

# SNAPS: The Solar System Notification Alert Processing System



David E. Trilling  
(Northern Arizona University)

Mike Gowanlock, **Daniel Kramer**, Revanth Munugala, **Maria Chernyavskaya**, **Erin Clark**, **Connor Metcalfe**, **Graceson Mule**, **Gunnar Johnson**, **Savannah Chappus**



# What is SNAPS?

SNAPS is a **downstream broker** that is dedicated to Solar System science. Our goals are the following:

- (1) Ingest alert data for moving objects (ZTF, LSST)
- (2) Derive various properties (colors, lightcurves, etc.)
- (3) Identify individual and population outliers
- (4) Serve this data to the community (web page, outgoing alert stream, API)
- (5) Do science related to small bodies

# Brief review of the LSST data flow

## Brief review of the LSST data flow

Every 30 seconds

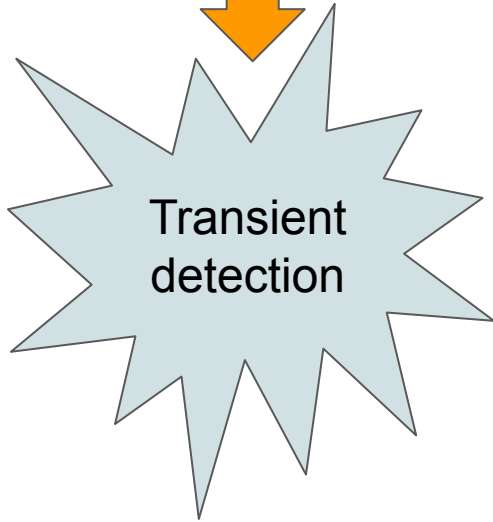


# Brief review of the LSST data flow

Every 30 seconds



Transient  
detection



# Brief review of the LSST data flow

Every 30 seconds



Transient  
detection

Known  
SSO?



# Brief review of the LSST data flow

Every 30 seconds

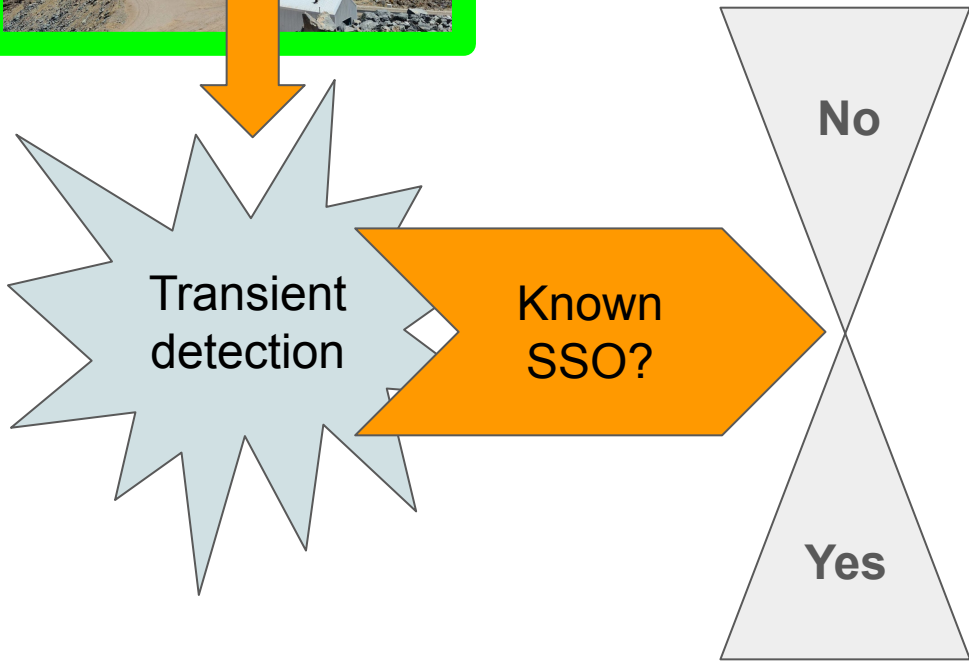


Transient  
detection

Known  
SSO?

No

Yes



# Brief review of the LSST data flow

Every 30 seconds



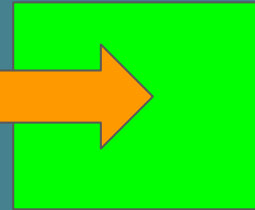
Transient  
detection

Known  
SSO?

No

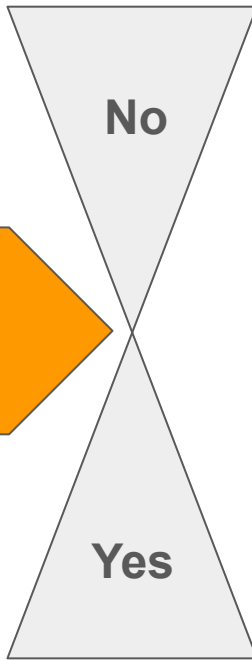
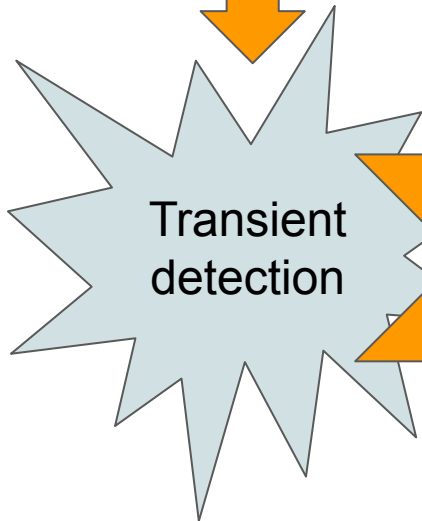
Yes

Brokers  
(incl.  
ANTARES)

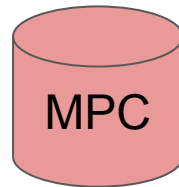
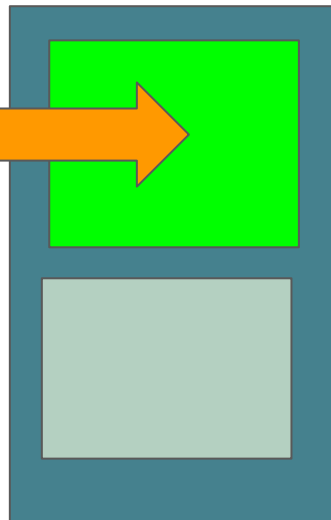


# Brief review of the LSST data flow

Every 30 seconds

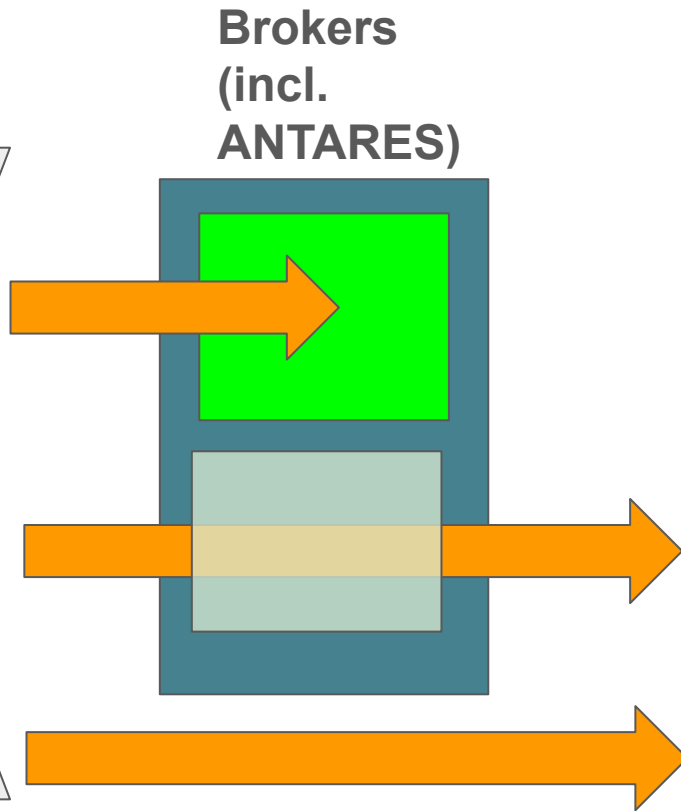
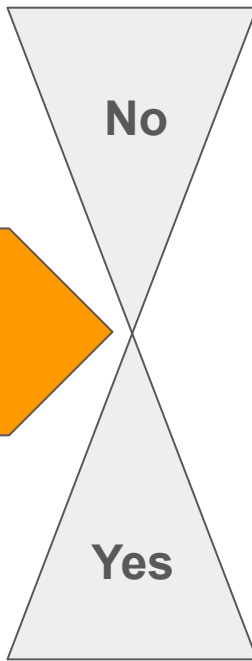
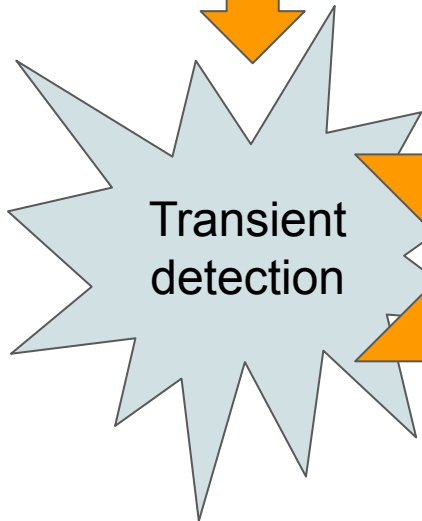


Brokers  
(incl.  
ANTARES)



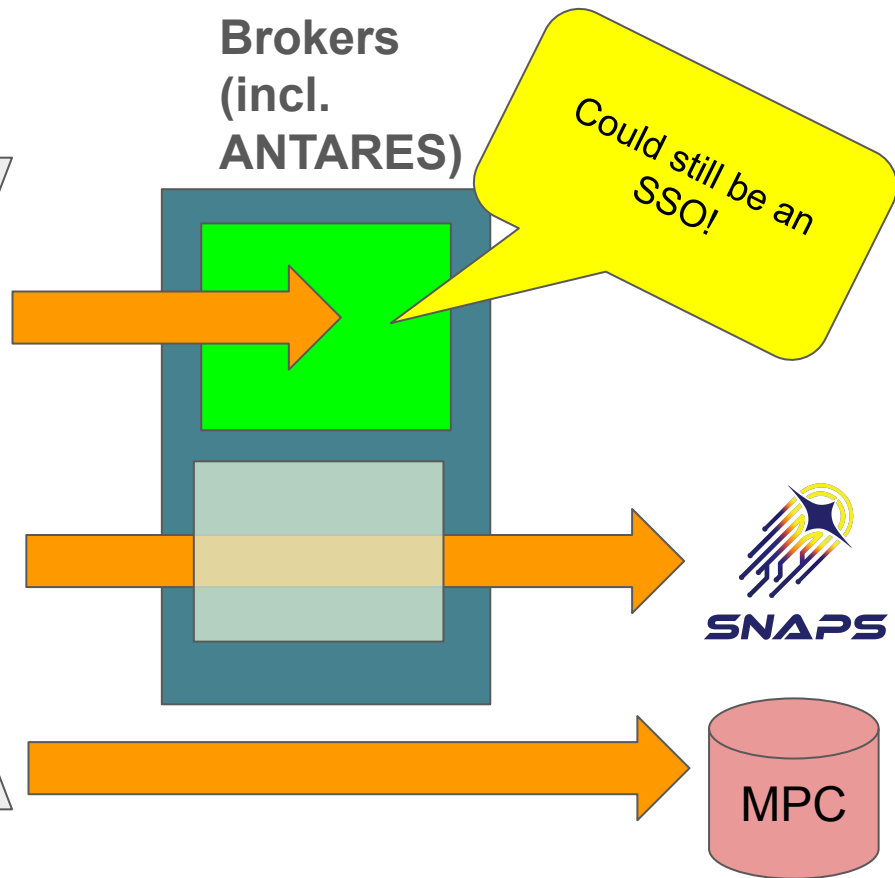
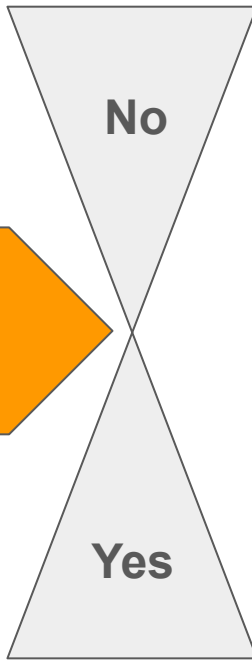
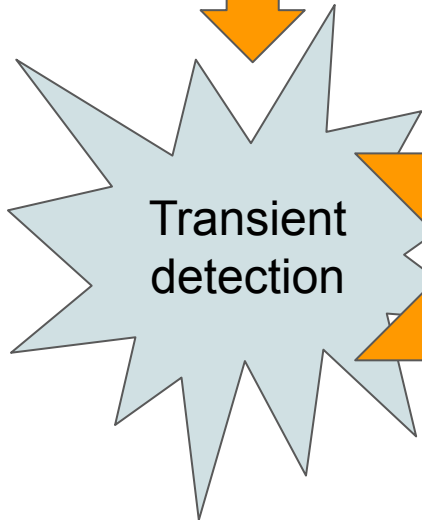
# Brief review of the LSST data flow

Every 30 seconds



# Brief review of the LSST data flow

Every 30 seconds





# What makes SNAPS unique

We are the only Solar System dedicated broker

Moving objects present special “challenges”

We collect and serve moving object data; derive moving object properties; enable moving object science



# What SNAPS does and does not

## What SNAPS does:

- Ingest observations of known moving objects
- Derive properties
- Value-added catalog
- Identify outliers

## What SNAPS does **not**:

- Discover new SS objects
- Non-SS objects



# SNAPS science

Trilling+ 2023: Architecture and SNAPShot1

Kramer+ 2023: Aliasing in period solutions

Gowanlock+ 2024: Population outliers

Gowanlock+ 2025: Combining ZTF and TESS data

Chernyavskaya+ (forthcoming): Super fast rotating asteroids

Clark+ (forthcoming): Active asteroids

Trilling+ (forthcoming): web page+API (**target:** arXiv, soon), SNAPShot2

Many others related to both astronomy and computer science

# SNAPS science

Trilling+ 2023: Architecture and SNAPShot1

Kramer+ 2023: Aliasing in period solutions

Gowanlock+ 2024: Population outliers

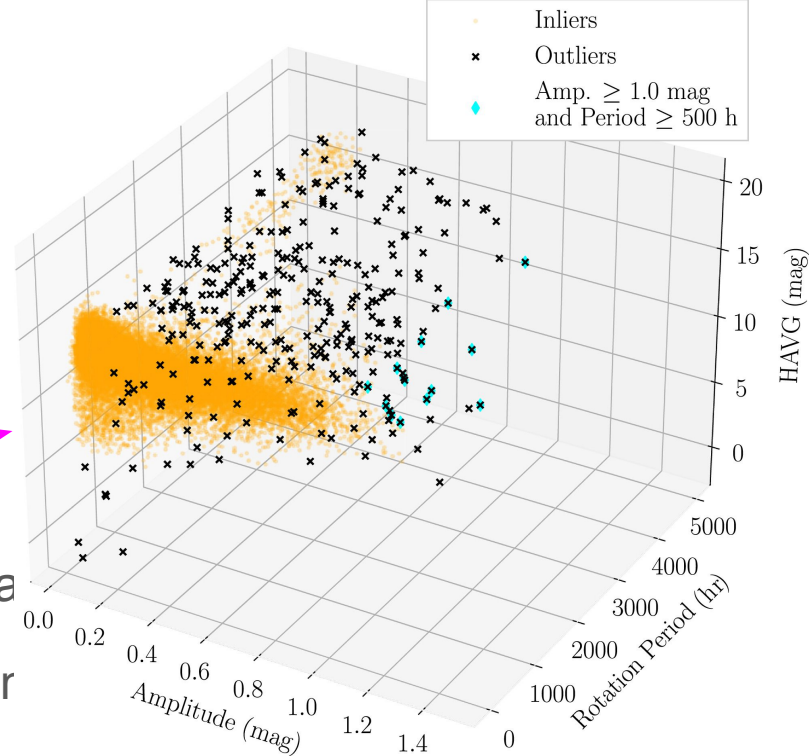
Gowanlock+ 2025: Combining ZTF and TESS data

Chernyavskaya+ (forthcoming): Super fast rotators

Clark+ (forthcoming): Active asteroids

Trilling+ (forthcoming): web page+API (target: arXiv, soon), SNAPShot2

Many others related to both astronomy and computer science



# SNAPS science

Trilling+ 2023: Architecture and SNA

Kramer+ 2023: Aliasing in period so

Gowanlock+ 2024: Population outlie

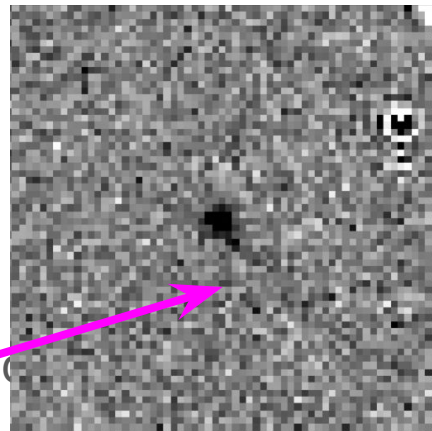
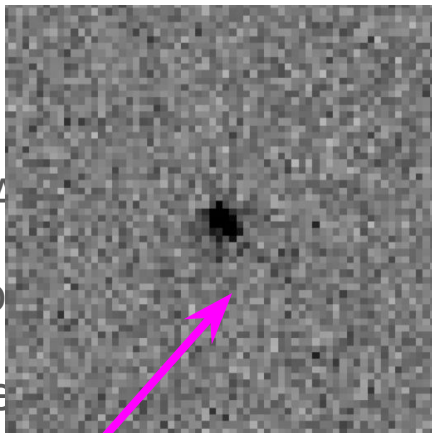
Gowanlock+ 2025: Combining ZTF and TESS data

Chernyavskaya+ (forthcoming): Super fast rotating asteroids

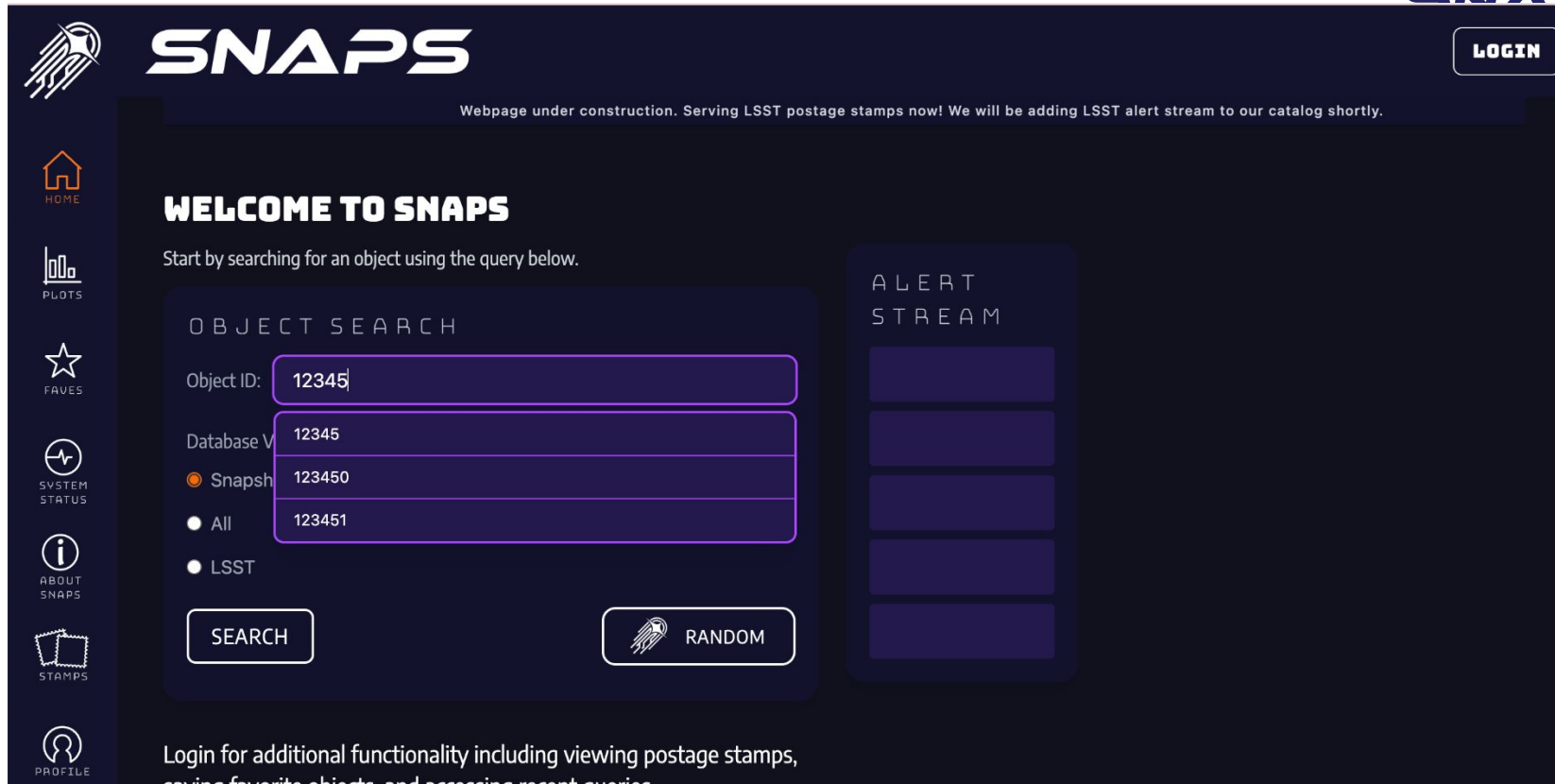
Clark+ (forthcoming): Active asteroids

Trilling+ (forthcoming): web page+API (**target:** arXiv, soon), SNAPShot2

Many others related to both astronomy and computer science



# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. At the top left is the SNAPS logo. To its right is the text "SNAPS" in a large, bold, white font. In the top right corner, there is a "LOGIN" button. Below the logo and text, a message reads: "Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly." The main content area is divided into two columns. The left column is titled "WELCOME TO SNAPS" and contains the text "Start by searching for an object using the query below." Below this is an "OBJECT SEARCH" section with a form. The form has three input fields: "Object ID:" with the value "12345", "Database V:" with the value "12345", and a radio button selection for "Snapsh" (selected), "All", and "LSST". Below the form are two buttons: "SEARCH" and "RANDOM". The right column is titled "ALERT STREAM" and contains five empty rectangular boxes. On the far left, there is a vertical sidebar with icons and labels: "HOME", "PLOTS", "FAVES", "SYSTEM STATUS", "ABOUT SNAPS", "STAMPS", and "PROFILE".

**SNAPS**

LOGIN

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.

## WELCOME TO SNAPS

Start by searching for an object using the query below.

### OBJECT SEARCH

Object ID: 12345

Database V: 12345

Snapsh

All

LSST

123450

123451

SEARCH

RANDOM

### ALERT STREAM

Empty alert stream boxes

Home

Plots

Faves

System Status

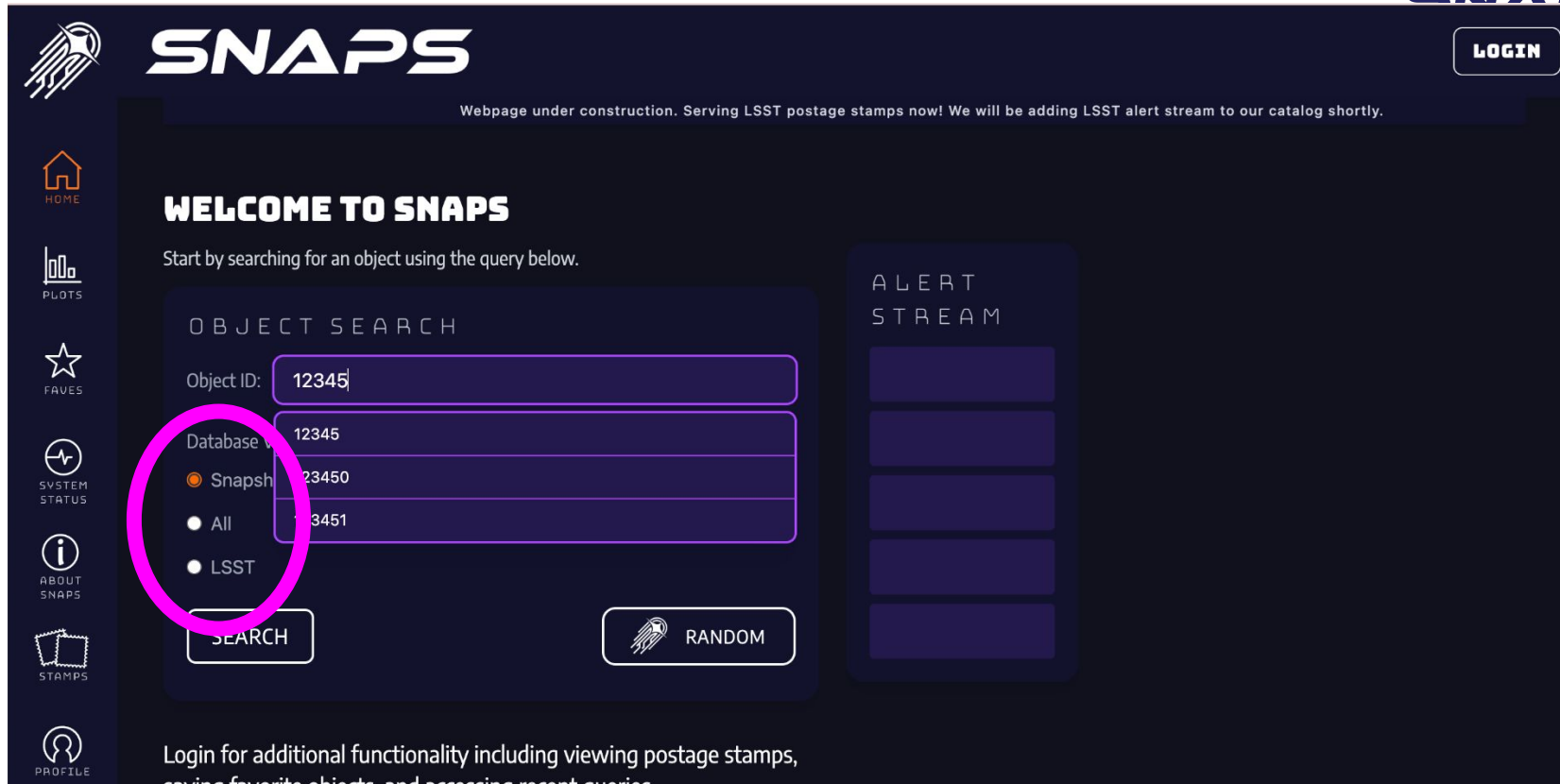
About SNAPS

Stamps

Profile

Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.

# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. At the top left is the SNAPS logo. At the top right is a 'LOGIN' button. Below the logo is a message: 'Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.'

The main content area is titled 'WELCOME TO SNAPS' and includes the instruction: 'Start by searching for an object using the query below.'

The 'OBJECT SEARCH' section contains a search form with the following fields and options:

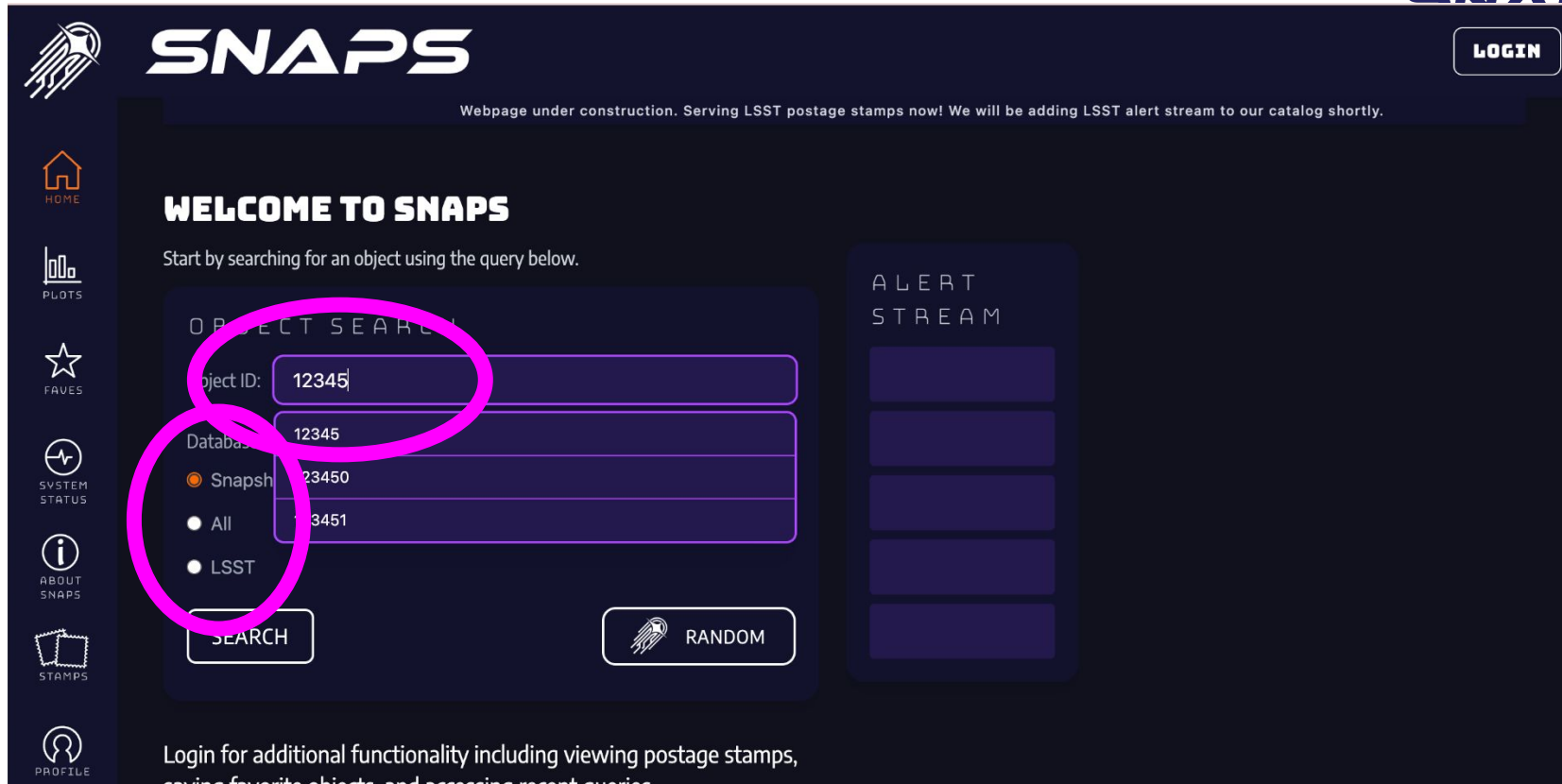
- Object ID:
- Database:
- Database selection options:
  - Snapshot
  - All
  - LSST
- 
- 

The 'ALERT STREAM' section is currently empty.

On the left sidebar, there are navigation icons for HOME, PLOTS, FAVES, SYSTEM STATUS, ABOUT SNAPS, STAMPS, and PROFILE.

At the bottom, there is a login prompt: 'Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.'

# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. At the top left is the SNAPS logo. To its right is the text "Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly." In the top right corner, there is a "LOGIN" button. On the left side, there is a vertical navigation menu with icons for HOME, PLOTS, FAVES, SYSTEM STATUS, ABOUT SNAPS, STAMPS, and PROFILE. The main content area features a "WELCOME TO SNAPS" heading and a sub-heading "Start by searching for an object using the query below." Below this is an "OBJECT SEARCH" section with a search form. The form includes an "Object ID:" field with the value "12345", a "Database:" field with the value "12345", and a list of radio buttons for "Snapshot" (selected), "All", and "LSST". A "SEARCH" button is located below the form. To the right of the search form is an "ALERT STREAM" section with five empty rows. At the bottom of the search form, there is a "RANDOM" button with a rocket icon. At the bottom of the page, there is a message: "Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries."

**SNAPS**

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.

**WELCOME TO SNAPS**

Start by searching for an object using the query below.

**OBJECT SEARCH**

Object ID: 12345

Database: 12345

Snapshot 123450

All 123451

LSST

**SEARCH**

**ALERT STREAM**

**RANDOM**

Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.

# How to interact with SNAPS: Web portal (1/2)



LOGIN



# SNAPS

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.



HOME



PLOTS



FAVES



SYSTEM STATUS



ABOUT SNAPS



STAMPS



PROFILE

## WELCOME TO SNAPS

Start by searching for an object using the query below.

### OBJECT SEARCH

Object ID: 12345

Database: 12345

Snapshot 123450

All 123451

LSST

SEARCH



RANDOM

### ALERT STREAM

Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.

# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. The top navigation bar includes a home icon, a bar chart icon, a star icon labeled 'FAVES', a system status icon, an information icon labeled 'ABOUT SNAPS', a stamps icon, and a profile icon. The main content area features a 'WELCOME TO SNAPS' heading and a search section. The search section has a text input field for 'Object ID' containing '12345', a dropdown menu for 'Database' with '12345' selected, and radio buttons for 'Snapshot' (selected), 'All', and 'LSST'. A 'SEARCH' button is located below the search fields. To the right, there is an 'ALERT STREAM' section with five empty rows. At the top right, a 'LOGIN' button is circled in pink. The search input field, the 'FAVES' icon, and the 'Snapshot' radio button are also circled in pink. A footer message reads: 'Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.'

SNAPS

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.

HOME

WELCOME TO SNAPS

Start by searching for an object using the query below.

OBJECT SEARCH

Object ID: 12345

Database: 12345

Snapshot 123450

All 123451

LSST

SEARCH

RANDOM

ALERT STREAM

FAVES

SYSTEM STATUS

ABOUT SNAPS

STAMPS

PROFILE

Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.

# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. The top navigation bar includes a home icon, a bar chart icon, a star icon labeled 'FAVES', a system status icon, an information icon labeled 'ABOUT SNAPS', a stamps icon, and a profile icon. The main content area features a 'WELCOME TO SNAPS' message and a search section. The search section includes a text input field for 'Object ID' containing '12345', a dropdown menu for 'Database' with '12345' selected, and radio buttons for 'Snapshot' (selected), 'All', and 'LSST'. A 'SEARCH' button is located below the search fields. To the right of the search section is an 'ALERT STREAM' section. A 'RANDOM' button is also present. The top right corner features a 'LOGIN' button. The page includes a notice: 'Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.'

SNAPS

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.

HOME

WELCOME TO SNAPS

Start by searching for an object using the query below.

OBJECT SEARCH

Object ID: 12345

Database: 12345

Snapshot 123450

All 123451

LSST

SEARCH

RANDOM

ALERT STREAM

FAVES

SYSTEM STATUS

ABOUT SNAPS

STAMPS

PROFILE

Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.

# How to interact with SNAPS: Web portal (1/2)



The screenshot shows the SNAPS web portal interface. The top navigation bar includes a home icon, a bar chart icon, a star icon labeled 'FAVES', a system status icon, an information icon labeled 'ABOUT SNAPS', a stamps icon, and a profile icon. The main content area features a 'WELCOME TO SNAPS' message and a search section. The search section includes a text input field for 'Object ID' containing '12345', a dropdown menu for 'Database' with '12345' selected, a radio button for 'Snapshot' (selected), and radio buttons for 'All' and 'LSST'. A 'SEARCH' button is located below the search fields. To the right of the search section is an 'ALERT STREAM' section. At the bottom of the search section is a 'RANDOM' button with a star icon. A 'LOGIN' button is located in the top right corner. The text 'Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.' is displayed below the SNAPS logo.

SNAPS

Webpage under construction. Serving LSST postage stamps now! We will be adding LSST alert stream to our catalog shortly.

HOME

WELCOME TO SNAPS

Start by searching for an object using the query below.

OBJECT SEARCH

Object ID: 12345

Database: 12345

Snapshot 123450

All 123451

LSST

SEARCH

ALERT STREAM

RANDOM

FAVES

SYSTEM STATUS

ABOUT SNAPS

STAMPS

PROFILE

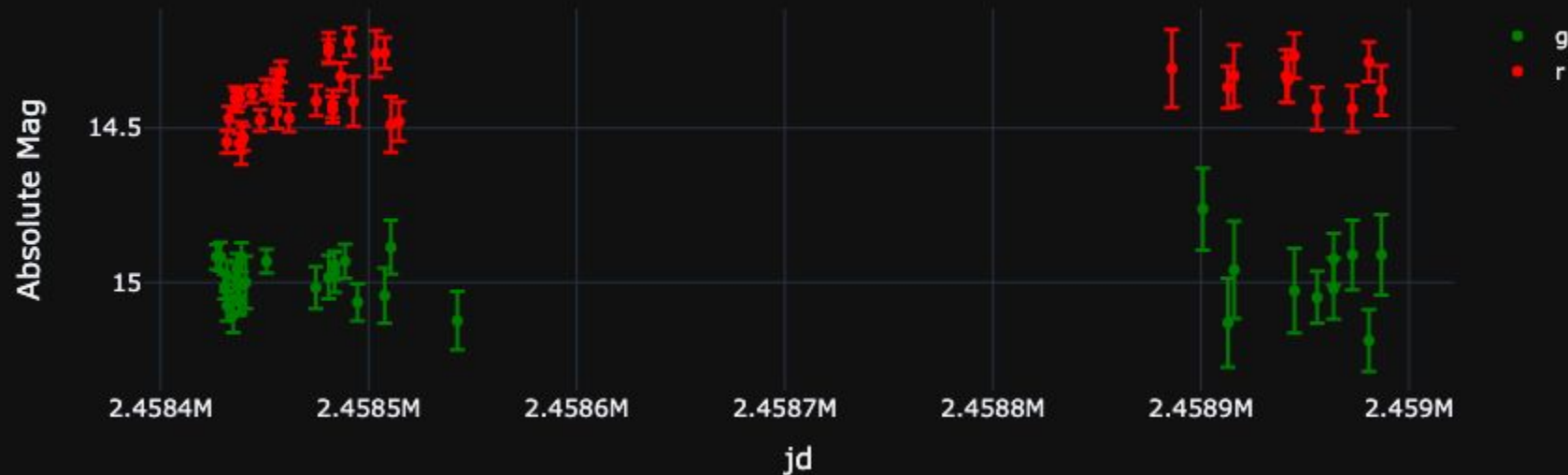
Login for additional functionality including viewing postage stamps, saving favorite objects, and accessing recent queries.



## How to interact with SNAPS: Web portal (2/2)

SNAPS

Observations for 12345





# How to interact with SNAPS: Web portal (2/2)

SNAPS

Observations for 12345

Light Curve for 12345

Absolute Mag

14.5

14

15

H

2.458

14.6

0

0.5

1

1.5

2

2.5

Phase (h)

g

r

Model Fit

± I T

T

T

T

T

g

a



# How to interact with SNAPS: API





# Hardware and status

We store, process, and serve all the SNAPS data from local (NAU) machines

This is perfectly doable and brings a lot of convenience



LSST DATA INGESTION TRACKER

## Nights ingested

Refresh this page to check updates.

TOTAL INGESTED NIGHTS

**11**

LSST ALERTS

**466,898**

SS OBJECTS

**456,282**

LAST UPDATED

**3/26/2026, 2:23:28 PM**

# Timeline

We are basically ~ready to serve LSST alerts (<2 weeks out)

“How to” document to arXiv on ~the same timeline

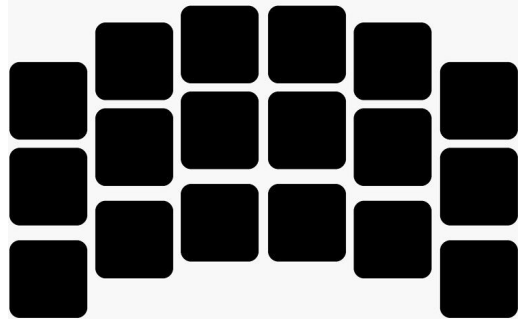


Coming attractions (since LSST is “solved”)

We will ingest and serve SSO data, plus value-add, from Roman and Argus (for example)

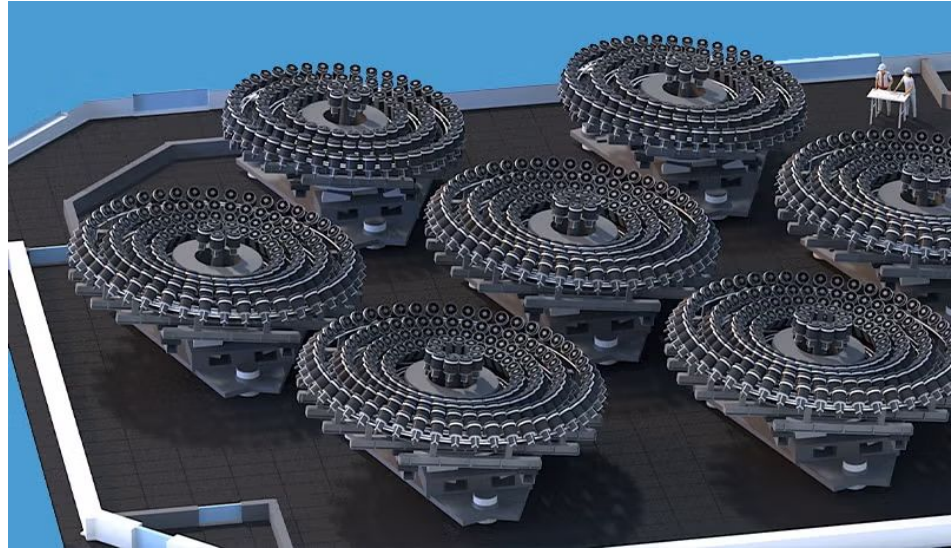


NANCY GRACE  
**R.OMAN**



SPACE TELESCOPE

**Argus**

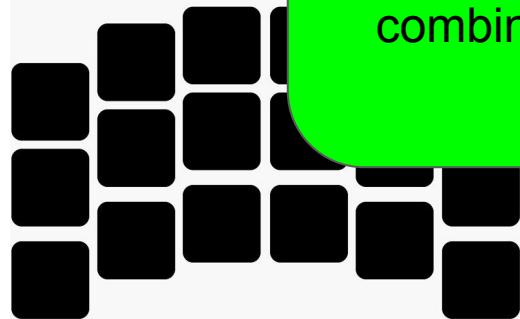


# Coming attractions (since LSST is “solved”)



We will ingest and serve SSO data, plus value-add, from Roman and Argus (for example)

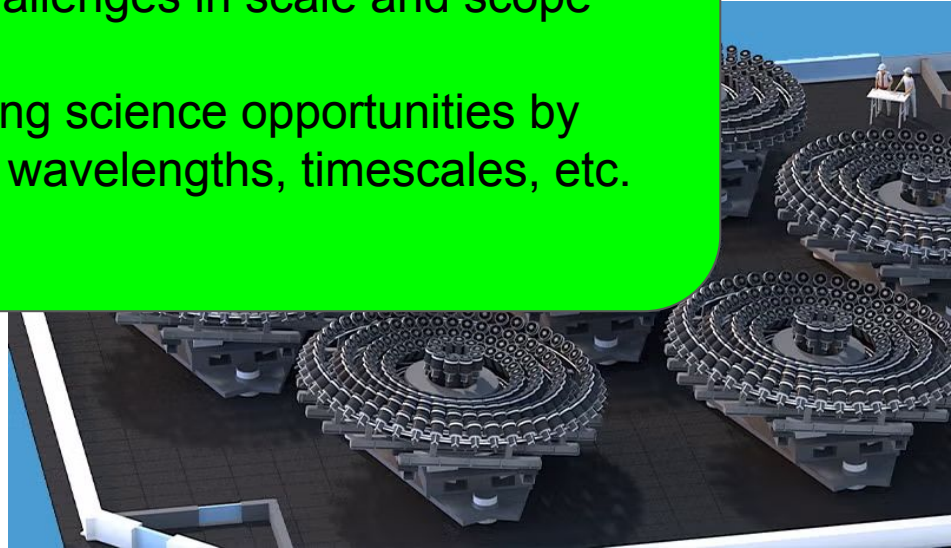
NANCY  
R.OMAN



SPACE TELESCOPE

Novel challenges in scale and scope

Interesting science opportunities by combining wavelengths, timescales, etc.



# Summary: SNAPS



SNAPS is the only dedicated Solar System broker:

“Doing science with your trash since 2018!”

Serve value-added moving object data

Detecting individual and population outliers

Timeline: Couple of weeks ...

Come get a sticker!