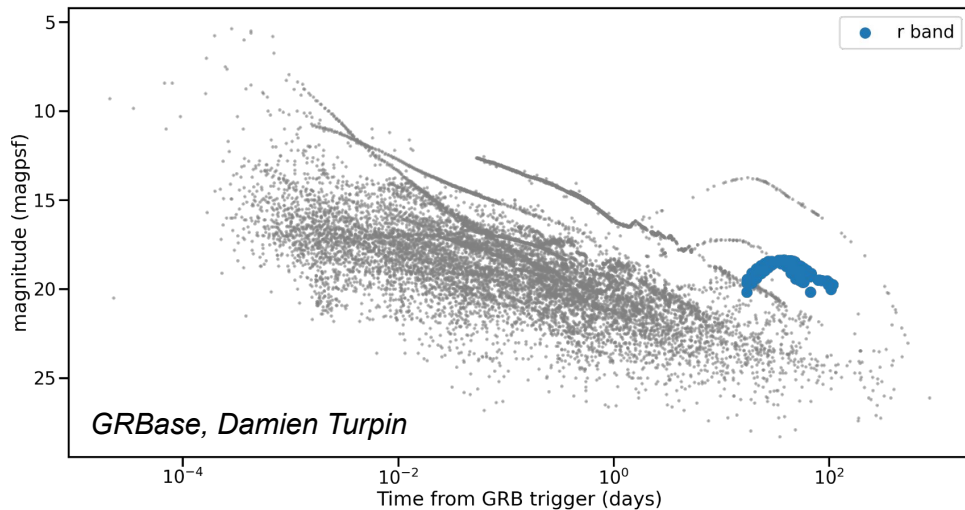
ZTF alert distribution
for the GRB triggerId=714809315



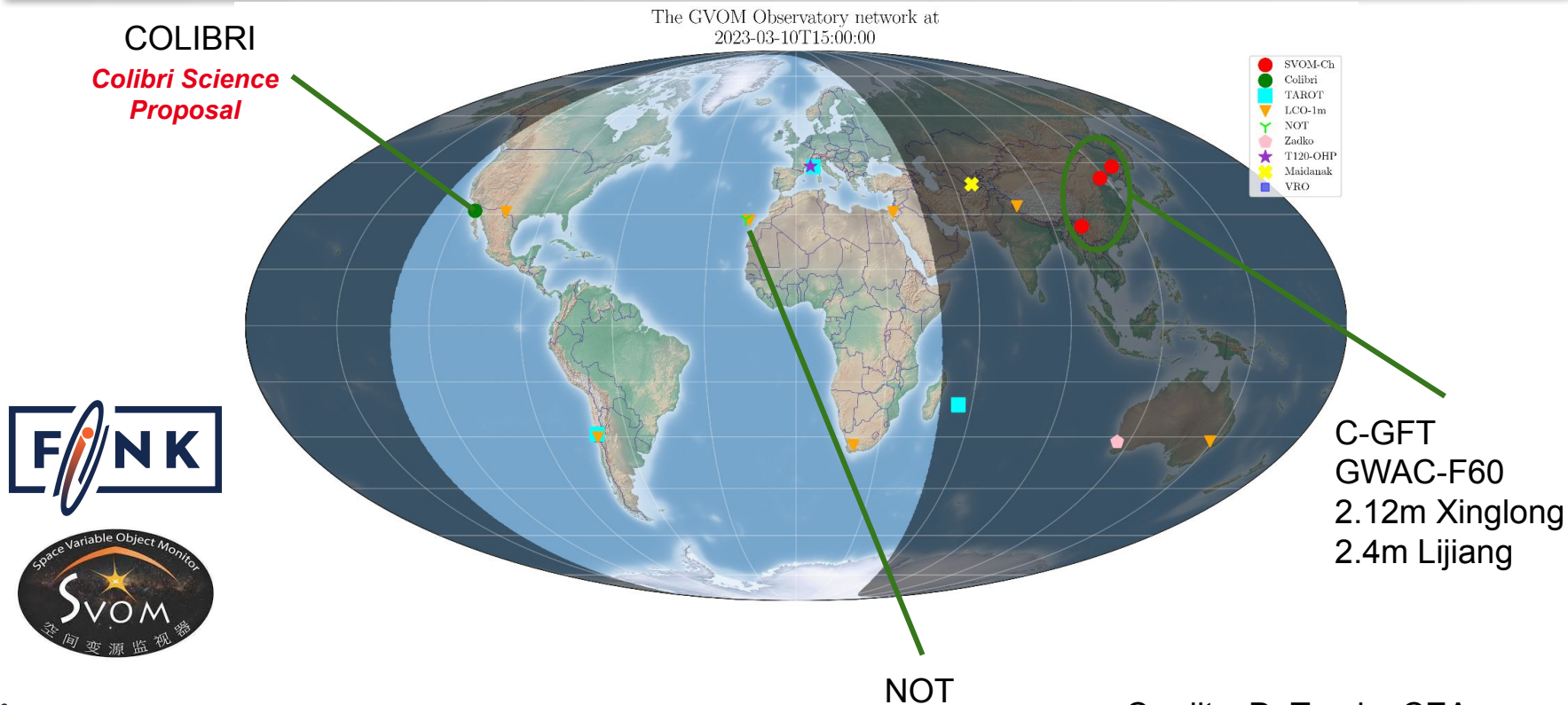
Results ([ZTF23aaspcfl](#) / SN 2023nlj)



- classified firstly by Fink as Smla
- classified by TNS as SN Ib (redshift = 0.03)
- Potentially associated with **GRB230701**
 - $T_{90}=24.832$



GVOM : A telescope network to build



Credits: D. Turpin, CEA

TOM-TOOLKIT



TOM TOOLKIT Las Cumbres
Observatory LC 

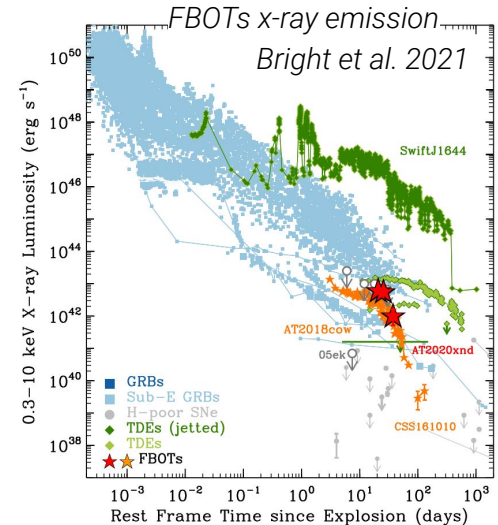
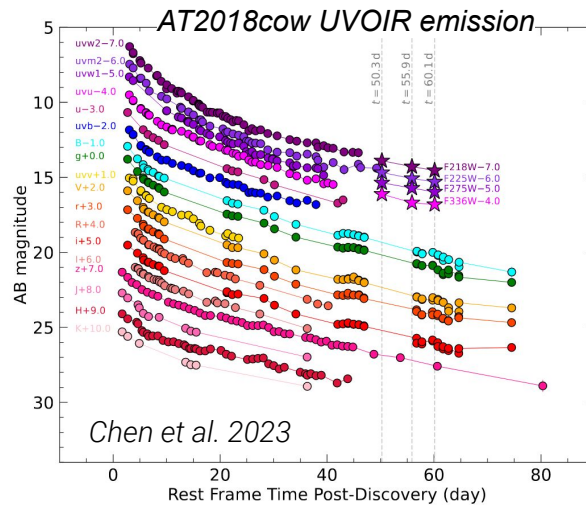
- Target and Observation Manager (TOM) Toolkit
 - *‘facilitate astronomical observing projects and collaborations’*
 - *‘particularly important for programs with a **large** number of potential targets and/or observations’.*
-
- Web development framework (Django)
 - easy as possible

<https://tom-toolkit.readthedocs.io/en/stable/introduction/about.html>



FBOT & Red-fast transient

- Fast Blue Optical Transient (FBOT)
 - 5 confirmed detections with significant follow-up efforts
 - multi- λ needed to study them!
- Red-fast transient
 - orphan kilonovae



TOM-TOOLKIT

Welcome to the Fink-TOM.



- The official [Fink website](#).

Latest Comments
No comments yet.

Latest Targets	
ID	Created
ZTF23abmcuiz	2023-12-06
ZTF23abrzfqq	2023-12-06
ZTF23abmdizb	2023-12-06
ZTF23abryude	2023-12-06
ZTF23abrzcceh	2023-12-06
ZTF23abokngu	2023-12-06
ZTF23abowjyf	2023-12-06
ZTF23abjfrmc	2023-12-06
ZTF23abrygsh	2023-12-06
ZTF23abryswc	2023-12-06



TOM-TOOLKIT

ZTF23abrqzvu

There are 2 observations with unknown status.

[Update](#) [Delete](#)

Names	ZTF23abrqzvu
Target Type	SIDEREAL
Right Ascension	281.8774
	18:47:30.564
Declination	81.5934
	+81:35:36.26
Epoch	2460268.6209
Tags	
triggerTimeUTC	2023-11-20 02:54:03.004
fink broker link	https://fink-portal.org/ /ZTF23abrqzvu

Recent Photometry	
Timestamp	Magnitude
2012-02-02 01:02:47	15.5820
2012-02-02 01:02:47	15.6760
2012-02-02 01:02:47	15.5010

[Observe](#) [Observations](#) [Manage Data](#) [Manage Groups](#) [Photometry](#)

[Spectroscopy](#)

Observe

[Colibri](#) [Xinglong](#) [OHP](#) [Jilin](#) [ORM](#) [Maidanak](#)

Apply an observation template

Observation template*

Cadence strategy

[Apply](#)

Plan

Start Time

16 / 12 / 2023 

End Time

18 / 12 / 2023 

Maximum Airmass

4 

[Plan](#)



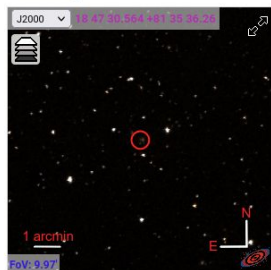
TOM-TOOLKIT

2012-02-02 01:02:47 15.5910

Share Data for ZTF23abrqzvu:

Not Configured

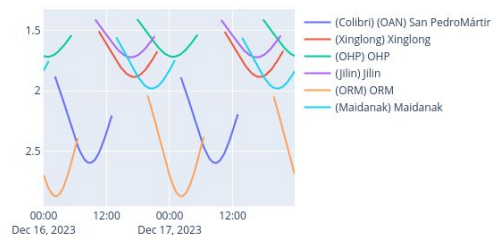
Survey View



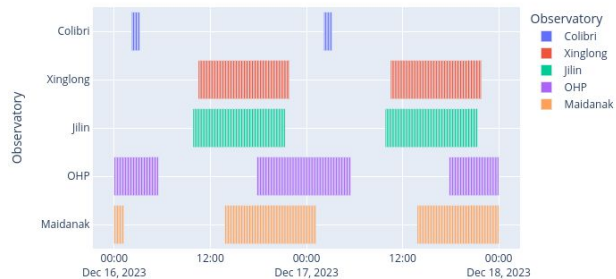
Field of view 10 arcmin

Scale bar 1 arcmin

Update Save Image



ZTF23abrqzvu Observability by gvom network



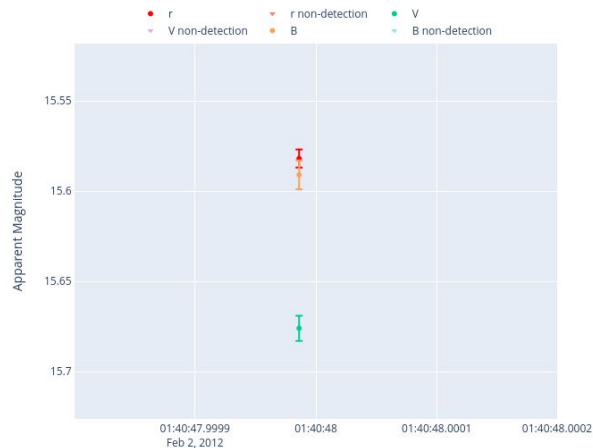
TOM-TOOLKIT

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Share Data for ZTF23abrqzvu:
Not Configured

Survey View



Photometry Data						
<input type="checkbox"/> Share	Timestamp	Telescope	Filter	Magnitude	Error	Source
<input type="checkbox"/>	2012-02-02 01:02:47		r	15.5820		ZTF
<input type="checkbox"/>	2012-02-02 01:02:47		V	15.6760		CSS
<input type="checkbox"/>	2012-02-02 01:02:47		B	15.5910		Las Cumbres
<input type="checkbox"/>	2012-02-02 01:02:47		B	> 18.0000		DLT40

Share Selected Data
Not Configured



Conclusion

- fink-mm is running on the Fink Broker every time ZTF observed
 - kafka topics are available to recover the alerts
 - documentation: <https://github.com/FusRoman/fink-mm>
 - how to access the topics: <https://github.com/astrolabsoftware/fink-client>
 - Ready for LSST and the next generation observatories
 - ET, CosmicExplorer, LISA, KM3NET, SVOM, ...
 - Investigating cross-match possibility with CC-GW alerts in O4
- GVOM will allow to increase the number of photometric points of the match and so, improve the fast transient science <https://fink-broker.org>
<https://fink-portal.org>
contact@fink-broker.org

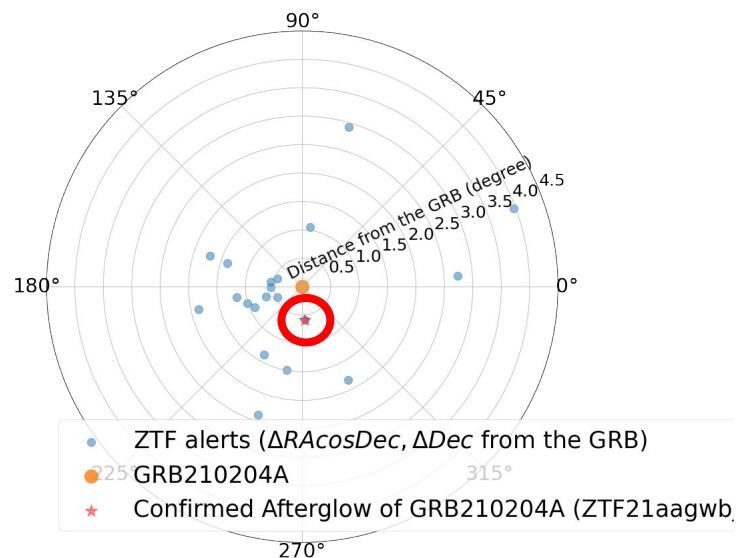


Backup slides



GRB Serendipitous Probability

20 ZTF alerts spatially and temporally consistent with the GRB210204A



Filtering : Serendipitous probability (Damien Turpin, CEA)

$\mu = \text{event_detection_rate} * \text{delay (between alerts and event)}$

$\Delta = \text{event error box}$

$$p_{\text{event}} = 1 - P(k = 1, \mu), P \sim \text{Pois}(\mu)$$

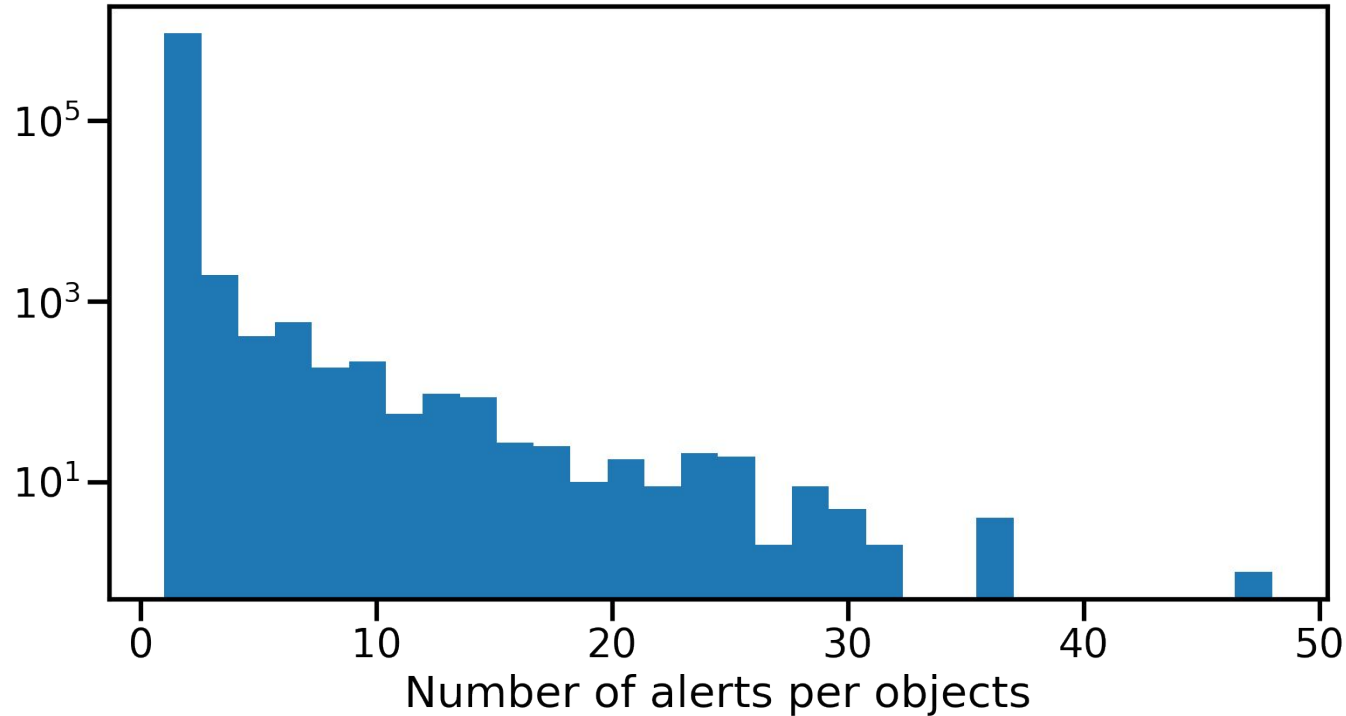
$$p_{\text{event_in_ZTF}} = \frac{\text{ZTF_sky_area}}{\text{all_sky_area}} * p_{\text{event}}$$

$$p_{\text{ser_event}} = p_{\text{event_in_ztf}} * \frac{\pi \Delta^2}{\text{ZTF_sky_area}}$$

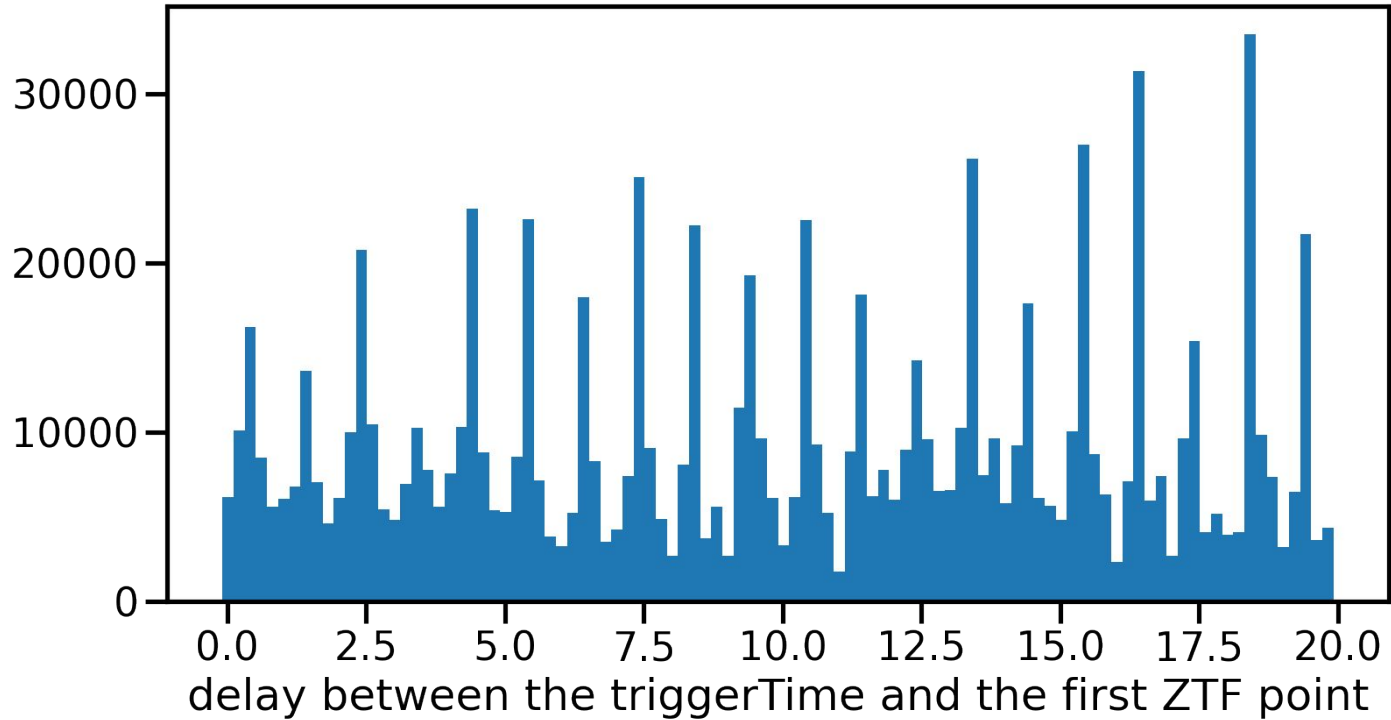
1. ZTF21aagwbjr (Reporter/s : Erik Kool, Igor Andreoni, Anna Ho, Michael Coughlin, Tomas Ahumada, Daniel Perley, Yuhan Yao)
2. https://heasarc.gsfc.nasa.gov/wsgi-scripts/tach/gcn_v2/tach.wsgi/



Number of detection per object



Object delay since trigger time



Magnitude distribution

