SWGO
The Southern Wide-field Gamma-ray Observatory

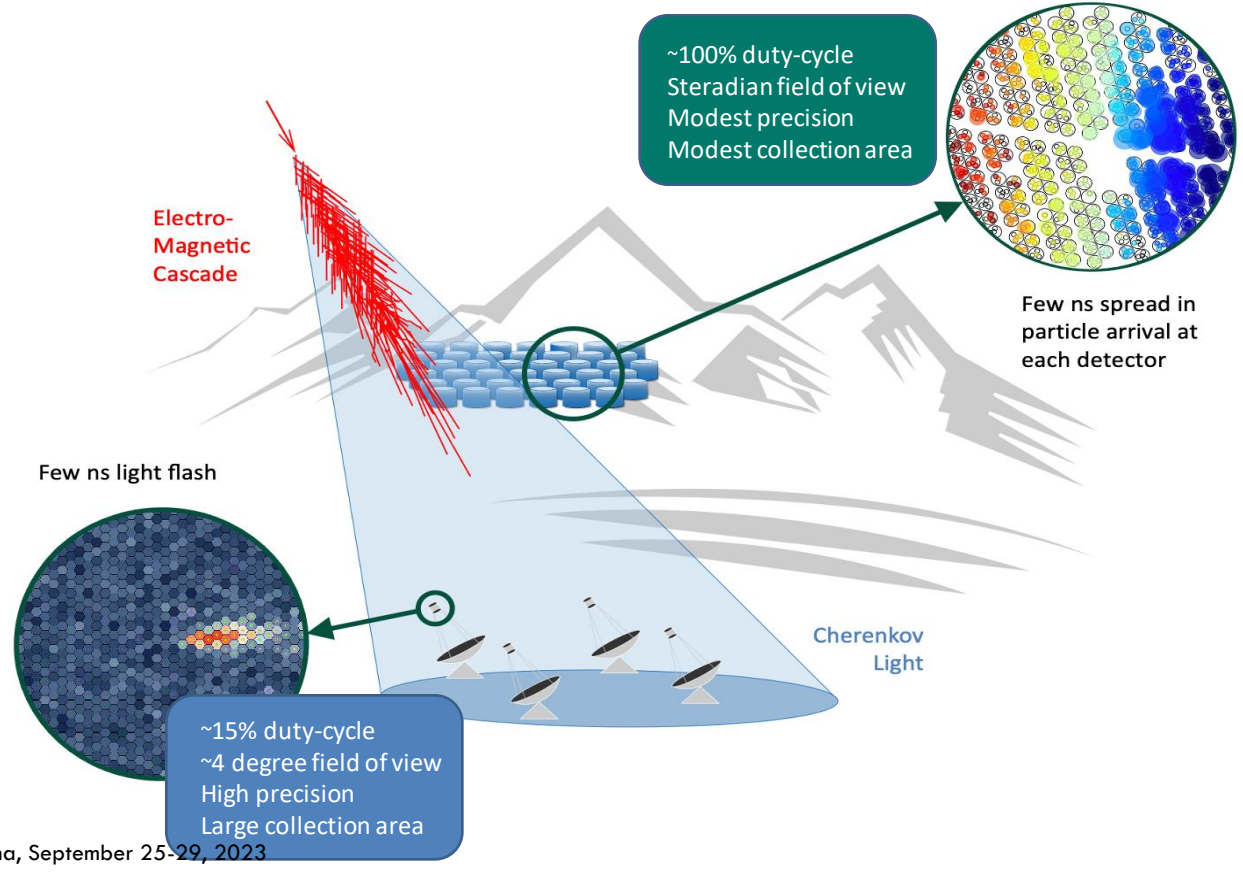
SWGO: a Wide-field of view Gamma-ray Observatory in the Southern Hemisphere

Andrea Chiavassa
Università degli Studi di Torino & INFN

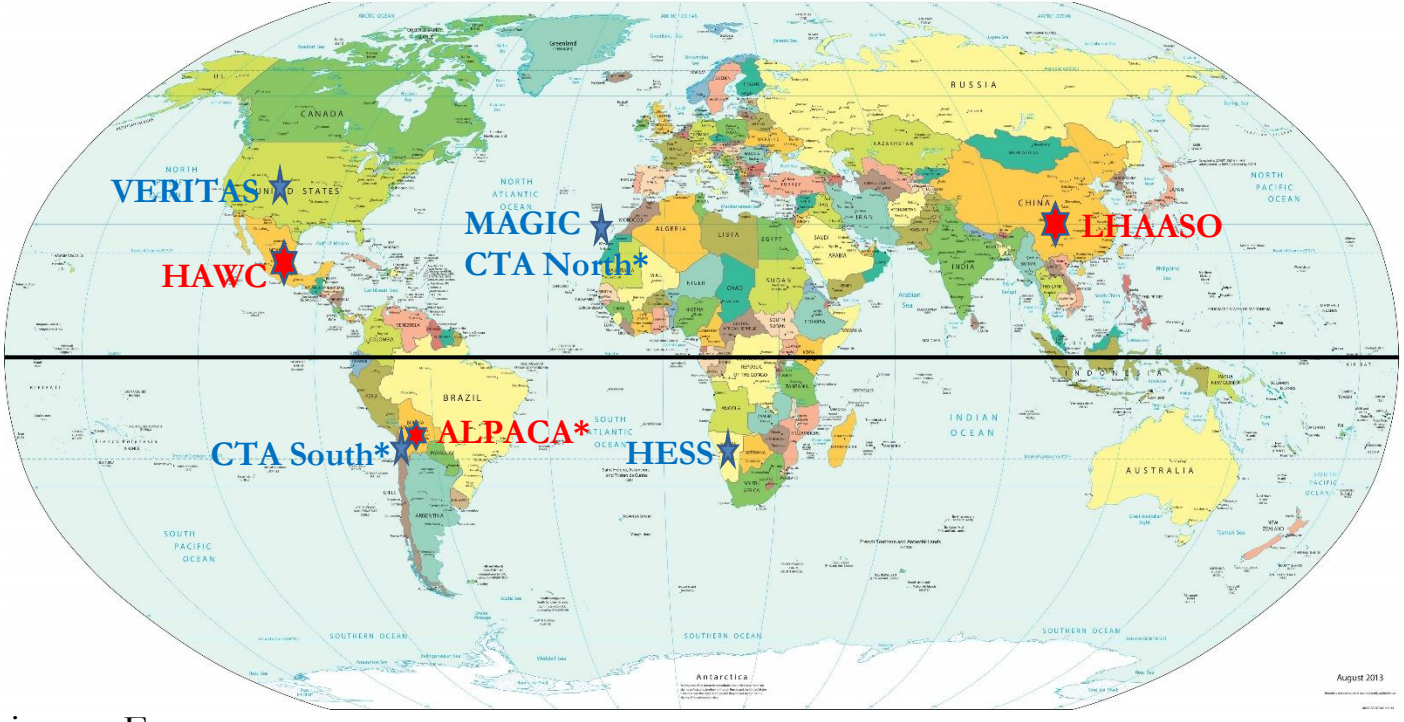
16th Topical Seminar on Innovative Particle and Radiation Detector
Siena 25-29 September 2023

- The new frontiers of the study of the high energy phenomena in the universe are multi-messengers and multi-wavelength observations.
- SWGO will measure high energy (E>100 GeV) γ-ray probes.
- E>300 GeV must be explored with indirect, ground-based experiments, not measuring directly the primary photon, but observing the products of the photon interaction in the high atmosphere.
- The background due to hadronic cosmic rays must be rejected.
- In the recent past gamma ray astronomy went through three major steps:
  - 2000 → TeV sources → IACT technique (WHIPPLE, HESS, MAGIC, VERITAS)
  - 2010 → GeV sources → Pair production telescopes (AGILE, FERMI)
  - 2020 → PeV sources → EAS experiments (HAWC, TIBET-ASγ, LHAASO)

γ-ray observations from the ground



Operating ground based experiments



* In construction or Foreseen

SWGO

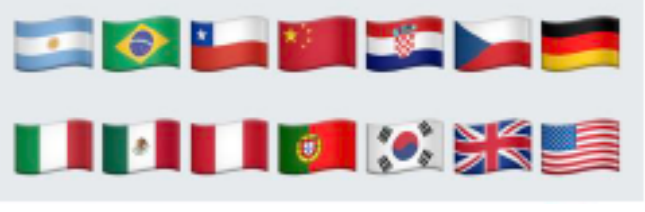
- SWGO: The Southern Wide-field Gamma-ray Observatory is a gamma-ray observatory based on ground-level particle detection, with close to 100% duty cycle and order steradian field of view.
- SWGO is currently in the R&D phase.
- Willing to cover the 100 GeV-100 TeV energy range the array must be located at an altitude of 4.4 km or higher (low energies) and extend over a km^2 area (high energies).
- Located in South America at a latitude between 10° and 30° south.
- Based primarily on water Cherenkov detector units.
- With a high fill-factor core detector with area considerably larger than HAWC and significantly better sensitivity, and a low-density outer array.
- Improved angular (0.2°) and energy resolutions (<30%) above 10 TeV.

SWGO Science cases

- Detection of short timescale phenomena
  - Low energy threshold for detection of short timescale (<1 hr) transient events down to 100 GeV.
- Search for PeVatrons
  - Improved sensitivity up to ~PeV to search for Galactic particle accelerators.
- PWNe and Gamma-ray Halos
  - Unique potential for accessing the high-energy end of the Galactic Population.
- Dark Matter and Diffuse Emission
  - Unique access to the Galactic Center and Halo at the high-energy end of the spectrum
- Cosmic Rays
  - Complement to LHAASO for anisotropy studies, with the possibility of reaching low angular scale
  - Good muon counting implies good mass resolution for composition studies.

SWGO Collaboration

- www.swgo.org
- SWGO partners
  - 66 institutes in 14 countries
  - + supporting scientists

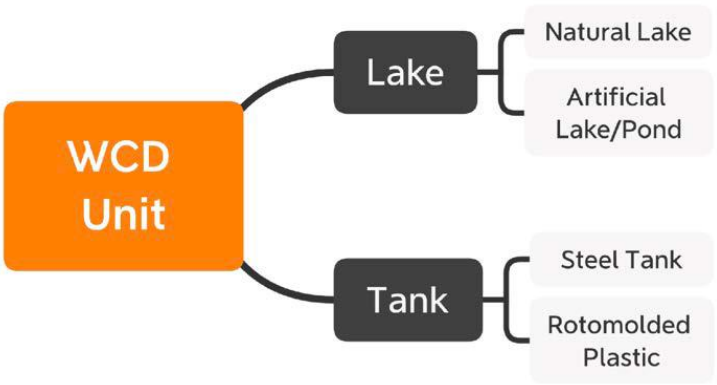


SWGO R&D Phase

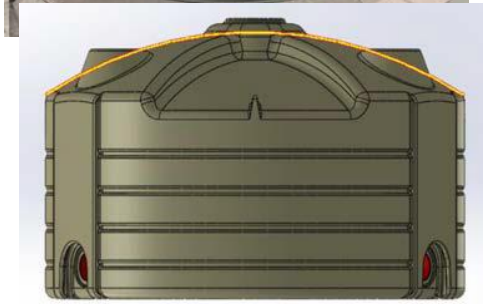
- The primary deliverable of the SWGO R&D phase is a detailed project proposal which will form the basis of funding requests in the partner countries and provide the overall plan for construction and operation

Milestone	2019	2020				2021				2022				2023				2024			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
R&D Phase Plan		M1																			
Science Benchmarks			M2																		
Reference Configuration				→	M3																
Site Shortlist Complete					→							M4									
Candidate Configurations							→			M5											
Perf. of Candidates Evaluated								→								M6					
Preferred Site Identified									→									M7			
Design Finalised											→									M8	
CDR Ready													→								M9

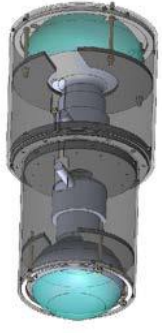
Detector R&D

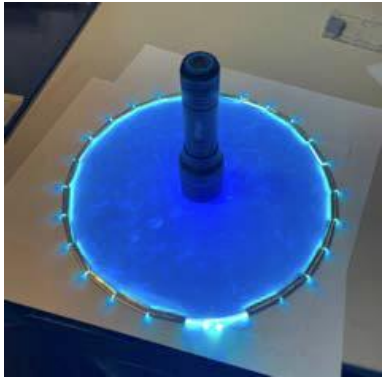

WCD Unit
Lake
Natural Lake
Artificial Lake/Pond
Tank
Steel Tank
Rotomolded Plastic


AQUAMATE
SWGO - 0004

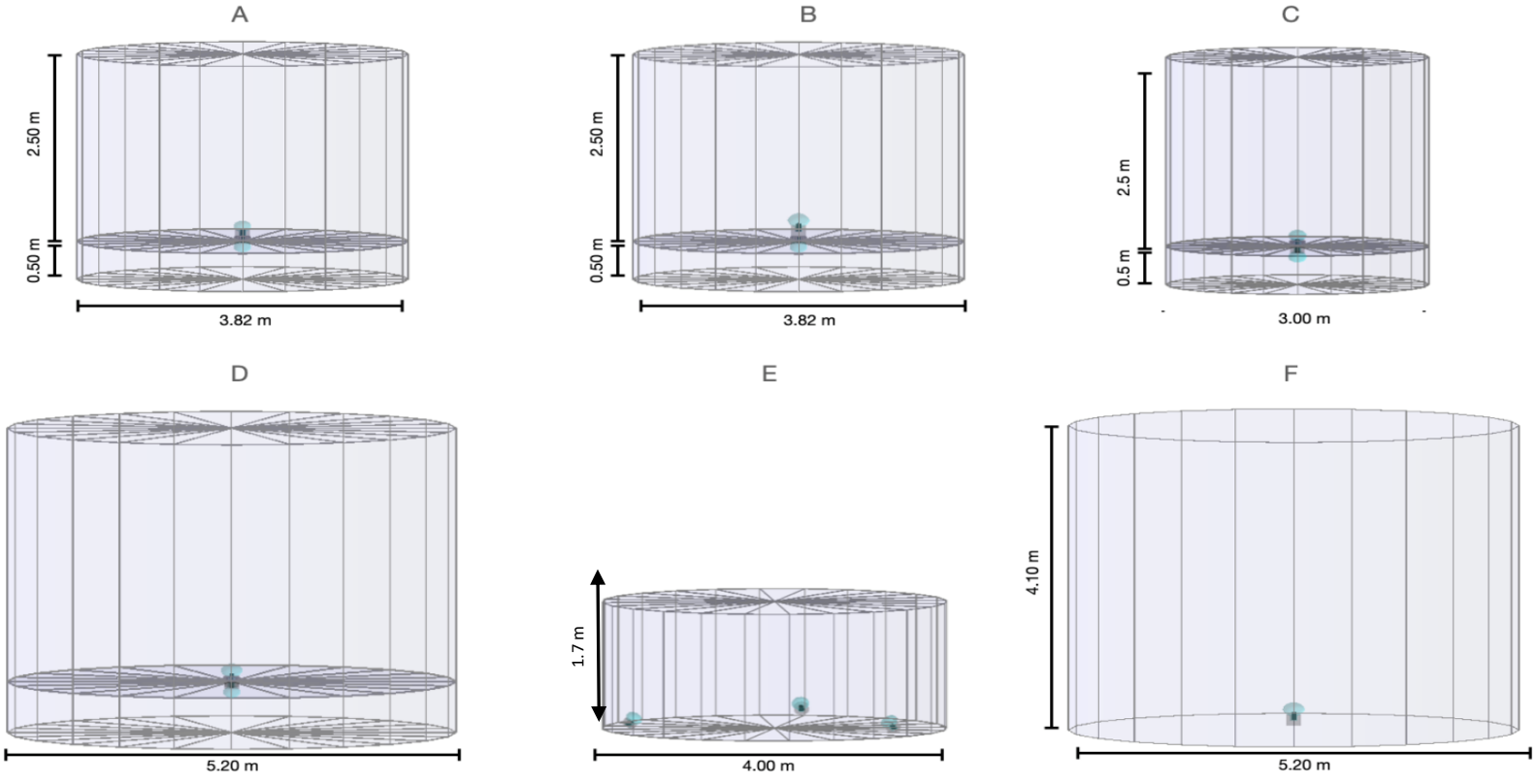


- Photodetectors
  - Detector
    - Large-area PMT
    - SiPM array
    - Multi-sensor
    - Distributed sensor
  - Light guide
    - None
    - Winston cone
    - WLS plate or fibres
- Electronics chain
  - Photodetector supply
    - Active base
    - Multi-channel HV
  - Digitiser
    - High-rate sampling
    - Medium-rate sampling + TDC
    - Time-over-threshold (ToT)
  - Clock distribution
    - White Rabbit
    - RapCal

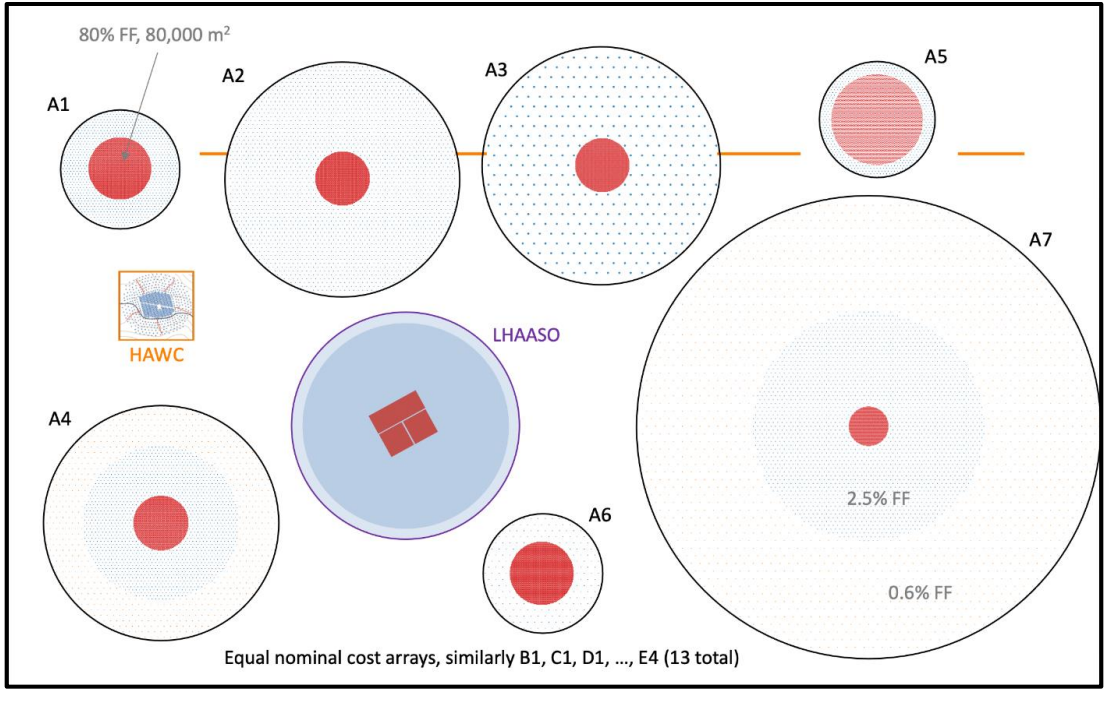




Comparison of the performances of different tank units and layouts



Candidate Configurations

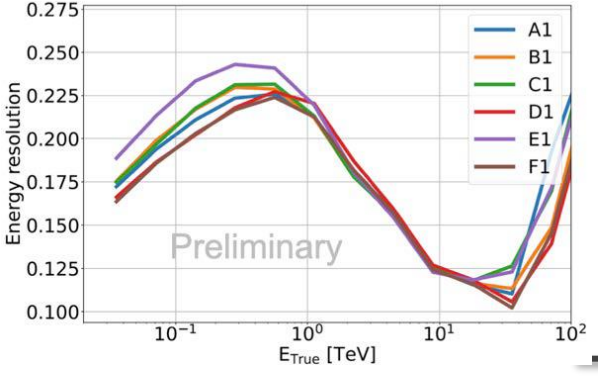


CORSIKA

HAWCsim

SWGO-RECO

PYSWGO



Candidate Sites

Country	Site Name	Altitude [m a.s.l.]
Argentina	Alto Tocomar	4,430
	Cerro Vecar	4,800
Chile	Pajonales	4,600
	Pampa La Bola	4,770
Peru	Imata	4,450
	Sibinacocha	4,900
	Yanque	4,800

Imata (Pe)

Sabinacocha (Pe)

Cerro Vecar (Ag)

Pampa La Bola (Cl)

Conclusions

- Strong motivation for a wide field of view, high duty cycle observatory in the Southern hemisphere
- Synergies with CTA-South
- Complementary location for all sky studies with LHAASO and HAWC
-
- Beginning 2024 preferred site identified
- Half 2024 Design Finalised
- 2025-26 → engineering array
- 2027-30 → construction phase