cherenkov telescope array

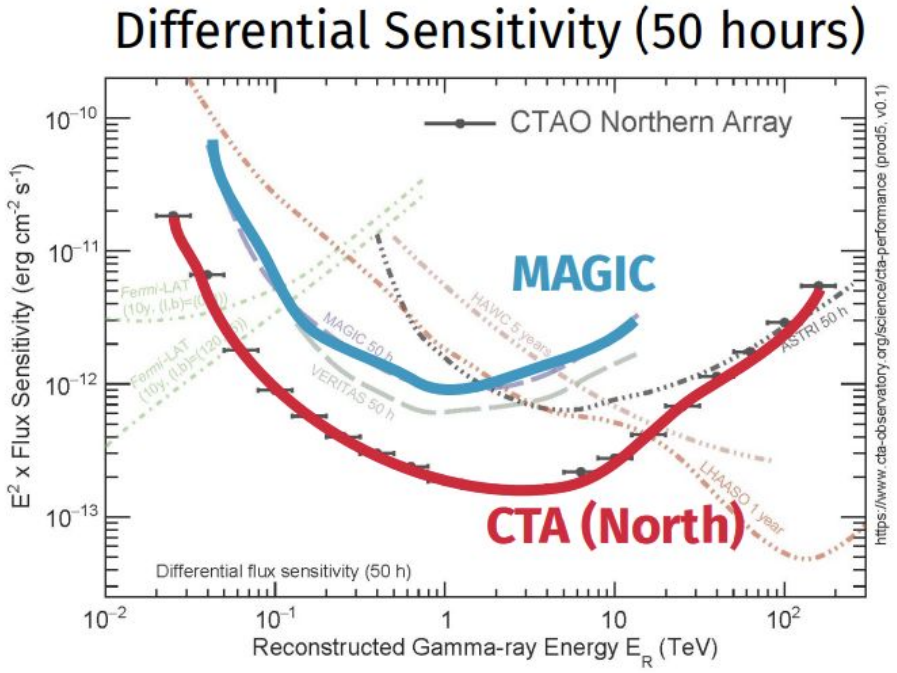
1st VHEGAM meeting,
Bologna
15-17/01/2024

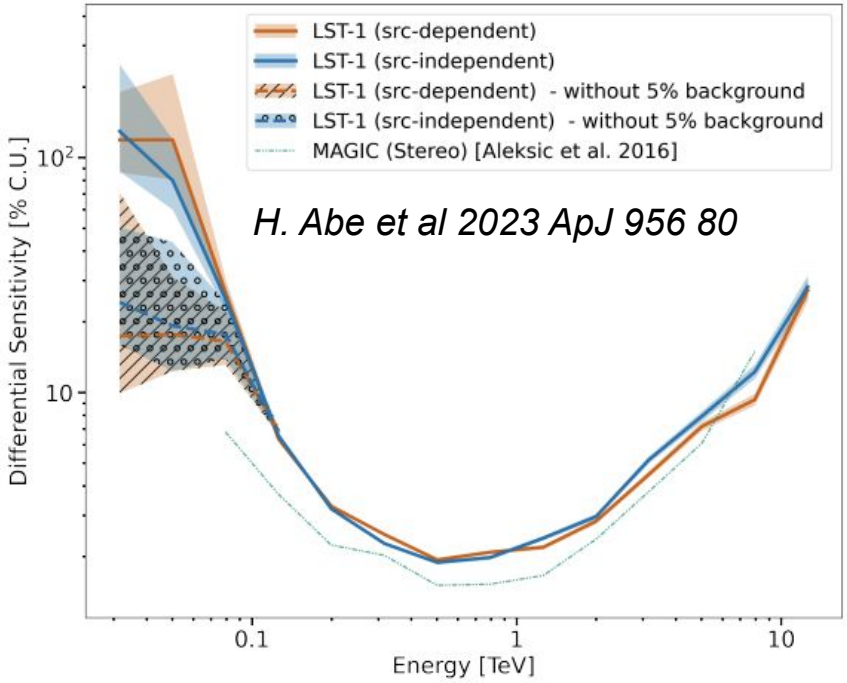
LST extragalactic-group activities

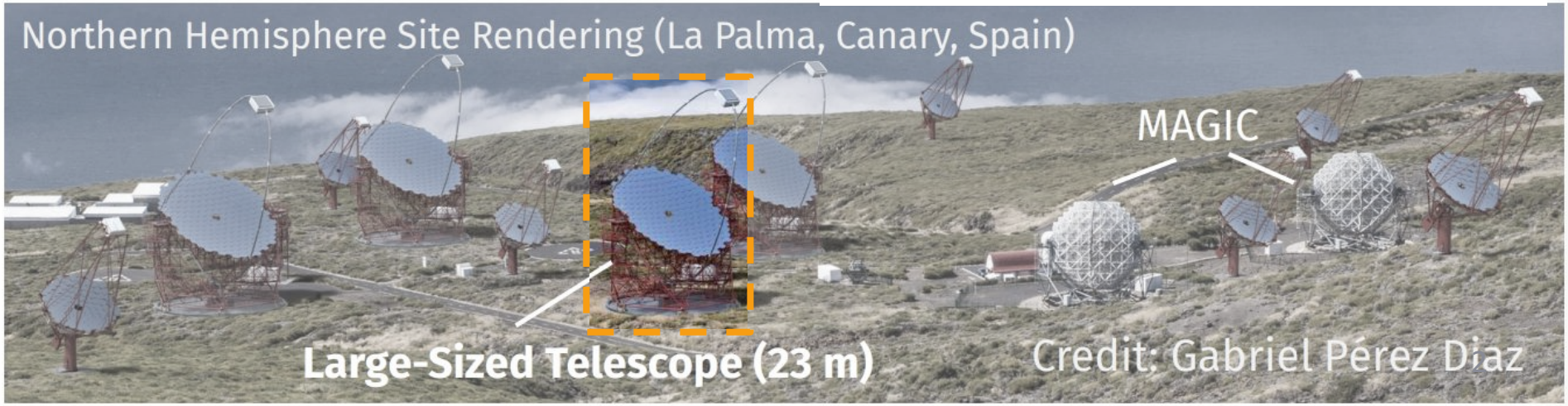
Mireia Nievas for the LST egal group

January 16, 2024

CTA-N and LST (and MAGIC)







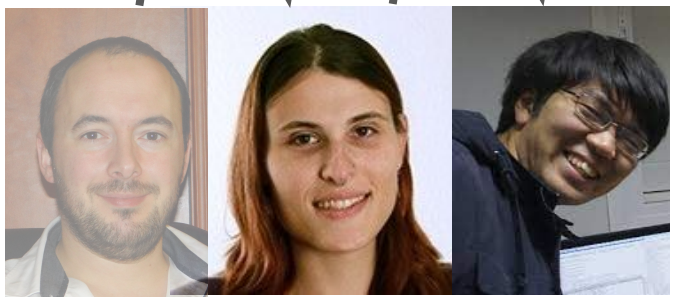
LST Extragalactic group organization

conveners:

- previous: David Sanchez <david.sanchez@lapp.in2p3.fr>
- current: Mireia Nievas <mnievas.work@gmail.com>
- debuty: Seiya Nozaki <nozaki@mpp.mpg.de>

(rotation every year, ~ Feb/March)

March '23 → March '24 ?



Communication channels

CTA North slack
#lst-extragalactic

email-list:
lst-extragalactic@cta-observatory.org

https://indico.cta-observatory.org/category/171/

https://www.lst1.iac.es/wiki/index.php/Extragalactic_Working_Group

group members:

- 60 people (in Slack)
- actively joining: ~ 10-15
- actively analyzing data: ~5

LST Extragalactic group organization

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(rotation every year, ~ Feb/March)

group members:

- 60 people (in Slack)
- actively joining: ~ 10-15
- actively analyzing data: ~5

this is a factor ½ with respect to the GAL group (yesterday's talk by Pol).

There's *life* outside the Galaxy, we just need people actively looking for it.

LST Extragalactic group activities (#lst-extragalactic, 60 people)

- Regular calls once a month with regular structure:
  1. Group news
  2. Paper updates
  3. Conference contributions
  4. New analyses
  5. ToO

- Papers in progress: BL Lac, AGN ‘zoo’ …

Next call: Thursday 18, 9:00 UTC (10:00 CEST)

Proposals:

- External proposals require a LST-PI
- Two types:
  - i) MAGIC+LST proposals (through MAGIC)
  - ii) LST-only → Deadline 23:00 CET on February 2nd, 2023

ToOs (#agn_too, 41 people !)

Two active pipelines:

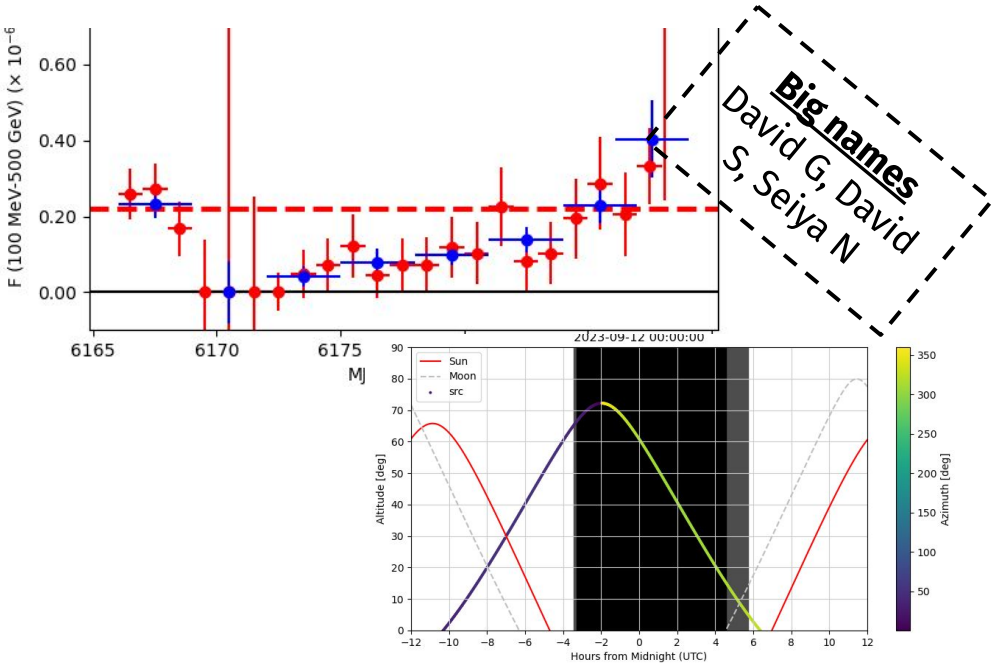
FLaapLUC (JP Lenain, David Sanchez in LST):

- Used in HESS, public code, based on aperture photometry & lists of sources (TeV, FAVA + few selected targets)

FFASA: Fast Fermi All Sky Analysis (David Green):

- weekly file data, ‘all’ sky. Threshold based on TS and flux.

Optical triggers: for now manual checks on ATLAS (forced photometry) and ZTF (Antares).



Additional triggers from MAGIC, Fermi, IceCube, ATeLs. Triggers discussed in slack’s #agn_too channel.

Data analysis: RTA + offline (next morning usually). Flare advocates being defined.

ToOs (#agn_too, 41 people !)

Many candidate targets and many ToOs (group becoming **very** active):

- December ‘22: NGC1275 (detected!, ATeL published),

(... censored information here ...)

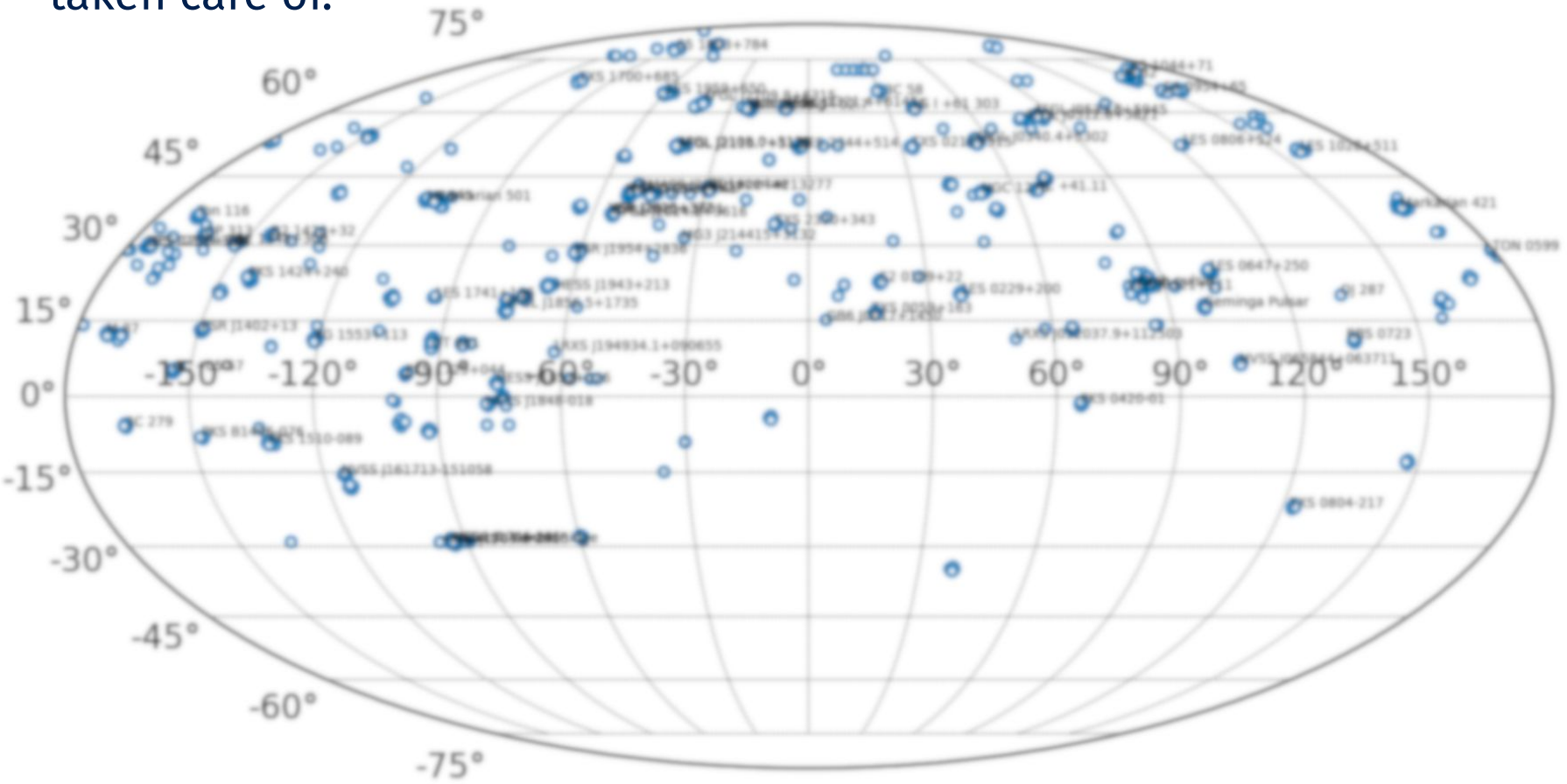
- December ‘23: OP313 (detected!, ATeL published),

Planning to implement ‘shifts’ (to be defined).

- ATeLs,
- LST (self-trigger): RTA, quick analyses.
- Fermi-LAT (flaapluc, FFASA) → flaapluc distributed through email
- Swift ? https://www.swift.ac.uk/LSXPS/ & https://www.swift.ac.uk/archive/ql.php ?

LST points / datacheck

Lots of observations, but not all the data being taken care of.



Paper updates & conference contributions

meetings and conference contributions currently dominated by the two big papers:

BL Lac and AGN Zoo.
(both w/BL Lac objects)

New analyses shown from time to time, but they should formally become projects that eventually end up in papers.

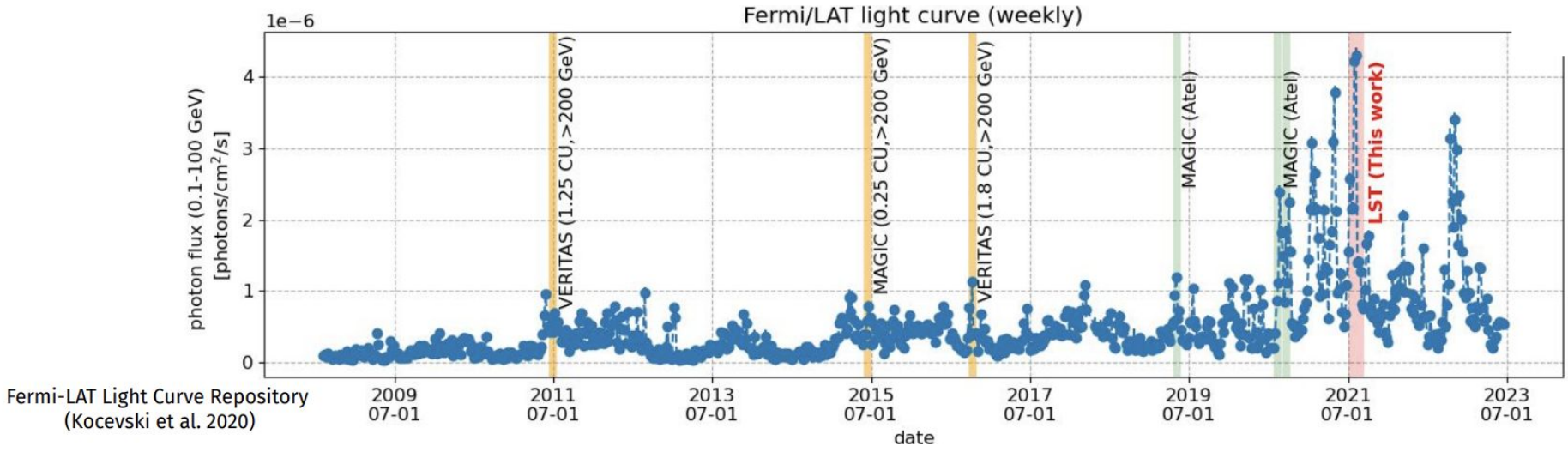
ID	Proposal Title	PI Name	Regular Hours	ToO Hours	Rank	Mean	STD
TRANS02	Gamma-ray burst observations	Dominí	0	50	A	9.11	0.78
GAL02	Target of Opportunity observations of Galactic Transient sources	López-Oramas	0	50	A	8.38	1.04
EGAL07	Target of Opportunity observations on AGN with LST-1	Sanchez	0	50	A	8.10	1.18
GAL05	Search for Very High Energy pulsed emission from PSR J2021+3651	Mas-Aguilar	50	0	A	8.10	1.50
TRANS01	Follow-up of gravitational wave events	Zaglar-Arroyo	0	75	A	7.71	1.20
TRANS03	Tick-Tock: Monitoring of an inspiraling binary SMBH	J. Green	0	50	B	7.10	1.10
GAL03	Studying the large scale, diffuse emission around the Gal Center with the LST1	Abe	75	0	B	6.85	0.63
EGAL04	Monitoring of low-frequency peak BL Lac (LBL)	Pons	50	0	B	6.79	0.80
EGAL01	Constraining short-term variability of PG 1553+113 in high emission state	Prandini	0	20	B	6.58	1.16
GAL04	Newly discovered GeV-emitting SNR G17.8+16.7	Katagiri	80	0	B	6.46	0.87
EGAL06	Monitoring of misaligned AGNs	Nievas Rosillo	40	20	B	6.45	0.93
GAL01	Large Zenith Angle observation of the hadronic PeVatron candidate in the Boomerang SNR G106.3+2.7) with LST-1	Cassol	20	0	B	6.15	1.14
EGAL02	Observations of distant bright FSRQs in active states	Nozaki	110	10	C	5.85	1.03
EGAL05	NGC1068 Multi-year Observations	Noda	80	0	C	5.36	1.40
EGAL03	AGN long-term monitoring and internal ToOs with LST1	Micanti	65.5	13.6	C	5.16	1.33

BL Lac: *context*

Multiple gamma-ray flares lately

- 2020: ATeL #14032 [many, inc. MAGIC]
- **2021**: ATeL #14783 [many, inc. MAGIC, LST]
- 2022: ATeL #15688 [many, inc. Fermi-LAT]

Big names
Seiya N, Juan Escudero, etc



BL Lac: *observations*

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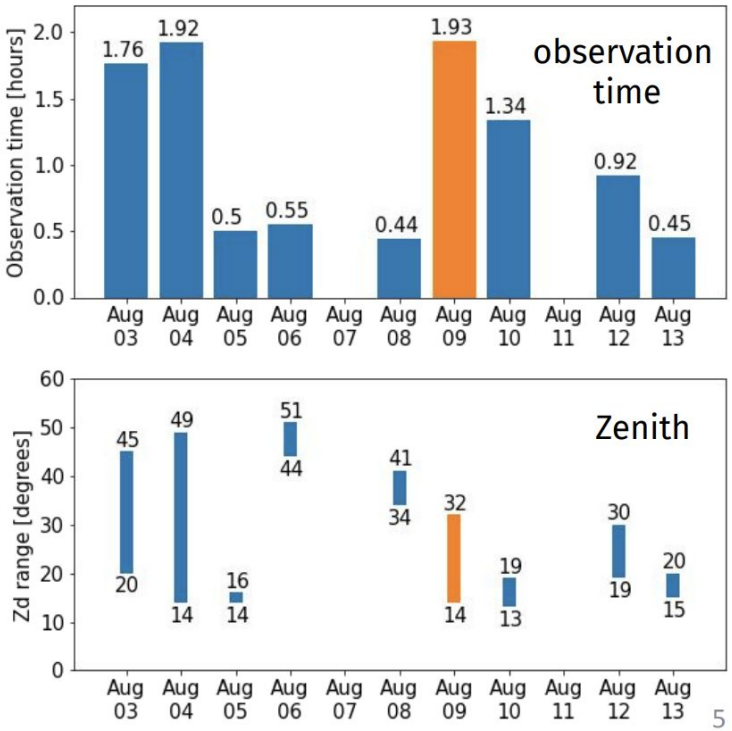

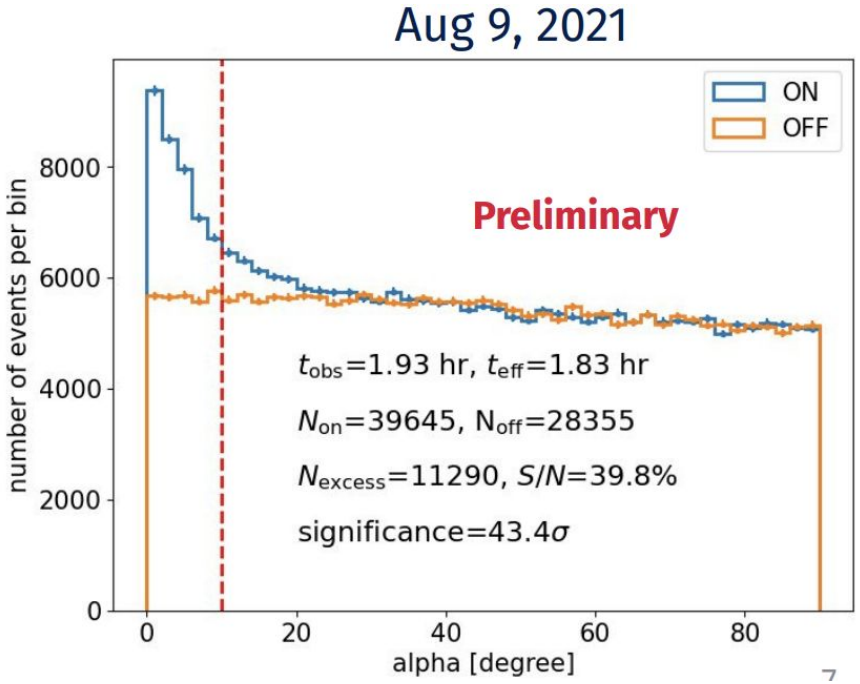

BL Lac: *SED*

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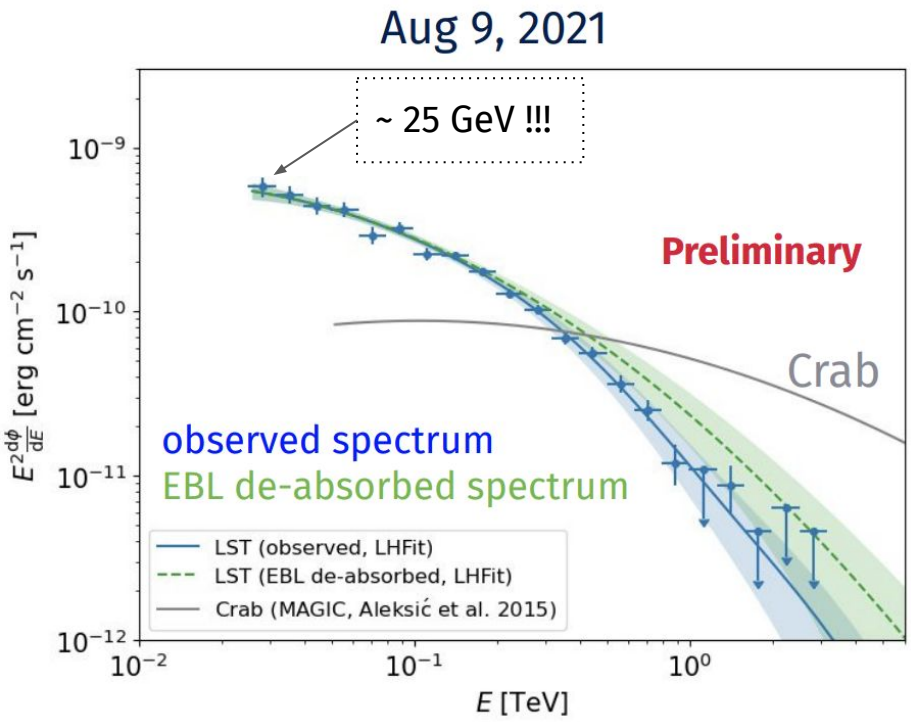
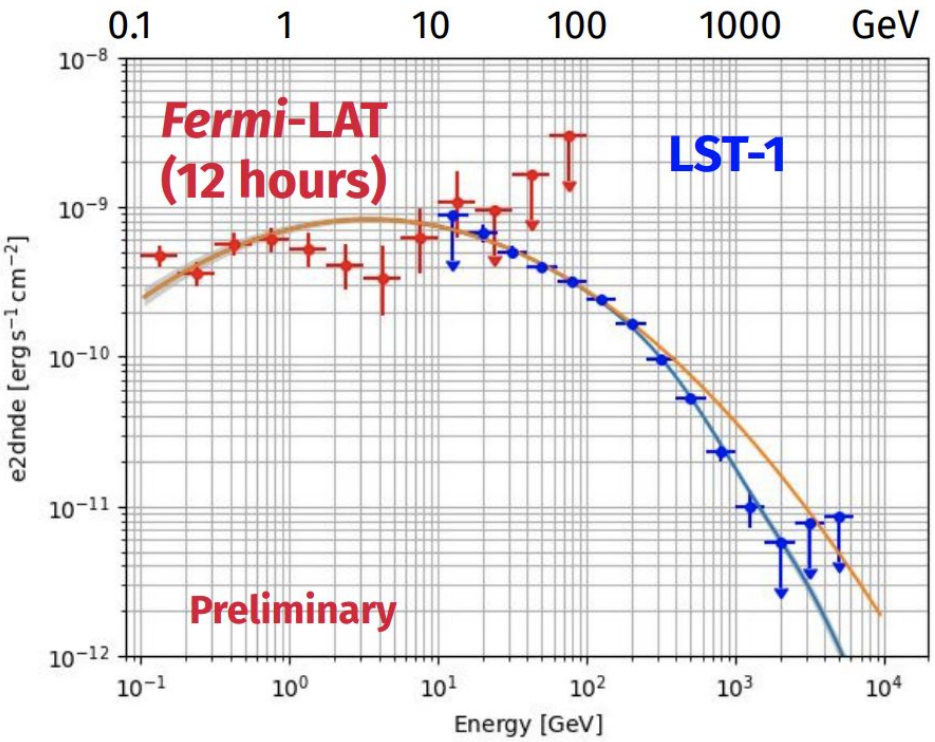
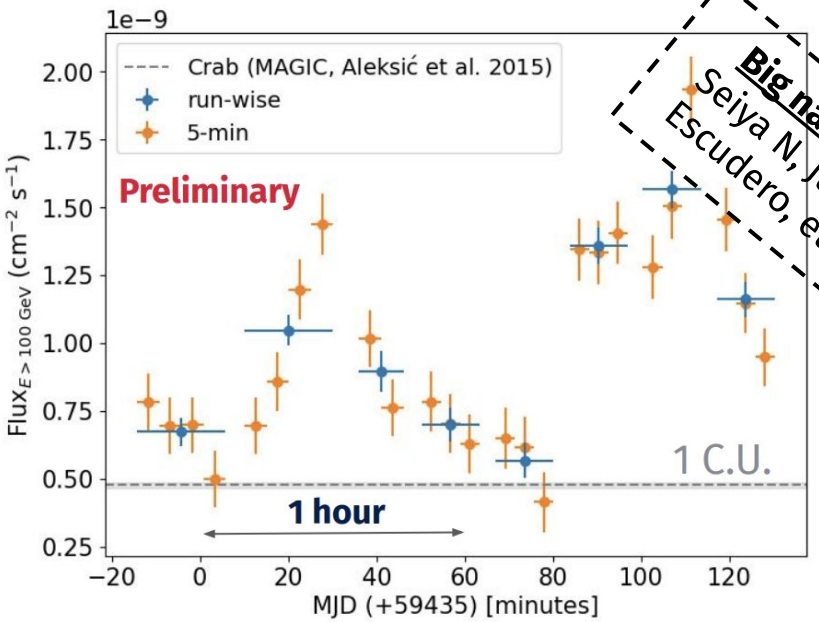


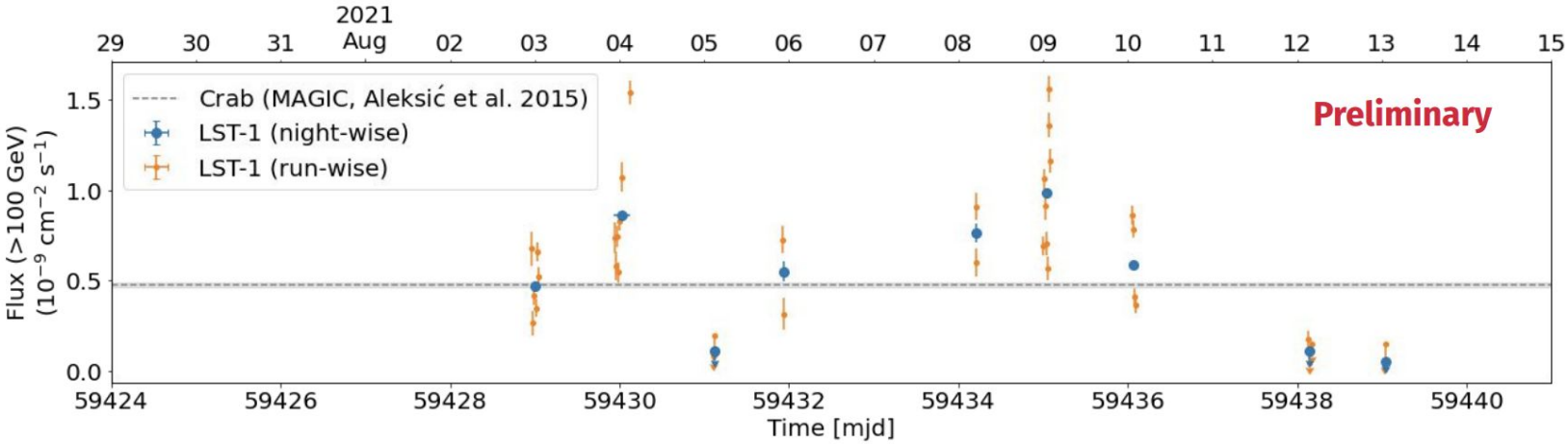


BL Lac: *variability*

- intra-night (minute-scale) variability detected ! (up to ~3 CU in some runs)
- strong night-to-night variability (<0.1 CU – 2 CU night averages)

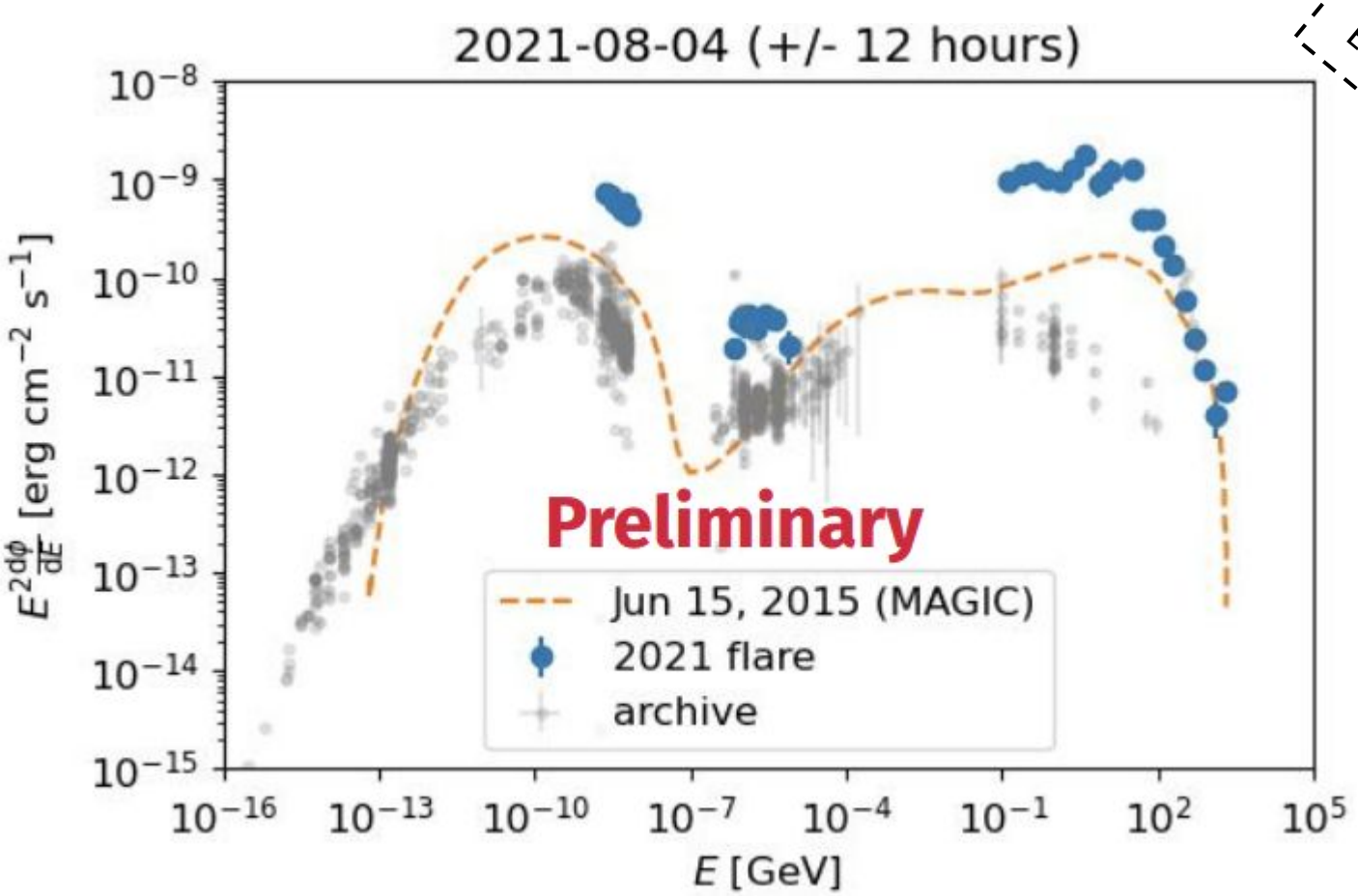


Big names
Seiya N, Juan Escudero, etc

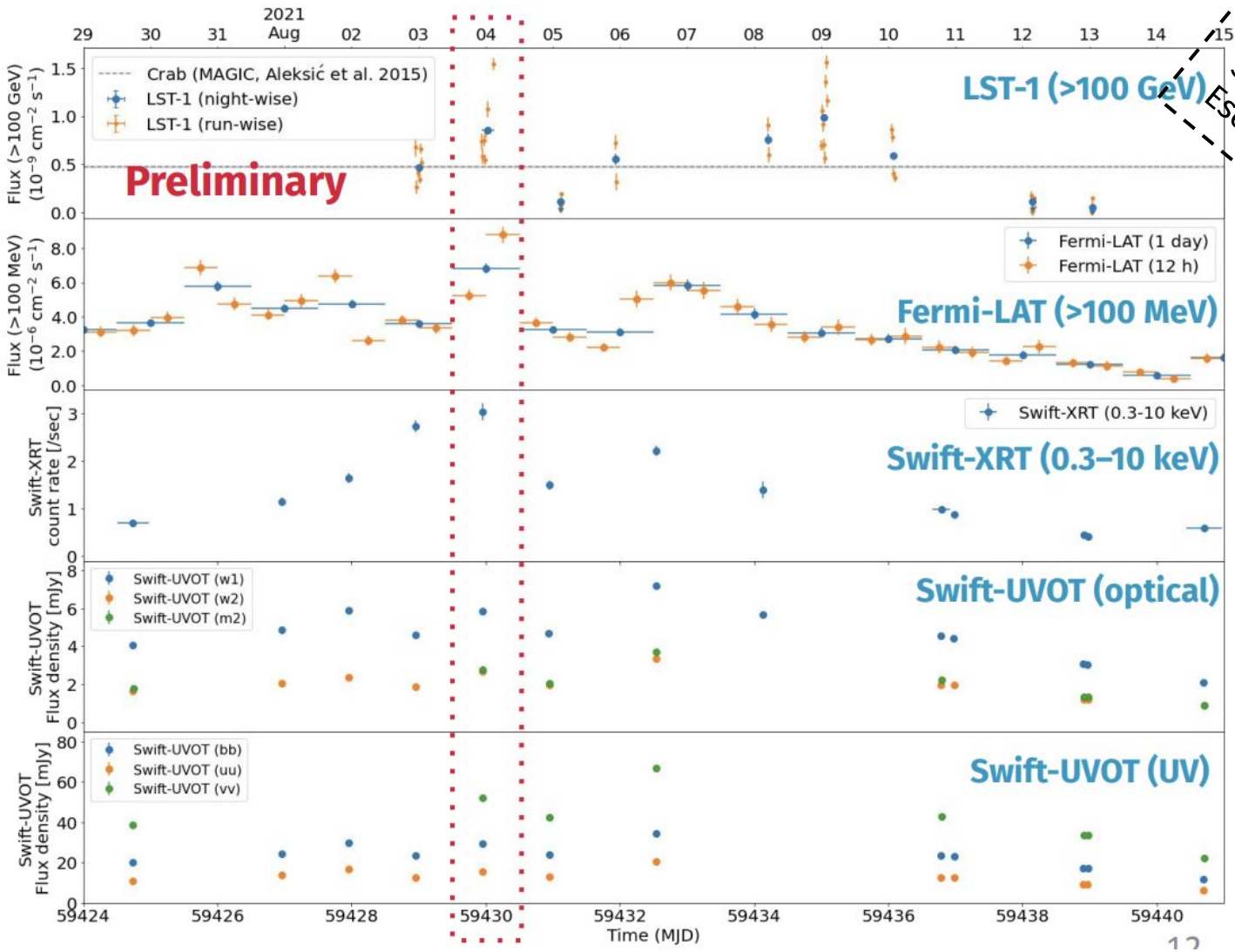


BL Lac: *SED modeling*

Big names
Seiya N, Juan Escudero, etc



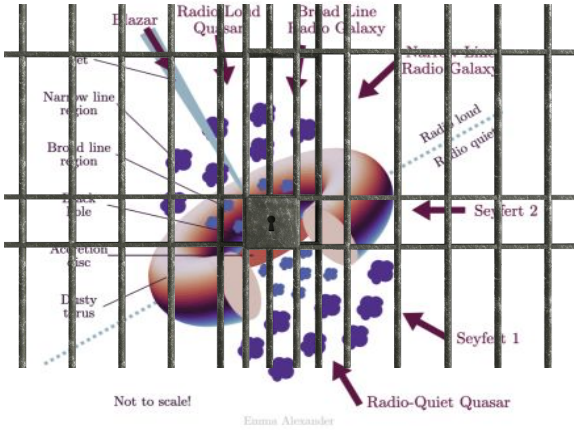
BL Lac: *MWL LC interpretation*



Big names
Seiya N, Juan Escudero, etc

AGN 'zoo' paper: sources

" an establishment which maintains a collection of wild AGNs, typically in a flaring state, for study, conservation, or display to the public "



Usual suspects:

Observation summary

Source	Observation date	Redshift	Observation time before/after cut (h)	Detection significance (σ)
Mrk 421	2020 Dec. 12 - 2022 May 23	0.031	68.5 / 31.9	31
Mrk 501	2020 July 10 - 2022 May 22	0.034	67.2 / 39.7	21
1ES 1959+650	2020 July 11 - 2022 May 5	0.048	21.3 / 11.8	12
1ES 0647+250	2020 Dec. 16 - 2020 Dec. 21	0.45±0.05	8.8 / 8.2	7
PG 1553+113	2021 Apr. 8 - 2022 May 23	0.433	12.2 / 9.9	16

\+ other non-detections

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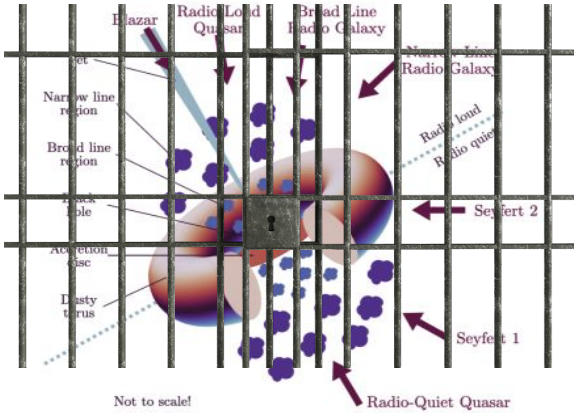

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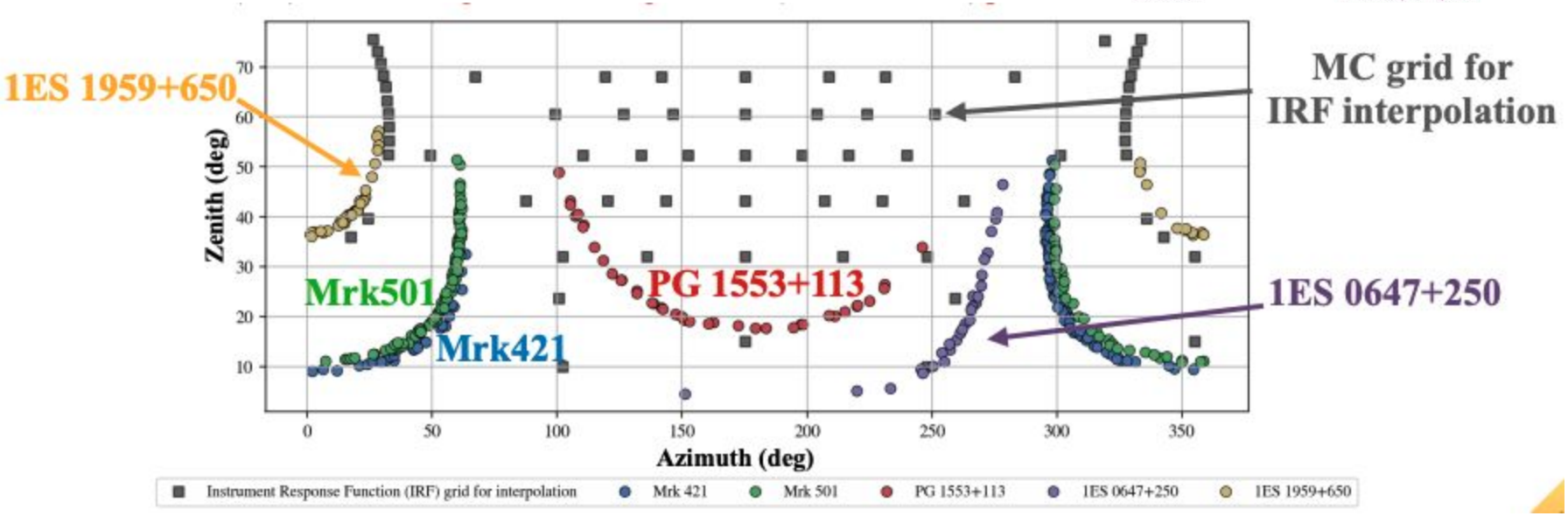

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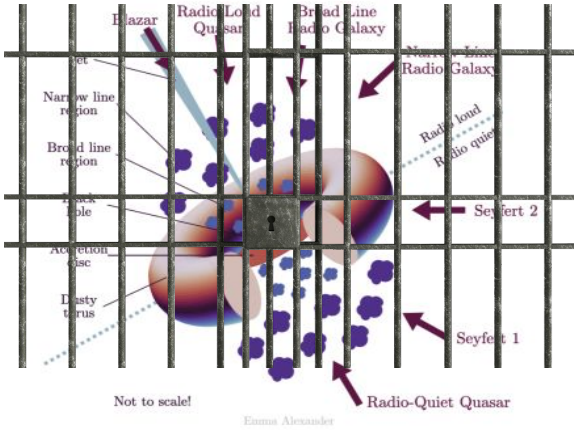

Lots of work → many people involved

Andres Baquero (UCM)
Axel Arbet-Engels (Max-Planck-Institut für Physik)
Chaitanya Priyadarshi (IFAE)
David Green (Max Planck Institut für Physik)
David Sanchez (Universidad Politécnica de Valencia)
Estelle Pons (Laboratoire d'Annecy de Physique des Particles)
Gaetano Di Marco (University of Padova)
José Luis Contreras González (UCM)
Joshua Baxter (ICRR, Japan)
Lea Heckmann
Lukas Nickel (TU Dortmund)
María Láinez (UCM)
Mireia Nievas Rosillo (Instituto de Astrofísica de Canarias (IAC))
Mónica Vázquez Acosta (Instituto de Astrofísica de Canarias (IAC))
Noah Biederbeck (TU Dortmund)
Nuria Alvarez Crespo (TO)
Ryuji Takeishi (ICRR, Japan)
Sami Caroff (PhD)
Vandad Fallah Ramazani (Tuorla observatory)

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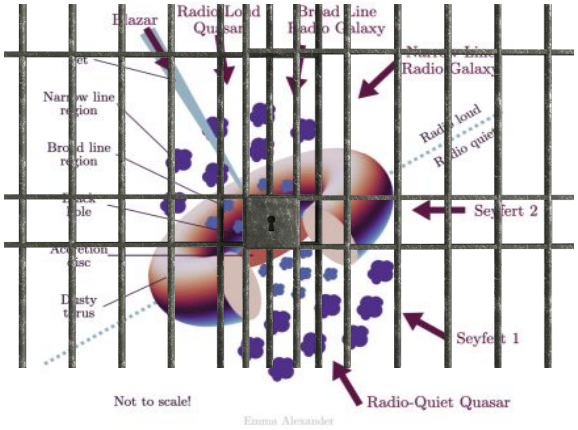
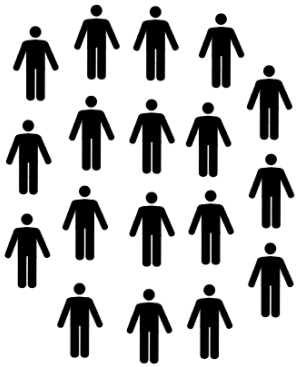


Lots of work → many people involved

people joining the calls



people doing stuff

Andres Baquero (UCM)
Axel Arbet-Engels (Max-Planck-Institut für Physik)
Chaitanya Priyadarshi (IFAE)
David Green (Max Planck Institut für Physik)
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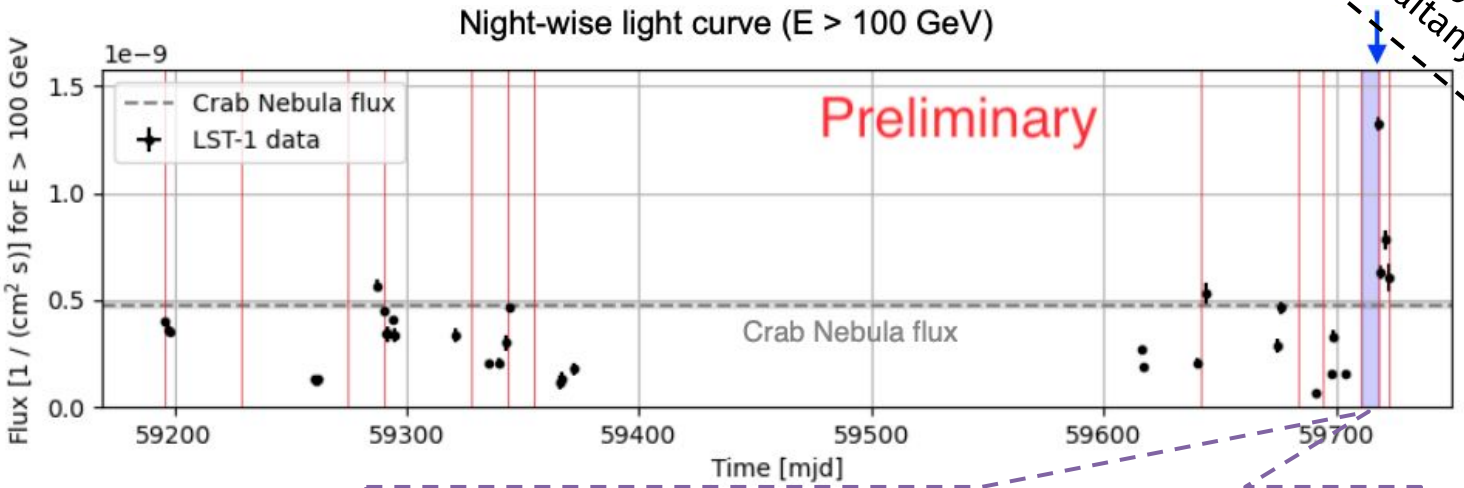
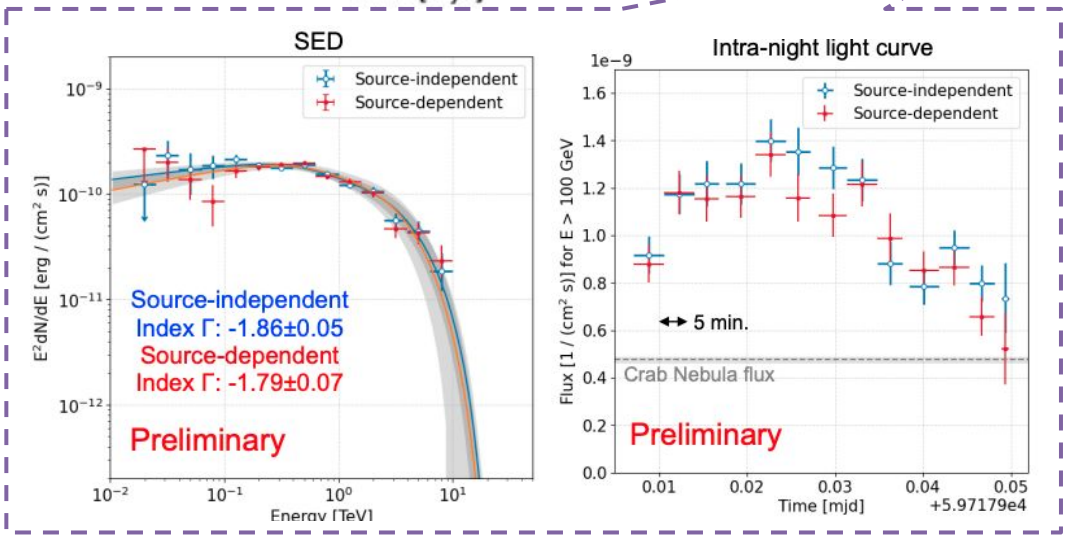
Sami Caroff (PhD)
Vandad Fallah Ramazani (Tuorla observatory)

AGN 'zoo' paper: Mrk 421

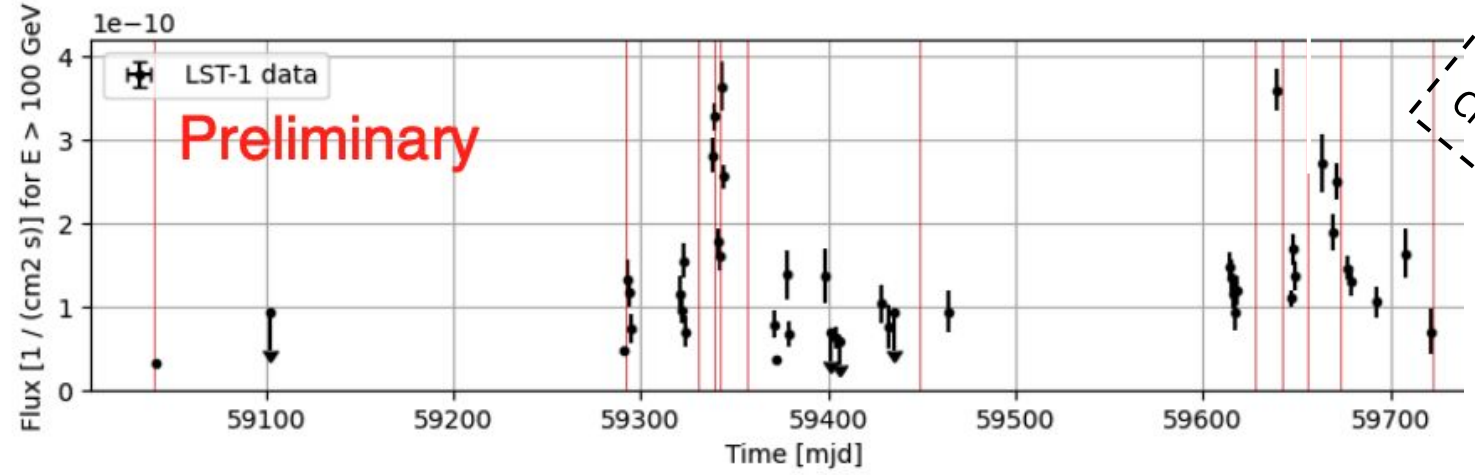
- One of the most observed sources during the commissioning (bright, closeby, always interesting)

Big names
Ryuji T,
Chaitanya P, etc

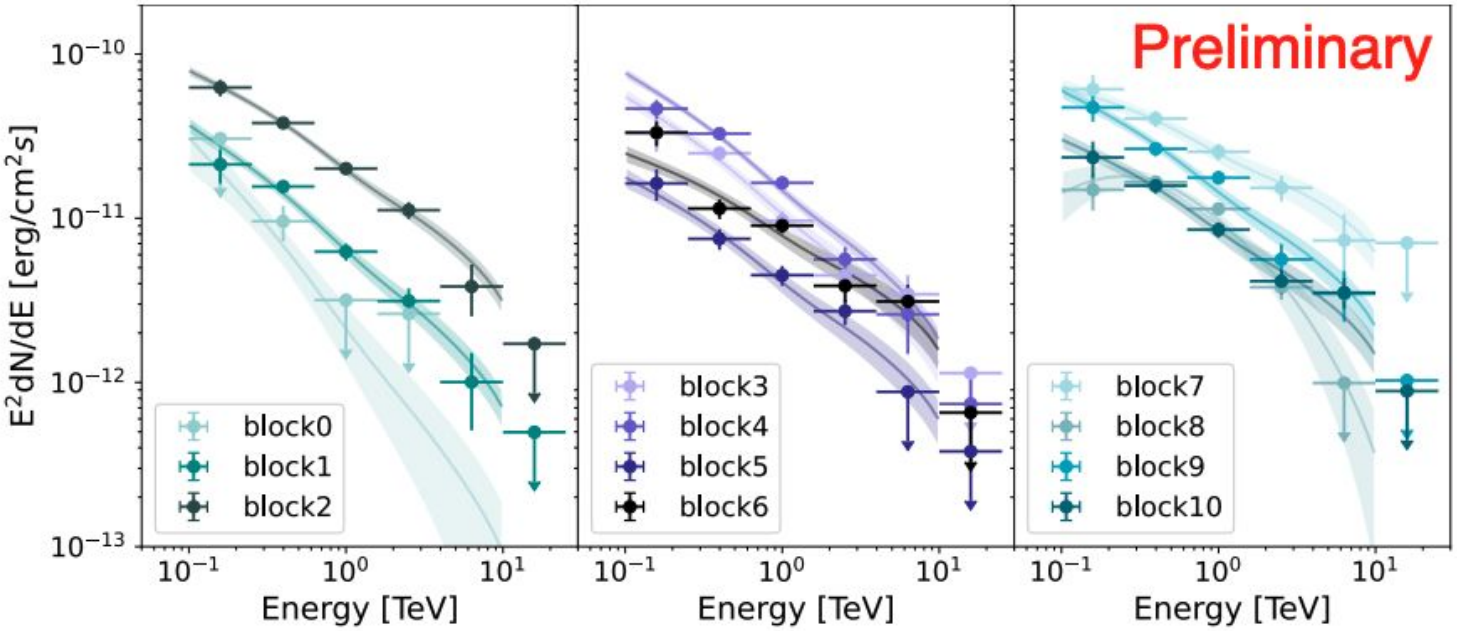




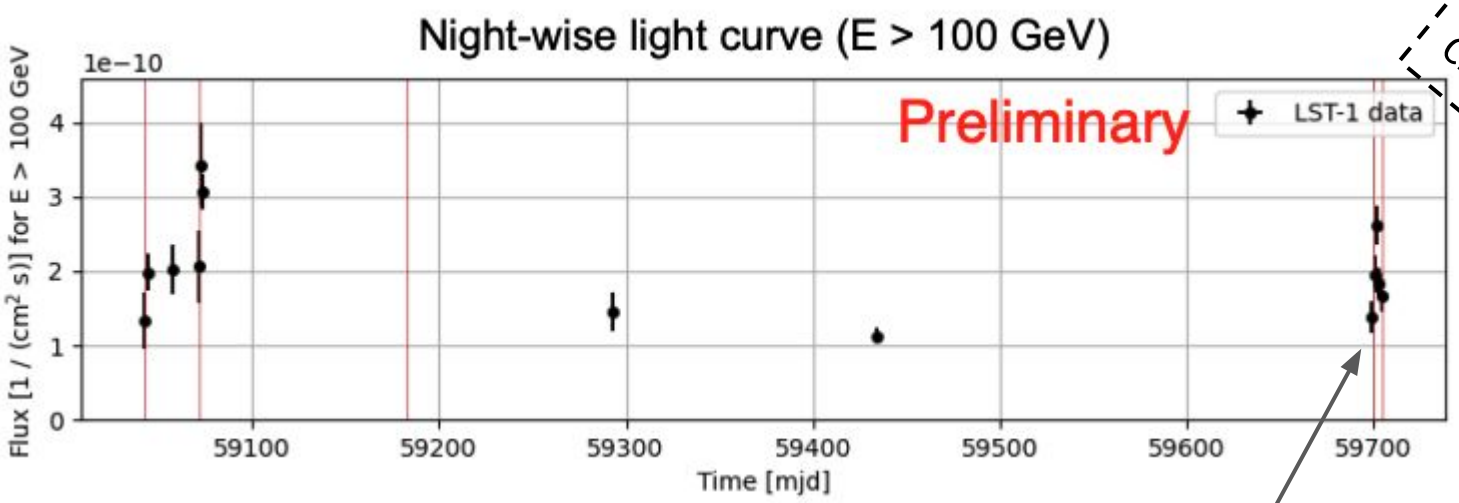
AGN 'zoo' paper: Mrk 501

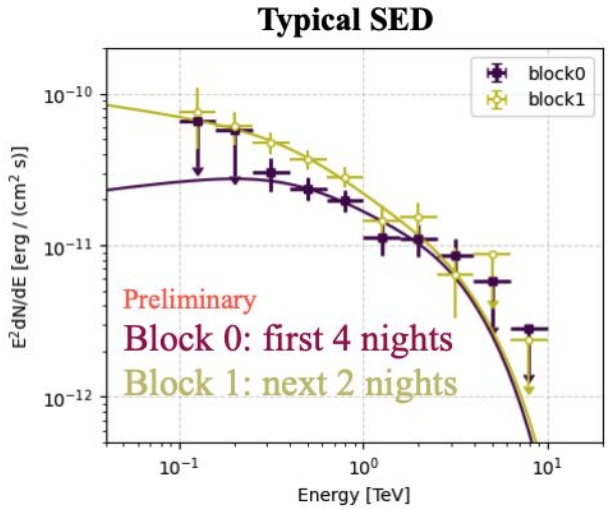


Big names
Lea H,
Chaitanya P, etc



AGN 'zoo' paper: 1ES 1959+650





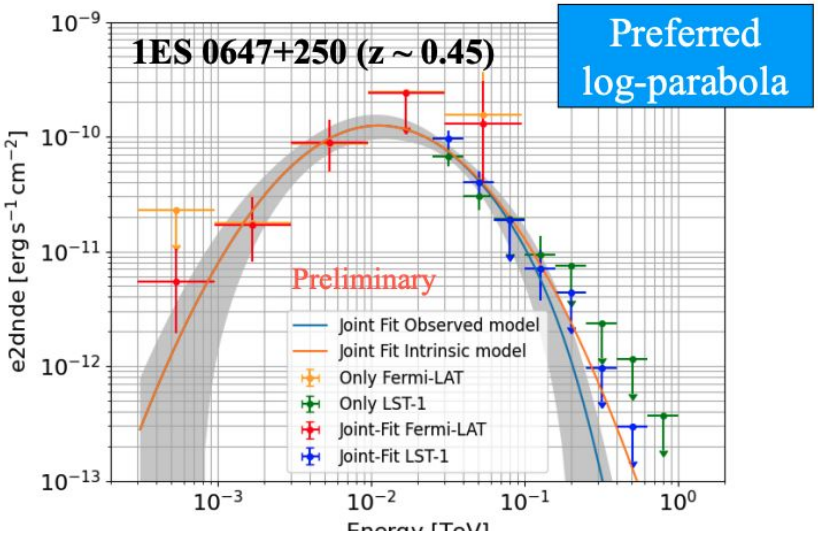
flare - night-scale variability

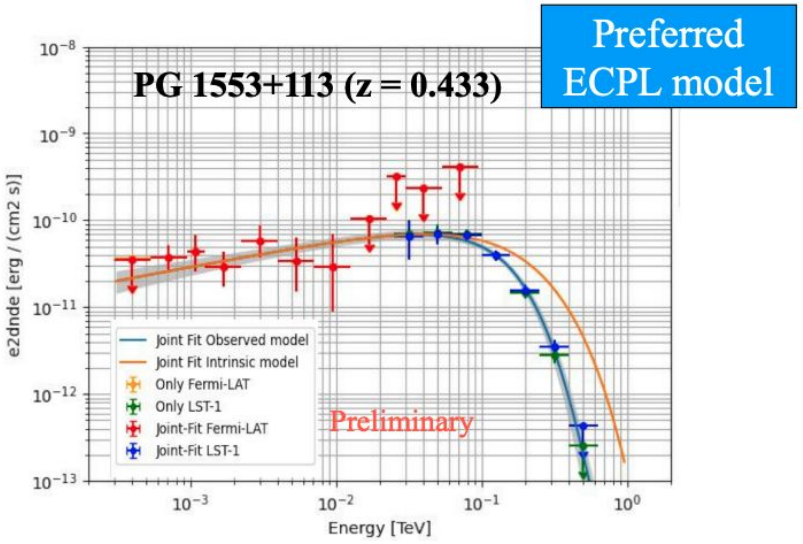
Big names
Ryuji T,
Chaitanya P, etc

AGN 'zoo' paper: *distant sources*
1ES 0647+250 & PG 1553+113

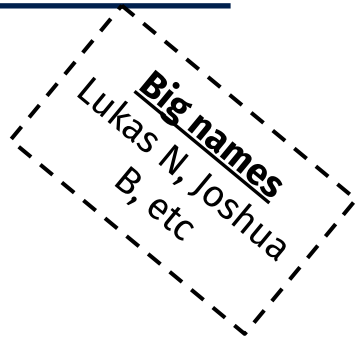
Big names
Estelle P,
Joshua B, etc

- Fermi-LAT + LST joint fits with Chaitanya's asgardpy code https://asgardpy.readthedocs.io/en/latest/
- Exposure too short (for now) to look for variability patterns & pseudo-periodicity in PG 1553+113.
- Excellent agreement with LAT, and very low threshold (first data at ~ few tens of GeV)





AGN ‘zoo’ paper: *paper plans*



- Analyses of the sources (LAT + LST): SED & LCs
- Spectral variability studies
- Fermi + LST joint analysis strongly used.
- Performance figures for LST (focused on low-energy threshold and soft sources)
- Aiming at reproducibility (all LST analyses fully cross-checked with developed robotic ‘snakemake’-based pipeline).
- Simulations of historical flares

Other results

LST-1 egal: *NGC1275*

[Previous | Next | ADS]

Detection of enhanced very-high-energy gamma-ray emission from the radio-galaxy NGC1275 with the LST-1

ATel #15819; *Juan Cortina (CIEMAT) for the CTA LST collaboration*
*on **21 Dec 2022; 22:29 UT***
Credential Certification: Juan Cortina (Juan.Cortina@ciemat.es)

Subjects: Gamma Ray, TeV, VHE, AGN, Transient

Referred to by ATel #: 15820, 15823, 15852, 15856, 15938

Tweet

The LST-1 telescope has observed an increase in the very-high-energy (VHE; >100 GeV) gamma-ray flux from the radio-galaxy NGC1275 (RA=03:19:48.1, DEC=+41:30:42, J2000.0). The LST-1 observed NGC1275 on the night of December 20 to December 21, 2022 (MJD 59934), triggered by an increase in gamma-ray flux detected by MAGIC and Fermi-LAT. In the preliminary offline analysis of the LST-1 data, NGC1275 has been detected with a significance of more than 10 sigma with an average flux of approximately 3.0 x 10^-10 cm^-2 s^-1 above 100 GeV, i.e. 70% that of the Crab Nebula, varying from

Related

15938 Slow but steady increase of brightness of NGC 1275 over the last 5 months
15856 Detection of Renewed Gamma-Ray Flare from the Radio Galaxy NGC 1275 with the MACE telescope
15852 NGC 1275: Upper limits from a neutrino search with IceCube
15823 MACE detection of very high energy gamma-ray flare from the radio galaxy NGC 1275
15820 Detection of flaring very-high-energy gamma-ray emission from NGC 1275 with the MAGIC telescopes
15819 Detection of enhanced very-high-energy gamma-ray emission from the radio-galaxy NGC1275 with the LST-1

LST-1 egal: *OP313*

[Previous | Next | ADS]

First detection of VHE gamma-ray emission from FSRQ OP 313 with LST-1

ATel #16381; *Juan Cortina (CIEMAT) for the CTAO LST collaboration*
*on **15 Dec 2023; 14:31 UT***
Credential Certification: Juan Cortina (Juan.Cortina@ciemat.es)

Subjects: Gamma Ray, >GeV, TeV, VHE, Request for Observations, AGN, Blazar, Quasar

𝕏 Post

The Large-Sized Telescope (LST-1) on La Palma has been monitoring the very distant Flat Spectrum Radio Quasar (FSRQ) OP 313 (z=0.997, Schneider et al. 2010, AJ, 139, 2360) since November 2023. Following the announcement of enhanced gamma-ray emission by Fermi-LAT (ATel #16356) and several optical facilities (ATel #16360) in early December, the Fermi-LAT emission of OP 313 has been closely monitored using the FlaapLUC pipeline (Astronomy and Computing, Volume 22, p. 9-15, 2018). This monitoring revealed the detection of renewed activity in the high-energy (HE, E>100 MeV) band and so, Target of Opportunity observations with LST-1 were triggered on December 10th 2023. OP 313 was detected by LST-1 with a preliminary offline analysis using data from 2023/12/11 to 2023/12/14. It was detected with a significance greater than 5 sigma and an integrated flux, above 100 GeV, at 15% flux of the Crab Nebula. LST-1 observations on OP 313 will continue during the next few nights and therefore multi-wavelength observations are highly

Related

16381 First detection of VHE gamma-ray emission from FSRQ OP 313 with LST-1
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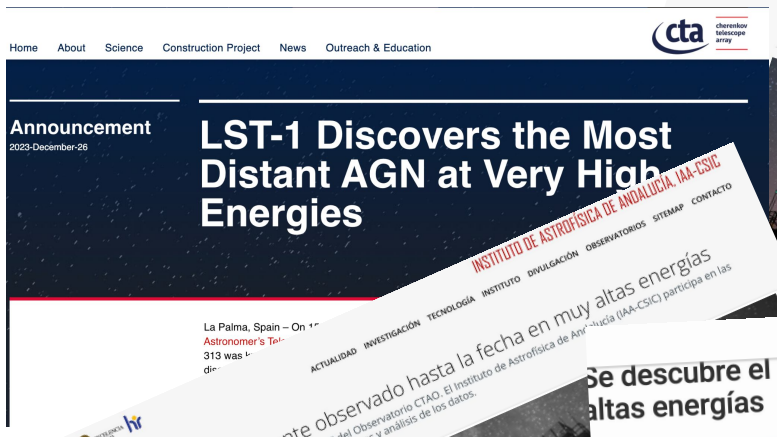
LST-1 egal: *OP313*



LST-1 during observations at CTAO-North, La Palma, Spain. (Credit: CTAO gGmbH.)

LST Mono Proposals (Cycle II)

Two types of calls offering LST time:

1- MAGIC + LST proposals (MAGIC-led, with LST offering time: LST member needs to be PI). Last call: November '23

2- LST-only proposals (Cycle II). Last call: active now.

My suggestions (take them or leave them):

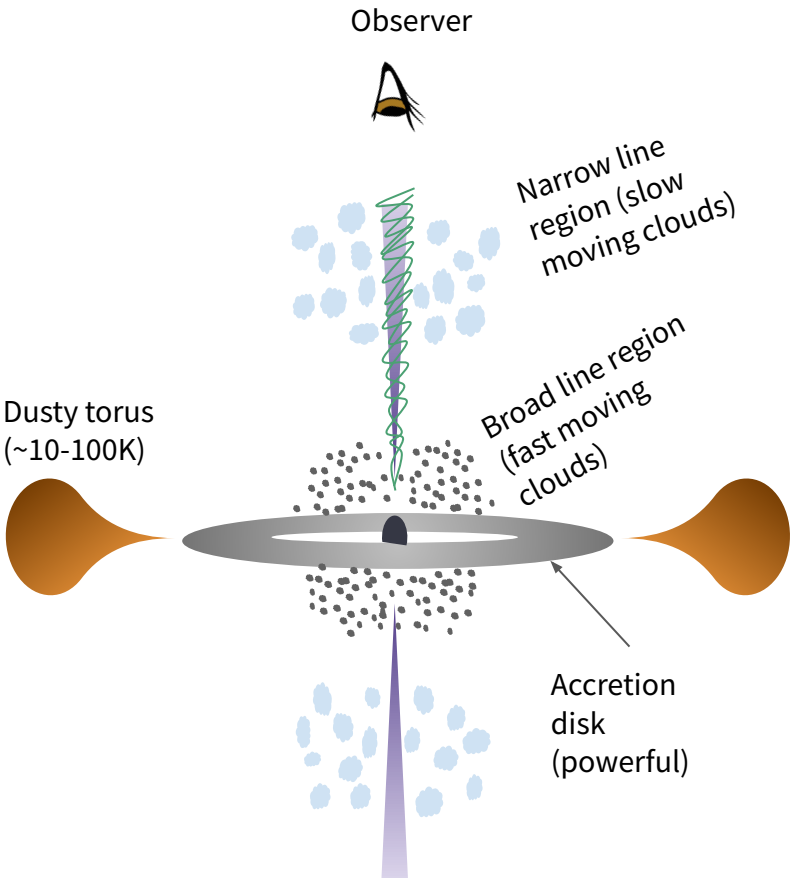
- Many egal proposals would be better off asking for MAGIC+LST time. If yours is in this box, you should have considered asking for MAGIC+LST time ;-) .

  However …
  - LST is slightly better off-axis (e.g. extended sources, but not many egal sources are extended …).
  - LST is better for the very lowest energies (<50 GeV) with very steep spectra: e.g. Geminga, OP313.

- Personal notes from last year's call: ToOs highly graded, but not too much room left for additional channels?

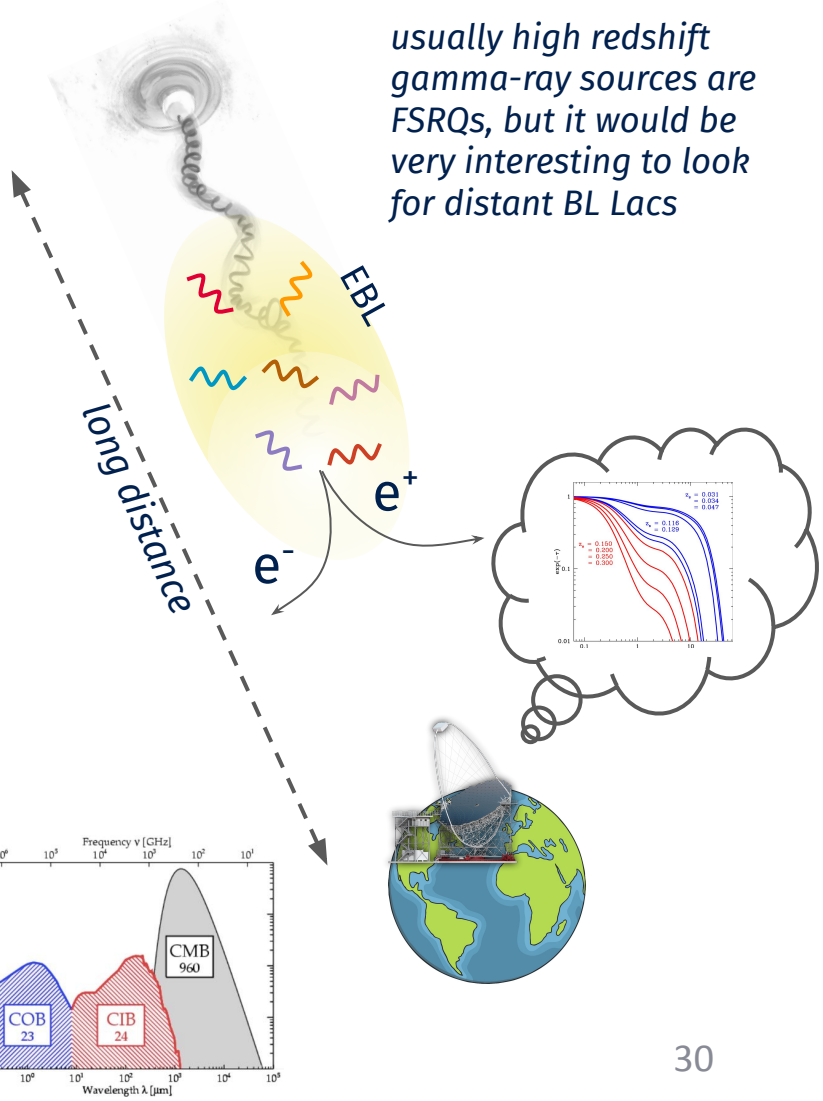
LST Mono Proposals (Cycle II)

Possible targets



High Power blazar:
Flat Spectrum Radio Quasars (FSRQs)

usually high redshift gamma-ray sources are FSRQs, but it would be very interesting to look for distant BL Lacs



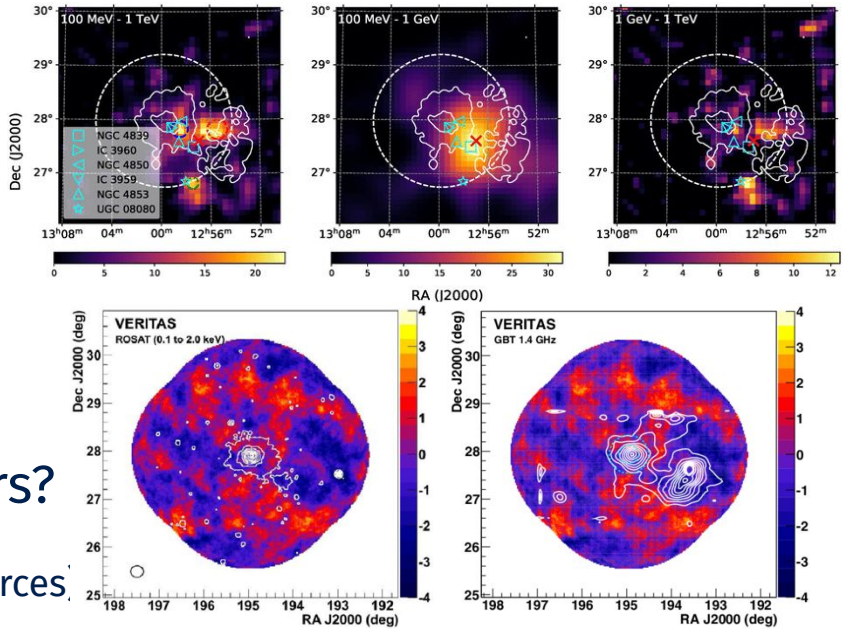
LST Mono Proposals (Cycle II)

Possible targets

Other populations with soft spectra or expected emission at very low energies:

- LBLs & IBLs (e.g. BL Lac)
- Seyferts (e.g. NGC1068, PKS 1502+036)
- Starbursts (e.g. NGC253, NGC 4945, NGC1068*)
- Radio Galaxies (e.g. NGC1275)
- Other radio sources (non-FRI)?
- M31?

Sources with alternative emission processes: secondary components, IGMF-induced cascade emission



Extended sources: e.g. galaxy clusters?

point-sources, diffuse emission, dark matter, interactions, strong lensing of potential distant sources)

LST-1 egal: conclusions

- ~ 5 years of Commissioning of LST-1
- Tons of data taken, mostly from bright sources
- Many detections from many sources already
- several papers published or in the pipeline
- Reaction to alerts (both *external*: Fermi-LAT, other IACTs and *internal / self-triggers*) very successful in the last ~ year.
- Software trigger (time tagging) with MAGIC performing well (paper published), hardware trigger being tested.
- First cycle of Mono proposals finishing, next cycle coming up. We need fresh ideas in the EGAL group. Two rounds of MAGIC+LST proposals (1st finished, 2nd in MAGIC TAC review phase).