

# Cherenkov Telescope Array Observatory (CTAO) 計画：全体報告 (27)



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邦仁(京都大)、田島宏康(名古屋大)、山本常夏(甲南大)  
他CTA Consortium

CTAO

CTAO Consortium

25か国

>1500名

















































2025年1月7日 CTAO ERIC発足

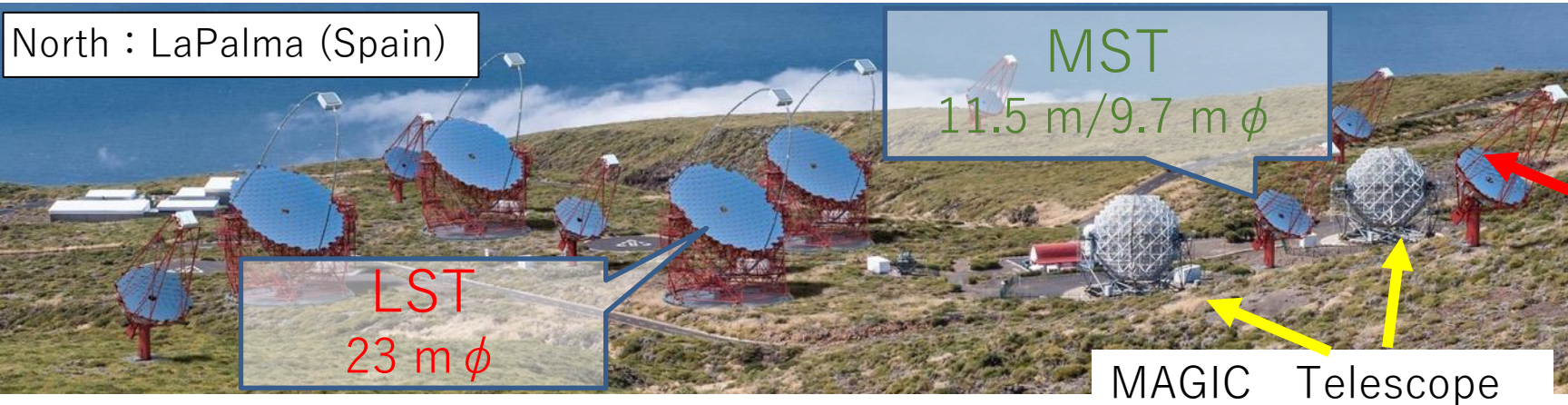
(European Research Infrastructure Consortium)

建設推進・データ配布の基盤となる法的組織

CTA-Japan 127名

|       |                                  |        |                                                                                                                                                                                  |
|-------|----------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 青山大   | 大林花織, 佐藤優理, 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, 栗井恭輔, 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, 手嶋政廣, 戸村友宣, 野崎誠也, バクスター ジョシュア 稜, 橋山和明, 吉越貴紀, Y. Chai, D. Hadasch, D. Mazin, M. Strzys, I. Vovk, P. K. H. Yeung |
| 茨城大   | 片桐秀明, 柳田昭平, 吉田龍生                 |        |                                                                                                                                                                                  |
| 宇宙研   | 鈴木 寛大, 林克洋                       |        |                                                                                                                                                                                  |
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| 神奈川大  | 辻直美                              |        |                                                                                                                                                                                  |
| 北里大   | 村石浩                              | 東北大    | 當真賢二, 石崎渉                                                                                                                                                                        |
| 岐阜大   | 佐野栄俊                             | 徳島大    | 折戸玲子                                                                                                                                                                             |
| 九州大   | 稲田知大                             | 名大理    | 立原研悟, 早川貴敬, 福井康雄, 山本宏昭                                                                                                                                                           |
| 京大基研  | 井岡邦仁                             | 名大ISEE | 安藤大地, 奥村暁, 重谷優斗, 河原崎琉, 高橋光成, 田島宏康, S. Bang                                                                                                                                       |
| 京大理   | 鶴剛, 寺内健太, 李兆衡                    |        |                                                                                                                                                                                  |
| 熊本大   | 高橋慶太郎                            | 広大先理工  | 今澤遼, 榎木大修, 木坂将大, 須田祐介, 高橋弘充, 仲野悟帆, 橋爪大樹, 深沢泰司, A. Roy                                                                                                                            |
| KEK   | 田中真伸                             |        |                                                                                                                                                                                  |
| 甲南大   | 井上剛志, 田中孝明, 千川道幸, 溝手雅也, 山本常夏     | 広大宇科セ  | 水野恒史                                                                                                                                                                             |
| 国立天文台 | 郡和範                              | 宮崎大    | 森浩二                                                                                                                                                                              |
| 埼玉大   | 勝田哲, 清本拓人, 寺田幸功                  | 山形大    | 郡司修一, 門叶冬樹, 中森健之                                                                                                                                                                 |
| 仙台高専  | 加賀谷美佳, 林航平                       | 山梨学院大  | 内藤統也, 原敏                                                                                                                                                                         |
| 千葉大   | 井上進, 小林志鳳, 野田浩司                  | 横浜国大   | 廣島渚                                                                                                                                                                              |
| 東海大   | 阿部和希, 韓 天舒, 櫛田淳子, 佐藤雄輝, 西嶋恭司, 姚屹 | 理研     | 長瀧重博, M. Barkov, G. Ferrand, H. He, E. R. Owen, D. Warren                                                                                                                        |
| 東大理   | 大平豊, 立石大, 戸谷友則, 馬場彩              | 立教大    | 内山泰伸, 澤田真理, 林田将明                                                                                                                                                                 |
| 東京都立大 | 川中宣太, 藤田裕                        | 早稲田大   | 片岡淳                                                                                                                                                                              |

North : LaPalma (Spain)

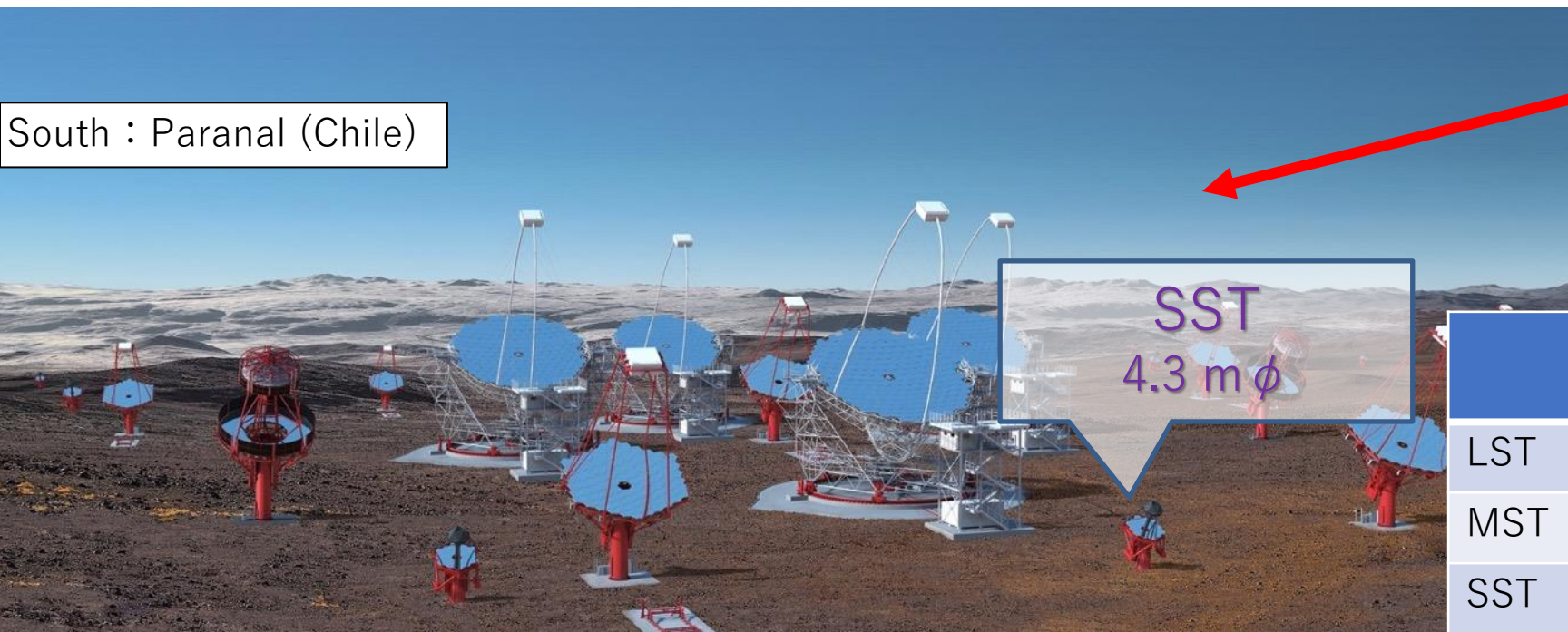


North

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



South : Paranal (Chile)

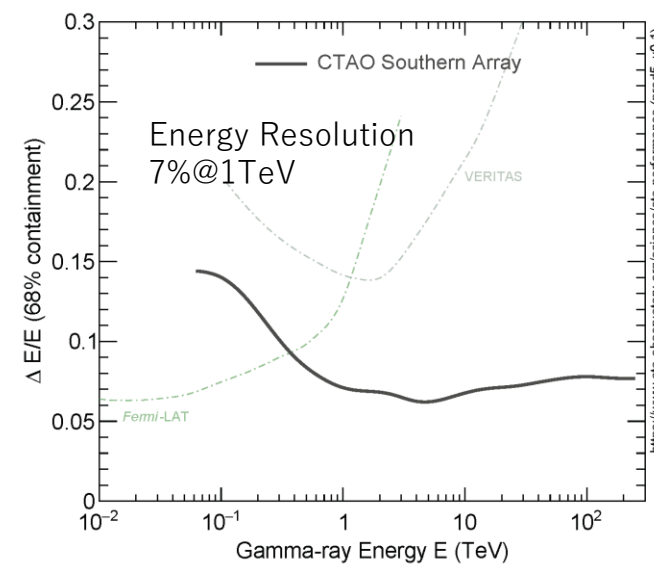
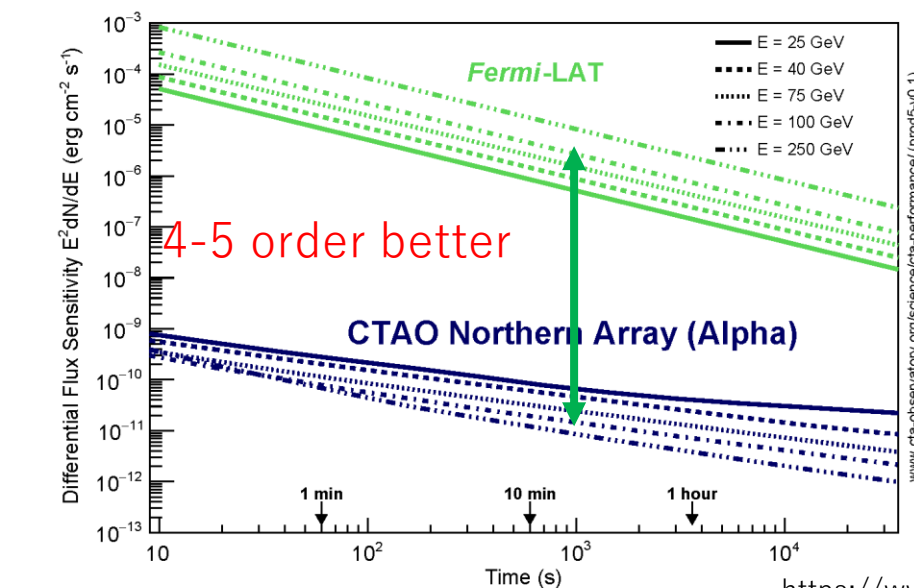
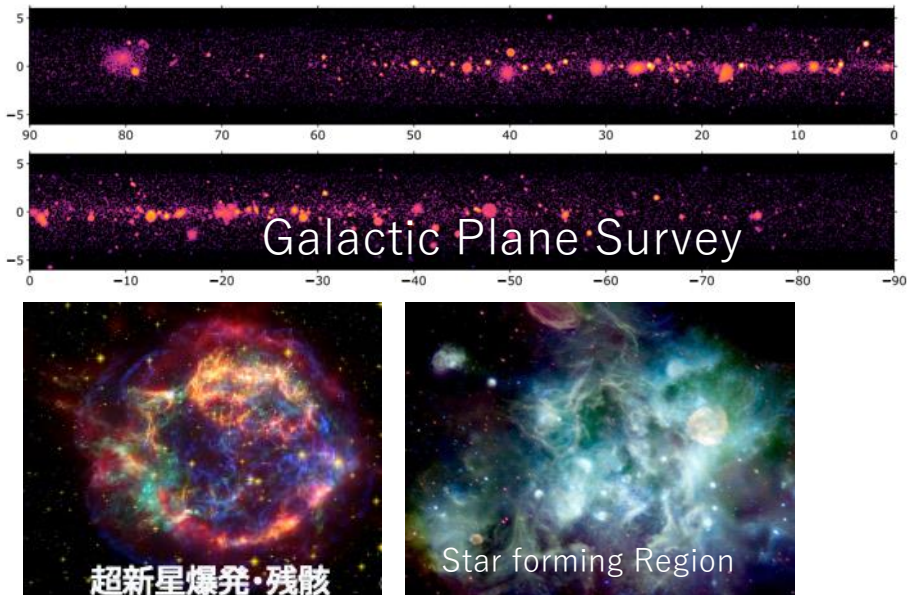
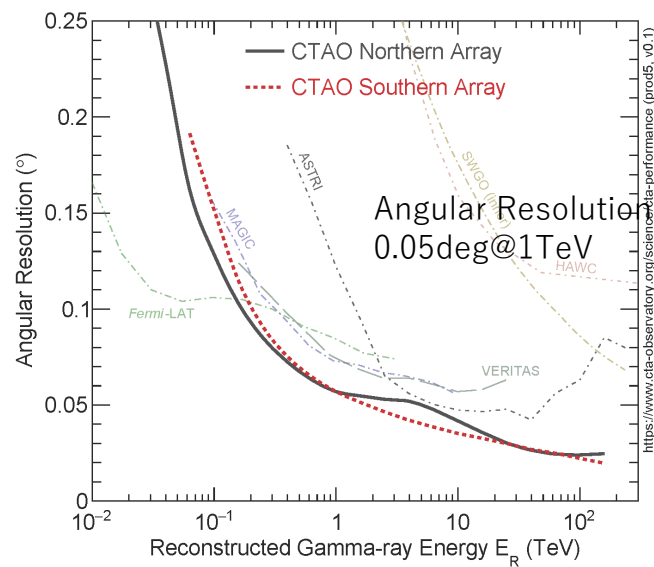
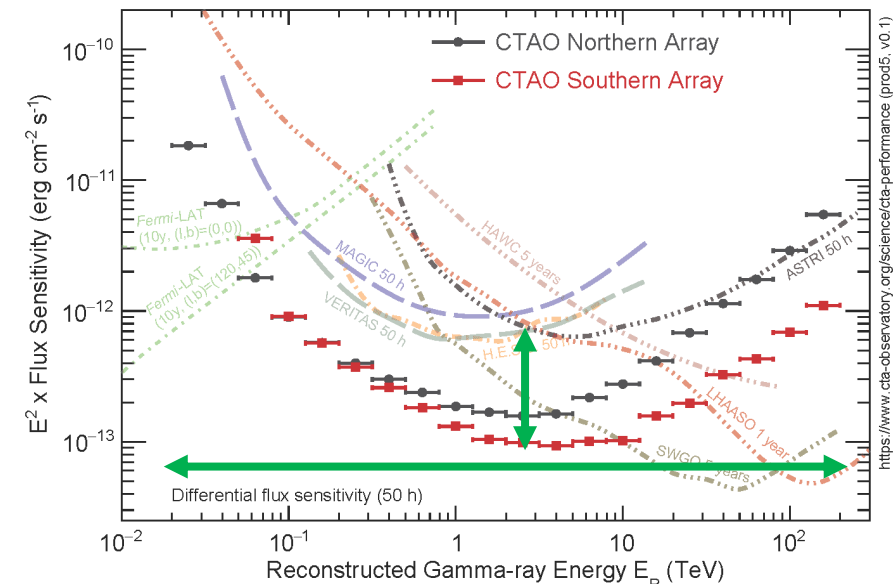


South

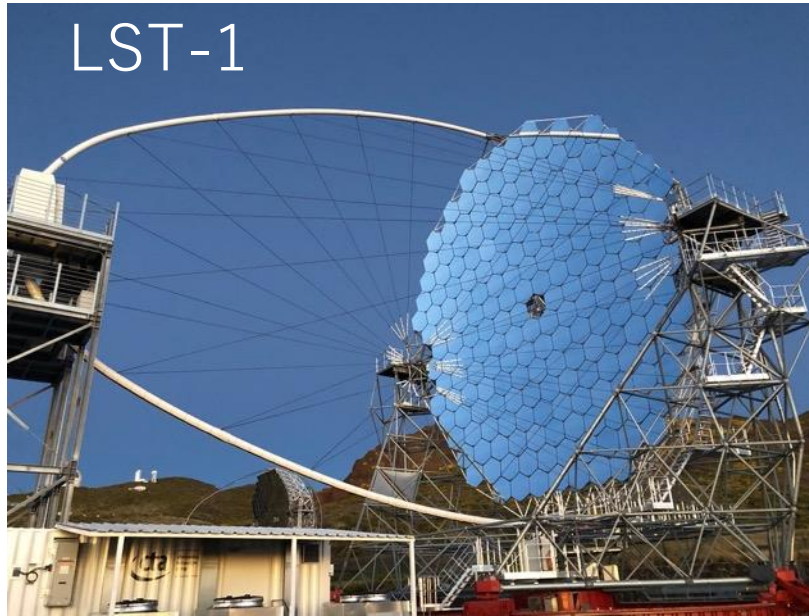
Array Coordinates 2 km x 2 km  
Latitude: 24° 41' 0.34" South  
Longitude: 70° 18' 58.84" West

|     | #tel<br>(N) | #tel<br>(S) | Energy<br>[ TeV ] | FoV<br>[ 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           |

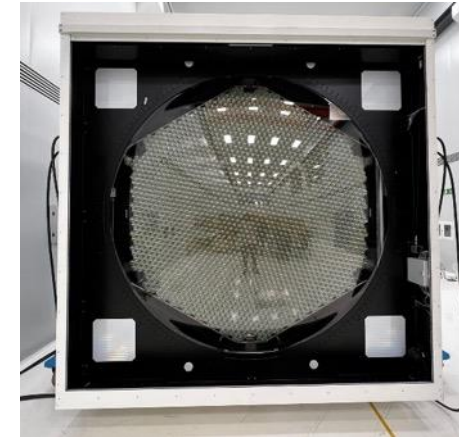
"Alpha" Configuration Operation starts in 2028.



LST-1



LST-3



Camera@Tenerife



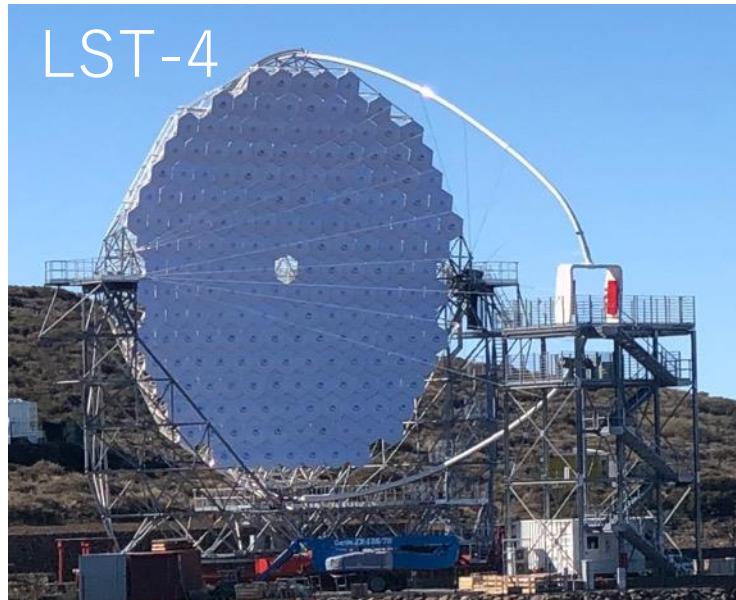
Mirror@LaPalma

Schedule

LST-2



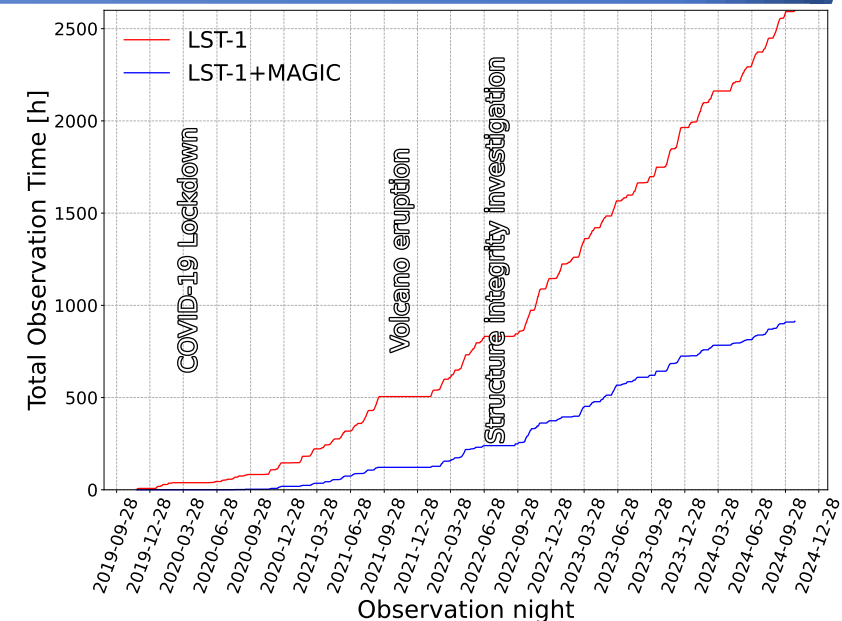
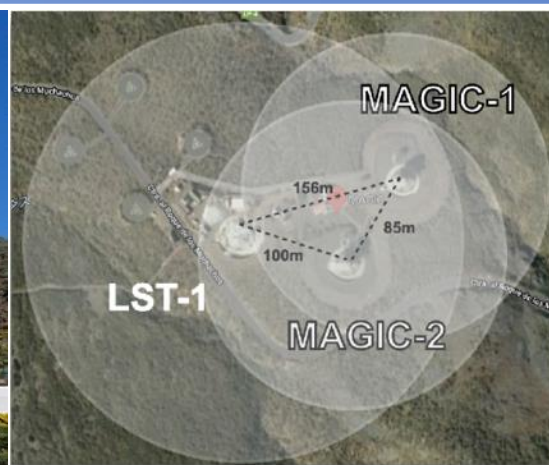
LST-4



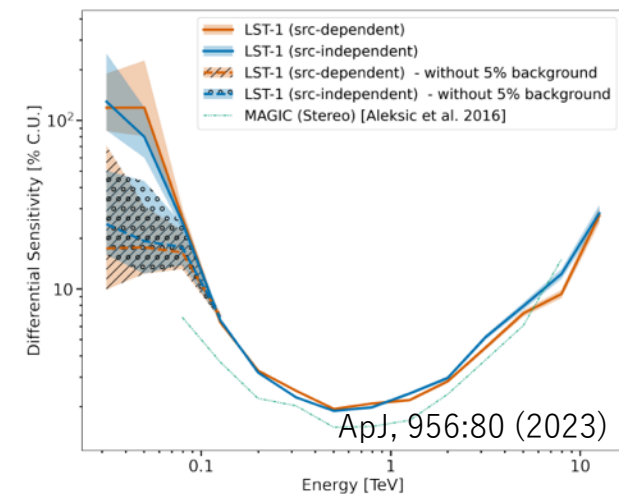
|      | Arch         | Mirror        | Camera |
|------|--------------|---------------|--------|
| LST1 |              | operational   |        |
| LST2 | 25/6         | 25/8          | 26/03  |
| LST3 | 24/1<br>done | 25/5          | 25/9   |
| LST4 | 24/8 done    | 24/12<br>done | 25/5   |

4-LST array obs. starts in 2026

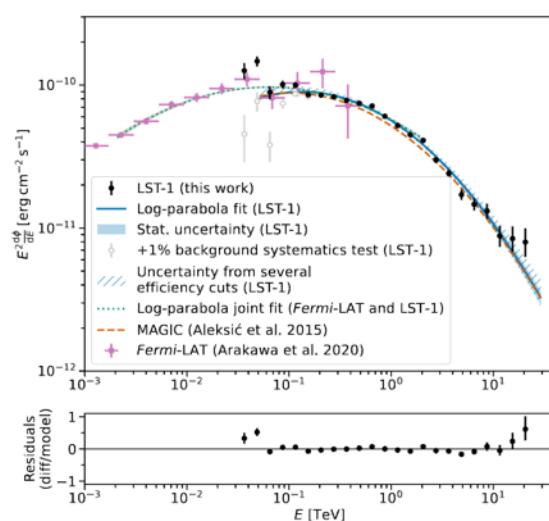
# CTAO LST-1 Operation Status



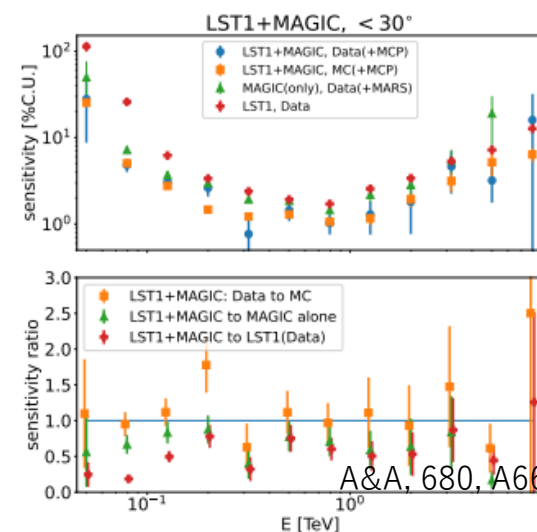
- More than 2700 hours since 2020
  - 30-40% of the time with MAGIC-Joint
  - 90% availability



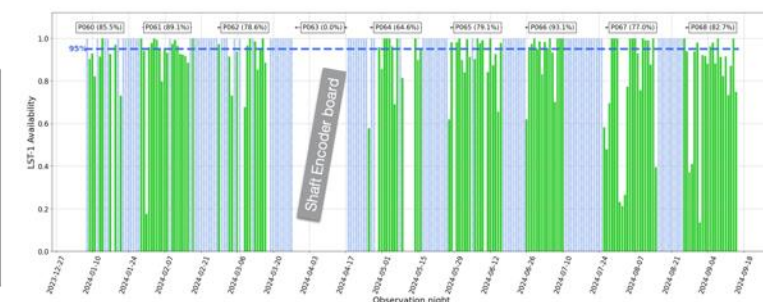
LST-1 Sensitivity



Crab Nebula SED



LST + MAGIC Sensitivity



Availability

A&A, 680, A66 (2023)

## Total

125 # total alerts

20 # observed alerts

46.7h observed

## GRBs

91 # total alerts

18 # observed alerts

43.4h observed

## GWs

26 # total alerts

2 # observed alerts

3.3h observed

## Neutrinos

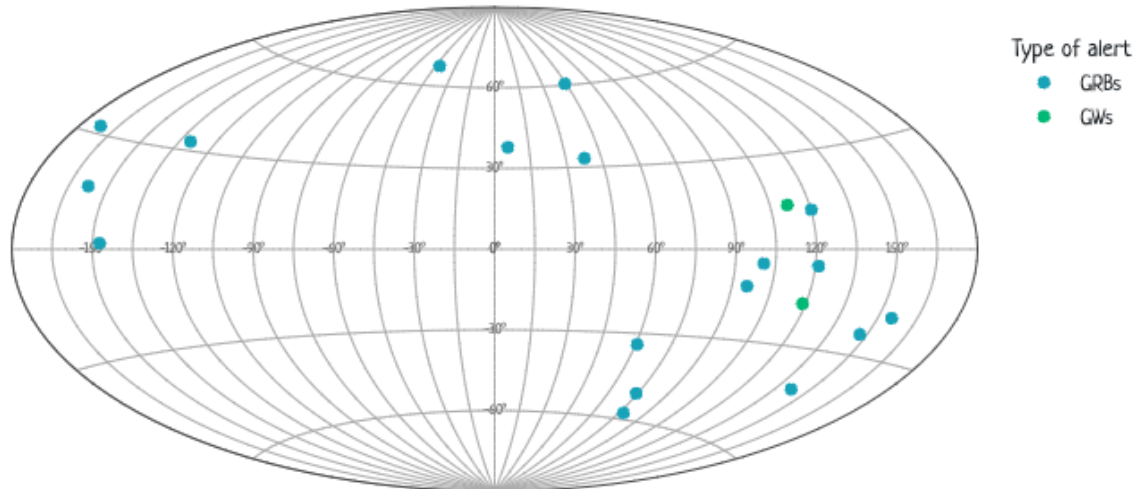
8 # total alerts

0 # observed alerts

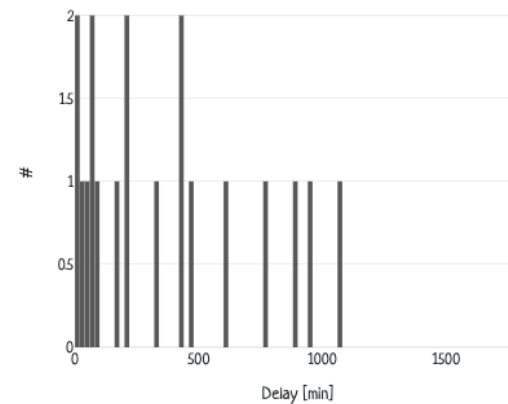
0.0h observed

- Fast rotation (180deg/20sec)
- Automatic Reaction on alert
- No detection so far

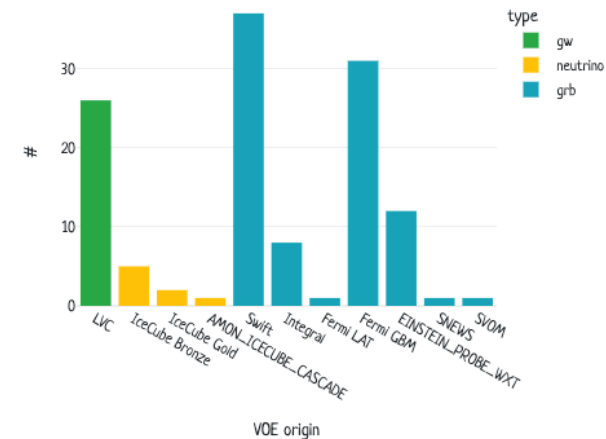
Sky map in Galactic coordinates of all observed alerts



Delay of observations wrt T0



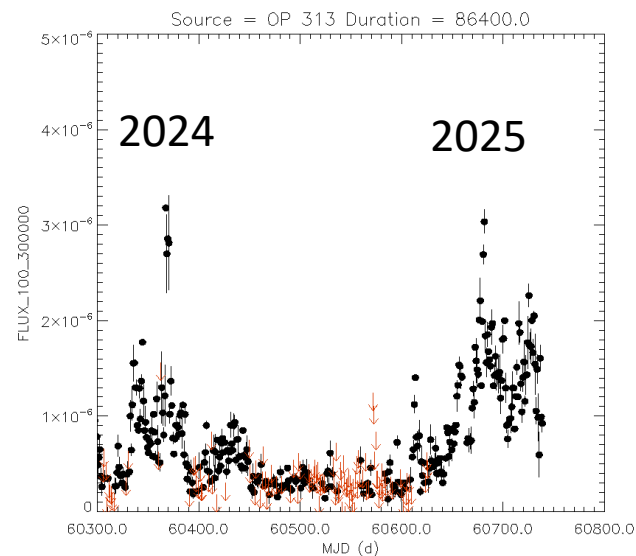
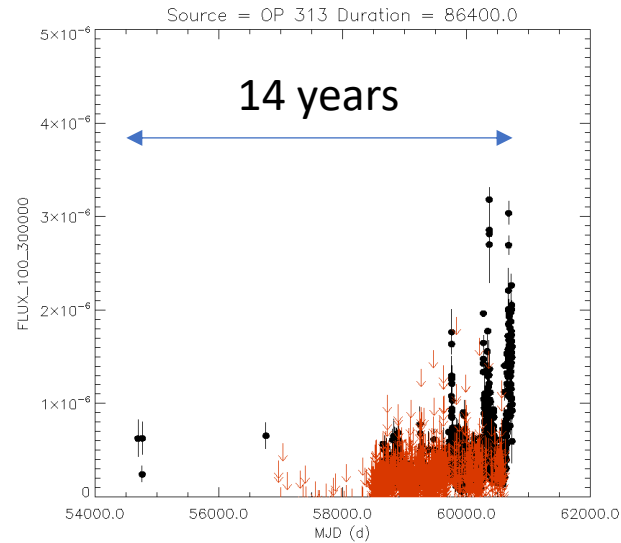
VOE origin of alerts



- **Brightest of All Time GRB.**  $Z = \sim 0.151$ ,  $E_{\text{iso}} \sim 10^{55}$  erg

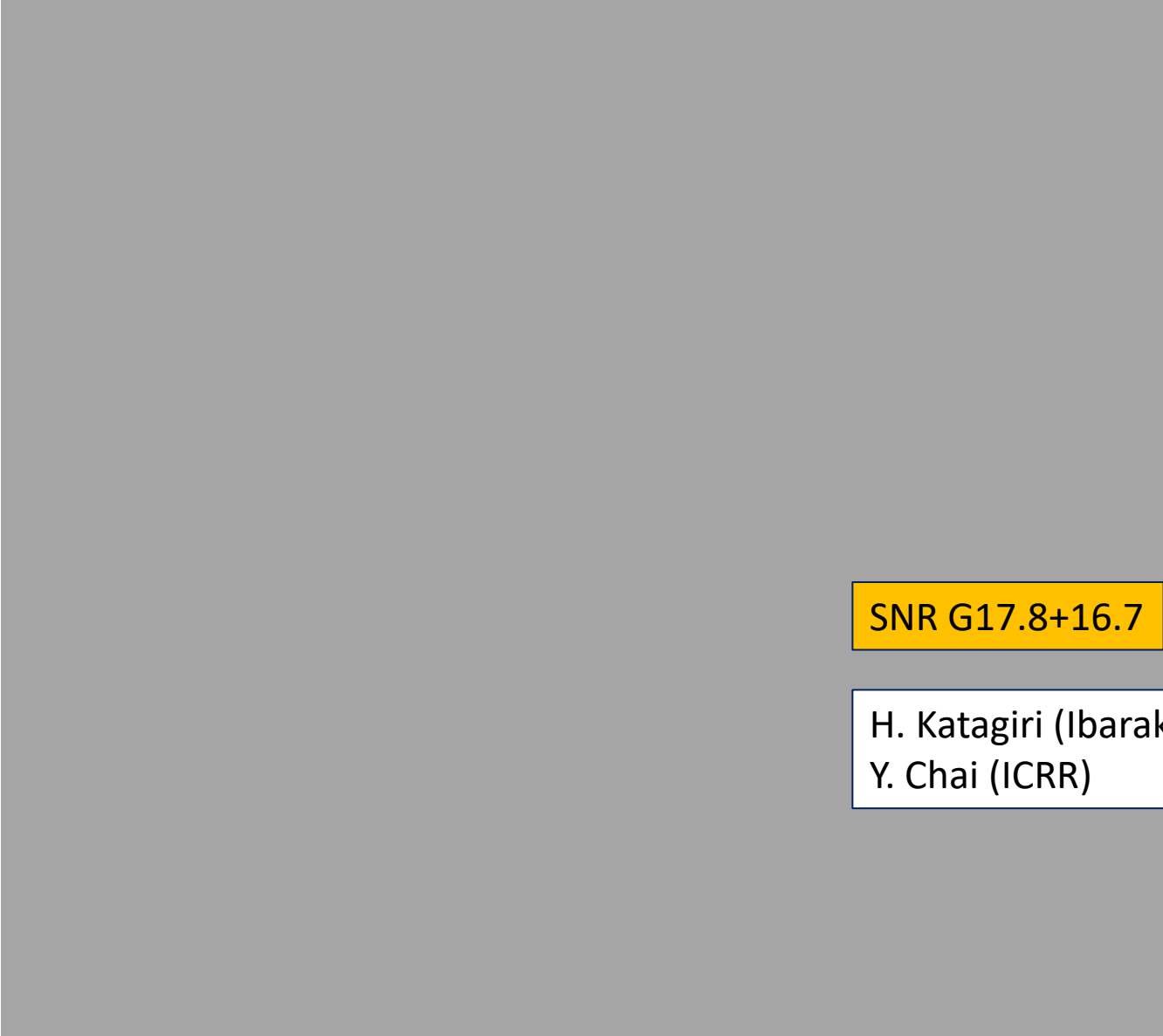
- Observation started at  $T_0+1.3\text{d}$  under very strong moon
- To bypass the “Safety Limit”, PMT HVs had to be reduced. Analysis was very difficult.
- 4 sigma excess could be obtained
- Consistent with LHAASO extrapolation after break.

- **Very distant FSRQ**  $Z = 0.997$ , the farthest AGN detected with IACT



J. Baxter (ICRR)  
S. Nozaki (ICRR, MPI)

- Very important for EBL study
- Very active again inand keep observing



SNR G17.8+16.7

H. Katagiri (Ibaraki)  
Y. Chai (ICRR)

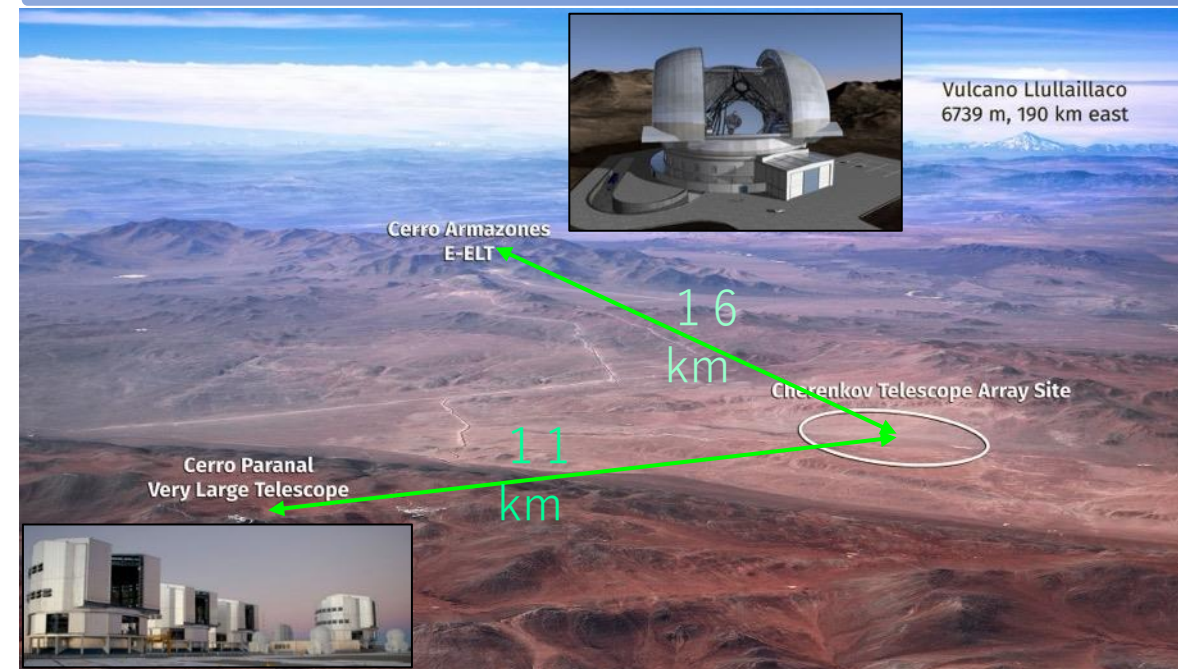


SGR 1935+2154



I. Vovk (ICRR)

Cygnus Cocoon Scan



## ❑ Infrastructure

- Array road construction till July 2026
- Power for first tels by Feb 2026
- Tentative data center by Feb 2026
- Foundation of 5 SST and 2 MST by Jan 2026

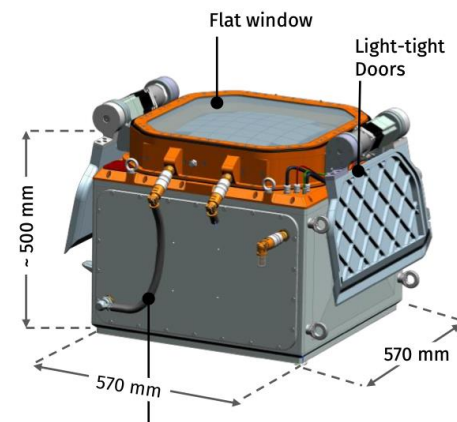
## ❑ Telescope elements

- LST
  - Copy of North Camera
  - New Structure designed.
  - New mirror developped.
- MST
  - Prototype tested.
  - Camera mounted on HESS and validated.
- SST
  - Prototype Telescope validated.
  - Prototype Array being constructed in Tenerife.

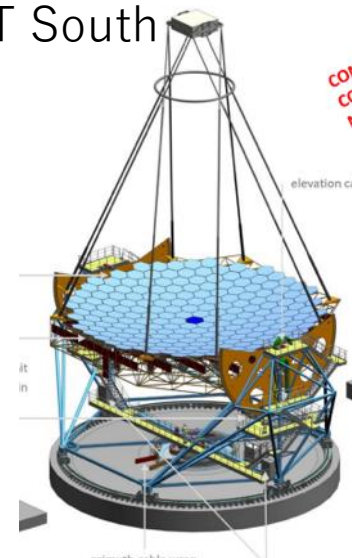
MST camera on HESS



SST Camera



LST South



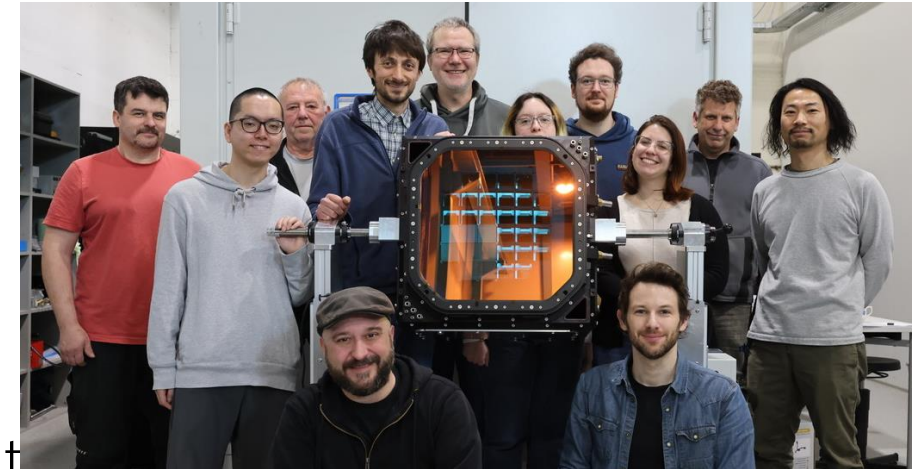
**5 SST, 2 MST, 2 LST will be ready in 2027**<sup>11</sup>

## ❖ Small-sized telescope started production of the first telescope

- Nagoya group is in charge of SiPM for SST camera.
  - 224 SiPM modules (14,336 channels, worth 5 SSTs) are being procured by Nagoya University
  - Currently, commissioning a quadrant of the camera

## ❖ Dark current of 64 channels of SiPMs is measured for more than 3 months

- One SiPM suffered  $\times 10$  dark current increase after 3 months
  - The dark count rate is similar to typical SiPM, which indicates large dark current does not originate from SiPM APDs
  - Visual inspection and temperature measurements found this is caused by a damage to the electrode. Automatic visual inspection will be added to screen out this kind of defects in the future.



- CTAO is next generation gamma-ray observatory, in both hemispheres.
  - Cosmic Ray origin, BH/NS physics, Cosmology/Basic physics
  - **CTAO ERIC** is established on Jan 2025, which will accelerate the construction.
  - Both arrays will be completed by 2028
- North Site construction is going well.
  - LST array will be **completed in this year**
- LST-1 is producing lots of scientific results
  - Recent ones include BOAT GRB, OP313, SNR G17.8 etc
  - Automatic Transient follow-up observation is on going
- South Site is also progressing well.
  - Starting from Infrastructure.
  - 5 SST, 2 MST, 2 LST will be ready in 2027