

Cherenkov Telescope Array Observatory (CTAO) 計画248：全体報告

LST-1

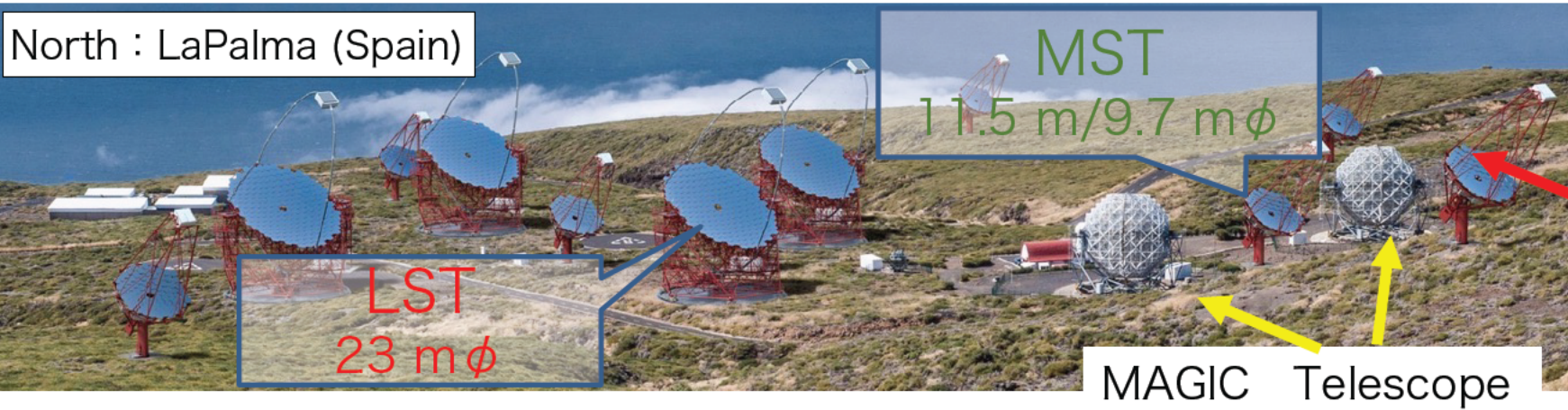
LST-4

LST-2

LST-3

齋藤隆之、窪秀利、手嶋政廣、戸谷友則、野崎誠也、吉越
貴紀(東京大)、野田浩司(千葉大)、吉田龍生(茨城大)、井岡
邦仁(京都大)、田島宏康(名古屋大)、山本常夏(甲南大)
他CTA Consortium

North : LaPalma (Spain)



LST
23 m ϕ

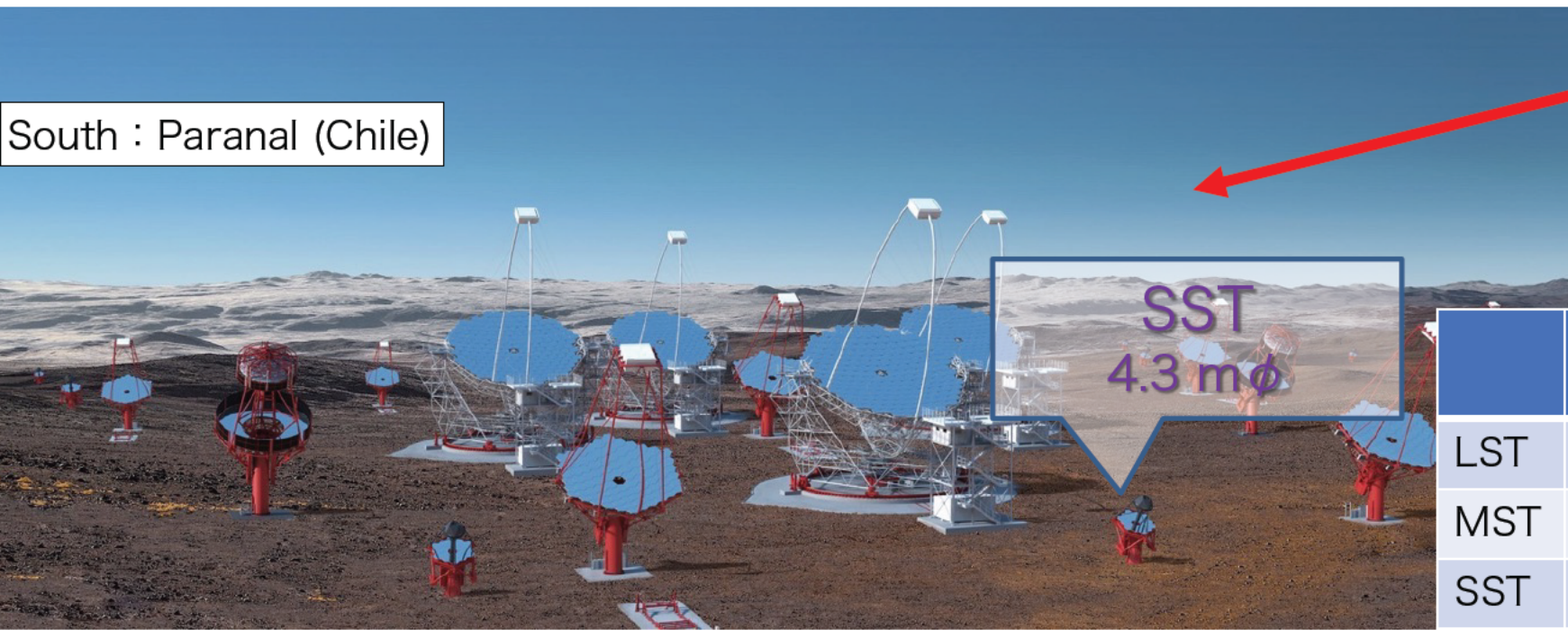
MST
11.5 m/9.7 m ϕ

MAGIC Telescope

North **Array Coordinates** 0.5 km x 0.5 km
 Latitude: 28° 45' 43.7904" North
 Longitude: 17° 53' 31.218" West



South : Paranal (Chile)

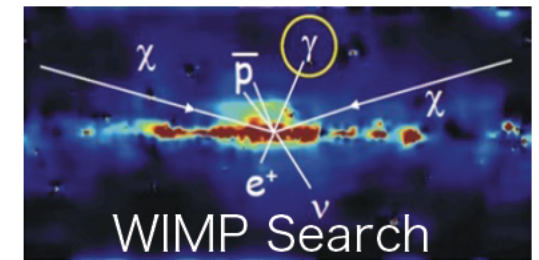
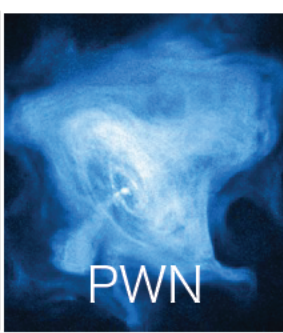
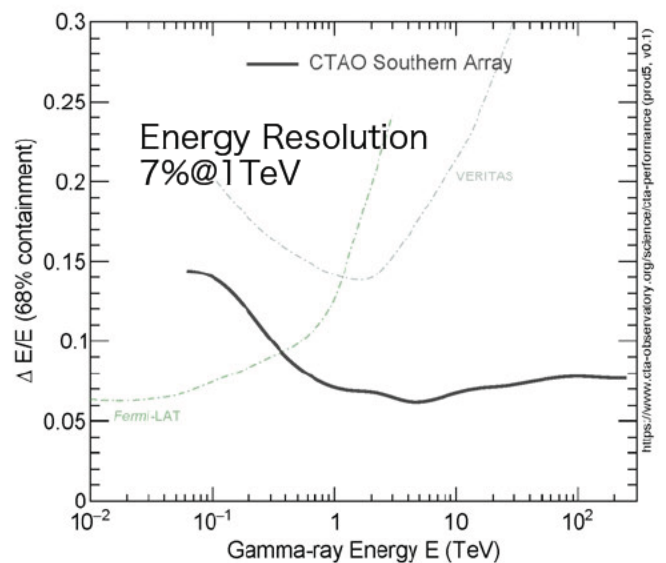
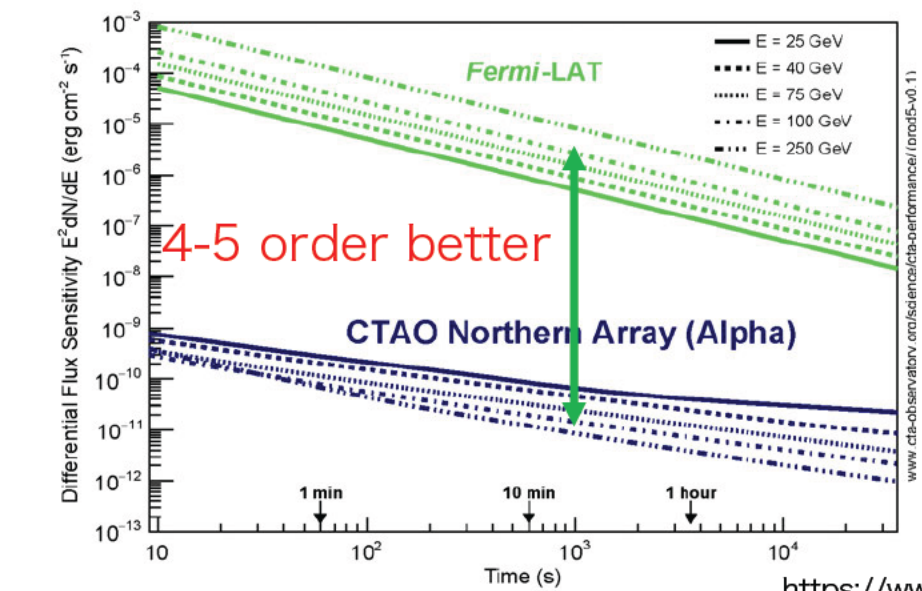
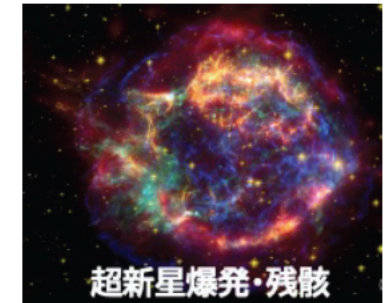
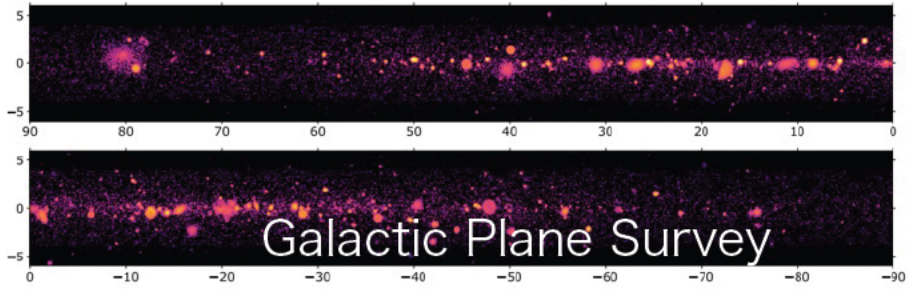
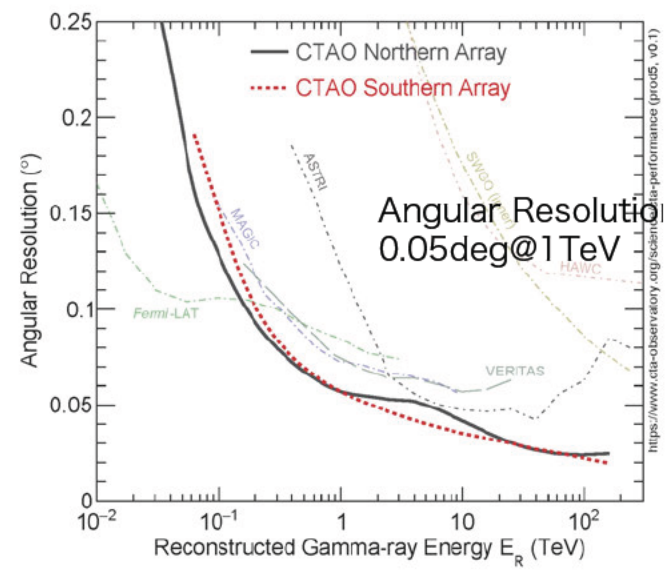
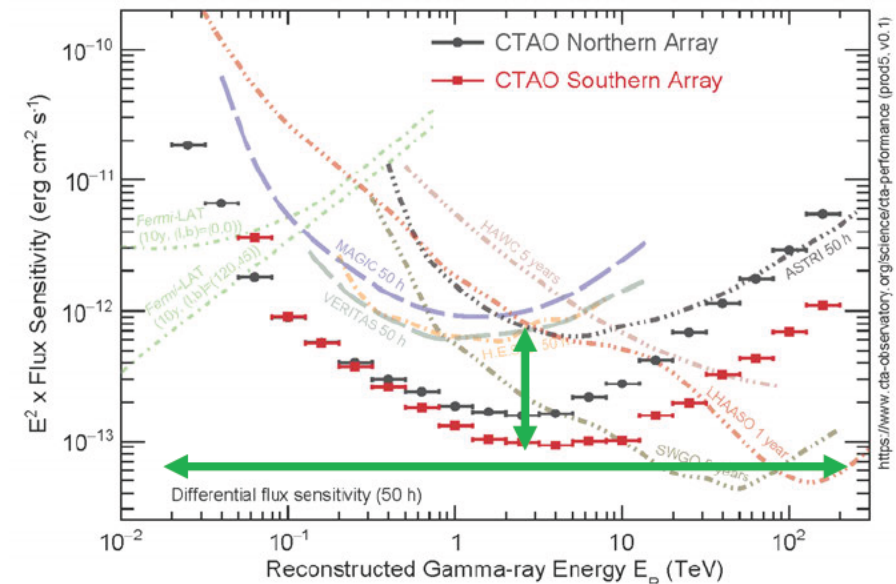


SST
4.3 m ϕ

South **Array Coordinates** 2 km x 2 km
 Latitude: 24° 41' 0.34" South
 Longitude: 70° 18' 58.84" West

	#tel (N)	#tel (S)	Energy [TeV]	FoV [deg]
LST	4	2→4	0.02 - 3	4.5
MST	9→15	14→25	0.08 - 50	7.5
SST	0	42→70	1 - 300	10.5

"Alpha" Configuration Operation starts in ~2030.



25か国
>1500名



CTA-Japan 128名

青山大	大林花織, 田中周太, 山崎了, 吉田篤正	東大宇宙線研	浅野勝晃, 阿部正太郎, 粟井恭輔, 糸川拓海, 猪目祐介, 大石理子, 大岡秀行, 大谷恵生, 窪秀利, 齋藤隆之, 武石隆治, 辻直美, 手嶋政廣, 戸村友宣, 永田柊弥, 野崎誠也, バクスター ジョシュア 稜, 橋山和明, 森田開, 吉越貴紀, Y. Chai, R. Grau Haro, D. Hadasch, D. Mazin, M. Strzys, I. Vovk, P. K. H. Yeung 共同研究員: 岡知彦, 櫻井駿介, 広谷幸一, 深見哲志, 村瀬孔大, K. S. Cheng, X. Cui, T. Dzhatdov, D. C. Y. Hui, A. K. Kong, P. Majumdar, J. Takata, T. P. H. Tam, W. Tian, L. Wan
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大阪大	井上芳幸, 藤原立樹, 松本浩典		
神奈川大	西嶋恭司		
北里大	村石浩		
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東海大	阿部和希, 飯沼慶介, 海老優希菜, 櫛田淳子, 佐藤雄輝, 姚屹	立教大	内山泰伸, 澤田真理, 林田将明
東大理	大平豊, 戸谷友則, 馬場彩	早稲田大	片岡淳
東京都立大	川中宣太, 藤田裕		

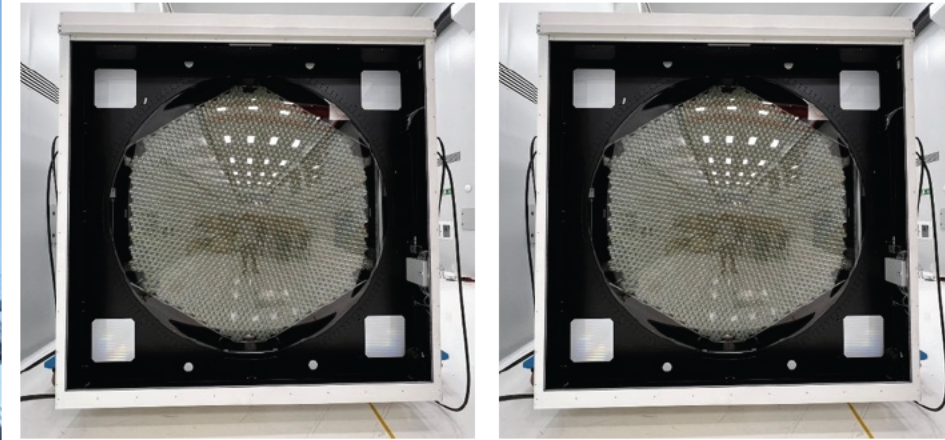
LST-1

Operational
Since 2020

LST-3

LST-2

LST-4



Camera 2 & 3 @Tenerife

Schedule

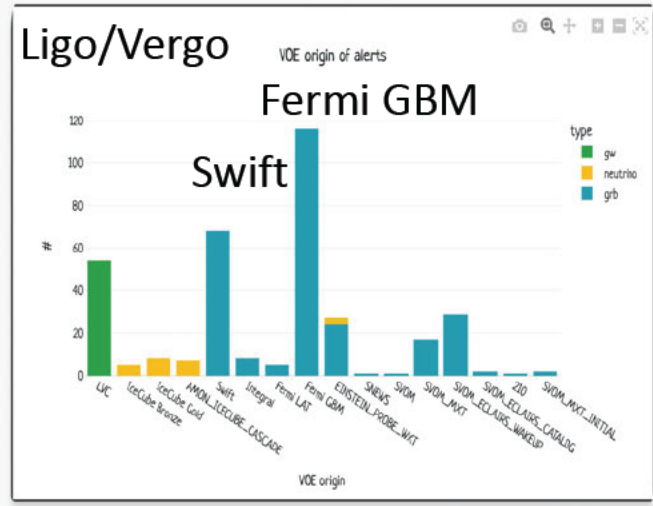
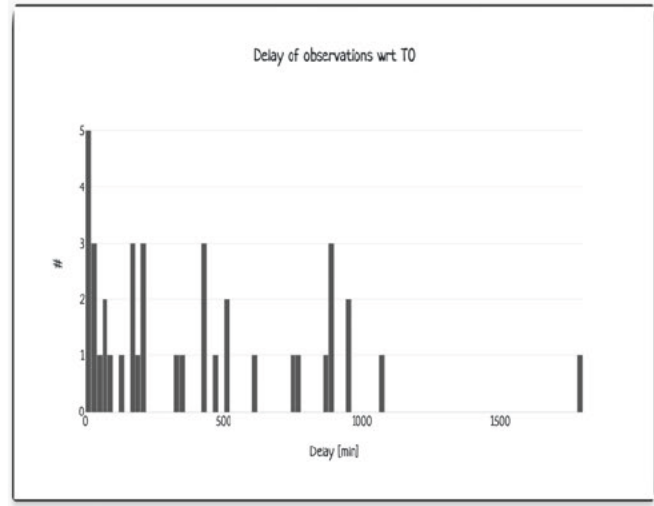
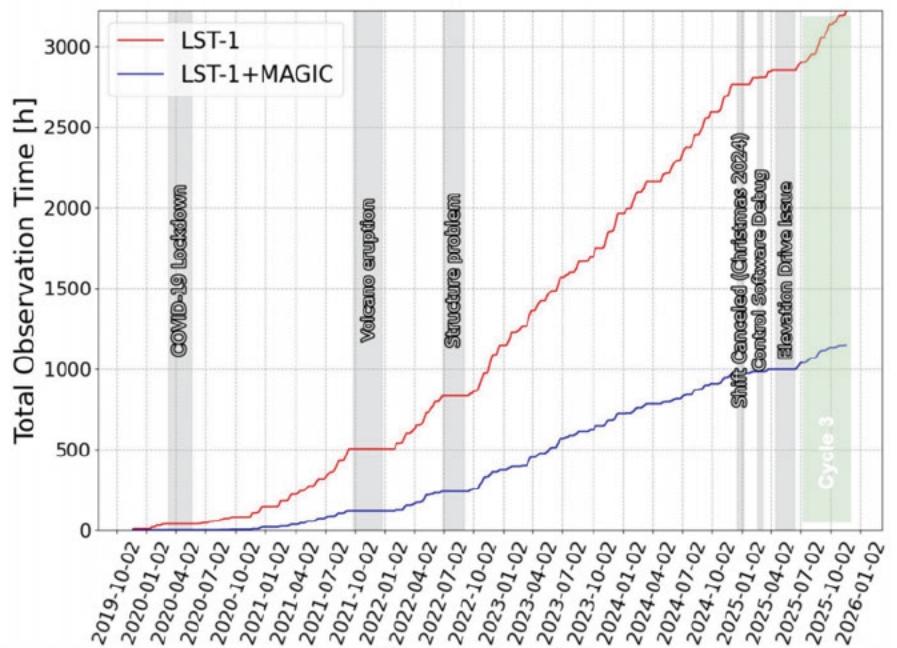
	Arch	Mirror	Camera
LST1	operational		
LST2	25/6 done	25/8 done	26/06
LST3	24/1 done	25/5 done	26/03 -> 26/05
LST4	24/8 done	24/12 done	25/5 done



LST Transient Statistics After Dec.2023

Total	GRBs	GWs	Neutrinos
351 # total alerts	274 # total alerts	54 # total alerts	20 # total alerts
42 # observed alerts	38 # observed alerts	2 # observed alerts	1 # observed alerts
80.5h observed	72.7h observed	3.3h observed	1.4h observed

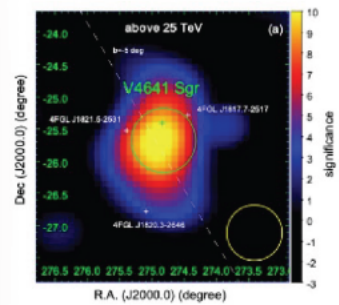
- More than 3200 hours since 2020
 - 30-40% of the time with MAGIC-Joint



- Automatic Reaction on alerts
- No detection so far

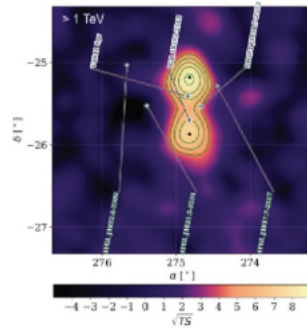
Monoscopic scientific observation continues for ~several months more.

LHAASO



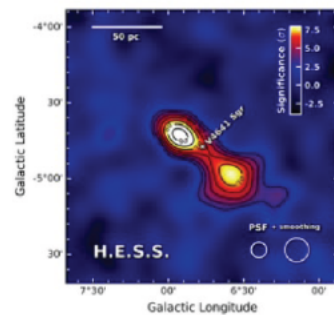
LHAASO collaboration 2024

HAWC



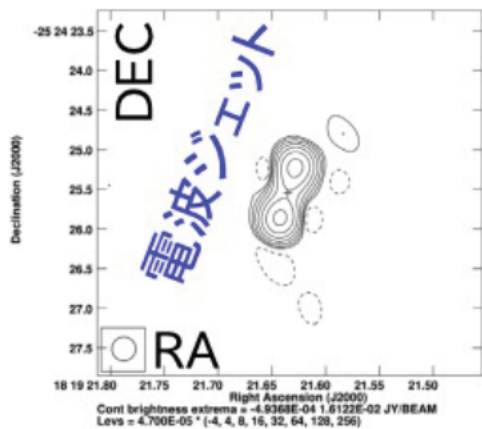
HAWC collaboration 2024

HESS



HESS collaboration 2025

LST-1 16.23 hours



Marti & Luque-Escamilla 2025

Galactic Latitude



Galactic Longitude

- One of the LHAASO microquasars
 - BH ($7M_{\odot}$) + B subgiant ($3M_{\odot}$)
 - Radio Jets observed
- TeV detected by LHAASO, HAWC, HESS.
 - 1-800 TeV
 - Axis possibly aligned with the gamma-ray morphology
 - No dense gas in the emission region ($n < 0.2$ /cc)
 - No bright X-ray emission tracing the gamma-ray morphology
- Detailed morphology & spectrum study are needed to understand the emission mechanism.

LST1で検出

(>5 sigma)

今後データ追加
で詳細研究

ICRR 森田、阿部、辻

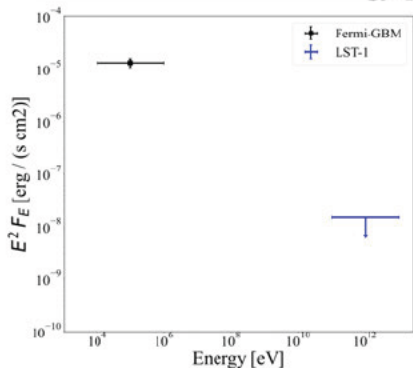
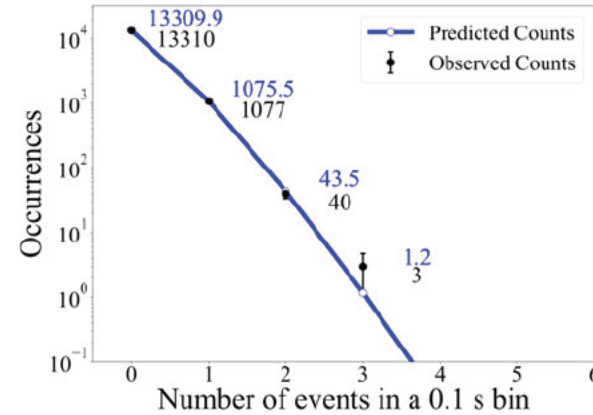
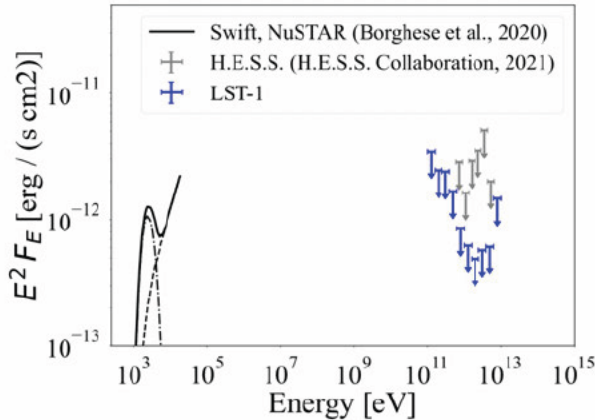
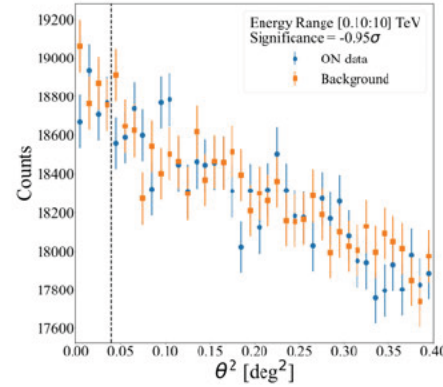


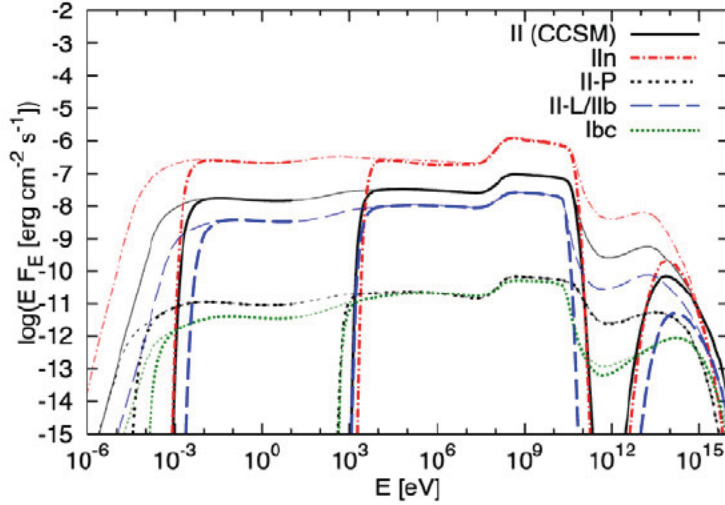
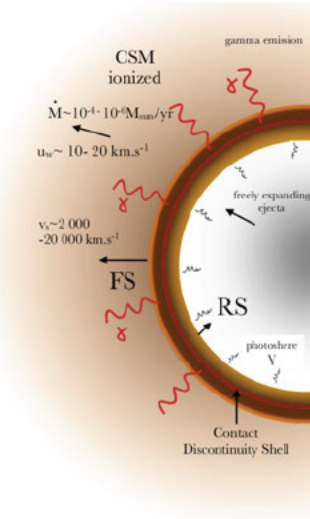
Fig. 5. Soft and VHE gamma-ray SED of the bursting emission of SGR 1935+2154 during the burst on July 7, 2021 00:33:31.670, measured on a ~ 0.1 s timescale.

Table 1. Upper limits in the [0.1 – 10] TeV range on known hard X-ray from SGR 1935+2154 observed by different satellites.

#	Time of Arrival ISOT UTC	Instrument	Exposure $10^8 \text{ cm}^2 \text{ s}$	R_{bkg} s^{-1}	N_{sig}	N_{ON}	s_{UL}	Flux UL $10^{-8} \text{ cm}^{-2} \text{ s}^{-1}$	Fluence UL $10^{-9} \text{ erg cm}^{-2}$
1	2021-07-07 00:33:31.670	Fermi-GBM	1.448	0.81 ± 0.02	4	0	2.16	1.49	1.09
2	2021-09-10 23:40:34.460	Fermi-GBM	1.485	1.05 ± 0.03	4	0	2.19	1.47	1.08
3	2021-09-11 22:51:41.600	GECAM	1.430	0.95 ± 0.03	4	0	2.17	1.52	1.11
4	2021-09-11 23:55:45.872	NICER	1.485	1.01 ± 0.03	4	0	2.18	1.47	1.07
5	2021-09-12 00:34:37.450	GECAM	1.491	0.61 ± 0.03	4	0	2.13	1.43	1.04
6	2021-09-12 00:45:49.400	GECAM	1.491	0.66 ± 0.03	4	0	2.14	1.43	1.05
7	2021-09-12 22:16:36.200	GECAM	1.296	0.68 ± 0.02	4	1	3.86	2.97	2.17
8	2021-09-12 23:19:32.080	Fermi-GBM	1.430	1.04 ± 0.03	4	0	2.18	1.53	1.12
9	2021-09-13 00:27:25.200	GECAM	1.485	1.04 ± 0.03	4	0	2.18	1.47	1.07
stacked $\delta t = 0.9$ s			13.041	0.87 ± 0.04	8	1	3.57	0.27	0.20

- Galactic Magnetar.
 - Repeating FRB.
 - Pulsar glitch observed at FRB (Hu et al, Nature 2024)
- Active X-ray burst episode in 2021
- Steady emission search & coincident burst emission search during the 9 bursts in 2021.
- No significant emission has been found. The upper limits are most stringent. $F_{\text{TeV}}/F_{\text{X}} < 10^{-3}$

Abe+ A&A 706 A25 (2026)



K. Murase, Phys. Rev. D 109, 2024

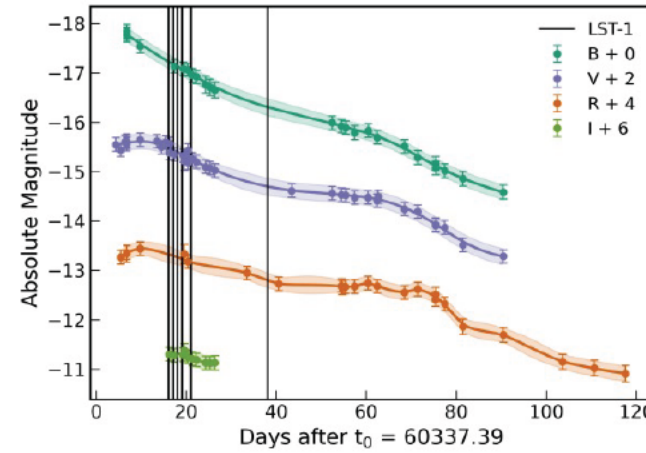
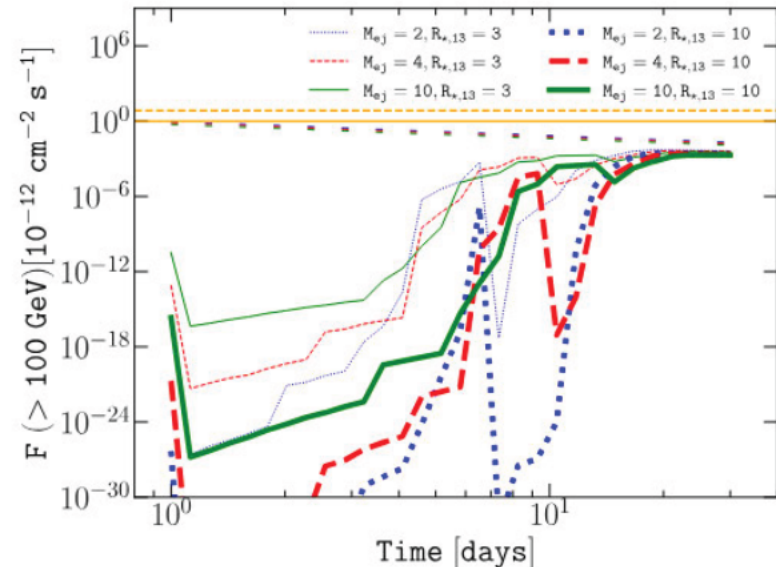


Fig. 3. Public photometry of SN 2024bch (filled points). We used observations in the four filters *B*, *V*, *R*, and *I*. An offset is added to the data points for a better visualization. Solid lines are the result of GP interpolation obtained with CASTOR (see the main text). The uncertainties of the interpolated lines are shown as shaded contours. The vertical solid black lines show the LST-1 observation windows.



P. Cristofari, MNRAS 2021

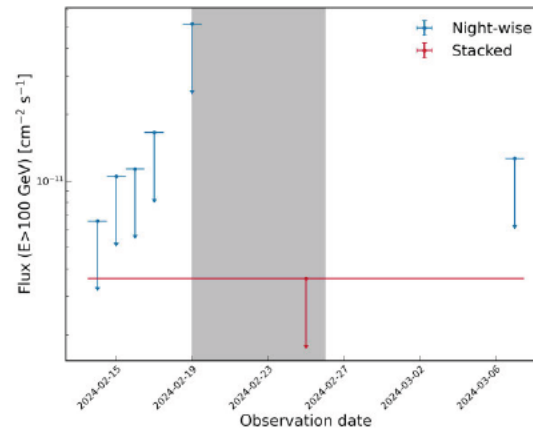
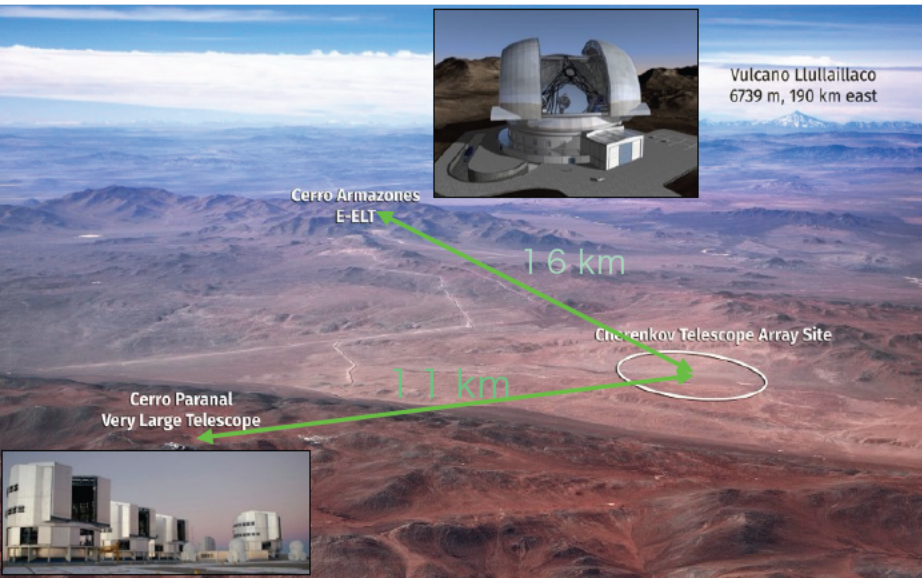


Fig. 2. ULs for the gamma-ray light curves of SN 2024bch, computed between 100 GeV and 10 TeV. We compare the night-wise ULs (blue) with the integrated UL, obtained by stacking all results together (red). The gray-shaded area covers the nights with strong moonlight. ULs are computed with a 2σ confidence level.

- Type II-L Supernova, occurred on Jan. 29th, 2024, 20 Mpc away (in NGC 3206)
- Particle acceleration expected in the shock formed in the dense CSM.
- Gamma-rays emissions may rise 10-100 days after the explosion, when internal absorption becomes weak. (Murase, Cristofari).
- LST1 observed it for 6 nights at 20 – 40 days later. No emission has been found above 100 GeV.
- Limits on Mass loss rate/wind speed

$$\dot{M}/u_w \leq 10^{-4} M_{\odot} / \text{yr s/km}$$



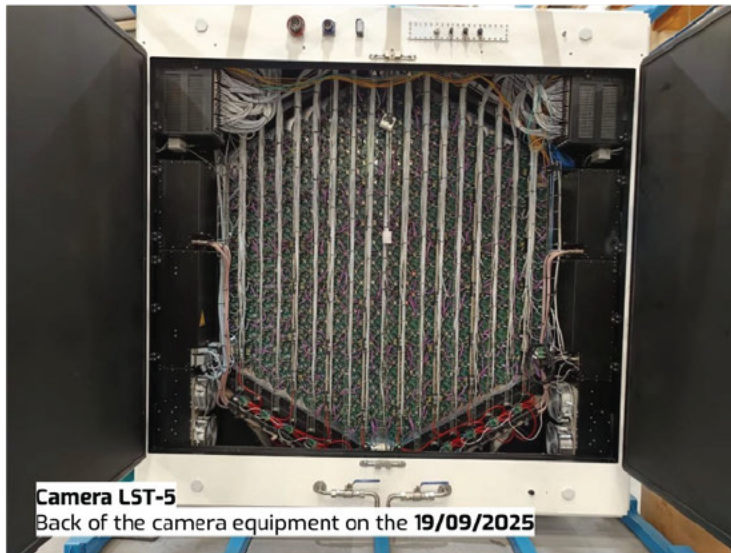
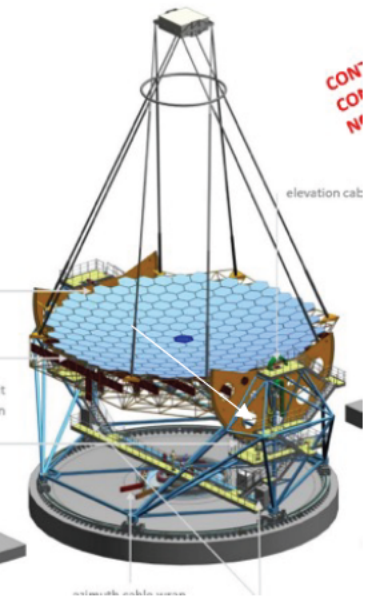
MST camera on HESS



- Infrastructure
 - Road, power lines, tentative data center will be ready in 2026
 - Foundation of 5 SST and 2 MST by in 2026
 - Telescope Elements are developed in different places.

- LST
 - Different Telescope Structure than North.
 - Camera is a copy of North.
 - PMT modules production is ongoing. Quality Control is to be started soon.

- MST
 - Camera has been tested on HESS.
 - Structure prototype is being built near the South site
- SST
 - See next talk by Okumura san



- CTAO is next generation gamma-ray observatory, in both hemispheres.
 - Cosmic Ray origin, BH/NS physics, Cosmology/Basic physics
 - Both arrays (Alpha configuration) will be completed by ~2030
- North Site construction is going well.
 - 4-LST array will start in 2026
- LST-1 is producing lots of scientific results
 - Recent ones include microquasar V4641, SGR 1935, SN2025bch etc.
 - Automatic Transient follow-up observation is on going
- South Site is also progressing well.
 - Starting from Infrastructure.
 - LST Camera production is going well.
 - See more in the next talk.