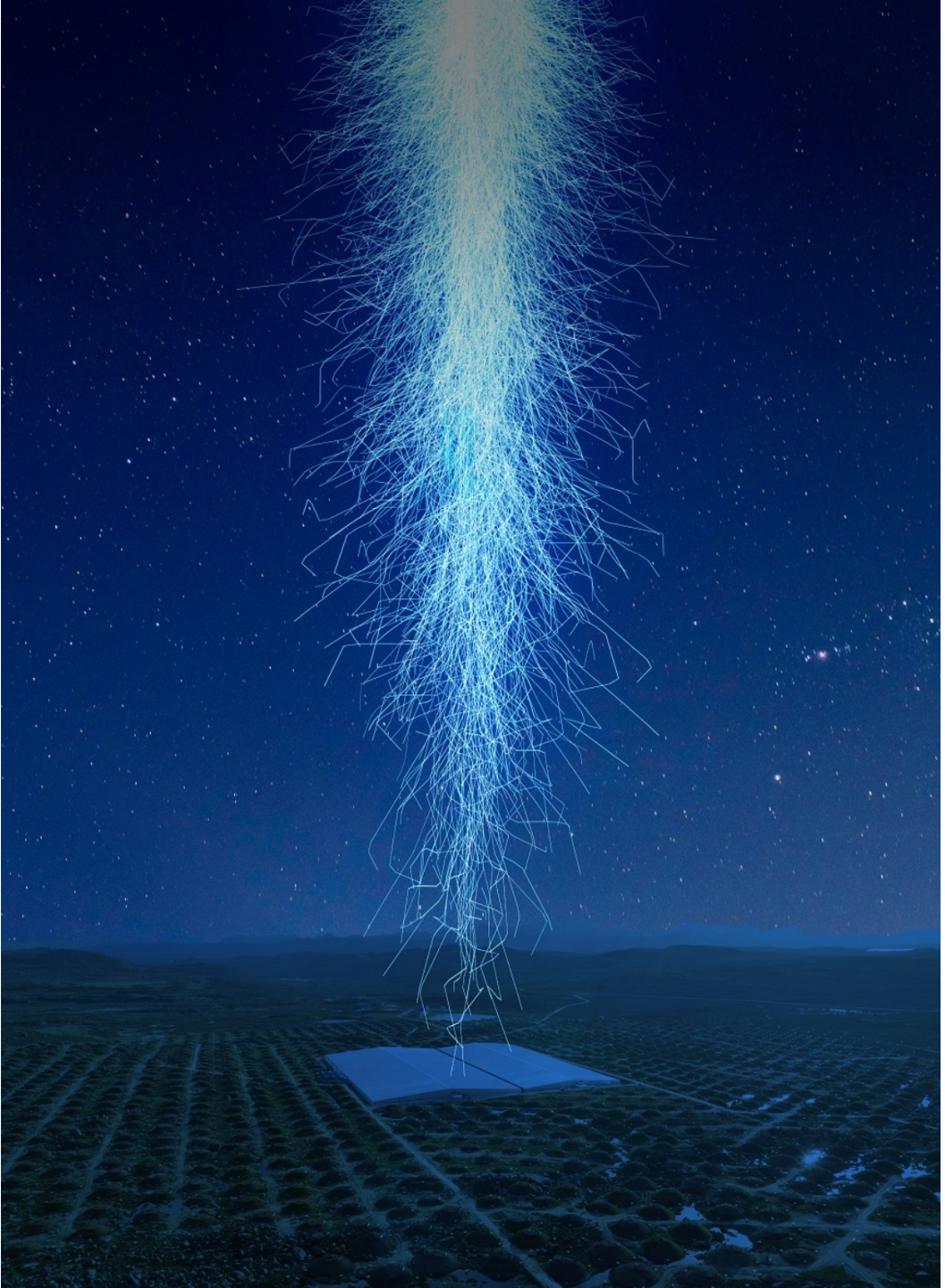
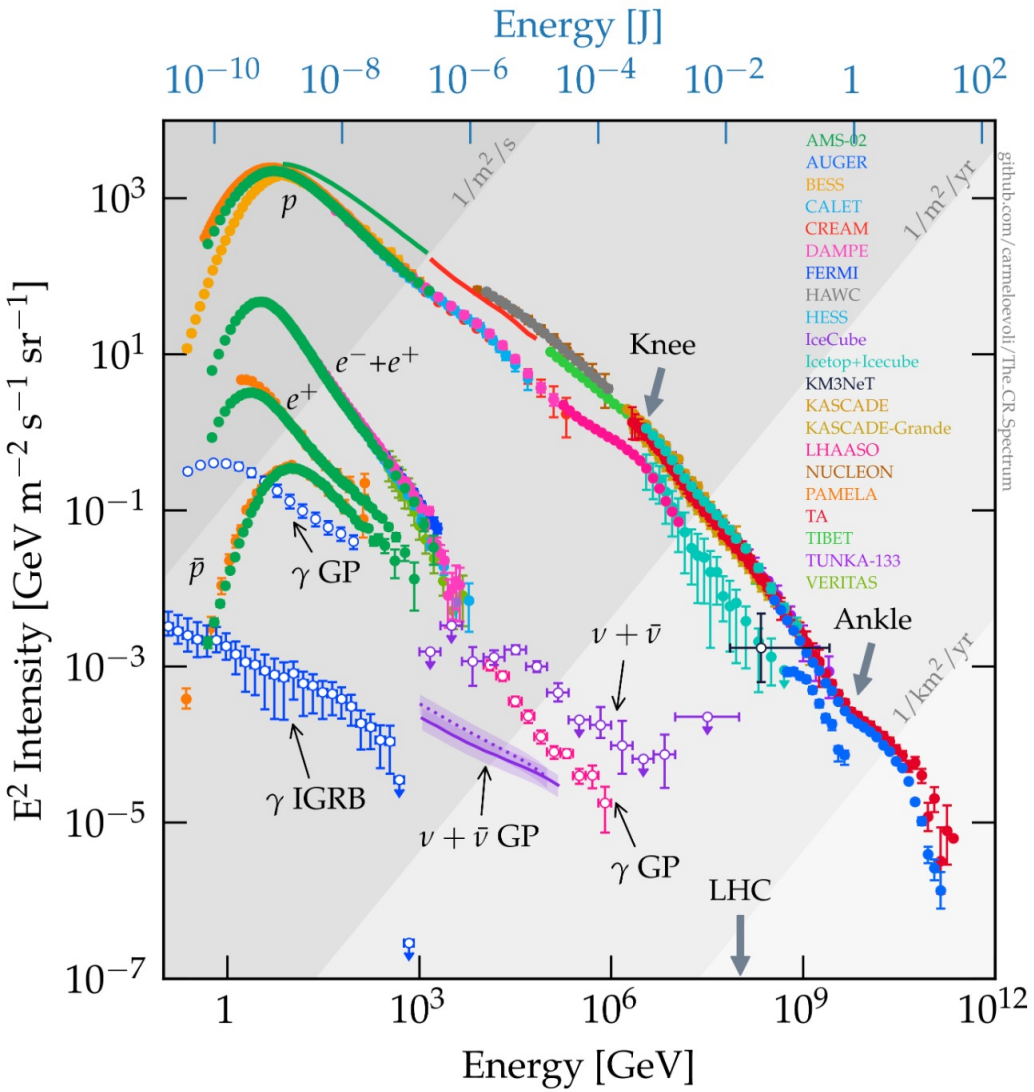


LHAASO Recent results on Diffuse gamma ray

Yanhong Yu (于艳红)
Henan Normal University
On behalf of the LHAASO Collaboration
yuyanhong@htu.edu.cn

Cosmic Ray



Below 10^{15} eV : Galactic （G）

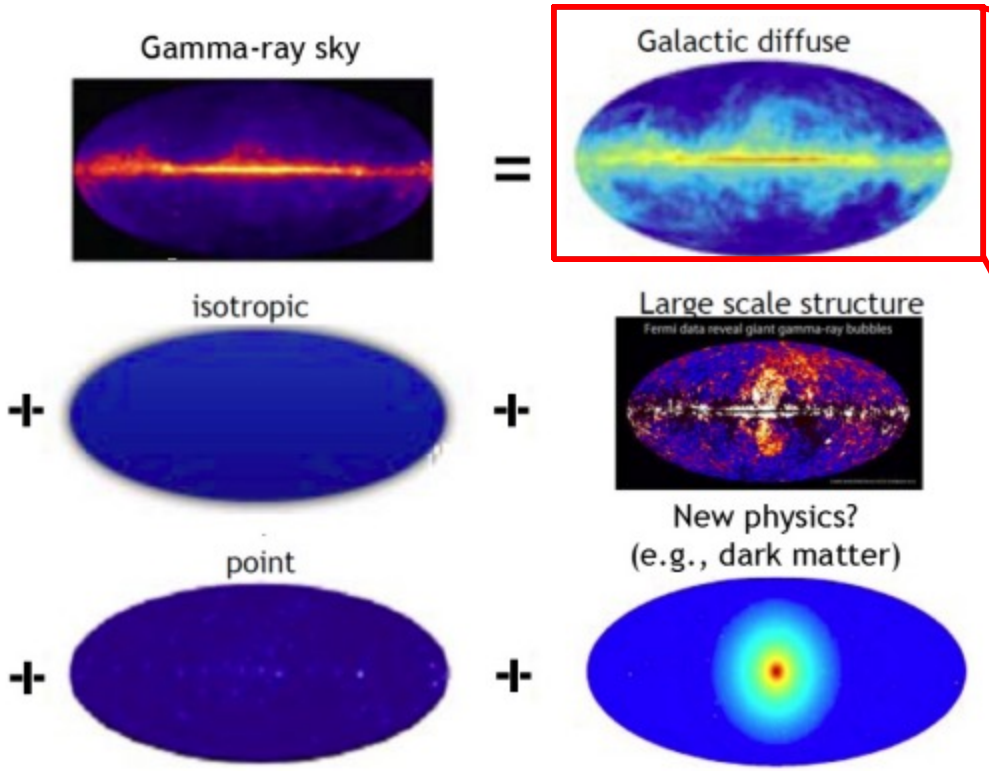
Beyond 10^{18} eV : Extragalactic (EXG)

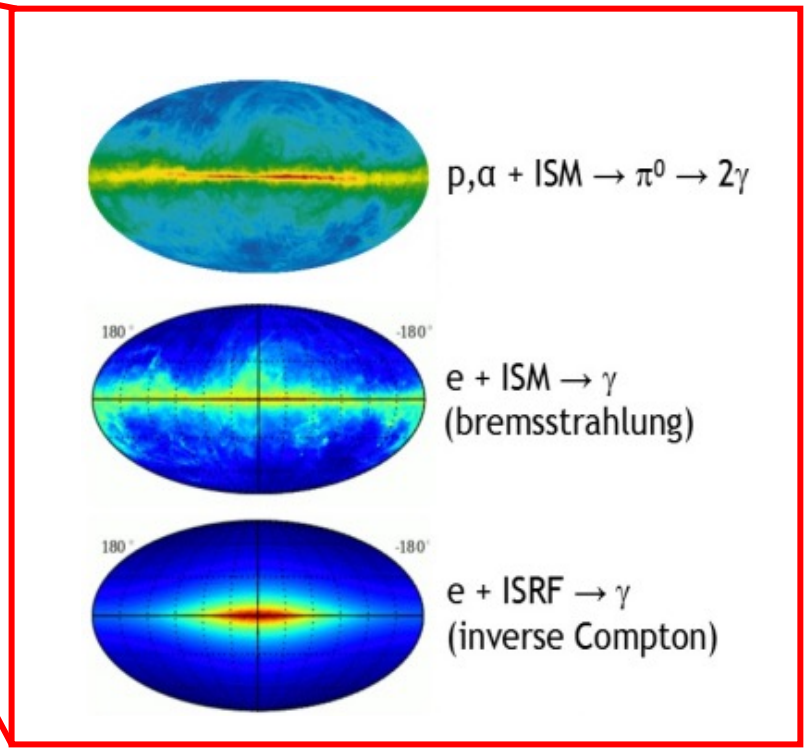
Between 10^{15} - 10^{18} eV : G/EXG

'After 100+ years of the discovery of cosmic rays, their origin remains a mystery'

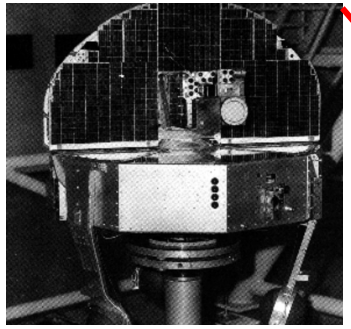
Investigating Galactic cosmic rays with γ-ray astronomy

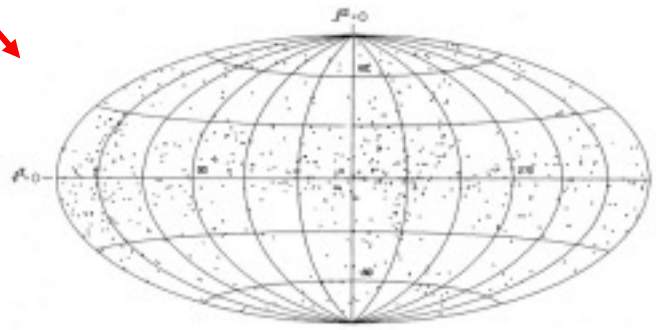
The Gamma Ray Sky

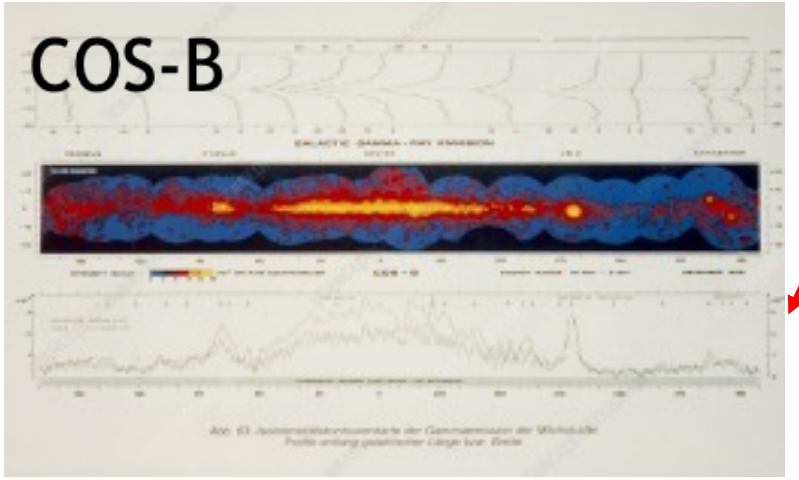


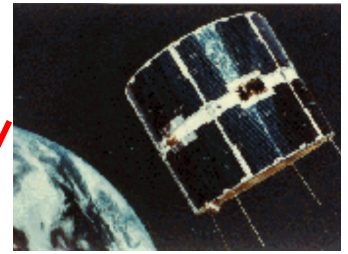


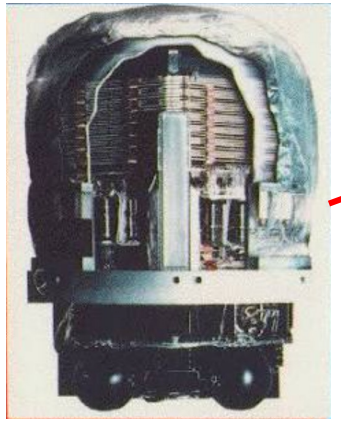
Diffuse gamma ray observations from space (<TeV)

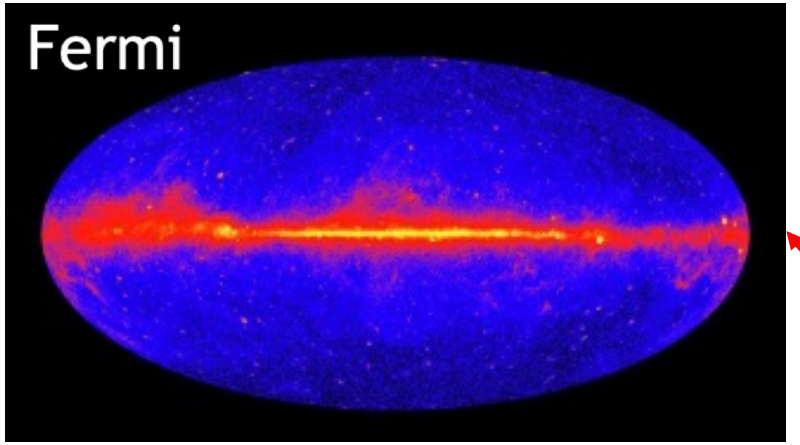




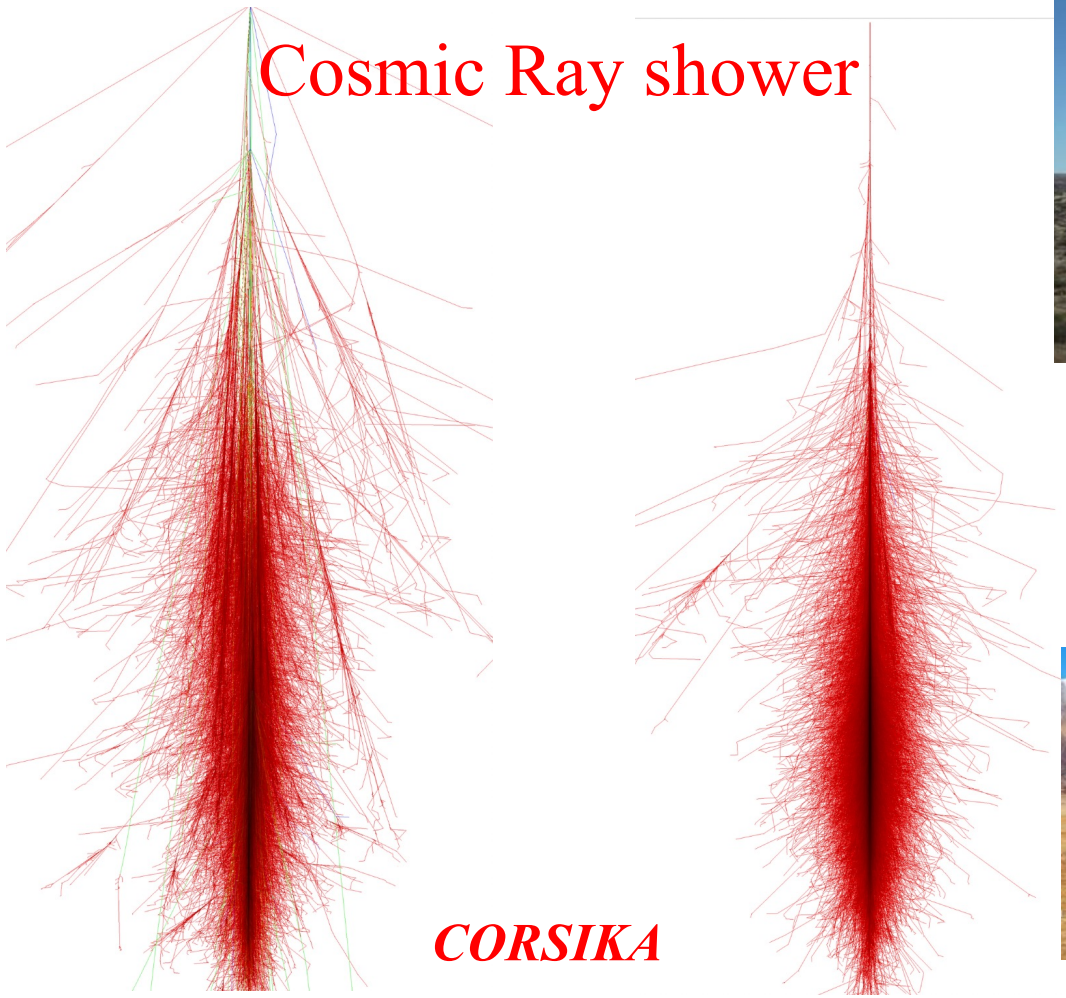




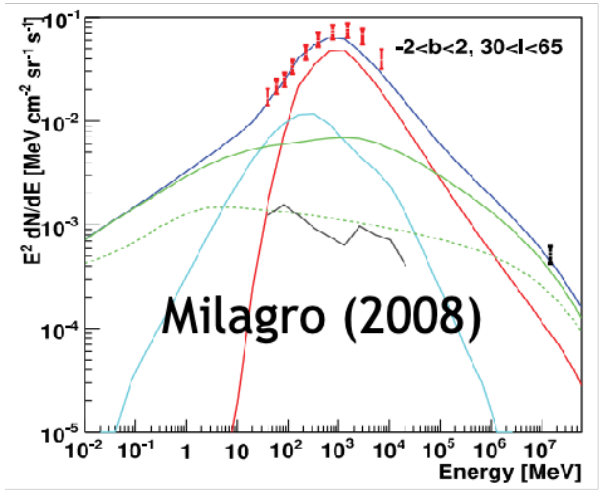


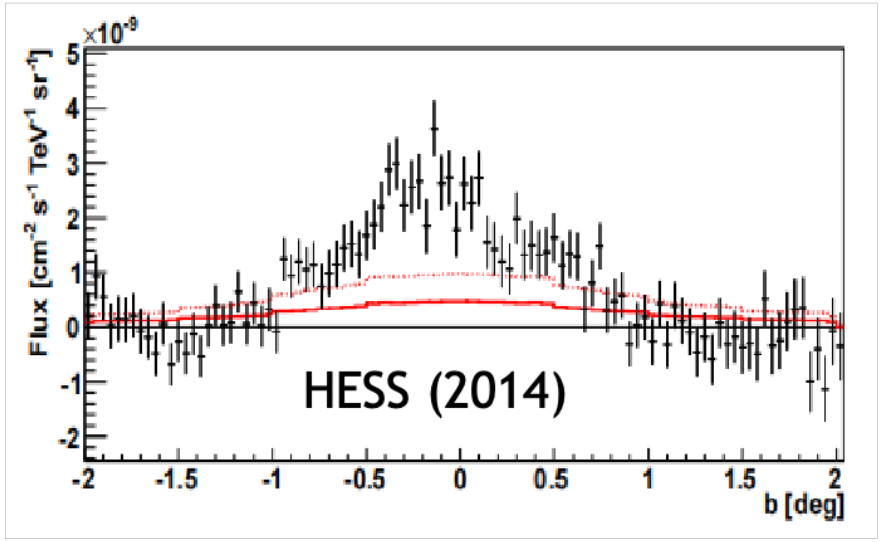


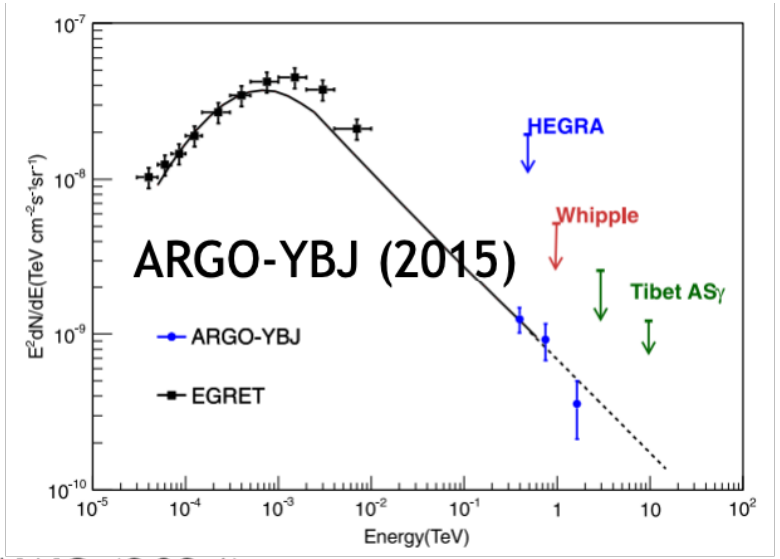
VHE gamma ray measurement on ground (key role >TeV)

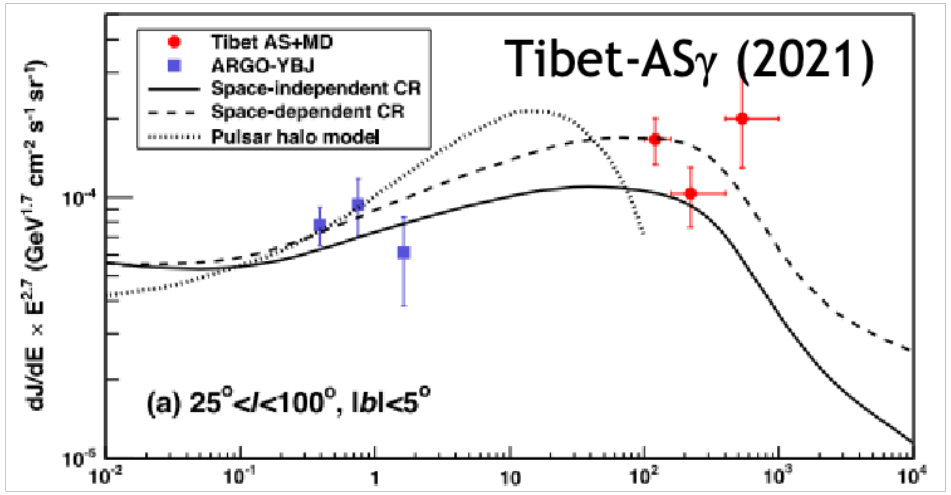


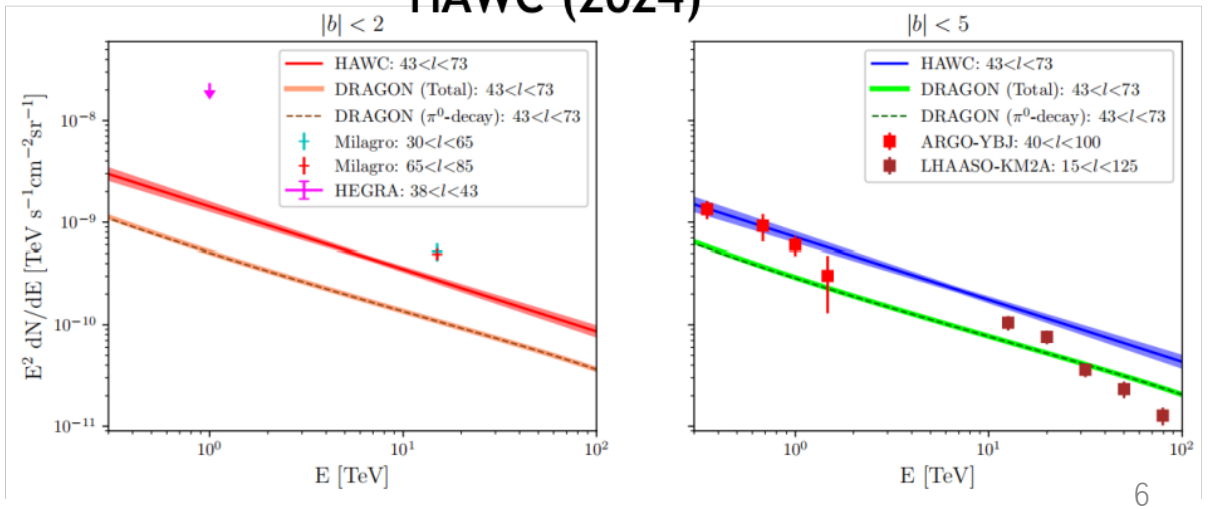
VHE gamma ray measurement on ground （key role >TeV)







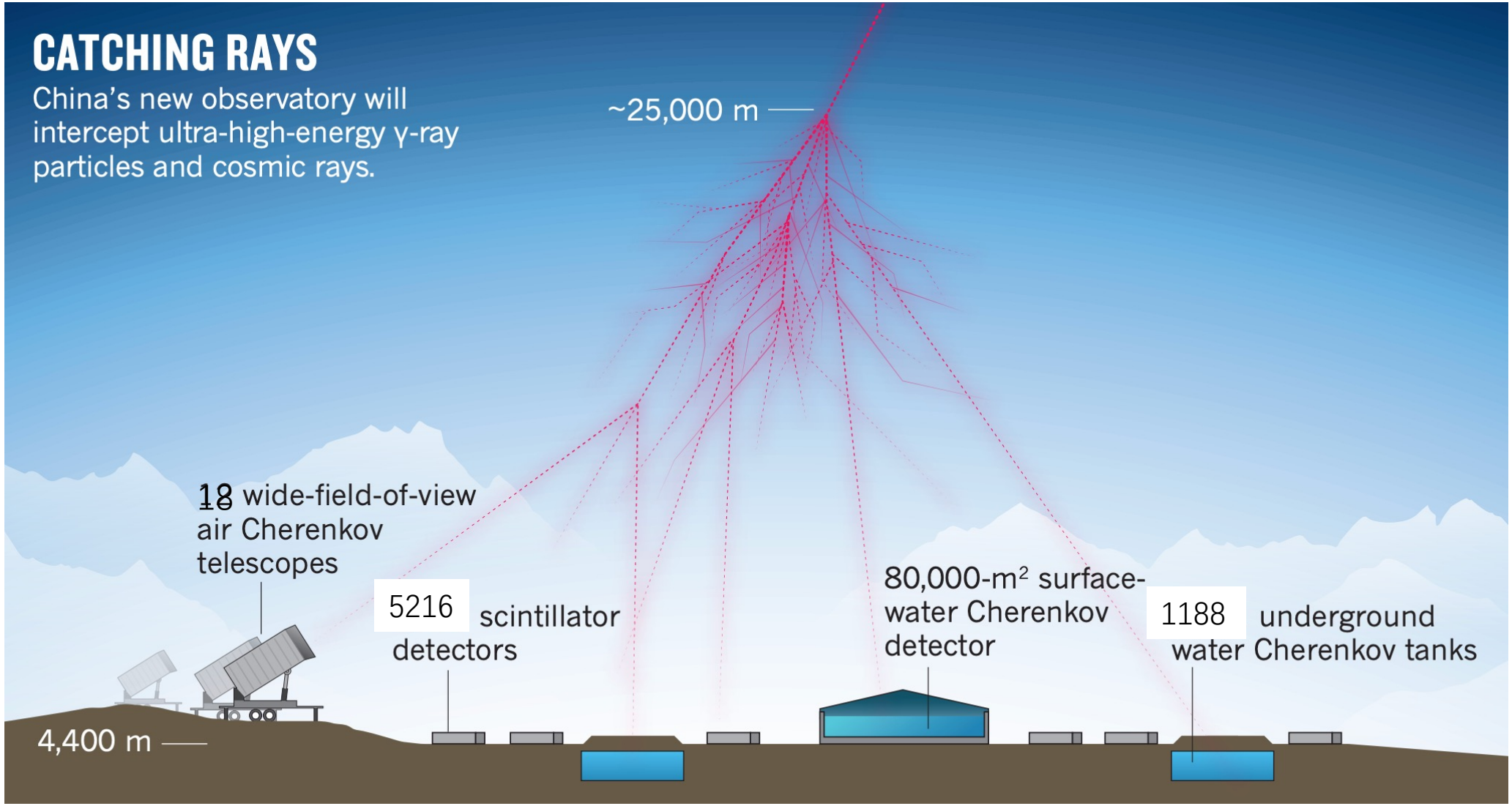




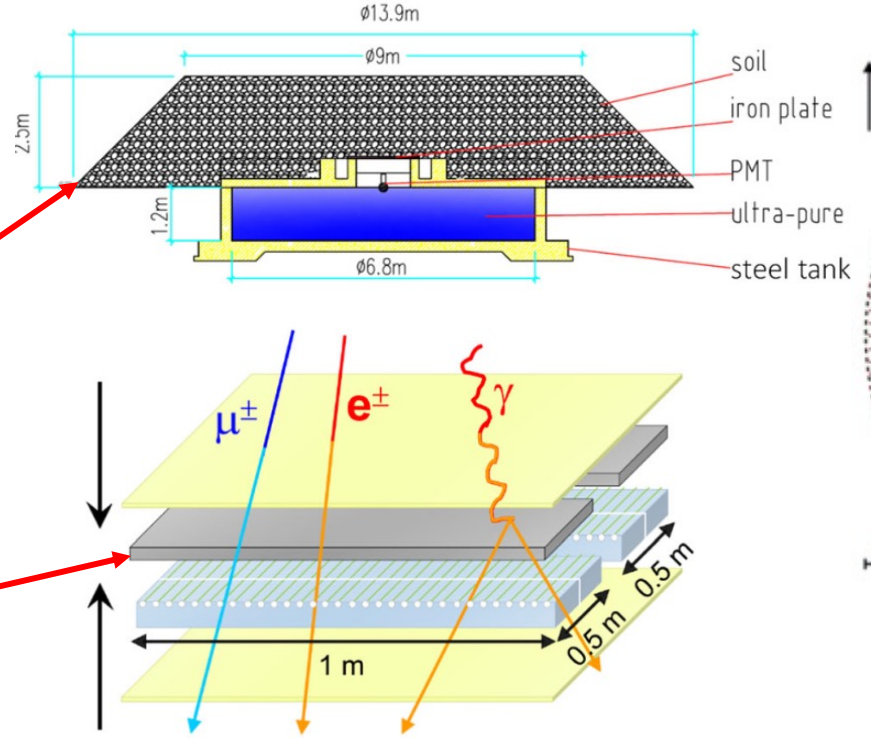
Large High Altitude Air Shower Observation (LHAASO, 拉索)

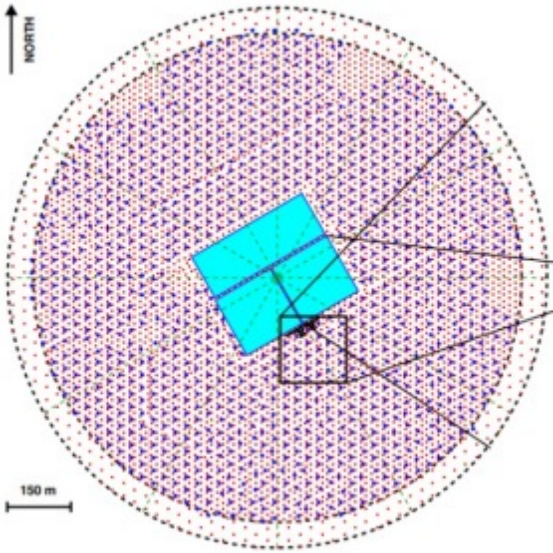
- Haizi Mountain, Sichuan, China, 4410 m above sea level
- LHAASO uses hybrid detector arrays: the square kilometer array (KM2A), the water Cherenkov detector array (WCDA), and the wide field-of-view Cherenkov telescope array (WFCTA)
- We have been in full operation since July 2021

LHAASO


CATCHING RAYS
China's new observatory will intercept ultra-high-energy γ-ray particles and cosmic rays.
~25,000 m
18 wide-field-of-view air Cherenkov telescopes
5216 scintillator detectors
80,000-m² surface-water Cherenkov detector
1188 underground water Cherenkov tanks
4,400 m

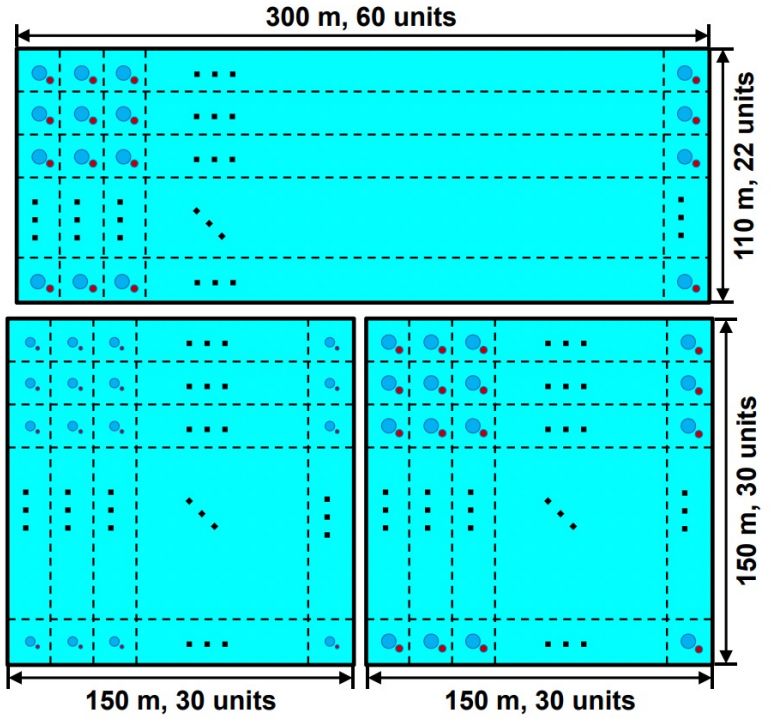
KM2A: Square Kilometer Array





- It covers 1.3 square kilometers with ~5,216 electromagnetic detectors for energy and direction reconstruction
- 1,188 muon detectors for gamma/hadron discrimination; largest of its kind; high rejection power for CRs
- Energy coverage: 4 TeV - 100 PeV

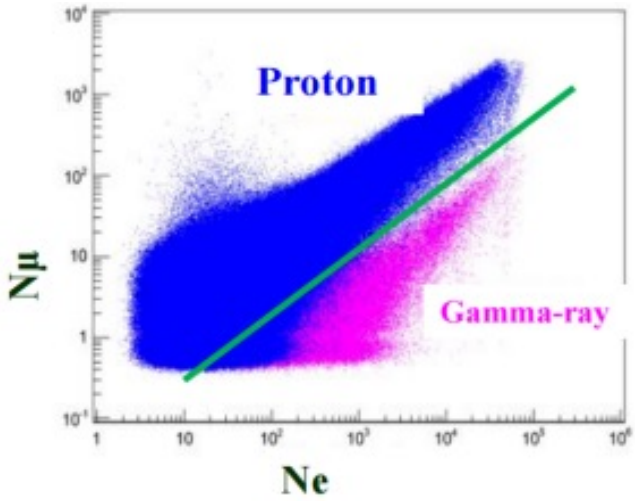
WCDA: Water Cherenkov Detector Array

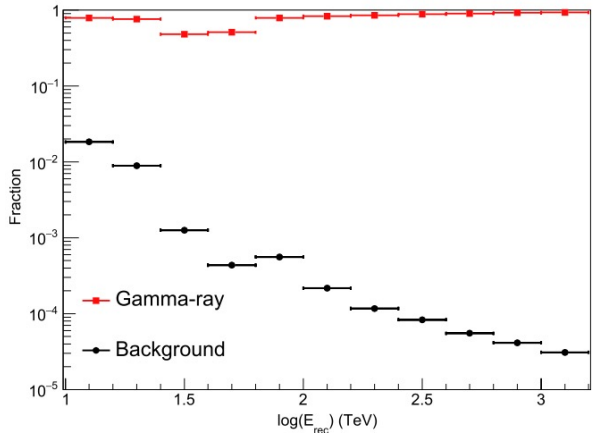


- 78000 m2 water pool to detect Cherenkov light produced by air shower secondary particles in water
- Energy coverage: 100 GeV – 20 TeV

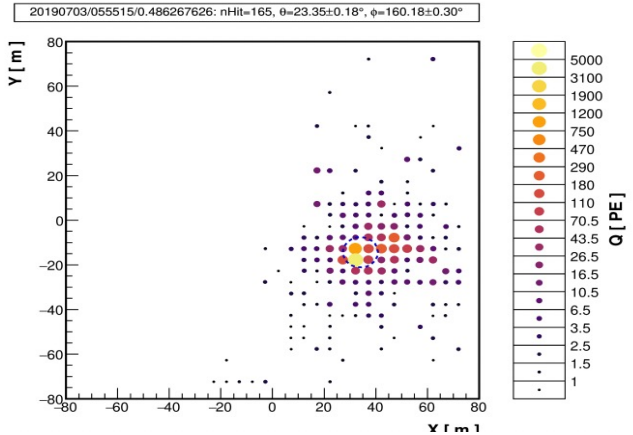
Gamma/CR discrimination

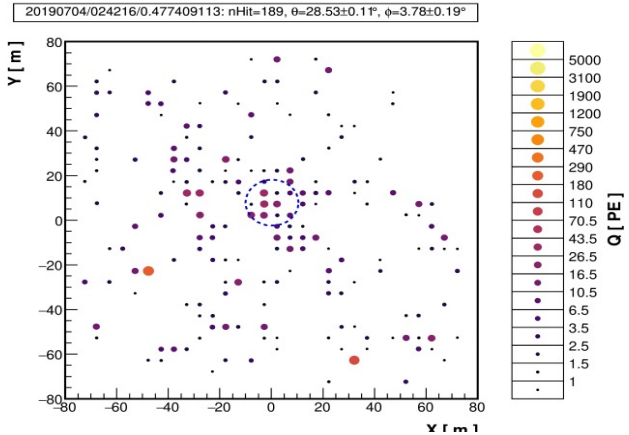
KM2A
Muon Contents





WCDA
Morphology





γ：a concentrated lateral distribution；CR： more dispersed

LHAASO 2020, 2021 *CPC*

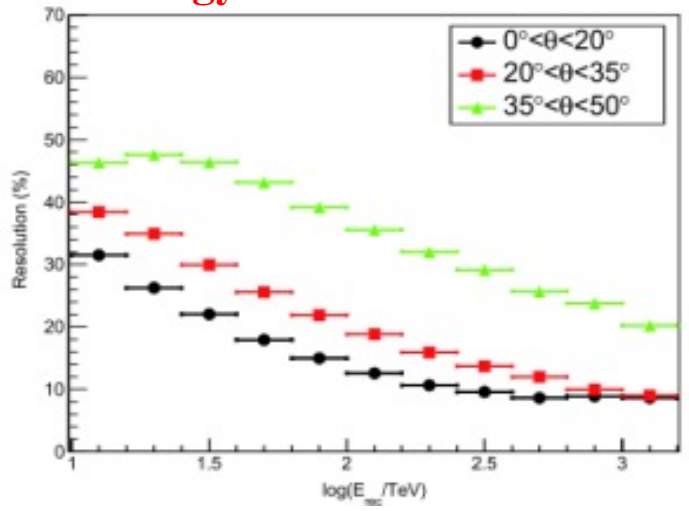
Gamma-ray performance for KM2A and WCDA

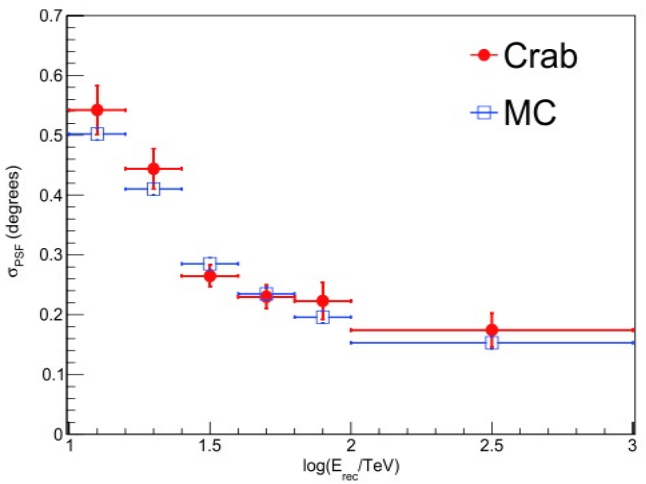
Energy

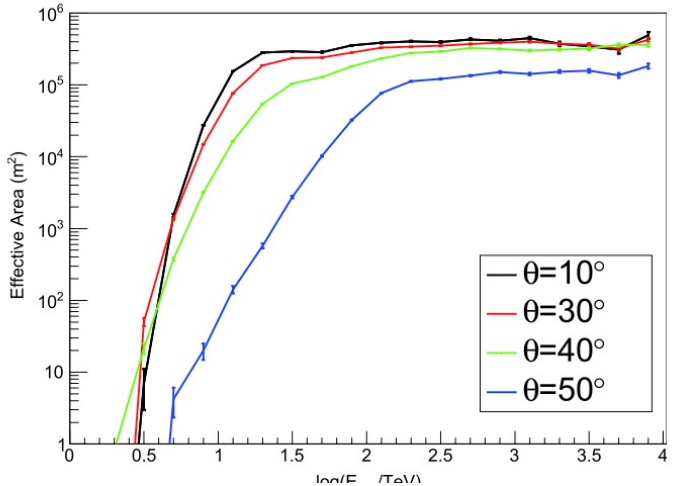
Angular resolution

Effective area

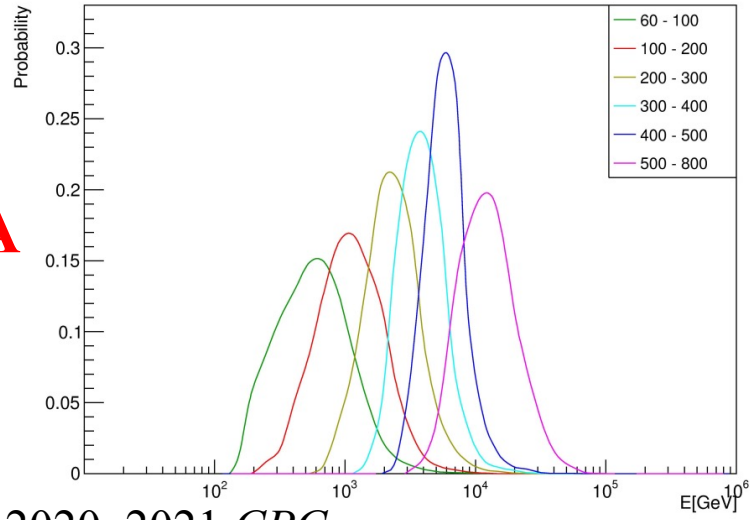
KM2A

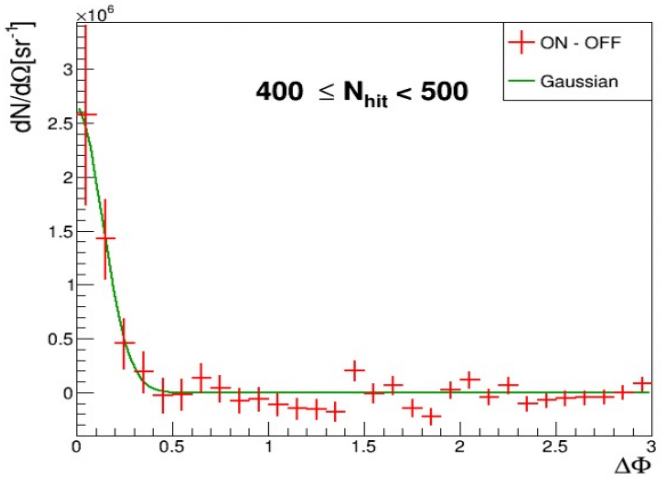


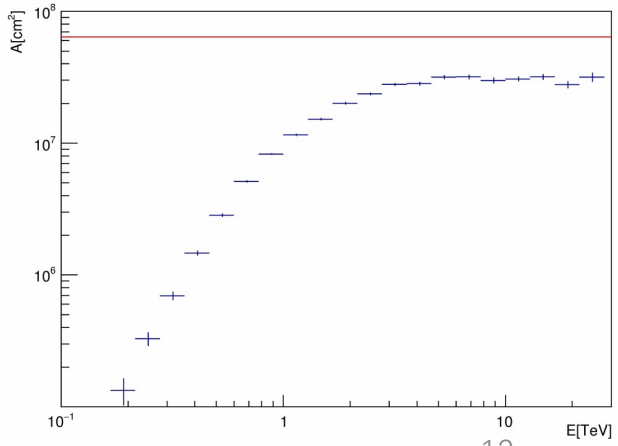




WCDA

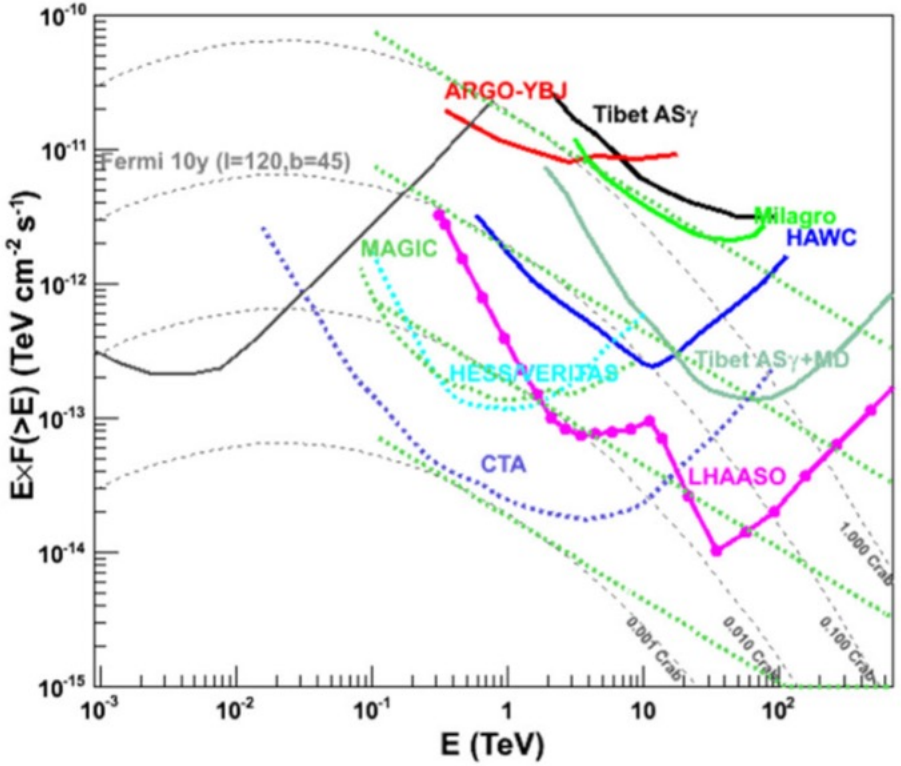


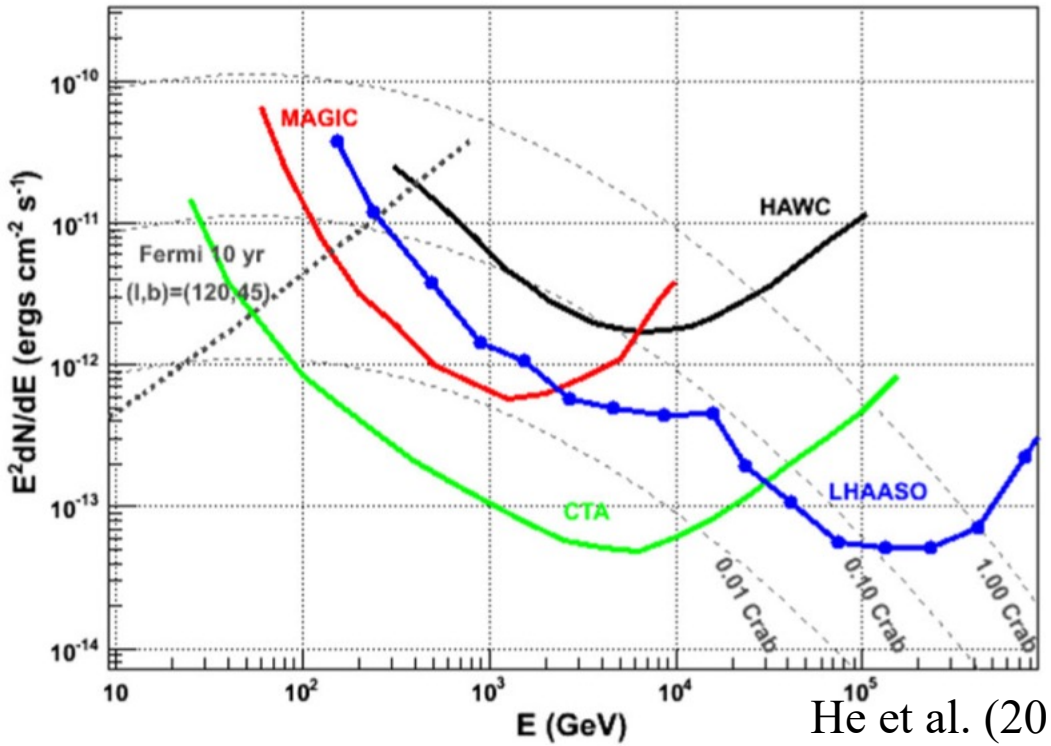




LHAASO 2020, 2021 *CPC*

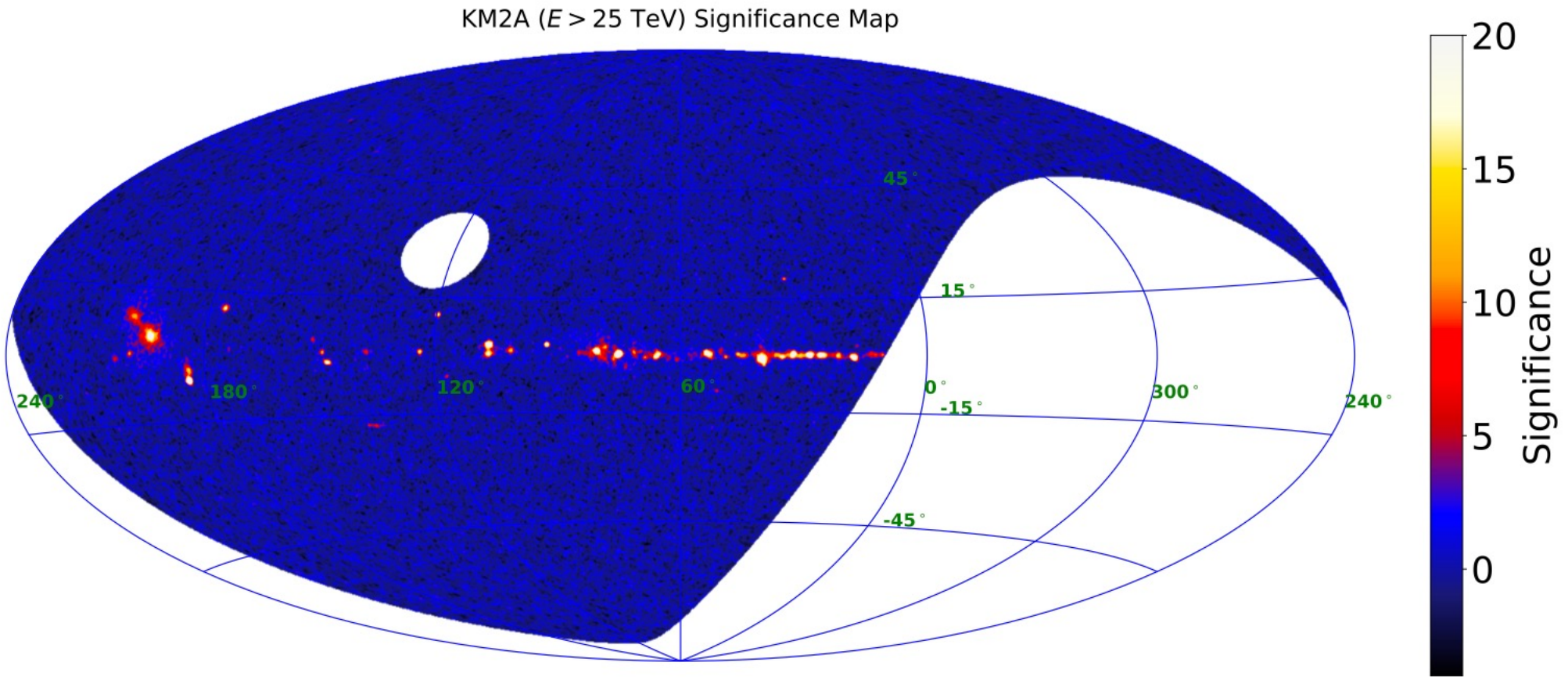
Sensitivity to gamma ray sources



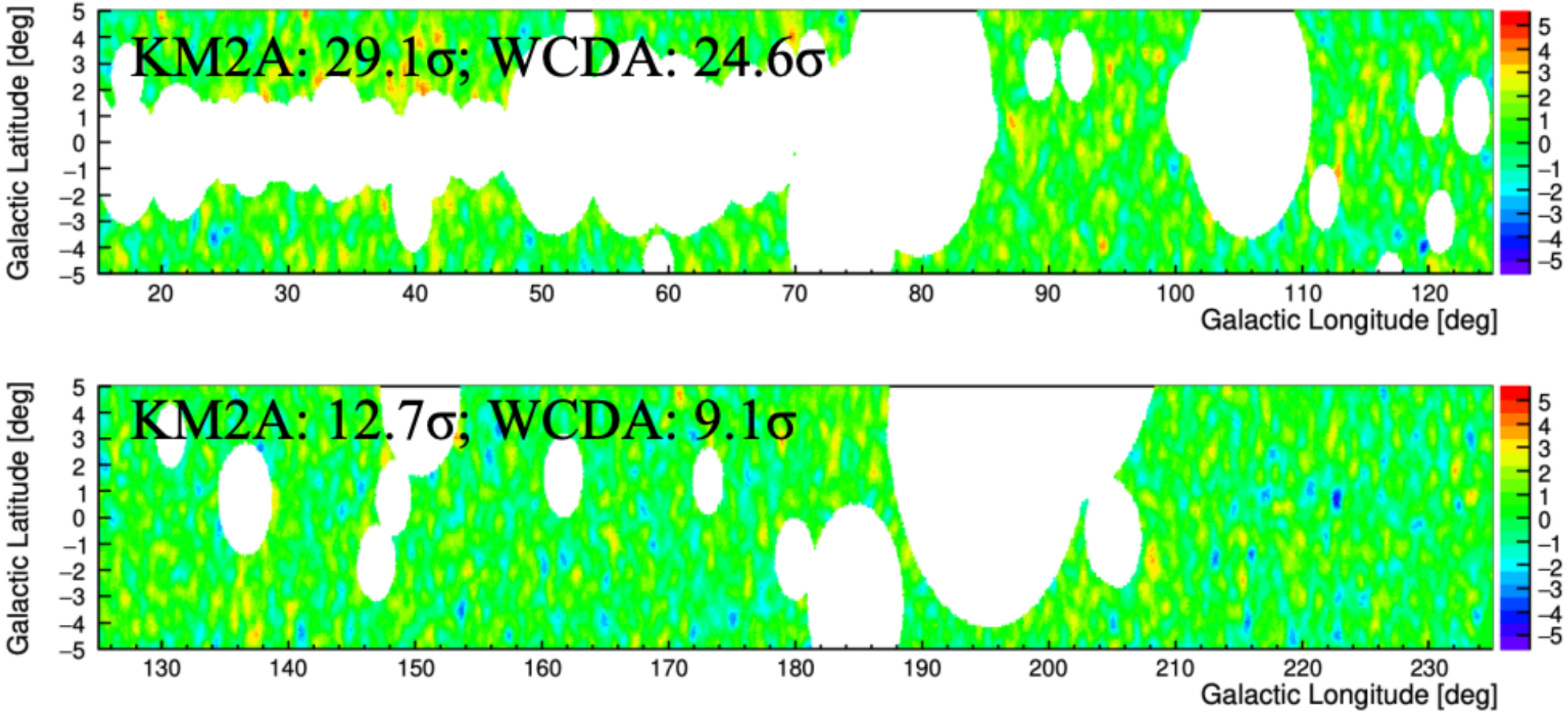


He et al. (2018)

LHAASO sky coverage

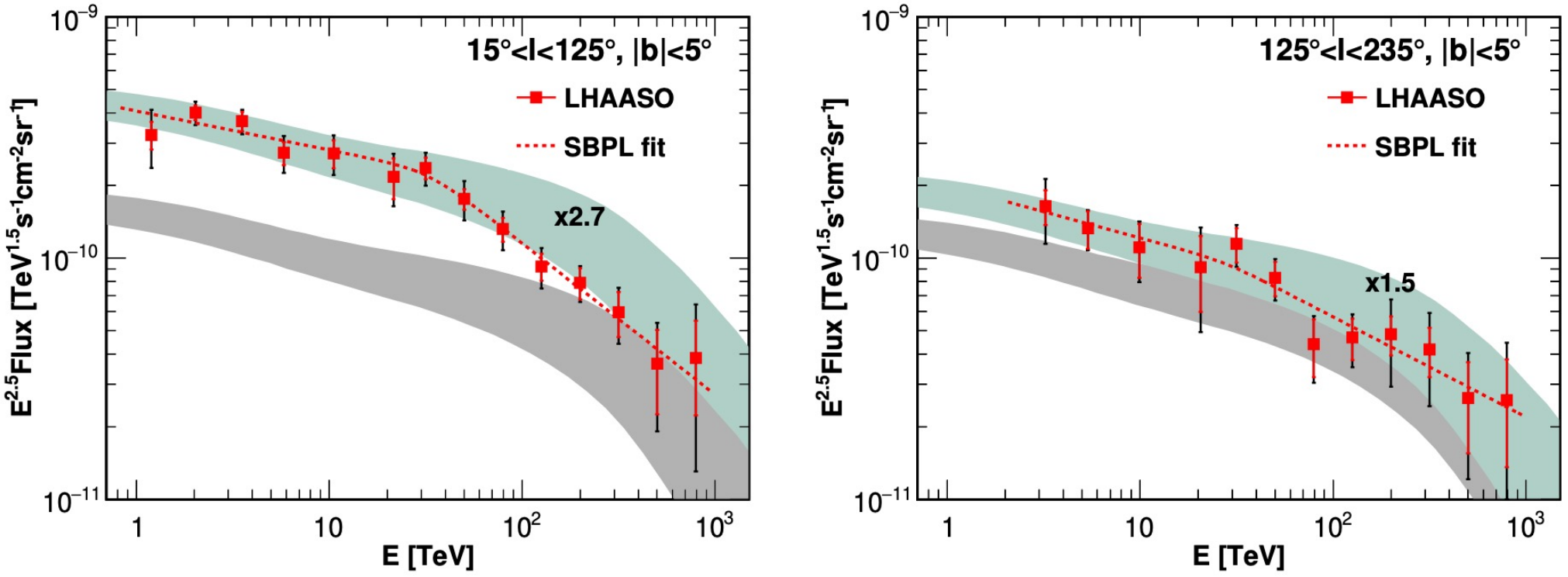


Galactic Plan γ Diffuse



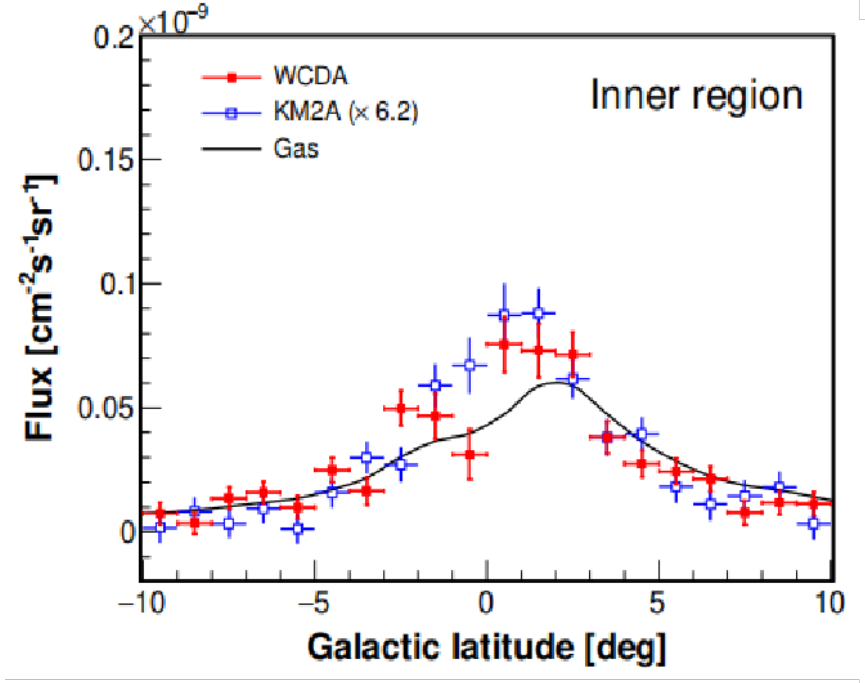
LHAASO 2023, 2025 *PRL*

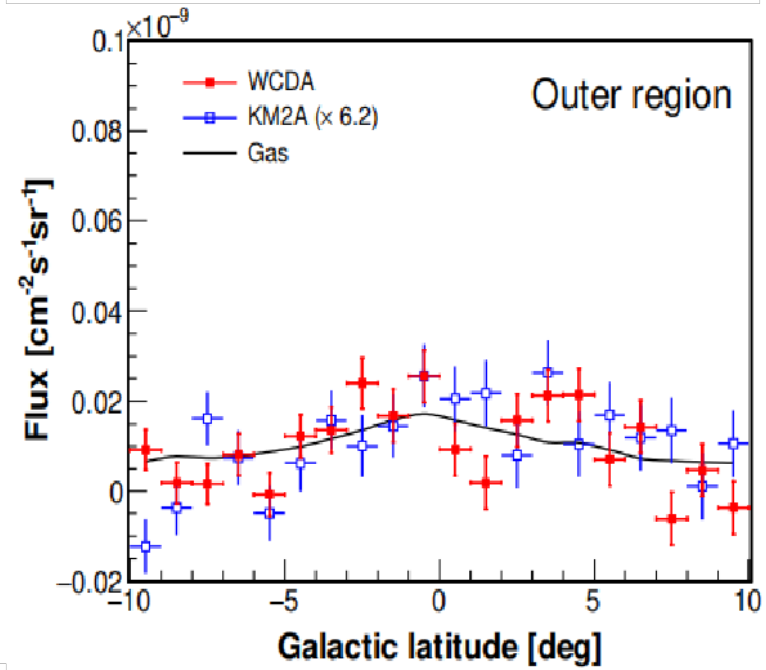
Galactic Plan γ Diffuse

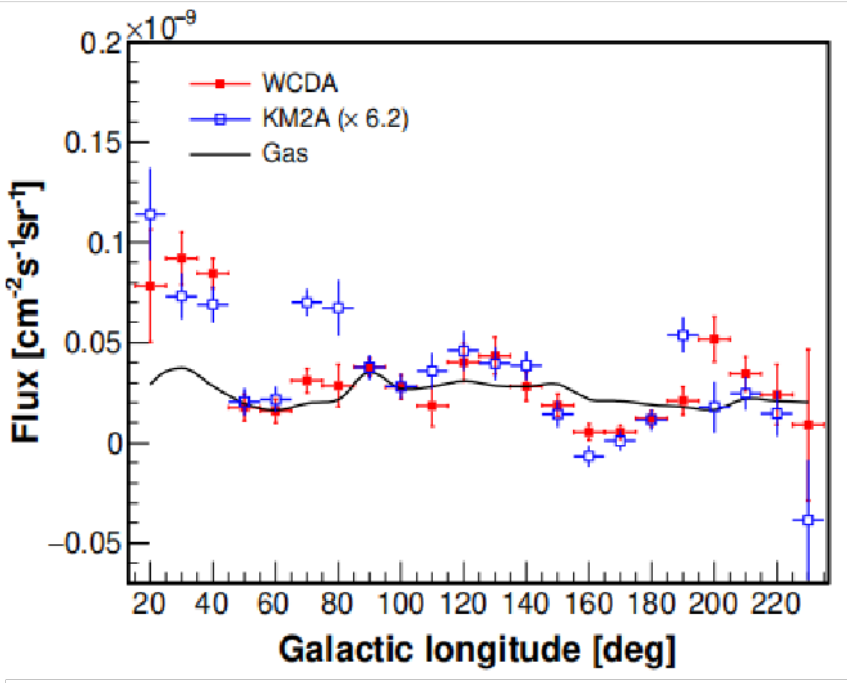


- LHAASO gives the first detection from the outer Galactic plane
- A spectral break around 30 TeV is revealed in the inner Galactic plane
- Measured fluxes are higher than predictions

Galactic Plan γ Diffuse

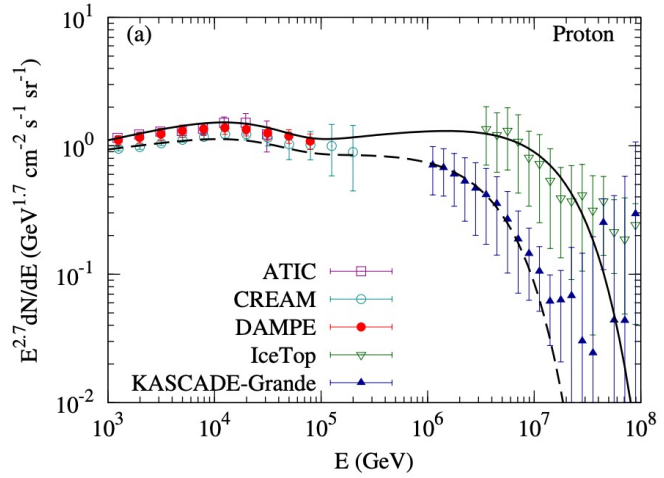


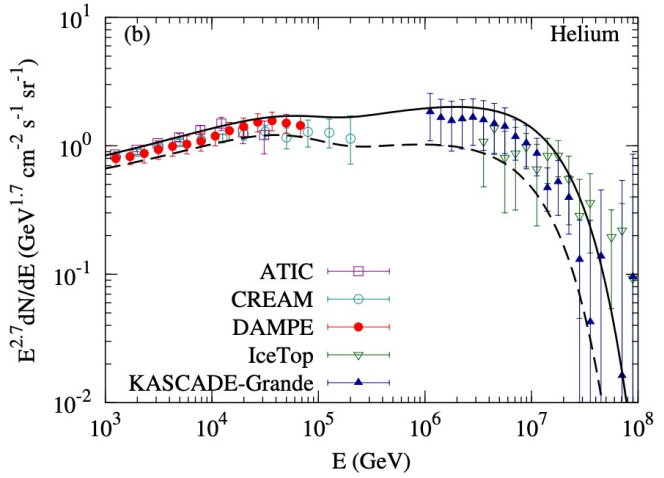




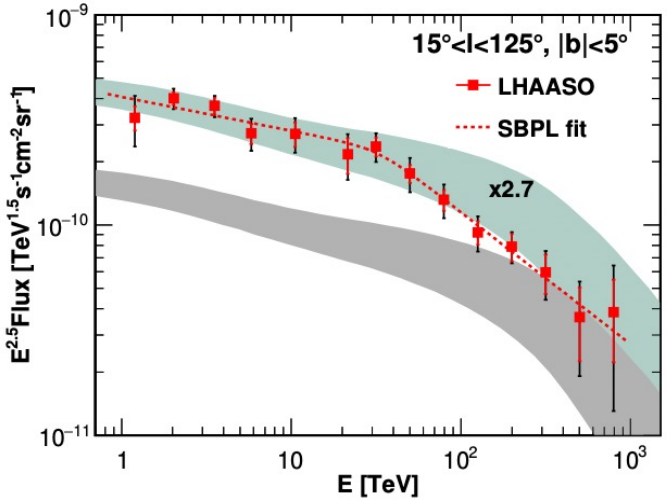
Roughly consistent with gas distributions for *b*, but shows significant deviation for *l*

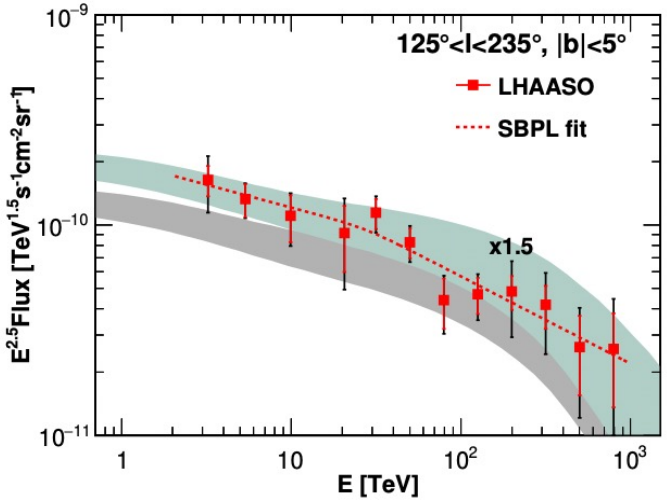
Galactic Plan γ Diffuse



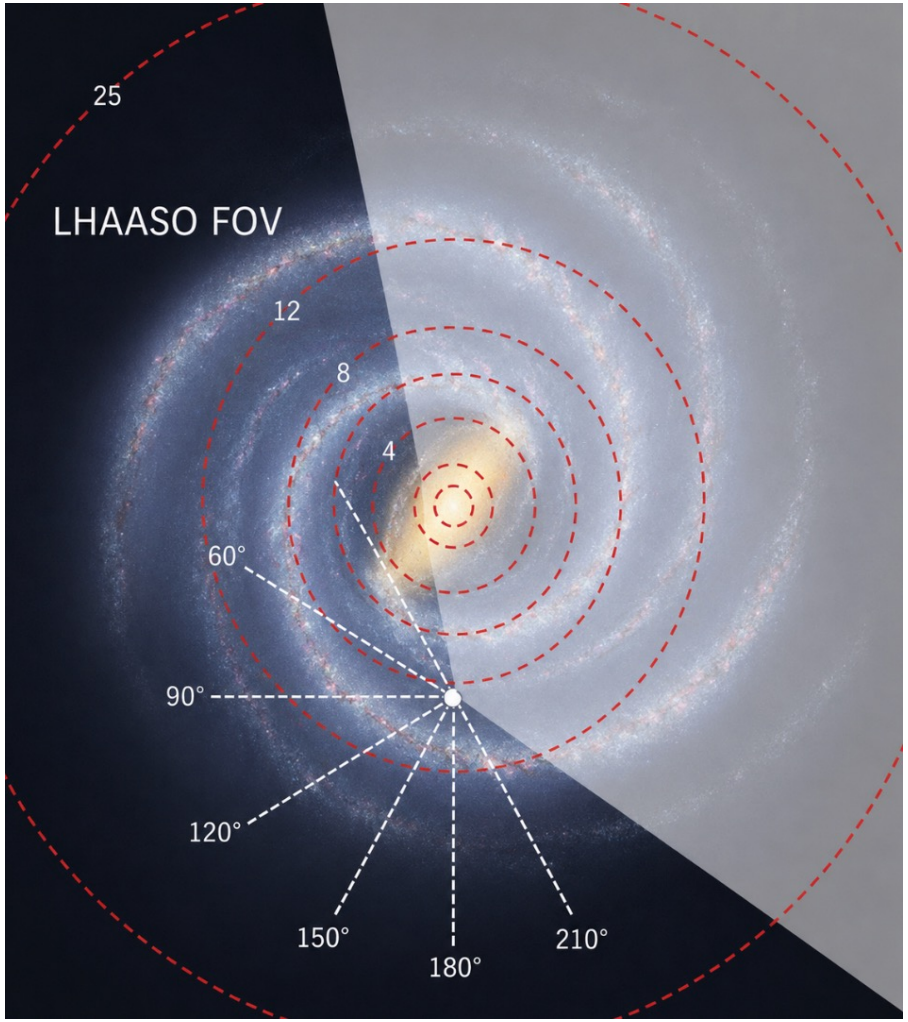


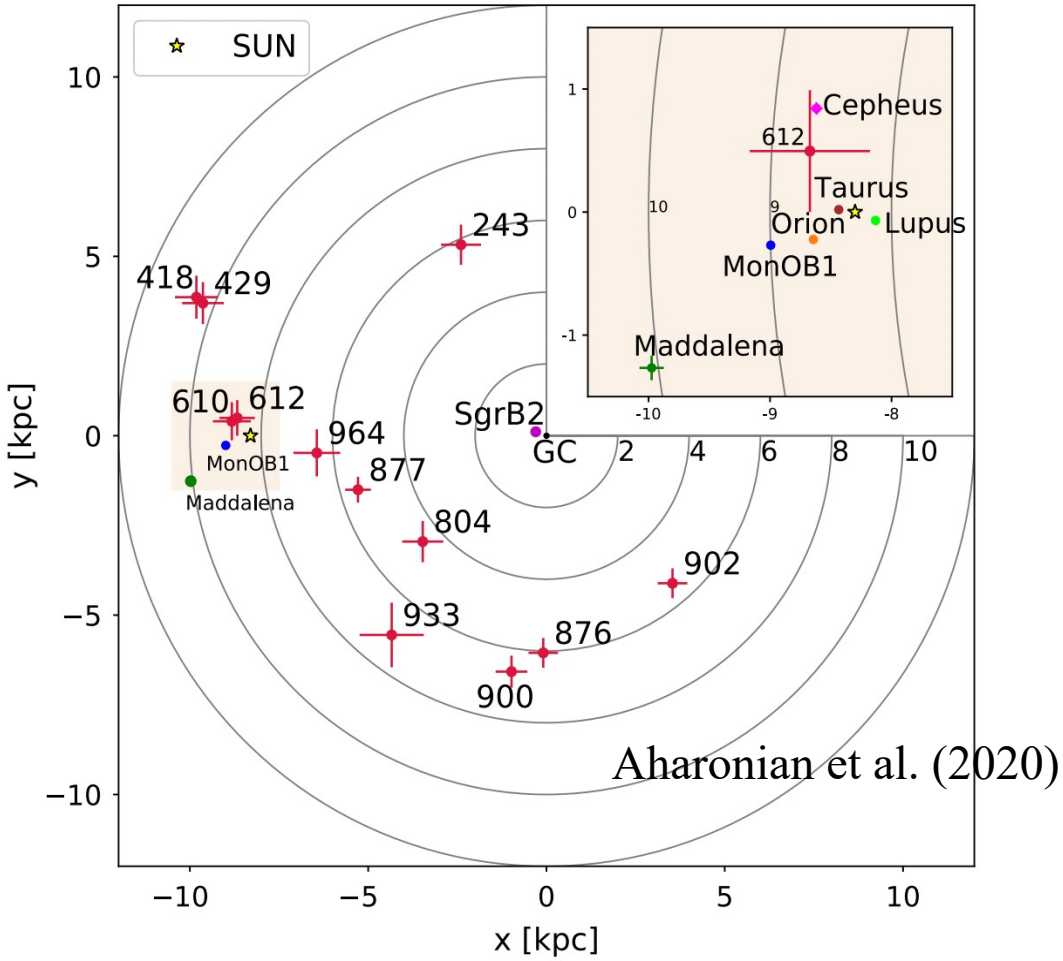
local CR × gas column density





Gamma Ray From Giant Molecular Clouds (GMC)

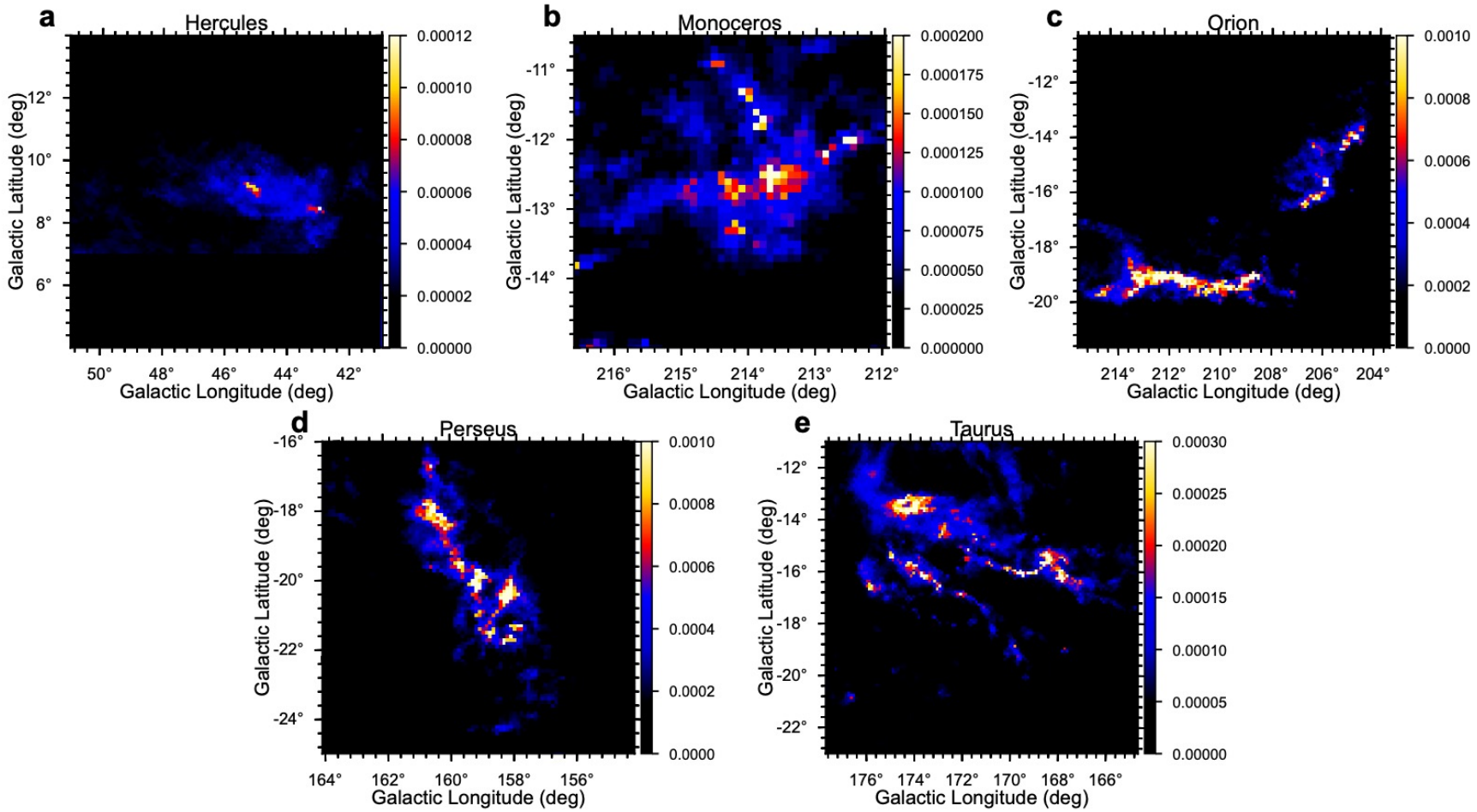




Aharonian et al. (2020)

Gamma Ray From Giant Molecular Clouds (GMC)

$$F \propto \frac{M}{d^2}$$



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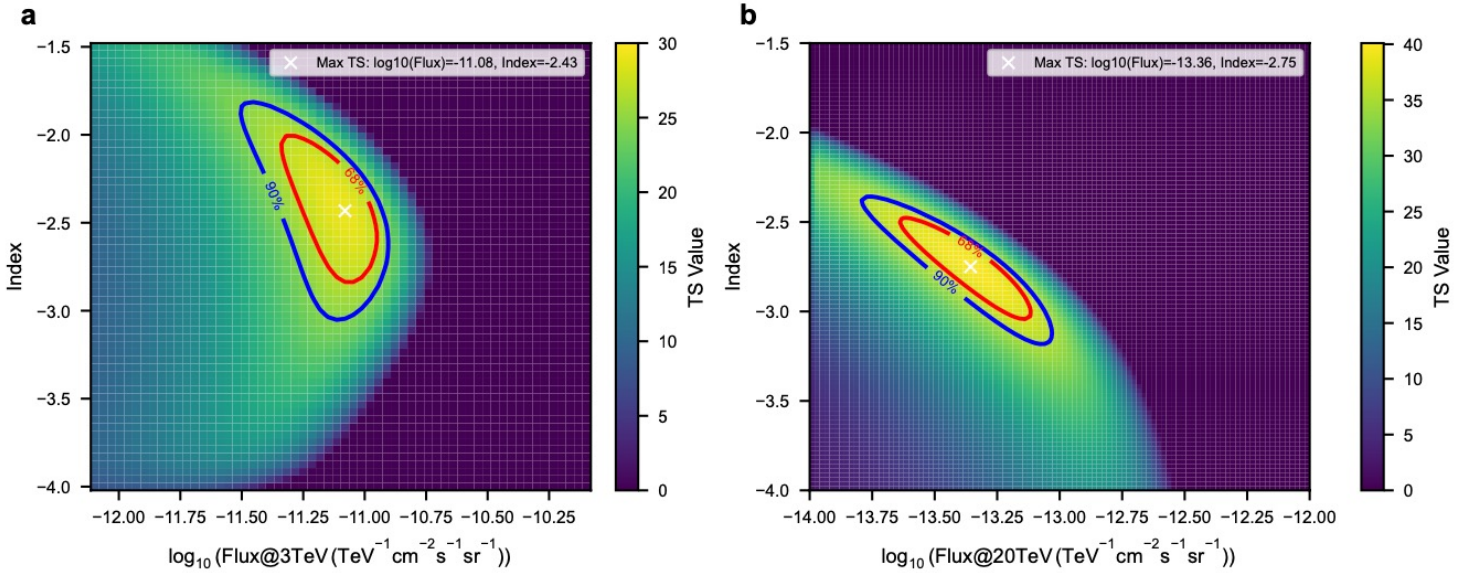
Gamma Ray From Giant Molecular Clouds (GMC)

GMC	Mass(±14%) ($10^5 Mass_\odot$)	Distance (pc)	R.A. (deg)	Decl. (deg)
Hercules	0.05	200±30	280.6	15.7
Monoceros	0.6	830±83	92.3	-6.8
Orion	1.62	490±50	87.3	-3.6
Perseus	0.15	315±32	52.9	30.9
Taurus	0.11	140±30	66.5	26.2



$$F \propto \frac{M}{d^2}$$

- Stacking analysis
- Maximum TS value of 30.0 (5.0σ) for WCDA data and 40.1 (5.9σ) for KM2A data

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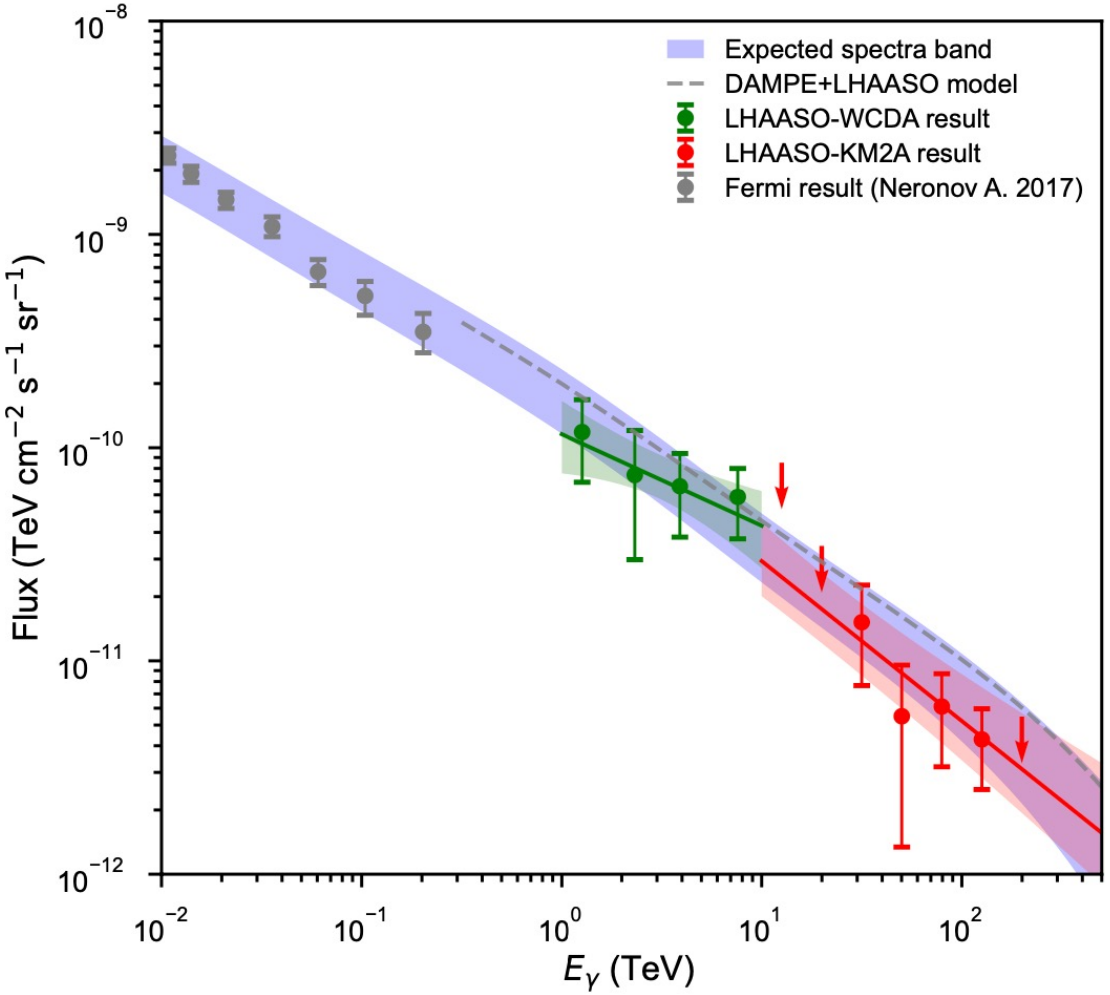
Gamma Ray From Giant Molecular Clouds (GMC)



- The emission of GMC is consistent with the expectation from gas: the CR density is similar to that around Earth

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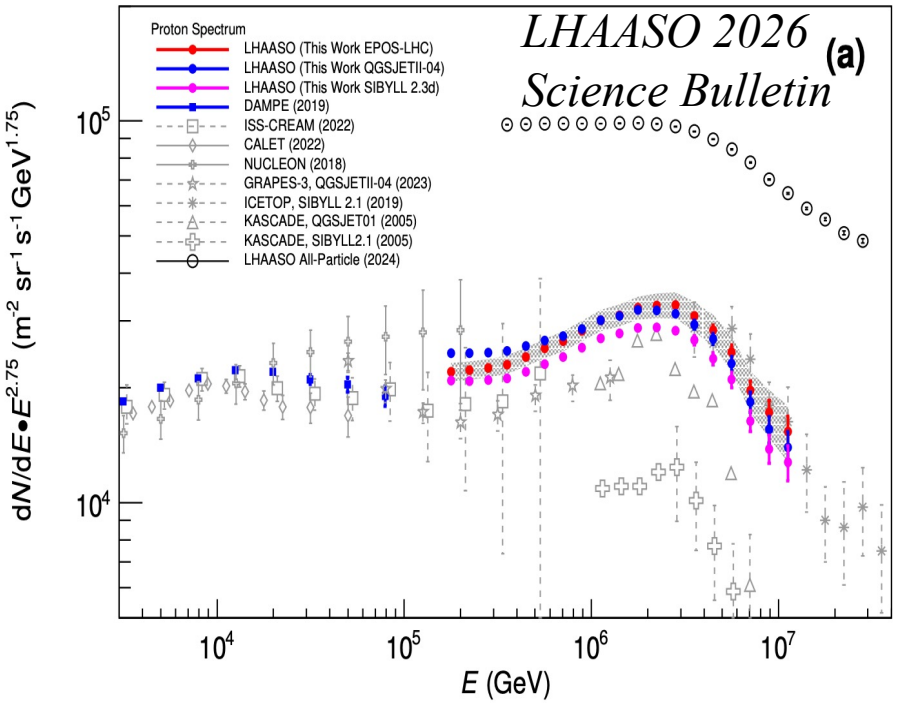
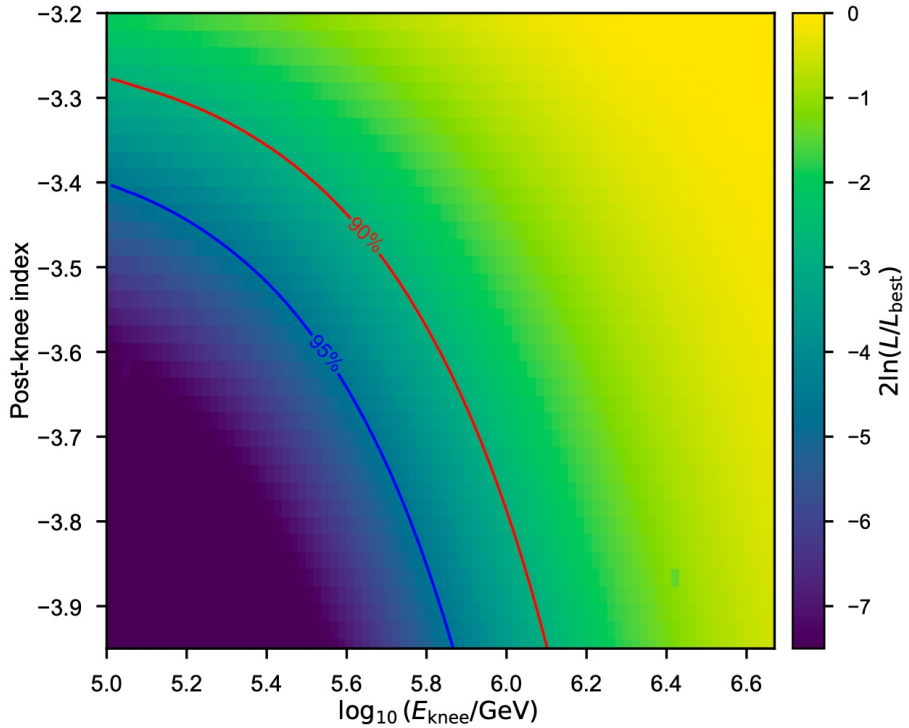
Gamma Ray From Giant Molecular Clouds (GMC)



Constraining to the CR 'Knee'



- The current KM2A measurements from GMCs are broadly compatible with a proton CR knee around or above 0.9 PeV

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Nature Astronomy 2026

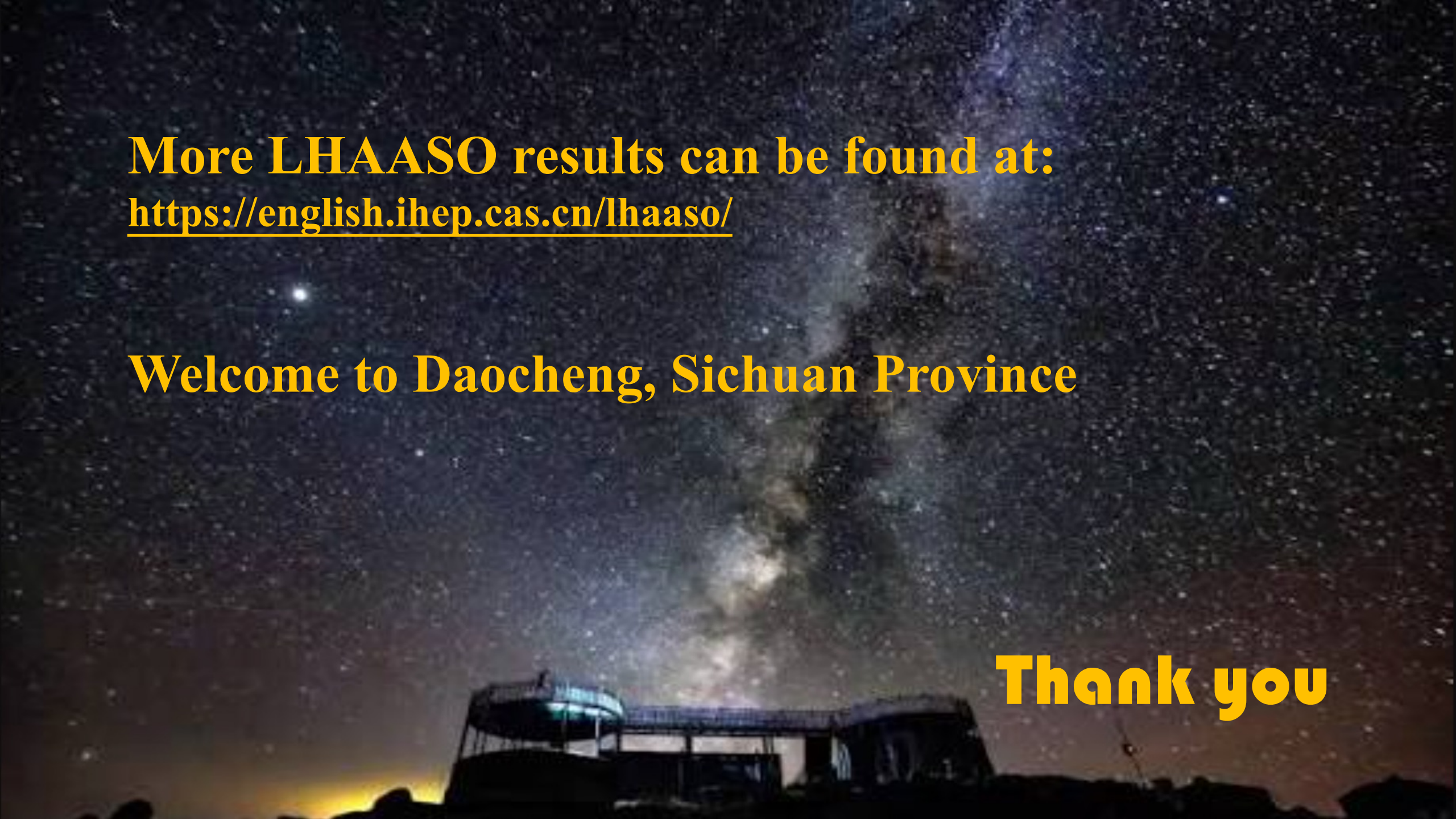
Summery and Prospect

Summary

- LHAASO opens a new era of diffuse γ-ray astronomy in the TeV–PeV energy range.
- Galactic diffuse emission provides a unique probe of cosmic-ray distribution and propagation.
- The detection of VHE γ-ray emission from GMCs establishes these regions as crucial laboratories for mapping the spatial distribution of CRs across the Milky Way, offering a unique avenue to fundamentally advance our understanding of the origin and propagation of Galactic CRs.

Prospect

- More exposure will enable precision studies of Galactic cosmic-ray physics.
- Combining γ-ray, cosmic-ray, and multi-messenger observations will help unveil the origin of high-energy cosmic rays.


More LHAASO results can be found at:
https://english.ihep.cas.cn/lhaaso/
Welcome to Daocheng, Sichuan Province
Thank you