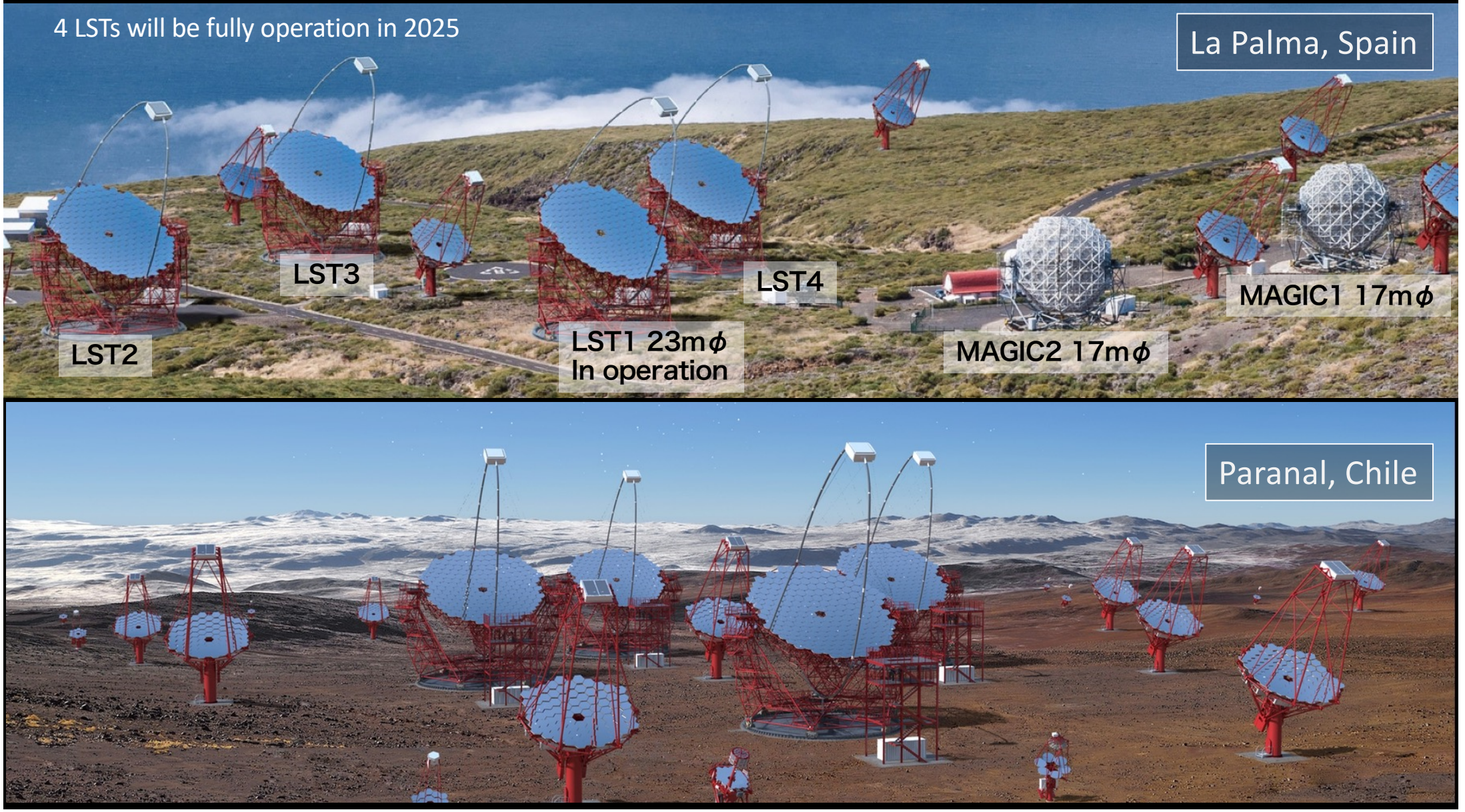
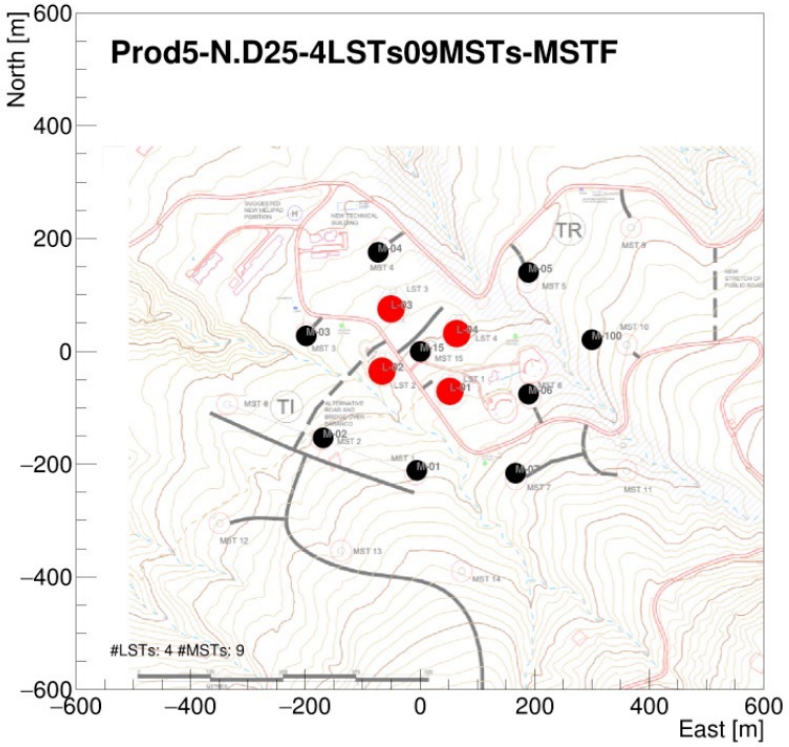
Highlights from CTA LST Project

Masahiro Teshima for the LST Collaboration

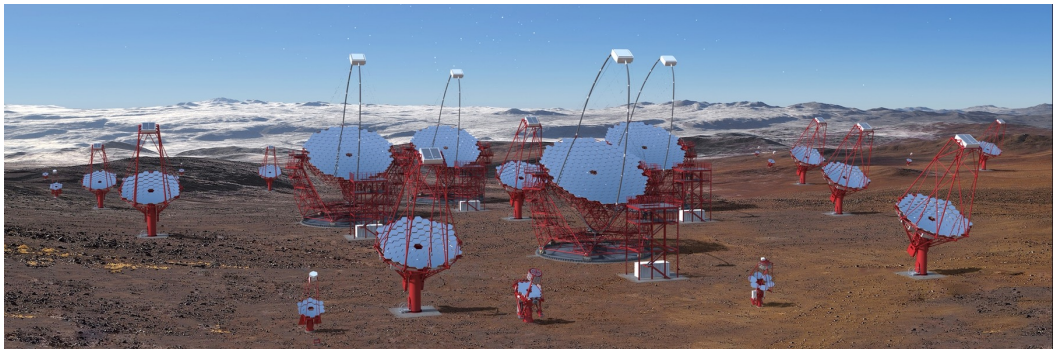


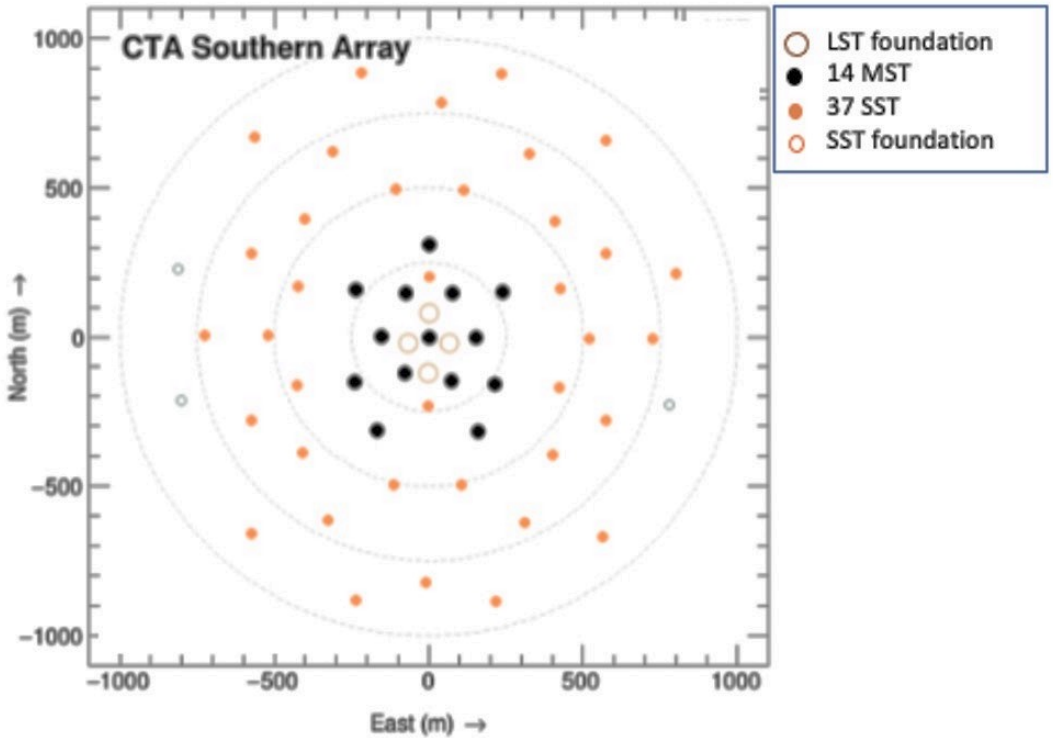
Alpha Configuration is decided with the financial constraints

Roque de los Muchachos Observatory
La Palma, Spain



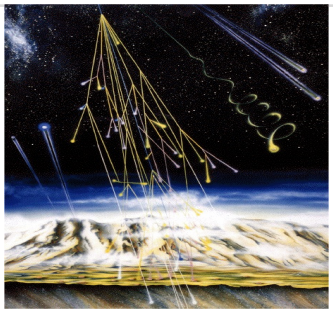
Paranal, Chile

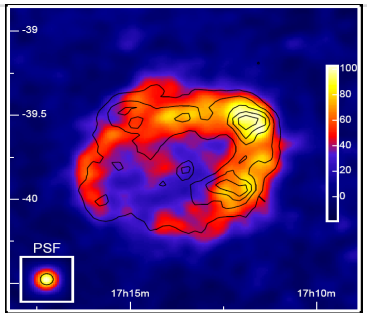




Science of CTA is very wide

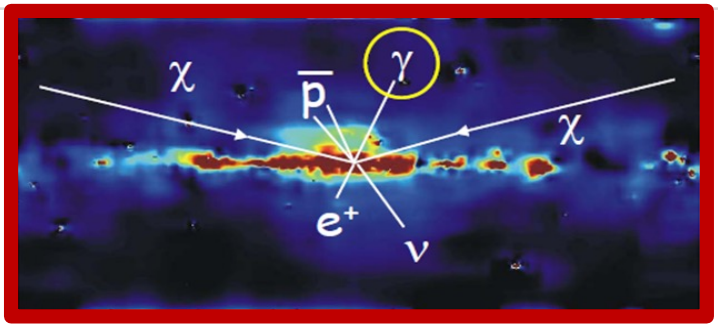
SNRs, PWNe, AGNs, GRBs, Dark Matter





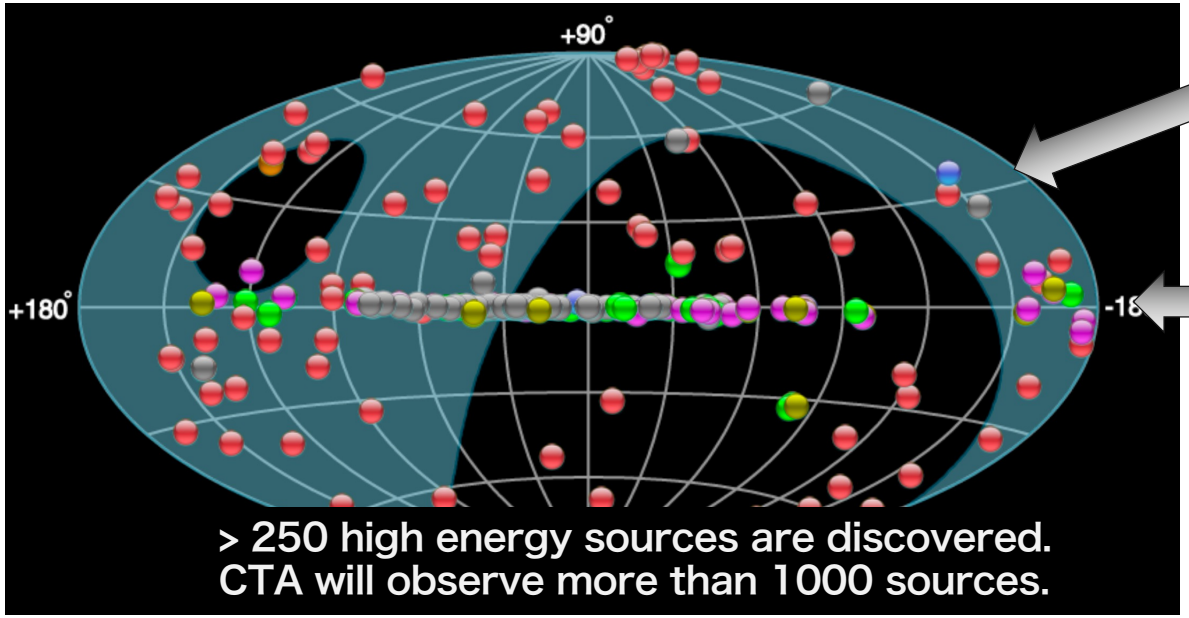
Cosmic Ray Origin

Super Massive Black Holes



Dark Matter Search (Discovery)

- Origin of Cosmic Rays (Big accelerators)
- Black Hole and S.M.B.H.
- Dark Matter Search

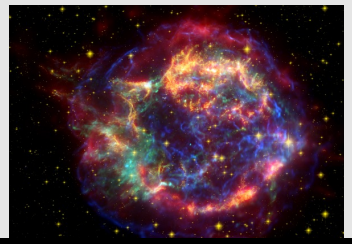


Extragalactic Sources

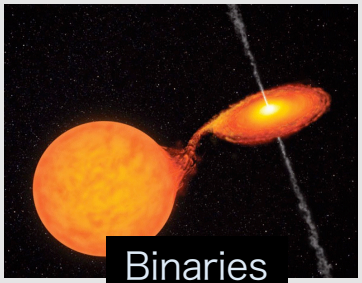
Active Galactic Nuclei

Gamma Ray Bursts

Galactic Sources

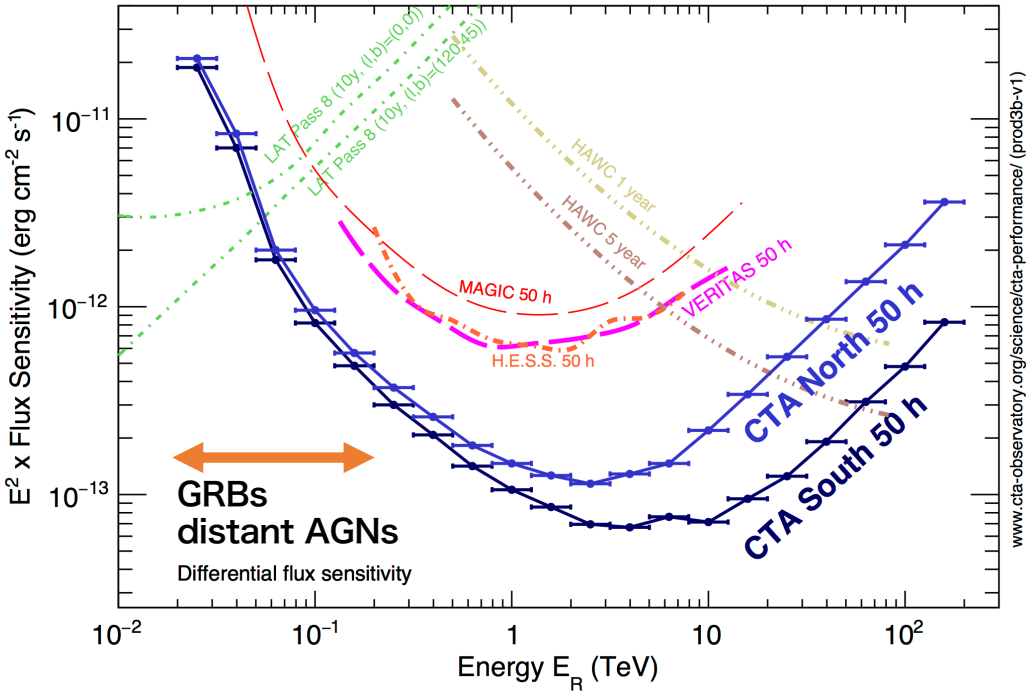


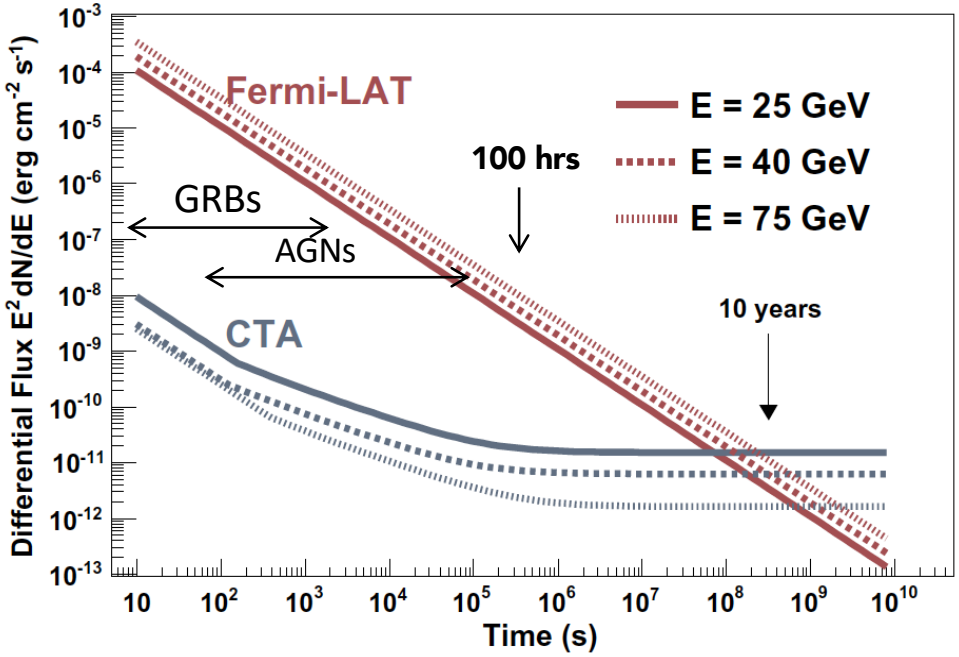
Super Nova Remnants



Binaries

Sensitivity x10, Angular Resolution x2 Energy Range 20GeV~200TeV

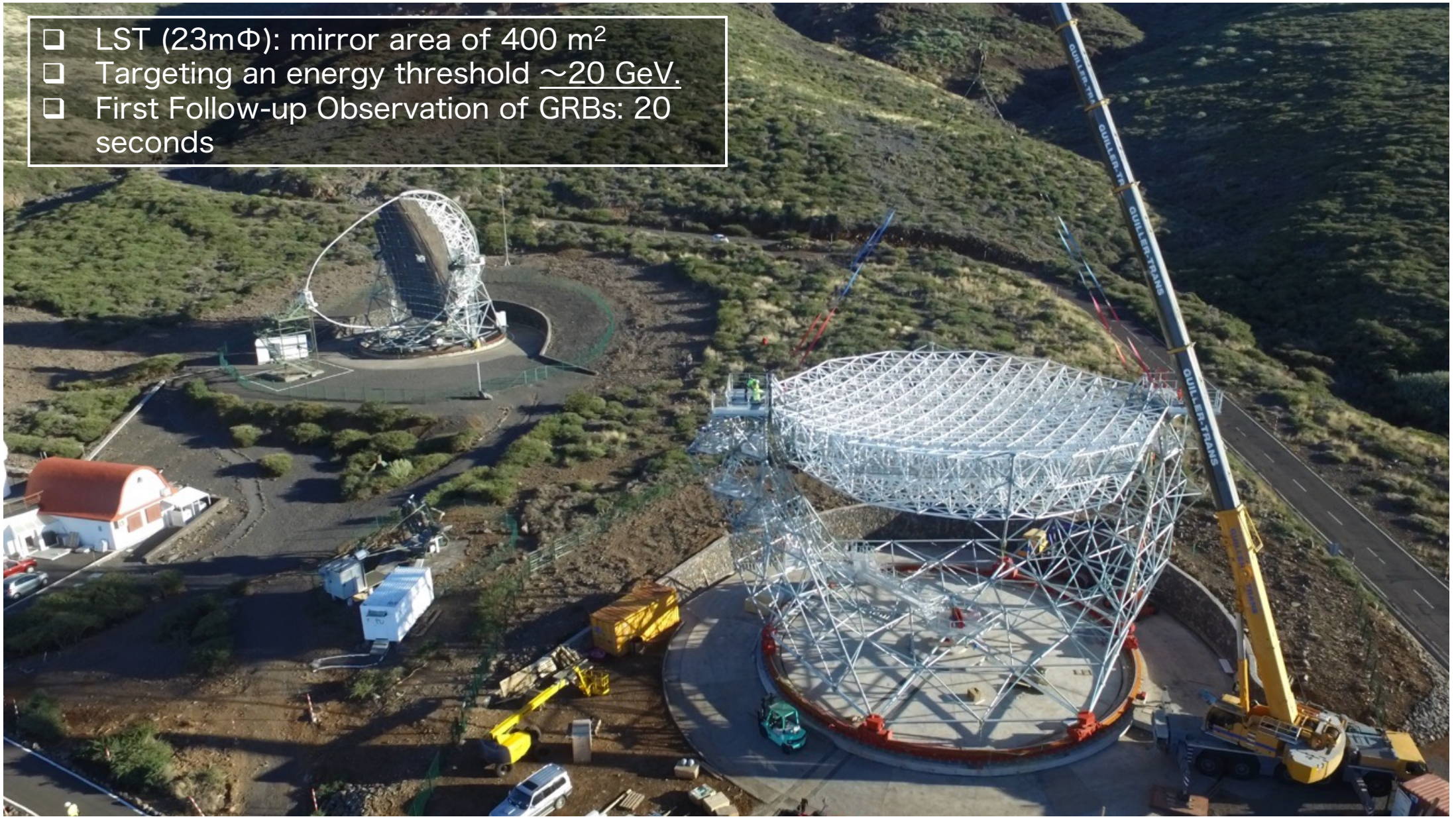




- CTA-LST array has a unique sensitivity in low energies 20-200 GeV
- Distant AGNs are observable up to z=2, and GRBs up to z=4
- X10000 sensitivity for GRBs and AGN flares than Fermi
- GRB Prompt emission, and afterglow with the fast rotation (20 sec)

The CTA Large Size Telescope LST1

(Photo under construction in December 2017)



cherenkov telescope array

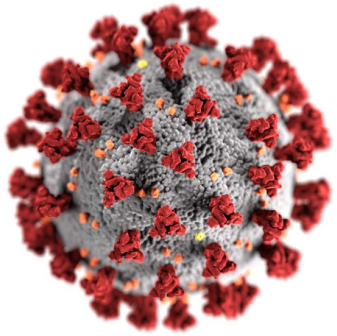
Commissioning since 2019 including Science Operation since 2020

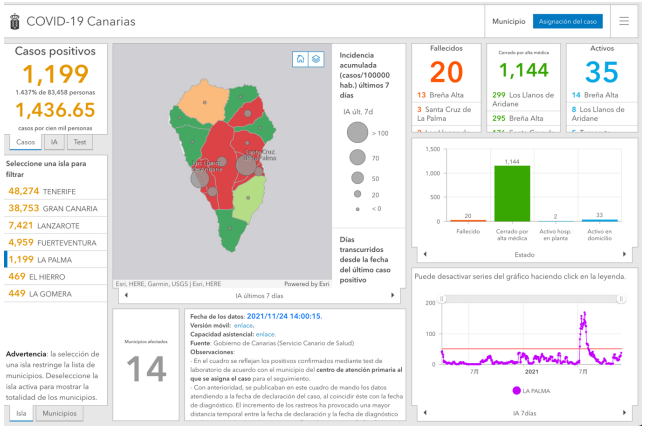
The LST collaboration

A collaboration of ~350 scientists and engineers from 11 countries in charge of building the 4 LSTs in CTA-North and the 4 LSTs in CTA-South

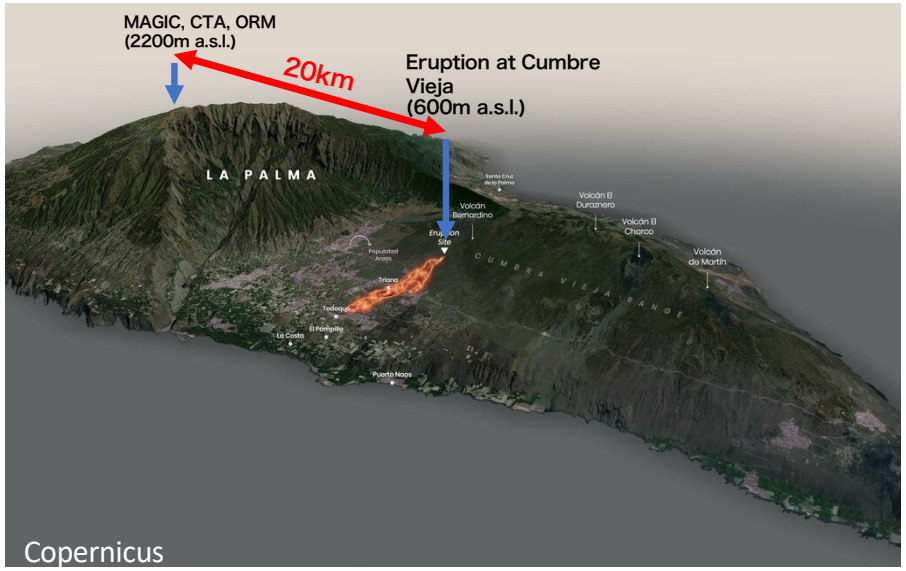
Last two years, we suffered from several Oh, my God!!

Covid-19





Volcano Eruption



Russian Aggression in Ukraine

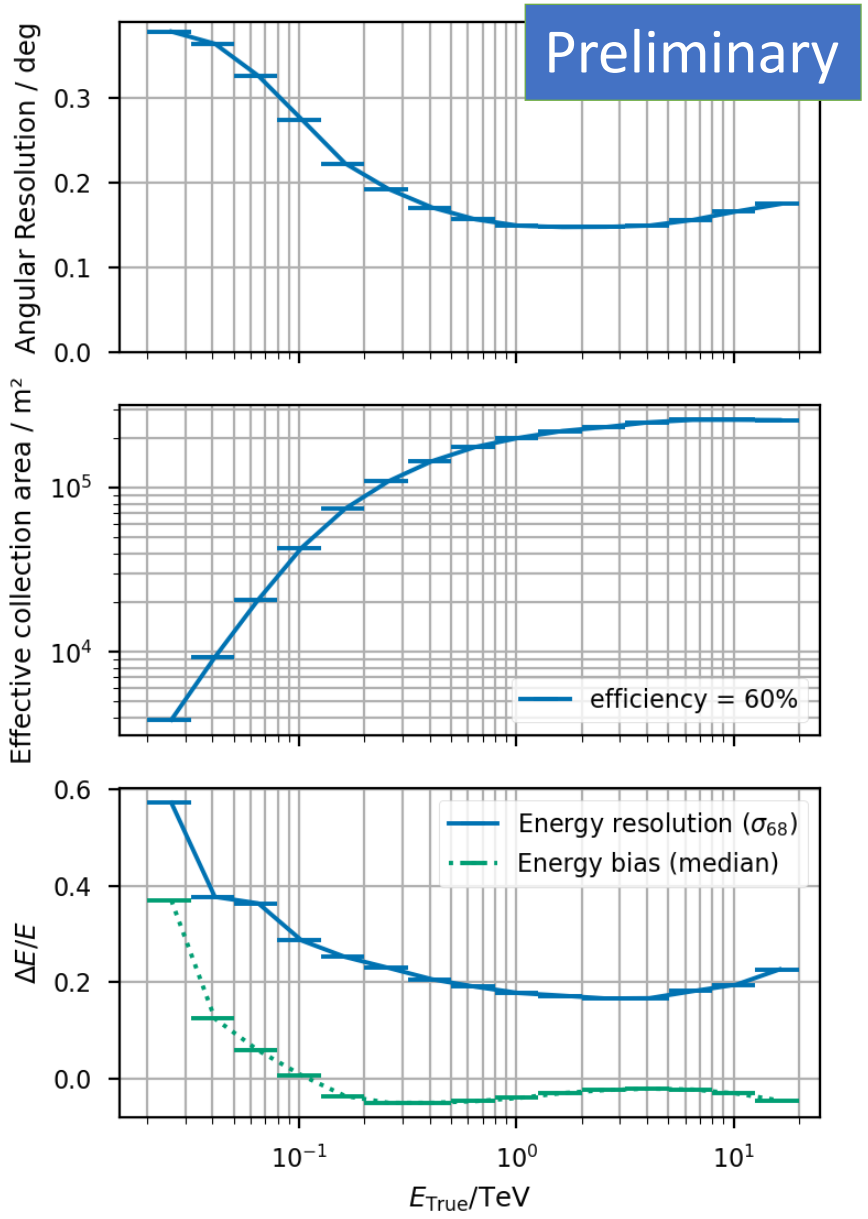
Price Increase

Shortage of semiconductors and materials

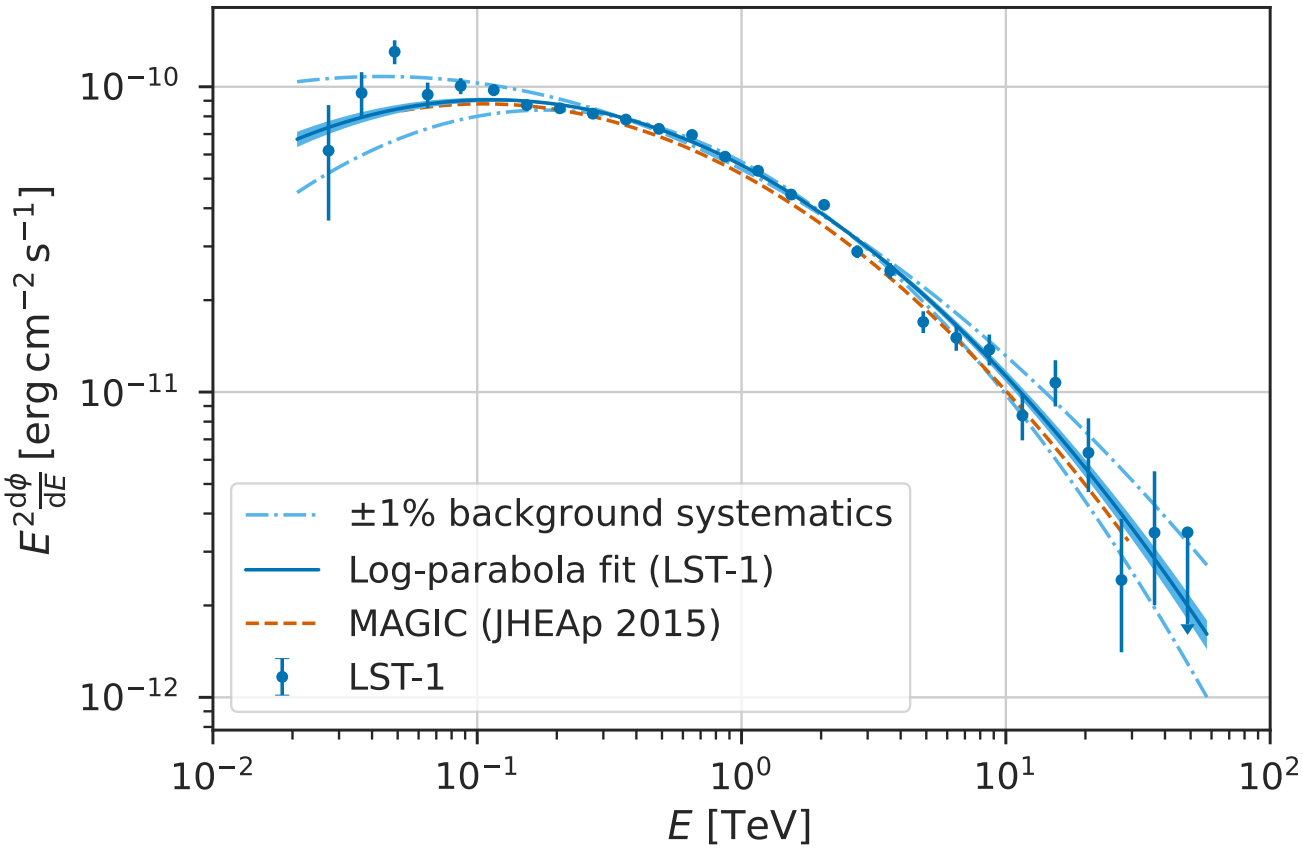
Erupciones históricas en La Palma			
#	Erupción	Año	Días erupción
1	nombre?	2021	85days ?
2	Teneguía	1971	24
3	San Juan	1949	47
4	Charco	1712	56
5	San Antonio	1667/1678	66
6	Tigalate	1646	82
7	Tehuya	1585	84
8	Tacande	1430/1440	?

Single Telescope LST-1 performance: effective area, angular+energy resolution

- Zenith angle= 10deg, γ-ray efficiency = 60% (due to gammaness cut)
- LST-1 is a single telescope so one cannot expect a great angular or energy resolution. Still they are competitive down to 100 GeV.
- Effective area >10^3 m^2 down to ~20 GeV.

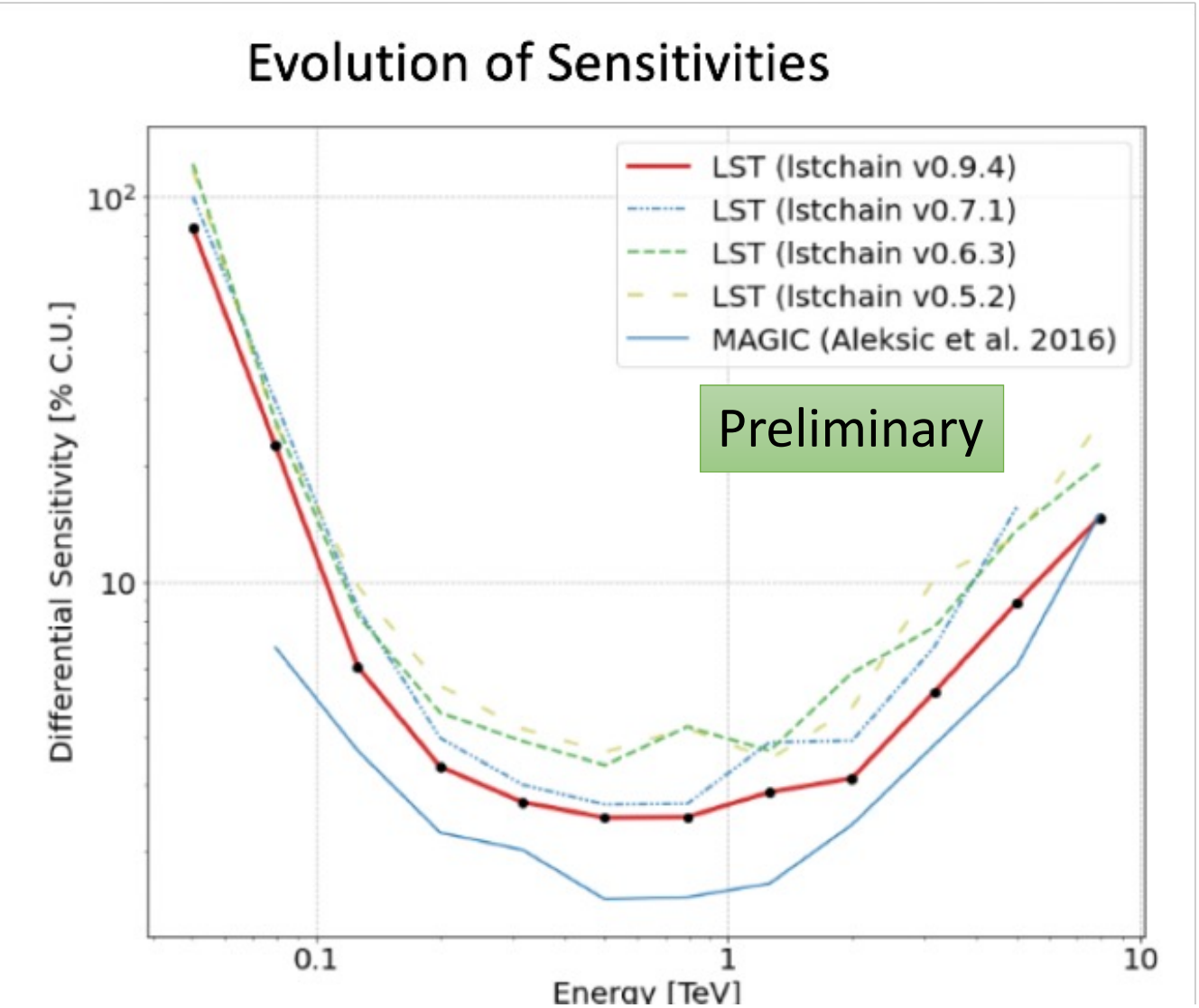


Performance: Crab Nebula spectrum



- 34 h effective time, γ-ray efficiency: 70% from gammaness cut and 70% from θ^2 cut
- Error bars are only statistical.
- Systematics: blue lines correspond to effect of ±1% background.
- Consistent with MAGIC and Fermi-LAT.
- Lowest data point at 25 GeV!

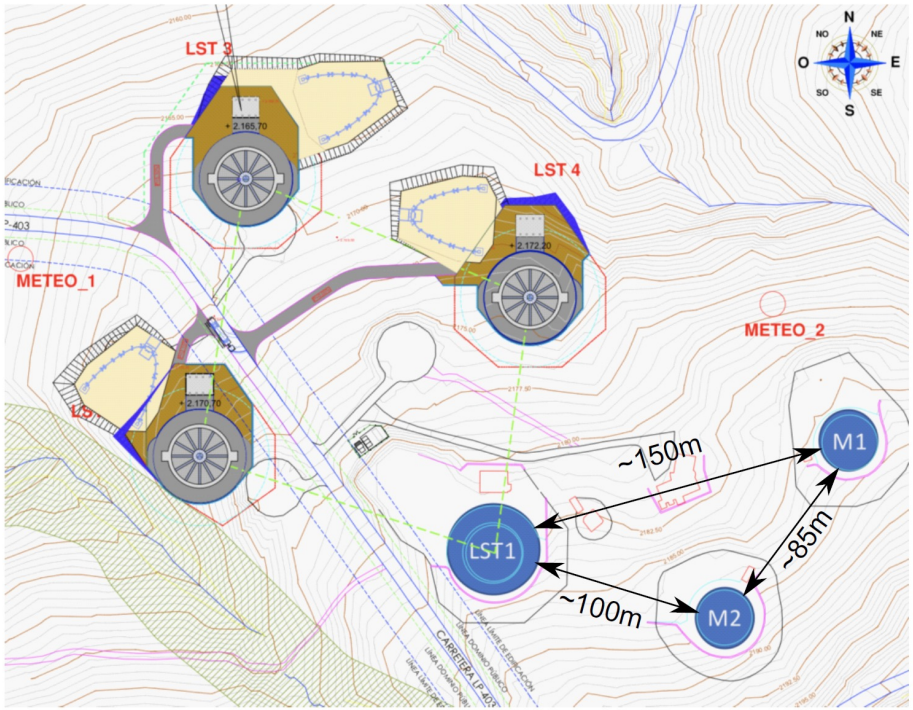
Single Telescope LST-1 performance: sensitivity

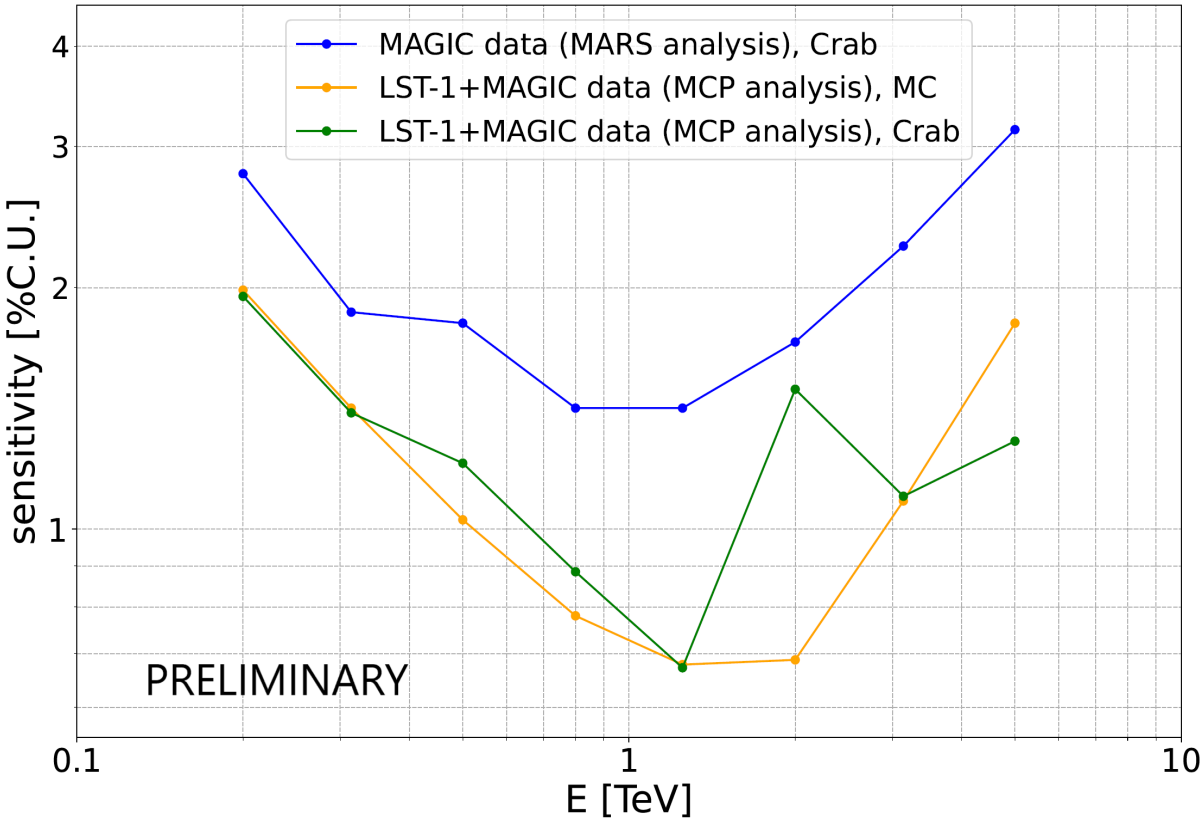


- Consistent sensitivity for source-dependent and source-independent analyses.
- The sensitivity is close to MAGIC stereo array.
- X10 better sensitivity is expected with 4 LST array

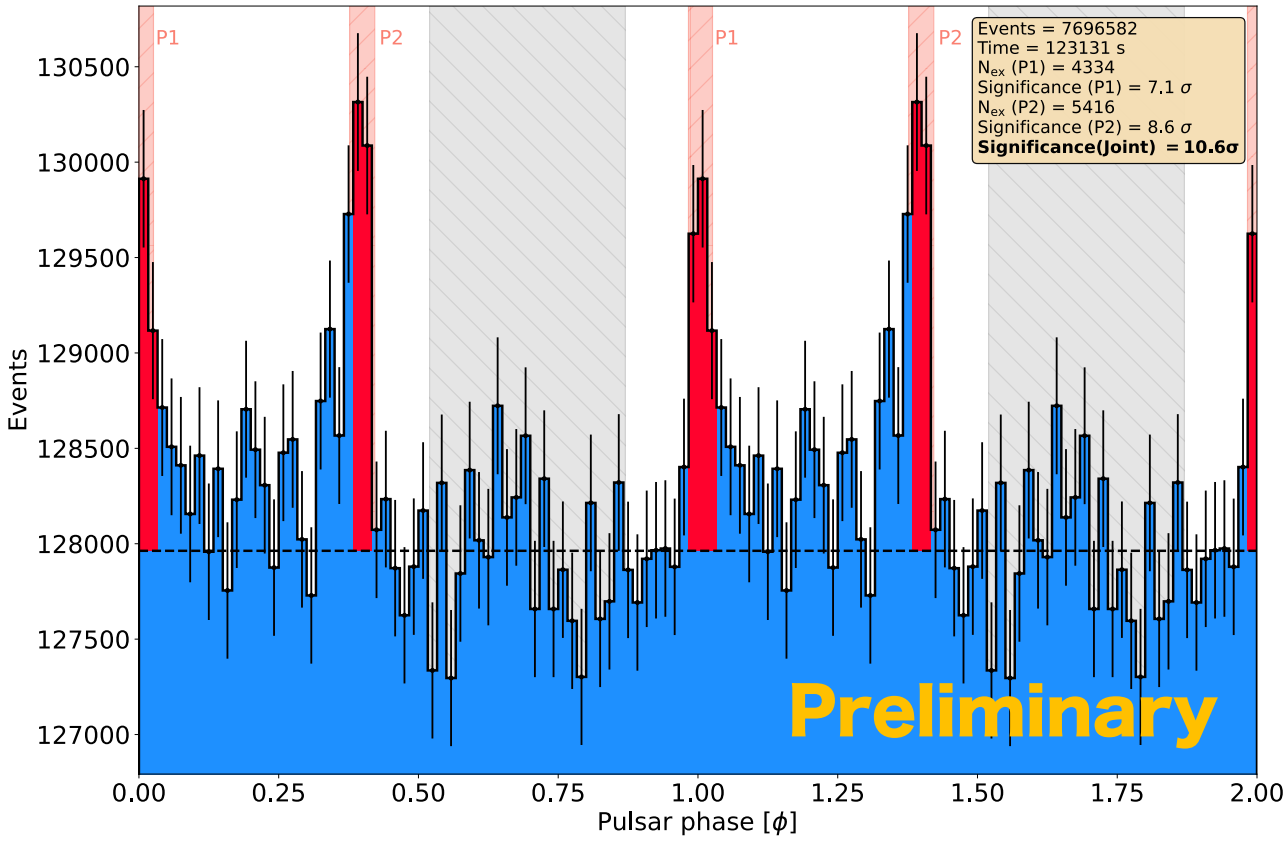
LST1 + MAGIC joint data analysis

Stereo Observations improve the sensitivity

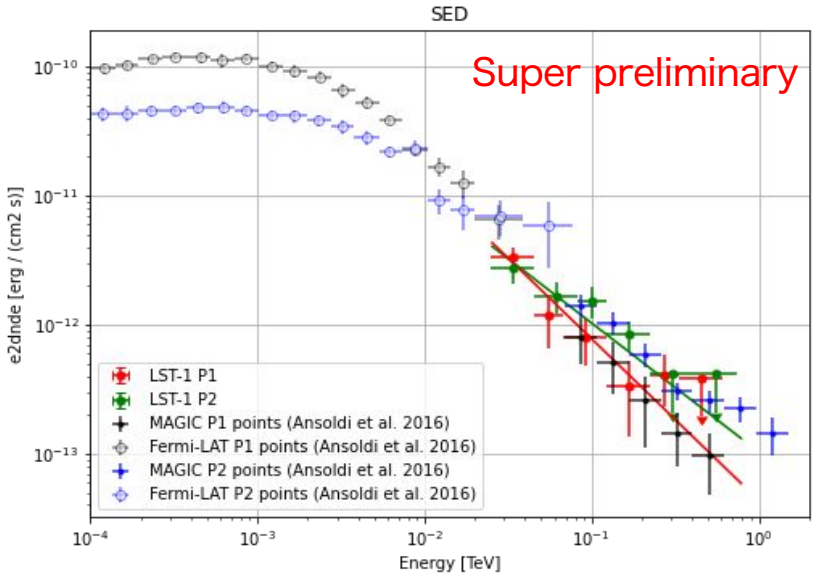




Crab pulsar phaseogram



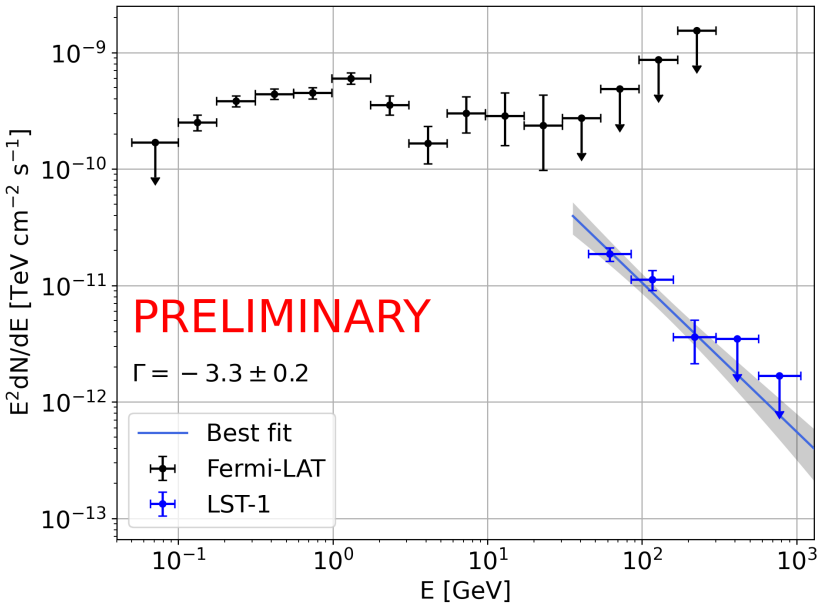
- Observation time: 34.2 hours
- Nov 2020 - March 2022
- Highly significant detection down to few tens of GeV.
- Low energies: P1/P2 tends to 1.
- Stay tuned for spectrum down to few tens of GeV…

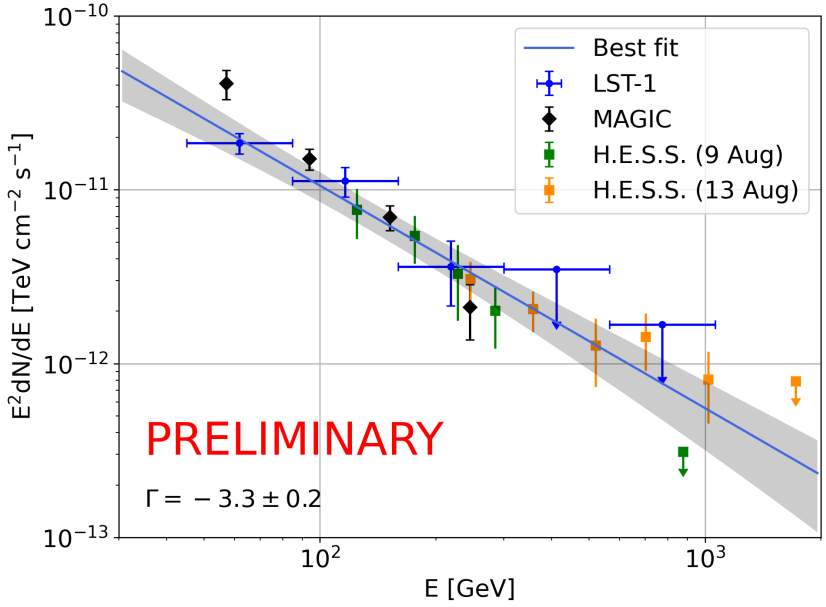


First VHE-detected Recurrent nova: RS Ophiuci

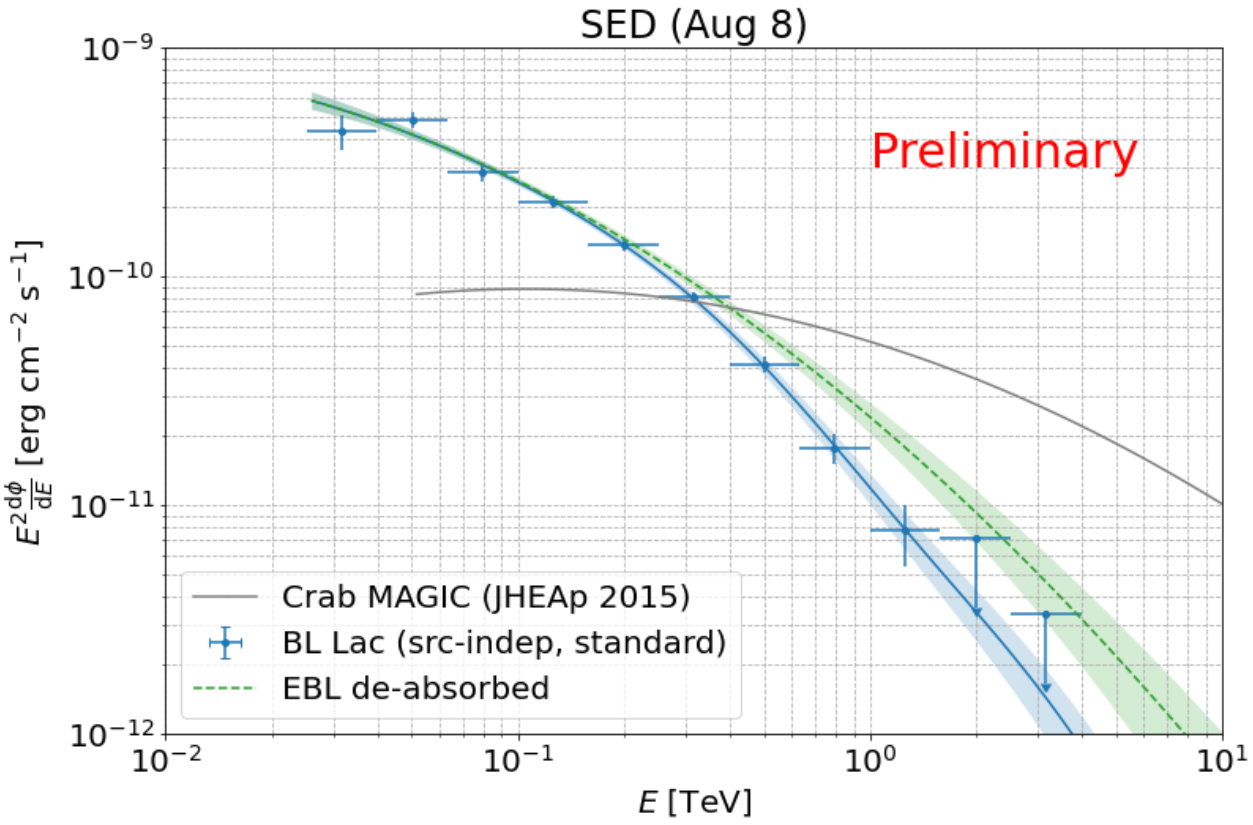
- RS Ophiuchi is a recurrent Nova.
- Explosions, 1898, 1933, 1958, 1985, 2006, 2021
- Mag 12.5 (low state) ➔ Mag 4.7 (~1000 times)
- Binary System with a White Dwarf and a Red Giant
- Accumulation of material on the WD, and then thermonuclear reaction makes recurrent explosions

Credit: David A.Hardy/ www.astroart.org & PPARC.

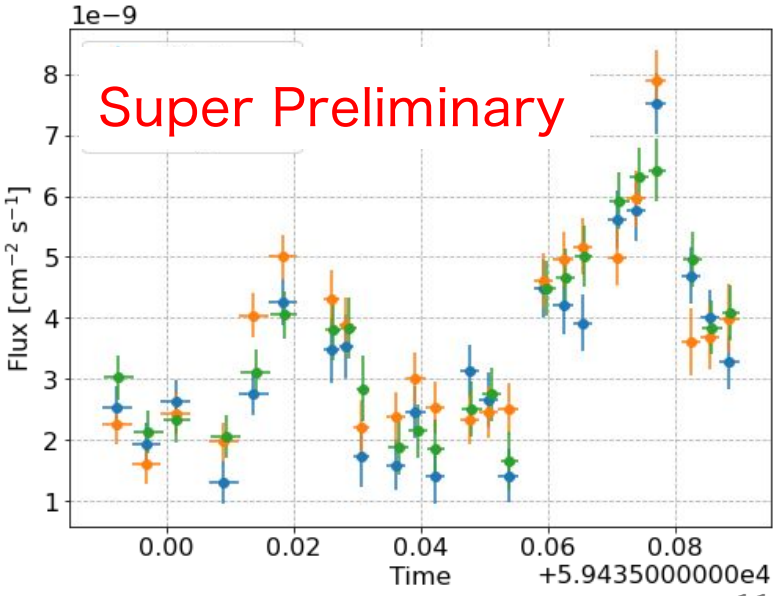




BL Lacertae flare
on 8th August 2021



- IBL at z=0.069
- In a high emission state since 2020
- August 8th 2021: High state >1 crab for E<300 GeV.
- Soft spectrum allows to extract spectral point at 30 GeV in <2 hour observation.



CTA and LST Timeline

- ❑ 2016 - 2018 LST1 in construction
- ❑ 2019 - LST1 in commissioning phase
- ❑ 2022 - 2024 LST2-4 will be constructed
- ❑ 2025 - LST1-4 in commissioning
- ❑ 2026 - 2027 The final Acceptance of LST1-LST4 and IKC process
- ❑ 2023 - 2027 LST5-8 construction

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Organization	CTAO gGmbH (Heidelberg)										
			CTAO ERIC (European Research Infrastructure Consortium)								
Alpha Config	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
LST North	Comissioning and Operation of LST1					Operation as 4 LST Array				Observatory Operation	
	CDR		Deployment of LST2-4								
MST North	Design and Finance		INFRA	Construction of 9MSTs							
CTA South	Array config, Finance and CDR		INFRA		Construction and Deplyment of 14 MSTs						
					Construction and Deployment of 37 SSTs						
Extension	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
LST South		Finance / CDR		Construction of 4 LSTs ???			Operation ???				

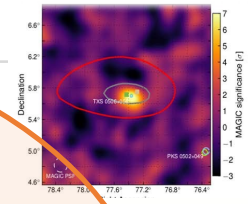
Multi-messenger and Multi-wavelength Astrophysics

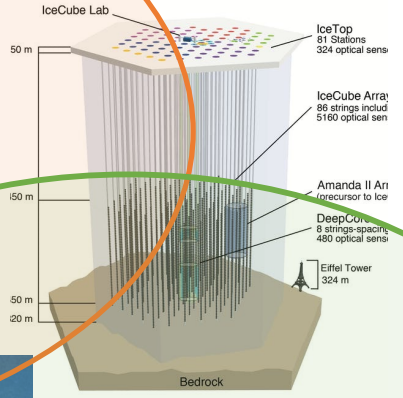
cherenkov telescope array

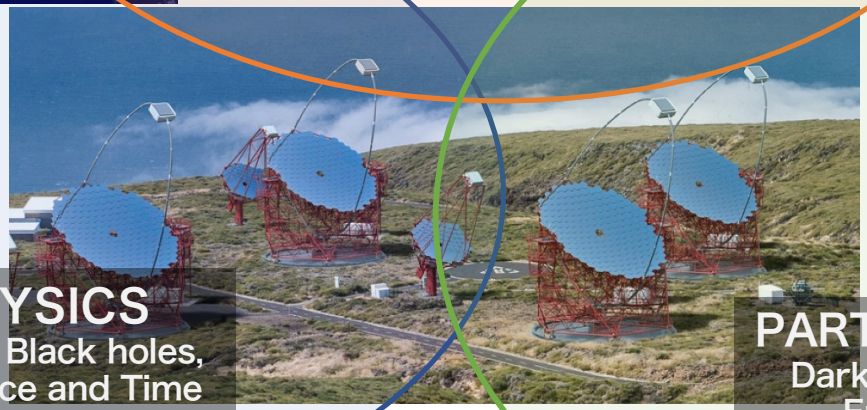
Wave AstroPhysics

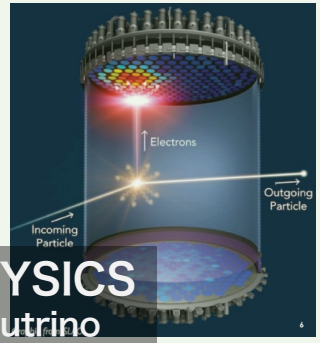
Particle Physics

ASTRO-PARTICLE PHYSICS
Cosmic Ray Physics
High Energy Astrophysics



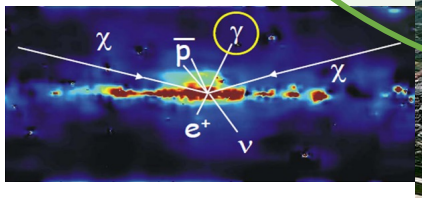






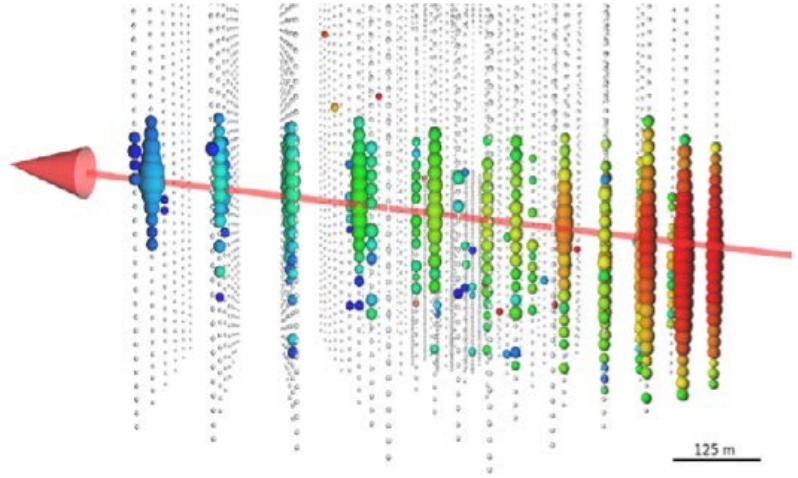
ASTRO-PHYSICS
Gamma Ray Bursts, Black holes,
Neutron Stars, Space and Time

PARTICLE PHYSICS
Dark Matter, Neutrino
Energy Frontier

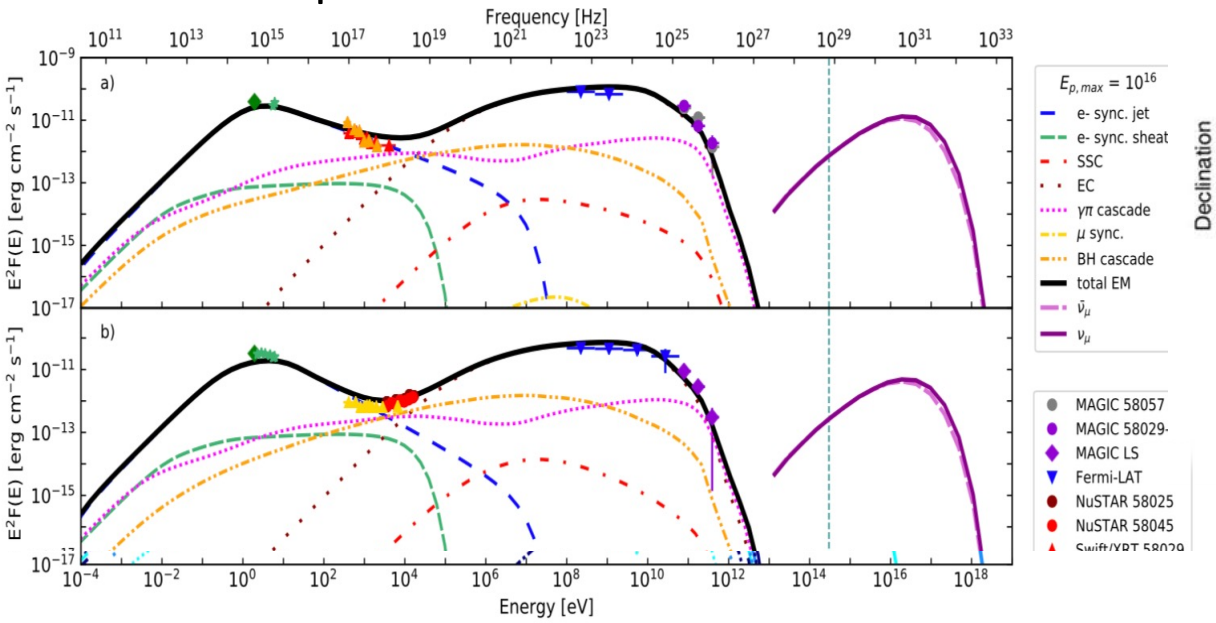


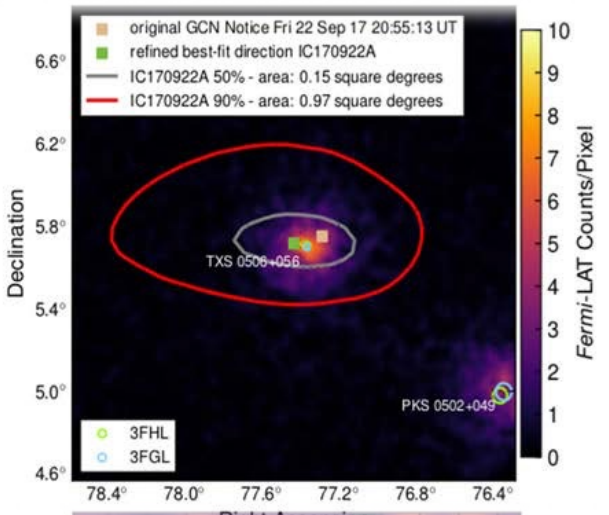
Multi Messenger Astronomy
IC170922A / TXS 0506+056

Ice Cube Observation (~300TeV)

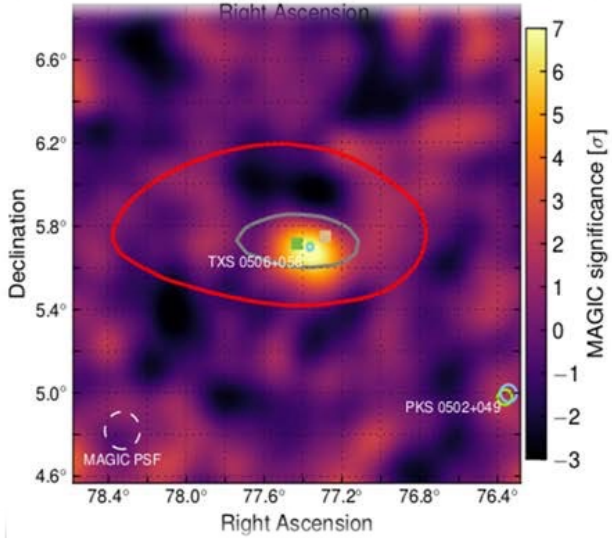


Lepto-Hadronic Scenario





Fermi LAT
(>100 MeV)



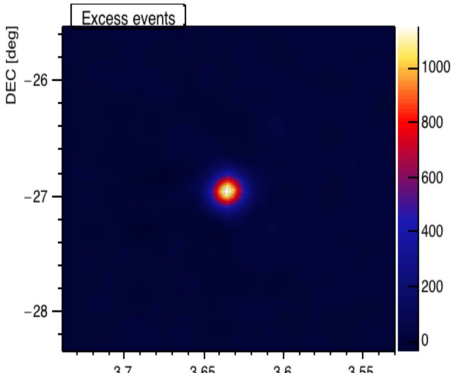
MAGIC
(>100GeV)

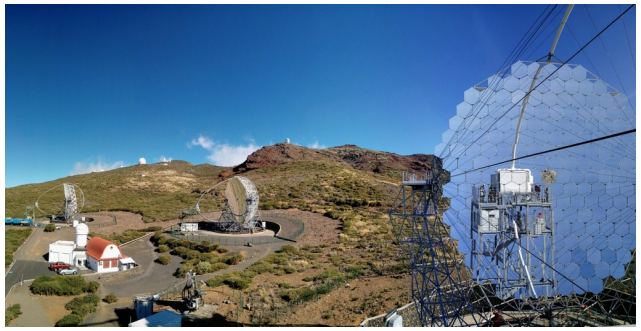
GTC Observation z = 0.3365
S. Paiano et. al 2018

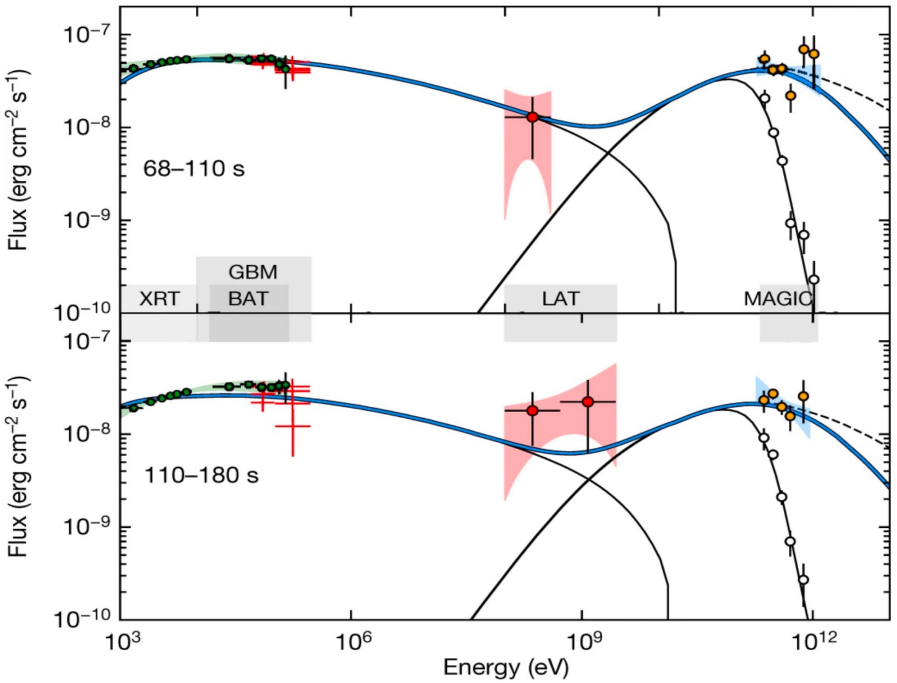
MAGIC Highlight, Gamma Ray Burst GRB190114C (z=0.42)

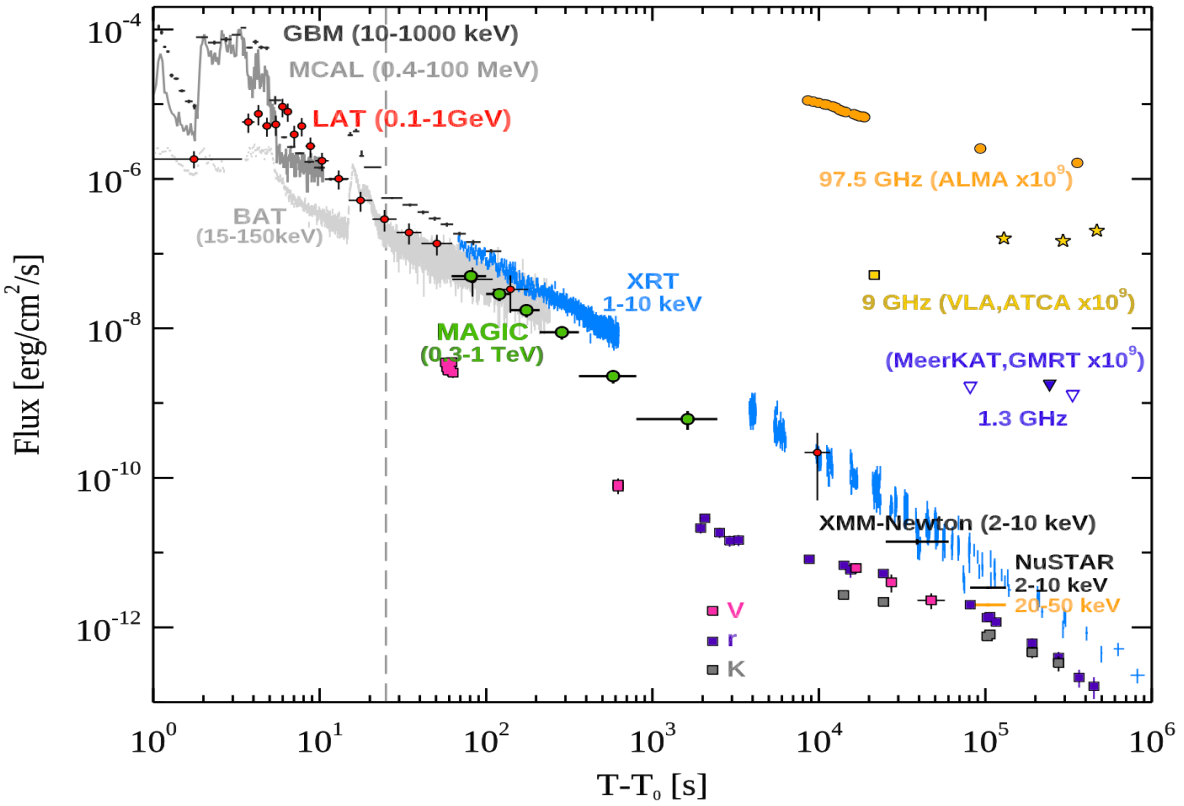
Historical achievement

- ❑ First Detection of the GRB from ground.
- ❑ ~100 Crab flux in the first minutes.
- ❑ TeV bump has a similar energetics with KeV-GeV bump



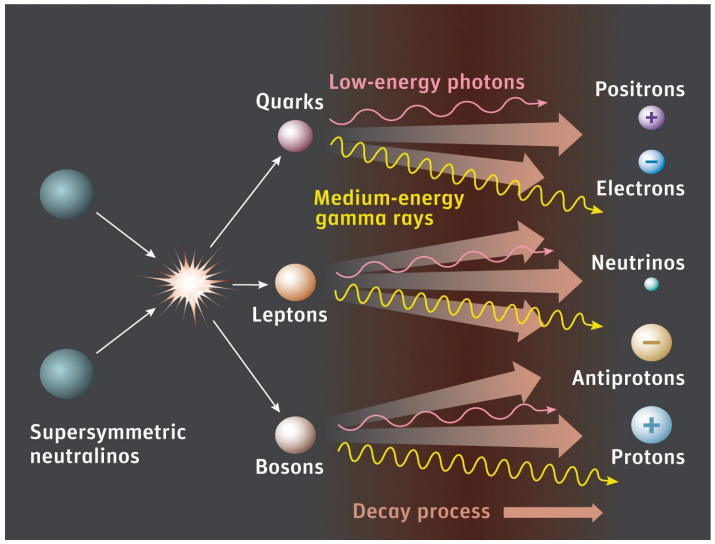






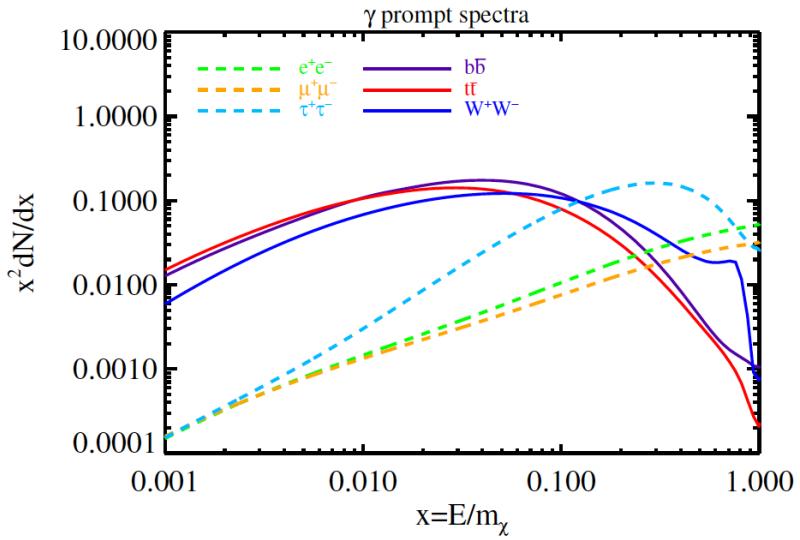
Dark Matter Search

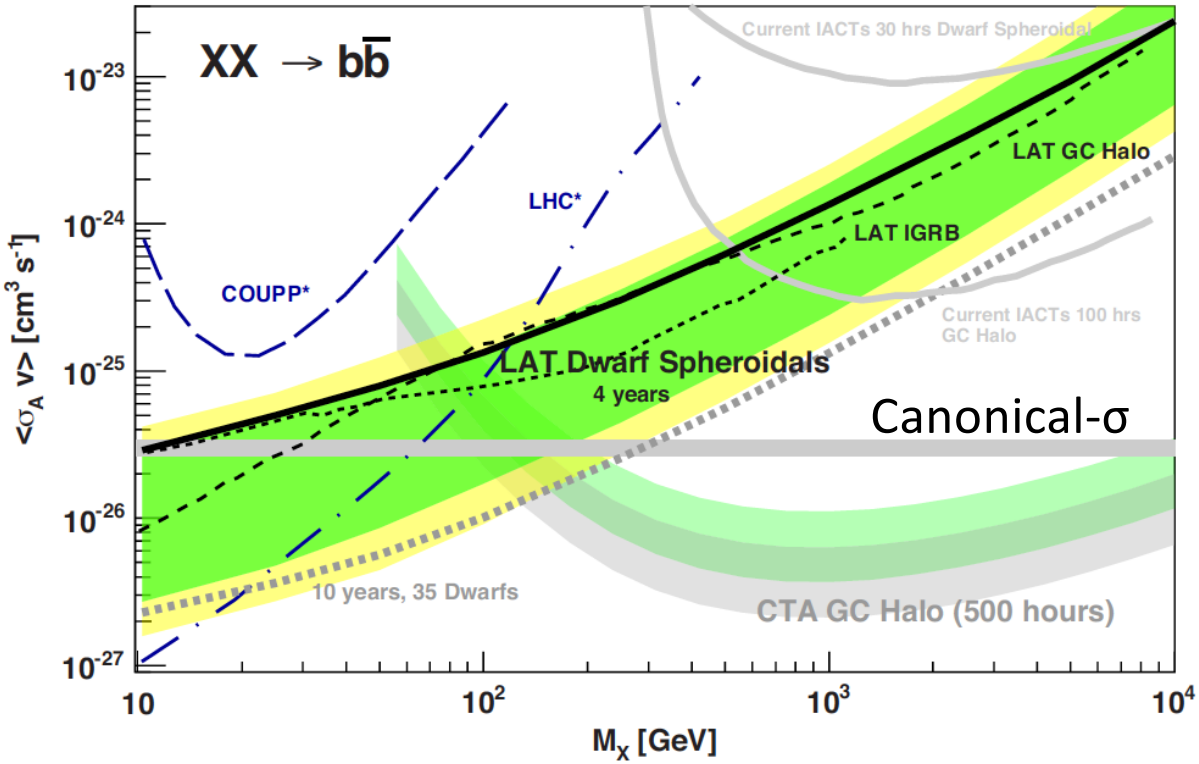
Sensitive M_χ: 200GeV - 10TeV



$$\frac{d\Phi_\gamma}{dE_\gamma} = \frac{1}{4\pi} \underbrace{\frac{<\sigma_{ann} v>}{2m^2_{WIMP}} \sum_f \frac{dN^f_\gamma}{dE_\gamma} B_f}_{\text{'Particle Physics'}} \times \underbrace{\int_{\Delta\Omega} d\Omega' \int_{los} \rho^2 dl(r,\theta')}_{\text{'Astrophysics' or } J(E)}$$

Particle Physics **Astrophysics**





Gamma rays from Annihilation produce the bump around 1/10 -1/20 Mχ ➔ 20GeV-1TeV domain

CTA gives the stringent upper limit. Stefan Funk 2015

Summary

- I appreciate our young colleagues' continuous development of Software and Hardware in CTA-LST Consortium.
- We should also continue to work to achieve our goal of a high-performance **all-sky observatory with LSTs.** PNRR (INAF and INFN) program will make it a reality.
- **LSTs are telescopes for observations of GRBs, transient sources, multi-messenger astronomy,** Gravitational-wave sources, High-Energy neutrino sources, and Search for Dark Matters.

- **Multi-wavelengths and Multi-messengers Astronomy**

- **Great Scientific results are waiting for you!!**


Thank you
Landscape in 2025


cta
cherenkov
telescope
array