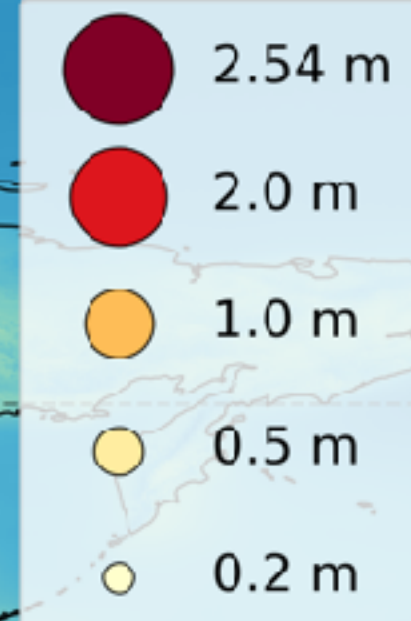




BHTOM GLOBAL NETWORK OF TELESCOPES

- A RESEARCH INFRASTRUCTURE FOR TIME-DOMAIN ASTRONOMY

Łukasz Wyrzykowski
(pron. Woo-cash Vi-zhi-kov-ski)



Astronomical Observatory,
University of Warsaw, Poland

National Centre for Nuclear
Research, Warsaw, Poland



TEAM AND COLLABORATIONS

Warsaw University Astronomical Observatory

collaborators

UMK Toruń

Heidelberg University



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Przemek Mikołajczyk
(staff)



Krzysztof Kotysz
(staff)



Mariusz Gromadzki
(postdoc)



Milena Ratajczak
(postdoc)



Monika Sitek
(staff)



Paweł Zieliński
(staff)

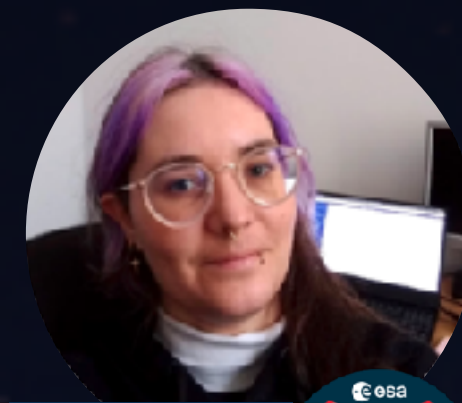


Zofia Kaczmarek
(PhD student)

students, former students:



Kris A. Rybicki
(postdoc)



Katarzyna Kruszyńska
(postdoc)



Nada Ihanec
(PhD student)



Mauritz Wicker
(PhD student)



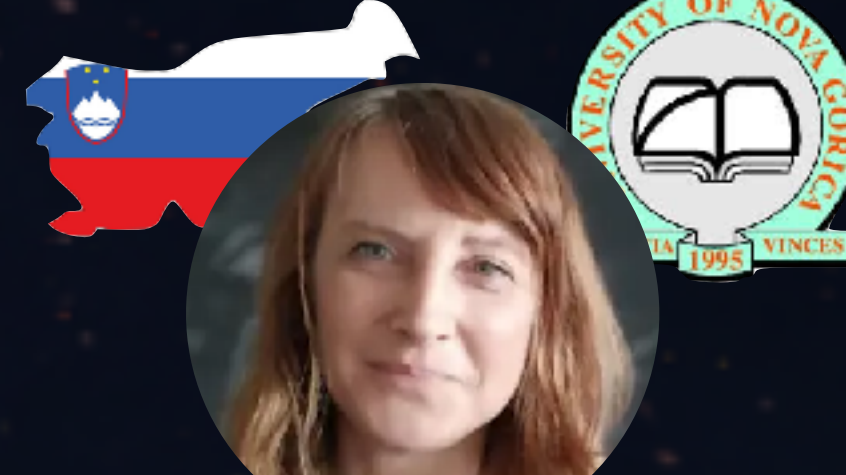
Kornel Howil
(BSc student)



Uliana Pylypenko
(MSc student)



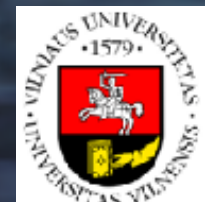
Marius Maskoliūnas
and his group



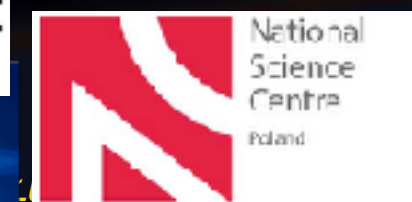
Andreja Gomboc
and her group

Former contributors: Maja Jabłońska, Piotr Trzcionkowski, Kacper Raciborski, Monika Sitek

AkondLab.



Funding:

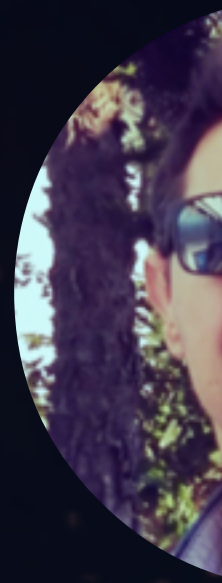




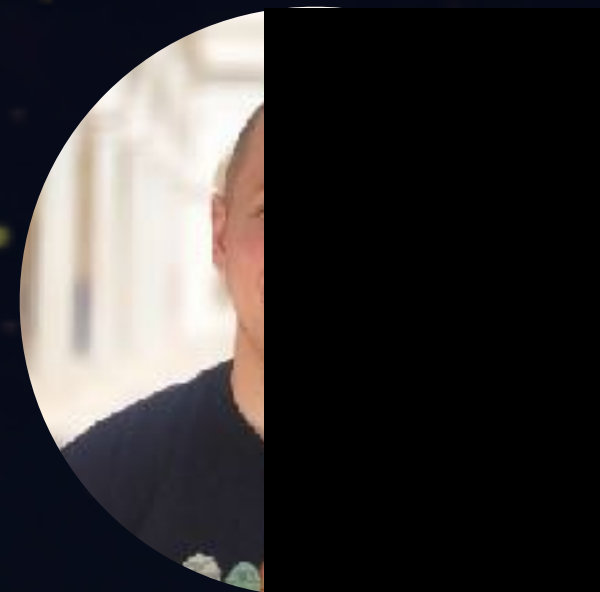
NCBJ: National Centre for Nuclear Research - Astrophysics Division



Łukasz Wyrzykowski
(staff)



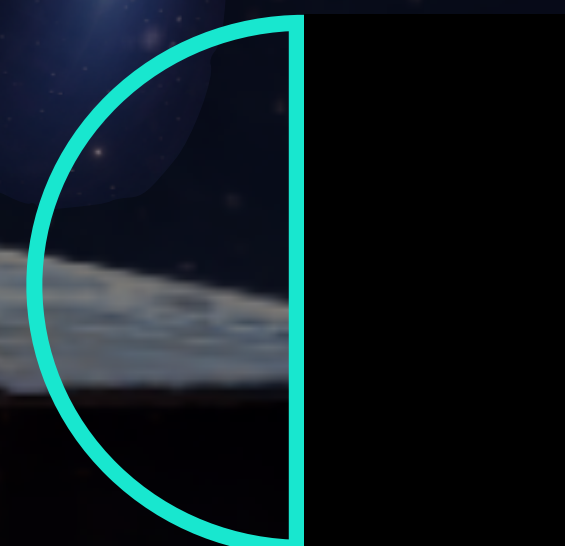
Przemek Mikołajczyk
(staff)



Krzysztof Kotysz
(staff)



Astronomer
(to be hired)



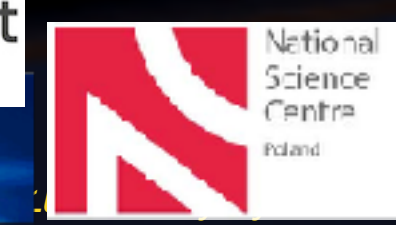
Software engineer
(to be hired)



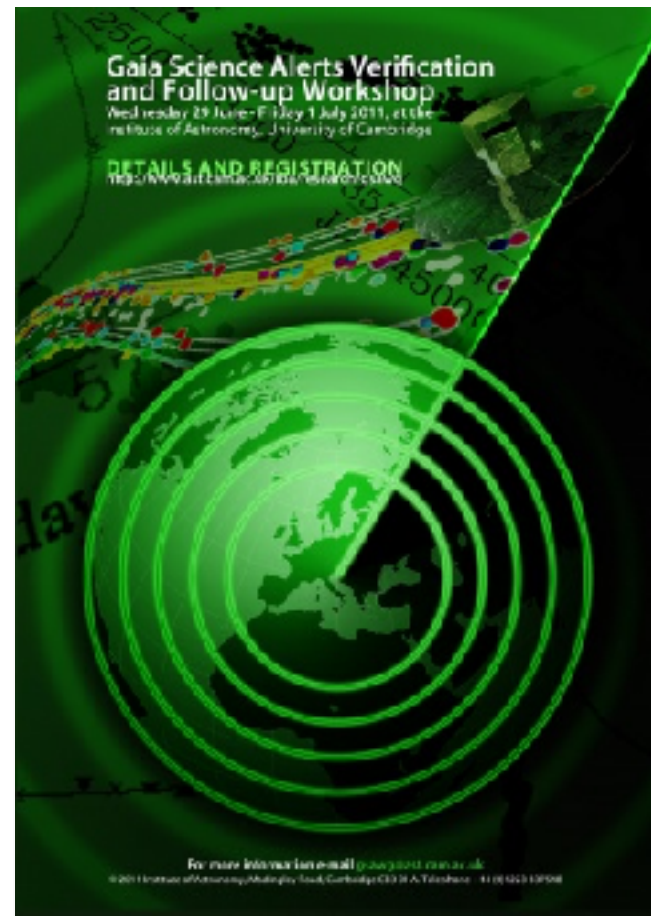
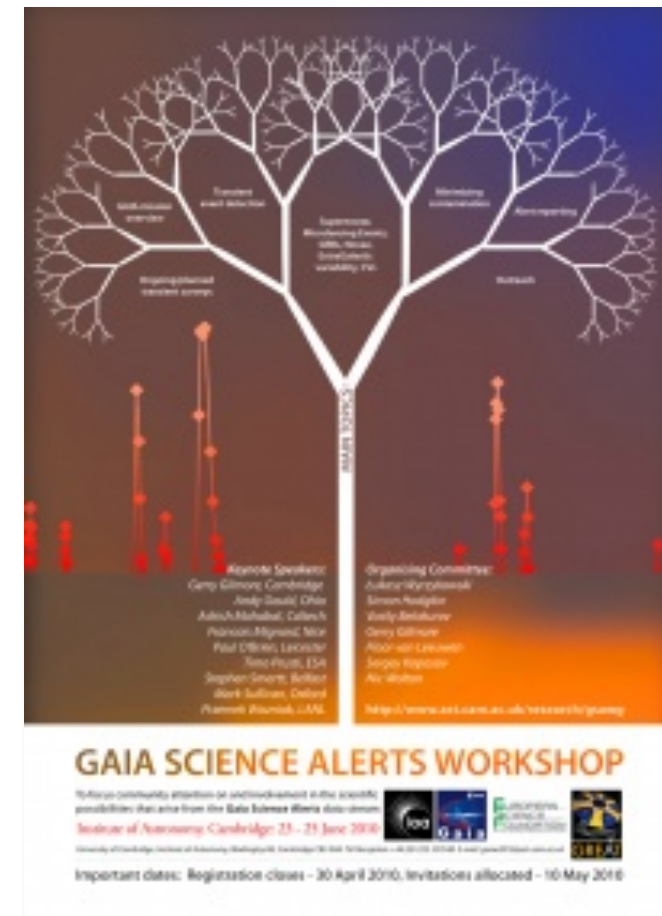
Software House
(to be subcontracted)



Funding:



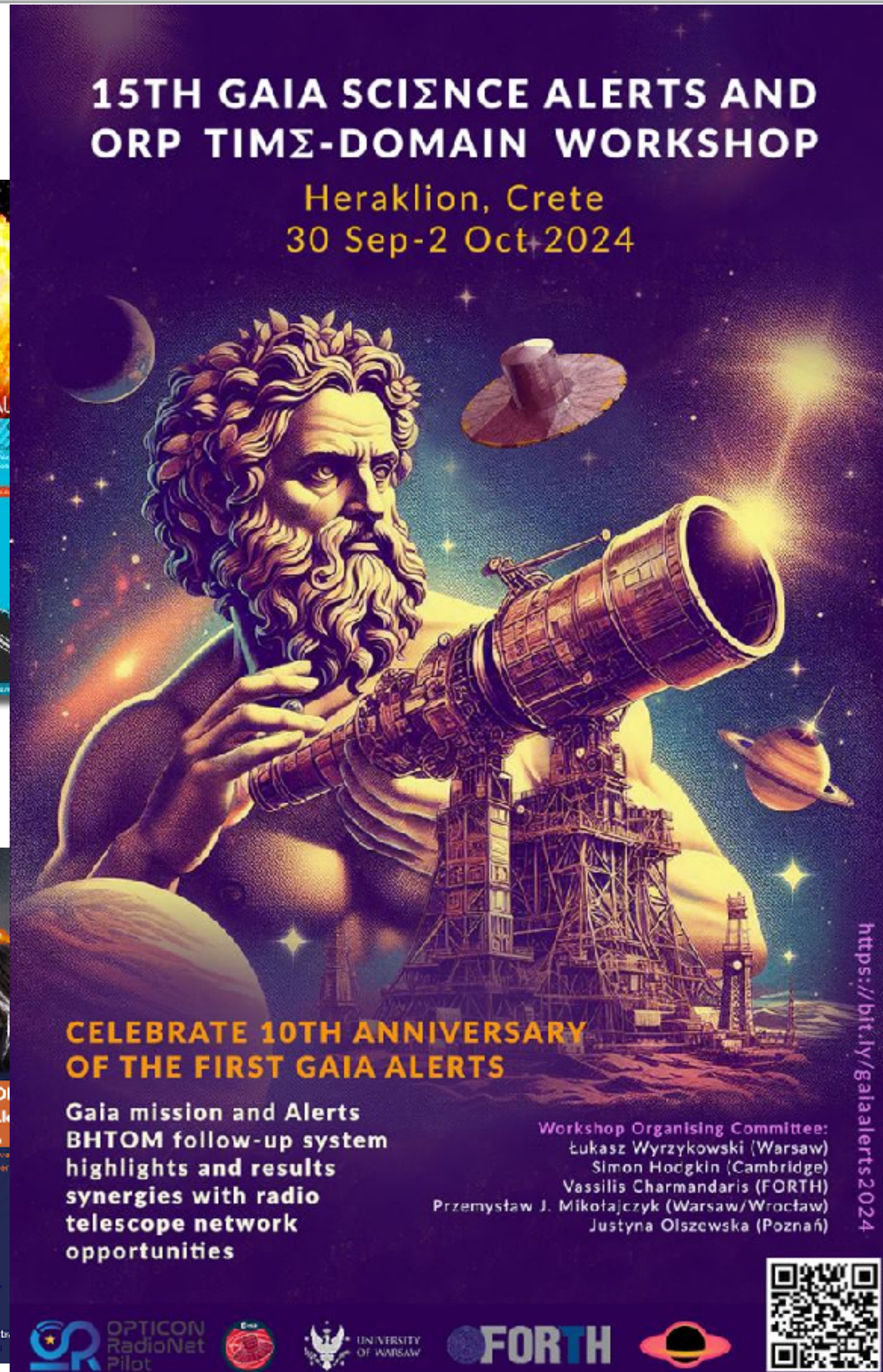
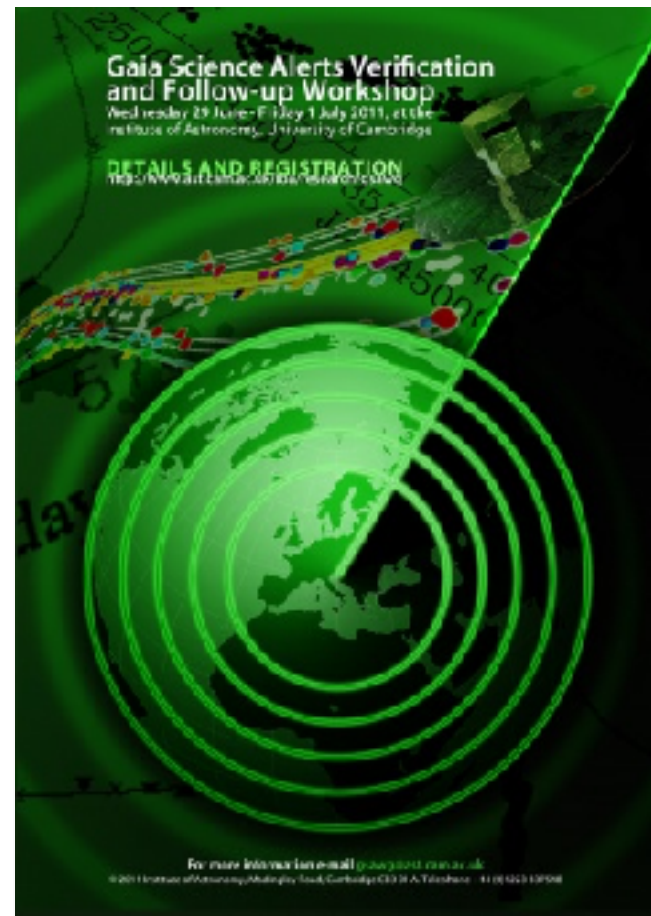
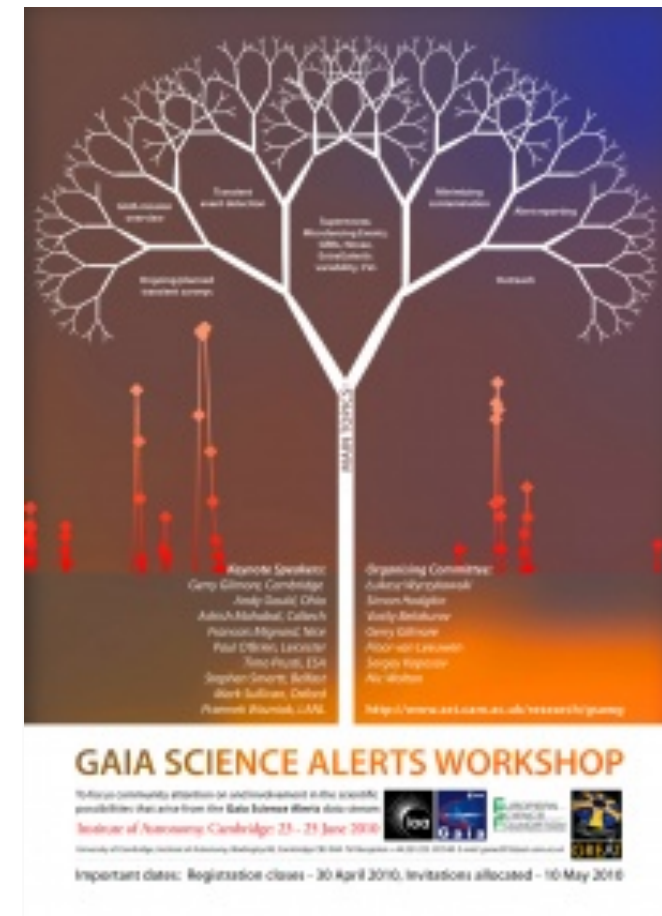
WORKSHOPS SINCE 2010



ARCHIVAL RECORDINGS: [HTTP://WWW.AST.CAM.AC.UK/IOA/WIKIS/GSAWGWIKI](http://www.ast.cam.ac.uk/IOA/WIKIS/GSAWGWIKI)

Łukasz Wyrzykowski

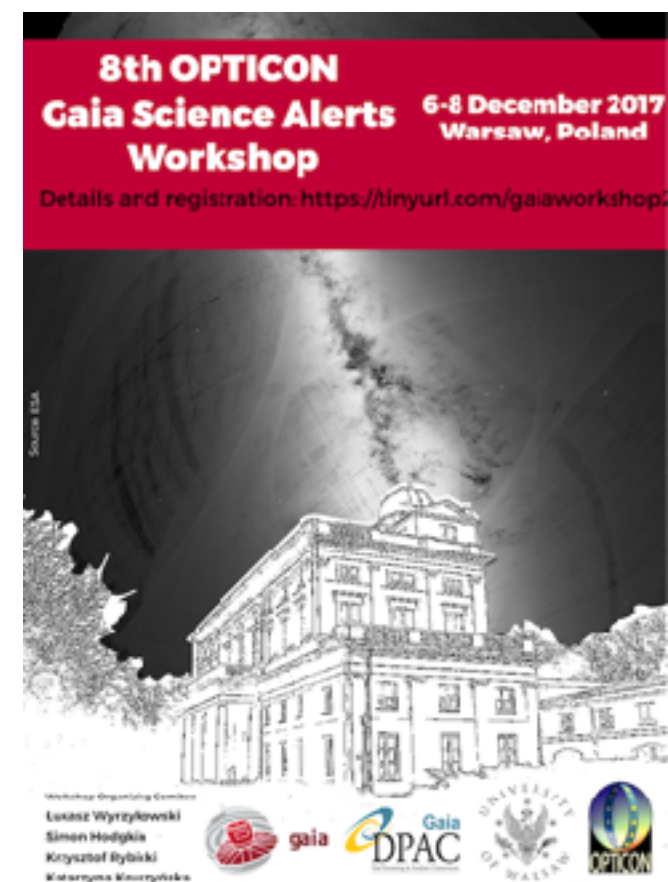
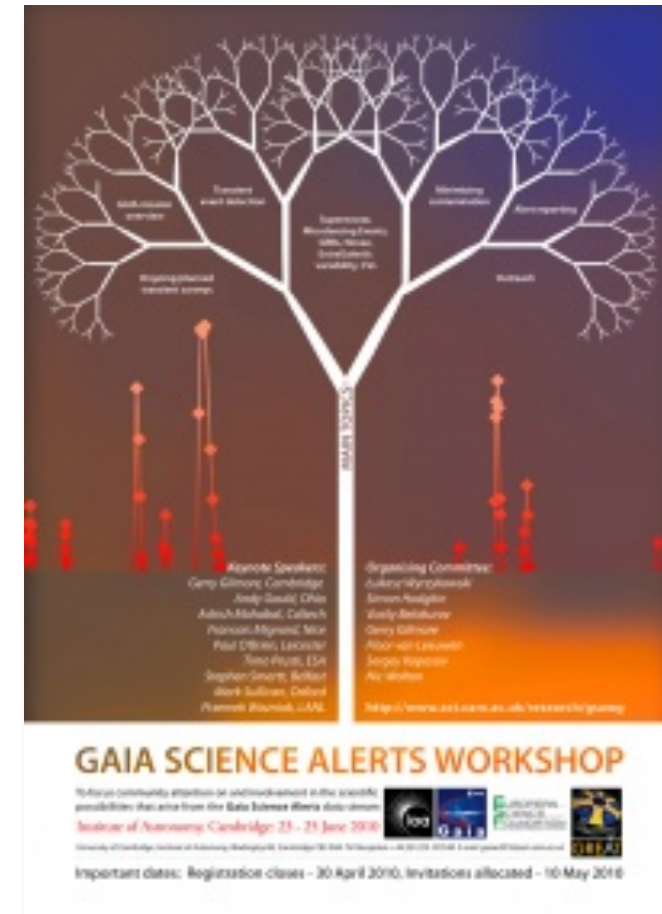
WORKSHOPS SINCE 2010



ARCHIVAL RECORDINGS: [HTTP://WWW.AST.CAM.AC.UK/IOA/WIKIS/GSAWG/WIKI](http://www.ast.cam.ac.uk/IOA/WIKIS/GSAWG/WIKI)

Łukasz Wyrzykowski

WORKSHOPS SINCE 2010



ACME Hackaton

on Time-Domain Astronomy Alerts and Archives IAC Tenerife September 2025 (prelim)

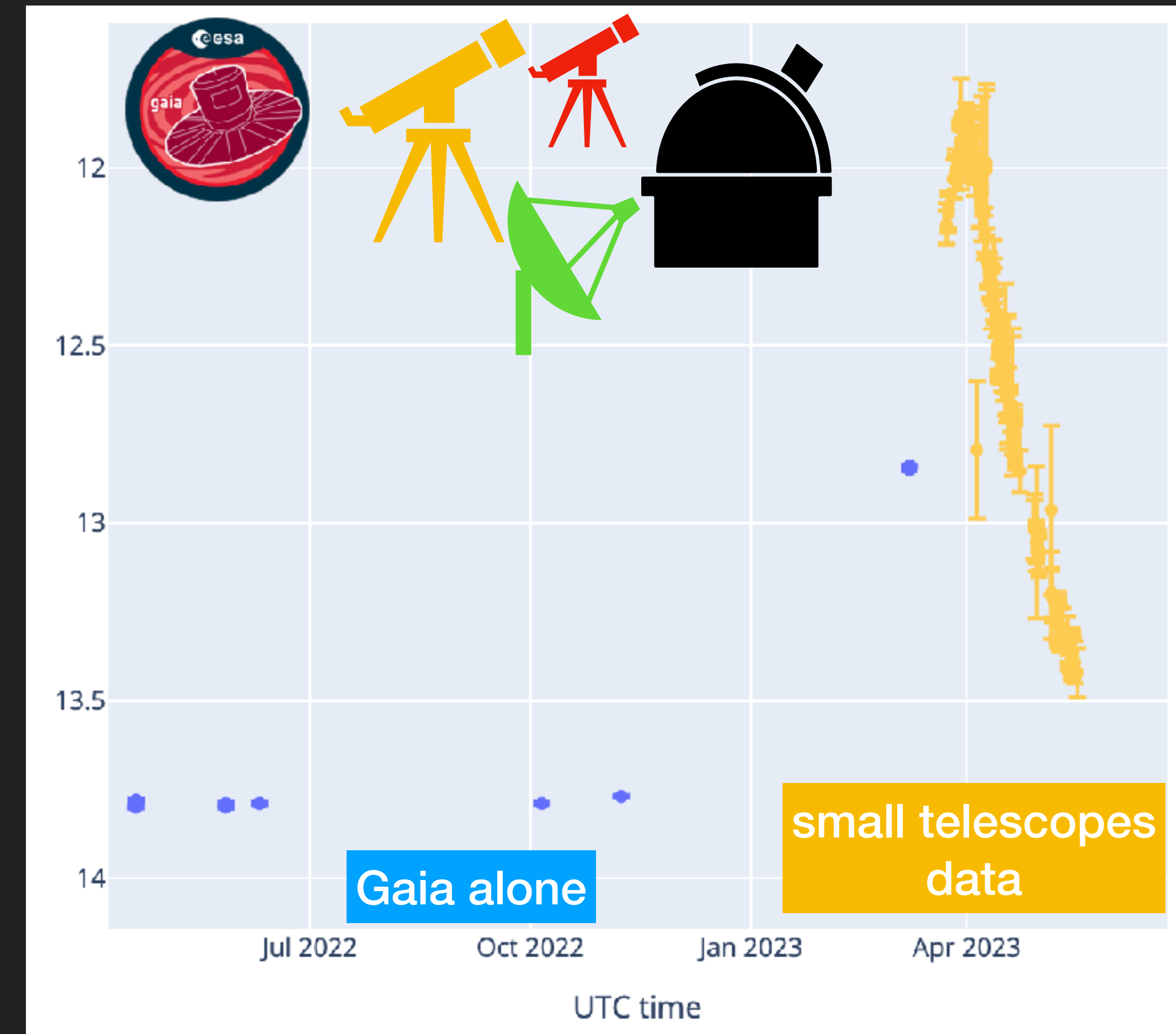


ARCHIVAL RECORDINGS: [HTTP://WWW.AST.CAM.AC.UK/IOA/WIKIS/GSAWGWIKI](http://www.ast.cam.ac.uk/IOA/WIKIS/GSAWGWIKI)

Łukasz Wyrzykowski

SMALL TELESCOPES FOR BIG SCIENCE

- ▶ part of OPTICON since 2013
- ▶ Cambridge Photometric Calibration Server (CPCS) - precursor
- ▶ started as a support for Gaia Science Alerts programme
- ▶ more than 100 small telescopes have donated their observing time
- ▶ 0.3-2.5m in diameter, from a couple of frames a week to hundreds
- ▶ universities, research institutes, outreach institutions, private
- ▶ BHTOM system started in 2020 based on LCO's TOM Toolkit
- ▶ thousands of images currently processed every week
- ▶ broad range of science cases in time-domain





BLACK HOLE TARGET AND OBSERVATION MANAGER (BHTOM)

- ▶ web tool for coordination for time-domain observation
- ▶ automated observation requests
- ▶ processing of raw images from heterogenous units
- ▶ automated standardisation
- ▶ archival multi-wavelength time-domain photometry
- ▶ open for new users, new telescopes, new targets!

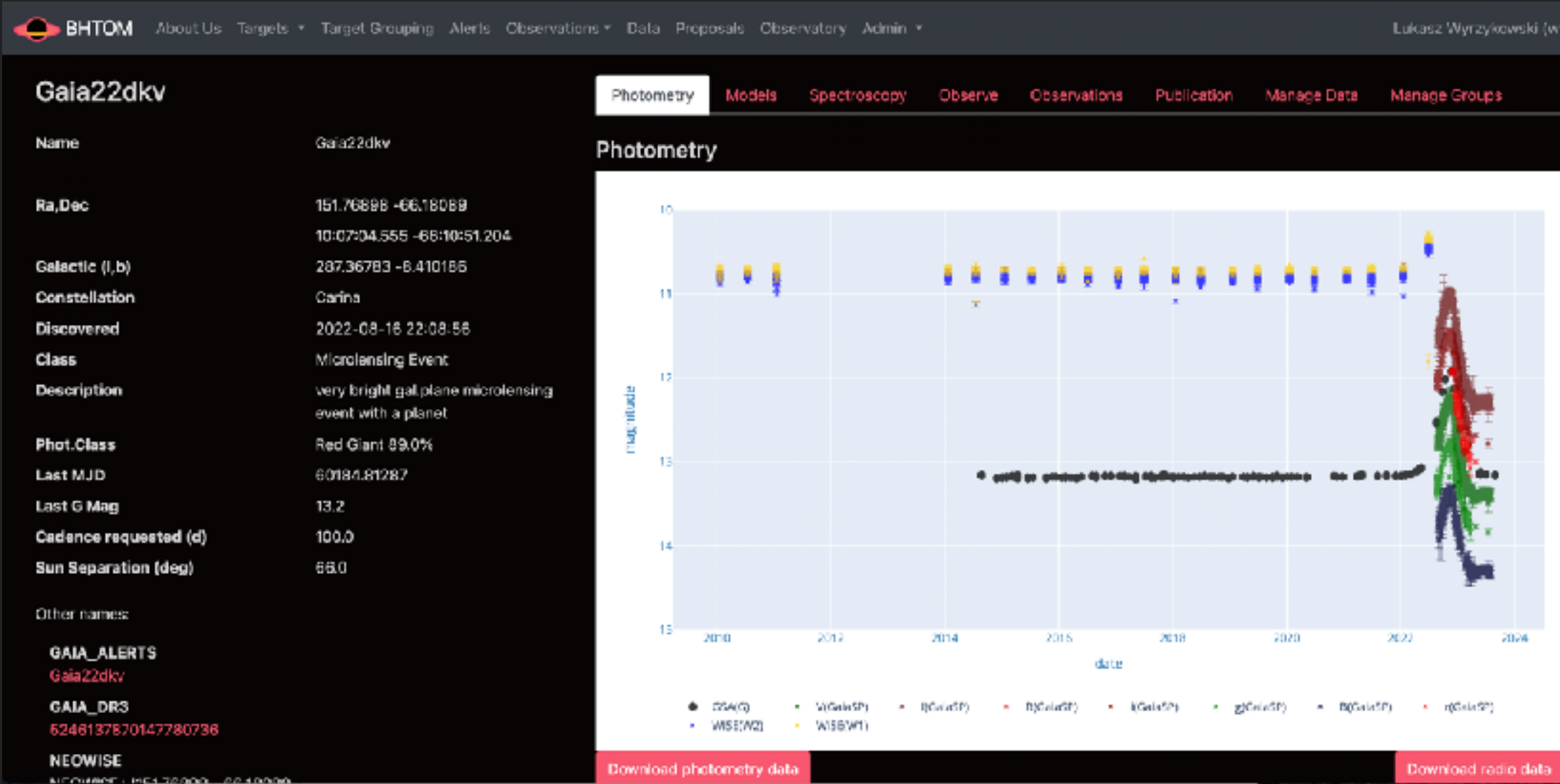


///AkondLab.



BHTOM 2.0 since Sardinia workshop in 2022

☐	Names	RA	Dec	Nobs	Last Gmag	Last Filter	Importance	Created	Priority	Sun	Class
☐	Gaia1Bacq	22:05:42.324	+03:39:17.064	982	20.2	Gaia/r	9.99	2023-09-18 10:09:17	799.0	155	long_period_variable
☐	Gaia22bpl	10:38:42.425	-61:15:49.680	903	12.7	Gaia/r	9.99	2023-09-18 10:09:48	208.6	64	microlensing_event
☐	Gaia22awa	19:04:51.962	-08:34:00.660	1602	15.0	Gaia/r	9.99	2023-09-17 21:09:11	770.1	111	microlensing_event
☐	ZTF19abflrit	18:24:23.314	-24:36:42.053	842	15.2	Gaia/r	0.0	2023-09-19 11:09:02	0.0	100	long_period_variable

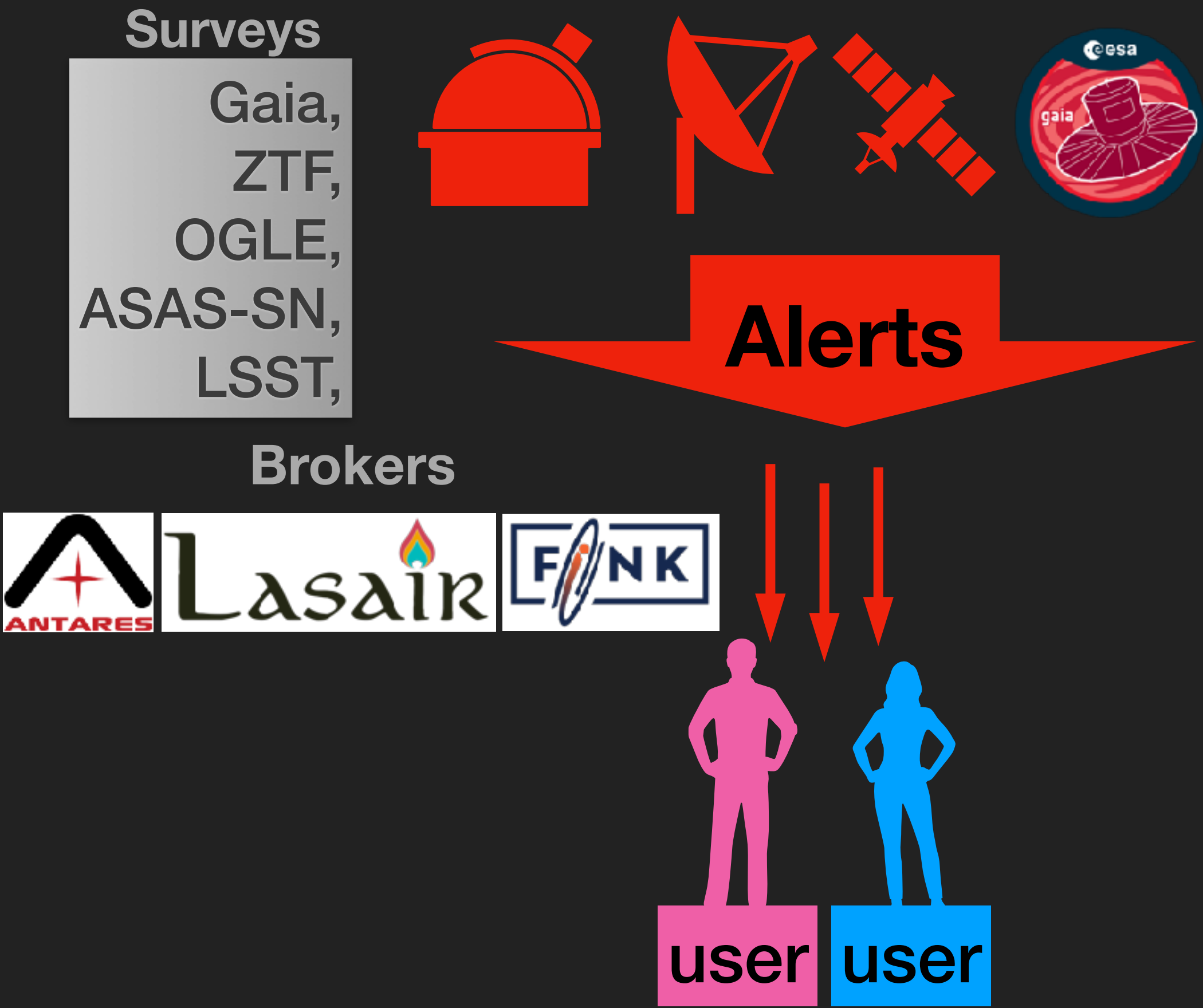


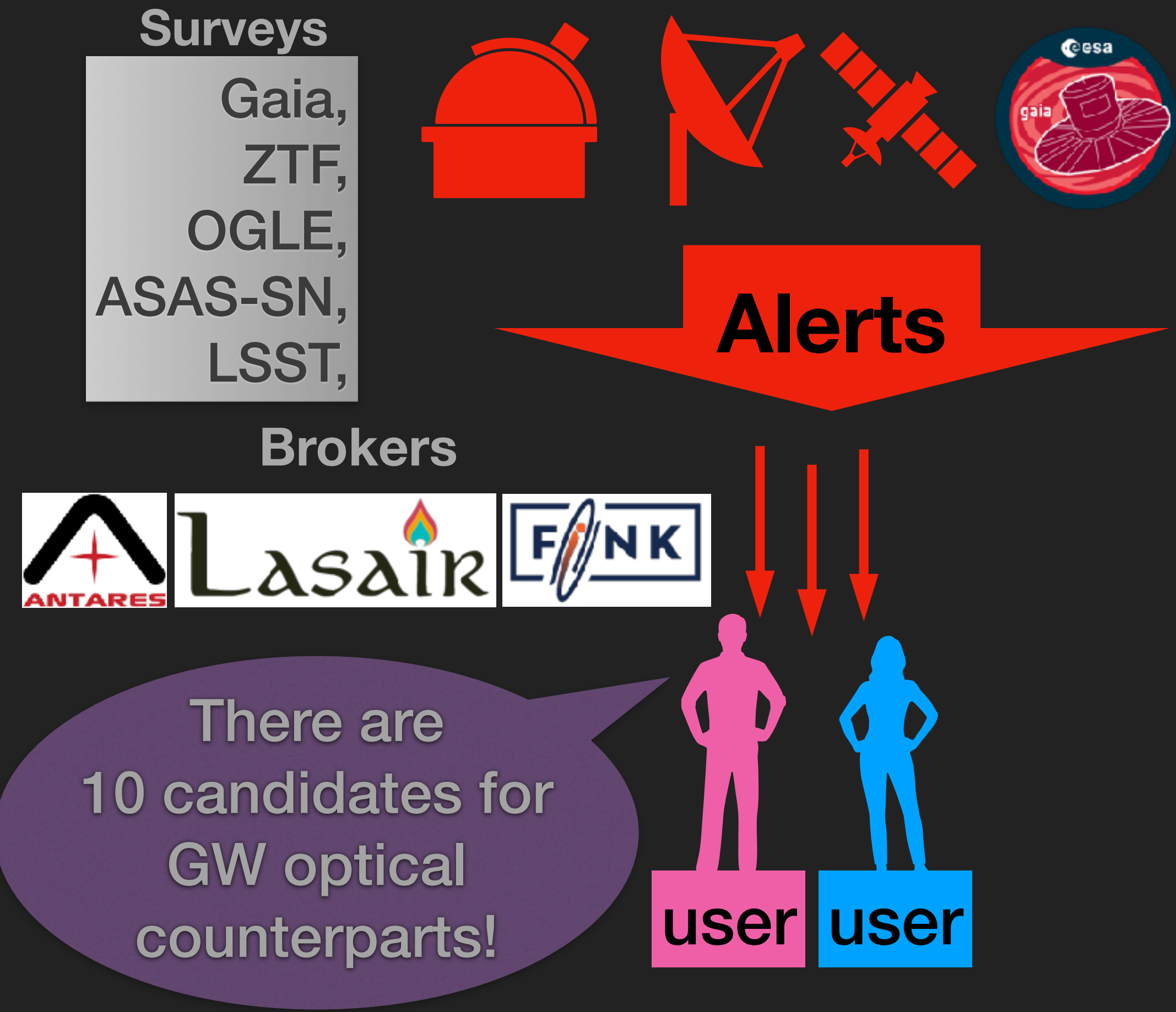
Surveys

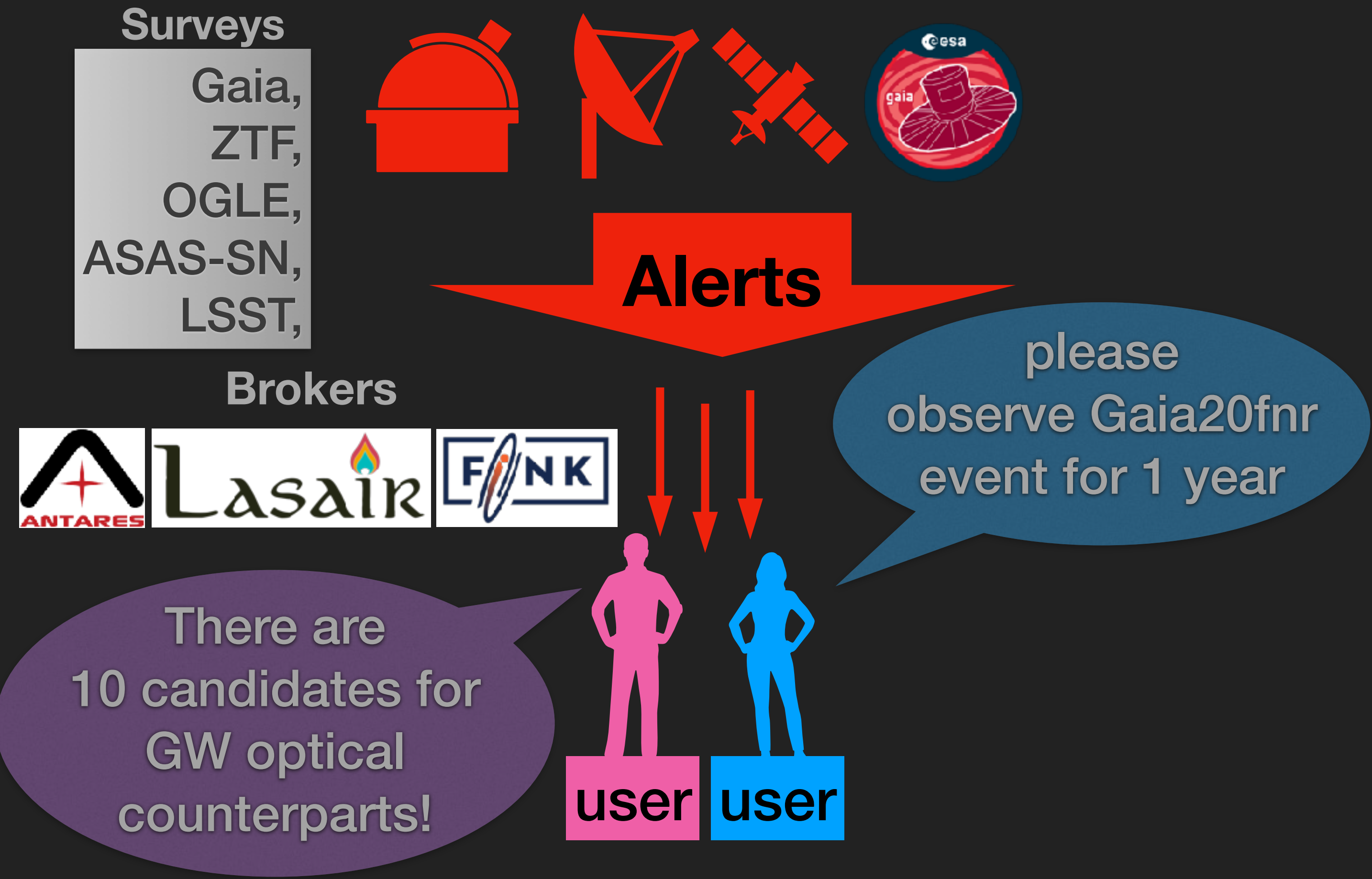
Gaia,
ZTF,
OGLE,
ASAS-SN,
LSST,

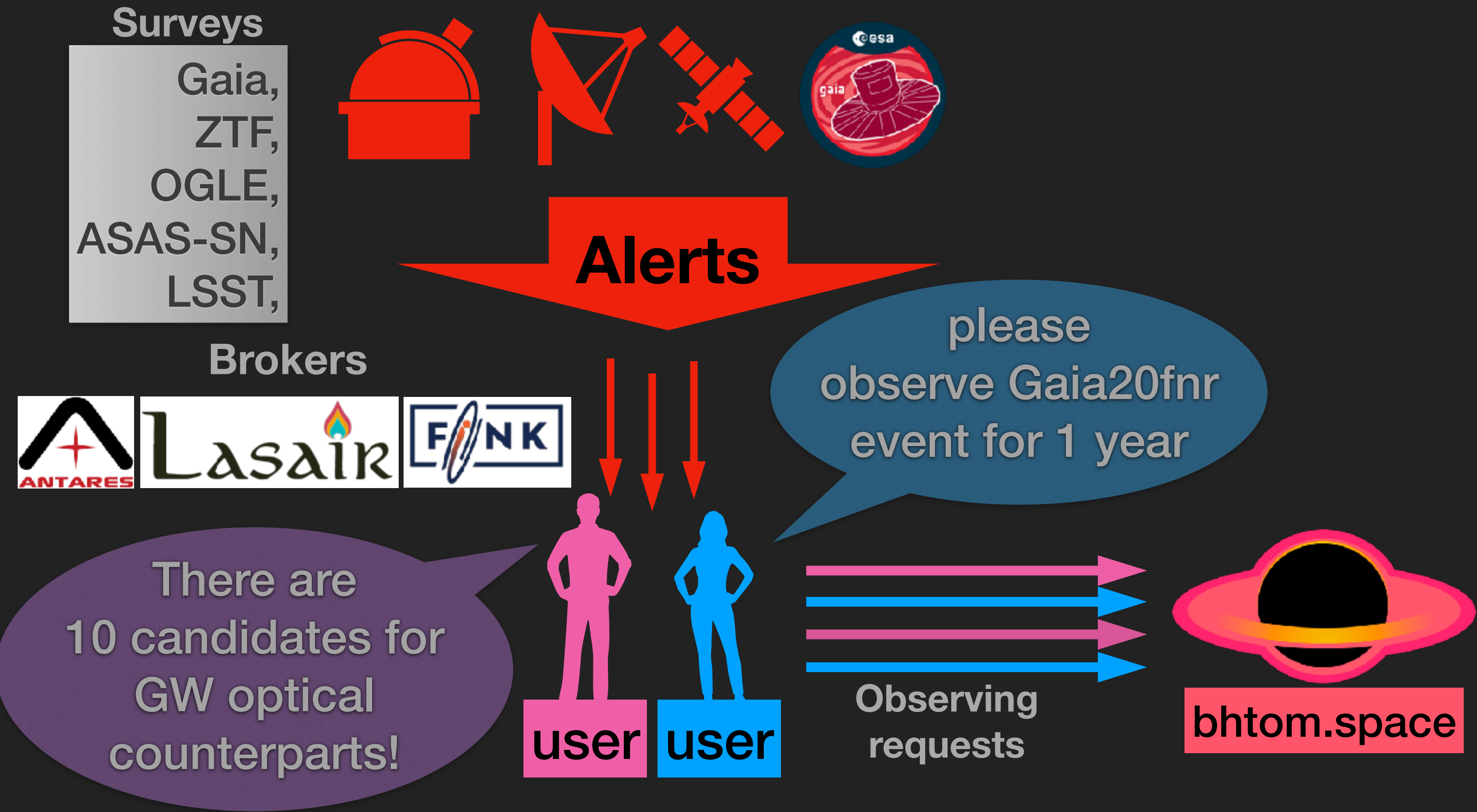


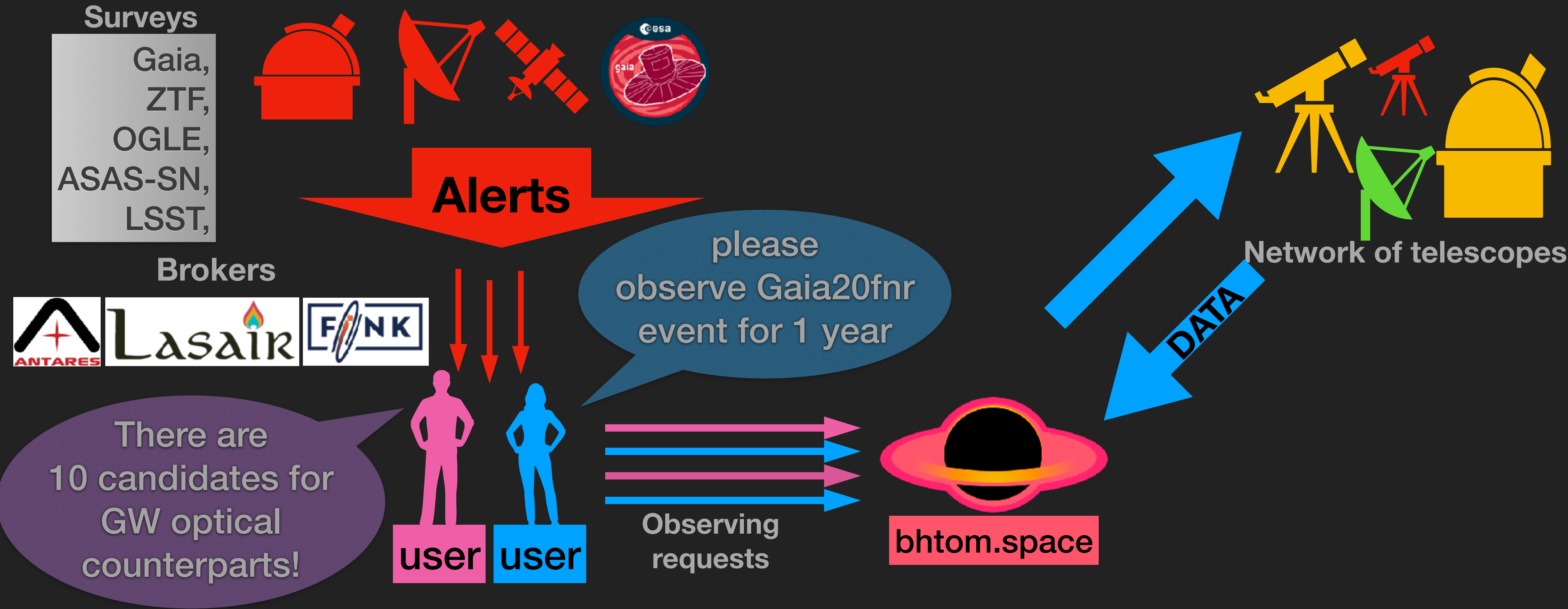
Alerts













please observe Gaia20fnr event
for 1 year



Network of telescopes

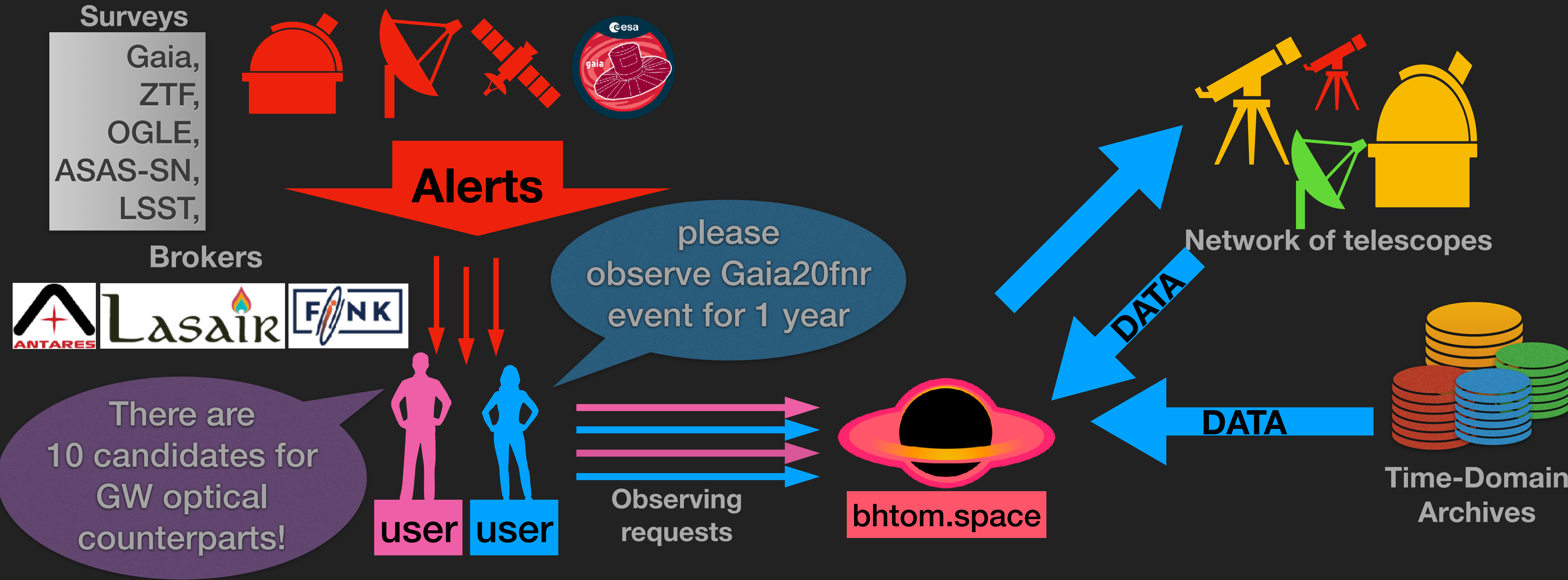
Observatory Control System
Observatory Control System
Observatory Control System
Observatory Control System

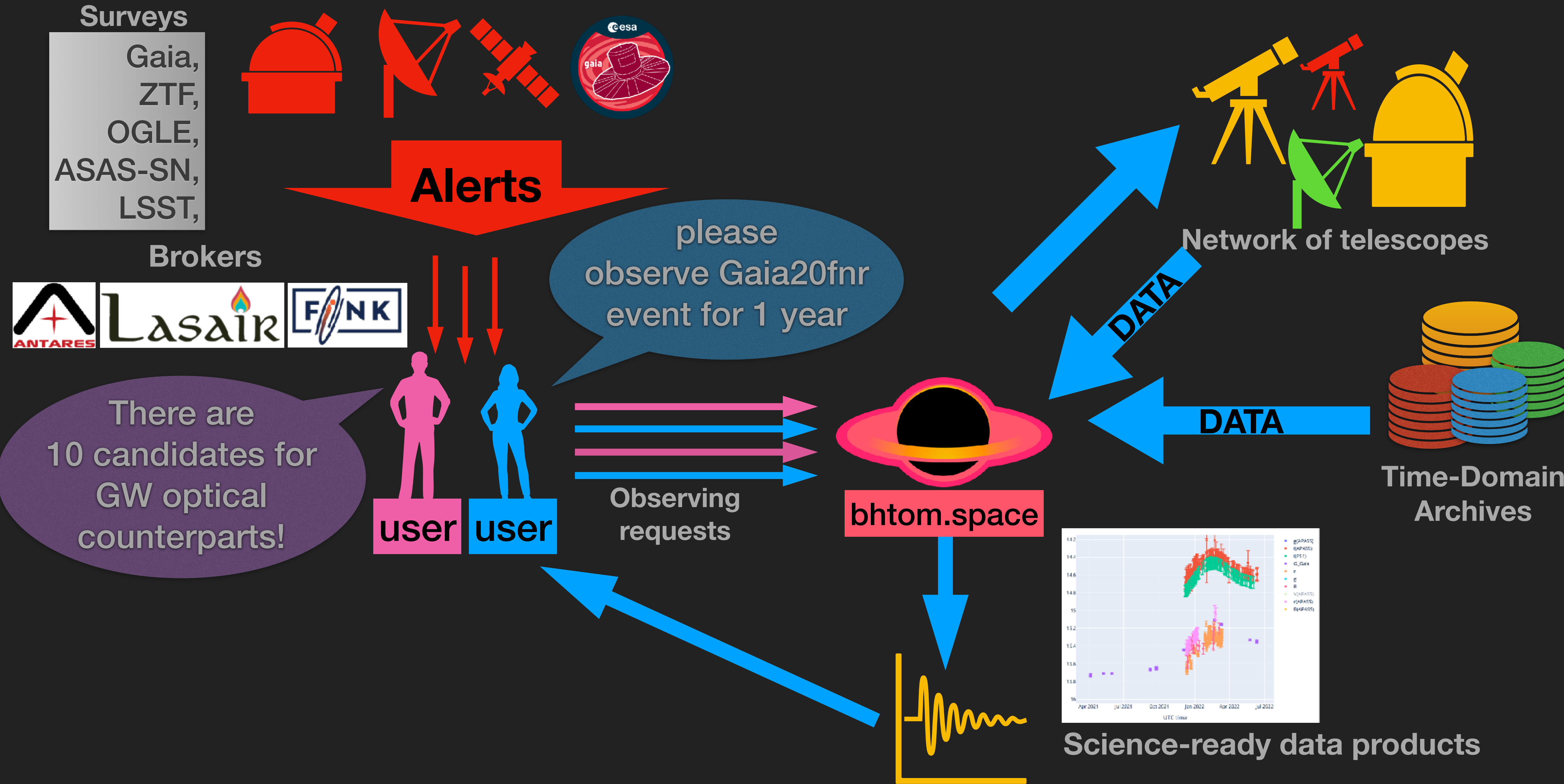


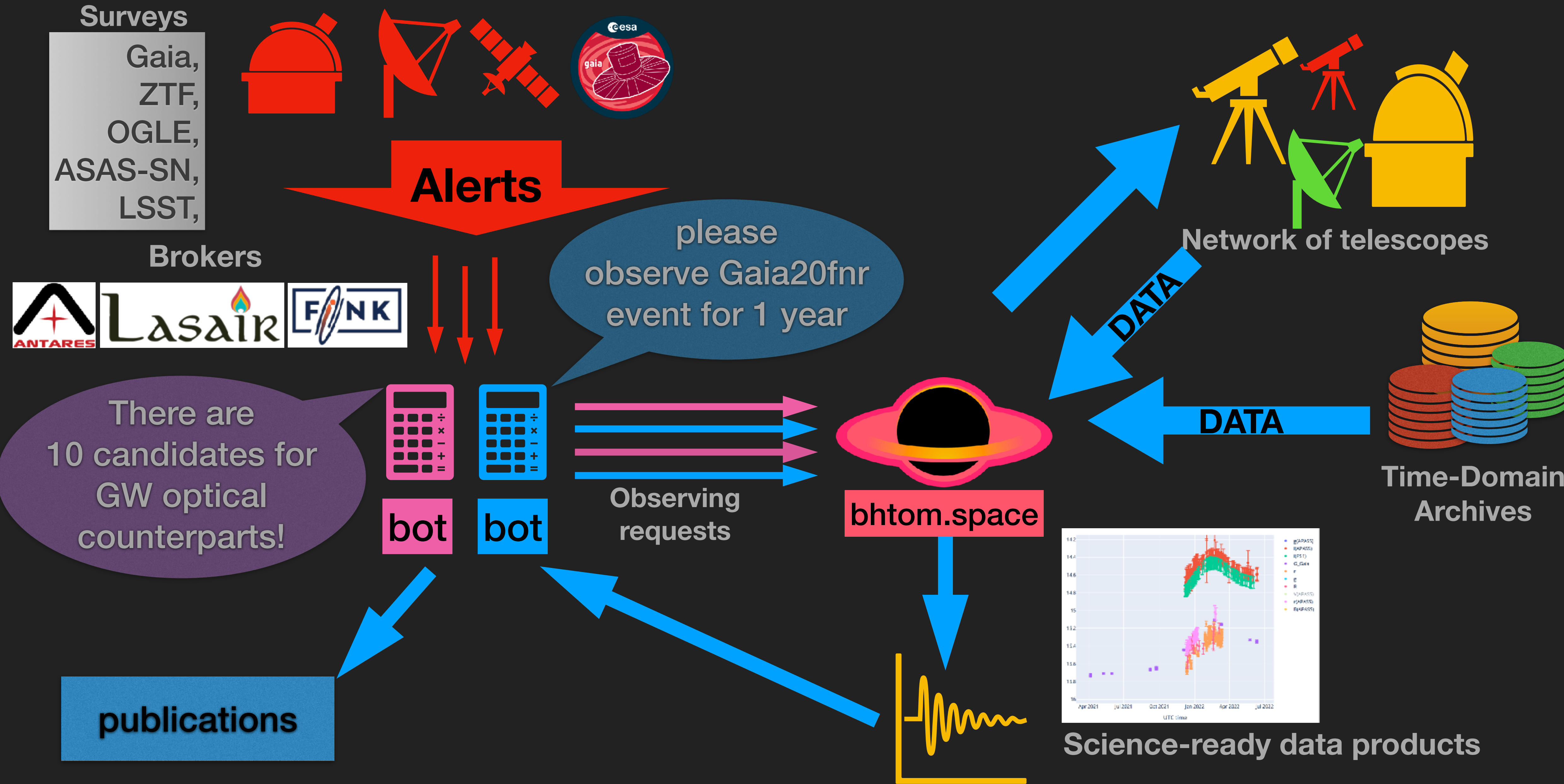
Observing
requests



bhtom.space

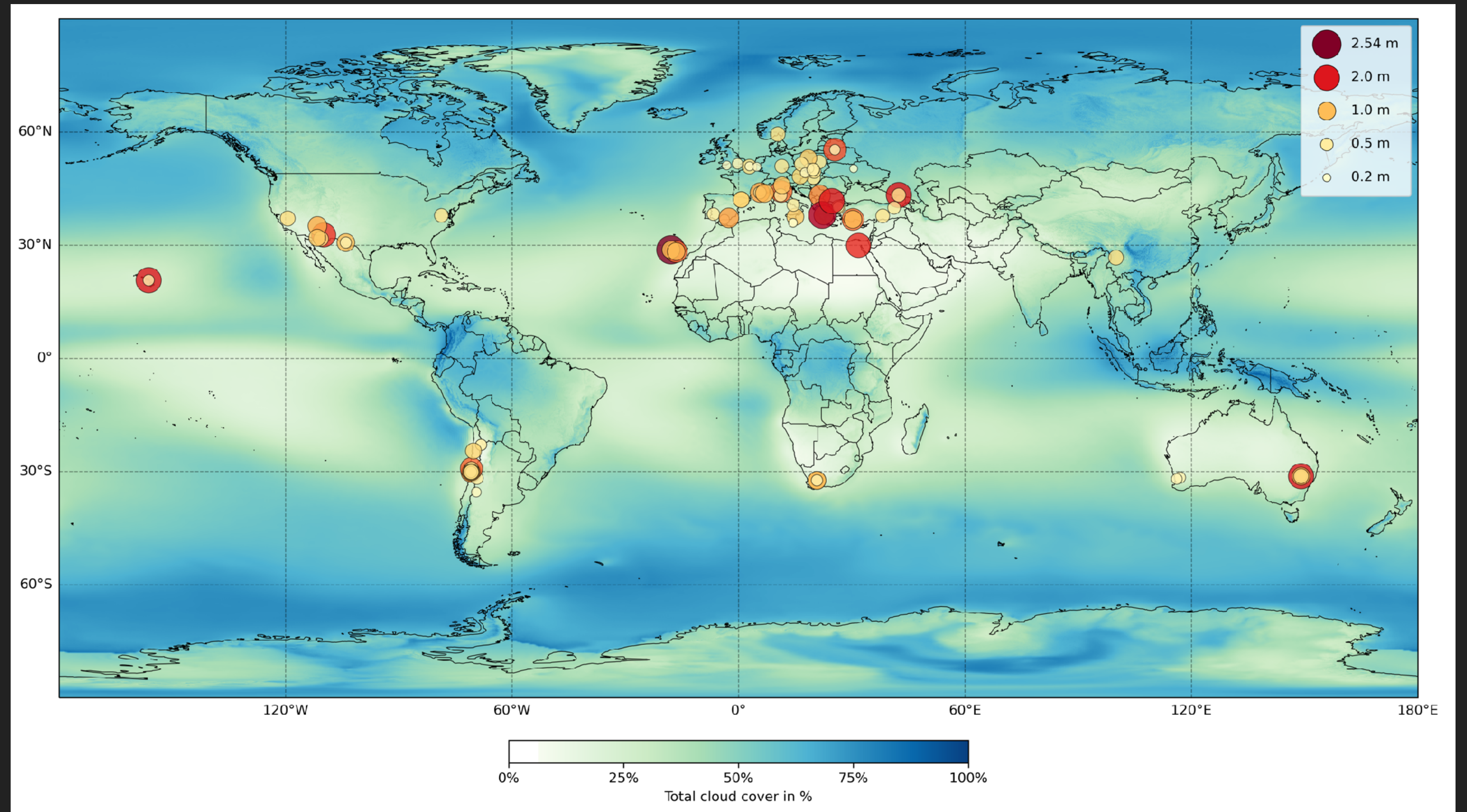






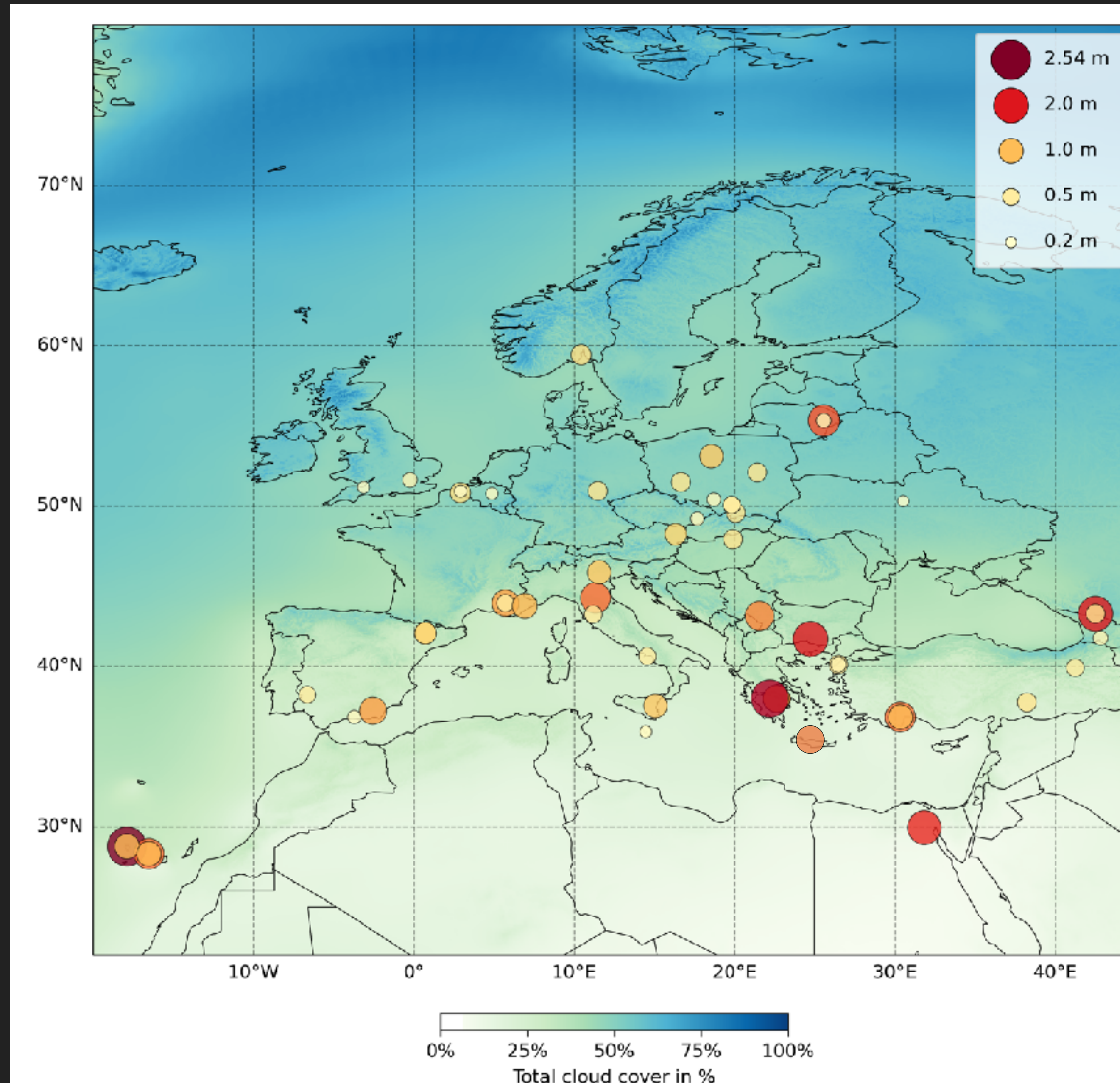
BHTOM GLOBAL TELESCOPE NETWORK

- ~100 telescopes
- sizes 0.25 - 2.5 m
- professional
- amateur
- schools
- outreach facilities
- manual
- robotic
- with good weather
- with poor weather
- volunteering
- via proposals



BHTOM GLOBAL TELESCOPE NETWORK

- ~100 telescopes
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- via proposals



Is Your telescope on the map?

map by K.Kotysz & P.Mikołajczyk

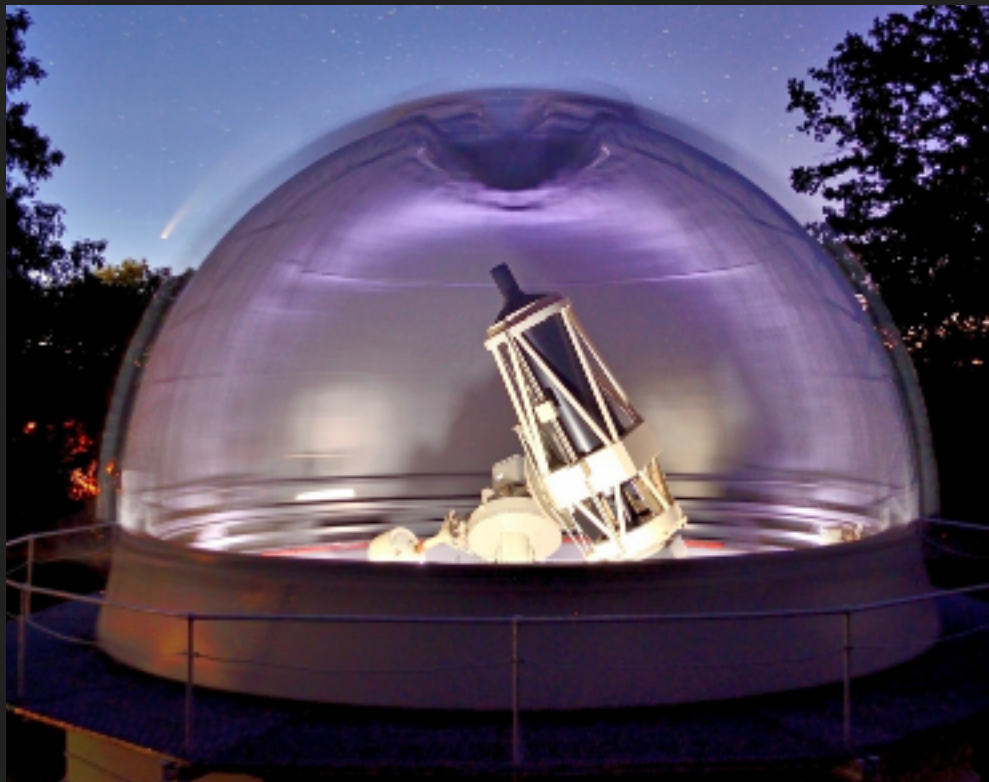
BHTOM GLOBAL TELESCOPE NETWORK



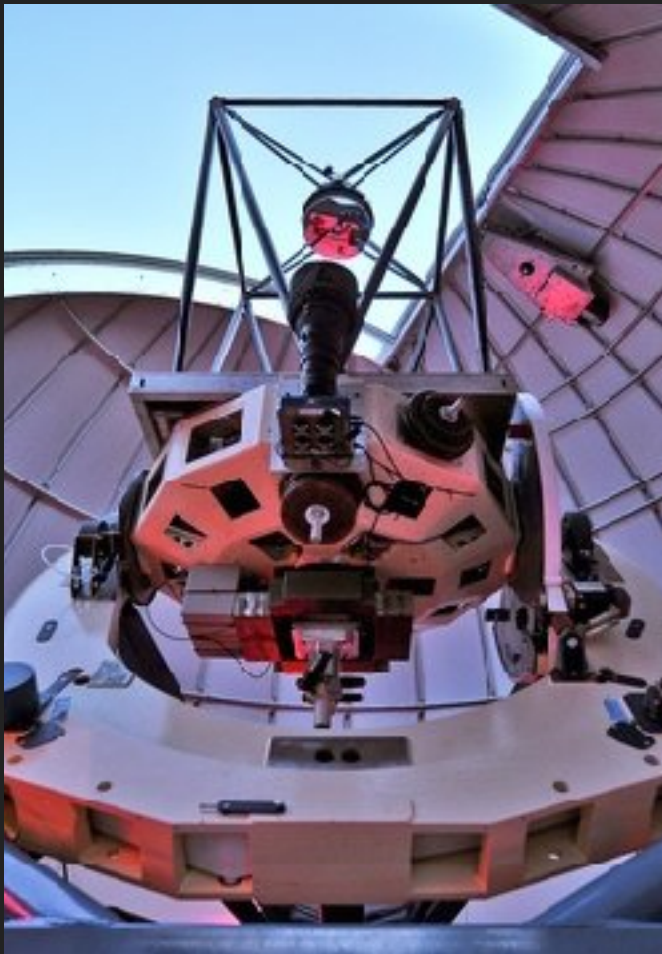
25cm



50cm



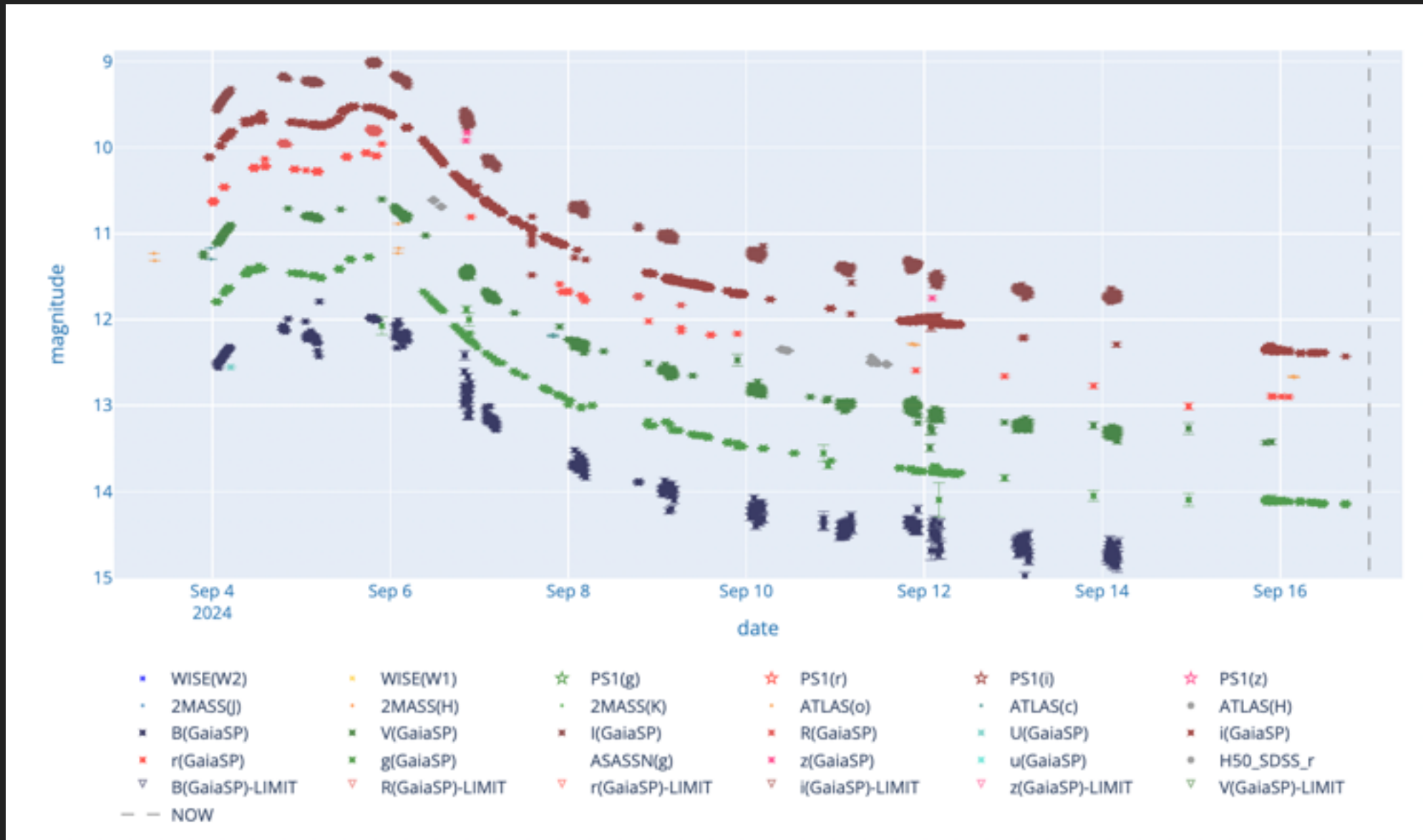
60cm



100cm



200cm



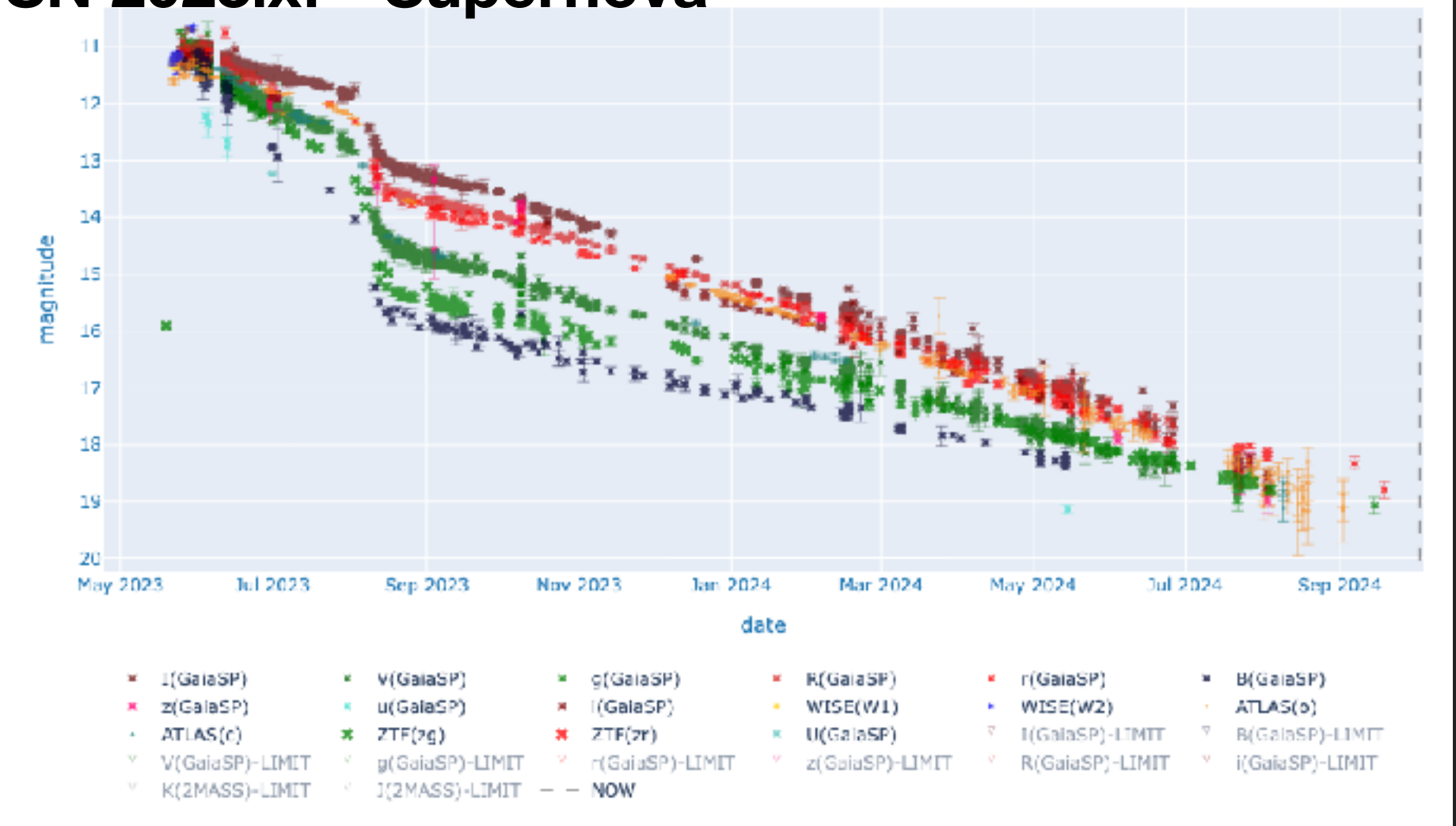
ASASSN-24fs:
>3000 frames

BHTOM – SCIENCE CASES

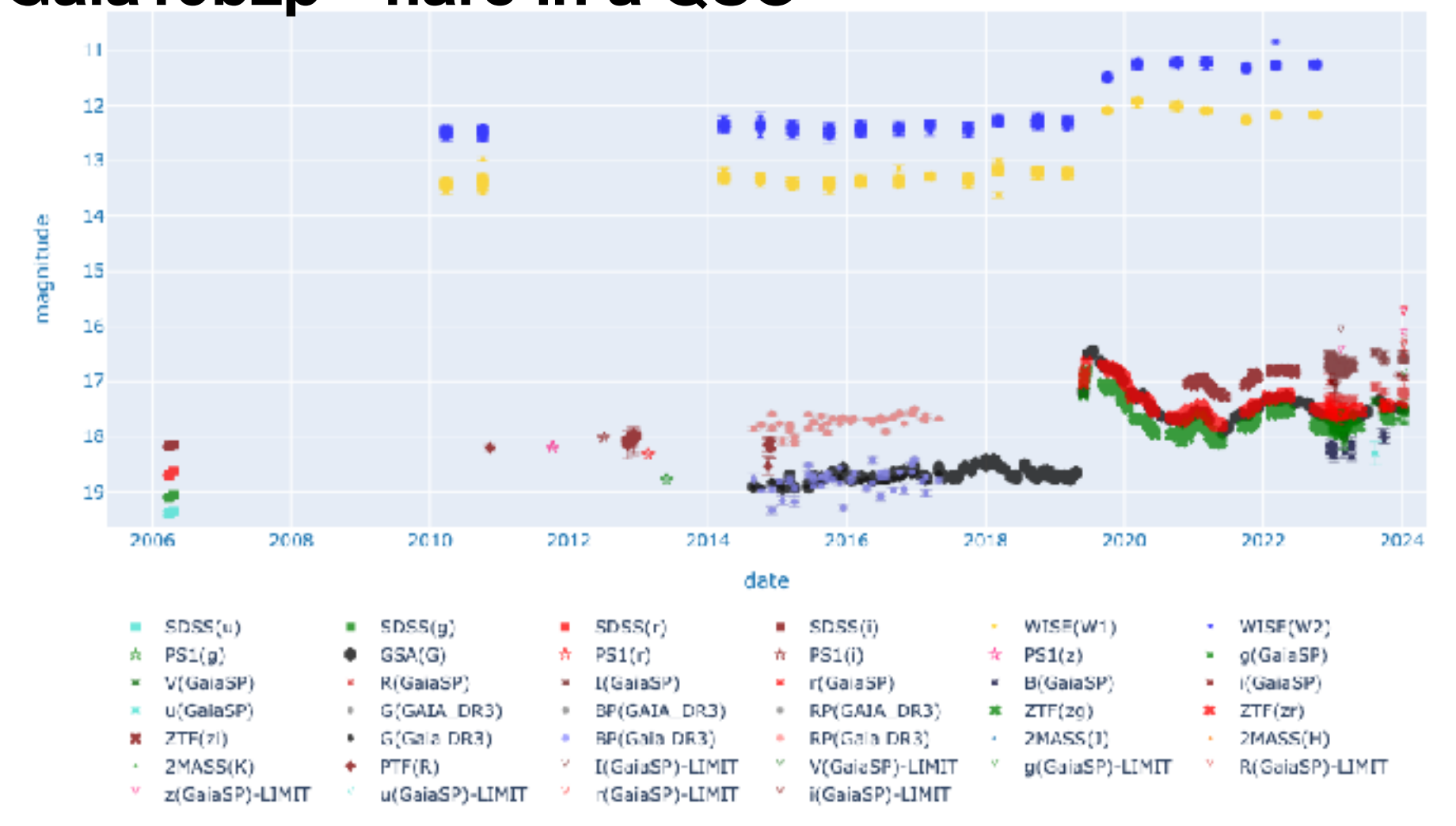
Gaia16apa - CV



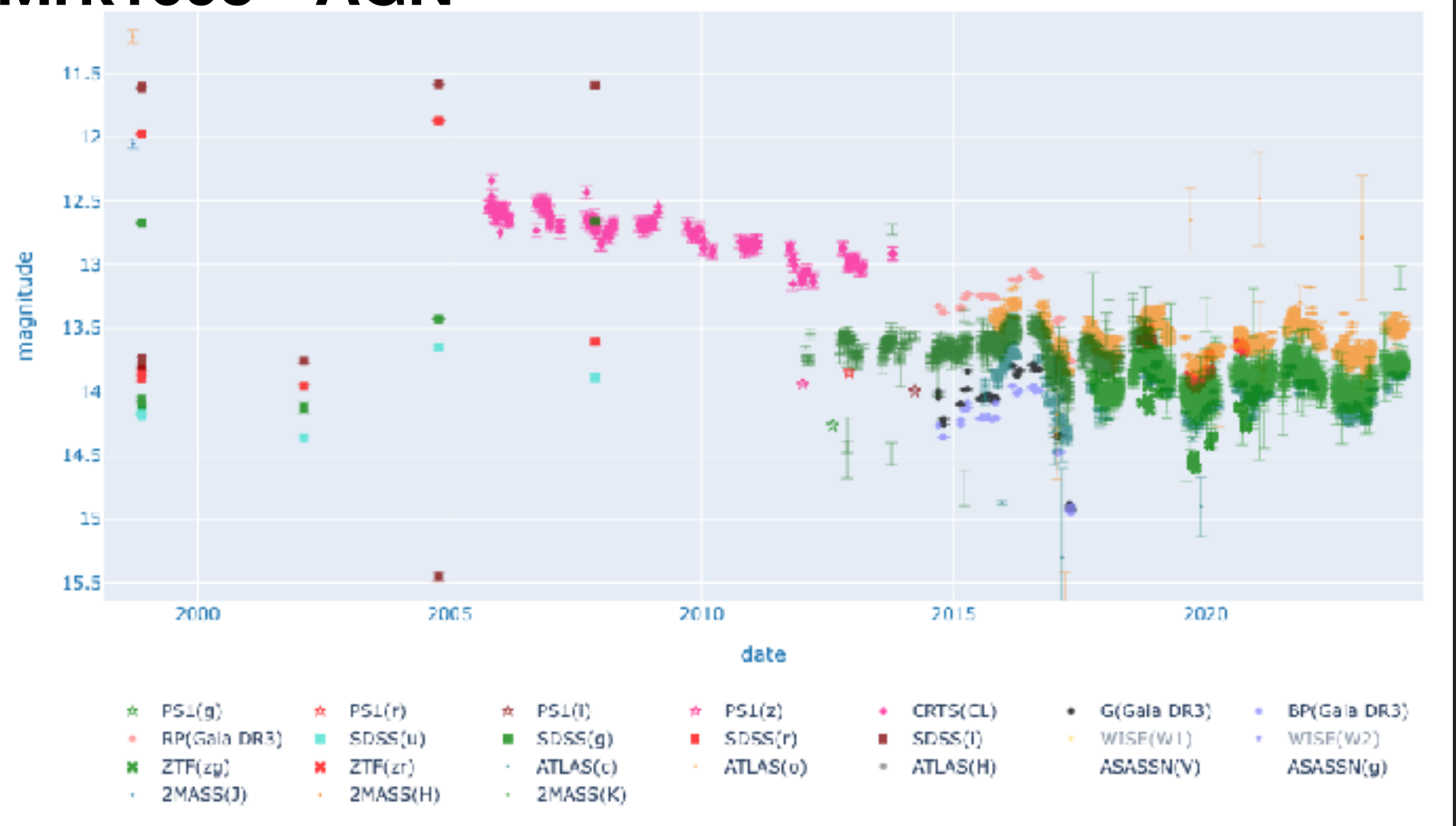
SN 2023ixf - Supernova



Gaia19bzb - flare in a QSO

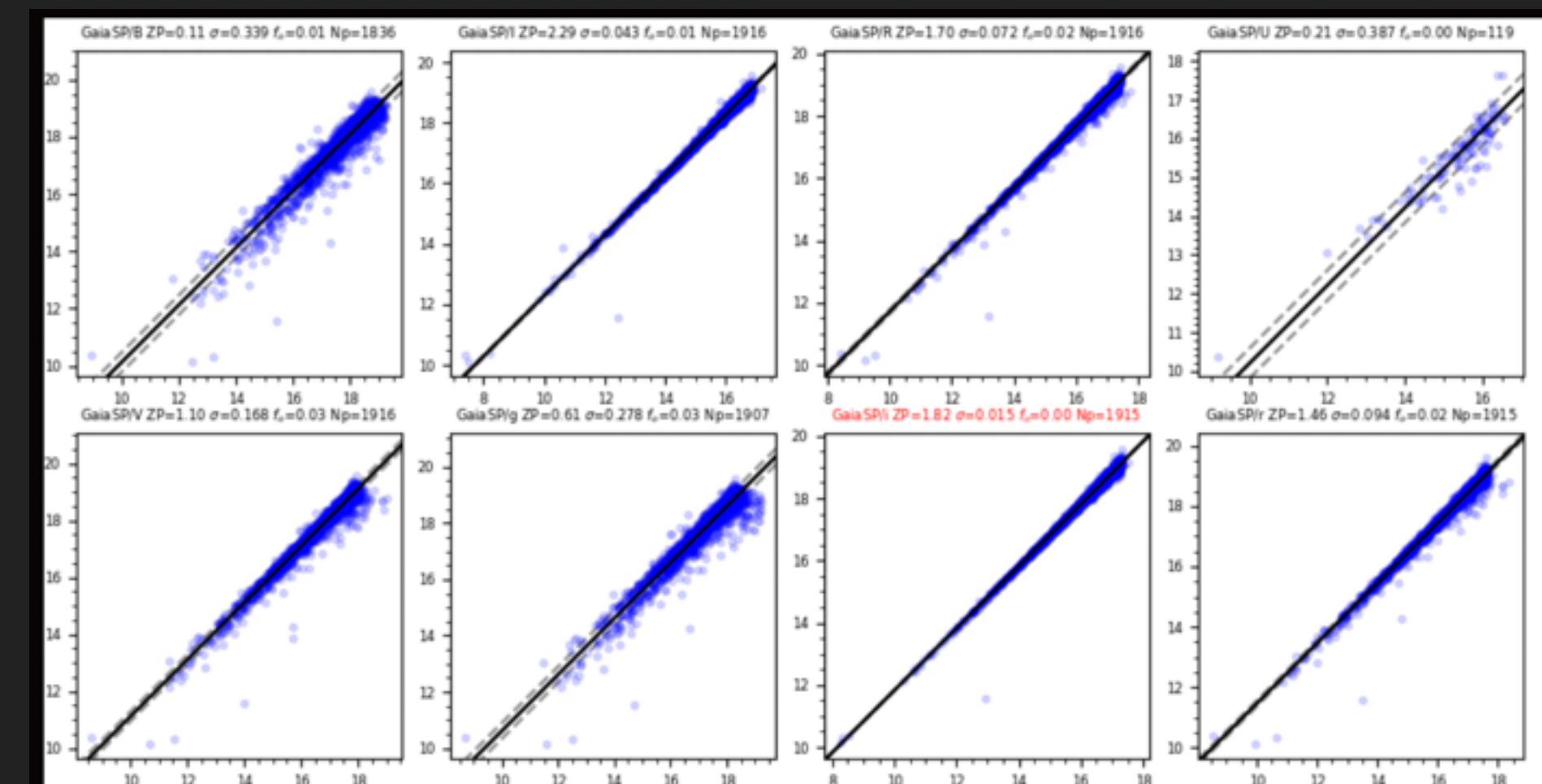
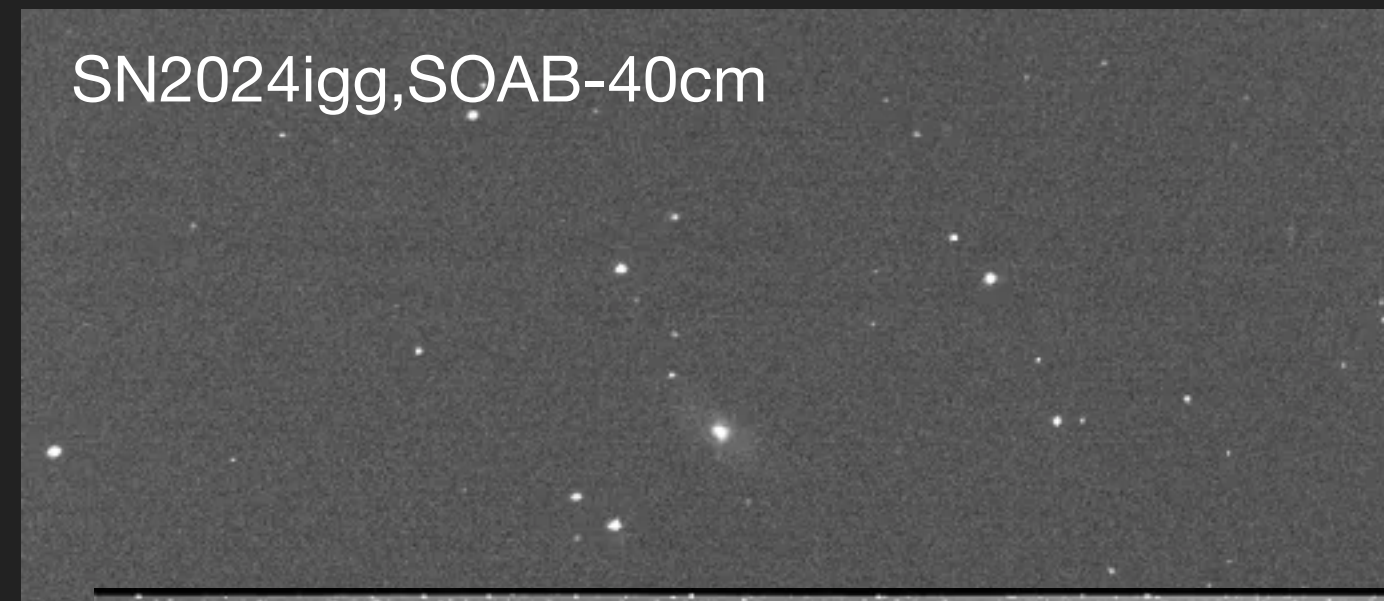
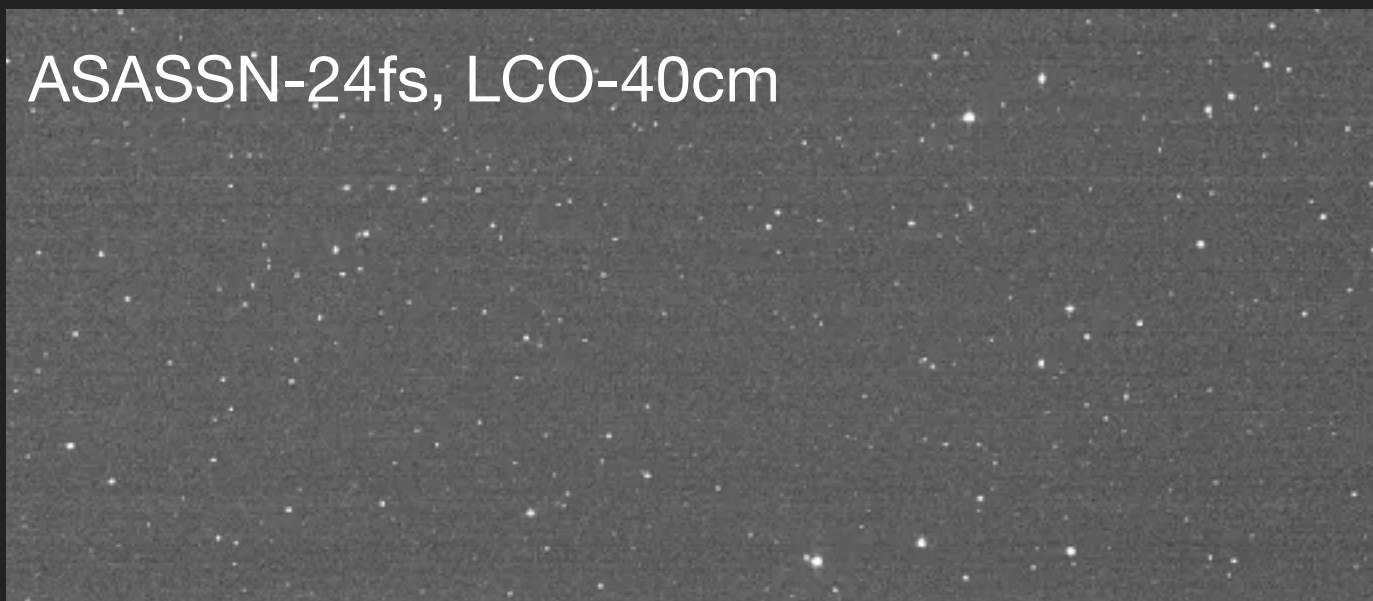


Mrk1095 - AGN



BHTOM – FROM IMAGE REQUEST TO SCIENCE-READY LIGHT CURVES

- ▶ fully automated data processing - PSF photometry
- ▶ standardisation of observations from any filter to Gaia Synthetic Photometry
- ▶ downloadable and science-ready - for registered users



Automated detection of filter
and zero-point fit to Gaia Synthetic Photometry

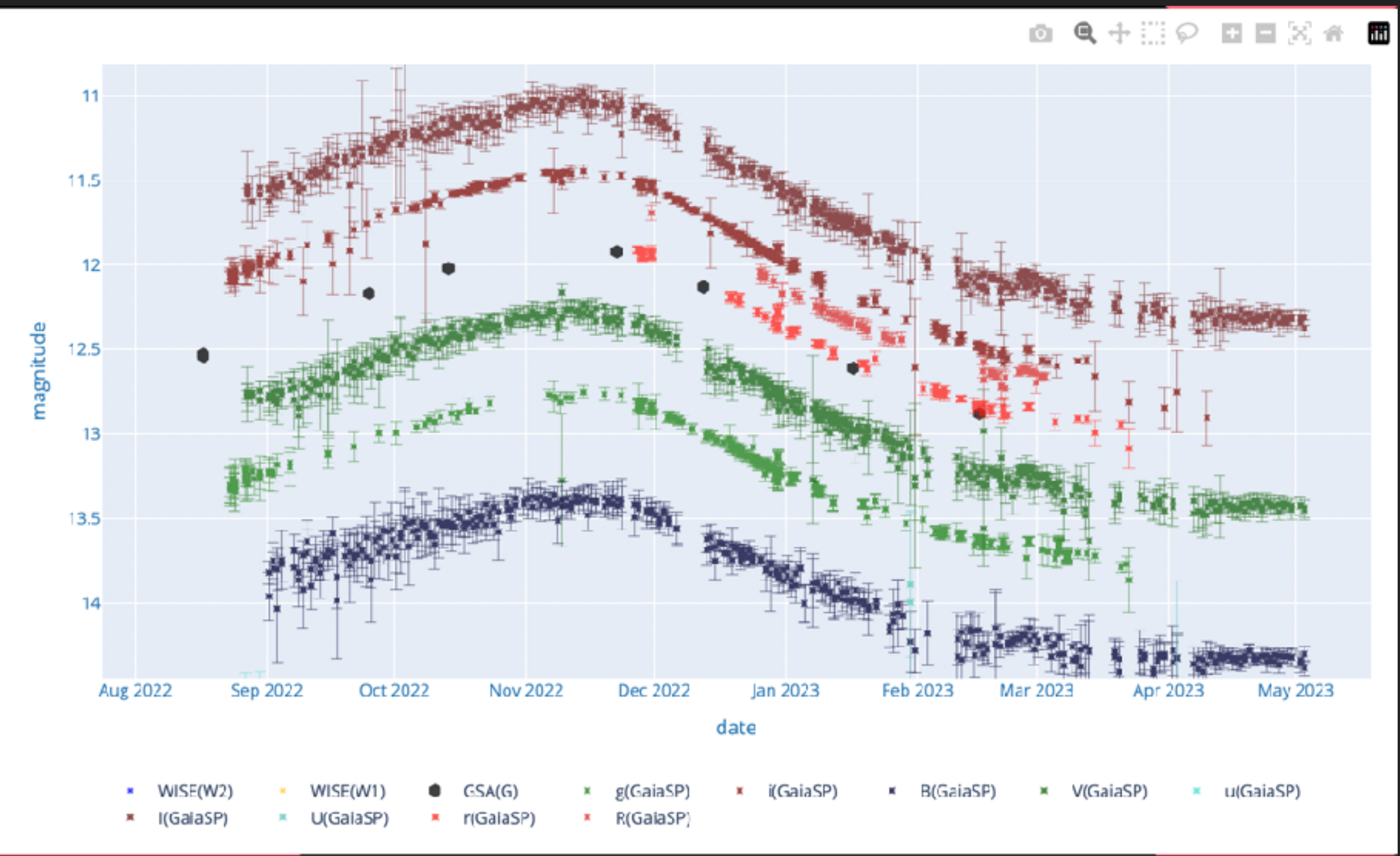
BHTOM – FROM IMAGE REQUEST TO SCIENCE-READY LIGHT CURVES

- ▶ fully automated data processing - PSF photometry
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SN2023ixf

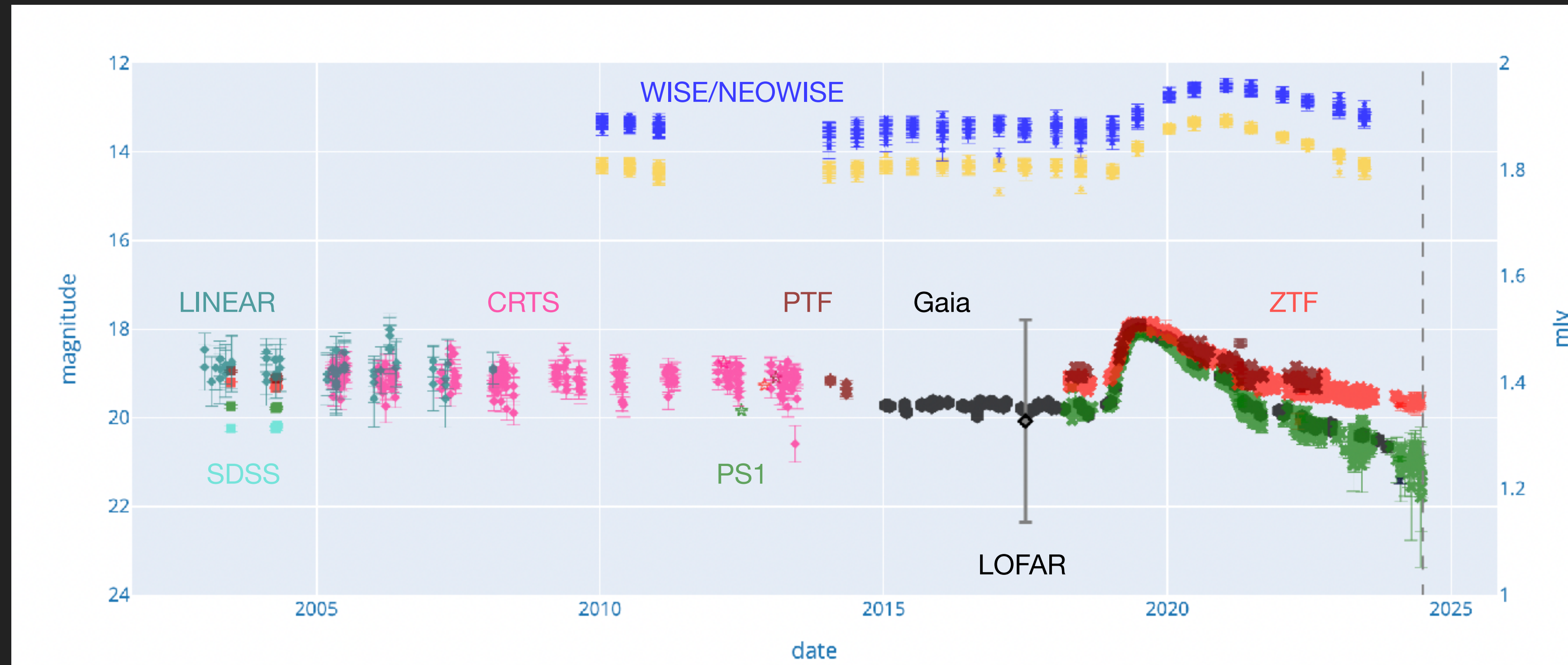


Gaia22dkv -planetary microlensing event



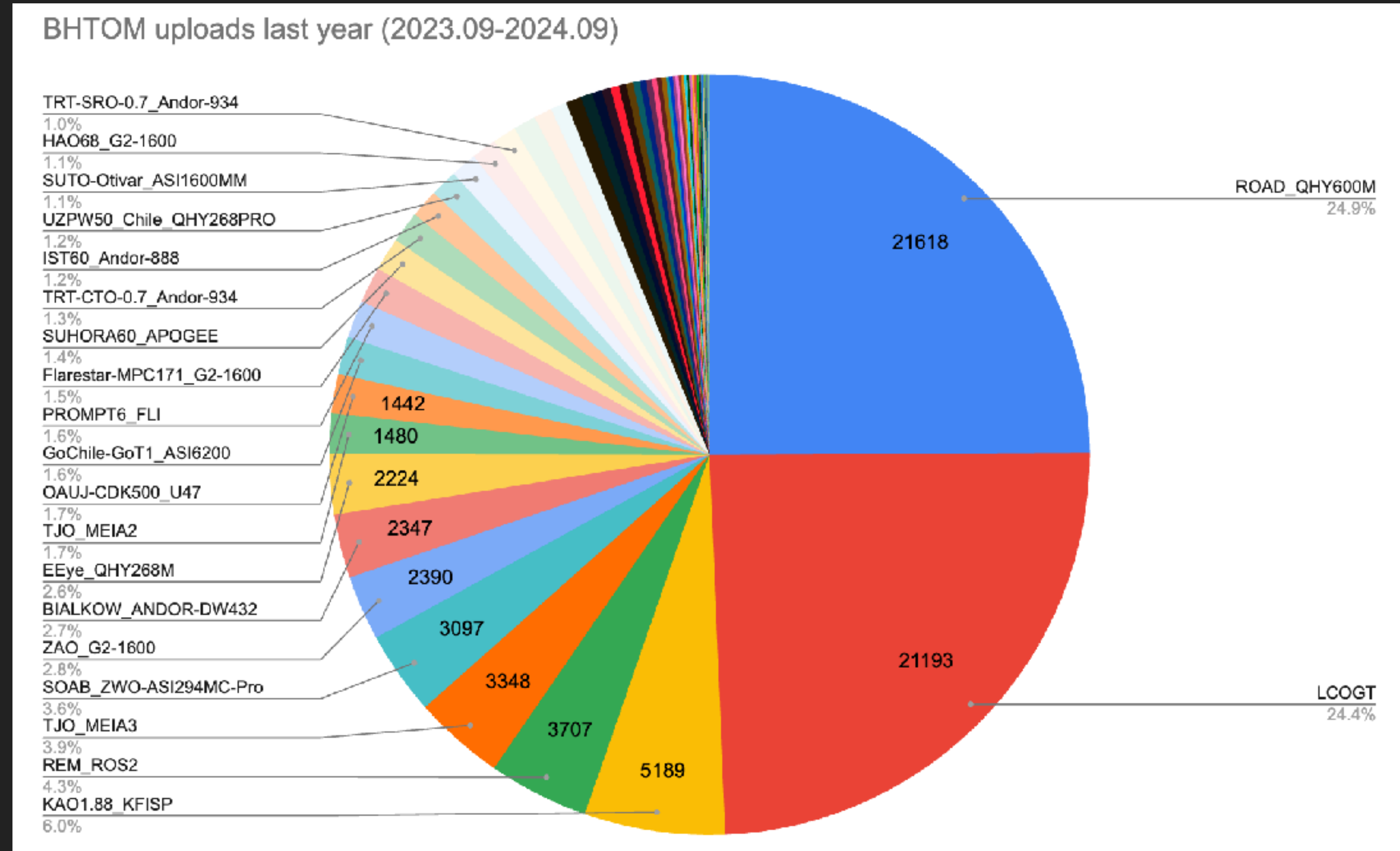
BHTOM – TIME-DOMAIN DATA ARCHIVES

- ▶ Automated harvesting archival time-domain data for any target with known coordinates
- ▶ only public data
- ▶ ZTF - *Optical*
- ▶ NEOWISE+ALLWISE - *NIR*
- ▶ 2MASS - *NIR*
- ▶ LOFAR - *Radio*
- ▶ LINEAR, CRTS - *Optical*
- ▶ Gaia DR3 - *Optical*
- ▶ Gaia Alerts - *Optical*
- ▶ SDSS, PS1, DECAPS - *Optical*
- ▶ ATLAS - *Optical*
- ▶ OGLE EWS - *Optical*
- ▶ Long list of TDA archives to add, e.g. DASH - Harvard photographic plates, MACHO, OGLE vars, radio light curves, XMM



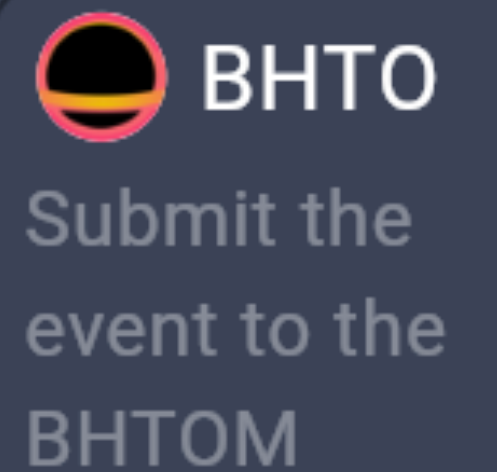
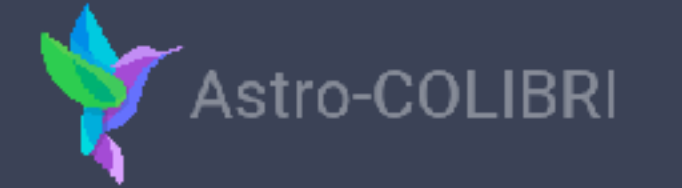
DATA STATS

- ▶ ~85k images uploaded in the last year
- ▶ 25% from one single amateur observer (ROAD)
- ▶ 25% from LCO network (proposal)
- ▶ 50% from 70 heterogeneous set of telescopes
- ▶ up to 5,000 images processed per week
- ▶ (we can handle more)
- ▶ Is your telescope observing with us?



BHTOM – PROGRAMABLE ACCES (API)

- ▶ All functionalities of BHTOM are accessible via API
- ▶ Scripting the data flow to/from telescopes, observing requests, images upload for processing
- ▶ Astro-COLIBRI connected already!
- ▶ We provide ready scripts for: data download, data upload, target selection



BHTOM2 API Documentation

DATA DOWNLOAD API

Here we present end-points how to download the photometry and radio data from BHTOM.

Please contact us if you plan to use the data in a publication. By downloading the data from BHTOM you agree to follow our data policy and to use this acknowledgment:

The data was obtained via [BHTOM] (<https://bhtom.space>), which has received funding from the European Union's Horizon 

For more information about acknowledgement and data policy please visit <https://about.bhtom.space>

1. Photometry download

With this API one can download all photometric observations (magnitudes) in semi-color separated form. The columns of the output are the following:

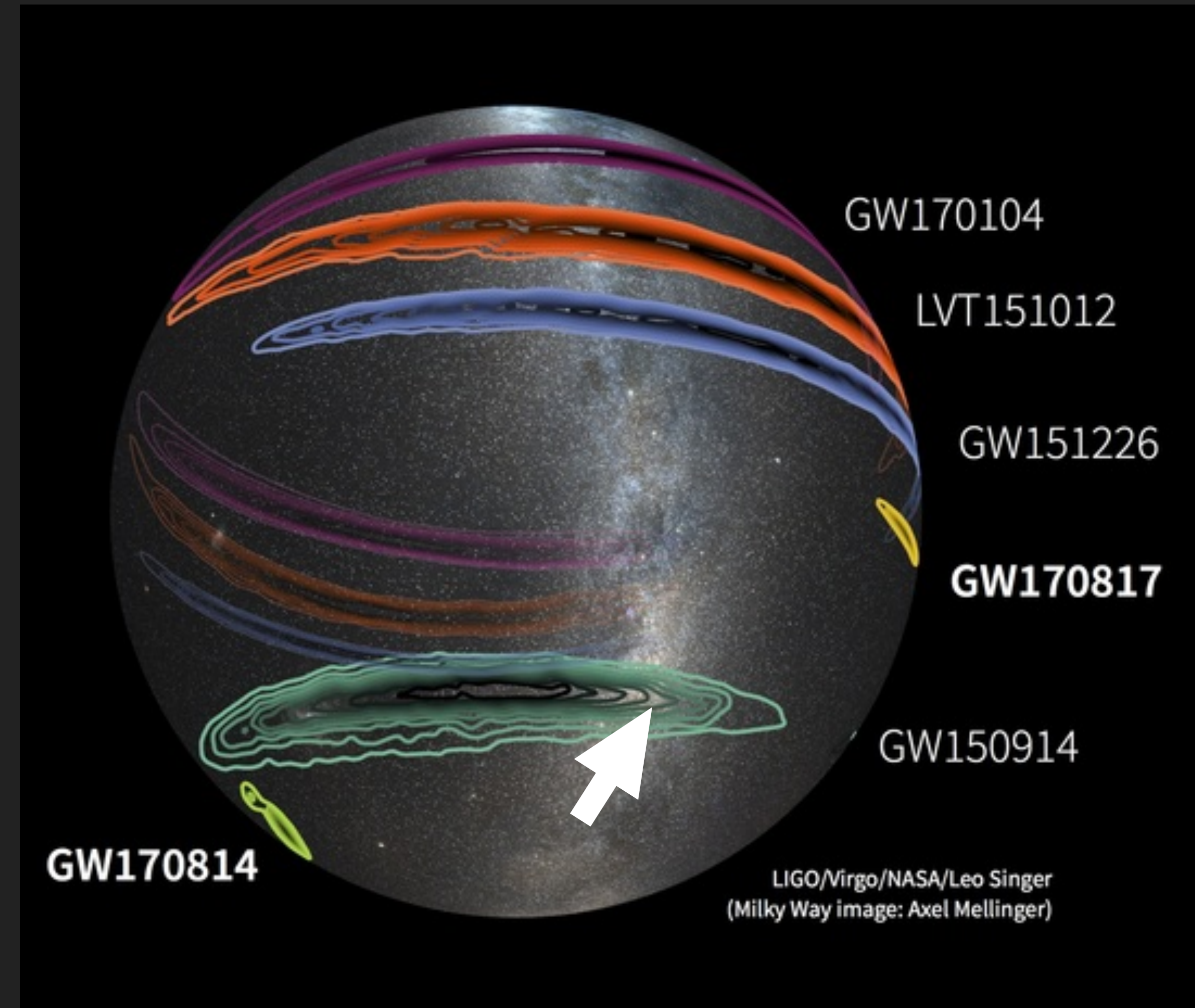
MJD;Magnitude;Error;Facility;Filter;Observer

Request

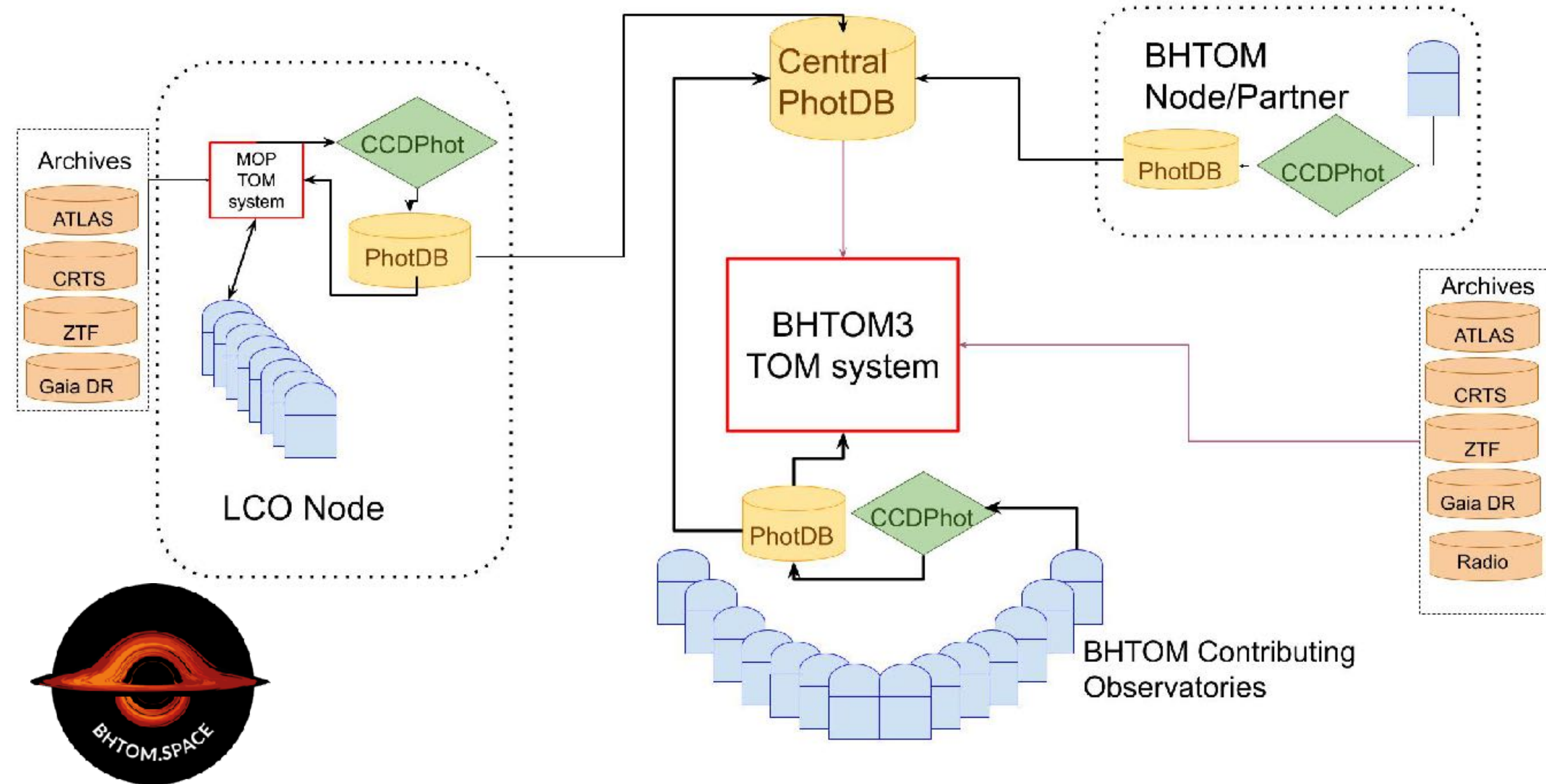
- Method: POST
- URL: `/targets/download-photometry/`

BHTOM FOR GW

- ▶ Distributed telescope network
 - can respond to multiple candidates for GW counterparts on both hemispheres
- ▶ Archives
 - can rule out a candidates just based on the historic time-domain data
- ▶ Automated data processing
 - automated confirmation or rejection of candidates
- ▶ Galactic Plane! → we are not afraid!



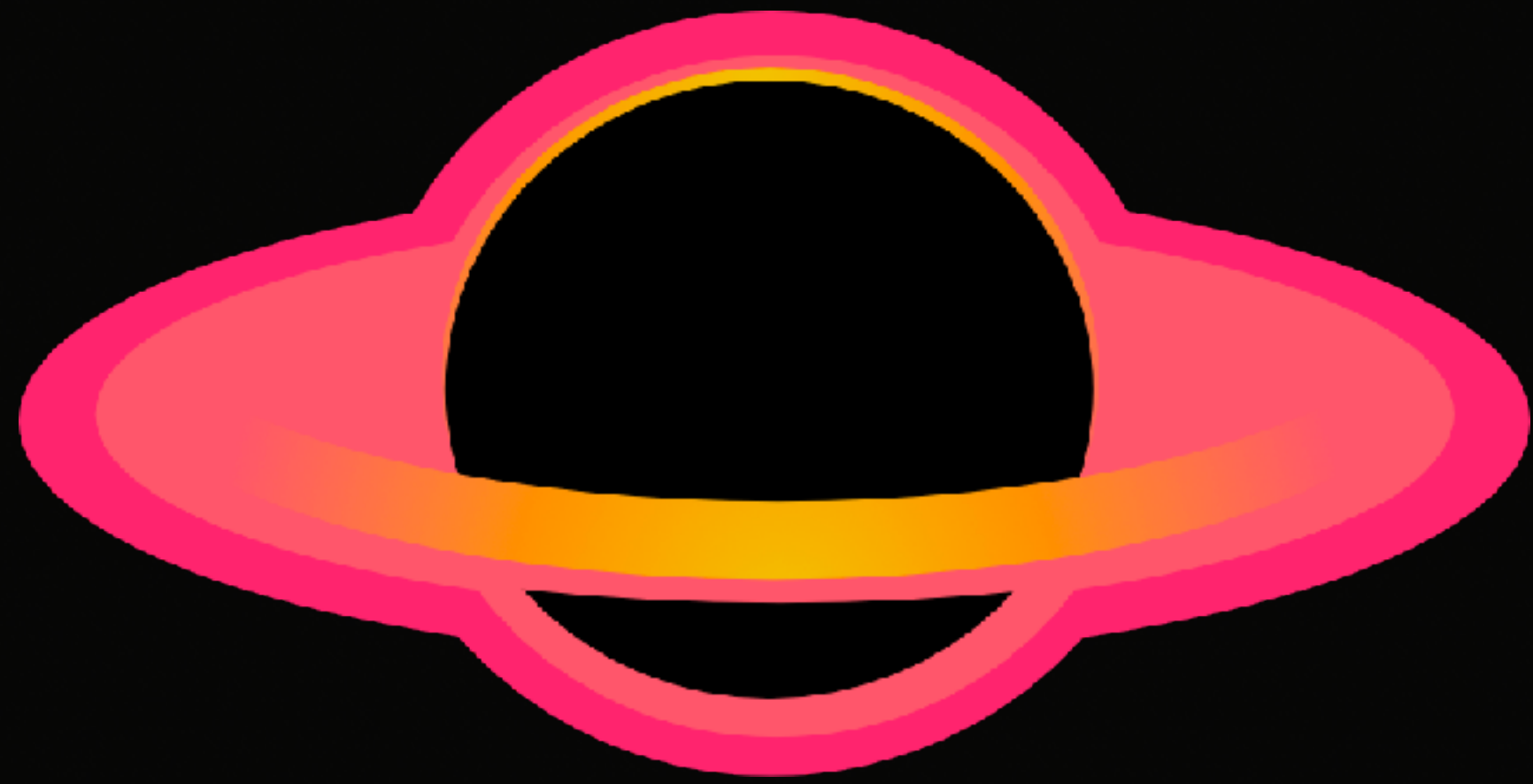
PLANS FOR THE FUTURE – BHTOM3



- Any more ideas?
- Any grant/funding ideas?

TOPICS TO DISCUSS AND FRESH IDEAS





enjoy bhtom !



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SLACK.
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