# a gateway to Rubin astronomical alerts

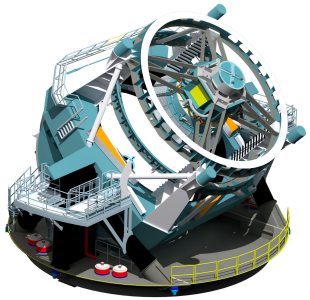
*Glimpses from the Euro-brokers initiative*

*First ACME workshop: The gravitational wave sky and complementary observations*
*IRAP, Toulouse - France*
*10 April 2025*

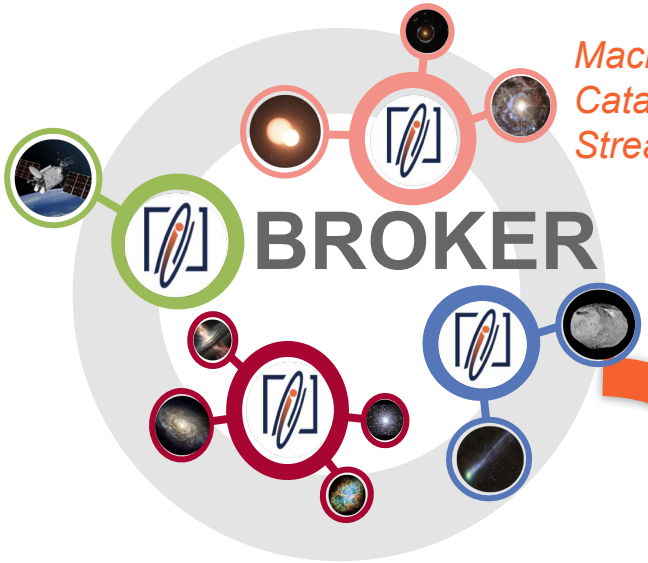
**Emille Ishida**, Julien Peloton and Anais Moller
on behalf of the Fink Team

# The data path

*every ~30 seconds down to mag ~24*



*10 million alerts per night…*

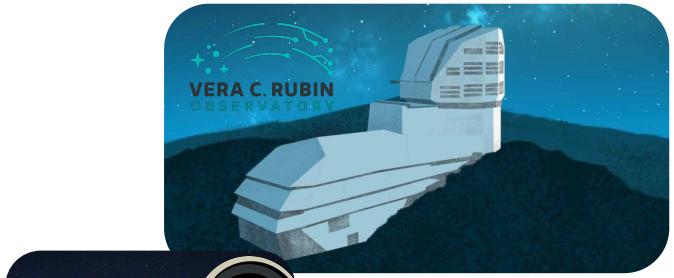



*Machine learning*
*Catalog association*
*Streams join*

*We would like the **interesting** ones ...*

# Fink in a nutshell

Fink is a broker serving the scientific community by ingesting, classifying, filtering, and redistributing alerts from telescopes and surveys.

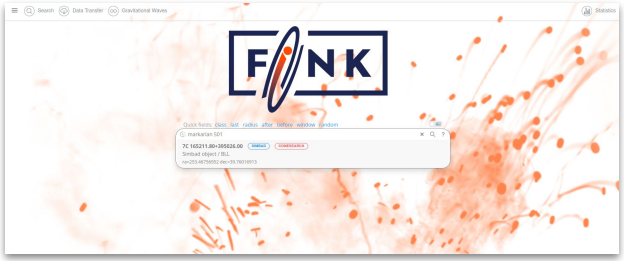




As of 2025: 70+ collaborators, 15 countries

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)

# What do we do?

Scientific roadmap is completely open

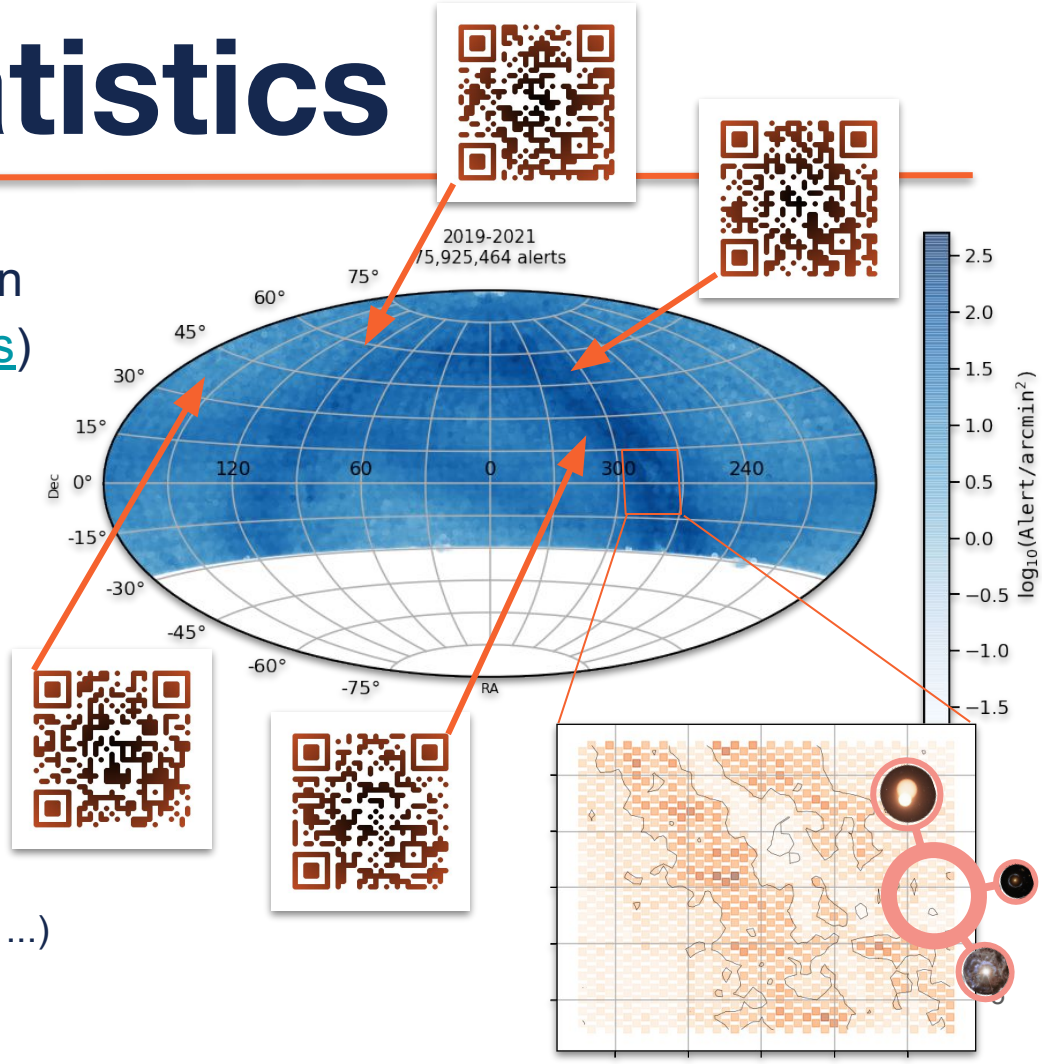
- Satellites & debris detection
- Solar System science [LSST SSSC]
- Galactic science: microlensing events [LSST TVS], cataclysmic variables, YSO…
- Extra-galactic science: supernovae [LSST DESC], gamma-ray bursts, blazars, kilonovae, tidal disruptive events, …
- Anomaly detection, hostless transients, …

# ZTF/Fink statistics

280 million alerts received, 190 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



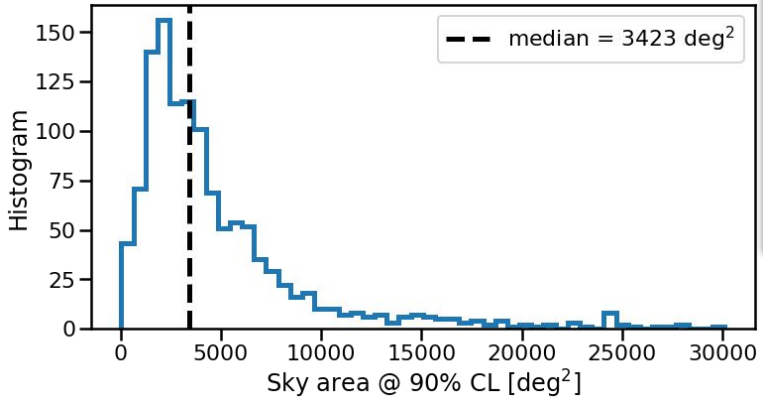
# Crossmatch with GW sky maps

Goal: provide any ZTF/Rubin alerts emitted within [-1, +6] days of a GW trigger https://fink-portal.org/gw

- Search among 200+ million ZTF alerts!
- O3 & O4 sky maps available
- API: /api/v1/bayestar endpoint.

Customisable to any existing source

- Contact us if you want to add your sky maps!

# Real-time MMA

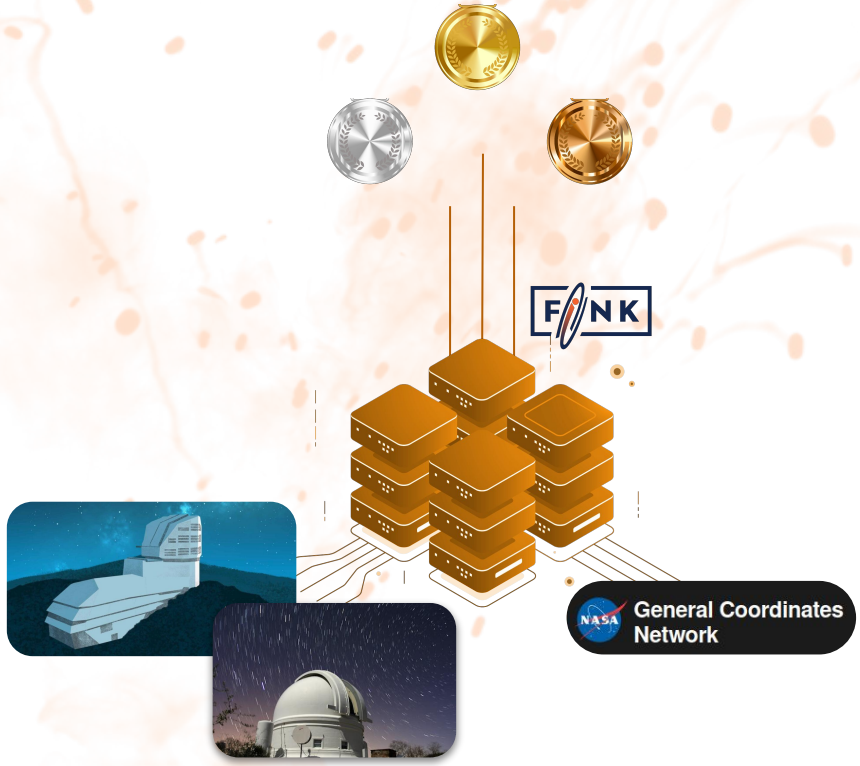
*Roman Le Montagner (IJCLab)*

[Fink-MM](): open source framework interfaced with Fink

Real time crossmatch between optical survey streams (ZTF/Rubin) and circulars from the GCN (Fermi, Swift, INTEGRAL, LVK, Icecube,…)

Series of custom filters implementing user-driven logic (physics!)

Scalable to million of alerts per night

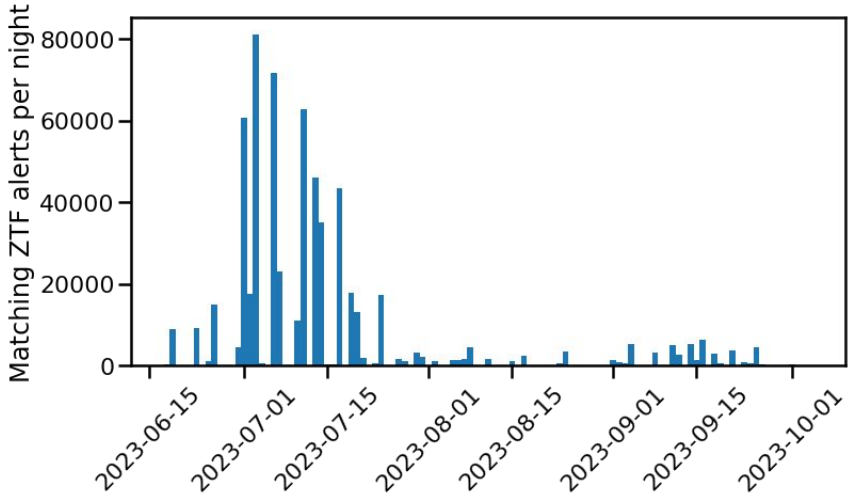


# Who are the GCN?

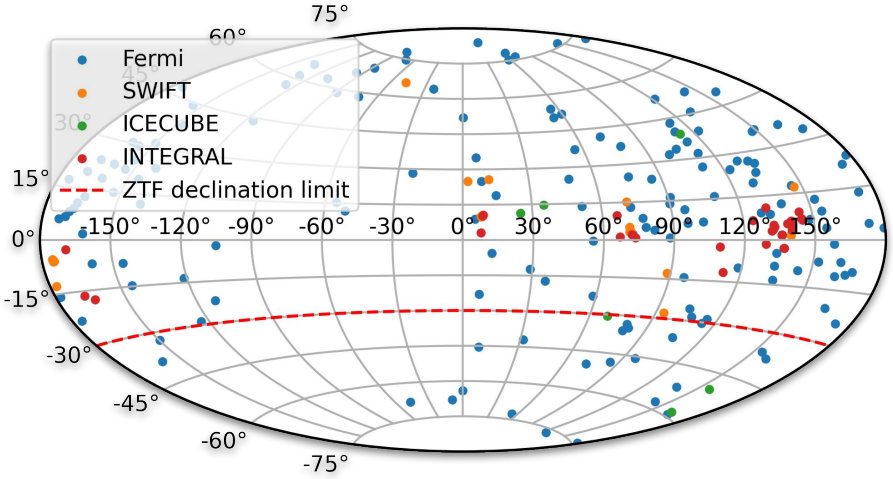
*Roman Le Montagner (IJCLab)*

GCN mainly from Fermi GBM…

… but error boxes can be huge!




**June - October 2023**

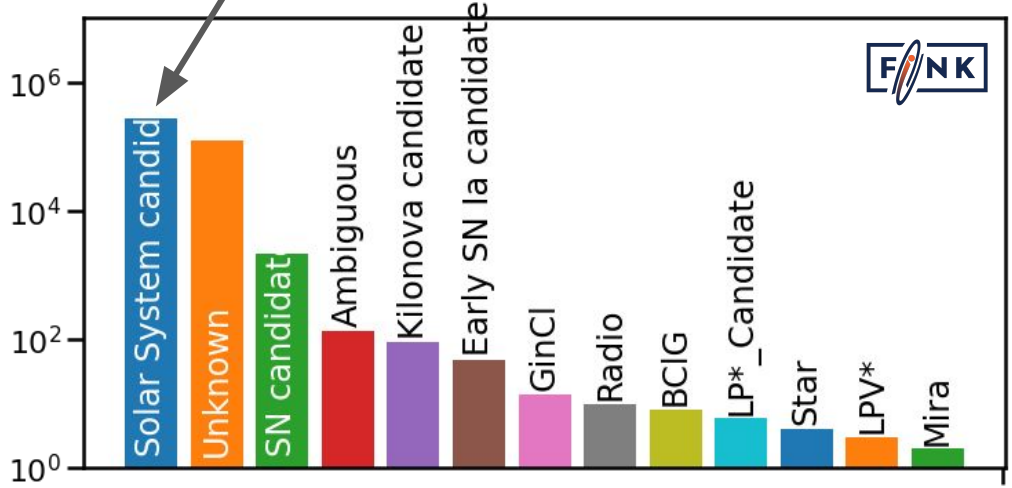


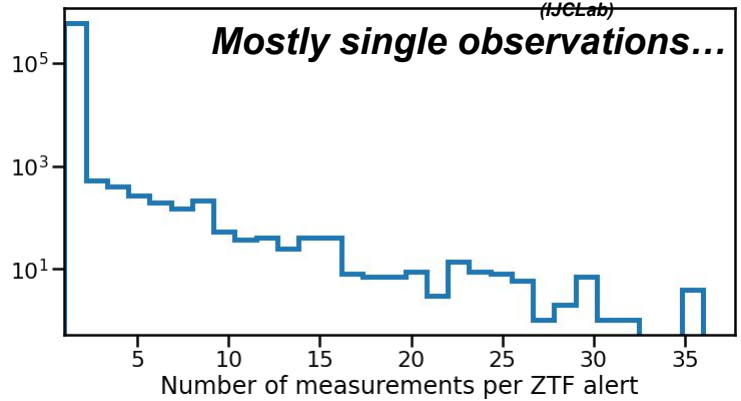

*O4 events not displayed*

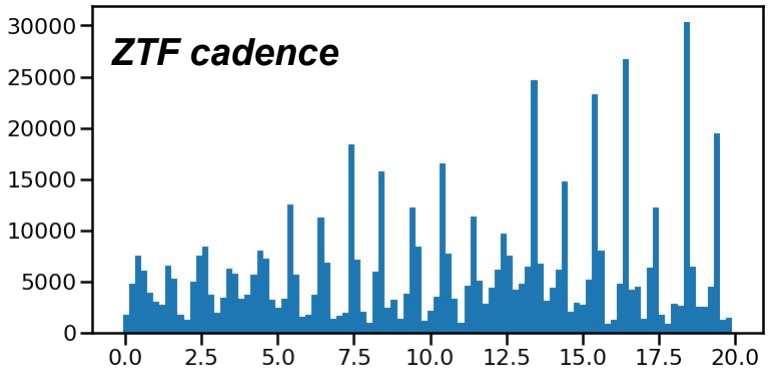
# Who are the ZTF match?

Roman Le Montagner (IJCLab)

[Le Montagner et al 2023, A&A, in press]



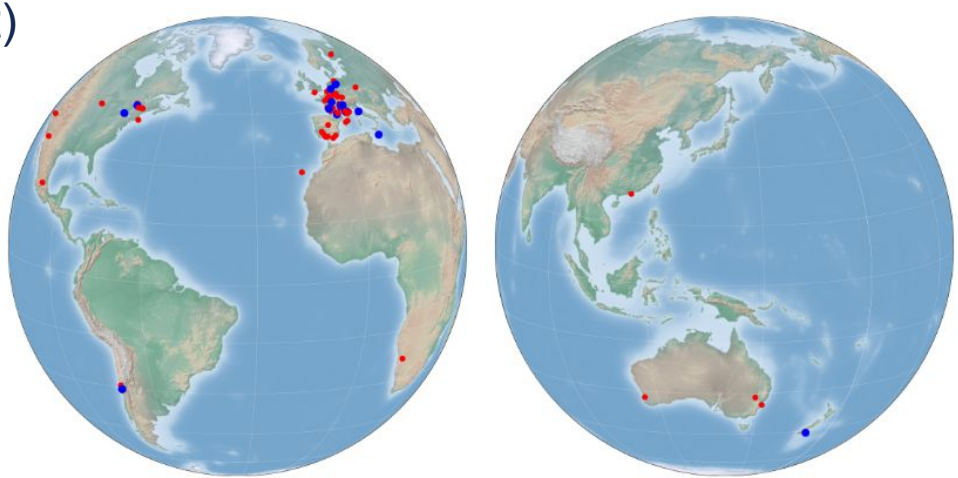
# GRANDMA network for fast transients follow-up

Fink classifies in real-time ZTF alerts from transient phenomena (~200k/night)

Selected fast transients (~1/night) are sent to the GRANDMA network in real-time for potential follow-up

- ML techniques
- Rate-based consideration
- Contextual consideration

Citizen science program in parallel



**GRANDMA Collaboration 2022 MNRAS 515 4, 6007-6022**
**B. Biswas et al 2023 A&A 677, A77**
**M. W. Coughlin et al 2023 ApJS 267 31**

# Philosophy

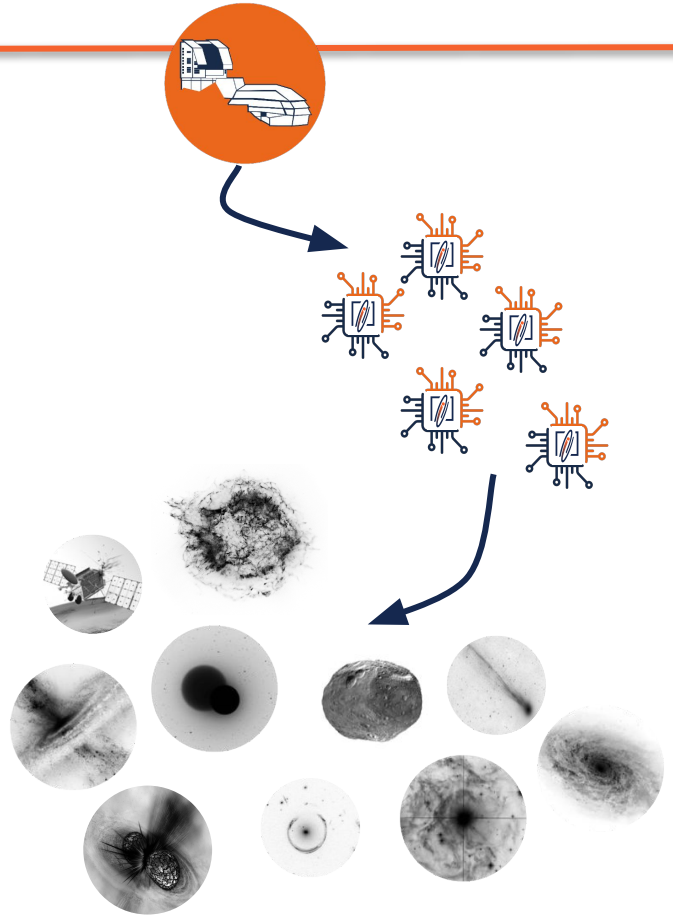
Centralised processing, decentralised science

- Fink core team provides infrastructure & technical assistance, users extend Fink capabilities by providing scientific codes

At the core of Fink are the *science modules*

- Enrichment of the alert packet. Output is available to anyone.
- Divide and conquer.
- One man's trash is another man's treasure
- 14 science modules currently

Each Fink community project is responsible for defining its own publication policy



# Turning information into science

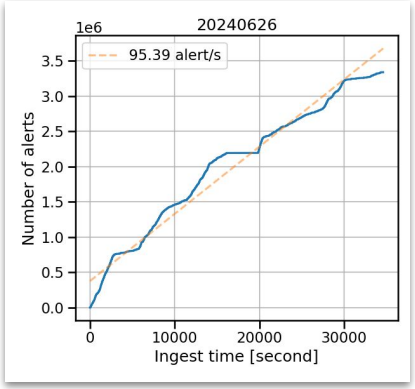
Alert information solely is not enough – we need experts to extract the science!

- More than 60 scientists worldwide contribute to the project.

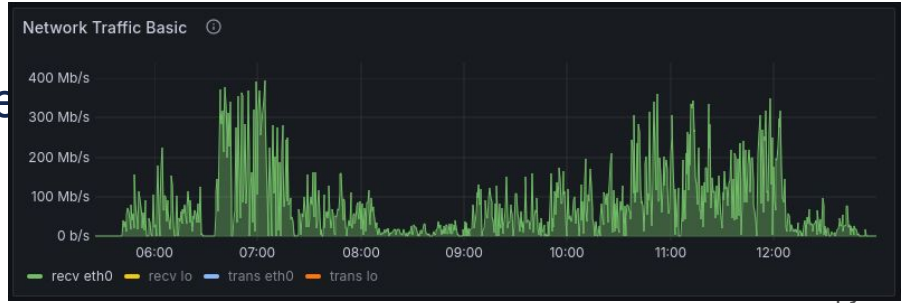
Our ambition is to **study the transient sky as a whole**, from solar system objects to galactic and extragalactic science.

# Road to LSST

- First light: July 2025 (expect alerts around Fall)
- Migration to CC-IN2P3 almost done
  - Close to LSST data
  - Fink/ZTF stays at Paris-Saclay (2027)




- Large-scale tests by Rubin
  - End-to-end real-time simulation, from telescope to brokers
  - Millions of alerts processed & transfe from USDF to CC-IN2P3
  - No major difficulties*




*caveat: using simulated data

# Rubin broker landscape

# The data path

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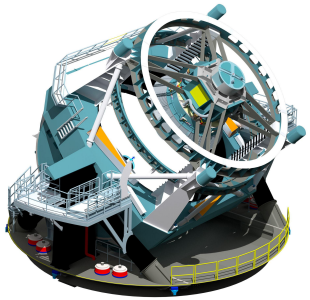

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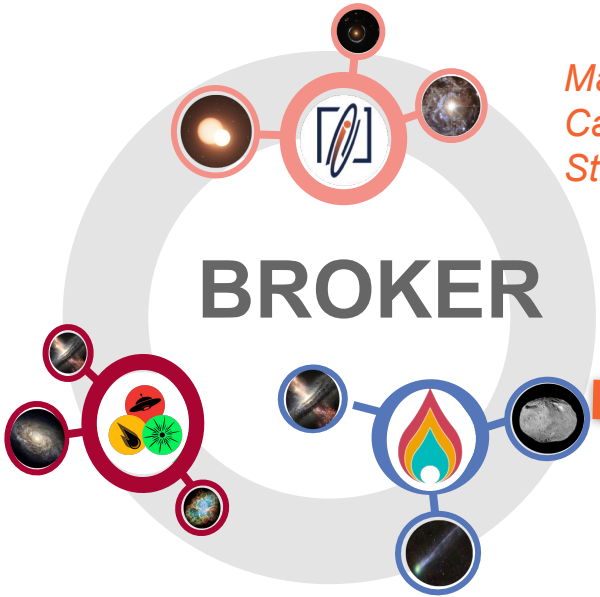


*Machine learning*
*Catalog association*
*Streams join*

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# In Europe …

- Somewhat regular conversations since Sep/2021


*Our letter of intentions …*

- Development of standards and protocols for combining data from different astronomical experiments;
- Development of standards for cross-match with existing catalogs and smooth addition of new ones;
- Development of unique framework for sharing input/output data for machine learning applications;
- Implementation of an unique European repository with the VRO alert information.

ACME ⇒ **The Euro-Broker Initiative**

*Focused on technical challenges and complementarity*

# EuroBroker & ACME

Central DB for all brokers?
What would be in it?
Cutouts case?

Registry of Kafka nodes and connectivity

Data flow between brokers

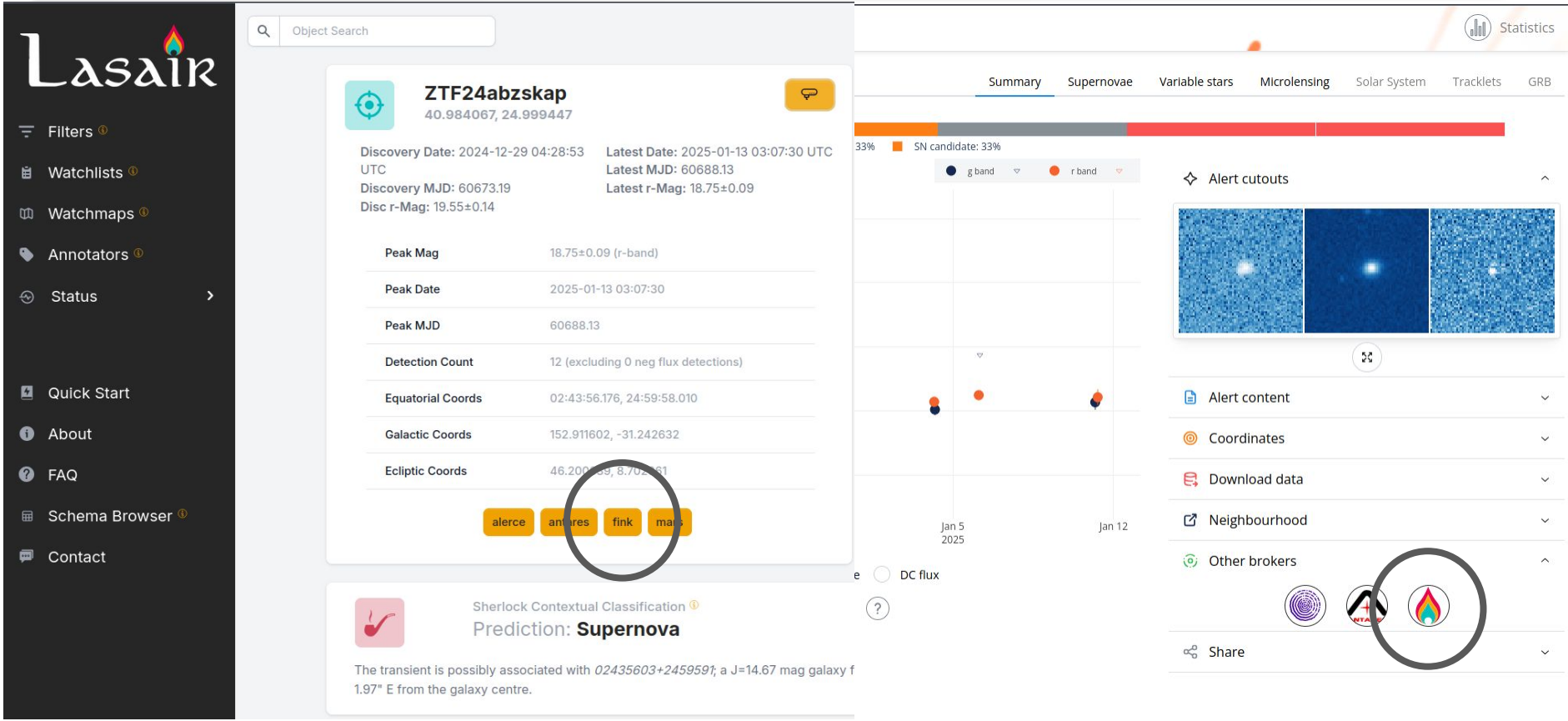
Share operation logs, ease a recovery operation

Interoperability, versioning

In 2024 … the EU decided to fund the ACME project, including a contribution from your favourite broker teams:

- Human power to concretise some plans drawn during our meetings.
- Among several, make the use of brokers easier for the community

# Small details that matters



# The real difficulties

A broker team cannot only be engineers talking to engineers

- The interfaces with the communities of users are crucial
- Companies have usually their own team dedicated to this

We are facing a LOT of sociological problems

- The use of computers is not innocent, even in 2025

Some pressing questions for all broker teams:

- How to make sure tools fit user skills and needs?
  - How to reach and teach our user base?
- How to make sure tools are used efficiently?
- How to make sure tools can be flexible enough to be adapted?

https://fink-broker.org




KubeCon CloudNativeCon Europe 2024