

The Southern Wide-field Gamma-ray Observatory



Jose Bellido

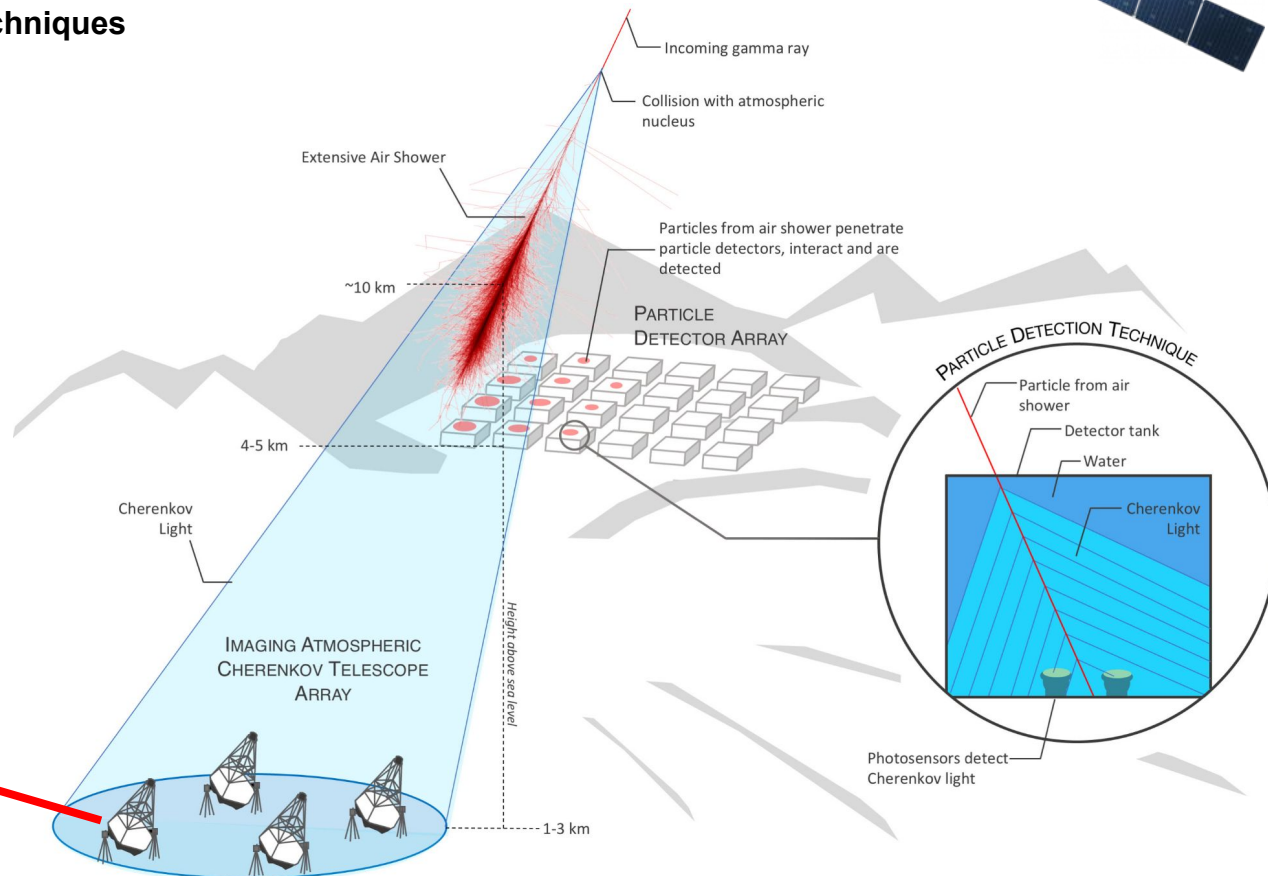
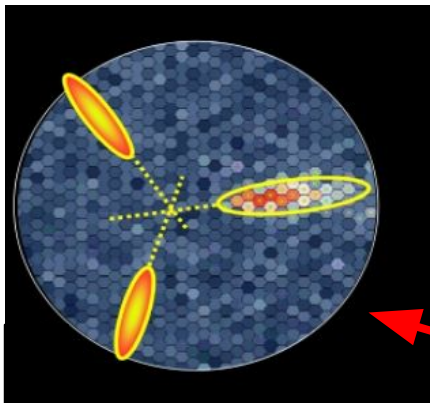


Particles and Nuclei International Conference, PANIC
5 -10 Sep. 2021, Lisbon, Portugal

Gamma-ray Astronomy

Complementary direct and indirect detection techniques

Atmospheric Cherenkov light image



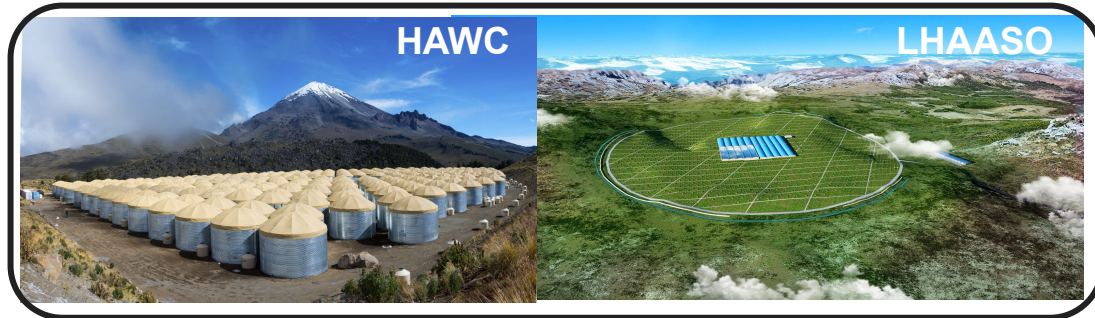
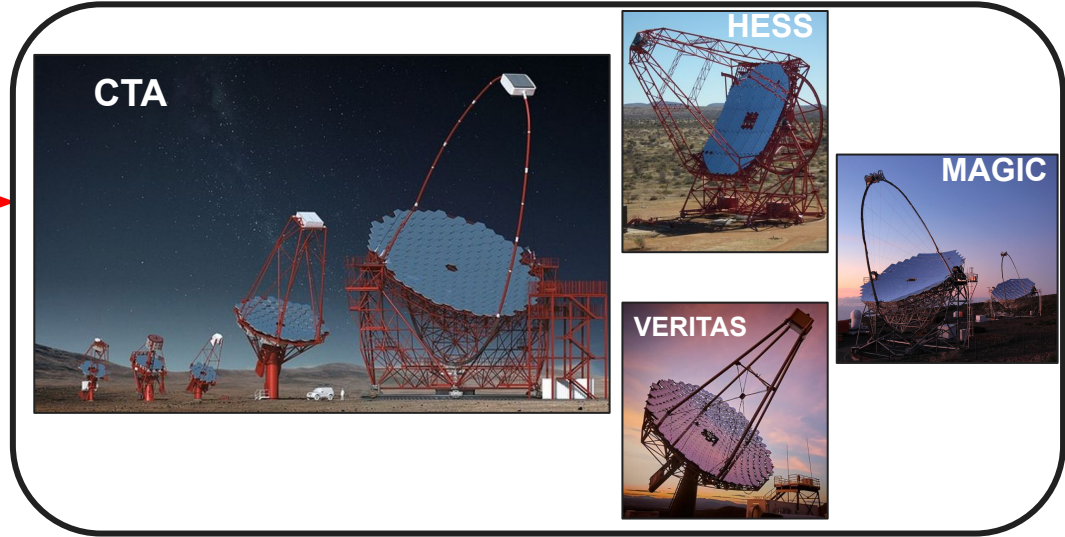
Shower image, 100 GeV γ -ray adapted from: F. Schmidt, J. Knapp, "CORSIKA Shower Images", 2005, <https://www-zeuthen.desy.de/~jknapp/fs/showerimages.html>

Not to scale

Observational Panorama

Cherenkov Atmospheric Telescopes

- 20% duty-cycle
- Pointing (few degrees FoV)
- Energy threshold down to 10s GeV
- Good energy and angular resolution

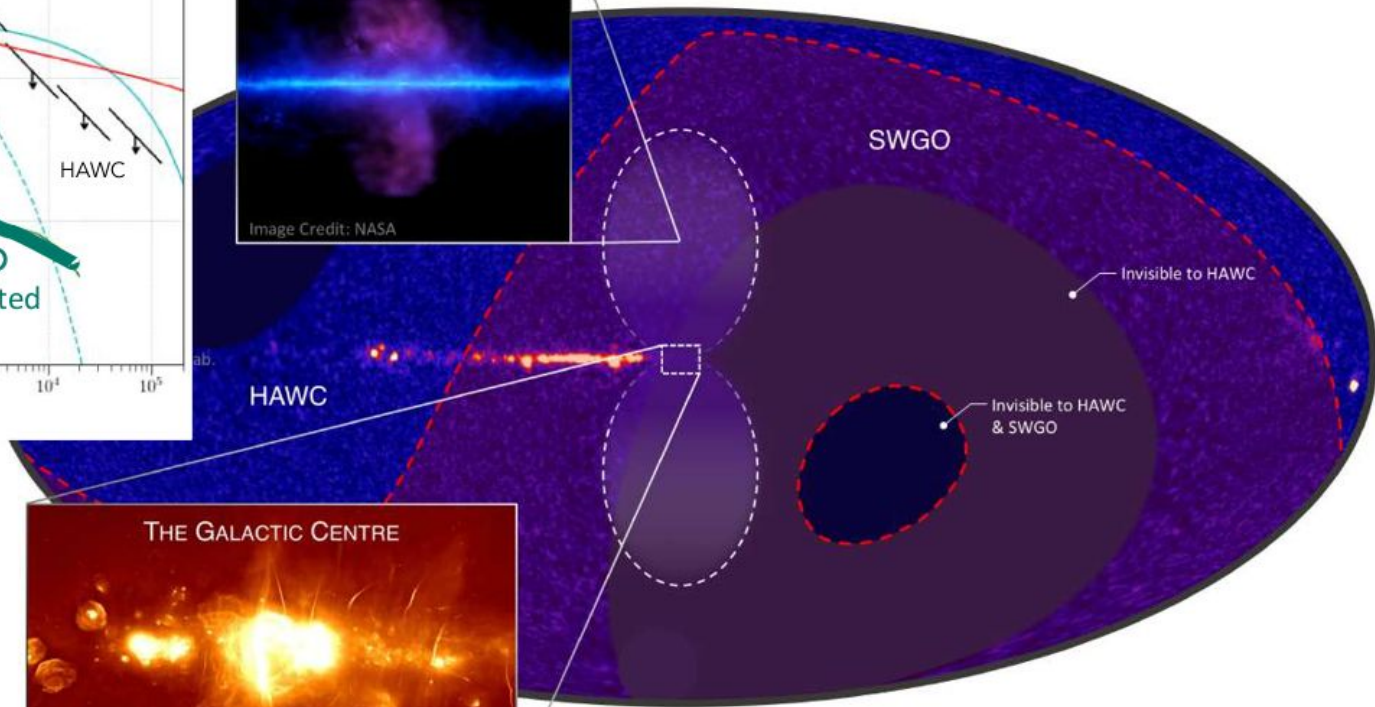
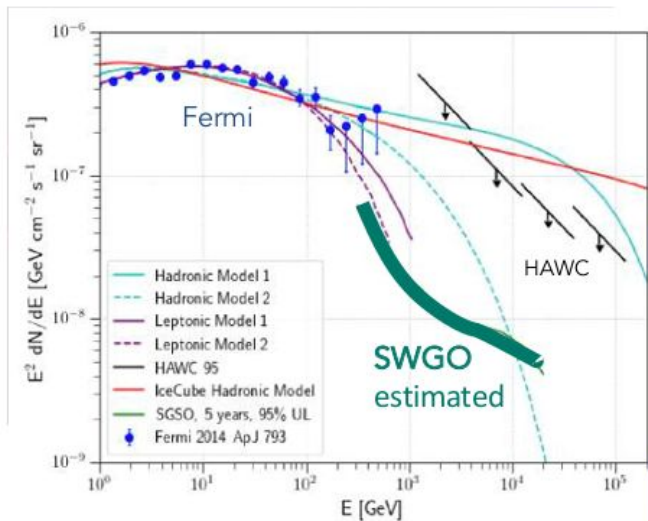


Particle Detector Arrays

- 100% duty-cycle
- Wide-field of View (\sim steradian)
- Energy range 100s GeV up to 100s TeV
- Long exposure and accurate background determination



A wide-field observatory in the South



Crucial access to the Galactic Plane and the Galactic Center, and a complementary view of the sky with HAWC and LHAASO for cosmic-rays and diffuse emission studies.

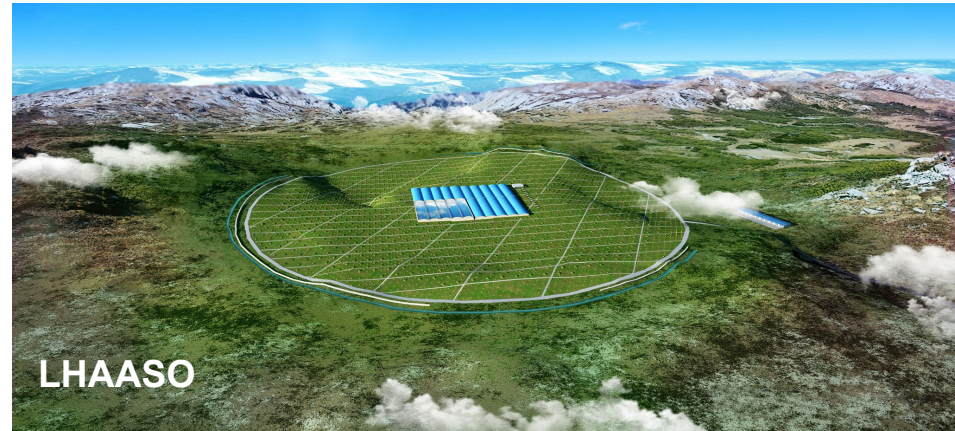
Science Case: <https://arxiv.org/abs/1902.08429>

Science Case for a Wide Field-of-View Very-High-Energy Gamma-Ray Observatory in the Southern Hemisphere

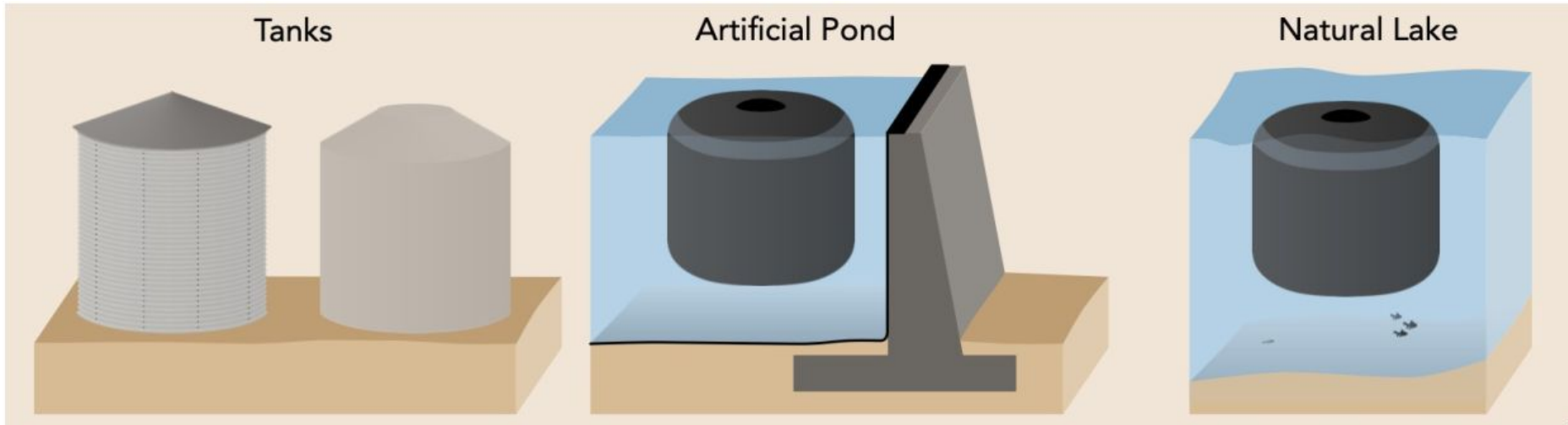
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The SWGO observatory concept design is similar to that of HAWC and LHAASO observatories

SWGO will be deployed in South America in a site (not yet defined) above ~4500m



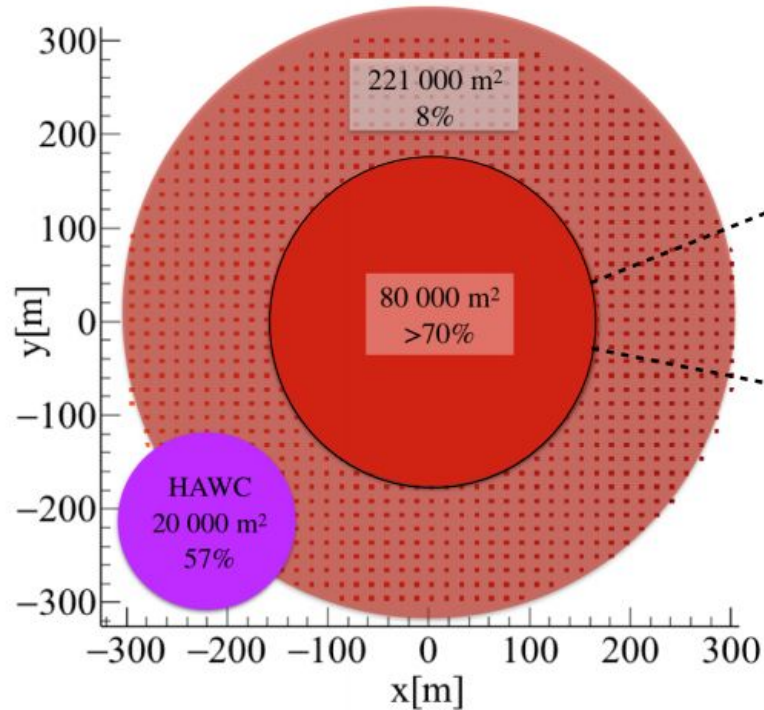
Three concepts for the detector units



- Exploring three concepts for the detector units
→ Tanks (like HAWC), Artificial Pond (like LHAASO) and Natural Lake
- ...as well unit dimensions, photosensors, +++

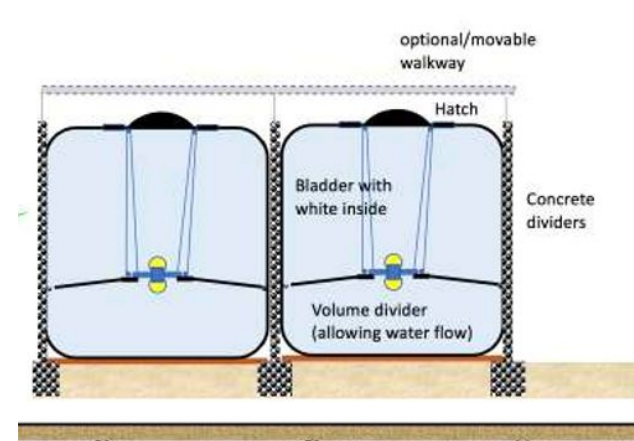
The SWGO Observatory layout design

Approximately 6500 water tanks are required.

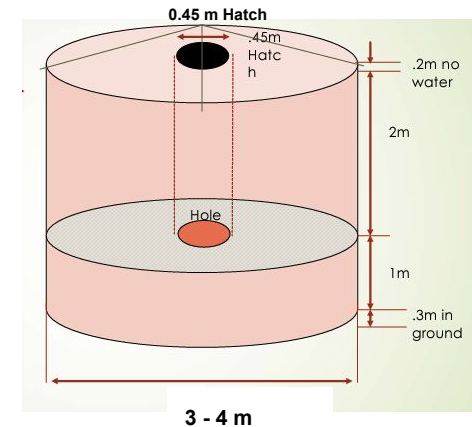


The SWGO Detector Concept

The interior will have two cavities



Reference design dimensions



Cosmic Ray Physics with SWGO

The **electromagnetic** and **muonic** components of the air shower will be recorded separately.

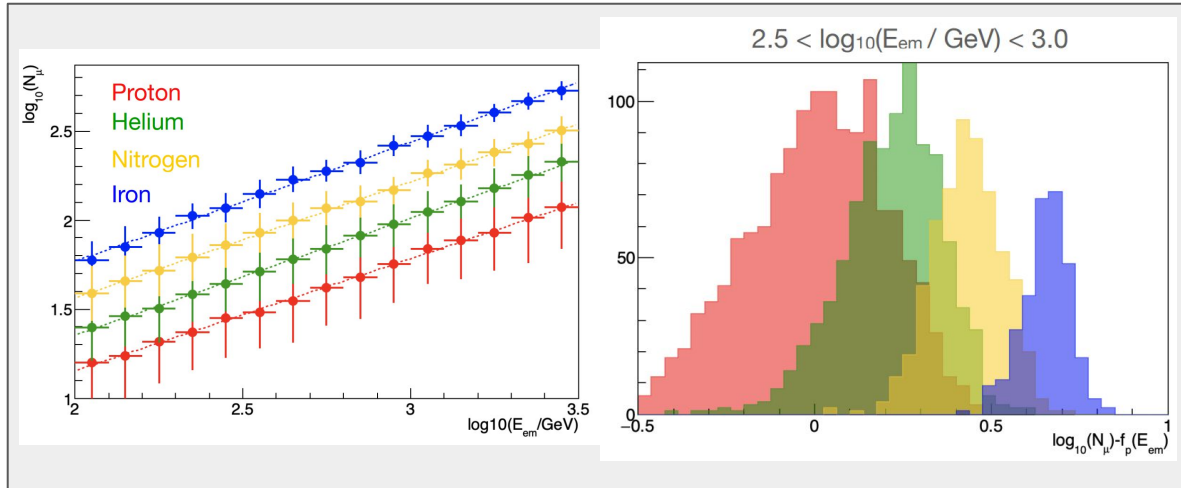
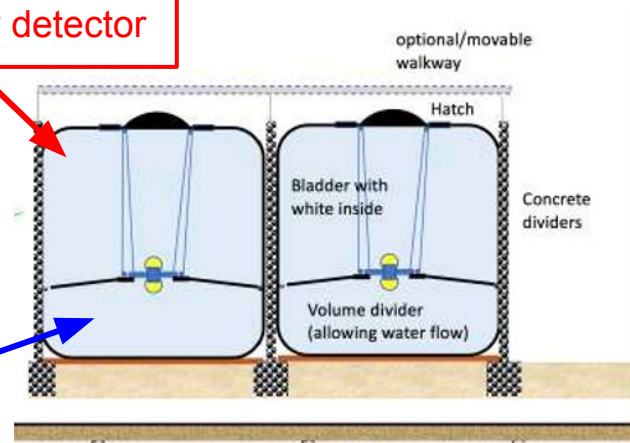
The **muonic** component will be used to discriminate between different cosmic ray species.

The exact relation between number of muons and the cosmic ray specie, is extracted from hadronic interaction models. Currently there are **systematic uncertainties on model predictions** that need to be improved.

A correct hadronic model should be able to find a cosmic ray composition spectrum, that could be used to reproduce all the different observable distributions in SWGO, LHAASO, and even at high energies (e.g. the Pierre Auger Observatory).

e^- , e^+ , and γ detector

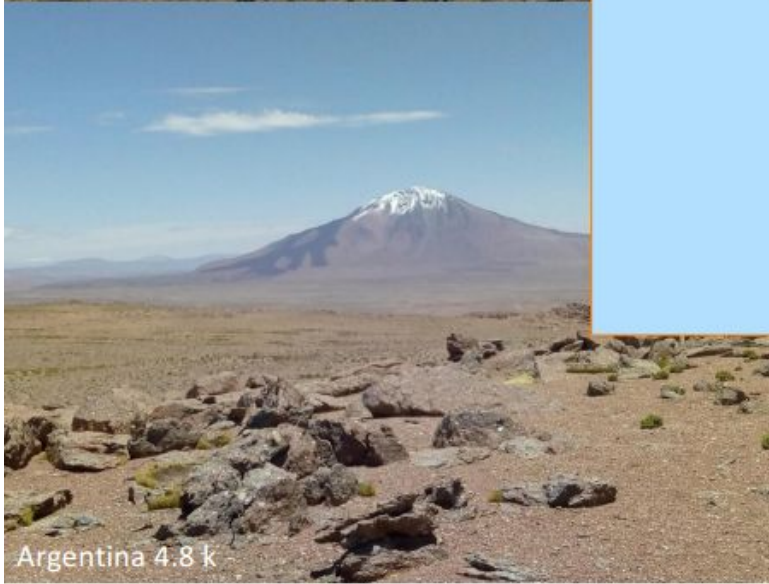
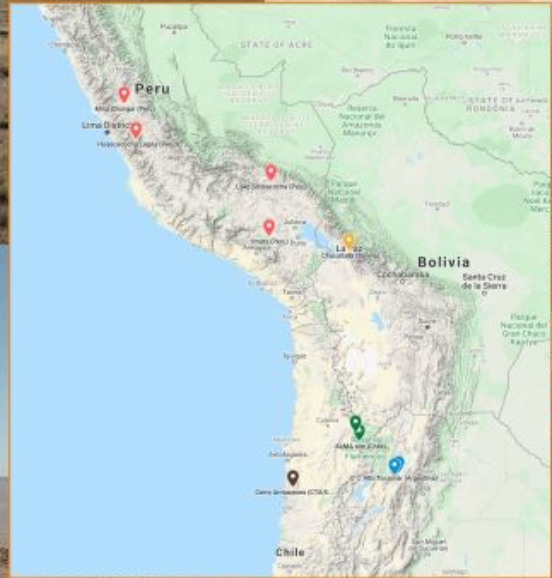
Muon detector



Bolivia 4.7k



Chile 4.8 k

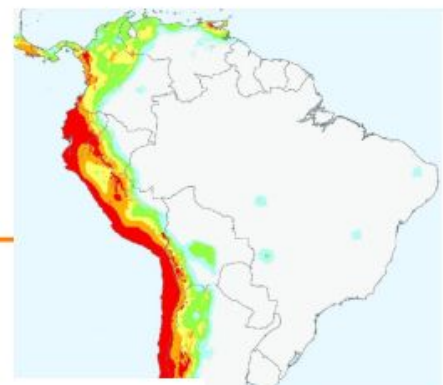
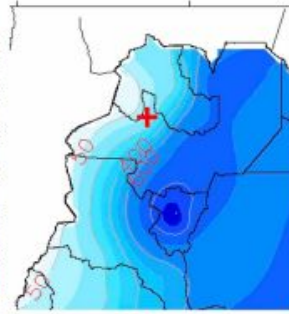
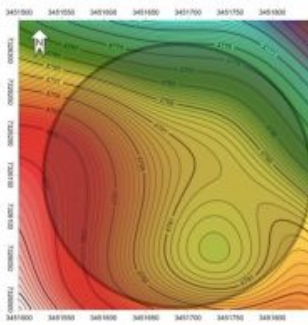


Argentina 4.8 k



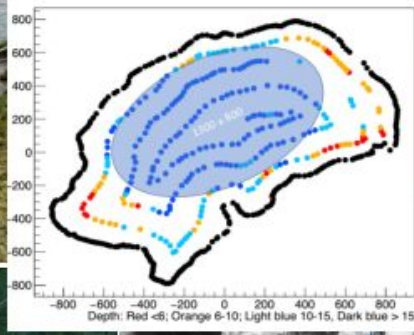
Peru 4.9 k

Curvas de nivel
(equedistancia 0.5m)

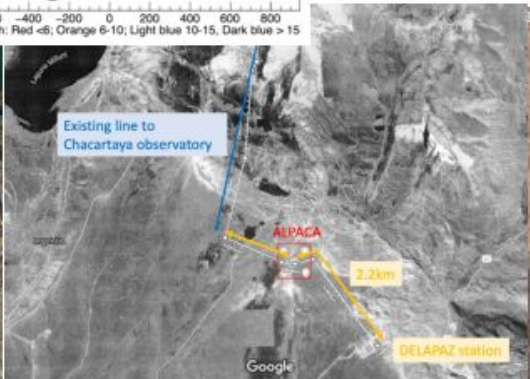
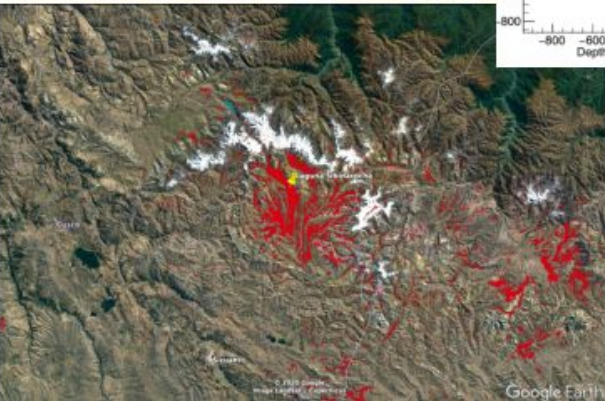
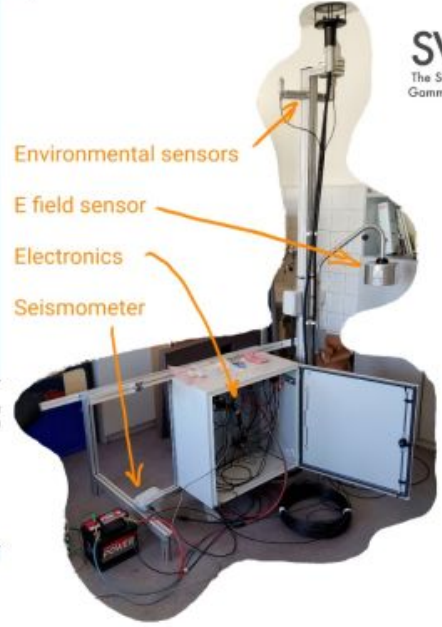


EXPLANATION
Chance of slight (or greater) damaging earthquake shake in 50 years

- < 15%
- 15%-30%
- 30%-50%
- 50%-70%
- 70%-85%
- > 85%



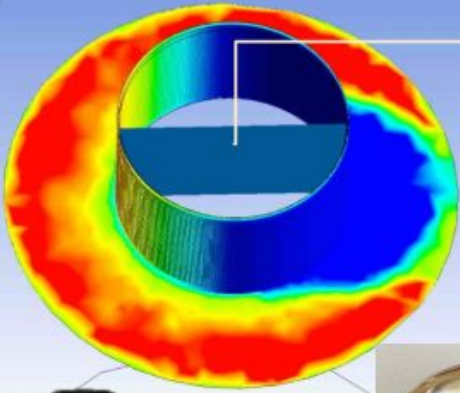
- Environmental sensors
- E field sensor
- Electronics
- Seismometer



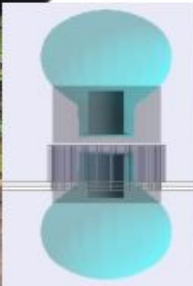
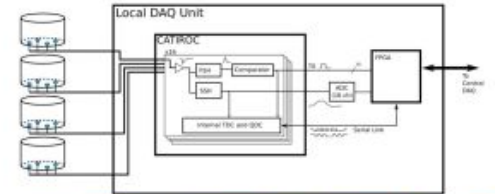


Temperature
rotation 1

38.79
36.36
33.94
31.52
29.09
26.67
24.24
21.82
19.39
16.97
14.55
12.12
9.70
7.27
4.85
2.42
-0.00



ANSYS
v18.2



Prototype detectors will be deployed at a Peruvian site

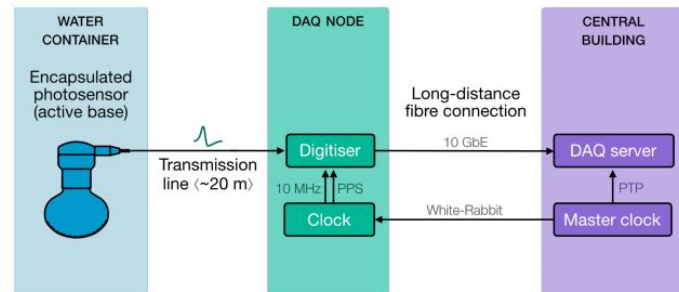
Customized water tanks are being designed by an Australian company, and 3 tanks will be delivered to Perú for installing the first SWGO detector prototype.



A DAQ node architecture will be tested at a Peruvian site (test in real conditions).

DAQ node? Reference architecture →

- **>100 DAQ nodes** spread over km²
- nodes need to be **maintenance-free**
 - ▶ start testing critical candidate components as early as possible in realistic conditions
- test tanks in Imata are a great opportunity
 - ▶ near-target altitude & climate
 - ▶ good access & infrastructure



Conclusions

- ◎ The Southern Sky needs a wide field VHE-UHE gamma-ray Instrument!
 - Strong synergies with CTA and LHAASO
 - Transient phenomena, diffuse emission, UHE sources +++

- ◎ SWGO advancing towards design and site choice

- ◎ SWGO will have capabilities to study the cosmic ray composition. For that, information from SWGO and information from experiments at higher energies (e.g. Pierre Auger) needs to be analyzed together. So, that hadronic interaction models can be improved.