FINK

and high-energy transients
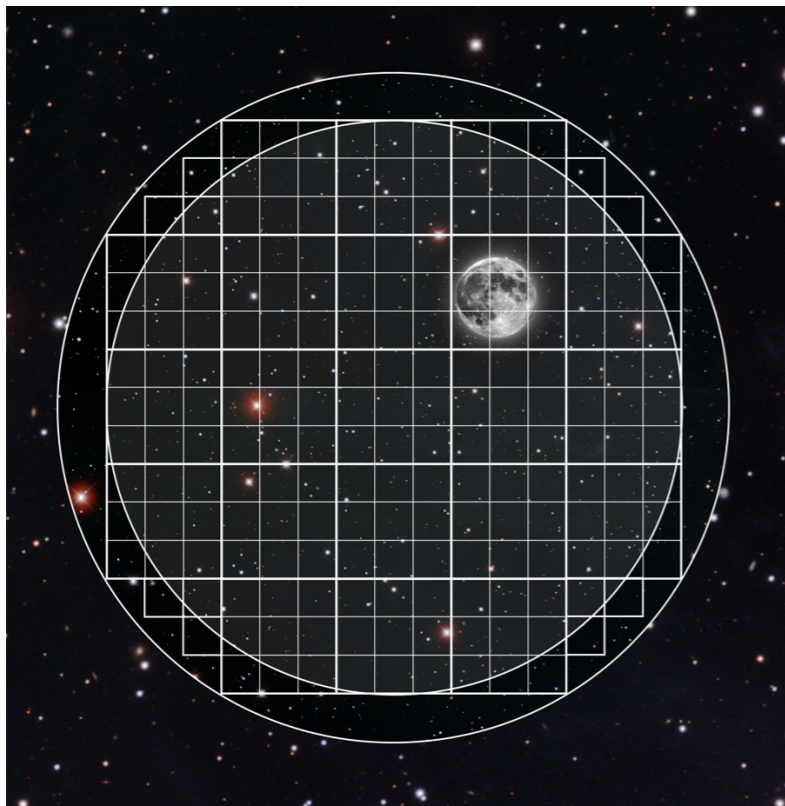
Anais Möller

CTA-Oz Meeting, November 22nd 2021

High-energy transients $\longleftrightarrow$ Optical transients

In a nutshell

- telescope: 6.7-m equivalent

- world's largest CCD camera: $3.2 * 10^9$ pixels

- resolves a *golf ball 24 kilometers away!*

- 6 optical bands: *ugrizy* (320-1050nm)
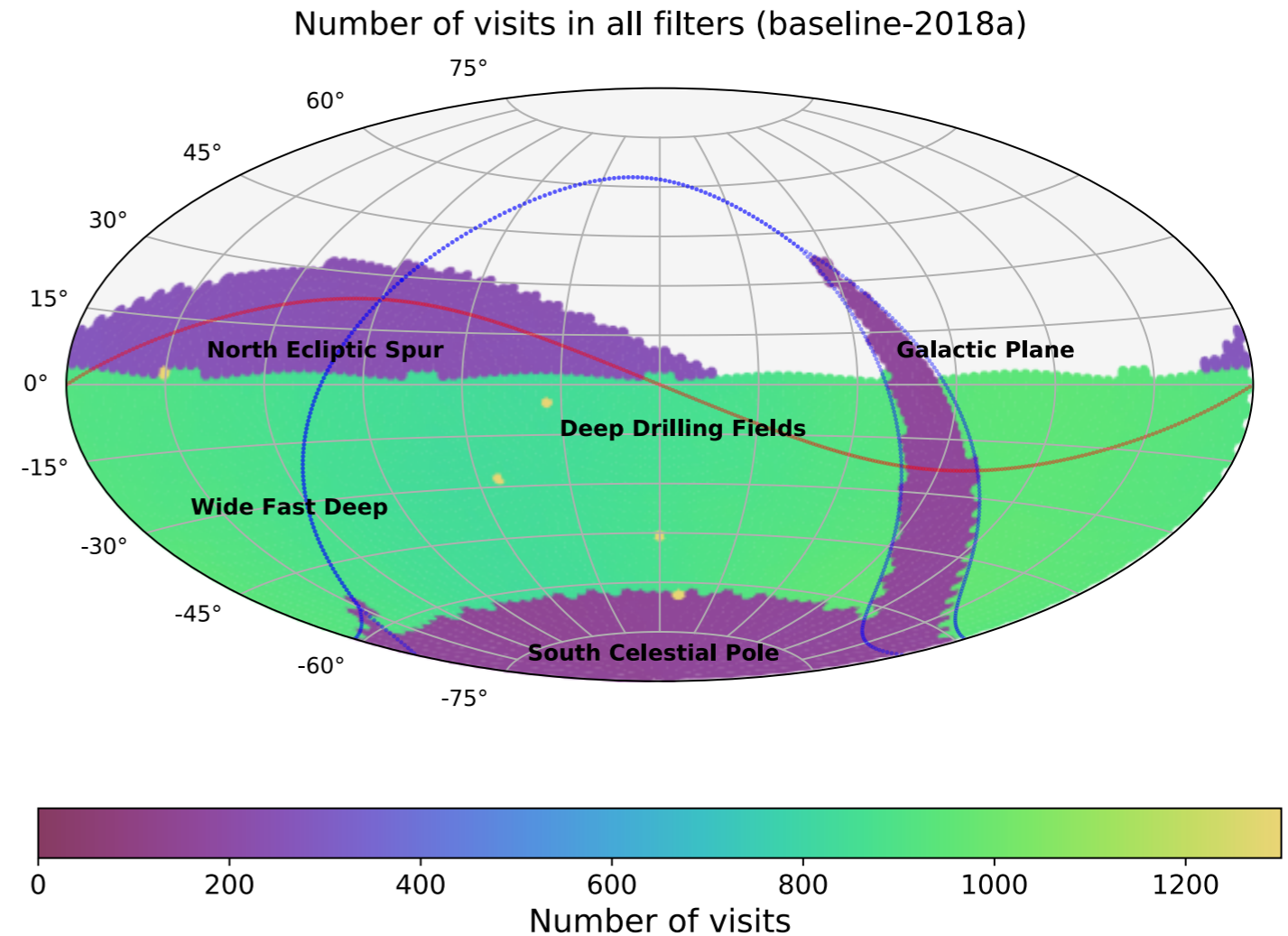

40 copies of the full moon

Rubin Obs/NSF/AURA
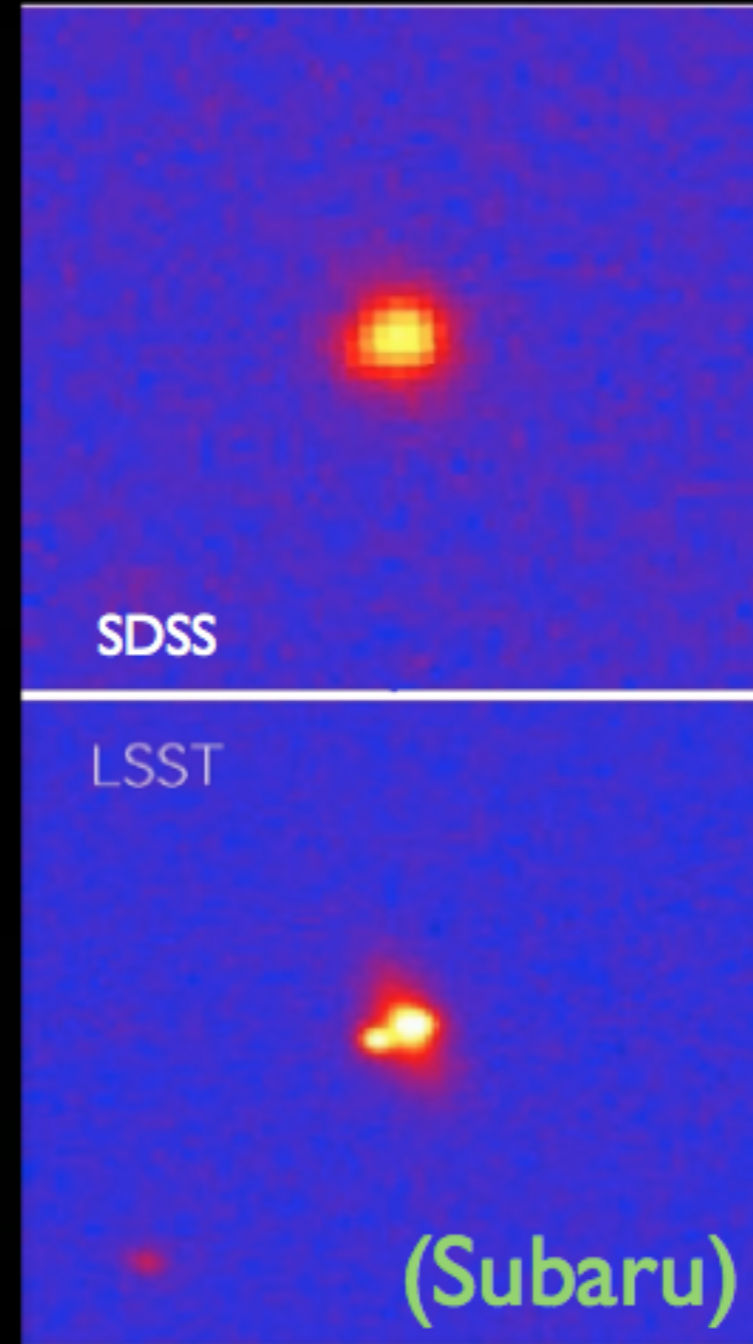
LSST a deep "video" of the sky

- Scanning the sky for 10 years

- 1,000 images/night = 15 TB/night

- 10 million transients **per night**

Number of visits in all filters (baseline-2018a)

Call for White Papers on LSST Cadence Optimization Document-28382

SDSS-LSST comparison: LSST=d(SDSS)/dt, LSST=SuperSDSS
7x7 arcmin, gri

SDSS

DLS

(Deep Lens Survey)

SDSS

LSST

(Subaru)

Slide from Ivezic

LSST data products

Now — **Raw Data**
Sequential 30s image, 20TB/night

37s — **Prompt Data Product**
Difference Image Analysis
Alerts: up to 10 million per night

Public data!

24h — **Prompt Products DataBase**
Images, Object and Source catalogs from DIA
Orbit catalog for ~6 million Solar System bodies
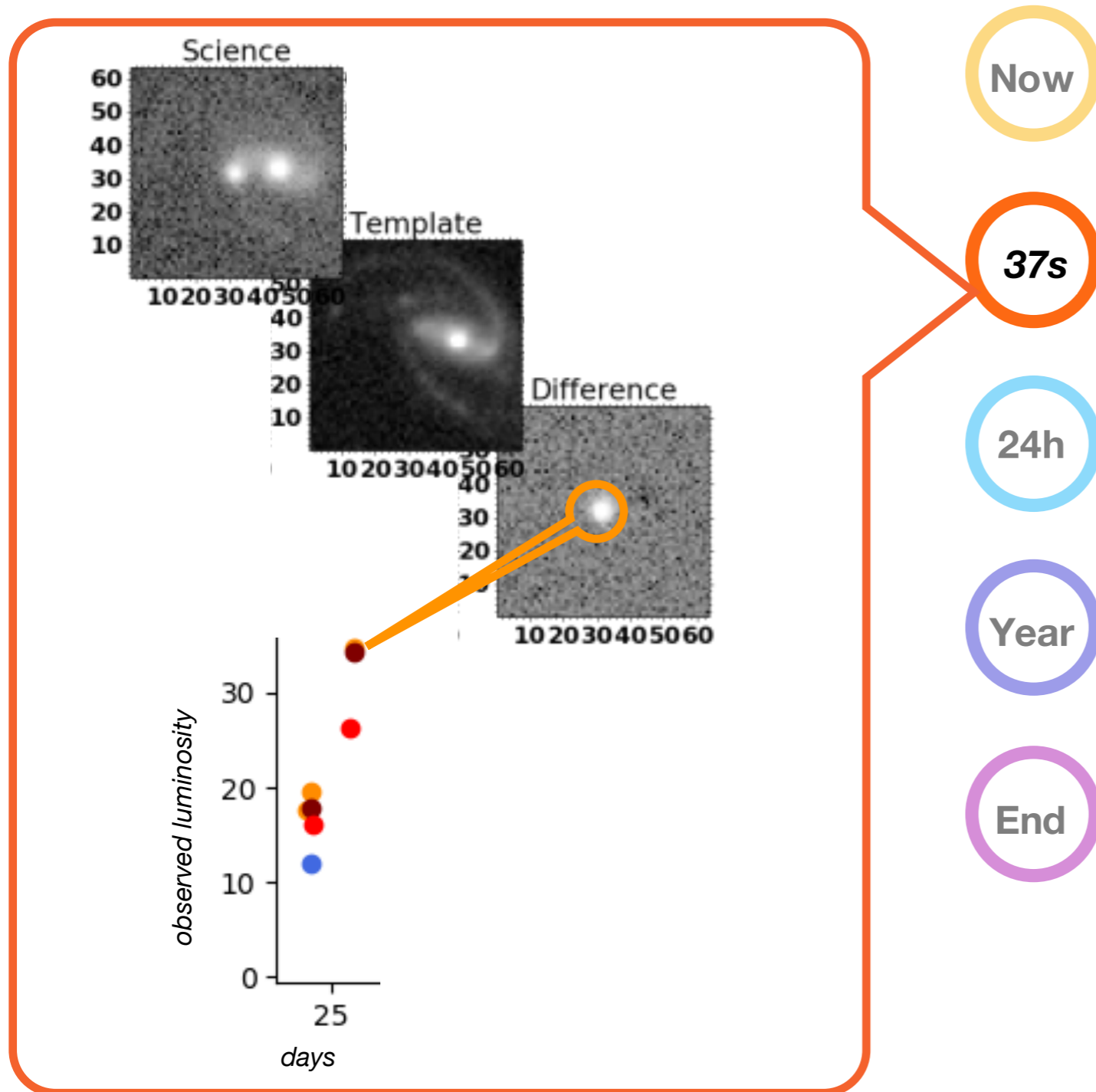
Year — **Annual Data Release**
Accessible via the LSST Science Platform &
LSST Data Access Centers.

End — **Final 10yr Data Release**
Images: 5.5 million x 3.2 Gpx
Catalog: 15PB, 37 billion objects

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LSST ~ 10 million transient alerts per night

?
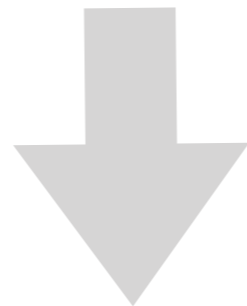
promising candidates for <X science>

+ connecting with other telescopes and data?

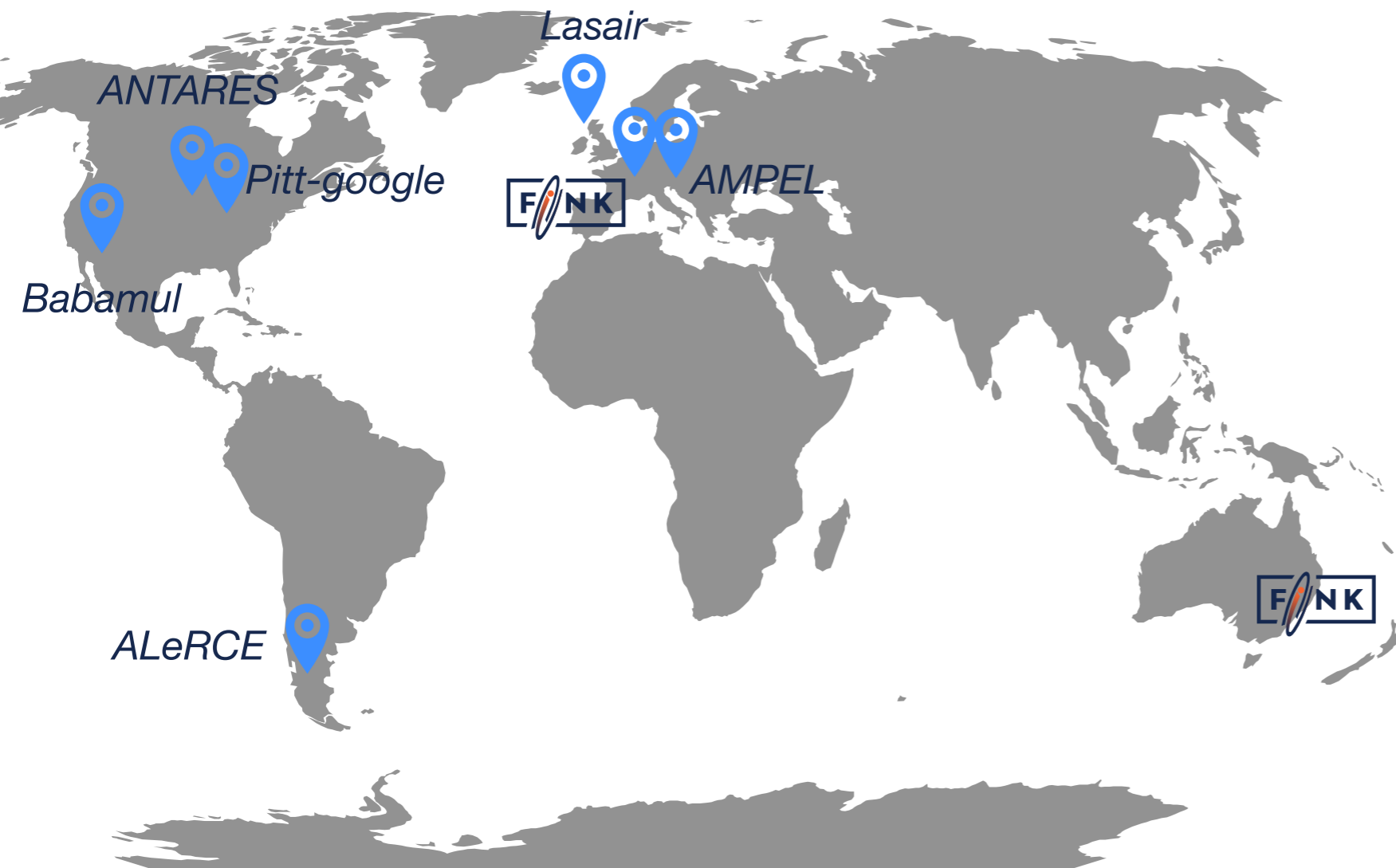**LSST ~ 10 million transient alerts per night**

Brokers

promising candidates for <X science>

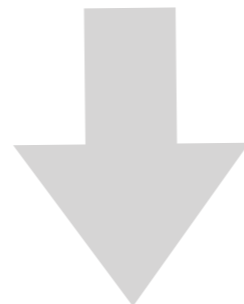**+ connecting with other telescopes and data?**

The broker panorama

Lasair

ANTARES

Pitt-google

F[I]NK

AMPEL

Babamul

ALeRCE

F[I]NK

Two years ago, call for Rubin community brokers

- 14 Letters of Intent

- A lot of work

- Decision on August 2021!

Full stream brokers

- Will receive from Rubin ALL transient candidates within 37 seconds of detection

- Will do this for the 10 years of operations

LSST ~ 10 million transient alerts per night

promising candidates for <X science>

+ connecting with other telescopes and data?

- A community driven effort, *open to anyone*

- A community of >40 *researchers and engineers* >7 countries and growing!

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- Now processing ZTF II public alert stream available at fink-portal.org

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- First publication *A. Möller, J. Peloton, E.E.O. Ishida et al. MNRAS 2020, arXiv: 2009.10185*

- Funding to deploy at CC-IN2P3 for LSST

French computing centre where half of the LSST data will be processed

Fink in a nutshell

LSST ~ *10 million transient alerts per night*

LSST ~ 10 million transient alerts per night

Cross-match

X
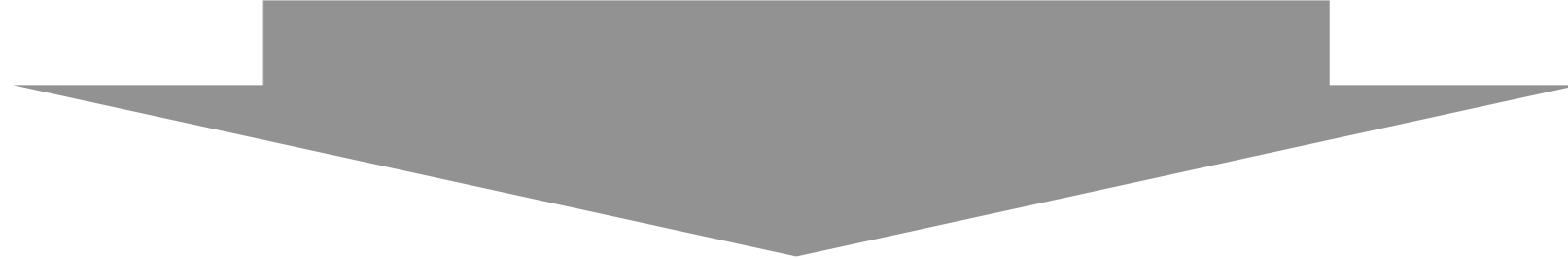
Catalogues

Survey streams

- *VOEvents / GCN*
- *Dynamic catalogues*

LSST ~ 10 million transient alerts per night
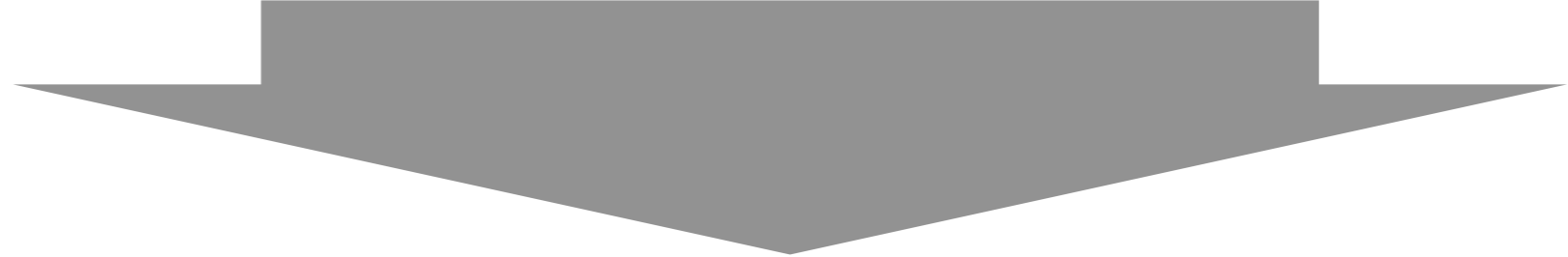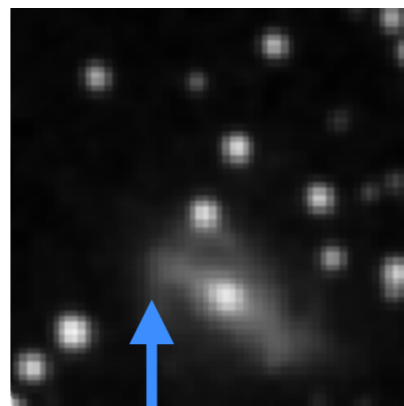

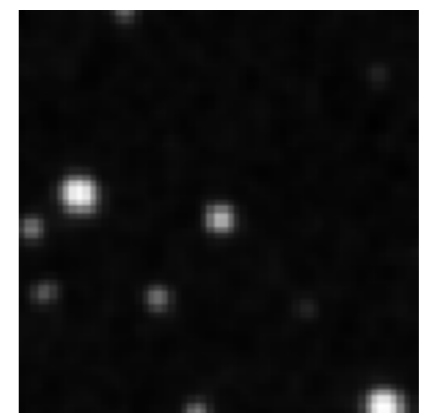## Cross-match

X CDS   *SIMBAD*

A known variable star….
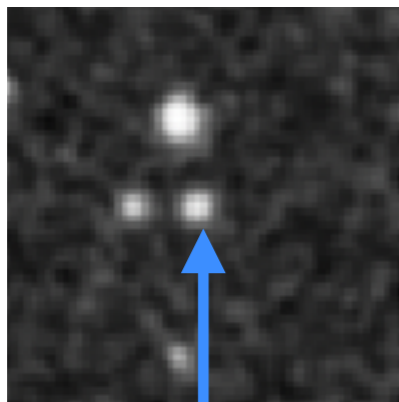
Known Variable Star

Extra-galactic?

Known galaxy close by
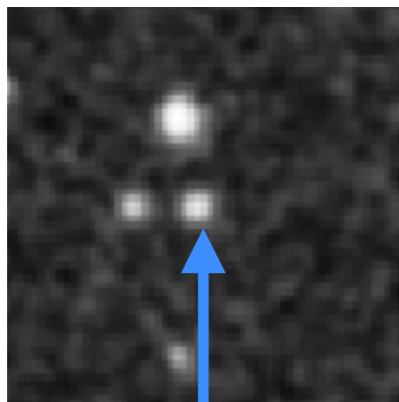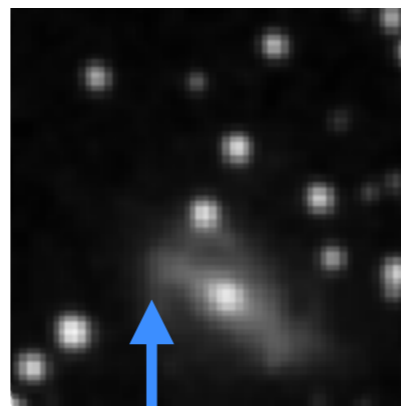
Or….

LSST ~ 10 million transient alerts per night

Cross-match

X Collaboration with GRANDMA

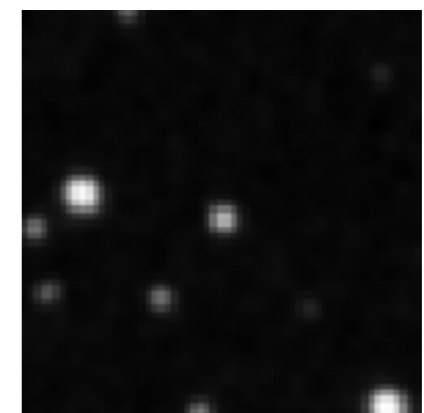Mangrove *Ducoin+20*

A known variable star….

Known Variable Star

Extra-galactic?

Known galaxy close by

Or….

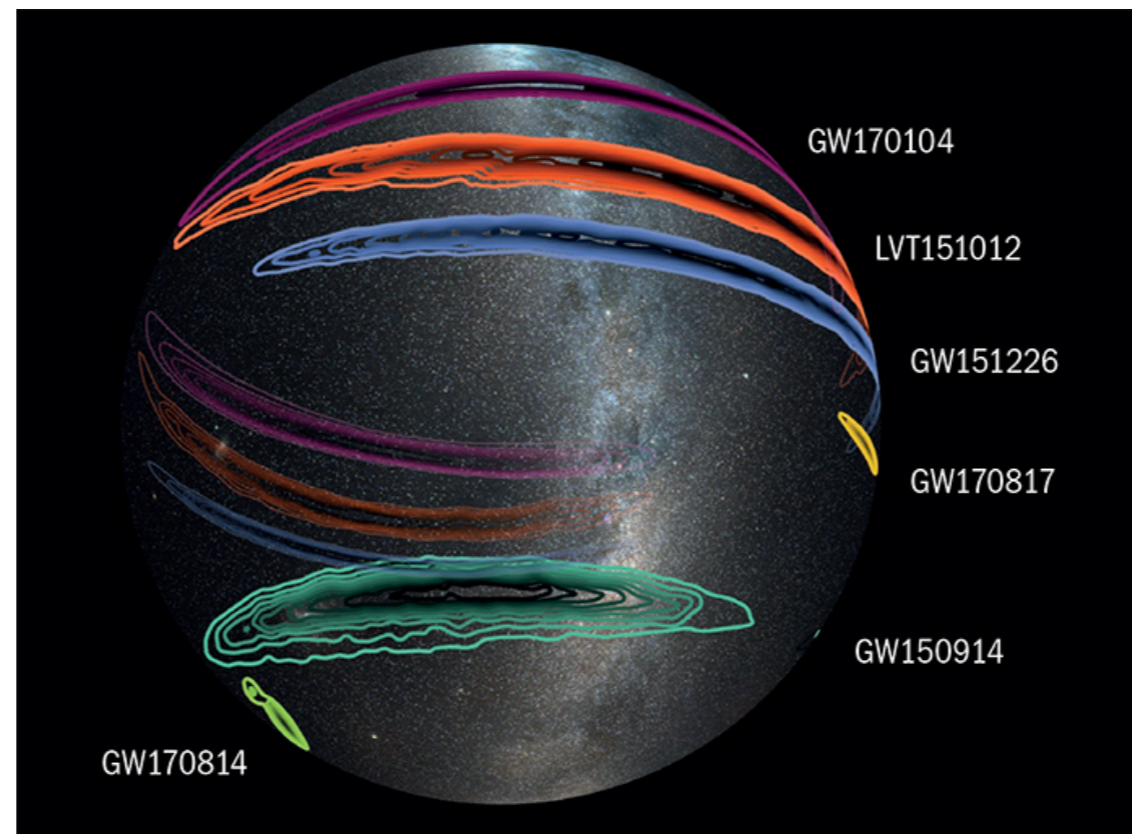# LSST ~ 10 million transient alerts per night
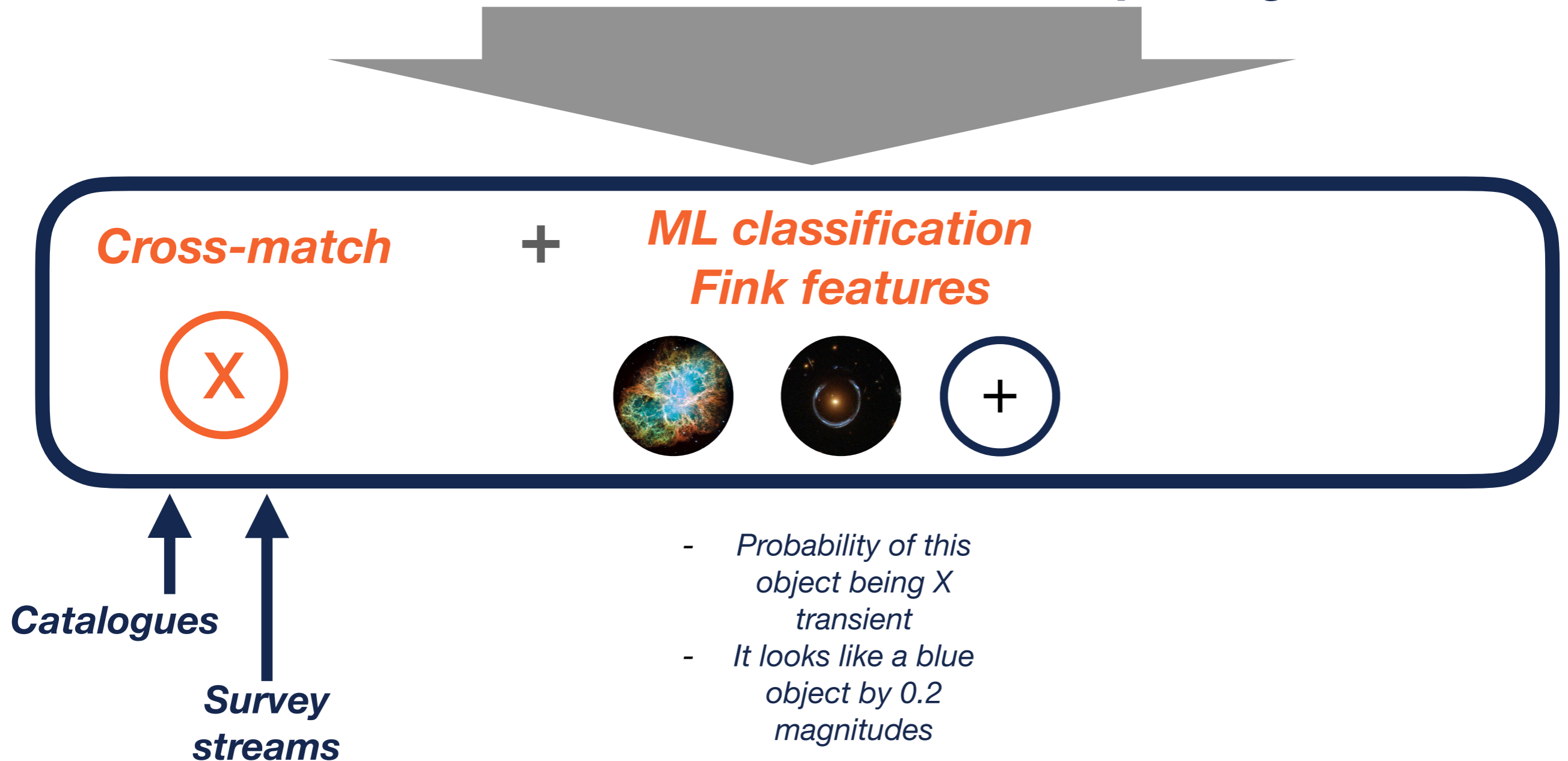

Cross-match

(X)

Catalogues

Survey streams

- **VOEvents / GCN**
- **Dynamic catalogues**

GW170104

LVT151012

GW151226

GW170817

GW150914

GW170814

cta cherenkov telescope array

footprint or real-time catalogues

LSST ~ 10 million transient alerts per night

Cross-match + **ML classification
Fink features**

Catalogues

**Survey
streams**

- *Probability of this object being X transient*
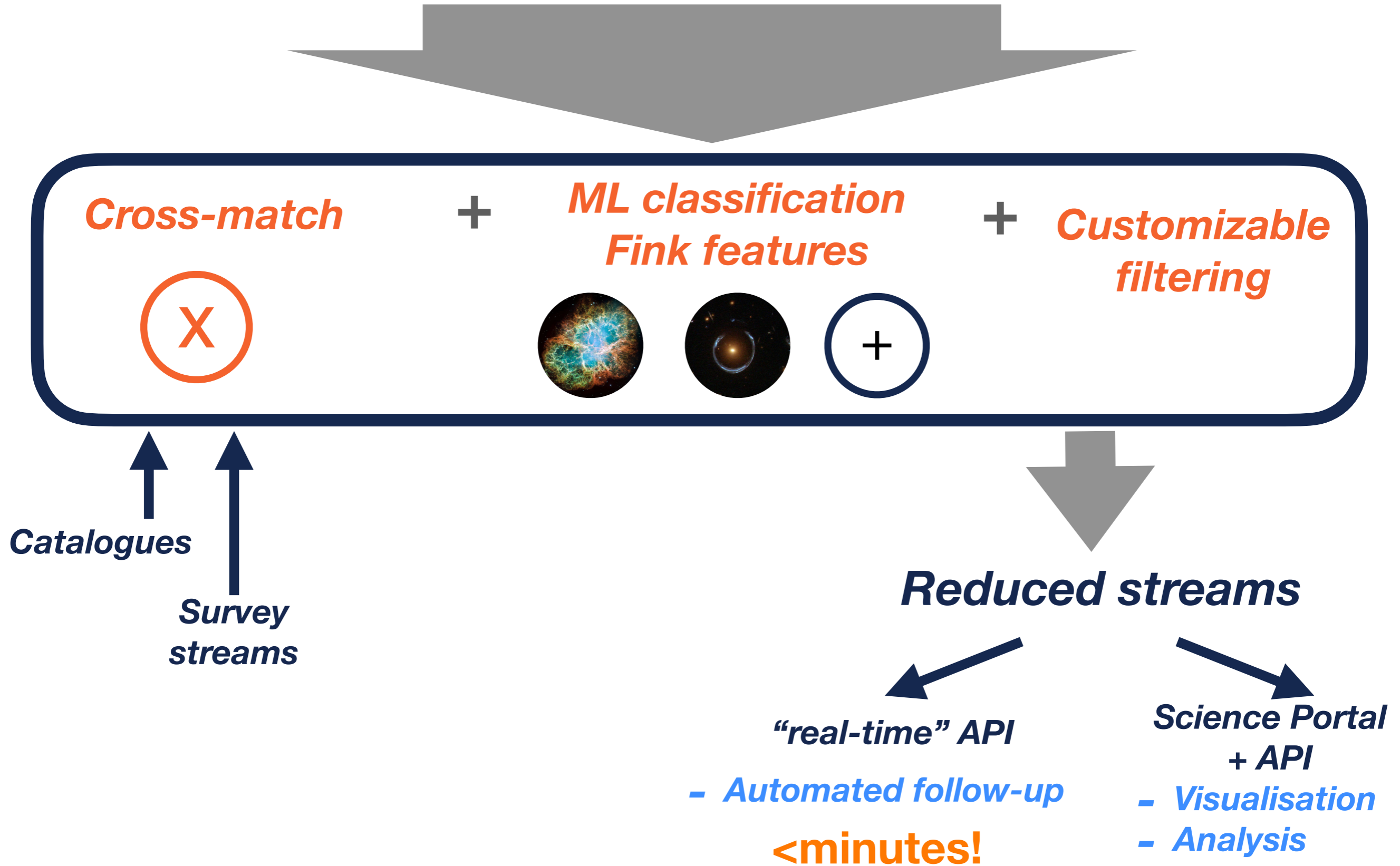- *It looks like a blue object by 0.2 magnitudes*

- Early Supernova with Active Learning *Leoni et al. in prep*

- Supernovae with RNN, SuperNNova *AM+2020*

- Microlensing LIA *Godines+2020*

- Kilonovae *Biswas+ in prep.*

LSST ~ 10 million transient alerts per night

Cross-match   +   **ML classification Fink features**   +   **Customizable filtering**

Catalogues

Survey streams

- Probability of this object being X transient
- It looks like a blue object by 0.2 magnitudes

I want transients that are close to a known galaxy and have large probability of being X

LSST ~ 10 million transient alerts per night

Cross-match + **ML classification Fink features** + **Customizable filtering**

Catalogues

Survey streams

Reduced streams

"real-time" API

– *Automated follow-up*

<minutes!

Science Portal + API

– *Visualisation*
– *Analysis*

Ongoing projects

✳ **Kilonovae**:

- ZTF + Kilonova catcher citizen science *GRANDMA + Fink in prep.*

- **Microlensing**

✳ **GRB** afterglows *D. Turpin, J.Bregeon, O.Godet, …*

- Swift-Fermi in preparation for SVOM

- **Satellites** and debris *S. Karpov et al. in prep.*

- Early **Supernova** with Active Learning *Leoni et al. in prep*

- **Supernovae** with RNN, SuperNNova *AM+2020*

✳ **Anomaly** detection

We welcome more collaborators!

contact@fink-broker.org

Integrations

Fink is integrated with:

- Transient Name Server bot: reporting automatically SN candidates

- Las Cumbres Observatory Target and Observation manager:
  Gemini, LCO, SOAR

- Integration into Astro-COLIBRI for multi-wavelength/messenger

F. Schüssler et al. 2021
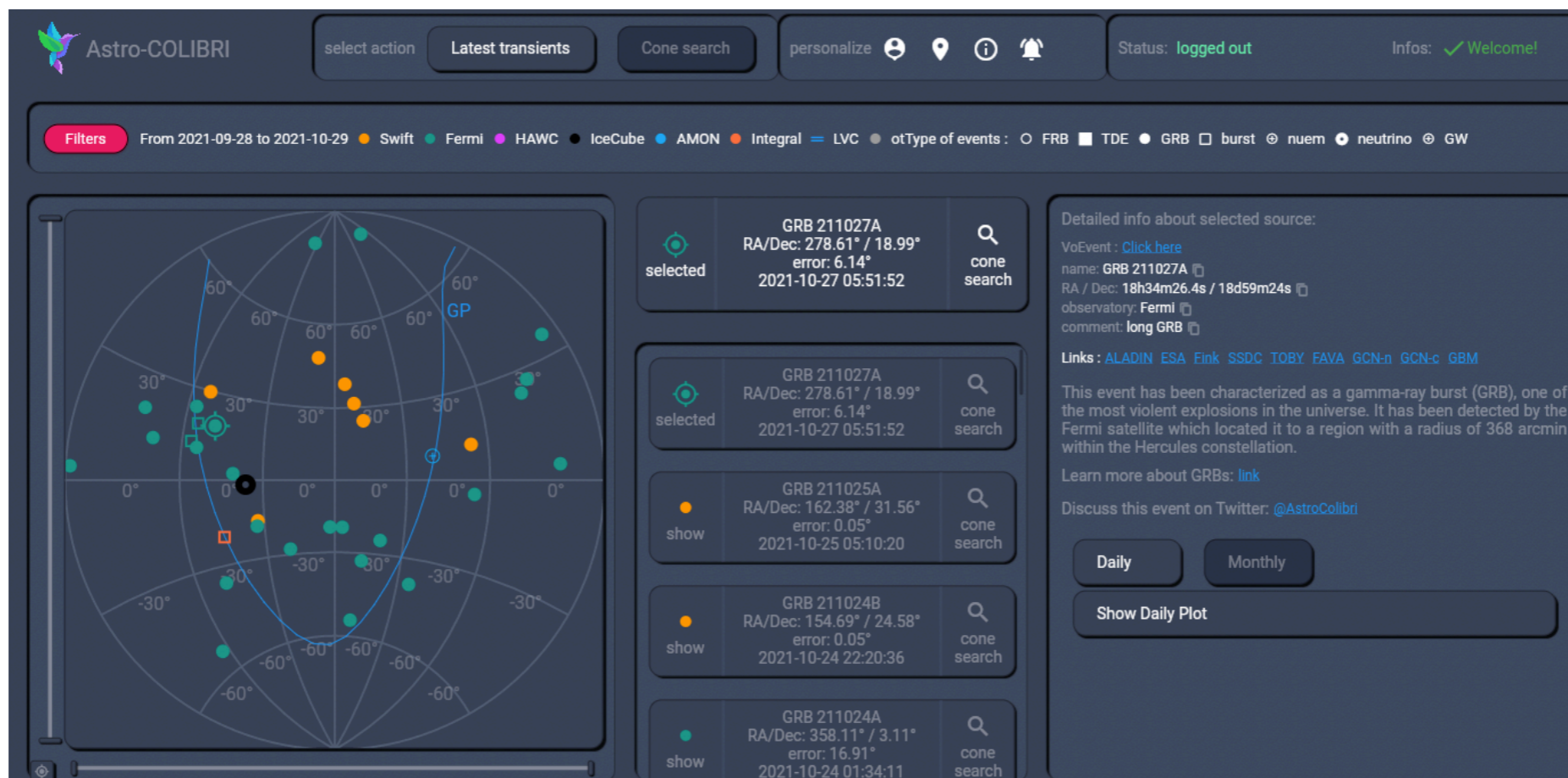
Deployment with ZTF

Summary statistics

Since 2019 we have received 123,237,400 alerts!

Equivalent to 571 nights

Processed alerts (quality cuts): 41,408,120

Monthly statistics: 2021/10

Total processed	1,624,096
Unknown	772,116
Tracklets	2,406
Solar System MPC	298,579
Solar System candidates	2,559
SN candidates	5,251
Early SN candidates	114
Kilonova candidates	3

CDS SIMBAD

543,484 matched with an object (33.5%)

7,728 matched with close-by galaxy (0.5%)

How to access

1. "real-time" API: *Kafka filtered stream, slack bot, …*

2a. Science Portal *https://fink-portal.org*
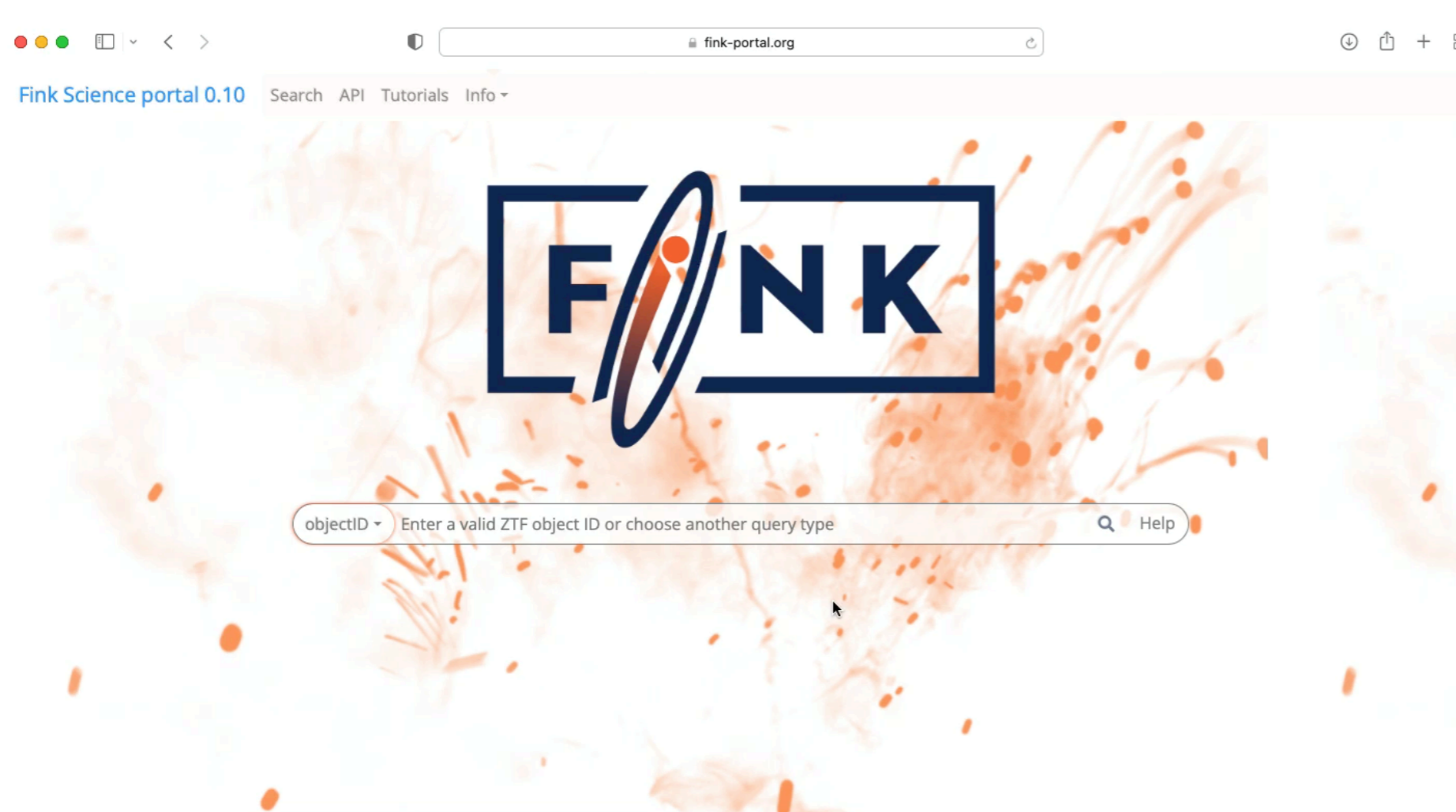
2b. REST API

Feedback welcomed!

contact@fink-broker.org

Cross-match + **ML classification Features** + **Customizable filtering**

Catalogues

Survey streams
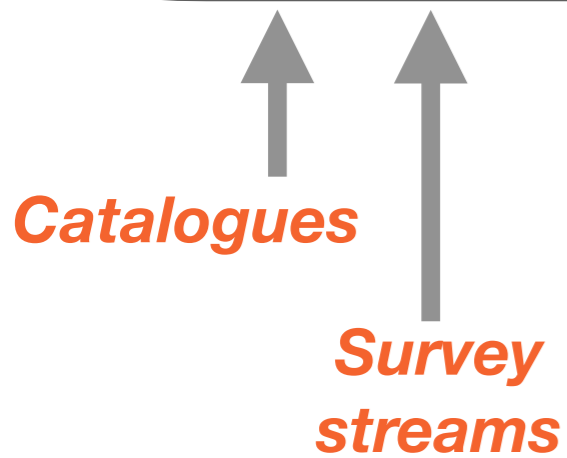
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Reduced streams

"real-time" API

- **Follow-up**

Science Portal + API

- **Feedback!**
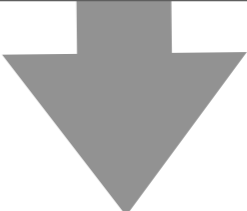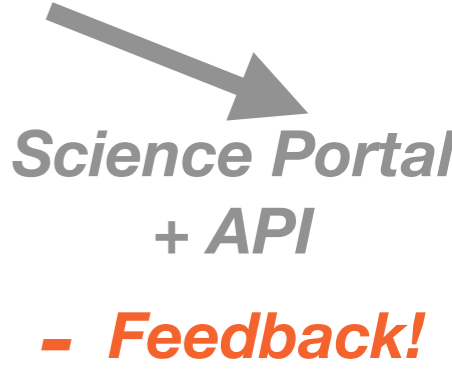
Your science case, your expertise

- Connecting optical big data with multi-wavelength & messenger transients
- Is already processing ZTF data stream (MoU 2020).
- Rubin community broker
- First science modules deployed: SNe, GRB, microlensing, …
- Automatic filtered streams <minutes for follow-up coordination
- Analysis capabilities with the web portal and API (python callable)

We want to connect to new teams, collaborations and facilities!

fink-broker.org   fink-portal.org   contact@fink-broker.org