cherenkov telescope array

CTAO | CONSORTIUM

Jan 2025: CTAO ERIC (European Research Infrastructure Consortium) established

Legal entity for construction and data distribution

A05 (gamma ray): CTAO LST status

Koji Noda (Chiba U.) for the A05 team

20 Nov 2025

Annual conference of Multi-Messenger Astrophysics

Cherenkov Telescope Array Observatory CTAO

New gamma-ray observatory with x~10 sensitivity in 20 GeV - ~10 TeV
up to ~0.3 PeV covered by 3 types of tel., all-sky coverage by N+S sites

CTAO-North: La Palma, Spain (4 LST, 9-15 MST)

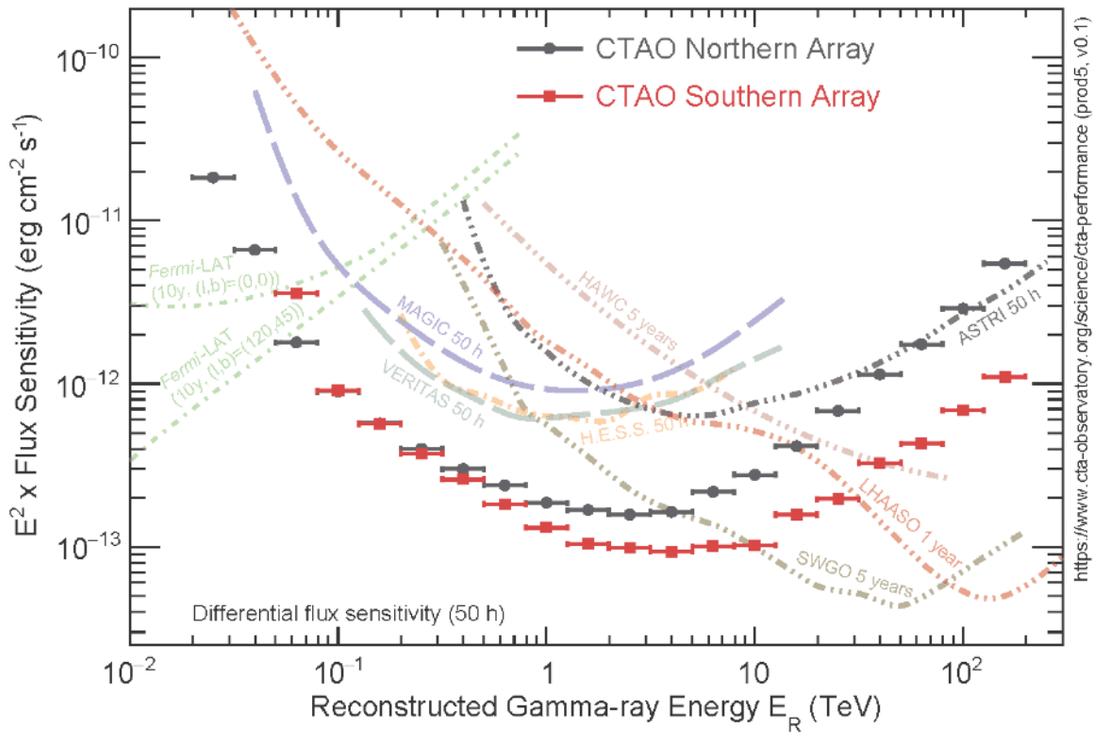
Large Sized Telescope (LST): 23 m diameter, 20 GeV - 3 TeV

CTAO-South: Paranal, Chile (0-4 LST, 14-25 MST, 37-70 SST)

2030~ full array

MST 12 m dia.
80 GeV - 50 TeV

SST 4 m dia.
1 TeV - 300 TeV
(See Akira's talk)



A05：Gamma-ray observation

- MM **scientific** observations with gamma rays
  - Follow-up observations by gamma-ray (with other MWL)
    - Neutrinos: variable gamma sources (AGN, binaries), SNe,,, **multiplet (existing and new alerts) for nearby sources**
    - GWs: Short GRBs, SNe,,,
  - Monitoring observations of (stable) "neutrino & gamma sources"
    - Seyferts (like NGC 1068), blazars,,,
  - Focusing on available/soon to be available telescopes
    => **LSTs** under construction at **CTAO-N (La Palma)**

- **Hardware** activities also focusing on **stable operation** by LSTs in La Palma, rather than new developments for future
  - Mirrors (production of spares)
  - Power system for the fast telescope repointing (maintenance)

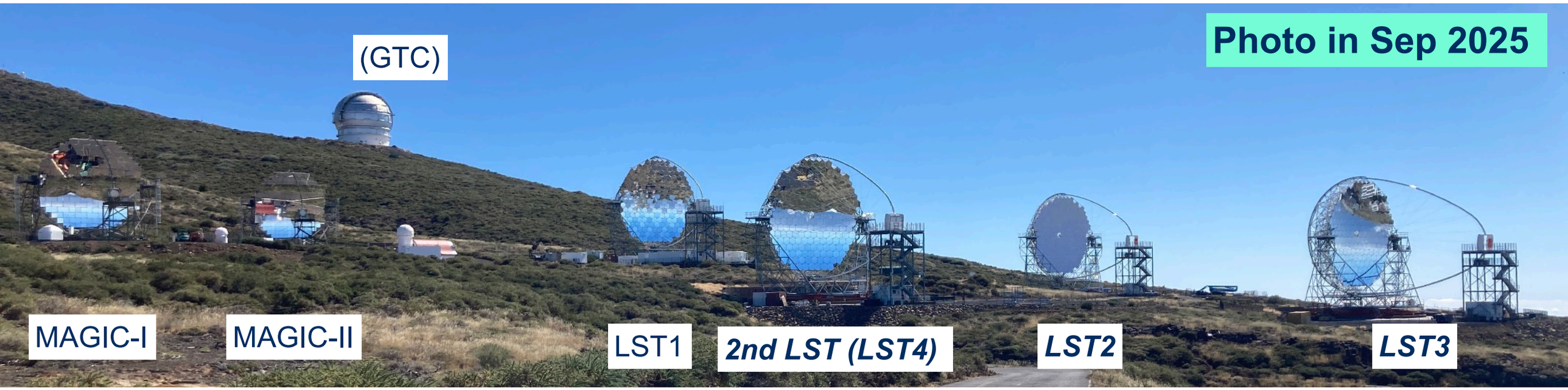
A05 contributions

- Summary (Koji Noda) this talk
  - CTAO LST status, some results by LST1
- AGN results with LST1 (Joshua Baxter, ICRR PD)
  - OP 313 & PKS 1725+123 first detections
- Microquasar prospects (Susumu Inoue, Chiba PD)
  - Theoretical aspects as a neutrino source, LHAASO PeVatron?
- PMT studies for CR physics (Masaki Hashizume, Hiroshima D2)
  - Correction for saturation induced by Direct Cherenkov from primary CRs

Abhradeep Roy (Hiroshima PD) in B01 session this time

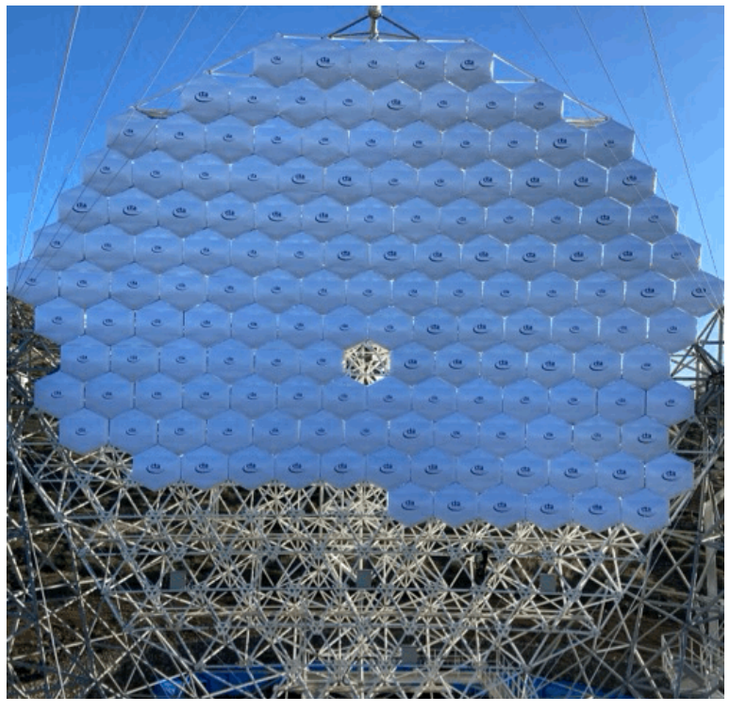
- NGC 1068 obs. with LST1 (Yi Yao, Tokai D1)
- Direct Cherenkov MC (Masakaze Mizuno, Hiroshima M1)
- Pointing systematics IRF (Toya Nagata, ICRR M1)
- 1ES 1959+650 long-term MWL (Joji Sakurai, Chiba M1)

CTAO-N LSTs are finally there!



- Construction timeline since Minakami and for coming 2026
  - Drive & Power systems all installed
  - Optics (mirrors) LST4 (Dec 2024), LST3 (May 2025), LST2 (Sep 2025)
  - Camera LST4 (May 2025), LST3&2 (Spring 2026)
- Commissioning timeline
  - **LST4: Drive now. Others spring-summer 2026. Stereo still in 2026?**
  - LST3&2: Optics FY2026, Others in 2027

A05 activities for LST Optics



Mirrors during the installation
(~20 min x 198) Youtube

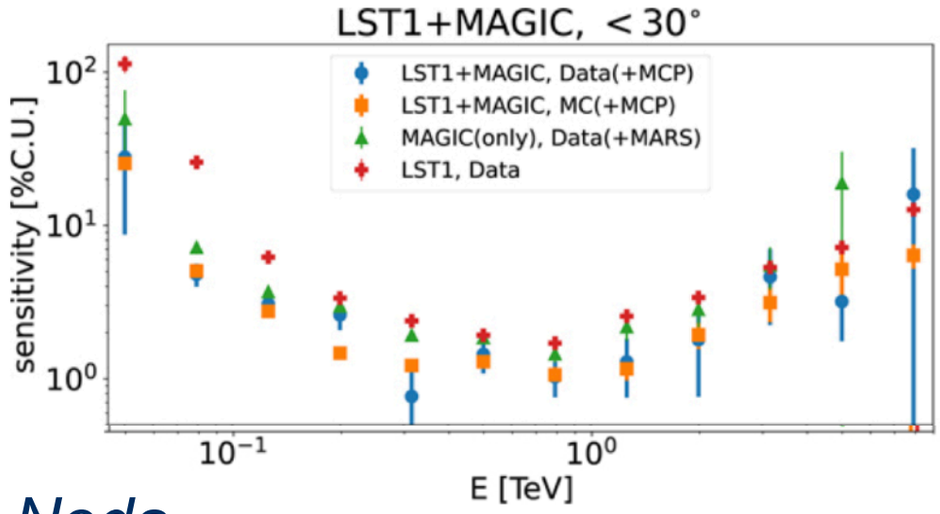
Masaki and company workers
in front of the final mirror installed

- Mirror & cable installation x 3 was a big task
  - ~10 from DE & CZ, ~4 shifters (2-3 weeks), 3-4 hired (local company)
    - 7/~12 shifters from Japan (Masaki x2, Tomura (ICRR eng.) x2, Koji x3)
  - 1 telescope typically 6-7 weeks
  - Spare mirror preparation in the sea-level storage
- Power system maintenance (Koji + Tomura)

LST1(/MAGIC) obs. cycles

- LST1 proposal Cycles
  - From this Cycle 3 (Mar 2025 - Mar 2026), merged with MAGIC (Cycle 20), managed by single Time Allocation Committee (TAC)
  - Continue it for **C4/C21 from Mar 2026**
    - Proposal deadline: 23 Jan 2026
      - *TAC members from A05: S. Inoue and K. Noda*

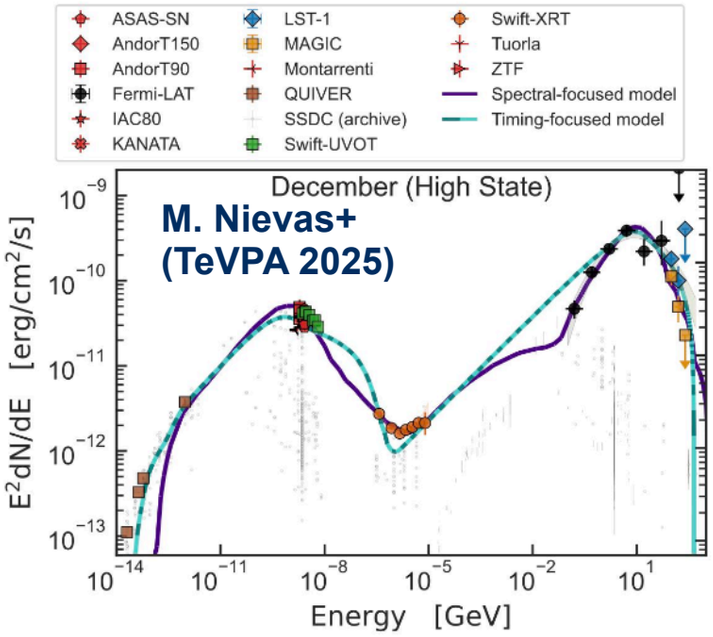
"LST1+MAGIC Performance paper"
A&A **680**, A66 (2023)

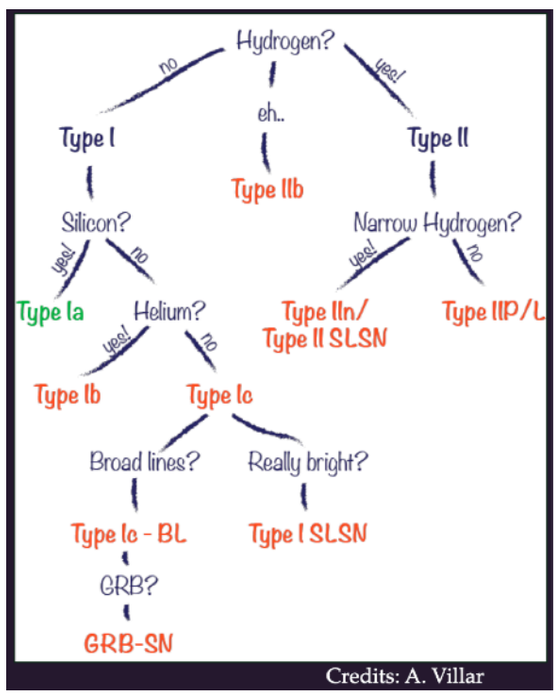


- In C3 ~1000 hr dark + 400 hr moon available, ~2800 hr requested
  - 1700 hr requested for LST+MAGIC joint (All likes more sensitive obs. :))
  - 700 hr requested for ToO: Transients highly ranked due to the sensitivity lower than full CTA. **ToO (related) proposals can be approved easily**
- **Probably C4 will be similar**
  - Not sure about C5 from Apr 2027. LST1+4 stereo will be surely discussed but maybe only for technical and privileged observations. Let's see...

Results 2025

- BOAT GRB: published (Jul 2025)
  - Press Release (CTAO and ICRR/Chiba/Kyoto)
- Bright blazars **BL Lacs**: reported, published (Oct 2025)
- OP313 **FSRQ** (TeVPA 2025): under review
  - The most distant quasar (z=0.997) detected by IACTs
- PKS 1725 **FSRQ** detection (ATel, Aug 2025) z=0.586
- RS Oph **nova**: reported, published (Mar 2025)
  - T CrB not yet coming...
- Geminga **pulsar**: reported, published (Jun 2025)
- SN 2024bch **supernova** IIn-L: new, published (Oct 2025)
- SGR 1935 (Gamma 2024) **magnetar**: new, accepted
- GW follow up (TeVPA) **BBH**: new, internal review



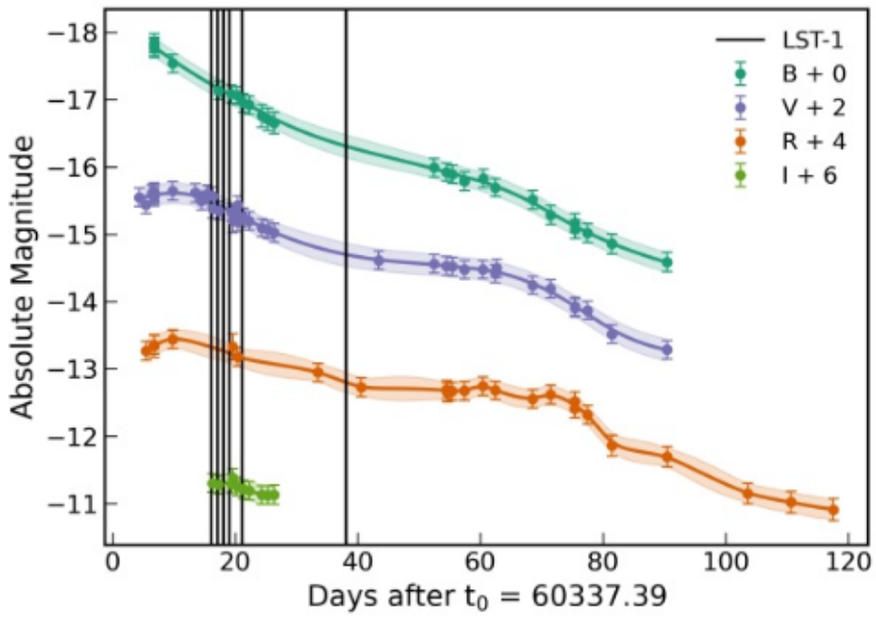


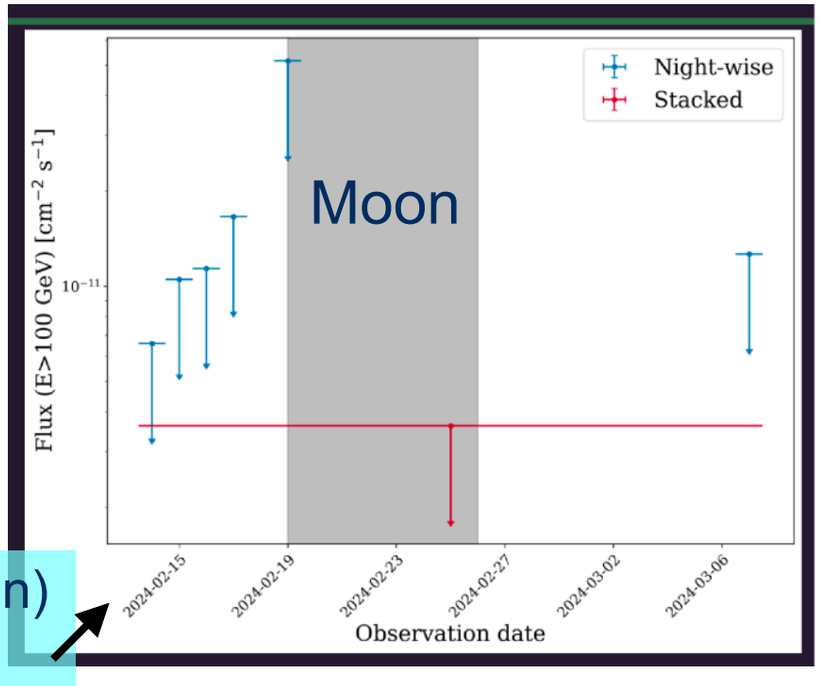
Covering several source types

Interacting SN 2024bch

From A. Simongini + (TeVPA 2025) and paper

IIn-L SN at 20 Mpc, on 29 Jan 2024
ToO triggered 2 weeks after T0





T0 (29 Jan)
+20 days

THE CASE OF SN 2024BCH

- We constrain $\rho_{CSM} \leq 10^{-4} \frac{M_\odot}{yr} \frac{s}{km}$ indicating a low density CSM.
- The photospheric evolution suggests that at the bulk of LST-1 observations (T0+20 days), the gamma-gamma attenuation could have had a minimum impact.
- From optical analysis we constrained progenitor's properties: combining optical + VHE results we conclude that the progenitor was a Red Super Giant.

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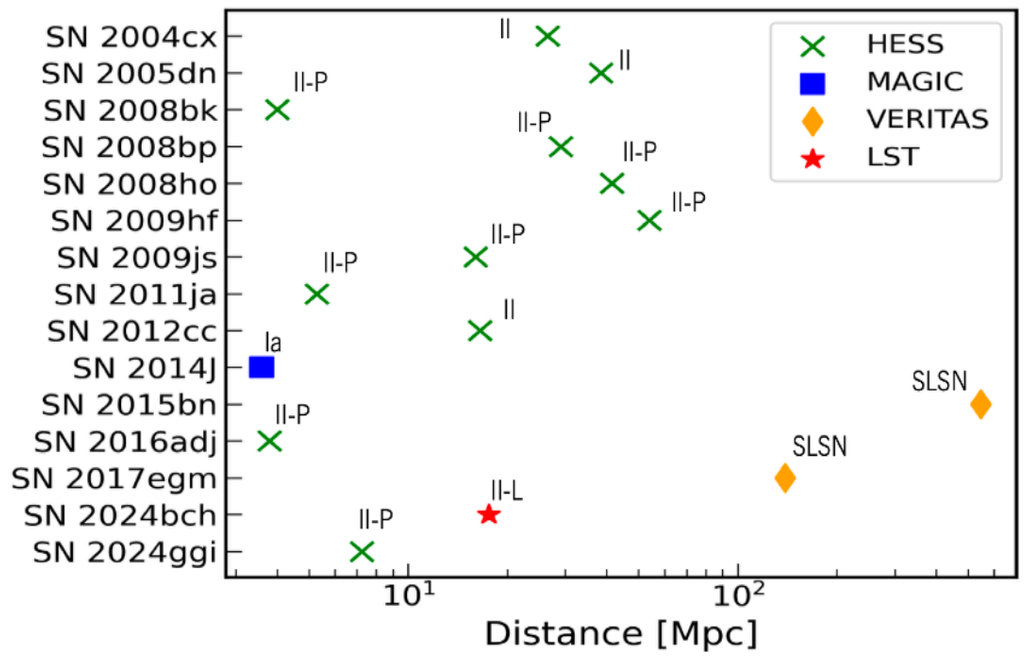
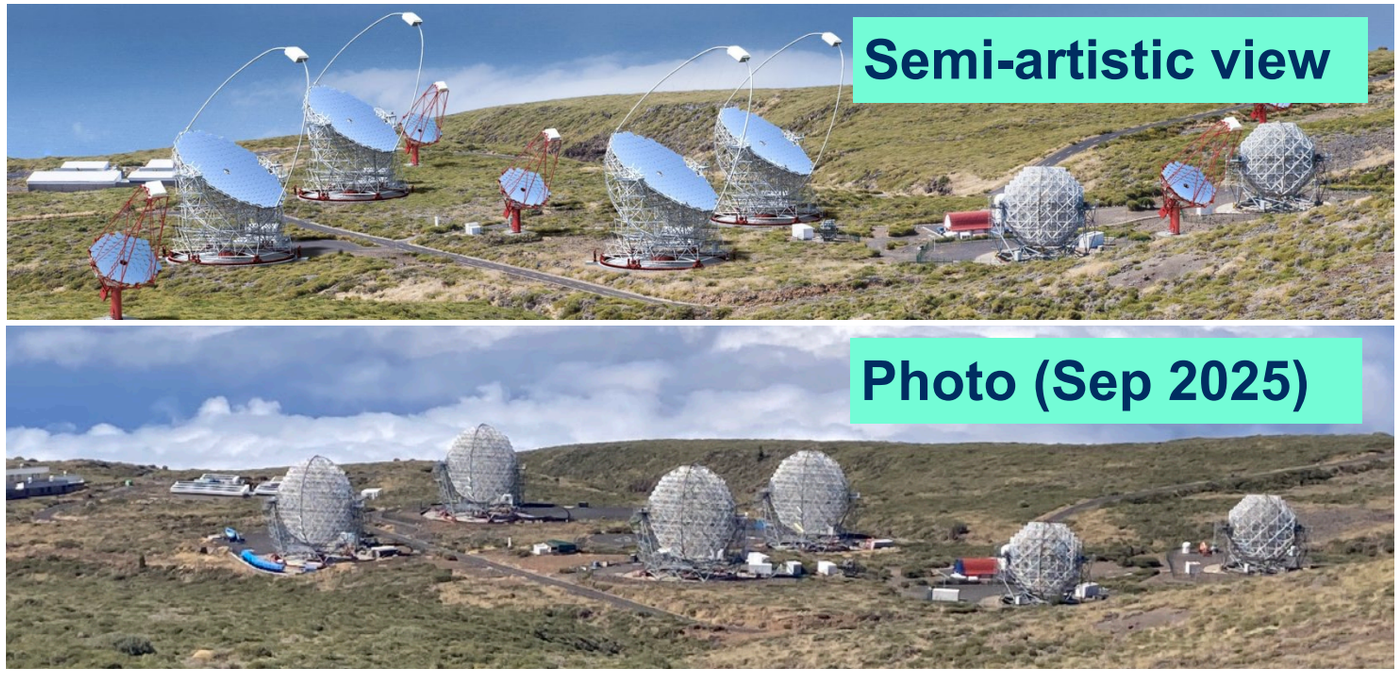
LST Collaboration, A&A, 2025 "Constraining the TeV gamma-ray emission of SN 2024bch, a possible type IIn-L from a red supergiant progenitor"



LST1/MAGIC Proposal already including Japan MWL researchers

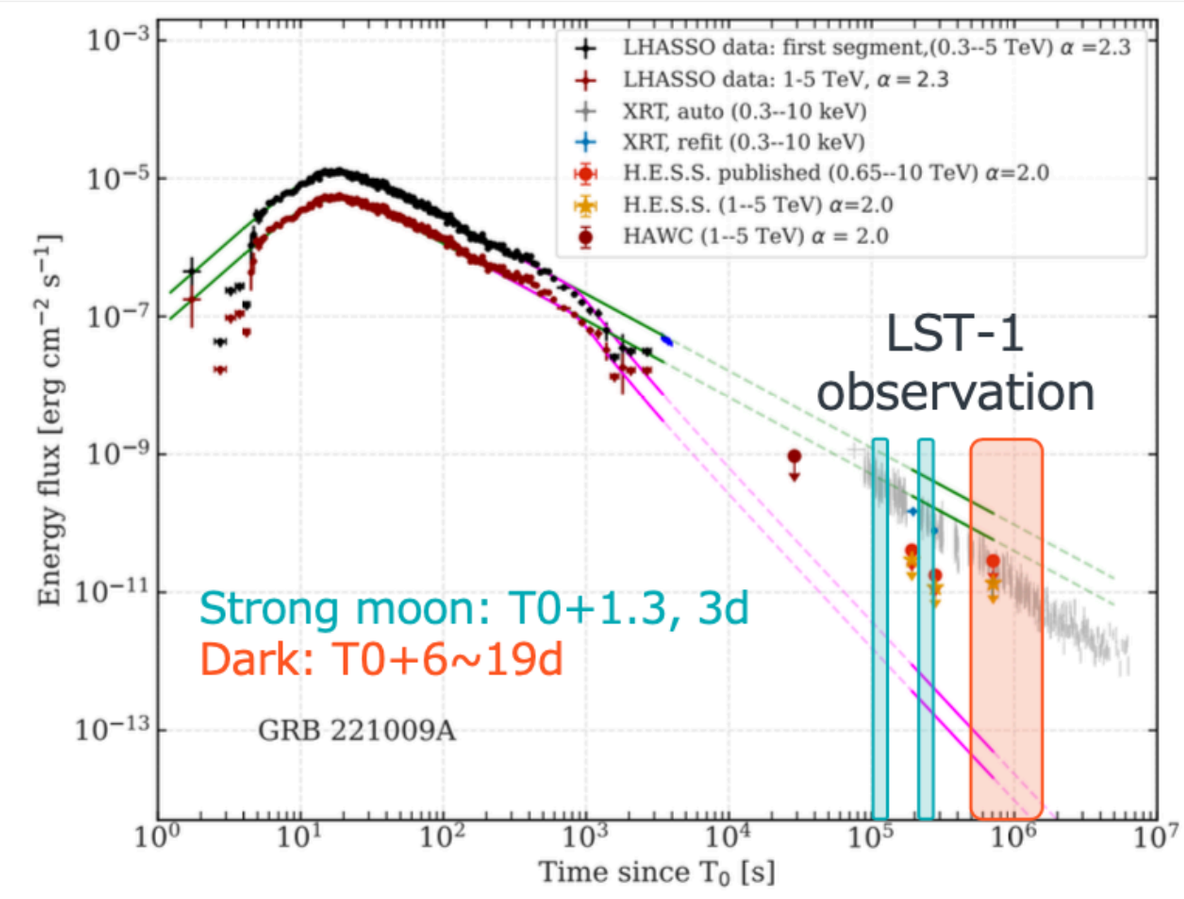
Summary & outlook

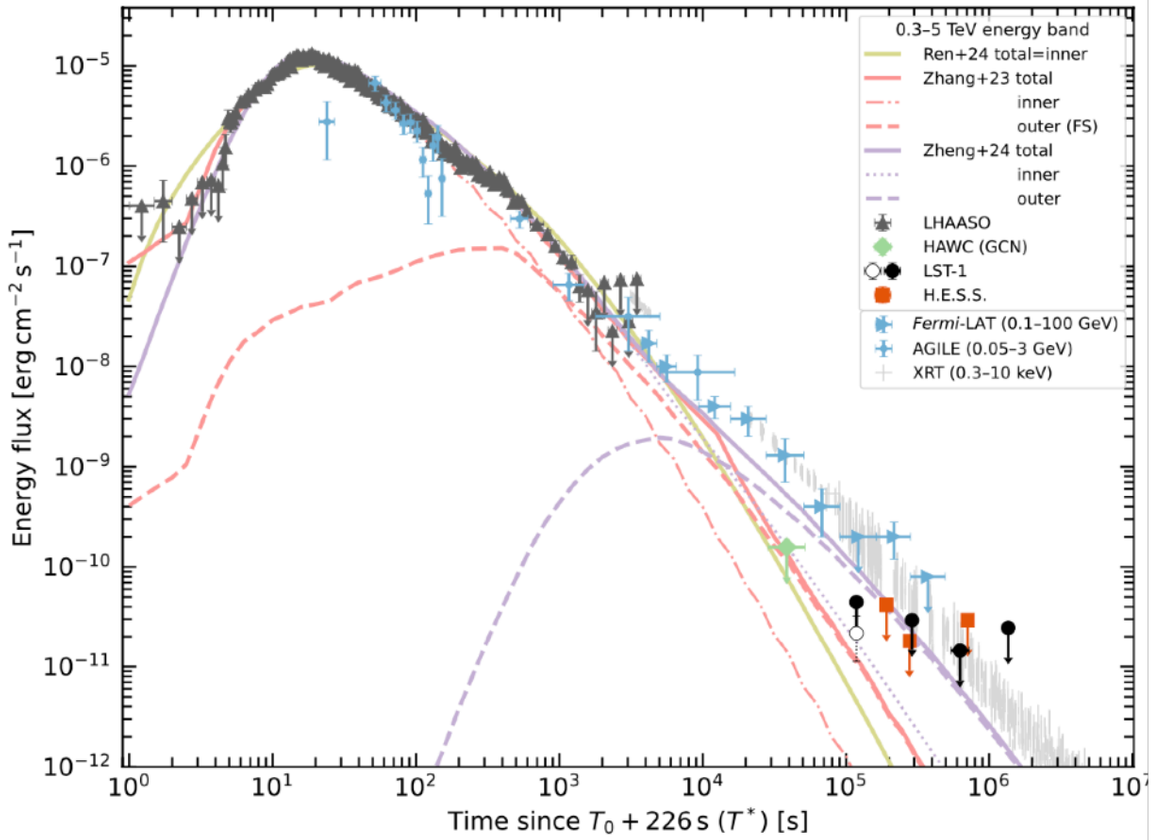
- A05 gamma-ray observation, focusing on science with (soon-to-be-)operating telescopes
- 4 LSTs in CTAO-North have been finally constructed, stereo (multiple telescopes obs.) to be commissioned in 2026
- LST1 (with MAGIC) already giving physics results
  - GRB, blazars (BL Lac, FSRQ), pulsar, nova, supernovae,,,
  - Please join us with your proposals!
- Results to come
  - More GRBs (~30 observed)
  - Another nova T CrB?
  - **More MM sources**
    Easier neutrino follow up, once multiplet alerts ready
  - **Stereo (2 tel) observation**



GRB 221009A (z=0.15)

- BOAT＝Brightest Of All Time
- LHAASO detected ~10 TeV γ
  can constain the structured jet model
  together with other TeV observations
- LST1 started obs. 1.3 day after,
  under strong moon light (Eth ~ a few hundreds GeV), detected **~4σ 'hint'**
- 1~3w later without moon light (Eth <100 GeV) , upper limit on flux
- Light curve (Energy flux)
  - Confirmed limits by HAWC and excluded models
  - Outer / inner of jet still survived
- Published, press release
- Need to continue similar obs.





SGR 1935+2154 (from G. Panebianco+, Gamma 2024)

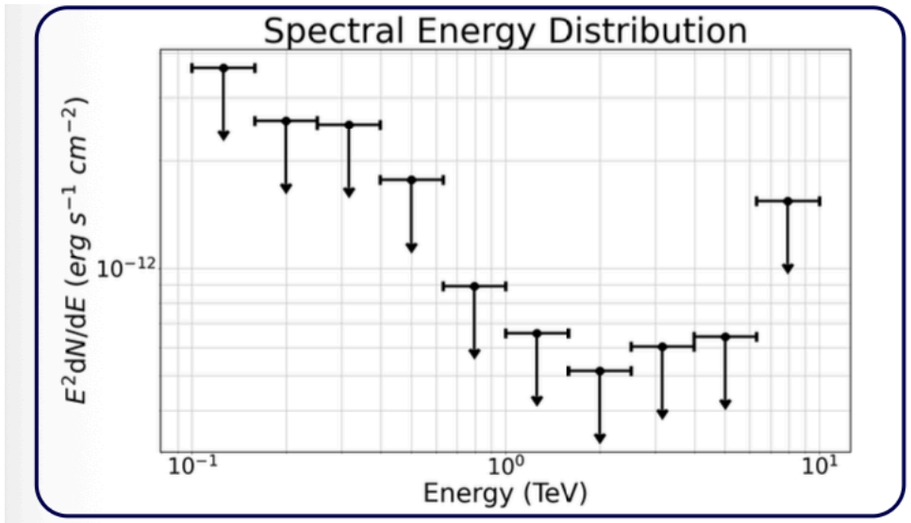


Fig. 1: Upper limits on the SED of the persistent emission of SGR 1935+2154 (≈25h observations).

2 - OBSERVATIONS

LST-1 performed ≈38h of observations on SGR 1935+2154 in 2021 and 2022, usually during periods of known keV-MeV activity, reported in Science Alerts (GCNs, ATels) by high-energy satellites.

LST-1 observed the source simultaneously to the **Time of Alert** (ToA) of 9 bursts that triggered high-energy satellites (Fermi-GBM, NICER, Konus-Wind, GECAM).

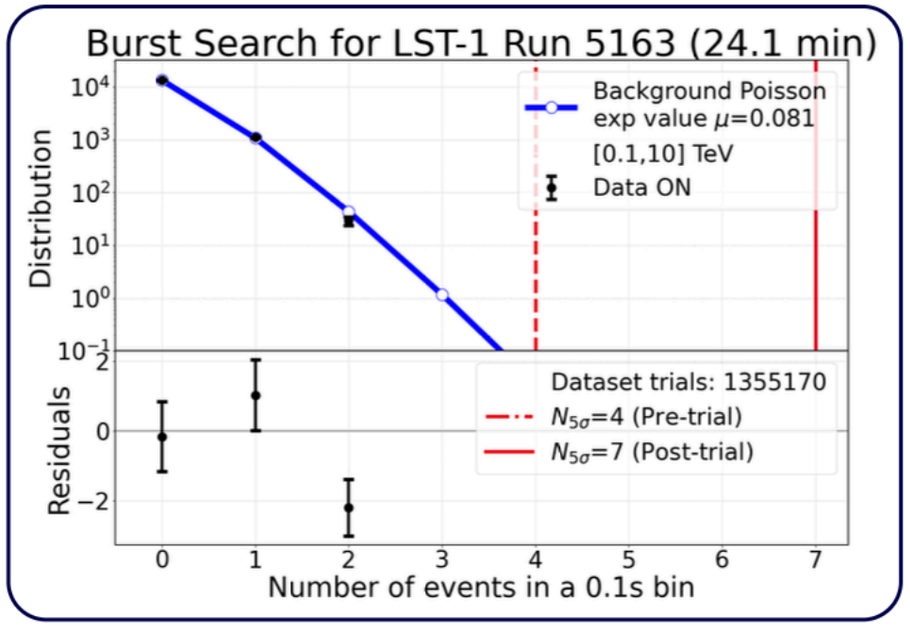


Fig. 3: Search for non-simultaneous bursts on a run. Data agree with a background distribution.

SUMMARY

LST-1 observed SGR 1935+2154 during periods of high activity in 2021 and 2022. Data analysis does not show any significant detection of signal from the source. We constrain both the persistent and, for the first time with LST-1, the transient very high-energy emission simultaneous to its keV-MeV bursts.

BBH (From J. Jimenez+, TeVPA 2025)

The BBH Merger Candidates

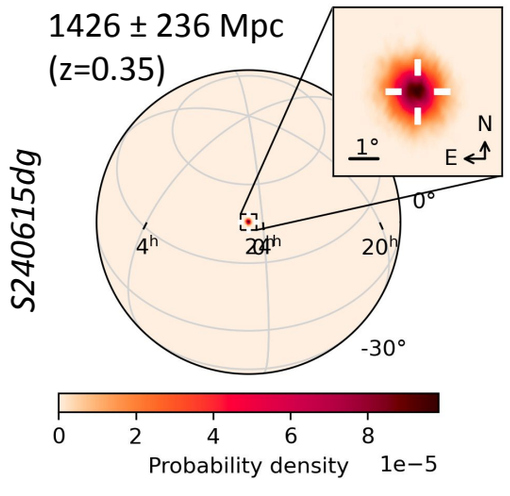
- Both classified as **Binary Black Holes** (BBHs)

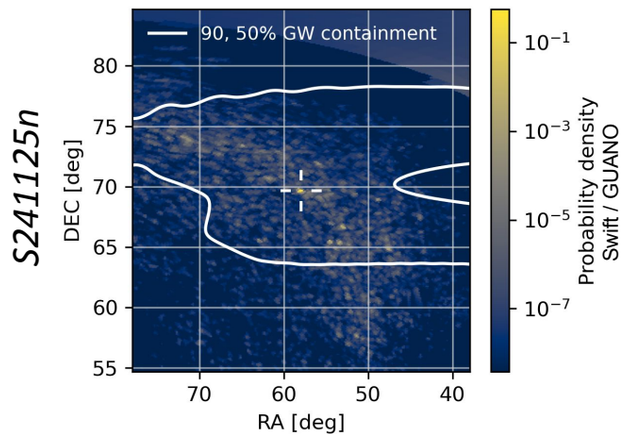
S240615dg [GCN, GraceDB]

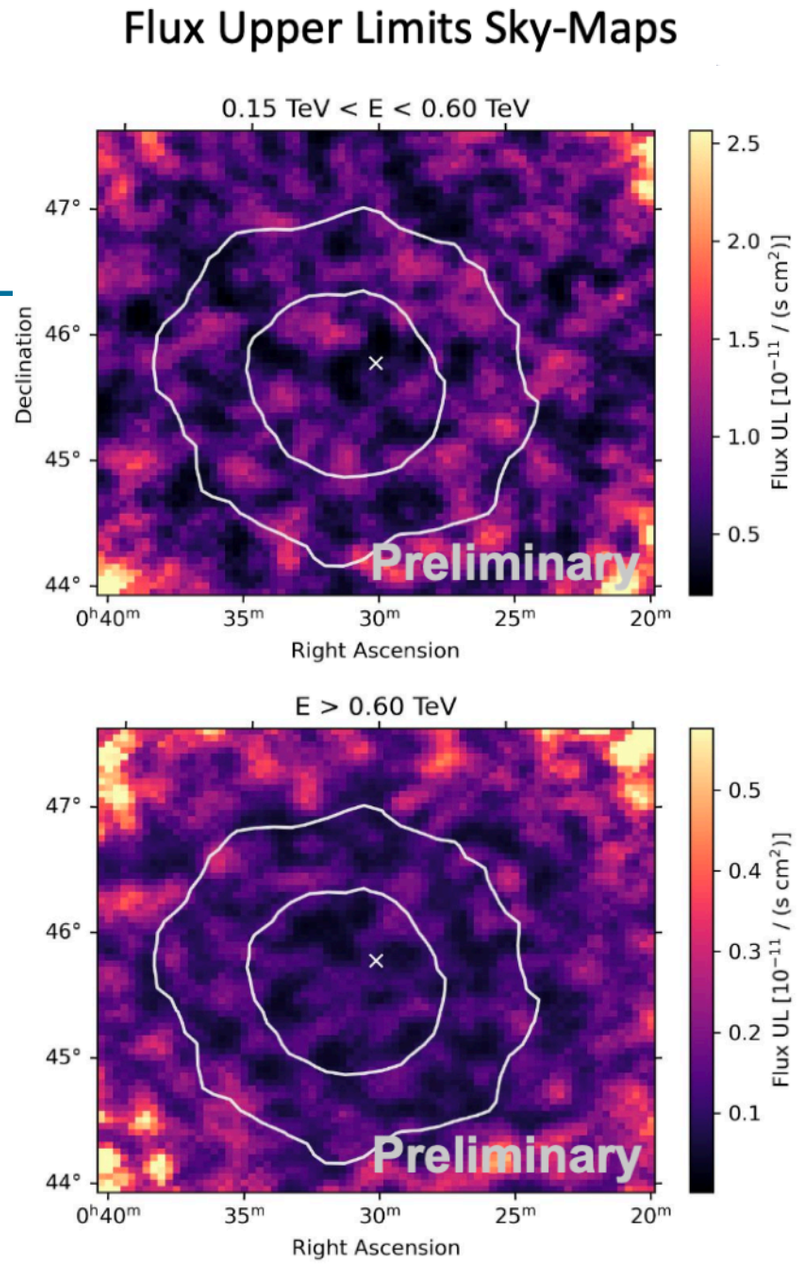
- **Best localized GW up to now** (90% area is ~5 deg²).
  - Could be covered by one MAGIC / LST pointing (No tiling).
  - No detection in the EM by any other instrument.
- Estimated chirp mass of the events: M ~ 140 M⊙.

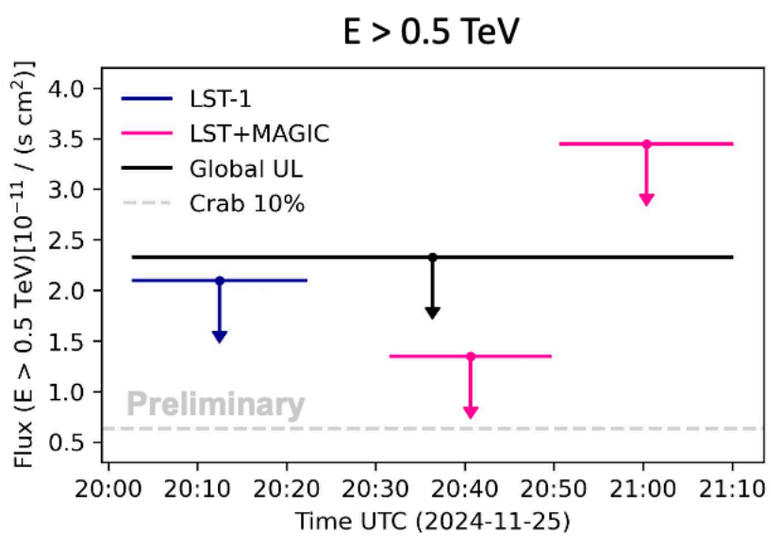
S241125n [GCN, GraceDB]

- **Swift/GUANO potential counterpart** (T - T₀ = 11 s).
  - Sub-threshold detection.
  - Spatial coincidence rate 1 / 12 yrs.
  - No known redshift.
- No other detection for other instruments. Many observed it.
- Estimated chirp mass: M ~ 115 M⊙.









- Physical Interpretation:
  - Non-detections consistent with current *Super-Eddington accretion* and *BZ jet* models (Tagawa et al. 2023).
  - No compelling evidence of AGN association, but **compatible with merger occurring in AGN disk.**