



A Specialized Alert Broker for Roman Time-Domain Science

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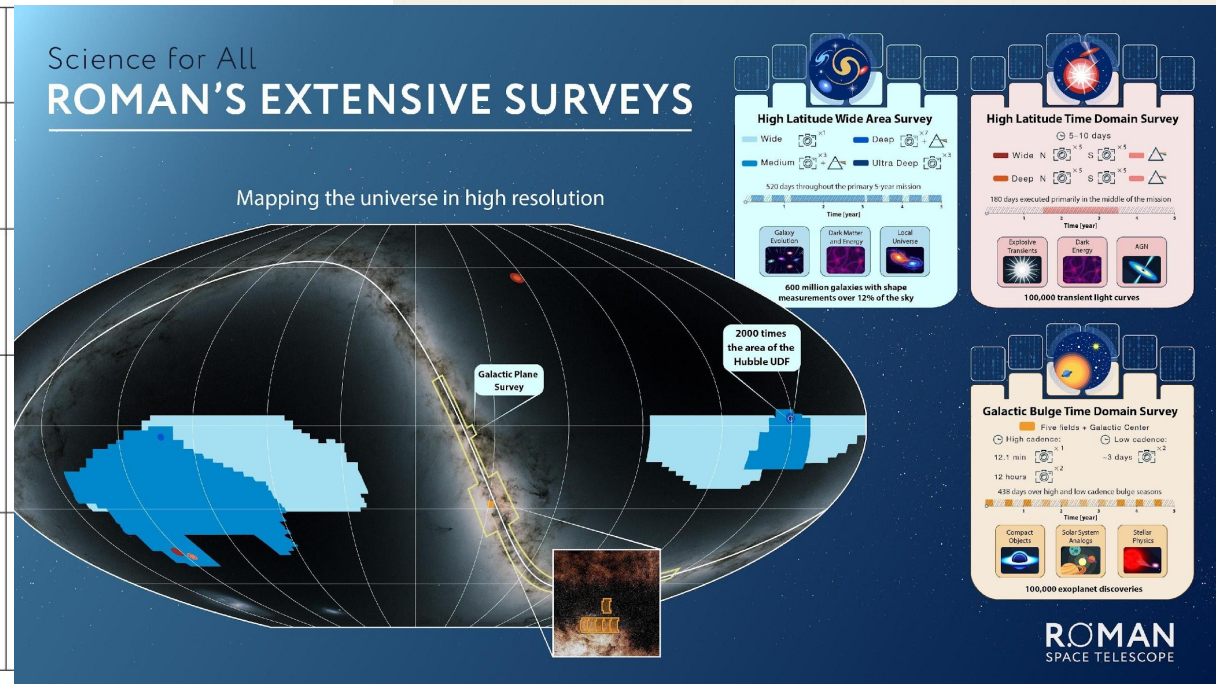


Shifting Landscape in Astrophysics, Caltech, 2026-07-16

Caltech

Roman Data Coming Soon

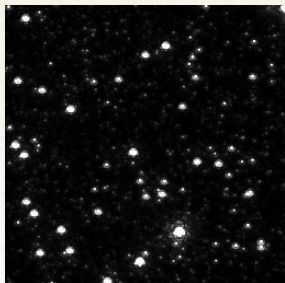
Survey	Area Covered (deg ²)	Filters
GBTDS (Galactic Bulge)	1.7	F146, F087, F213
HLTDS (High Latitude)	Wide: 18.3 Deep: 6.5	F062, F087, F106, F129, F158, F184
GPS (Galactic Plane)	19 (Time Domain) + Galactic Plane	Full WFI Suite
HLWAS (Wide Area)	2,000+	F106, F129, F158, F184



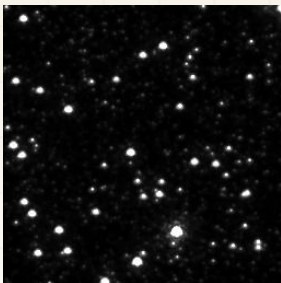
What do we expect from Roman?

Roman will take us to parameter spaces where we have never been.
And multiple times

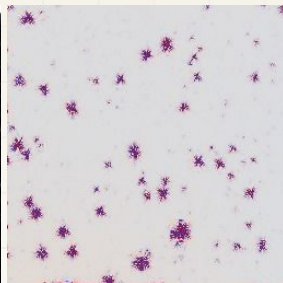
GBTDS



science



reference



difference

(Very) rough expectations:

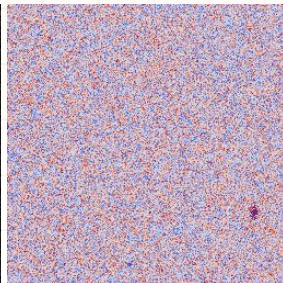
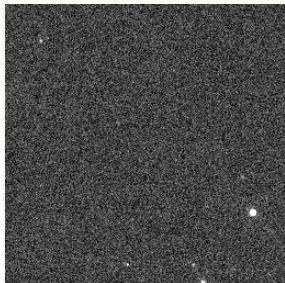
GBTDS: 2000 alerts/SCA

HLTDS/HLWAS: 500 alerts/SCA

Down to 26th mag

R/B and S/G from alerts

HLTDS



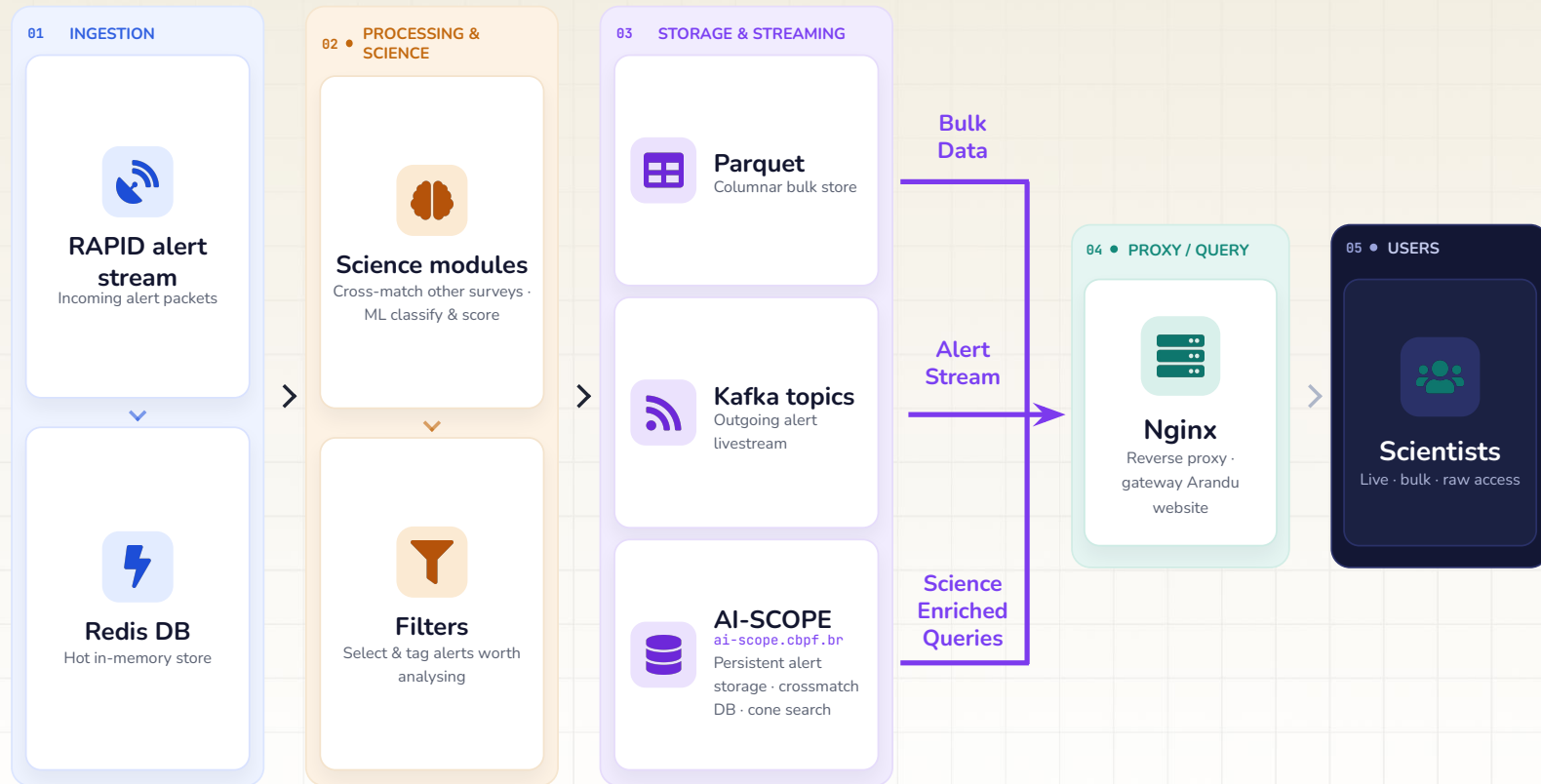
Enter Arandu

Arandu will ingest the alerts produced by RAPID and provide many value added products:

- cross-matches
- characterization and classification
- confidences
- comprehension

Arandu will be modular and is the first Roman-only broker. It will complement other brokers for Roman.

General scope of Arandu



Ingestion

Incoming Alerts

Roman alerts arrive from RAPID and are received by Arandu in real time. Each packet is immediately validated and registered for downstream processing.

RAPID · real time · high volume



Hot Storage

Clean alert packets first land in Redis, which acts as a fast in-memory buffer for immediate access, temporary state, and rapid decision-making before archival storage.

Redis · in-memory



Pre-Processing

A lightweight pre-processing step removes obvious artifacts, applies basic quality checks, and tags alerts that should continue to science processing or be queued for database ingestion.

quality filters · artifact rejection · DB queue

Science Enrichment

Classification

Alerts are separated into likely transients, variables, moving objects, and artifacts.

The classification layer is designed to evolve into a hierarchical system with increasingly detailed science labels.

**Transient · variable · artifact ·
hierarchical classes**

Solar System Objects

A dedicated module identifies known asteroids and other Solar System bodies, reducing contamination in the transient stream and preserving extragalactic discovery space.

SSO module · moving-object filtering

Cross-Matching & Simulation

Alerts are cross-matched with external catalogs such as Gaia and Legacy Surveys (in AI-Scope), while OpenUniverse simulations are used to test the pipeline before full Roman operations. Host-galaxy association and contextual features can be added here.

Gaia · Legacy · OpenUniverse

Classifier example(s)

Transient-Variable

Variable Subclassification

Transient Subclassification

GBTDS object-level transient/variable results

Input features	Macro-F1	Variable recall	Transient recall
Image + PSF meas. + LC	0.95	0.97	0.94
Light curve only	0.92	0.93	0.95
Image + PSF meas. only	0.90	0.95	0.85

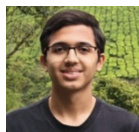
Currently being developed from injections

Currently being developed from
OpenUniverse24 injections

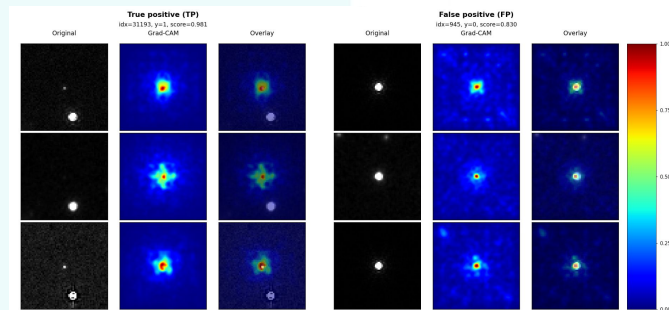
See poster by A Kuloor for details



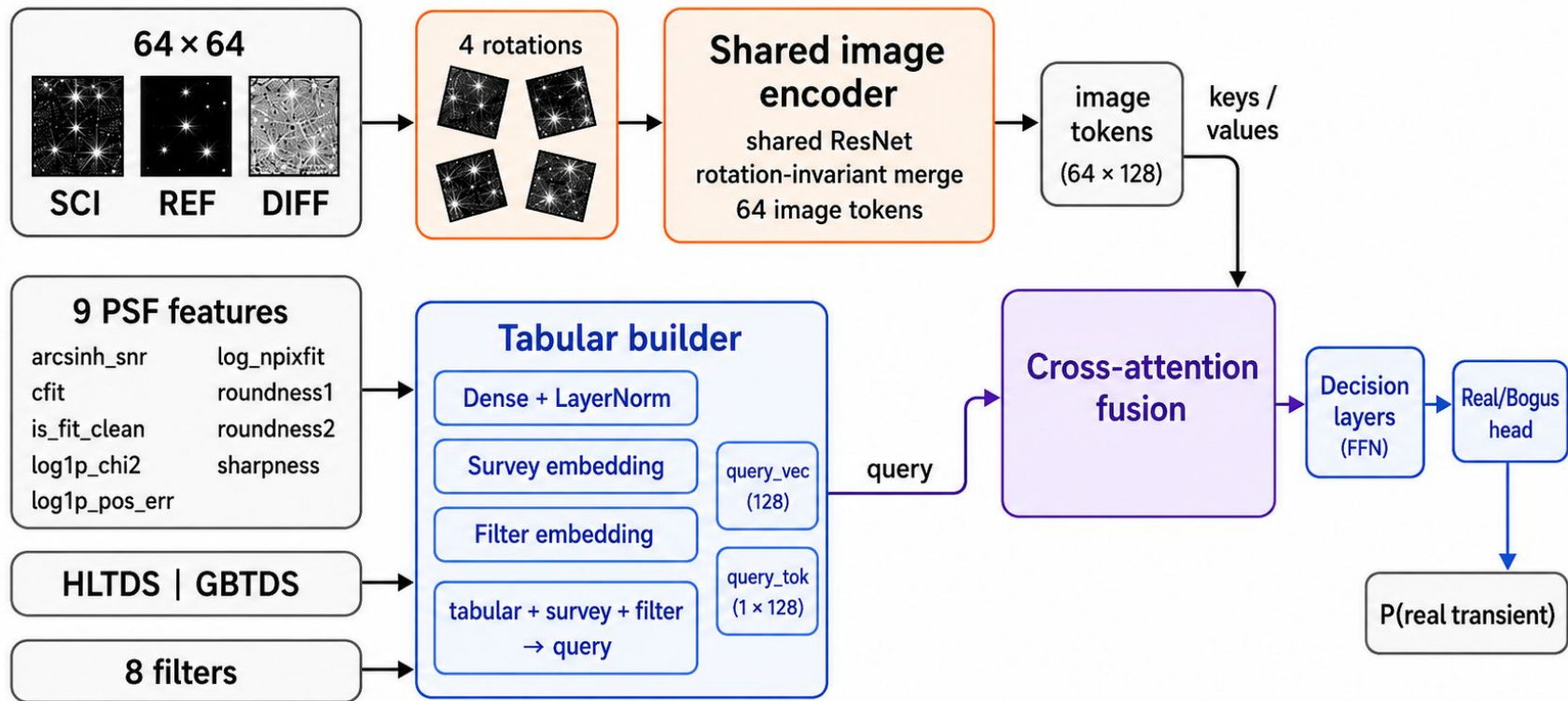
Karan Gandhi



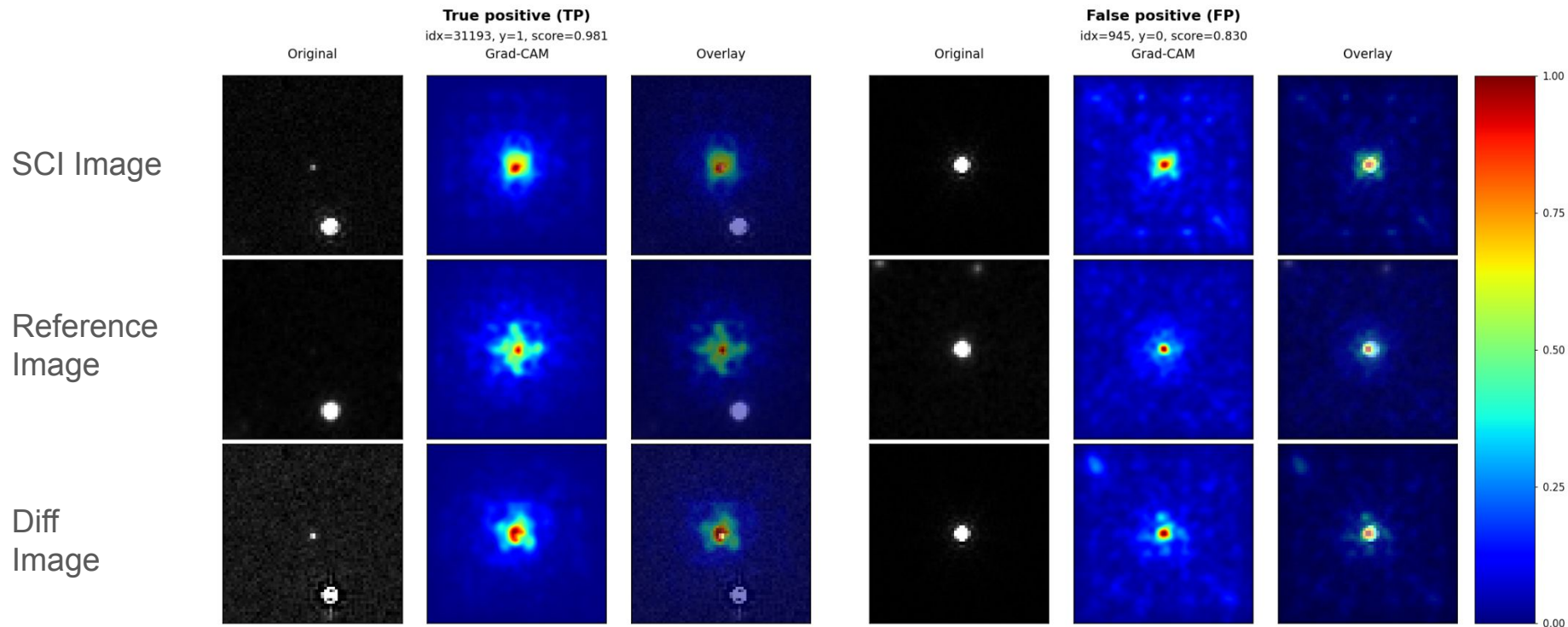
Aayush Kuloor



RuBRaT Model Architecture



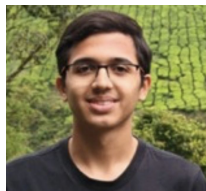
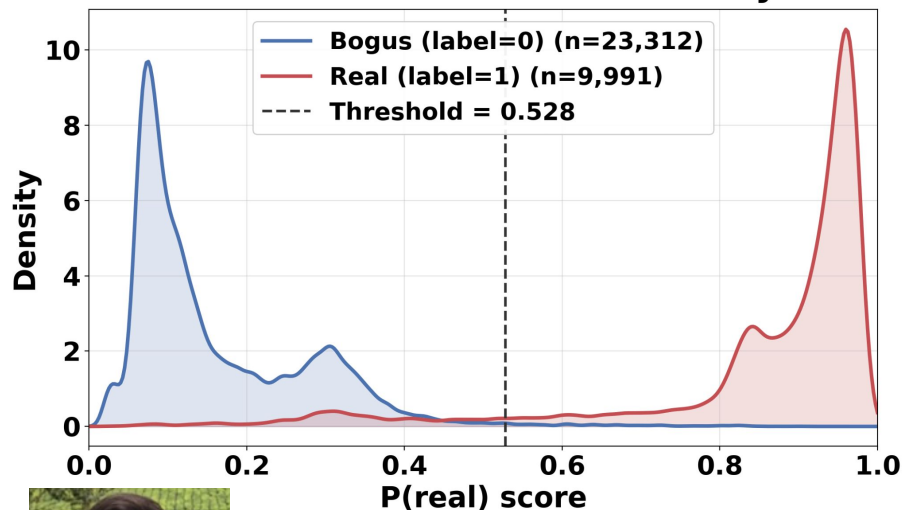
GradCam Activations indicating attention - RuBR-AT model



Expt: Train on HLTDS+GBTDS, Test on HLTDS

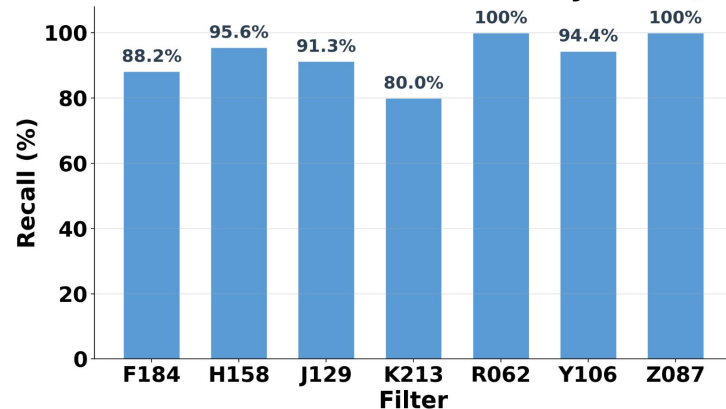
Model	Precision	Recall	F1
RuBRaT	0.97	0.91	0.94
RuBR	0.83	0.84	0.83

HLTDS test — score distribution by label



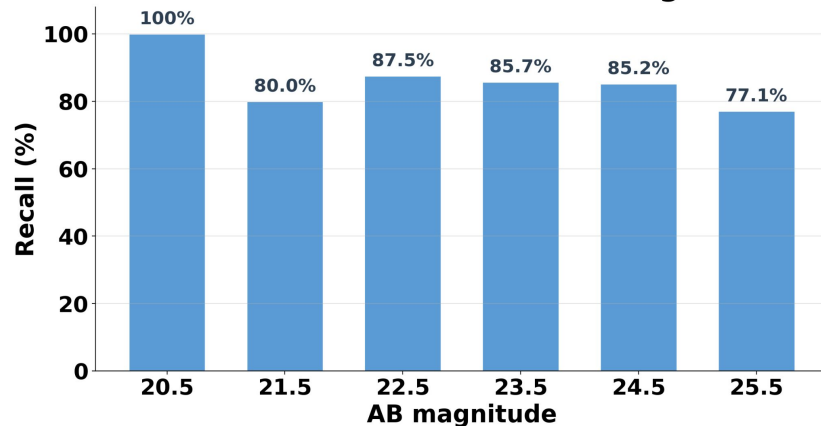
Aayush Kuloor

HLTDS allOU24 tuned — OU24 recall by filter (mag ≤ 26)



Similar performance across all filters

HLTDS — transient recall vs magnitude



RuBRaT - RuBR + transformers for attention - includes GBTDS data

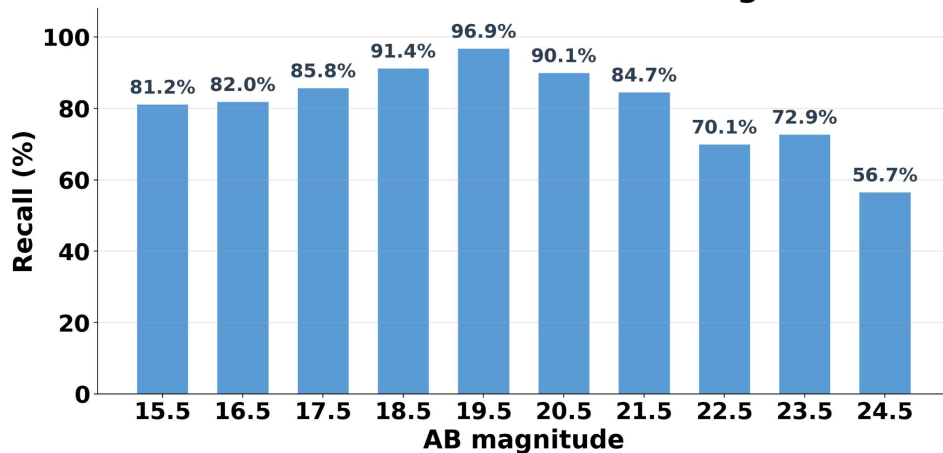
Real/Bogus - GBTDS

Expt: Train on HLTDS+GBTDS, Test on GBTDS			
Model	Precision	Recall	F1
New Model	0.9531	0.8511	0.8993
RuBR	0.8608	0.8156	0.8376

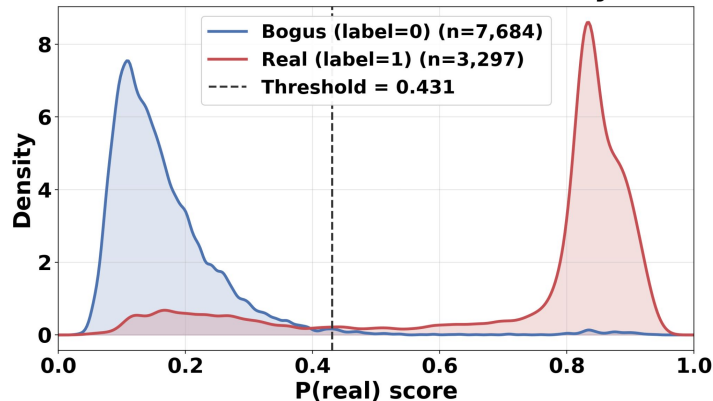
Note: Variables in GBTDS (RimTimSims) are faint in general

PU-learning. Train/test on GBTDS (injections as +ves)			
Run	Precision	Recall	F1
pos_prior=0.30	0.963	0.837	0.895
pos_prior=0.50	0.891	0.868	0.879

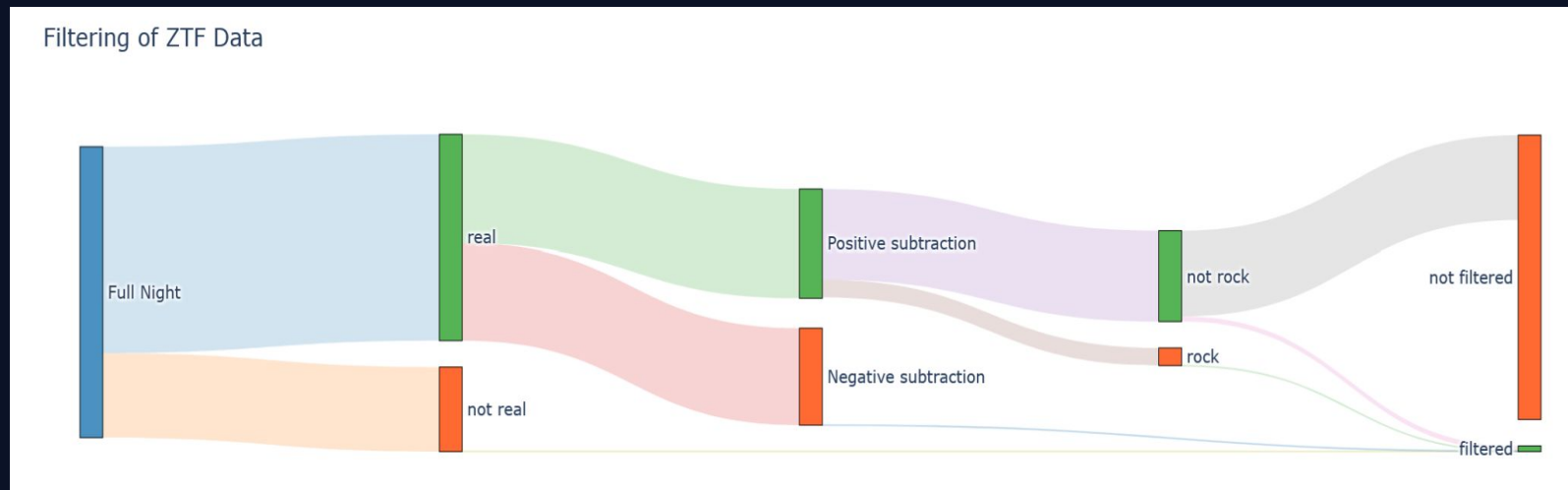
GBTDS — transient recall vs magnitude



GBTDS test — score distribution by label



From a flood of detections to a ranked set of targets



FRIGATE



<https://conference.ipac.caltech.edu/rapid-hotwiring2026/page/hacksession>

Store and Streaming

All in API

Bulk Data

The full Parquet archive — columnar and downloadable, built for offline analysis, training, and reprocessing.

Parquet · full history (in discussion)

Alert Stream

A live Kafka feed — one alert at a time, the moment it is issued, for same-night follow-up decisions.

Kafka · real time

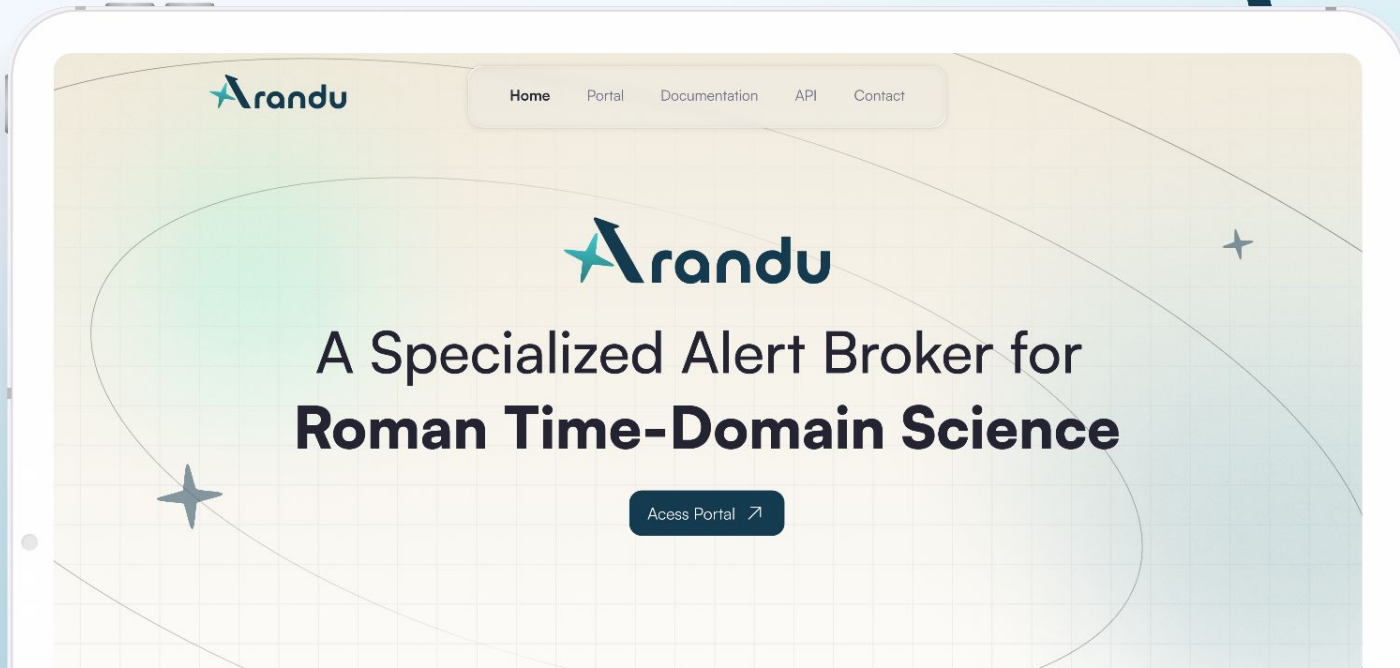
Science Enriched Queries

On-demand AI-SCOPE lookups — targeted queries with crossmatch and classification already attached.

AI-SCOPE · on demand



Data Visualization Web Portal





AI-SCOPE

<https://ai-scope.cbpf.br/>



All catalogs together



Easy cross-matches

• ZTF DR22

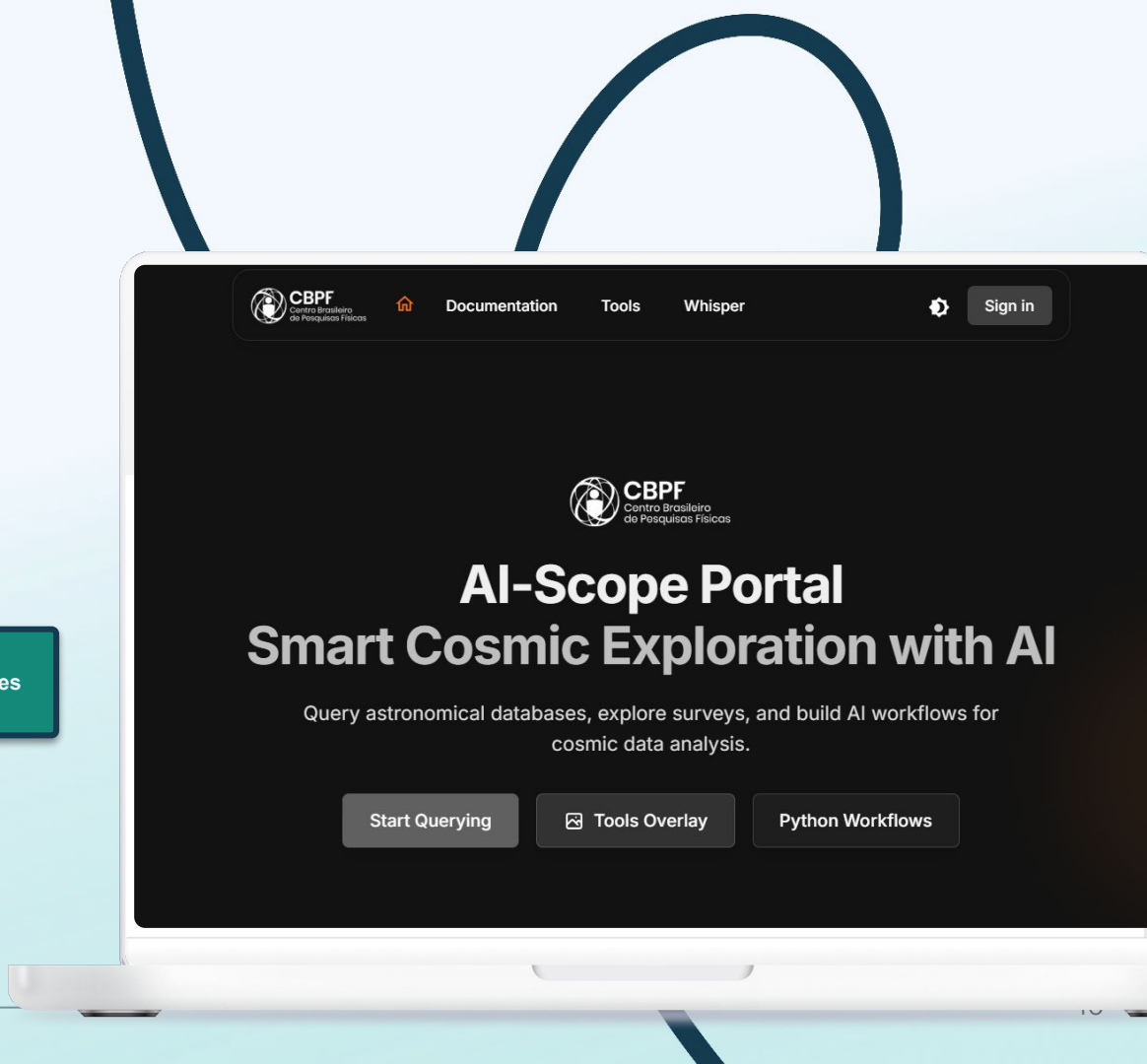
• DESI DR1

• Legacy DR10

• Gaia DR3

• Milliquas

• Others





What's inside AI_SCOPE



Query Tool — AstroQL

Simple spatial queries; run sync or async (also ADQL & SQL).



Cone Search

Quick positional lookups with instant plotting.



Image & File Collections

Cutouts, colored images (Lupton & Trilogy) and FITS downloads.



Interactive Viewer

Aladin-based sky exploration wired to AI-Scope data.



History & Dashboard

Revisit past queries, track jobs and share results by link.



What you can build

Example use-cases the platform is designed to support:



Transient & variable science

ZTF DR22 light curves now; Rubin/LSST next.



Photometric redshifts

Multi-band photometry with DESI spec-z / S-PLUS photo-z labels.



Star / QSO / galaxy separation

Gaia + WISE + S-PLUS features, like the DR5 SQG VAC.



Foundation models & training sets

Pretrain on images + spectra; crossmatch surveys in one query.



Clecio de Bom



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Fabiana Amorim



Jacob Jencson



Ryan Lau



Mansi Kasliwal

You!

Summary



Caltech



Roman-only broker

Will ingest alerts

Cross-match, Characterize, Classify and redistribute.

Advanced visualization, and filtering.

Thank you.

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