

HAWC & SWGO @ University of Seoul

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자연과학연구소 워크숍

9 - 12 January, 2024

HAWC

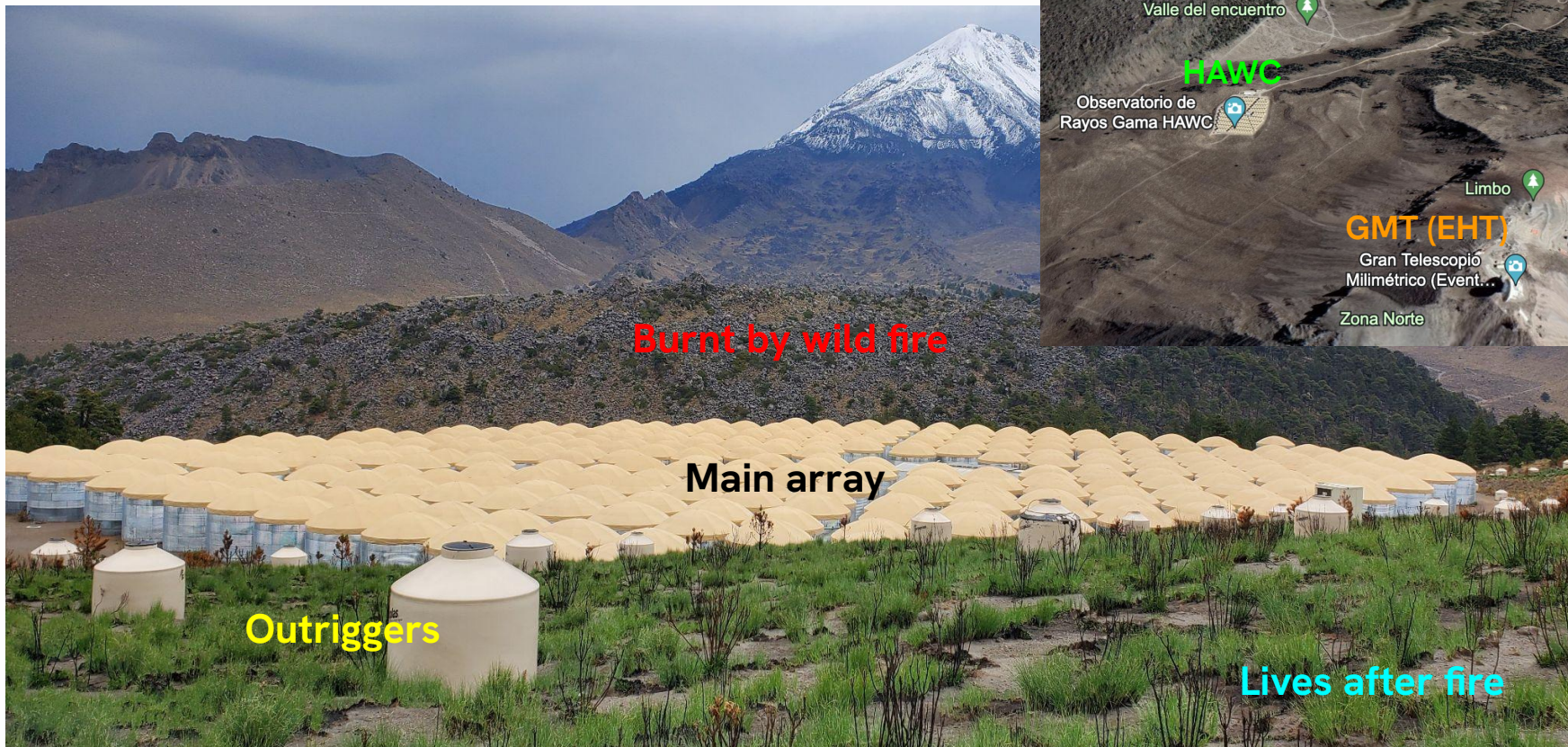
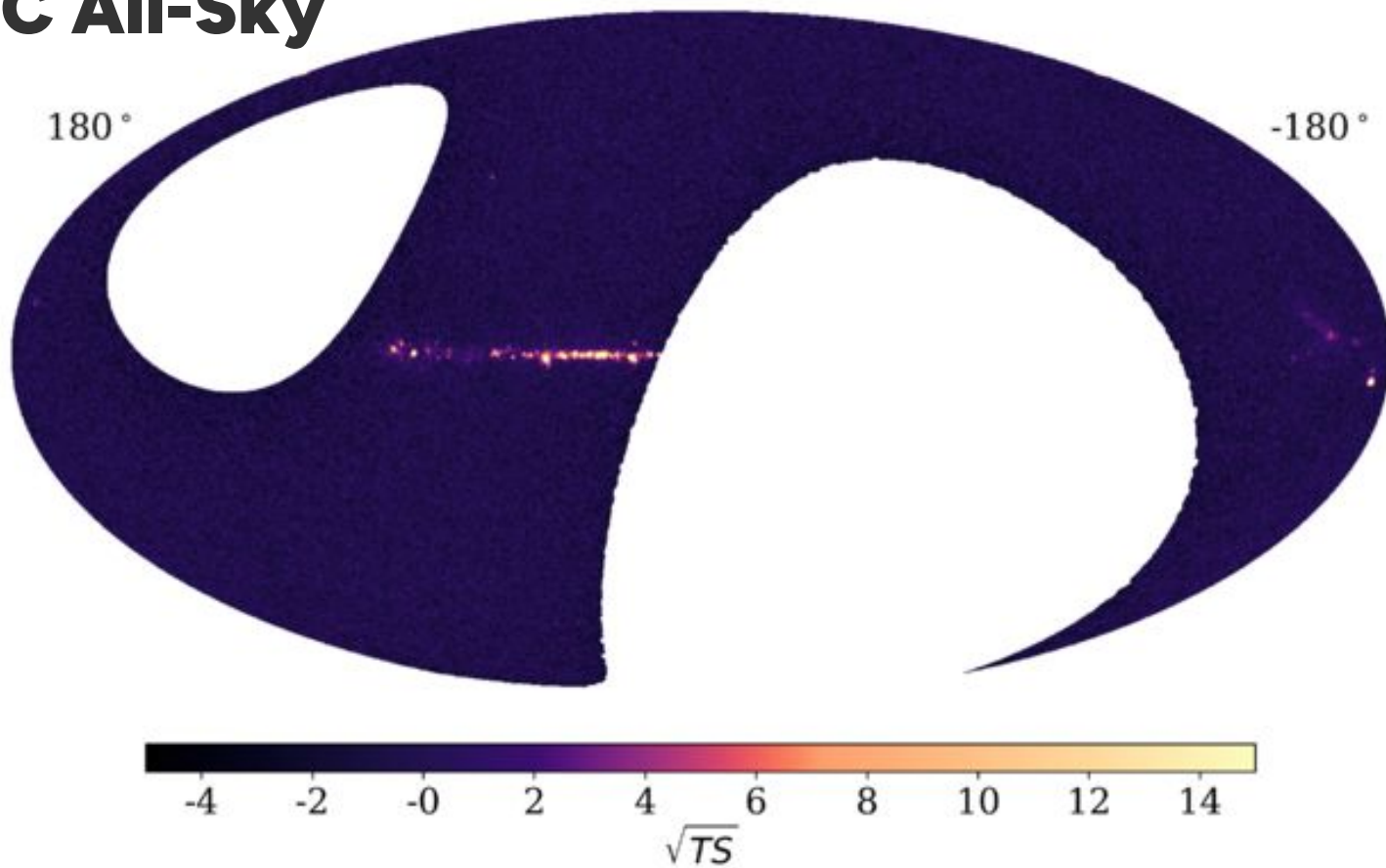


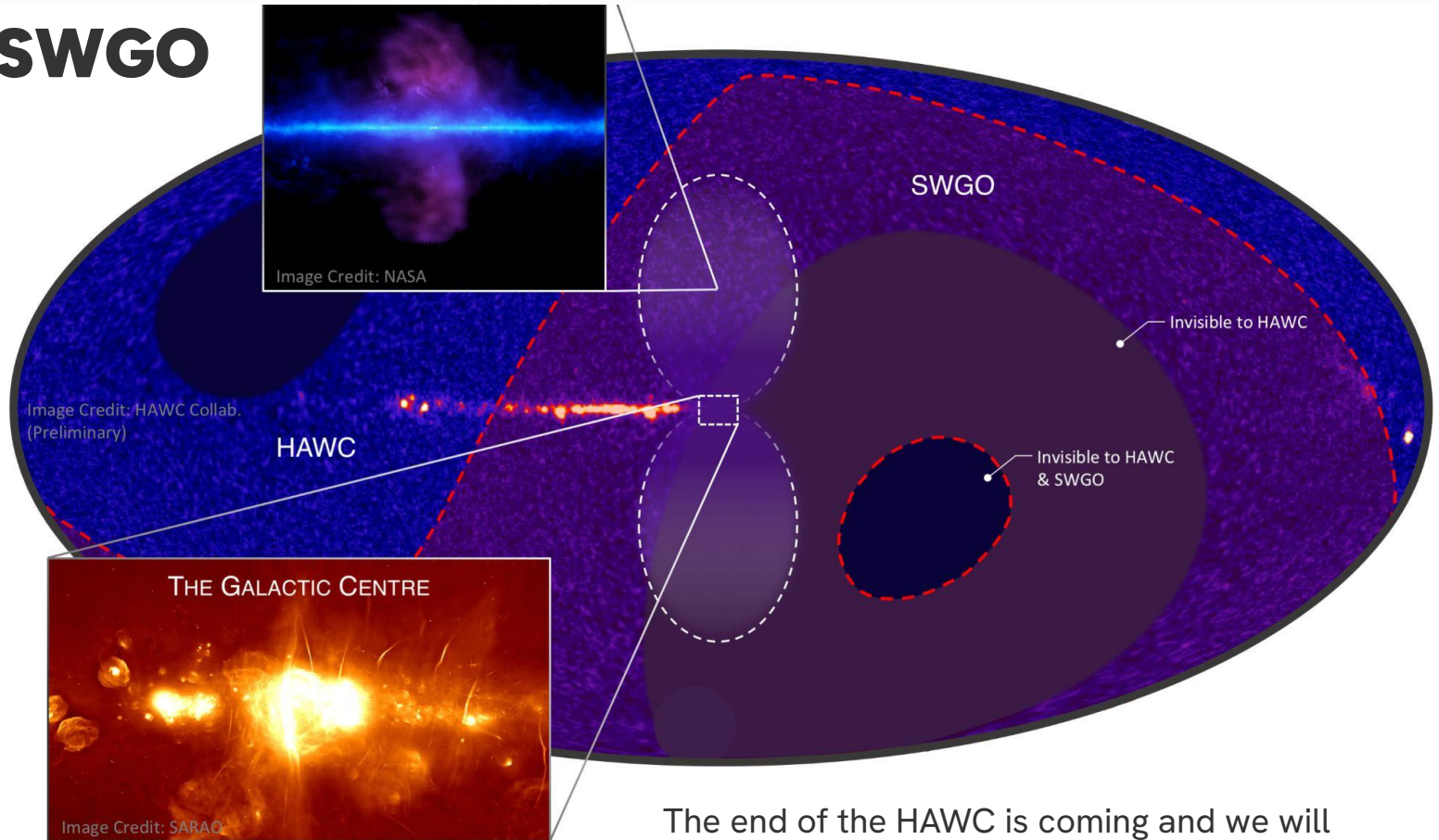
Photo @ HAWC, May Collaboration Meeting



HAWC All-Sky



To SWGO



The end of the HAWC is coming and we will move to the Southern hemisphere; SWGO.

SWGGO Concept

Unique TeV observatory in the Southern Hemisphere

Better background rejection

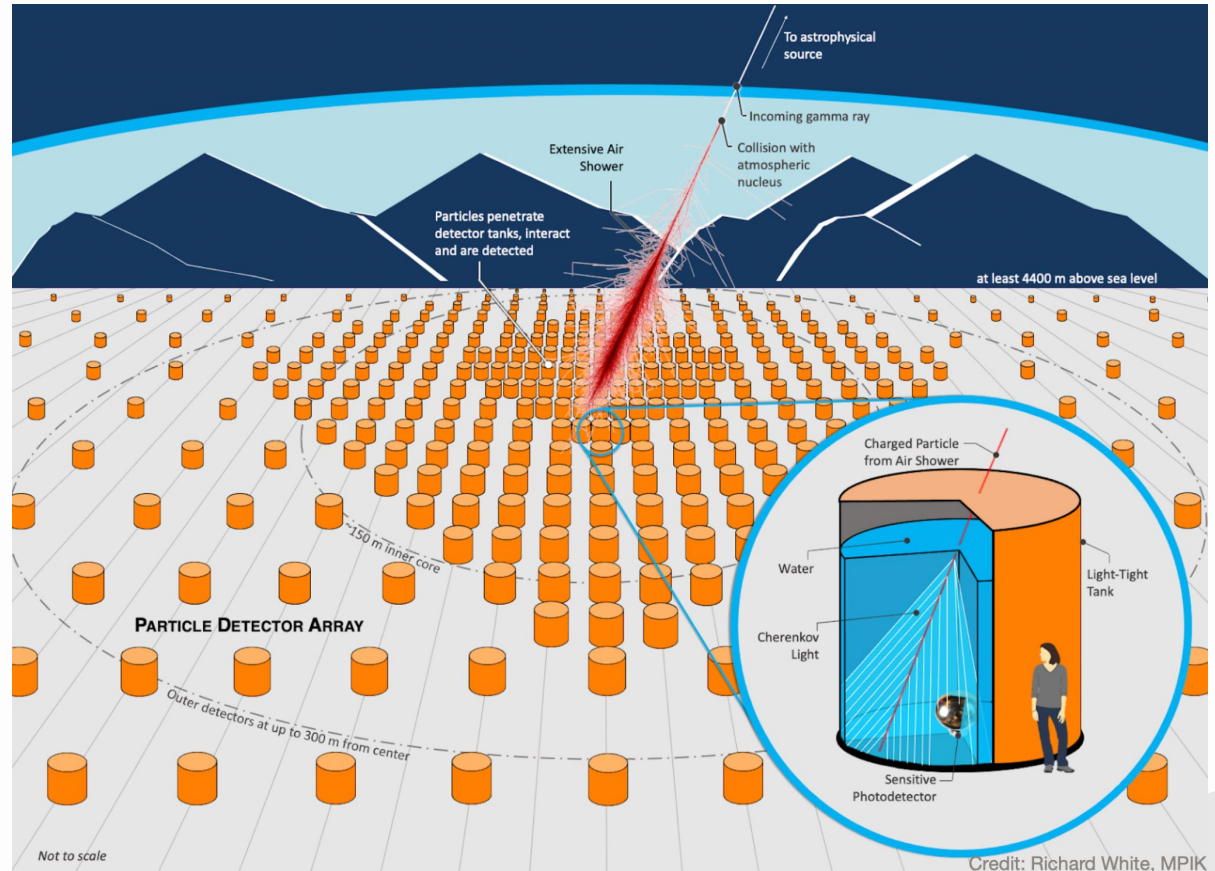
- Muon tagging layer

Larger effective area than HAWC

- 20,000 m²
→ 80,000 - 221,000 m²

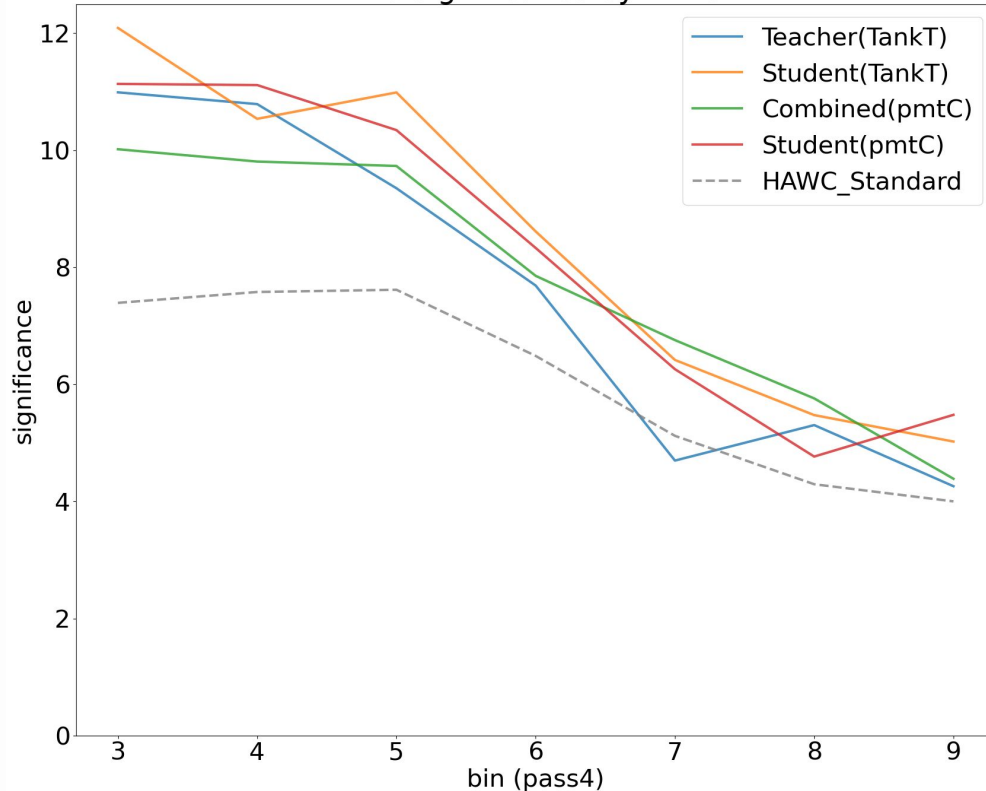
Wider energy range than HAWC

- 316 GeV-316 TeV
→ 31.6 GeV - 1 PeV



Gamma-hadron separation (Student-Teacher)

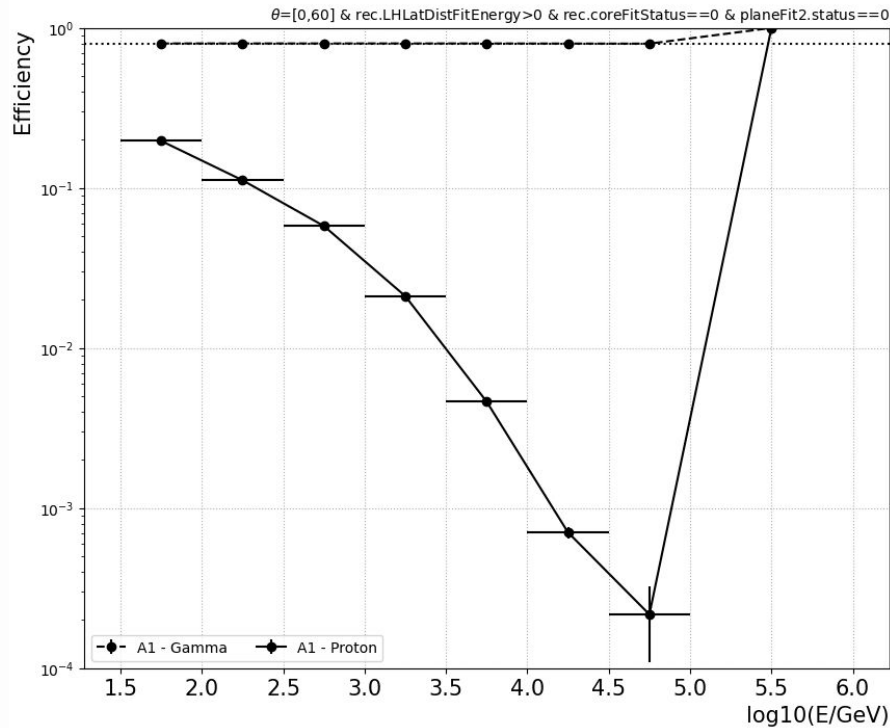
Li-ma significance by fhit bin



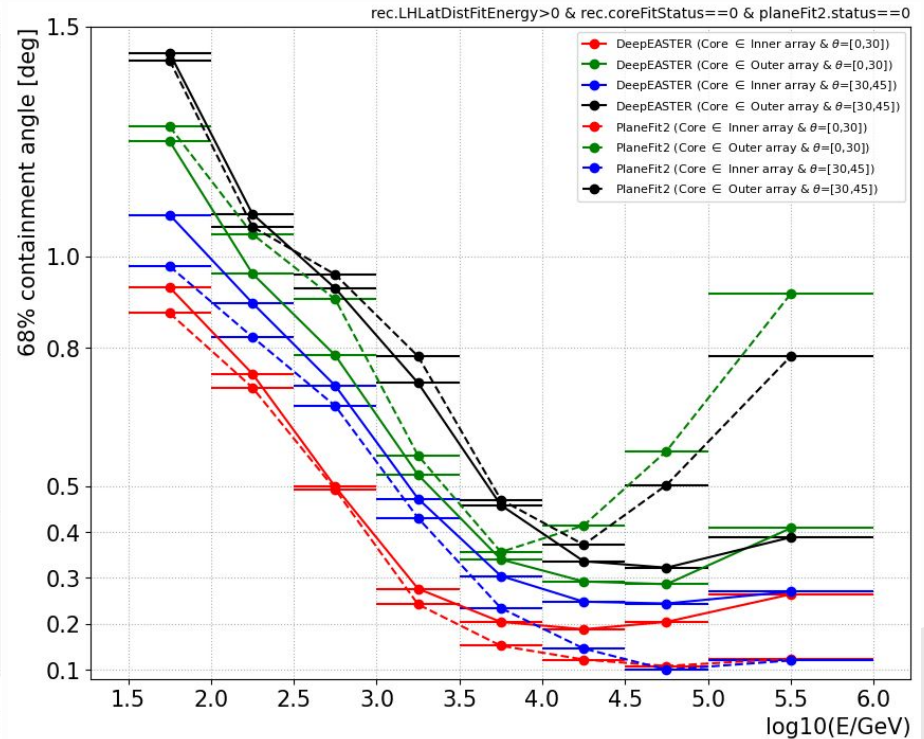
- TankT and pmtC are our machine learning models.
- They offers better performance than HAWC currently using
- Student-Teacher method further improves performance of machine learning model.
- TankT : Self-attention mechanism on tank-wise latent vector. Classifier attention to extract classifier.
- pmtC : No self-attention mechanism. Classifier attention on pmt-wise latent vector to extract classifier.
- Classifier attention : Attention mechanism by Query from classifier token, Key and Value from (tank or pmt's) latent vector.

Also for SWGO

GH separation



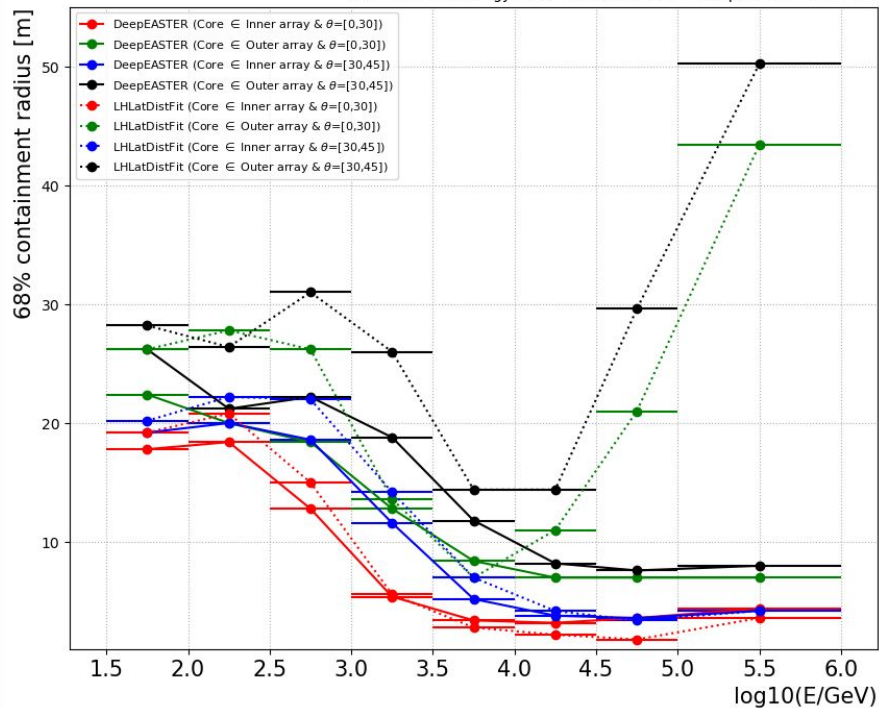
Angle (Not good for > TeV && inner array.)



Also for SWGO

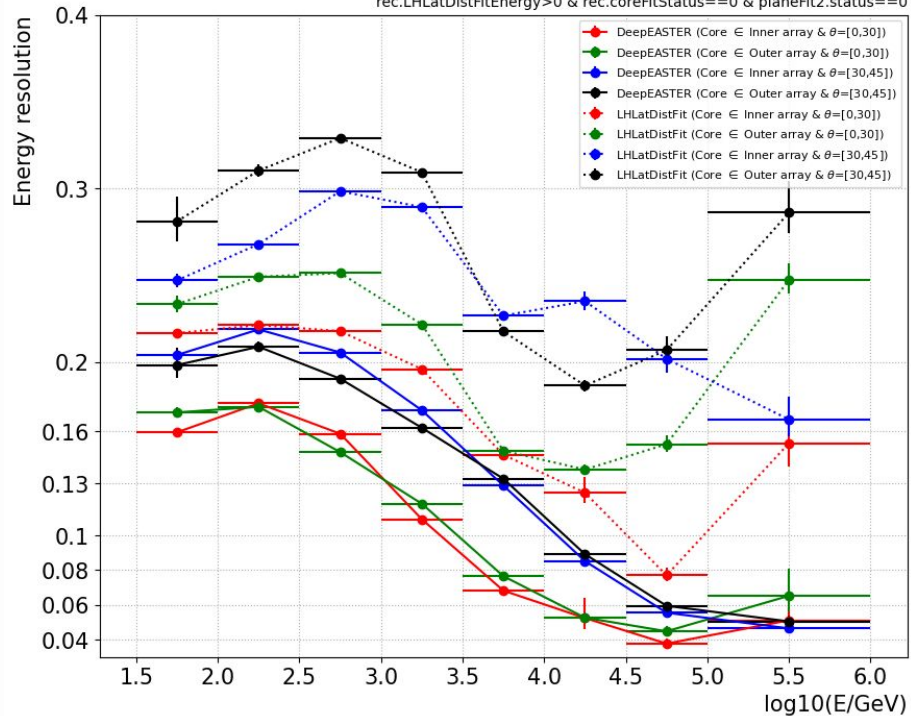
Core (Super nice for outer array, not good for >TeV & inner array.)

rec.LHLatDistFitEnergy>0 & rec.coreFitStatus==0 & planeFit2.status==0



Energy (Ours is outperforming!)

rec.LHLatDistFitEnergy>0 & rec.coreFitStatus==0 & planeFit2.status==0



HAWC - Galactic source analyses

THE ASTROPHYSICAL JOURNAL, 954:205 (13pp), 2023 September 10

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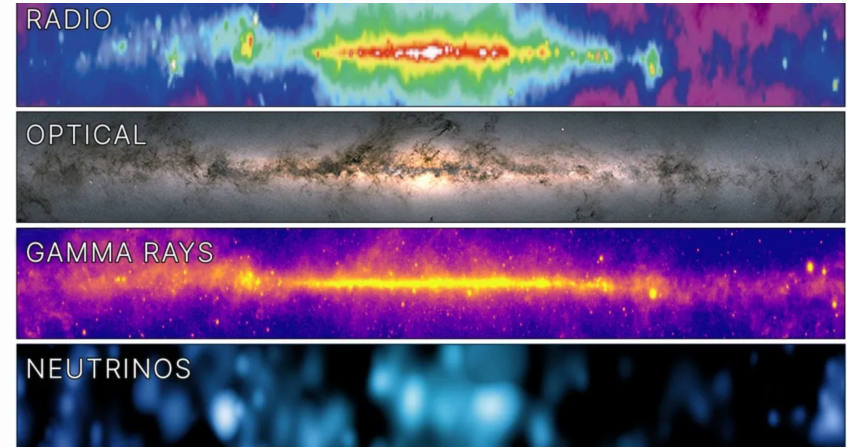
<https://doi.org/10.3847/1538-4357/ace967>



HAWC Study of the Very-high-energy γ -Ray Spectrum of HAWC J1844–034

A. Albert¹, C. Alvarez², D. Avila Rojas³, H. A. Ayala Solares⁴, R. Babu⁵, E. Belmont-Moreno³, M. Breuhaus⁶, T. Capistrán⁷, A. Carramiñana⁸, S. Casanova⁹, J. Cotzomi¹⁰, S. Coutiño de León¹¹, E. De la Fuente¹², D. Depaoli⁶, R. Diaz Hernandez⁸, B. L. Dingus¹, M. A. DuVernois¹¹, M. Durocher¹, K. Engel¹³, C. Espinoza³, K. L. Fan¹³, K. Fang¹¹, N. Fraija⁷, J. A. García-González¹⁴, M. M. González⁷, J. A. Goodman¹³, S. Groetsch⁵, J. P. Harding¹, I. Herzog¹⁵, J. Hinton⁶, D. Huang⁵, F. Hueyotl-Zahuantitla², T. B. Humensky¹⁶, P. Hütemeyer¹⁶, V. Joshi¹⁷, S. Kaufmann¹⁸, J. Lee¹⁹, H. León Vargas³, A. L. Longinotti⁷, G. Luis-Raya¹⁸, K. Malone²⁰, O. Martínez¹⁰, J. Martínez-Castro²¹, J. A. Matthews²², P. Miranda-Romagnoli²³, J. A. Morales-Soto²⁴, E. Moreno¹⁰, M. Mostafá⁴, L. Nellen²⁵, R. Noriega-Papaqui²³, L. Olivera-Nieto⁶, N. Omodei²⁶, E. G. Pérez-Pérez¹⁸, C. D. Rho²⁷, D. Rosa-González⁸, E. Ruiz-Velasco⁶, H. Salazar¹⁰, D. Salazar-Gallegos¹⁵, A. Sandoval³, M. Schneider¹³, J. Serna-Franco³, A. J. Smith¹³, Y. Son¹⁹, R. W. Springer²⁸, O. Tibolla¹⁸, K. Tollefson¹⁵, I. Torres⁸, R. Torres-Escobedo²⁹, R. Turner⁵, F. Ureña-Mena⁸, E. Varela¹⁰, L. Villaseñor¹⁰, X. Wang⁵, I. J. Watson¹⁹, E. Willcox¹³, and H. Zhou²⁹
(HAWC collaboration)

Milky Way Galaxy (Credit: IceCube)



Analyses for sources inside the Milky Way galaxy.

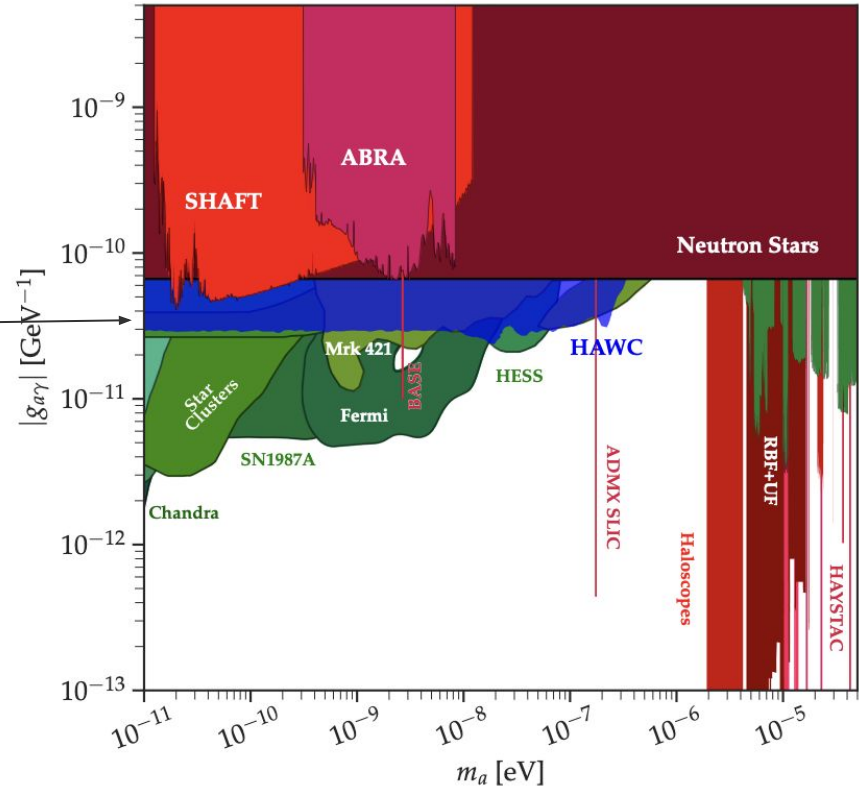
- One paper published on September (ApJ, Supernova remnant or pulsar wind nebula)
- Writing SS433 update paper is ongoing (TeV microquasar)
- J1849 complex analysis is ongoing (Pulsar wind nebula, star-forming region, ...)

HAWC - Particle physics analysis

arXiv:2203.04332 [hep-ph]

Axion-like particle search from blazars (Youngwan)

- Searching a clue of ALP - TeV photon oscillation.
- We recently started this, and the preliminary result can push out more that blue area!
- No public figure available so far, stay tuned.



2023 Summary

Publications

- One paper published in the ApJ, Sep
- Two conference proceedings

Collaboration meetings

- HAWC (Ian, Youngwan) @ Puebla, Mexico, May
- SWGO (Youngwan) @ Prague, Czech, Oct

Conferences

- KPS Spring (Myeonghun, Baeksun), Apr
- KPS Fall (Ian, Youngwan), Oct
- ICRC 2023 (Ian, Youngwan) @ Nagoya, Japan, Jul

Other Talks

- KIAS Astro.-Lunch Seminar (Ian), Dec
- KAML Workshop (Ian), Feb



Thanks!



Backup

Galactic source analysis (Published)

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(HAWC collaboration)

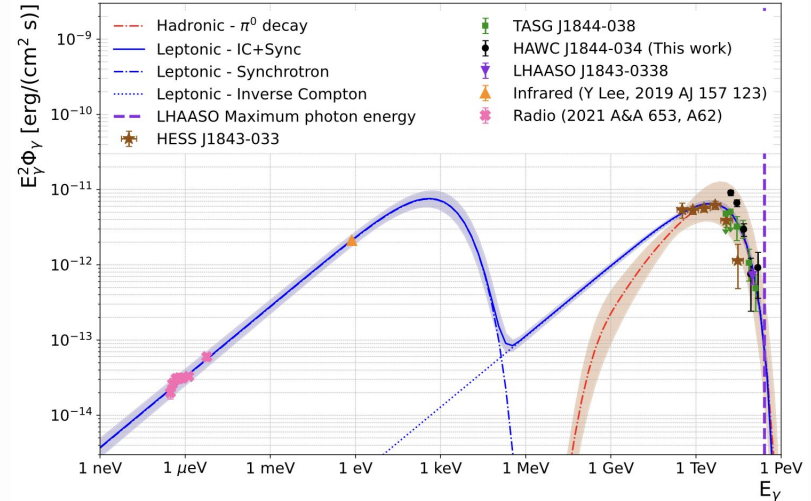


Figure 9. Spectral distribution plot with the best-fit leptonic (blue) and hadronic (red) scenarios for SNR G28.6–0.1.

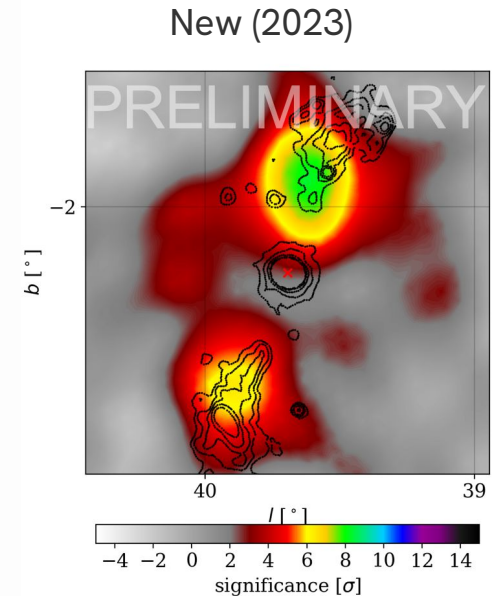
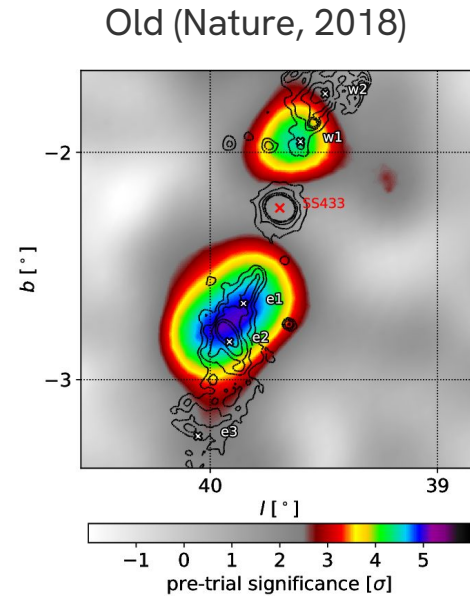
Unidentified source in J1844 complex

- No one knows what causes J1844's TeV emission.
- We singled out two possible candidates as the origin of J1844's TeV emission.
 - Supernova remnant G28.6-0.1 or GeV gamma-ray pulsar J1844-0346.
- Leptonic scenario can explain radio-to-TeV observations if the origin is G28.6-0.1.

Galactic source analysis (Ongoing)

SS 433 update

- First TeV Microquasar reported by HAWC in 2018.
- More data and better reconstruction have been ready than 2018.
- Systematic algorithm applied.



Galactic source analysis (Ongoing)

J1849 Complex

Pulsar Wind Nebula (PWN) PSR J1849-0001

- Superfast spinning neutron star
- One of the most powerful sources in the current HAWC data

Star-forming region (SF) W 43

- One of the most active SFs in the Milky Way Galaxy
- Only few SFs have been identified as a TeV source (+ PeV proton source).
- This can be the next one.

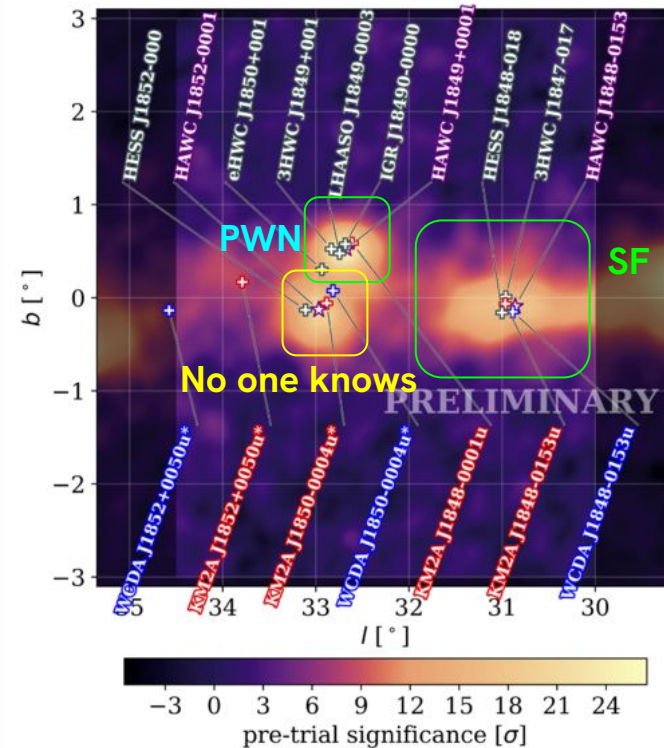


Photo @ HAWC

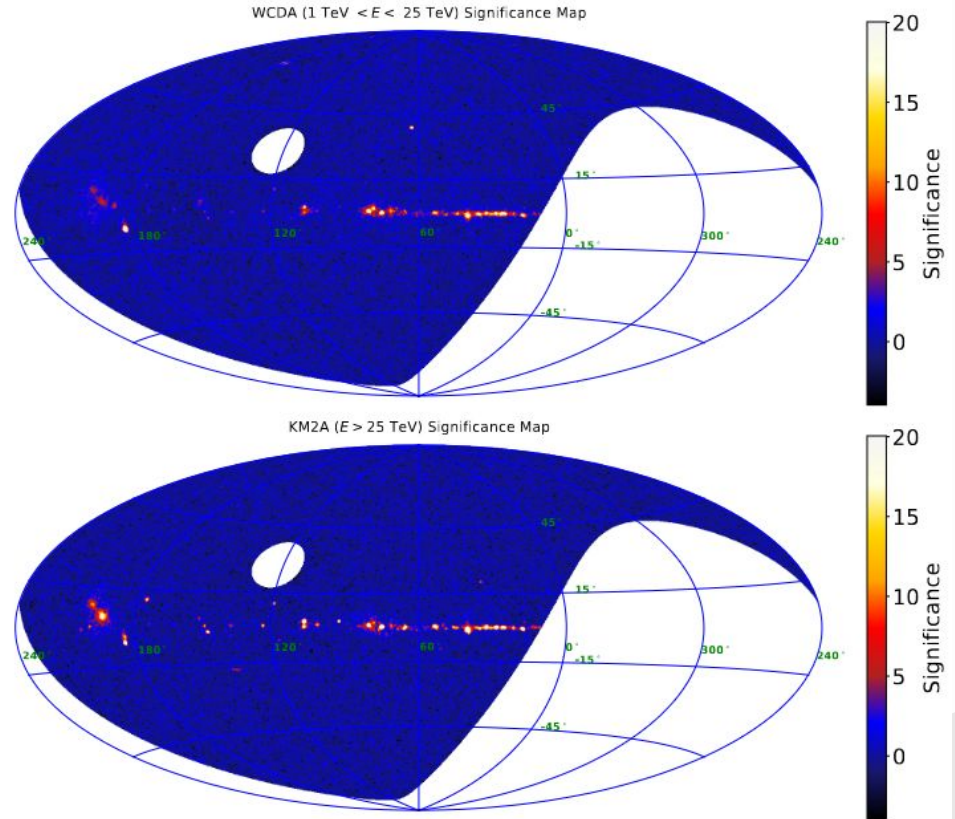


LHAASO will beat HAWC...

LHAASO is the composite of WCDA, KM2A, and WFCTA.

- WCDA for < 25 TeV: Water Cherenkov detectors like HAWC, but big pull rather than tanks.
- KM2A for multi-TeV: plastic scintillators (ED), water Cherenkov detectors (MD).
 - 300,000 m² effective area
 - $1e-4$ background rejection
 - Can detect PeV photons

This will outperform HAWC in near future...



Gamma-ray reconstruction

DeepHAWC Skymap?

Generative models for fast simulation