Astro-COLIBRI

COincidence **LIB**rary for **R**eal-time **I**nquiry for multi-messenger astrophysics

Valentin Lefranc (IRFU, CEA Paris-Saclay)
on behalf of the Astro-COLIBRI team

Fabian Schussler

Patrick Reichhetzer

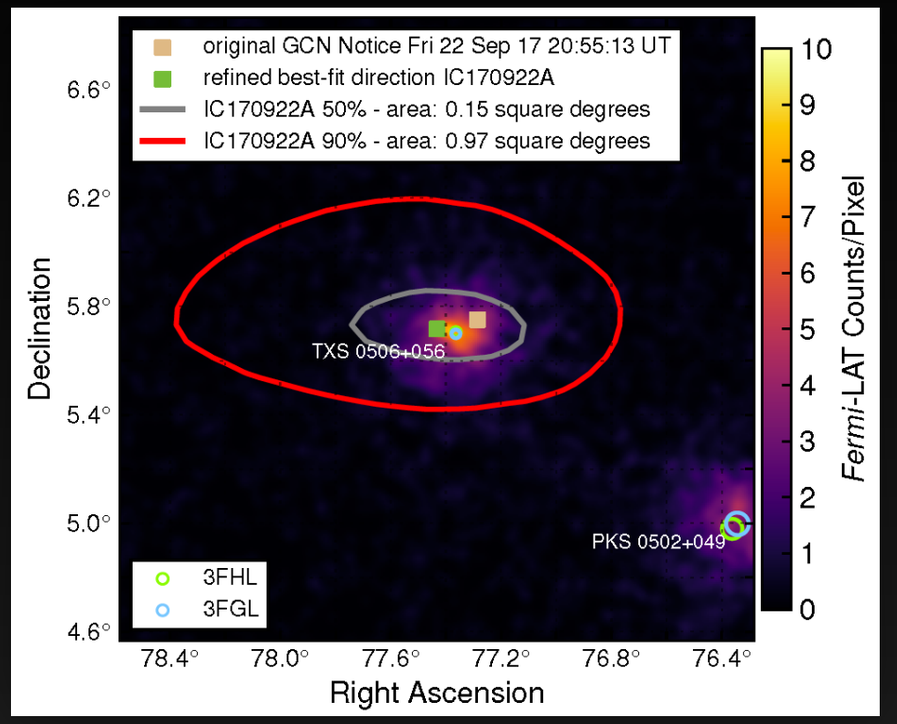
Valentin Lefranc

Atilla Alkan

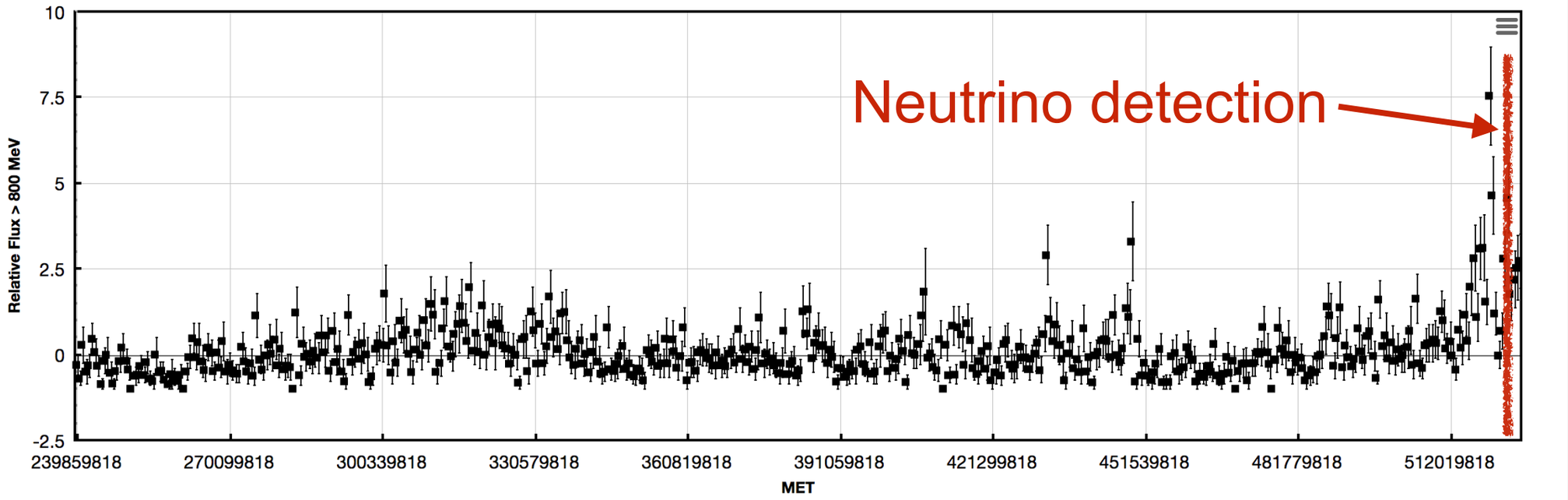
AHEAD 2020
INTEGRATED ACTIVITIES FOR THE HIGH-ENERGY ASTROPHYSICS DOMAIN
Funded by the Horizon 2020 Framework Programme of the European Union
Grant Agreement No. 871158

IceCube-170922A and TXS 0506+056

- 22/09/2017: Detection of another high-energy neutrino of about 300 TeV by IceCube: automatic and public alert distribution to follow-up observatories at all wavelengths
- 28/09/2017 Fermi-LAT: Detection of an active blazar within the neutrino uncertainty region ATEL #10791

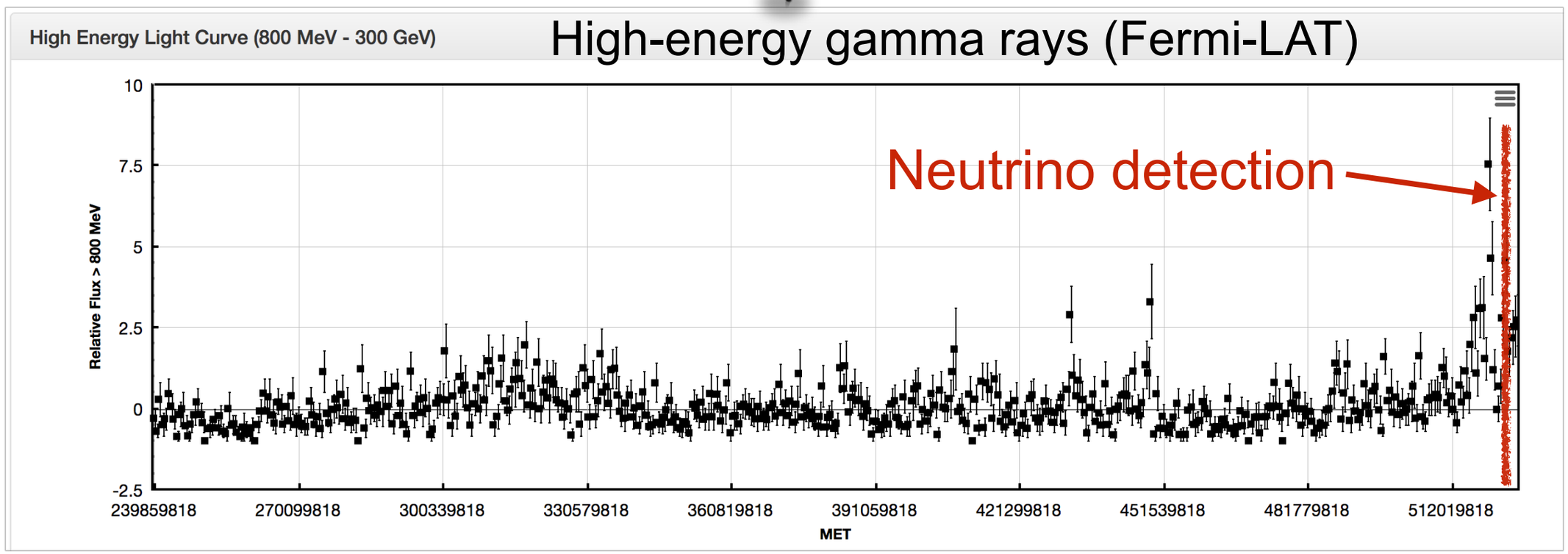


High-energy gamma rays (Fermi-LAT)



Behind the curtain

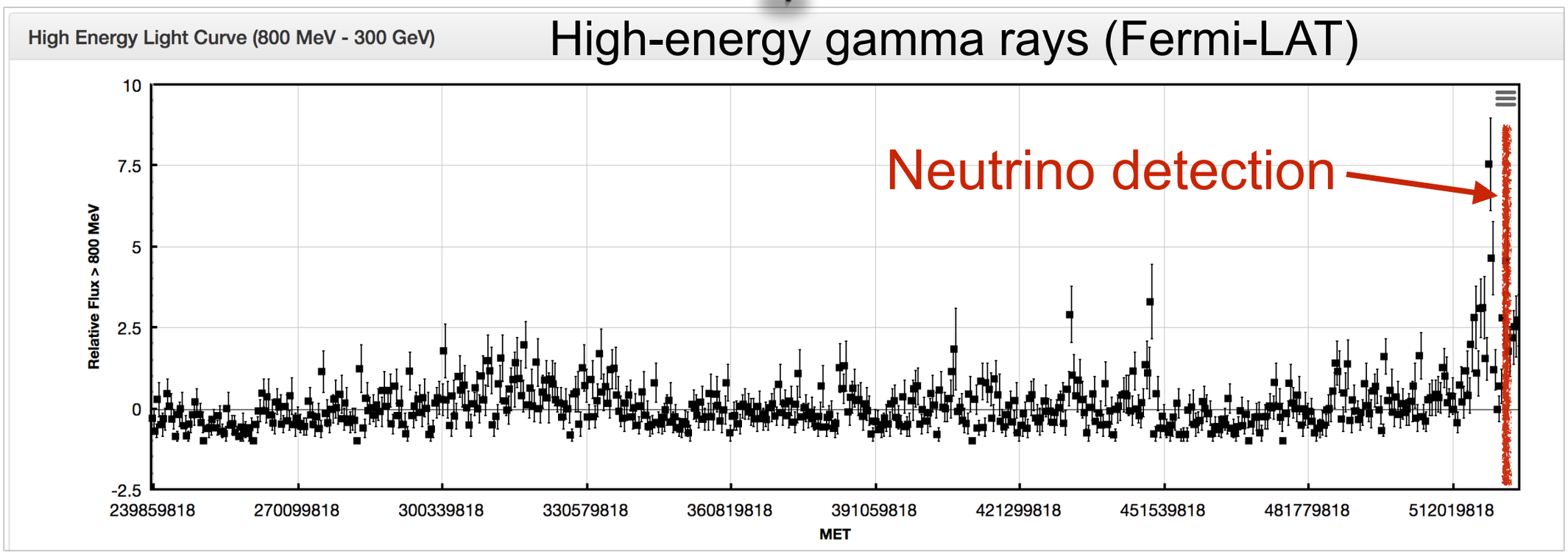
- It took 6 days between the neutrino detection and the realization that there is a flaring blazar within the localisation uncertainty!



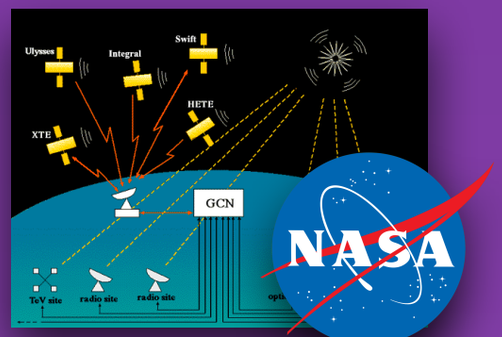
Behind the curtain

- It took 6 days between the neutrino detection and the realization that there is a flaring blazar within the localisation uncertainty!

- Cone search within the neutrino uncertainty => TXS 0506+056
- Check state of the source(s) in FAVA
- Get optimal observation window for various observatories
- Many tools are available but need for automatisation + interfaces



Main idea



TRANSIENT NAME SERVER

four π sky

Fermi Gamma-ray Space Telescope

AMON Astrophysical Multimessenger Observatory Network

LSC LIGO Scientific Collaboration VIRGO

SVOM

...

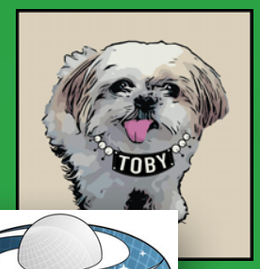
SIMBAD

ALADIN

Fermi Gamma-ray Space Telescope

SSDC SPACE SCIENCE DATA CENTER

esa



IVOA

NED

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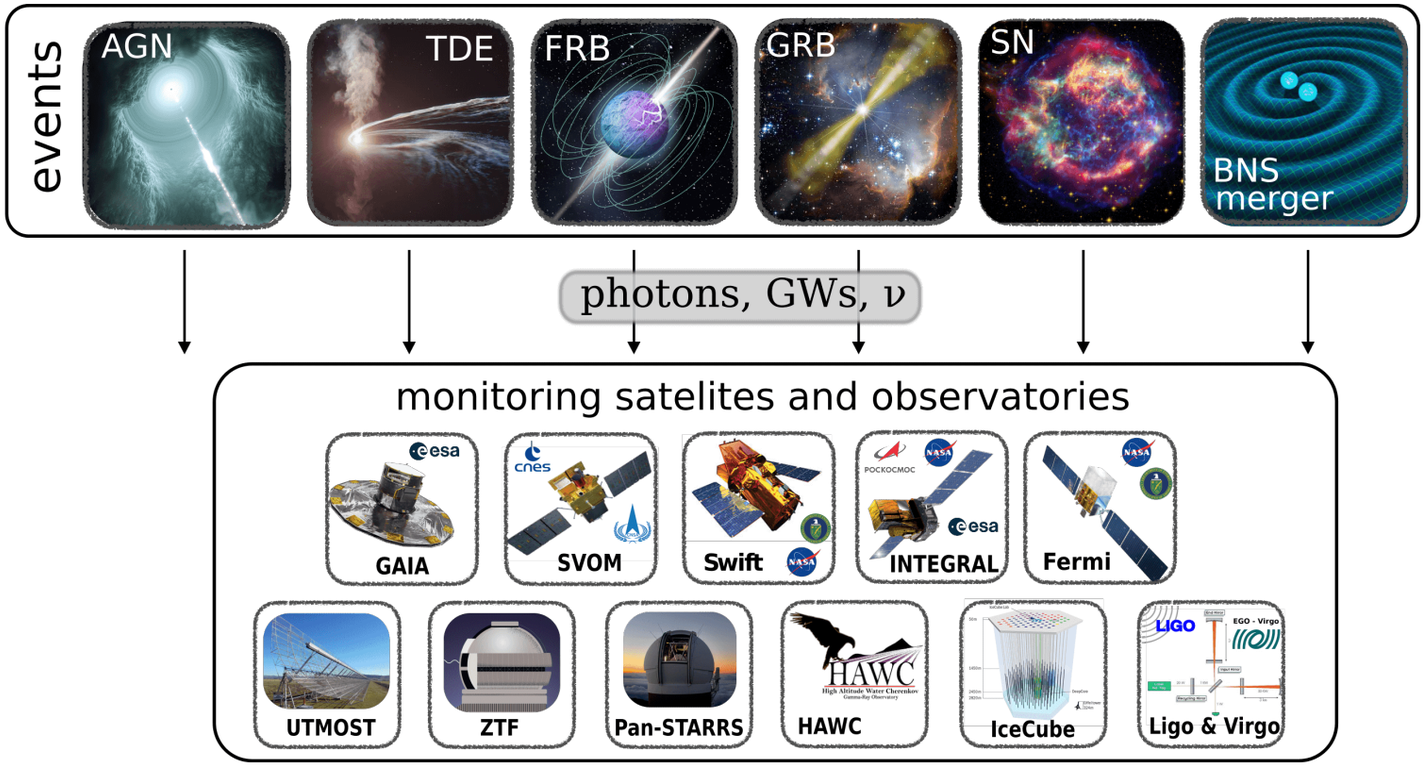
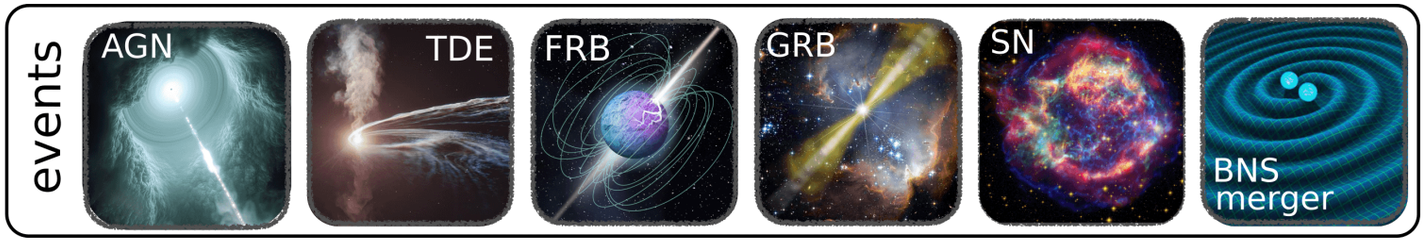
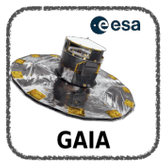
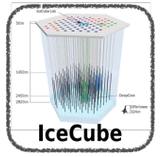

events
AGN
TDE
FRB
GRB
SN
BNS merger
photons, GWs, ν
monitoring satelites and observatories
GAIA
SVOM
Swift
INTEGRAL
Fermi
UTMOST
ZTF
Pan-STARRS
HAWC
IceCube
Ligo & Virgo



photons, GWs, ν

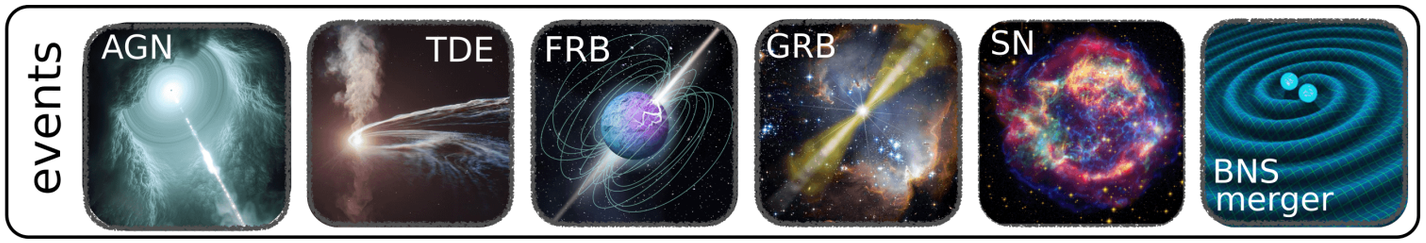
monitoring satelites and observatories



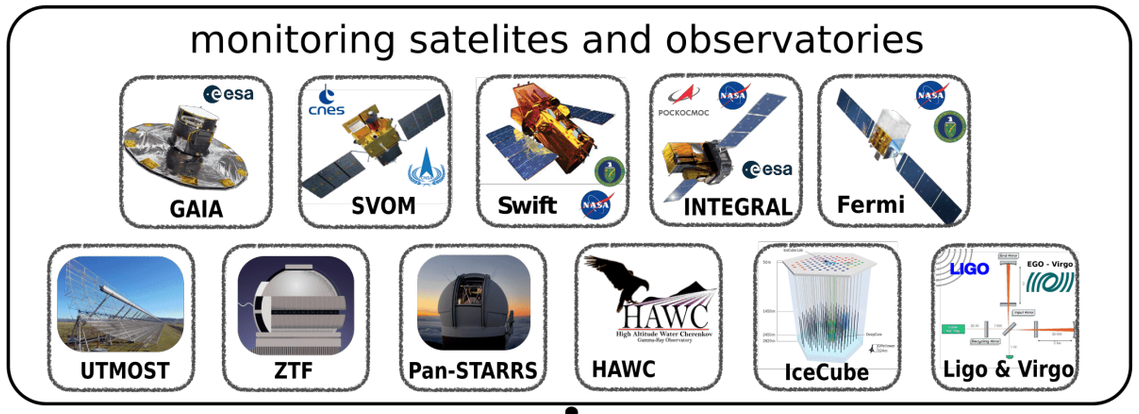


alert
- creator
- streams
- broker

follow-up-observ.



photons, GWs, ν



follow-up-observ.

The following new classification/s were reported on:

2021agrk RA=*16:31:36.210*, DEC=*+13:38:14.93*, Classification=*SN II*, Redshift=*0.026*, Time received: *2022-03-23 18:56:17*, Classifier: *T. Moore, S. Srivastav, K. W. Smith, M. Fulton, O. Yaron on behalf of ePESSTO+*, Source group: *ePESSTO+*

2022dkw RA=*14:35:50.295*, DEC=*+24:40:58.20*, Classification=*SN IIn*, Redshift=*0.036*, Time received: *2022-03-23 18:56:17*, Classifier: *T. Moore, S. Srivastav, K. W. Smith, M. Fulton, O. Yaron on behalf of ePESSTO+*, Source group: *ePESSTO+*

2022dlf RA=*13:24:06.914*, DEC=*-00:41:34.50*, Classification=*SN Ia-91T-like*, Redshift=*0.092*, Time received: *2022-03-23 18:56:17*, Classifier: *T. Moore, S. Srivastav, K. W. Smith, M. Fulton, O. Yaron on behalf of ePESSTO+*, Source group: *ePESSTO+*

2022dsu RA=*14:05:30.767*, DEC=*+15:43:15.52*, Classification=*SN Ia-91bg-like*, Redshift=*0.07*, Time received: *2022-03-23 18:56:17*, Classifier: *T. Moore, S. Srivastav, K. W. Smith, M. Fulton, O. Yaron on behalf of ePESSTO+*, Source group: *ePESSTO+*

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2022ehu RA=*20:17:04.032*, DEC=*-47:46:21.15*, Classifi… behalf of ePESSTO+, Source group: *ePESSTO+*

2022eml RA=*10:28:26.131*, DEC=*-34:28:22.63*, Classifi… behalf of ePESSTO+, Source group: *ePESSTO+*

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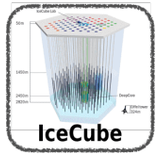
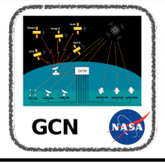
events

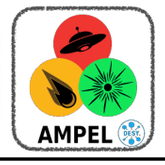
photons, GWs, ν

monitoring satelites and observatories

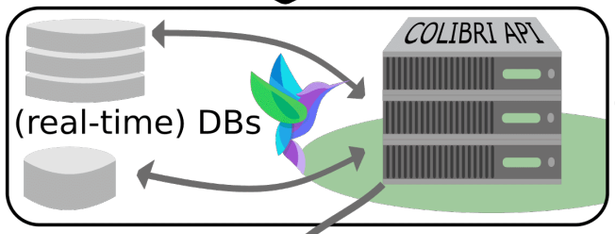


alert
- creator
- streams
- broker





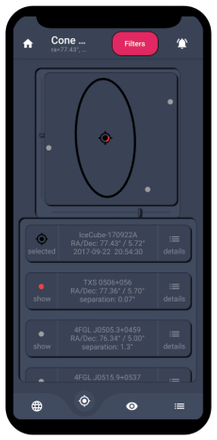
follow-up-observ.



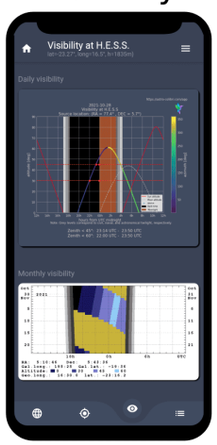
detailed event/src. info

push alerts

cone search



visibility



event info

Astro-COLIBRI App / Website

Web interface

Astro-COLIBRI

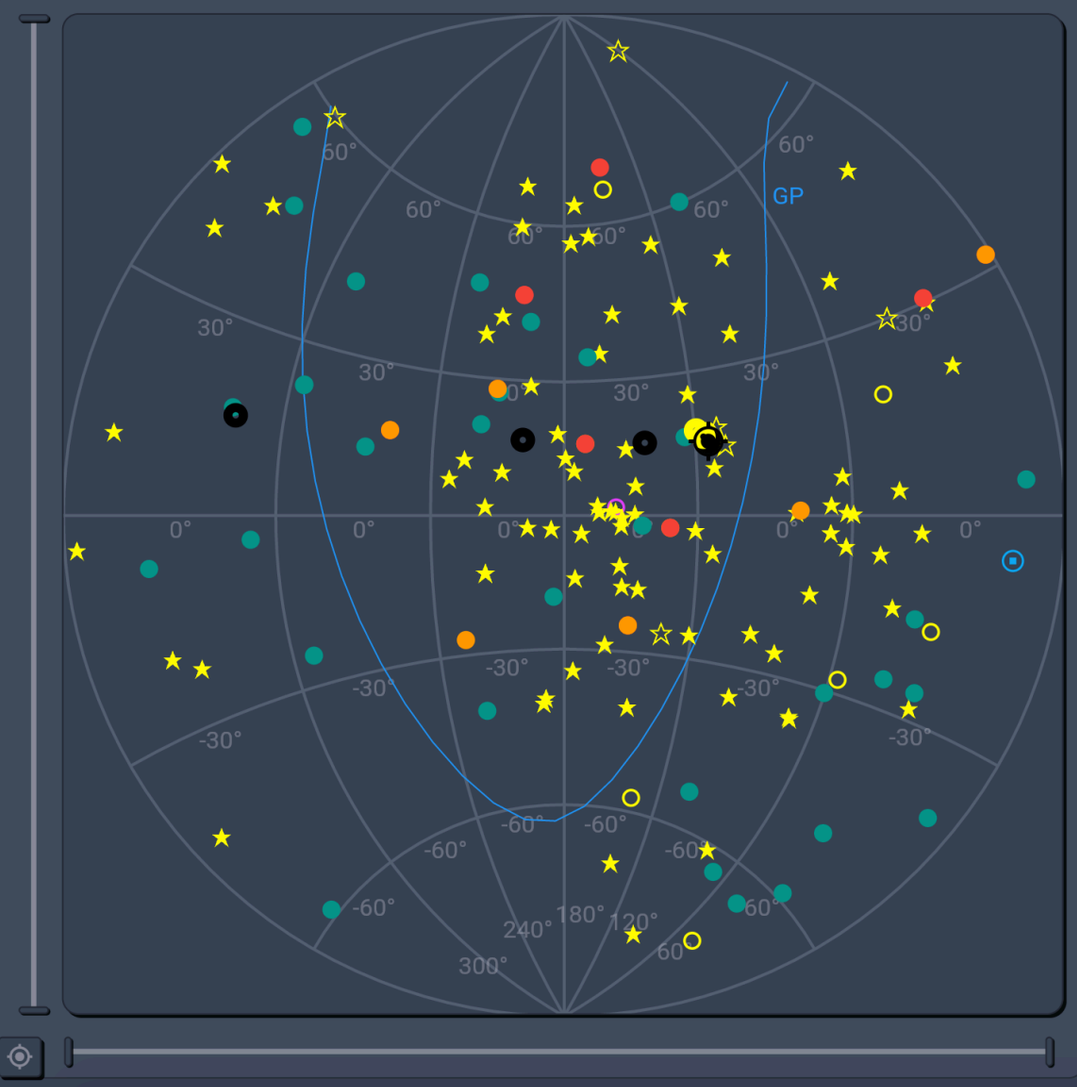
select action | Latest transients | Cone search

personalize

Status: logged in as fabian.schu Infos: v release: v1.3.0

Filters | From 2021-12-01 to 2022-01-11 | Swift | Fermi | HAWC | IceCube | AMON | Integral | SVOM | LVC | other

Type of events : FRB | OT | SN | GRB | burst | neutrino | GW | nuem



selected
IceCube-211208A
RA/Dec: 114.52° / 15.56°
error: 2.129°
2021-12-08 20:02:51
cone search

show
RA/Dec: 326.33° / 47.68°
error: 12.93°
2022-01-10 04:31:43
cone search

show
PKS0903-57
RA/Dec: 136.23° / -57.58°
2022-01-10 02:48:21
cone search

show
SN 2022is
RA/Dec: 154.08° / 43.07°
2022-01-09 12:28:48
cone search

show
SN 2022fw
RA/Dec: 185.98° / -3.44°
2022-01-09 11:45:36
cone search

show
SN 2022io
RA/Dec: 126.16° / 54.67°
2022-01-09 11:29:45
cone search

show
SN 2022im
RA/Dec: 118.75° / 42.77°
2022-01-09 11:28:19
cone search

Detailed info about selected source:

VoEvent : Click here
name: IceCube-211208A
RA / Dec: 7h38m4.78s / 15d33m36s
observatory: IceCube
FAR: 1.20/yr P_astro: 0.50 E: 171.08 TeV

Links : ALADIN ESA Pan-STAARS Fink SSDC TOBY FAVA ASAS-SN GCN-n GCN-c

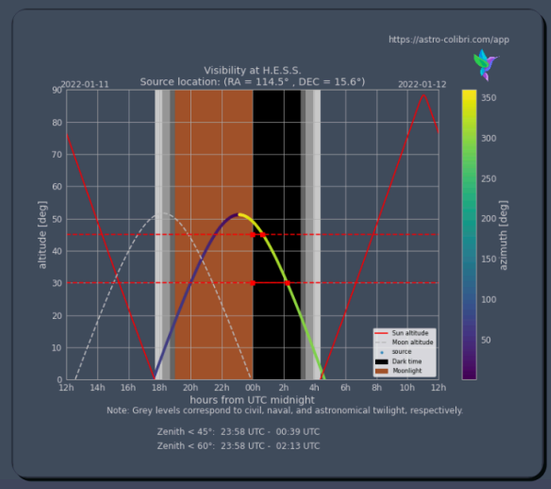
This is a high-energy neutrino detected by the IceCube observatory in Antarctica. It has an energy of 171 TeV but its origin is not totally clear: events like this happen due to statistical fluctuations roughly every 0.8 years and the probability of the neutrino to be of astrophysical origin (and not terrestrial background noise) is 50 %. IceCube located the origin of the neutrino to a region with a radius of 128 arcmin within the Gemini constellation.

Learn more about IceCube: link

Discuss this event on Twitter: @AstroColibri

Daily | Monthly

Weather: Forecast Seeing Sky view: HeavensAbove



https://astro-colibri.com

Latest transients

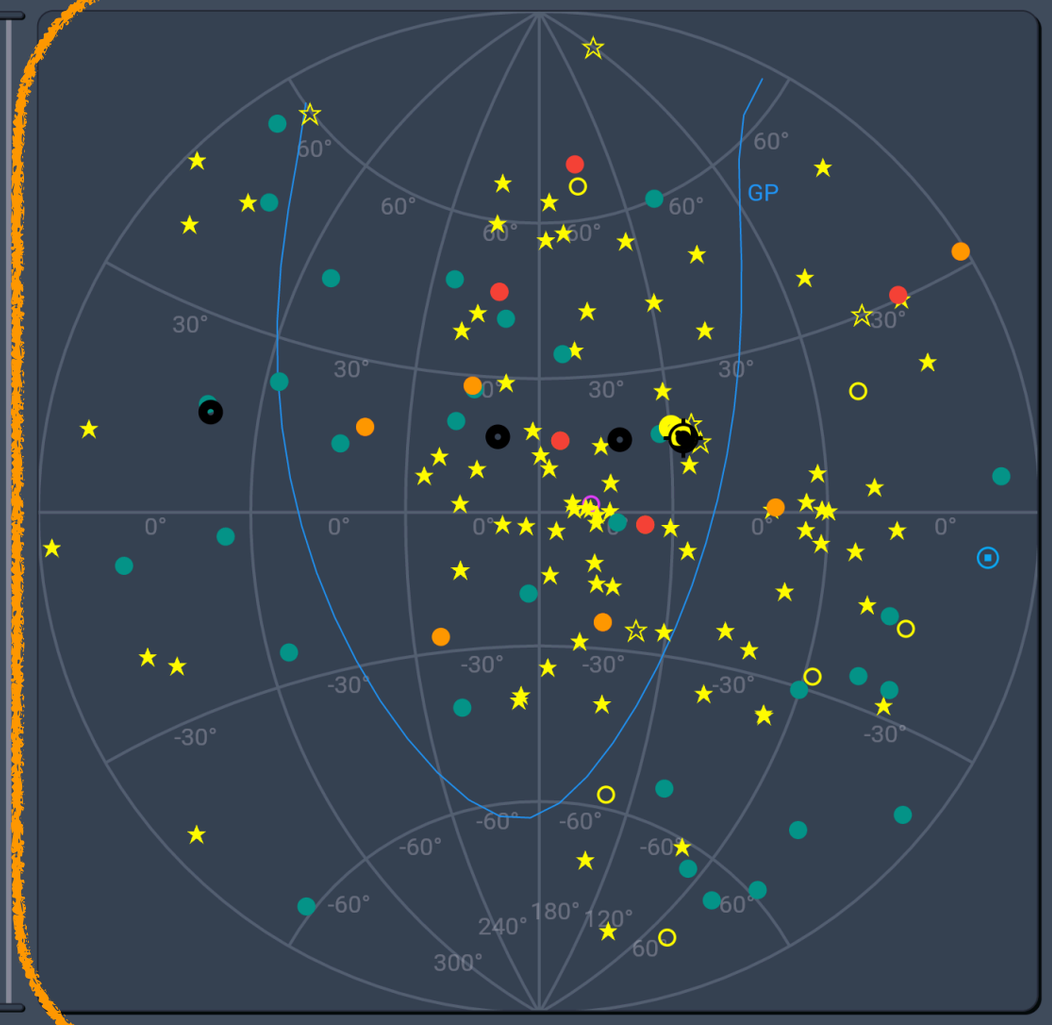
Astro-COLIBRI

select action | Latest transients | Cone search

personalize

Status: logged in as fabian.schu Infos: v release: v1.3.0

Filters | From 2021-12-01 to 2022-01-11 | Swift | Fermi | HAWC | IceCube | AMON | Integral | SVOM | LVC | other | Type of events : FRB | OT | SN | GRB | burst | neutrino | GW | nuem



selected | IceCube-211208A | RA/Dec: 114.52° / 15.56° | error: 2.129° | 2021-12-08 20:02:51 | cone search

show | RA/Dec: 326.33° / 47.68° | error: 12.93° | 2022-01-10 04:31:43 | cone search

show | PKS0903-57 | RA/Dec: 136.23° / -57.58° | 2022-01-10 02:48:21 | cone search

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show | SN 2022im | RA/Dec: 118.75° / 42.77° | 2022-01-09 11:28:19 | cone search

Detailed info about selected source:

VoEvent : Click here

name: IceCube-211208A

RA / Dec: 7h38m4.78s / 15d33m36s

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Daily | Monthly

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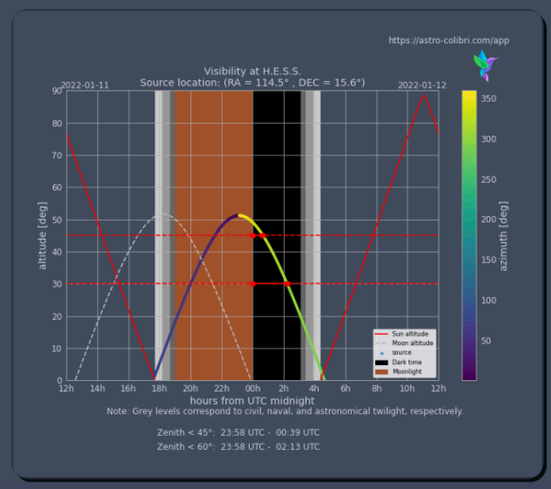


https://astro-colibri.com

Additional information

https://astro-colibri.com

Additional information

https://astro-colibri.com

Cone searches

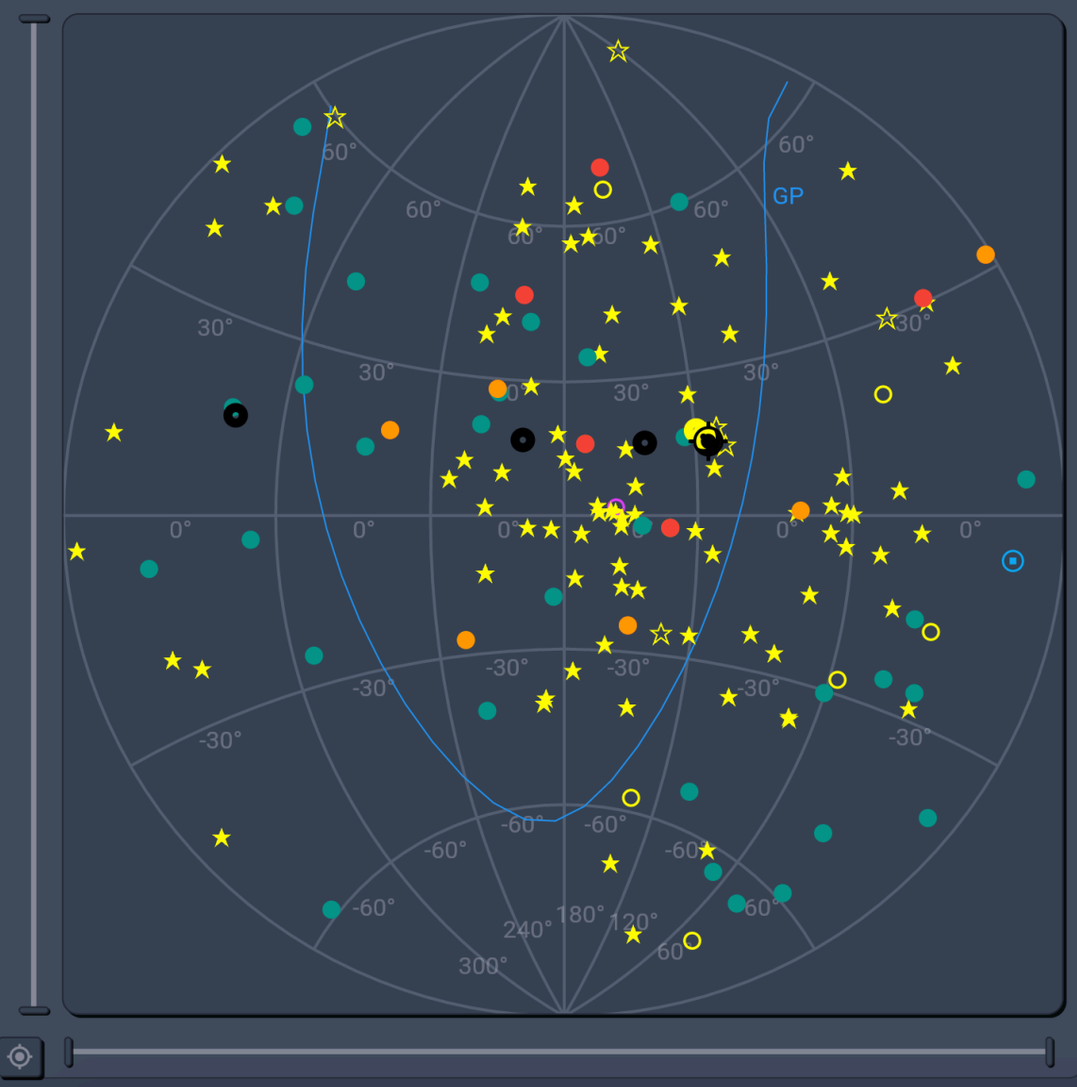
Astro-COLIBRI

select action | Latest transients | Cone search

personalize

Status: logged in as fabian.schu Infos: v release: v1.3.0

Filters | From 2021-12-01 to 2022-01-11 | Swift | Fermi | HAWC | IceCube | AMON | Integral | SVOM | LVC | other | Type of events : FRB | OT | SN | GRB | burst | neutrino | GW | nuem



selected | IceCube-211208A | RA/Dec: 114.52° / 15.56° | error: 2.129° | 2021-12-08 20:02:51 | cone search

show	RA/Dec: 326.33° / 47.68° error: 12.93° 2022-01-10 04:31:43	cone search
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show	SN 2022is RA/Dec: 154.08° / 43.07° 2022-01-09 12:28:48	cone search
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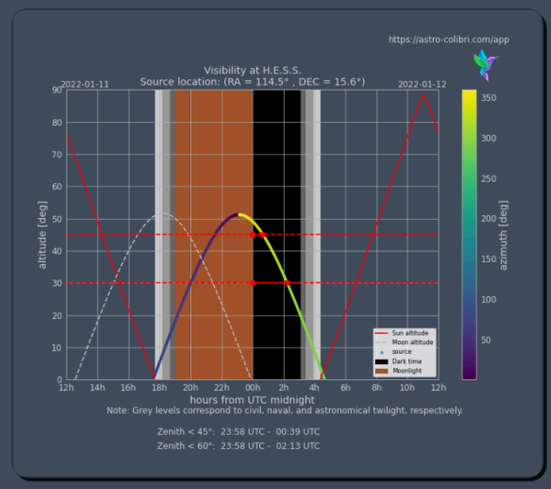


https://astro-colibri.com

Cone searches

Astro-COLIBRI

select action | Latest transients | Cone search

personalize

Status: logged in as fabian.schu Infos: ie: v1.3.0

Filters | From 2021-12-01 to 2021-12-13 | Swift | Fermi | HAWC | IceCube | AMON | Integral | SVOM | LVC | other | Type of events : | FRB | GRB | burst | neutrino | GW | nuem | 4FGL | TeVCAT | SGR/AXP

Cone search
RA / Dec: 114.52° 15.56°
source: IceCube-211208A
radius: 2.13°

show | IceCube-211208A RA/Dec: 114.52° / 15.56° error: 2.129° 2021-12-08 20:02:51 | cone search

show | 4FGL J0738.4+1539 RA/Dec: 114.61° / 15.66° separation: 0.13° | cone search

show | 4FGL J0743.1+1713 RA/Dec: 115.78° / 17.22° separation: 2.05° | cone search

selected | 4FGL J0738.1+1742 RA/Dec: 114.54° / 17.71° separation: 2.15° | cone search

show | BUST-211204A RA/Dec: 116.50° / 16.60° sep: 2.17° (err: 2.5°) 2021-12-04 14:52:47 | cone search

show | 4FGL J0739.7+1743 RA/Dec: 114.95° / 17.72° separation: 2.2° | cone search

show | 4FGL J0738.6+1311 RA/Dec: 114.66° / 13.19° separation: 2.38° | cone search

Detailed info about selected source:
name: 4FGL J0738.1+1742
name FGL: 3FGLJ0738.1+1741
RA / Dec: 7h38m9.36s / 17d42m25.2s
assoc: PKS 0735+17

Links : SIMBAD NED ALADIN ESA Pan-STAARS Fink SSDC TOBY FAVA LAT-LCR ASAS-SN

FLaapLUC : longterm shortterm

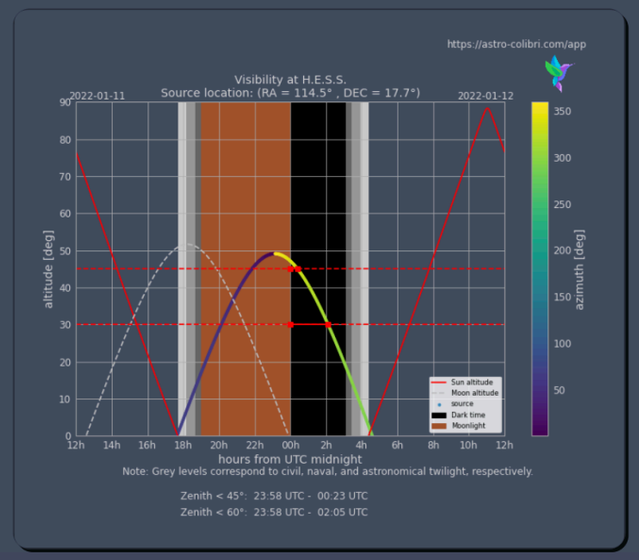
This is a source know to emit high-energy gamma rays in the GeV domain. It has been detected by the LAT instrument onboard the Fermi satellite and is part of the 4FGL catalog.

You can find details about the Fermi spacecraft here: link

Discuss this event on Twitter: @AstroColibri

Daily | Monthly

Weather: Forecast Seeing Sky view: HeavensAbove



https://astro-colibri.com

Visibility

Observatory selection

Astro-COLIBRI

select action | Latest transients | Cone search

personalize

Status: logged in as fabian.schu Infos: ie: v1.3.0

Filters From 2021-

Type of events : FRB GRB burst neutrino GW nuem 4FGL TeVCAT SGR/AXP

Location of observer

The visibility plots are calculated for an observer at custom position: long = -70.76497999999998°, lat = -30.30312298435946°, height = 0m.

You can change the observer location by choosing one of the following observatories

Radio

ALMA | ASKAP | ATCA | MWA | Nançay | Yunnan

Optical

Jilin | Keck | Mount Wilson | OHP | Palomar | SALT | San Pedro Mártir | VLT Paranal | Xinglong

High energy

HAWC | H.E.S.S. | LHAASO | MAGIC | VERITAS

My observatories :

ATLAS Chile, Rio Hurtado | Haute Provence | Paris

Search for observatories using their IAU code or name:

Or by indicating a custom observer position:
The longitude and latitude must be expressed in decimal degrees.
The altitude must be expressed in meters above sea level.
Longitudes are negative toward West. The sign + of the longitude and latitude can be omitted.

-70.76497999 | -30.30312298 | 0 | ATLAS Chile, Rio Hurtado | Select coordinates

Save observatory

ok

Detailed info about selected source:
name: 4FGL J0738.1+1742
name FGL: 3FGLJ0738.1+1741
RA / Dec: 7h38m9.36s / 17d42m25.2s
assoc: PKS 0735+17

Links : SIMBAD NED ALADIN ESA Pan-STAARS Fink SSDC TOBY FAVA LAT-LCR ASAS-SN

FLaapLUC : longterm shortterm

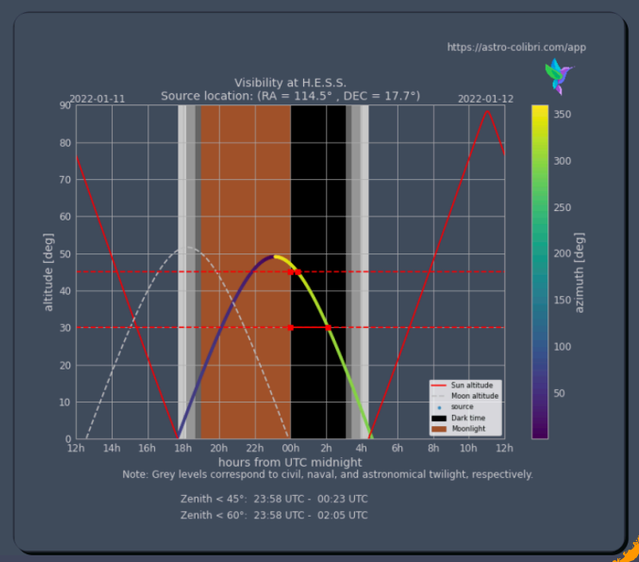
This is a source know to emit high-energy gamma rays in the GeV domain. It has been detected by the LAT instrument onboard the Fermi satellite and is part of the 4FGL catalog.

You can find details about the Fermi spacecraft here: link

Discuss this event on Twitter: @AstroColibri

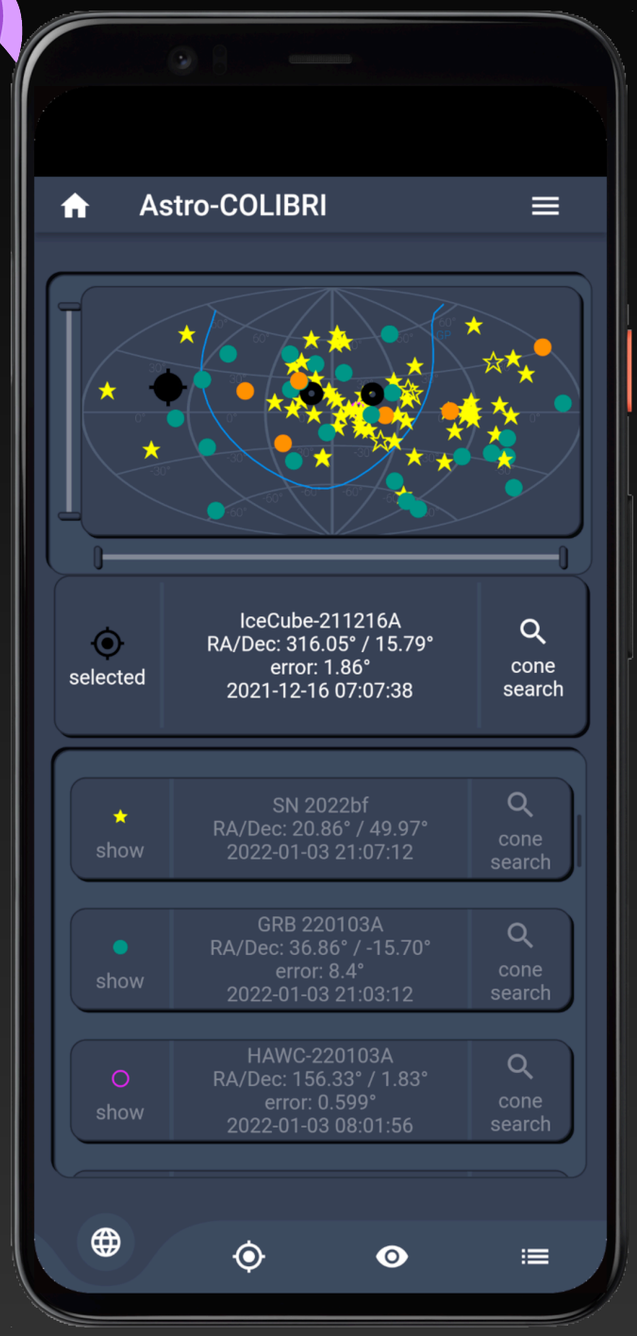
Daily | Monthly

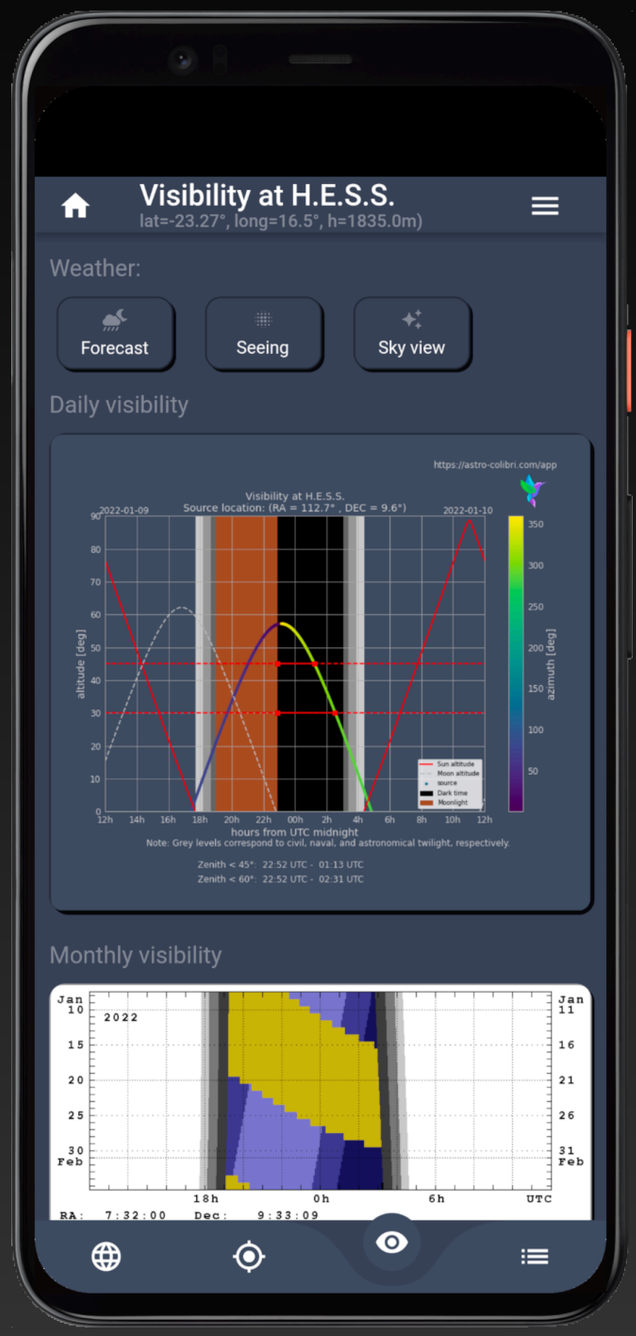
Weather: Forecast Seeing Sky view: HeavensAbove

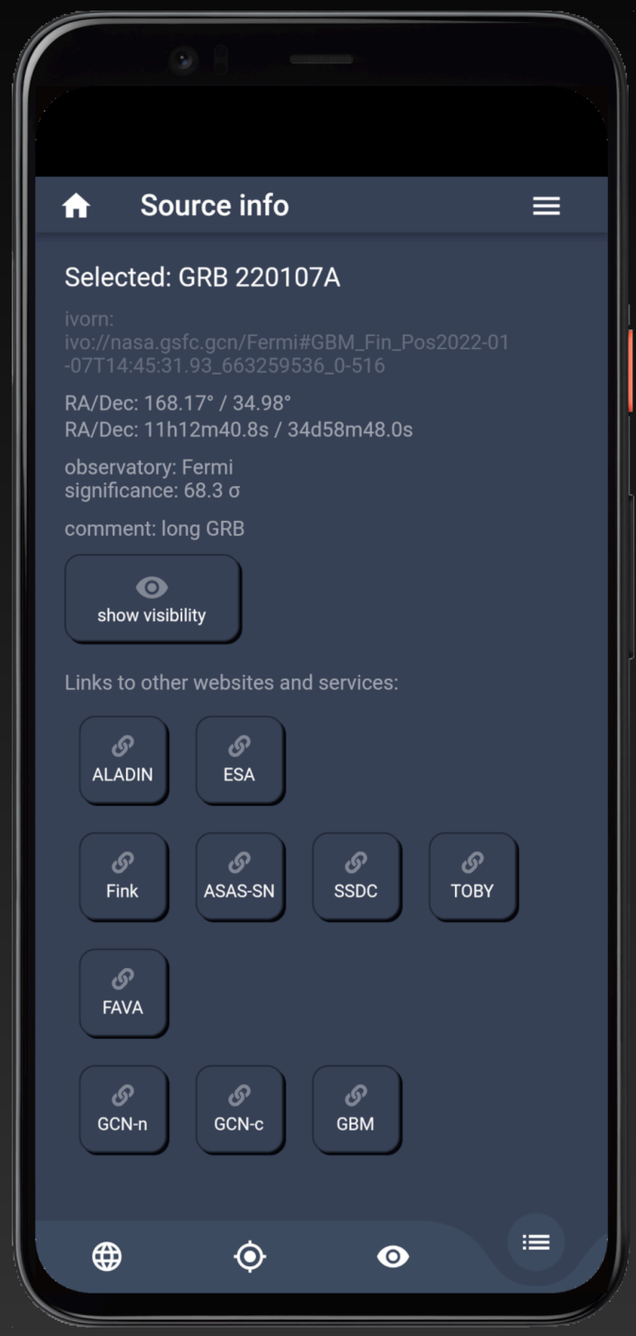


https://astro-colibri.com

Android + iOS







Alert notifications in real-time

A growing community

- Notifications are very useful for amateur astronomers
- Stay tuned for new features and projects

Astro-COLIBRI

- **Astro-COLIBRI: automatic pipeline providing easy access to**
  - transient detections (GRBs, FRBs, TDEs, SNe, OTs, high-energy neutrinos, GWs, etc.)
  - interfaces: https://astro-colibri.com + Android + iOS
  - a central API with publicly available endpoints for cone searches, etc.
- **Version 1.0 was released in August (>1000 users at the moment)**
  - New releases roughly every 1-2 months (currently V 1.4.2)
- **Paper published: P. Reichherzer et al., 2021 ApJS 256 5 (link)**

Next steps

- **Continued development + improvements**
  - detailed internal development plan (e.g. improved interfaces, GWs: preparation for O4, VO compatibility, …)
  - user + community feedback
  - contributions via Sciathon/Hackathon
- **1st Astro-COLIBRI Multi-messenger astrophysics workshop**
  - September 26-30 (Bochum/Germany)
  - https://astrophysics-workshop.web.app
- **Increase the link with Amateur astronomy communities**

Astro-COLIBRI

Contact/feedback: astro.colibri@gmail.com

- Web interface: https://astro-colibri.com
- API (incl. documentation): https://astro-colibri.science

Android Play Store

Apple iOS App Store

Introductions/tutorials on YouTube

Twitter: @AstroColibri

Online shop

Gamma catcher

- **A game where you catch gamma rays !**
  - **https://gamma-catcher.web.app/ + android**

Gamma catcher

- **A game where you catch gamma rays !**
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Also t-shirt available

JOIN US !

Architecture