
The Southern Wide-field Gamma Ray Observatory (SWGGO)

Karen Salomé Caballero Mora on behalf of the SWGO Collaboration

FCFM-MCTP-UNACH



Content

- ⊙ SWGO Collaboration
- ⊙ Science Program
 - Galactic
 - Extragalactic & Transients
 - Fundamental Physics
 - Cosmic Rays
- ⊙ Site Candidates
 - Shortlist
- ⊙ The detector
 - Concept array
 - WCD concepts
 - Detector Options
- ⊙ Sensitivity
- ⊙ Status and plan
- ⊙ Outreach

SWGGO Partners

- First meeting 2019
- 15 Countries, around 90 institutions
- ~ 48 Supporting Scientists

Argentina

Brazil

Chile

China

Croatia

Czech Republic

France

Germany

Italy

Mexico

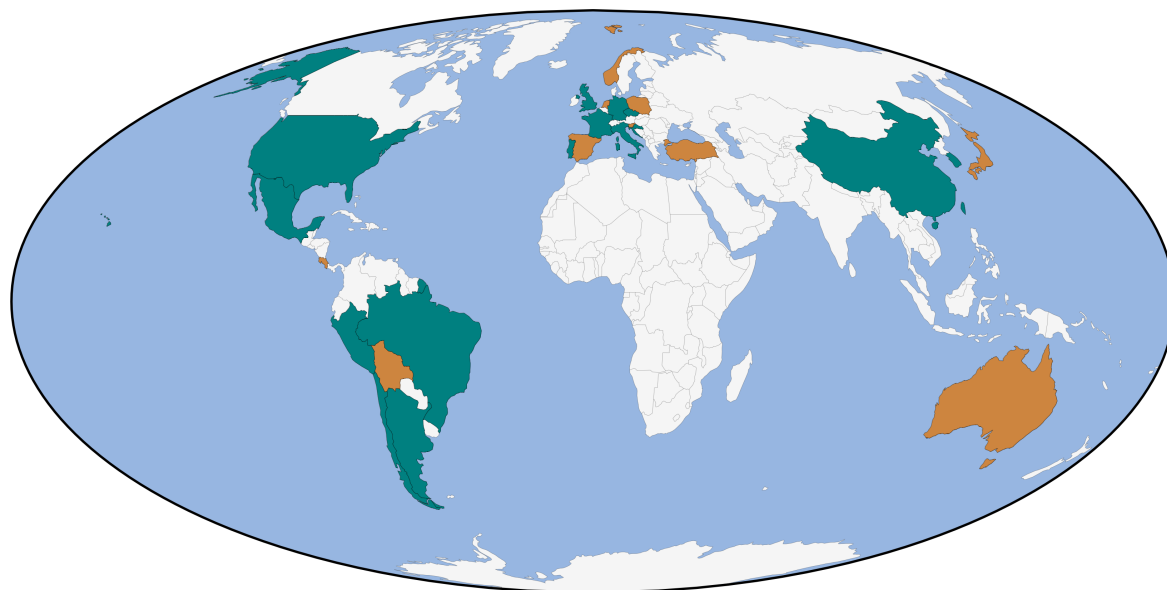
Peru

Portugal

South Korea

United Kingdom

United States

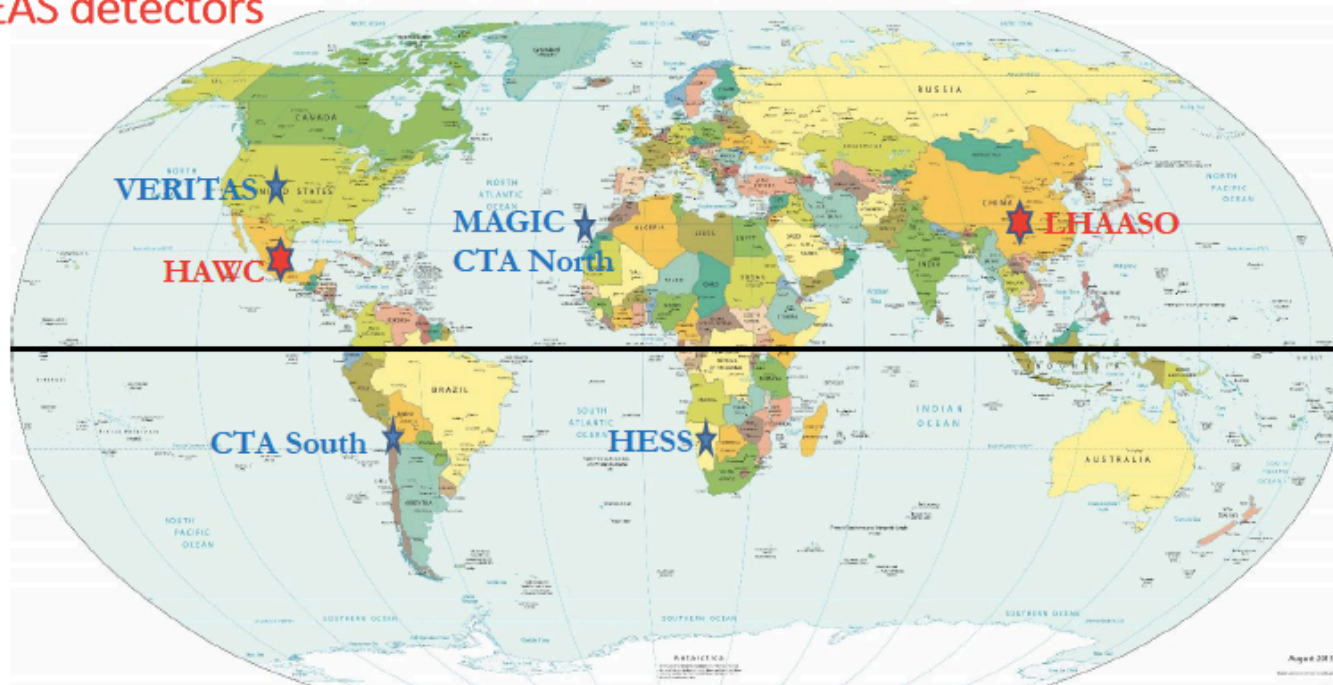
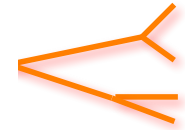


Complement IACT's and existing ground-based detectors in the Northern Hemisphere



★ → IACT

★ → EAS detectors



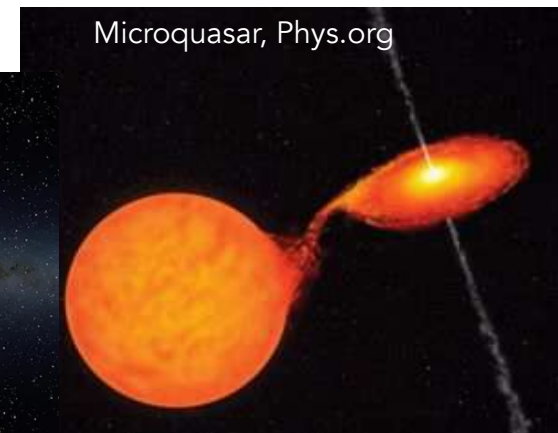
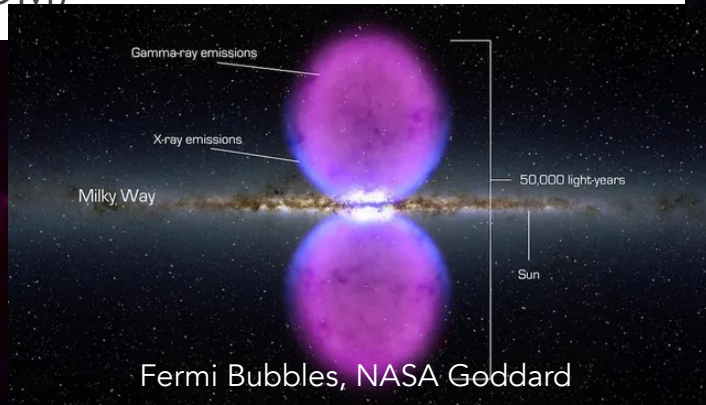
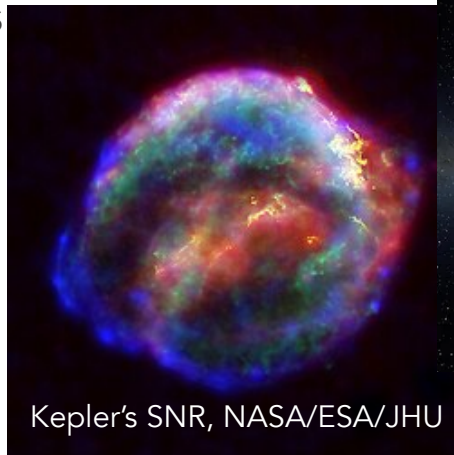
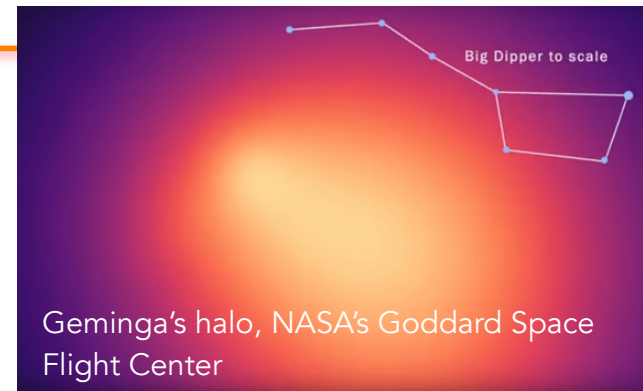
* Image credited to A.Chiavassa, SWGO Collaboration
CRIS-MAC 2024, Trapani, June 17-21, 2024

Complement IACTs and existing ground-based
detectors in the Northern Hemisphere and synergies
with the dominant ones in the Southern Hemisphere

Science Program

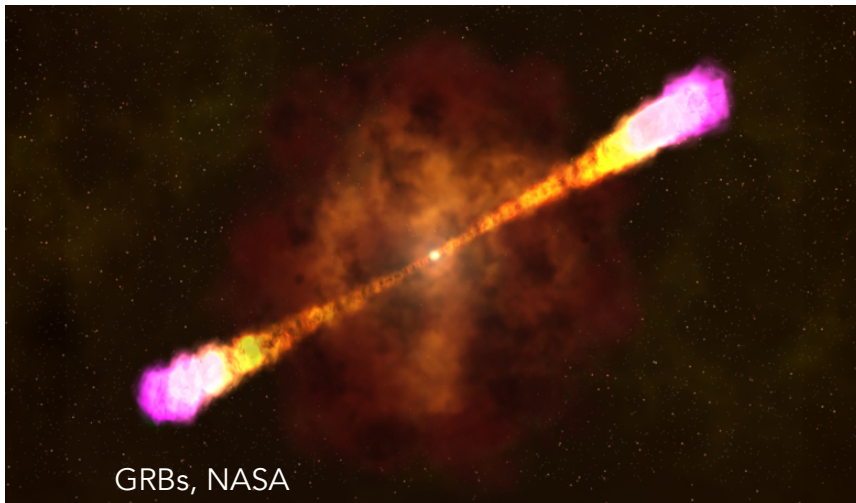
Galactic

- Pulsar Halos (IACTs, HAWC, LHAASO)
- Galactic PeVatrons (H.E.S.S.)
 - Supernova Remnants (SNR)
- Galactic Diffuse Emission & Fermi Bubbles (Fermi-LAT, IACTs, Radio)
- Galactic Center region Dark Matter (DM)
- Galactic Binaries
 - Microquasars



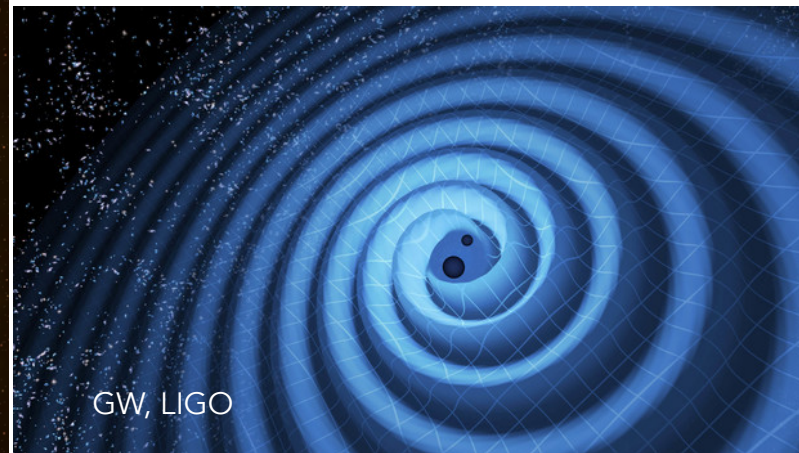
⊙ Extragalactic and Transients

- Gamma Ray Bursts (GRB's)
- Cosmic Rays Flux
- Particle Physics BSM
- Gravitational Waves (GW)



⊙ Fundamental Physics

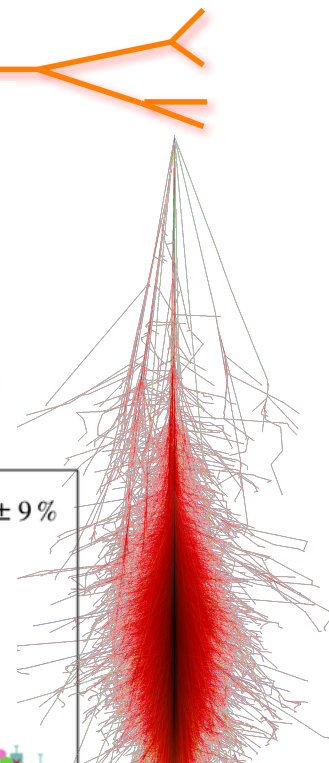
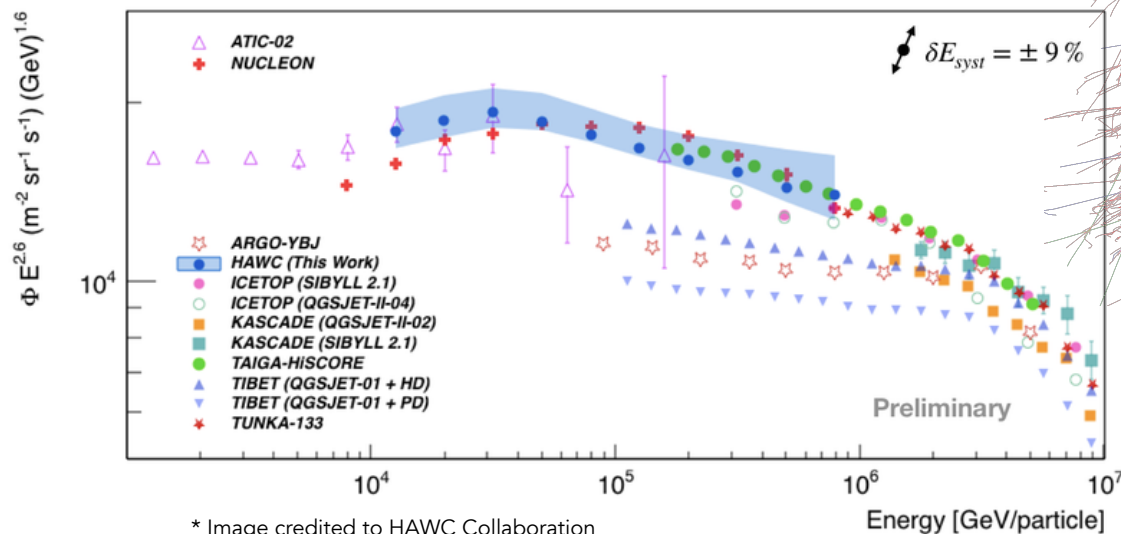
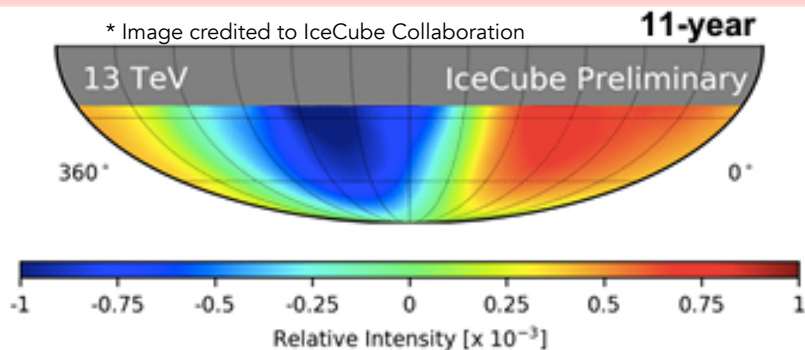
- Weakly Interacting Massive Particle (WIMP's)
- Primordial Black Holes (PBH)
- Axion like particles
- Lorentz Invariance Violation (LIV)



Science Program

⊙ Cosmic Rays

- Anisotropy
- Spectrum and Composition
 - Knee,
 - ARGO vs KASCADE
 - HAWC break @30TeV
- UHECR accelerators
 - Nearby sources
- EAS Studies
 - Hadronic interaction
- Heliospheric Physics
 - Gamma rays from the Sun
 - Solar modulation



Site Candidates

Country	Site Name	Altitude [m a.s.l.]	Latitude	Notes
Argentina	Alto Tocomar	4,430	24.19 S	Primary
	Cerro Vecar	4,800	24.19 S	
Chile	Pajonales	4,600	22.57 S	Primary
	Pampa La Bola	4,770	22.25 S	
Peru	Imata	4,450	15.50 S	Lake site Primary
	Sibinacocha	4,900	13.51 S	
	Yanque	4,800	15.44 S	

Shortlist

- Alto Tocomar, Argentina
- Pampa La Bola, Chile
- Imata, Perú

Costs

Cost of constructing and operating, and maintaining SWGO at a given candidate primary site.

Risks

Major risks that could be faced during the construction or operation of the observatory. Mitigation strategies.


Impacts

Environmental, cultural, and social impacts. **Integration of SWGO into a local community.**

* Image credited to R.Conceição, ICRC2023, SWGO Collaboration

Site Candidates


Alto Tocomar, Argentina
4,430 m.a.s.l.



Pampa La Bola, Chile - 4770 m




Imata, Peru - 4450 m



2020-21: Site Candidacies
2022-23: Site Characterization
2024 (July): Site Selection!

Sites visited in 2022

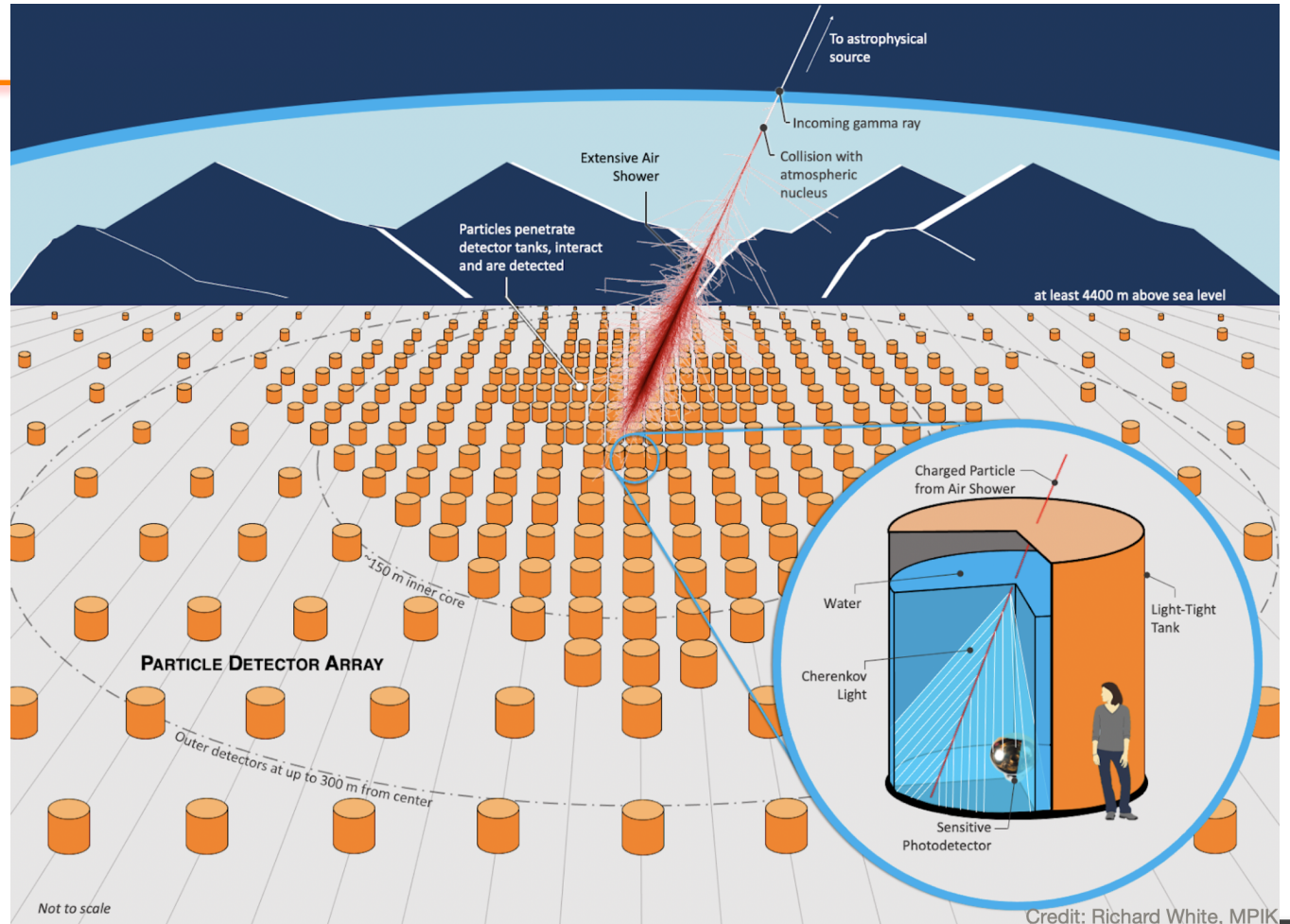
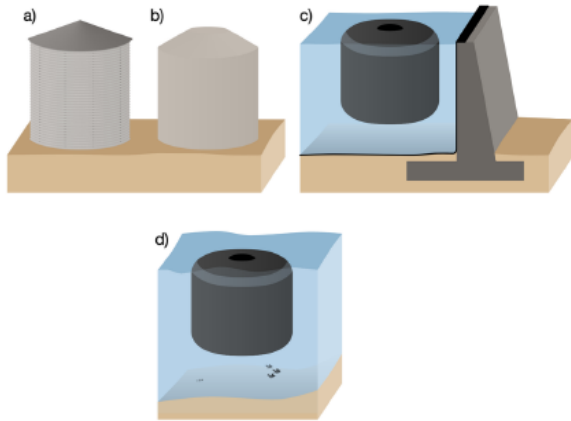


- ⊙ Characteristics
 - Can host a 1 Km² array
 - Latitude between 14°S and 24°S
 - Altitude between 4400 m and 4850 ma.s.l
 - Pond option is feasible only at Imata site
 - Lake option currently considered as part of the program for a future extension towards higher energies

The detector

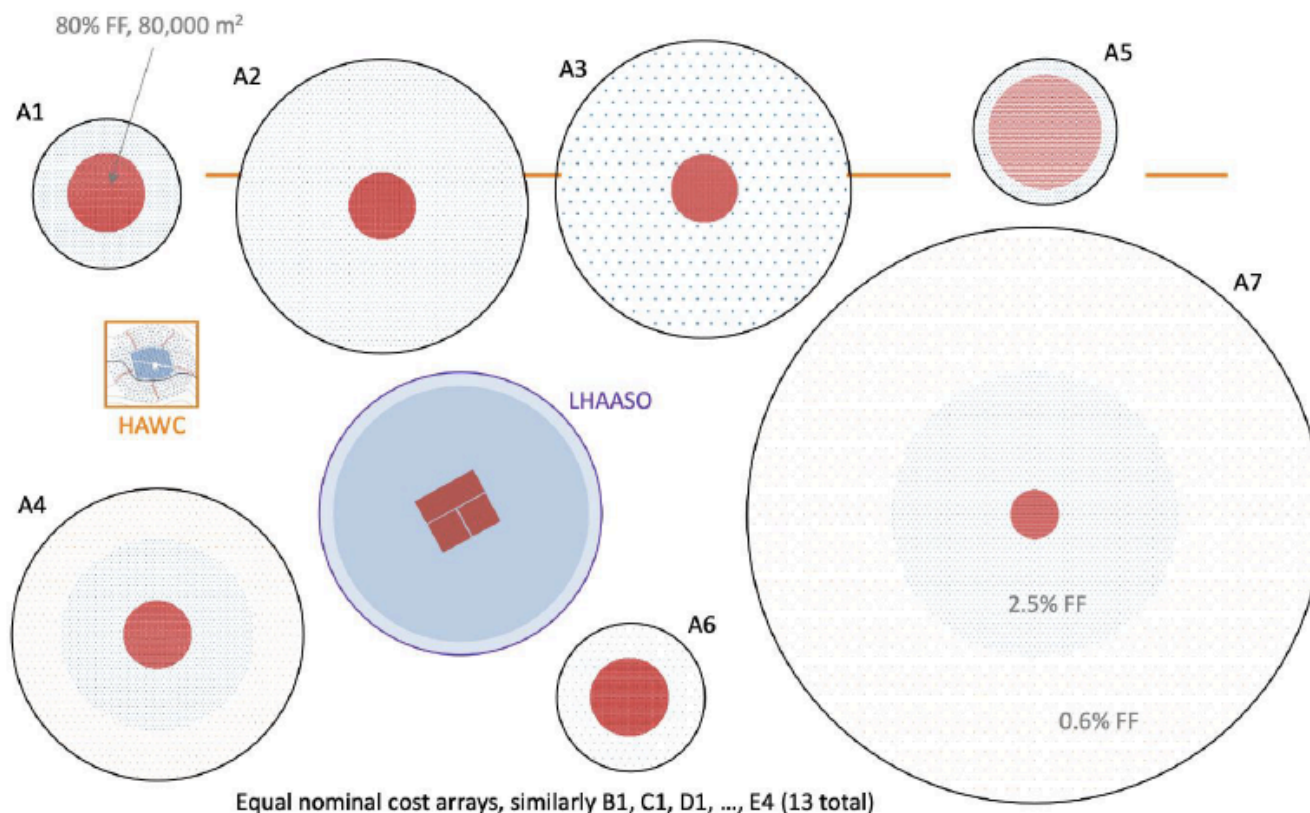
Concepts studied:

- Cylindrical tanks
- Corrugated steel sheets
- Roto molded
- Open pond with floating bladder
- Natural lake with floating bladder



Credit: Richard White, MPIK

The reference detector concept array

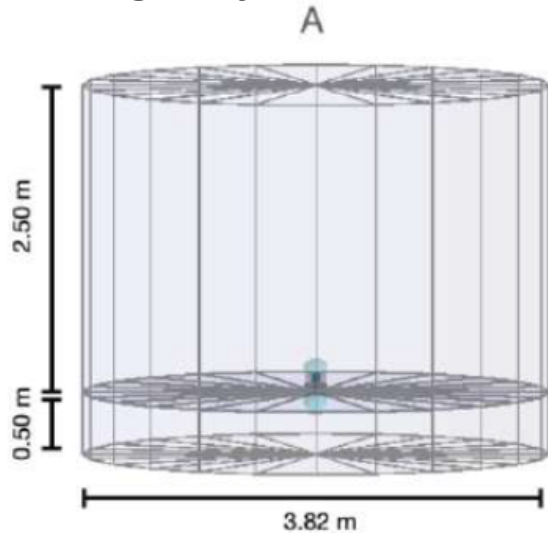


- ◉ We are working on an updated reference design with layout area of 0.99 km²
- ◉ Zones with decreasing fill factor (FF) are being studied:
 - Inner array for low energies
 - 40% < FF < 80%
 - 140 m < radius < 220 m
 - Outer array
 - ~1.7 % FF
 - 600 m < radius < 800 m
 - Two zones approach being explored

WCD concepts

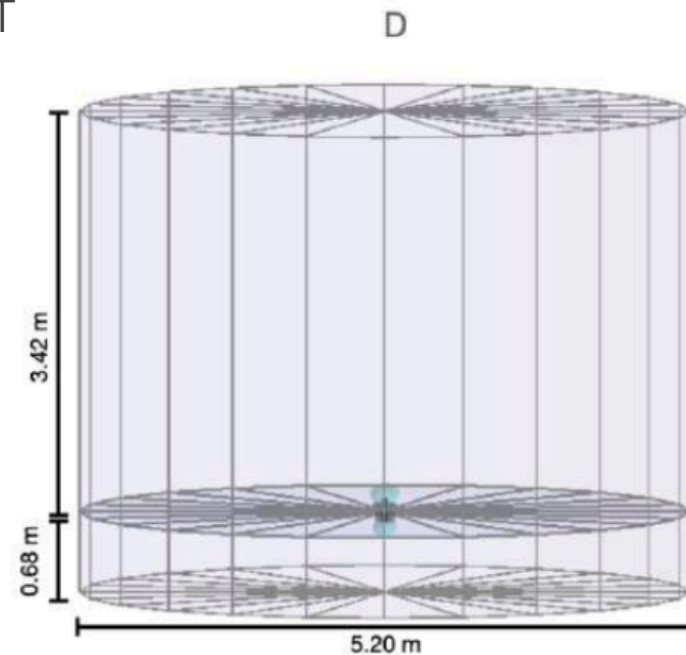
⊙ Tank designs:

- Double layer with a single central PMT per layer
- Deep single layer with a single central PMT
- Shallow single layer with 3 PMT's



⊙ Double layer WCD unit

- Large background rejection power $> 1\text{TeV}$
- 400 with 50% gamma efficiency

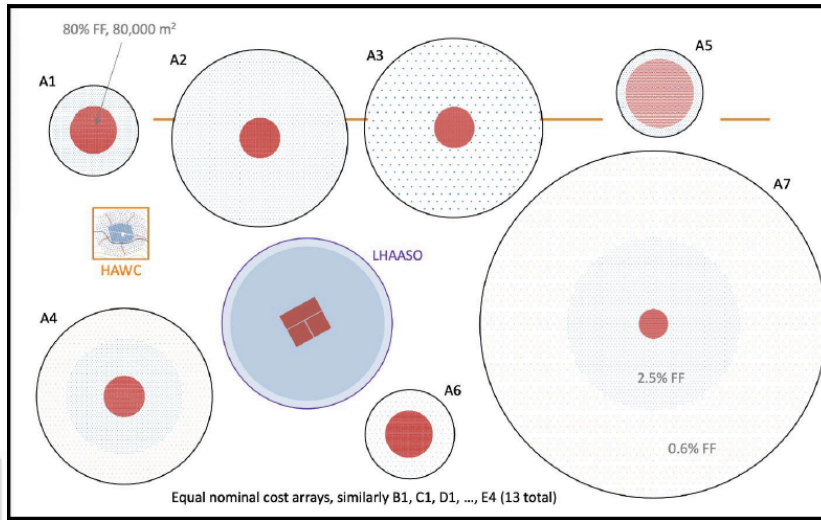
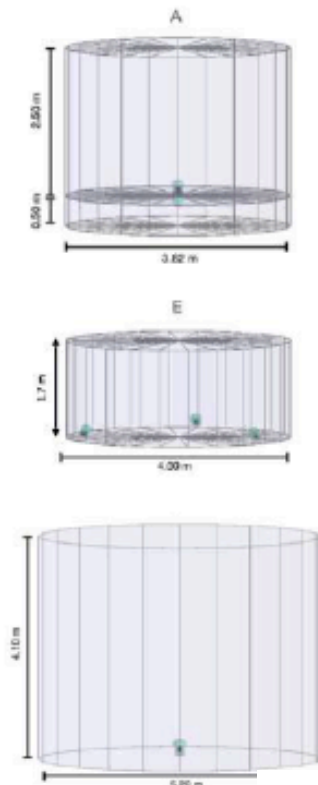




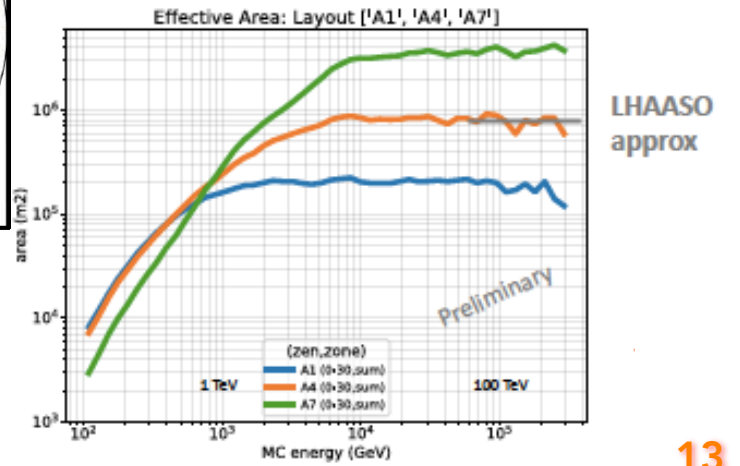
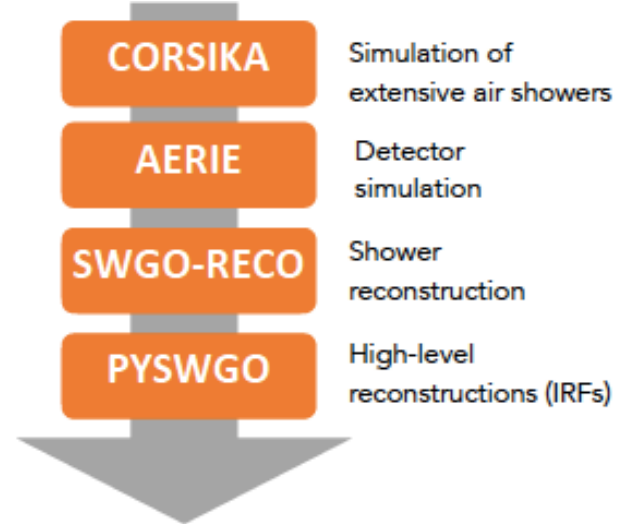
WCD concepts

Comprehensive simulations of 13 configurations completed; several reconstruction and γ /hadron separation passes.

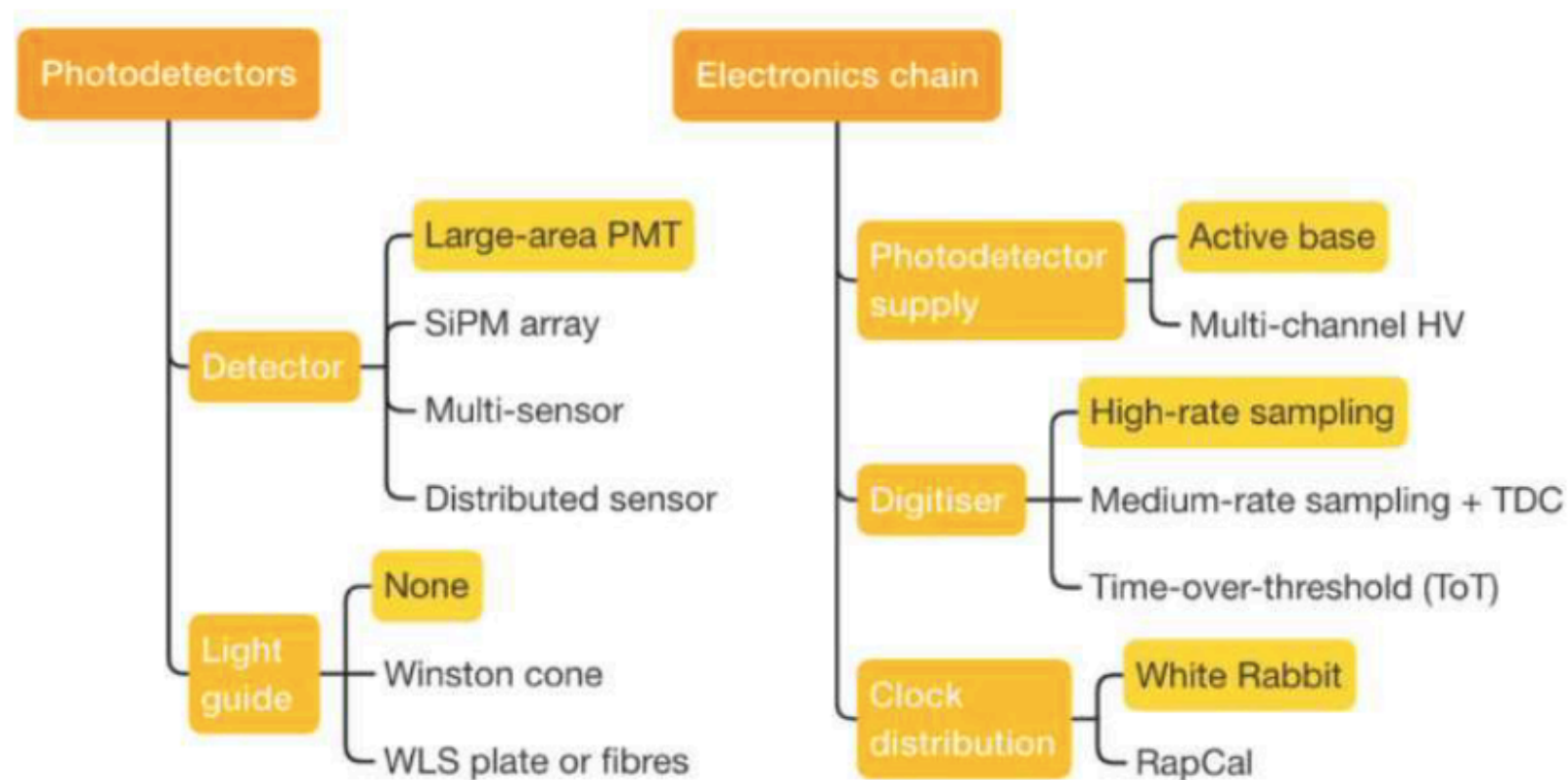
All layouts present in the SWGO simulation framework



* Images credited to Ulisses Barres, CTAO Symposium 2024, SWGO Collaboration



Detector Options



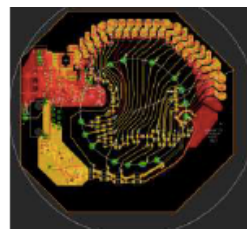
Detector Options



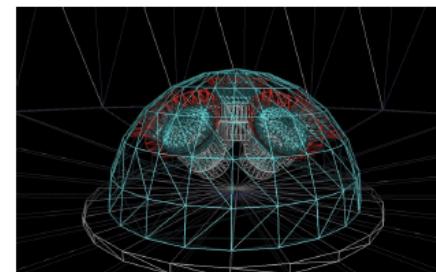
Single PMT model



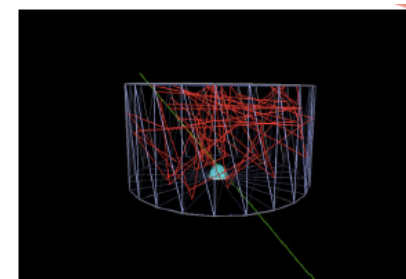
Five single PMT array with different sizes



SiPM array and electronics



MultiPMT
→ Large area PMT

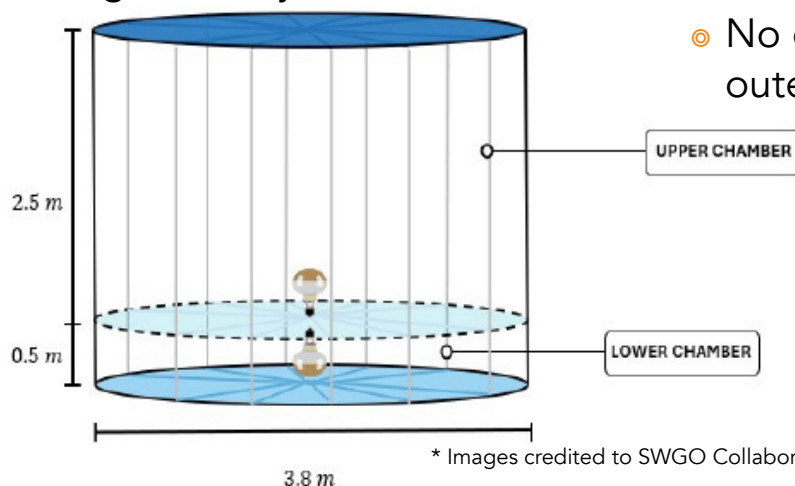


* Images credited to Ulisses Barres, CTAO Symposium 2024 and M.Wuaqas, CRIS-MAC 2024, SWGO Collaboration

Detector Options

- ⦿ All tank designs reach a performance allowing to obtain the SWGO scientific objectives
- ⦿ Results at $E > 50$ TeV are strongly limited by the available simulated statistics
- ⦿ For the inner array double layer tanks give the most promising performance
- ⦿ Large WCD unit results in significant improvements in background rejection

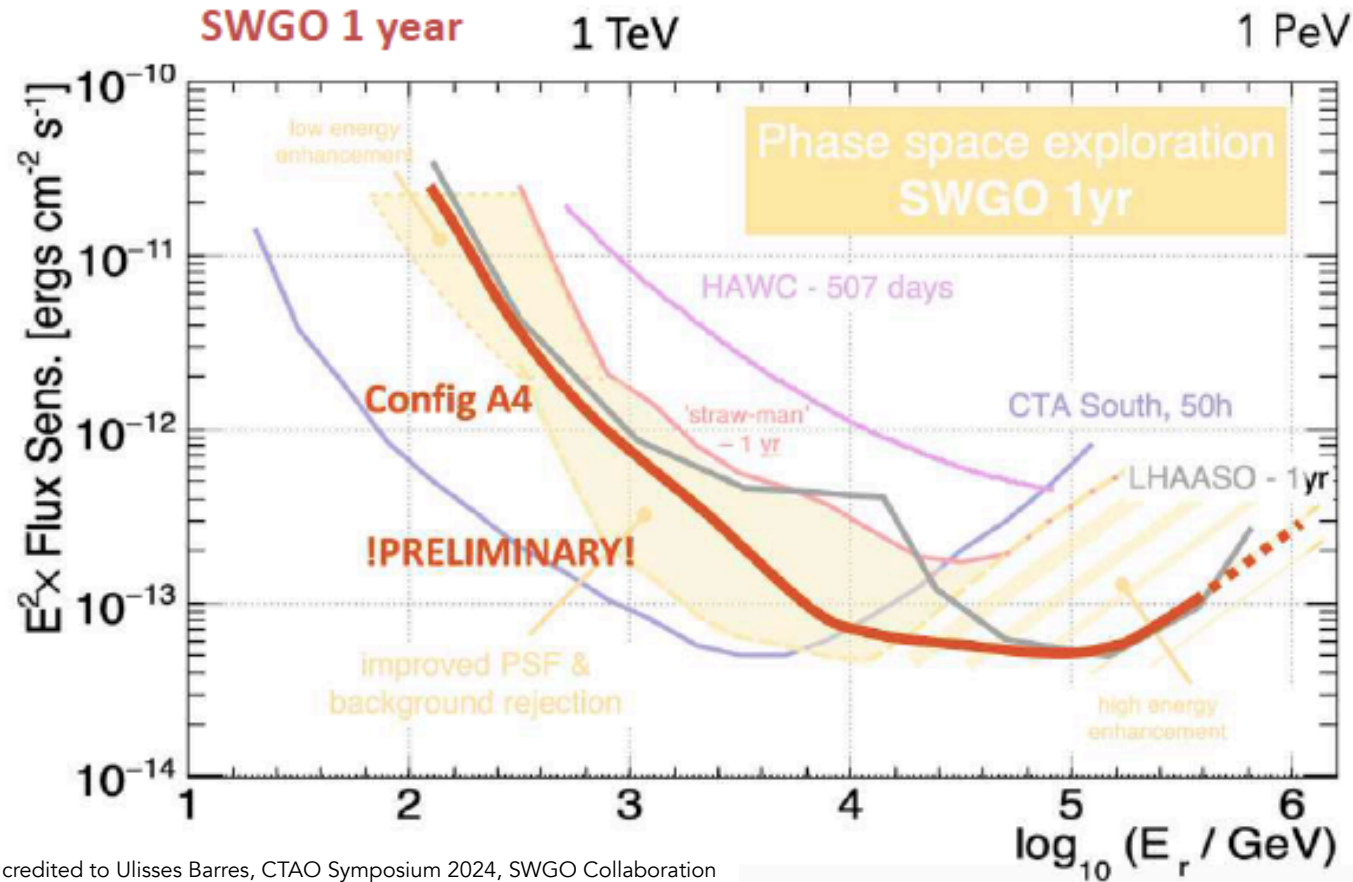
- ⦿ From the simulation studies for the inner array it is concluded:
 - A double layer tank with a single centrally deployed photo-sensor unit
 - Diameter between 3.8m and 5.5m
 - Overall depth between 3m and 4.5m
 - White wall lower chamber and either partially or fully black upper
- ⦿ No conclusions reached on the detectors for the outer array yet



* Images credited to SWGO Collaboration

Sensitivity

- Point-like source differential sensitivity
- Angular reconstruction methods still being refined



* Images credited to Ulisses Barres, CTAO Symposium 2024, SWGO Collaboration

Status and plan

SWGO R&D Phase Milestones








✓	M1	R&D Phase Plan Established
✓	M2	Science Benchmarks Defined
✓	M3	Reference Configuration & Options Defined
✓	M4	Site Shortlist Complete
✓	M5	Candidate Configurations Defined
→	M6	Performance of Candidate Configurations Evaluated
	M7	Preferred Site Identified
	M8	Design Finalised
	M9	Construction & Operation Proposal Complete

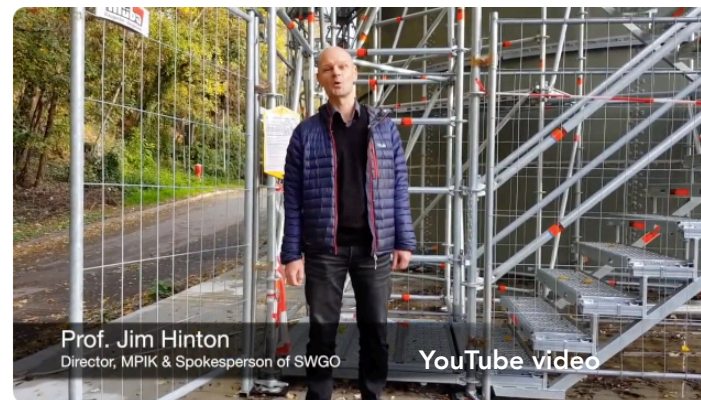
- ⦿ Expected completion early 2025
- ⦿ Preparatory phase
 - Detailed construction planning
 - Engineering Array (2026)
- ⦿ Full Construction Phase
 - From 2027

Outreach Material

→ https://www.swgo.org/SWGOWiki/doku.php#outreach_material

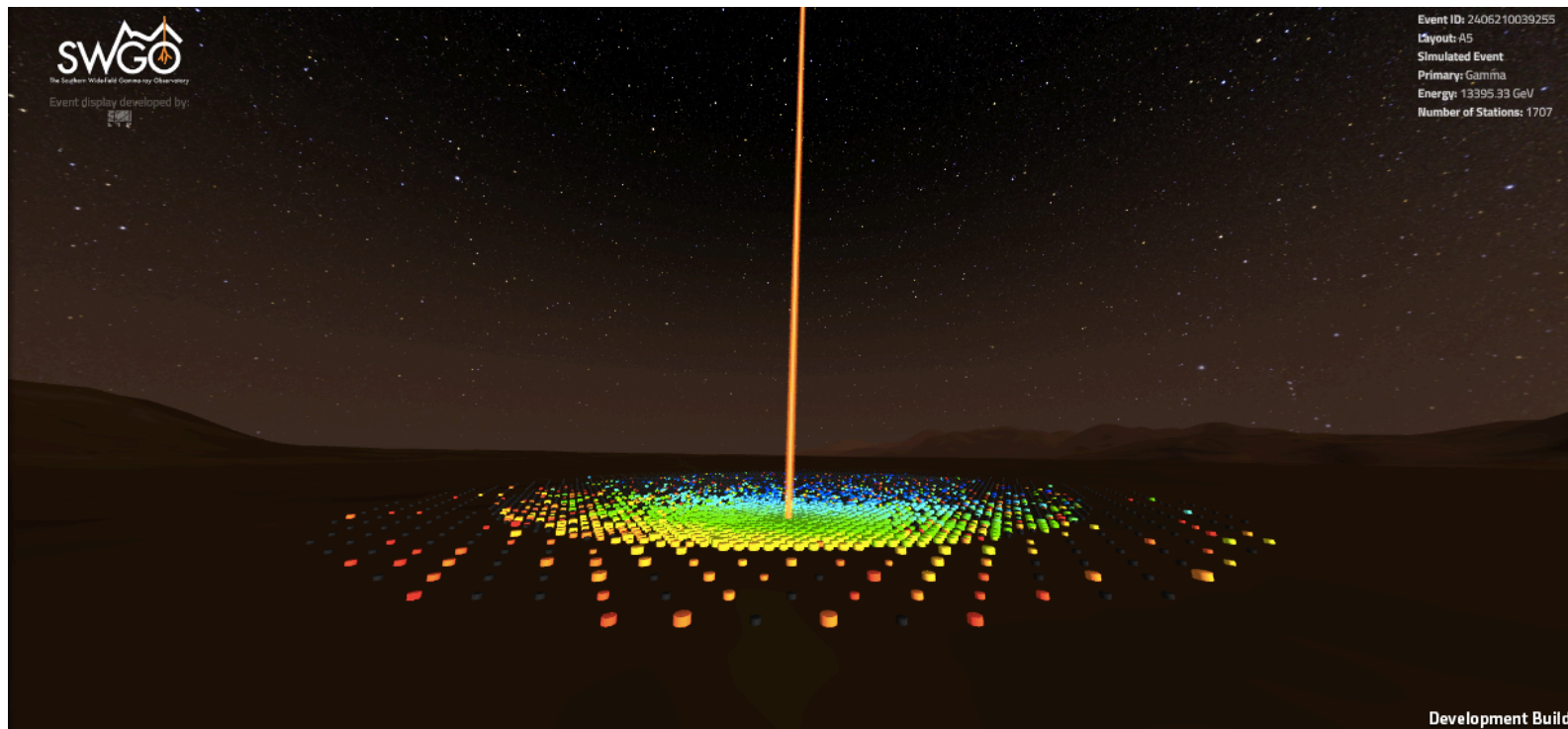
Outreach Material

- YouTube video:  [The Southern Wide-field Gamma-ray Observatory \(SWGO\)](#)
- Outreach video:  [Spanish](#)
- SWGO event visualizer for outreach:  [link](#)
- SWGO Leaflet  [English A](#)  [English B](#)  [English C](#)  [Spanish A](#)  [Spanish B](#)  [Spanish C](#)
- SWGO Poster  [English](#) /  [Spanish](#)



⦿ Event visualizer

→ <https://wminho.lip.pt/swgo/>



Summary

◎ SWGO

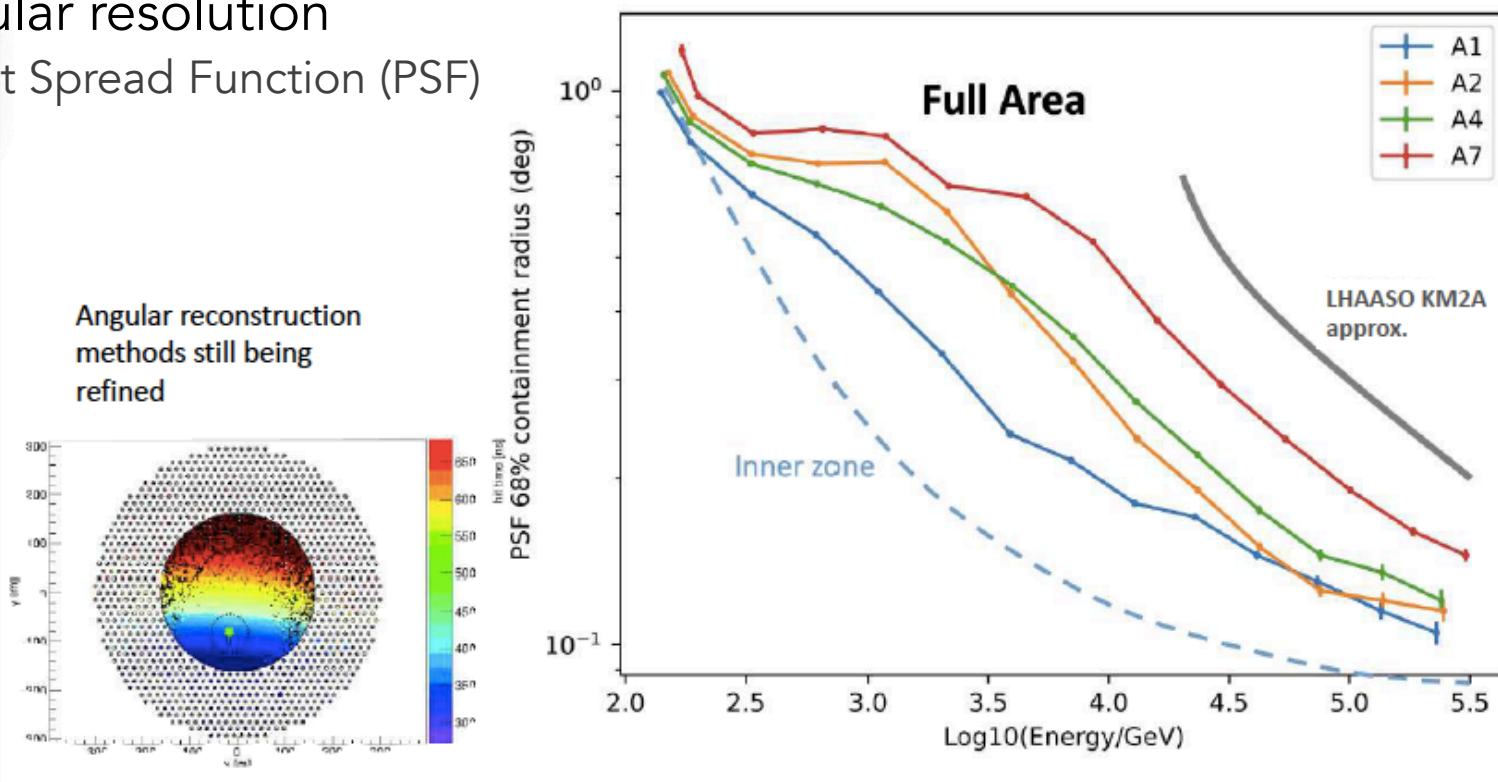
- R&D project gamma ray Observatory in the Southern Hemisphere
- Energies from few hundred GeV up to the PeV scale
- Complement of CTA, HAWC, LHAASO and other IACTs, satellite and ground based instruments.
- Rich Science Program
- Synergies with current and future instruments
- Site selection at the end of July 2024

Thank you!

karen.mora@unach.mx



- Angular resolution
 - Point Spread Function (PSF)



* Images credited to Ulisses Barres, CTAO Symposium 2024, SWGO Collaboration